Environmental Impact Assessment

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India: Nagpur Metro Urban Mobility Project

Main Report

Prepared by MITCON Consultancy and Engineering Services Ltd. for the Maharashtra Metro Rail Corporation Limited (Maha Metro) and the Asian Development Bank (ADB). This is an updated version of the draft originally posted in December 2023 available on https://www.adb.org/projects/documents/ind-56297-001-eia.

ABBREVIATIONS

ADB	-	Asian Development Bank
CGWB	-	Central Ground Water Board
C&D	-	Construction and Demolition
CPCB	-	Central Pollution Control Board
CMP	-	Comprehensive Mobility Plan
CRZ	-	Coastal Regulatory Zone
DP/s	-	Displaced Person/s
DRM	-	District Resource Map
EHS	-	Environmental, Health, and Safety
EIA	-	Environmental Impact Assessment
EIB	-	European Investment Bank
EMP	-	Environmental Management Plan
EMS	-	Environment Management System
EMoP	-	Environmental Monitoring Plan
ESF	-	Environment and Social Framework
ESP	-	Environment and Social Policy
ESHS	-	Environment, Social, Health and Safety
FTA	-	Federal Transit Administration
GI	-	Galvanised Iron
GoI	-	Government of India
GoM	-	Government of Maharashtra
GC	-	General Consultants
GRM	-	Grievance Redress Mechanism
HT/HT line	-	High Tension / High Tension line
IFC-PS	-	International Finance Corporation – Performance Standards
IMD	-	India Meteorological Department
INR	-	Indian National Rupee/s
KBA/s	-	Key Biodiversity Area/s
KLD	-	Kilo Litres Per Day
MoEF&CC	-	Ministry of Environment, Forests and Climate Change
MDB/s	-	Multilateral Development Bank/s
MPCB	-	Maharashtra Pollution Control Board
MRTS	-	Mass Rapid Transit System
NAAQS	-	National Ambient Air Quality Standards
NBWL	-	National Board of Wildlife
NGT	-	National Green Tribunal
NMRP	-	Nagpur Metro Rail Project
PAP/s	-	Project Affected Person/s
PC	-	Public Consultation
PEB	-	Pre-Engineering Building
RDSO	-	Railway Design & Standards Organisation
RAP	-	Resettlement Action Plan
SHE	-	Safety, Health & Environment
SPS	-	Safeguards Policy Statement
SPV	-	Special Purpose Vehicle
SIA	-	Social Impact Assessment
TBM	-	Tunnel Boring Machine
ToD	-	Transit oriented Development
USD	-	United States Dollar
WB	-	World Bank
WBG-EHS	-	World Bank Group – Environment, Health and Safety
WHO	-	World Health Organization

WEIGHTS AND MEASURES

I.	amsl / AMSL	-	above mean sea level
II.	^{o}C	-	degree Celsius
III.	cu.m	-	cubic meters
IV.	dB(A)	-	decibel acoustic
V.	ha.	-	hectare
VI.	km	-	kilometer
VII.	km/h, kmph	-	kilometer per hour
VIII.	KLD	-	Kilo litre per day
IX.	kWe	-	kilowatt-electric
X.	kV	-	Kilo volt(s)
XI.	kVA	-	kilo Volt-Amps
XII.	kW	-	kilowatt
XIII.	m	-	meter
XIV.	mm	-	millimetre
XV.	MLD	-	Million litre per day
XVI.	msl / MSL	-	mean sea level
XVII.	MVA	-	Megavolt Ampere
XVIII.	MW	-	Megawatt
XIX.	m^3	-	cubic meter
XX.	m^3/hr	-	cubic meters per hour
XXI.	mg/l	-	milligrams per liter
XXII.	m/s	-	meters per second
XXIII.	MT	-	metric tons
XXIV.	MTPA	-	metric tons per annum
XXV.	MW	-	megawatt
XXVI.	ppm	-	parts per million
XXVII.	ppt	-	parts per thousand
XXVIII.	rpm	-	revolutions per minute
XXIX.	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.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ANNEXURES

Annexure-1 : NABET Accreditation Certificate – MITCON
Annexure-2 : Drawings
Annexure-3 : Detailed Laboratory Analyses Results
Annexure-4 : Vibration Modelling Studies
Annexure-5 : Air Modelling Studies
Annexure-6 : Noise Modelling Report
Annexure-7 : Detailed list of Trees likely to be affected during Project construction
Annexure-8 : List of Utilities along Project Alignment
Annexure 9 : 9A - Guidelines for Site Selection and Management
9B - Guidelines for Muck Disposal
9C - Guidelines for Construction Waste Disposal
Annexure-10 : Terms of Reference for GC in implementation of EMP & EMoP
Annexure-11 : Terms of Reference for engaging the External Monitoring Agencies
Annexure-12 : Maha Metro SHE Manual
Annexure-13 : List of Sensitive Receptors
Annexure-14 : IBAT Analysis
Annexure-15 : Public Consultation details
Annexure-16 : Outline for Labour Management Plan
Annexure-17 : EIA report of Nagpur Metro Phase-I
Annexure-18 : Social Impact Assessment (SIA) Report
Annexure 19 : MoEF&CC letter regarding requirement of EC for Metro Rail projects
Annexure 20 : Details of Batching Plant / Casting Yards finalised and Labour Camps

EXECUTIVE SUMMARY

(NMRP Phase II EIA–EMP Report)

1. Nagpur—the Orange City of India, is the third largest city of India and second capital of Maharashtra state. As per 2011 Census data, the city has 2.4 million population under the jurisdiction of Nagpur Municipal Corporation (NMC). Rapid urbanization and development of IT hub in the city has increased the load on the current transit facilities including Nagpur Metro Rail Project (NMRP) Phase I. Thus, in order to meet future traffic demands expansion of Metro Railway Network has become a prime requisite.

2. 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 state, excluding the Mumbai metropolitan area. Maha Metro as the implementing agency, will be responsible for implementing, operating, and maintaining the city's metro system. NMRP Phase II comprises extension of both the Phase I corridors—North–South and East–West. Thus, the four resulting alignments, included in Phase II are named Line and/or Reach 1A, 2A, 3A, and 4A respectively.

3. The NMRP Phase II project is proposed for financing by the Asian Development Bank (ADB) and the European Investment Bank (EIB).

4. NMRP Phase II shall run from North-South Corridor (Reach 1A-MIHAN to MIDC ESR and Reach 2A Automotive Square–Kanhan river), East–West Corridor (Reach 3A–Lokmanya Nagar–Hingna and Reach 4A–Prajapati Nagar (Pardi)–Transport Nagar). The total cost including taxes and duties of the project is estimated of ₹58,538.7 million. As per the project implementation plan, the duration of the project from commencement to operational work is about 4 years i.e. civil work shall commence in 2024 and Phase II Metro shall be operational from October 2027.

5. As per provisions of the environmental impact assessment (EIA) Notification 2006 and its subsequent amendments by the Ministry of Environment, Forests and Climate Change (MoEF&CC), Metro Rail Projects are exempted from requirements of prior environmental clearance.

6. The EIA addresses analysis and potential impact of all the activities from construction phase to the operational phase and proposes mitigation measures for the same. Social impact assessment (SIA) is presented as a separate report (**Annexure-18**).

7. The EIA and environmental management plan (EMP) are prepared in line with Environmental Framework/ Environmental Assessment Policy of International Funding Agency i.e., ADB's Safeguard Policy Statement (2009). (OP/BP-4.01, OP/BP-4.02, OP/BP-4.04 etc.) and EIB Environmental and Social Standards (2 Feb 2022). The Metro Rail Project is financed by agencies like ADB and EIB.

8. Without mitigation measures the NMRP Phase II may potentially have a major impact on noise and vibration Total 32 new stations are proposed in NMRP Phase II; Corridor / Reach 1A will be of length 18.768 km and will have 10 stations (8 elevated and 2 grade). Reach 2A will have 12 elevated stations and of length of corridor is 12.925 km. Reach 3A corridor is of length 6.65 km and has 7 elevated stations. Reach 4A shall have 3 elevated stations and the length of corridor will be 5.441 km. Standard gauge (1435 mm) will be adopted with a minimum track centre distance of 4000 mm, 16-tonne maximum axle load capacity and a design speed of 80 kmph.

9. The terrain for all the four corridors is flat and at some parts slightly undulated. Soil sampling was carried at NMRP-Phase II corridors, and the results were compared with Bureau

of Indian Standards (BIS) and as per UK Soil Guideline Values (SGV), it can be concluded that soil in study area is Clayey to Loamy in texture.

10. Waiganga and Wardha Rivers are two main sources of water for Nagpur District. Wardha, Bor, Kanhan and Venna are perennial rivers. NMRP Phase II crosses Venna River which is crossed by two of the alignments, namely Line 3A and Line 1A. Kanhan river is in proximity towards the end of Reach 2A alignment. Analysis for surface water and ground water was carried out and results were compared with IS 10500:2012. Most of the samples were found to be within the permissible limits or only slightly exceeding permissible limits. Microbiological parameters–Total coliform and E-coli are present in most of the surface water samples collected, similarly for ground water physico-chemical parameters were analysed and were found to be within permissible limits as per IS 10500:2012 except in pH, chlorides and coliforms.

11. Ambient Air Quality Monitoring was carried out for all the 4 corridors (i.e., Reach 1A, 2A, 3A and 4A). 24-hour air quality monitoring results indicates that all parameters were within the permissible level of National Ambient Air Quality Standards (NAAQS), except Particulate Matter (both PM10 and PM2.5). Similarly, both PM10 and PM2.5 as well as NOx exceed the WHO guidelines.

12. Ambient noise levels were monitored at 34 locations, identified during preliminary baseline survey within the study area using digital Noise Meter and results at all sampling locations are found to be within the prescribed standards, except a few locations.

13. The vibration measurement was carried out at 7 locations (identified sensitive receptors) located near the alignments, using portable Vibration Meter 2040. The observed levels at all 7 locations are well below the building vibration damage criteria for construction relevant to structures existing at those locations. The measured levels are also below limits set by Directorate General of Mines Safety (DGMS), GoI.

14. Based on analysis of project and environmental settings, a detailed assessment of potential impacts due project location and design, construction and operation has been carried out. For each of these adverse impacts, mitigation measures have been proposed. Significant impacts are Aesthetic impact, Sourcing of construction material, Emissions from machinery, Noise and Vibration due to operation of construction equipment and vehicular movement.

15. Few mitigation measures proposed are as follows: (i) noise barriers close to vehicles and noise barriers at Right of Way (RoW), acoustic enclosures for noise generating equipment; (ii) DRDO based STP shall be installed at each station; (iii) the loss of trees will be compensated through planting of 10 saplings for each tree cut for NMRP- Phase II project; (iv) people affected due to NMRP- Phase II shall be paid cash compensation at market rates for land and structures, compensation for loss of livelihood and rehabilitation benefits as per policy approved by GoM; and (v) sleek columns will be incorporated in the structural design as much as possible without compromising safety.

16. Qualitative evaluation was done for available alternatives like Normal Bus System, Elevated Bus Rapid Transit, Metro and Light Rail Transit. Quantitative evaluation was done by considering parameters like mobility effects, conceptual civil engineering effect, system effects, environmental effects, social effects, cost effectiveness and affordability, financial and economic effects and approvals and implementation. Based on both qualitative and quantitative screening and analysis, metro system has emerged as the most viable alternative of mass transport system for Phase II corridors in Nagpur.

17. The Safeguard Policy Statement states that meaningful public consultation shall have to be carried out for the project. Meaningful consultation is a process that (i) begins early in the project preparation stage and is carried out on an ongoing basis throughout the project cycle; (ii) provides timely disclosure of relevant and adequate information that is

understandable and readily accessible to affected people; (iii) is undertaken in an atmosphere free of intimidation or coercion; (iv) is gender inclusive and responsive, and tailored to the needs of disadvantaged and vulnerable groups; and (v) enables the incorporation of all relevant views of affected people and other stakeholders into decision making, such as project design, mitigation measures, the sharing of development benefits and opportunities, and implementation issues. The consultation will continue throughout the project implementation phase. Information disclosure will follow the procedure and requirements of ADB's policy for category A projects. As per Safeguard Policy Statement, the draft EIA including the draft EMP will be disclosed 120 days prior to the Board consideration.

18. The NMRP will formulate a project specific grievance redress mechanism (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. As per ADB's guidelines, NMRP will constitute two-tier constitution of grievance redress committee (GRC) with representative from implementing agency, community, nongovernment organizations, etc. for NMRP Phase II project. If the affected party is not satisfied by the response of two-tier committee, then they option to escalate the grievances to the judiciary system.

19. The EMP is prepared in accordance with Multilateral Development Bank (MDB) applicable policies, and regulatory requirements of GoM and GoI. The EMP consists of a set of mitigation, monitoring and institutional measures to be taken for NMRP Phase II project corridors to avoid, minimize and mitigate adverse environmental and social impacts and enhance positive impacts. EMP will be committed by Maha Metro as part of its agreement with MDBs. External monitor will be engaged for entire NMRP Phase II Project corridors. The external monitor will conduct independent monitoring and inspections to inform Maha Metro of any remediation actions to ensure the safeguard compliances. NMRP will submit at least semiannual monitoring reports during construction. The total estimated cost for EMP of all 4 corridors of Nagpur Metro Project- Phase 2 Corridors is ₹139.3 million.

20. Environmental monitoring plan (EMoP) is an allied document of EMP. The EMoP comprises parameters, location, sampling and analysis methods, frequency, and compared to standards or agreed actions that will indicate non-compliances and highlight necessary corrective actions. As per the detailed survey conducted for NMRP-Phase- II, none of the four corridors falls under any protected area or near a site of historical and/or cultural significance. After mitigation some residual impacts are expected, predominantly due to noise, vibration, visual intrusion and health and safety risks. Environmental and social benefits of the project and long-term investment program objectives outweigh the temporary negative impacts.

21. The structure of EIA is as follows: (i) introduction or background, objective of the study, scope of EIA–EMP study, EIA consultant, EIA; (ii) policy, legal and administrative framework within which environmental safeguards will be recommended and implemented; (iii) project description of NMRP Phase II highlighting construction activities and methodology, implementation plan and construction schedule, detailed project cost estimate, associated facilities; (iv) environmental baseline data in terms of physical, ambient and ecological baseline (socioeconomic baseline will be presented in social impact assessment report); (v) anticipated impacts and mitigation measures with respect to air, noise, vibration surface water and groundwater quality, land degradation, flora, fauna, private land and buildings, public property/infrastructures/utility services, aesthetics, occupational health and safety, carbon credit study; (vi) analysis of alternatives; (vii) public consultation and information disclosure; (viii) GRM; (ix) EMP; and (x) conclusions and recommendations.

I. INTRODUCTION

A. BACKGROUND

1. Nagpur, the Orange city of India, is third largest city in the state of Maharashtra and second capital of the state. It is the seat of annual winter session of the Maharashtra State Vidhan Sabha. Nagpur lies precisely at centre of the country with Zero Mile Marker indicating the geographical centre of India. It is a major commercial and political centre of the Vidarbha region of Maharashtra. The city is also considered as the second greenest city in India along with title 'Tiger Capital of India' as it connects to many tiger reserves in the country. Due to its proximity from various parts of country, the city is also emerging as one of economical hubs in recent times.

2. The city of Nagpur acts as the headquarter for the Nagpur district with a population of about 4.6 million of which about 2.4 million population accounts to Nagpur Municipal Corporation as per 2011 Census [1]data. Nagpur has large number of technical institutes which can cater to the rising needs of the IT-ITES industry in the region by generating enough manpower resources. Nagpur, also considered as a low living cost city, has become a prime destination for Information Technology Enabled Services (ITES) and Business Process Outsourcing (BPO) units. In addition to establishment of Multi-modal International Cargo Hub & Airport (MIHAN), Nagpur is also expected to be established as one of the major IT sectors in the country.

3. Rapid urbanization and intense commercial developments in recent past have resulted in steep rise in travel demand putting Nagpur's transport infrastructure to stress. To relieve this stress MRT system i.e., Nagpur Metro Phase I is already in operation.

4. Based on the proposals from comprehensive mobility plan (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 corridors of Phase 1 in order to meet the future traffic demands. Nationally and globally, it is seen that the metro network expands progressively to cover an entire city. Hence, it is essential that in Nagpur also, such expansion of Metro Rail network is taken up in time.

5. NMRP Phase II project is proposed to be financed by the Asian Development Bank (ADB) and the European Investment Bank (EIB). The exact pattern of funding and roles are summarised in **Table 1-1** below:

Table 1-1: Summary Statement indicating funding of Civil & System Packages through ADB, EIB, and Equity[2]

No.	Proposed Funding from Agencies	Million	Funding Available (Excl. GST) (₹ in Crores)	Civil Cost (excl. GST) (₹ in Crores)	Systems Cost (excl. GST) (₹ in Crores)	Total Cost (excl. GST) (₹ in Crores)	Surplus (+) / Shortfall (-) in proposal (₹ in Crores)
		A	B	C	D	E=C+D	F=B-E
I	ADB	200 (USD)	1527.20	873.82	644.16	1517.98	-9.22
II	EIB	239.35 (EURO)	2058.40	1427.89	601.16	2029.05	-29.35
III	**Total Funding package cost (excl. GST)**	**-**	**3585.60**	**2301.70**	**1245.32**	**3547.02**	**-38.58**

[1] *The census is done every 10 years. The 2021 census has been postponed until after the 2024 general elections. Hence, the 2011 census is the most recent one.*

[2] *As approved by Competent Authority of Maha Metro on 21/01/2023 vide Note no.: Maha-Metro/ED(Proc)/NMRP-Phase 2/2022 dated 31.12.2022 (C.P 3&4 of 4).*

No.	Proposed Funding from Agencies	Million	Funding Available (Excl. GST) (₹ in Crores)	Civil Cost (excl. GST) (₹ in Crores)	Systems Cost (excl. GST) (₹ in Crores)	Total Cost (excl. GST) (₹ in Crores)	Surplus (+) / Shortfall (-) in proposal (₹ in Crores)
		A	B	C	D	E=C+D	F=B-E
	(ADB+EIB) [III=I+II]						
IV	GST Component of Funded Package	-	-	414.31	224.16	638.46	-
V	Total Funding package cost (incl. GST) [V=III+IV]	-	-	2716.01	1469.48	4185.49	-
VI	Packages funded from Equity	-	-	898.01	846.52	1744.53	-
VII	Packages funding from Equity (incl. GST component of Funded Packages) [VII=IV+VI]	-	-	1312.32	1070.68	2383.00	-
VIII	**Total Packages cost [VIII=III+VII]**	**-**	**-**	**3614.02**	**2316.00**	**5930.02**	**-**
IX	DPR provision for Contingency, Interest during Construction, Staff Salary, GC, Land and others, etc.	-	-	-	-	777.86	-
X	**Total Project Cost [X=VIII+IX]**	**-**	**-**	**-**	**-**	**6707.88**	**-**

6. Gap Analysis – ADB vs EIB vs MoEF&CC:

This section presents a detailed gap analysis of environmental standards across three frameworks: the Asian Development Bank (ADB) Safeguard Policy Statement (SPS) 2009, the European Investment Bank (EIB) Environmental, Health, and Safety (EHS) Guidelines 2022, and the Ministry of Environment, Forest and Climate Change (MoEF&CC) standards and guidelines in India. Specific differences in requirements and procedures among these standards are also identified and summarised in brief, along with addressal of the gaps, if any.

Table 1-2: Gap Analysis – ADB vs EIB vs MoEF&CC

Aspect	Funding / Evaluating Agency	Specific requirements, procedures and monitoring	Gap Analysis	Measures to bridge the GAP
Environmental Assessment and Management	**ADB SPS 2009**	**Requirement**: Projects are categorized based on their potential environmental impacts (Category A, B, C, and FI). Category A requires a full Environmental Impact Assessment (EIA), Category B requires an Initial Environmental Examination (IEE), and Category C does not require an environmental assessment. **Procedure:** The EIA or IEE must include a description of the project, baseline data, impact assessment, mitigation measures, and an Environmental Management Plan (EMP). Public consultation is required for Category A projects. **Monitoring:** Regular monitoring and reporting on the implementation of the EMP are mandatory.	**ADB vs. EIB:** EIB requires a more integrative ESIA covering environmental, social, and health impacts comprehensively. ADB focuses more on environmental impacts with separate consideration for social aspects. **ADB vs. MoEF&CC:** ADB's categorization is similar to MoEF&CC, but MoEF&CC has a more detailed regulatory framework specific to India, including public consultation as a crucial component. **EIB vs. MoEF&CC:** EIB's guidelines are more comprehensive and integrative compared to the MoEF&CC's EIA process which does not require Environmental Clearance or	• Require EIA for all potential-risk projects including Metro rail project; • Comprehensive EIA report has been prepared as per ADB SPS 2009 and EIB EHS Guidelines 2022.
	EIB EHS Guidelines 2022	**Requirement**: An Environmental and Social Impact Assessment (ESIA) is required for all projects, with a focus on integrating environmental, social, and health impacts. **Procedure:** The ESIA must include project description, baseline data, analysis of alternatives, impact assessment, mitigation measures, and management plans. Public consultation and stakeholder engagement are mandatory throughout the project lifecycle. **Monitoring:** Continuous monitoring, reporting, and adaptive management are required to ensure compliance and effectiveness of mitigation measures.		

	MoEF&CC Standards	**Requirement**: An EIA is mandatory for certain categories of projects as specified in the EIA Notification 2006. Projects are categorized based on their potential impacts (Category A and B). **Procedure:** The EIA process includes screening, scoping, public consultation, and appraisal. The EIA report must cover project details, baseline data, impact assessment, mitigation measures, and an EMP. **Monitoring:** Regular environmental monitoring and compliance reporting to the regulatory authorities are required.	Environmental Impact Assessment for Metro Rail projects.	
Pollution Prevention and Abatement	**ADB SPS 2009**	**Requirement**: Projects must prevent pollution by implementing pollution control technologies, waste minimization practices, and adopting cleaner production techniques. **Procedure:** Develop and implement a Pollution Prevention and Abatement Plan (PPAP) as part of the EMP. Compliance with national pollution control standards and international best practices is required. **Monitoring:** Regular monitoring of pollution levels and effectiveness of control measures is required.	**ADB vs. EIB**: EIB's guidelines are more detailed and prescriptive, with specific performance standards and emphasis on BAT. ADB focuses on general principles of pollution prevention. **ADB vs. MoEF&CC:** ADB's guidelines are more flexible and principle-based, while MoEF&CC has legally binding national standards. **EIB vs. MoEF&CC:** EIB's standards are more stringent and detailed, focusing on continuous improvement and BAT, whereas MoEF&CC's standards are based on national regulations and compliance.	• Harmonise thresholds and incorporate specific performance standards and Best Available Techniques (BAT) from EIB and ADB instead of MoEF&CC guidelines. • Wherever possible the more stringent guideline with respect to limits and pollution criteria has been adopted throughout the EIA and the EMP.
	EIB EHS Guidelines 2022	**Requirement**: Projects must meet specific performance standards for air, water, and soil pollution. The use of Best Available Techniques (BAT) is mandated. **Procedure:** Implement a comprehensive pollution prevention and control plan, integrating BAT and best practices. Continuous improvement and adaptive management are emphasized. **Monitoring:** Rigorous monitoring, reporting, and verification of pollution levels against performance standards are mandatory.		
	MoEF&CC Standards	**Requirement**: National standards for air and water quality, effluent discharge limits, and waste management must be adhered to. **Procedure:** Develop and implement pollution control		

		measures as per the specific requirements of the project category. Compliance with national standards is mandatory. **Monitoring:** Regular monitoring and reporting to regulatory authorities on pollution levels and compliance with standards.		
Conservation of Biodiversity and Natural Resources	**ADB SPS 2009**	**Requirement**: Projects must conserve biodiversity, manage living natural resources sustainably, and protect critical habitats. **Procedure:** Implement measures to mitigate adverse effects and enhance positive impacts. **Monitoring:** Regular monitoring and reporting on biodiversity conservation measures are required.	**ADB vs. EIB**: Both ADB SPS and EIB EHS guidelines aim for no net loss of biodiversity and mandatory offsets and focus on stringent conservation principles. **ADB vs. MoEF&CC:** ADB's guidelines are more flexible, whereas MoEF&CC's standards are specific to national biodiversity policies and regulations. **EIB vs. MoEF&CC:** EIB's guidelines are more detailed and globally focused, whereas MoEF&CC's standards are tailored to India's regulatory environment.	• No Gap between ADB and EIB standards / guidelines. • Stringent measures will be adopted to conserve the biodiversity and minimise use of natural resources.
	EIB EHS Guidelines 2022	**Requirement**: Projects must ensure no net loss of biodiversity, protect critical habitats, and implement biodiversity offsets where necessary. **Procedure:** Integrate biodiversity conservation into project planning and management. **Monitoring:** Continuous monitoring, adaptive management, and reporting on biodiversity conservation measures are required.		
	MoEF&CC Standards	**Requirement**: Compliance with national policies on wildlife protection, biodiversity conservation, and management of protected areas. **Procedure:** Implement biodiversity management plans and comply with national regulations. **Monitoring:** Regular monitoring and reporting on biodiversity conservation measures to regulatory authorities are required.		
Community Health and Safety	**ADB SPS 2009**	**Requirement**: Projects must address community health and safety risks associated with project activities and natural hazards. **Procedure:** Develop and implement Community Health and Safety Plans (CHSPs) as part of the EMP. Mitigate risks through design, construction, and operation measures.	**ADB vs. EIB**: Both ADB's and EIB's guidelines are comprehensive, covering community health, safety, and security in detail, including emergency preparedness.	• ADB as well as EIB guidelines ensure that all community, Health & Safety aspects are to be part of the EIA.

		Monitoring: Regular monitoring of community health and safety impacts and effectiveness of mitigation measures is required.	**ADB vs. MoEF&CC:** ADB's guidelines are broader, while MoEF&CC incorporates health impacts into the EIA process with a focus on compliance with national regulations. **EIB vs. MoEF&CC:** EIB's guidelines are more detailed and integrative, focusing on continuous engagement and adaptive management, whereas MoEF&CC's standards are more rigid and specific to national regulations.	• Social, health, and safety aspects are comprehensively complied by the EMP and SHE manual.
	EIB EHS Guidelines 2022	**Requirement**: Projects must ensure community health, safety, and security, including emergency preparedness and response. **Procedure:** Conduct comprehensive health and safety risk assessments, develop CHSPs, and implement mitigation measures. Engage with communities throughout the project lifecycle. **Monitoring:** Continuous monitoring, reporting, and adaptive management of community health and safety measures are required.		
	MoEF&CC Standards	**Requirement**: Projects must consider public health impacts as part of the EIA process and implement disaster management plans. **Procedure:** Assess health impacts during the EIA process, develop and implement health and safety measures, and comply with national regulations. **Monitoring:** Regular monitoring and reporting on health impacts and mitigation measures to regulatory authorities are required.		
Physical Cultural Resources	**ADB SPS 2009**	**Requirement**: Projects must identify and protect physical cultural resources (PCR) potentially affected by project activities. **Procedure:** Conduct PCR assessments during the EIA process, implement a chance find procedure, and develop PCR management plans. **Monitoring:** Regular monitoring of PCR protection measures and reporting on any finds and their management are required.	**ADB vs. EIB**: EIB's guidelines include both tangible and intangible cultural heritage comprehensively. ADB focuses primarily on tangible resources and requires a chance find procedure.	• Gap is not very significant as ADB SPS and EIB EHS Standards are more or less similar. • EMP comprehensively addresses the protection measures for cultural resources to include

	EIB EHS Guidelines 2022	**Requirement**: Projects must protect both tangible and intangible cultural heritage. **Procedure:** Conduct cultural heritage assessments, develop and implement Cultural Heritage Management Plans (CHMPs), and ensure stakeholder engagement. **Monitoring:** Continuous monitoring, reporting, and adaptive management of cultural heritage protection measures are required.	**ADB vs. MoEF&CC:** Both ADB and MoEF&CC focus on tangible cultural heritage, but MoEF&CC follows specific national regulations. **EIB vs. MoEF&CC:** EIB's guidelines are more comprehensive and include broader definitions and protection measures for cultural heritage, whereas MoEF&CC's standards are specific to India's regulatory framework.	both tangible and intangible heritage.
	MoEF&CC Standards	**Requirement**: Compliance with national laws on cultural heritage protection and consideration of cultural heritage in the EIA process. **Procedure:** Conduct assessments of cultural heritage during the EIA process, implement protection measures, and comply with national regulations. **Monitoring:** Regular monitoring and reporting on cultural heritage protection measures to regulatory authorities are required.		

1. Existing Nagpur Metro Rail Network

7. As per detailed project report (DPR) for NMRP Phase I, the project covers around 38.22 km in two corridors – North South Corridor (Automotive Square to Khapri) of 19.66 km (18 stations) and East West Corridor (Prajapati Nagar to Lokmanya Nagar) of 18.56 km (20 stations). As of August 2023, the NMRP Phase I[3] is in commercial operation. However, the lengths of the alignments have slightly increased due to some minor changes made during construction phase. Details of the corridors and planned versus actual route lengths for NMRP Phase I project is summarised in **Table 1-3**.

Table 1-3: Description of NMRP Phase I Project Corridors[4]

	Stations			Length (in Km) As per DPR			Length (in Km) As per Execution		
Corridor	**Elevated**	**At Grade**	**Total**	**Elevated**	**At Grade**	**Total**	**Elevated**	**At Grade**	**Total**
NS Corridor	15	**3**	**18**	15.06	4.6	19.66	15.39	5.15	20.54*
EW Corridor	20	**0**	**20**	18.56	-	18.56	19.41#	0	19.41
Total	**35**	**3**	**38**	**33.62**	**4.6**	**38.22**	**34.80**	**5.15**	**39.95**

** Increase in Length due to change in Alignment near Central Jail.*
 # Increase in Length due to additional Depot connection (entry/exit).

8. Phase II of the NMRP includes extension of both the North–South and the East–West corridors as shown in **Figure 1-1**. This EIA covers all four corridors of NMRP Phase II.

2. Nature, Size and Location of Nagpur Metro Phase II

9. In order to alleviate the transport[5] related problems in the city, CMP for Nagpur has been prepared in 2013. 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 corridors of Phase 1 in order to meet the future traffic demand.

10. 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.

11. As mentioned earlier, NMRP Phase II comprises extension of both the Phase I corridors – North–South and East–West. Thus the 4 resulting alignments, included in Phase II, are named Line/Reach 1A, 2A, 3A and 4A, as explained in subsequent sections. The NMRP Phase II project is proposed for financing by ADB and EIB.

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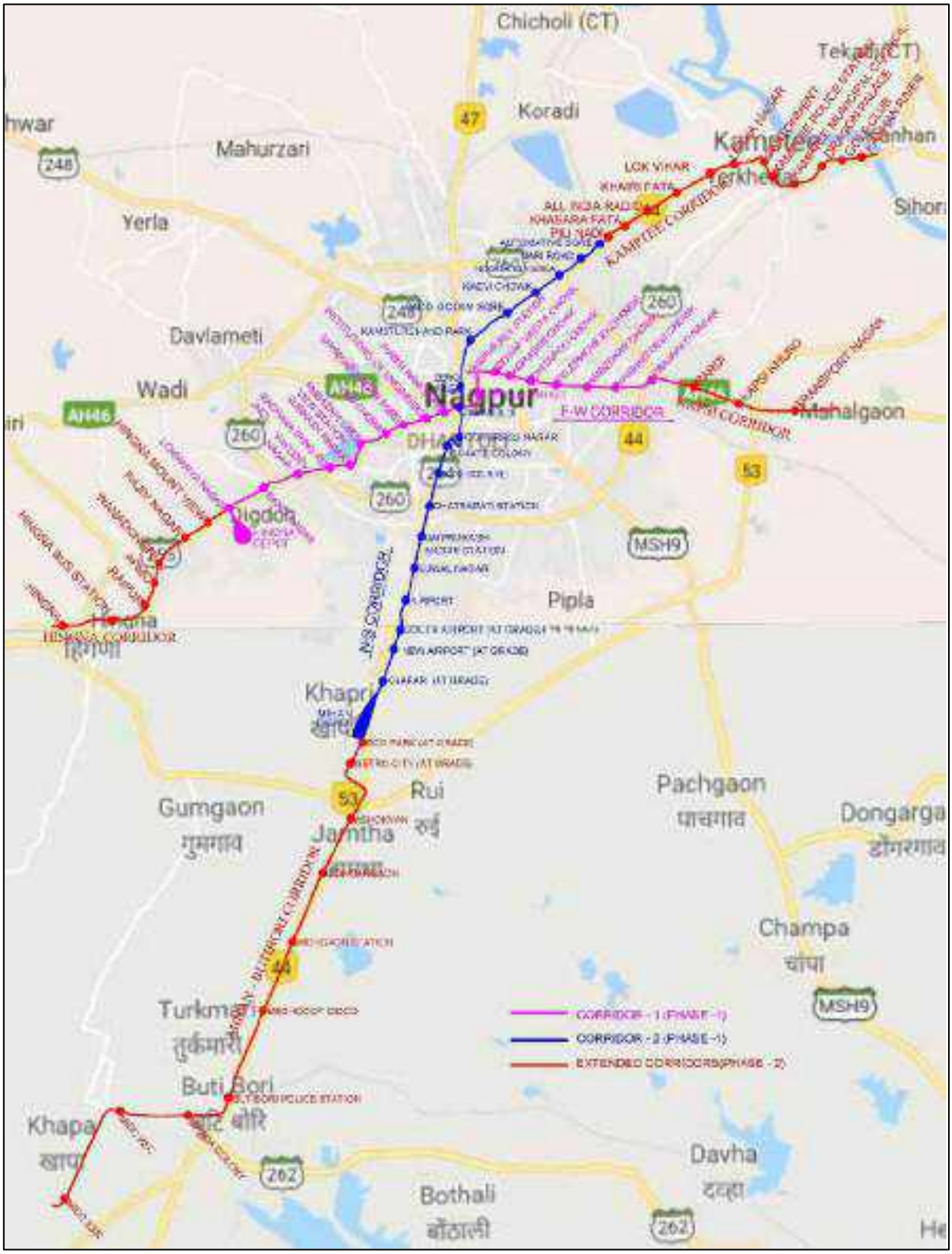
[3] *Phase I Construction started in May 2015 and was operational in March 2019.*
[4] *Source: Nagpur Metro Rail Project Phase II (NMRP-P2) Detailed Project Report (DPR), November 2019.*
[5] *No other metro line has been planned in the CMP (2013) except NMRP P-II. Provision for connectivity from MIDC ESR to Wardha Road - Only future option to connect NMRP P-II to Wardha Road (NH-44).*

Figure 1-1: Routes of the Existing NMRP Phase I and Proposed NMRP Phase II[6]



B. OBJECTIVE OF THE STUDY

12. The objective of the Nagpur Metro Rail Project Phase-II is to strengthening the need

[6] *Source: Nagpur Metro Rail Project Phase II (NMRP-P2) Detailed Project Report (DPR), November 2019.*

for augmenting the transport infrastructure in Nagpur 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.

13. The specific objectives of this EIA study include, but are not limited to, anticipate and appraise any foreseeable impact the project may have on the existing environment and to identify and prevent any negative impact, or limit it to a tolerable level and (provided that the negative impact is inevitable but still tolerable) introduce compensation measures. In addition, the assessment intends to identify, monitor and manage any residual risks. The EIA–environmental management plan (EMP) studies also intend to raise awareness of development approaches that are ecologically sustainable.

C. SCOPE OF ENVIRONMENTAL IMPACT ASSESSMENT–ENVIRONMENTAL MANAGEMENT PLAN STUDY

14. The scope of work for the EIA study for entire stretch is given below:

(i) Undertake Environmental Impact Assessment (EIA) and prepare Environmental Management Plan (EMP) in accordance with international funding agency policies (e.g., World Bank, ADB, EIB) 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 for the establishment of social baseline conditions 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, including public consultation and disclosure strategies, as per applicable national laws and international funding agency guidelines.

D. ENVIRONMENTAL IMPACT ASSESSMENT CONSULTANT

15. MITCON Consultancy and 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.

16. MITCON Consultancy and Engineering Services Ltd. is accredited from National Accreditation Board for Education and Training (NABET), Quality Council of India for EIA consultancy services in 16 sectors; NABET Certificate (No.: NABET/EIA/21-24/RA 0229_Rev.03) is attached as **Annexure-1** of this report.

E. ENVIRONMENTAL IMPACT ASSESSMENT

1. Categorization

17. Based on preliminary assessment of significance of impacts borne out of field visits and secondary information, NMRP-P2 is not expected to have significant adverse impacts other than comprising aesthetics, noise and vibration. Conversely, the proposed project will bring in many benefits to the project area.

18. However, the civil works of NMRP-P2 corridors will entail construction of viaducts and elevated stations. Also, construction will take place along existing road corridors in a busy urban area. 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. Due to the significant environmental risks described above, the project is categorized as category “A” for environmental safeguards.

19. 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 NMRP-P2 corridors of the metro project is not required to secure prior environmental clearance in the form of an approved EIA from the Ministry of Environment, Forest and Climate Change (MoEF&CC) 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 prescribing environmental clearance.

F. Purpose of the Environmental Impact Assessment Report

20. This EIA report documents the environmental impacts assessment for Nagpur Metro Rail Project Phase-II (NMRP-P2). In this report the different activities that are likely to take place during construction and operation have been analyzed and the potential impacts, that may accompany them, have been discussed. The EIA addresses the environmental management requirements of GoI as well as those of the international funding agencies. In general, the EIA Report is outlined as below to address various aspects:

(i) Provide background of the project in terms of land use, existing metrorail network and the proposed Metrorail corridors, methodology of preparation of the report and its content;
(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 NMRP-P2 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.

21. Social impact assessment (SIA) is presented as a separate report and attached as **Annexure 18** of this EIA-EMP

2. Approach and Methodology

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

(i) Review of available baseline reports, DPR, and other technical reports / studies related to Nagpur Metro Rail Project (NMRP) – Phase I (P1) and Phase II (P2);
(ii) Conduct field visits to collect primary and / or secondary data relevant to Nagpur Metro Phase-II corridors to establish the environmental baseline;
(iii) Assess the potential impacts on environmental attributes due to the location, design, installation and operation of Nagpur Metro Phase-II Corridors through field investigations and data analysis;
(iv) Explore opportunities for environmental enhancement and identify measures;
(v) Prepare an EMP 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 NMRP-P2 and prepare an EMoP;
(vii) Carry out consultation with key stakeholders and administrative authorities to identify their perception on NMRP-P2 by introducing project components and anticipated impacts; and
(viii) Disclose the draft EIA at Maha Metro and ADB websites and prepare the executive summary in local language (Marathi) to be made publicly available.

Figure 1-2: Methodology followed in the present EIA studies

23. The baseline data for air, water and soil quality was collected in width 100 meter (m) on either side of proposed center line of all the four alignments of NMRP-P2, and data for noise and vibration in width 50 m on either side of alignment. Sensitive receptors located in width 100 m on either side of center line of alignment were identified according to the silence zone defined by the Central Pollution Control Board (CPCB). The structure of the EIA report is as per **Table 1-4**.

Table 1-4: Structure of the EIA Report

No.	Item	Remarks
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 management plan (EMP)	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.

Source: Asian Development Bank.

II. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

24. 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 NMRP Phase II project.

25. 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) ADB and 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

26. 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

27. 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. Legislations Relevant to the Project

28. The policies and requirements which are most relevant in the context of this Corridor are provided in **Table 2-1** below:

Table 2-1: Summary of Applicable Legislation for NMRP-P2 corridors

Legislation	Objective	Responsible Institution
- Environment (Protection) Act (1986) and Rules (1986); - National Conservation Strategy and Policy Statement on Environment and Development of 1992; - National Environment Policy of 2006	To protect and improve the overall environment	Ministry of Environment, Forests, and Climate Change (MoEF&CC)

Legislation	Objective	Responsible Institution
Environmental impact assessment (EIA) Notification (2006) under Environmental Protection Rules (2006, 2009, 2011) and relevant Office Memorandums (OM)	To provide guidance on environmental clearance requirements and clarification on related specific technical issues	MoEF&CC
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	CPCB
The Maharashtra Prevention of Water Pollution Act, 1969 (Amended 1981)		Maharashtra Pollution Control Board (MPCB)
Model Groundwater (Control and Regulation) Bill 1970, amended in 1972, 1996 and 2005	To provide for the prevention, control and abatement of groundwater pollution	Central Ground Water Authority (CGWA)
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; - 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 appropriate approvals from the local authority before starting construction or demolition or remodeling work	MPCB
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	Conservation of Cultural and historical remains found in India (Chance finds, if	Archaeological Survey of India (ASI), GoI

Legislation	Objective	Responsible Institution
1949); - Ancient Monuments and Archaeological Sites and Remains Act (1958)	any, during construction)	
- National Policy on HIV/AIDS and the World of Work - National Policy on Safety, Health and Environment at Workplace	To regulate the safety, health and environment at workplace	Ministry of Labour and Employment
A. Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996 B. Maharashtra Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Rules, 2007. C. The Contract Labour (Regulation & Abolition) Act, 1970 D. Employees State Insurance Act, 1948 (ESI); E. Minimum Wages Act, 1948, The Payment of Wages Act, 1936, amended in 2005; F. The Maharashtra Labour Welfare Act & Rules, 1953 G. The Equal Remuneration Act 1976; 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.
Schedule – XXIV of the Model Factories Rules 120 (MFR 120) under Section 87 of the Factories Act (1984)	Operations involving high Noise and Vibration levels	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

3. Required Clearances and/or Permissions

29. Railway is not listed among activities requiring prior environmental clearance in GoI's EIA Notification 2006 and therefore NMRP Phase II 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 Nagpur 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 20,000m^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.

30. In light of the above, prior environmental clearance is not required for NMRP Phase-II, if commercial development equal to or above threshold of 20,000 sq.m is not proposed. As both the phase maintenance depots have built-up areas lesser than 20,000 sq.m, no environmental clearance is required for the depots. However, before the start of civil works for any section of NMRP Phase-II, Maha Metro through the contractor, must obtain necessary clearances and/or permissions related to environment and labour safeguards from statutory authorities of GoI; these have been summarized in **Table 2-2**.

Table 2-2: Applicable Permissions and Clearances for NMRP Phase II 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	Forest Conservation Act (1980); Procedural Guidelines developed by the Department of Environment, GoM; Maharashtra (Urban Area) Protection of Trees Act, 1975	Tree Authority – Nagpur Municipal Corporation (NMC), 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.	Consent to Operate (CtO) for Maintenance Depots at Hingna and MIHAN	Air (Prevention and Control of Pollution) Act 1981	MPCB, to be obtained before installation (if applicable)	Contractor engaged by Maha Metro
4.	Permission for withdrawal / dewatering of	Environment (Protection) Act, 1986; Groundwater Survey and	CGWA, 3 months (to be obtained before start of construction)	Contractor engaged by Maha Metro

Sl	Permissions / Clearances	Acts / Rules / Notifications / Guidelines	Concerned Agency and approx. Timeline	Responsibility
	groundwater[11]	Development Authority (GSDA), GoM; Guidelines / Criteria for evaluation of proposals / requests for groundwater abstraction (With effect from 16.11.2015)		
5.	Consent to recharge groundwater with dewatering water, if any	Water (Prevention and Control of Pollution) Act 1974 amended 1988, Environment (Protection) Amendment Rules, 2017 [Discharge Standard for Sewage Treatment Plants (STPs)], Model Groundwater (Control and Regulation) Bill 1970, amended in 1972, 1996 and 2005	CGWB / PWD, 3 months (to be obtained before start of construction)	Contractor engaged by Maha Metro
6.	Permission for sand mining from riverbed, if any	Environment (Protection) Act, 1986	State Mining Dept. / MoEF&CC	Contractor engaged by Maha Metro
7.	Authorization for storage (diesel) 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
8.	Consent for disposal of sewage from Labour camps.	Water (Prevention and Control of Pollution) Act 1974 amended 1988 Environment (Protection) Amendment Rules, 2017 [Discharge Standard for Sewage Treatment Plants (STPs)]	MPCB, 3 months, to be obtained before installation	Contractor engaged by Maha Metro
9.	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 Centers, to be obtained before start of construction / project implementation) and regularly updated	Contractor engaged by Maha Metro
10.	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
11.	Roof Top Rainwater Harvesting (RWH)	Central Groundwater Authority (CGWA) Guidelines	CGWA, 3 months, to be obtained before installation	Contractor engaged by Maha Metro
12.	Permission for use of fresh water for construction and drinking purpose.	Environment (Protection) Act, 1986	NMC, 3 months, to be obtained before installation	Contractor engaged by Maha Metro
13.	Permission for Quarry Operations	The Mines and Minerals (Development and Regulation) Act, 1957	State Department of Mines and Geology, 2-6 months, to be obtained before construction	Contractor engaged by Maha Metro
14.	Authorization for Disposal of Construction and	Construction and Demolition Waste Management Rules,	NMC, 2 months, to be obtained before	Contractor engaged by

[11] *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
	Demolition (C&D) Waste	2016	installation	Maha Metro
15.	Consent to Establish Labour camps, pre-casting and material yards, hot mix plant, crushers, batching plant, stations	Air (Prevention and Control of Pollution) Act 1981 and amendments; The Noise Pollution (Regulation and Control) Rules, 2000 and amendments; Water (Prevention and Control of Pollution) Act 1974 and amendments	MPCB, 3 months, to be obtained before installation	Contractor engaged by Maha Metro
16.	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
17	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

4. Institutional Framework

31. 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

32. 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.

III.

(b) Central Pollution Control Board

33. 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.

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

(c) Maharashtra Pollution Control Board

35. 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) Central Ground Water Board

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

(e) The National Green Tribunal

37. 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.

38. The Tribunal's dedicated jurisdiction in environmental matters shall provide speedy environmental justice and help reduce the burden of litigation in the higher courts. The Tribunal is mandated to make 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.

B. INTERNATIONAL AND REGIONAL AGREEMENTS AND CONVENTIONS

39. 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)
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)

IV.

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

1. ADB's Safeguards Policy Statement (2009)[12]

41. ADB is committed to ensuring the social and environmental sustainability of the projects it supports. In this context, the goal of the Safeguards Policy Statement (2009) is to promote the sustainability of project outcomes by protecting the environment and people from projects' potential adverse impacts. The objectives of ADB's safeguards are to:

(i) avoid adverse impacts of projects on the environment and affected people, where possible;
(ii) minimize, mitigate, and/or compensate for adverse project impacts on the environment and affected people when avoidance is not possible; and
(iii) help borrowers / clients to strengthen their safeguard systems and develop the capacity to manage environmental and social risks.

V.

42. The Safeguards Policy Statement sets out the policy objectives, scope and triggers, and principles for three key safeguard areas:

(i) Environmental safeguards,

[12] *Source: ADB SPS Policy paper (June 2009) [https://www.adb.org/sites/default/files/institutional-document/32056/safeguard-policy-statement-june2009.pdf].*

(ii) Involuntary resettlement safeguards, and
(iii) Indigenous people's safeguards.

43. Policy principles of ADB's Environment Safeguards (ADB's Safeguards Policy Statement 2009) are summarized below**:**

(i) Use a screening process for each proposed project, as early as possible, to determine the appropriate extent and type of environmental assessment so that appropriate studies are undertaken commensurate with the significance of potential impacts and risks.
(ii) Conduct an environmental assessment for each proposed project to identify potential direct, indirect, cumulative, and induced impacts and risks to physical, biological, socioeconomic (including impacts on livelihood through environmental media, health and safety, vulnerable groups, and gender issues), and physical cultural resources in the context of the project's area of influence. Assess potential transboundary and global impacts, including climate change. Use strategic environmental assessment where appropriate.
(iii) Examine alternatives to the project's location, design, technology, and components and their potential environmental and social impacts and document the rationale for selecting the particular alternative proposed. Also consider the no project alternative.
(iv) Avoid, and where avoidance is not possible, minimize, mitigate, and/or offset adverse impacts and enhance positive impacts by means of environmental planning and management. Prepare an EMP that includes the proposed mitigation measures, environmental monitoring and reporting requirements, related institutional or organizational arrangements, capacity development and training measures, implementation schedule, cost estimates, and performance indicators. Key considerations for EMP preparation include mitigation of potential adverse impacts to the level of no significant harm to third parties, and the polluter pays principle.
(v) Carry out meaningful consultation with affected people and facilitate their informed participation. Ensure women's participation in consultation. Involve stakeholders, including affected people and concerned nongovernment organizations, early in the project preparation process and ensure that their views and concerns are made known to and understood by decision makers and considered. Continue consultations with stakeholders throughout project implementation as necessary to address issues related to environmental assessment. Establish a grievance redress mechanism to receive and facilitate resolution of the affected people's concerns and grievances regarding the project's environmental performance.
(vi) Disclose a draft environmental assessment (including the EMP) in a timely manner, before project appraisal, in an accessible place and in a form and language(s) understandable to affected people and other stakeholders. Disclose the final environmental assessment, and its updates if any, to affected people and other stakeholders.
(vii) Implement the EMP and monitor its effectiveness. Document monitoring results, including the development and implementation of corrective actions, and disclose monitoring reports.
(viii) Do not implement project activities in areas of critical habitats, unless (i) there are no measurable adverse impacts on the critical habitat that could impair its ability to function, (ii) there is no reduction in the population of any recognized endangered or critically endangered species, and (iii) any lesser impacts are mitigated. If a project is located within a legally protected area, implement additional programs to promote and enhance the conservation aims of the protected area. In an area of natural habitats, there must be no significant conversion or degradation, unless (i) alternatives are not available, (ii) the overall benefits from the project substantially outweigh the environmental costs, and (iii) any conversion or degradation is appropriately mitigated. Use a precautionary approach to the use, development, and management of

renewable natural resources.

(ix) Apply pollution prevention and control technologies and practices consistent with international good practices as reflected in internationally recognized standards such as the World Bank Group's Environmental, Health and Safety Guidelines. Adopt cleaner production processes and good energy efficiency practices. Avoid pollution, or, when avoidance is not possible, minimize or control the intensity or load of pollutant emissions and discharges, including direct and indirect greenhouse gases emissions, waste generation, and release of hazardous materials from their production, transportation, handling, and storage. Avoid the use of hazardous materials subject to international bans or phase-outs. Purchase, use, and manage pesticides based on integrated pest management approaches and reduce reliance on synthetic chemical pesticides.

(x) Provide workers with safe and healthy working conditions and prevent accidents, injuries, and disease. Establish preventive and emergency preparedness and response measures to avoid, and where avoidance is not possible, to minimize, adverse impacts and risks to the health and safety of local communities.

(xi) Conserve physical cultural resources and avoid destroying or damaging them by using field-based surveys that employ qualified and experienced experts during environmental assessment. Provide for the use of "chance find" procedures that include a pre-approved management and conservation approach for materials that may be discovered during project construction.

44. The Safeguards Policy Statement requires assessment, mitigation and commitment towards environmental protection, and the extent of assessment depends on the category of the project. The Safeguards Policy Standard classifies a project depending on following three categories.

(i) **Category A**: A proposed project is classified as category A if it is likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented. These impacts may affect an area larger than the sites or facilities subject to physical works. An environmental impact assessment is required.

(ii) **Category B**: A proposed project is classified as category B if its potential adverse environmental impacts are less adverse than those of category A projects. These impacts are site-specific, none or very few of them are irreversible, and in most cases mitigation measures can be designed more readily than for category A projects. An IEE is required.

(iii) **Category C**: A proposed project is classified as category C if it is likely to have minimal or no adverse environmental impacts. No environmental assessment is required although environmental implications need to be reviewed.

45. The project has been evaluated considering the above, and overall the NMRP Phase II project is expected to generate positive environmental and socio-economic benefits in terms of decreasing air pollution from traffic congestion and serving the growing travel demand. The lines proposed under the Project for ADB financing neither passes through nor are located close to any other environmentally sensitive or protected areas. Majority of the negative environmental impacts are anticipated during construction phase of the project owing to the permanent and/or irreversible change in land use, dust generated due to excavation, fugitive emissions, and impacts due to noise and vibration due to operation of heavy machinery. The key long-term environmental impact anticipated is noise and vibration from the operation of the rolling stock. However, given the existing noisy conditions of the project area due to heavy road traffic, the incremental impacts are expected to be minimal. Some occupational health and safety impacts may also be experienced during installation and operation of the rolling stock and signalling & telecommunication systems. However, these are also expected to be minor and easily mitigated. Category A was assigned to NMRP Phase II due to the significant impacts anticipated during construction phase.

46. Pursuant to ADB's Safeguard Policy Statement (2009), ADB funds may not be applied to the activities described on the ADB Prohibited Investment Activities List (PIAL) set forth at Appendix 5 of the Safeguard Policy Statement. None of the activities included in the PIAL list will be financed under the project. None of these activities are being followed in the NMRP Phase II project.

2. Requirements of EIA study as per EIB EHS (Feb 2022)[13]

47. This section discusses the processes and contents of the EIA which ensure that the assessment meets requirements of EIB's Environmental and Social Standards, pertaining to the proposed NMRP Phase II project. EIB's Environmental and Social Standards (updated in February 2022).

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

48. 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.

49. 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.

50. 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.

51. 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

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

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; and (iii) the preparation of an ESIA report and an environmental and social management plan (ESMP). Engagement with the project stakeholders21 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 EIA 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 EIA 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 EIA 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

52. This Standard recognises the importance of stakeholder engagement, as a means to ensure respect for the rights to[14]: (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.

53. 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;

[14] *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.*

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

54. 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.

55. 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.

56. Public participation in environmental decision-making processes is not limited to the requirements of the EU EIA 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.

57. 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

58. 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.

59. 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.

60. 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

61. 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.

62. 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.

63. 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.

64. 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

65. 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.

66. This Standard promotes the alignment of projects supported by the EIB with the goals and principles of: (i) the Paris Agreement[15] 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).

[15] *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.*

67. 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 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 1.5o 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.

68. 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.

69. 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".

1) 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:

(i) 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;

(ii) 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;

(iii) 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.

70. For all projects listed in Annex I and Annex II of the EIA (Environmental Impact Assessment) Directive, in respect of which the relevant competent authorities have concluded that an EIA 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 EIA report.

(f) Standard 6: Involuntary Resettlement

71. 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.

72. Since there is no involuntary resettlement involved in the NMRP Phase II project, this Standard shall not be applicable.

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

73. 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.

74. 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.

75. 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.

76. 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

77. 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.

78. 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.

79. 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[16], are determined during the EIA/ESIA process (as outlined in Standard 1).

80. 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).

81. Some of the specific requirements of this Standard relevant to the NMRP Phase II 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

[16] *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].*

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 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.

82. 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

83. 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.

84. 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).

85. 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.

86. 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[17].

(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.

87. 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 that project workers get medical benefits and employment injury benefits (including for occupational diseases). The promoter shall require

[17] *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.*

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

88. 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.

89. 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.

90. 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.

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

(i) Tangible cultural heritage[18] refers to monuments (Architectural works, works of monumental 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[19] 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.

92. This Standard applies also to natural heritage[20] recognised by the local communities

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

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

[20] *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).*

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.

93. 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.

94. 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.

95. 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.

96. 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.

97. 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;
(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.

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

(i) **Stakeholder engagement.** The promoter shall carry out meaningful consultation with and provide timely and adequate information to affected communities who use or have used the cultural heritage within living memory

for longstanding cultural purposes, with due attention to intangible cultural heritage. Consultation shall be carried out to identify cultural heritage of importance and incorporate the views of the affected communities on such cultural heritage into the project design, while assessing risks and impacts, applying the mitigation hierarchy and identifying opportunities for potential benefit-sharing arrangements with the community. Consultation shall also involve other relevant stakeholders, including national or local regulatory authorities entrusted with the protection of tangible and/or intangible cultural heritage. The engagement process shall be carried out and documented in line with the requirements of Standard 2 and in line with the requirements of Standard 7 in case vulnerable groups or Indigenous People are likely to be affected.

(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.

99. 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.

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

3. International Finance Corporation Performance Standards on Environmental & Social Sustainability

101. 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

102. 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) UK EA Soil Guideline Values cover hydrocarbons and toxic metals;
(ii) environmental clearance Regulations 1881/2006, 629/2008 and 835/2011 cover toxic metals, nitrates, Persistent Organic Pollutants (POPs) and Polycyclic Aromatic Hydrocarbons (PAHs); and
(iii) 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 (ADB)

(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)

III. PROJECT DESCRIPTION

A. RATIONALE

103. 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[21]. By 2030, Indian cities are projected to be home to another 250 million people[22]. The metropolitan areas are facing extremely high population densities and traffic congestion.

104. 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.

105. Nagpur is the third largest city of Maharashtra and also the winter capital of the state with a population of approximately 2,5 million. Nagpur Metropolitan Area (NMA) is the 13th largest urban conglomeration in India. It has also recently been ranked as the cleanest city and the second greenest city of India. In addition to being the seat of annual winter session of Maharashtra state assembly "Vidhan Sabha", Nagpur is also a major commercial and political center of the Vidarbha region. Rapid urbanization and intense commercial developments in recent past have resulted in steep rise in travel demand putting Nagpur's transport infrastructure to stress. To relieve this stress MRTs system i.e. Nagpur Metro Phase-1 is already under operation.

106. The existing Public Transport system of the city is quite robust, yet inadequate in meeting the transport demand of the commuters. With a view of developing effective and efficient mass transit system in addition to the existing public transportation, the NMRCL, Maha Metro (Maharashtra Metro Rail Corporation Ltd.) intends to develop the proposed Nagpur Metro Rail Project–Phase 2 (NMRP-P2).

107. NMRCL, Maha Metro is a Special Purpose Vehicle (SPV) created for the smooth implementation and operations of the Nagpur Metro Rail Project and is an equal equity joint venture of Government of India (GoI) & Government of Maharashtra (GoM). NMRCL shall be solely responsible for the successful and timely completion of the project & its operations subsequently. Nagpur Metro Rail Corporation Limited is Incorporated by Govt. of India-Ministry of Corporate affairs on 18 February 2015.

B. DESCRIPTION OF NMRP PHASE II PROJECT[23]

108. Two corridors were finalized for implementation of Nagpur Metro Rail Project (NMRP). Phase I of the NMRP consisted two corridors – the North-South corridor (Automotive Square to MIHAN) and the East-West corridor (Prajapati Nagar to Lokmanya Nagar) as explained earlier. having North-South and East-West Corridors. Phase II of NMRP comprises extension of both these corridors, which will provide connectivity to all congested, important and densely populated areas of the city. Details about the length of corridors and number of stations is given in **Table 3-1**.

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

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

[23] *Source: Nagpur Metro Rail Project Phase II (NMRP-P2) Detailed Project Report (DPR), November 2019.*

Table 3-1: Details of Nagpur Metro Rail Project - Phase 2 Corridors

Corridor	Line / Alignment	Description	Length (km)	Stations
North-South	Reach 1A	MIHAN to MIDC ESR	18.77	10
	Reach 2A	Automotive Square - Kanhan river	12.93	12
East-West	Reach 3A	Lokmanya Nagar - Hingna	6.66	7
	Reach 4A	Prajapati Nagar (Pardi) - Transport Nagar	5.44	3
Total			**43.80**	**32**

109. Geotechnical investigations were carried out along the proposed Phase II alignments, to determine the required strength characteristics of the underlying soil and/or rock strata for designing foundations of the proposed structures. A total of 50 bore holes were drilled for 30 m depth each, all along the proposed NMRP Phase II corridors. 22 bore holes were drilled along Reach-1A (MIHAN–MIDC ESR), 13 were drilled along Corridor-2A (Automotive Square–Kanhan River), 9 along Corridor-3A (Lokmanya Nagar–Hingna) and 6 along Corridor-4A (Prajapati Nagar to Transport Nagar). More boreholes will be drilled as necessary for detailed design.

110. Detailed Topographical Surveys were also conducted, for all the NMRP Phase II corridors using modern surveying instruments, based on differential GPS.

(a) Reach 1A (MIHAN to MIDC ESR)

111. The proposed alignment of Line-1A is an extension of Reach 1 of NMRP Phase I and starts from Chainage 20200m before ECO Park Station terminating near MIDC ESR at Chainage 38852m. The total length of the corridor is about 18.768 km, of which about 1.25 km is at-grade (up to Ch. 21450m) and 17.518 km is elevated.

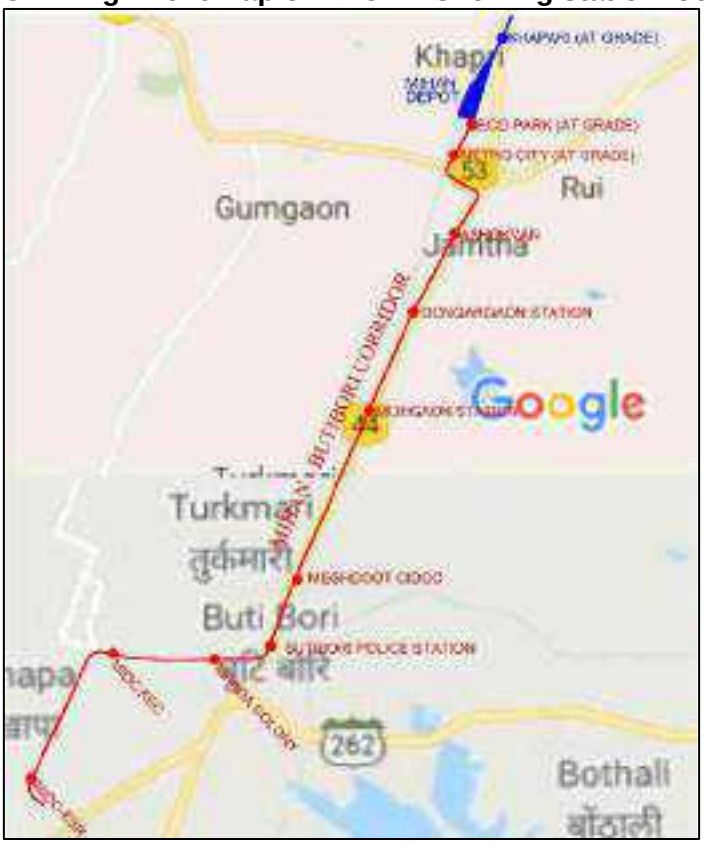
112. Total 10 stations (2 At-grade & 8 elevated) are proposed in this corridor, starting from ECO Park Station (Ch.: 20462m) and terminating at MIDC ESR Station (Ch: 38352m). Details of Line 1A are summarized as under in **Table 3-2**, while Line 1A map if presented as **Figure 3-1**.

Table 3-2: Reach-1A Stations with chainage and distance

Description	Station	Chainage (m)**	Intermediate Distance (m)
Start Point	-	20200	-
Stations	ECO Park (At Grade)	20462	262
	Metro City (At Grade)	21058	596
	Ashokwan	23843	2593
	Dongargaon	26693	2850
	Mohgaon	29878	3185
	Meghdoot CIDCO	32802	2924
	Butibori Police Station	33540	738
	MHADA Colony	34233	693
	MIDC KEC	37360	3127
	MIDC ESR	38352	992
Terminal Point		38852	500
Additional Length for Stabling Entry / Exits		-	116
Total		**18768 m**	

** For the planning convenience, the chainages are given in continuation with Phase-I North-South corridors.

Figure 3-1: Alignment Map of Line-1A showing station locations



(i) The elevated Ashokvan station is located at NH-44 and the At-grade Metro city station is an extension of old network i.e. Phase I. These stations are roughly at 90 degrees to each other. Hence, to connect the stations as well as to negotiate the new proposed ring road and railway track, introduction of strip curves is non-avoidable. Please refer to **Figure A (Annexue 2)** for details.

(ii) Alignment from MIDC KEC and MIDC ESR runs along the median of existing road leading to MIDC as the several industrial establishments located surrounding this stretch. However, it will be ensured that no construction is affected in the turning alignment after MIDC KEC. Moreover, in order to extend the metro in future from MIDC ESR towards Wardha Road (which is an existing densified area) on the east side of MIDC ESR and also, there is an Industrial development named Indorama and a residential area of Takalghat on the west side of MIDC ESR. Please refer to **Figure C (Annexue 2)**.

(b) Reach 2A (Automotive Square to Kanhan river)

113. The proposed alignment of Corridor-2A is an extension of Reach 2 of Phase 1 and starts from Chainage (-) 575m beyond Automotive Square and terminates near Kanhan River at Chainage (-) 13500. The total length of the corridor is about 12.925 Km and is completely elevated.

114. Total 12 elevated stations are proposed in this corridor, starting from Pili Nadi Station (Ch: -1409m) and terminating at Kanhan River Station (Ch: -13324m). Details of Line 2A are summarized as under in **Table 3-3**, while Line 2A map if presented as **Figure 3-2**.

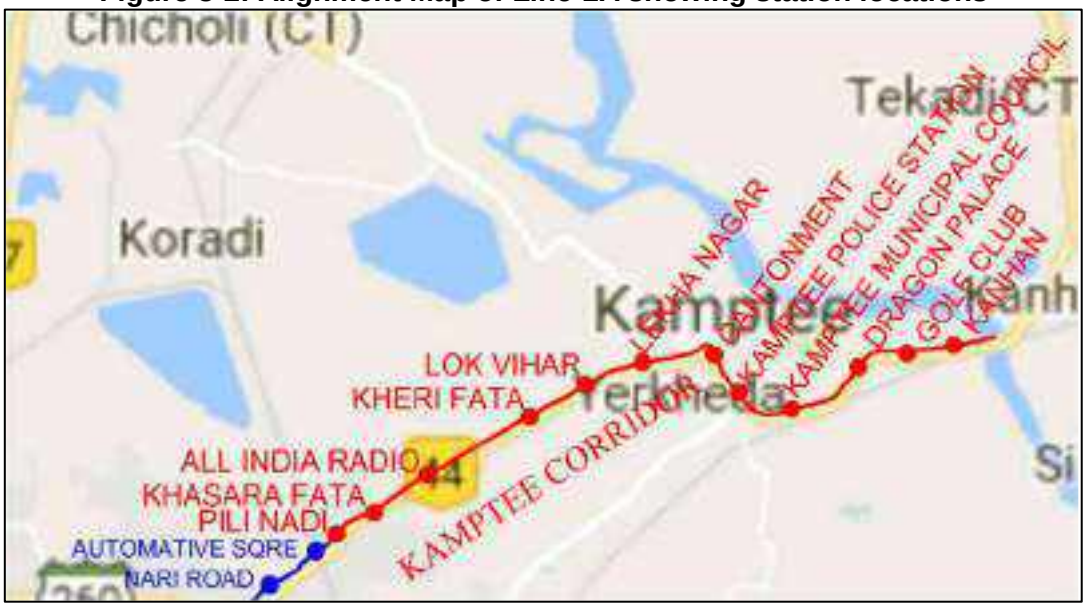
Table 3-3: Reach-2A Stations with chainage and distance

Description	Station	Chainage (m)**	Intermediate Distance (m)
Start Point	-	-575	-
Stations	Pili Nadi	-1409	834
	Khasara Fata	-2286	877

Description	Station	Chainage (m)**	Intermediate Distance (m)
	All India Radio	-3314	1028
	Khairi Fata	-5250	1936
	Lok Vihar	-6176	926
	Lekha Nagar	-7199	1023
	Cantonment	-8681	1482
	Kamptee Police Station	-9410	729
	Kamptee Municipal Council	-10225	815
	Dragon Palace	-11196	971
	Golf Club	-12468	1272
	Kanhan River	-13324	856
Terminal Point		-13500	176
Total		**12925 m**	

** *For planning convenience, the chainages are given in continuation with Phase-1 North-South corridors.*

Figure 3-2: Alignment Map of Line-2A showing station locations



(i) The existing structure towards Automotive Square station seems to be a combined road and metro structure in two layers on single column. However, this Double Decker viaduct portion (NH & Maha Metro) terminates just after Automotive Square station of NMRP Phase I (Reach 2), before the start of Phase II extension alignment. In Phase II extension, the proposed structure will consist elevated viaduct catering to loads only for NMRP metro. Required piers are already provided in the central verge of ramp after Automotive square station (Phase I). Please refer to **Figure E (Annexue 2)** for details.

(ii) The Alignment between Lekha Nagar and Kampthee Police Station passes along the road adjoining Cantonment (414 Army Batallion) where Metro station is proposed. Required consent has been obtained and the further negotiations are in progress for acquisition of land with Cantonment board. Please refer to **Figure H (Annexue 2)** for details.

(c) Reach 3A (Lokmanya Nagar to Hingna)

115. The proposed alignment of Corridor-3A is west extension of Reach 3 of Phase 1 and starts from Chainage 18218m beyond Lokmanya Nagar and terminates near Hingna at Chainage 24874.650m. The total length of the corridor is about 6.657 Km and is completely

elevated.

116. Total 7 elevated stations are proposed in this corridor, starting from Hingna Mount View Station (Ch.: 18761m) and terminating at Hingna Station (Ch.: 24504m). Details of Line 3A are summarized as under in **Table 3-4**, while Line 3A map if presented as **Figure 3-3**.

Table 3-4: Reach-3A Stations with chainage and distance

Description	Station	Chainage (m)**	Intermediate Distance (m)
Start Point	-	18218	-
Stations	Hingna Mountview	18761	543
	Rajiv Nagar	19607	846
	Wanadongri	21006	1399
	APMC	21715	709
	Raipur	22823	1108
	Hingna Bus Stand	23625	802
	Hingna	24504	879
Terminal Point		24875	371
Total		**6657 m**	

** *For the planning convenience, the chainages are given in continuation with Phase-1 East-West corridors.*

Figure 3-3: Alignment Map of Line-3A showing station locations

(i) There is a number of hotels present near the alignment, shortly after the starting point. This has been addressed in the Noise modelling analysis for the project.

(d) Reach 4A (Prajapati Nagar to Transport Nagar)

117. The proposed alignment of Corridor-4A is the extension of Reach 4 (Phase I) and starts from Chainage (-) 580m beyond Prajapati Nagar and terminates near Transport Nagar at Chainage (-) 6021m. The total length of the corridor is about 5.441 Km and is completely elevated. Total 3 elevated stations are proposed in this corridor, starting from Pardi Station (Ch: -1365m) and terminating at Transport Nagar Station (Ch: -5126m). Details of Line 4A are summarized as under in **Table 3-5**, while Line 4A map if presented as **Figure 3-4**.

Table 3-5: Alignment Description of Corridor-4A

Description	Station	Chainage (m)**	Intermediate Distance (m)
Start Point	-	-580	-
Stations	Pardi	-1365	785
	Kapsi Khurd	-3200	1835
	Transport Nagar	-5126	1926
Terminal Point		-6021	895
Total		**5441 m**	

** *For the planning convenience, the chainages are given in continuation with Phase-1 East-West corridors.*

Figure 3-4: Alignment Map of Line-4A showing station locations

1. Salient Design Features

118. The salient features of NMRP Phase II Project are summarized in **Table 3-6**.

Table 3-6: Salient Features of NMRP Phase II extension corridors

Gauge (Standard):	1435 mm
Route Lengths (Number of Stations):	Reach 1A – 18.768 km (10 stations) Reach 2A – 12.925 km (12 stations) Reach 3A – 6.657 km (7 stations) Reach 4A – 5.441 km (3 stations) Total Length = 43.80 km (32 stations)
Speed:	
Design Speed	90 kmph
Maximum Operational Speed	80 kmph
Schedule (Booked) Speed	34 kmph
Maximum Acceleration	1.0 m/s^2
Maximum Deceleration	1.1 m/s^2
Traffic Forecast: Incremental Daily Ridership due to NMRP Phase II –	

Horizon Year	Daily Passenger Trips		
	Phase I as per DPR prepared by DMRC (2013)	**Full Network (Phase I & Phase II) as per RITES Model**	**Incremental Ridership due to Phase II Extensions**
2024	2,59,892	5,16,899	2,57,007
2031	2,94,241	5,94,304	3,00,063

2041	3,66,121	7,27,213	3,61,092

Train Operation Plan:

Train Operation / Corridors	Particulars		2024	2031	2041
North-South Corridor (Reach 1A and Reach 2A)					
Kanhan River to MIDC ESR	Cars per Train		3	3	3
	Head Way (Second)		900	900	600
	Trains/hour		4	4	6
	Capacity provided	6p/m^2	3064	4596	4596
		8p/m^2	3900	5850	5850
	Max. PHPDT Demand		3246	3921	5126
Kamptee Police Station to Ashokvan	Cars per Train		3	3	3
	Head Way (Second)		360	360	327
	Trains/hour		10	10	11
	Capacity provided	6p/m^2	7660	8426	8426
		8p/m^2	9750	10725	10725
	Max. PHPDT Demand		12952	13407	15743
East-West Corridor (Reach 3A and Reach 4A)					
Transport Nagar to Hingna	Cars per Train		3	3	3
	Head Way (Second)		1200	1200	900
	Trains/hour		3	3	4
	Capacity provided	6p/m^2	2298	2298	3064
		8p/m^2	2925	2925	3900
	Max. PHPDT Demand		1063	3032	3571
Transport Nagar to Hingna Mount View	Cars per Train		3	3	3
	Head Way (Second)		450	360	240
	Trains/hour		8	10	14
	Capacity provided	6p/m^2	6128	7660	10724
		8p/m^2	7800	9750	13650
	Max. PHPDT Demand		10195	11411	16889

Rake Requirement:

Corridor	Year	Rake composition	No. of Rakes			No. of cars		
			Phase I	Phase II	Total	Phase I	Phase II	Total
North - South Corridor (Reach 1A and 2A)	2024	3-car	21	14	35	63	42	105
	2031	3-car	22	14	36	66	42	108
	2041	3-car	25	20	45	75	60	135
East West Corridor (Reach 3A and 4A)	2024	3-car	16	2	18	48	6	54
	2031	3-car	18	5	23	54	15	69
	2041	3-car	25	6	31	75	18	93

Traction Power Supply:

Traction System Voltage	25kV AC OHE
Current Collection	Overhead Current Collection System
Sources of Power Supply for Nagpur Metro Phase 1 and Phase 2	

RSS for Metro rail System		Feeding Zone
NMRP Phase I	Morris College Ground RSS near Sitabuldi Station (132/33/25 kV)	N-S Corridor (MIDC ESR to Sitabuldi Station)
New proposed RSS for NMRP Phase II	Kanhan River RSS (132/33/25 kV)	N-S Corridor (Sitabuldi to Kanhan River Station)
NMRP Phase I	Jhansi Rani RSS beside Jhansi Rani	E-W Corridor (including Phase 2

		Station (132/33/25 kV)	extension corridors)

Incremental Power Demand (MVA) due to NMRP Phase II corridors:

Corridor	Load	Year		
		2024	**2031**	**2041**
Phase 2 Extension (North - South Corridor) – Reach 1A & Reach 2A	Traction	6.21	5.75	7.84
	Auxiliary	3.85	5.13	6.42
	Total	**10.06**	**10.88**	**14.26**
Phase 2 Extension (East - West Corridor) – Reach 3A & Reach 4A	Traction	1.43	2.04	2.64
	Auxiliary	1.75	2.33	2.92
	Total	**3.18**	**4.37**	**5.56**

Rolling Stock:

Basic Unit	3 Car basic unit comprising 2 DMC and 1 TC (Every coach fully interchangeable with any other coach of same type)
Train Composition	3 Car: DMC+TC+DMC
Sitting Arrangement	Longitudinal
Coach construction	Light weight Stainless Steel/Aluminum Body
Max. Axle Load	≤ 16 T
Braking System	Regenerative Braking
Propulsion system	3 phase drive system with VVVF control
Dimensions (L×W×H)	Driving Motor Car (DMC) – 21.64 m × 2.9 m × 3.9 m Trailer Car (TC) – 21.34 m × 2.9 m × 3.9 m

Passenger Carrying Capacity:

Description	Driving Motor Car (DMC)			Trailer Car (TC)			3 Car Train		
	Normal*	**Crush****	**Dense Crush#**	**Normal***	**Crush****	**Dense Crush#**	**Normal***	**Crush****	**Dense Crush#**
Seated	43	43	43	50	50	50	136	136	136
Standing	137	205	273	147	220	293	421	630	839
Total	**180**	**248**	**316**	**197**	**270**	**343**	**557**	**766**	**975**

*Normal = 4 Per/ sq.m of standee area, **Crush = 6 Per/ sq.m of standee area, #Dense Crush = 8 Per/ sq.m of standee area.

Maintenance Depots / Facilities:

Following existing NMRP Phase I Depots shall be used for stabling, washing and inspection of rakes:

a) Maintenance Depot for N-S Corridor: MIHAN Depot
b) Maintenance Depot for E-W Corridor: Hingna Mount View Depot

Signaling, Telecommunication and Train Control:

Type of signaling	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.
Telecommunication	Integrated IPGE based System with Supervisory Control and Data Acquisition (SCADA), Close Circuit Television (CCTV), Central Voice Recording System (CVRS) etc.

Fare Collection:

Automatic Fare Collection System with the features of recharging of Travel Cards using Cash, Debit / Credit Cards and Net-banking / web portal etc.

Platform Screen Doors (PSD):

Platform Screen Doors (PSD) are proposed at stations to screen the passengers on the platform from the track. These glass doors shall be powered for automatic operation and located along the platform at the platform edge throughout the passenger area. Opening / closing of the PSD will be after receipt of command signals from the Signalling Link, which enables automatic operation of PSD only when the train stops within ±300mm limits.

2. Station and Viaduct Arrangement

119. Elevated stations with elevated concourse over the road are proposed for elevated

stretch of alignment. To keep the rail level low, it is proposed not to take viaduct through the stations. Thus, a separate structural configuration is required, with shorter spans and lower depth of superstructure.

120. The stations have been planned on the basis of following parameters:

(i) Peak hour traffic load for each station;
(ii) 3 cars train;
(iii) The total evacuation time for the movement of all passengers in an emergency from platform level to the landing at the point of safety does not exceed 4.0 minutes (as per "NFPA 130 Guidelines");
(iv) The station planning complies to the "Guidelines and space Standards for Barrier Free Built Environment for Disabled and Elderly persons" published by the Ministry of Urban Affairs and Employment India in 1998;
(v) Preferably, all stations have been planned on level stretch. There shall be no change of grade on turnouts on the track; and
(vi) Typically designed Elevated stations dimensions: 79.00m x 20.85m.

121. Typical design of Elevated Stations in NMRP Phase II has been suggested as shown in **Figure K (Annexure-2)**, which will form basis for planning of all the stations. Typically, an elevated station located on the road median of existing roads, will be 79 m long and 20.85 m wide and is a three-level structure. Passenger area on concourse is spread throughout the length of the station, with staircases leading from either side of the road. Passenger facilities as well as operational areas are provided at the concourse level. Generally, the concourse is divided into public and non-public zones. The non-public zone or the restricted zone contains station operational areas. The public zone is further divided into paid and unpaid areas. Area left over in the unpaid zone, after accommodating the passenger movement and other station facilities is earmarked for commercial utilization.

122. There are only two "At grade" stations proposed in Line 3A, typical section and plan of which is shown in **Figure L (Annexure-2).**

123. Since the stations are planned generally in the middle of the road, minimum vertical clearance of 5.50 m has been provided under the concourse. Concourse floor level is about 7.0 m above the road. Consequently, platforms are at a level of about 13.0 m from the road. To reduce physical and visual impact of the elevated station, stations have been made transparent with minimum walls on the sides.

124. Other facilities provided at the stations include:

(i) **NMV and pedestrian facilities.** Pedestrian facilities like continuous footpath of 2m wide, demarcation of pick and drop for PT/IPT, Zebra crossing at intersections, table top crossings, relocation of encroachments, strengthen of ROW have been proposed near the station influence area for ease for pedestrian movement. For non-motorized vehicles facilities like cycle tracks have been planned on the basis of land availability near the station for seamless movement.
(ii) **Accessibility for differently-abled.** The Metro Rail system has been planned user-friendly ensuring accessibility to persons with disabilities, people travelling with small children or are carrying luggage, as well as people with temporary mobility problems and the elderly persons. The standards are extracted from 'Guidelines for Pedestrian Facilities' and 'NFPA Guidelines', 'Space Standards for Barrier Free Built Environment for differently-abled and Elderly Persons' etc. Standards for differently-abled facilities within station areas have been provided for seamless movement.
(iii) **Parking at stations.** Dedicated parking provision for commuters is one of the key factors determining success of the metro system. Parking provisions along with priority to pedestrians through Foot Over Bridges and Bus feeder services have been planned to encourage more commuters to use the metro system who could safely park their vehicles at the nearest station, walk to the station

or rely on feeder connectivity. Details of parking provided for different corridors are shown in **Table 3-7**.

Table 3-7: Details of Parking For NMRP-P2 Corridors

Sr. No.	Station / Location	Parking area provided (sq. m)
Corridor-1A: MIHAN (Ashokwan) to MIDC ESR		
1.	Ashokwan	1312
2.	MIDC ESR	1155
Corridor-2A: Automotive Square to Kanhan River		
3.	Cantonment	4413
4.	Kanhan River	2200
Corridor-3A: Lokmanya Nagar (Hingna Mountview) to Hingna		
5.	Hingna Mountview	2000
6.	Hingna	614
Corridor-4A: Prajapati Nagar (Pardi) to Transport Nagar		
7.	Pardi	460
8.	Transport Nagar	1800
Total Parking Area (sq. m)		**13954**

125. The viaduct superstructure will be supported on single cast-in-place RC pier. The shape of the pier follows the flow of forces. For the standard spans, the pier gradually widens at the top to support the bearing under the box webs. Circular pier of dia. in the range of 1.5 to 1.7 m are commonly used as it occupies the minimum space at ground/road level where the alignment often follows the central verge of existing roads. To prevent the direct collision of vehicle to pier, a Jersey Shaped crash barrier of 1.0m height above existing road level has been proposed all around the pier. A gap of 25mm has been also provided in between the crash barrier and outer face of pier. The shape of upper part of pier has been so dimensioned that the required minimum clearance of 5.5m is always available on road side beyond vertical plane drawn on outer face of crash barrier. **Figure M (Annexure-2)** shows the typical structural arrangement of Metro Viaduct with Pier Arm for Supporting Platform (At Connecting Bridge) and PEB Single Decker Portion.

3. Signalling and Telecommunication

126. **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 3-8** 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 3-8: Standards Proposed to be Adopted for Signalling System

Description	Standards
CBTC System	IEEE 1474.1
Interlocking	Computer Based Interlocking (CBI) adopted for station having switches and crossing shall be Hot Standby system with object controller conforming to SIL4 level of CENELEC standards EN 50126, EN 50128 and EN 50129.
Operation of Points	With Direct current 110V D.C. point machines or 380 volts 3 phase, 50 Hz. AC point machines.
Signals at Stations with point & crossings	Line Side signals to protect the points (switches). LED type signals for increased reliability and less maintenance efforts.
Automatic Train Protection Systems (ATPS)	ATPS conforming to SIL4 level of CENELEC standards EN 50126, EN 50128 and EN 50129.
Automatic Train Supervision System (ATSS)	Movement of all trains to be logged on to a central computer and displayed on workstations in operation control centre (OCC) and at SCR. Remote control of stations from the OCC as

Description	Standards
	well as local control from the interlocked stations. ATS/ATO will conform to SIL2 level of CENELEC standards EN 50126, EN 50128 and EN 50129.
Immunity to External Interference	All data transmission on Optical Fibre Cables / Radio. All signalling cables will be separated from power cables. CENELEC standards EN50121-2&4 and EN50082-2 and EN 50081-2 as applicable for EMI/EMC.
Fail Safe Principles	SIL4 safety levels as per CENELEC standard for signal application.
Fall back system	Digital Axle Counter
Other Items	Suitable International Standards like CENELEC etc. shall be followed as per good industry practices.
Maintenance philosophy	Philosophy of continuous monitoring of system status and preventive &corrective maintenance of signalling equipment shall be followed. Card / module / sub-system level replacement shall be done in the field and repairs under taken in the central laboratory/manufacturer's premises.

127. **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

4. Power Supply and Traction

128. Nagpur Metro Phase-I corridors are planned with 25kV OHE traction system. To ensure continuity and compatibility of systems, 25kV OHE traction system is proposed for Phase-II corridors of Nagpur Metro. Since complete elevated corridor is planned for Phase II, flexible overhead equipment (OHE) will be provided. The power supply system design has been conceptualized considering 3 car rake composition and train operation at peak headway for the corridors. The ultimate (design) power requirement for these corridors is conceptualized considering following norms, directives/ guidelines:

(i) Train operation with 3-car rakes with carrying capacity of 766 passengers (standing @ 6 passengers/m² area)
(ii) Peak period headway for N-S and E-W corridors
(iii) Specific energy consumption of rolling stock – 75 KWh / 1000 GTKM
(iv) Regeneration @ 30%
(v) Elevated station load – initially 150 kW, ultimate design 250 kW
(vi) Depot auxiliary load – initially 2000 kW, ultimate design 2500 KW
(vii) Power factor of load – 0.9
(viii) Transmission losses @ 5%

129. Keeping in view of the above norms, power demand estimation for the proposed corridors of Nagpur Metro Phase I and Phase 2 is given in **Table 3-9**. Additional power demand estimation for the proposed corridors of Nagpur Metro Phase 2 is given in **Table 3-10**.

Table 3-9: Power Demand Estimation (MVA) of NMRP Phase I & Phase II Corridors

Corridor	N-S Corridor (in MVA)			E-W Corridor (in MVA)		
Year	**2024**	**2031**	**2041**	**2024**	**2031**	**2041**
Traction	14.10	14.34	17.59	8.13	9.41	12.43
Auxiliary	9.33	12.02	14.58	7.58	9.68	11.67
Total	**23.43**	**26.36**	**32.17**	**15.71**	**19.09**	**24.10**

Table 3-10: Incremental Power Demand Estimation of NMRP Phase II Corridors

Corridor	N-S Corridor (in MVA)			E-W Corridor (in MVA)		
Year	**2024**	**2031**	**2041**	**2024**	**2031**	**2041**
Traction	6.21	5.75	7.84	1.43	2.04	2.64
Auxiliary	3.85	5.13	6.42	1.75	2.33	2.92
Total	**10.06**	**10.88**	**14.26**	**3.18**	**4.37**	**5.56**

130. **Sources of power supply.** Nagpur City has 220kV, 132kV, 33kV power transmission and distribution network to cater to various types of demand in the vicinity of the proposed corridors. Two receiving substations (RSS), one for each corridor, have been planned to cater to the requirement of both the N-S and E-W corridors in Phase 1. Considering the increased power demand of corridors due inclusion of Phase 2 extension corridors, one additional RSS is required to meet the requirement. The additional RSS is proposed near Kanhan River station.

131. The RSS planned for the power requirements of the corridors of Nagpur Metro PhaseI1 and Phase II have been given in the **Table 3-11**.

Table 3-11: Sources of Power Supply for Nagpur Metro Phase 1 and Phase 2

RSS for Metro rail System		Feeding Zone
NMRP Phase 1	Morris College Ground RSS near Sitabuldi Station (132/33/25 kV)	N-S Corridor (MIDC ESR to Sitabuldi Station)
New proposed RSS for NMRP Phase 2	Kanhan River RSS (132/33/25 kV)	N-S Corridor (Sitabuldi to Kanhan River Station)
NMRP Phase 1	Jhansi Rani RSS beside Jhansi Rani Station (132/33/25 kV)	E-W Corridor (including Phase 2 extension corridors)

132. The capacity for each RSS for each corridor has been planned as 2 nos. 21.6/ 30.24 MVA Traction transformer and 2 nos. 20/ 25 MVA Auxiliary main transformer. When RSS of one corridor fails, the traction supply will be maintained by extending feed from RSS of the other corridor. This ensures the reliability of power supply arrangement. However, in case of total grid failure, all trains may come to a halt, but emergency lighting, fire, hydraulics and other essential services can be catered to by stand-by UPS/ DG sets.

133. **Auxiliary supply arrangements and standby power supply.** Auxiliary sub-stations (ASS) are envisaged to be provided at each station for stepping down 33kV supply to 415V for auxiliary applications. The ASS will be located at mezzanine or platform level inside a room. The demand of power at each elevated station is expected to be about 150 kW in the initial years and is likely to reach 250 kW in the horizon year. The average load considered for elevated station will have to be fine-tuned to suit station requirement during detailed design stage. Each elevated station has been provided with an Auxiliary Substation with two 33kV/ 415V, 3-phase, 315 kVA dry type cast resin transformers (one transformer as standby) and the associated HT & LT switchgear. In addition, provision shall be made for one DG set at each station for emergency loads.

134. **Solar energy harnessing system.** Provision of a grid connected solar photovoltaic power plant utilizing all possible areas viz. roof top of stations is proposed for Nagpur Phase 2 corridors. Based on the solar radiation intensity in the city of Nagpur, the peak solar power

generation of Nagpur Metro corridor is expected to be about 50 kWp for the elevated stations.

5. Labour Camp

135. During execution of the project, manpower will be needed for various project activities. During construction phase, about 5000 people are estimated to be employed, while in post-construction phase, about 1500 people will be employed for operation and maintenance of the system. In addition to these, more people would be indirectly employed for allied activities.

136. The workers' camps will be developed by contractors for each package work, as and where required. Alternatively, Labour camp of NMRP Phase-I may also be used for the Phase II extensions project. The accommodation, sanitation & other facilities required at camps shall be governed by Country labour laws. These clauses are part of the civil contract works and will be obligatory to the contractors.

137. 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 (detailed in **Annexure-20**):

(i) Accommodation facilities to workers
(ii) Good sanitation facilities,
(iii) Drinking water facilities,
(iv) Recreational facilities,
(v) Medical facilities (First Aid)
(vi) House keeping

138. 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.

139. Community based specific facilities for workers are as follows:

(i) HIV AIDS Policy,
(ii) Grievance Redressal procedure, and
(iii) Equality in wages

140. The above facilities will be part of the contract document and will be ensured by the Contractor. 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). In this regard, ADB cannot approve any documents from the Contractor (since ADB is not a contract partner), however ADB can provide advice to the executing agency on the matter.

141. 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.

142. 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

143. Main construction activities of the NMRP Phase II project include ground clearing, excavation and fill, transport of construction materials & C&D waste (muck), casting of concrete elements and preparation of concrete & their transportation, Pile driving, etc.

144. Construction of elevated alignment involves following type of constructions: -

(i) **Sub-structure:** Two broad categories of sub-structure i.e. Pile Foundation and Open foundation are considered for Metro Systems. For heavy / medium loads and weathered loose / soft / filled up upper strata, Pile foundation systems are proposed. This requires lesser space and time for excavation. At locations where, hard strata / rock is available close to ground level, open foundations may be adopted. Columns on Open / Pile foundations with pier cap at top of columns. Alternatively, Portal arrangement is provided at certain locations. Substructure such as open foundation, pile, pile caps, columns, station structure, earth retaining structures will be cast-in-situ.

(ii) **Superstructure:** By segmental construction of whole unit construction. Box segments are most common type of segmental construction. I-Girder and U-girder are most common type of non-segmental construction methods where the structural element for whole span length is pre-cast and launched in position. Casting yard is required for casting of precast structural segments and other precast units like U-girder, I-Girder etc. The construction yard has arrangement for casting beds, curing and stacking area, batching plant with storage facilities for aggregates and cement, site testing laboratories, reinforcement steel yard and fabrication yard etc. An area of about 2.5 Ha to 3 Ha is required for each construction yard.

145. **Construction of elevated stations.** Elevated stations over the road are proposed for elevated stretches of all four alignments, except the two At Grade stations in the start of Line 3A. Sub-structure for the elevated station portion will also be similar to that of viaduct and will be carried out in the same manner. To reduce physical and visual impact of the elevated station, stations have been made transparent with minimum walls on the sides.

146. **Pre-engineering building.** The stations are provided with roofing supported by pre-engineering building **(**PEB) structures which is fabricated in workshop and erected component-wise. The PEB structures allows for different shapes & sizes to be erected on which the roofing is normally of steel / polycarbonate sheet. The PEB structures also supports the system requirement such as OHE & Solar panels etc.

147. **General construction work practice.** As all the alignments are passing over existing road network, the construction work will be executed mainly on the road. The construction work will be carried out within a width of 4.5 meter either side from the road median and enclosures of 2-meter height barricades shall be provided on both sides. The temporary / short term impact anticipated during construction work includes dust formation, emissions from construction vehicles and noise due to construction activities. Implementation of efficient environment and social management plan (ESMP) at site will control the pollution to the maximum extent possible. The workers' camp will be located outside the urban area mostly at / near the Casting Yard locations and will be in purview of environmental monitoring.

148. During construction of the project, workers shall be engaged by the contractors. The accommodation, sanitation & other facilities required at camps shall be governed by Country labour laws. These clauses are part of the civil contract works and will be obligatory to the contractors. The contractors have to provide a plan with yard layout including sewage and drainage systems, access roads, first aid facilities, etc., to be approved by Maha Metro before

establishment.

149. **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

150. 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 3-5** and **Figure 3-6** respectively.

Figure 3-5: Typical Traffic Diversion Plan - One Way

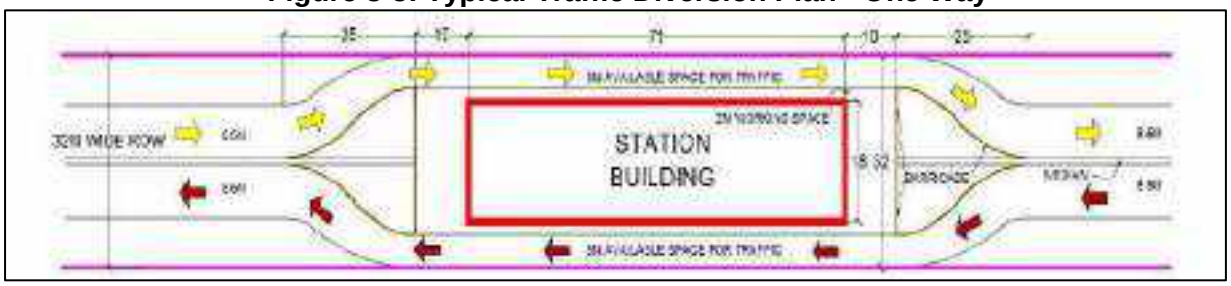
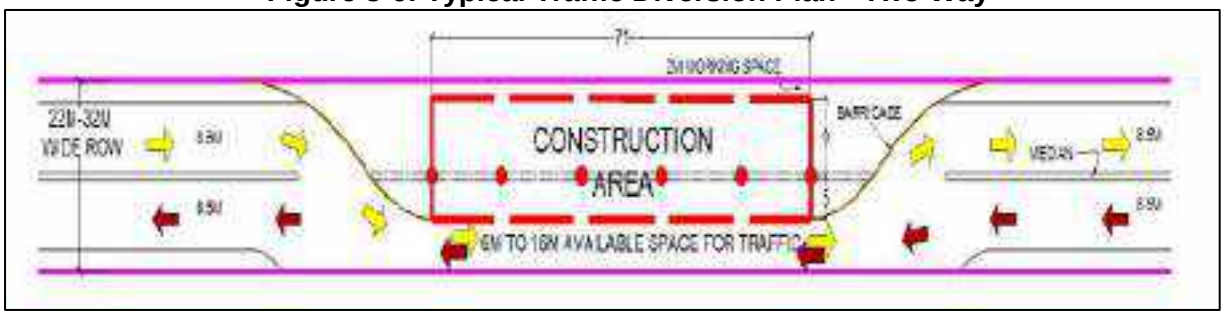


Figure 3-6: Typical Traffic Diversion Plan - Two Way



151. In order to retain satisfactory levels of traffic flow during the construction period; following measures must be taken by the contractors:

(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) The primary traffic control devices used in work zones shall include signs, delineators, barricades, cones, pylons, pavement markings and flashing lights.
(v) Deployment of traffic marshals at all traffic diversion locations

152. **Location of quarries.** Metro construction is a material intensive project. However, quarry operations are independently regulated activity and beyond the purview of the project proponent. Construction materials viz. aggregates (fine & course), cement, reinforcement & structural steel, etc. are required to be arranged by the prospective contractors. These materials are available in abundance within close proximity of Nagpur. Project estimates have been prepared looking into their availability in nearby locations. Contractor is obliged to procure construction materials from approved quarries only. The contractor shall submit the requisite test certificates of materials well in advance before commencement of work. In case, material from any source is found to be unacceptable, it shall be rejected by the Engineer and the contractor shall forthwith remove the material immediately from the site as directed by the Engineer. A summary of approximate construction material required for NMRP Phase-II corridors is given in **Table 3-12**. The location of Material sources such as

course & fine aggregates available near Nagpur city are shown in **Figure 3-7** and distance from sources to Casting Yards are given in the **Table 3-13**.

Table 3-12: Construction Material Requirement for NMRP Phase II Project

Materials	Unit	Total Quantity
Cement	MT	3,570,387
Aggregates	MT	7,140,774
Sand	MT	5,355,580
Fly Ash	MT	40,312
Reinforcement	MT	2,028,628

Table 3-13: Distance of Material Sources to Casting Yards

Sr. No.	Casting Yard	Coarse Aggregate		Fine Aggregate/Sand	
		Source (Quarry)	Distance (km)	Source	Distance (km)
1	Jamtha -R-1	Pachgaon	23	Kanhan River	38
2	Asoli R-4	Pachgaon	17	Kanhan River	17
3	Khairy R-2	Pachgaon	32	Kanhan River	15
4	Nagalwadi R-3	Pachgaon & Mohgaon	37 & 14	Kanhan River	38
5	Mondha R-3	Pachgaon & Mohgaon	33 & 11	Kanhan River	43

153. The sand from Kanhan River is considered to be of high quality as far as the construction of buildings is concerned. Sand will only be procured from Authorised Sand vendors with valid certification, as required[24]. The cement & reinforcement will be procured from local authorized dealers. The source of cement manufacturer for the metro project is Ultratech and ACC. Their manufacturing units are located at Chandrapur district which is 170 km from Nagpur. Similarly, the reinforced steel and structural steel will be procured from Bhilai steel plant located about 265 km from Nagpur. Nagpur, being the centre of India, is well connected with railways as well as roadways for bulk carriage of these materials from their sources.

154. The sources of construction materials are available in ample way in the vicinity of Nagpur 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.

155. **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. NMRP Phase-II is basically an extension of Phase-I. Its terminals are located in NMRDA region having several pockets of non-agriculture / vacant land. In addition of above, option of utilization of existing casting yards especially constructed for NMRP Phase I shall be preferred. The location of casting yards used by the NMRP Phase-I in all the Reaches is shown in**Figure 3-7**.

156. Contractors can use the same casting yards or may establish an alternate casting yard of their choice, on approval by Maha Metro. 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/ADB for review as per ADB SPS requirements for existing facilities. As on May 2024, location of 1 casting yard proposed for Reach 2A is finalised. Details of the same are furnished in Annexure-20 of this EIA-EMP report.

[24] *Permission for Sand Mining from riverbed to be obtained from State Mining Department (GoM) shall be a prerequisite while finalising Authorised Sand vendors during construction of Phase II. Contractor shall ensure that this permission / NOC and its implementation status is included in the Monthly Environment Report, shall be the responsibility of the Contractor engaged by Maha Metro / GC.*

157. 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 a 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.

Figure 3-7: Locations of NMRP Phase I Casting Yards

D. IMPLEMENTATION PLAN & CONSTRUCTION SCHEDULE[25]

1. Project Implementation Plan

158. 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 3-14**.

Table 3-14: Proposed Project Implementation Plan

S. No.	Tasks	Timelines	Status (May 2024)
1	First Detailed Project Report (DPR) Final Approved DPR	July, 2018 November, 2019	Completed
2	State Government Approval of DPR	January, 2019	Completed
3	Final Approval by GoI	December, 2022	Completed
4	Appointment of DDC for Civil Works	August, 2023	Completed
5	Packaging and Invitation of Bids	February, 2023	In Process
6	Appointment of General Consultants	-	Completed

[25] *Source: Nagpur Metro Rail Project Phase II (NMRP-P2) Detailed Project Report (DPR), November 2019.*

7	Commencement of Civil Works	October, 2023	In Process
8	Commencement of Operation	October, 2027	After completion of Construction

2. Implementation Structure

159. Maharashtra has a successful example of metro operation in Mumbai on SPV model by Mumbai Metro Rail Corporation Limited (MMRCL). Nagpur Metro Rail Phase-I project is also implemented on SPV model by Maha Metro, and is currently in operation. Similarly, Nagpur Metro Phase II project may also be implemented on SPV model. However, some subcomponents of operations & maintenance may be taken up with private sector participation (PPP) model. The PPP model to be adopted and implementation structure shall be decided at the time of implementation.

E. DETAILED PROJECT COST ESTIMATE

160. **Capital cost estimate.** Cost estimate for Nagpur Metro corridors has been prepared covering civil, electrical, signalling and telecommunications works, rolling stock, environmental protection, rehaSSabilitation, etc. at February 2019 price level is presented in **Table 3-15**. Cost Estimate has been updated based on the rates for individual components as per Benchmarking of Cost Estimates for Metro Rail Projects by MoHUA published in February 2019. Basic cost is exclusive of taxes and duties. i.e. GST and Custom duty. Taxes and duties mainly comprising of latest prevalent GST & Custom duty are worked out for each corridor. Public procurement order-2017, issued by Department of Industrial Policy on minimum Indian component in Procurement in Metro Rail systems have also been taken into consideration.

Table 3-15: Summary of Detailed Cost Estimates for NMRP-P2 Project

Sr. No.	Item	February 2019 Price Level (₹ in Crore)				Total
		Corridor 1A	Corridor 2A	Corridor 3A	Corridor 4A	
1.	Land	72.27	25.69	26.63	17.25	**141.84**
2.	Alignment and Formation	684.37	493.88	259.19	218.64	**1656.07**
3.	Station Buildings incl. Civil works, EM works, ECS, TVS, Lift, escalators etc.	262.80	320.56	188.66	83.14	**855.16**
4.	Depot including civil, EM, Machinery & plants, general works & OCC building	70.00	32.00	65.00	16.00	**183.00**
5.	P-Way for main line, depot and depot connectivity	136.76	85.80	51.93	37.10	**311.59**
6.	Traction & power supply for main line and depot incl. OHE, ASS, GIS etc.	146.07	138.00	54.03	42.16	**380.26**
7.	Signalling and Telecommunication	165.05	136.35	73.28	50.09	**424.78**
8a.	Environmental works	4.50	3.50	2.06	1.70	**11.76**
8b.	R & R incl. Hutments etc.	2.00	2.00	5.00	2.00	**11.00**
9.	Misc. Utilities, road works, Topographic Surveys, Geotechnical Investigation, Barricading, Tree Cutting and replanting, other civil works such as signage's,	110.71	78.00	39.94	33.73	**262.38**

Sr. No.	Item	February 2019 Price Level (₹ in Crore)				Total
		Corridor 1A	Corridor 2A	Corridor 3A	Corridor 4A	
	Environmental protection and traffic management					
10.	Capital Expenditure on Security including civil and EM works	3.70	4.44	2.59	1.11	**11.84**
11.	Staff Quarters and buildings including civil, electrical works	30.08	21.19	10.85	9.16	**71.28**
12.	Rolling Stock	96.00	240.00	24.00	24.00	**384.00**
13.	Capital Expenditure on Inter modal integration including Footpath for pedestrians	30.00	36.00	21.00	9.00	**96.00**
14.	Total of all items except Land and R&R	1740.04	1589.72	792.53	525.82	**4648.12**
15.	General Charges incl. Design charges, (Civil+EM works) @ 5% on all items except land and R&R.	87.00	79.49	39.63	26.29	**232.41**
16.	Total of all items including G. Charges	1827.04	1669.20	832.16	552.11	**4880.52**
17.	Contingencies @ 3% on all items except land and R&R	54.81	50.08	24.96	16.56	**146.42**
Gross Total including Contingencies (excluding Land and R&R Cost)		**1881.85**	**1719.28**	**857.13**	**568.68**	**5026.94**
Gross Total including Contingencies (including Land and R&R Cost)		**1956.13**	**1746.97**	**888.76**	**587.93**	**5179.78**
Central Taxes & Duties		132.21	126.01	58.82	39.45	**356.49**
State Taxes & Duties		118.39	110.26	53.36	35.58	**317.60**
Total Cost including Taxes & Duties		**2206.73**	**1938.24**	**1000.94**	**662.96**	**5853.87**

F. EXISTING FACILITIES[26]

161. The **double decker section[27] near Pardi station in Reach 4A** is considered as an

[26] Environmental Audit: ADB sometimes enters into a project with facilities that already exist or are underconstruction. These facilities may have been constructed or started to be built without adequate safeguard measures. Projects that will use existing facilities or where construction has commenced require an environment compliance audit to determine whether the facilities are in accordance with ADB safeguard principles and requirements for borrowers/clients. Where noncompliance is identified, a corrective action plan will be prepared by the borrower/client and concurred by ADB. The plan will define remedial actions, the budget for these actions, and timeframe for achieving compliance. ADB understands that some existing facilities are difficult to dismantle for the sake of compliance. In such situations, compliance with national standards, even if less stringent than ADB's environment safeguards, is acceptable. Deviations from the general procedure are documented in the plan. The environmental audit and, if necessary, the corrective action plan is required prior to Board approval of the project.

[27] Maha metro has been explained about the Environmental Audit for the existing facility and the process fr conducting the study has been initiated. This will be added as an addendum to the EIA report once completed.

existing facility. The total length of Reach 4A is 5.44 km of which around 1.95 km consists of existing flyover of NH-53. This section starts from the NMRP Phase I Metro station of Projapati Nagar and continues for around 1.95 km along the proposed Reach 4A aligment. However, this is already built-up section and no additional construction is ongoing or proposed, since provision of the Metro piers was done during costruction of the flyover. Beyond the 1.95 km section, metro rail viaduct will continue as a single elevated track. The elevation of this track will be around 14.5 m above GL, which is higher than the existing flyover. This existing facility currently caters to heavy goods / freight traffic which reduces the road congestion in the area and reduces the traffic stress on the existing highway towards Bhandara city.

G. ASSOCIATED FACILITIES

162. Associated facilities[28] are those that are not included or funded by the Project but are:

(i) directly and materially related to the Project;
(ii) carried out or planned to be carried out, contemporaneously with the Project;
(iii) whose viability and existence depend exclusively on the project and;
(iv) whose goods and services are essential for successful operation of the project and would not be constructed or expanded if the Project did not exist.

163. The NMRP Phase I[29], which is already under operation, constitutes one of the main Associated Facilities to this project. Many of the components of NMRP Phase I including the two maintenance depots at Hingna Mount View and MIHAN, are planned on being used for the Phase II project.

164. **Maintenance depots.** It has been planned to use the already existing NMRP Phase I depots at MIHAN (for the NS corridor) and at Hingna Mount View (for the EW corridor) for the proposed Phase II project. 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 MIHAN Depot and those at Hingna Depot are respectively summarized in **Table 3-16** and **Table 3-17**.

Table 3-16: Infrastructure Facilities: MIHAN Depot

Facility	NMRP Phase I (Existing)	NMRP Phase II (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 3-17: Infrastructure Facilities: Hingna Depot

Facility	NMRP Phase I (Existing)	NMRP Phase II (Proposed)

[28] As per ADB Safeguard Policy Statement, 2009 Associated facilities not funded by the project but whose existence and viability are entirely dependent on the project and whose services are essential to project operation. Examples of associated facilities are a transmission line constructed by government for the sole purpose of connecting an ADB-supported hydropower project to the existing electricity grid, and a gas pipeline installed by the gas supplier to supply an ADB-supported thermal power plant. Even though the impacts and mitigation measures from the development of associated facilities donot have to be analyzed in detail in the EIA/IEE of the project financed by ADB, basic information about the main design features, their location, the significance of potential impacts, the required approval process, and institutional arrangements should be described in the EIA/IEE. ADB reviews these facilities as part of its due diligence to determine if the associated level of impacts and risks to the environment and people is acceptable, recognizing that the borrower/client should address these impacts and risks in a manner that is commensurate to the borrower/client's control and influence over the associated facilities.

*[29] EIA of Nagpur Metro Phase I-(**Annexure 17**).*

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	

165. As per EIA notification (2006) Section 8(a), prior Environmental Clearance is not required for Metro rail projects. However, as per MoEF&CC letter (attached as Annexure - 19) 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. Since none of the stations in NMRP Phase II exceed 20000 sq. m built up area, hence the condition is not applicable. Also construction built-up areas of both MIHAN & Hingna Depots of NMRP have area less than 20000 sq.m. hence no environmental clearance is required for either depots. Moreover, under Air & Water Act (1954), Consent to Establish (CtE) and Consent to Operate (CtO) have already been acquired for both the Depots.

166. The construction and operation of Nagpur Metro Phase II corridors 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.

167. Nagpur City has 220kV, 132kV, 33kV power transmission and distribution network to cater for various types of demand in the vicinity of the proposed corridors. Nagpur Metro Phase I corridors are planned with 25kV OHE traction system. To ensure continuity and compatibility of systems, 25kV OHE traction system is proposed for Phase 2 corridors of Nagpur Metro. Two Receiving Sub Stations (RSS) (one RSS for each corridor) have already been planned to cater to the requirement of both the N-S and E-W corridors in Phase 1. Considering the increase in power demand of corridors due inclusion of Phase 2 extension corridors, one additional RSS is required to meet the requirement. The additional RSS is proposed near Kanhan River station. Discussions are being held with M/s MSETCL to confirm the availability of Input Power Supply Source for the proposed RSS near Kanhan River station. Kanhan Grid Substation (GSS) has been identified near the corridor alignment for receiving the power at Kanhan River RSS for metro operation.

168. Each elevated station shall be provided with an Auxiliary Substation with two 33kV/415V, 3-phase, 315 kVA dry type cast resin transformers (one transformer as standby) and the associated HT & LT switchgear. In addition, provision shall be made for one DG set at each station for emergency loads.

IV. ENVIRONMENTAL BASELINE DATA

A. INTRODUCTION

170. 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.

171. 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.

172. 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

173. Two reconnaissance visits were conducted to Nagpur Metro Rail Project Phase II corridors, one from 12th to 16th April, 2023 and another from 25th to 28th April 2023. During the visits, sampling sites were identified and finalized for monitoring of environmental parameters.

174. 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 NMRP-Phase II corridors 1A, 2A, 3A & 4A along with Core and Buffer study areas around each alignment, are presented as **Figure 4-1**, **Figure 4-2**, **Figure 4-3** and **Figure 4-4** respectively.

175. As a requirement of the EIA process, primary baseline data for prominent environmental attributes like ambient air, noise, water (groundwater and surface water), soil, were collected through field monitoring conducted in April-May 2023. Data on socio-economics at the Project corridors, as well as within 'Core and Buffer Study Areas' were collected through surveys conducted in May-June 2023. Data on ecology & biodiversity (terrestrial, aquatic and riparian) was collected through the field studies during April to August 2023.

Figure 4-1: Satellite map of the NMRP-Phase II Line 1A showing Project Study area

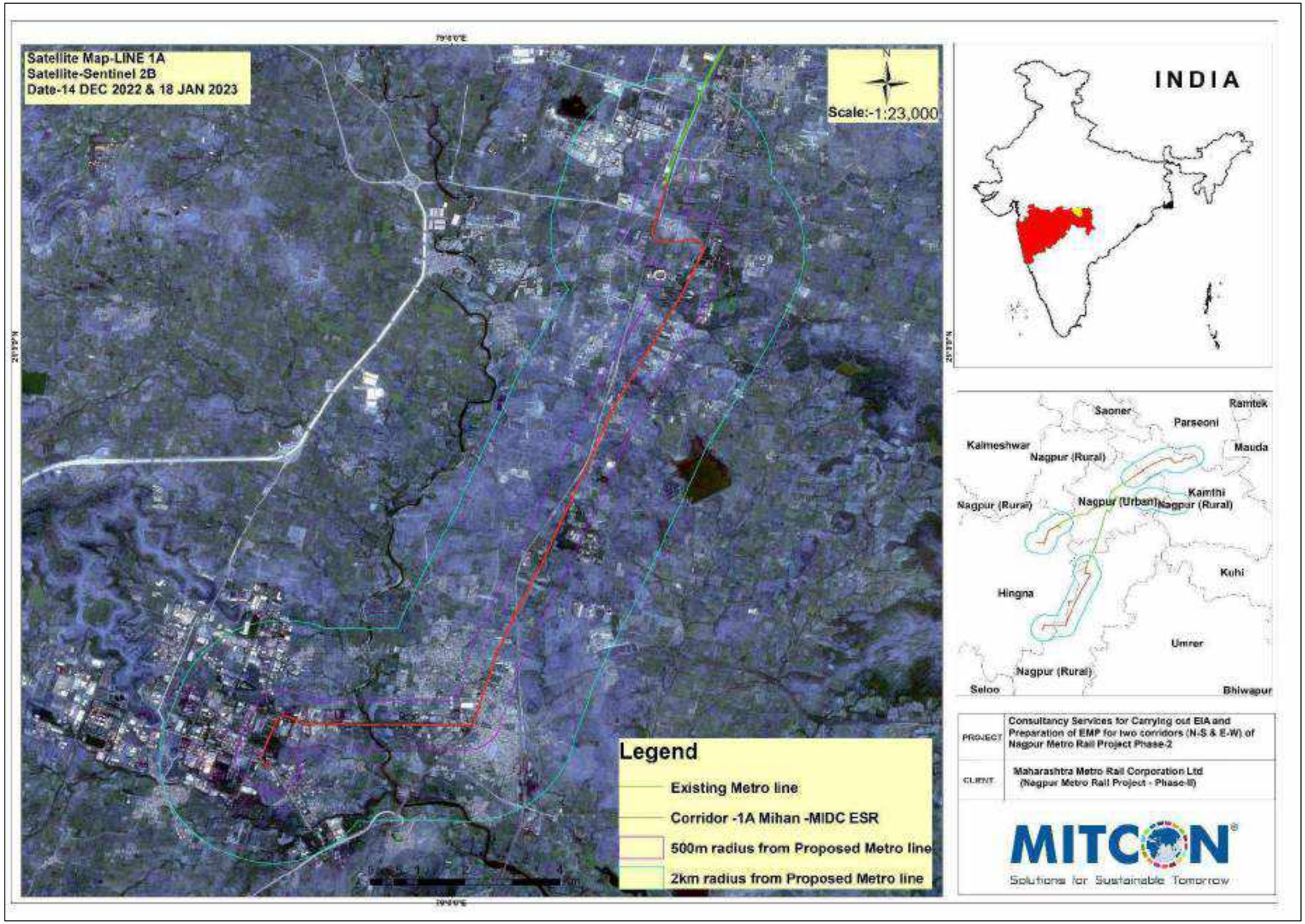


Figure 4-2: Satellite map of the NMRP-Phase II Line 2A showing Project Study area

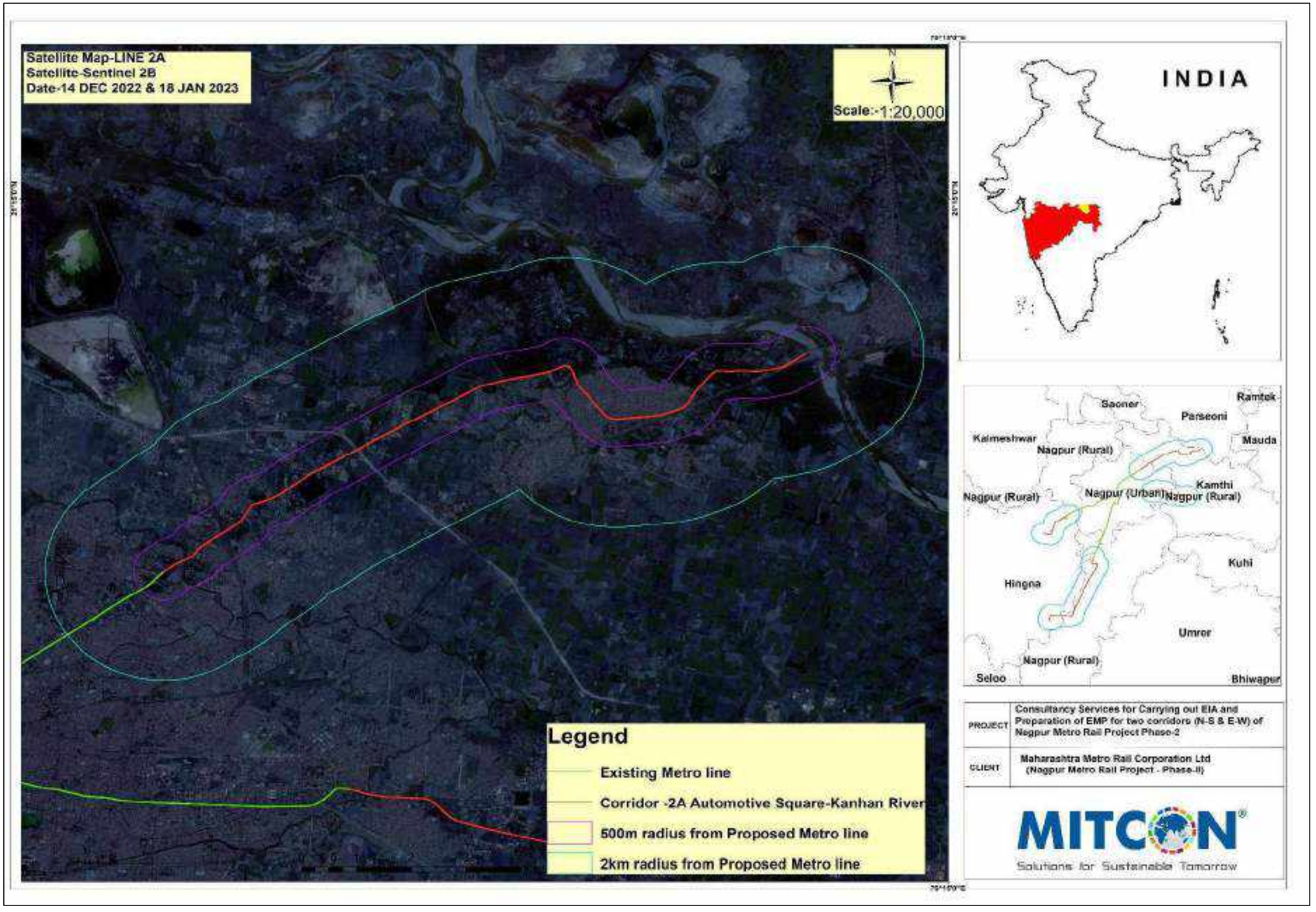


Figure 4-3: Satellite map of the NMRP-Phase II Line 3A showing Project Study area

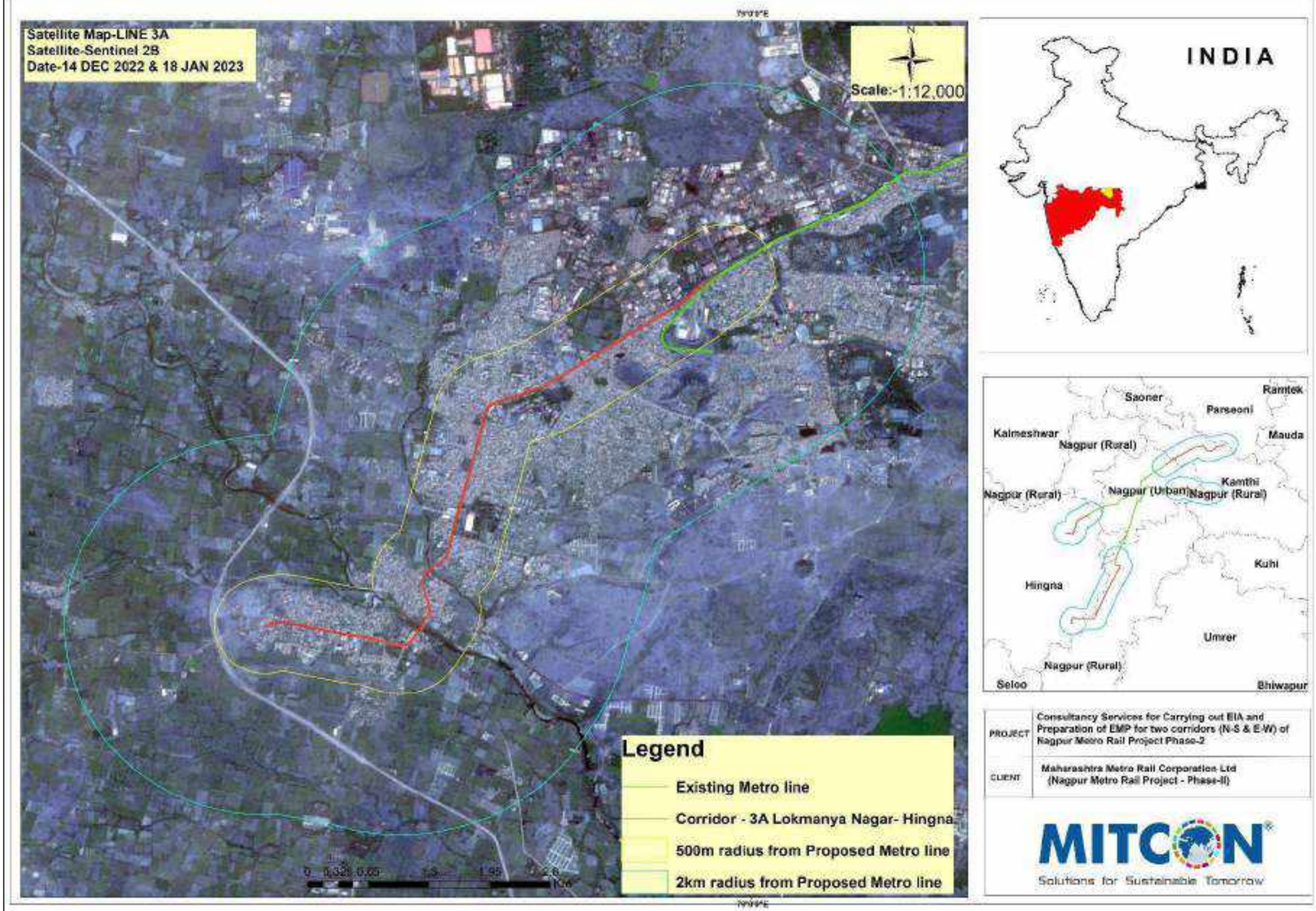
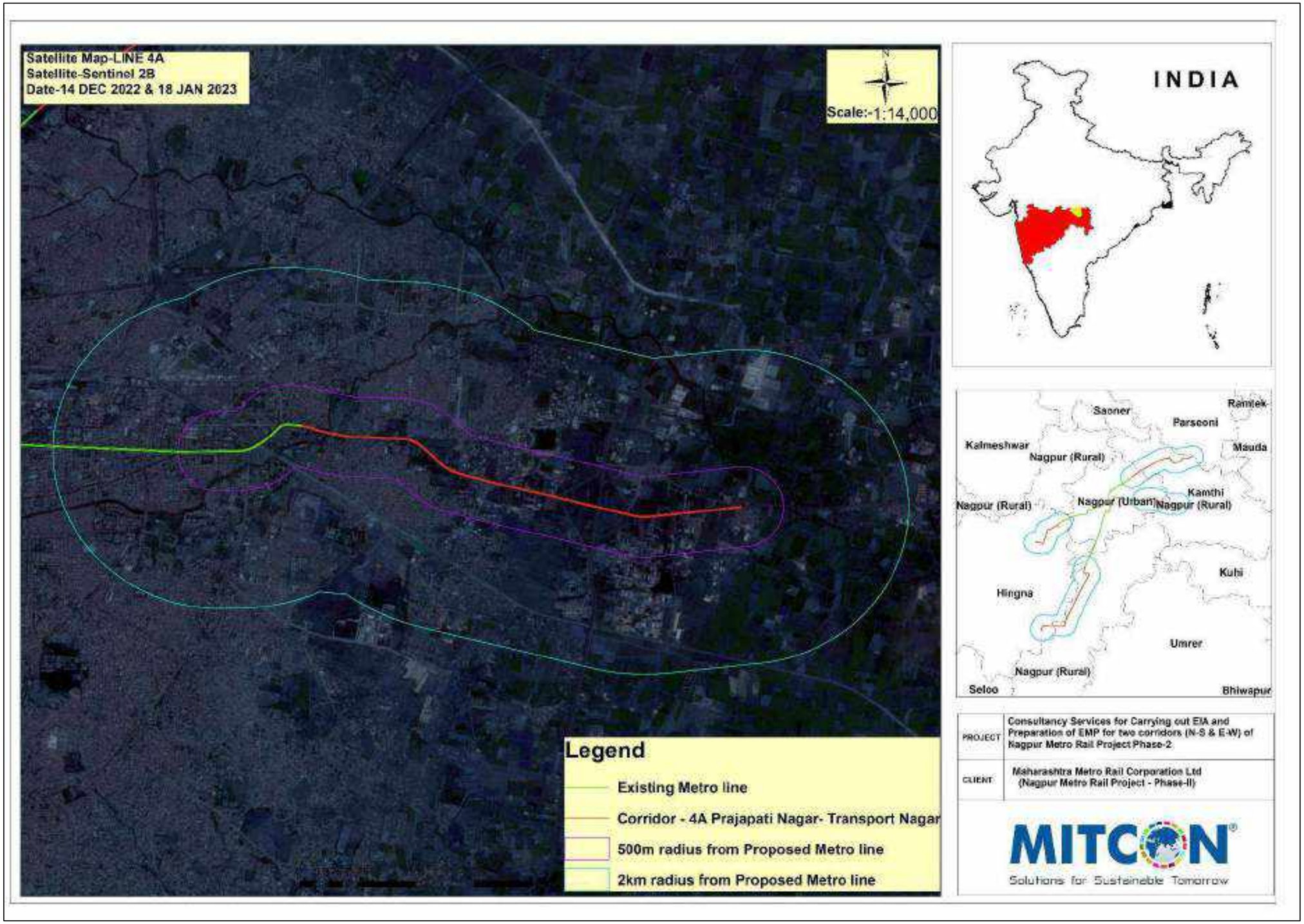


Figure 4-4: Satellite map of the NMRP-Phase II Line 4A showing Project Study area



C. ENVIRONMENTAL PARAMETERS

176. 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 – Nagpur	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 34 locations for 24 hours once during the study period. Sampling locations were chosen, such that: Upwind locations (11 nos.) Downwind locations (17 nos.) Crosswind locations (6 nos.)	PM_{10} / $PM_{2.5}$: Gravimetric method SO_2: Modified West and Gaeke Method. (IS: 5182, Part II) NOx: Jacobs and Hochheiser Method. (IS 5182 Part VI)
Ambient Noise	Noise levels in dB(A)	Continuous 24 – hourly monitoring at 34 locations once during the study period.	IS: 4954 as adopted by CPCB.
Vibration		Continuous 24 – hourly monitoring at 7 sensitive receptor locations once during the study period.	
Water quality	Physical, Chemical and Biological parameters.	Sampling was done once during the study period at 24 locations for groundwater quality and 18 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 20 locations in the project study area during the study period.	BIS specifications
Land use pattern	Land use for different categories	10 km radius, based on data published in Primary Census Abstract and satellite imagery LISS –III.	Toposheets and Satellite imagery
Geology and Hydrogeology	Lithological types, drainage basins, etc.	Field observations in 10 km 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 2 km Study area, once during the study period and secondary data. Actual tree count survey of trees likely to be affected along all four alignments of the NMRP-P2.	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.	Primary survey carried out once during the Study period.

D. PHYSICAL / LAND ENVIRONMENT

1. Physiography and Geomorphology

177. The Satpuda mountain ranges, comprising plateaus & hillock landforms, constitute the northern & north-western part of Nagpur district. The district forms part of Deccan Plateau having flat topped and terraced features. Eastward and north-eastwards the landscape changes due to the change in the underlying rocks. The rocks of Gondwana series present a low rolling topography with a poor soil cover and vegetation. On the north the upland ranges are the extension of Satpudas which gradually narrow down towards the west. South of these upland range stretches the Ambegad hills, the western extremity of which is the Nagpur district. The Ramtek temple of Nagpur is on a spur of this range. The Girad hill ranges extend along the southeast and separates the valley of the Kar from that of Jamb up to Kondhali. Another main hill range runs northwards through Katol taluka from Kondhali to Kelod separating the Wardha and Wainganga valleys. The central part of the district is plain terrain. Highest altitude of 652m above MSL is observed in the northern side and the lowest altitude of 274 m above MSL is seen near the Kanhan River.

178. Digital Elevation Modelling (DEM) maps of the Core and Buffer study areas of each of the NMRP-Phase II corridors – Reach 1A, Reach 2A, Reach 3A & Reach 4A, are presented as **Figure 4-5**, **Figure 4-6**, **Figure 4-7** and **Figure 4-8** respectively.

Figure 4-5: DEM of the Core and Buffer study areas of Reach 1A (NMRP Phase II)

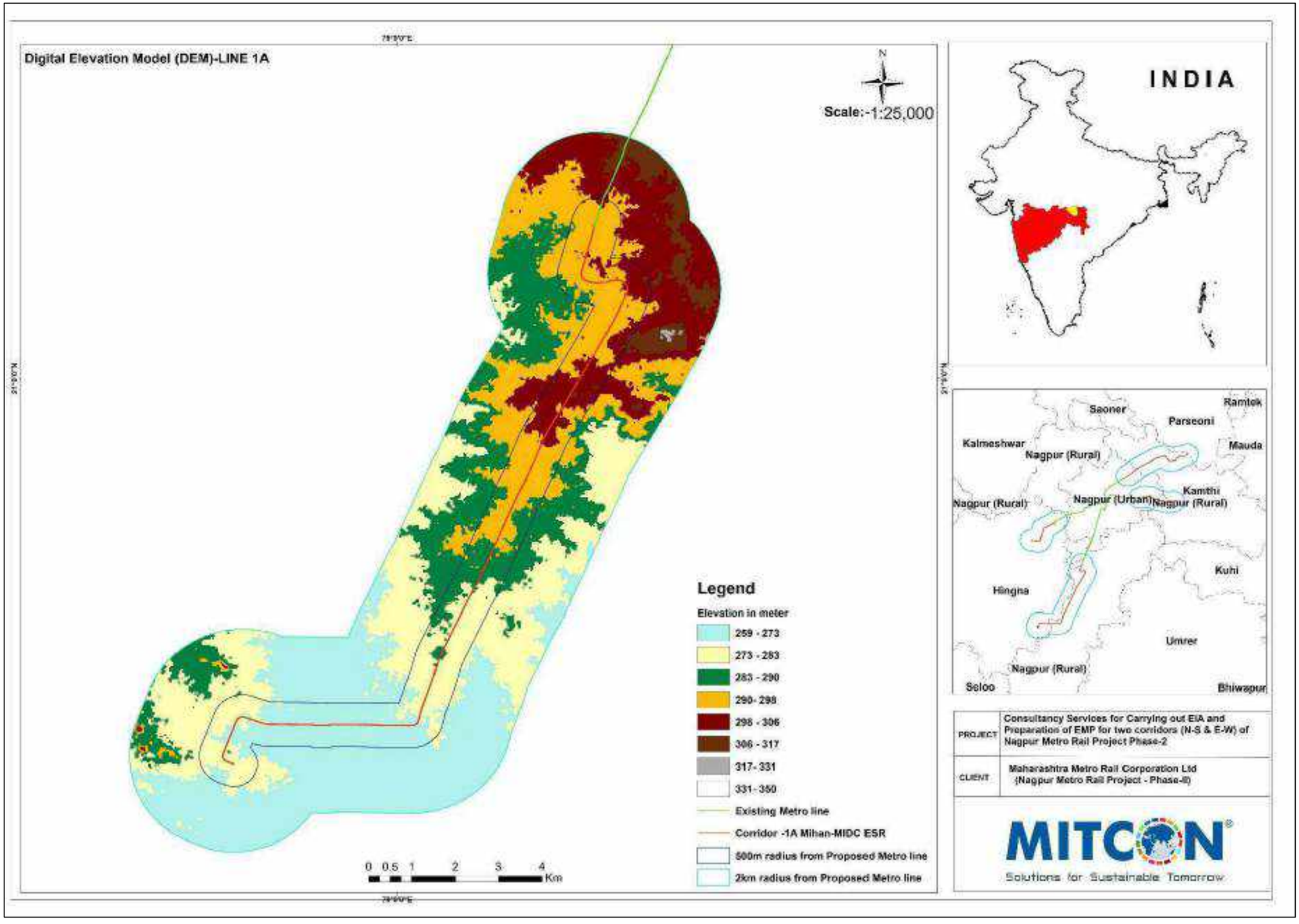


Figure 4-6: DEM of the Core and Buffer study areas of Reach 2A (NMRP Phase II)

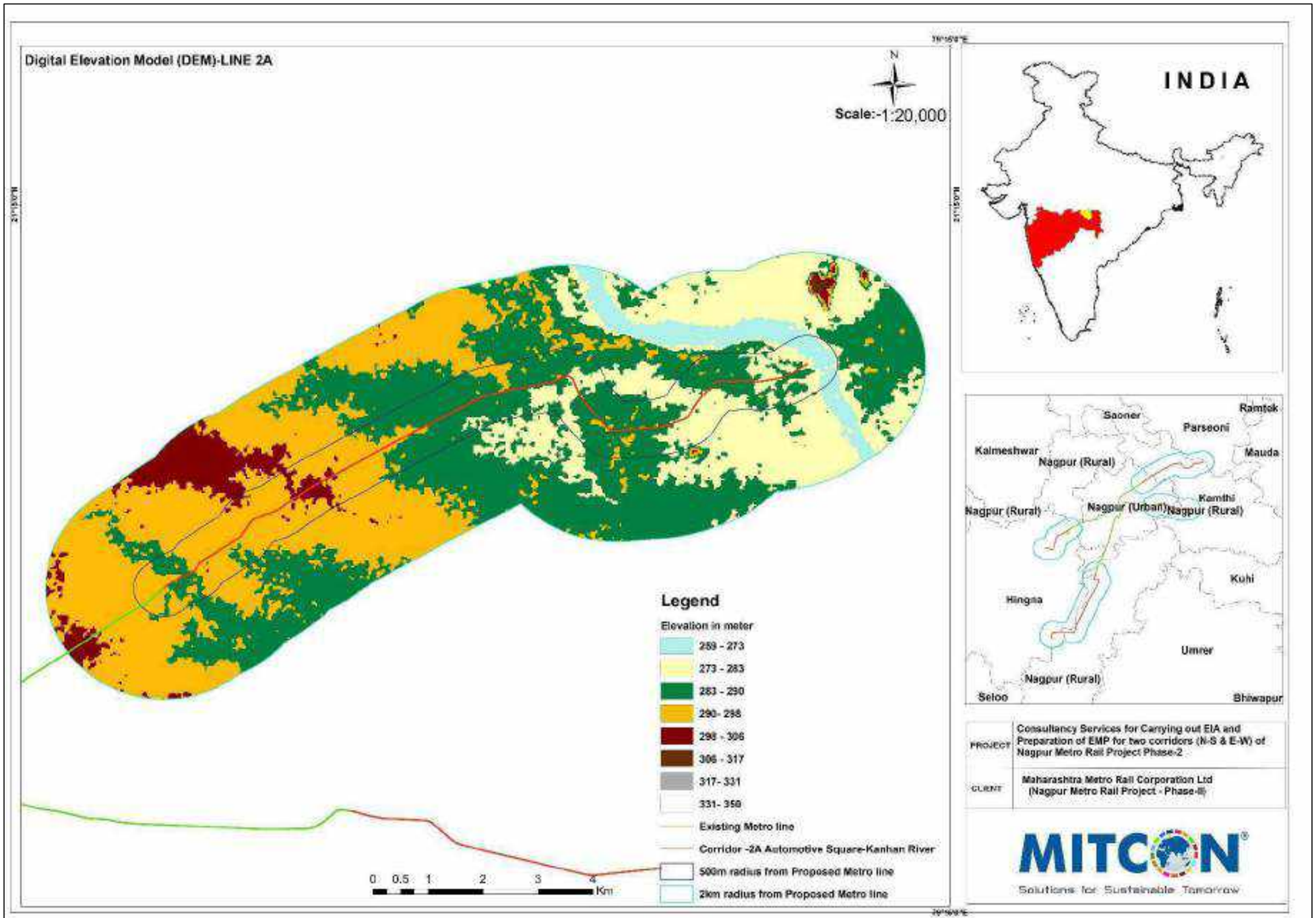


Figure 4-7: DEM of the Core and Buffer study areas of Reach 3A (NMRP Phase II)

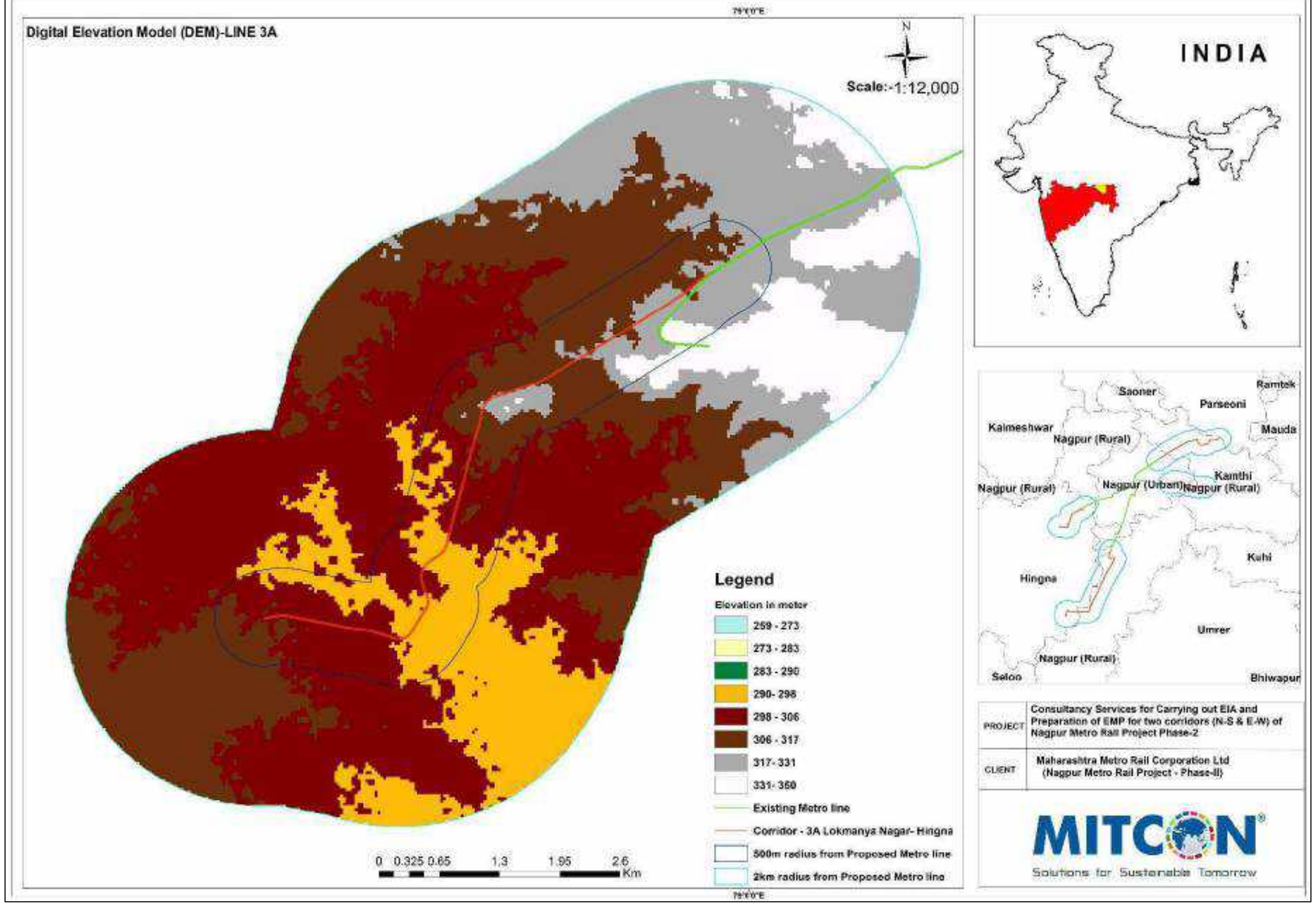
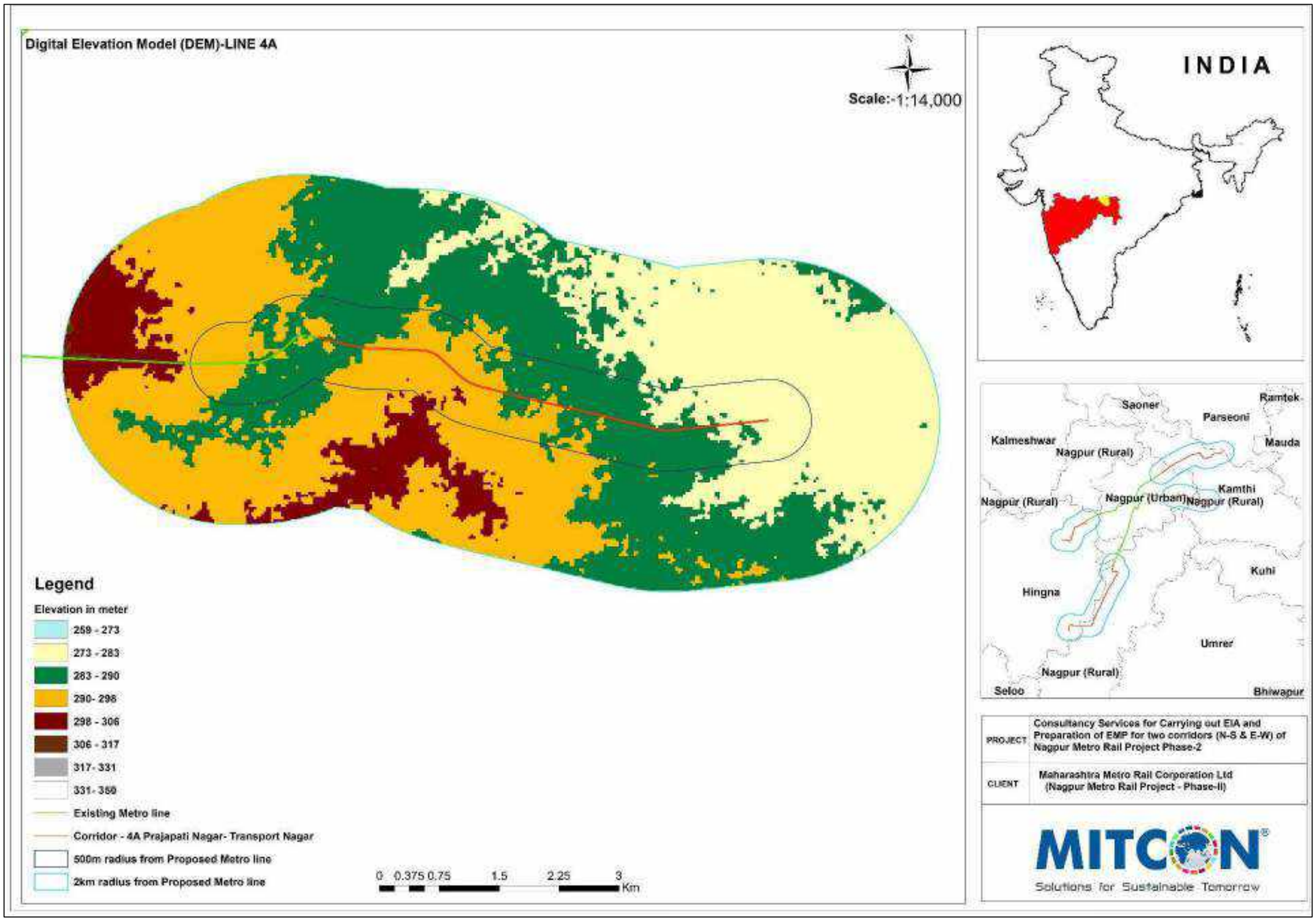


Figure 4-8: DEM of the Core and Buffer study areas of Reach 4A (NMRP Phase II)



2. Geology

179. Nagpur has a varied Geology with all kinds of rock types like igneous, sedimentary, and metamorphic. Generalised stratigraphy of rocks observed in Nagpur district can be summarised as given in **Table 4-2**.

Table 4-2: Generalized Stratigraphy of Nagpur District

Age	Formation	Lithology
Recent to sub-recent	Alluvial	Sand, Silt & Clay
Upper cretaceous to lower Eocene	Deccan trap (Basalt)	Basaltic lava flows with associated inter-trappean sediments
Upper carboniferous to lower cretaceous	Lameta beds	Calcareous Sandstone, Sandy Limestone with intercalations of chert and clay
Lower Permian to upper Permian	Gondwana (Kamthi, Barakar and Talchir stages)	Sandstone, grit, clay, carboniferous shales and basal conglomerates
Archean	Sausar and Sakoli	Streaky Granite Gniess and metasediments of Sausar and Sakoli formations

180. **Archean formations.** The Archeans comprise two lithological units, the older unit comprising of various Gneisses, granulites and Schists resulting from metamorphism of ancient sediments and younger group of Gneisses.

(i) Tirodi Gneissic Complex of Archaean to paleo Proterozoic age comprising Migmatite, ortho-gneiss, and Granite occupies the eastern and north eastern part. An Outcrop of granulite is marked at 14 km NE of Mauda.

(ii) Amgaon Gneissic complex of Archaean to paleo Proterozoic age occupies the South Eastern part and comprises granitic gneisses, Migmatite gneiss, calc-silicates, quartzite, Ultramafics and Amphibolites. Sakoli Group of Meso Proterozoic age occupies the southern part and comprises mica schist, phyllite, and carbonaceous phyllite, meta-basalt with associated tuff, metarhyolite and felsic volcanics with associated tuff.

(iii) Sausar and Sakoli Group of Meso Proterozoic age occupies the northern part and comprises quartz-muscovite schist, feldspar-muscovite schist and intercalated quartzite (Sitasawangi Formation); calc-gneiss and manganiferous marble with pockets of manganese ore (Lohangi Formation); muscovite biotite schist with manganese ore (Mansar Formation); quartzite and quartzite muscovite schist (Chorbaoli Formation); muscovite –biotite schist and quartzite-biotite granite (Junewani Formation)and crystalline Limestone and dolomite (Bichua Formation) which are repeatedly tight folded. Sausar group is a store house of Manganese ore deposits. Sakoli group is considered to be continuation of Saucer group.

181. **Gondwana group.** Rocks comprising of Talchir, barakar and kamthi stages of Gondwana formation are of fluviatile and lacustrine origin. These sediments were deposited in troughs and synclines, consolidated and lifted and now preserved in troughs produced by faults. The Kelod-Kamtee line which marks the north-east boundary of Kamthi beds with Archeans is a boundary fault.

(i) **Talchir formation.** Basal beds of Gondwana group comprising green shales and sandstones with minor intercalations of clay and a basal conglomerate and rest unconformable over the Archean rocks. These are exposed at Kodadonagri (north of Patansaongi) and 9 km north of Nagpur near Suradevi hills.

(ii) **Barakars.** Following Talchirs, the Barakar consists of white and grey sandstones and grits, fire clays and carbonaceous shales with workable coal seams.

(iii) **Kamthis.** These are predominantly composed of soft and coarse-grained sandstones with some micaceous sandstones and homogenous and compact shales. These rocks occupy an area which is bounded by Kelod-Kamtee line towards north-east along which Kamtees have been faulted. Southwards they stretch up to Bokhara 6km north of Nagpur. At Silewara about 8 km north west of Kamtee a low range of hills composed of Kamthis and extending upto Bokhara forms the type area. Two inliers of Kamthi rocks are seen in Deccan trap basalt area to the west of Nagpur. One of these lies to the north east of Bazargaon and another north west of Nagpur at Gonkheri.

182. **Lametas.** Lametas also known as infra-trappeans are fresh water deposits and rest horizontally over the older Gondwana and Archean rocks. Lametas have limited extent and rarely attains a thickness of more than 15-20 m. They comprise calcareous sandstones, to sandy limestones, with intercalations of chert and clay. They occur at the foothills of Kelod and Sitabuldi (Nagpur) hills. A large spread of Lametas is seen immediately west of Umred.

183. **Deccan Trap.** Basalt is the main formation of the district which occupies an area of about 4300 sq.km, i.e., about 50% of the total area of the district. The area covering Katol, Narkhed, Hingna & Umred talukas and some part of Nagpur, Saoner, Kalmeshwar, Bhiwapur & Kuhi talukas. The thickness of individual layers is generally 15 to 30 m. Within the two layers inter-trapean clay deposits are found which are known as red bole beds. Individual flow is generally Massive towards the bottom and Vesicular or Amygdaloidal towards the top. Secondary fillings of vesicles comprise calcite, zeolite and quartz.

184. **Alluvium**. Alluvium deposits of recent age deposited by the tributaries of Kanhan and Wainganaga rivers. The Alluvium is composed of sand, garvel, clay and kankar and its thickness seldom exceeds 30m. They overlie the older formations such as Archaeans, Gondwana and Basalt and have thickness more than 25 m.

185. Geology of Project Study Area i.e. 2 km radial distance around each of the four alignments of NMRP Phase II is shown separately as **Figure 4-9**, **Figure 4-10**, **Figure 4-11** and **Figure 4-12** respectively. Lithology found in the Project study area, as per GSI classification, can be summarised as given in **Table 4-3**.

Table 4-3: Lithology of the Project Area as per Geological Survey of India (GSI)

Code as per GSI	Lithology	Stratigraphy	Nature & Characteristics
28	Alluvium	-	Loamu, consisting of sand, silt & clay with pebbles and gravels, vat places, soft, unconsolidated
26	Simple flow – Basalt	Sahyadri Group (Deccan Trap)	Dark grey, sparsely to moderately porphyritic, massive rock
24	Intra-trappean beds	Sahyadri Group (Deccan Trap)	Red & grey clay, limestone and sandstone
23	Undifferentiated Basalt	Sahyadri Group (Deccan Trap)	Dark grey, fine grained with compact and massive clinkery surface
2a	Granitic Gneisses with Migmatite / Granite	Tirodi Gneissic Complex	**Magmatite:** coarse to medium grained, mesocratic, distinctly gneissose and often porphyroblastic **Gneiss:** light to dark grey, medium to coarse grained and distinctly banded **Granite:** light grey, medium to coarse grained and massive

Figure 4-9: Geology of Project Study Area of Reach 1A as per GSI – Nagpur DRM

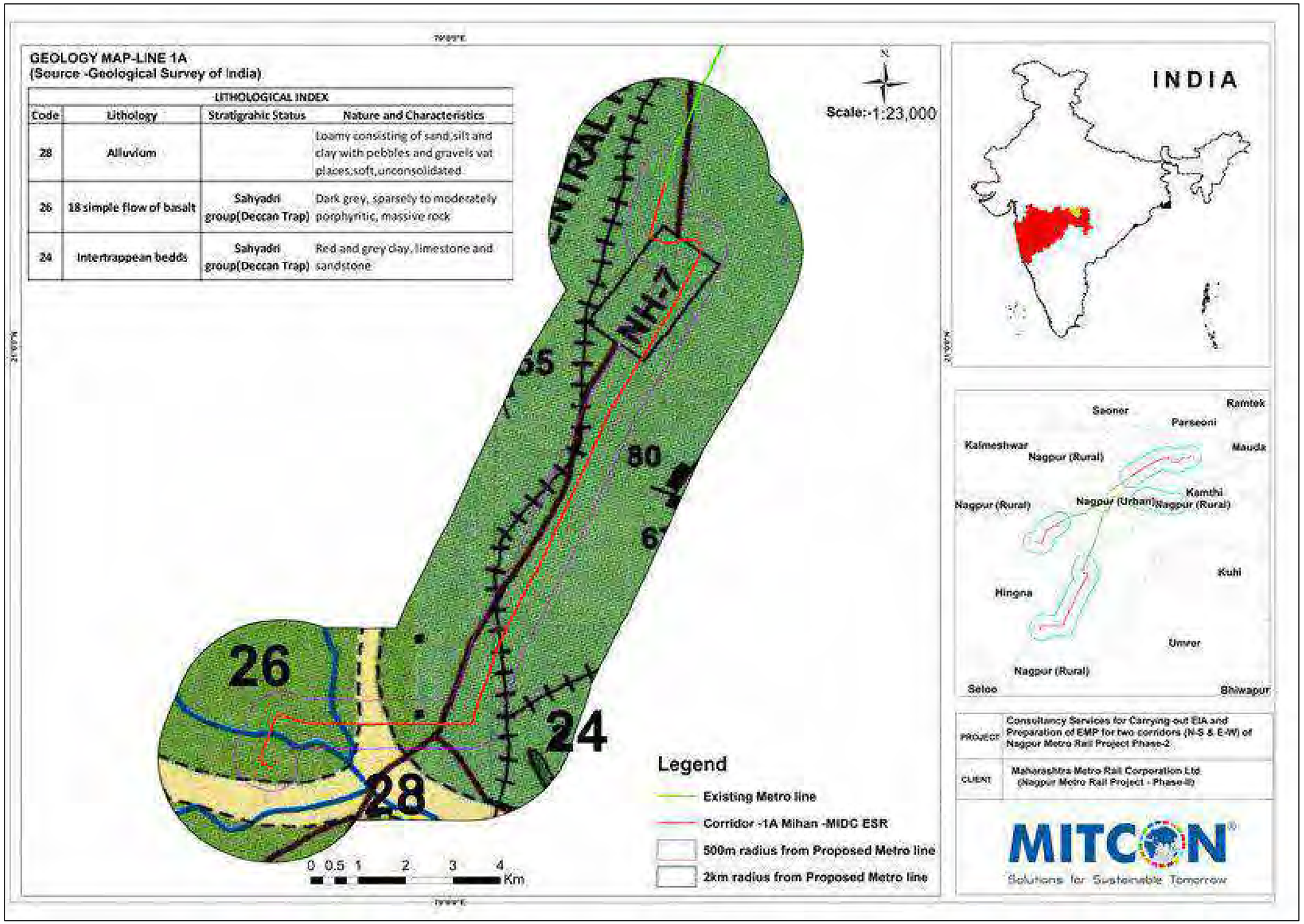


Figure 4-10: Geology of Project Study Area of Reach 2A as per GSI – Nagpur DRM

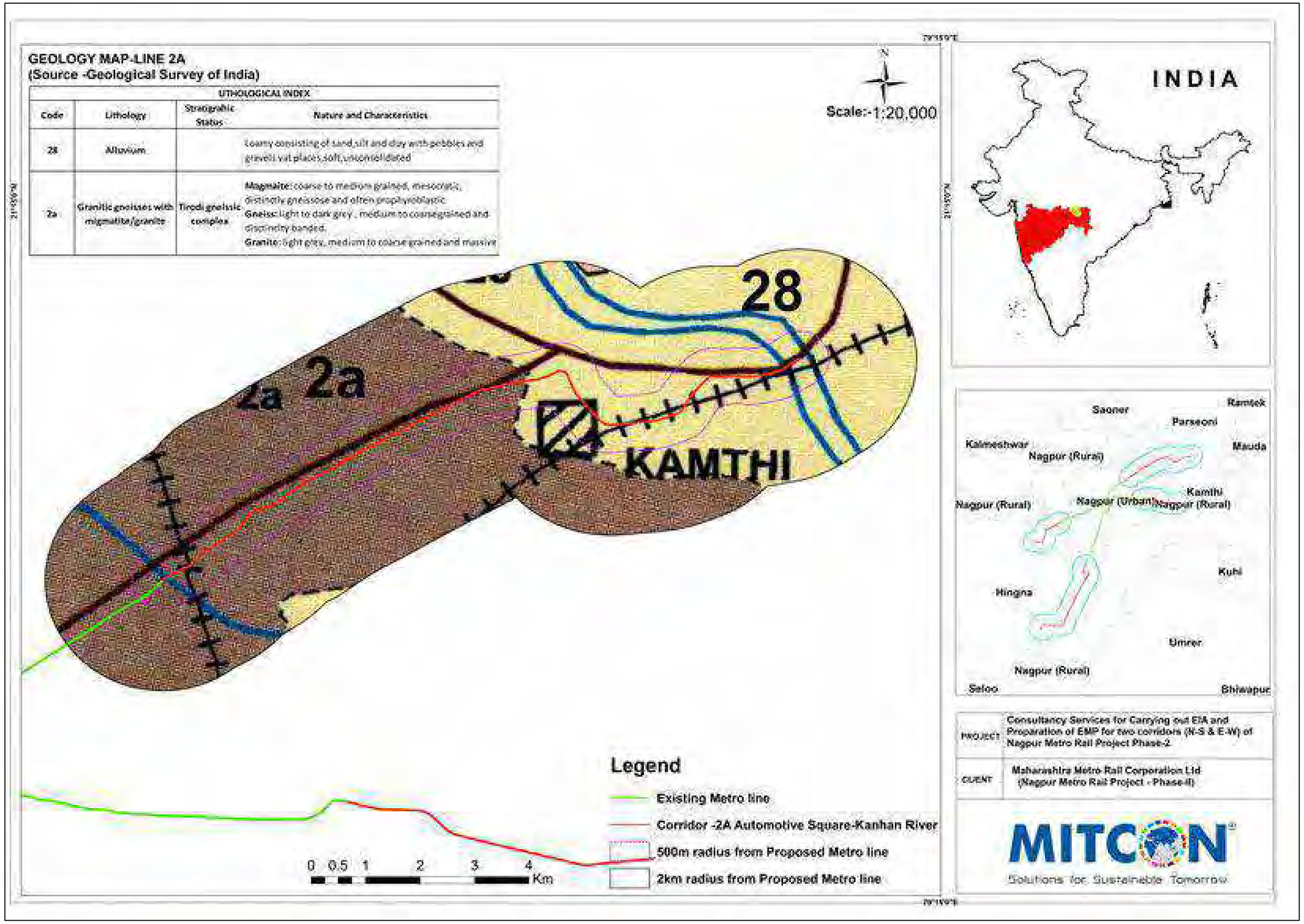


Figure 4-11: Geology of Project Study Area of Reach 3A as per GSI – Nagpur DRM

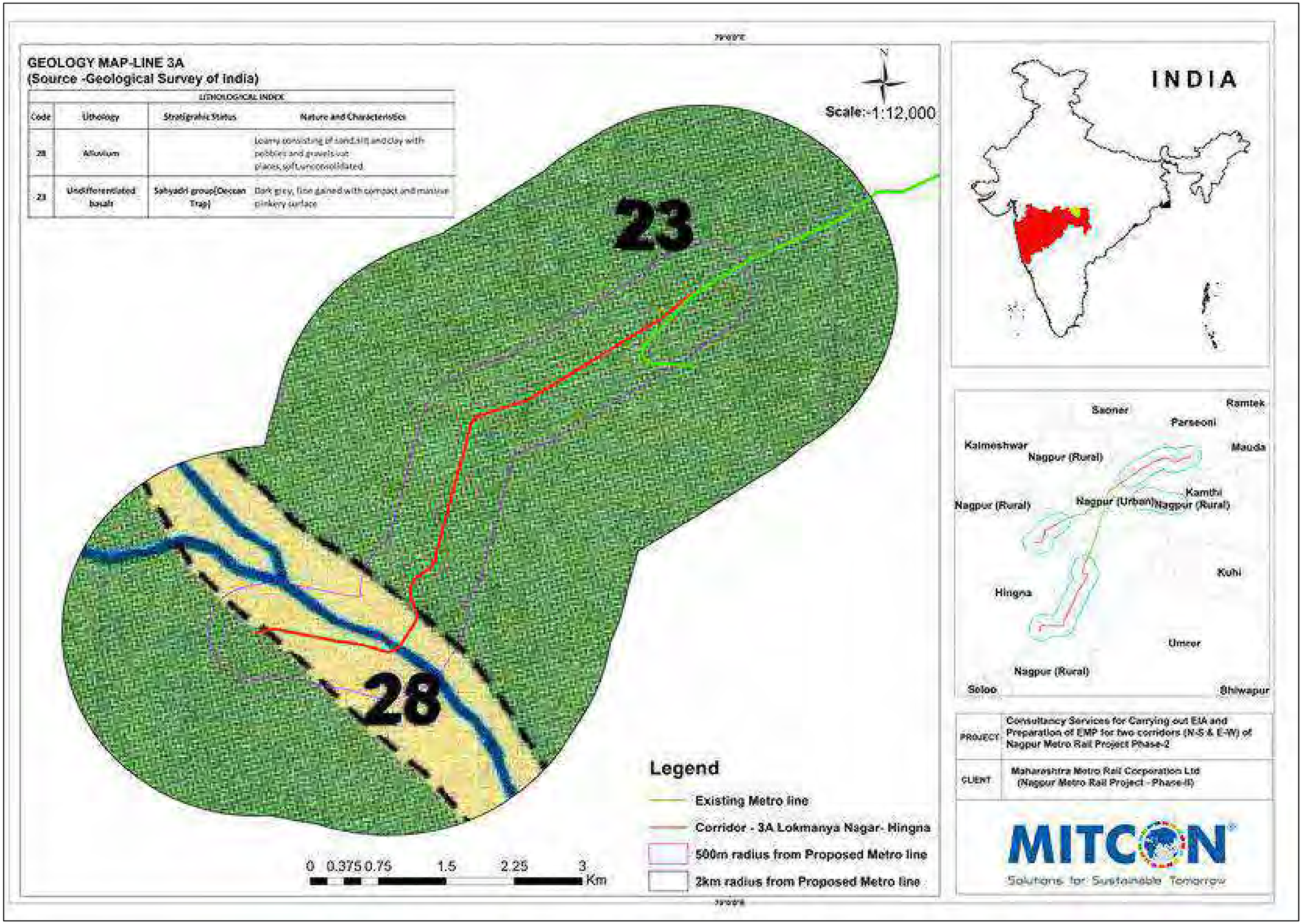
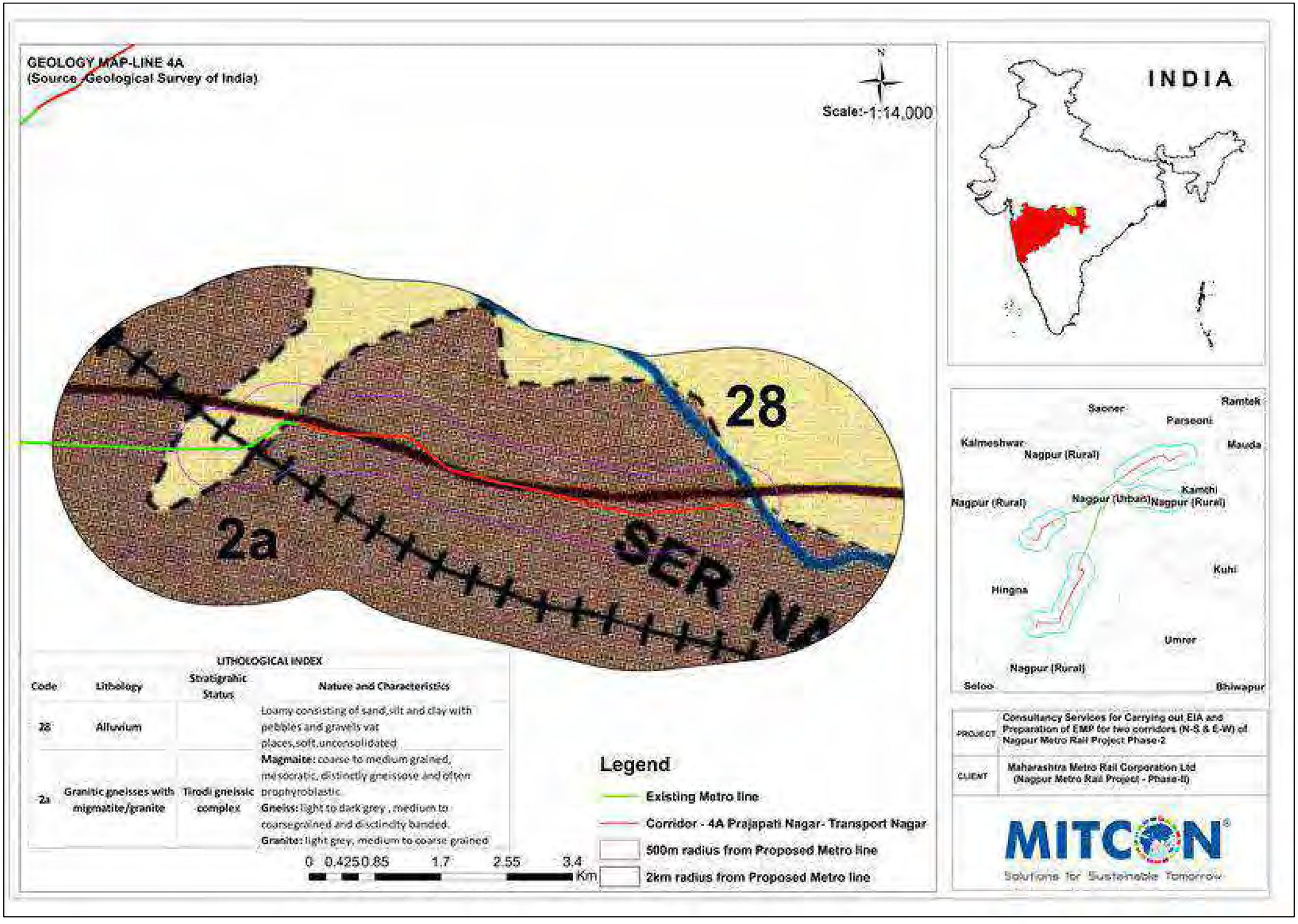


Figure 4-12: Geology of Project Study Area of Reach 4A as per GSI – Nagpur DRM



186. **Geotechnical Investigations.** Geotechnical Investigation was carried out by RITES with the objective of determining subsurface profile of the underlying strata and required strength characteristics of the underlying soil / rock strata in order to propose the suitable substructure for elevated section, stations buildings and other buildings.

187. The Geotechnical investigation work included drilling of 150mm diameter boreholes (BHs) in all kind of soil including gravels and cobbles, & 76 mm dia. drilling in weathered rock, soft rock & hard Rock up to depths ranging from 6m to 30m. Boreholes have been terminated at shallower depths after completing at least 3m drilling in fresh and hard rock. Boreholes have been drilled at an interval of about 1000m distance along the alignment or at change of strata. In total, 50 BHs were drilled (up to 30 m depth each), along the lengths of all four proposed Metro alignments.

188. The sub-soil strata at proposed alignment are generally homogeneous and comprises of mainly three types of layers, based on field tests & laboratory test result data, namely:

(i) **Layer Type-I**: Overburden comprising of silty sandy soil with gravels and pebbles yellowish brown in colour.
(ii) **Layer Type-II**: Moderately to highly weathered amygdaloidal basalt/augen gneiss.
(iii) **Layer Type-III**: Bedrock Rock comprising fresh & hard Basalt with zeolite/ augen gneiss.

3. Soils

189. '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 Nagpur district as described below:

(i) **Kali soils.** These are black cotton soils which are fine grained clayey in texture and varies in depth from 1 to 6 m or more and retain moisture. They are found around Kalmeshwar, Saoner and Nagpur.
(ii) **Morand soils.** These are predominant in the district. They are black cotton soils with higher percentage of lime than the Kali soils. They are black, grey or light to dark brown in colour, clayey in texture and have a depth of about 1 to 3 m.
(iii) **Khardi soils.** They are shallow soils mixed with sand and found mainly in hills. These are grey in colour, clay loam in texture.
(iv) **Bardi soils.** They are red gravel covered with boulders found on summits and slopes of trap hills and are less fertile in nature.
(v) **Kachchar soils.** They are mainly found in the banks of Kanhan River and are alluvial soils, loamy in nature and vary in depth from 1 to 3 m.
(vi) **Wardi soils.** They are red soils with a large amount of sand. They are shallower and clayey loam in nature. They are mainly found in the paddy tracts in the eastern part of the district

(a) Methodology

190. 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.
(iv) Contamination of soil by hydrocarbons and pesticides is not observed in the project area and therefore other parameters including metals were measured.

(b) Locations & Frequency of Monitoring

Soil samples were collected once from 20 different locations within the study area, as shown in **Table 4-4**. The locations are taken at proposed NMRP Phase II stations, chosen randomly, so as to provide a representative of the soils present in the project study area. **Figure 4-13** shows some photographs taken during Soil sampling in the Project Study area. Soil Sampling locations for Reach 1A, Reach 2A, Reach 3A and Reach 4A are respectively shown as **Figure 4-14**, **Figure 4-15**, **Figure 4-16** and **Figure 4-17**.

Table 4-4: Soil Sampling Locations for NMRP-P2 corridors

Line	Sampling Code	Sampling Location	Latitude	Longitude
3A	S1	Rajiv Nagar	21° 5'48.08" N	78°58'51.25" E
3A	S2	Hingna	21° 4'25.06" N	78°57'25.09" E
3A	S3	Wanadongri	21° 5'32.57" N	78°58'26.24" E
3A	S4	Raipur	21° 4'36.73" N	78°58'7.24" E
1A	S5	Dongargaon	20°58'56.50" N	79° 1'45.40" E
1A	S6	Mohgaon	20°57'36.68" N	79° 1'3.21" E
1A	S7	Meghdoot CIDCO	20°56'9.16" N	79° 0'25.70" E
1A	S8	MIDC ESR	20°55'26.69" N	78°57'49.82" E
1A	S9	Kinhi (MIDC KEC)	20°55'37.90" N	78°58'46.69" E
1A	S10	MHADA Colony	20°55'44.35" N	78°59'56.71" E
4A	S11	Kapsi Khurd	21° 8'33.14" N	79°10'33.84" E
4A	S12	Transport Nagar	21° 8'31.37" N	79°11'40.76" E
2A	S13	Pili Nadi	21°11'32.73" N	79° 7'46.45" E
2A	S14	All India Radio	21°12'10.54"N	79° 8'36.92"E
2A	S15	Khairi fata	21°12'41.47"N	79° 9'33.10"E
2A	S16	Lekha Nagar	21°13'9.76" N	79°10'32.81" E
2A	S17	Kanhan River	21°13'23.68" N	79°13'26.36" E
1A	S18	Ashokwan	21° 0'46.16" N	79° 2'44.45" E
3A	S19	Hingna Mount View	21° 6'21.65"N	78°59'36.69"E
4A	S20	Pardi	21° 8'59.29" N	79° 9'42.10" E

Figure 4-13: Photographs of Soil Sampling

Photo no.	Date of Sampling	Location Geo-coordinates
1	23/04/2023	20°55'37.90"N / 78°58'46.31"E
2	23/04/2023	21° 8'33.15"N / 79°10'33.87"E
3	18/04/2023	21°12'17.7"N / 79° 8'42.94"E
4	22/04/2023	21°13'23.68"N / 79°13'26.36"E
5	21/04/2023	21° 5'32.57"N / 78°58'26.24"E
6	18/04/2023	21°12'41.47"N / 79° 9'33.10"E
7	20/04/2023	21°13' 9.76"N / 79°10'32.81"E
8	17/04/2023	21°11'32.73"N / 79° 7'46.45"E

Figure 4-14: Soil sampling locations for NMRP Phase II project - Reach 1A

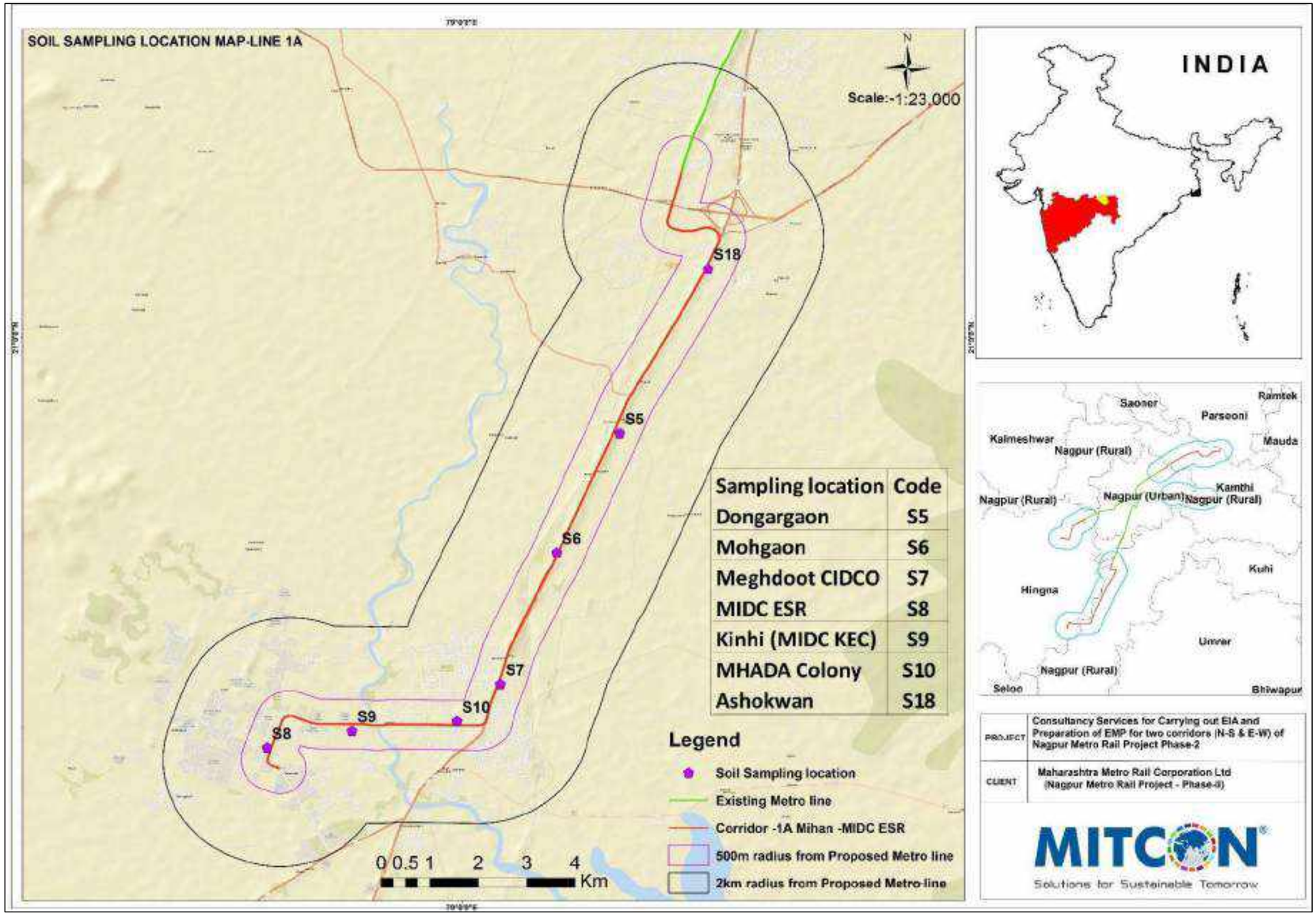


Figure 4-15: Soil sampling locations for NMRP Phase II project - Reach 2A

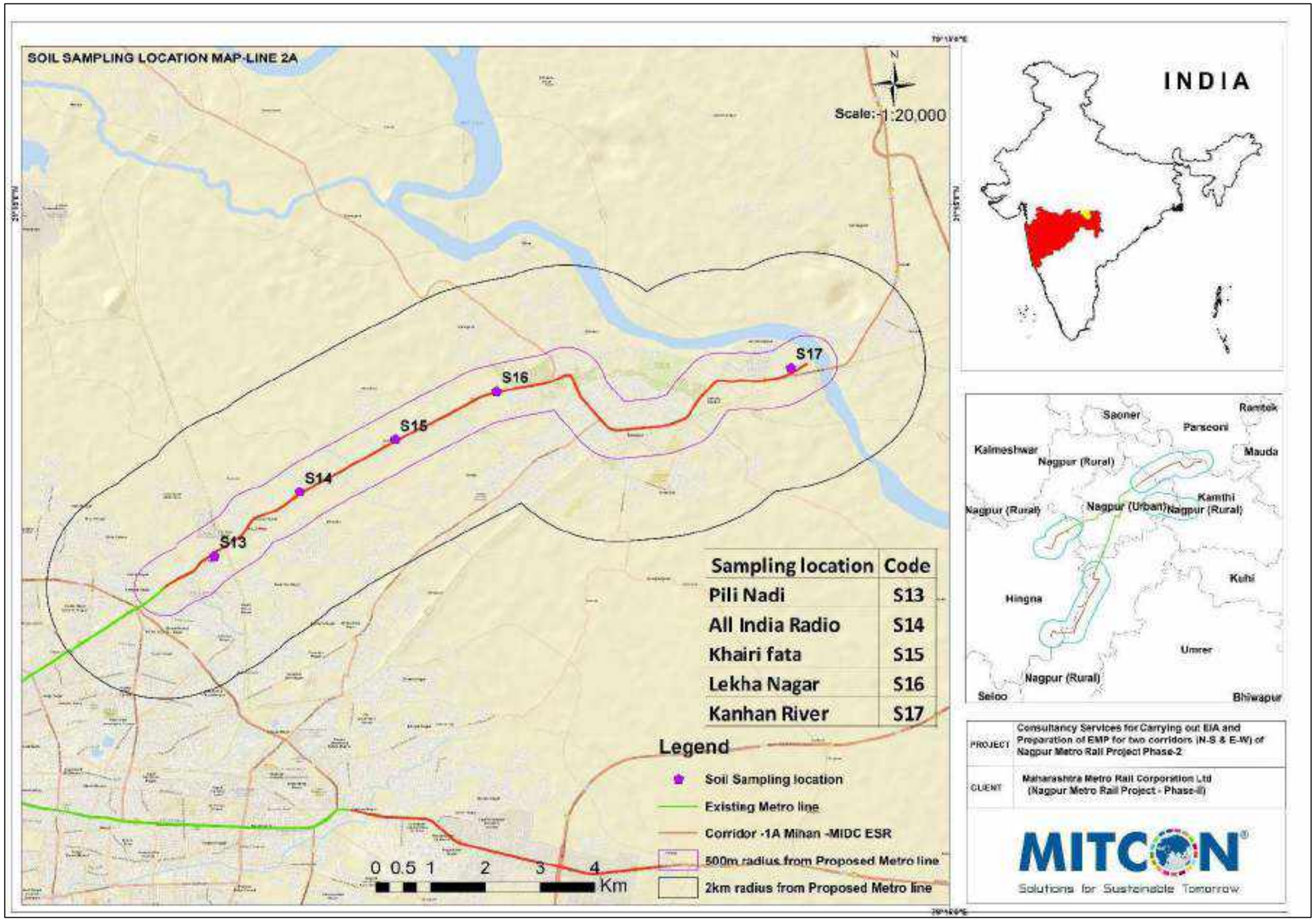


Figure 4-16: Soil sampling locations for NMRP Phase II project - Reach 3A

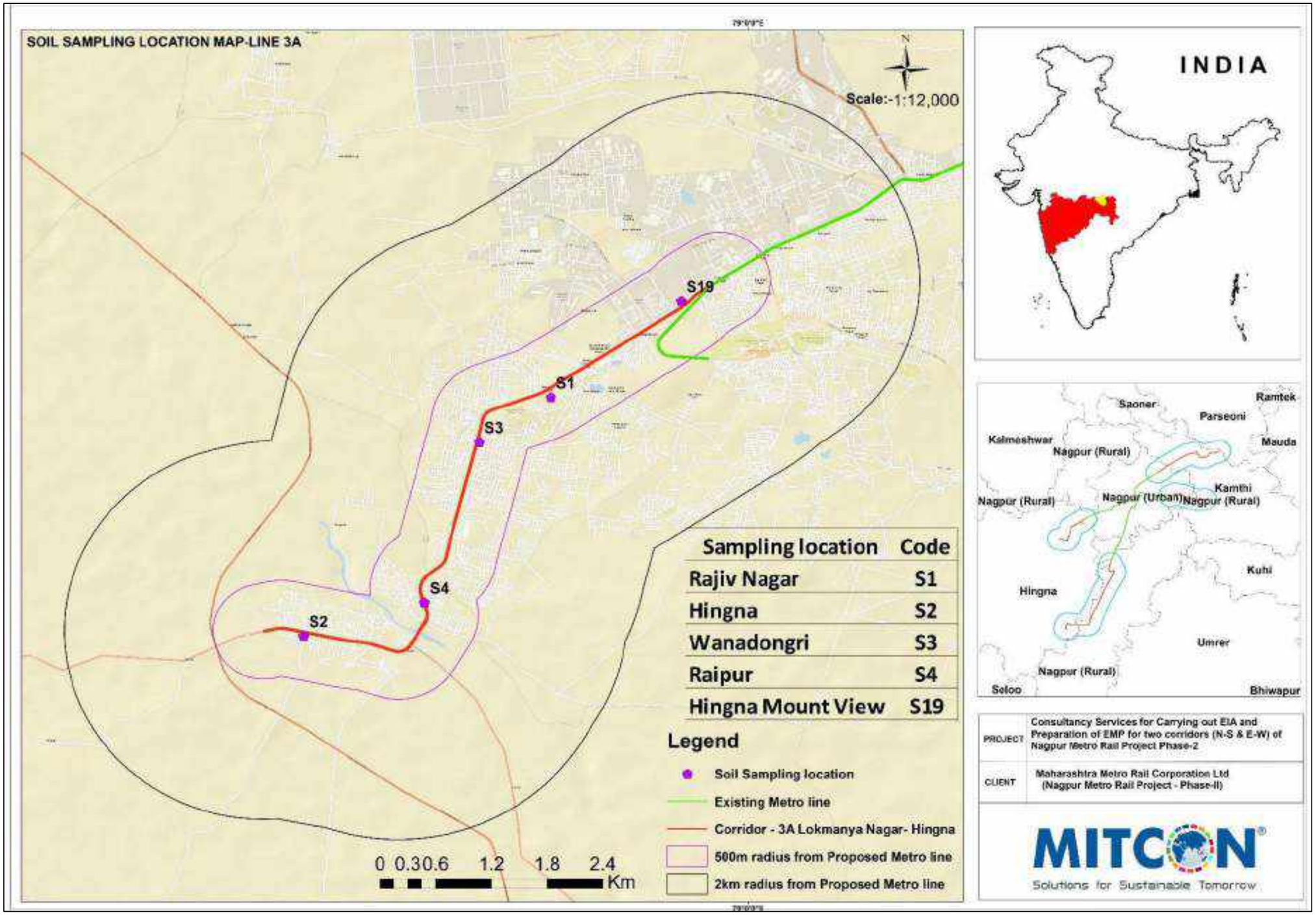
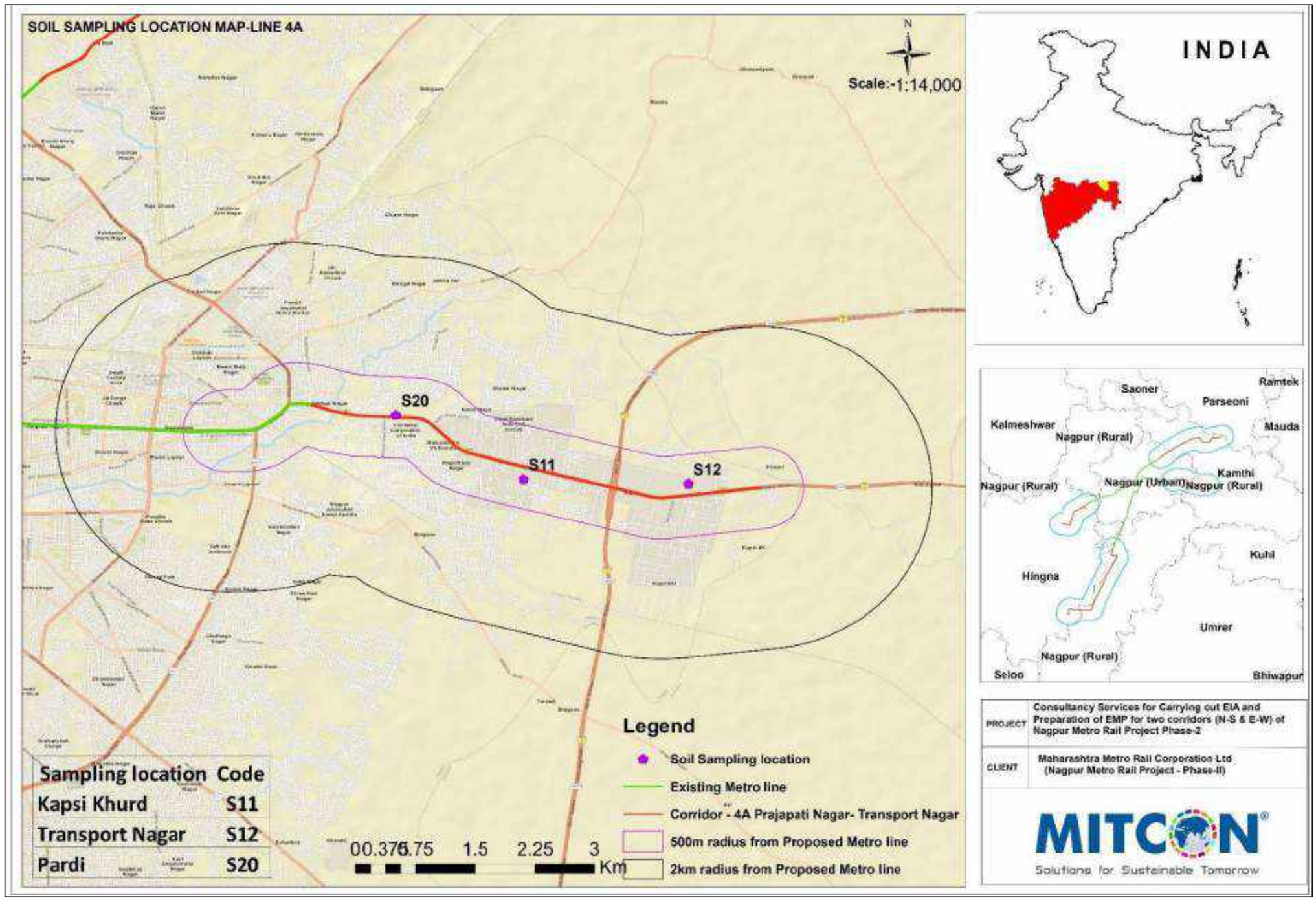


Figure 4-17: Soil sampling locations for NMRP Phase II project - Reach 4A



(c) Soil Sampling Results

191. Soil analysis results of all 20 soil samples collected in the project area are comparatively summarized in **Table 4-5**. Detailed results of Soil sampling are given as **Annexure-3**.

Table 4-5: Results of Soil Sampling locations in NMRP-P2 Project study area

Alignment (Line)	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	-
3A	S1	Rajiv Nagar	Clay	20	30	50	2.32	1.12	53.2	0.34	98.3	42.3	112.3	9.42	135.7	1.07
3A	S2	Hingna	Silty Loam	23	55	22	3.13	1.07	50.5	0.52	85.32	20.12	110.5	10.2	132.7	1.25
3A	S3	Wanadongri	Clay	30	20	50	1.83	1.12	51.7	0.52	101.4	52.1	103.8	13.6	151.5	0.84
3A	S4	Raipur	Clay	25	25	50	3.02	1.08	50.1	0.48	89.3	24.3	108.9	14.2	187.5	1.08
1A	S5	Dongargaon	Loam	45	25	30	3.02	1.08	42.3	0.28	89.3	24.3	108.9	14.2	103.25	1.08
1A	S6	Mohgaon	Clay Loam	35	35	30	1.42	1.12	53.6	0.62	101.4	40.3	152.7	20.6	195.4	0.85
1A	S7	Meghdoot CIDCO	Clay	20	35	45	1.01	1.16	57.8	0.54	120.6	52.3	165.7	23.3	180.1	0.85
1A	S8	MIDC ESR	Clay	20	20	60	1.23	1.05	60.2	0.3	95.3	37.6	145.1	16.2	164.2	1.07
1A	S9	Kinhi (MIDC KEC)	Clay	20	30	50	0.83	1.09	45.8	0.42	80.2	23.4	114.3	12.8	148.7	1.27
1A	S10	MHADA Colony	Clay	45	10	45	0.9	1.13	52.7	0.52	801.8	0.43	95.67	47.3	55.13	4.52
4A	S11	Kapsi Khurd	Clay Loam	40	20	40	0.72	1.04	51.7	0.38	69.1	28.3	110.7	13.45	130.6	1.62
4A	S12	Transport Nagar	Clay Loam	45	20	35	0.52	1.11	47.2	0.22	104.25	55.12	115.28	10.21	128.18	0.89
2A	S13	Pili Nadi	Clay	30	20	50	1.23	1.08	50.1	0.32	89.23	41.6	121.8	13.46	167.25	0.89
2A	S14	All India Radio	Clay	20	30	50	1.19	1.13	53.7	0.23	45.7	31.6	134.5	14.7	103.2	1.59
2A	S15	Khairi fata	Loam	35	30	35	0.52	1.09	56.8	0.14	78.25	25.8	74.13	5.28	95.27	0.97

Alignment (Line)	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	-
2A	S16	Lekha Nagar	Clay	23	30	47	1.07	1.17	56.2	0.32	87.3	30.7	118.7	19.1	125.1	1.45
2A	S17	Kanhan River	Clay	27	30	43	1.04	1.09	53.8	0.28	100.3	41.4	131.87	14.3	120.8	1.43
1A	S18	Ashokwan	Clay Loam	40	20	40	0.21	1.04	40.2	0.14	70.2	55.3	84.3	7.37	89.34	1.36
3A	S19	Hingna Mount View	Loam	30	30	40	0.72	1.02	51.6	0.48	85.6	41.7	65.02	7.13	98.3	0.95
4A	S20	Pardi	Clay Loam	40	20	40	1.11	1.08	55.6	0.52	83.15	51.3	71.7	8.12	83.2	1.00

(d) Inferences of Soil Sampling

192. The soil sample analyses results were compared with Bureau of Indian Standards (BIS) and the rest are as per UK Soil Guideline Values (SGV) for residential area[30]. Conclusions from Soil sampling in the Study area during study period are summarised below:

(i) Soil found in the Study area is generally Clayey to Loamy in texture;
(ii) Soil Moisture or Porosity of the samples ranges between 0.21% to 3.13%;
(iii) Water holding capacity of the soil samples ranges from 40.2% to 60.2%
(iv) Organic Carbon ranges from 0.28% to 0.62%; and
(v) N, P, K concentration in all soil samples are in the range of 65.02 to 165.7 kg/ha, 5.28 to 47.3 kg/ha and 55.13 to 195.4 kg/ha respectively.

4. Land Use and/or Land Cover

193. 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.

194. Land use/land cover for 10 km 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 agricultural as seen from **Table 4-6**. Land Use in the 500m Core study area around each of the alignments is shown in **Figure 4-18**, **Figure 4-19**, **Figure 4-20** and **Figure 4-21**.

Table 4-6: Land Use in the Study Area (Cumulative)

Sr. No.	Classes	Area in Ha.	Area in sq. km	Area in %
1	Agricultural land	870.72	8.71	17.72
2	Built-up	2204.89	22.05	44.88
3	Scrubland	1765.77	17.66	35.94
4	Water bodies	71.24	0.71	1.45
Total		**4912.62**	**49.13**	**100.00**

[30] *Source: http://www.environmentagency.gov.uk/clea.*

Figure 4-18: Land Use / Land Cover in 500 m Core Study Area of Line 1A

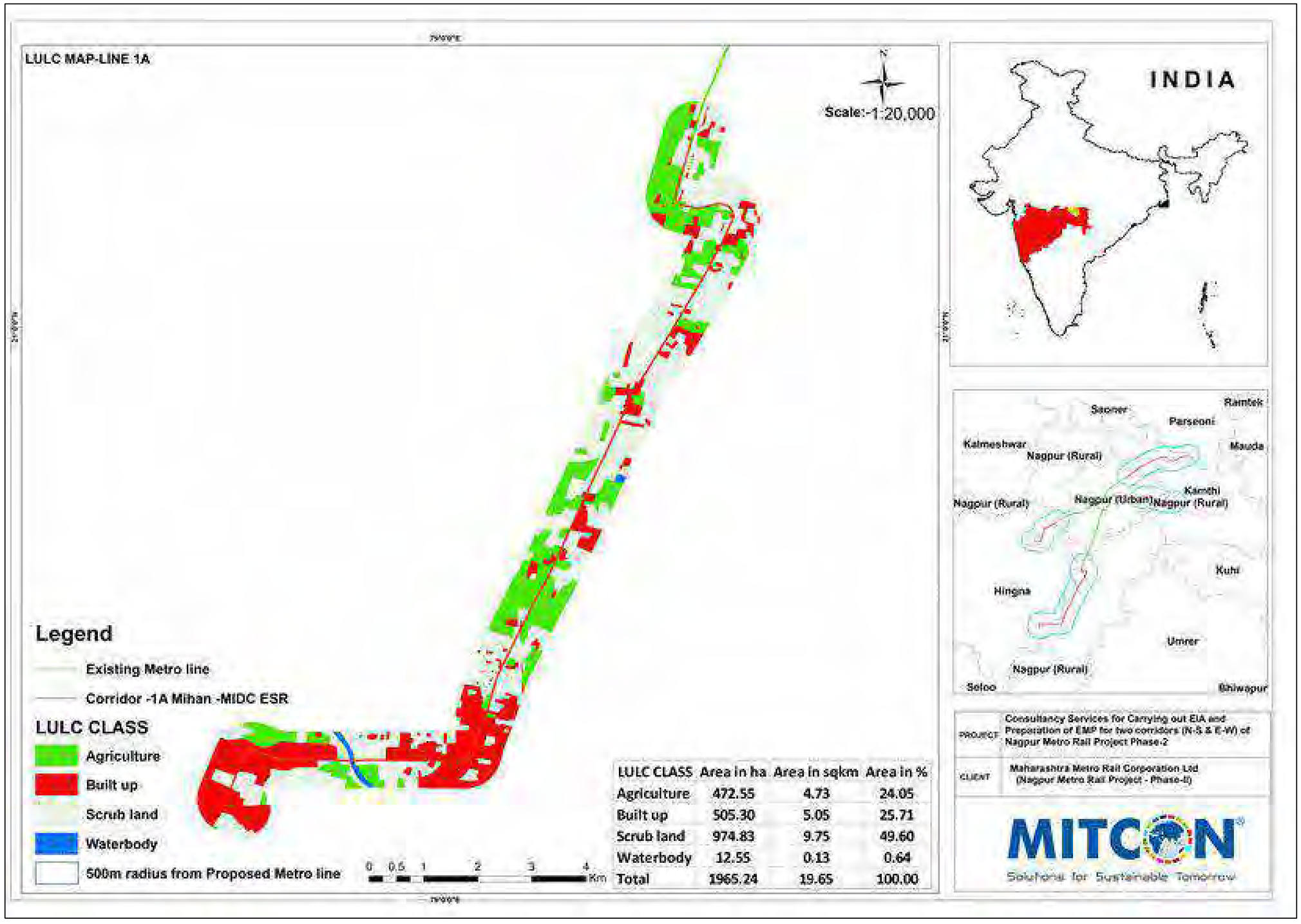


Figure 4-19: Land use / Land Cover in 500 m Core Study Area of Line 2A

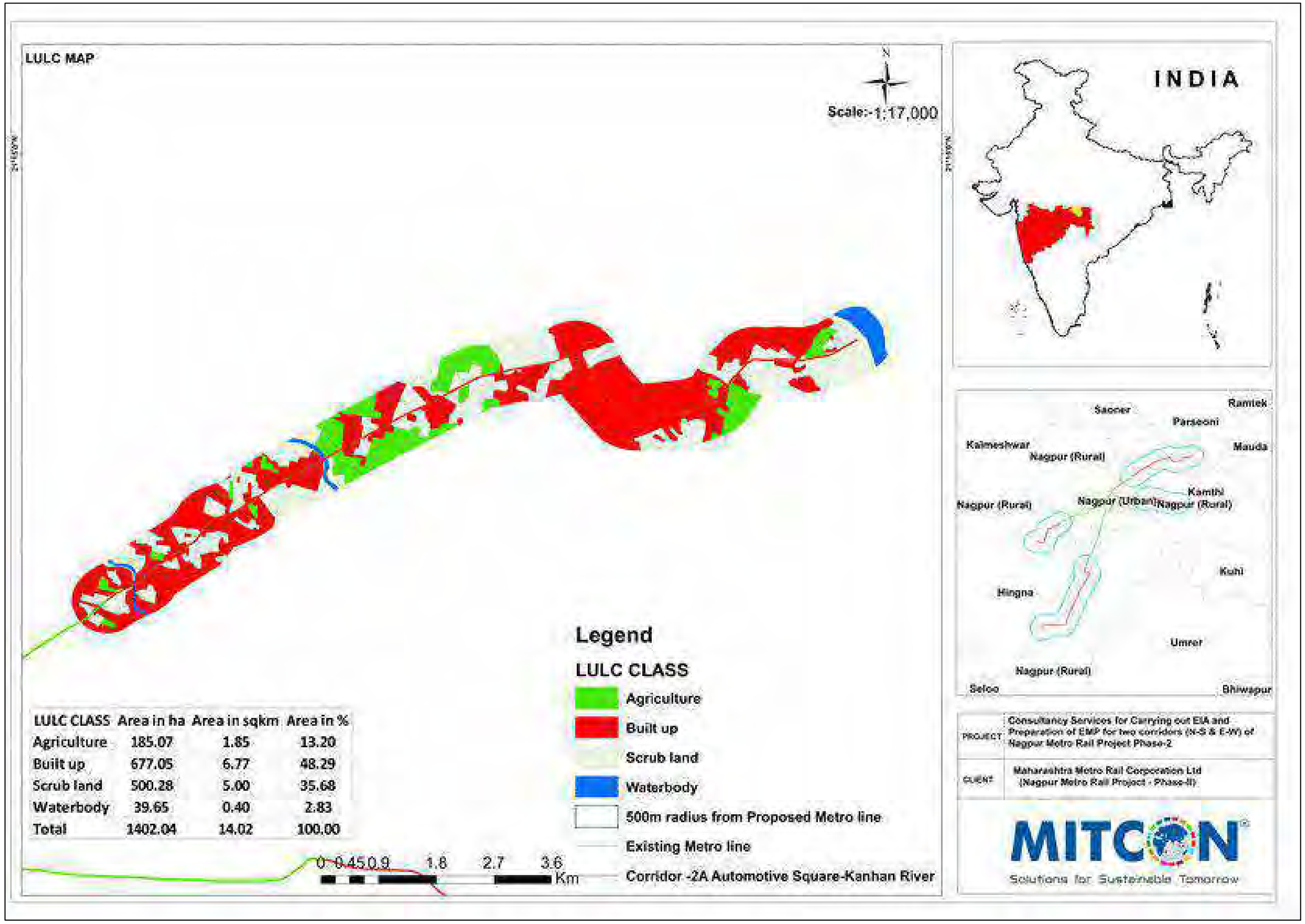


Figure 4-20: Land use / Land Cover in 500 m Core Study Area of Line 3A

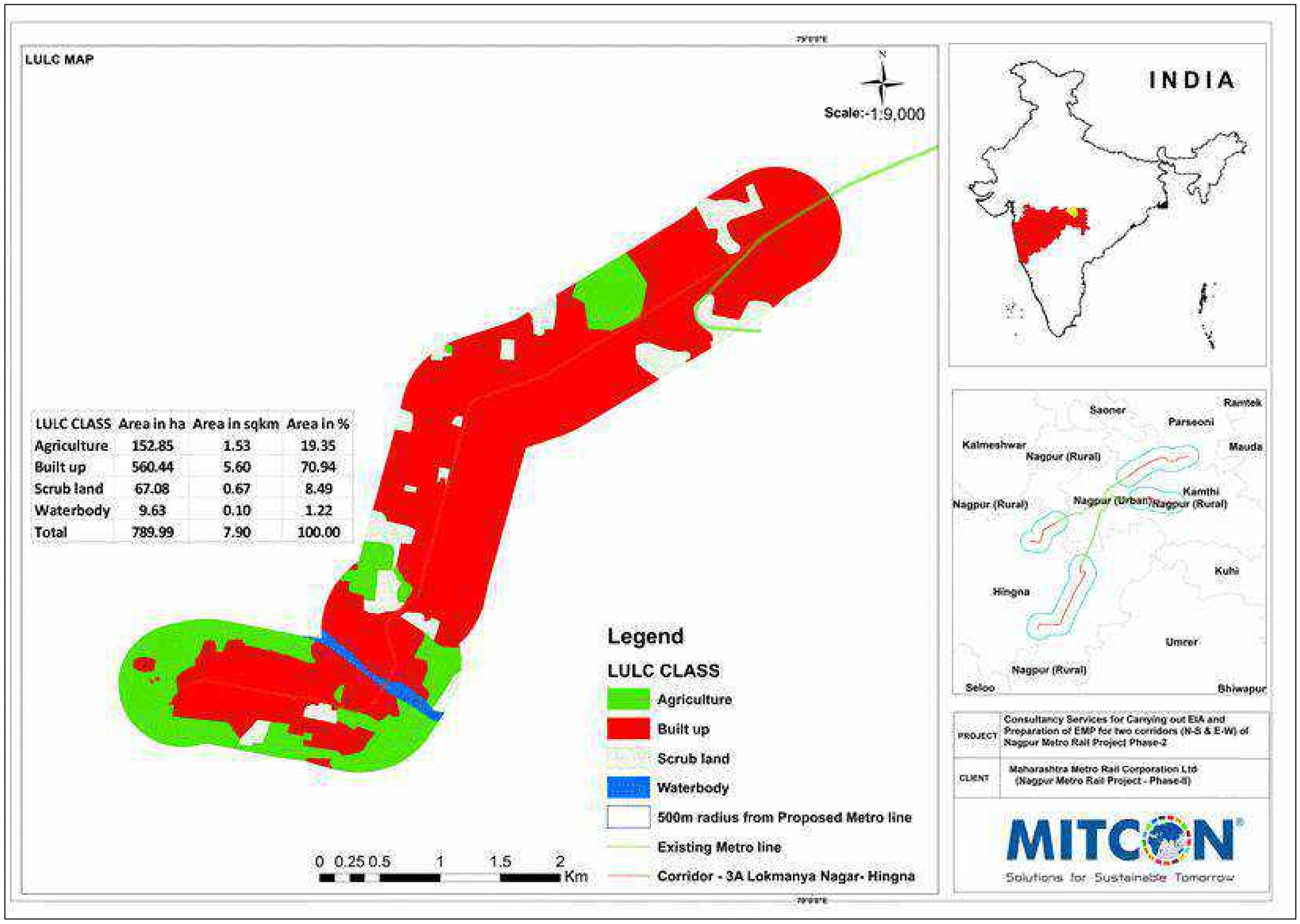
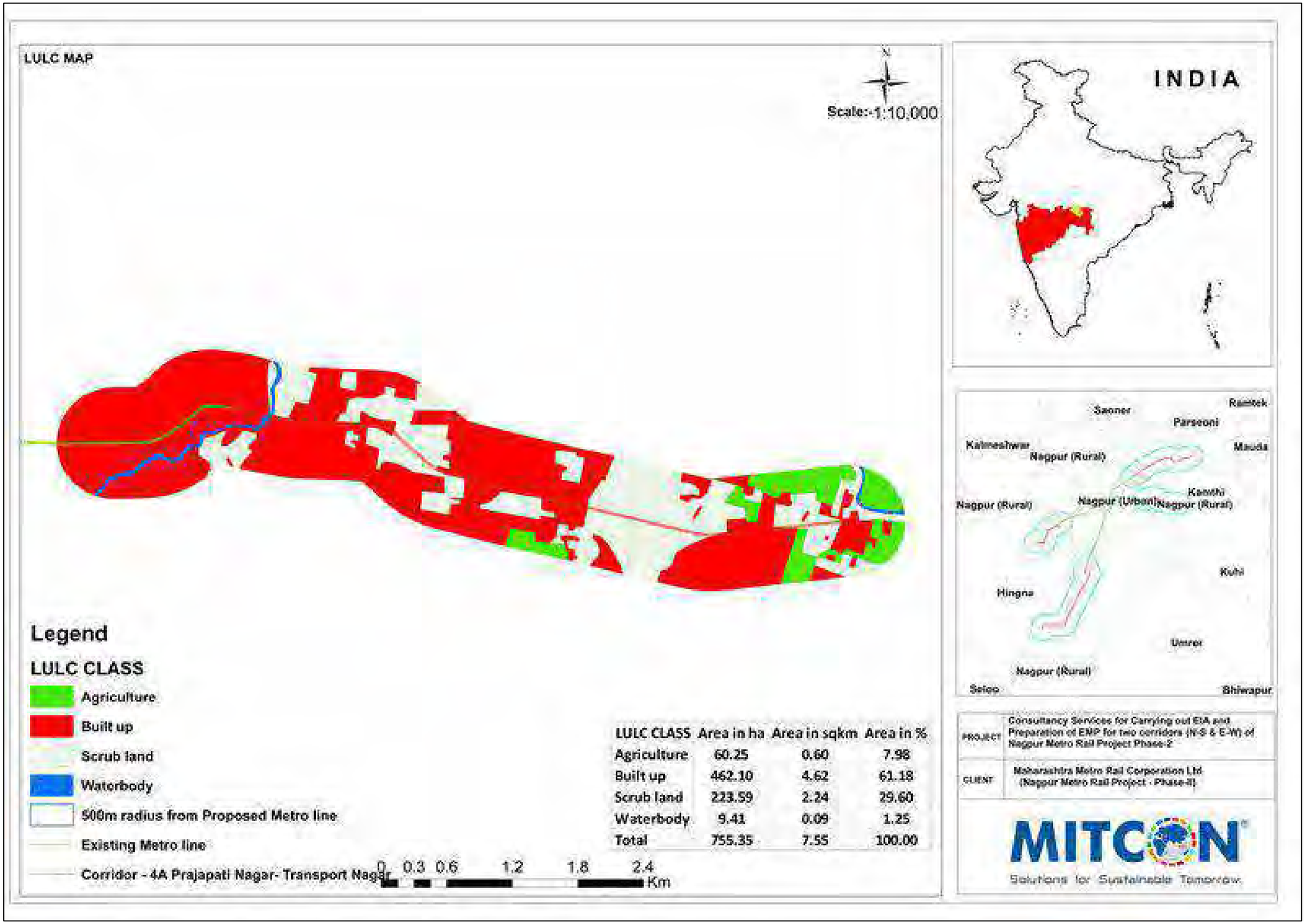


Figure 4-21: Land use / Land Cover in 500 m Core Study Area of Line 4A



5. Natural Hazards

195. The district of Nagpur 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.

196. 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

197. Nagpur city, especially, suffers the urban flooding due to lack of adequate sewers and proper flow management system. In the rural areas, the villages which are in the low-lying areas of the of rivers which gets flood-prone during monsoons. There have been seven major floods in Nagpur in the last 30 years as summarised in **Table 4-7** and 13% of the population lives in flood-prone areas.

Table 4-7: History of Floods in Nagpur District[31]

Name of the disaster	Date/year of Occurrence	Period of Impact	Area Affected (Location) (Ex. Village names/Taluka names)
Major Flood (Maha-pur)	31.07.1991	5 days	Mowad Narkhed Taluka
Flood	31.07.2013	1 day	Jahnsi rani Chowk, Vaishali nagar, Smata Nagar, Kalmana, Hudkeshwar Chowk (Nag Nadi and Pili Nadi)
Major Flood (Maha-pur)	07-07.2013	1 day	Butibori (Vena River)
Major Flood (Maha-pur)	12.08.2013	1 day	Hingana Ghat (Vena River)
Major Flood (Maha-pur)	24.08.2013	1 day	Ghoghara Village , Chindwara
Major Flood (Maha-pur)	24.08.2013	2 days	Kuhi, Mauda, Umred, Parseoni (Kanhan River)

198. The city has a tropical savannah climate (Aw in Köppen climate classification), typically hot, dry and tropical weather with an average annual rainfall of 1018 mm, where summer temperature escalates to 48ºC and the winter temperature dips to 10-12ºC. Due to the recent socio-economic changes, population growth and urbanization, the city is witnessing spatial expansion in administrative boundaries, thus the natural landscape once forming the edge of the city are now within the city limits. In this rapid urban transition scenario, the natural and managed public urban green spaces such as lakes, drainage basins of Nag and Pili River, urban forests, institutional green spaces, parks, playgrounds and gardens, are under tremendous pressure of destruction and degradation. Owing to urban sprawl with subsequent land use changes, the urban dwellers are witnessing increased air and water pollution, shrinking green spaces, increased flash floods due to increased build-

[31] *Source: District Disaster Management Plan for Nagpur District (2017-18) by District Disaster Management Authority, Nagpur.[https://static.s3waas.gov.in/s3d1f491a404d6854880943e5c3cd9ca25/uploads/2018/03/2018031651.pdf]*

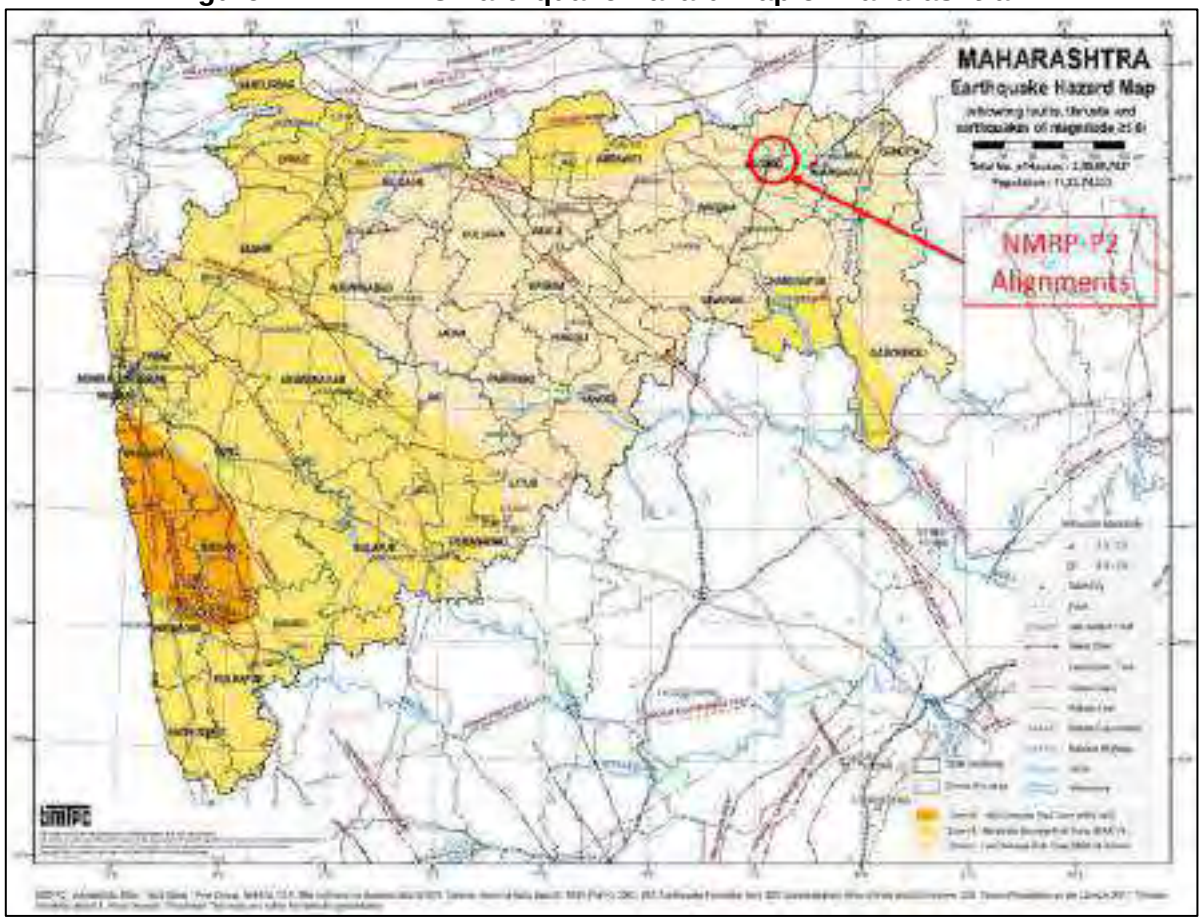
up areas and emergence of urban heat islands etc.[32]

199. Additionally, the uncontrolled development taking place in the city limits and outside has worsened the flood events occurring in and around the city. The existing physical infrastructure and social attributes have made the population vulnerable to urban floods. Urban flood is an event arising mostly due to anthropogenic activities such as rapid and haphazard development, encroachment of water bodies and pasture lands [33]. Land cover changes intensify the surface runoff and decreases water percolation. In other words, uncontrolled urban growth adds to the propensity of flooding, and at the same time increases the vulnerability of people towards the same. Urban floods have a devastating effect on the lives of the people, their properties, social and physical infrastructure as well as livelihood resources. Thus, in order to withstand the hazard, outlining the vulnerability of communities can be a first step towards making them resilient and prepared.

(b) Seismicity

200. Bureau of Indian Standards (BIS) has prepared a seismic zoning map of India based on tectonic features and records of past earthquakes. **Figure 4-22** 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).

Figure 4-22: BMTPC Earthquake Hazard Map of Maharashtra[34]



[32] *Source: Environment Status Report: Nagpur City – CSIR NEERI, Nagpur (2019-20).*

[33] *Source: A Place-based Approach to Assess the Vulnerability of Communities to Urban Floods: Case of Nagpur, India – Ingale K. & Chattopadhyay S. (June 2022)*

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

E. AMBIENT ENVIRONMENT

1. Meteorology

201. 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

202. 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 Nagpur is located at Dr. Babasaheb Ambedkar Airport, Sonegaon. Secondary data was obtained from IMD Nagpur (Sonegaon) and is presented in this report.

(b) Average Meteorological Condition at IMD – Nagpur (Sonegaon)

203. 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 Normals (1981-2010) for the IMD Regional Meteorological Centre (RMC) at Nagpur (Sonegaon) is presented in **Table 4-8**.

Table 4-8: Average of Meteorological Data from RMC – IMD Nagpur (Sonegaon)[35]

Location: In the compound of the Meteorological Office building at Sonegaon Airport. Open ground on all sides. Wind instruments on terrace of the building; exposure good. (Latitude: 21º06'N, Longitude: 79º03'E)
Approximate aerial distance from Project Site: ~8.46 km NNE from Ashokwan station on Line 1A, ~13.77 km SW of Pili Nadi station on Line 2A, ~6.93 km ESE from Hingna Mount View station on Line 3A and ~8.4 km SW of Pardi station on Line 4A
Elevation: 12 m above MSL

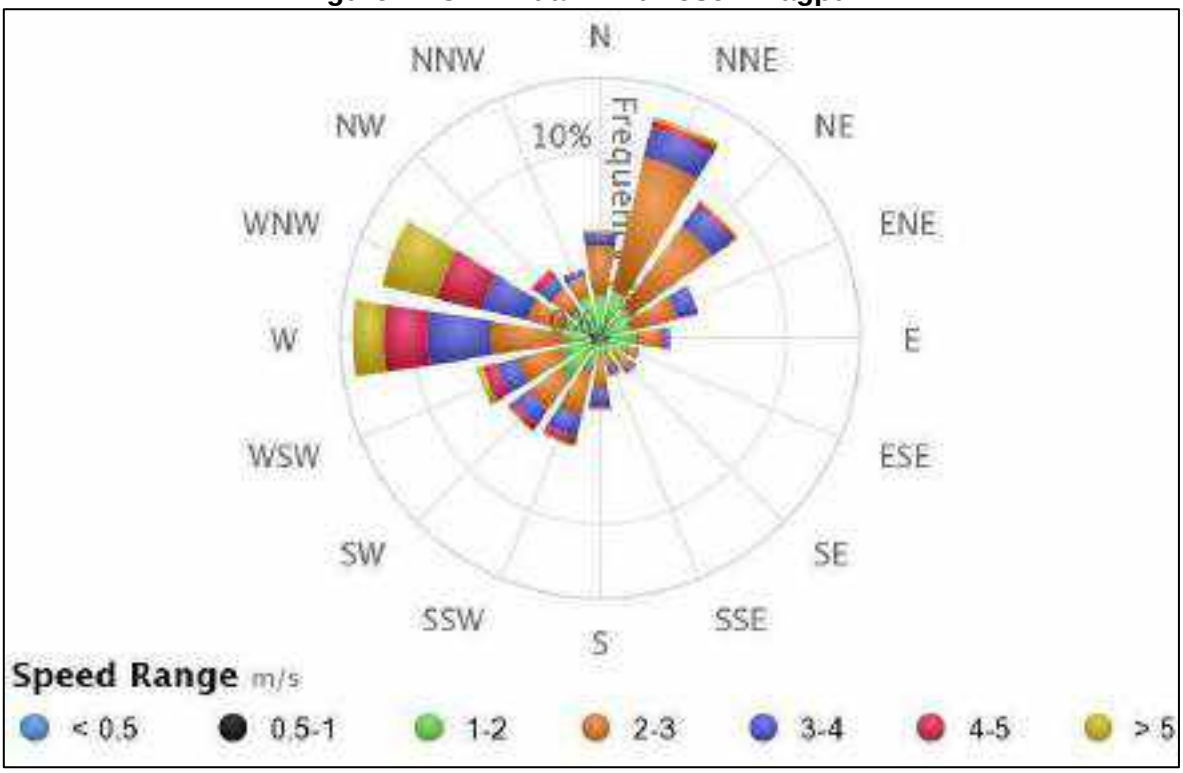
Month	Temperature º C				Humidity %		Rainfall		Mean Wind Speed m/s	Predominant direction
	Daily Max	Daily Min	Highest in Month	Lowest in Month	Max	Min	Monthly Total in mm	No. of Rainy Days		
January	29.0	13.4	32.5	8.8	67	42	21.6	1.2	4.7	N, NNE
February	31.8	15.6	35.7	11.1	54	31	15.6	1.2	5.6	N, NNE
March	36.4	19.7	40.4	15.3	41	24	21.7	1.6	5.8	N, NNE
April	40.7	24.1	43.9	19.4	33	19	9.2	0.9	6.4	N, NW
May	42.7	27.8	45.6	22.8	35	22	21.2	2.1	8.4	N, W-NW
June	38.0	26.5	44.3	22.5	61	49	168.8	8.8	8.5	SW, W-NW
July	31.8	24.3	36.0	22.5	82	72	313.7	13.9	6.9	SW, W-NW
August	30.7	23.8	34.1	21.8	85	76	267	13.1	6..5	SW, W-NW
September	32.3	23.2	35.3	21.0	81	71	170.2	8.7	5.4	N, W-NW

[35] *Source: GOI, Ministry of Earth Sciences, IMD, Climatological Tables 1981-2010*

Month	Temperature º C				Humidity %		Rainfall		Mean Wind Speed m/s	Predominant direction
	Daily Max	Daily Min	Highest in Month	Lowest in Month	Max	Min	Monthly Total in mm	No. of Rainy Days		
October	32.9	20.0	35.6	15.4	71	58	64	3.2	4.7	NNE, NE
November	30.9	15.8	33.3	11.8	65	51	16	1	4.6	NNE, NE
December	28.9	12.9	31.9	9.1	66	47	11.3	0.8	4.2	NNE, NE
Annual Average or Mean	**33.8**	**20.6**	**46.1**	**7.8**	**62**	**47**	**1100.3**	**56.6**	**6.0**	**N-NE, W-NW**

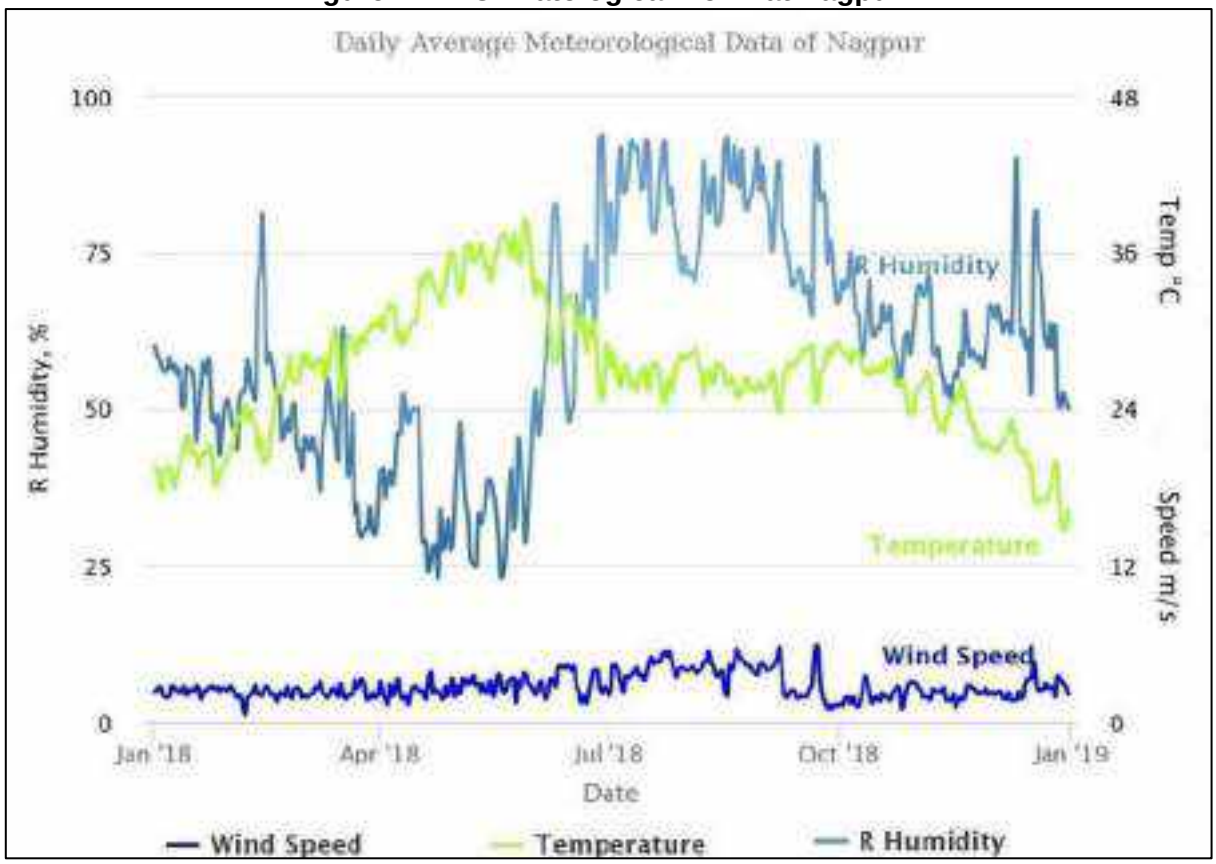
204. The Annual Wind-rose has been obtained from IMD Nagpur (Sonegaon) and shown as **Figure 4-23** and Daily Average Meteorological data (Climatological Norm) for Nagpur i.e. Temperature, Rainfall and Relative Humidity are shown as **Figure 4-24**.

Figure 4-23: Annual Wind-rose – Nagpur[36]



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

Figure 4-24: Climatological Norm at Nagpur[37]



2. Ambient Air Environment

205. 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)

206. 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).

207. The biggest source of lead in air is petrol and mining: neither of them are present in Nagpur 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

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

therefore ozone was not measured.

208. 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).

209. 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

210. The ambient air quality monitoring was undertaken once in the study period at all the proposed NMRP-P2 station locations on all 4 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 each of these locations. Measurement techniques used for Air quality analysis are presented in **Table 4-9**.

Table 4-9: 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

211. Ambient air quality monitoring was conducted at a total of 34 locations in the project study area. Location maps showing Air sampling locations for Reach 1A, Reach 2A, Reach 3A and Reach 4A are presented as **Figure 4-26**, **Figure 4-27**, **Figure 4-28** and **Figure 4-29** respectively. 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 4-10**, while details of the same are given in **Table 4-11.**

Table 4-10: Justification for selection of AAQ locations for NMRP-P2

Line	AAQ locations at NMRP-P2 Stations	AAQ locations at Sensitive Receptors	Crosswind Locations	Downwind Locations	Upwind Locations
1A	8	2	0	6	4
2A	9	2	3	4	4
3A	7	3	3	4	3
4A	3	0	0	3	0
Total	**27**	**7**	**6**	**17**	**11**

Table 4-11: Ambient Air Quality Stations monitored in Project Study Area

Line	Sampling Date	Machine Details	Sampling Code	Sampling Location	Type of Sample	Latitude	Longitude	Wind type[#]
1A	27.04.2023	Combo	AAQ.1	Ashokwan	Residential	21° 0'47.21"N	79° 2'42.47"E	DW
1A	22.04.2023	FPS, RDS	AAQ.2	Dongargaon	Residential	20°59'13.84"N	79° 1'48.28"E	DW
1A	23.04.2023	Combo	AAQ.3	Mohgaon	Residential	20°57'34.55"N	79° 1'2.22"E	DW
1A	23.04.2023	FPS, RDS	AAQ.4	Meghdoot CIDCO	Commercial	20°56'11.46"N	79° 0'26.81"E	DW
1A	24.04.2023	FPS, RDS	AAQ.5	Butibori Police Station	Commercial	20°55'45.14"N	79° 0'13.97"E	DW
1A	25.04.2023	Combo	AAQ.6	MHADA Colony	Commercial	20°55'42.22"N	78°59'56.08"E	UW
1A	25.04.2023	FPS, RDS	AAQ.7	MIDC KEC	Industrial	20°55'46.66"N	78°58'11.74"E	UW
1A	26.04.2023	Combo	AAQ.8	MIDC ESR	Industrial	20°55'24.58"N	78°57'51.47"E	UW
1A	24.04.2023	Combo	AAQ.9	Jijamata High School & Jr. College	Sensitive Receptor (School)	20°55'46.73"N	79° 0'18.04"E	DW
1A	26.04.2023	FPS, RDS	AAQ.10	Rachana Hospital	Sensitive Receptor (Hospital)	20°55'44.18"N	79° 0'0.43"E	UW
2A	17.04.2023	FPS, RDS	AAQ.11	Pili Nadi	Commercial	21°11'31.78"N	79° 7'43.52"E	UW
2A	17.04.2023	Combo	AAQ.12	Khasara fata	Commercial	21°11'49.19"N	79° 8'6.65"E	UW
2A	18.04.2023	Combo	AAQ.13	All India Radio	Commercial	21°12'10.21"N	79° 8'37.93"E	UW
2A	18.04.2023	FPS, RDS	AAQ.14	Khairi fata	Commercial	21°12'39.95"N	79° 9'33.83"E	UW
2A	19.04.2023	FPS, RDS	AAQ.15	Lok Vihar	Residential	21°12'56.59"N	79°10'3.96"E	CW
2A	19.04.2023	Combo	AAQ.16	Lekha Nagar	Residential and Sensitive Receptor (School & Hospital)	21°13'8.90"N	79°10'36.83"E	CW
				Asha Hospital and Asharam College & School of Nursing				
2A	20.04.2023	FPS, RDS	AAQ.17	Kamptee Police station**	Commercial	21°12'57.05"N	79°11'30.05"E	DW
2A	20.04.2023	FPS, RDS	AAQ.18	Kamptee Municipal Council	Commercial	21°12'46.36"N	79°11'56.90"E	DW
2A	21.04.2023	FPS, RDS	AAQ.19	Dragon Palace	Residential	21°13'1.64"N	79°12'29.2"E	DW
2A	22.04.2023	Combo	AAQ.20	Kanhan River	Residential	21°13'21.88"N	79°13'26.78"E	DW
2A	19.04.2023	Combo	AAQ.21	Delhi Public School (DPS), Khairy, Kamptee	Sensitive Receptor (School)	21°12'48.91"N	79° 9'35.83"E	CW

Line	Sampling Date	Machine Details	Sampling Code	Sampling Location	Type of Sample	Latitude	Longitude	Wind type#
				Road, Nagpur				
3A	21.04.2023	FPS, RDS	AAQ.22	Hingna Mount View	Commercial	21° 6'12.70"N	78°59'24.86"E	DW
3A	21.04.2023	FPS, RDS	AAQ.23	Rajiv Nagar	Commercial	21° 5'48.38"N	78°58'50.21"E	DW
3A	19.04.2023	FPS, RDS	AAQ.24	Wanadongri	Commercial	21° 5'30.72"N	78°58'25.46"E	CW
3A	19.04.2023	FPS, RDS	AAQ.25	APMC	Commercial	21° 5'9.26"N	78°58'18.62"E	CW
3A	18.04.2023	FPS, RDS	AAQ.26	Raipur	Commercial	21° 4'38.63"N	78°58'6.9"E	CW
3A	18.04.2023	FPS, RDS	AAQ.27	Hingna Bus Station	Commercial	21° 4'21.45"N	78°57'52.82"E	UW
3A	17.04.2023	FPS, RDS	AAQ.28	Hingna	Commercial	21° 4'27.11"N	78°57'23.17"E	UW
3A	17.04.2023	FPS, RDS	AAQ.29	Rural Hospital - Hingna	Sensitive Receptor (Hospital)	21° 4'29.05"N	78°57'15.89"E	UW
3A	20.04.2023	FPS, RDS	AAQ.30	YCCE	Sensitive Receptor (Engg. College)	21° 5'43.60"N	78°58'42.68"E	DW
3A	20.04.2023	FPS, RDS	AAQ.31	Shalinitai Meghe Hospital	Sensitive Receptor (Hospital)	21° 5'42.14"N	78°58'28.75"E	DW
4A	22.04.2023	FPS, RDS	AAQ.32	Pardi (Prakash Krishi Vidyalay High School gate)	Residential / Sensitive Receptor (School)	21° 8'58.03"N	79° 9'37.51"E	DW
4A	22.04.2023	FPS, RDS	AAQ.33	Kapsi Kh.	Residential	21° 8'38.86"N	79°10'35.17"E	DW
4A	22.04.2023	FPS, RDS	AAQ.34	Transport Nagar	Commercial	21° 8'27.22"N	79°11'36.07"E	DW

** *No environmental monitoring could be carried out in the vicinity of Cantonment station, as it is Defence area and permission is required from the Commanding Officer for same.*

DW – Down-wind; CW – Cross-wind; UW – Up-wind.

Figure 4-25: Photographs taken during Air-sampling in the Project Study Area

Photo no.	Date of Sampling	Location Geo-coordinates
1	17/04/2023	21°11'31.90"N / 79° 7'43.44"E
2	18/04/2023	21°12'10.21"N / 79° 8'37.93"E
3	20/04/2023	21°12'56.97"N / 79°11'29.99"E
4	21/04/2023	21° 6'12.70"N / 78°59'24.86"E
5	19/04/2023	21° 5'30.73"N / 78°58'25.46"E
6	23/04/2023	21° 8'27.19"N / 79°11'36.12"E
7	26/04/2023	20°55'44.18"N / 79° 0'0.43"E
8	27/04/2023	21° 0'47.21"N / 79° 2'42.47"E

Figure 4-26: Air Monitoring Locations for Reach 1A of NMRP-Phase II Project

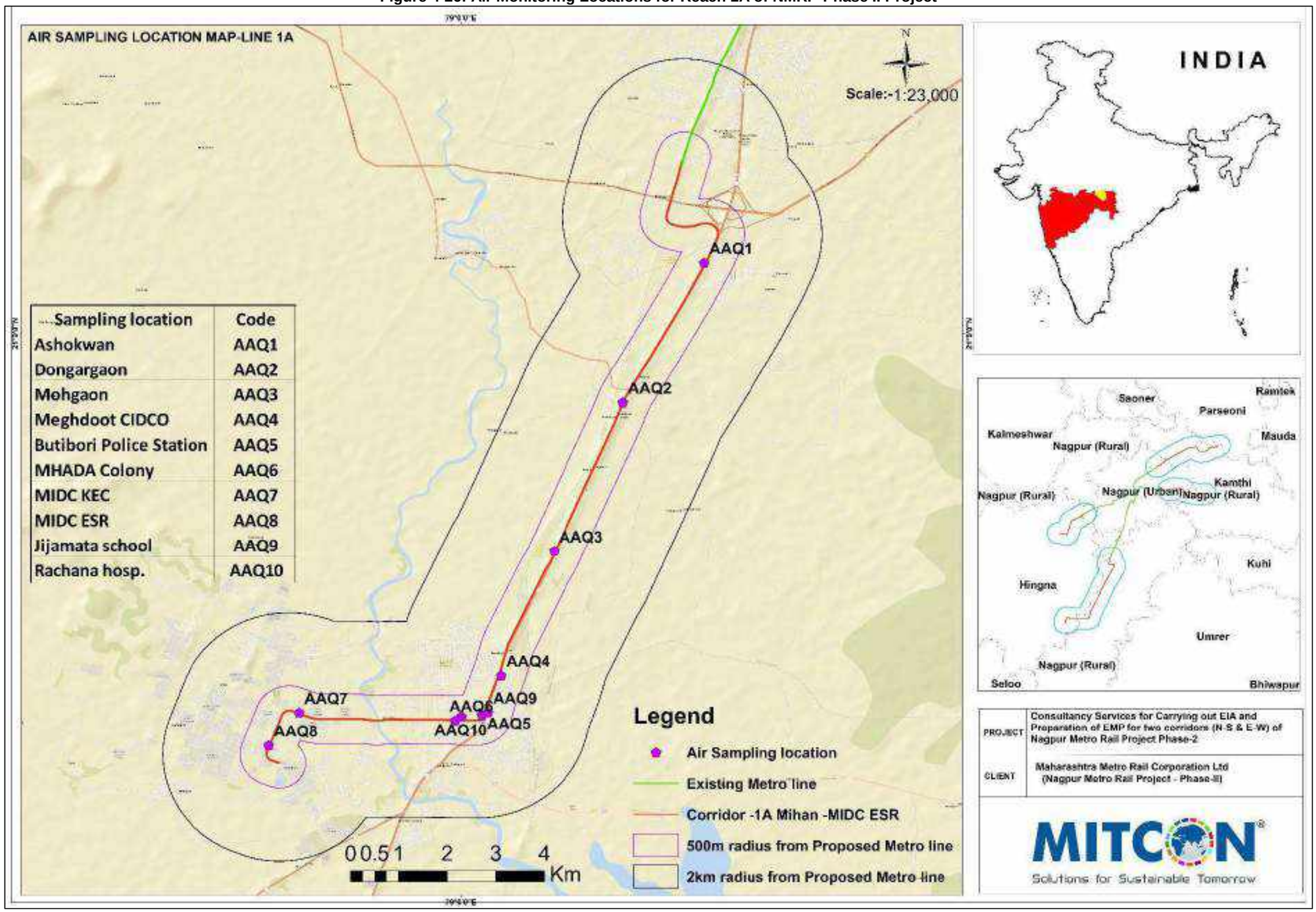


Figure 4-27: Air Monitoring Locations for Reach 2A of NMRP-Phase II Project

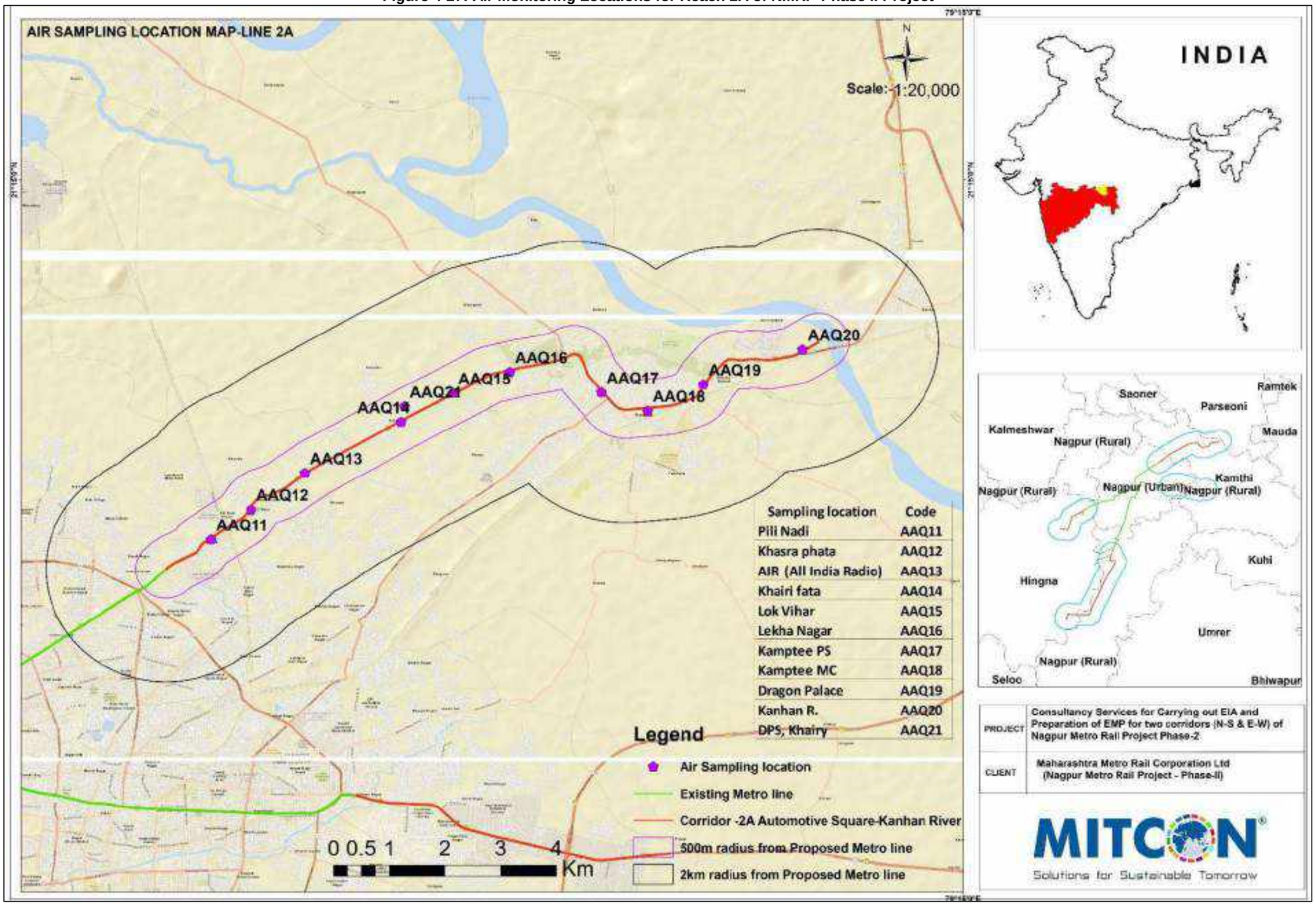


Figure 4-28: Air Monitoring Locations for Reach 3A of NMRP-Phase II Project

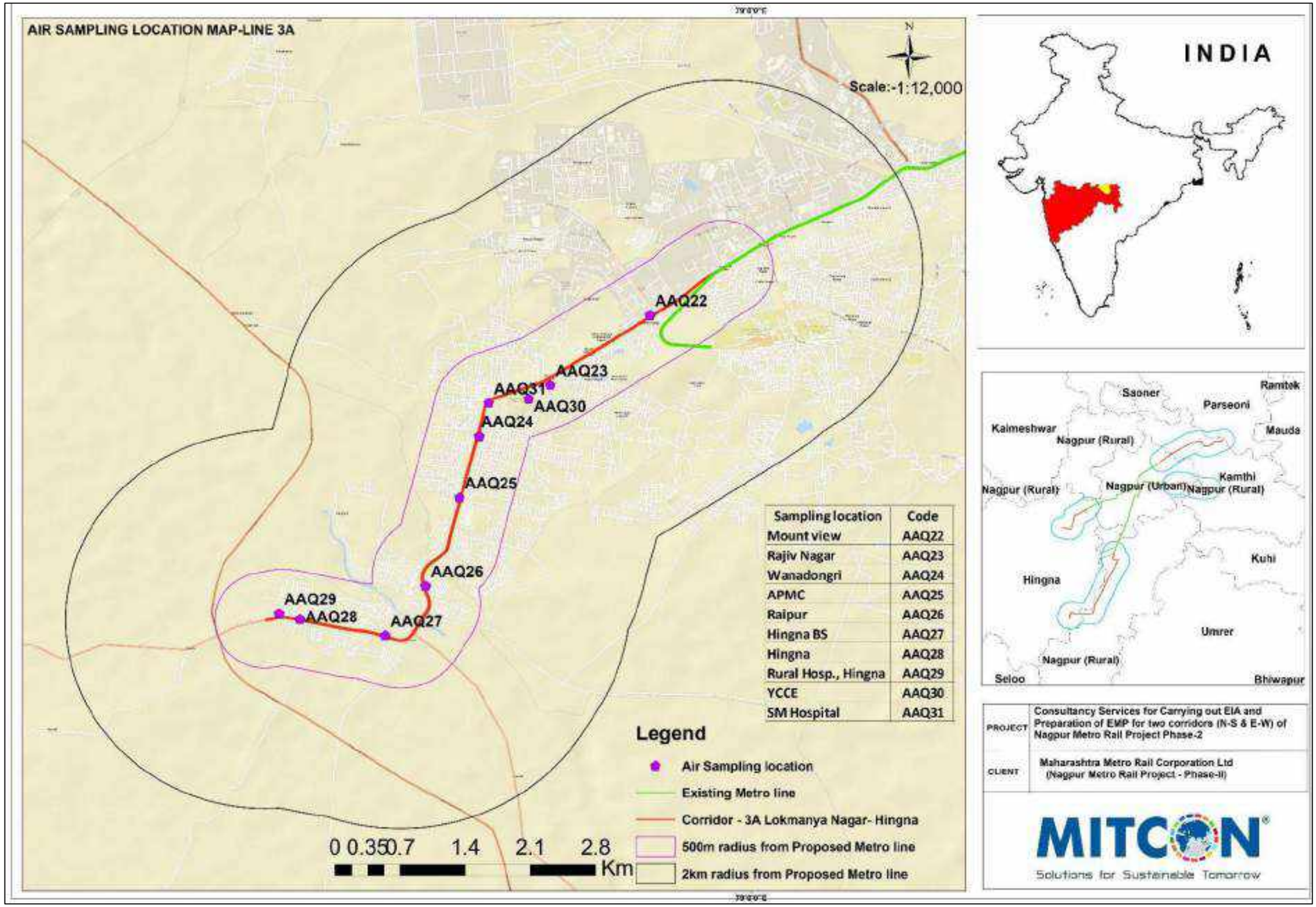
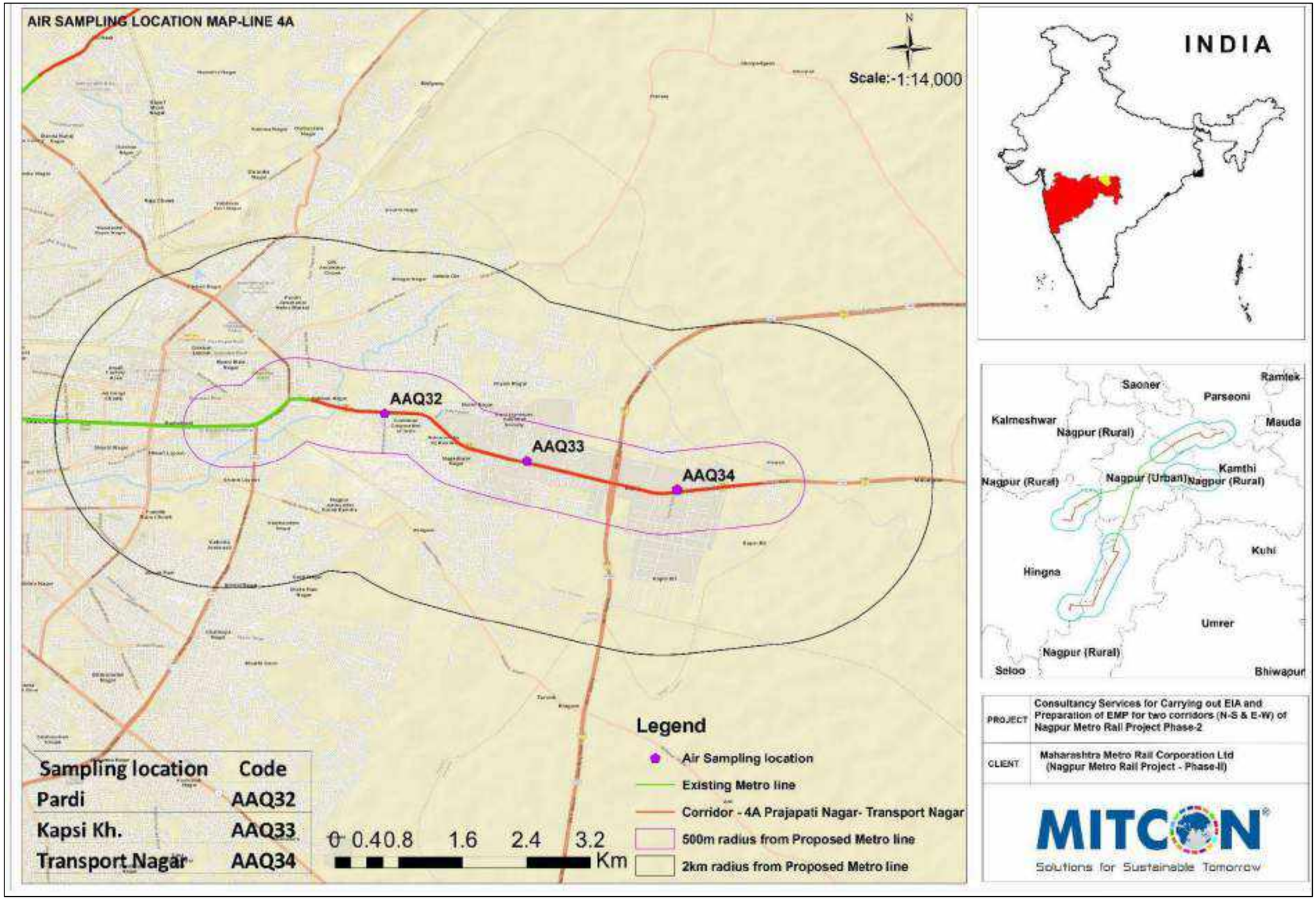


Figure 4-29: Air Monitoring Locations for Reach 4A of NMRP-Phase II Project



(d) Ambient Air Quality Results

212. The air pollutants emitted by point and non-point sources are transported, dispersed or concentrated by meteorological and topographical conditions. **Table 4-12** shows a summary of the analytical results of Air Quality monitoring samples gathered in the Project Study Area.

Table 4-12: Summary of Results of Ambient Air Quality monitoring

Sampling Location	$PM_{2.5}$ (60 µg/m^3)	PM_{10} (100 µg/m^3)	SO_2 (80 µg/m^3)	NO_X (80 µg/m^3)	CO (2 mg/m^3)
AAQ1	48.2	80.7	27.8	35.5	0.8
AAQ2	50.1	92.5	29.1	38.7	0.7
AAQ3	51.2	85.4	30.1	36.9	1.1
AAQ4	50.7	93.6	26.5	35.4	0.9
AAQ5	52.6	98.7	25.1	37.4	1.0
AAQ6	56.7	85.8	28.2	38.2	1.2
AAQ7	59.5	92.7	26.9	33.1	1.1
AAQ8	60.2	93.1	32.3	41.6	1.4
AAQ9	58.9	86.9	23.6	33.1	1.0
AAQ10	53.2	88.1	31.3	37.8	1.2
AAQ11	51.4	83.7	28.9	35.4	0.8
AAQ12	52.5	87.8	24.5	30.6	1.0
AAQ13	52.9	85.4	26.1	32.5	0.9
AAQ14	55.6	90.1	25.6	33.1	1.0
AAQ15	57.8	92.5	27.8	41.1	0.9
AAQ16	55.7	89.4	24.1	38.7	0.8
AAQ17	57.1	90.2	26.3	40.3	1.1
AAQ18	56.9	91.5	22.1	45.6	1.1
AAQ19	54.1	87.4	23.2	46.1	0.9
AAQ20	52.3	82.1	25.7	44.2	0.7
AAQ21	50.9	86.3	28.4	45.2	0.6
AAQ22	57.4	91.2	30.1	46.3	0.9
AAQ23	56.4	95.2	29.8	45.7	0.9
AAQ24	57.8	88.7	30.6	48.9	1.1
AAQ25	55.9	86.5	31.2	47.5	1.0
AAQ26	56.3	95.9	30.4	48.5	1.0
AAQ27	58.7	98.6	31.5	50.2	1.1
AAQ28	57.9	97.9	30.7	50.8	1.2
AAQ29	55.4	80.2	27.9	49.6	1.0
AAQ30	57.2	86.3	26.7	47.6	0.9
AAQ31	58.2	88.1	25.2	45.6	1.2
AAQ32	60.3	98.3	24.1	48.2	1.2
AAQ33	59.8	94.8	25.6	44.8	1.1
AAQ34	61.6	100.9	26.3	50.2	1.2

213. 24-hour air quality monitoring results indicates that all parameters were within the permissible level of National Ambient Air Quality Standards (NAAQS), except Particulate Matter (both PM10 and PM2.5). However, both PM10 and PM2.5 as well as NOx exceed the WHO guidelines and the WBG-EHS guidelines and SO_2 exceed the WBG-EHS guidelines. The measured parameters were compared with the NAAQS laid down by CPCB, the WHO guidelines (2021 AQGs) as well as the WBG-EHS limits for ambient air quality (2007) as given in **Table 4-13**.

Table 4-13: National and International Ambient Air Quality Standards

Pollutant, Unit	Time Weighted Average	Concentration in Ambient Air[38]		WHO Guidelines (2021 AQGs)[39]	WBG-EHS Guidelines (2007)[40]
		Industrial, Residential, Rural, and Other Areas	Ecologically Sensitive Area (notified by Central Government)		
Sulphur dioxide (SO_2), µg/m^3	Annual **24 hours** 	50 **80** 	20 80 	- **40** 	 **20**
Nitrogen dioxide (NO_2), µg/m^3	Annual **24 hours** 1 hour	40 **80** 	30 80 	10 **25** 	 200
Particulate matter (<10 µm) or PM_{10}, µg/m^3	Annual **24 hours**	60 **100**	60 100	15 **45**	 **50**
Particulate matter (< 2.5 µm) or $PM_{2.5}$, µg/m^3	Annual **24 hours**	40 **60**	40 60	5 **15**	 **25**
Carbon monoxide or CO, mg/m^3	24 hours **8 hours** 1 hour	- **2** 4	- 2 4	4 **-** -	

(e) Air Modelling Studies

214. Prediction of impacts on air environment in both Construction and Operation phases of the project have been carried out by employing a mathematical model. 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.

215. The hourly secondary data collected from IMD has been used for the period April to June 2023. The air pollution modelling carried out represents the worst case and normal operating scenarios for Nagpur metro corridors. Analysis of data is under process and the results for predicted incremental Ground Level Concentrations (GLCs) shall be incorporated in the final report. Detailed report on Air quality modelling is attached as **Annexure-5** of this report.

3. Ambient Noise

(a) Methodology

216. 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, 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,

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

[39] *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]*

[40] *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].*

adverse meteorological conditions, if any, etc., the "Pause" function on the instrument can be used to exclude any such extra noise.

217. 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 NMRP Phase II Noise level assessment include hospitals, schools and colleges.

(b) Sampling Period, Frequency and Parameters

218. Ambient noise levels were monitored at 34 locations, identified during preliminary baseline survey within the study area, as shown in **Table 4-14**. Some of the photographs taken during noise monitoring in the Study area are shown as **Figure 4-30**. Noise sampling locations for Reach 1A, Reach 2A, Reach 3A and Reach 4A are shown as **Figure 4-31**, **Figure 4-32**, **Figure 4-33** and **Figure 4-34** respectively.

Table 4-14: Noise Monitoring Sampling Locations of NMRP-P2 corridors

Line	Sampling Code	Sampling Location	Significance / Zone	Proximity to proposed NMRP-P2 station	Side of Alignment	Latitude	Longitude
1A	NQ1	Ashokwan	NMRP P2 station / Residential	At Ashokwan station	RHS	21° 0'46.64" N	79° 2'42.53" E
1A	NQ2	Dongargaon	NMRP P2 station / Residential	At Dongargaon station	RHS	20°59'12.64" N	79° 1'47.68" E
1A	NQ3	Mohgaon	Near NMRP P2 station / Residential	45 m SW of Mohgaon station	RHS	20°57'35.33" N	79° 1'2.72" E
1A	NQ4	Meghdoot CIDCO	NMRP P2 station / Commercial	At Meghdoot CIDCO station	LHS	20°56'11.89" N	79° 0'25.86" E
1A	NQ5	Butibori Police Station	NMRP P2 station / Commercial	119 m SW of Butibori station (in the area allotted for Parking)	RHS	20°55'45.83" N	79° 0'14.09" E
1A	NQ6	MHADA Colony	NMRP P2 station / Commercial	At MHADA Colony station	RHS	20°55'42.27" N	78°59'56.53" E
1A	NQ7	MIDC KEC	Near NMRP P2 station / Industrial	33m ESE of MIDC KEC station	LHS	20°55'45.70" N	78°58'11.06" E
1A	NQ8	MIDC ESR	Near NMRP P2 station / Industrial	55m SSW of MIDC ESR station	RHS	20°55'24.14" N	78°57'51.55" E
1A	NQ9	Jijamata High School & Jr. College	Sensitive Receptor (School) / Silence	55 m SSE of Butibori PS station	LHS	20°55'46.75" N	79° 0'18.26" E

Line	Sampling Code	Sampling Location	Significance / Zone	Proximity to proposed NMRP-P2 station	Side of Alignment	Latitude	Longitude
1A	NQ10	Rachana Hospital	Sensitive Receptor (Hospital)	104 m NE of MHADA Colony station	RHS	20°55'43.41"N	79° 0'0.56"E
2A	NQ11	Pili Nadi	NMRP P2 station / Commercial	At Pili Nadi station	RHS	21°11'32.28"N	79° 7'44.11"E
2A	NQ12	Khasara fata	NMRP P2 station / Commercial	40 m NE of Khasara fata station	RHS	21°11'49.79" N	79° 8'6.70" E
2A	NQ13	All India Radio	NMRP P2 station / Commercial	6 m NE of AIR station	LHS	21°12'9.97"N	79° 8'37.43"E
2A	NQ14	Khairi fata	NMRP P2 station / Commercial	At Khairi fata station	LHS	21°12'40.05" N	79° 9'32.12" E
2A	NQ15	Lok Vihar	NMRP P2 station / Residential	At Lok Vihar station	RHS	21°12'54.36" N	79°10'1.8" E
2A	NQ16	Lekha Nagar Asha Hospital and Asharam College & School of Nursing	Near NMRP Phase II station and Sensitive receptor - School & Hospital / Silence	This location taken at the proposed Lekha Nagar staton, is common for Asha Hospital & College (Sensitive Receptor)	RHS	21°13'9.11" N	79°10'35.50" E
2A	NQ17	Kamptee Police station**	NMRP P2 station / Commercial	At Kamptee PS station	RHS	21°12'55.03" N	79°11'32.30" E
2A	NQ18	Kamptee Municipal Council	NMRP P2 station / Commercial	At Kamptee Municipal Council station	RHS	21°12'47.51" N	79°11'56.43" E
2A	NQ19	Dragon Palace	NMRP P2 station / Residential	13m NE of Dragon Palace station	RHS	21°13'1.00"N	79°12'30.16"E
2A	NQ20	Kanhan River	Proposed NMRP P2 station (revised)	At Kanhan station	LHS	21°13'21.24" N	79°13'26.03" E
2A	NQ21	Delhi Public School (DPS), Khairy, Kamptee Road, Nagpur	School / Silence	201 m NW of Reach 2A alignment (near Khairi fata station)	LHS	21°12'49.14" N	79° 9'35.39" E
3A	NQ22	Hingna Mount View	NMRP P2 station / Commercial	At Hingna mount View station	LHS	21° 6'12.21" N	78°59'24.77" E
3A	NQ23	Rajiv Nagar	NMRP P2 station / Commercial	At Rajiv Nagar station	LHS	21° 5'50.78" N	78°58'51.05" E
3A	NQ24	Wanadongri	NMRP P2 station / Commercial	At Wanadongri station	RHS	21° 5'32.24" N	78°58'24.93" E
3A	NQ25	APMC	NMRP P2 station / Commercial	At APMC station	RHS	21° 5'8.39" N	78°58'18.37" E

Line	Sampling Code	Sampling Location	Significance / Zone	Proximity to proposed NMRP-P2 station	Side of Alignment	Latitude	Longitude
3A	NQ26	Raipur	NMRP P2 station / Commercial	At Raipur station (in the area allotted for Parking)	LHS	21° 4'37.69" N	78°58'7.10" E
3A	NQ27	Hingna Bus Station	NMRP P2 station / Commercial	At Hingna BS station (in the area allotted for Parking)	RHS	21° 4'20.91" N	78°57'54.13" E
3A	NQ28	Hingna	NMRP P2 station / Commercial	At Hingna station	LHS	21° 4'26.42" N	78°57'22.52" E
3A	NQ29	Rural Hospital - Hingna	Hospital / Silence	38m N of Reach 3A alignment (169m WNW of Hingna station RHS)	RHS	21° 4'29.18" N	78°57'16.31" E
3A	NQ30	YCCE	College / Silence	104 m SSE of Reach 3A alignment	LHS	21° 5'43.27" N	78°58'41.14" E
3A	NQ31	Shalinitai Meghe Hospital	Hospital / Silence	Along the Reach 3A alignment	LHS	21° 5'42.77" N	78°58'29.87" E
4A	NQ32	Pardi (Prakash Krishi Vidyalay High School)	NMRP P2 station and School / Silence	At Pardi station, around 25m NE of Prakash Krishi Vidyalay High School)	RHS	21° 8'58.10" N	79° 9'38.54" E
4A	NQ33	Kapsi Kh.	NMRP P2 station / Residential	At Kapsi Kh. Station	RHS	21° 8'37.52" N	79°10'33.68" E
4A	NQ34	Transport Nagar	NMRP P2 station / Commercial	56m E of Transport Nagar station	RHS	21° 8'25.97" N	79°11'41.65" E

*** No environmental monitoring could not be carried out in the vicinity of Cantonment station, as it is Defence area and permission is required from the Commanding Officer.*

Figure 4-30: Some Photographs taken during Noise Monitoring in the Study Area

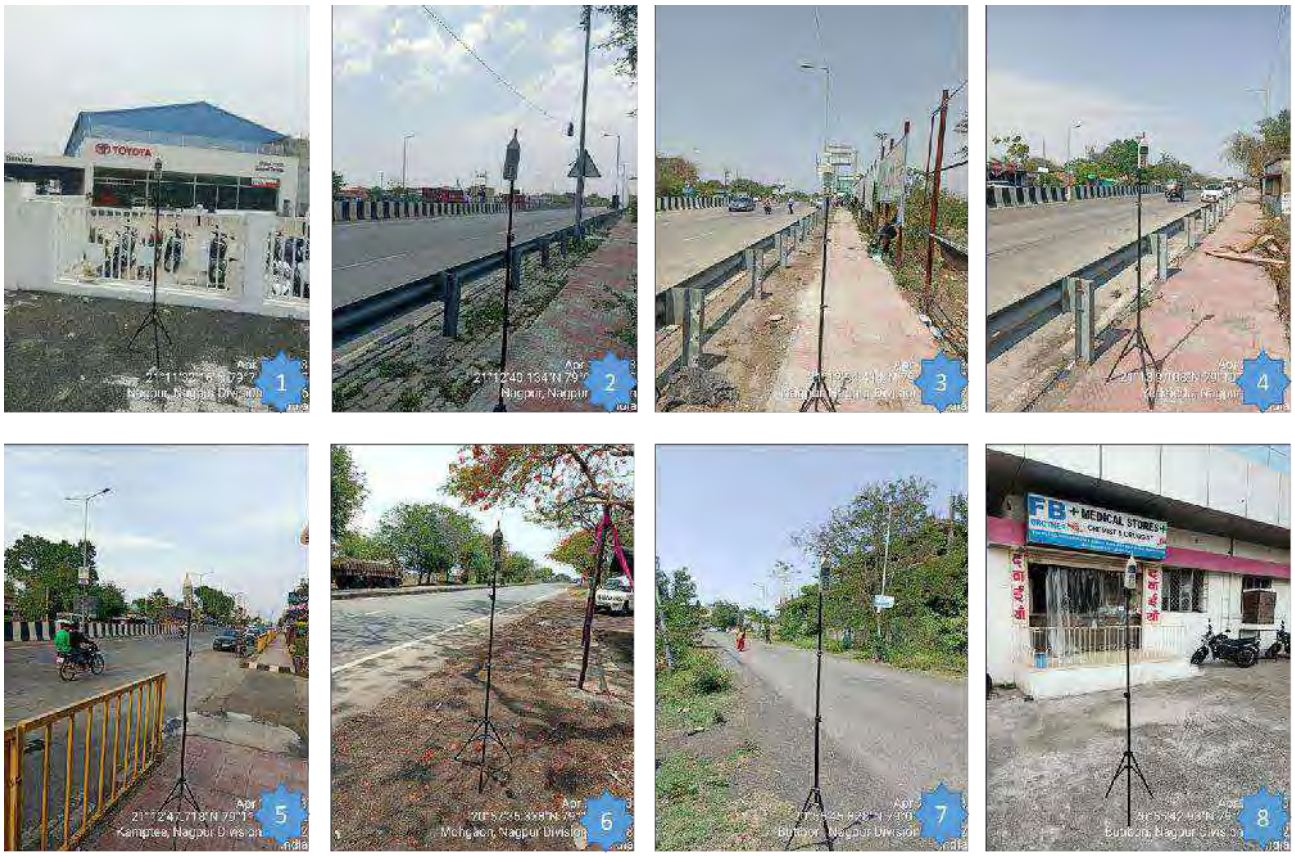
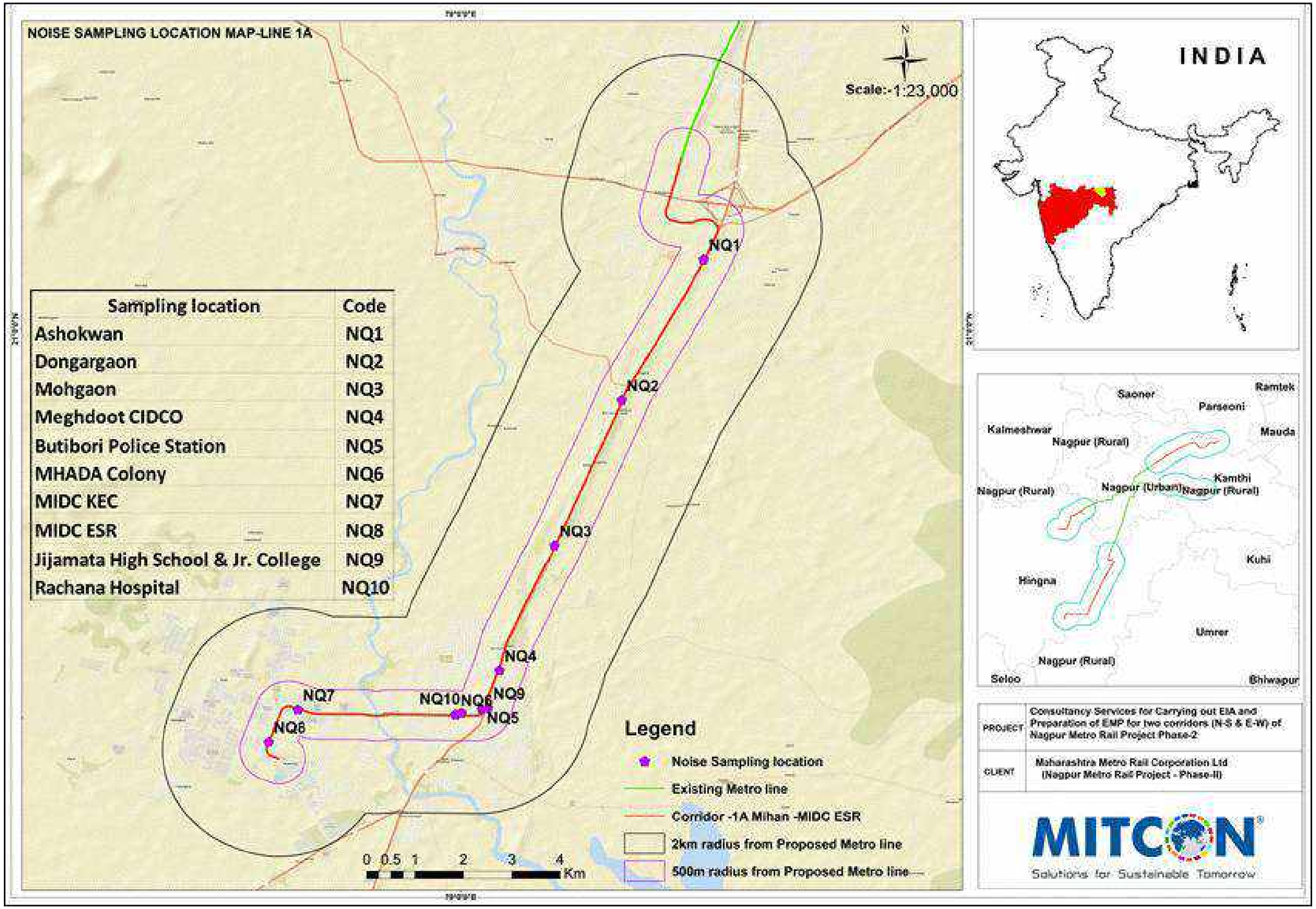


Photo no.	Date of Sampling	Location Geo-coordinates
1	17/04/2023	21°11'32.16"N / 79° 7'44.05"E
2	18/04/2023	21°12'40.13"N / 79° 9'32.13"E
3	19/04/2023	21°12'54.41"N / 79°10'1.8"E
4	20/04/2023	21°13'9.11"N / 79°10'35.50"E
5	21/04/2023	21°12'47.72"N / 79°11'56.56"E
6	23/04/2023	20°57'35.33"N / 79° 1'2.72"E
7	24/04/2023	20°55'45.83"N / 79° 0'14.09"E
8	26/04/2023	20°55'42.93"N / 79° 0'0.34"E

Figure 4-31: Noise Monitoring Sampling Locations for Reach 1A



Sampling location	Code
Ashokwan	NQ1
Dongargaon	NQ2
Mohgaon	NQ3
Meghdoot CIDCO	NQ4
Butibori Police Station	NQ5
MHADA Colony	NQ6
MIDC KEC	NQ7
MIDC ESR	NQ8
Jijamata High School & Jr. College	NQ9
Rachana Hospital	NQ10

Figure 4-32: Noise Monitoring Sampling Locations for Reach 2A

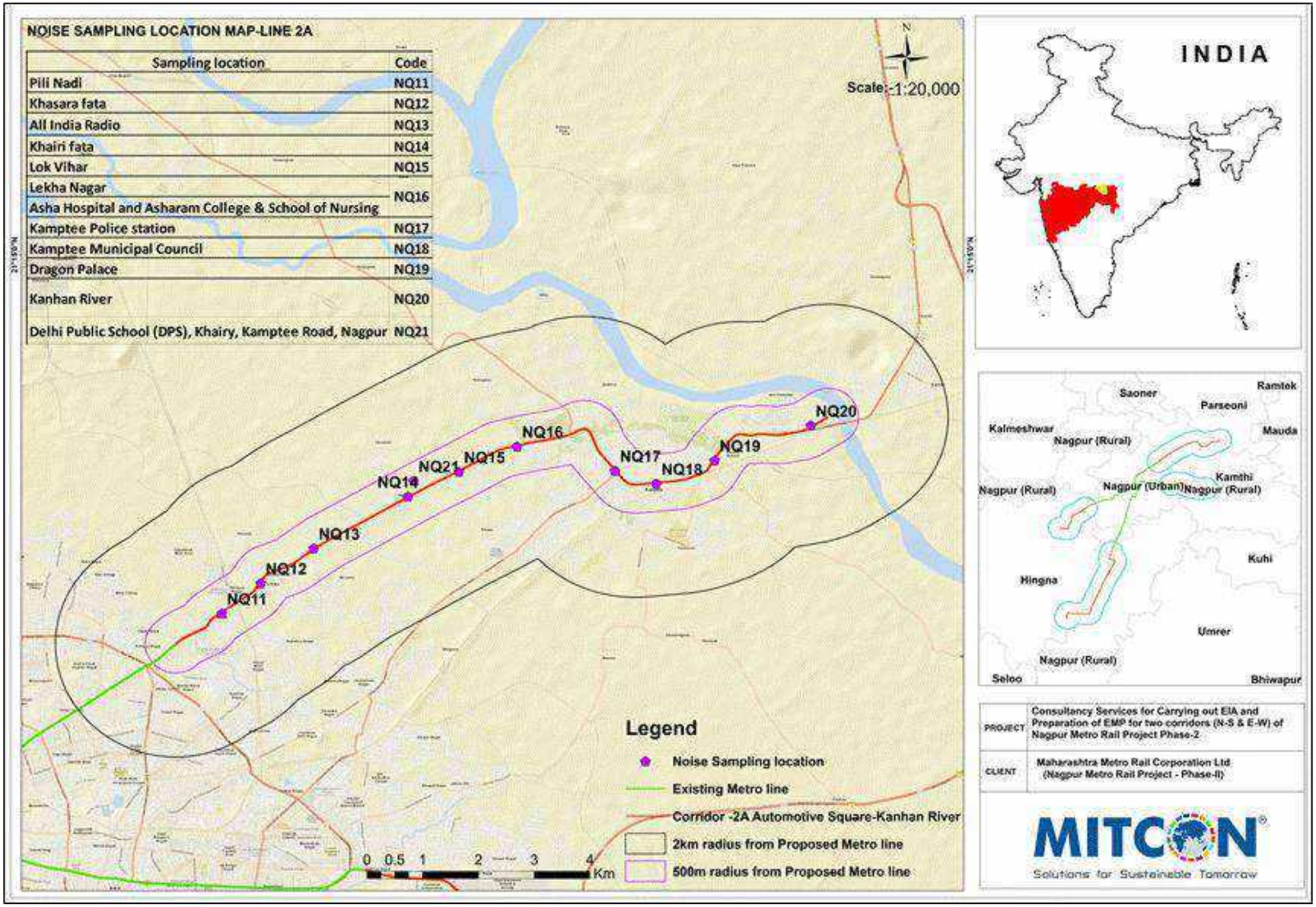


Figure 4-33: Noise Monitoring Sampling Locations for Reach 3A

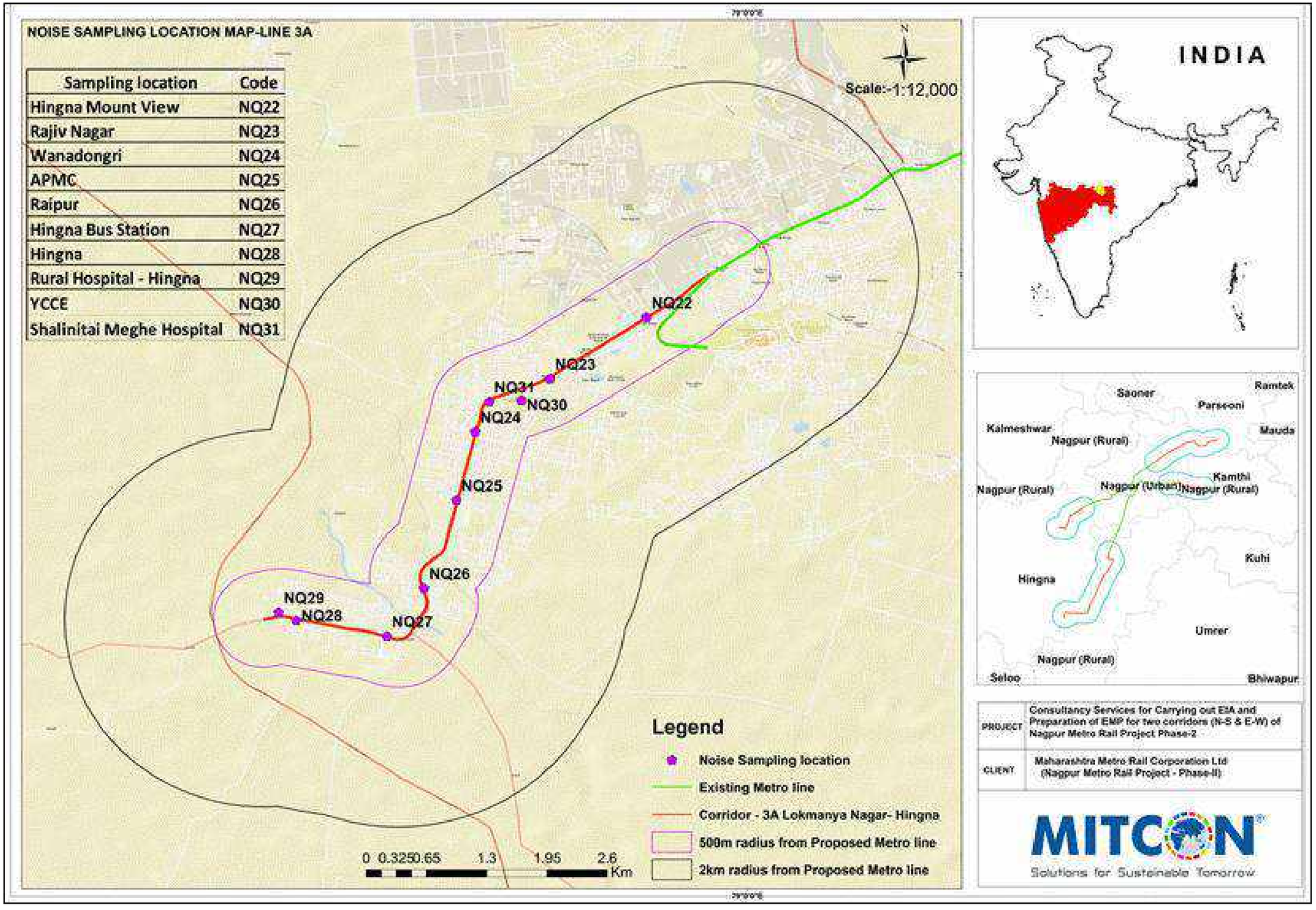
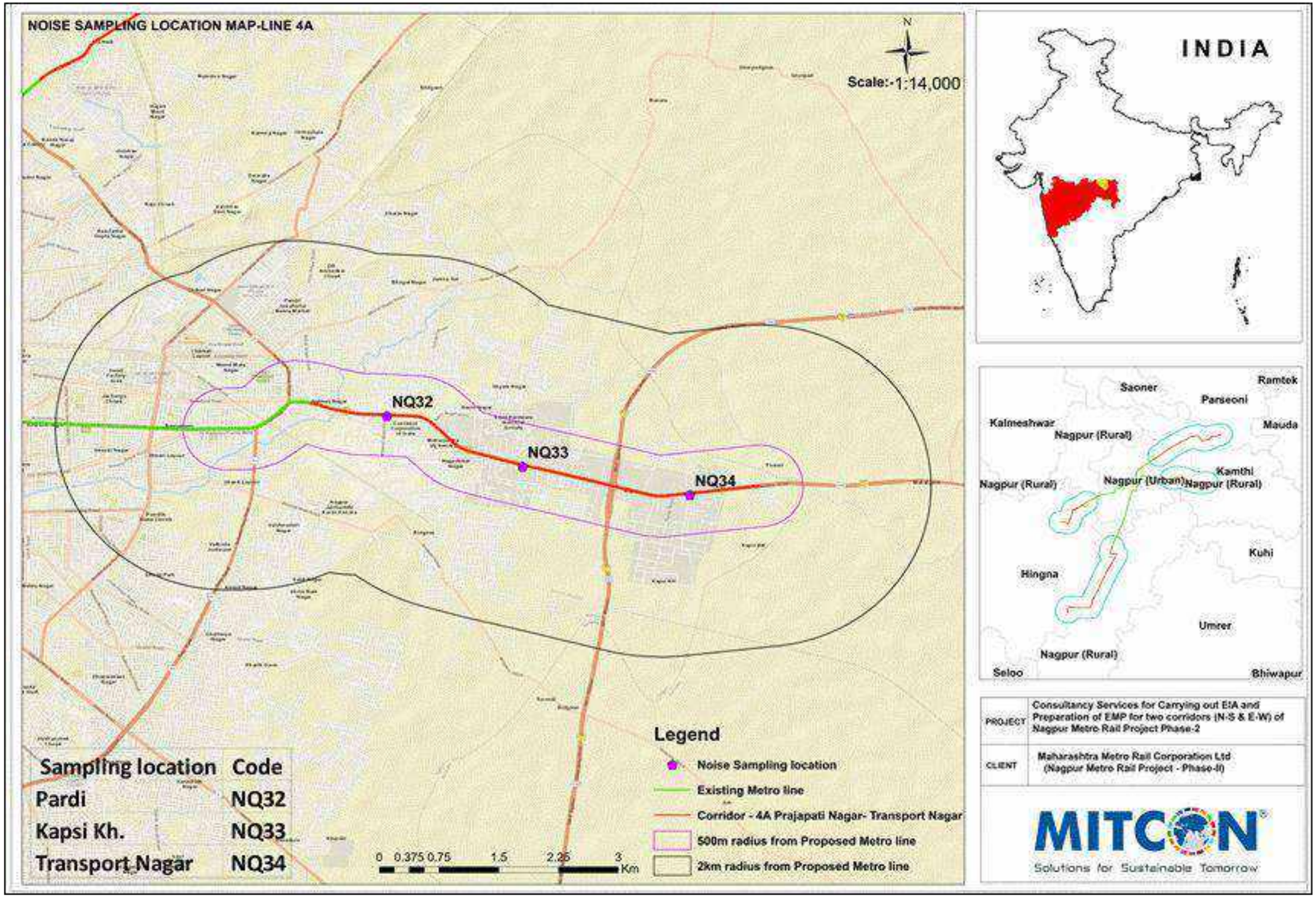


Figure 4-34: Noise Monitoring Sampling Locations for Reach 4A



(c) Noise Quality Sampling Results

219. 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 4-15**.

Table 4-15: Summary of Noise Monitoring Results for NMRP-P2

Sample No.	Locations (Village)	Category of Area / Zone	24 hourly Average Noise Level Values [in L_{eq} dB (A)]	
			Day	Night
NQ1	Ashokwan	Residential	50.1	36.1
NQ2	Dongargaon	Residential	47.2	30.6
NQ3	Mohgaon	Residential	51.6	40.5
NQ4	Meghdoot CIDCO	Commercial	62.7	49.4
NQ5	Butibori Police Station	Commercial	59.8	48.3
NQ6	MHADA Colony	Commercial	61.6	49.8
NQ7	MIDC KEC	Industrial	**73.6**	52.5
NQ8	MIDC ESR	Industrial	68.0	54.9
NQ9	Jijamata High School & Jr. College	Silence	51.6	44.7
NQ10	Rachana Hospital	Silence	54.2	45.6
NQ11	Pili Nadi	Commercial	60.3	51.3
NQ12	Khasara fata	Commercial	61.4	52.1
NQ13	All India Radio	Commercial	64.2	50.4
NQ14	Khairi fata	Commercial	60.9	51.9
NQ15	Lok Vihar	Residential	54.9	**45.7**
NQ16	Lekha Nagar Asha Hospital and Asharam College & School of Nursing	Silence	56.8	44.9
NQ17	Kamptee Police station	Commercial	59.8	50.1
NQ18	Kamptee Municipal Council	Commercial	55.1	45.6
NQ19	Dragon Palace	Residential	54.9	44.2
NQ20	Kanhan River	Residential	52.1	40.6
NQ21	Delhi Public School (DPS), Khairy, Kamptee Road, Nagpur	Silence	50.1	43.6
NQ22	Hingna Mount View	Commercial	56.9	42.3
NQ23	Rajiv Nagar	Commercial	60.3	46.9
NQ24	Wanadongri	Commercial	59.8	44.8
NQ25	APMC	Commercial	61.2	**55.1**
NQ26	Raipur	Commercial	64.1	53.7
NQ27	Hingna Bus Station	Commercial	62.7	**55.9**
NQ28	Hingna	Commercial	**67.4**	52.1
NQ29	Rural Hospital - Hingna	Silence	**53.2**	**46.8**
NQ30	YCCE	Silence	**55.4**	**43.9**
NQ31	Shalinitai Meghe Hospital	Silence	**56.6**	**47.8**
NQ32	Pardi (Prakash Krishi Vidyalay High School gate)	Silence	**59.8**	**49.1**
NQ33	Kapsi Kh.	Residential	**62.3**	**50.2**
NQ34	Transport Nagar	Commercial	64.9	51.3

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

(d) Inferences

220. The Noise monitoring results most of the sampling locations are found to be within the prescribed standards (shown in **Table 4-16**), except a few locations. 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 4-16: Guidelines/Standards with respect to Noise

Area Code	Category	CPCB Limits[41] in dB(A) Leq		WBG-EHS Limits[42] 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*

(e) Noise Modelling Studies

221. Noise modelling for the NMRP Phase II alignments was carried out using SoundPlan software. Detailed Report on Noise modelling studies undertaken for NMRP Phase II Project for construction as well as operation phases is attached as **Annexure-6** to this Report.

222. 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.

223. The baseline noise levels at receptors on four routes, along with the modelled noise values from the metro train, are as presented in **Annexure-6** (Table 6). The daytime and night-time contour maps and the single-point maps for each receiver are also provided in **Annexure-6**. The findings are summarised in following paragraphs:

- For Line 1A the total noise levels during metro operation are within permissible limits for all the modelled locations except at two receptors Daruloom Amjadia School and Masjid & Dargah where total night-time noise levels increase by 6 dB(A) and 5.5 dB(A) respectively over the baseline levels. Both these sensitive receptors have landuse category of silent zone as per Central Pollution Control Board (CPCB) norms. However, there is no activity at these sensitive receptors during night time and metro will not be operational during whole night. Therefore, no mitigation measures are required at these receptors.

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

[42] *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]*

- For Line 2A the total noise levels during metro operation are within CPCB permissible
- limits at all the modelled receptors. Maximum increment in noise is observed at Christ Church where daytime noise levels increases by 0.5 dB(A) and night-time levels are increased by 2.4 dB(A).
- For Line 3A the total noise levels during metro operation are within CPCB permissible
- limits at all the modelled receptors except at Dr. Babasaheb Ambedkar Super Speciality Hospital where daytime noise levels increase by 1.4 dB(A) and night-time levels are increased by 3.2 dB(A).
- For Line 4A the total noise levels during metro operation are within CPCB permissible limits at all the sensitive receptors. Maximum increment in noise is observed at Pardi Residential Area where daytime noise levels increases by 0.6 dB(A) and night-time levels are increased by 2 dB(A).

4. Vibration Analysis

(a) Methodology

224. Construction and operation of metro will cause vibration from equipment during construction and wheel-rail interaction during operation. As part of the detailed design, a vibration analysis at pre-identified receptors comprising educational and medical buildings and other fragile buildings, if any, located within recommended screening distance of 62m (RRT, cat.2) on either side of alignment will be carried out, based on which, a set of mitigations will be prepared and implemented.

225. 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 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

226. The vibration measurement has been carried out at 9 locations (identified sensitive receptors) located near the alignments as shown in **Table 4-17**, 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. Some photographs taken during vibration monitoring in the Study area are shown as **Figure 4-35**. Since there were no identified sensitive receptors on Reach 4A, only one sample was taken at a Residential area near Pardi station. Sampling locations taken for Vibration monitoring, at Reach 1A, Reach 2A, Reach 3A and Reach 4A are respectively shown in **Figure 4-36**, **Figure 4-37** and **Figure 4-38** and **Figure 4-39**.

Table 4-17: Vibration Sampling Locations of NMRP-P2 corridors

Line	Sampling Code	Sampling Location	Significance	Latitude	Longitude
1A	VB9	Jijamata High School & Jr. College	Sensitive Receptor (School)	20°55'46.79" N	79° 0'18.23" E
1A	VB10	Rachana Hospital	Sensitive Receptor (Hospital)	20°55'43.79"N	78°59'59.7"E
2A	VB16	Asha Hospital and Asharam College & School of Nursing	Sensitive Receptor (School & Hospital)	21°13'8.52"N	79°10'36.74"E
2A	VB17	Girijadhar Balaji Hanuman Temple	Temple (PCR)	21°12'52.41"N	79°11'31.24"E
2A	VB21	Delhi Public School (DPS), Khairy, Kamptee Road, Nagpur	Sensitive Receptor (School)	21°12'43.34"N	79° 9'36.93"E
3A	VB29	Rural Hospital - Hingna	Sensitive Receptor (Hospital)	21° 4'29.01"N	78°57'15.34"E
3A	VB30	YCCE	Sensitive Receptor (Engg. College)	21° 5'43.55" N	78°58'41.26" E
3A	VB31	Dr. Babasaheb Ambedkar Superspeciality Hospital	Sensitive Receptor (Hospital)	21° 5'42.41" N	78°58'29.12" E
4A	VB32	Pardi	NMRP-P2 station / Sample Residential Area	21° 8'57.99" N	79° 9'37.53" E

Figure 4-35:Some Photographs taken during Vibration Monitoring in the Study Area

Photo no.	Date of Sampling	Location Geo-coordinates
1	18/05/2023	20°55'43.72"N / 78°59'59.77"E
2	31/05/2023	21°13'7.53"N / 79°10'38.12"E
3	05/05/2023	21° 5'42.42"N / 78°58'29.02"E
4	11/05/2023	21° 4'28.81"N / 78°57'15.08"E

Figure 4-36: Vibration Sampling Locations for Reach 1A

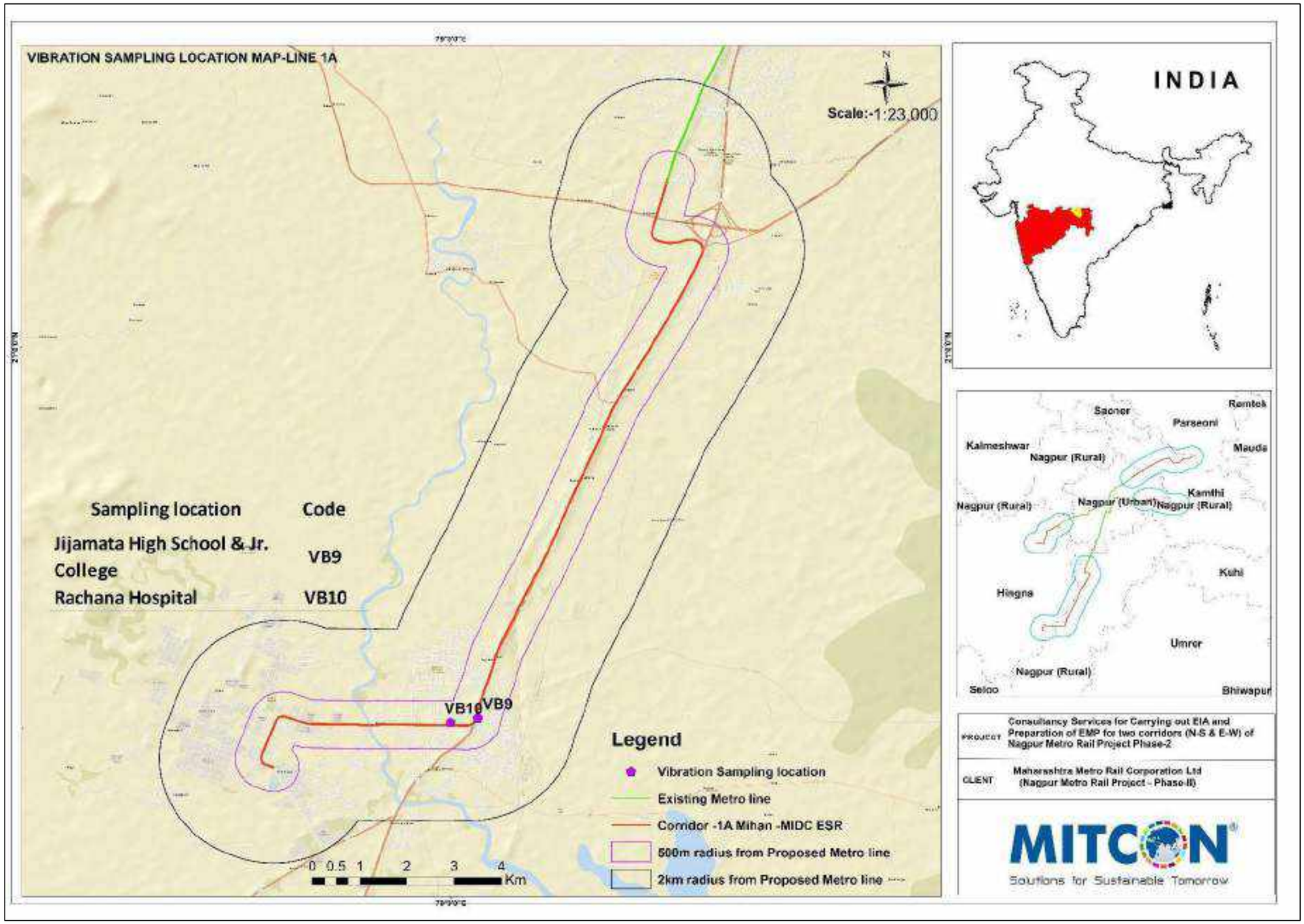


Figure 4-37: Vibration Sampling Locations for Reach 2A

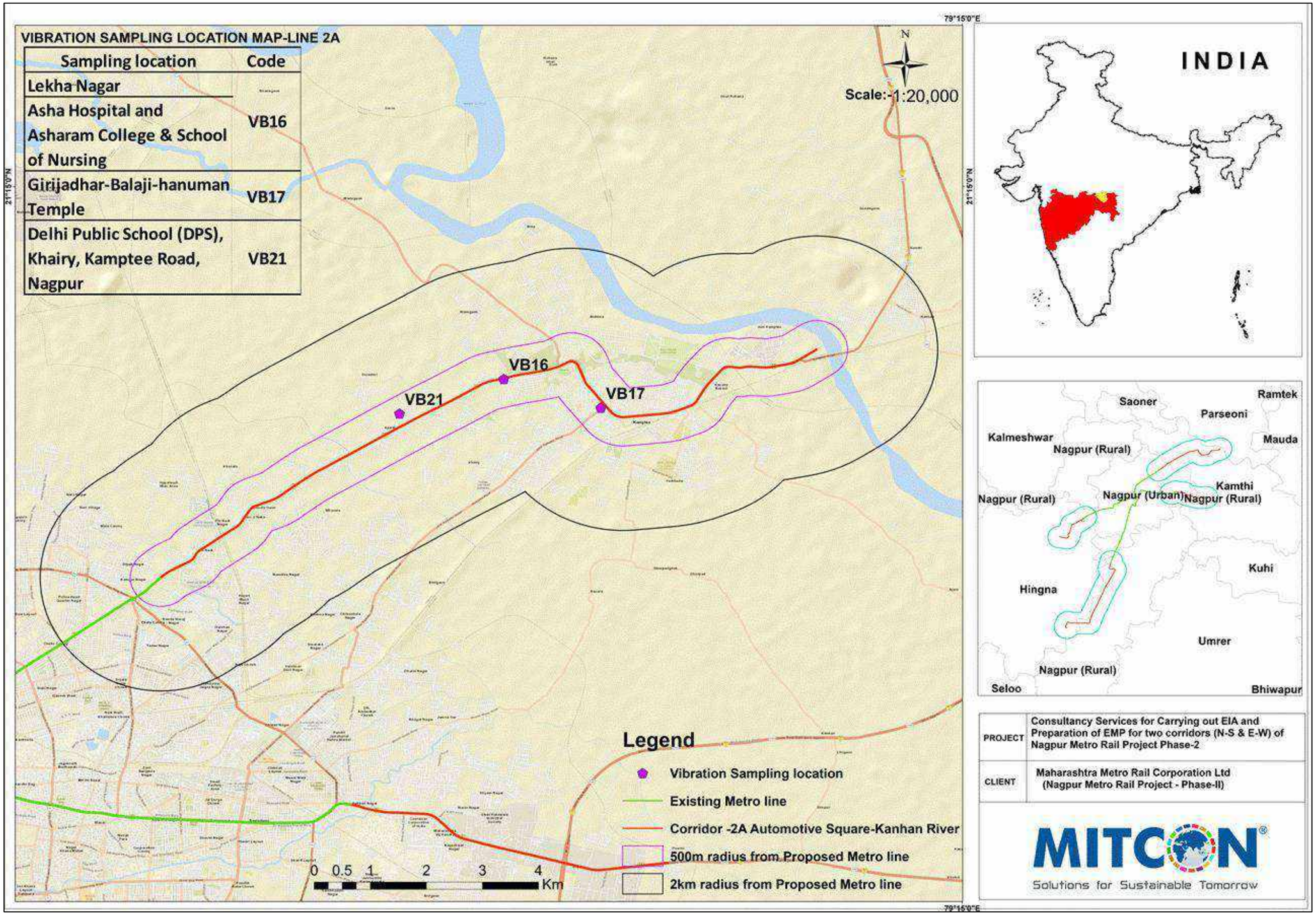


Figure 4-38: Vibration Sampling Locations for Reach 3A

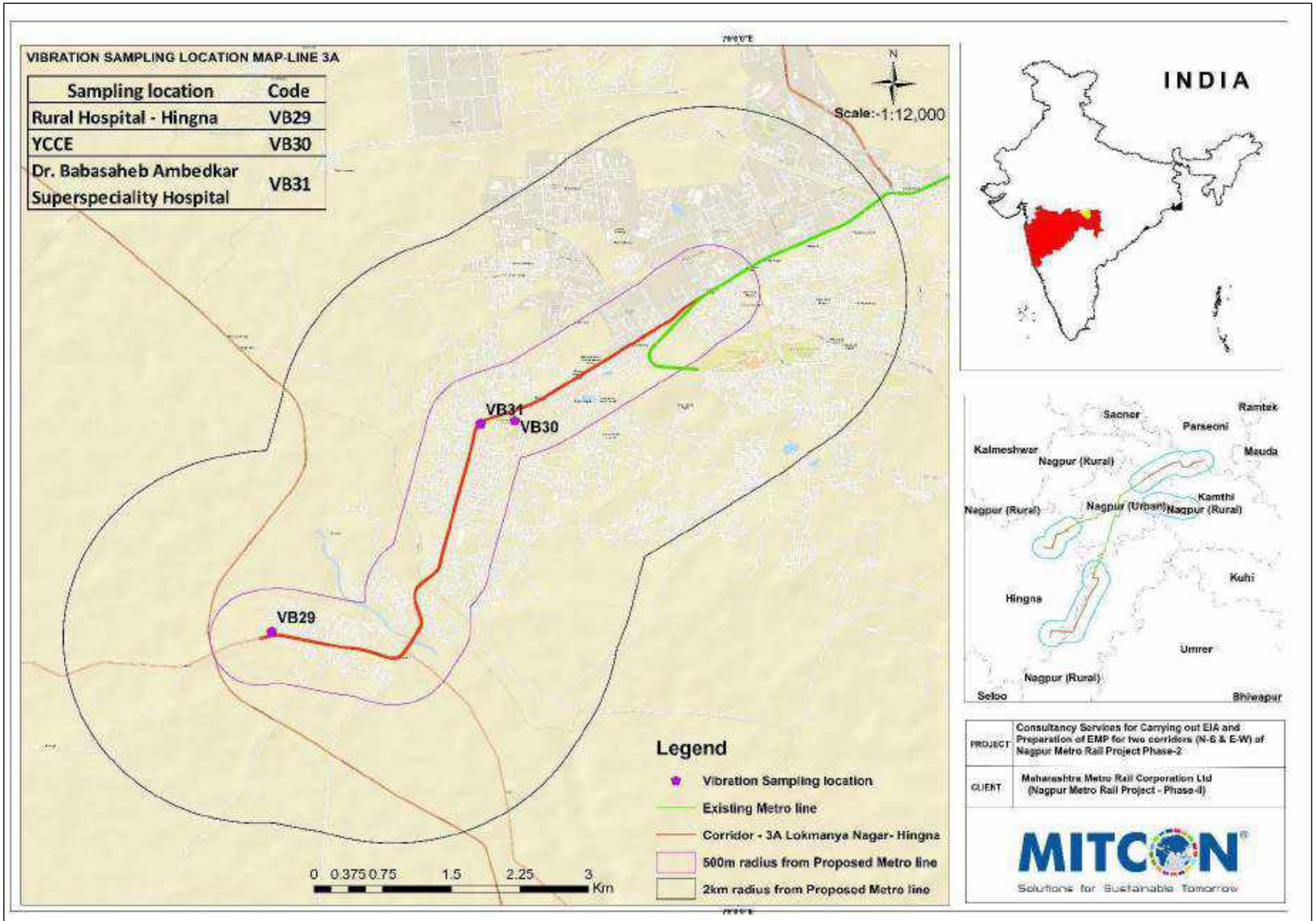
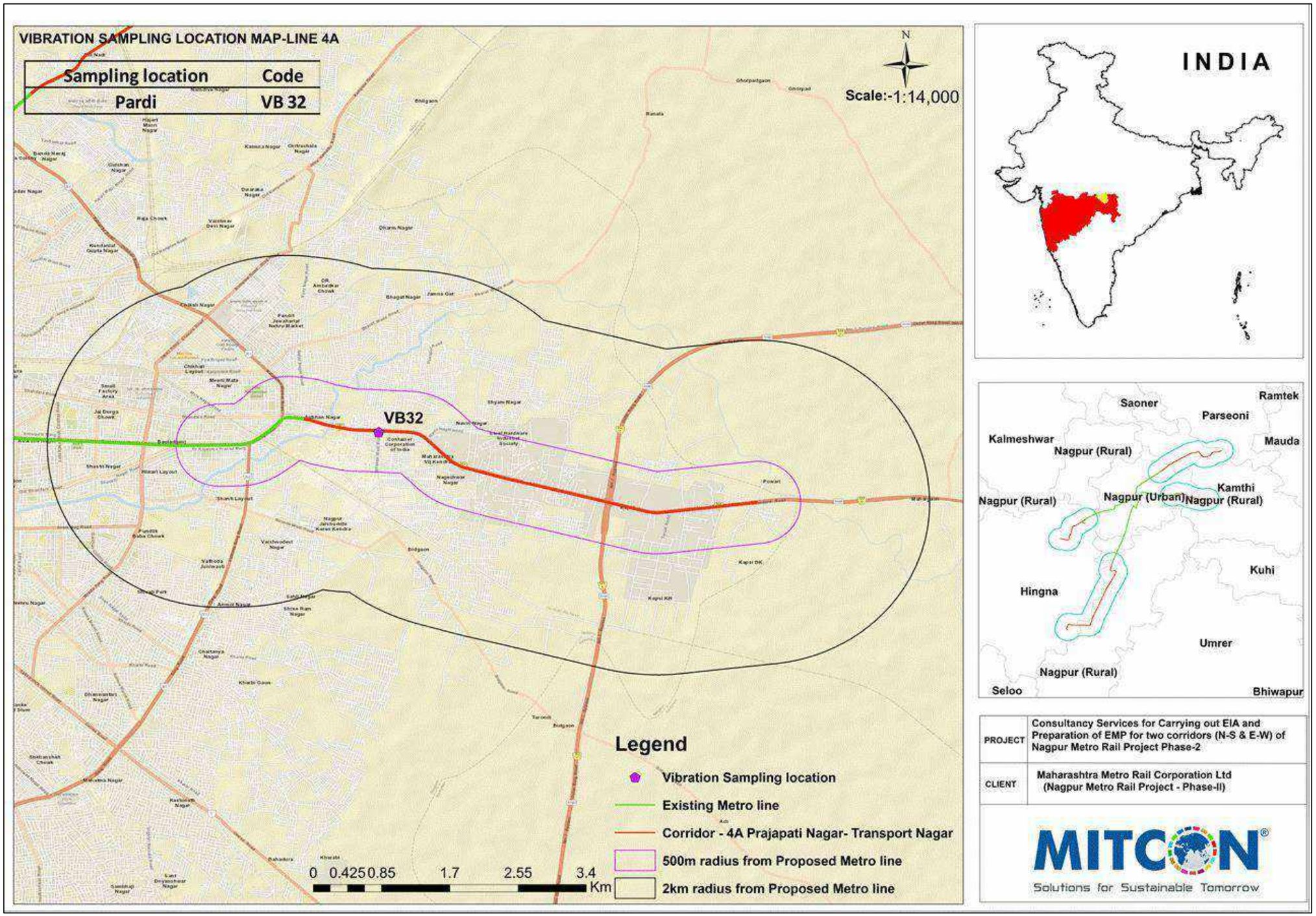


Figure 4-39: Vibration Sampling Location for Reach 4A



(c) Vibration Sampling Results

227. The induced ground vibration levels measured are summarized in **Table 4-18**.

Table 4-18: Baseline Vibration levels along NMRP Phase II Corridors

Line / Reach	Sampling Code	Sampling Location	PPV (Maximum) in mm/s
1A	VB9	Jijamata High School & Jr. College	0.3
1A	VB10	Rachana Hospital	0.2
2A	VB16	Asha Hospital and Asharam College & School of Nursing	0.3
2A	VB17	Girijadhar Balaji Hanuman Temple	0.2
2A	VB21	Delhi Public School (DPS), Khairy, Kamptee Road, Nagpur	0.1
3A	VB29	Rural Hospital - Hingna	0.2
3A	VB30	YCCE	0.5
3A	VB31	Dr. Babasaheb Ambedkar Superspeciality Hospital	0.4
4A	VB32	Pardi	0.3

228. The observed levels at all 9 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 EMP 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 4-19**. The measured levels are also below limits set by Directorate General of Mines Safety (DGMS), GoI as shown in **Table 4-20** (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 4-40**) based on the FTA Transit Noise and Vibration Impact Manual, September 2018 as given in **Figure 4-43**, the Caltrans Guidelines for Vibration Damage Potential Threshold Criteria given in the Transportation and Construction Vibration Guidance Manual, Caltrans, September 2013 (**Figure 4-41**) and the Human Response to typical levels of Ground-Borne Vibration (GBV) given in the FTA Transit Noise and Vibration Impact Manual, September 2018 (**Figure 4-42**), are also provided for reference.

Table 4-19: CMFRI guidelines w.r.t. Vibration[43]

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		

[43] *Source: Central Institute of Mining and Fuel Research (CMFRI) guidelines w.r.t. Vibration (Dhar et al, 1993)*

Soil, weathered or soft conditions	: 70 mm/s
Hard rock conditions	: 100 mm/s

Table 4-20: Directorate General of Mines Safety (DGMS) guidelines w.r.t. Vibration[44]

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/structures (kuccha, bricks & cement)	5	10	15
Industrial building	10	20	25
Objects of historical importance & sensitive Structures	2	5	10
(B) Buildings belonging to the owner with limited span of life			
Domestic houses/structures	10	15	20
Industrial buildings	15	25	50

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

Figure 4-40: Recommended Criteria for Ground-borne Vibration & Ground-Borne Noise for General Assessment[45]

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[1]
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

[1] Vibration sensitive equipment is not sensitive to ground-borne noise

Figure 4-41: Caltrans Guidelines for Vibration Damage Potential Threshold Criteria[46]

Structure and Condition	Maximum PPV (in/sec)	
	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.

[44] *Source: DGMS (Tech) (S&T) Circular No. 7 of 1997.*
[45] *Source: Metro Rail Transit System Guidelines for Noise and Vibrations, RDSO India, Sept 2015.*
[46] *Source: Transportation and Construction Vibration Guidance Manual, Caltrans, Sept 2013.*

Figure 4-42: Human Response to typical levels of Ground-Borne Vibration (GBV) [47]

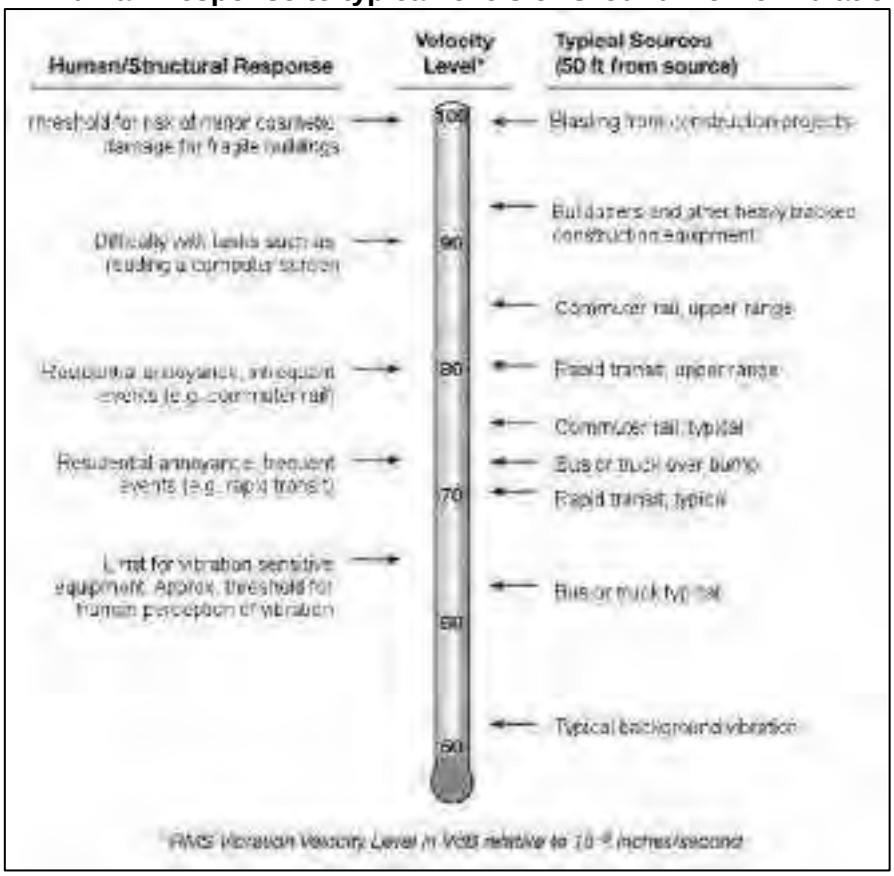


Figure 4-43: Ground-Borne Vibration (GBV) and Ground-Borne Noise (GBN) Impact Criteria for General Assessment[48]

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[5]	N/A[5]	N/A[5]
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 rail projects fall into this category.
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 equipment may require detailed evaluation to define the acceptable vibration levels. Ensuring low vibration levels in a building often requires special design of the HVAC system and is rarely achieved for sensitive equipment in existing buildings.
5. Vibration-sensitive equipment is generally not sensitive to ground-borne noise.

[47] *Source: FTA Transit Noise and Vibration Impact Manual, September 2018.*

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

F. WATER ENVIRONMENT

1. Hydrology / Drainage

229. Nagpur District is drained by the Wainganga and Wardha Rivers. The north, north-east & south-east part of the district is occupied by Wainganga river basin, while the north-west, west & south-west part of the district is occupied by the Wardha river basin. Kanhan, Pench, Kolar, Bawanthadi, Sur, Aam & Maru rivers are important tributaries of the Wainganga river basin. All these rivers flow form north - north-east towards south - south-east. The Chandrabhaga & Nag rivers flow from west towards east & meet the Kolar river sub-basin. The Kanhan, Pench, Kolar, Bawanthadi, Chandrabhaga & Nag Rivers are perennial. The Jam, Kad, Venna, Nand & Bor rivers for part of the Wardha river basin. The Wardha, Bor & Venna rivers are perennial. Prominent perennial rivers crossed by the NMRP Phase II alignments include the Venna River which is crossed by two of the alignments, namely Line 3A as well as Line 1A. Kanhan River is another perennial river of Nagpur district which is encountered at the end of Reach 2A alignment. **Figure 4-44** shows Hydrology of the 10 km Study Area around NMRP Phase II Project alignments including drainage, with water shed details and DEM, while **Figure 4-45**, **Figure 4-46**, **Figure 4-47** and **Figure 4-48** show drainage pattern in the 2km Study area aound Reach 1A, Reach 2A, Reach 3A and Reach 4A respectively.

230. The NMRP Phase II alignments cross a number of streams / *nallahs* at various locations. Venna River is crossed by both Reach 1A and Reach 3A. Reach-wise specific locations where water courses are crossed by the NMRP Phase II alignments are described below:

Reach 1A:

(i) The alignment crosses Venna river between MHADA Colony and MIDC KEC stations, where a bridge is proposed which will be parallel to the existing road bridge on the downstream side, with span of 34m between each pier. A total of 4 piers will thus be required to negotiate the river, which will be placed exactly opposite of the existing bridge piers, so as to avoid any obstruction / conflict to the water flow. Please refer to **Figure B (Annexure-2)** for details.

(ii) The section between MIDC KEC and MIDC ESR crosses a minor stream / *nallah* (Kanholibara). This is a small seasonal water-course carrying waste water from nearby industrial areas. Here a special single span of 41m has been provided with PSC U-Girder. The alignment over the river is straight, hence there is no issue of construction and obstruction of water flow or otherwise. Please refer to **Figure D (Annexure-2)** for details.

Reach 2A:

(i) Alignment crosses “Kumhar Nallah” (a small water course having a clear width of 30m) on the northeastern outskirts of Kamptee. Here a special single span of 34m with PSC U-Girder/Box Girder has been provided due to which waterway and flora fauna is not affected. Please refer to **Figure F (Annexure 2)** for details.

(ii) The end of this alignment i.e. Kanhan River station, lies at a distance of more than 250m from the river, hence the river will not be impacted in any way **Figure G (Annexure-2).**

Reach 3A:

(i) Between Raipur and Hingna Bus Stand stations, the alignment crosses Venna River where a bridge of about 100m is planned to be constructed as a balanced cantilever

bridge, without any support on river bed. Since there is no obstruction to the waterway and no obstruction to existing traffic over the existing road bridge, the span provided is the most suitable and viable preposition. Please refer to **Figure I (Annexure-2)** for details.

Figure 4-44: Map showing Hydrology of the Project Study area

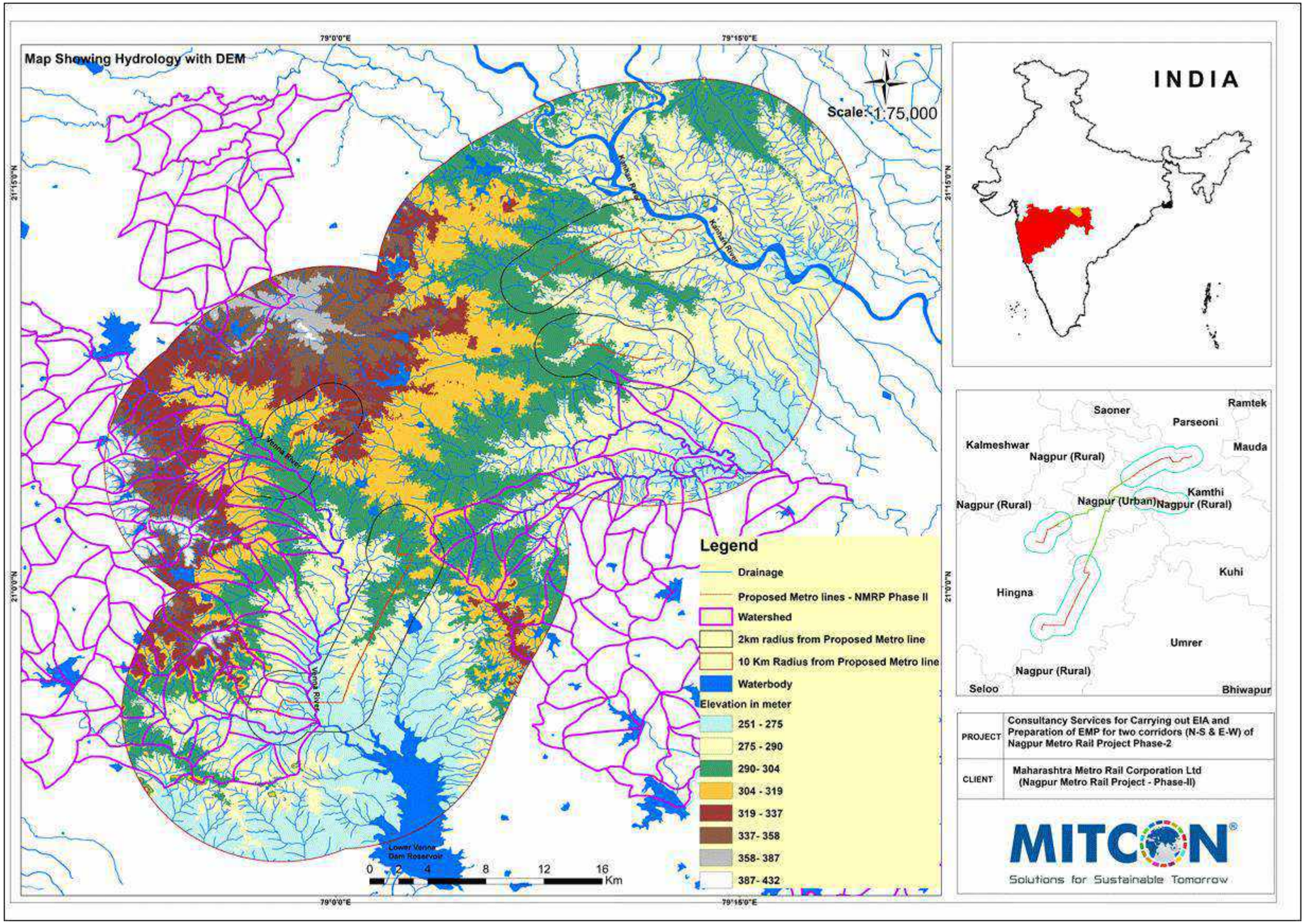


Figure 4-45: Drainage Pattern in 2km study area of Reach 1A - NMRP Phase II

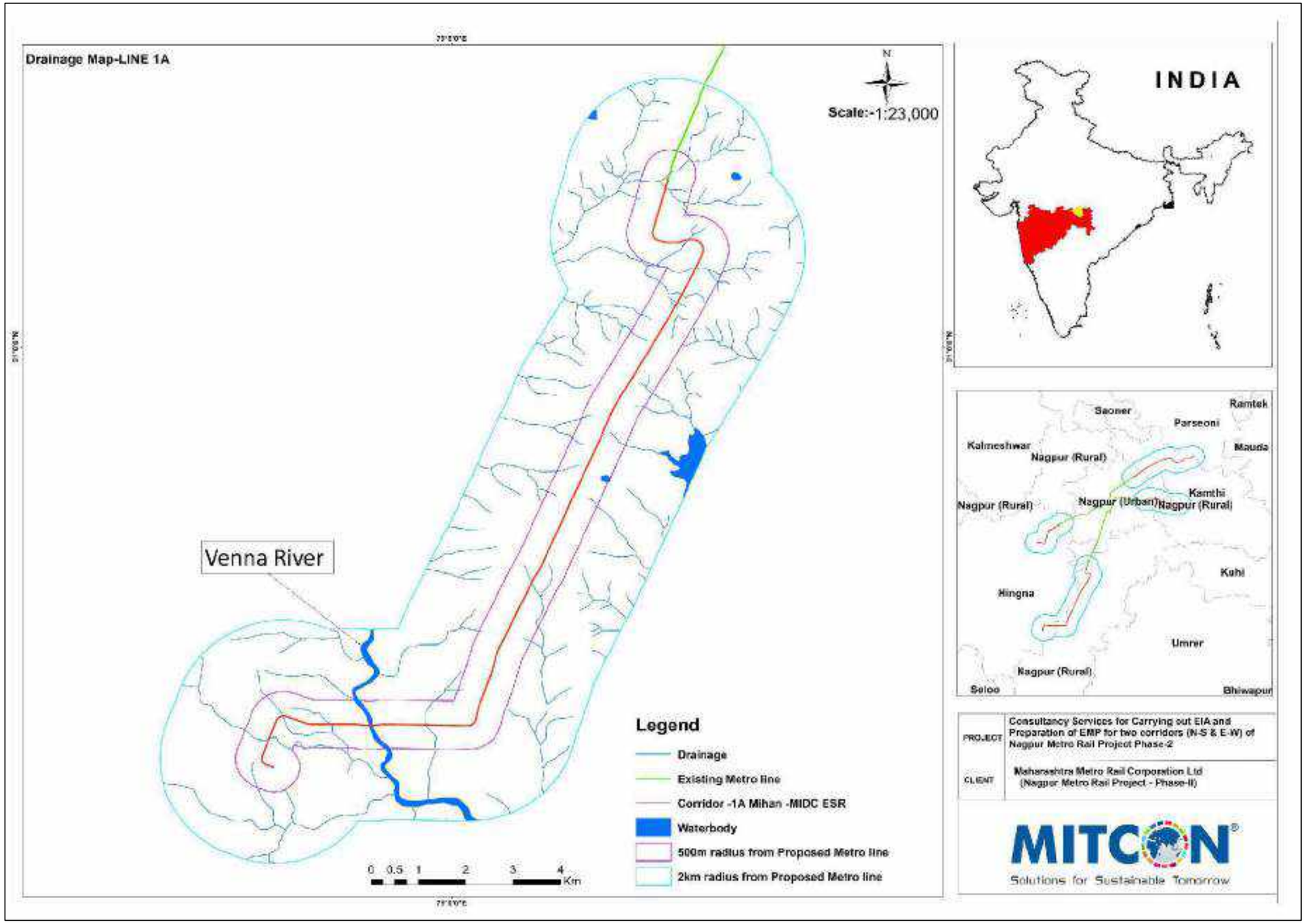


Figure 4-46: Drainage Pattern in 2km study area of Reach 2A - NMRP Phase II

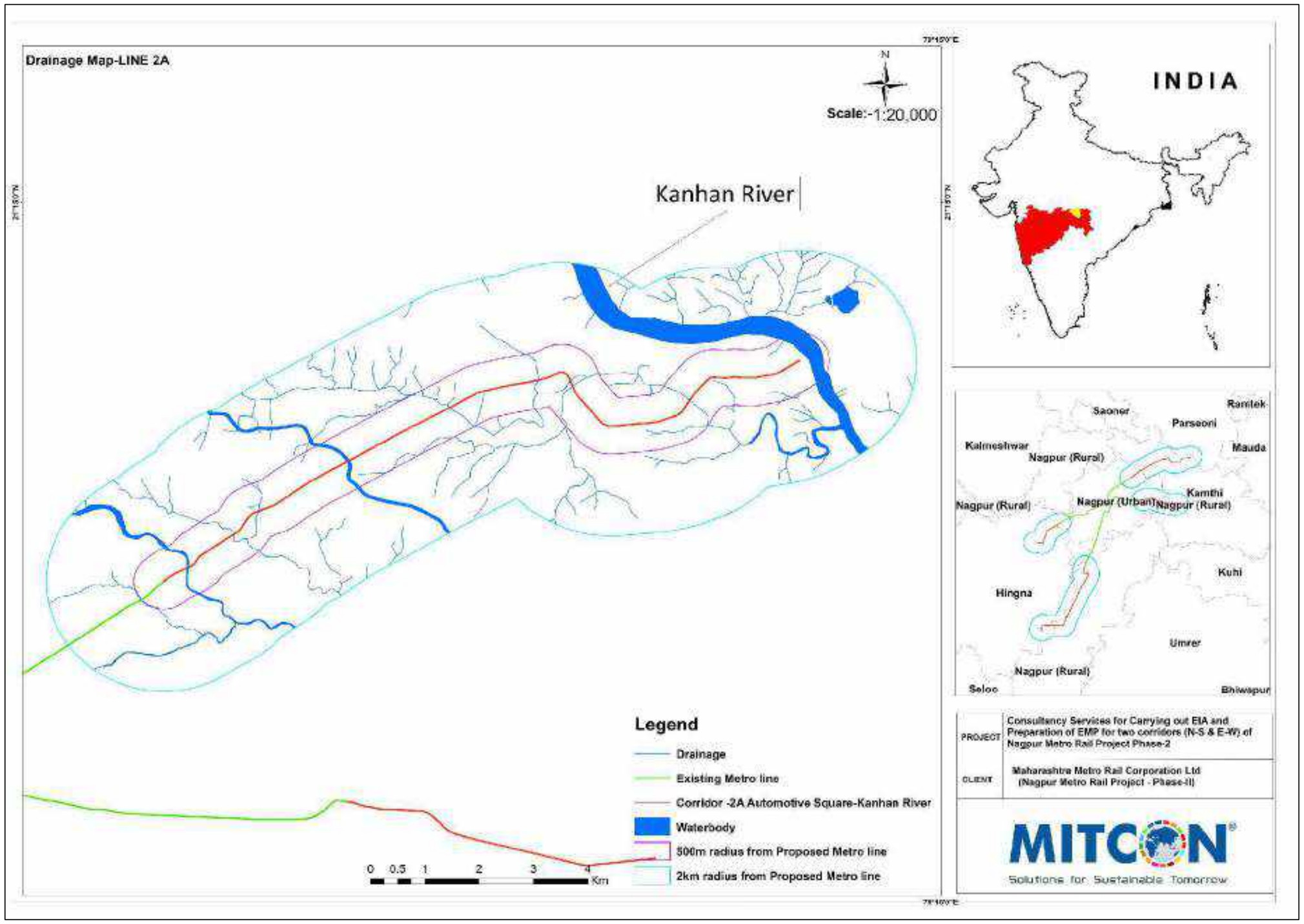


Figure 4-47: Drainage Pattern in 2km study area of Reach 3A - NMRP Phase II

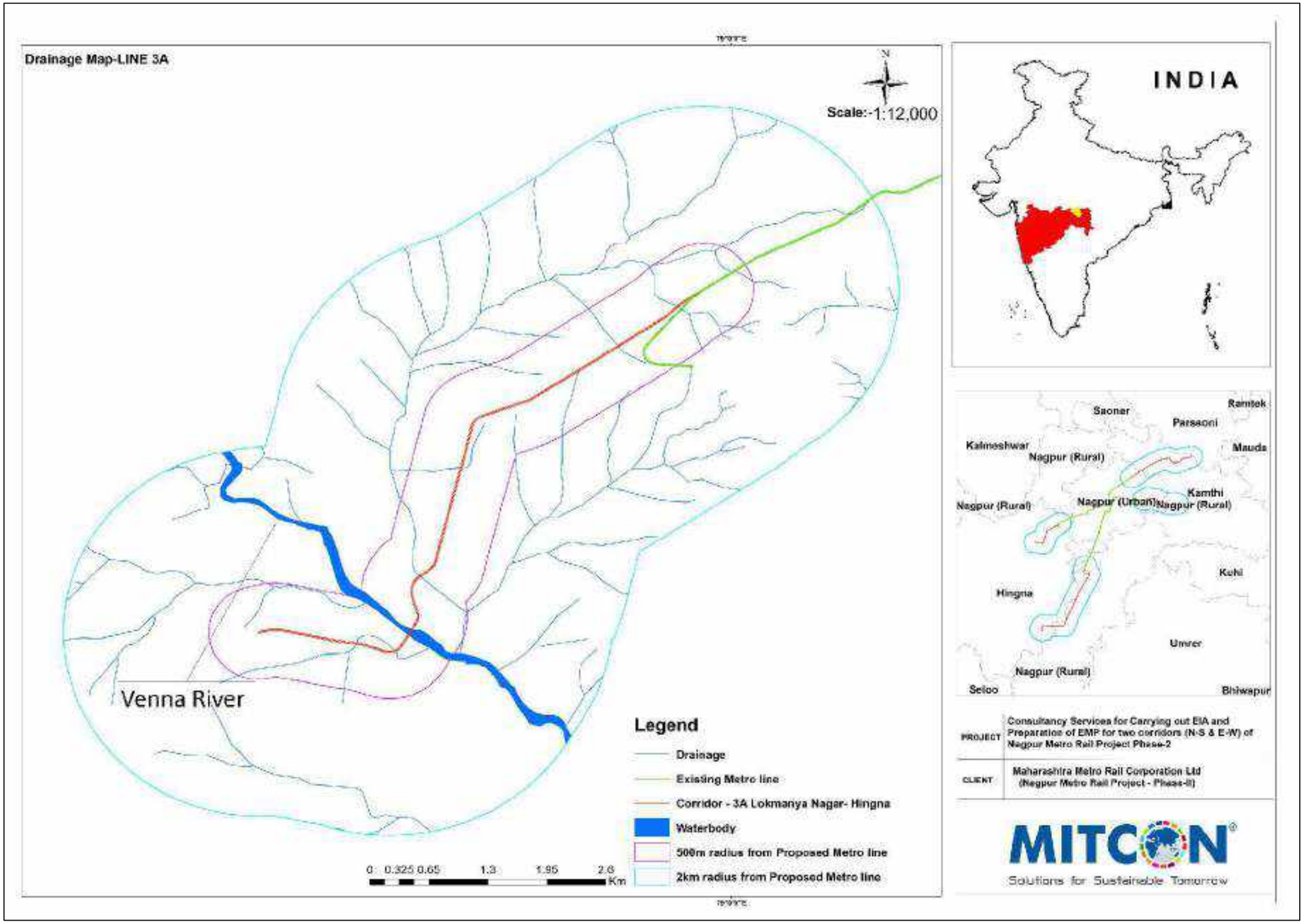
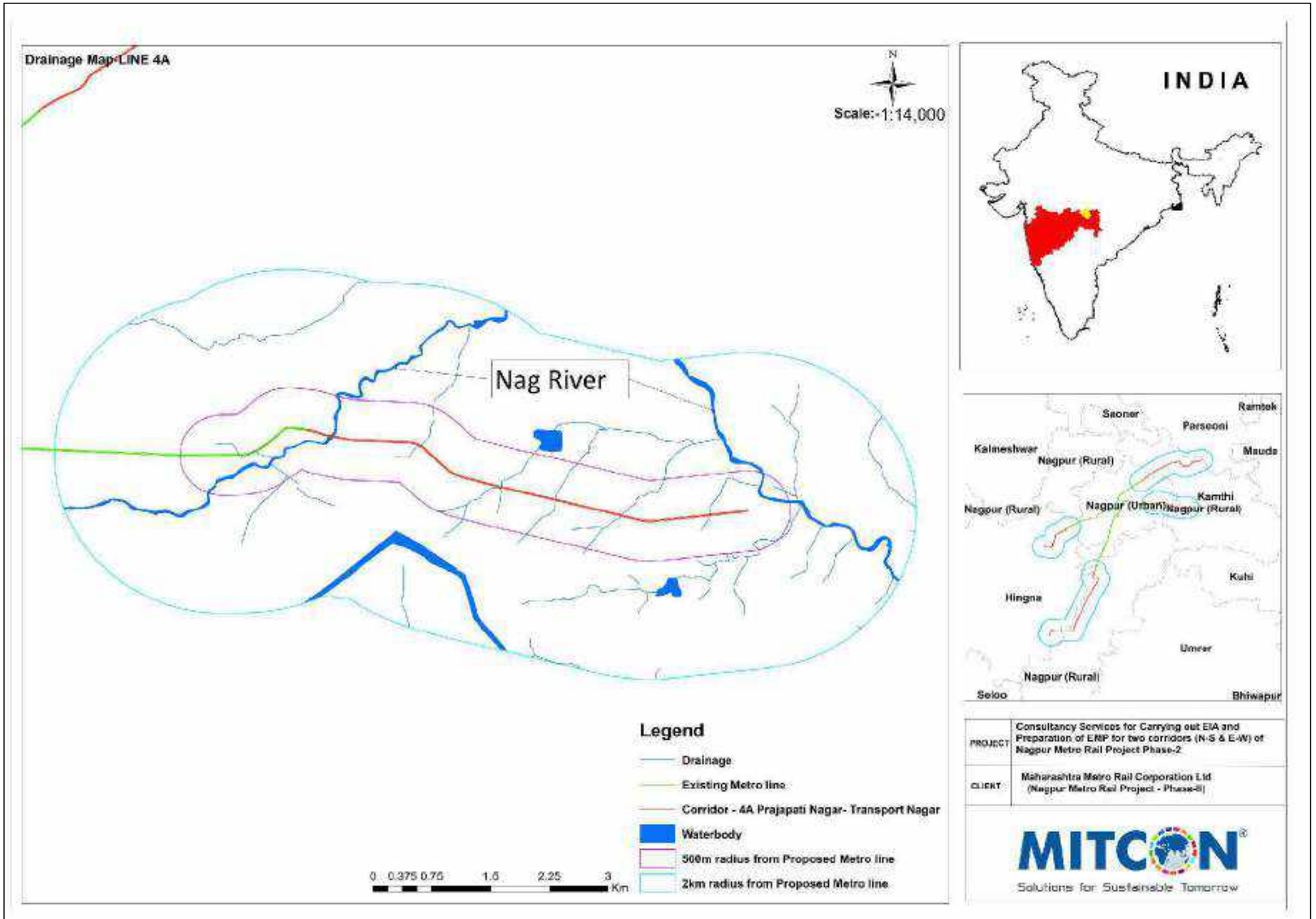


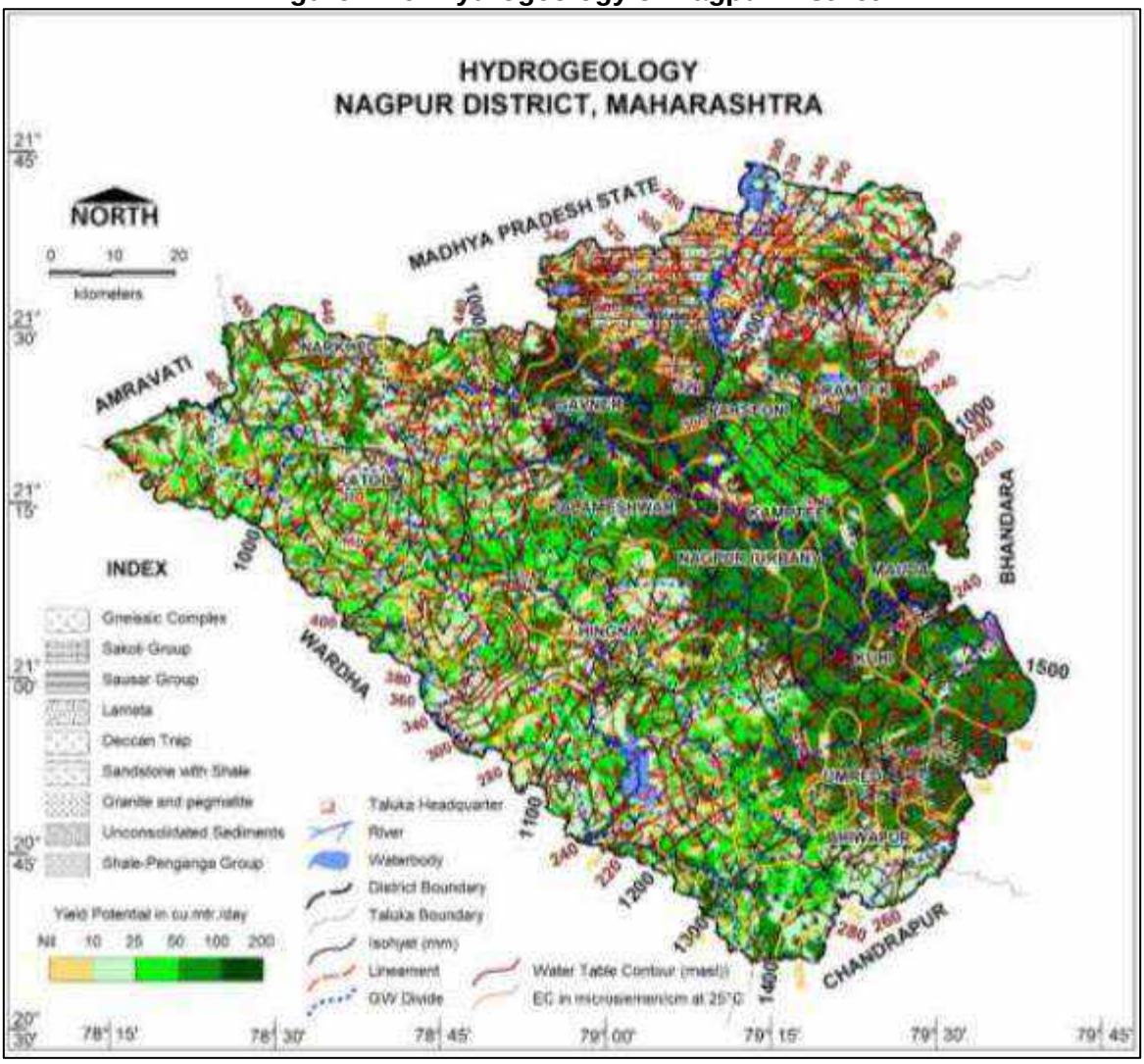
Figure 4-48: Drainage Pattern in 2km study area of Reach 4A - NMRP Phase II.



2. Hydrogeology and Groundwater[49]

231. Hydrogeology is concerned primarily with the mode of occurrence, distribution, movement and chemistry of water occurring in the subsurface in relation to the geological environment. The occurrence and movement of water in the subsurface is broadly governed by geological frameworks i.e., nature of rock formations including their porosity (primary and secondary) and permeability. The important water bearing formations of Nagpur district are discussed below. A map depicting the hydrogeological features of Nagpur district is shown in **Figure 4-49**.

Figure 4-49: Hydrogeology of Nagpur District



(a) Groundwater bearing Formations

232. **Consolidated Formations:** Archaean and the Deccan trap basalts are the two consolidated formations, which form the hard rock aquifers occurring in the district.

(i) **Archaean.** The crystalline rocks comprising of gneiss, schist, pegmatite and quartzite are the main formations occurring in north-eastern and south eastern parts of the district. In these rocks, weathered parts, in general, observed down to a depth of 25 mbgl, forms the important shallow aquifers being exploited through dug wells. In crystalline rocks, besides weathered parts of the rock, the occurrence

[49] *Source: CGWB Groundwater Information Booklet for Nagpur District*

and movement of ground water is controlled mainly by joints and fractures. The yields are generally controlled by the density, intensity and interconnection of joints/fractures in the rock formations.

(ii) **Deccan traps.** Basalt is the main rock formation of the district and occupies an area of about 4300 sq. km. Deccan basalts are hydrogeologically inhomogeneous rocks. The weathered and jointed /fractured parts of the rock constitute the zone of ground water flow. Each individual lava flow consists of lower massive part becoming vesicular/amygdaloidal towards top, range in their individual thickness from a few centimetres to tens of meters. The groundwater occupies under phreatic conditions in the exposed lava flows and in semi confined to confine in the subsurface flows. Groundwater is present in pore spaces in the vesicular units of each flow and in the jointed and fractured portions of massive basalt. However secondary porosity and permeability developed due to weathering, fracturing & joints play a very important role in the storage and movements of ground water. This has given rise to good aquifer in Deccan trap.

233. **Semi-Consolidated Formations:**

(i) **Lameta beds.** Lameta beds, found to the north of the district in a small patch are compact, clayey and poor in permeability. Hence it is not a good water bearing formation.

(ii) **Gondwana sediments**. Gondwana formation, occupying a total area of about 470 sq.km, occurs in the northern part of the Nagpur city extending from Kamptee to Saoner, and an isolated patch also occurs near north of Satnaori. Among the Gondwanas, the Barakars and Kamthis generally consist of medium to coarse-grained friable sandstone. These constitute the important water bearing formations in the district. Barakars are usually associated with coal seams of economic importance. The depth of this aquifer is about 45 to 50 m bgl.

234. **Unconsolidated Alluvial Formations**. Alluvium consisting of sand, silt, clay and kankar forms the potential water bearing formations and occurs in southern part of the district from Butibori to Bela. The alluvium of recent to sub-recent age and are found to have been deposited along the Kanhan and Pench Rivers and their tributaries. These formations are highly productive aquifers and sustain long duration pumping with very less drawdown and fast recuperation. Ground water occurs in water table and semi-confined conditions in the alluvial formation.

(b) Aquifer Characteristics

235. Deccan basalts are hydrogeologically in-homogeneous rocks. The weathered and jointed / fractured parts of the rock constitute the zone of groundwater storage and flow. The existence of multiple aquifers is characteristic of basalt and is indicative of wide variation in the joint / fracture pattern and intensity. The yield of wells is function of the permeability and transmissivity of aquifer, and it depends upon the degree of weathering, intensity of joints / fractures and topographic setting of the aquifer. Due to wide variation in secondary openings, the potential areas for ground water are generally localized. In general Groundwater occurs under phreatic / unconfined to semi-confined conditions in basalts. Based on groundwater exploration in the district, aquifer-wise characteristics are given in **Table 4-21**.

Table 4-21: Aquifer Characteristics of Nagpur district

Major Aquifers	Basalt (Deccan Traps)		Gondwana (Sandstone)		Granite Gneiss / Biotite gneiss	
Type of Aquifer	**Aquifer-I**	**Aquifer-II**	**Aquifer-I**	**Aquifer-II**	**Aquifer-I**	**Aquifer-II**
Formation	Weathered/ Fractured Basalt	Jointed / Fractured Basalt	Weathered Sandstone	TCG	Weathered	Jointed / Fractured
Depth of Occurrence (mbgl)	5 to 32	32 to 186	12 to 28	26 to 194	11 to 25	25 to 172
Granular / Weathered / Fractured rock thickness (m)	0.2 to 11	1 to 36.36	up to 28	2 to 54	0.3 to 7	1 to 40.35
SWL (mbgl)	1 to 20	1.2 to 29.03	5 to 11	2.32 to 22	0.1 to 19.4	1 to 24.15
Yield	10 to 100 m^3/day	50 to 150 m^3/day	20 to 80 m^3/day	1.37 to 17.90 lps	10 to 33 m^3/day	18 to 33 m^3/day
Transmissivity (m^2/day)	30 to 131.80	25 to 210	15 to 70.5	9.32	130 to 279.13	198.35 to 336.5
Specific Yield / Storativity (Sy/S)	0.02	1.2×10^{-4} to 3.57×10^{-4}	0.015 to 0.020	9.8×10^{-3} to 1.14×10^{-4}	-	2.37×10^{-4} to 8.0×10^{-5}
Suitability for drinking / irrigation	Suitable for both (except high environmental clearance, Fluoride and Nitrate affected villages) drinking & agriculture.					

3. Water Quality Analyses

236. The development of any region is dependent on the availability of sufficient water resources, as developmental activities require water for construction, domestic and other purposes. Water environment consists of water availability in the form of surface- and ground water resources, its quality and use (both present and intended). The water resources in the NMRP-P2 project study area broadly fall into following categories:

(i) Surface Water resources: Rivers / Nallahs / Ponds & Lakes / Dam Reservoirs.
(ii) Ground Water resources: Dug Wells (open and covered) / Bore wells / Hand pumps.

237. Surface Water and Groundwater quality within 2 Km radius of all the 4 NMRP-P2 alignments, as well as that along the alignments, has been studied for assessing the water environment and to evaluate the anticipated impact of the proposed project.
Water quality of the project area may get affected due to various factors like sedimentation & deposition of natural organic material, nutrients, bacteria & toxic substances, etc.
Study of the water environment is essential in preparation of EIA for identification of critical issues including planning the mitigation measures with a view to have optimum use of the water resources. Assessment of baseline data of the Water environment (both surface- and ground-water) in a study area includes:

(i) Identification of surface water sources
(ii) Identification of ground water sources
(iii) Collection of water samples
(iv) Analysing water samples for physico-chemical and biological parameters
(v) In this context, 24 groundwater samples and 18 surface water samples were

collected from the study area (combined for all 4 alignments) for analysis of existing water quality in the area.

(vi) The criteria for selection of sites for water sampling was based on the following rationale:

(vii) To characterize the groundwater in the study area in terms of location, behaviour, and quality.

(viii) To identify potential effects of road construction and operation activities on groundwater regime of the area and any potential effects of groundwater quality on road construction and integrity.

(ix) To identify measures to avoid, mitigate and manage any potential effects including any relevant design features of the road or techniques for construction.

(x) To identify residual effects of Project construction and operation activities on groundwater in the project area.

238. The surface and ground water quality of the project area may get affected due to various factors like sedimentation & deposition of natural organic material, nutrients, bacteria & toxic substances, etc. These contaminants can contribute to water by either point or non-point sources. Point sources contribute contaminants from a discrete site, such as the outflow from a pipe, ditch, well, leakages in storage lagoons, storage of solid waste, etc. These sources can be controlled by treatment at or before the point of discharge. Non-point sources, on the other hand include the atmosphere, agricultural areas, golf courses, residential developments, roads, parking lots, and contributions from groundwater along lengthy reaches of streams.

(c) Monitoring Stations for Water Quality Assessment

239. Water quality sampling was carried out in the month of April-May 2023. During the study period, few surface water bodies were found within the project study area i.e. in 2 km radius of the 4 alignments.

240. The details of sampling locations for Surface water and Groundwater samples are shown in **Table 4-22** and **Table 4-23**, respectively. Sampling locations for Surface water samples for Reach 1A, Reach 2A, Reach 3A and Reach 4A are respectively depicted in **Figure 4-50**, ***Figure 4-51***, **Figure 4-52** and **Figure 4-53**, while those for Ground water samples are shown in **Figure 4-54**, **Figure 4-55**, **Figure 4-56** and **Figure 4-57**, respectively.

Table 4-22: Monitoring Stations for Surface Water Quality Assessment

Line	Sampling Code	Sampling Location / Type	Latitude	Longitude
2A	SW1	Pioli River or Pili Nadi (Nallah) - D/S	21°11'19.66" N	79° 7'30.53" E
2A	SW2	Nallah near Lekha Nagar station - D/S	21°12'56.41"N	79°10'7.69"E
2A	SW3	Nag river at Kamptee - D/S	21°13'9.87" N	79°11'18.25" E
2A	SW4	Kamptee Nallah - D/S	21°13'3.47" N	79°12'31.72"E
2A	SW5	Kanhan river	21°13'26.34" N	79°13'47.68" E
3A	SW6	Raipur Nallah - U/S	21° 4'46.14" N	78°58'8.28" E
3A	SW7	Vena River - U/S	21° 4'31.67" N	78°57'57.1" E
3A	SW8	Vena River - D/S	21° 4'24.23"N	78°58'7.00"E
1A	SW9	Vena River - D/S 2	20°55'37.94"N	78°59'5.75"E
1A	SW10	Vena River U/S 2	20°55'42.43"N	78°59'4.97"E
1A	SW11	Wakeshwar Dam	20°58'27.32"N	79° 3'5.41"E
2A	SW12	Nag river at Kamptee - U/S	21°13'14.80" N	79°11'19.52" E
2A	SW13	Pioli River or Pili Nadi (Nallah) - U/S	21°13'14.80" N	79°11'19.52" E
3A	SW14	Raipur Nallah - D/S	21° 4'46.01" N	78°58'8.96" E

Line	Sampling Code	Sampling Location / Type	Latitude	Longitude
3A	SW15	Ambazari lake	21° 7'32.14"N	79° 2'37.48"E
3A	SW16	MIDC Butibori Nallah	20°55'29.26"N	78°57'53.61"E
4A	SW17	Nag River near Mahalgaon - U/S	21° 8'32.31"N	79°12'19.91"E
4A	SW18	Nag River near Pardi station	21° 8'59.91" N	79° 9'17.75" E

Table 4-23: Monitoring Stations for Ground Water Quality Assessment

Line	Sampling Code	Sampling Location	Abstraction Structure	Latitude	Longitude
2A	GW 1	Dharmanand Nagar (Ganesh Mandir Handpump)	Hand-pump	21°11'20.71" N	79° 7'44.1" E
2A	GW 2	Khasara fata	Hand-pump	21°11'51.80" N	79° 7'58.35" E
2A	GW3	All India Radio	Bore-well	21°12'14.26" N	79° 8'42.95" E
2A	GW4	Khairi Phata	Bore-well	21°12'39.04"N	79° 9'36.69"E
2A	GW5	Lokvihar	Covered Dug-well with piped connection	21°12'57.25"N	79°10'4.79"E
2A	GW6	Lekha nagar	Bore-well	21°13'11.56"N	79°10'36.37"E
2A	GW7	Ganj ke Balaji temple near Kamptee Police Station	Covered Dug-well	21°12'54.07"N	79°11'31.67"E
2A	GW8	Near Sub-district Hospital Kamptee	Hand-pump	21°12'48.75"N	79°11'55.13"E
2A	GW9	Modi padav nagar, near Dragon Palace	Bore-well	21°12'54.79"N	79°12'17.86"E
2A	GW10	Sanjay Nagar Bengali colony, Kamptee	Hand-pump	21°13' 1.45"N	79°12'28.97"E
4A	GW11	Transport nagar	Bore-well	21° 8'28.99"N	79°11'40.12"E
4A	GW12	Pardi	Bore-well	21° 8'55.96"N	79° 9'37.84"E
3A	GW13	Hingna Mount-view (Lokmanya Nagar)	Bore-well	21° 6'7.49"N	78°59'25.00"E
3A	GW14	Rajiv Nagar	Bore-well	21° 5'53.65"N	78°58'46.65"E
3A	GW15	Wanadongri	Hand-pump	21° 5'29.79"N	78°58'29.28"E
3A	GW16	Hingna Bus stand	Dug-well	21° 4'21.86"N	78°57'52.04"E
3A	GW17	Hingna	Hand-pump	21° 4'27.85"N	78°57'25.40"E
3A	GW18	Raipur	Hand-pump	21° 4'41.71"N	78°57'56.29"E
4A	GW19	Kapsi Kh.	Bore-well	21° 8'42.27"N	79°10'31.72"E
1A	GW20	Dongargaon	Hand-pump	20°59'14.23"N	79° 1'50.62"E
1A	GW21	Mohgaon	Dug-well	20°57'39.54"N	79° 1'2.80"E
1A	GW22	Meghdoot CIDCO	Hand-pump	20°56'4.11"N	79° 0'28.45"E
1A	GW23	Butibori Police station	Covered Dug-well with piped connectton	20°55'45.65"N	79° 0'13.65"E
1A	GW24	Ashokwan	Hand-pump	21° 0'45.43"N	79° 2'41.71"E

Figure 4-50: Surface Water monitoring locations for Reach 1A

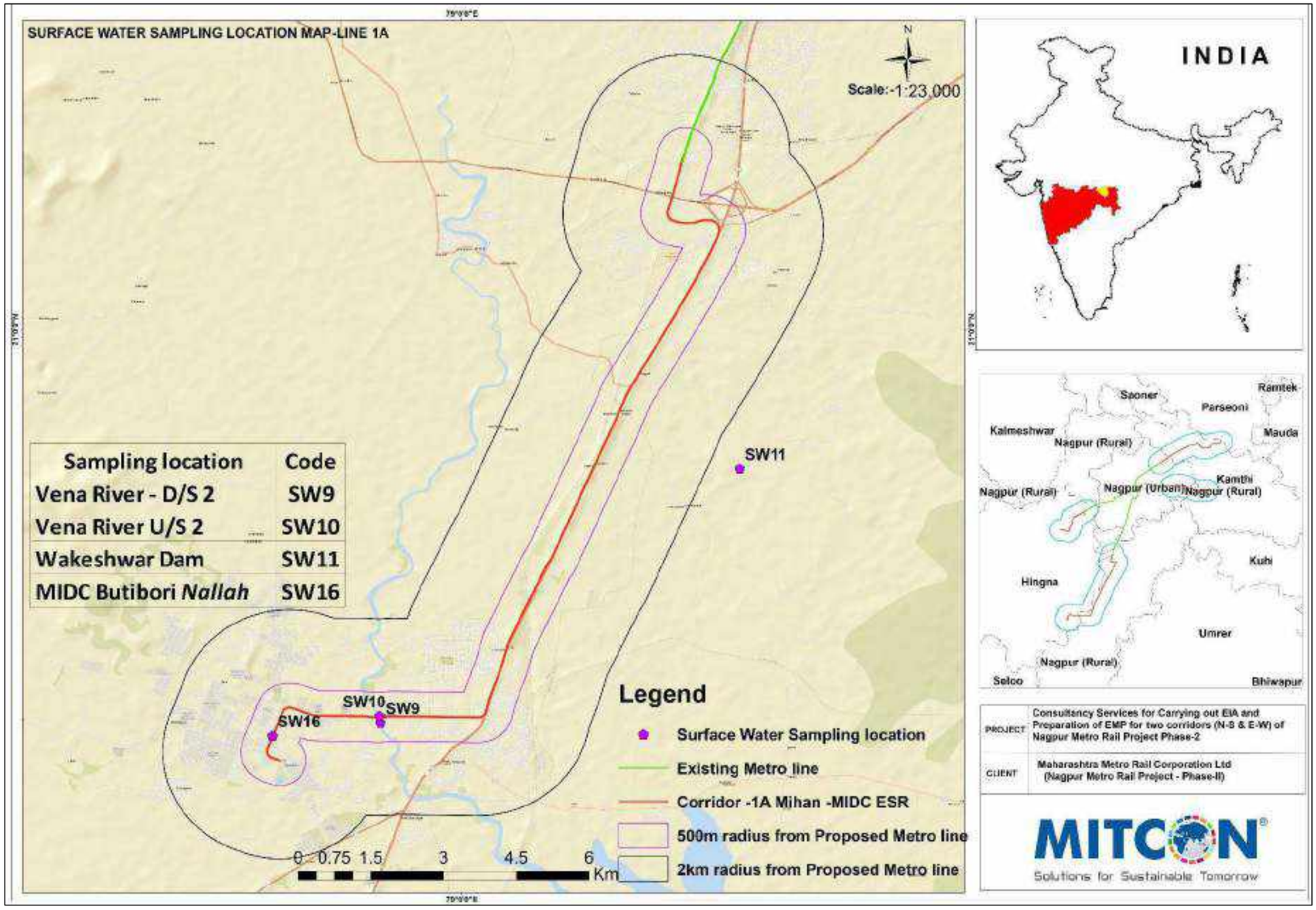


Figure 4-51: Surface Water monitoring locations for Reach 2A

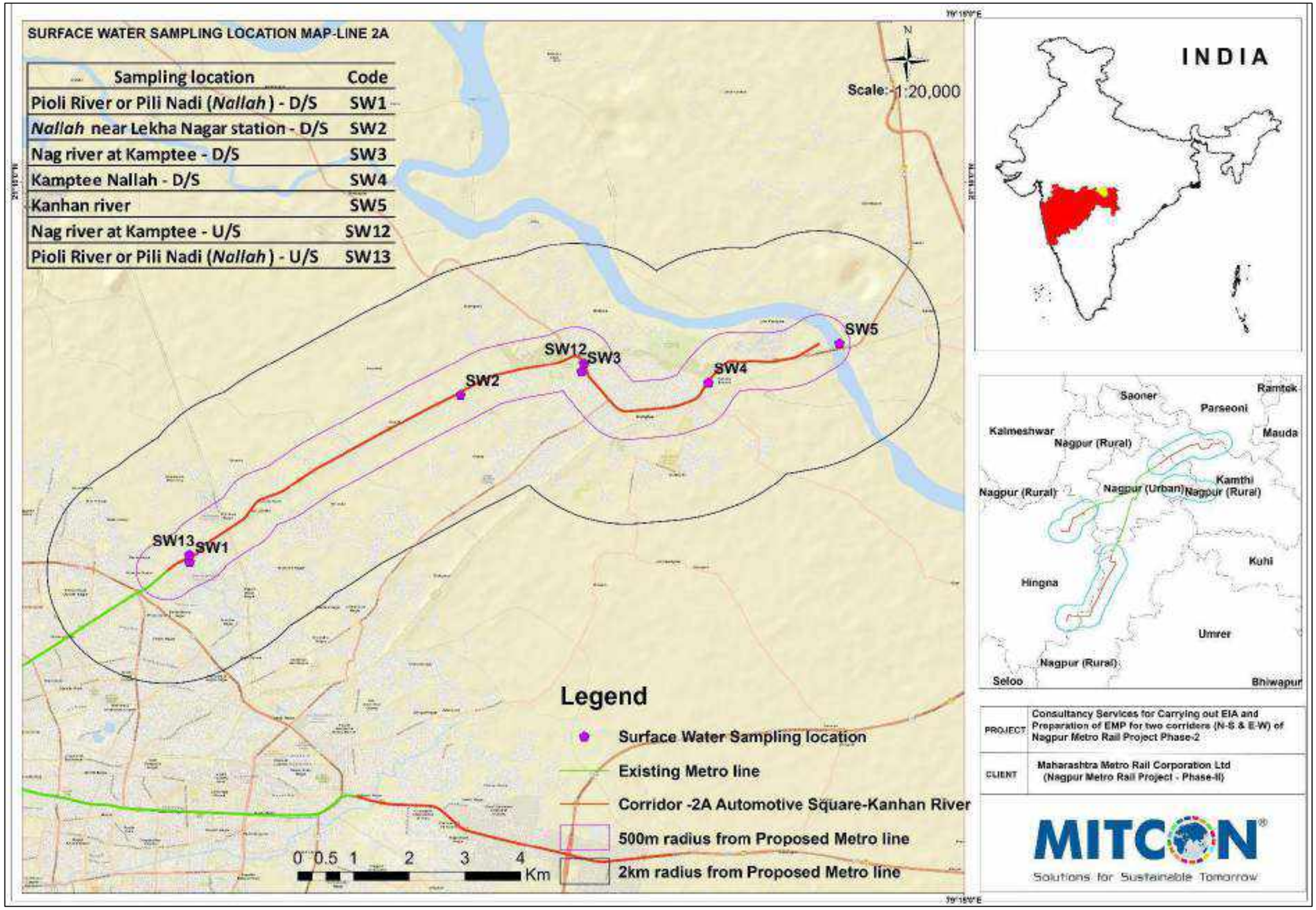


Figure 4-52: Surface Water monitoring locations for Reach 3A

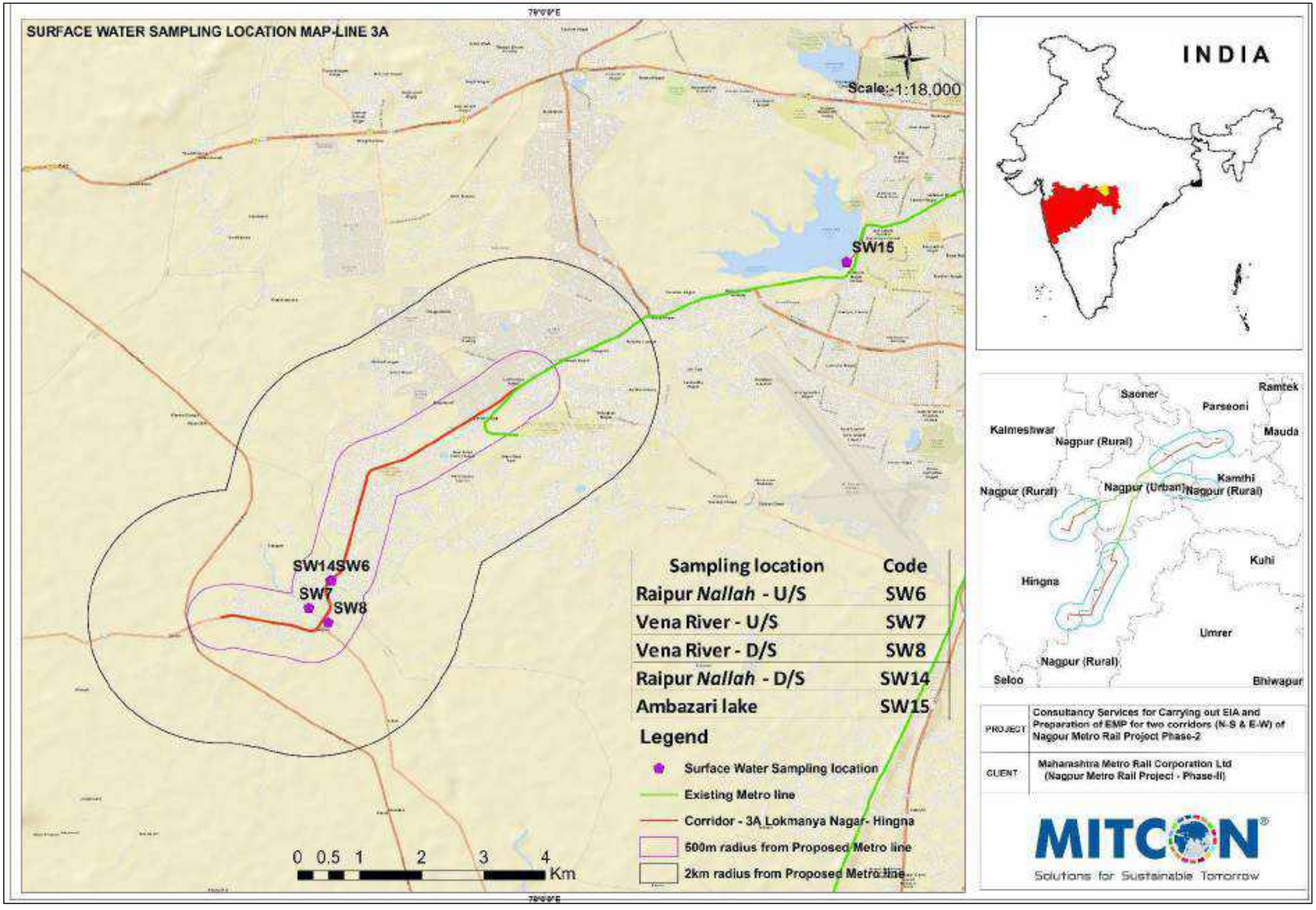


Figure 4-53:Surface Water monitoring locations for Reach 4A

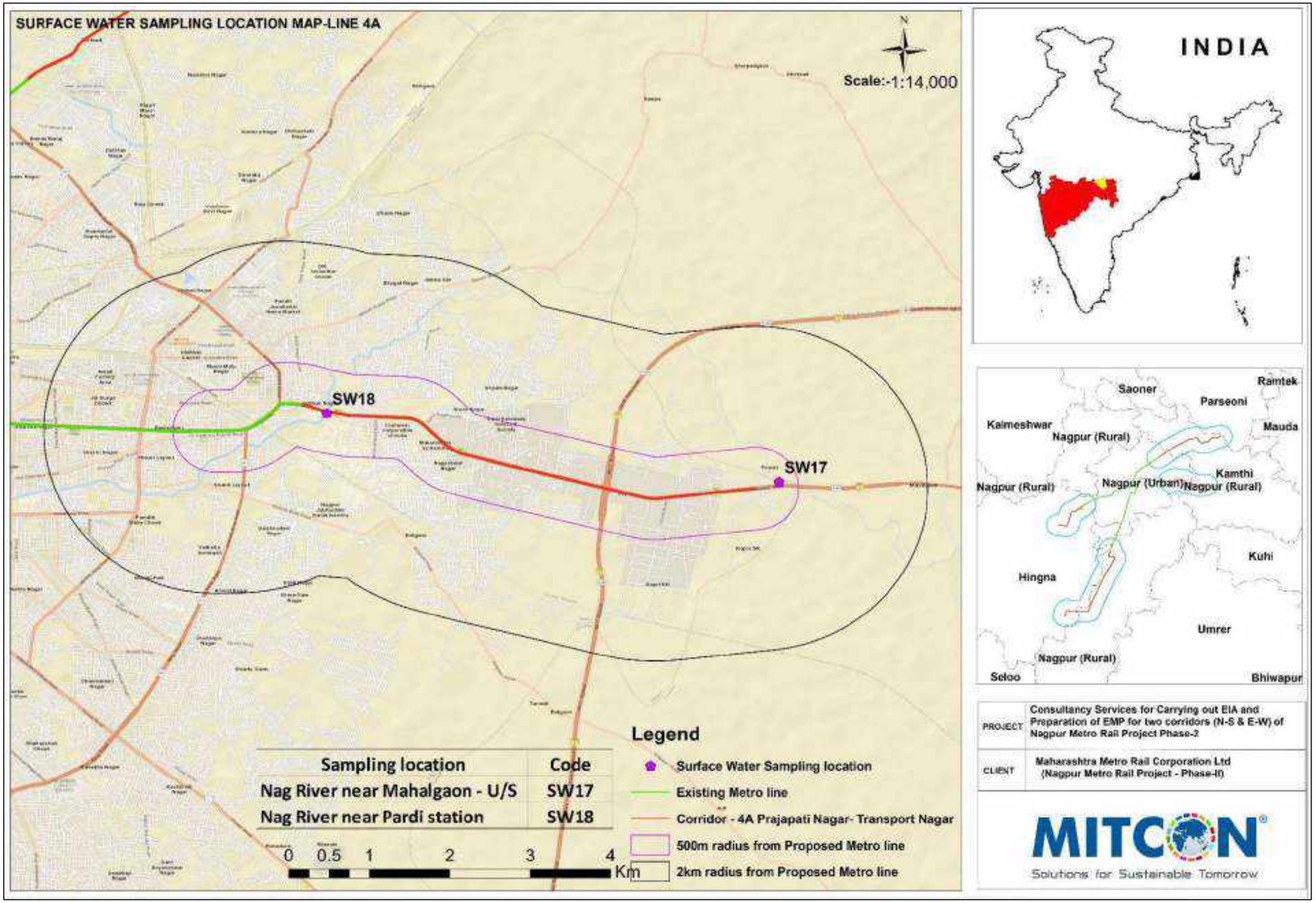


Figure 4-54: Groundwater monitoring locations for Reach 1A

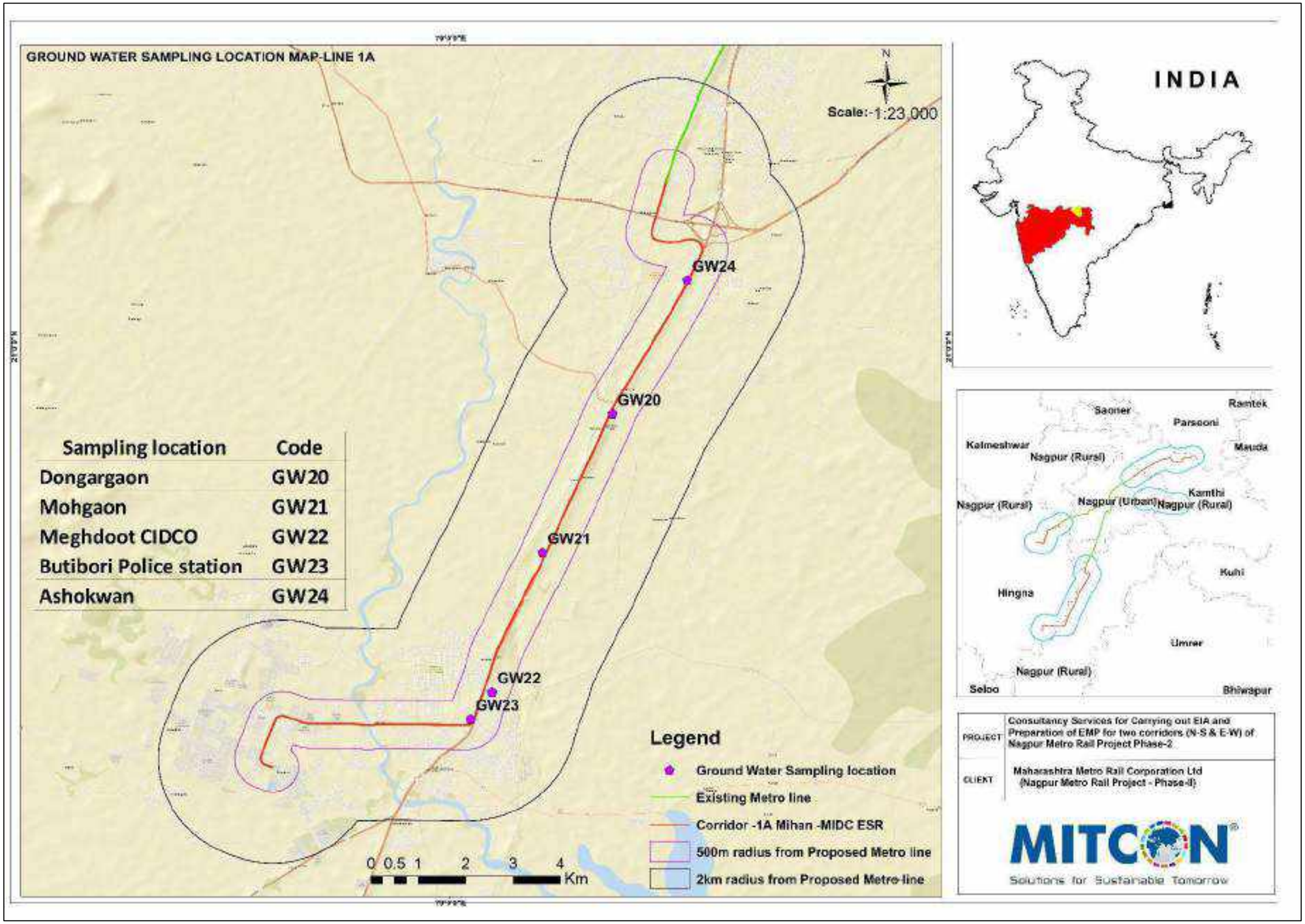


Figure 4-55: Groundwater monitoring locations for Reach 2A

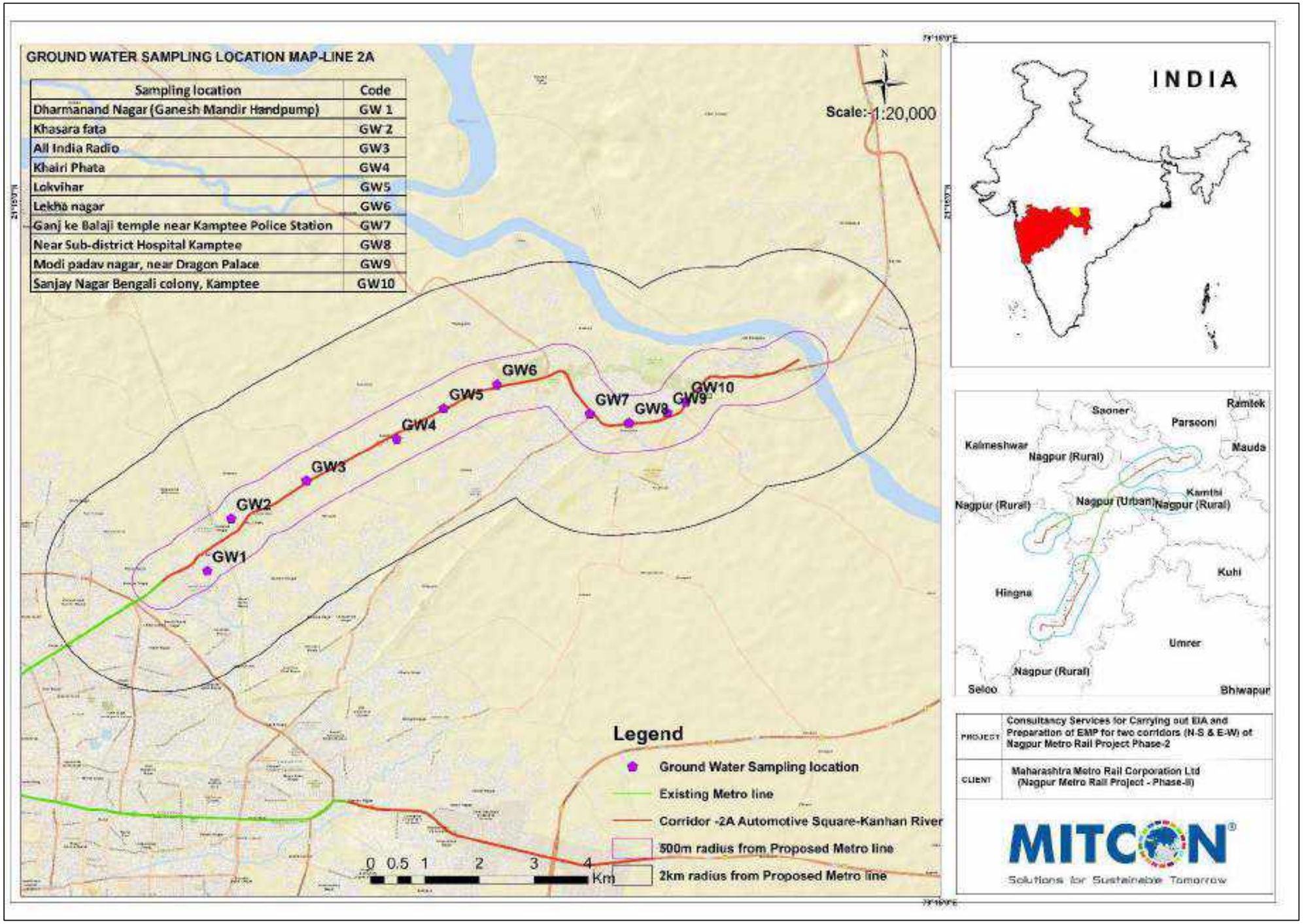


Figure 4-56: Groundwater monitoring locations for Reach 3A

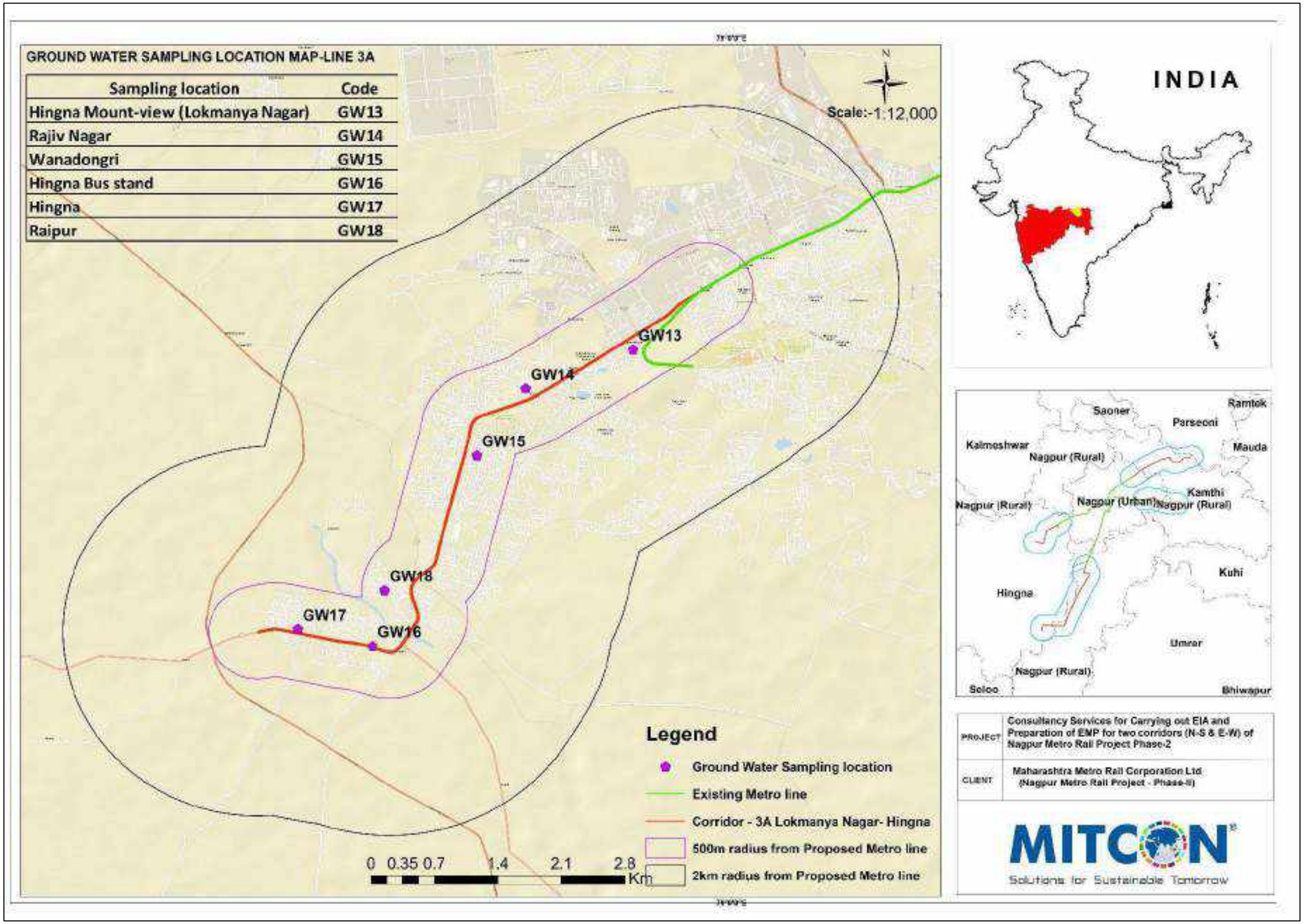
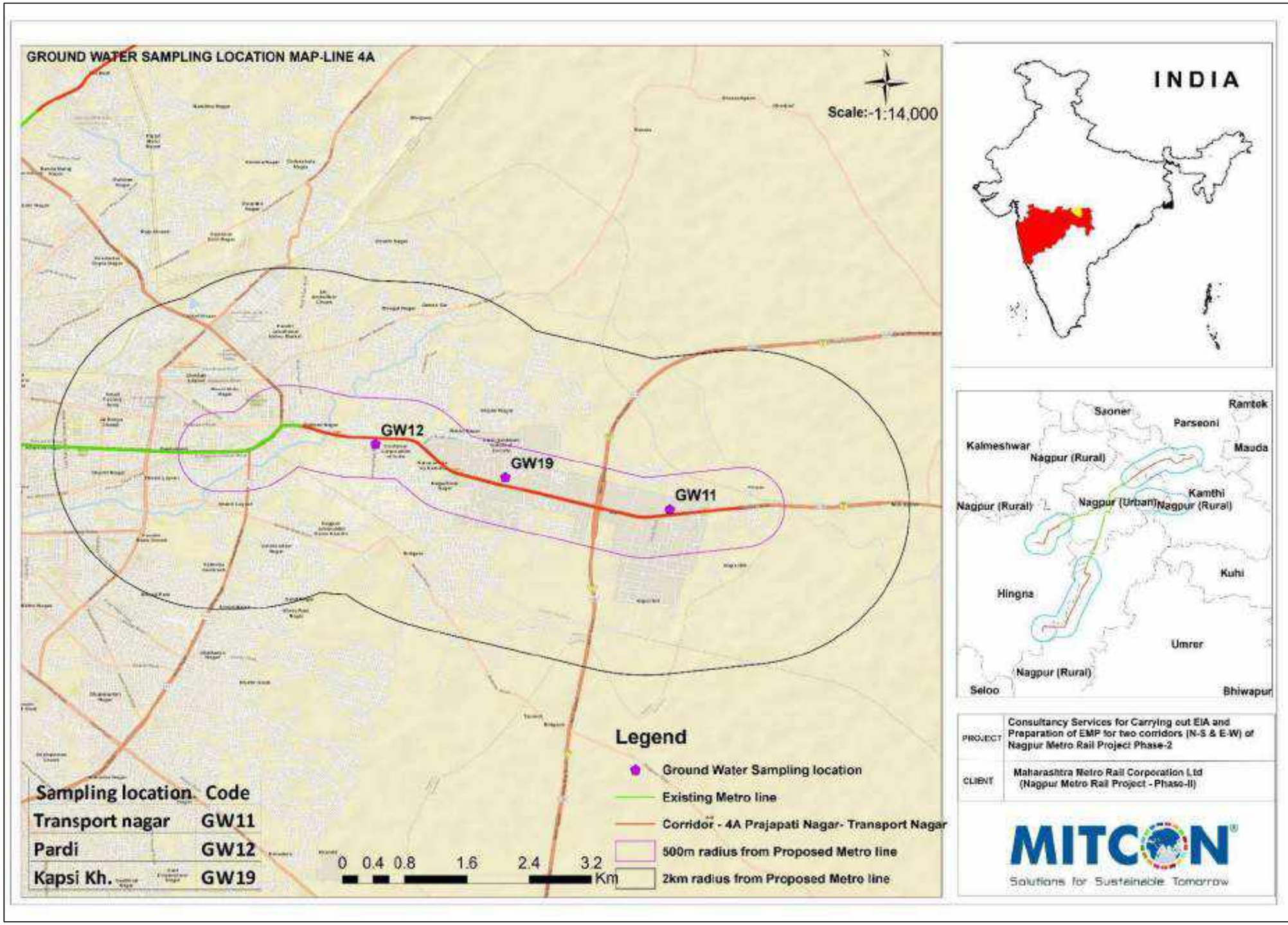


Figure 4-57: Groundwater monitoring locations for Reach 4A



241. Some photographs taken during surface and groundwater quality, in the study area are presented in **Figure 4-58** and **Figure 4-59** respectively.

Figure 4-58: Some Photographs Showing Surface Water Quality Monitoring

Photo no.	Date of Sampling	Location Geo-coordinates
1	20/04/2023	21°11'19.64"N / 79° 7'30.54"E
2	21/04/2023	21° 4'48.08"N / 78°58'8.19"E
3	23/04/2023	20°55'42.40"N / 78°59'4.97"E
4	20/04/2023	21°13'9.87"N / 79°11'18.25"E
5	03/05/2023	21° 7'32.06"N / 79° 2'37.55"E
6	03/05/2023	21° 8'59.84"N / 79° 9'17.66"E

Figure 4-59: Some Photographs Showing Groundwater Quality Monitoring

Photo no.	Date of Sampling	Location Geo-coordinates
1	20/04/2023	21°11'20.71"N / 79° 7'44.1"E
2	20/04/2023	21°13'11.56"N / 79°10'36.37"E
3	21/04/2023	21° 5'29.79"N / 78°58'29.28"E
4	21/04/2023	21° 4'27.85"N / 78°57'25.40"E
5	23/05/2023	20°57'39.58"N / 79° 1'2.82"E
6	23/05/2023	21° 0'45.41"N / 79° 2'41.66"E

(d) Water Quality Analyses Results

242. Summary of the results of important Surface Water quality & Groundwater quality parameters are given in **Table 4-24** and **Table 4-25**, respectively. Detailed results of all parameters analysed are given in **Annexure-3**.

Table 4-24: Summary of Surface Water Quality Analyses forNMRP-P2 corridors

Alignment (Line)	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
2A	SW1	Pioli River or Pili Nadi (Nallah) - D/S	7.23	849.6	570	604	191.28	55.23	<0.1	28	72	2	>1600	>1600
2A	SW2	Nallah near Lekha Nagar station - D/S	7.89	997.7	676	898	212.4	27.12	<0.1	9	28	3	110	90
2A	SW3	Nag river at Kamptee - D/S	8.02	1200.4	814	847	212.35	45.16	<0.1	25	75	1.9	120	40
2A	SW4	Kamptee Nallah - D/S	8.057	870.1	545	555	224.51	42.13	<0.1	80	259	1	>1600	>1600
2A	SW5	Kanhan river	7.58	855	575	589	220.3	38.67	<0.1	4	16	24	30	20
3A	SW6	Raipur Nallah - U/S	7.83	1470	1008	1092	404.02	55.17	<0.1	19	54	2.4	400	150
3A	SW7	Vena River - U/S	7.12	678.9	413	433	204.23	55.42	<0.1	2	8	5.6	70	Absent
3A	SW8	Vena River - D/S	7.19	751.9	442	445	198.72	62.12	<0.1	12	43	4.3	140	20
1A	SW9	Vena River - D/S 2	7.23	763.9	467	471	193.25	70.38	<0.1	2	6	5.8	30	Absent
1A	SW10	Vena River U/S 2	7.26	767.3	413	433	204.23	55.42	<0.1	3	11	5.5	40	20
1A	SW11	Wakeshwar Dam	7.32	359.4	185	189	100.2	13.25	<0.1	<1.0	<5.0	5.8	20	Absent
2A	SW12	Nag river at Kamptee - U/S	7.62	568	345	347	167.25	23.12	<0.1	13	42	4.3	90	30
2A	SW13	Pioli River or Pili Nadi (Nallah) - U/S	7.42	901.7	580	613	208.7	60.13	<0.1	32	82	2	>1600	>1600

Alignment (Line)	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
3A	SW14	Raipur Nallah - D/S	7.2	438.4	287	314	135.24	43.12	<0.1	20	65	3.6	600	300
3A	SW15	Ambazari lake	7.39	337.1	215	218	110.06	32.12	<0.1	2	7	5.9	40	Absent
3A	SW16	MIDC Butibori Nallah	6.92	614.4	378	413	180.25	52.13	<0.1	25	80	1.9	>1600	>1600
4A	SW17	Nag River near Mahalgaon - U/S	7.36	555.8	368	380	183.14	30.13	<0.1	11	47	4.1	300	110
4A	SW18	Nag River near Pardi station	7.29	512.7	371	384	165.13	29.37	<0.1	23	80	4.3	240	90

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 4-25: Summary of Groundwater Quality Analyses for NMRP-P2 corridors

Alignment (Line)	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
2A	GW 1	Dharmanand Nagar (Ganesh Mandir Handpump)	7.27	1190	710	<5	300.14	38.46	<0.1	Absent	Absent
2A	GW 2	Khasara fata	7.29	1810	980	<5	402.13	120.24	<0.1	Absent	Absent
2A	GW3	All India Radio	7.65	1320	832	<5	375.83	119.52	<0.1	Absent	Absent
2A	GW4	Khairi Phata	7.32	3520	1800	<5	800.25	198.25	<0.1	Absent	Absent
2A	GW5	Lokvihar	7.52	2023	1215	<5	585.12	213.25	<0.1	Absent	Absent
2A	GW6	Lekha nagar	7.83	1460	913	<5	402.12	95.13	<0.1	Absent	Absent
2A	GW7	Ganj ke Balaji temple near Kamptee Police Station	7.52	2280	1400	<5	589.65	180.12	<0.1	Absent	Absent
2A	GW8	Near Sub-district Hospital Kamptee	7.29	1480	802	<5	368.25	168.14	<0.1	Absent	Absent
2A	GW9	Modi padav nagar, near Dragon Palace	7.45	1950	980	<5	300.21	52.14	<0.1	Absent	Absent
2A	GW10	Sanjay Nagar Bengali colony, Kamptee	7.24	1890	1204	<5	375.8	227.43	<0.1	Absent	Absent
4A	GW11	Transport nagar	7.56	1484	810	<5	301.83	145.54	<0.1	Absent	Absent
4A	GW12	Pardi	7.24	951.3	478	<5	198.13	85.12	<0.1	Absent	Absent

Alignment (Line)	Sample Code	Potability	Chemical						Bacteriological	
		Parameter	pH at 25 ^{o}C	Electrical Conductivity at 25 ^{o}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
3A	GW13	Hingna Mount-view (Lokmanya Nagar)	7.18	743.2	402	<5	188.47	80.13	<0.1	Absent	Absent
3A	GW14	Rajiv Nagar	7.34	652.1	383	<5	181.25	62.17	<0.1	Absent	Absent
3A	GW15	Wanadongri	7.26	905.8	520	<5	283.7	75.14	<0.1	Absent	Absent
3A	GW16	Hingna Bus stand	7.15	1235	825	<5	371.7	88.37	<0.1	Absent	Absent
3A	GW17	Hingna	7.32	792.5	467	<5	220.13	84.13	<0.1	Absent	Absent
3A	GW18	Raipur	7.02	751.3	492	<5	240.17	47.15	<0.1	Absent	Absent
4A	GW19	Kapsi Kh.	7.17	902.3	540	<5	260.13	85.1	<0.1	Absent	Absent
1A	GW20	Dongargaon	7.09	1025	540	<5	274	72.1	<0.1	Absent	Absent
1A	GW21	Mohgaon	7.37	1038	555	<5	280.16	78.12	<0.1	Absent	Absent
1A	GW22	Meghdoot CIDCO	7.24	604.3	398	<5	194.23	35.12	<0.1	Absent	Absent
1A	GW23	Butibori Police station	7.81	506.2	290	<5	140.1	30.46	<0.1	Absent	Absent
1A	GW24	Ashokwan	7.39	751.3	471	<5	193.36	48.16	<0.1	Absent	Absent

(e) Water Quality Inferences

243. 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 (see Table 4-24). 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. Table 4-24 indicates that the Nallahs contain the lowest class "E" water due to a lack of Dissolved Oxygen (DO). Kahnan river has the best water quality, kwalifying as drinking water source without conventional treatment but after disinfection (class "A"). Vena river, Wakeshar dam and Ambazari lake meet the criteria for outdoor bathing (class "B"), the other rivers can be used fas drinking water source after conventional treatment and disinfection (class "C").

(i) The measured values for groundwater were compared with IS 10500:2012. The values for dissolved solids and total hardness exceed the limit in many cases, the other analysed parameters are within the limits. Coliforms were not detected in the groundwater samples.

G. ECOLOGY AND BIODIVERSITY

1. Introduction and Study Area

244. An ecological study is essential to understand the impact due to project development activities on flora and fauna of the area. Nagpur city is referred to as Tiger capitalsince there are 3 – 4 National parks/ Wildlife Sancturies around Nagpur city. However, Metro Rail project is outside the vicinity of these parks (>30 km). The proposed corridors do not pass through any reserve / protected forest in their entire stretches. Moreover, no protected areas / environmentally sensitive areas are found in the Indirect or Secondary Influence zone (10 km radial distance around the alignments). Following was carried out as part of the detailed ecology and biodiversity study for NMRP Phase II project.

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

(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

245. Ecology and Biodiversity studies were carried out from April to August 2023. 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. **Table 4-26** gives the study period for all the ecological studies carried out.

Table 4-26: Summary of the Ecological Studies Carried Out

Sl. No.	Type of Study / Faunal Class	Particulars	Methods	Duration / Time period of Sampling (Site Visit Dates)
1	Floral		Listing and Affected count due to proposed alignment	• 12th to 15th April 2023 • 25th to 29th April 2023

Sl. No.	Type of Study / Faunal Class	Particulars	Methods	Duration / Time period of Sampling (Site Visit Dates)
				• 31st July to 3rd August 2023
2	Birds	Terrestrial and Aquatic	Listing & Visual Encounter Survey	**Listing Survey:** • 12th to 15th April 2023 • 25th to 29th April 2023 • 31st July to 3rd August 2023 • Collection of secondary data throughout the study period
3	Reptiles	Terrestrial and Aquatic	Listing & Visual Encounter Survey	
4	Amphibians	-	Listing & Visual Encounter Survey	
5	Insects	Butterfly and Dragonfly	Listing	
6	Fishes	-	Listing, Market Survey & Discussion with Local fishermen	
7	Riparian & Aquatic ecology	Floral & faunal	Listing	• 31st July to 3rd August 2023

3. Approach & Methodologies of the Studies

(a) Approach to the Study

246. Data collection on the status of flora and fauna in the project study area are mandatory and a primary requirement of EIA studies. EB study was carried as per guidelines of MoEF&CC, CPCB, World Bank & ADB. 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., 10 km radius form the alignments).

(iii) Listing of Riparian flora observed from all Streams / Nallahs / River adjacent to or crossed by the alignments.

(c) Methodology for Aquatic Ecology Study

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

248. **Aquatic Fauna**

A. Fish Survey

249. 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

250. 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

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

252. 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) Methodology for Riparian Ecology

253. The riparian ecosystem includes the Streams / Nallahs / Ponds along the proposed alignments. The survey team has conducted listing survey on the riparian ecology at these sites.

(g) Gardens in the Nagpur City

254. The nearest gardens from the proposed alignments has been identified and marked on google image (**Figure 4-73**). List of gardens in the study area is also enumerated (**Table 4-40**).

4. Ecology & Biodiversity Study

(a) Terrestrial Ecology

5. Floral Studies

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

1	Floral Diversity	• Total 538 number of Trees (63 species) likely to be affected during construction of the Project of which only 1 species (*Tectona grandis*) is EN as per IUCN. • 255 species (163 trees, 75 Herbs, 12 Shrubs, 5 climbers) found in the Project study area of which 4 species are VU, 5 are NT, 1 CR and 1 EN as per IUCN.

(b) Trees likely to be affected

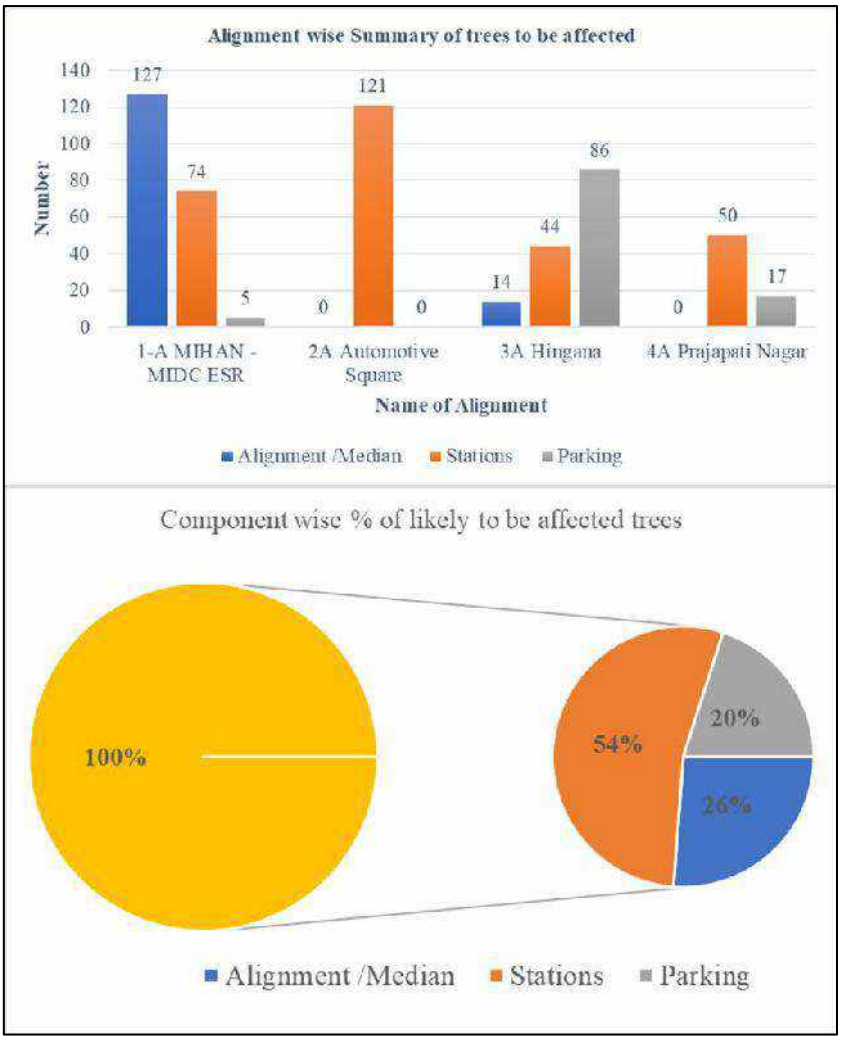
256. Trees likely to be affected during site construction activities along the NMRP-Phase II corridors were identified based on actual surveys. About 538 trees (63 species) will be affected due to proposed Metro alignments, summary of which is presented as **Table 4-27**

and **Figure 4-60**. Complete list of trees likely to be affected by the NMRP Phase II project with details like girth, height, canopy, approximate age, GPS location, and IUCN status, etc. is attached as **Annexure-7** of this EIA-EMP report.

Table 4-27: Alignment-wise Summary of Trees to be affected along NMRP Phase-II

Sr. No.	Name of the Alignment	Alignment / Median	Stations	Parking	Total
1	Reach 1A – MIHAN to MIDC ESR	127	74	5	206
2	Reach 2A – Automotive Square to Kanhan River	0	121	0	121
3	Reach 3A – Hingna	14	44	86	144
4	Reach 4A – Pardi to Transport Nagar	0	50	17	67
	Total	**141**	**289**	**108**	**538**

Figure 4-60: Alignment wise Summary of Trees likely to be Affected



257. Among the 63 affected species, *Azadirachta indica* (A. Juss.) is the most abundant with a count of 74 nos. followed by *Acacia nilotica* (47 nos.), *Pongamia piñata* (41 nos.), *Senna siamia* (38 nos.) and *Leucaena leucocephala* (26 nos.). Rest of the 58 species have a count of 1 to 23 nos. Girth wise summary of all the 538 trees likely to be affected along the four proposed NMRP Phase II corridors is presented as **Table 4-28**. Some photographs of tree surveys undertaken in the Project Study area are shown as **Figure 4-61**.

Table 4-28: Girth-wise Summary of Trees to be Affected along NMRP-P2 Corridors

Side of Alignment	Girth size (in cm)						Total
	0 – 30	31 – 60	61 – 90	91 – 120	121 – 150	> 150	
LHS	86	89	34	27	11	20	**267**
RHS	33	35	20	20	8	14	**130**
Median	5	44	29	29	21	13	**141**
Total	**124**	**168**	**83**	**76**	**40**	**47**	**538**

Figure 4-61: Tree Surveys undertaken in Project Study Area

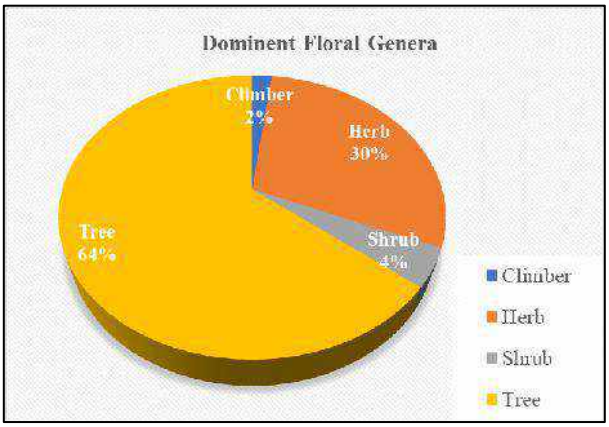
Date of Photo: 14/04/2023

Date of Photo: 27/04/2023

(c) Floral Diversity

258. Primary data were generated by preparing a general checklist of the trees around 2 km around the proposed alignment. The study recorded overall 255 species belonging to 71 families which included 163 species of Trees, 75 species of Herbs, 12 species of Shrubs and 5 species of Climbers. Dominant genera (type of flora) found in the study area is presented graphically as **Figure 4-62**.

Figure 4-62: 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, 127 species under Least Concern (LC), four species namely *Acacia ferruginea* DC., *Khaya senegalensis* (Desv.) A. Juss., *Santalum album* (L.) & *Saraca asoca* (Roxb.) Willd. are categorised as Vulnerable (VU), five species namely *Aegle marmelos* (L.) Corrêa, *Cupressus glabra* (Sudw.), *Dalbergia melanoxylon* (Guill. & Perr.), *Platycladus orientalis* (L.) Franco) &

Swietenia mahagoni (L.) Jacq. are categorised as Near Threatened (NT), one species namely *Hyophorbe verschaffeltii* (H. Wendl.) under Critically endangered (CR), and one species *Tectona grandis* (Linn. f.) under Endangered (EN) category, while no data is available for around 114 floral species. IUCN Category wise number of species recorded has been graphically presented in **Figure 4-63**. Family-wise number of Species observed in the Project Study Area is depicted in **Figure 4-64**, while photographs of Floral diversity observed in the project study area is shown in **Figure 4-65**. The List of Floral Diversity in the study area is presented in **Table 4-29**.

Figure 4-63: IUCN Category wise No. of species recorded

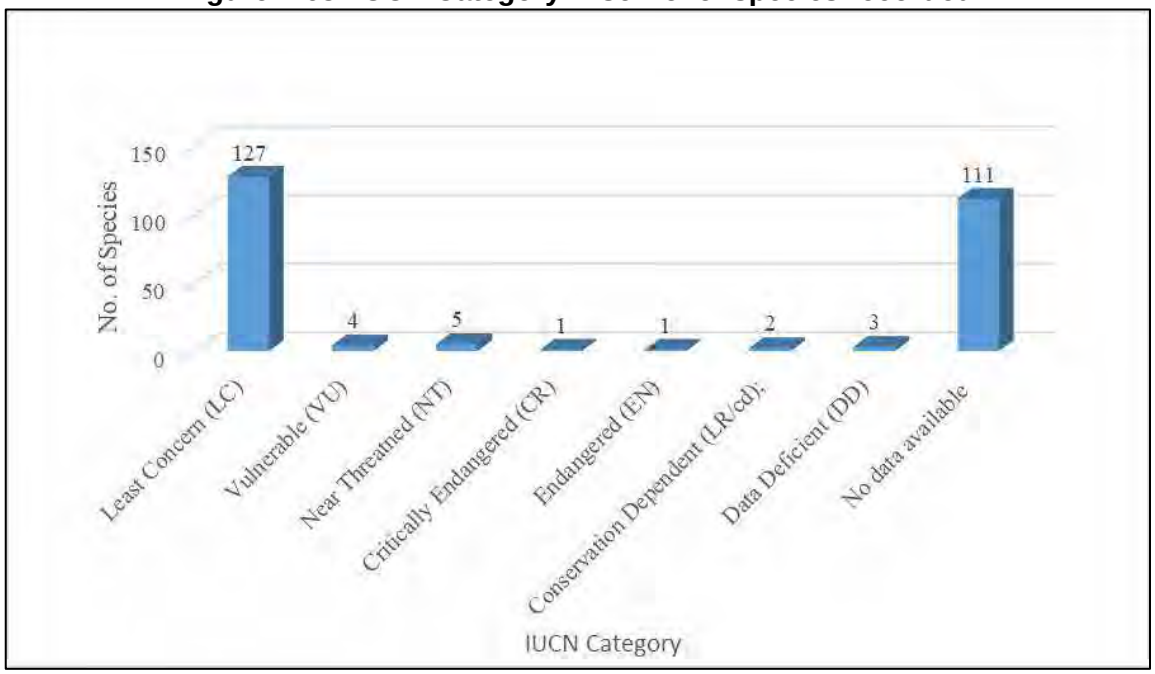


Figure 4-64: Family-wise number of Species observed in the Project Study Area

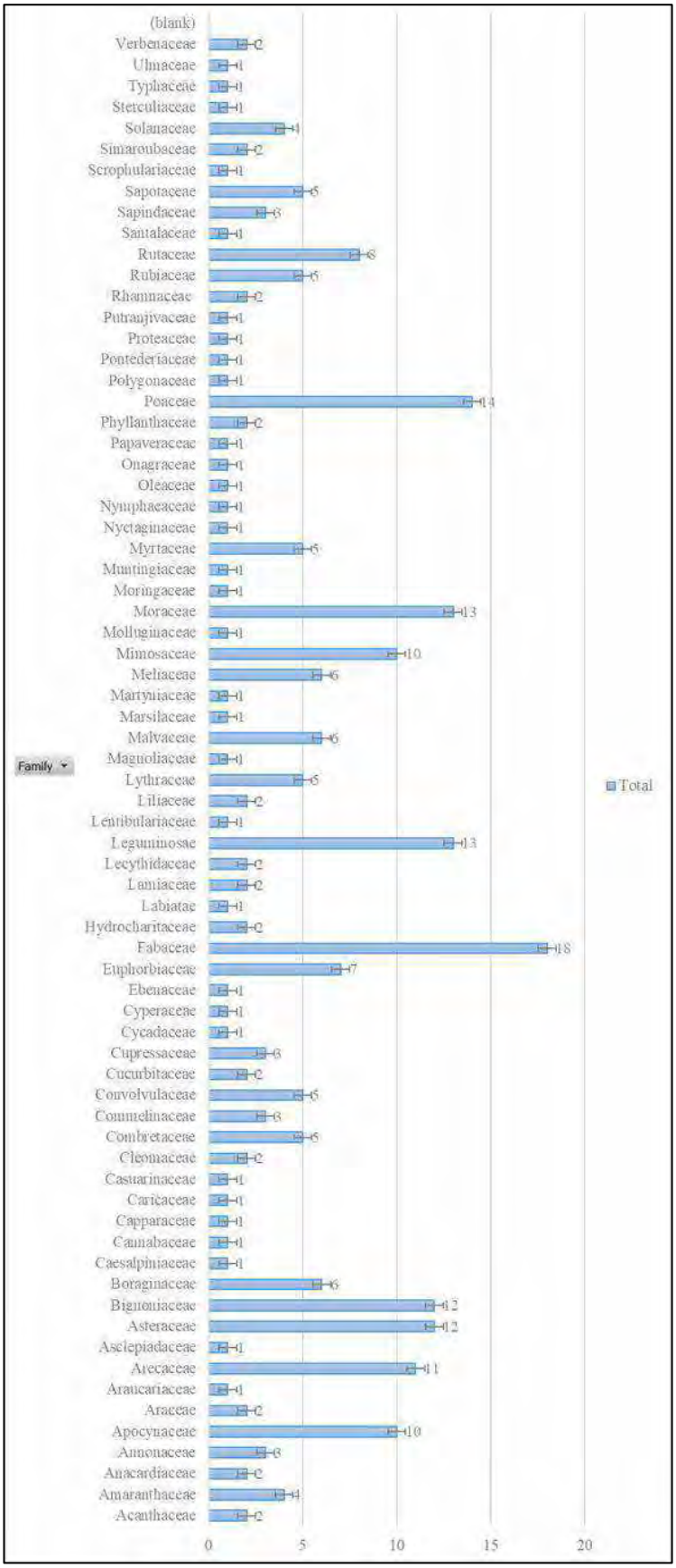


Figure 4-65: Some Photographs of Floral Diversity observed in the Project Study Area[50]

	
Abutilon indicum	*Acacia farnesiana* (L.) Willd.
	
Argemone Mexicana L.	*Blumea lacera* (Burm.f.) DC.
	
Calotropis gigantea (L.) Dryand.	*Chrozophora rottleri* (Geiseler) A. Juss. ex Spreng.

[50] *Source: Photographs were taken during primary Floral Surveys conducted by MITCON as per Table 4-26.*

	
Cleome viscosa L.	*Heliotropium indicum* L.
	
Dichrostachys cinerea (L.)	*Peltophorum pterocarpum* (DC.) K. Heyne
	
Erythrina variegata L.	*Solanum elaeagnifolium*
Tree Diversity	
	
Ailanthus excelsus Roxb.	*Alstonia scholaris* (L.) R.Br.

	
Azadirachta indica A. Juss.	*Ceiba pentandra* (L.) Gaertn
	
Cordia dichotoma G. Forst	*Ficus hispida* L.f.
	
Senna siamea (Lam.) H.S. Irwin & Barneby	*Ipomoea carnea* Jacq.

Table 4-29: Floral Diversity observed in the Project Study Area

Sr.No.	Botanical Name	Family	Common Name	Class	IUCN Status
1	*Abrus precatorius* L.	Fabaceae	Jequirity bean or Rosary pea	Climber	
2	*Abutilon indicum* (L.) Sweet	Malvaceae	Indian Mallow	Shrub	
3	*Acacia auriculiformis* A. cunh ex Benth.	Mimosaceae	Ear-leaf Acacia	Tree	LC

Sr.No.	Botanical Name	Family	Common Name	Class	IUCN Status
4	*Acacia catechu* (L.f.) Willd.	Mimosaceae	Cutch tree	Tree	LC
5	*Acacia chundra* (Roxb. ex Rottler) Willd.	Fabaceae	Khair	Tree	
6	***Acacia ferruginea* DC.**	**Mimosaceae**	**Safed Khair**	**Tree**	**VU**
7	*Acacia leucophloea* (Roxb.) Willd.	Mimosaceae	Kuteera-Gum, White-barked acacia.	Tree	LC
8	*Acacia nilotica* (Linn.) Del.	Mimosaceae	Babul	Tree	LC
9	*Acacia polyacantha* Willd.	Mimosaceae	White Catechu	Tree	
10	*Acalypha indica* L.	Euphorbiaceae	Indian acalypha	Herb	
11	*Acanthospermum hispidum* DC.	Asteraceae	Bristly starbur	Herb	
12	*Achyranthes aspera* L.	Asteraceae	prickly chaff flower	Herb	
13	***Aegle marmelos* (L.) Corrêa**	**Rutaceae**	**Stone apple**	**Tree**	**NT**
14	*Aeschynomene virginica* (L.)	Fabaceae	Laugauni	Herb	
15	*Agave americana* L.	Asteraceae	Century Plant	Herb	LC
16	*Ageratum conyzoides* L.	Asteraceae	Billygoat-weed	Herb	LC
17	*Ailanthus excelsa* Roxb.	Simaroubaceae	Tree of heaven	Tree	
18	*Albizia lebbeck* (L.) Benth.	Leguminosae	Lebbek tree	Tree	LC
19	*Albizia procera* (Roxb.) Benth.	Fabaceae	White siris	Tree	LC
20	*Albizia saman* (Jacq.) Merr.	Leguminosae	Rain tree	Tree	
21	*Aloe vera* (L.) Burm.f.	Liliaceae	Aloe barbadensis miller	Herb	
22	*Alstonia scholaris* (L.) R. Br.	Apocynaceae	Blackboard tree	Tree	LC
23	*Alternanthera pubescens* Hort.Prag. ex Moq.	Amaranthaceae		Herb	
24	*Alternanthera sessilis* (L.) DC.	Amaranthaceae	Kanchari	Herb	
25	*Alternanthera sessilis* (L.) R. Br. ex DC.	Acanthaceae	Stalkless Joyweed	Herb	LC
26	*Amaranthus viridis* L.	Amaranthaceae	Amaranth	Herb	
27	*Ammannia baccifera* Roth	Lythraceae	Aginbuti	Herb	LC
28	*Andrographis echioides* (L.) Nees	Asteraceae	False Water-Willow	Herb	
29	*Andropogon pumilus* Roxb.	Poaceae	Baerki, Diwartan	Herb	
30	*Annona reticulata* Linn.	Annonaceae	Bull's Heart	Tree	LC
31	*Annona squamosa* L.	Annonaceae	Custard Apple	Tree	LC
32	*Anogeissus latifolia* (Roxb. ex DC.) Guillemin & Perottet	Combretaceae	Axle Wood Tree	Tree	
33	*Aphanamixis polystachya* (Wall.) Parker	Meliaceae	Rohitak	Tree	LC
34	*Apluda mutica* L.	Poaceae	Mauritian Grass	Herb	
35	*Araucaria columnaris* (G. Forst.) Hook.	Araucariaceae	Cook pine	Tree	LC
36	*Areca catechu* L.	Arecaceae	Areca nut palm, betel palm	Tree	DD
37	*Argemone mexicana* L.	Papaveraceae	Mexican prickly poppy	Herb	
38	*Aristida adscensionis* L.	Poaceae	Common needle grass	Herb	
39	*Artocarpus heterophyllus* Lam.	Moraceae	Jack fruit	Tree	

Sr.No.	Botanical Name	Family	Common Name	Class	IUCN Status
40	*Asparagus racemosus* Willd.	Liliaceae	Shatavari	Climber	
41	*Azadirachta indica* A. Juss.	Meliaceae	Neem	Tree	LC
42	*Bambusa arundinacea* Willd.	Poaceae	Common Bamboo	Tree	
43	*Bambusa vulgaris* Schrad.	Poaceae	Common bamboo	Tree	
44	*Bauhinia purpurea* L.	Leguminosae	Orchid tree, Purple Bauhinia	Tree	LC
45	*Bauhinia racemosa* Lam.	Caesalpiniaceae	The bidi leaf tree	Tree	
46	*Bauhinia variegata* L.	Leguminosae	Mountain ebony	Tree	LC
47	*Blumea axillaris* (Lam.) DC	Asteraceae	Pink Blumea	Herb	
48	*Blumea lacera* (Burm. f.) DC.	Asteraceae	Kakronda, Jangli Muda	Herb	LC
49	*Boerhavia diffusa* L.	Nyctaginaceae	punarnava	Herb	
50	*Bombax ceiba* L.	Malvaceae	Silk cotton tree	Tree	LC
51	*Broussonetia papyrifera* (Linn.) L'Herrit ex Vent	Moraceae	Paper Mulberry	Tree	LC
52	*Butea monosperma* (Lamk.) Taub.	Fabaceae	Flame Of The Forest	Tree	LC
53	*Calliandra haematocephala* Hassk.	Mimosaceae	Powder-puff	Tree	
54	*Callistemon citrinus* (Curtis) Skeels	Myrtaceae	Lemon bottlebrush	Tree	
55	*Calotropis gigantea* (L.) Dryand.	Apocynaceae	Crown Flower	Herb	
56	*Calotropis procera* (Aiton.) R. Br.	Asclepiadaceae	Apple of Sodom	Shrub	LC
57	*Capparis divaricata* Lam.	Capparaceae	Spreading Caper	Tree	
58	*Cardiospermum halicacabum* L.	Sapindaceae	lesser balloon vine	Climber	LC
59	*Careya arborea* Roxb.	Lecythidaceae	Wild guava	Tree	
60	*Carica papaya* L.	Caricaceae	Papaw or pawpaw	Tree	DD
61	*Carissa congesta* Wight	Apocynaceae	Karvand	Shrub	LC
62	*Caryota urens* L.	Arecaceae	Solitary fishtail palm	Tree	LC
63	*Cascabela thevetia* (L.) Lippold	Apocynaceae	Bitti	Tree	LC
64	*Cassia fistula* L.	Leguminosae	Golden shower	Tree	LC
65	*Cassia grandis* L.f.	Fabaceae	Pink Shower	Tree	LC
66	*Cassia javanica* L.	Fabaceae	Java Cassia	Tree	LC
67	*Cassia siamea* Lam.	Fabaceae	Siamese cassia, kassod tree	Tree	LC
68	*Cassia tora* L.	Fabaceae	Takla	Shrub	
69	*Casuarina equisetifolia* L.	Casuarinaceae	Coast she-oak	Tree	LC
70	*Ceiba pentandra* (L.) Gaertn.	Malvaceae	Kapok	Tree	LC
71	*Chenopodium album* L.	Amaranthaceae	Chakvat	Herb	
72	*Chloris virgata* Sw.	Poaceae	Rhodes grass	Herb	
73	*Chrozophora rottleri* (Geiseler) Spreng	Euphorbiaceae	Survanti	Herb	
74	*Citharexylum spinosum* L.	Verbenaceae	Fiddle Wood	Tree	LC
75	*Citrus aurantiifolia* (christ.)Swingle	Rutaceae	Lemon	Tree	
76	*Citrus limon* (L.) Burm. f.	Rutaceae	Lemon Tree	Tree	LC

Sr.No.	Botanical Name	Family	Common Name	Class	IUCN Status
77	*Citrus maxima* (Burm.) Merr.	Rutaceae	Pomelo	Tree	LC
78	*Citrus sinensis* (L.) Osbeck	Rutaceae	Sweet Lime	Tree	
79	*Cleome viscosa* L.	Cleomaceae	Asian spider flower	Herb	
80	*Coccinia grandis* (L.) Voigt	Cucurbitaceae	Ivy Guard	Herb	
81	*Cocos nucifera* L.	Arecaceae	Coconut tree	Tree	
82	*Colocasia esculenta* (L.) Schott	Araceae	Taro	Herb	LC
83	*Commelina benghalensis* L.	Commelinaceae	Kena	Herb	LC
84	*Cordia dichotoma* Forst. f.	Boraginaceae	Bhokar	Tree	LC
85	*Cordia myxa* Linn.	Boraginaceae	Gunda	Tree	LC
86	*Cordia sebestena* Linn.	Boraginaceae	Scarlet Cordia	Tree	LC
87	*Cordia sinensis* Lam.	Boraginaceae	Grey-leaved saucer berry	Tree	LC
88	*Corynandra elegans* Chandore, U.S. Yadav & S.R. Yadav	Cleomaceae	Elegant Spider Flower, Kapare Kamal	Herb	
89	*Couroupita guianensis* Aubl.	Lecythidaceae	Cannon Ball Tree	Tree	LC
90	*Croton bonplandianus* Baill.	Euphorbiaceae	Ban Tulsi	Herb	
91	***Cupressus glabra* Sudw.**	**Cupressaceae**	**Smooth Arizona**	**Tree**	**NT**
92	*Cupressus sempervirens* L.	Cupressaceae	Italian Cypress	Tree	LC
93	*Cyanotis axillaris* (L.) D. Don ex Sweet	Commelinaceae	Spreading dayflower	Herb	LC
94	*Cyanotis fasciculata* (B. Heyne ex Roth) Schult. & Schult. f.	Commelinaceae	Nilwanti	Herb	LC
95	*Cycas circinalis* L.	Cycadaceae	Cycas	Tree	LC
96	*Cynodon dactylon* (L.) Pers.	Poaceae	Common Lawn Grass	Herb	
97	*Dalbergia lanceolaria* L.f.	Leguminosae	Takoli	Tree	LC
98	***Dalbergia melanoxylon* Guill. & Perr.**	**Leguminosae**	**African Blackwood**	**Tree**	**NT**
99	*Dalbergia sissoo* DC.	Leguminosae	North Indian rosewood	Tree	LC
100	*Datura inoxia* Mill.	Solanaceae	Angel's trumpet	Herb	
101	*Datura stramonium* L.	Solanaceae	Dhotra	Herb	
102	*Delonix regia* (Hook.) Raf.	Leguminosae	Gulmohar	Tree	LC
103	*Dichrostachys cinerea* (L.) Wight & Arn.	Fabaceae	Sickle Bush	Tree	LC
104	*Diospyros malabarica* (Desr.) Kostel	Ebenaceae	Jangali Chicko	Tree	
105	*Dolichandrone falcata* (Wall ex DC.) Seem.	Bignoniaceae	Medhshingi	Tree	
106	*Echinochloa colona* (L.) Link	Poaceae		Herb	LC
107	*Echinochloa crus-galli* (L.) P. Beauv.	Poaceae		Herb	LC
108	*Echinops echinatus* Roxb.	Asteraceae	Indian Globe Thistle	Herb	
109	*Eclipta prostrata* Lour.	Asteraceae	Bhringranj	Herb	LC
110	*Eichhornia crassipes* (Mart.) Solms	Pontederiaceae	Water Hyacinth	Herb	
111	*Ervatamia divaricata* (L.) Burkill	Apocynaceae	Tagar	Tree	
112	*Erythrina variegata* L.	Fabaceae	Indian Coral Tree	Tree	LC

Sr.No.	Botanical Name	Family	Common Name	Class	IUCN Status
113	*Eucalyptus globulus* Labil.	Myrtaceae	Nilgiri	Tree	LC
114	*Euphorbia hirta* L.	Euphorbiaceae	Hairy Spurge	Herb	
115	*Evolvulus nummularius* (L.) L.	Convolvulaceae	Nimulvel	Herb	
116	*Fernandoa adenophylla* (G. Don.) Steenis	Bignoniaceae	Medshing	Tree	
117	*Ficus amplissima* Sm.	Moraceae	Indian Bat tree	Tree	
118	*Ficus benghalensis* L.	Moraceae	Banyan	Tree	
119	*Ficus benjamina* L.	Moraceae	Green Ficus	Tree	LC
120	*Ficus carica* Linn.	Moraceae	Anjir (Fig)	Tree	LC
121	*Ficus elastica* Roxb. ex Hornem	Moraceae	Indian Rubber Tree	Tree	LC
122	*Ficus hispida* L. f.	Moraceae	Hairy Fig	Tree	LC
123	*Ficus longifolia* Schott	Moraceae	Narrow Leaf Fig	Tree	
124	*Ficus microcarpa* L. f.	Moraceae	Malayan Banyan	Tree	LC
125	*Ficus racemosa* L.	Moraceae	Cluster fig	Tree	LC
126	*Ficus religiosa* L.	Moraceae	Bodhi tree	Tree	LC
127	*Filicium decipiens* (Wight & Arn.) Thawaites	Sapindaceae	Fern Tree	Tree	LC
128	*Glinus oppositifolius* Aug.DC.	Molluginaceae	Jima	Herb	LC
129	*Gliricidia sepium* (Jacq.) Walp.	Fabaceae	Giripushpa	Tree	LC
130	*Grevillea robusta* A. Cunn. ex R.Br.	Proteaceae	Silver Oak	Tree	LC
131	*Hardwickia binata* Roxb.	Fabaceae	Anjan	Tree	LC
132	*Heliotropium indicum* L.	Boraginaceae	Burundi	Herb	
133	*Heterophragma quadriloculare* (Roxb.) K. Schum.	Bignoniaceae	Varas	Tree	
134	*Heteropogon contortus* (L.) P. Beauv. ex Roem. & Schult.	Poaceae	Black Spear-grass	Herb	
135	*Holarrhena pubescens* Wall.	Apocynaceae	Indrajao	Tree	LC
136	*Holoptelia integrifolia* (Roxb.) Planch	Ulmaceae	Indian Elm	Tree	
137	*Hydrilla verticillata* (Roxb.) Royle	Hydrocharitaceae	Seval	Herb	LC
138	*Hygrophila auriculata* (Schumach.) Heine	Acanthaceae	Marsh Barbel	Shrub	LC
139	***Hyophorbe verschaffeltii*, H. Wendl.**	**Arecaceae**	**Spindle palm**	**Tree**	**CR**
140	*Indigofera cordifolia* B. Heyne ex Roth	Fabaceae	Heart-leaf Indigo	Herb	
141	*Ipomoea aquatica* Forssk.	Convolvulaceae	Panivel bhaji	Herb	LC
142	*Ipomoea carnea* Jacq.	Convolvulaceae	Morning Glory	Climber	
143	*Ipomoea fistulosa* Mart. ex Choisy	Convolvulaceae	Besharam	Herb	
144	*Ipomoea pes-caprae* (L.) R.Br.	Convolvulaceae	Goat Foot Vine	Climber	LC
145	*Jacaranda acutifolia* Bonpl	Bignoniaceae	Nilmohar	Tree	LC
146	*Jatropha curcas* L.	Euphorbiaceae	Physics nut	Shrub	LC
147	*Jatropha curcas* Linn.	Euphorbiaceae	Jatropha	Tree	LC
148	***Khaya senegalensis* (Desv.) A. Juss.**	**Meliaceae**	**Khaya**	**Tree**	**VU**
149	*Kigelia africana* (Lam.) Benth.	Bignoniaceae	Sausage tree	Tree	LC
150	*Lagerstroemia speciosa* (Linn.) Pers.	Lythraceae	Pride of India	Tree	
151	*Lannea coromandelica* (Houtt.) Merr.	Anacardiaceae	Shemat	Tree	LC
152	*Lantana camara* L.	Verbenaceae	Lantana	Shrub	
153	*Lawsonia inermis* L.	Lythraceae	Henna	Shrub	LC

Sr.No.	Botanical Name	Family	Common Name	Class	IUCN Status
154	*Leucaena leucocephala* (Lam.) de Wit	Mimosaceae	Jumbay, white leadtree	Tree	
155	*Limonia acidissima* Houtt.	Rutaceae	Kavath	Tree	
156	*Livistona chinensis* (Jacq.) R.Br. ex Mart.	Arecaceae	Chinese Fan Palm	Tree	
157	*Livistona rotundifolia* (Lam.) Mart.	Arecaceae	Footstool Palm	Tree	
158	*Lophopogon tridentatus* (Roxb.) Hack	Poaceae	Three-Teeth Beardgrass	Herb	
159	*Ludwigia adscendens* (L.) H. Hara	Onagraceae	Kavkula	Herb	LC
160	*Madhuca indica* Gmel.	Sapotaceae	Indian Butter Tree	Tree	
161	*Madhuca longifolia* (Koenig) MacBr	Sapotaceae	South Indian Mahua	Tree	
162	*Mangifera indica* L.	Anacardiaceae	Mango	Tree	DD
163	*Manilkara hexandra* (Roxb.) Dubard.	Sapotaceae	Ceylon Iron Wood Tree	Tree	
164	*Manilkara zapota* (L.) P.Royen	Sapotaceae	Sapodilla	Tree	LC
165	*Markhamia lutea* (Benth.) Schum.	Bignoniaceae	Markhamia	Tree	LC
166	*Marsilea quadrifolia* L.	Marsilaceae	Caupatia	Herb	LC
167	*Martynia annua* L	Martyniaceae	Cat's claw, tiger's claw	Herb	
168	*Melia azedarach* L.	Meliaceae	Chinaberry tree, pride of India	Tree	LC
169	*Melia dubia* Cav.	Meliaceae	Malabar Neem	Tree	
170	*Meyna spinosa* Roxb.ex Link	Rubiaceae	Muyna	Tree	
171	*Michelia champaca* Linn.	Magnoliaceae	Sonchapha	Tree	LC
172	*Millingtonia hortensis* Linn.	Bignoniaceae	Indian Cork Tree	Tree	
173	*Mimusops elengi* L.	Sapotaceae	Spanish cherry	Tree	LC
174	*Mitragyna parvifolia* Korth.	Rubiaceae	Kalamb	Tree	
175	*Morinda citrifolia* Linn.	Rubiaceae	Noni	Tree	
176	*Morinda pubescens* J.E. Sm.	Rubiaceae	Indian mulberry	Tree	
177	*Moringa oleifera* Lam.	Moringaceae	Drumstick tree	Tree	LC
178	*Morus alba* Linn.	Moraceae	Mulberry	Tree	LC
179	*Muntingia calabura* L.	Muntingiaceae	Singapore cherry	Tree	
180	*Murraya koenigii* (L.) Spreng.	Rutaceae	Curry patta	Tree	LC
181	*Murraya paniculata* (L.) Jack	Rutaceae	Bakul	Tree	
182	*Neolamarckia cadamba* (Roxb.) Bosser	Rubiaceae	Burflower-tree	Tree	
183	*Nyctanthes arbor-tristis* Linn.	Oleaceae	Parijatak	Tree	LC
184	*Nymphaea nouchali* Burm.f.	Nymphaeaceae	Kamal	Herb	LC
185	*Ocimum sanctum* L.	Lamiaceae	Tulsi	Herb	
186	*Oroxylum indicum* (L.) Benth. ex Kurz	Bignoniaceae	Broken Bones Trees	Tree	
187	*Oryza* sp.	Poaceae	Devtandul	Herb	LC
188	*Ottelia alismoides* (L.) Pers.	Hydrocharitaceae	Duck Lettuce	Herb	LC
189	*Parkia biglandulosa* Wight & Arn.	Leguminosae	African locust bean	Tree	
190	*Parthenium hysterophorus* L.	Asteraceae	Congress Grass	Herb	
191	*Paspalidium flavidum* (Retz.) A.	Poaceae	Yellow Water-	Herb	LC

Sr.No.	Botanical Name	Family	Common Name	Class	IUCN Status
	Camus		crown Grass		
192	*Peltophorum pterocarpum* (DC.) Baker	Fabaceae	Copper Pod	Tree	
193	*Phoenix robusta* (Becc.) Hook.f.	Arecaceae	Mountain date palm	Tree	
194	*Phoenix roebelenii* O'Brien	Arecaceae	Pygmy Date Palm	Tree	
195	*Phoenix sylvestris* (L.) Roxb.	Arecaceae	Silver Date Palm	Tree	
196	*Phyllanthus emblica* Linn.	Phyllanthaceae	Amla	Tree	LC
197	*Phyllanthus niruri* L.	Phyllanthaceae	Gale of the wind	Herb	
198	*Pimenta dioica* (Linn.) Merrill.	Myrtaceae	All Spice Tree	Tree	LC
199	*Pistia stratiotes* L.	Araceae	Pan Kumbhi	Herb	LC
200	*Pithecellobium dulce* (Roxb.) Benth	Mimosaceae	Manila tamarind	Tree	LC
201	***Platycladus orientalis* (L.) Franco**	**Cupressaceae**	**Chinese arborvitae**	**Tree**	**NT**
202	*Plumeria alba* Linn.	Apocynaceae	Safed Chapha	Tree	LC
203	*Plumeria obtusa* Linn.	Apocynaceae	Chapha (O)	Tree	LC
204	*Plumeria pudica* Jacq.	Apocynaceae	Bridal Bouquet	Tree	LC
205	*Plumeria rubra* L.	Apocynaceae	Frangipani, Common Frangipani	Tree	LC
206	*Polyalthia longifolia* (Sonn.) Thwaites	Annonaceae	Ashoka	Tree	
207	*Polygonum glabrum* Willd.	Polygonaceae	Gulabi Godhri	Herb	LC
208	*Pongamia pinnata* (L.) Pierre	Leguminosae	Millettia pinnata	Tree	LC
209	*Prosopis juliflora* (Sw.) DC.	Mimosaceae	Algaroba	Tree	
210	*Psidium guajava* L.	Myrtaceae	Common guava	Tree	LC
211	*Pterospermum acerifolium* (L.) Willd.	Malvaceae	Kanak Champa	Tree	LC
212	*Pulicaria wightiana* C. B. Clarke	Asteraceae	Sontikli	Herb	
213	*Punica granatum* L.	Lythraceae	Pomegranate	Tree	LC
214	*Putranjiva roxburghii* Wall.	Putranjivaceae	Lucky Bean Tree	Tree	LC
215	*Ricinus communis* L.	Euphorbiaceae	castor oil plant	Shrub	
216	*Rotala fimbriata* Wight	Lythraceae	Fringed Flower Rotala	Herb	LC
217	*Roystonea regia* (Kunth) O.F. Cook	Arecaceae	Florida Royal Palm	Tree	LC
218	*Sacciolepis interrupta* Stapf	Poaceae	Interrupted Cupscale Grass	Herb	
219	***Santalum album* L.**	**Santalaceae**	**Sandalwood**	**Tree**	**VU**
220	*Sapindus trifoliatus* L.	Sapindaceae	Phenil	Tree	
221	***Saraca asoca* (Roxb.) Willd.**	**Leguminosae**	**Ashoka tree**	**Tree**	**VU**
222	*Schenoplectus* sp.	Cyperaceae	Gad	Herb	
223	*Senna siamea* (Lam.) Irwin & Barneby	Fabaceae	Siamese Cassia	Tree	LC
224	*Senna tora* (L.) Roxb.	Fabaceae	Stinking Cassia,Takla	Herb	
225	*Sida acuta* Burm. f.	Malvaceae	Common wireweed	Shrub	
226	*Simarouba glauca* DC.	Simaroubaceae	Lakshmi Taru	Tree	LC
227	*Solanum surattense* Burm.f.	Solanaceae	Kateringani	Herb	

Sr.No.	Botanical Name	Family	Common Name	Class	IUCN Status
228	*Solanum virginianum* L.	Solanaceae	Thorny Nightshade, Kateringani	Herb	
229	*Spathodea campanulata* P. Beauv.	Bignoniaceae	African tulip tree	Tree	LC
230	*Sterculia foetida* Linn.	Sterculiaceae	Devil's Tree	Tree	
231	*Striga densiflora* (Benth.) Benth.	Scrophulariaceae	Agya	Herb	
232	***Swietenia mahagoni* (L.) Jacq.**	**Meliaceae**	**Small-leaved mahogany**	**Tree**	**NT**
233	*Syzygium cumini* (L.) Skeels	Myrtaceae	Indian blackberry or Jamun.	Tree	LC
234	*Tabebuia aurea* (Silva Manso) Benth. & Hook.f. ex S. Moore	Bignoniaceae	Yellow Tabebuia	Tree	
235	*Tabebuia pentaphylla* (Linn.) Hemsi	Bignoniaceae	Pink Tecoma	Tree	LC
236	*Tamarindus indica* L.	Leguminosae	Tamarind	Tree	LC
237	*Tecoma stans* (L.) Juss. ex Kunth	Bignoniaceae	Yellow Bells	Tree	LC
238	***Tectona grandis* Linn.f.**	**Labiatae**	**Teak Wood Tree**	**Tree**	**EN**
239	*Tephrosia purpurea* (L.) Pers.	Fabaceae	Wild Indigo, Unhali	Herb	LC
240	*Terminalia arjuna* (Roxb. ex DC.) Wight & Arn.	Combretaceae	Arjuna	Tree	
241	*Terminalia catappa* L.	Combretaceae	Indian almond	Tree	LC
242	*Terminalia mantaly* H. Perrier	Combretaceae	China Almond Tree	Tree	LC
243	*Terminalia bellirica* (Gaertn.) Roxb.	Combretaceae	Behada	Tree	LC
244	*Thespesia populnea* (L.) Sol. ex Correa	Malvaceae	The Portia tree	Tree	LC
245	*Trema orientalis* (Linn.) Bl.	Cannabaceae	Indian Charcoal Tree	Tree	LC
246	*Trichosanthes cucumerina* L.	Cucurbitaceae	Snake gourd	Herb	
247	*Tridax procumbens* L.	Asteraceae	Coat-buttons or Tridax daisy	Herb	
248	*Typha angustifolia* L.	Typhaceae	Narrow-leaf Cat-tail	Herb	LC
249	*Utricularia reticulata* Sm.	Lentibulariaceae	Nili Papni	Herb	LC
250	*Vitex nigundo* L.	Lamiaceae	Chaste Tree	Tree	
251	*Wodyetia bifurcata* A.K. Irvine	Arecaceae	Foxtail Palm	Tree	CD
252	*Xanthium indicum* Koen.	Boraginaceae	Rough cocklebur	Shrub	
253	*Ziziphus jujuba* Mill.	Rhamnaceae	Indian Jujube	Tree	LC
254	*Ziziphus mauritiana* Lamk.	Rhamnaceae	Ber	Tree	LC

(d) Faunal Studies

260. The baseline faunal surveys were carried out from April to August 2023 via visual encounters & available secondary data etc. as detailed out in the methodology section. A total of 392 various faunal species, as summarised in **Table 4-30**, including 283 species of avifauna, 14 species of herpatofauna, 65 species of butterflies, 22 species of dragonfly, 8

species of Fish have been observed / recorded during the study. Some photographs of Faunal Diversity found in the Project Study Area is depicted in **Figure 4-67**.

Table 4-30: Faunal Community of Project Area[51]

Sl	Type (Class) of Fauna	Total Number of Species observed / recorded
1	Avian species	283
2	Herpatofauna	14
3	Butterfly	65
4	Dragonfly	22
5	Fishes	08
Total		**392**

1. Avifaunal Diversity

261. Total 283 bird species found in and around Nagpur City[52], of which 5 species are VU, 10 are NT, 4 are CR and 3 are EN as per IUCN. Bird diversity represented as IUCN Status is depicted in **Figure 4-66**, while list of bird species found in and around Nagpur city is given in **Table 4-31**.

Figure 4-66: Bird Diversity - IUCN Status

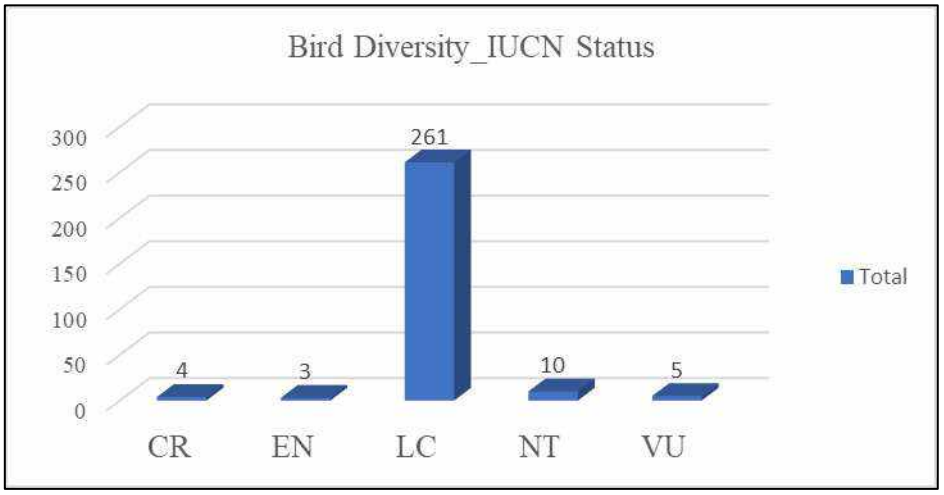


Table 4-31: Avian Diversity of Nagpur

Sr. No.	Name of Bird	Zoological Name	Status	Abundance	IUCN Status
1	Shikra	*Accipiter badius dussumieri*	R	C	LC
2	Eurasian Sparrowhawk	*Accipiter nisus*	W	Rr	LC
3	Crested Goshawk	*Accipiter trivirgatus*	V	Rr	LC
4	Bank Myna	*Acridotheres gingianus*	R	U	LC
5	Common Myna	*Acridotheres tristis tristis*	R	A	LC
6	Paddy-field Warbler	*Acrocephalus agricola*	W	Rr	LC
7	Blyth's Reed Warbler	*Acrocephalus dumetorum*	W	U	LC

[51] *Source: Primary Survey by MITCON and secondary data acquired from authenticated sources (various research papers).*

[52] *Kasambe, R. and Tarique Sani, T. (2009): Avifauna in and around Nagpur city of Maharashtra- an annotated, authentic, contemporary checklist. Newsletter for Birdwatchers. 49(3): 35-40.*

Sr. No.	Name of Bird	Zoological Name	Status	Abundance	IUCN Status
8	Clamorous Reed Warbler	*Acrocephalus stentoreus*	W	U	LC
9	Common Sandpiper	*Actitis hypoleucos*	W	C	LC
10	Common Iora	*Aegithina tiphia*	R	C	LC
11	Oriental Skylark	*Alauda gulgula*	R	C	LC
12	Common Kingfisher	*Alcedo atthis*	R	C	LC
13	Red Avadavat	*Amandava amandava*	R	U	LC
14	Green Avadavat	*Amandava formosa*	R	Rr	LC
15	Brown Crake	*Amaurornis akool*	R	Rr	LC
16	White-breasted Waterhen	*Amaurornis phoenicurus*	R	C	LC
17	Rufoustailed Lark	*Ammomanes phoenicrurus*	R	C	LC
18	Northern Pintail	*Anas acuta*	W	C	LC
19	Northern Shoveler	*Anas clypeata*	W	C	LC
20	Common Teal	*Anas crecca*	W	C	LC
21	Eurasian Wigeon	*Anas penelope*	W	U	LC
22	Mallard	*Anas platyrhynchos*	W	Rr	LC
23	Spot-billed Duck	*Anas poecilhorhynchus*	R	C	LC
24	Garganey	*Anas querquedula*	W	O	LC
25	Gadwall	*Anas strepera strepera*	W	U	LC
26	Asian Openbill	*Anastomus oscitans*	R	U	LC
27	Darter	*Anhinga melanogaster*	LM	U	LC
28	Tawny Pipit	*Anthus campestris*	W	U	NT
29	Blyth's Pipit	*Anthus godlewski*	W	Rr	LC
30	Olivebacked Pipit	*Anthus hodgsoni*	W	Rr	LC
31	Paddyfield Pipit	*Anthus rufulus*	R	C	LC
32	Tree Pipit	*Anthus trivialis*	R	U	LC
33	House Swift	*Apus affinis affinis*	R	A	LC
34	Tawny Eagle	*Aquila rapax*	R	Rr	VU
35	Grey Heron	*Ardea cinerea*	LM	U	LC
36	Purple Heron	*Ardea purpurea*	LM	U	LC
37	Indian Pond Heron	*Ardeola grayii*	R	C	LC
38	Great Indian Bustard	*Ardeotis nigriceps*	R	Rr	CR
39	Spotted Owlet	*Athene brama*	R	C	LC
40	Common Pochard	*Aythya ferina*	W	C	VU
41	Tufted Duck	*Aythya fuligula*	W	U	LC
42	Ferruginous Pochard	*Aythya nyroca*	W	Rr	NT
43	Rock Eagle-Owl	*Bubo bengalensis*	R	C	LC
44	Cattle Egret	*Bubulcus ibis*	R	A	LC
45	Eurasian Thick-knee	*Burhinus oedicnemus*	R	U	LC
46	White-eyed Buzzard	*Butastur teesa*	R	U	LC
47	Common Buzzard	*Buteo buteo*	W	Rr	LC
48	Little Heron	*Butorides striata*	R	U	LC
49	Grey-bellied Cuckoo	*Cacomantis passerinus*	R	U	LC
50	Little Stint	*Calidris minuta*	W	U	LC
51	Temminck's Stint	*Calidris temminckii*	W	U	LC
52	Savanna Nightjar	*Caprimulgus affinis*	R	C	LC
53	Indian Nightjar	*Caprimulgus asiaticus*	R	C	LC
54	Grey Nightjar	*Caprimulgus indicus*	R	C	LC
55	Common Rosefinch	*Carpodacus erythrinus*	W	O	LC
56	Great Egret	*Casmerodius albus*	R	U	LC
57	Greater Coucal	*Centropus sinensis*	R	C	LC

Sr. No.	Name of Bird	Zoological Name	Status	Abundance	IUCN Status
58	Brown Rock Chat	*Cercomela fusca*	R	C	LC
59	Pied Kingfisher	*Ceryle rudis*	R	C	LC
60	Kentish Plover	*Charadrius alexandrinus*	BM	U	LC
61	Little Ringed Plover	*Charadrius dubius*	R	C	LC
62	Lesser Sand Plover	*Charadrius mongolus*	PM	Rr	LC
63	Whiskered Tern	*Chlidonias hybridus*	W	O	LC
64	Bluewinged Leafbird	*Chloropsis cochinchinensis*	R	Rr	EN
65	White-naped Woodpecker	*Chrysocolaptes festivus*	R	U	LC
66	Greater Flameback	*Chrysocolaptes lucidus*	R	U	LC
67	Yellow-eyed Babbler	*Chrysomma sinense*	R	U	LC
68	Woollynecked Stork	*Ciconia episcopus*	R	U	NT
69	Black Stork	*Ciconia nigra*	W	Rr	LC
70	Short-toed Eagle	*Circaetus gallicus*	R	U	LC
71	Eurasian Marsh Harrier	*Circus aeruginosus*	W	C	LC
72	Hen Harrier	*Circus cyaneus*	W	Rr	LC
73	Pallid Harrier	*Circus macrorous*	W	Rr	LC
74	Pied Harrier	*Circus melanoleucos*	W	Rr	LC
75	Montagu's Harrier	*Circus pygargus*	W	Rr	LC
76	Zitting cisticola	*Cisticola juncidis*	R	U	LC
77	Pied Cuckoo	*Clamator jacobinus*	BM	C	LC
78	Rock Pigeon	*Columba livia*	R	A	LC
79	Oriental Magpie Robin	*Copsychus saularis*	R	C	LC
80	Indian Roller	*Coracias benghalensis*	R	C	LC
81	European Roller	*Coracias garrulus*	PM	Rr	LC
82	Large Cuckooshrike	*Coracina macei*	R	O	LC
83	Blackheaded Cuckoo-shrike	*Coracina melanoptera*	R	O	LC
84	Largebilled Crow	*Corvus macrorhynchos*	R	U	LC
85	House Crow	*Corvus splendens*	R	A	LC
86	Rain Quail	*Coturnix coromandelica*	W	C	LC
87	Common Quail	*Coturnix coturnix*	R	C	LC
88	Eurasian Cuckoo	*Cuculus canorus*	R	U	LC
89	Indian Cuckoo	*Cuculus micropterus*	R	U	LC
90	Indian Courser	*Cursorius coromandelicus*	R	U	LC
91	Tickell's Blue Flycatcher	*Cyornis tickelliae*	R	O	LC
92	Asian Palm Swift	*Cypsiurus balasiensis*	R	C	LC
93	Rufous Treepie	*Dendrocitta vagabunda*	R	U	LC
94	Brown-capped Pygmy Woodpecker	*Dendrocopos nanus*	R	U	LC
95	Yellow-crowned Woodpecker	*Dendrocopos mahrattensis*	R	C	LC
96	Lesser Whistling-Duck	*Dendrocygna javanica*	R	C	LC
97	Thickbilled Flowerpecker	*Dicaeum agile*	R	U	LC
98	Whitebellied Drongo	*Dicrurus caerulescens*	R	U	LC
99	Ashy Drongo	*Dicrurus leucophaeus*	W	Rr	LC
100	Black Drongo	*Dicrurus macrocercus*	R	A	LC
101	Blackrumped Flameback	*Dinopium benghalense*	R	C	LC
102	Tawnybellied Babbler	*Dumetia hyperythra*	R	O	LC
103	Black Bittern	*Dupetor flavicollis*	R	Rr	LC
104	Little Egret	*Egretta garzetta*	R	U	LC

Sr. No.	Name of Bird	Zoological Name	Status	Abundance	IUCN Status
105	Black-shouldered Kite	*Elanus caeruleus*	R	C	LC
106	Ashycrowned Sparrow Lark	*Eremopterix grisea*	R	C	LC
107	Great Thick-knee	*Esacus recurvirostris*	R	U	NT
108	Asian Koel	*Eudynamys scolopacea*	R	A	LC
109	Verditer Flycatcher	*Eumyias thalassina*	W	O	LC
110	Amur Falcon	*Falco amurensis*	PM	Rr	LC
111	Red-necked Falcon	*Falco chicquera*	R	Rr	NT
112	Laggar Falcon	*Falco jugger*	R	Rr	NT
113	Peregrine Falcon	*Falco peregrinus*	W	Rr	LC
114	Common Kestrel	*Falco tinnunculus*	R	O	LC
115	Redthroated Flycatcher	*Ficedula parva*	R	O	LC
116	Painted Francolin	*Francolinus pictus*	R	C	LC
117	Grey Francolin	*Francolinus pondicerianus*	R	C	LC
118	Common Coot	*Fulica atra*	R	C	LC
119	Sykes' Lark	*Galerida deva*	R	C	LC
120	Common Snipe	*Gallinago gallinago*	W	U	LC
121	Common Moorhen	*Gallinula chloropus*	R	C	LC
122	Red Spurfowl	*Galloperdix spadicea*	R	O	LC
123	Gull-billed Tern	*Gelochelidon nilotica*	W	Rr	LC
124	Small Pratincole	*Glareola lactea*	R	C	LC
125	Oriental Pratincole	*Glareola maldivarum*	BM	Rr	LC
126	Jungle Owlet	*Glaucidium radiatum*	R	U	LC
127	Whiterumped Vulture	*Gyps bengalensis*	R	Rr	CR
128	Black-capped Kingfisher	*Halcyon pileata*	V	Rr	VU
129	Whitethroated Kingfisher	*Halcyon smyrnensis*	R	C	LC
130	Crested Treeswift	*Hemiprocne coronata*	R	U	LC
131	Bonneli's Eagle	*Hieraaetus fasciatus*	V	Rr	LC
132	Common Hawk-Cuckoo	*Hierococcyx varius*	R	C	LC
133	Blackwinged Stilt	*Himantopus himantopus*	R	C	LC
134	Booted Warbler	*Hippolais caligata*	W	U	LC
135	Syke's Warbler	*Hippolais rama*	W	Rr	LC
136	Dusky Crag Martin	*Hirundo concolor*	R	C	LC
137	Red-rumped Swallow	*Hirundo daurica*	R	A	LC
138	Streak-throated Swallow	*Hirundo fluvicola*	R	C	LC
139	Barn Swallow	*Hirundo rustica*	W	U	LC
140	Wiretailed Swallow	*Hirundo smithii*	R	A	LC
141	Pheasant-tailed Jacana	*Hydrophasianus chirurgus*	R	C	LC
142	Blacknaped Monarch	*Hypothymis azurea*	R	O	LC
143	Black Eagle	*Ictinaetus malayensis*	V	Rr	LC
144	Cinnamon Bittern	*Ixobrychus cinnamomeus*	R	U	LC
145	Yellow Bittern	*Ixobrychus sinensis*	R	U	LC
146	Eurasian Wryneck	*Jynx torquilla*	W	Rr	LC
147	Brown Shrike	*Lanius cristatus*	W	O	LC
148	Southern Grey Shrike	*Lanius meridionalis*	R	Rr	VU
149	Longtailed Shrike	*Lanius schach*	R	C	LC
150	Baybacked Shrike	*Lanius vittatus*	R	C	LC
151	Brown-headed Gull	*Larus brunnicephalus*	PM	Rr	LC
152	Blackheaded Gull	*Larus ridibundus*	W	Rr	LC
153	Black-tailed Godwit	*Limosa limosa*	PM	U	NT
154	Indian Silverbill	*Lonchura malabarica*	R	A	LC

Sr. No.	Name of Bird	Zoological Name	Status	Abundance	IUCN Status
155	Blackheaded Munia	*Lonchura malacca*	R	U	LC
156	Scalybreasted Munia	*Lonchura punctulata*	R	C	LC
157	Whiterumped Munia	*Lonchura striata*	R	Rr	LC
158	Siberian Blue Robin	*Luscinia cyane*	V	Rr	LC
159	Bluethroat	*Luscinia svecica*	W	U	LC
160	Coppersmith Barbet	*Megalaima haemacephala*	R	A	LC
161	Brownheaded Barbet	*Megalaima zeylanica*	R	U	LC
162	Crested Bunting	*Melophus lathami*	R	O	LC
163	Green Bee-eater	*Merops orientalis*	R	A	LC
164	Bluetailed Bee-eater	*Merops philippinus*	BM	U	LC
165	Intermediate Egret	*Ardea intermedia*	R	U	LC
166	Bronzewinged Jacana	*Metopidius indicus*	R	C	LC
167	Black Kite	*Milvus migrans*	R	C	LC
168	Singing Bushlark	*Mirafra cantillans*	R	U	LC
169	Indian Bushlark	*Mirafra erythroptera*	R	U	LC
170	Blue-capped Rock Thrush	*Monticola oncorhynchus*	W	Rr	LC
171	Blue Rock Thrush	*Monticola solitarius*	W	Rr	LC
172	White Wagtail	*Motacilla alba*	W	U	LC
173	Citrine Wagtail	*Motacilla citreola*	W	U	LC
174	Grey Wagtail	*Motacilla cinerea*	W	U	LC
175	Yellow Wagtail	*Motacilla flava*	W	U	LC
176	Whitebrowed Wagtail	*Motacilla madraspatensis*	R	C	LC
177	Asian Brown Flycatcher	*Muscicapa dauurica*	W	Rr	LC
178	Painted Stork	*Mycteria leucocephala*	R	O	NT
179	Purple Sunbird	*Nectarinia asiatica*	R	A	LC
180	Purple-rumped Sunbird	*Nectarinia zeylonica*	R	A	LC
181	Egyptian (Scavenger) Vulture	*Neophron percnopterus*	R	Rr	EN
182	Cotton Pygmy-Goose	*Nettapus coromandelianus*	R	C	LC
183	Black-crowned Night Heron	*Nycticorax nycticorax*	R	U	LC
184	Indian Grey Hornbill	*Ocyceros birostris*	R	U	LC
185	Eurasian Golden Oriole	*Oriolus oriolus*	R	C	LC
186	Black-hooded Oriole	*Oriolus xanthornus*	R	U	LC
187	Common Tailorbird	*Orthotomus sutorius*	R	A	LC
188	Collared Scops Owl	*Otus bakkamoena*	R	U	LC
189	Osprey	*Pandion haliaetus*	W	O	LC
190	Great Tit	*Parus major*	R	O	LC
191	Black-lored Tit	*Parus xanthogenys*	R	U	LC
192	House Sparrow	*Passer domesticus*	R	A	LC
193	Common Peafowl	*Pavo cristatus*	R	C	LC
194	Rock Bush Quail	*Perdicula argoondah*	R	C	LC
195	Jungle Bush Quail	*Perdicula asiatica*	R	C	LC
196	Small Minivet	*Pericrocotus cinnamomeus*	R	U	LC
197	Oriental Honey Buzzard	*Pernis ptilorhynchus*	R	C	LC
198	Chestnut-shouldered Petronia	*Petronia xanthocollis*	R	U	LC
199	Sirkeer Malkoha	*Phaenicophaeus leschenaultii*	R	O	LC
200	Great Cormorant	*Phalacrocorax carbo*	LM	O	LC

Sr. No.	Name of Bird	Zoological Name	Status	Abundance	IUCN Status
201	Indian Cormorant	*Phalacrocorax fuscicollis*	R	U	LC
202	Little Cormorant	*Phalacrocorax niger*	R	C	LC
203	Red-necked Phalarope	*Phalaropus lobatus*	PM	Rr	LC
204	Ruff	*Philomachus pugnax*	W	U	LC
205	Black Redstart	*Phoenicurus ochruros*	W	C	LC
206	Tickell's Leaf Warbler	*Phylloscopus affinis*	W	Rr	LC
207	Common Chiffchaff	*Phylloscopus collybita*	W	U	LC
208	Sulphur-bellied Warbler	*Phylloscopus griseolus*	W	U	LC
209	Greenish Warbler	*Phylloscopus trochiloides*	W	U	LC
210	Indian Pitta	*Pitta brachyura*	BM	U	LC
211	Eurasian Spoonbill	*Platalea leucorodia*	R	U	LC
212	Baya Weaver	*Ploceus philippinus*	R	U	LC
213	Great Crested Grebe	*Podiceps cristatus*	W	Rr	LC
214	Purple Swamphen	*Porphyrio porphyrio*	R	C	LC
215	Ruddy-breasted Crake	*Porzana fusca*	R	Rr	LC
216	Little Crake	*Porzana parva*	W	O	LC
217	Baillon's Crake	*Porzana pusilla*	W	O	LC
218	Greybreasted Prinia	*Prinia hodgsoni*	R	O	LC
219	Plain Prinia	*Prinia inornata*	R	C	LC
220	Ashy Prinia	*Prinia socialis*	R	C	LC
221	Jungle Prinia	*Prinia sylvatica*	R	C	LC
222	Black Ibis	*Pseudibis papillosa*	R	U	LC
223	Plumheaded Parakeet	*Psittacula cyanocephala*	R	C	LC
224	Alexandrine Parakeet	*Psittacula eupatria*	R	U	NT
225	Rose-ringed Parakeet	*Psittacula krameri*	R	A	LC
226	Chestnutbellied Sandgrouse	*Pterocles exustus*	R	U	LC
227	Redvented Bulbul	*Pycnonotus cafer*	R	A	LC
228	Red-whiskered Bulbul	*Pycnonotus jocosus*	R	Rr	LC
229	Whitebrowed Bulbul	*Pycnonotus luteolus*	R	U	LC
230	Pied Avocet	*Recurvirostra avosetta*	PM	Rr	LC
231	Whitethroated Fantail	*Rhipidura albicollis*	R	O	LC
232	Whitebrowed Fantail	*Rhipidura aureola*	R	U	LC
233	Redcrested Pochard	*Rhodonessa rufina*	W	C	CR
234	Greater Painted Snipe	*Rostratula benghalensis*	R	U	LC
235	Red-headed Vulture	*Sarcogyps calvus*	R	Rr	CR
236	Comb Duck	*Sarkidiornis melanotos*	R	U	LC
237	Pied Bushchat	*Saxicola caprata*	R	U	LC
238	Common Stonechat	*Saxicola torquata*	R	C	LC
239	Indian Robin	*Saxicoloides fulicata*	R	C	LC
240	Crested Serpent Eagle	*Spilornis cheela melanotis*	R	O	LC
241	Changeable Hawk Eagle	*Nisaetus cirrhatus*	V	Rr	LC
242	Parasitic Jaeger	*Stercorarius parasiticus*	V	Rr	LC
243	Blackbellied Tern	*Sterna acuticauda*	W	Rr	EN
244	Little Tern	*Sterna albifrons*	BM	U	LC
245	River Tern	*Sterna aurantia*	R	C	VU
246	Caspian Tern	*Sterna caspia*	V	Rr	LC
247	Spotted Dove	*Streptopelia chinensis*	R	U	LC
248	Eurasian Collared Dove	*Streptopelia decaocto*	R	C	LC
249	Oriental Turtle-Dove	*Streptopelia orientalis*	R	U	LC
250	Little Brown Dove	*Streptopelia senegalensis*	R	A	LC

Sr. No.	Name of Bird	Zoological Name	Status	Abundance	IUCN Status
251	Red Collared Dove	*Streptopelia tranquebarica*	R	U	LC
252	Asian Pied Starling	*Sturnus contra*	R	C	LC
253	Chestnut-tailed Starling	*Sturnus malabaricus*	PM	C	LC
254	Brahminy Starling	*Sturnus pagodarum*	R	A	LC
255	Rosy Starling	*Sturnus roseus*	W	C	LC
256	Common Starling	*Sturnus vulgaris*	PM	Rr	LC
257	Drongo Cuckoo	*Surniculus lugubris*	V	Rr	LC
258	Lesser Whitethroat	*Sylvia curruca*	W	U	LC
259	Orphean Warbler	*Sylvia hortensis*	W	U	LC
260	Little Grebe	*Tachybaptus ruficollis*	R	C	LC
261	Ruddy Shelduck	*Tadorna ferruginea*	W	U	LC
262	Common Woodshrike	*Tephrodornis pondicerianus*	R	U	LC
263	Asian Paradise Flycatcher	*Terpsiphone paradisi*	R	U	LC
264	Blackheaded Ibis	*Threskiornis melanocephalus*	R	U	NT
265	Yellow-footed Green Pigeon	*Treron phoenicoptera*	R	U	LC
266	Spotted Redshank	*Tringa erythropus*	PM	Rr	LC
267	Wood Sandpiper	*Tringa glareola*	W	C	LC
268	Common Greenshank	*Tringa nebularia*	W	U	LC
269	Green Sandpiper	*Tringa ochropus*	W	U	LC
270	Common Redshank	*Tringa totanus*	W	U	LC
271	Common Babbler	*Turdoides caudatus*	R	U	LC
272	Large Grey Babbler	*Turdoides malcolmi*	R	C	LC
273	Jungle Babbler	*Turdoides striata*	R	A	LC
274	Indian Blackbird	*Turdus simillimus*	V	Rr	LC
275	Barred Button Quail	*Turnix suscitator*	R	U	LC
276	Small Button Quail	*Turnix sylvatica*	R	U	LC
277	Yellowlegged Button Quail	*Turnix tanki*	R	U	LC
278	Barn Owl	*Tyto alba*	R	C	LC
279	Common Hoopoe	*Upupa epops*	R	U	LC
280	Red-wattled Lapwing	*Vanellus indicus*	R	A	LC
281	Yellow-wattled Lapwing	*Vanellus malabaricus*	R	C	LC
282	Orange-headed Ground Thrush	*Zoothera citrina*	R	U	LC
283	Oriental White-eye	*Zosterops palpebrosus*	R	C	LC

2. Herpatofaunal Diversity

262. 14 species of Herpetofauna have been recorded in Nagpur city and surrounding areas by various authors[53], which are all LC species as per IUCN, as summarised in **Table 4-32**.

Table 4-32: Herpatofaunal Diversity of Nagpur

Sl	Zoological Name	Common Name	Family	IUCN Status
1	*Duttaphrynus melanostictus*	Common Indian Toad	Bufonidae	LC

[53] *Sawarkar, D. B. & Kasambe, R. (2009): A survey of the amphibian fauna of Nagpur, Maharashtra. BIONOTES. 11(3): 84-85.*

Sl	Zoological Name	Common Name	Family	IUCN Status
2	*Duttaphrynus stomaticus*	Marbled Toad	Bufonidae	LC
3	*Rana cyanophlyctis*	Skipping Fron	Bufonidae	LC
4	*Euphlyctis hexadactylu*	Pond Frog	Dicroglossidae	LC
5	*Hoplobatrachus tigerinus*	Indian Bull Frog	Dicroglossidae	LC
6	*Sphaerotheca rolandae*	Indian Burrowing Frog	Dicroglossidae	LC
7	*Hydrophylax malabaricus*	Fungoid Frog	Dicroglossidae	LC
8	*Fejervarya limnocharis*	Indian Cricket Frog	Dicroglossidae	LC
9	*Polypedates leucomystax*	Common Tree Frog	Rhacophoridae	LC
10	*Microhyla ornata*	Ornate Microhylid	Microhylidae	LC
11	*Calotes versicolor*	Oriental Garden Lizard	Agamid	LC
12	*Naja naja*	Indian Cobra	Elapid	LC
13	*Bungarus caeruleus*	Common Krait	Elapid	LC
14	*Ptyas mucosa*	Oriental Rat Snake	Colubrid	LC

3. Butterfly Diversity

263. Ashis D. Tiple has recoded 65 butterflies in Nagpur City[54], of which 18 species are LC as per IUCN and no data is available for the rest, as given in **Table 4-33**.

Table 4-33: Butterfly Diversity of Nagpur

Sl	Zoological Name	Common Name	Family	IUCN Status
1	*Pachliopta aristolochiae*	Common Rose	Papilionidae	LC
2	*Pachliopta hector*	Crimson Rose	Papilionidae	LC
3	*Graphium doson*	Common Jay	Papilionidae	-
4	*Graphium agamemnon*	Tailed Jay	Papilionidae	-
5	*Graphium nomius*	Spot Swordtail	Papilionidae	-
6	*Papilio demoleus*	Lime	Papilionidae	-
7	*Papilio polytes*	Common Mormon	Papilionidae	-
8	*Catopsilia pomona*	Common Eigrant	Pieridae	-
9	*Catopsilia pyranthe*	Mottled Emigrant	Pieridae	-
10	*Eurema brigitta*	Small Grass Yellow	Pieridae	LC
11	*Eurema laeta*	Spotless Grass Yellow	Pieridae	-
12	*Eurema hecabe*	Common grass yellow	Pieridae	LC
13	*Eurema blanda*	Three Spot Grass Yellow	Pieridae	-
14	*Delias eucharis*	Common Jezebel	Pieridae	-
15	*Cepora nerissa*	Common Gull	Pieridae	-
16	*Belenois aurota*	Pioneer or Caper White	Pieridae	LC
17	*Colotis etrida*	Small Orange Tip	Pieridae	-
18	*Pareronia valeria*	Common Wandrer	Pieridae	-
19	*Melanitis leda*	Twilight Brown / Common evening brown	Nymphalidae	LC
20	*Mycalesis perseus*	Common Bushbrown		
21	*Mycalesis subdita*	Tamil Bushbrown	Nymphalidae	-
22	*Charaxes marmax*	Yellow Rajah	Nymphalidae	-
23	*Acraea terpsicore*	Twany Coster	Nymphalidae	-

[54] *Ashis D Tiple & Arun M. Khurad (2009), Butterflies recorded from Nagpur, Central India, Bionotes, Vol. II (4), December 2009.*

Sl	Zoological Name	Common Name	Family	IUCN Status
24	*Phalanta phalantha*	Common Leopard	Nymphalidae	LC
25	*Neptis hylas*	Common Sailor	Nymphalidae	-
26	*Byblia ilithyia*	Joker	Nymphalidae	LC
27	*Ariadne ariadne*	Angled Castor	Nymphalidae	-
28	*Ariadne merione*	Common Castor	Nymphalidae	-
29	*Junonia hierta*	Yellow Pansy	Nymphalidae	LC
30	*Junonia orithya*	Blue Pansy	Nymphalidae	LC
31	*Junonia lemonias*	Lemmon Pansy	Nymphalidae	-
32	*Junonia almana*	Peacock Pansy	Nymphalidae	LC
33	*Junonia atlites*	Gray Pansy	Nymphalidae	-
34	*Junonia iphita*	Chocolate Pansy	Nymphalidae	-
35	*Hypolimnas bolina*	Great Eggfly	Nymphalidae	-
36	*Hypolimnas misippus*	Dannid Eggfly	Nymphalidae	LC
37	*Tirumala limniace*	Blue Tiger	Nymphalidae	-
38	*Danaus chrysippus*	Plain Tiger	Nymphalidae	LC
39	*Danaus genutia*	Striped Tiger	Nymphalidae	-
40	*Euploea core*	Common Indian Crow	Nymphalidae	LC
41	*Castalius rosimon*	Common Pierrot	Lycaenidae	-
42	*Tarucus nara*	Rounded/Striped Pierrot	Lycaenidae	-
43	*Leptotes plinius*	Zebra Blue	Lycaenidae	-
44	*Everes lacturnus*	Indian Cupid	Lycaenidae	-
45	*Acytolepis puspa*	Common Hdge Blue	Lycaenidae	-
46	*Pseudozizeeria maha*	Pale Grass Blue	Lycaenidae	-
47	*Zizeeria karsandra*	Indian Grass Blue/ Dark Grass Blue	Lycaenidae	LC
48	*Zizina Otis*	Lesser Grass Blue	Lycaenidae	LC
49	*Chilades parrhasius*	Small Cupid	Lycaenidae	-
5	*Chilades lajus*	Lime Blue	Lycaenidae	-
51	*Freyeria putli*	Easter Grass Jewel	Lycaenidae	-
52	*Freyeria trochylus*	Grass Jewel	Lycaenidae	-
53	*Euchrysops cnejus*	Gram Blue	Lycaenidae	-
54	*Catochrysops strabo*	Forget Me Not	Lycaenidae	-
55	*Lampides boeticus*	Pea Blue	Lycaenidae	LC
56	*Jamides bochus*	Dark Cerulean	Lycaenidae	-
57	*Jamides celeno*	Common Cerulean	Lycaenidae	-
58	*Nacaduba kurava*	Transparent Lime blue	Lycaenidae	-
59	*Prosotas nora*	Common Lime Blue	Lycaenidae	-
60	*Spindasis vulcanus*	Common Guava Blue	Lycaenidae	-
61	*Ancistroides folus*	Grass Demon	Hesperiidae	-
62	*Telicota ancilla*	Dark Palm dart	Hesperiidae	-
63	*Telicota colon*	Pale Palm Dart	Hesperiidae	
64	*Pelopidas mathias*	Small/Black Branded Swift	Hesperiidae	LC
65	*Borbo cinnara*	Rice Swift	Hesperiidae	-

4. Damselflies and dragonflies

264. Total 34 species of dragonflies belonging to 24 genera and 4 families (Gomphidae, Aeshnidae, Libellulidae and Macromiidae) have been recorded by Virendra Shende & Kishor

Gopal Patil at Nagpur[55], all of which are LC as per IUCN, as presented in **Table 4-34**.

Table 4-34: Dragonfly and Damsel-Fly Diversity of Nagpur

Sl	Zoological Name	Common Name	Family	Status	IUCN Status
1	*Ictinogomphus rapax* (Rambur, 1842)	Common Clubtail	Gomphidae	C	LC
2	*Paragomphus lineatus* (Selys, 1850)	Common Hooktail	Gomphidae	C	LC
3	*Anax guttatus* (Selys, 1839)	Blue-Tailed Green Darner	Aeshnidae	C	LC
4	*Anax immaculifrons* (Rambur, 1842)	Blue Darner	Aeshnidae	C	LC
5	*Gynacantha bayadera* (Selys, 1891)	Parakeet Darter	Aeshnidae	C	LC
6	*Hemianax ephippiger* (Burmeister, 1839)	Ochre tailed Brown Darter	Aeshnidae	C	LC
7	*Acisoma panorpoides* (Rambur, 1842)	Trumpet Tail	Libellulidae	C	LC
8	*Aethriamanta brevipennis* (Rambur, 1842)	Scarlet Marsh Hawk	Libellulidae	O	LC
9	*Brachydiplax sobrina* (Rambur, 1842)	Blue Tailed Black Marsh Skimmer	Libellulidae	C	LC
10	*Brachythemis contaminata* (Fabricius, 1793)	Ditch Jewel	Libellulidae	C	LC
11	*Bradinopyga geminata* (Rambur, 1842)	Granite Ghost	Libellulidae	C	LC
12	*Crocothemis servilia* (Drury, 1770)	Ruddy Marsh Skimmer	Libellulidae	C	LC
13	*Diplacodes trivialis* (Rambur, 1842)	Ground Skimmer	Libellulidae	C	LC
14	*Neurothemis intermedia* (Rambur, 1842)	Ruddy Meadow Skimmer	Libellulidae	O	LC
15	*Neurothemis tullia* (Drury, 1773)	Pied Paddy Skimmer	Libellulidae	C	LC
16	*Orthetrum chrysis* (Selys, 1892)	Brown-Backed Red Marsh Hawk	Libellulidae	C	LC
17	*Orthetrum glaucum* (Brauer, 1865)	Blue Marsh Hawk	Libellulidae	C	LC
18	*Orthetrum luzonicum* (Brauer, 1868)	Tri-coloured Marsh Hawk	Libellulidae	O	LC
19	*Orthetrum pruinosum* (Rambur, 1842)	Crimson Tailed Marsh Hawk	Libellulidae	C	LC
20	*Orthetrum sabina* (Drury, 1770)	Green Marsh Hawk	Libellulidae	C	LC
21	*Orthetrum taeniolatum* (Schneider, 1845)	Taeniolate Marsh Hawk	Libellulidae	O	LC
22	*Pantala flavescens* (Fabricius, 1798)	Wandering Glider	Libellulidae	C	LC
23	*Potamarcha congener* (Rambur, 1842)	Yellow Tailed Ashy Skimmer	Libellulidae	C	LC
24	*Rhodothemis rufa* (Rambur, 1842)	Rufous Marsh Glider	Libellulidae	O	LC
25	*Rhyothemis variegata* (Linnaeus, 1763)	Common Picture Wing	Libellulidae	C	LC
26	*Tetrathemis platyptera* (Selys, 1878)	Pigmy Skimmer	Libellulidae	O	LC
27	*Tholymis tillarga* (Fabricius, 1798)	Coral Tailed Cloud Wing	Libellulidae	C	LC
28	*Tramea basilaris* (Kirby, 1889)	Red Marsh Trotter	Libellulidae	C	LC
29	*Tramea limbata* (Desjardins, 1842)	Black Marsh Trotter	Libellulidae	O	LC
30	*Trithemis aurora* (Burmeister,	Crimson Marsh	Libellulidae	C	LC

[55] *Virendra Shende & Kishor Gopal Patil (2013), Diversity of dragonflies (Anisoptera) in Nagpur, Central India, Arthropods, 2013, 2(4): 200-207*

Sl	Zoological Name	Common Name	Family	Status	IUCN Status
	1839)	Skimmer			
31	*Trithemis festiva* (Rambur, 1842)	Black Stream Glider	Libellulidae	C	LC
32	*Trithemis pallidinervis* (Kirby, 1889)	Long-Legged Marsh Skimmer	Libellulidae	C	LC
33	*Zyxomma petiolatum* (Rambur, 1842)	Brown Dusk Hawk	Libellulidae	O	LC
34	*Epophthalmia vittata* (Burmeister, 1839)	Common Torrent Hawk	Macromiidae	C	LC

5. Arthropod biodiversity

265. VD Raut & et. al. recorded 195 litter arthropods representing 13 insect orders at Gorewada lake, Aambazari lake, Futala lake, Civiline forest. Distribution of litter anthropod taxa includes Hymenoptera (Ants), Isoptera (Termites), Thysanura (Silverfishes), Blattodea (Cockroaches), Coleoptera (Beetles), Hemiptera (Bugs), Orthoptera (Crickets), Chilopoda (Centipedes), Araneae (Spiders), Opiliones (Harvestmen), Acarinae (Mites), Pseudoscorpiones (Pseudoscorpions) and Collembola (Springtails)[56].

Figure 4-67: Some photographs showing Faunal Diversity of the Study Area

[56] *VD Raut, PH Chavhan and JK Kirsan (2022), Arthropod biodiversity in tropical forest litter around Nagpur (Maharashtra), Journal of Entomology and Zoology Studies 2022; 10(5): 133-136.*

***Dates of Photgraphs: 1st to 3rd August 2023 during Faunal studies.*

(e) Integrated Biodiversity Assessment Tool (IBAT) Analysis

266. IBAT is a web-based map and reporting tool that compares the current distribution of protected areas with the distribution of Key Biodiversity Areas and IUCN Red list of Threatened species. The Assesment was carried out at 4 different locations at proposed project (Reach 1A, Reach 2A, Reach 3A, Reach 4A) at 1km-10km-20km-25km buffer distance. In the assessment no Protected Areas and Key Biodiversity Areas were located within the buffer zone. However, total 38 Threatened species were potentially found within 50 km of area as presented in **Table 4-35**. Detailed IBAT analyses of the 4 alignments of NMRP Phase II Project are presented in **Annexure-14**.

Table 4-35: Checklist of potential floral and faunal species found within 50 km of intrest area (as per IBAT)

Sr. No	Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome	1A	2A	3A	4A
1	*Nilssonia leithii*	Leith's Softshell Turtle	REPTILIA	CR	Decreasing	Terrestrial, Freshwater	✓	✓	✓	✓
2	*Sypheotides indicus*	Lesser Florican	AVES	CR	Decreasing	Terrestrial	✓	✓	✓	✓
3	*Vanellus gregarius*	Sociable Lapwing	AVES	CR	Decreasing	Terrestrial	✓	✓	✓	✓
4	*Gyps bengalensis*	White-rumped Vulture	AVES	CR	Decreasing	Terrestrial	✓	✓	✓	✓
5	*Sarcogyps calvus*	Red-headed Vulture	AVES	CR	Decreasing	Terrestrial	✓	✓	✓	✓
6	*Gyps indicus*	Indian Vulture	AVES	CR	Decreasing	Terrestrial	✓	✓	✓	✓
7	*Cuon alpinus*	Dhole	MAMMALIA	EN	Decreasing	Terrestrial	✓	✓	✓	✓
8	*Manis crassicaudata*	Indian Pangolin	MAMMALIA	EN	Decreasing	Terrestrial	✓	✓	✓	✓
9	*Panthera tigris*	Tiger	MAMMALIA	EN	Decreasing	Terrestrial	✓	✓	✓	✓
10	*Silonia childreni*	Schilbid Catfish	ACTINOPTERYGII	EN	Decreasing	Freshwater	✓	✓	✓	✓
11	*Ammannia nagpurensis*		MAGNOLIOPSIDA	EN	Unknown	Freshwater	✓	✓	✓	✓
12	*Rynchops albicollis*	Indian Skimmer	AVES	EN	Decreasing	Terrestrial, Freshwater	✓	✓	✓	✓
13	*Sterna acuticauda*	Black-bellied Tern	AVES	EN	Decreasing	Terrestrial, Freshwater	✓	✓	✓	✓
14	*Neophron percnopterus*	Egyptian Vulture	AVES	EN	Decreasing	Terrestrial, Freshwater	✓	✓	✓	✓
15	*Aquila nipalensis*	Steppe Eagle	AVES	EN	Decreasing	Terrestrial	✓	✓	✓	✓
16	*Acinonyx jubatus*	Cheetah	MAMMALIA	VU	Decreasing	Terrestrial	✓	✓	✓	✓
17	*Bos gaurus*	Gaur	MAMMALIA	VU	Decreasing	Terrestrial	✓	✓	✓	✓
18	*Crocodylus palustris*	Mugger	REPTILIA	VU	Stable	Terrestrial, Freshwater	✓	✓	✓	✓
19	Hipposideros durgadasi	Durga Das's Leaf-nosed Bat	MAMMALIA	VU	Decreasing	Terrestrial	-	✓	-	-
20	*Lutrogale perspicillata*	Smooth-coated Otter	MAMMALIA	VU	Decreasing	Terrestrial, Marine, Freshwater	✓	✓	✓	✓

Sr. No	Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome	1A	2A	3A	4A
21	*Melursus ursinus*	Sloth Bear	MAMMALIA	VU	Decreasing	Terrestrial	✓	✓	✓	✓
22	*Panthera pardus*	Leopard	MAMMALIA	VU	Decreasing	Terrestrial	✓	✓	✓	✓
23	*Tetracerus quadricornis*	Four-horned Antelope	MAMMALIA	VU	Decreasing	Terrestrial	✓	✓	✓	✓
24	*Rusa unicolor*	Sambar	MAMMALIA	VU	Decreasing	Terrestrial	✓	✓	✓	✓
25	*Wallago attu*	Wallago Catfish	ACTINOPTERYGII	VU	Decreasing	Freshwater	✓	✓	✓	✓
26	*Aythya ferina*	Common Pochard	AVES	VU	Decreasing	Terrestrial, Marine, Freshwater	✓	✓	✓	✓
27	*Grus antigone*	Sarus Crane	AVES	VU	Decreasing	Terrestrial, Freshwater	✓	✓	✓	✓
28	*Sterna aurantia*	River Tern	AVES	VU	Decreasing	Terrestrial, Marine, Freshwater	✓	✓	✓	✓
29	*Clanga clanga*	Greater Spotted Eagle	AVES	VU	Decreasing	Terrestrial	✓	✓	✓	✓
30	Aquila rapax	Tawny Eagle	AVES	VU	Decreasing	Terrestrial, Freshwater	✓	✓	✓	✓
31	Leptoptilos javanicus	Lesser Adjutant	AVES	VU	Decreasing	Terrestrial, Marine, Freshwater	✓	✓	✓	✓
32	Schoenicola striatus	Bristled Grassbird	AVES	VU	Decreasing	Terrestrial, Freshwater	✓	✓	✓	✓
33	Amandava formosa	Green Avadavat	AVES	VU	Decreasing	Terrestrial	✓	✓	✓	✓
34	Clanga hastata	Indian Spotted Eagle	AVES	VU	Decreasing	Terrestrial	✓	✓	✓	✓
35	*Oryza malampuzhaensis*		LILIOPSIDA	VU	Decreasing	Terrestrial	✓	✓	✓	✓
36	*Lissemys punctata*	Indian Flapshell Turtle	REPTILIA	VU	Decreasing	Terrestrial, Freshwater	✓	✓	✓	✓
37	*Schizothorax plagiostomus*	Snow Trout	ACTINOPTERYGII	VU	Decreasing	Freshwater	✓	✓	✓	✓
38	*Bagarius bagarius*	Goonch Catfish	ACTINOPTERYGII	VU	Decreasing	Freshwater	✓	✓	✓	✓

(f) Aquatic Ecology Studies

1. Benthic Diversity

267. Most of the lakes, especially near urban or residential areas, are found to be polluted at different levels because of anthropogenic activities. Samples collected at Phutala Lake were showing 10-13 phytoplankton species in 1996 while 10-22 species were observed in 2010. Similarly, the samples showed 6-8 zooplankton species in 1996 and 5-13 species in 2010. Bacillariophyceae and Chlorophyceae groups of algae and Rotifera, Ciliata and Cladocera groups of zooplankton were found to be dominant. Abundance of phytoplankton groups was in decreasing order of Chlorophyceae, Bacillariophyceae, Cynophyceae, Euglenophyceae and Pyrrhophyceae and that for zooplankton was observed as Rotifera, Cladocera, Ciliata, Copepoda, Ostracoda and other forms. Algal species like Euglena acus, Microcystis aeruginosa, Oscillatoria limnetica, Raphidiopsis curjanta, Ankistrodesmus falcatus, Chlorella vulgaris, Navicula schizanema & Nitzchia bilobata and zooplankton species like Brachionus, Keratella, Lecane and Asplanchna indicated the presence of organic pollution in lake water[57].

268. Benthic diversity of Ambazari, Sakkardara, Gandhi, Sagar and Sonegaon lakes, as given in **Table 4-36** shows presence of various organisms such as Phylum Platyhelminthes, Annelidans, Molluscan shells, Aquatic Hemipteran Bugs, Odonates larvae, Caddisfly larvae, May fly larvae, Coleopteran larvae and Beetles, Chironomus Larvae, etc. are idicators of organic and inorganic pollution[58].

Table 4-36: Benthic diversity - Ambazari, Sakkardara, Gandhisagar & Sonegaon lakes

Phylum	Class / Order	Families	Genus
Arthropoda	Diptera	Chironomidae	Chironomus
		Simulidae	-
		Tipulidae	-
	Odonata	Coenagrionidae	Ceriagrioncoromandelianu M
	Hemiptera	Pleidae	Neoplea striola
		Belostomatidae	Belostoma
		Nepidae	Nepacinera
	Trichoptera	Hydropsychidae	Hydropsyche
	Coleoptera	Dytiscidae	Hydrovatus concerts
		Hydrophilidae	-
Annelida	Hirudinea	Erpobdelidae	Erpobdella
		Viviparidae	B. Bengalensis f. colairensis
		Physidae	Physaacuta
		Lumbriculidae	-
		Tubificidae	Tubifex tubifex
		Naididae	Limnodrilushoffmeisteri
Mollusca	Gastropoda	Ampularidae	Pila
		Thiaridae	-
		Planorbidae	-

[57] *Sanyogita R. Verma, P.R. Chaudhari, R.K. Singh and S.R Wate (2011), Studies On The Ecology And Trophic Status Of An Urban Lake At Nagpur City, India, Rasayan J. Chem.*

[58] *Environmental Status Report: Nagpur City, Nagpur Municipal Corporation ESR (2019-20), CSIR-National Environmental Engineering Research Institute, Nagpur.*

2. Fish Diversity

269. Local fishermen catching fish at various water bodies of surrounding village were interviewed to know more about the fish diversity observed in the Study area. List of fish species observed in the local markets is given as **Table 4-37**, while some photographs showing fish diversity in the project study area, during interaction and consultations with local fishermen are shown as **Figure 4-68**.

Table 4-37: List of Fish diversity in nearby waterbodies[59]

Sl	Zoological Name	Family	Local Name	IUCN Status
1	*Labeo rohita* (Hamilton Buchanan)	Cyprinidae	Rui / Rohu	LC
2	*Cirrhinus mrigala* (Hamilton Buchanan)	Cyprinidae	Mrigala / Mrigal	LC
3	*Catla catla* (Hamilton Buchanan)	Cyprinidae	Catla	-
4	*Cyprinus carpio specularies*	Cyprinidae	Mirror Carp	-
4	*Cyprinus carpio comnlullis*	Cyprinidae	Scale Carp	-
5	*Cyprillus carpio carpio*	Cyprinidae	Leather Carp	-
6	*Ctenopharyngodon idella* (Valenciennes)	Cyprinidae	Grass Carp	-
7	*Tilapia* sps.	-	Tilapia	LC
8	*Channa striata*	Channidae	Snakehead Fish	LC

Figure 4-68: Some Photographs of Fish diversity in the Project Study Area[60]

Catla sps & Cat Fish at Hinga River

Spotted snakehead fish

[59] *Source: Primary Survey by MITCON.*
[60] *Source: Primary Survey by MITCON*

	
Tilapi	Maral sps at Gorewadi Lake
	
Tilapi	Rohu Sps.

***Dates of Photgraphs: 1st August 2023 during Faunal studies.*

(g) Riparian studies

1. Sampling Locations:

270. As explained in the **Methodology** section, Riparian ecology survey was carried out at 18 locations in the study area as mentioned in **Table 4-38**. Photographs of Riparian ecology locations are shown as **Figure 4-69**.

Table 4-38: Riparian Ecology Sampling Locations[61]

SN	Name of Nallah or River/Waterbody	Latitude	longitude
Reach 1A (Mihan to MIDC ECR)			
1	Dongargaon Stream	20° 59' 36.815" N	79° 2' 3.091" E
2	Mohagaon Stream	-	-
3	Vena River	20° 55' 42.055" N	78° 59' 4.031" E
4	MIDC KEC Nallah	20°55'31.09"N	78°57'55.51"E
Reach 2A (Automotive Square to Kanhan River)			
5	Pili Nadi	21° 11' 23.285" N	79° 7' 31.234" E
6	Lok Vihar Nallah	21° 12' 55.853" N	79° 10' 7.643" E
7	Lekha Nagar Nallah	21° 13' 13.947" N	79° 11' 1.233" E
8	Cantonment Nallah	21°13'13.97"N	79°11'1.49"E

[61] Source: Primary Survey by MITCON.

SN	Name of Nallah or River/Waterbody	Latitude	longitude
9	Kamptee Nallah	21°13'10.922"N	79°11'19.454"E
10	Dragon Palace Nallah	21° 13' 3.543" N	79° 12' 31.742" E
11	Kanhan River	21° 13' 26.326" N	79° 13' 41.201" E
12	Pench Right Canal	21° 12' 25.961" N	79° 9' 5.485" E
Reach 3A (Lokmanya Nagar to Hingna)			
13	Ambazari Lake	21° 7'30.294" N	79° 2' 36.601" E
14	Hingana Nallah	21° 4'50.929" N	78° 58' 6.704" E
15	Hingana River	21° 4'24.25"N	78°58'6.92"E
Reach 4A (Prajapati Nagar to Transport Nagar)			
16	Nag River near Pardi	21° 8'59.87"N	79° 9'18.09"E
17	Umiya Lake	21° 8'1.064"N	79°11'39.946"E
18	Nag River Near Transport Nagar	21° 8'29.62"N	79°12'32.86"E

Figure 4-69: Riparian Study Locations along the NMRP Phase II corridors

Dongargaon Stream

Lekha Nagar Nallah

Vena River

MIDC KEC Nallah


Pili Nadi


Lok Vihar Nallah


Cantonment Nallah


Kamptee Nallah


Dragon Palace Nallah


Kanhan River


Pench Right Canal


Ambazari Lake


Hingana Nallah


Hingana River


Nag River near Pardi


Umiya Lake


Nag River Near Transport Nagar

***Photgraphs at Ambazari Lake, Hingna Nallah and Hingna river taken on 31st July during Riparian studies. Photographs at Nag river, Umiya lake, MIDC KEC Nallah taken on 3rd August 2023.*

2. Riparian Flora

271. A total 50 Herbaceous floral species recorded at these locations, 20 of which are LC as per IUCN and no data is available for the rest, are presented in **Table 4-39**. Some photographs of the same are shown as **Figure 4-70**.

Table 4-39: Herbaceous flora recorded along selected ponds (Riparian ecosystem)

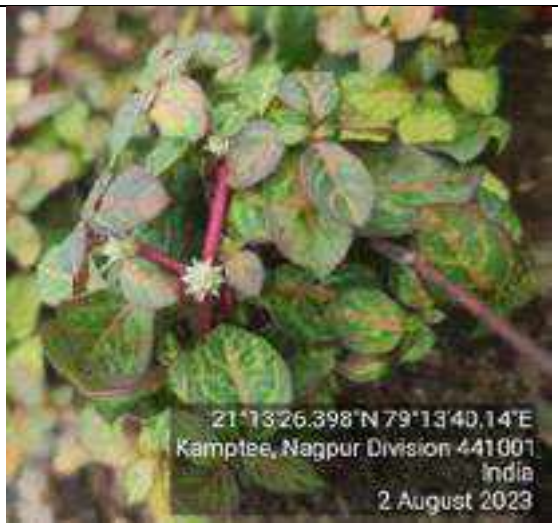
Sr. No.	Botanical Name	Family	Dongargaon Stream	Mohagaon Stream	Vena River	MIDC KEC Nala	Pili Nadi	Lok Vihar Nala	Lekha Nagar Nala	Cantonment Nala	Kamptee Nala	Dragon Palace Nala	Kanhan River	Pench Right Canal	Ambazari Lake	Hingana Nala	Hingana River	Nag River near Pardi	Umiya Lake	Nag River Near Transport Nagar	IUCN Status
1	*Acalypha indica* L.	Euphorbiaceae	+	-	+	+	+	+	-	+	+	+	-	-	+	+	-	+	+	-	-
2	*Aeschynomene virginica* (L.)	Fabaceae	-	-	-	-	+	-	+	-	+	-	-	-	+	-	-	-	-	-	-
3	*Alternanthera pubescens* Hort.Prag. ex Moq.	Amaranthaceae	-	-	+	-	-	+	-	-	-	-	+	-	+	-	-	-	-	-	-
4	*Alternanthera sessilis* (L.) DC.	Amaranthaceae	+	+	+	+	+	+	+	-	+	-	+	+	+	+	+	+	+	+	LC
5	*Ammannia baccifera* Roth	Lythraceae	-	-	-	+	-	+	-	-	+	-	-	+	-	-	-	-	-	+	LC
6	*Amaranthus viridis* L.	Amaranthaceae	+	+	+	+	+	+	+	+	+	-	+	-	+	+	+	+	-	+	-
7	*Blumea lacera* (Burm.f.) DC.	Asteraceae	-	-	-	-	+	+	-	-	-	-	-	-	-	+	-	-	-	-	LC
8	*Calotropis gigantea* (L.) Dryand.	Apocynaceae	-	+	-	-	+	+	+	-	+	-	-	+	+	+	+	+	+	+	-
9	*Chloris virgata* Sw.	Poaceae	+	+	+	+	+	-	+	+	-	+	+	-	+	+	-	+	+	+	-
10	*Cleome viscosa* L.	Cleomaceae	+	+	-	+	+	+	+	-	-	-	+	+	+	+	+	+	-	+	-
11	*Coccinia grandis* (L.) Voigt	Cucurbitaceae	-	-	+	-	+	+	+	+	+	+	-	+	+	-	+	-	+	+	LC
12	*Colocasia esculenta* (L.) Schott	Araceae	+	-	+	-	+	+	+	-	+	-	-	-	+	+	-	+	+	+	LC
13	*Commelina benghalensis* L.	Commelinaceae	+	+	+	-	+	+	-	+	-	-	+	-	+	+	+	+	-	-	LC

Sr. No.	Botanical Name	Family	Dongargaon Stream	Mohagaon Stream	Vena River	MIDC KEC Nala	Pili Nadi	Lok Vihar Nala	Lekha Nagar Nala	Cantonment Nala	Kamptee Nala	Dragon Palace Nala	Kanhan River	Pench Right Canal	Ambazari Lake	Hingana Nala	Hingana River	Nag River near Pardi	Umiya Lake	Nag River Near Transport Nagar	IUCN Status
14	*Corynandra elegans* Chandore, U.S.Yadav & S.R.Yadav	Cleomaceae	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15	*Croton bonplandianus* Baill.	Euphorbiaceae	-	-	-	-	+	-	-	+	+	-	+	-	-	+	+	-	-	-	-
16	*Datura stramonium* L.	Solanaceae	-	-	-	-	+	-	-	+	+	-	+	-	+	+	-	+	+	+	-
17	*Echinochloa colona* (L.) Link	Poaceae	+	+	+	-	+	-	+	+	+	-	+	+	+	+	+	-	-	+	LC
18	*Echinochloa crus-galli* (L.) P.Beauv.	Poaceae	+	+	-	+	+	+	+	+	-	+	-	+	+	+	+	+	-	+	LC
19	*Eclipta prostrata* Lour.	Asteraceae	+	-	-	+	-	-	-	+	+	-	-	-	+	+	-	-	-	-	LC
20	*Eichhornia crassipes* (Mart.) Solms	Pontederiaceae	-	-	+	-	-	-	-	-	-	-	-	-	+	-	-	-	+	-	-
21	*Euphorbia hirta* L.	Euphorbiaceae	+	+	+	+	+	-	+	+	+	+	+	+	+	+	-	+	-	+	-
22	*Evolvulus nummularius* (L.) L.	Convolvulaceae	-	-	-	-	+	-	-	-	-	-	-	-	+	+	-	-	-	-	-
23	*Glinus oppositifolius* Aug.DC.	Molluginaceae	-	-	-	-	-	-	-	-	-	-	+	-	-	+	-	+	-	+	-
24	*Heliotropium indicum* L.	Boraginaceae	-	-	-	-	+	-	+	-	-	-	-	-	+	-	-	-	-	-	-
25	*Hydrilla verticillata* (Roxb.) Royle	Hydrocharitaceae	-	-	+	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	LC
26	*Hygrophila auriculata* (Schumach.) Heine	Acanthaceae	-	-	-	-	-	+	-	-	+	-	+	-	-	+	+	-	+	-	LC

Sr. No.	Botanical Name	Family	Dongargaon Stream	Mohagaon Stream	Vena River	MIDC KEC Nala	Pili Nadi	Lok Vihar Nala	Lekha Nagar Nala	Cantonment Nala	Kamptee Nala	Dragon Palace Nala	Kanhan River	Pench Right Canal	Ambazari Lake	Hingana Nala	Hingana River	Nag River near Pardi	Umiya Lake	Nag River Near Transport Nagar	IUCN Status
27	*Ipomoea aquatica* Forssk.	Convolvulaceae	-	+	+	-	+	-	+	-	+	-	+	+	-	+	+	+	+	+	LC
28	*Ipomoea fistulosa* Mart. ex Choisy	Convolvulaceae	+	+	+	+	+	-	+	+	-	-	+	-	+	+	+	-	+	-	-
29	*Lantana camara* L.	Verbenaceae	+	+	+	+	+	+	+	+	+	-	+	+	+	-	+	+	-	+	-
30	*Ludwigia adscendens* (L.) H.Hara	Onagraceae	+	+	+	-	+	-	-	-	-	-	+	-	+	-	+	-	-	-	LC
31	*Marsilea quadrifolia* L.	Marsilaceae	+	+	+	-	-	-	-	-	-	-	+	-	+	-	+	-	+	-	LC
32	*Nymphaea nouchali* Burm.f.	Nymphaeaceae	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	+	-	LC
33	*Oryza* sp.	Poaceae	-	-	-	-	-	-	+	-	-	+	-	-	-	-	-	+	-	+	-
34	*Ottelia alismoides* (L.) Pers.	Hydrocharitaceae	-	-	+	-	-	-	-	-	-	-	+	-	+	-	-	-	-	-	-
35	*Parthenium hysterophorus* L.	Asteraceae	+	+	+	+	+	+	+	-	+	-	+	+	+	+	+	-	+	+	-
36	*Phyllanthus niruri* L.	Phyllanthaceae	+	-	-	-	+	+	+	-	+	-	-	-	-	-	-	+	-	+	-
37	*Pistia stratiotes* L.	Araceae	-	-	-	-	+	-	-	-	-	-	+	-	+	-	-	-	+	-	LC
38	*Polygonum glabrum* Willd.	Polygonaceae	+	+	+	-	+	+	-	+	+	-	-	-	+	+	+	-	+	+	LC
39	*Ricinus communis* L.	Euphorbiaceae	+	+	+	+	+	+	+	+	+	+	-	-	+	+	+	+	+	+	-
40	*Rotala fimbriata* Wight	Lythraceae	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	+	-	LC
41	*Sacciolepis interrupta* Stapf	Poaceae	-	-	-	-	+	-	+	-	+	-	-	-	-	-	-	-	-	-	-

Sr. No.	Botanical Name	Family	Dongargaon Stream	Mohagaon Stream	Vena River	MIDC KEC Nala	Pili Nadi	Lok Vihar Nala	Lekha Nagar Nala	Cantonment Nala	Kamptee Nala	Dragon Palace Nala	Kanhan River	Pench Right Canal	Ambazari Lake	Hingana Nala	Hingana River	Nag River near Pardi	Umiya Lake	Nag River Near Transport Nagar	IUCN Status
42	*Schenoplectus* sp.	Cyperaceae	+	-	+	+	-	+	+	+	-	+	-	-	-	+	+	+	-	+	-
43	*Senna tora* (L.) Roxb.	Fabaceae	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+	+	+	+	-
44	*Solanum virginianum* L.	Solanaceae	-	-	+	-	+	-	+	+	+	-	+	+	+	+	+	+	-	+	-
45	*Striga densiflora* (Benth.) Benth.	Scrophulariaceae	-	-	-	+	-	+	-	-	-	-	-	-	-	+	-	-	-	-	-
46	*Tephrosia purpurea* (L.) Pers.	Fabaceae	+	+	-	-	+	-	-	-	+	-	-	-	-	+	+	-	-	-	-
47	*Trichosanthes cucumerina* L.	Cucurbitaceae	-	+	-	-	+	-	+	+	-	-	-	+	+	-	+	-	+	+	-
48	Tridax procumbens L.	Asteraceae	+	+	-	-	+	-	-	-	+	-	+	-	+	-	+	+	-	+	-
49	*Typha angustifolia* L.	Typhaceae	-	-	+	-	+	+	+	-	+	+	-	-	+	+	+	+	+	+	LC
50	*Utricularia reticulata* Sm.	Lentibulariaceae	+	+	-	-	+	-	-	-	-	-	+	-	-	+	-	-	-	-	LC

Figure 4-70: Herbaceous Flora observed during Riparian Ecology Surveys

	
Corynandra elegans Chandore, U.S.Yadav & S.R.Yadav	*Tephrosia purpurea* (L.) Pers.
	
Cleome viscosa L.	*Heliotropium indicum* L.
	
Alternanthera pubescens Hort.Prag. ex Moq.	*Solanum virginianum* L.

Croton bonplandianus Baill.

Trichosanthes cucumerina L.

Polygonum glabrum Willd.

Amaranthus viridis L.

	
Pistia stratiotes L.	*Glinus oppositifolius* Aug.DC.

***Dates of Photgraphs: 2nd and 3rd August 2023.*

(h) Habitat analysis

272. Nagpur is known as the second greenest city in India. The city is flourished with greeneries in all part of the city with varied plantation. The study area comprises of different habitats like Agricultural, Plantations / Vegetation / Deciduous Scrubland, Gardens, Water bodies, Human settlements, etc.

1. **Agriculture:**

Figure 4-71: Agricultural Habitat in the Project Study Area

2. **Plantation / Vegetation / Deciduous Scrubland:**

273. Nagpur is one of the greenest cities of India. It was observed that the city has nearly 18% area under forests and plantation/parks, 17% under cultivation and 2% under water bodies[62]

Figure 4-72: Plantation / Vegetation / Deciduous Scrubland Habitats

[62] *Arun Chaturvedi, Rahul Kamble, N.G. Patil, Alka Chaturvedi (2013) City–forest relationship in Nagpur: One of the greenest cities of India, Urban Forestry & Urban Greening Volume 12, Issue 1, 2013, Pages 79-87*

3. **Garden**

274. There are several parks in Nagpur locality. Most of the gardens are well maintained with beautiful arrangement of trees, shrubs & climbers with all the aspects. There are around 110 gardens present in and around Nagpur City. The list of garden in the study area along with its distance from proposed alignment is as below along with maps.

Figure 4-73: Map showing gardens in Nagpur City (Project Study Area)

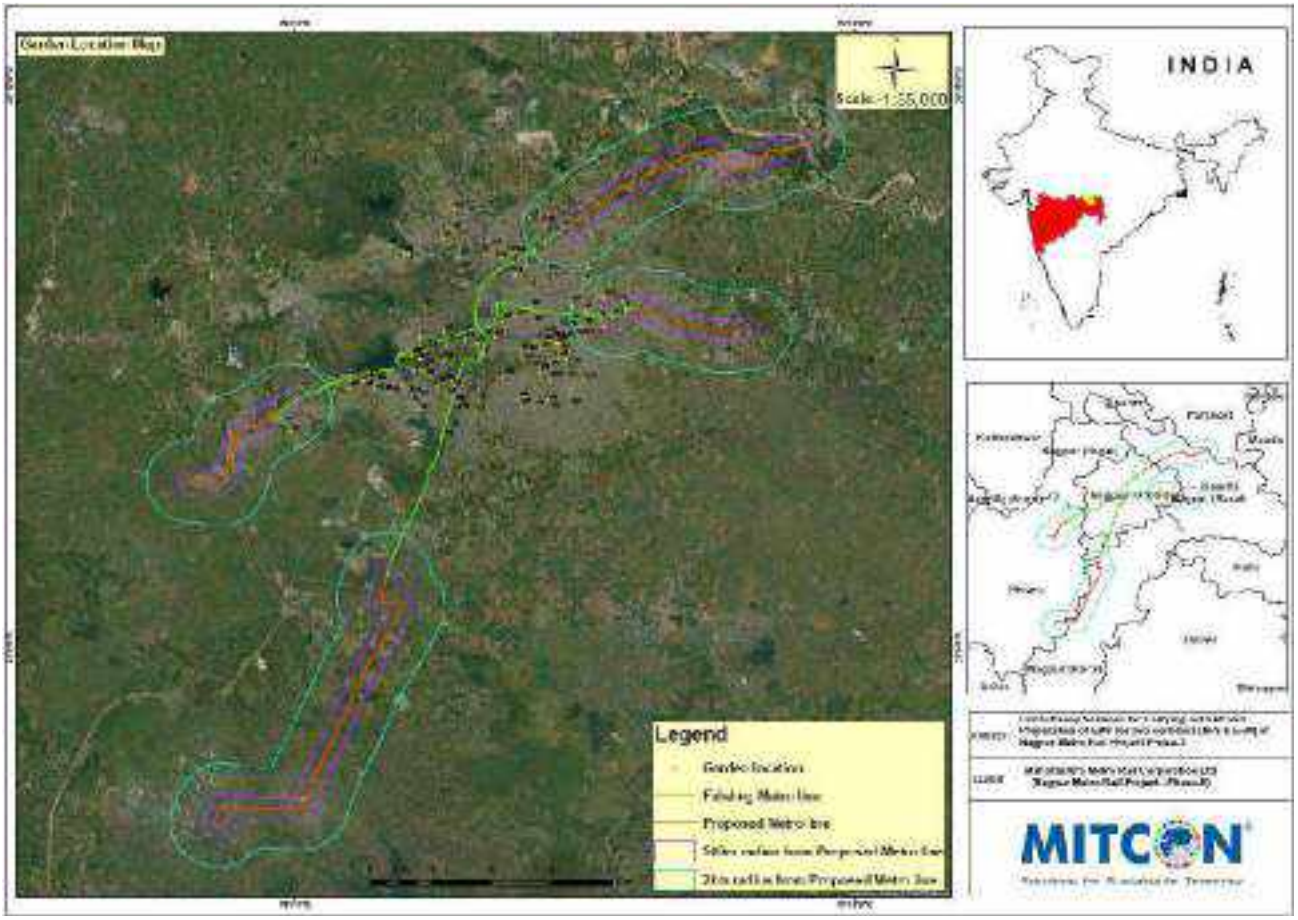


Table 4-40: Gardens in Nagpur - Distance from nearest NMRP Phase II Alignment

Code	Name of Garden	Distance in km	From Alignment
1	Mahatma Phule,Om nagar Udyan	3.59	4A
2	Shantinagar housing board colony udyan	2.18	4A
3	Naik Talav udyan	2.9	2A
4	Lal Bahadur Shastri udyan	3.46	2A
5	Namdevnagar udyan	2.3	2A
6	Bharatmata and Dr. Babasaheb Ambedkar Udyan	1.3	4A
7	Hivari Nagr, Power house Udyan	0.66	2A
8	Maheshwari Bhavan Udyan	0.68	4A
9	Suryanagar Udyan	0.1	4A
10	Kapilnagar Udyan	0.98	2A
11	Ramanagar Udyan	1.77	2A
12	Tathagat Vihar, Vaishali nagar	1.99	2A
13	Guru Nanakpura Udyan	2.66	2A
14	Samrat Ashok Vihar Udyan	2.78	2A
15	Lashkari Bag Udyan	3.43	2A
16	Sariputra Buddha Vihar	2.7	2A
17	Green park, Rajnagar	5.22	2A
18	Sindhu Bal Udyan	3.65	2A
19	Sugat Colony Udyan	5.78	2A
20	Mansarovar Udyan	5.3	2A

Code	Name of Garden	Distance in km	From Alignment
21	Namantar Shahid Smarak Udyan	3.1	2A
22	Indora Udyan	2.85	2A
23	Ulhasnagar Udyan	6.2	4A
24	Azad park Udyan	3	4A
25	Dyanyogi Dr. Shrikant Jichakar, Trafic Park Udyan	7.95	4A
26	Shankar Nagar Trikoni Park udyan	6.8	3A
27	Shivaji Nagar udyan	6.9	3A
28	Shankar Nagar Udyan	6.98	3A
29	Kachipura Udyan	7.88	3A
30	Abhyankarnagar udyan	6.55	3A
31	Ravinagar udyan	7.72	2A
32	Rajbhavan udyan	5.3	2A
33	Kasturaba library Udyan	5.48	2A
34	Utkarshanagar Udyan	7.45	2A
35	Choti Dhantoli Udyan	6.1	4A
36	Dagdi Park Udyan	7	4A
37	Narmada colony Udyan	8.33	2A
38	KT Nagar, Nakshtranagar Udyan	7.65	2A
39	Mahatma Gandhi udyan, Hanumannagar	4.72	4A
40	Ramabai Ambedkar udyan, Chandannaga	4.6	4A
41	Reshimbag udyan	3.77	4A
42	Ram mandir, Chandannagar Udyan	4.4	4A
43	Sadbhavananagar Udyan	5.24	2A
44	Sacchidanand nagar Udyan	5.88	4A
45	Durga Park Udyan	3	4A
46	Trisharan Boudhavihar Udyan	6.06	4A
47	Bhujipage Udyan	4.55	4A
48	Bhapkar Park, Cotton Market Udyan	5.2	4A
49	Mokshadham Dahanghat udyan	5.67	4A
50	Ujwalnagar udyan	7.25	1A
51	Mahatma Phule udyan, Suyognaga	7.6	4A
52	Panchadipnagar Udyan.	1.15	3A
53	Trishatabdi Udyan	2.88	5A
54	Neharunagar Udyan	3.3	4A
55	PMG Society Udyan	8	4A
56	Mejor Surendradev Park	6.52	4A
57	Congress Nagr Udyan	6.4	4A
58	Sahas Colony Udyan	7.6	3A
59	Laxminagar Buti layout Udyan	6.5	3A
60	Tatya Tope Nagar Udyan	6.97	3A
61	Shastri layout Udyan	4.87	3A
62	Renuka Mata Udyan	3.1	3A
63	Dindayal Udyan	4.45	4A
64	Bajaj Nagar Udyan	6.46	3A
65	LIC Colony, Surendranagar Udyan	7.66	3A
66	Cosmopolitan Society Udyan	7.6	3A
67	Adhyapak Layout Udyan	3.9	3A
68	Survenagar Udyan	4	3A
69	Tisharan Layout Udyan	3.65	3A
70	Yashodanagar Udyan	2.9	3A
71	Rajendra Nagar Udyan	3.68	3A

Code	Name of Garden	Distance in km	From Alignment
72	Shastri Layout, Khamla	6	3A
73	Sambhaji Park	7.97	3A
74	Indraprast Nagar Udyan	5.63	3A
75	Civil Office Udyan	5.98	3A
76	Laxmi Narayan Mandir Udyan	2.55	4A
77	Darshna Colony Udyan	1.75	4A
78	Aayurvedic layout Udyan	3.9	4A
79	Juna Bagadganj Udyan	2.27	4A
80	Gandhibag Udyan	3.88	4A
81	Amar Shahid Sunil Dhyaneshwar Smruti Udyan	3.7	4A
82	Gangabai Dahan Ghat Udyan	2.62	4A
83	Chitanvispura (Khode) Udyan	3.36	4A
84	Tulshi bag Udyan	3.45	4A
85	Barbate Udyan	2.05	4A
86	Ratan Colony Udyan	3.16	4A
87	Mochipura bagadganj Udyan	2.06	4A
88	Mattipura, Siraspeth Udyan	3.85	4A
89	Bhange layout udyan	4.7	3A
90	Rajiv Gandhi Udyan	4.8	3A
91	Ramkrashna Nagar Udyan	7.64	3A
92	Sawarkar Nagar udyan	7.33	3A
93	Telecom Nagar udyan	6	3A
94	Chatrapati Nagar udyan	7.74	3A
95	Adiwashi Layout udyan	4.2	3A
96	PMG Ravindranagar udyan	6.35	3A
97	Gayatrinagar udyan	5.35	3A
98	Ambazari Vasti Daga layout Udyan	6.15	3A
99	Dikshabhumi Udyan	7.5	3A
100	New Subhedar layout Udyan	5.2	4A
101	Mhalgi nagar Udyan	5	4A
102	Raghuji nagar Udyan	4.22	4A
103	Janki nagar Udyan	0.96	4A
104	Kukade layout Udyan	6	4A
105	Friends Co-Op Housing Society layout	5.48	3A
106	Sant Dnyaneshwar Sanjivani Samadhi Udyan	4.39	4A
107	Mahavir Udyan	3.14	4A
108	Chitnisnagar Udyan	3.35	4A
109	Uday Nagar Udyan	5.38	4A
110	Gurudev Nagar Udyan	3.06	4A
111	Lata Mangesshkar Udyan	0.44	4A
112	Swatantrya Swaraj Jayanti Udyan, Deshpande layout	0.2	4A
113	Shashtri Nagar Udyan	1.48	4A
114	Datta Nagar Udyan	1.64	4A
115	Dr. Babasaheb Udyan,Vaishali nagar	2.45	2A
116	Kapil Nagar Udyan	1	2A
117	Nazul layout	3.76	2A
118	Avale Babu Chouk	3.35	2A
119	Bezanbag Udyan	3.4	4A

4. **Streams/Nallahs/River/Water body:**

275. Following are the different water bodies were observed around the proposed alignment:

(i) **1A (Mihan to MIDC ECR):** Dongargaon Stream, Mohagaon Stream, Venna River, MIDC KEC *Nallah*
(ii) **2A (Automotive Square to Kanhan River):** Pili Nadi, Lok Vihar *Nallah*, Lekha Nagar *Nallah*, Cantonment *Nallah*, Kamptee *Nallah*, Dragon Palace *Nallah*, Kanhan River, Pench Right Canal
(iii) **3A Hingana:** Ambazari Lake, Hingana *Nallah*, Hingana River
(iv) **4A Prajapati Nagar:** Nag River near Pardi, Umiya Lake, Nag River Near Transport Nagar

5. **Protected Areas**

276. Vidharbha region in Maharashtra is located in the heart of India. Nagpur city which is part of the Vidharbha division, particularly has a number of tiger reserves surrounding it, and hence is sometimes called as the Tiger Capital of the country. Within 200 km radius of Nagpur city, there are three tiger reserve namely Melghat, Pench and Tadoba-Andhari, as well as four wildlife sanctuaries (WLS) namely Mansingdeo, Bor, Nagzira and Navegaon which have a sizeable breeding population of Tigers. However, there is no such ecologically protected area and/or any other Key Biodiversity Area (KBA) within the project buffer study area or even within 20 km radius of any of the project alignments (as is clear from the IBAT analyses given in **Annexure-14**). The nearest Tiger Reserves/WLS from the project alignments are the Pench National Park (Tiger Reserve) at 31 km, Mansingdeo WLS at 23 km and Bor WLS at 26 km. A list of nearest ecologically protected areas in Maharashtra is presented in **Table 4-41**.

Table 4-41: List of Nearest Protected Areas

Sr. No	Protected Areas	District	Distance from the nearest NMRP Phase II Alignment
National Parks (NP)			
1	**Pench (Tiger Reserve)**	**Nagpur**	**31 km**
2	Tadoba-Andhari (Tiger Reserve)	Chandrapur	55 km
3	Nawegaon	Gondia	97 km
Wildlife Sanctuaries (WLS)			
1	**Mansingdeo**	**Nagpur**	**23 km**
2	**Bor**	**Wardha**	**26 km**
3	Umred-Kharngla	Bhandara	42 km
4	Koka	Bhandara	60 km
5	Ghodazari	Chandapur	68 km
6	Nagzira	Bhandara	80 km
7	Andhari	Chandrapur	88 Km
8	Nawegaon	Gondia	100 km
9	Kanhargaon	Chandrapur	120 km
10	Chaprala	Gadchiroli	157 km
11	Melghat	Amravati	177 km
12	Bhamragarh	Chandrapur	230 km
13	Dhyanganga	Buldhana	263 km
Ramsar Site			
1	Lonar Lake	Buldhana	275 Km

277. Most of the water bodies, especially near urban or residential areas, are found to be polluted at different levels because of anthropogenic activities.

H. SOCIO ECONOMIC ENVIRONMENT

278. 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.

279. 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.

280. 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. A detailed Social Impact Assessment (SIA) report dated 24.05.2024 has been attached as **Annexure-18** of this EIA-EMP report. Based on the Social Impact Assessment (SIA) for the project, NMRP Phase II alignments will impact a total of 51 TH households and 47 NTH (kiosks, street vendors, etc.) leading to loss of business premises, business income and rental income. Affected households will be duly compensated following the Entitlement Matrix.. No residential households are being impacted due to the project.

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

(i) The immediate benefits of NMRP Phase II project will come in the form of employment opportunities for those who are engaged as wage laborer, petty contractor, and suppliers of raw materials.
(ii) The mass transport under Phase II 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 Phase II metro rail network, there will be improved linkage between the sub-urban areas to Nagpur city thereby providing wider work and business opportunities. People can travel from Nagpur city to industrial zones like Butibori MIDC, MIHAN, Hingna MIDC and Transport Nagar etc. to work.
(iv) This will also help people to get faster access to essential services like school, health center, public distribution system etc.

282. The possible adverse impacts of the Phase-II project are:
(i) Loss of Private land: Despite efforts to minimize the resettlement impact some Private land will be acquired for Phase-II 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 corridor of impact.

The compensation for such losses has been addressed in the Entitlement Matrix (Table 8.1 of the SIA report i.e. Annexure-18).

283. Apart from this, secondary data was gathered from publications of the Census Department, Government of India (2011 Census), Nagpur District Survey Report (DSR) and other authenticated sources, as presented in the following sections.

1. Demographic Features of Nagpur District

284. Nagpur, a district of Maharashtra is situated in Vidarbha region. Nagpur city is the winter capital of the state of Maharashtra. It is an emerging Metropolis of India and the fastest growing millionaire city. Nagpur has been the main centre of commerce in the Vidarbha region since early days and is an important trading location.

285. The city is ranked 11th most competitive city in the country by the Institute for Competitiveness in its 2012 report. It has also recently been ranked as the cleanest city and the second greenest city of India. In addition to being the seat of annual winter session of Maharashtra state assembly "Vidhan Sabha", Nagpur is also a major commercial and political centre of the Vidarbha region of Maharashtra. Nagpur lies precisely at the centre of the country with the "Zero Mile Marker" indicating the geographical centre of India.

286. Demography of Nagpur District is controlled by socio-economic and environmental conditions. According to the 2011 census, Nagpur District comprising of 14 tehsils had a population of 46,53,171 and Nagpur city had a population of 24,05,421 and the urban agglomeration had a population of 25,23,911. The district had a sex ratio of 948 per 1000 male. Average literacy rate was 89.52% from which, male literacy was 93.76% and female literacy was 85.07%. Working population of Nagpur (15–59 yrs. age category) was 52.5%. The population under six years old was 10.35%. Out of the total District population, 68.30 percent lives in urban regions of district. Sex Ratio in urban region of Nagpur district is 951 whereas for rural area it is 942. Demographics of Nagpur District is presented in **Table 4-42**.

Table 4-42: Demographics of Nagpur District[63]

Indicators	Values
Area Sq. Km	9,892.00
Population (2011 Census)	4,653,171
Male	2,384,975
Female	2,268,595
Total Number of Households	1,041,544
Total Child Population (0-6 Age)	10.35%
Working population (15-59)	52.5%
Urban population Growth (%)	68.31
Density/km2	470
Urban Sex Ratio (Per 1000)	951
Rural Sex Ratio (Per 1000)	942
Average Literacy	89.52%
Male Literacy	93.76%
Female Literacy	85.07%

287. The Nagpur district covers a total area of about 9897 sq. km. of which Nagpur city

[63] *Source: www.censusindia.co.in/subdistrict/nagpur and www.nagpur.gov.in*

accounts for 217.65 sq. km. (2.2%). Nagpur city is governed by Nagpur Municipal Corporation (NMC) which comes under Nagpur Metropolitan Region. As per the 2011 census, population of Nagpur city is 2,405,665; of which male and female are 1,225,405 and 1,180,260 respectively. Although Nagpur city has population of 2,405,665; its urban / metropolitan population is 2,497,870 of which 1,274,138 are males and 1,223,732 are females. Children contributes 10.27% of total population of Nagpur. The municipality has a sex ratio of 963 females per 1,000 males and child sex ratio of 926 girls per 1,000 boys.

A. Population

288. The current estimate population of Nagpur city in 2023 is 3,316,000. The last census was conducted in 2011 and the schedule census for Nagpur city in 2021 was postponed due to COVID-19 epidemic. The current estimates of Nagpur city are based on past growth rate.

Year	Population	±%
1981	1,219,500	—
1991	1,664,000	+36.4%
2001	2,052,066	+23.3%
2011	2,405,665	+17.2%

289. **Religion-wise population.** Hinduism is the major religion in Nagpur city with 69.46% followers. Buddhism is the second most popular religion in Nagpur city with 15.57% following it. Nagpur is popular for the Buddhist monument of Deeksha Bhoomi. In Nagpur city, Islam is followed by 11.95%, Christianity by 1.15%, Jainism by 0.90% and Sikhism by 0.68%. Around 0.10% stated 'Other Religion' and approximately 0.20% stated 'No Particular Religion', as given below:

Religion	No. of followers	% of Total population	Male	Female
Hindu	1,670,932	(69.46%)	853,897	817,035
Muslim	287,436	(11.95%)	147,286	140,150
Christian	27,569	(1.15%)	13,416	14,153
Sikh	16,369	(0.68%)	8,534	7,835
Buddhist	374,537	(15.57%)	187,754	186,783
Jain	21,689	(0.9%)	10,993	10,696
Other Religion	2,348	(0.1%)	1,191	1,157
No Religion Specified	4,785	(0.2%)	2,334	2,451

290. **Caste-wise population.** Schedule Caste (SC) constitutes 19.8% while Schedule Tribe (ST) were 7.7% of total population of Nagpur, as given below:

Caste	Total	Male	Female
Scheduled Caste (SC)	475,425	238,629	236,796
Scheduled Tribe (ST)	185,281	94,638	90,643

291. **Nagpur slum population.** As of 2023, The total no. of Slums in Nagpur city are 1,79,952 in which a population of 8,59,487 resides. This is around 35.73% of total population of Nagpur city.

B. Education

292. Nagpur is a major education hub in Central India. There are two types of schools in the city; NMC (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). Nagpur has four state universities, four government medical colleges and also a private MBBS institute. Nagpur has two major management institutes. Government Chitrakala Mahavidyalaya is also a premier institute in the city. Nagpur also has an IGNOU and YCMOU regional centre.

293. Total literates in Nagpur city are 1,984,123 of which 1,036,097 are males while 948,026 are females. Average literacy rate of Nagpur city is 91.92 percent of which male and female literacy was 94.44 and 89.31 percent.

C. Employment

294. In Nagpur Municipal Corporation (NMC), out of the total population, 843,771 individuals were engaged in work activities. 92.4% of workers describe their work as Main Work (Employment or Earning more than 6 Months) while 7.6% were involved in marginal activity providing livelihood for less than 6 months. Of 843,771 workers engaged in Main Work, 3,424 were cultivators (owner or co-owner) while 5,683 were agricultural labourers. The details are given below:

Type of Workers	Total	Male	Female
Main Workers	779,259	620,325	158,934
Cultivators	3,424	2,728	696
Agriculture Labourer	5,683	4,164	1,519
Household Industries	26,731	18,144	8,587
Other Workers	743,421	595,289	148,132
Marginal Workers	64,512	39,138	25,374
Non-Working	1,561,894	565,942	995,952

2. Utilities and households

295. 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 corridor 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.

296. The NMRP Phase II corridors will be mostly running through the urban area at an elevated 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 Utility information including list of utilities required to be shifted / diverted during construction and operation phase of the project is given in **Annexure-8**. The alignments will also cross storm water drains in some locations, which are not considered part of Utilities.

297. NMRP Phase II alignments pass number of educational and medical institutions

located within 100 meters from the alignment centre. Exact details of these sensitive receptors including their coordinates and distance to the alignment can be found in **Annexure-13**. 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

298. 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.[64]

299. ADB safeguard requirements on physical cultural resources (PCR) apply when a project has the potential to either directly or indirectly affect PCR, regardless of whether these resources are legally protected or not or previously disturbed. The primary objective of PCR management is to protect cultural heritage from adverse project impacts and support its preservation.

300. 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; and (iv) movable objects such as paintings, religious artefacts and antiquities such as coins and seals.[65] Other examples of PCR include sites used for religious or social functions such as weddings, funerals or other traditional community activities, etc.

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

302. Other resources of religious and cultural nature, and community resources are located within 100-150m from the NMRP Phase II alignments are presented in Table below:

Sr. No.	Physical Cultural Resources (PCR)	Type of PCR	Side of Alignment	Distance from Alignment centre (m)
Line 1A				
1	Anvita Farms	Wedding hall	LHS	30
2	Iora Palms	Wedding hall	LHS	30
3	Gurudwara Shri Guru Nanak Niwas	Gurudwara	LHS	38
4	Hashmatee Masjid	Mosque	LHS	100
5	Al Jamiatur Razvia Darululoom Amjadia Masjid	Mosque	LHS	85
6	Bansal Celebrations	Wedding Hall	RHS	122

[64] *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]*

[65] *Source: ADB Environment Safeguards: A Good Practice Sourcebook Draft Working Document (Dec. 2012) – Section VII (Physical Cultural Resources).*

Sr. No.	Physical Cultural Resources (PCR)	Type of PCR	Side of Alignment	Distance from Alignment centre (m)
7	Shri Swami Samarth Kendra	Temple & community centre	LHS	107
8	Aai Sabhagruha	Banquet and Wedding Hall	LHS	30
Line 2A				
9	Sai Mandir, Kamptee rd., Pili Nadi	Temple	LHS	30
10	Vishva Deep Buddh Vihar / Puraso Buddh Vihar / Piyodasshi Buddha Vihar	Buddhist Temple	RHS	56
11	Mata Mandir Khasala, Kamptee rd.	Temple	LHS	77
12	Royal Celebrations	Wedding Hall	LHS	27
13	Tudsa Mata Mandir	Temple	RHS	83
14	Jashan Lawns	Wedding Hall	RHS	62
15	The Palm Greens	Wedding Hall	RHS	28
16	TNJ Palace	Wedding Hall	RHS	27
17	Royals Weddings	Wedding Hall	LHS	33
18	Chandani Lawns	Wedding Hall	RHS	60
19	Sarah Celebraions	Wedding Hall	RHS	47
20	Danish Celebrations	Wedding Hall	RHS	79
21	Sanjeevan hall & Lawns	Wedding Hall	LHS	49
22	Khairy Buddh Vihar	Temple	RHS	76
23	The Raj Royal Lawns & Banquets	Wedding Hall	RHS	53
24	Shitla Mata Mandir, Bhedikhana (Kamptee)	Temple	LHS	60
25	Shri Girijadhar Balaji Hanuman Mandir	Temple	LHS	15
26	Christ Church (Cantonment area)	Church	LHS	39
27	Christ Church Cemetery	Christian Graveyard	RHS	102
28	Shri Kamtheshwar Panchayatan Mandir	Temple	LHS	24
29	Methodist Church, Kamptee	Church	RHS	67
30	Ganj ke Balaji Mandir	Temple	RHS	54
31	Hazrat baba Dargah, Kamptee	Mosque	LHS	29
32	Sai Mandir (Kanhan)	Temple	LHS	53
Line 3A				
33	Hingna MIDC Masjid	Mosque	RHS	35
34	Manasi Celebrations	Wedding Hall	LHS	26
35	Babade Sabhagrugh	Wedding Hall	RHS	25
36	Maharaja Celebrations	Wedding Hall	RHS	34
37	Sivaji Maharaj Statue	Statue	LHS	35
38	Marigold Celebrations	Wedding Hall	LHS	20
Line 4A				
39	Vishal Celebrations	Wedding Hall	LHS	42

Sr. No.	Physical Cultural Resources (PCR)	Type of PCR	Side of Alignment	Distance from Alignment centre (m)
40	Vaibhavi Laxmi Mata Mandir/Jai Maa Ghanteshwari Mandir	Temple	LHS	

V. ANTICIPATED IMPACTS AND MITIGATION MEASURES

A. METHODOLOGY

303. 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.

B. IDENTIFICATION OF ENVIRONMENTAL COMPONENTS

304. 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.

305. **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.

306. **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;

307. **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.

308. **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.

309. 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 50.1 to 61.6 µg/m^3 and 80.2 to 100.9 µg/m^3 respectively, whereas SO_2 and NOx values vary between 22.1 to 31.5 µg/m^3 and 30.6 to 50.8 µg/m^3 respectively. CO values vary between 0.6 to 1.4 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. According to the ESR report for Nagpur Metropolitan area, all surface water bodies in Nagpur act as wastewater streams.
1.4	Groundwater quality	Medium	Water quality of the groundwater in the project area is moderate
1.5	Groundwater quantity	Medium	Nagpur is 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 538 trees (63 species) are likely to be affected in the construction of the four project alignments.
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 around all four NMRP Phase II alignments
3.0	**Social Environment**		
3.1	Private land and buildings	Medium	Approximately 98 households (51 TH and 47 NTH) will be affected, and approx. 57768.4 m^2 of private land needs to be acquired
3.2	Public property /	Medium	The alignment will cross sub-surface, surface

Sr. No.	Valued Environmental Components (VECs)	Sensitivity Level	Remarks
	infrastructure / utility structures		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	The project area already experiences some road safety issues due to the traffic on the highway
3.6	Public health and safety	Medium	
3.7	Physical Cultural Resources (PCR)	Low	There are very few religious places located close to the alignment (within 50m on either side)

310. **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.

311. **Extent of impact:** The extent of impact entails the spatial scale of impact on one or more of the VECs. The terms NMA (Nagpur Metropolitan Area, regional), 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.

312. **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.

313. 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

314. 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.

315. 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 height of viaduct and lighting on birds			*		*		*				*		Moderate	Minimal -ve
8	Transfer of 3.53 ha government land and acquisition of 5.78 ha private land			*		*			*				*	Minor	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

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		
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
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		*		*			*				*		Moderate	Minimal –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		
	construction sites, 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 538 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		*		*				*				*	Major	Minimal –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		
	operation of construction equipment and vehicular movement														
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
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			*	*				*				*	Major	Minimal –ve
5	Vibration due to metro operations			*	*			*					*	Major	Minimal –ve
6	Accidents, electromagnetic interference, exposure to electromagnetic radiation and communicable diseases		*			*			*			*		Moderate	Minimal –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		
D.	**Positive Impacts during Operation phase**														
1	Reduced air pollution due to modal shift towards public transport			*			*			*			*	-	Major +ve
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 (Nagpur 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

316. **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 height of viaduct and lighting on birds (Moderate)
(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)

317. 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) Imoact 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).

318. 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.

319. 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 afforestations;
(v) Creation of Economic opportunities.

E. ANTICIPATED IMPACTS AND MITIGATION MEASURES

320. 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

321. 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. The reduction of air pollutants with the present corridors is presented in **Table 5-4**.

Table 5-4: Reduction in Pollution (Ton/Year)[66]

Pollutant	Horizon Year		
	2024	2031	2041
Carbon Monoxide (CO)	435.07	513.47	640.08
Hydro-Carbons (HC)	175.49	206.89	256.97
Nitrogen Oxide (NOx)	122.80	138.60	161.34
Particulate Matter (PM)	15.48	18.14	22.32
Carbon Dioxide (CO2)	18204.73	20981.47	25471.96
Treatment cost ₹ (million)	83,9	98,2	46,8

322. **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.

323. 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. Vehicular emission is estimated as in **Table 5-5**. The estimate 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.

Table 5-5: Emissions due to truck movement during demolition and construction[67]

Pollutant	Emission (ton)
Carbon Monoxide (CO)	27
Particulate Matter	31
Hydro-Carbons (HC)	1
Nitrogen Oxide (NOx)	33
VOC	9
Carbon dioxide (CO_2)	3531

324. **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.

325. 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.

326. DG sets compliant with emission standards will be used.

66 Detailed Project Report (DPR) for Extension of Nagpur Metro Rail Phase 2, November 2019
67 Detailed Project Report (DPR) for Extension of Nagpur Metro Rail Phase 2, November 2019

327. 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

328. 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.

329. 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.

330. 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.

331. 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.

332. Labour residing in camps will be provided with LPG fuel for cooking.

333. Prediction of impacts on air environment in both Construction and Operation phases of the project have been carried out by employing a mathematical model. 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.

334. The hourly secondary data collected from IMD has been used for the period April to June 2023. The air pollution modelling carried out represents the worst case and normal operating scenarios for Nagpur metro corridors. Analysis of data is completed and a summary of the conclusions drawn from the predicted incremental Ground Level Concentrations (GLCs) is given below. Detailed report on Air quality modelling is attached as **Annexure-5** of this report.

- Incremental concentration of PM10, SO2 & NOx was observed at 5 out of the 8 monitored locations along Line 1A. Maximum Incremental concentrations were observed at Dongargaon for PM10 (0.15 µg/m3), SO2 (0.55 µg/m3) & NOx (0.15µg/m3).
- 4 of the 11 monitored locations locations along Line 2A showed predicted increase in concentration of PM10, SO2 & NOx. Maximum Incremental concentration of PM10 was

observed at Kamptee Police station (0.15 µg/m3), while maximum concentration of SO2 (0.70 µg/m3) and NOx (4.41 µg/m3) was observed at Kanhan river location.

- Along Line 3A, incremental concentrations of PM10, SO2 & NOx were observed at 4 of the 10 monitored locations. Maximum Incremental concentrations were observed at Shalinitai Meghe hospital for PM10 (0.21 µg/m3), SO2 (0.75 µg/m3) & NOx (4.75 µg/m3).
- Predicted increase in the concentrations of PM10, SO2 and NOx was observed at 2 of the 3 monitored locations along Line 4A, with maximum incremental concentrations seen at Kapsi Kh. For PM10 (0.06(µg/m3), SO2 (0.23 µg/m3) and NOx (1.47 µg/m3).

335. **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 high positive.

336. **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

337. Baseline noise without metro is within permissible limits, except at 11 of the 34 monitored locations, but the NMRP Phase II project has the likelihood of increasing noise levels.

338. **Impact due to Construction Phase.** 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[69] ranged from 76 dB(A) to 84 dB(A); vibratory pile driver at 101 dB(A). The average / typical noise levels generated by various types of construction equipment are given in **Table 5-6**, while actual noise generated by various construction equipment is summarised in **Table 5-7**.

Table 5-6: Average Noise Levels Generated by Various Construction Equipment[70]

Equipment	Typical Noise Level (dBA) at 50 ft from source
Air Compressor	81
Backhoe	80
Ballast Equalizer	82
Ballast Tamper	83
Compactor	82
Concrete Mixer	85
Concrete Pump	82
Concrete Vibrator	76
Crane Derrick	88
Crane Mobile	83
Dozer	85

[69] *Construction Noise Handbook August 2006, FHWA, USA*
[70] *Source: FTA Transit Noise and Vibration Guidance Handbook, May 2006*

Equipment	Typical Noise Level (dBA) at 50 ft from source
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 5-7: Actual Noise Levels Generated by Various Construction Equipment[71]

Equipment	Actual Lmax Noise Level (dBA) at 50 ft from source
Auger drill rig *	84
Compressor *	78
Dump truck *	76
Excavator *	81
Flat bed truck *	74
Front end loader *	79
Vibratory Pile driver *	101
Press Pile	70
Batching Plant	90
Booster pump	80

339. 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.

340. 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 recommendeds that the exposure period of affected persons is limited (**Table 5-8**).

Table 5-8: 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[72]
85	8
88	4
91	2
94	1
97	½

[71] *Source: Construction Noise Handbook, US FHWA, Aug 2006*

[72] *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*

Maximum equivalent continuous Noise level dB(A)	Unprotected exposure period per day for 8 hrs/day and 5 days/week[72]
100	¼
103	No exposure permitted at or above this level

341. **Mitigation Measures.** During construction various measures such as noise mufflers, enclosures, low-noise equipment and temporary noise barriers will reduce noise. If baseline noise is below the CPCB and IFC-EHS standards, the construction noise has to be less than level prescribed in these standards. Vehicles and construction equipment will be in good state of maintenance, where feasible of low noise design, fitted with noise mufflers. Other mitigation measures to be taken are:

(i) At all 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 will effectively cut down noise levels by 10-15 dB (A). Piling operations will be restricted during day time hours only

(ii) Noisy construction activities will be enclosed by use of transportable noise screens between noise sources and identified noise sensitive areas for the duration of noisy construction activities;

(iii) RCC pumps will be covered from all sides. Bends and excessive head will be avoided;

(iv) If needed, construction traffic will 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);

(v) Local residents and shop owners will be informed about the nature and duration of intended activities including the construction method, probable effects, quality control measures and precautions prior to commencement;

(vi) Noise monitoring is required during construction, including field observations and measurements.

342. 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.

343. **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.

344. In the context of rapid rail transit, noise levels exhibit distinct variations: when trains traverse viaducts (elevated corridor) at a speed of 50 mph (i.e around 80kmph), the noise level at a distance of 15 m from the tracks registers at 85 dB (A); a corresponding value of 80 dB (A) is observed at ground level, while rail transit at stations yields a noise level of 65 dB (A). The primary noise source arises from the movement of metro trains, with the dominant contributors being the noise emanating from train operations and track structures. However, since an average (schedule) speed of 32-34 kmph (around 20-21 mph) will be adopted, significantly lower noise levels will be generated throughout the operation phase of NMRP Phase II.About 22 sensitive receptors have been found to be located within 100 m on either side of the project alignment. There are additional 3 sensitive receptors beyond 100 m offset considered in this

study as they have direct exposure to the metro alignment. This includes educational institutes, hospitals and places of worship. The baseline noise levels at sensitive receptors are presented in the table below.

Table 5-9: Baseline Noise Levels at Sensitive Receptors

Line	Receptor Description	Latitude Longitude	Offset from Centreline, meter	Existing 24 hr Day Equivalent	Existing 24 hr Night Equivalent
1A	Sharirik Shikshan Mahavidyalaya	21° 0'13.12"N 79° 2'26.53"E	45	50.1	36.1
1A	Rachana Hospital	20°55'43.41"N 79° 0'0.56"E	48	54.2	45.6
1A	Masjid and Dargah	20°58'40.38"N 79° 1'37.08"E	75	47.2	30.6
1A	Al Jamiatur Razvia Darululoom Amjadia School	20°58'34.95"N 79° 1'34.44"E	75	47.2	30.6
1A	Jijamata High School & Jr. College	20°55'46.75" N 79° 0'18.26" E	65	51.6	44.7
1A	St. Claire School	20°56'36.97"N 79° 0'38.53"E	125	62.7	49.4
1A	Datta Meghe College	20°55'45.25"N 78°59'36.82"E	50	61.6	49.8
1A	Ira International School	20°55'45.15"N 78°59'51.09"E	100	61.6	49.8
1A	KEC Training Centre	20°55'46.08"N 78°59'31.40"E	100	61.6	49.8
1A	Balbharti School	20°55'35.47"N 78°59'38.01"E	140	61.6	49.8
2A	Orange City Park - Residential area	21°13'10.70"N 79°10'48.91"E	25	56.8	44.9
2A	Asha Hospital and Asharam College & School of Nursing	21°13'9.11" N 79°10'35.50" E	40	56.8	44.9
2A	Christ Church	21°13'18.44"N 79°11'8.62"E	50	56.8	44.9
2A	Kamptee sub district hospital	21°12'47.51" N 79°11'56.43" E	30	55.1	45.6
2A	Buddha Vihar	21°12'41.46"N 79° 9'41.72"E	75	60.9	51.9
2A	Delhi Public School (DPS), Khairi	21°12'49.33"N 79° 9'39.19"E	95	50.1	43.6

Line	Receptor Description	Latitude Longitude	Offset from Centreline, meter	Existing 24 hr Day Equivalent	Existing 24 hr Night Equivalent
2A	Girijadhar Balaji Hanuman Temple	21°13'15.86"N 79°11'3.71"E	2	56.8	44.9
3A	Yeshwantrao Chavan College of Engineering (YCCE), Nagpur	21° 5'43.27" N 78°58'41.14" E	90	55.4	43.9
3A	Rural Hospital Hingna	21° 4'29.18" N 78°57'16.31" E	40	53.2	46.8
3A	Dr. Babasaheb Ambedkar Super Speciality Hospital	21° 5'42.38"N 78°58'29.78"E	8	56.6	47.8
3A	School of Scholars, Wanadongri	21° 5'42.82"N 78°58'32.22"E	30	56.6	47.8
4A	Nagpur City Hospital	21° 9'2.89"N 79° 8'56.81"E	20	59.8	49.1
4A	Tarangan Hospital	21° 9'4.84"N 79° 9'2.53"E	30	59.8	49.1
4A	Prakash Krishi Educational institute	21° 8'58.10" N 79° 9'38.54" E	30	59.8	49.1
4A	Pardi Residential area	21° 8'57.99"N 79° 9'37.53"E	5-10	59.8	49.1

345. To estimate the operational noise level, the internationally recognized noise modelling software 'SoundPLAN' version 8.2 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.

346. Using SoundPlan 8.2, 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 the table below. As mentioned earlier, in addition to the FTA/FRA-HSGT (2005) standards that were applied, the following options were adopted:

- The maximum and minimum distance between any two stations is 3.2km and 600m, respectively. Both of which are in line 1A.
- The metro train service timing for all routes is 5:00 AM till midnight, 19 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 5-10: 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)

Parameter	Detail
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)
Number of trains per hour	Line / 2024 / 2031 / 2041 1A / 4 / 4 / 6 2A / 10 / 10 / 11 3A / 3 / 3 / 4 4A / 8 / 10 / 14

347. **Noise Emission Sources:** 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 is 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

348. 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.

- **Ground Elevation and Digital Ground Model**: The ground elevation data was taken from Google Earth to generate Digital Ground Model.
- **Superstructure**: 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, whereas it is 0.75m AGL for at-grade stations. All the stations in all the routes are elevated except two stations on route 1A.
- **Rail Elevation**: The rail elevations from the engineering vertical profiles were used to establish the absolute and relative height of the railway every 11.16 meters.
- **Building Location and Heights:** 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.

349. The baseline noise levels at receptors on four routes, along with the modelled noise values from the metro train, are as presented in Table 6 of the **Noise Modelling report** (attached as **Annexure-6** to this EIA-EMP report), while the day-time and night-time contour maps along with single-point maps for each receiver are provided in Annexure 1 to Annexure 4 of the same. The findings of the **Noise Modelling report (Annexure-6)** are summarised in following paragraphs.

350. For Line 1A the total noise levels during metro operation are within permissible limits for all the modelled locations except at two receptors Daruloom Amjadia School and Masjid & Dargah where total night-time noise levels increase by 6 dB(A) and 5.5 dB(A) respectively over the baseline levels. Both these sensitive receptors have landuse category of silent zone as per Central Pollution Control Board (CPCB) norms. However, there is no activity at these sensitive receptors during night time and metro will not be operational during whole night. Therefore, no mitigation measures are required at these receptors.

351. For Line 2A the total noise levels during metro operation are within CPCB permissible limits at all the modelled receptors. Maximum increment in noise is observed at Christ Church where daytime noise levels increases by 0.5 dB(A) and night-time levels are increased by 2.4 dB(A).

352. For Line 3A the total noise levels during metro operation are within CPCB permissible limits at all the modelled receptors except at Dr. Babasaheb Ambedkar Super Speciality Hospital where daytime noise levels increase by 1.4 dB(A) and night-time levels are increased by 3.2 dB(A).

353. For Line 4A the total noise levels during metro operation are within CPCB permissible limits at all the sensitive receptors. Maximum increment in noise is observed at Pardi Residential Area where daytime noise levels increases by 0.6 dB(A) and night-time levels are increased by 2 dB(A).

354. **Mitigation.** The design will include noise reducing features such as, but not limited to, baffle wall as parapets up to the rail level, resilient mounting and dampers and welded rails.

The noise from the operation of the metro is well within the permissible limits of CPCB as well as WB-EHS or IFC guidelines and do not exceed +3 dB(A) of the existing ambient noise levels except at two sensitive receptors along line 1A where noise levels are within permissible limits but exceeding the +3 dB(A) during night time. Since these two sensitive receptors i.e. Daruloom Amjadia School and Masjid & Dargah will be closed during night time and metro will not be running entire night time, no control measures are needed at this stage. The noise levels are also exceeded at Dr. Babasaheb Ambedkar Super Speciality Hospital along line 1A where night -time levels exceed by +3.2 dB(A). 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.

Table 5-11: Noise levels due to Metro Operation

Name of Receptor	Landuse Category as per CPCB	Baseline Noise Levels, dB(A)		Predicted Noise Levels, dB(A)		Projected Noise Levels, dB(A)		Increase over Baseline Noise Levels, dB(A)		Central Pollution Control Board Noise Standards (dBA)	Respective WB-EHS or IFC Standards (dBA)
		Day time	Night time	Day time	Night time	Day time	Night time	Day time	Night time		
Line 1A											
Sharirik Shikshan Mahavidyala	Silent Zone	50.1	36.1	39.7	35.5	50.5	38.8	0.4	2.7	Day: 50 Night: 40	Day: 55 Night: 45
Daruloom Amjadia School	Silent Zone	47.2	30.6	39.7	35.4	47.9	36.6	0.7	6.0	Day: 50 Night: 40	Day: 55 Night: 45
Masjid & Dargah	Silent Zone	47.2	30.6	39.0	34.7	47.8	36.1	0.6	5.5	Day: 50 Night: 40	Day: 55 Night: 45
St. Claire School	Silent Zone	62.7	49.4	38.0	33.7	62.7	49.5	0.0	0.1	Day: 50 Night: 40	Day: 55 Night: 45
Datta Meghe College	Silent Zone	61.6	49.8	35.9	31.6	61.6	49.9	0.0	0.1	Day: 50 Night: 40	Day: 55 Night: 45
Ira International School	Silent Zone	61.6	49.8	39.3	35.1	61.6	49.9	0.0	0.1	Day: 50 Night: 40	Day: 55 Night: 45
EC Training Centre	Silent Zone	61.6	49.8	38.6	34.3	61.6	49.9	0.0	0.1	Day: 50 Night: 40	Day: 55 Night: 45
Balbharti School	Silent Zone	61.6	49.8	37.7	33.5	61.6	49.9	0.0	0.1	Day: 50 Night: 40	Day: 55 Night: 45
Jijamata High School & College	Silent Zone	51.6	44.7	39.8	35.6	51.9	45.2	0.3	0.5	Day: 50 Night: 40	Day: 55 Night: 45
Rachana Hospital	Silent Zone	54.2	45.6	40.8	36.5	54.4	46.1	0.2	0.5	Day: 50 Night: 40	Day: 55 Night: 45
Line 2A											
Kamptee Sub-district Hospital	Silence	55.1	45.6	46.3	42	55.6	47.2	0.5	1.6	Day: 50 Night: 40	Day: 55 Night: 45
Christ Church	Silence	56.8	44.9	47.8	43.6	57.3	47.3	0.5	2.4	Day: 50 Night: 40	Day: 55 Night: 45
Asha hospital, Ashram school & college of Nursing	Silence	56.8	44.9	42.6	38.4	57	45.8	0.2	0.9	Day: 50 Night: 40	Day: 55 Night: 45

Name of Receptor	Landuse Category as per CPCB	Baseline Noise Levels, dB(A)		Predicted Noise Levels, dB(A)		Projected Noise Levels, dB(A)		Increase over Baseline Noise Levels, dB(A)		Central Pollution Control Board Noise Standards (dBA)	Respective WB-EHS or IFC Standards (dBA)
		Day time	Night time	Day time	Night time	Day time	Night time	Day time	Night time		
Orange City Park	Residential	54.9	45.7	45.6	41.4	55.4	47.1	0.5	1.4	Day: 55 Night: 45	Day: 55 Night: 45
Budhha Vihar	Silence	60.9	51.9	45.3	41	61	52.2	0.1	0.3	Day: 50 Night: 40	Day: 55 Night: 45
Girijadhar Balaji Hanuman Temple	Silence	56.8	44.9	46.6	42.3	57.2	46.8	0.4	1.9	Day: 50 Night: 40	Day: 55 Night: 45
Delhi Public School	Silence	50.1	43.6	39.9	35.7	50.5	44.3	0.4	0.7	Day: 50 Night: 40	Day: 55 Night: 45
Line 3A											
Yeshwantrao Chavan College of Engineering (YCCE)	Silence	55.4	43.9	38.1	33.8	55.5	44.3	0.1	0.4	Day: 50 Night: 40	Day: 55 Night: 45
School of Scholars, Wanadongri	Silence	56.6	47.8	44.4	40	56.9	48.5	0.3	0.7	Day: 50 Night: 40	Day: 55 Night: 45
Rural Hospital Hingna	Silence	53.2	46.8	38.8	34.5	53.4	47	0.2	0.2	Day: 50 Night: 40	Day: 55 Night: 45
Dr. Babasaheb Ambedkar Super Speciality Hospital	Silence	56.6	47.8	52.4	48.1	58	51	1.4	3.2	Day: 50 Night: 40	Day: 55 Night: 45
Line 4A											
Prakash Krishi Educational Institute	Silence	59.8	49.1	48.3	44	60.1	50.3	0.3	1.2	Day: 50 Night: 40	Day: 55 Night: 45
Tarangan Hospital	Silence	59.8	49.1	46	41.7	60	49.8	0.2	0.7	Day: 50 Night: 40	Day: 55 Night: 45
Nagpur City Hospital	Silence	59.8	49.1	36.5	32.2	59.8	49.2	0	0.1	Day: 50 Night: 40	Day: 55 Night: 45
Pardi Residential Area	Residential	59.8	49.1	51.2	46.9	60.4	51.1	0.6	2	Day: 55 Night: 45	Day: 55 Night: 45

355. **Embedded Measures.** The ballast-less track supported on two layers of rubber pads will reduce track noise and ground vibrations. In addition, providing skirting of coach shell covering the wheel will screen any noise coming from the rail wheel interaction as of propagating beyond the viaduct. Screening of noise can be ensured by providing parabolic noise barriers on each side of the track along the curved portion of the viaduct and at identified sections during operation.

356. **Proposed Measures.** Since the projected noise levels are well within the prescribed limits and do not exceed +3dBA, operational noise monitoring will be carried out, and if required nosie barriers will be considered during that time.

357. In order to verify the predicted noise levels, the EMP provides for noise monitoring during the first three years of operation.

358. **Residual impact.** The residual impacts due to metro operation will be negligible.

359. **Impact Significance:**

- Design and pre-construction stage – major negative
- Construction stage – major negative
- Operation stage – major negative
- Residual Impact after Mitigation – negligible

3. Vibration

360. Construction and operation of metro will cause vibration from equipment during construction and wheel-rail interaction during operation. As part of the detailed design, a vibration analysis at pre-identified receptors comprising educational and medical buildings and other fragile buildings, if any, located within recommended screening distance of 62m (RRT, cat.2) on either side of alignment will be carried out, based on which, a set of mitigations will be prepared and shared with all lenders for review, prior to commencement of construction.

361. However, as part of this EIA, a general vibration and annoyance assessment for both construction and operational phase has been carried out as well as an assessment of the vibration impacts on 9 identified sensitive receptors has been provided. 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 Administratons 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.

362. **Impact.** 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 equipments 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.

363. 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.

364. 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 5-1** provides typical PPV values at 25 ft. for several types of construction machinery as per the FTA, 2018.

365. 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.)

366. 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. As mentioned, further vibration modeling will be conducted, based on the detailed engineering design to inform the incremental impacts and suggest the mitigations accordingly.

367. During operation vibration is found to be higher with higher speeds and lower with heavier transit structure.

Figure 5-1: Vibration source levels for construction equipment (FTA) [73]

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

368. Vibration modelling for the NMRP Phase II alignments was carried out by NDGIS (Mumbai). Detailed Report on Vibration modelling studies undertaken for NMRP Phase II Project for construction as well as operation phases is attached as **Annexure-4** to this Report. Modelling of operation phase showed that at 3 locations (namely VB 16 on Reach 2A, VB31 on Reach 3A and VB32 on Reach 4A) Vibration Levels are higher than RDSO guidelines. These are predicted modelling results; however, actual vibration will be measured during operation phase of NMRP Phase II. If the actual vibration levels are still high, suitable mitigation measures shall be suggested by the project proponent. Building Condition Surveyu will be carried out by the Contractor as it is part of the Contractors scope.

369. **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,

[73] *Source: FTA Transit Noise and Vibration Impact Manual, September 2018.*

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.

370. The contractor will prepare a mitigation plan and implement the same during the final design and construction phase of the project. This scheme will include:

(i) Monitoring requirements for vibrations at regular intervals throughout the construction period; Pre-construction structural integrity inspections of sensitive structures.
(ii) Information dissemination about the construction method, probable effects, quality control measures and precautions to be used.
(iii) vibration monitoring plan during final design and the implementation of a compliance monitoring program during construction.

371. Damping treatments, localized stiffening or mass addition at the receptors to reduce post-construction vibration. Wave-impleding blocks (WIP), 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.

372. 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[74]. 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.

373. Detailed vibration modeling 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.

374. **Residual impact.** Baseline vibration in 1 or 2 locations is just high enough to cause annoyance and metro operation will add to it. However, since vibration impacts decrease with an increase in distance from the alignment, the impact will be much localized. Therefore, the residual impact is considered minimal negative.

[74] *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.*

375. **Mitigation.** Vibration monitoring and building condition surveys are required to determine if there are negative impacts and annoyance post mitigation implementation. In cases, wherever required, additional mitigation measures shall be provided to ensure that vibration and annoyance impacts are below the threshold criteria.

376. **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

377. **Impact.** The construction of infrastructure projects like a metro system, including the construction of piers, can have various impacts on hydrology and surface water bodies. These impacts can be both positive and negative, and they depend on various factors including the design and construction of the project, as well as the local environmental conditions.

378. The construction of metro piers, stations, and tracks often leads to an increase in impervious surfaces such as concrete and asphalt. This can result in increased surface runoff and reduced infiltration of rainwater into the soil. As a result, there may be more storm-water entering local water bodies, which can lead to increased erosion and potential water quality issues.

379. Metro Construction may alter the natural drainage patterns of the area. New drainage systems may be installed to manage storm-water, which could change the flow of water in the area. This alteration can have implications for local streams, rivers, and wetlands. Pollutants which include sediment, construction materials, chemicals, and oils etc. can be introduced into nearby surface water bodies through surface run-off. Proper erosion and sediment control measures shall be put in place to mitigate these impacts, if required.

380. Piling and excavation activities during construction can temporarily lower the water table in the vicinity of the metro construction. Mitigation measures like construction of retention ponds or wetlands to manage storm-water, the use of permeable pavement in station areas, and the implementation of best management practices for erosion and sediment control measures shall be recommended wherever required.

381. **Mitigation.** Anticipated impacts of pier construction will be mitigated by construction of Phase II metro piers parallel (adjacent) to the piers of existing bridges on downstream side so as to avoid obstruction / conflict of water flows. Work will be executed by providing suitable cofferdams for foundations / sub-structures.

382. Where the alignments cross water ways, appropriate measures will be implemented so as to avoid any impact on the respective water course, as described earlier (Para 222 of Chapter IV – Section F). Following Precautions will be taken during construction of piers / box girders across waterways:

(i) Construction will be carried out in such a way that no disturbance is caused to the river bank or embankment of the stream/*Nallah*;
(ii) All construction work will be finished strictly adhering to the time schedules decided;
(iii) Restoration of the work sites will be done as soon as work is completed;
(iv) All necessary precautions will be taken to avoid spillage of concrete and other construction material at the work sites;
(v) Ecology of the area will be maintained by minimal disturbance to the surroundings;
(vi) It is prohibited to dispose excavated spoils and wastes into river/streams water;

(vii) All chemicals, fuel and oil will be stored away from water and will be stored at concreted platform with catchment pits for spills collection;
(viii) The contractor will 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;
(ix) If required, silt fencing and/or brush barrier will be installed for collecting sediments before letting them into the water body. Silt/sediment will be collected and stockpiled for possible reuse as surfacing of slopes for re-vegetation;
(x) All wastes arising from the construction sites will be collected and disposed in a designated location. The wastes will be collected, stored and transported at approved disposal sites;
(xi) No vehicles or equipment will be washed, parked or refueled near streams water, to avoid contamination of streams water from fuel and lubricants;
(xii) Vehicle parking and maintenance areas will have waterproof floors from which drainage is collected and treated to legal standards;
(xiii) No untreated sanitary wastewater from camps will be discharged into the streams water;
(xiv) 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;
(xv) The contractor will take appropriate measures to avoid and contain any spillage and pollution of the water;
(xvi) Quarterly monitoring of wastewater quality and regular monitoring of surface water quality to ensure compliance with the standards;
(xvii) It will be mandatory for the Contractor to adhere to the mitigation measures provided in the EMP section of Contract documents.

383. **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.

384. **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

385. **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.

386. 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.

387. **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.

388. 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.

389. 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.

390. 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.

391. Equipment/vehicle repair/maintenance and re-fueling 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.

392. 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 liters. 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.

393. Spill cleanup 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 cleanup will be undertaken, and all cleanup 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.

394. **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.

395. **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

396. **Impact.** Water consumption during construction shall be about 643 KLD for NMRP Phase II project. Dewatering necessary for pile foundation construction will lead to a decrease in ground water quantity. Water demand at stations during operation is estimated at 678 KLD and will be met through municipal water supply, thus impacting the availability of this commodity.

397. **Mitigation**. Stations of NMRP Phase II corridors will be connected to the municipal water supply system; there will be no direct use of surface water. However, since Nagpur 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.

398. As a design feature, rainwater harvesting at elevated stations and along the viaduct will be implemented as an environmental conservation measure, to conserve and augment the storage of groundwater. Regular inspection and maintenance of the rainwater harvesting system will be required in order to let it function effectively.

399. 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.

400. 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.

401. **Residual impact.** Rainwater harvesting will be implemented to recharge groundwater. Since no groundwater will be extracted for the project the residual impact on groundwater quantity is high positive. Since Nagpur 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.

402. **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

403. **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 elevated metro corridor and stations, leading to depletion in construction material at source.

404. 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 NMRP Phase II project is not foreseen under this EIA.

405. 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).

406. 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.

407. **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-9A** of this EIA-EMP report and Maha Metro's SHE Manual (**Annexure-12**), 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.

408. 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, NMA and 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.

409. 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.

410. 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.

411. 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.

412. 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 Nagpur 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.

413. 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.

414. **Residual impact**. Metro construction will inevitably lead to depletion in construction material at source, the residual impact is considered to be minimal negative.

415. 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.

416. **Impact Significance**

- Design and pre-construction stage – minor negative
- Construction stage – moderate negative
- Operation stage – neutral
- Residual Impact after Mitigation – minimal negative

8. Flora

417. **Impact.** The alignment has been chosen in such a way that loss of trees and other

vegetation is minimized as much as possible. However, Total 538 Trees (63 species) are likely to be affected due to proposed alignments. 14 of these trees to be cut are from an endangered species (Tectona Grandis – Teak). With removal of these trees, the process for CO_2 sequestration will get affected as follows:

(i) Total number of Trees affected: 538
(ii) Decrease in CO_2 absorption due to loss of 538 trees (@ 20 kg per tree per year): 10.76 tons/year
(iii) Decrease in Oxygen production due to tree loss of 538 trees (@ 110 kg per tree per year): 59.18 tons/year

418. The only significant long term ecological impact of the project will be due to the loss of the 538 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 5380 trees to replace the 538 trees that will need removal, as per the mandatory compensatory plantation rate of 1:10. There will be no net loss of biodiversty because of the project.

419. 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.

420. **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 Nagpur Municipal Corporation will be responsible for the conservation and management of the trees. It is found that about 538 trees are likely to be lost in the project under line and stations, hence 5380 trees are likely to be planted. Native plant species and miscellaneous indigenous tree species are recommended for plantation. For the Endangered species (Tectona Grandis), saplings of the same species will be planted in the 1:10 ratio. The saplings will be planted on government land pockets located along the project corridor. 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.

421. 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.

422. 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.

423. 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.

424. **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.

425. **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

426. The alignment does not pass through ecologically sensitive areas or KBA. Construction yards and waste disposal sites will not be located near sensitive areas.

427. **Impact.** The elevated project does not impede movement of terrestrial fauna; however, the elevated metro could intercept flight paths of birds.

428. **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 will be kept to the minimum and of frequencies and brightness which do not affect bird behaviour.

429. **Residual impact.** The impact of noise & vibration and lighting on birds will be accentuated by the height of elevated structure. Since there are no endangered species present the residual impact will be minimal negative.

430. **Impact Significance**

- Design and pre-construction stage – neutral
- Construction stage – minor negative
- Operation stage – neutral
- Residual Impact after Mitigation – minimal negative

10. Private Land and Buildings

431. **Impact:** The proposed project will require transfer of 3.53 ha government land and acquisition of 5.78 ha private land. These figures may be revised during actual construction activities, revision of detailed drawings, preparation of land plan and micro plan of impacts. It is foreseen that 98 PAPs (51 TH and 47 NTH) will be impacted.

432. **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 policy approved by GoM. Details are in the separate Social Impact Assessment (SIA) Report (Annexure-18).

433. **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.

434. **Impact Significance:**

- Design and pre-construction stage – moderate negative
- Construction stage – moderate negative
- Operation stage – neutral / positive
- Residual Impact after Mitigation – minimal negative

11. Public Property / Infrastructure / Utility Services

435. **Impact:** NMRP Phase II corridors are planned to run elevated majorly on the medians of existing roads. 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. 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 5-12**.

Table 5-12: Organizations Responsible for Utilities and Services

SN	Organization/ Department	Utility/Services
1	Maharashtra Public Works Department	Roads and bridges other than National Highways
2	Nagpur 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 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

436. 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 EMP 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.

437. 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.

438. In case of shifting of utilities and temporary traffic diversions, it might be necessary to temporarily use land outside of the construction zone.

439. **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 or span of viaduct, 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.

440. 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.

441. 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.

442. 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.

443. 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.

444. **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.

445. **Impact Significance:**

- Design and pre-construction stage – moderate negative
- Construction stage – moderate negative
- Operation stage – neutral
- Residual Impact after Mitigation – none

12. Aesthetics

446. **Impact.** In some of the proposed alignments, the metro is proposed as a second level above an elevated road which is planned as a separate project. The spans, columns and foundations of the metro viaduct and stations will be aligned with but structurally independent of the elevated road. As mentioned in project description, columns of metro and elevated road will be mutually independent resulting in average span of about half the typical metro span which means more columns and hindered sightlines. This will result in a large mass of concrete leading to significant distortion of aesthetics.

447. **Mitigation.** Sleek columns will be incorporated in the structural design as much as possible without compromising safety.

448. **Residual impact.** Notwithstanding the sleek structure, the visual impact of the elevated metro will be high and will be accentuated after any future infrastructure project is constructed. Since construction will take place in an urbanized area with a lot of concrete buildings already present the overall residual impact will be moderate negative. However, in cases where residential buildings are near the alignment the residual impact could be high negative.

449. **Impact Significance:**

- Design and pre-construction stage – moderate negative
- Construction stage – moderate negative
- Operation stage – neutral / positive
- Residual Impact after Mitigation – moderate to high negative

13. Occupational Health and Safety

450. **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.

451. It is estimated that about 1500 persons will work during peak construction activity on site and casting yards. Estimated total population in the labour camps will be 5000. 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.

452. The following elements impact worker safety – working at heights, excavations,

electrical and mechanical; gases, machinery; equipment; blasting; formwork; piling; PPE; medical facilities; firefighting; housekeeping; segment launching; batching plant; transport; security; explosives; general safety.

453. 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.

454. 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 upto 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.

455. **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 NMRP Phase II project. 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 NMRP Phase II 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.

456. SHE Manual, comprising the above-mentioned sections, as mandated by Maha Metro for elevated construction are placed in **Annexure-12** to this EIA-EMP report. Compliance with sections i) and ii) is mandatory, section iii) is intended to provide guidance to the contractor. 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 corridor.

457. 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, NMC and Public Health Officer. 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.

458. 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.

459. 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.

460. 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.

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

462. 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.

463. 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.

464. 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.

465. 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.

466. 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.

467. **Residual impact:** Even with SHE manuals and procedures in place the risk of workplace accidents during construction, risk of accidents due to failure in operating systems and security and risk of exposure to electromagnetic radiation will be a continuing feature, however proven technologies will ensure that the residual impact is minimal negative. During operation safety risks can be mitigated to a large extent through proper equipment, PPE's, procedures and education, however a chance remains the procedures may not always be followed in full. Therefore, a moderate negative residual impact remains.

468. **Impact Significance**

- Design and pre-construction stage – moderate negative
- Construction stage – moderate negative
- Operation stage – neutral
- Residual Impact after Mitigation – moderate negative

14. Physical Cultural Resources (PCR)

469. No known protected archaeological monuments / sites or heritage assets are located on the project corridor.

470. **Impact**. Seven resources of educational and medical nature are located within 100m from the alignment and are listed as Sensitive Receptors.
Since the project involves piling for piers there are possibilities that artefacts are encountered during construction.

471. **Mitigation.** The physical cultural resources located within the screening distance (100m) for noise and screening distance (62m) for vibration will form part of the detailed noise and vibration analysis.

472. The project will implement, where required, chance finds procedure contained in ESS8 of WBG ESF, Policy Principle No. 11 of ADB SPS 2009 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.

473. 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.

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

475. 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.

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

477. **Residual impact.** Since no PCRs are located within the project's direct zone of impact no residual impact is expected.

478. **Impact Significance:**

- Design and pre-construction stage – neutral
- Construction stage – minor negative
- Operation stage – neutral
- Residual Impact after Mitigation – none

15. Energy consumption

479. **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.

480. **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 post-construction by means of ground water recharge and recharge of groundwater aquifers by rainwater. The building will be designed to incorporate low ODP materials, indoor air quality and comfort, low-VOC paints and adhesives, reduced landscape water demand, sustainable building materials and renewable energy utilization etc.

481. **Impact Significance:**

- Design and pre-construction stage – neutral
- Construction stage – moderate negative
- Operation stage – neutral / positive
- Residual Impact after Mitigation – minimal negative

482. Construction of metro project in a city like Nagpur 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 Nagpur 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

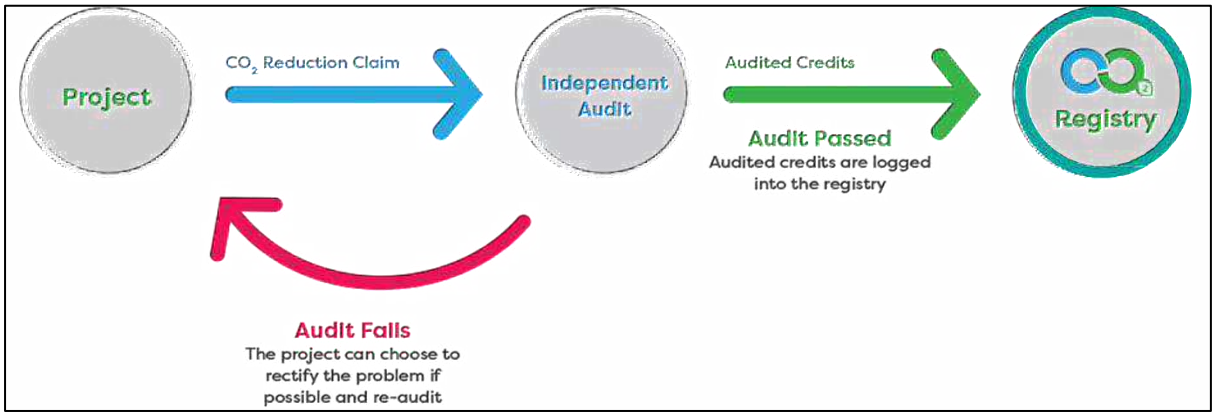
costs, savings in travel time, improvement in safety and quality of life and reduction in loss of productivity due to health disorders resulting from pollution;

F. CARBON CREDIT STUDY

1. What is Carbon Credit?

483. 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 5-2** below.

Figure 5-2: Process of Registering Carbon Credits



2. How it Works?

484. 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.

485. 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.

486. 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 5-3**. Types of Carbon Credit Markets are shown in **Figure 5-4**.

Figure 5-3: How Carbon Markets work

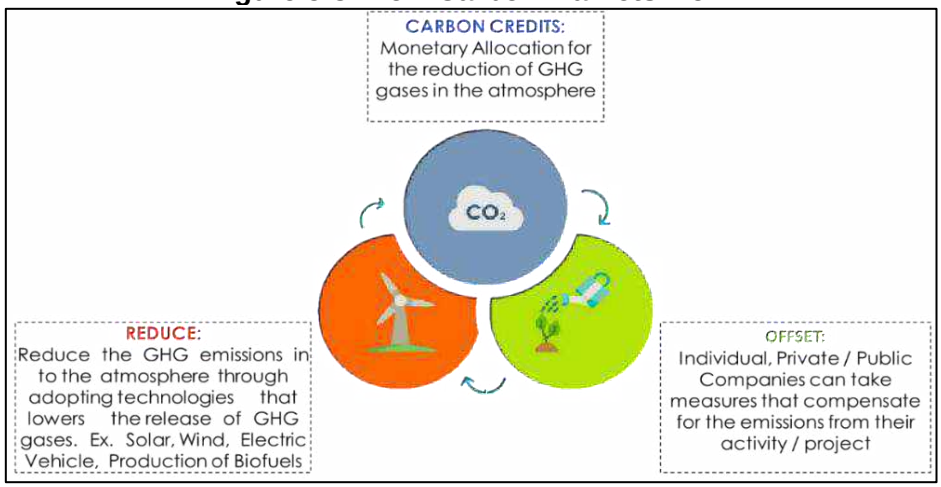
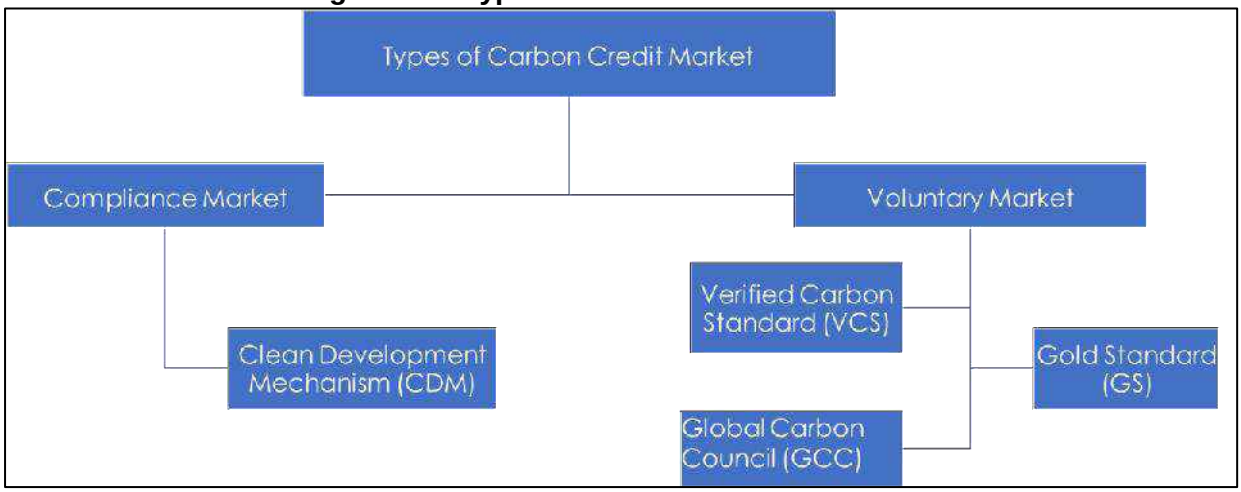


Figure 5-4: Types of Carbon Credit Markets



487. 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 5-13** below.

Table 5-13: 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 decided 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. Estimation of Carbon Credits for NMRP Phase II corridors

488. As per the DPR (Nov. 2019) daily ridership of Nagpur Metro (after construction of both Phase I and Phase II corridors) is presented in **Table 5-14**.

Table 5-14: Daily Ridership for NMRP project (Phase I + Phase II)

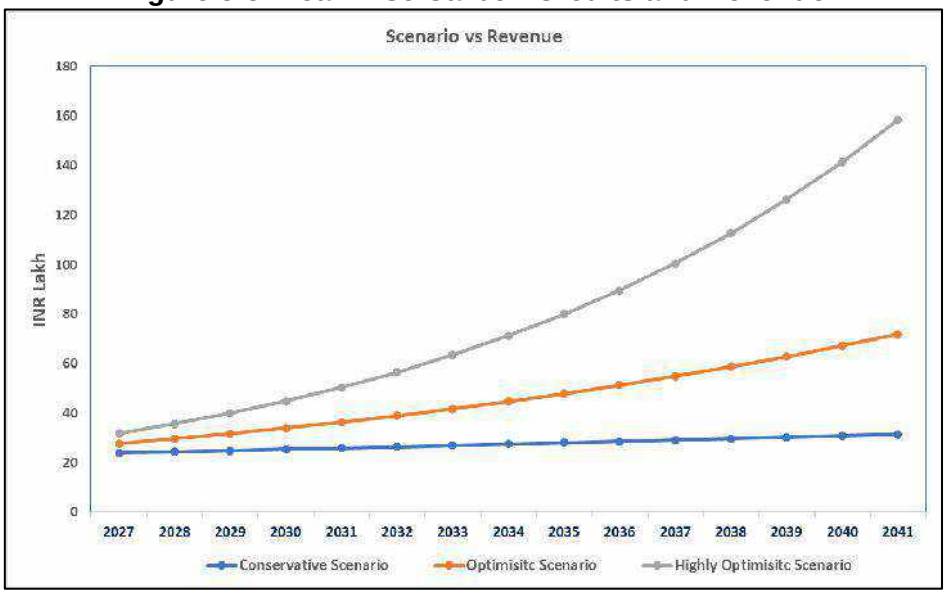
Corridor	Daily Ridership (Lakh Passengers)	
	2031	2041
Kanhan-MIHAN (NS corridor)	2.98	3.69
Transport Ngr –Hingna (EW Corridor)	2.96	3.58
Total Ridership	**5.94**	**7.27**

489. One Carbon Credit equals one ton of reduced GHG emissions expressed in tons of CO2 equivalent (tCO2eq). Total Carbon Credits generated during operation Phase of NMRP Phase II for two horizon years are summarized in **Table 5-15** below. Year-wise Carbon credits and estimated revenue generated in different scenarios for NMRP Phase II project is graphically represented in **Figure 5-5**.

Table 5-15: Details for calculation of Carbon Credits

Year	2031	2041
Ridership (Lakh/year)	5.94	7.27
tCO2eq (Carbon Credits generated) [75]	20981	25471
tCO2eq/Rider/year	0.0353	0.0350
Average Distance Travelled by Metro (km per day)	16844	20615
tCO2eq/km/day	1.246	1.236

Figure 5-5: Year-wise Carbon Credits and Revenue



[75] Source: Nagpur Metro Rail Project Phase II (NMRP-P2) Detailed Project Report (DPR), November 2019. The DPR states that system-level generation of CO_2 from generation of grid electricity which powers Metro is not included.

VI. ANALYSIS OF ALTERNATIVES

A. PROJECT PURPOSE

490. Urbanization and rapid growth of vehicles population has laid severe stress on the urban transport system in Nagpur. Increase in vehicular traffic and limited augmentation road infrastructure facilities have been observed in the city. Private modes have gained more usage due to limited public transport facilities with poor level of service.

491. In addition to the existing public transport and Nagpur metro Phase-I, the Government of Maharashtra through Maharashtra Metro Rail Corporation have decided to introduce efficient, safe and high-capacity public transport system for Phase-II corridors.

B. PUBLIC TRANSPORT PLAN IN CMP

492. The Comprehensive Mobility Plan (CMP) considers bus rationalization, bus augmentation and Mass Rapid Transit System (MRTS) for Nagpur city. Multi Modal Hub are also proposed in CMP. Apart from physical integration fare integration, information integration is also proposed. Intelligent Transport System is considered for Nagpur city including AFCs, Validators, Electronic Ticket Machines, Security Access Modules etc. High and medium capacity public transport systems have also been conceived in CMP. A total of about 110 km of rail based public transport network in 2 phases have been proposed.

1. Options of Mass Transport Systems

493. Mass transport systems in cities / urban agglomerations can be broadly classified into the following 6 categories:

(i) **Normal Bus System:** Normal/ordinary bus system is the main public transport system in many major Indian cities. They are normally characterised by sharing the common Right of Way with other modes of transport in the city.

(ii) **Bus Rapid Transit System (BRTS):** BRTS are physically demarcated bus lanes along the main carriageway with a segregated corridor for movement only for buses. At the intersections, buses may be given priority over other modes through a signalling system. Elevated BRTS is preferred system to have higher capacity in terms of peak hour peak directional traffic.

(iii) **Light Rail Transit System (LRT):** LRT is at-grade/grade separated rail-based mass transit system, which is generally segregated from the main carriageway.

(iv) **Metro Rail System:** Metro rail is a fully segregated rail-based mass transit system, which could be at grade, elevated or underground. Due to its physical segregation and system technology, metro rail can have a very high passenger carrying capacity of 40,000 – 80,000 peak hour peak directional traffic (PHPDT). Metro rail, though being capital intensive, provides the much-needed high capacity rapid transit in cities. They should be planned and executed with a longer future perspective. Being a high-capacity transport system, they are suited for growing cities having prospective increase in population over several years.

(v) **Regional Rail:** Regional rail caters to passenger services within a larger urban agglomerate or metropolitan area connecting the outskirts to the centre of the city. Regional rail systems (suburban rail) are common in large metropolitan cities and help in decongesting the city centre by providing safe, and speedy access to the city centre for commuters residing in less congested suburbs.

2. Selection of alignment and stations in CMP

494. Comprehensive Mobility Plan for Nagpur has been prepared in 2013 and updated in 2018 (nitnagpur.org). Comprehensive Mobility Plan has been prepared for a planning period of 15 years with a vision for transport in Nagpur to ensure that the city has a planned, best

performing transport systems to address the needs and concerns of the City. The objectives of CMP is to develop specific actions in form of short, medium and long term improvement proposals that will achieve the transportation vision for the area. The ultimate objective of the CMP is to provide a long-term strategy for the desirable mobility pattern of the city"s populace. To achieve this, the following are the main objectives:

(i) To provide a long-term vision(s) and goals for desirable urban development in Nagpur
(ii) To illustrate a basic plan for urban development and include a list of proposed urban land use and transport measures to be implemented within a time span of 20 years or more; and
(iii) To ensure that the most appropriate, sustainable and cost-effective implementation program is undertaken in the urban transport sector.

(a) CMP Vision Statement:

495. The mobility plan seeks to “move people, not vehicles”. The CMP vision for transport in Nagpur ensures that the city will have a planned, best performing transport system(s) that addresses the needs and concerns of the city. 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 Nagpur 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.
   Goal 3: 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.

496. 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.

497. The CMP observes that the city clearly indicates the radial road network development. Majority of these corridors are either state or national highways and are important mobility corridors of Nagpur. These corridors will act as mobility corridors in the city. This radial network is designated as the structure for mobility corridors, as illustrated in **Figure 6-1**.

Figure 6-1: Mobility Corridors in Nagpur

498. An urban transport model to replicate the “Nagpur Metropolitan Area” transportation system (roads, congestion delays, transit system, etc.) has been developed with a state-of-the-art software and modelling technology. This model can be used for forecasting, using altered model inputs to reflect future year conditions. Considered scenarios are:

(i) Do Nothing – Without Any Development
(ii) Do Something – Considering Sanctioned Projects
(iii) Do Everything – Sustainable Urban Transport

499. The Transport Demand modelling has shown that in the “do nothing” scenario, average congestion will increase form a V/C ratio of 0.57 in 2012 to a ratio of 0.96 in 2032 (V/C ratio greater than 0.85 indicates congestion). The average network speed will decrease from 27 kmph in 2012 to 19 km/h in 2032. In the “Do Minimum (Do Something)” scenario these numbers are slightly better with an average speed of 23 km/h in 2032, but still unfavourable. The “Do Everything” Sustainable Urban Transport scenario, on the other hand, indicates increase in speed due to decrease in traffic congestion.

500. Based on the PPHPD (Passengers per Hour per Direction) values estimated from the transport model, Kamptee Road, CA Road, Wardha Road and Hingna Road (i.e. around 43.8 km, as proposed in the Project) are recommended for higher order rail-based mass transit system. The remaining mobility corridors are recommended for developing a BRT (Bus Rapid Transit) network (102.5 km) which will support the Metro Rail corridors as a feeder service.

501. Based on the above the CMP proposes the mass transit corridors as depicted in **Figure 6-2**. The LRT corridors in Nagpur, broadly correspond with the proposed NMRP Phase II extension corridors.

Figure 6-2: Proposed mass transit corridors in Nagpur

502. Since these corridors are “fast growing” in terms of population, it is justifiable to give priority to the development and extension of existing corridors of Nagpur Metro. The CMP anticipates that the proposed plans will help to achieve sustainable development goals by means of reducing private mode share, emission levels and travel time. Anticipated impacts of the proposed mass rapid transit projects are segregated into social and environmental impacts. The main impacts considered are:

(i) Land acquisition / Right of Way;
(ii) Rehabilitation and resettlement;
(iii) Improved mobility and reduction in travel time
(iv) Increase in air pollution, noise, traffic congestion during construction phase;
(v) Improved air quality and reduction of GHG emission during operational phase.

503. RITES Ltd. has prepared an ‘Alternatives Analysis Report for Mass Transit System” in addition to the existing public transport and Nagpur Metro Phase-I. Alternatives analysis is about finding best alternative to address the transportation related problems for specific corridors or areas of a city. Detailed appraisal guidelines for mass transport project proposals have been laid down by Ministry of Housing and Urban Affairs (MoHUA), Government of India in September 2017 and Alternative Analysis Report has been prepared adhering to these guidelines.

504. In the Alternatives Analysis Report for Nagpur Metro Rail Phase II Corridors (July 2018), a comparison has been made between different modes of transport for the corridors. Subsequent section presents the screening parameters and qualitative & quantitative analyses of options for the mass transport system. Alternatives Analysis is required to identify the best option among alternative transport modes to address the traffic related problems in the city. Identification and implementation of most feasible transport system would alleviate the existing transportation woes.

C. SCREENING CRITERIA FOR IDENTIFIED ALTERNATIVES

1. Goals & Objectives

505. The basic goals and objectives have been identified to establish the screening criteria that satisfy the project purpose and need. Screening of alternatives modes has been done to shortlist most viable alternatives for following proposed Phase-2 corridors in the Study Area:

(i) MIHAN to MIDC ESR (18.5 km)
(ii) Automotive Square to Kanhan River (13 km)
(iii) Lokmanya Nagar to Hingna (6.7 km)
(iv) Prajapati Nagar to Transport Nagar (5.6 km)

506. NMRP Phase II is an extension of the Phase I corridors in all directions. Hence there is no choice for selection of other alignment alternatives.

507. 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.

508. 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 6-1**.

Table 6-1: 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**

509. 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%)

510. The overall weightages assigned to various parameters for qualitative evaluation have been summarised in **Table 6-2**.

Table 6-2: Scoring Criteria For Qualitative Evaluation

SI	Criterion	Objectives	Weightage
1	Mobility Effects	• Serve the maximum peak travel demand • Minimize congestion and reduce reliance on automobile • Provide convenient accessibility and improve interchange facilities • Increase public transportation ridership and mode share • Provide higher modal utilisation	20
2	Conceptual Civil Engineering Effect	• Utilisation of available of existing right of way • Suitability of Geometric parameters • Assess constructability of alternative mode • Possible extent of land acquisition considering right of way, civil structures and stations	15
3	System Effects	• Provide better safety and comfort • Ability to carry more passengers • Indigenous availability of rolling stock	10
4	Environmental Effects	• Preserve the natural environment • Reduce pollution from shifting of vehicles from private to public modes of transport • Protect and enhance cultural heritage, landmarks and archaeological monuments	15
5	Social Effects	• Impact on existing structures and families	5
6	Cost Effectiveness & Affordability	• Provide quality, affordable public transport service with an optimum investment cost • Consumption of minimum possible maintenance costs	15
7	Financial and Economic Effects	• Provision of a public transport system that would be longstanding and has a higher life cycle cost • Provision of economic friendly transport system with higher economic benefits to the society	15
8	Approvals and Implementation	• Time taken for approval of system • Ease of implementing the proposed and approved system	5

SI	Criterion	Objectives	Weightage
		Total	**100**

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. Metro among rail-based systems have higher carrying capacity and offer higher economic returns than all other systems.

(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.

(b) Screening Results:

511. The summary of analysis of various modes for the given qualitative screening parameters is presented in **Table 6-3**.

Table 6-3: Qualitative Screening - Scoring of Parameters

Screening Parameter	Description	Total Score	Metro Rail	LRT	Elevated BRT	Normal Bus System
Mobility Effects	Ability to cater Travel Demand - Max. PHPDT	6	**6**	4.5	3	1.5
	Ease of Passenger Transfer at Terminals	4	**4**	2	2	1
	Daily System Utilisation-PKM/Route KM	4	**4**	3	2	1
	Average Trip Time	3	**3**	3	2.25	1.5
	Catchment Area Connectivity and Circulation	3	**3**	3	3	3
	Total	**20**	**20**	**15.5**	**12.25**	**8**
Conceptual Civil Engineering Effect	Available Right of Way (Land Acquisition)	4	**3**	3	3	4
	Alignment Design and Constructability	3	**1.5**	1.5	2.25	3
	Geotechnical Characteristics and Civil Structures	3	**1.5**	1.5	1.5	3
	Station Planning and Intermodal Integration	3	**3**	3	3	2.25
	Requirement for Utility Shifting	2	**1**	1	1.5	2
	Total	**15**	**10**	**10**	**11.25**	**14.25**
System Effects	Interoperability with Phase-1 System	4	**4**	2	1	1
	Rolling Stock Requirement	2	**2**	2	1	0.5
	Land for Maintenance Depot	2	**2**	2	2	0.5
	Indigenous Availability	2	**2**	1	2	2
	Total	**10**	**10**	**7**	**6**	**4**
Environmental Effects	Air Pollution	6	**6**	6	3	1.5
	Noise Pollution	4	**4**	4	2	1
	Trees affected	3	**1.5**	1.5	2.25	3
	Waste management	2	**2**	2	2	0.5
	Total	**15**	**13.5**	**13.5**	**9.25**	6
Social Effects	Structures/Persons Affected	5	**2.5**	3.75	3.75	5
	Total	**5**	**2.5**	**3.75**	**3.75**	**5**
Cost Effectiveness & Affordability	Capital Cost (per Passenger KM)	10	**5**	5	7.5	10
	Operation & Maintenance Cost (per Passenger KM)	5	**2.5**	2.5	3.75	5
	Total	**15**	**7.5**	**7.5**	**11.25**	**15**

Screening Parameter	Description	Total Score	Metro Rail	LRT	Elevated BRT	Normal Bus System
Financial and Economic Effects	Economic Returns	10	**10**	7.5	7.5	5
	Life Cycle Cost	5	**5**	5	3.75	1.25
	Total	**15**	**15**	**12.5**	**11.25**	**6.25**
Approvals & Implementation	Time Required for Approvals	3	**1.5**	0.75	2.25	3
	Ease of Implementation	2	**1.5**	0.5	1.5	2
	Total	**5**	**3**	**1.25**	**3.75**	**5**
Grand Total		**100**	**81.5**	**71.0**	**68.75**	**63.5**

512. From the screening and analysis of qualitative parameters for different alternative modes in Nagpur, it is inferred that Metro and LRT score 81.50 and 71.0 respectively on a scale of 100. The other bus-based modes elevated BRT and Normal Bus System score 68.75 and 63.5 respectively. Considering this, Metro, LRT and Elevated BRT (scores being very close to LRT) have qualified for qualitative evaluation stage.

3. Quantitative Evaluation of Alternatives

513. The relative influence of each of screening parameters for qualitative evaluation with respect to each alternative mode has been considered while assigning score to the parameters. The result of this qualitative evaluation will narrow down the alternatives from the identified modes for further quantitative evaluation of the mass transport modes.

(i) Basis of Scoring the Screening Parameters for Quantitative Evaluation:

514. **Mobility Effects:** The factors contributing to mobility effects considering the local conditions which have been quantified include max. PHPDT, ease of passenger transfer at terminals, passenger utilization in terms of passenger-km/ km and betterment of environment with reduced number of vehicles on road due to proposed mass transit system. The number of commuters travelling in the peak direction in peak hour will be most important guiding factor. Metro will have a 3-car arrangement (as per minimum permissible system motorisation of 67% as recommended by Metro Rail Policy 2017 and configuration adopted in Nagpur Metro Phase 1). While LRT is considered to have a 2-car arrangement as this configuration will satisfy the maximum PHPDTs up to various horizon years. Thus, on basis of car configuration, LRT caters to a maximum PHPDT of 12,500 while BRT around 8,000. Metro Rail, on the other hand, will be catering to maximum PHPDT of 23,000 PHPDT with a 3-car arrangement. However, it is observed that BRT will be saturated since the beginning from 2024. While Metro and LRT will cater to same number of maximum passengers in peak hour up to the year 2047. Beyond 2047, maximum PHPDT of LRT will get saturated at 12500 and Metro will be able to further cater to peak travel demand till 2051 and beyond. The utilisation of a system can be established by number of passengers travelling on the specified route length. This ratio of passenger-km over the total transit route length will provide the utilisation of the proposed system. The utilisation in terms of PKM/Km ratios are compared and provided in below **Table 6-4**.

Table 6-4: Daily System Utilisation (PKM/Km, In Rs. Lakh)

System Network / Year	2024	2031	2041	2044	2047	2051
Phase 1 Metro + Phase 2 Metro	0.63	0.74	0.89	0.94	1.00	1.08
Phase 1 Metro + Phase 2 LRT	0.63	0.74	0.89	0.94	1.00	1.00
Phase 1 Metro + Phase 2 BRT	0.63	0.74	0.89	0.94	0.94	0.94

515. The PKM/KM has been estimated till 2041 and further projected upto 2051. It is observed from the table above that Metro provides better utilisation in the longer perspective whereas BRT and LRT get saturated in year 2044 and 2047 respectively. Considering the fact that a mass transport system has to serve the city for long period of time, Metro system

appears to be more serviceable mode of transport for Nagpur with the long-term perspective as compared with LRT & BRT. The 'With & Without Project Scenario' is compared for mass transport systems. The mode-wise passenger trips for the horizon years have been worked out and shown in **Table 6-5.**

Table 6-5: Mode-Wise Trips in 'With & Without' Project Scenarios

Mode	Trips without Phase 2 MRTS Extension (Lakh)				Trips with Phase 2 MRTS Extension (Lakh)				Daily Trips Reduced on Roads due to Phase 2 MRTS (in Lakh)			
	2024	2031	2041	2051	2024	2031	2041	2051	2024	2031	2041	2051
Car	4.8	5.7	7.0	8.7	4.6	5.4	6.7	8.2	0.2	0.2	0.3	0.4
2-W	32.7	37.7	43.5	50.2	31.6	36.5	42.0	48.4	1.1	1.2	1.5	1.8
Auto	5.4	6.4	9.1	13.0	5.3	6.3	8.9	12.6	0.1	0.2	0.2	0.3
S. Auto	2.0	2.8	3.9	5.3	1.5	2.2	3.1	4.2	0.4	0.6	0.8	1.1
Bus	4.8	5.3	5.8	6.4	3.8	4.1	4.6	5.1	1.1	1.2	1.2	1.3
MRTS	2.6	2.9	3.7	4.6	5.5	6.3	7.8	9.5	2.9	3.4	4.1	4.9
Total	**52.3**	**60.9**	**73.0**	**88.1**	**52.3**	**60.9**	**73.0**	**88.1**	**-**	**-**	**-**	**-**

516. Considering the fact that a mass transport system has to serve the city for long period of time, Metro system appears to be more serviceable mode of transport for Nagpur with the long-term perspective. The introduction of mass rapid transit system in the Study Area will help in reducing vehicular traffic on the road thereby contributing to relieving traffic congestion along proposed corridors, reduction in accidents and larger environmental savings.

517. Metro Rail system score high as it offers higher carrying capacity and high frequency of regulated services, better utilization in terms of more passenger-km and higher convenience in ease of passenger transfers than BRT and LRT due to continuity in existing system as Phase-2. Accordingly, Metro, LRT and BRT have been assigned 20.0, 15.0 and 7.25 on a scale of 20.0 based on mobility related performance.

(i) **Conceptual Civil Engineering Effects:** Civil engineering effects have been analysed for three alternative modes of Metro, LRT and BRT.

(ii) **Geometric Parameters:** Under operation Phase-I metro project is of conventional metro system. Phase-II is basically and extension of Phase-I and therefore same geometric system as placed before has been adopted.

(iii) **Design Speed:** Design speed of the Phase-I operational metro is 80 km/hr, hence same has been recommended for phase-II also. LRT & Metro have good average speed of 25-55 km/h as compared to BRT.

(iv) **Station Planning:** Stations are planned at the centre of road median. Land for station building i.e. entry/exit is planned to be acquired from private / Government bodies. Rail based systems are more efficient in station planning and intermodal integration opportunities. Land requirement for Metro & LRT is almost same while large parcel of land is required for depot of BRT.

(v) **Environmental Effects:** Environment savings will be same for all three modes till 2044 when BRT gets saturated. LRT will reach its capacity in 2047 after which Metro will continue to provide savings. It has been estimated that metro rail results in more air pollution savings, as BRT and LRT get saturated in 2044 and 2047 respectively, as shown in **Table 6-6** below.

Table 6-6: Pollution Reduction (Tons/Year)

	Metro of LRT or Elevated BRT				Metro of LRT	Metro
Pollutant	**2024**	**2031**	**2041**	**2044**	**2047**	**2051**
Carbon Monoxide (CO)	490.07	579.50	724.11	774.71	829.13	908.15

Pollutant	Metro of LRT or Elevated BRT				Metro of LRT	Metro
	2024	2031	2041	2044	2047	2051
Hydro-Carbons (HC)	197.68	233.50	289.01	310.56	331.83	362.56
Nitrogen Oxide (NO_X)	138.32	156.42	181.16	191.38	200.78	214.22
Particulate Matter (PM)	17.43	20.48	25.03	26.92	28.70	31.28
Carbon Dioxide (CO_2)	20506.09	23679.82	27238.50	30621.24	32567.81	35403.67

518. Typical noise level due to rapid rail transit on viaduct at speed 50 mph and distance 50 feet from tracks is 85 dBA; respective value for at grade is 80 dBA. Typical ground borne vibration (GBV) level due to rapid transit (Metro) is 70VdB. Typical noise from at grade LRT at 50 mph at distance of 100 feet from track is 78 dBA; typical GBV for normal LRT track is 68 VdB. Noise levels commuting by bus 82 dBA. Typical vibration level due to bus or truck is 65 VdB at 50 feet distance. Considering the poorer pavement condition level in Indian cities is likely to be higher.

519. The noise and vibration due to Metro / LRT and BRT are in the same order of magnitude. The higher number of vehicle trips operated in normal bus system and BRT vis a vis Metro and LRT will result in cumulative noise and vibration; maintenance of Metro/LRT can be controlled better than on road and bus. Therefore, BRT/normal buses are likely to result in higher impact than Metro/LRT.

520. The parameters considered are air & noise pollution. Rail based systems have been assigned better scores more than bus-based systems considering their ability to reduce pollution levels on the roads. Metro Rail, LRT being electrified systems play an important role in minimizing the air and noise pollution levels in the city. Accordingly, Metro rail score a maximum of 15.0, followed by LRT systems and Elevated BRT with 12.5 and 7.5 respectively in environmental effects on a scale of 15.

521. **Social effects.** Social impact has been compared in terms of structures located in impact zone along the priority mass transport corridors. Among Metro, LRT consumes least possible right of way for land acquisition.

(i) Cost Effectiveness and Affordability:

(a) **Capital Cost -** Preliminary Cost estimate for Metro, LRT and elevated BRT systems has been prepared at February 2018 price level. Total Cost including Taxes & Duties for Metro, LRT & elevated BRT are Rs. 9163.35 crore, Rs. 9514.95 crore & Rs. 5505.71 crore respectively. Rail based systems incur high capital cost whereas bus system requires comparatively less investment costs.

(b) **Operational & Maintenance Costs -** BRT is more affordable than rail-based systems due to lower capital and O&M costs per passenger km and accordingly is assigned higher scores than metro and light rail systems. Rail based systems like Metro rail and LRT consume more O&M costs as they are planned for a much higher operational period.

522. **Financial and economic effects.** Metro scores higher than LRT considering life cycle costs and economic benefits. 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. Metro rail among rail-based systems cater more passengers and offer higher economic returns attributed to comparatively less rolling stock.

523. **Approvals and implementation.** Light Rail Transit system is new in India. With no previous experience in light rail technology in the country specifically in rolling stock design and O&M, the technical expertise will have to be developed afresh which may result in time delays in approval of LRT. As there are set standards and procedures for Metro Rail and BRT, these two modes will relatively consume less time for approvals than LRT.

524. The summary of scoring for Metro, LRT and elevated BRT based on the quantitative evaluation is presented in **Table 6-7**. From the quantitative evaluation of parameters for Metro, LRT and elevated BRT Systems, it can be inferred that Metro System with a score of 87.5 scores higher than LRT and elevated BRT which score 71.0 and 67.50 respectively. The Metro System henceforth emerges to be the most viable mass transit mode for Phase 2 corridors of Nagpur Mass Transport System.

Table 6-7: Quantitative Evaluation - Scoring Of Parameters

Screening Parameter	Description	Total Score	Metro Rail	LRT	Elevated BRT
Mobility Effects	Ability to cater Travel Demand - Max. PHPDT	6	6	4.5	3
	Ease of Passenger Transfer at Terminals	6	6	4.5	1.5
	Daily System Utilisation-PKM/Route KM	5	5	3.75	1.25
	Reduced Vehicles on road due to proposed system	3	3	2.75	1.50
	Total	**20**	**20**	**15.0**	**7.25**
Conceptual Civil Engineering Effect	Available Right of Way (Land Acquisition)	4	3	4	2
	Alignment Design and Constructability	3	2.25	1.5	3
	Geotechnical Characteristics and Civil Structures	3	3	3	3
	Station Planning and Intermodal Integration	3	3	2.25	1.5
	Requirement for Utility Shifting	2	2	2	2
	Total	**15**	**13.75**	**12.75**	**11.50**
System Effects	Interoperability with Phase-1 System	4	4	3	1
	Rolling Stock Requirement	2	2	2	1
	Land for Maintenance Depot	2	2	1	1
	Indigenous Availability	2	2	1	2
	Total	**10**	**10**	**7**	**5**
Environmental Effects	Air Pollution	10	10	7.5	5
	Noise Pollution	5	5	5	2.5
	Total	**15**	**15**	**1.50**	**7.50**
Social Effects	Structures/Persons Affected	5	3.75	5	3.75
	Total	**5**	**3.75**	**5**	**3.75**
Cost Effectiveness & Affordability	Capital Cost (per Passenger KM)	10	5	5	10
	Operation & Maintenance Cost (per Passenger KM)	5	3.75	2.5	5
	Total	**15**	**8.75**	**7.50**	**15**
Financial and	Economic Returns	10	7.5	5	10

Screening Parameter	Description	Total Score	Metro Rail	LRT	Elevated BRT
Economic Effects	Life Cycle Cost	5	5	5	2.50
	Total	**15**	**12.50**	**10**	**12.50**
Approvals & Implementation	Time Required for Approvals	3	2.25	0.75	3
	Ease of Implementation	2	1.5	0.5	2
	Total	**5**	**3.75**	**1.25**	**5**
	Grand Total	**100**	**87.50**	**71.0**	**67.50**

525. Based on both qualitative and quantitative screening carried out in previous sections, Metro Rail System has emerged as the most viable alternative mass transport system to meet the transport needs of Nagpur city along Phase 2 corridors.

526. The assessment of the environmental and social impacts of the alternative modes of transport are summarised below **Table 6-8**.

Table 6-8: Summary of Environmental & Social Impacts - Assessment of Alternatives

Impacts	Metro	LRT	BRTS
Impact due to Project Design	**Lowest (Land acquisition is least)**	Lowest (Land acquisition is least)	Highest
Impact on air quality	**Significant Negative impacts during construction.**	Significant Negative impacts during construction.	Significant Negative impacts during operation.
Impact on Noise levels	**Negative impacts during construction only.**	Negative impacts during construction only.	Negative impacts during operation & maintenance
Impact due to waste disposal	**Negative impacts during construction only.**	Negative impacts during construction only.	Negative impacts during construction only.
Impact due to Vibration	**Negative impacts during construction only.**	Negative impacts during construction only.	Negative impacts during construction only.
Impact on water resources and land	**Less impact on land & water**	Less impact on land & water	Medium impact on land & water

4. Alignment Alternatives

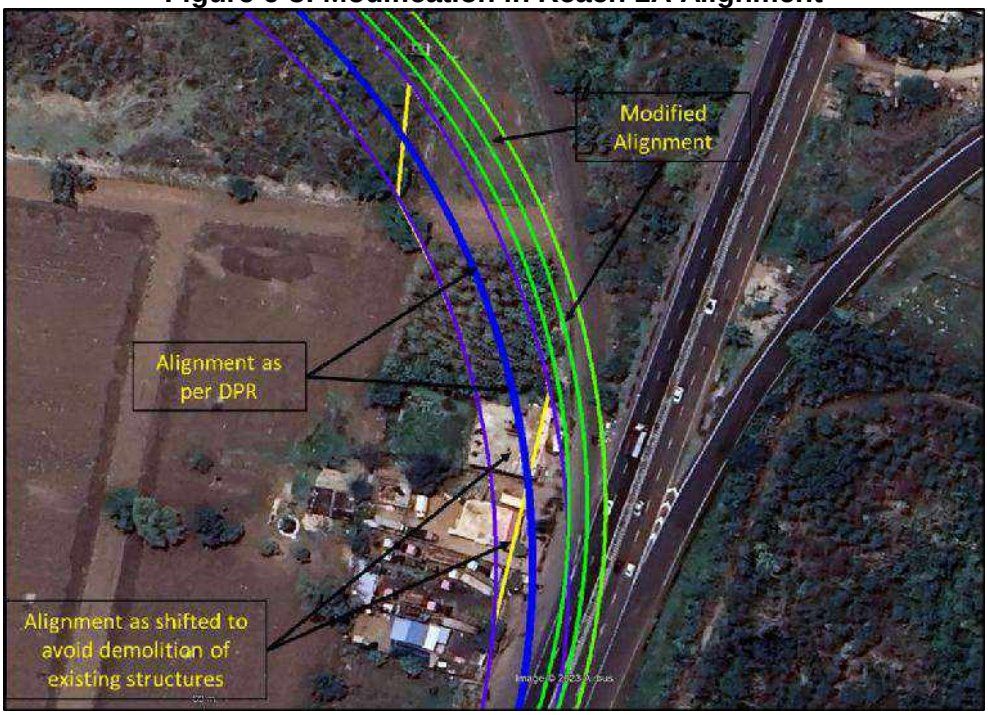
527. Alignment alternatives other than the proposed alignments are not feasible as the NMRP Phase II corridors are a mere extension of the Phase I metro corridors. Hence the proposed extension corridors need to be constructed as continuation of the Phase I metro lines. Also, construction of both viaduct structures and metro stations requires large areas of land. There is no land available to accommodate the viaduct structures and metro stations, except the available space along the medians of existing roads, which have sufficient width / RoW.

528. However, based on environmental baseline surveys and socio-economic surveys undertaken along the NMRP Phase II corridors, certain changes have been made to the alignments from those proposed in the DPR (November 2019). Some of the locations where such changes have been incorporated in the project design are described below:

(i) Reach 1A:

529. Near Ashokwan station the alignment has been shifted to avoid some dwellings / kiosks as illustrated in **Figure 6-3**.

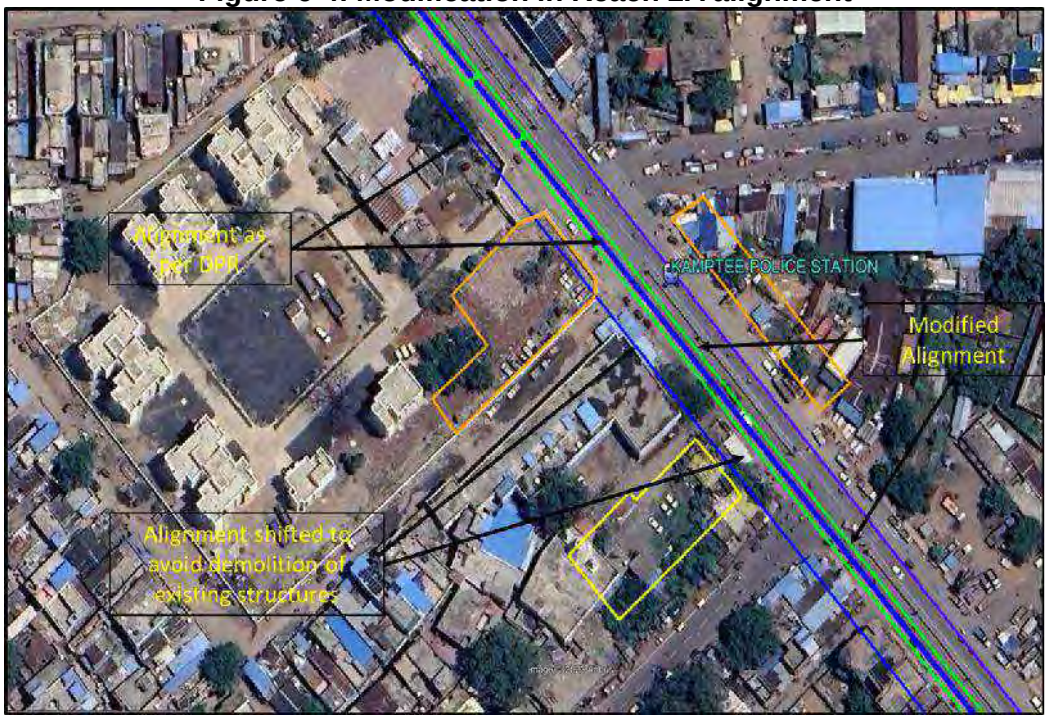
Figure 6-3: Modification in Reach 1A Alignment



(ii) Reach 2A

530. Near Kamptee poilice station alignment has been shifted to avoid demolition of the Kamptee Municipal Council wall and some kiosks (stamp vendors) as shown in ***Figure 6-4***.

Figure 6-4: Modification in Reach 2A alignment

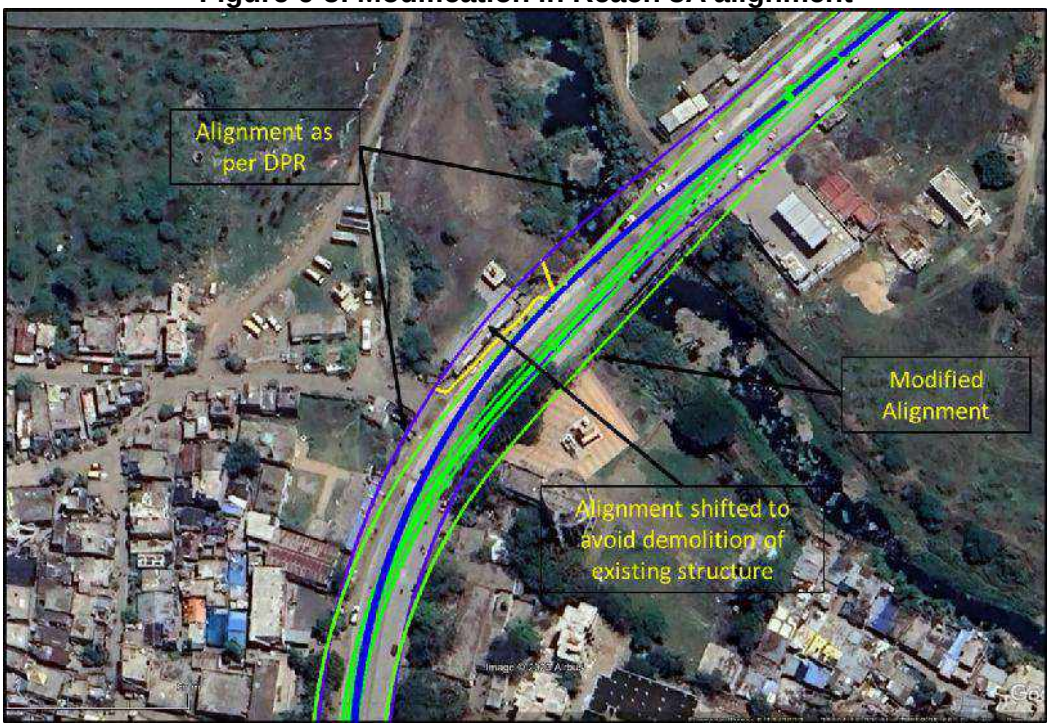


(iii) Reach 3A

531. In Reach 3A, the alignment is slightly shifted to avoid demolition of existing structures

as shown in ***Figure 6-5***.

Figure 6-5: Modification in Reach 3A alignment



D. CONCLUSIONS

(i) Qualitative evaluation of the available alternatives namely Normal Bus System, Elevated Bus Rapid Transit, Metro and Light Rail Transit have been carried out on the identified mass transport corridors for the alternative analysis report.

(ii) NMRP Phase II is an extension of the Phase I corridors in all directions. Hence there is no choice for selection of other alignment alternatives. However, some modifications have been made to the alignments to avoid obstruction / conflict with respect to environmental or social factors.

(iii) In the screening of qualitative parameters, Metro Rail, Light Rail Transit and Elevated BRT have emerged as prospective mass transport systems for Phase-2 corridors in Nagpur for further quantitative evaluations. Normal Bus has been ruled out in view of inability to meet the passenger demand in future and significant greenhouse gas emissions.

(iv) All three modes namely Metro (3 car train), LRT (2 car train) and BRT systems can cater to Peak Hour Peak Direction Passenger Trips (PHPDPT) up to the horizon year 2044. BRT and LRT Systems will get saturated in the years 2044 and 2047 respectively and no additional traffic can be catered by these two modes beyond 2047. However, Metro system will continue to cater the peak hour passenger demand much beyond 2047 attributed to its higher carrying capacity.

(v) With metro being constructed in Phase I, its technology as well as various components like track gauge, civil structures and rolling stock components are easily available and standardised in Nagpur. Efforts have also been made by Government and implementing agencies to indigenize various components of metro rail systems.

(vi) The inter-operability between proposed system in Phase II and the mass transit system already in place for Phase I is an important parameter. The introduction of same system can have better system efficiency, optimized use of system resources and enhanced passenger comfort at the terminal stations as well. Whereas, a different mode on the extension of existing corridors may require entirely new set of infrastructure facilities for operation and maintenance.

(vii) Based on detailed quantitative evaluations of screening parameters, Metro System has scored higher than that of LRT and Elevated BRT Systems.

(viii) Based on both qualitative and quantitative screening and analysis, Metro System has emerged as the most viable alternative of mass transport system for Phase II corridors in Nagpur.

VII. PUBLIC CONSULTATIONS AND INFORMATION DISCLOSURE

A. CONSULTATIONS

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

533. 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.

534. Public consultation/information is an integral part of the NMRP Phase II 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 were consulted to make them aware and identify adverse impacts of the project.

535. Public Consultations have been initiated right from planning stage and will continue till the completion of the Phase II project to ensure people's participation during the entire phase of the project. Aiming at promotion of public understanding and fruitful solutions of developmental and construction problems such as local needs and problems and prospects of resettlement, various sections of DPs/PAPs and other stakeholders were consulted through focus group discussions and individual interviews.

B. IDENTIFICATION OF STAKEHOLDERS

536. 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 Displaced Persons (DPs/PAPs),
(ii) Project beneficiaries, and
(iii) Implementing agency.

537. The secondary stakeholders include the revenue officials, village heads, gram panchayat offices, NGOs and business communities in the affected areas.

538. 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) Nagpur Municipal Corporation (NMC)
(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

C. SCOPE OF WORK

539. 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 Nagpur Metro Rail Project – Phase II alignments and minimization of impacts.
(ii) Understand the views of the community on land acquisition & compensation,
(iii) Identify the major socio-economic characteristics of the TH and NTH (Kiosk) 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 from Phase II project.
(vii) Establish an understanding for identification of overall Phase II metro transport goals and benefits of the project.

D. METHODOLOGY

540. 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 of the Social Impact Assessment (SIA) studies carried out for the project. Methodology used for the consultations, is given in **Table 7-1** below.

Table 7-1: 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.

541. As part of the EIA-EMP study, in order to enhance public understanding about the project and address the prior concerns of the community pertaining to mitigation of adverse impacts due to the Corridor, meetings with groups of persons in the community were conducted in April 2023 at proposed locations of stations along all four alignments. Public consultations were conducted by meeting the DPs/PAPs and other stakeholders as per the schedule plan and shared their views and opinions about the NMRP Phase II project. Total thirteen (13) public consultations were conducted for the project across all four reached, as mentioned in **Table 7-2** below.

Table 7-2: Reach-wise number of Public Consultations conducted

Sr. No.	Particulars of PC	Reach-wise number of Public Consultations held				Total no. of Participants
		R-1A	R-2A	R-3A	R-4A	
1	Public Consultation with local community	1	3	2	1	88
2	Consultation with Rickshaw drivers	0	2	0	1	37
3	Consultation with Traders	1	1	0	0	25
4	Consultation with Students	0	0	1	0	12
Total		**2**	**6**	**3**	**2**	**162**

542. Public consultations were done at 2 locations on 28th April 2023, in Reach 1A, one with local community and another with Gram panchayat office Dongargaon and traders in the area. On 11th & 12th April 2023, six consultations were held at the proposed stations of Pili Nadi, Khasara Fata, All India Radio, Khairi Fata, Lok Vihar & Lekha Nagar on Reach 2A (Automotive Square to Kanhan River). Two consultations were held at Pardi & Transport Nagar proposed stations in Reach 4A (Prajapati Nagar to Transport Nagar) on 10th April 2023. Similarly, two consultations were done at Hingna Bus stand & Raipur proposed stations on Reach 3A (Lokmanya nagar to Hingna), while one student consultation has been done near Raipur.

E. FINDINGS AND OUTCOMES

543. The DPs/PAPs and stakeholders have shown their satisfaction with the existing metro rail project Phase I. When they were informed about the proposed extension of the existing network, they have given a positive response. The DPs/PAPs said it is necessary to extend the metro line further because there are many hurdles to travel from outskirts of the city into Nagpur 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. Some of the issues raised by the participants in the public consultations are summarized in **Table 7-3**. Some photographs taken during the Socio-economic surveys undertaken in the Project study area are shown as

544. **Figure 7-1**.

Table 7-3: Summary of Public Consultations carried out for NMRP Phase II Project[76]

Sr. No	Location (Reach) & Date	Participants	Issue raised by Participants	Reply from Maha Metro
1	Dongargaon traders and Gram panchayat (R-1A) 28.04.2023	10	a) People were in favour of Phase II project, and they wanted to complete the project as early as possible. People demanded the alternative land for relocation of market.	a) The suggestion has been incorporated and this will circulate to the concerned office for further approval[77]. b) The necessary safety precaution will take

[76] A project road map was displayed at each consultation site. Alignment details with project benefits were first discussed. Information about this project was given through the concerned employees of Maha-Metro. The possible consequences and mitigation measures were then discussed in the meeting. Then the queries of the people related to the project were answered by the concerned staff.The complaint details including name, designation and contact number & e-mail ID will be displayed at each station location during project construction.Maha-Metro will try to complete the project as per the schedule time frame.

[77] This is one of the Common Property Resource (CPR) affected due to project. Maha-Metro with the help of local government authority will relocate the market to the nearby location. The stakeholders will be given advance information about the relocation. The issue is considered in RP.

			b) Peoples also concerned about arrangement of safety precaution during civil activity as they are located near station.	during the civil work.
2	MIDC Colony (R-1A) 28.04.2023	11	a) All the kiosk holders were concerned about alternative locations. b) People wanted to start the work early and complete within the time so that there will be no traffic conjunction closer of roads during civil work.	a) Provision will be kept in the RP for NTH (Kiosk). They will relocate in very nearby feasible location without affecting their livelihood. b) Suggestion noted
3	Pili Nadi, (R-2A) 11.04.2023	13	a) People were in favor of Phase II project, and they wanted project to be completed as early as possible. b) Some people were concerned about dust formation during civil work.	a) The Project will be completed as per the scheduled timeline. b) Necessary precaution will be taken by the NMRP to mitigate the environmental impact. Regular water sprinkling will be done during construction activities.
4	Khasara Fata, (R-2A) 11.04.2023 (traders)	15	a) Proper care of safety of people should be considered during execution of civil work. b) Compensation for the loss of land and structure should be paid more than market rate.	a) All types of safety measures will be adopted during the execution of the project. b) The compensation against loss property will be decided by the Committee under the chairmanship of Collector, Nagpur.
5	All India Radio, (R-2A) 12.04.2023	10	a) The participants wanted to know the actual rate of compensation against acquisition of land and loss of structures. b) People wanted basic amenities like wider roads during the construction of Project. c) Peoples are keen to know the date of commencement of work.	a) The compensation against loss property will be decided by the Committee under the chairmanship of Collector, Nagpur. b) Work will be executed, and it will be ensured that no traffic will be affected[78]. Also, for this purpose coordination shall be done on day-to-day basis with traffic police. c) The civil work will start in the year 2024.
6	Khairi Fata, (R-2A)	15	a) Proper care of safety of people should be considered	a) All types of safety measures will be adopted

[78] Traffic may be affected only at station locations. For this purpose, coordination will be done on day-to-day basis with traffic police department. Proper diversion will be provided wherever feasible. Traffic marshals will be deployed at each traffic diversion and near proposed metro stations during construction to ensure smooth traffic flow.

	12.04. 2023		during execution of civil work.	during the execution of the project.
7	Lok Vihar, (R-2A) 12.04. 2023	12	a) Participants demanded for jobs in the proposed metro stations. People wanted basic amenities like wider roads during the construction of Project.	a) The suggestion of the participants has been noted and every effort will be made to recruit local people during the construction phase of the project.
8	Lekha Nagar, (R-2A) 12.04.2023	13	a) Proper care of safety of people should be considered during execution of civil work. b) Compensation for the loss of land and structure should be paid more than market rate. c) Some of people ask about the where to give complaint for Phase II project.	a) All types of safety measures will be adopted during the execution of the project. b) The compensation against loss property will be decided by the Committee under the chairmanship of Collector, Nagpur. c) The Grievance Redress Committee (GRC) will constitute by NMRC, and Grievance register will keep at site location during civil work.
9	Hingna bus stop (R-3A) 06.04. 2023	14	a) Proper care of safety of people should be considered during execution of civil work. b) compensation for the loss of land and structure should be paid more than market rate.	a) All types of safety measures will be adopted during the execution of the project. b) The compensation against loss property will decide by competent authority.
10	Raipur, (R-3A) 06.04.2023	10	a) People are in favour of Phase II project, and they wanted to complete the project as early as possible. b) People wanted basic amenities like wider roads during the construction of Project.	a) The Project will be completed as per the scheduled timeline. b) Work will be executed, and it will be ensured that no traffic will be affected. Also, for this purpose coordination shall be done on day-to-day basis with traffic police.
11	Pardi, (R-4A) 10.04.2023	15	a) People are in favour of Phase-II project, and they wanted to complete the project as early as possible. b) People wanted basic amenities like wider roads during the construction of Project. c) Some of the kiosk holders (NTH) was concern about their relocation.	a) The Project will be completed as per the scheduled timeline. b) Work will be executed, and it will be ensured that no traffic will be affected. Also, for this purpose coordination shall be done on day-to-day basis with traffic police. c) Provision is kept in this RP for NTH (Kiosk).
12	Transport Nagar, (R-4A)	12	a) The compensation against loss of land or property will	a) The compensation against loss property will

	10.04.2023		get fair. b) Participant demand for job in the proposed metro stations. c) The rickshaw drivers were concern about loss of passenger due to running of proposed Phase II metro.	be decided by the Committee under the chairmanship of Collector, Nagpur. b) The suggestion of the participants has been noted and every effort will be made to recruit local people in the construction phase of the project. c) After commencement of Phase II metro at Transport Nagar metro station, passenger will increase and they opt rickshaws to reach their destination.
13	Consultation with Students 08.05.2023	12	a) All the students are happy for proposed Phase II project, as majority of them are travelling long distances by road to reach their college. b) They have suggested that the fare should be minimum.	Noted

Figure 7-1: Some Photographs of Socio-economic Surveys in the Project Study Area

*** Date of photographs: 9th and 10th August 2023*

545. Most of the participants are happy to hear about the proposed NMRP Phase II project. They said that Phase II will cater to majority of the sub-urban population of the city and increase connectivity to the heart of the Nagpur city. They are interested to know about the compensation package against their loss of land. They have also requested to complete the work within the stipulated timeline so that the benefit of the metro network will start soon. They are also concerned about the safety component to be implemented during the construction phase. Furthermore, they are very happy with provision of women safety measures adopted in existing NMRP Phase-I and requested the same to be followed in NMRP Phase-II. Overall, the public consultations were found very fruitful and positive.

546. As a requirement of the ADB SPS, 2009, public consultations were held for, one in each Reach of the NMRP Project on 26th & 27th October, 2023. The main objective of these public consultations was to understand the public awareness about NMRP Phase II project and to gather opinion on the Environmental and Social Impacts due to the project and its mitigation measures from public. Other objectives of the PC include:

i) To discuss the resettlement or compensation opinion from NTH about their loss.
ii) To inform the public about GRM and GRC established by NMRP (Maha Metro) for registration o relevant complaints from time to time during construction and operation phases of the project.
iii) To inform the public about availability of ADB's Accountability Mechanism for registering their grievances on ADB website if the GRM is unable to solve their complaints.

547. The exact proceedings of these PC with their minutes, photographs and other details are attached as **Annexure-15** of this Report.

F. PLAN FOR FUTURE PUBLIC CONSULTATIONS

548. 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:

i) 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.
ii) 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.
iii) 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 NMRP-Phase II project.
iv) 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.
v) To ensure facilities for women in the project construction & operation phases, they will be specifically involved in the consultation process.

G. INFORMATION DISCLOSURE

549. To keep more transparency in planning and for further active participation for

DPs/PAPs and other stakeholders, in Phase II project, the project information will be disseminated through disclosure of all project related documents. Information disclosure will follow the procedure and requirements of ADBs' policy for category A projects. As per ADB's SPS 2009, the draft EIA including the draft EMP will be disclosed 120 days prior to the Board consideration.

550. All environmental documents such as the final EIA, any updated EIA, 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, NMRC will translate the Executive Summary of the EIA in Marathi and disclose it on their website. The same will be disclosed on ADB website also. For DPs/PAPs who are illiterate, appropriate, and implementable methods will be followed to aware them. The NMRC 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 EIA 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.

VIII. GRIEVANCE REDRESSAL MECHANISM

A. INTRODUCTION

551. 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 NMRP 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 NMRP 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.

552. 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 Nagpur Metro Rail Corporation Ltd. (NMRCL) of dealing with DP/PAPs grievances in Phase I of the Nagpur 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)

553. To receive and facilitate resolution of the DPs/PAPs concern & complaints in a transparent process. As per ADB's requirement, NMRP shall constitute two-tier constitution of Grievance Redress Committee (GRC) with representative from implementing agency, community, NGOs etc. for NMRP Phase II project. 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 NMRP / GC / Contractor will have to be in writing and recorded by the field staff in a register which will be given to respective GRC.

554. 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.

555. 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 NMRP head office.

(v) The Tier-2 GRC will include competent authority from land department of NMRP, designated officers from Revenue Department, Government of Maharashtra (GoM) along with representatives from NGOs / Community and a Social Expert.

(vi) The NMRP 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.

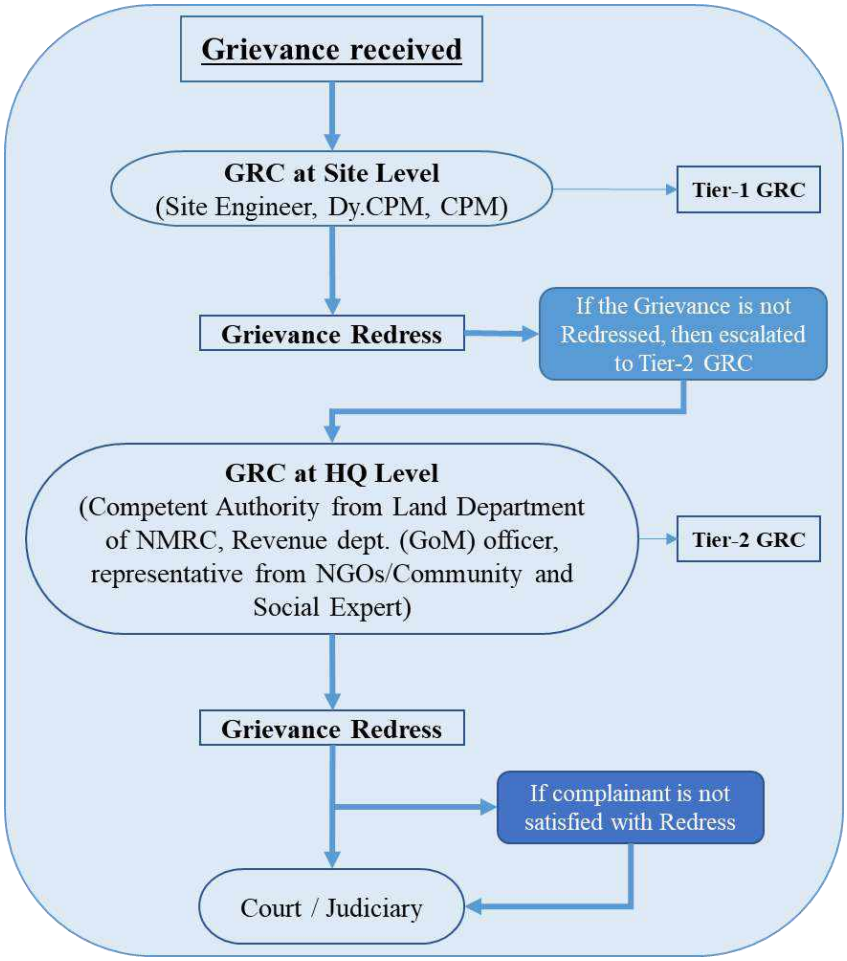
(ix) When any grievance is brought to the Tier-1 GRC (Site level), it shall be resolved within 30 days from the date of complaint, whereas the time taken to redress the grievance at Tier-2 (HQ level) will be 2 weeks (14 days).

(x) NMRP will maintain a log of grievances documented at site and HQ levels respectively.

556. People who are, or may in the future be, adversely affected by the project may also submit complaint to ADB's Accountability Mechanism. The Accountability Mechanism provides an independent forum and process whereby people adversely affected by ADB-assisted projects can voice, and seek a resolution of their problems, as well as report alleged violations of ADB's operational policies and procedures. Before submitting a complaint to the Accountability Mechanism, affected people should make a good faith effort to solve their problems by working with the concerned ADB operations department. Only after doing that, and if they are still dissatisfied, should they approach the Accountability Mechanism. 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 although Phase II GRM is the preferred route. The GRC records will be made available to the external monitor for its review.

557. A flow chart of the GRM in place for the NMRP-Phase 2 project is indicated in **Figure 8-1**.

Figure 8-1: Grievance Redressal Mechanism for NMRP-P2 Project



IX. ENVIRONMENTAL MANAGEMENT PLAN

A. INTRODUCTION

558. The Environmental Management Plan (EMP) consists of a set of mitigation, monitoring and institutional measures to be taken for NMRP Phase II project corridors to avoid, minimize and mitigate adverse environmental and social impacts and enhance positive impacts. The plan also includes the actions needed for the implementation of these measures. The major components of the EMP are:

(i) Mitigation of potentially adverse impacts;
(ii) Environmental monitoring;
(iii) Emergency response procedures;
(iv) Institutional arrangements and reporting mechanism;
(v) Implementation Schedule;
(vi) Training and capacity building, and
(vii) Cost estimates.

559. The purpose of environmental monitoring is to ensure that the EMP 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

560. The main objectives of this EMP 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

561. 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 Nagpur 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 four corridors of metro project.

562. Maha Metro shall be responsible for implementation of the proposed four corridors 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).

563. 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 EMP. 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 EMP 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 EMP

(a) Maha Metro:

564. EMP will be committed by Maha Metro as part of its agreement with Multilateral Development Banks (MDBs). The responsibility to implement the EMP 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:

565. Permits required during construction and those directly related to construction shall be the responsibility of the Contractor. The EMP will be implemented by the Contractors of different packages based on the contract agreement. The Contractor 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. 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).

566. The contractors' environmental team should include an environmental expert with proven experience in preparing Site-Specific EMP 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 EMP to meet international financing institutions' requirements. The Site-Specific EMP will provide;

(vii) Clear description of the project influence area especially broader affected areas subject to induced or secondary impacts
(viii) Clear identification of sensitive receptors along the alignment on a plan of appropriate scale
(ix) 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.).
(x) 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.
(xi) 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 EMP, to be used for regular inspections) and how corrective action is initiated and resolved (internal communication mechanisms to ensure compliance with the Site-Specific EMP). For example, inspection reports are discussed and provided to management,

reported in progress meetings for action, etc.

567. The Employer Requirements for Health, Safety and Environment have been prepared for NMRP Phase II Project. They will be issued to the Contractors as part of the contract documentation for construction. The requirements comprise the following 3 documents:

(i) Volume 1: Control Document
(ii) Volume 2: Health and Safety Manual
(iii) Volume 3: Environmental Management Arrangements

(c) Maha Metro and GC:

568. 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 EMP and common project implementation philosophy of MDB projects, GC will be common for all MDB projects in Phase II that is Reach 1A, Reach 2A, Reach 3A and Reach 4A. Implementation of EMP will be continuously monitored by the Safety, Health and Environment (SH&E) team of environment experts from GC and Maha Metro. Separate Maha Metro team will work on construction of each project; GC team will be common for all the corridors with a view to facilitate unified approach and knowledge enhancement.

569. Mahametro'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.

570. Terms of Reference for GC in implementation of the EMP and EMoP is provided in **Annexure-10** of this EIA-EMP 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 EMP and its internal monitoring by Maha Metro to MDBs.
    (d) Orientation and training of Maha Metro team in implementation of EMP and environmental monitoring will be undertaken at the beginning of the project.

(d) MDBs:

571. The monitoring of EMP 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 ADB SPS requirements once shared by Maha Metro. Implementation of the EMP will be monitored half yearly by MDBs through their experts.

572. 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.

573. 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 EMP and Site-Specific EMP.

(e) External Monitor:

574. 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 NMRP Phase II Project corridors. The terms of reference for engaging the External Monitoring Agencies are attached as **Annexure-11** and include:

(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.

575. 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.

576. 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 EMP is shown in **Table 9-1**.

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

Particulars	Frequency of reporting	Reporting by / Reporting to	Review by / Monitoring by
Implementation of EMP: • Start of the construction & during construction. (Monthly Environmental Monitoring Report)[79]	Monthly till completion of construction	Contractor to GC	Maha-Metro
Submission of EMP & EMoP Progress report to	Half Yearly	GC to MDBs	Maha-Metro

[79] 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.

MDBs			
Submission of External E&S progress report by third party (If required)	• Semi-annually for the four years of construction phase • Yearly during first 2 years of Operation & Maintenance.	GC to MDBs	Maha-Metro

D. EMP FOR NMRP PHASE II CORRIDORS

577. Environmental Management Plan (EMP) Matrix including mitigation measures proposed for NMRP Phase II corridors is presented in **Table 9-2**. The EMP 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 EMP to ensure that sufficient resources are allocated for EMP implementation.

578. Following requirements of ADB SPS, MPMRCL 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, MPMRCL will achieve whichever is more stringent. If less stringent levels or measures are appropriate in view of specific project circumstances, MPMRCL will provide full and detailed justification for any proposed alternatives that are consistent with the requirements presented in ADB SPS.

Table 9-2: Environmental Management Plan (EMP) Matrix

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
Planning and Design Phase							
1.	Land Acquisition and resettlement	Social	Permanent acquisition of 5.78 ha private land. The final size of land to acquired will be updated based on the optimization of project design.	• Land Acquisition is being carried out as per the provisions of GoM, GoI and ADB policies. The affected people will be compensated and assisted as per the provisions of Resettlement Plan (RP).	Land selling records of project affected community	Maha Metro	GoM
2.	Change in Land use	Land	Land use will be slightly changed	• Nagpur Improvement Trust (NIT) developed the Comprehensive Mobility Plan (CMP) for NMRDA in 2013 to identify the present and future mobility patterns of Nagpur Municipal Area (NMA), including development of NMRP Phase II corridors. • 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)
3.	Contractor Management	EHS	• EHS accidents • Reputational Risk	• Integration of EHS contractor management into broader project management, procurement, human resources, legal, and financial management. • 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	EHS/Incident-Accident records	Contractor / GC	Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				prepare subcontract agreements accordingly. • Contractor management incorporates “adaptive management” to monitor and adapt over time; integration with sustainable procurement approach or concepts. • 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. • Training and Health & Sadety plans			
4.	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, (a) appoint contractor’s Safety, Health and Environmental Officer (SHEO); (b) SHEO will engage GC-Environment Specialist to discuss	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
				EMP, seek clarification and recommend corresponding revisions if necessary; (c) SHEO will agree with GC the monthly monitoring template and deadlines for submission; (d) SHEO will submit for GC's approval all necessary sub-plans as listed in this EIA (**Table 9-4**). 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; (e) SHEO will submit for GC's approval of the construction camp layout and management plan before its establishment; and (f) SHEO will update EIA (in consultation with GC, in case of design changes) and also prepare site-specific EMPs.			

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
5.	Labour Management	Labour	Labour rights	• Compliance with GoI's labour legislation, ratified with International Labour Organization (ILO) conventions. • 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. • Elimination of discrimination with respect to employment and occupation, to be defined as any distinction, exclusion, or preference based on race, gender, religion, political opinion, trade union affiliation, national extraction, or social origin. • 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. • Grievance Redress Mechanism (GRM)	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
				for workers should be established as early as possible to function no later than construction commencement. • There will be provision for group accidental and medical insurance for the workers. • Contractor will refer to **Annexure 16- Outline for Labour Management Plan** and prepare a detailed plan.			
		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. • Necessary planning and safety approach will be made for rescue during emergency. • Use of dust controls (exhaust ventilation) for dust control • Workers will be provided with first aid and health facilities at the site. • There should have facility to deal with medical aspects of HIV/AIDS treatment with specialized services • 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 Covid-19 hospitals; daily disinfection of site, equipment and	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
				vehicles.			
6.	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[80] (see table 2-2 of the EIA for a list of required permissions and clearances). • 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 (NMC), Maharashtra Forest Dept. / MPCB
7.	Site Clearance and Demolition	Tree felling	About 538 trees will be affected on viaduct and stations. Additionally, in some areas, pruning will be required. Other existing structures may need to be demolished	• 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. • 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. • If unavoidable, implementation of	Government approvals and Tree felling records	Maha Metro / Contractor	Tree Authority (NMC), Maharashtra Forest Dept., GoM and NMRDA

[80] Permission for Sand Mining from riverbed to be obtained from State Mining Department (GoM) shall be a prerequisite while finalising Authorised Sand vendors during construction of Phase II. Contractor shall ensure that this permission / NOC and its implementation status is included in the Monthly Environment Report, shall be the responsibility of the Contractor engaged by Maha Metro / GC.

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				acceptable plans for transplanting (to the extent technically and economically viable) or replacing such trees and for their short-term maintenance and care. • Adequate coordination with applicable government regulatory authorities. As alignment passes through built-up land use, green belt development along elevated section is not feasible. Compensatory plantation of 10 saplings for every tree felled will be done in sites to be identified in consultation with Nagpur Municipal Corporation (NMC) and Maharashtra Forest Dept. Maha Metro to allocate sufficient tree replantation budget. • Prior to demolition of any building or structure contractor has to 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 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. • Stakeholder communication to avoid or minimize public concerns or protests. • Definition of adequate budget and contingencies as well as financial	Government licenses and approvals ACM handling and Management Plan Stakehodler Anlysis records of meetings		

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				resources to cover all related costs. This will be finalized before work on relevant section is commenced between Maha Metro and the Contractor. • Families impacted due to fully affected (displaced/demolished) structures and partially affected structures will be compensated in accordance with the approved Resettlement Plan. • 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, leveling etc. in the river/nallah basin. • Proper management of waste material will be ensured. No excavated material should not be stored near river/nallah basin • Vegetation clearing by chemicals / herbicides will not be permitted • 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. • Sedimentation of storm water will be minimized by avoiding stockpiling of excavated material. Portable	Waste Management Plan and Waste registers maintained at site Worker training records		

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				sanitation, treatment and disposal facility shall be provided at construction site.			
		Noise	Noise will be generated by the use of hand tools such as jackhammers, sledgehammers and picks etc.	• The procedure of demolition will be conducted as per the demolition plan prepared by the Contractor in consultation with Maha Metro. • The existing structures should be demolished one after another cautiously.	Noise Monitoring records	Contractor	GC / Maha Metro
		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. • 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. • 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. • Compliance with applicable legislation (permits and procedures) and good	Site Inspection report by contractor	Contractor	GC / Maha Metro / NMRDA

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				international practice. • Adaptive management in site-specific EMP during final design, including site locations (stations and construction staging areas). • Chance finds procedure to be prepared by Contractor and reviewed by GC/Maha Metro before submitting to all lenders.			
8.	Severance of utilities	Social EHS	The proposed alignments will cross drains and utility services such as sewer, storm water drains, water and wastewater pipes, roadside lights, telephone cables, electricity power lines, electric poles, natural gas lines and traffic signals etc.	• Assets and utilities will be maintained without affecting and damages by shifting temporary/ permanently where it is necessary. • 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 diversions and protection measures to minimize the risk to existing utilities from ground movement and surface settlement.	Daily site inspection reports/records Hazard risk	Maha Metro / Contractor	Maha Metro / NMC, NMRDA, MSEB, MNGL, Telecon companies, etc.

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				• For gas pipelines and HT electricity lines, Contractor will conduct the hazardous operation study to ensure the smooth and safe shifting. • 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. Following completion of construction of metro, such utilities shall be rehabilitated on public land.	assessment study for utilities Utility Shifting Plan		
9.	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 modeling) at pre-identified receptors comprising educational, medical and physical cultural buildings and other fragile buildings located within recommended screening distance of 62m (RRT,	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
				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. • Visual inspections of these buildings shall be done by the contractor so as to serve as baseline to monitor progression of building damage if any due to vibration. • Ballast less track structure is supported on two 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. • Noise barriers made of suitable polycarbonate will be installed at identified sensitive receptor locations, where required.			
10.	Coordinate with the Traffic Department on Traffic	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	Traffic Management Plan Road Safety Awareness campaign records	Contractor	GC / Maha Metro / Traffic Police

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
	Management Plan			for respective sections with site- or station-specific plans and measures to minimize the overall impact on traffic throughout the construction and operation periods. • At congested sections, the temporary traffic coordinators will be engaged by Maha Metro to facilitate the traffic management. • 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. • 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. • The logistics should be considered to manage transport materials from storage areas outside of the dense urban core to worksites and to return excavated soil and other materials to disposal locations. If needed, construction traffic may be confined to	Incident/accident register at site		Dept.

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				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). • 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. • 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.			

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
11.	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. • Construction material shall be sourced from legalized and approved quarries. • Energy saving technologies will be embedded into the Project design wherever possible. For instance, solar panels, rainwater harvesting, etc. • Update of plan based on final contractor-defined estimated volumes and timing for groundwater pumping with intension of minimizing the groundwater consumption. The primary objective shall be to avoid extraction of groundwater for construction. However, use of groundwater which has been generated by dewatering of excavations can be used in construction activities. In those instances, where extraction of groundwater becomes unavoidable, contractor shall, with consent of Maha Metro and the respective Water Authority, resort to such extraction. In such instances contractor-defined estimated volumes and timing for groundwater pumping with intention of minimizing the groundwater consumption. • Procedures for minimizing waste	Site inspection Site specific EMP MPCB yearly compliance emonitoring reports	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				segregation, reuse, temporary storage, recycling, donation, and disposal. • 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). • 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. • Focus will be placed on reuse of the extracted soil for enhancement of green space, waste recycle, and storm water runoff. • Construction yards with aggregate crushing and screening, pre-casting, material and fuel storage and ready-mix concrete plants will be located away from habituated or ecologically sensitive areas. Locations will be decided by Maha Metro and GC before construction commencement in consultation with NMC and NMRDA. • Sites for disposal of excavated soil and C&D waste (muck) will be decided by Maha Metro before start of construction in consultation with			

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				MPCB, Nagpur Municipal Corporation and NMRDA, to ensure a safe distance from residential areas, water bodies and ecologically sensitive locations as to avoid disrupting natural drainage. The muck shall be filled in the dumping site in layers and compacted mechanically. Suitable slopes will be maintained on the stockpile. Once the filling is complete, it will be protected by low walls, provided with a layer of good earth on the top and covered with vegetation. A muck disposal plan will be prepared by Contractor and approved by Maha Metro. Hazardous waste will be taken away by licensed vendors who will be responsible for due disposal at permitted sites.			
12.	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. • 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 alignment. • Increased number of pits for RWH from elevated metro to cater to flood waters and heavy rains. • Climate change mitigation measures shall be implemented, such as solar panels on station buildings and roofs	Disaster Management Plan Emergency Response and Communication Plan	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				to reduce the extensive use of grid-generated electricity supplied to the station for operation and maintenance.			
13.	Site-specific Environmental Baseline Collection and Assessment	Environment	Benchmark of assessing project impacts	• Prior to mobilization, contractor to collect a full set of baseline data of air, water (surface and ground), noise and vibration and soil quality. • Additional investigations in areas identified as having contaminated soil or groundwater to define the degree and extent of contamination and alternatives for soil and groundwater disposal. Assessment of potentially contaminated soil at site locations where soil work and excavations will be performed to examine the site situation. If there is a reasonable likelihood of contamination, then a specific management plan that includes (a) monitoring during construction consisting of visual inspections, on-site and in-situ monitoring to detect and confirm levels of contamination (and 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. • Assessment and site-specific measures for controlling noise, dust, and illumination during construction (for example, when working 24 hours a day).	Ambient Monitoring reports MPCB yearly compliance emonitoring reports EHS register	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				• Contractor to prepare site-specific EMPs for Maha Metro to approve before mobilization, if required. • Based on detailed construction work plan and associated occupational health and safety risks, strengthening the contractor health and safety management system in site-specific EMPs. • Maha Metro and GC to provide EMP orientation to contractor.			
14.	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. • 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 Physical inspection	Maha Metro	GoM
15.	Establishment of Grievance Redress Mechanism	EHS	Complaints not resolved in time	• Grievance Redress Mechanism for workers and project affected people should be established as early as possible to function no later than ground work commencement. • The GRM information and focal should be disseminated to public through the Maha Metro website or other media as approved by Maha Metro	GRC committee formulation	Maha Metro	GoM
16.	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	Community /External Communication Plan	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				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).			
Construction Phase							
17.	Construction Monitoring	EHS	Breach of legislation, EIA, EMP, 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. • GC / Maha Metro to review the data compared to baseline data and urge Contractor to take immediate actions over any project generated pollution / contamination. • GC to submit monitoring reports on quarterly basis to Maha Metro. • If any unanticipated EHS impacts arise during construction, implementation or operation of the Project that were not considered in the EIA / EMP, Contractor and GC to promptly inform 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. • Maha Metro to engage qualified and experienced third-party monitor, if	Environment Monitoring reports/records for all parameters MPCB compliance reports	Contractor / GC	Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				required, to verify information produced through the Project monitoring process, and facilitate the carrying out of any verification activities by such third party monitor. • Maha Metro to submit the semi-annual monitoring reports (GC's and third party's) using the agreed the template to all lenders. • Maha Metro to report all lenders any actual or potential breach of compliance with the measures and requirements set forth in the EMP promptly after becoming aware of the breach.			
18.	Community Liaison	Social	Complaints	• GRM for affected people should function effectively with well documented grievance log. • 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. • Adaptive management that monitors, adjusts, or adds measures to reflect actual community risks. • Important measures to reduce community risk, such as fence and	GRM records/Register Action Plans	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				related protection around work sites (including strength and visual protection), education and awareness signs and information, and placement of safety risks (explosive and flammable materials, generators)			
19.	Construction Vehicle Management	Environment Social	Community disruption Accidents Reputational risk	• Contractor's transport vehicles and other equipment shall conform to emission standards. • 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. • Definition of allowable routes, speeds, and times (day or week). • 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. • Driver contracts with clearly specified requirements and remedies for noncompliance.	Accident/Incident register Site EHS records Physical Verification Worker Training records	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				• Procedure for truck maintenance, including selection of service providers considering environmental aspects, application of low-Sulphur fuel, no idling of trucks, routine maintenance (including assurance of proper engine operations related to emissions and noise), and disposal of used oil and other fluids, batteries, and tires etc. • Equipment/vehicle repair/maintenance and re-fueling 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. • 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	Noise Quality Monitoring reports	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				by 10-15 dB (A). Piling operations will be restricted during day time hours only. • Efforts should be made to keep the noise levels under control by appropriate noise attenuation and adopting employee safety measures. • Use of low-noise equipment and ensuring good maintenance, and trying to avoid using high-noise equipment simultaneously at the same section. • 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. • 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. • Monitoring required during construction, including field observations and measurements.			
		Vibration	Piling for viaduct piers and buildings maygenerate vibrations	• Cast-in-situ piling will be deployed at locations with sensitive receptors so as to reduce vibration. • At pre-identified receptors comprising educational, medical and physical	Building condition Survey Vibrtaion Monitoring reports	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				cultural buildings and other fragile buildings located within recommended screening distance of 62m (for cat. 2) on either side of each alignment, the contractor shall implement the pre-construction structural integrity inspections, if required. • Contractor to ensure that vibration levels will not exceed 5.0 mm/s • 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. • Monitoring during construction including field observations and measurements.			
		Surface water	Degradation of water quality due to pier foundation construction in water courses	• It is prohibited to dispose excavated spoils and wastes into river/streams water; • 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; • Contractor will make sure that spill kits are on site at any time in case of an accident or incident; • The contractor shall arrange awareness programme to all	Spill control and prevention plan Surface water quality monitoring reports Water Quality management Plan	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				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; • 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; • 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; • No vehicles or equipment shall be washed, parked or refueled within 100 m distance to the nearest surface water, to avoid contamination of streams water from fuel and lubricants; • Vehicle parking and maintenance areas will have waterproof floors from which drainage is collected and treated to legal standards; • No untreated sanitary wastewater from camps shall be discharged into the streams water; • Bridge and cross drainage work at			

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						Implementation	Supervision
				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; • 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 Conflicts with community	• On-site training shall be provided to site workers if any historical or cultural artefact is noticed during pilling. • The work shall be immediately stopped and information will be delivered to the higher authority. • All workers will undergo a briefing with the Archaeology Department to ensure safeguarding of heritage resource and / or cultural / religious practices. • A proof of compliance to this requirement to include the name of participants and date and location of briefing will form part of the monthly report to Maha Metro. • 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 conduct an assessment of found objects or sites by cultural heritage experts; to identify and implement actions consistent with	Physical Verification EHS records	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				the requirements of this ESS and national law; and to train project personnel and project workers on chance find procedures.			
		Health & Safety	Noise and vibration generated during piling will affect the health and safety of the workers	• Auger piling methods will be used to reduce the impacts of noise. 2m tall screens of GI sheets will be installed between source (pile driver) and receptors (workers & nearby populations). • To reduce the harmful effects, personnel working at high noise levels would be provided with noise protective gears such as ear mufflers, sound barriers, job rotations per occupational exposure limits etc. • Procedure to receive, evaluate, and compensate (if applicable) damages due to construction and establishment of financial resources to cover this expense.	EHS records Noise Monitoring reports	Contractor	GC / Maha Metro
22.	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. • Imposition of speed controls for vehicles on unpaved site roads. 10-30 kmph is the recommended limit. • Every vehicle should be washed to remove any dusty materials from its	Air quality Monitoring reports	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				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. • Excavation machinery will be topped up by low-Sulphur fuel.			
		Noise and Vibration	Nuisance	• Efforts should be made to keep the noise levels under control by appropriate noise attenuation and adopting employee safety measures. • Use of low-noise equipment and ensuring good maintenance, and trying to avoid using high-noise equipment simultaneously at the same section. • 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. • 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.	Noise and Vibration Monitoring reports Site inspection	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				• Monitoring required during construction, including field observations and measurements. • Construction activities shall 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 construction at such locations. In case of sensitive structures, vibration mitigation measures will be implemented. • Vibratory rollers near sensitive receptors shall be avoided. • 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: a. Monitoring requirements for vibrations at sensitive receptors during the construction period; Pre-construction structural integrity inspections of sensitive structures, if required. b. Information dissemination about the construction method, probable effects, quality control measures and precautions to be used. c. vibration monitoring plan during final design and the			

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						Implementation	Supervision
				implementation of a compliance monitoring program during construction • 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. • 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 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.	Ground water quality Monitoring reports Site inspection	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				• 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. • The topsoil should be preserved (by storing it at appropriate places) so that same can be restored after completion of work.	Site inspection EHS audit reports	Contractor	GC / Maha Metro
		Physical Cultural Resources	Historic and cultural value loss Conflicts with community	• If any artefacts of archaeological importance are noticed, work should be stopped and information to be given to the higher authorities. • All workers will undergo a briefing with the Archaeology Department to ensure safeguarding of heritage resource and cultural/religious practices. • A proof of compliance to this requirement to include the name of participants and date and location of briefing will form part of the monthly report to Maha Metro. • 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	Site inspection EHS audit reports	Contractor	GC / Maha Metro

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				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			
		Health and Safety	Accidents	• To specify the number and length of shifts for each worker. • 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. • 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.	Site inspection EHS audit reports	Contractor	GC / Maha Metro
		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. • Aesthetic value of the site will be restored after completion of the works.	Site inspection EHS audit reports	Contractor	GC / Maha Metro
23.	Hauling of excavated material	Air	During transportation of excavated material, fugitive	• The traffic management plan will be stringently implemented with regular monitoring and inspections.	Traffic Management Plan	Contractor	GC / Maha Metro /

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			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	• Trucks / dumpers carrying the excavated material will be covered using tarpaulin/similar covering materials. • Sprinkling of water should be carried out. • 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. • 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. • Haul roads will be kept in good state of maintenance.	Site inspection EHS audit reports		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	• The routing, timing and logistics of the haul truck movement should be planned to have minimal impacts on noise level. • The route selection will avoid any sensitive receptors. • Efforts should be made to keep the	Site inspection EHS audit reports	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
			(A) at 10 m distance). The adverse impacts of noise will be most intense in the residential / urban areas.	noise levels under control by appropriate noise attenuation and adopting employee safety measures. • 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. • 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. • 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. • 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 EHS audit reports	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
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24.	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. • The disposal plan will be stringently implemented with site monitoring and inspections. • It will be located outside of urban habitation. • 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 EHS audit reports	Contractor	Maha Metro / NMRDA / 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 NMRDA/NMC, MPCB, and Maha Metro for this specific purpose. • The disposal plan will be stringently implemented with regular monitoring and inspections. • Field inspections, monitoring, and documentation of dumping excavated materials.	Site inspection EHS audit reports	Contractor	GC / Maha Metro
25.	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	• Permission from Nagpur 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. • Adaptive management with field inspections and monitoring during plan	Applicable permit/license copies Site inspection EHS audit reports	Contractor	GC / Maha Metro / Traffic Police Dept.

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
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			may also result into traffic congestion and air pollution from stagnated vehicles in urban areas. Primary pollutants will be NOx, CO, NMHC, and VOCs.	implementation and adjustments, as needed, to reflect actual traffic congestion or related issues • 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.			
		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 Nagpur 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. • Detour route selection to avoid sensitive receptors to noise. • 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 Site inspection 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	Traffic Management Plan Applicable permit/license copies Site inspection EHS audit reports	Contractor	GC / Maha Metro

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				furniture for pedestrians will be provided wherever possible. • 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. • Adaptive management with field inspections and 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
26.	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. • GRM for affected people should function effectively with grievance log well documented.	Applicable permit/license copies Site inspection EHS audit reports GRm register	Contractor	GC / Maha Metro

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		Health & Safety	Movement though constricted space may cause potential health & safety issues amongst pedestrians	• Movement through construction area shall be prohibited. • Safe passage for pedestrians with proper fall protection and signage will be planned. This applies to movement along existing roads on which elevated metro is constructed. It is clarified that their movement through construction areas shall be prohibited.		Contractor	GC / Maha Metro
27.	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. • The construction sites will be provided with garland drains with intercepting pits to trap silt & muck. • Muck will be stored in lined tanks / ponds. Such tank/ ponds could be covered during monsoon to control runoff. • 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 • Transportation of muck will be scheduled by time and route to minimize air pollution in habitat areas.	Muck Disposal Plan Applicable permit/license copies Site inspection EHS audit reports	Contractor	GC / Maha Metro
		Groundwater	Muck, spent polymer slurry & drill fluids may settle down from pond / tanks and will affect	• 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	Muck Disposal Plan Applicable permit/license copies	Contractor	GC / Maha Metro

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			groundwater	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. • Groundwater quality monitoring before, during and after the use of muck tanks/ponds.	Site inspection EHS audit reports		
		Aesthetics	Muck generation will create an aesthetic issue	• The construction site will be covered from all sides to reduce visual impacts.	Muck Disposal Plan Applicable permit/license copies Site inspection EHS audit reports	Contractor	GC / Maha Metro
28.	Steel structure preparation	Soil	Steel structure preparation will create steel scraps	• Steel scrap will be collected, sorted by diameter and sold to scrap dealers at regular intervals.	Site inspection EHS audit reports	Contractor	GC / Maha Metro
		Health & safety	Bar bending & other activities (inc. working at heights) might pose a H&S threat to workers	• Workers will be provided appropriate hand gloves and other personal protective equipment (PPE) such as fall protection when working at height. • Skilled workers working at height or doing hot work will be required to seek permission from site	Toolbox talk kit Worker Training records	Contractor	GC / Maha Metro
29.	Stacking & warehousing of raw	Surface water	Washed out raw material could pose serious threat to	• Small dykes and garlanding drains along the periphery of the yard and ploy boundary could be constructed.	Site inspection EHS audit reports	Contractor	GC / Maha Metro

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	material		surface water bodies	This will control runoff and washing out of finer material.			
		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 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. • Dust filters atop cement silos, wet suppression for aggregate crushing and screening will be employed	Site inspection 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 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 areas.	• Timing of using RCC pumps will be planned and specified by the Engineer. • RCC pumps will be covered from all sides. • Bends and excessive head will be avoided. •	Site inspection EHS audit reports	Contractor	GC / Maha Metro
		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 EHS audit reports	Contractor	GC / Maha Metro

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		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 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 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 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. • 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. • Curing needs will be met from municipal supply, water resulting from dewatering during piling and surface runoff water. • Rainwater harvesting (as a compensatory measure) will be practiced.	Site inspection EHS audit reports	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
		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 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 EHS audit reports	Contractor	GC / Maha Metro
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. • Workers working inside or near construction equipment should be provided with proper PPEs like ear plugs / muffs complying with IS 4869. • 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. • 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 Site inspection EHS audit reports	Contractor	GC / Maha Metro

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		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 Applicable permit/license copies Site inspection 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. • 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 Site inspection EHS audit reports	Contractor	GC / Maha Metro
		Groundwater	Surface water on flat terrain could percolate and contaminate	• Contractor to collect the groundwater baseline data prior to construction. • Disposal in compliance with applicable regulatory requirements.	Applicable permit/license copies Site inspection	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
			groundwater.	• Groundwater quality monitoring. • Water abstracted must be measured / recorded periodically. • After Construction, Contractor will conduct groundwater analysis and be obliged to reinstate the used sites no worse than the conditions of pre-construction.	EHS audit reports		
		Soil	Solid waste generated from the labour camps will cause soil pollution	• Contractor to collect the soil baseline data prior to construction. • Municipal solid waste will be collected and taken away and disposed by municipality. • Solid waste will have to be disposed in compliance with Municipal Solid Waste (Management & Handling) Rules, 2000, as amended to date. • 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 Applicable permit/license copies Site inspection 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. • To avoid labor influx risk, sensitizing of local community and the non-local workers separately as well as jointly will be done regularly.	Applicable permit/license copies Site inspection 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 checkups and treatment at separate clinics, coordination with local health authorities will be conducted. • As per the Building & Other Construction Workers (BOCW)	Applicable permit/license copies Site inspection	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				(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. • 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, 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.	EHS audit reports		
		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. • 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 Site inspection 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. • The trucks/dumpers carrying the material will be covered using tarpaulin/similar covering materials.	Air Quality Monitoring reports Site inspection records	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				• Fugitive dust could be controlled using water sprinkling. Contractors should carry out water sprinkling. • 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. • Water for sprinkling and tyre washing will be sourced from treated effluent from ETPs located nearby, or surface runoff.	EHS register		
		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. • Concrete preparation will only take place in casting yards (away from habitation). • 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 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. • Batching plant / casting yard shall be barricaded and made as a compulsory PPE zone. This will effectively reduce the fugitive dust generation.	AirQuality 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. • 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 Physical verification of Woker 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.	Ground Wtare qulity Monitoring reports	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				• 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 surface water. • Soil and Groundwater quality monitoring. • 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.			
		Hazardous waste	Health impacts and soil and groundwater pollution from hazardous water at batching/casting yards	• The use and storage of hazardous materials at the casting yard and batching plant should adhere to SPCB requirements. • 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 labeled, recorded, stored in impermeable containment and for periods not exceeding mandated periods and, in a	License (Consent to Establish / Consent to Operate) from MPCB Hazardous Waste Management Plan Waste management register	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				manner, suitable for handling storage and transport. • The contractor shall maintain a record of sale, transfer, storage of hazardous waste and make these records available for inspection. • The contractor shall get Authorized Recyclers to transport and dispose Hazardous Waste. • Proper collection and storage facilities will be provided especially for hazardous waste.			
		Resources	If the batching plant will get its power from DG sets, substantial diesel will be consumed. (A 30 m^3/hr. batching plant will require 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. • 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). • 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. • 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.		Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				• Refer to Activity 42 “Use of DG sets” and Activity 44 “Storage of Diesel” for further measures.			
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 surface water. • Groundwater quality monitoring.	R-CGWA permits and ground water quality monitoring records	Contractor	GC / Maha Metro
		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. • Groundwater quality monitoring. • 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.	Site inspection Groudn Water quality Monitoring reports	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				• Groundwater will not be used. Water will be sourced from municipal supply, surface runoff or water from dewatering.			
39.	Hauling of segments to site	Air	During transportation of segments, fugitive dust will be generated from re-suspension of dust from road surface. Plus, there will be air emission from trucks	• The traffic management plan will be stringently implemented with regular monitoring and inspections. • Sprinkling of water should be carried out. • 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. • Water for sprinkling and tire washing will be sourced from treated effluent from ETPs located nearby, or surface runoff. • Haul roads will be kept in good state of maintenance. • Project affected community members will be consulted prior to hauling of segments to site' to ensure adequate awareness of any disruption of temporary noise and air disturbance is disseminated to those affected	Traffic Management Plan Water Sprinking records	Contractor	GC / Maha Metro
		Noise	Trucks carrying segments will result	• The routing, timing and logistics of the haul truck movement should be	Noise monitoring reports	Contractor	GC / Maha

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
			into high noise (typically in excess of 85 dB(A) at1 m distance, or 57 dB(A) at 10 m distance). The adverse impacts of noise will be most intense in the residential/urban areas	planned to have minimal impacts on noise level. The route selection will avoid any sensitive receptors. • Efforts should be made to keep the noise levels under control by appropriate noise attenuation and adopting employee safety measures. • 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. • 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. • Monitoring required during construction, including field observations and measurements.	Field Verification		Metro
		Social	Incessant movement of trucks could create social issues	• The local community has to be taken into confidence before the construction commences. Their advice has to be taken and incorporated in decision making. • GRM for affected people should function effectively with well documented grievance log.	GRM register/records Community consultation records	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
		Health & safety	The movement of trucks will increase the traffic risk of the commuters	• The routing, timing and logistics of the haul truck movement will be planned to have minimal impacts on occupational and community health and safety.	Community and Occupational health and safety Management Plan	Contractor	GC / Maha Metro
		Aesthetics	Movement of trucks will create an aesthetic problem	• Proper housekeeping activities have to be undertaken near the casting yard and nearby areas.	Housekeeping reocrds	Contractor	GC / Maha Metro
40.	Use of DG sets	Air	Emission of NOx, SOx, CO, PM10, PM2.5 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. • 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. • Stack height of DG sets will be as per CPCB requirement [stack ht. = 0.2*(rating in kVA)0.5] • Stack monitoring of the criteria pollutants will be conducted monthly, if the DG set id operated regularly. • Compliance monitoring will be done to the regularly and check the monitoring instruments. • Fuels used for DG will be High Speed Diesel with low-sulfur 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. • Monitoring required during construction, including field observations and measurements. • 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. • Noise will be controlled using acoustic enclosure. • The DG sets will be mounted on damping skids, which will reduce the vibration generated from DG sets.	Noise and Vibrtaion 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. • Refer to Activity 42 “Storage of Diesel” for further measures.	Site inspection and 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. • 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
41.	All Construction Activities	Environment	Construction and Demolition (C&D) waste results from land clearing, excavation, construction, demolition,	• Records of movement and loading/unloading of C&D waste and records of waste loaded by vendors. • 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	Waste management register Site inspection records	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
			remodelling and repair of structures, roads and utilities	from metro construction has potential use after processing and grading. • The contractor will segregate and temporarily store the C&D waste till the vendor takes it away for recycling and disposal at authorized facilities. • Contractor will adhere with the C&D Waste Management Rules. • 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 liters. 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. • Spill cleanup 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 cleanup will be undertaken, and all cleanup 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			

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				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 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. • Contractor shall report significant environmental incidents to NMRCL / GC within 8 hrs. of the event and shall take necessary measures to rectify it as soon as possible. • Contractor will provide regular training and 'tool box talks' to ensure workers safety. • 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) • Provision of PPE for workers especially working ay heights or near water bodies in accordance with GIP health and safety regulations and requirements. This will include the provision of (as needed): life jackets, safety boots, helmets, gloves, protective clothing, respirators, goggles,	EHS reports Accident/Incident records Worker safety training records Tool Box talk records Site Health and safety Plan Labour Audit records.	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				earplugs, harnesses etc. • 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 • 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. • 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. • Provide personal protection equipment to workers as needed, e.g. safety boots, helmets, gloves, protective clothing, goggles, ear protection. • Core labor 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 labor. Specific targets for employment have been included in the project gender action plan			
42.	Storage of Diesel	Groundwater Health & safety	Diesel spillage (from underground or above ground storage facility) will affect groundwater	• 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	Daily Site inspection reports with photos Spill prevention and control plan	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
			quality adversely	collected into steel trays and disposed to authorized recyclers. • All bulk diesel tanks shall be properly supported in an elevated position to facilitate gravity discharge. • Spillage will be controlled using methods mentioned in the environmental contingency plan, to be included in the emergency response plan. • Groundwater quality monitoring before installation of the tanks and after demobilization.	Ground Water quality Monitoring reports		
			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. • 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). • 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. • All chemicals, toxic, hazardous, and harmful materials will be transported in spill-proof tanks with filling hoses and nozzles in working order. • 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	Onsite Emergency Plan Hazardous/Non-hazardous Material register Hazard/non-hazardous material storage handling and amanagement plan. Dialy site inspection reports.	Contractor	GC / Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				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. • Good housekeeping procedures will be established to avoid the risk of spills. • Spills will be dealt with immediately, and personnel will be trained and tasked with this responsibility. • Workers will be properly trained before handling hazardous wastes and have the required protective equipment.			
43.	Cleanup 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
Operation Phase							
44.	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. • Since the rakes will be air conditioned and enclosed from all side, the impacts	Noise and Vibration moitoring report 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
				of noise on the travellers will be nominal. • Noise barriers will be installed at sensitive receptor locations based on final design noise prediction analysis, if required. • 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. • The mitigations suggested based on the detailed noise and vibration analysis carried out prior to commencement of construction, should be strictly followed. • 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: a. 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. b. Elastic pad between seat of the			

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				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. c. Using floating slab and high resilience fasteners to reduce the vibration at the point of emission. • Vibration monitoring and building condition surveys is required to determine if there are negative impacts and annoyance post mitigation implementation. • In cases, especially at Hospitals, additional mitigation measures shall be provided to ensure that vibration and annoyance impacts are below the threshold criteria.			
		Health and Safety	Accidents 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. • 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	Site EHS register Incident/Accident records Site inspection/Physical Verification	O & M -Maha Metro	Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				standards for whole railway system to the outside world shall comply with EN50121-2. • Automatic Train Protection and Automatic Train Supervision sub-systems will be installed to provide a high level of safety. • CCTV system will be installed for local and centralized monitor of operation. • 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. • Emergency team, ambulance, contact number and hospital should be available. Emergency response plan should be implemented during operation periods.			
			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. • Well-designed workstations, lighting in Control Centre. • Emotional resilience training, counselling for recovery and rehabilitation.	Medical records at site	O & M -Maha Metro	Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
		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 Nagpur	• A proper housekeeping routine will be followed to enhance the aesthetics of metro rail station.		O & M -Maha Metro	Maha Metro
45.	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	
46.	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. • Fuel used for DG sets will have a low-sulphur content	Dg stack monitoring eport	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. • Noise enclosures will be used and will comply with GSR 371(E) dt. 17-05-2002. • Wherever baseline noise already exceeds the standards, only 3dB of	Noise and monitoring reports	O & M -Maha Metro	Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				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. • The DG sets will be mounted on damping skids, which will reduce the vibration generated from the use of the DG sets			
		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. • Precautions shall be taken to avoid any spillage of diesel. • 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 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 /	• Diesel should be stored in designated sites prior to final disposal. • 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. • Proper onsite emergency plan will be prepared by GC and will be approved through Maha Metro.		O & M -Maha Metro	Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
			property if ignited				
		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
47.	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: a. follow proper timetable; b. should have frequent services during the morning & evening peak; c. should have a limited carrying capacity. • The feeder buses should arrive and depart from designated bus bays or similar structures. Proper arrangements for road crossing should be established.	Site inspect records	O & M -Maha Metro	Maha Metro

Sr. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Performance Indicator	Responsibility	
						Implementation	Supervision
				• 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
48.	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
49.	Ancillary development along metro routes	Land	Ancillary developments will take place along with metro corridor	• 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. • Implementation of increased densities is decided by State Government and managed by NMRDA in accordance with demand.	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 meetimgs/consultations.	O & M -Maha Metro	Maha Metro

Note: This EMP Matrix will form part of the contract document together with Maha Metro's SHE Manual for all contractors. This EMP has been aligned with the SHE Manual wherever possible.

E. EMP BUDGET

579. Mitigation measures proposed in the EMP will be implemented by the Contractor. The budgetary provisions for the implementation of the environmental management plan of Nagpur Metro rail Project- Phase 2 Corridor are presented in **Table 9-3**.

Table 9-3: Summary of EMP Budget for NMRP-P2 project

Sr, No.	Item	Estimated Total Cost (₹)
1.	Compensatory Plantation of 5380 trees in lieu of 538 affected trees (in 1:10 ratio)	5,380,000
2.	Rainwater Harvesting[81]	83,521,000
3.	Environmental Monitoring	26,040,000
4.	Training and Capacity building[82]	1,850,000
Total EMP Cost for NMRP Phase II corridors		**116,791,000**

580. Thus, total cost of EMP for all 4 Nagpur Metro Project- Phase 2 Corridors works out to be around **₹ 116.8 million**.

F. DEVELOPMENT AND IMPLEMENTATION OF SUB-PLANS

581. As part of the Construction phase EMP, the contractors need to develop various sub-plans as discussed in the EMP (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-12**). These plans are aimed at good environmental management practices and serve as guide documents. While the relevant impacts have been adequately assessed in this EIA, 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 EMP at the time of approval. These sub-plans will form part of Construction phase EMP, 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[83]
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	Yes	Yes	No

[81] *Source: Nagpur Metro Rail Project Phase II (NMRP-P2) Detailed Project Report (DPR), November 2019*
[82] *Source: Nagpur Metro Rail Project Phase II (NMRP-P2) Detailed Project Report (DPR), November 2019*
[83] *ADB will not approve these plans since ADB will not have accontractual relationship with the Contractor. However ADB can review, provide recommendations and give a 'No-Objection'*.

Sr. No.	Plan	Description	Approvals / NoC		
			PIU	GC	MDBs[83]
		waste management, supply of water for drinking and bathing, waste water and drainage management, traffic movement routes etc.			
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 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 EIA must be considered.	Yes	Yes	Yes
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 EIA 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.,	Yes	Yes	Yes

Sr. No.	Plan	Description	Approvals / NoC		
			PIU	GC	MDBs[83]
		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 EIA must be considered.			
8.	Labour and Working Conditions Management Plan (Annexure-16 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 Management Plan	Detailing the procedures for vibration surveys, monitoring and control. Such details shall include; procedures to complete condition surveys (for all sensitive receptors indicated in this EIA), Measurement locations and methods; methodology statements for works likely to induce vibrations, including programs of trial construction sections to determine the likely magnitude of vibrations at defined distances from the vibration source, in sufficient detail for the contractor to develop a final method for constructing the works without excessive	Yes	Yes	Yes

Sr. No.	Plan	Description	Approvals / NoC		
			PIU	GC	MDBs[83]
		vibration; description of the instrumentation and equipment to be used; copies of the instruction manuals and the laboratory calibration and test equipment certification. The resumes of the vibration monitoring technical support personnel, sufficient to define details of relevant experience; procedures for data collection and analysis; frequency of measurements; means and methods of providing warnings when the specified construction vibration limits are reached; and Action Plans to be implemented in the event that the specified construction vibration limits are reached. The generalized plans of action shall comprise the positive measures by the Contractor to control vibrations using alternative construction methods.			
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

G. ENVIRONMENTAL MONITORING PLAN (EMOP)

582. Environmental Monitoring Plan (EMoP) is a companion document of the EMP. 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 EIA report
(iii) Monitor implementation of the EMP
(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

583. 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: EMoP for NMRP Phase II project

Environmental Features	Aspect to be Monitored	Standard to be complied with	Time and Frequency of Monitoring	Location	Estimated Total Cost (₹)
Pre-Construction stage					
Air	Emission of dust and particulate matter as	GoI and WHO / IFC (most	Once, 24 hours	Each station, batching plant	1,360,000

Environmental Features	Aspect to be Monitored	Standard to be complied with	Time and Frequency of Monitoring	Location	Estimated Total Cost (₹)
	PM2.5 and PM10, NOx and SOx, CO	stringent)	continuously	and casting yard, Muck disposal site	
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 at wherever waterbody located within 100m from sites	1,680,000
Soil	pH, Sulphate (SO3), Chloride, ORP, water Soluble salts environmental clearance, 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	640,000
a) Noise & vibration b) Building condition survey	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 Hourly basis for 24 hours (noise & vibration) b) 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.	1,360,000
				Sub-Total (A)	**5,040,000**
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	For each station until civil works completed batching plant and casting yard,	2,720,000

Environmental Features	Aspect to be Monitored	Standard to be complied with	Time and Frequency of Monitoring	Location	Estimated Total Cost (₹)
				Muck disposal site, throughout construction phase (at each work-front site)	
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	3,360,000
Soil	PH, Sulphate (SO3), Chloride, ORP, water Soluble salts environmental clearance, 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	1,280,000
a) Noise, b) Vibration c) Building Condition Survey	a) Noise levels in dB(A) b) Vibration PPV mm/s c) Building Condition Survey	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) Building Condition Survey: crack sensors, tilt sensors, continuous height measurement etc.	a) For each station (at work front site) until completion of civil works b) At sensitive receptor locations c) 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. The	2,720,000

Environmental Features	Aspect to be Monitored	Standard to be complied with	Time and Frequency of Monitoring	Location	Estimated Total Cost (₹)
				vibration survey has been done during pre-construction stage. Any structures identified to be at risk need to be monitored during construction.	
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	4,000,000
				Sub-Total (B)	**14,080,000**
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	1,360,000
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.	840,000
Noise	Noise levels in dB(A)	GoI and WHO / IFC (most stringent)	At least 2 times in a year for the first year, annually for next 3 years	Alignment, Stations	1,360,000
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	1,360,000

Environmental Features	Aspect to be Monitored	Standard to be complied with	Time and Frequency of Monitoring	Location	Estimated Total Cost (₹)
				(for cat. 2) on either side of alignment	
Health and Safety	As specified in project EMP and Maha Metro's SHE Manual	IFC General and Sector EHS Guidelines or any other international recognized guidelines	Monthly for 4 years	Station locations	2,000,000
				Sub-Total (C)	**6,920,000**
				Grand Total (A + B + C)	**26,040,000**

H. GENERAL CONDITIONS FOR E&S WELFARE

584. In addition to implementation of EMP 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	Reference from SHE manual of NMRCL	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.	PART I SHE Management Clause 4.0 and its subsections	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	PART I SHE Management Clause 2.0 and its subsections	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.	PART I SHE Management Clause 3.0 and its subsections	Project Manager / SHE Head / Quality Head

Sr. No.	General Condition	Reference from SHE manual of NMRCL	Responsibility
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.	PART I SHE Management Clause 5.0 and its subsections	Project Manager / Designer / SHE Head
5	The Contractor shall appoint the required SHE personnel as prescribed in General Instruction NMRP/SHE/GI/001 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 NMRP/SHE/GI/002.	PART I SHE Management Clause 6.0 and its subsections	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.	PART I SHE Management Clause 7.0 and its subsections	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 NMRCL/SHE/GI/004.	PART I SHE Management Clause 8.0 and its subsections	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 NMRCL / GC.	PART I SHE Management Clause 9.0 and its subsections	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/NMRCL observations	PART I SHE Management Clause 10 and its subsections	Project Manager / SHE Head

Sr. No.	General Condition	Reference from SHE manual of NMRCL	Responsibility
10	Monthly environmental report shall be submitted by the contractor to GC / NMRCL on or before 10th of day of every month. The report shall track the progress in brief, compliance status of observations given by GC / NMRCL 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.	PART I SHE Management Clause 11 and its subsections	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.	PART I SHE Management Clause 11 and its subsections	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. Posters should be in Hindi, English, and other suitable language as deemed appropriate. Posters / billboards / banners/ glow signs should be changed at least once in a month to maintain the impact. The Contractor shall also observe important days as listed in General Instruction NMRCL/SHE/GI/008 and printing and displaying safety signage and posters as listed in General Instruction NMRCL/SHE/GI/009	PART I SHE Management Clause 11 and its subsections	Project Manager / SHE Head
13	Contractor shall report significant environmental incidents to NMRCL / 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.	PART I SHE Management Clause 14 and its subsections	Project Manager / SHE Head

I. TRAINING AND CAPACITY BUILDING PROGRAMS

585. Maha Metro's current capacity in monitoring of metro projects in adequate. However, it is proposed to conduct a training program for Maha Metro as well as GC and Contractors' environmental, health and safety officials particularly on MDBs' monitoring and reporting requirements. If engaged, the External monitor will also undertake training and capacity building activities. Training modules will be discussed and confirmed by Maha Metro and the MDBs. A budget for the same has been allocated in the EMP.

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

587. The tentative schedule of the training programs for Environmental Engineers is as follows:

Sr. No.	Particulars	Frequency	Agency
1	Awareness about principles, guidelines & compliance requirements of funding instituitions	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 MahaMetro	Contractor / GC

X. CONCLUSIONS AND RECOMMENDATIONS

588. None of the four alignments of the proposed Nagpur Metro Rail Project – Phase II, are located in any protected area or near a site of historical / cultural significance. Some impact is anticipated due to cutting of about 538 public trees along existing roads.

589. 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.

590. Measures to mitigate adverse impacts have been recommended.

591. After mitigation some residual impacts are expected, predominantly due to noise, vibration, visual intrusion and health and safety risks.

592. 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.

593. Public consultations highlighted opinions of participants on benefits of Metro in terms of easing connectivity, pollution, congestion, accidents and travel on roads. Public consultations during construction and operation will form part of periodic reports sent by NMRP to ADB & EIB. These consultations will focus on the efficacy of mitigation measures being implemented.

594. 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.

595. 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.

596. 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.

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

598. 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

Environmental Impact Assessment

PUBLIC

5th July 2024
Revision No. 7
Final Draft

India: Nagpur Metro Urban Mobility Project

Annexures 1–10

Prepared by MITCON Consultancy and Engineering Services Ltd. for the Maharashtra Metro Rail Corporation Limited (Maha Metro) and the Asian Development Bank (ADB). This is an updated version of the draft originally posted in December 2023 available on https://www.adb.org/projects/documents/ind-56297-001-eia.

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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	3	1 (c)	A
2	Thermal power plants	4	1 (d)	A
3	Metallurgical industries	8	3 (a)	A
4	Cement plants	9	3 (b)	B
5	Petro-chemical complexes (industries based on processing of petroleum fractions & natural gas and/or reforming to aromatics)	18	5 (c)	A
6	Synthetic organic chemicals industry	21	5 (f)	A
7	Distilleries	22	5 (g)	A
8	Pulp & paper industry excluding manufacturing of paper from wastepaper and manufacture of paper from ready pulp without bleaching	24	5 (i)	A
9	Sugar Industry	25	5 (j)	B
10	Ports, harbours, break waters and dredging	33	7 (e)	A
11	Highways	34	7 (f)	A
12	Common Effluent Treatment Plants (CETPs)	36	7 (h)	B
13	Common Municipal Solid Waste Management Facility (CMSWMF)	37	7 (i)	B
14	Building and construction projects	38	8 (a)	B
15	Townships and Area development projects	39	8 (b)	B

Note: Names of approved EIA Coordinators and Functional Area Experts are mentioned in RAAC minutes dated Oct 22, 2021 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/22/2202 dated Jan 06, 2022. The accreditation needs to be renewed before the expiry date by MITCON Consultancy and Engineering Services Ltd., Pune following due process of assessment.

Sr. Director, NABET
Dated: Jan 06, 2022

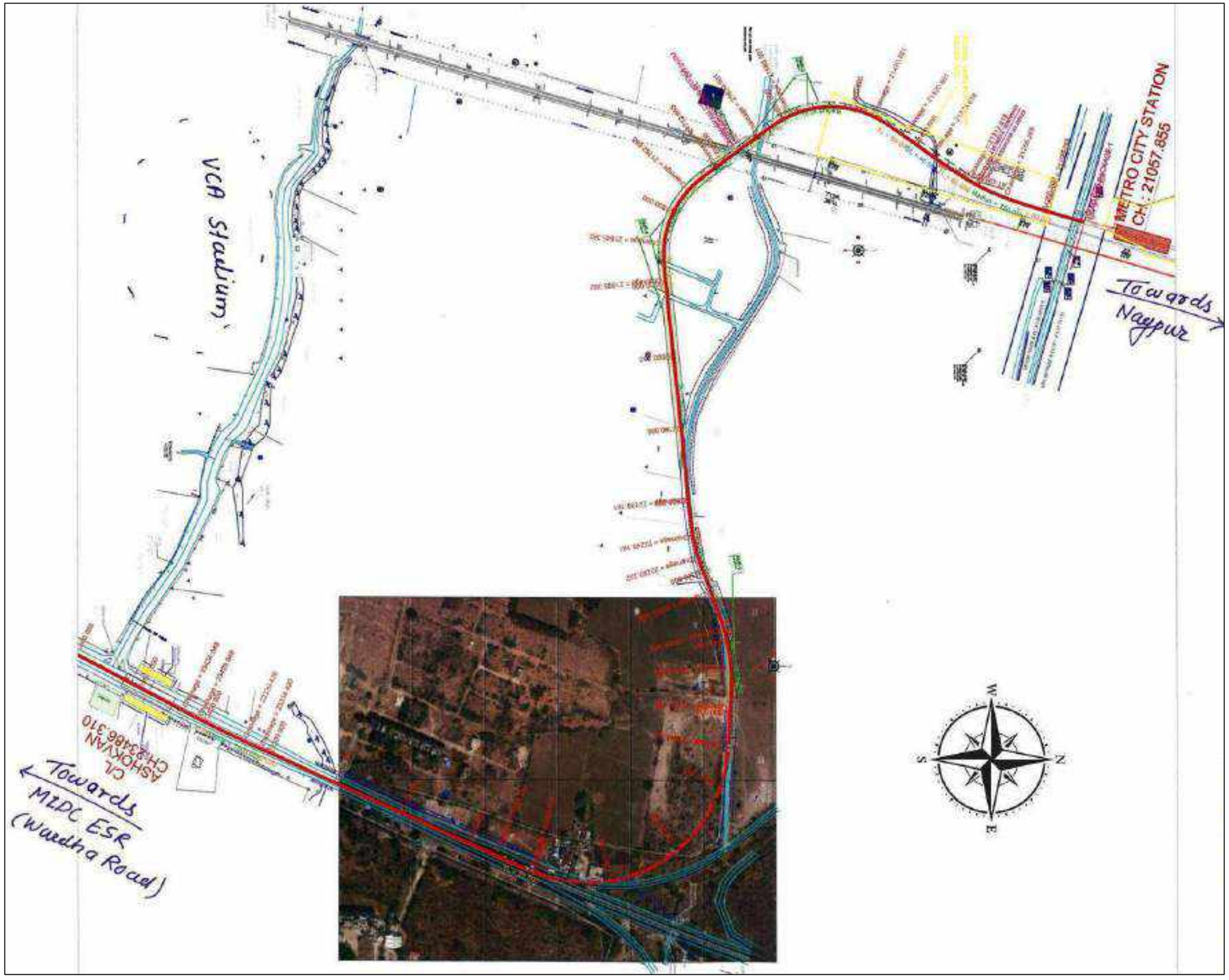
Certificate No.
NABET/EIA/2124/RA 0229_Rev 02

Valid up to
Feb 05, 2024

For the updated List of Accredited EIA Consultant Organizations with approved Sectors please refer to QCI-NABET website.

ANNEXURE 2: Drawings

Figure A


VCA Stadium
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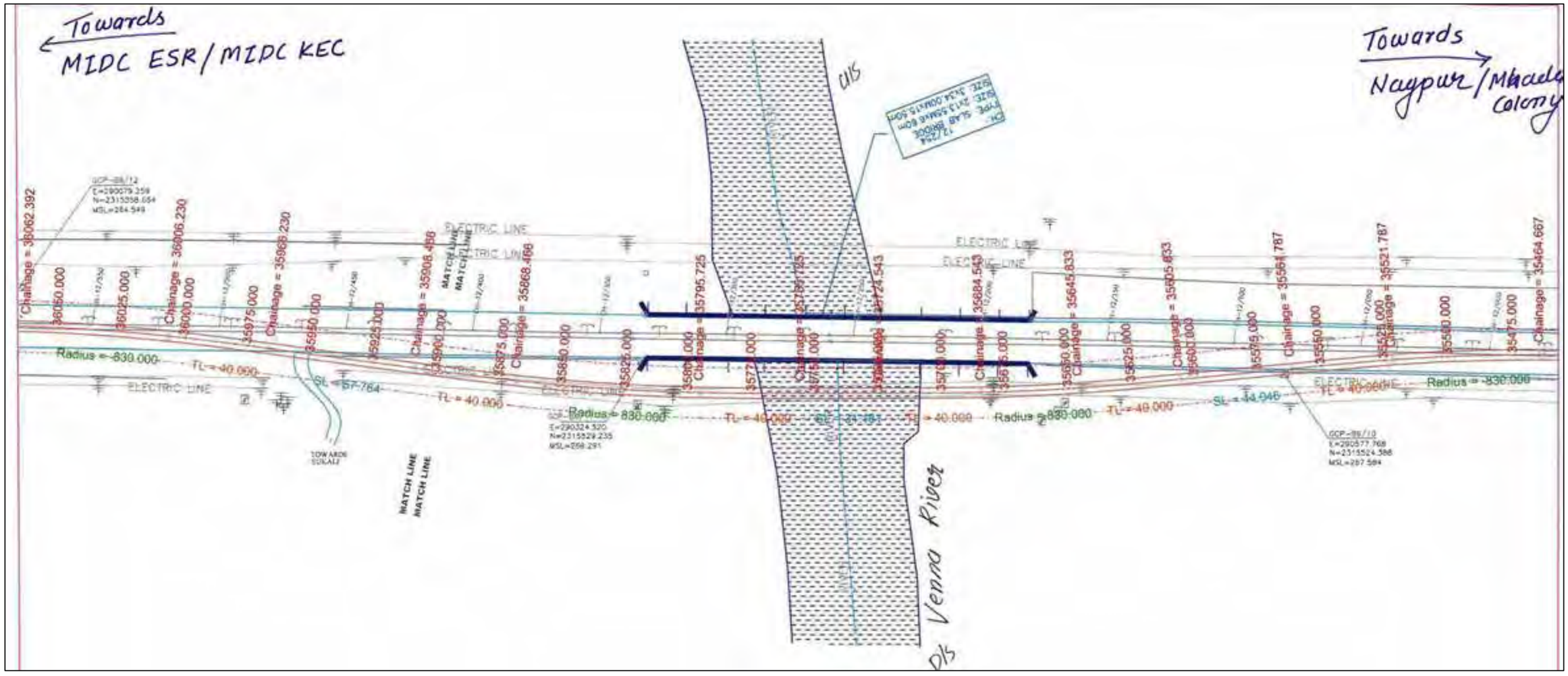
Towards
Nagpur
C/L
ASHOKVAN
CH:23486.310
Towards
MIDC ESR
(Wardha Road)
W
N
S
E

Figure B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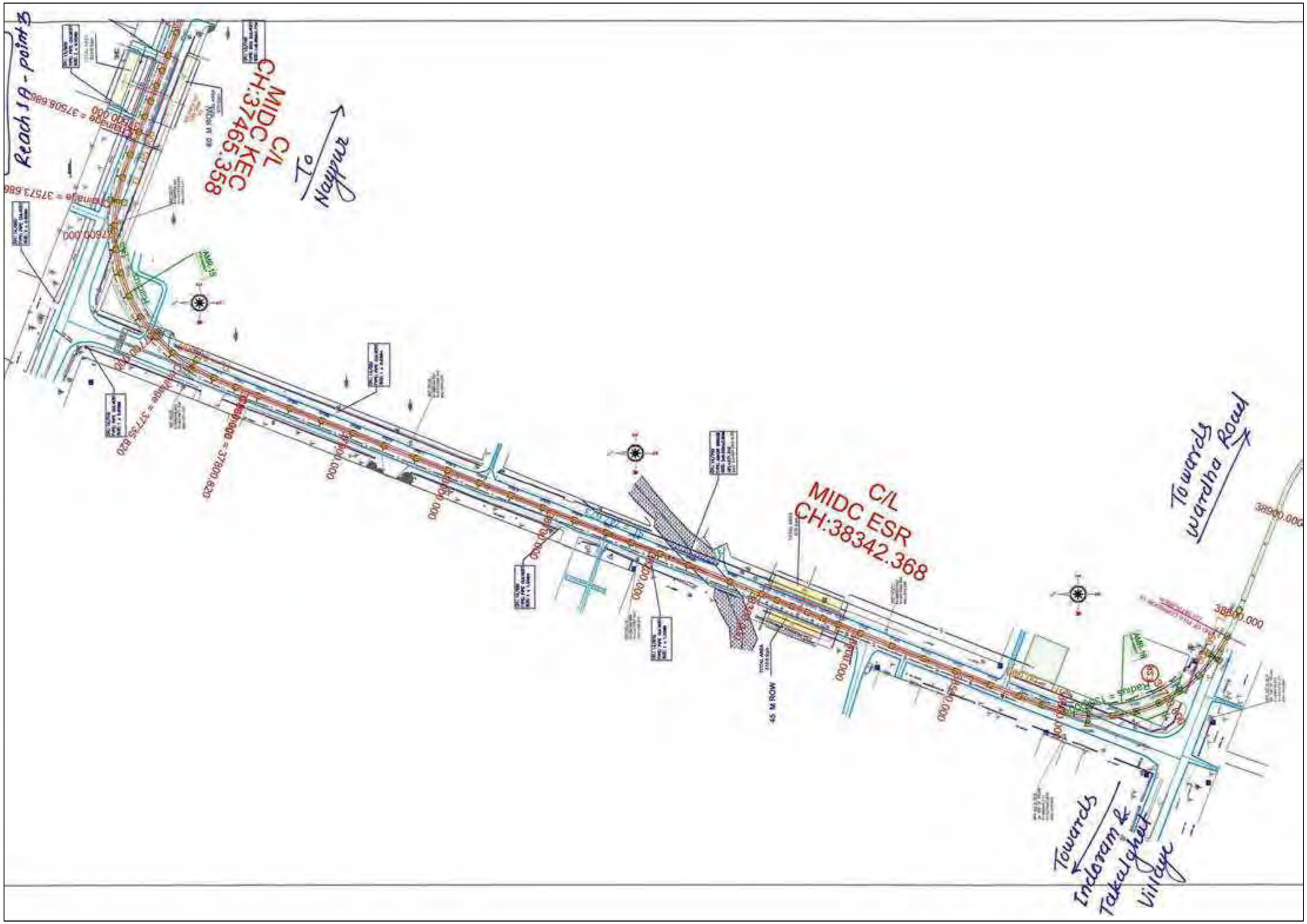
MIDC ESR / MIDC KEC
Towards
Naypur / Mhada Colony
D/S Venna River

Figure C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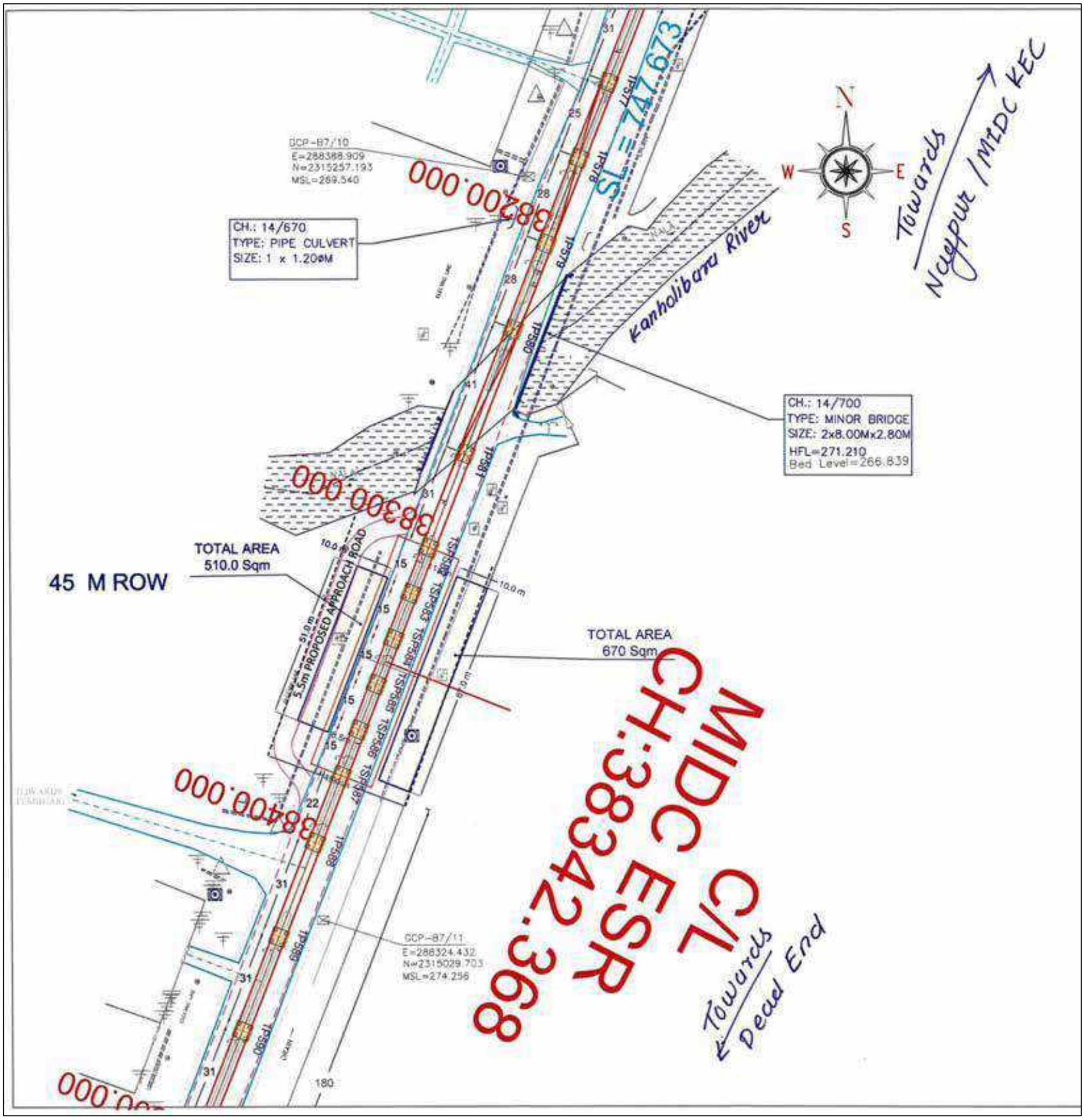
To Nagpur
C/L MIDC ESR CH:38342.368
45 M ROW
To wards wardha Road
Towards Indoram & Takalghat Village

Figure D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CH.: 14/700
TYPE: MINOR BRIDGE
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Bed Level=266.839
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45 M ROW
5.5m PROPOSED APPROACH ROAD
TOTAL AREA
670 Sqm
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N=2315029.703
MSL=274.256
Kanholibara River
Towards Nagpur / MIDC KEC
Towards Dead End
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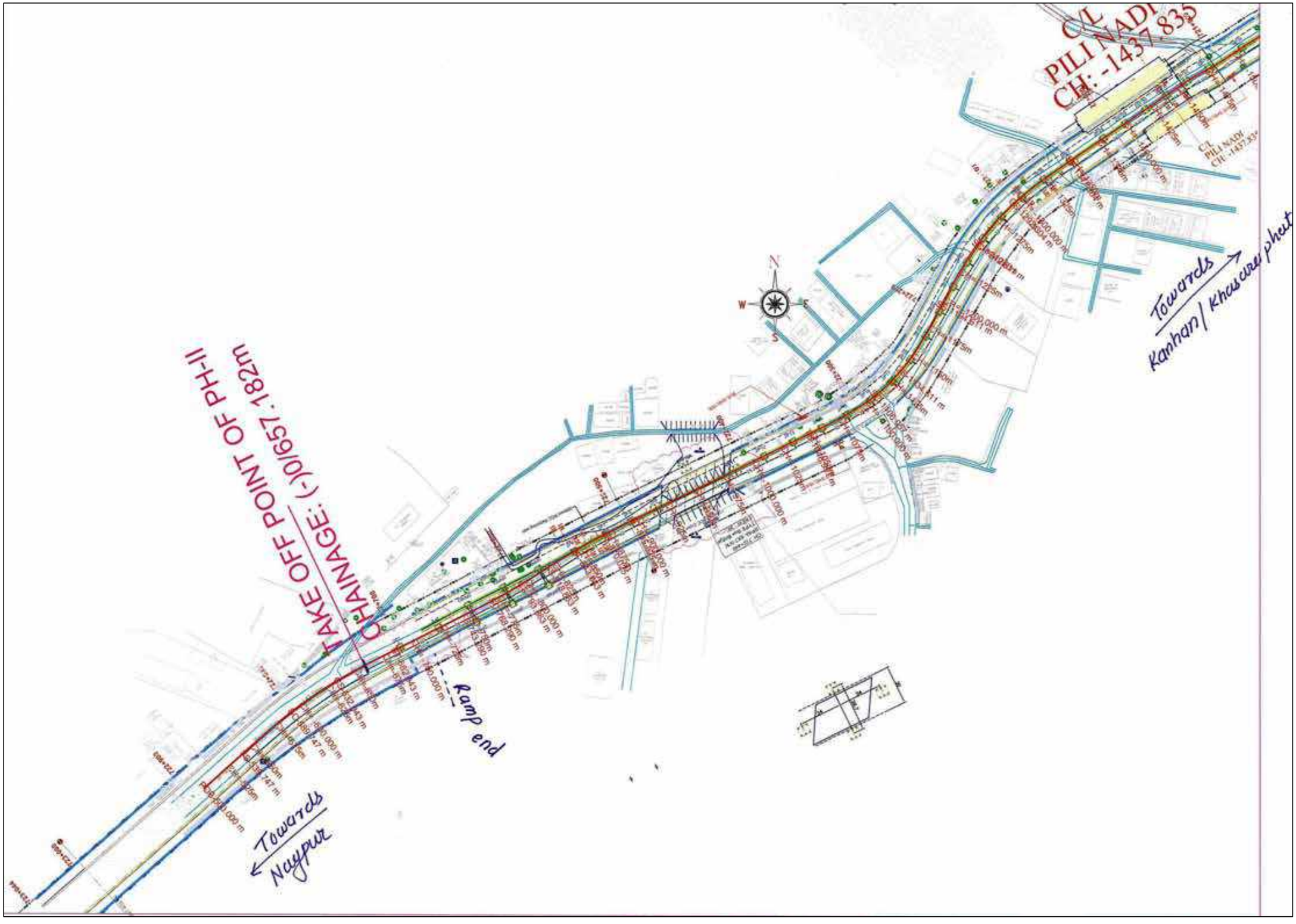
000.00
N
S
E
W

Figure E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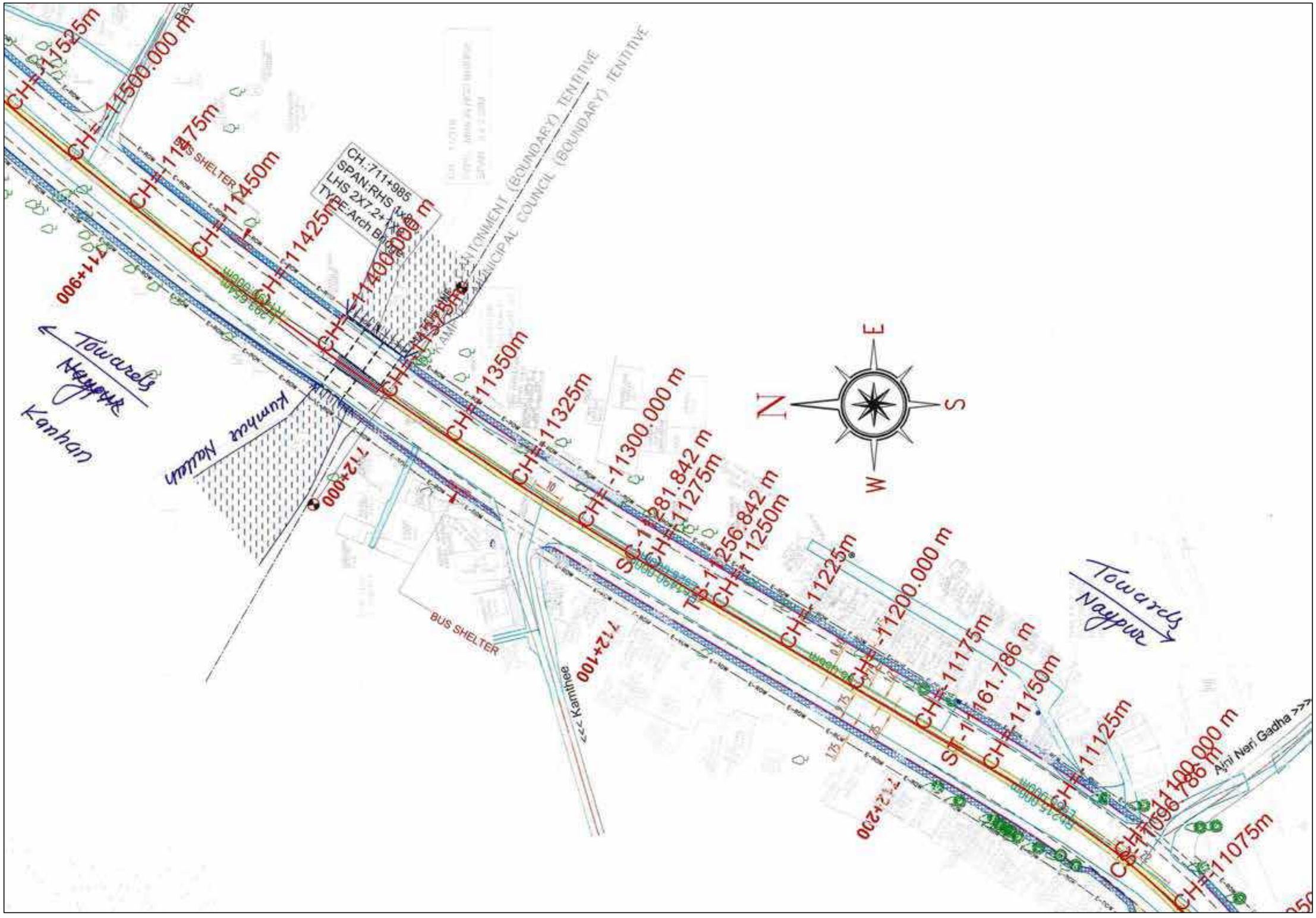
Towards Kamhan/ Khaparkheda
Ramp end
Towards Nagpur

Figure F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CH-11250m
CH-11225m
CH-11200.000 m
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LHS 2X7.2+1X
TYPE:Arch B
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712+000
712+100
712+200
BUS SHELTER
Towards Nagpur
Towards Nagpur
Kanhan Nadi
Kamthee
Ajni Nari Gadha >>>
ANTONMENT (BOUNDARY) TENTITIVE
MUNICIPAL COUNCIL (BOUNDARY) TENTITIVE
E
N
S
W

Figure G

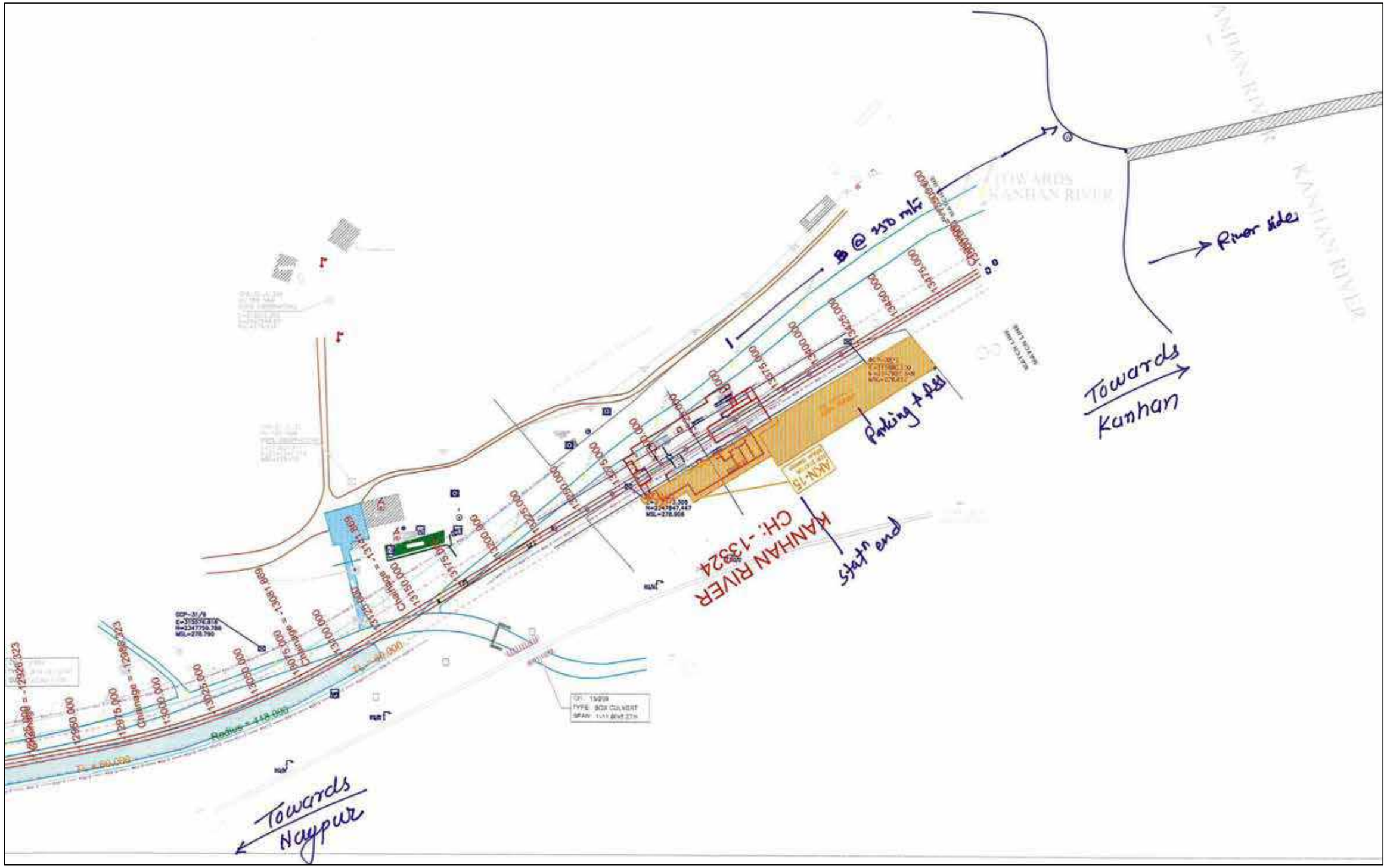

B @ 150 mtr
River side
Towards Kanhan
Parking area
KANHAN RIVER
CH: -13324
Start end
Towards Nagpur

Figure H

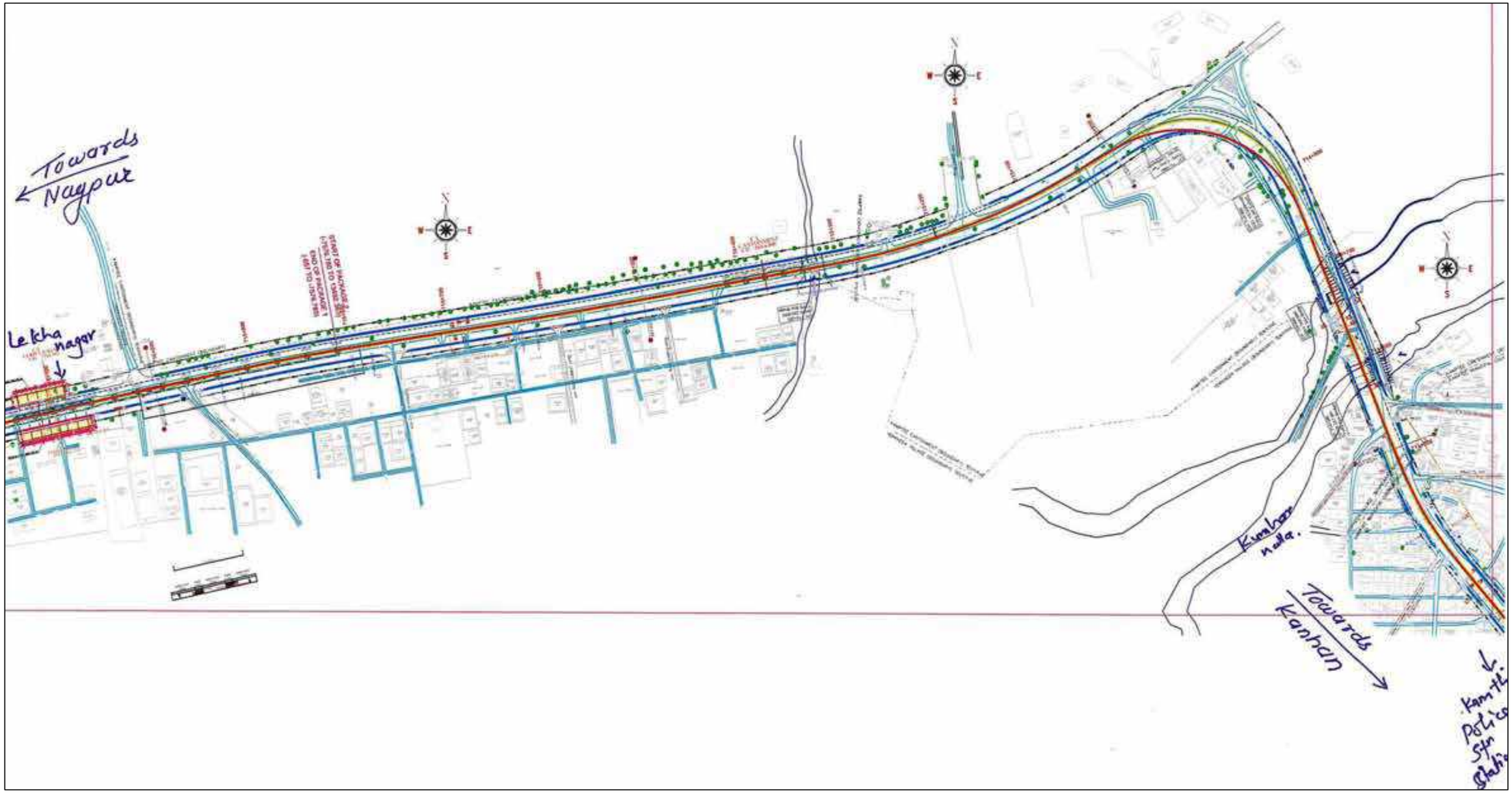


Figure I

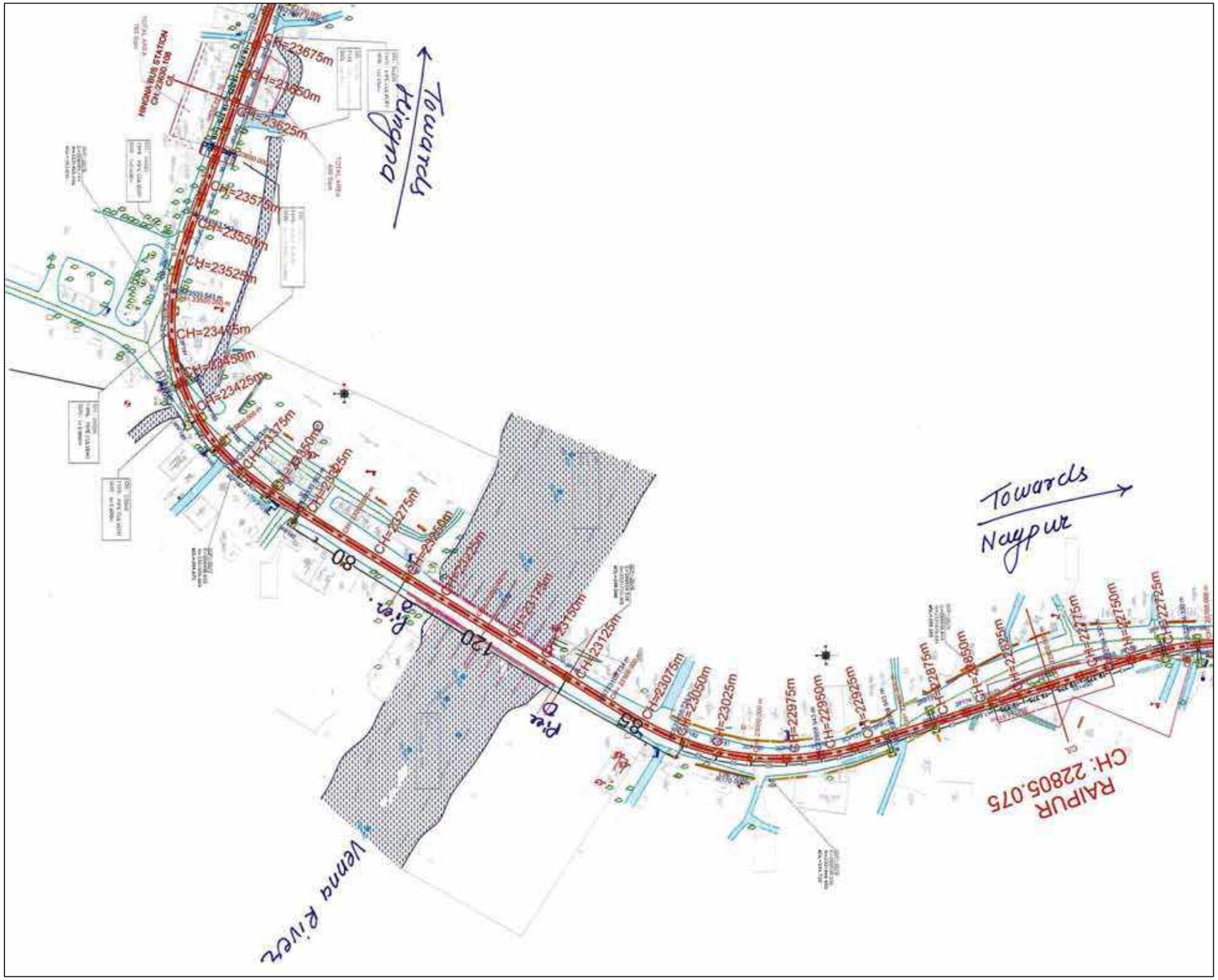

Towards Nagpur
HINGNA BUS STATION
CH: 23600.108
CH=23675m
CH=23650m
CH=23625m
CH=23575m
CH=23550m
CH=23525m
CH=23475m
CH=23450m
CH=23425m
CH=23375m
CH=23350m
CH=23325m
CH=23275m
CH=23250m
CH=23225m
CH=23175m
CH=23150m
CH=23125m
CH=23075m
CH=23050m
CH=23025m
CH=22975m
CH=22950m
CH=22925m
CH=22875m
CH=22850m
CH=22825m
CH=22775m
CH=22750m
CH=22725m
80
120
80
Towards Nagpur
RAIPUR
CH: 22805.075
Vena River

Figure J

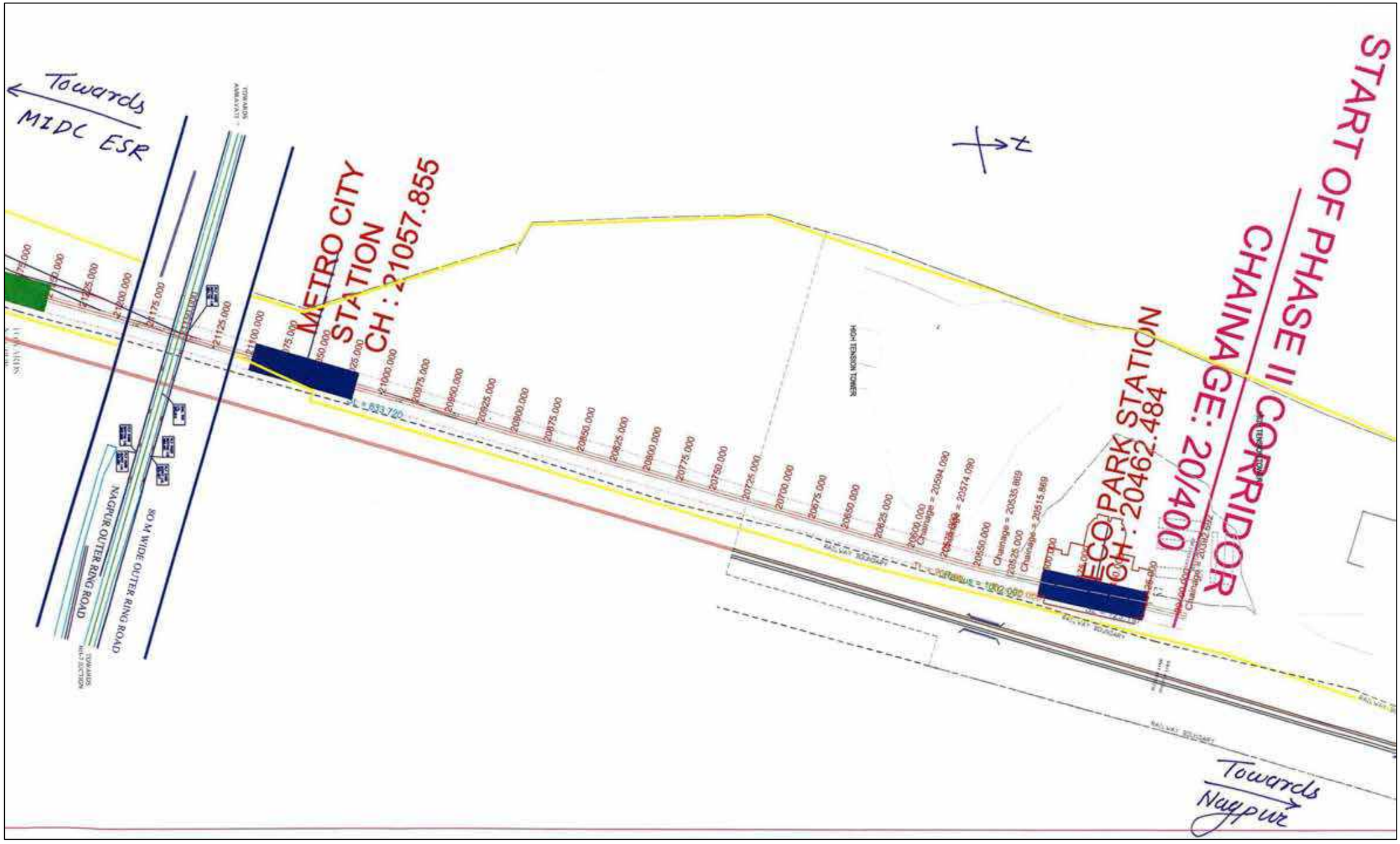

Towards
MIDC ESR
METRO CITY
STATION
CH : 21057.855
START OF PHASE II CORRIDOR
CHAINAGE: 20400
ECO PARK STATION
CH : 20462.484
HIGH TENSION TOWER
NAGPUR OUTER RING ROAD
80 M WIDE OUTER RING ROAD
Towards
Nagpur

Figure K

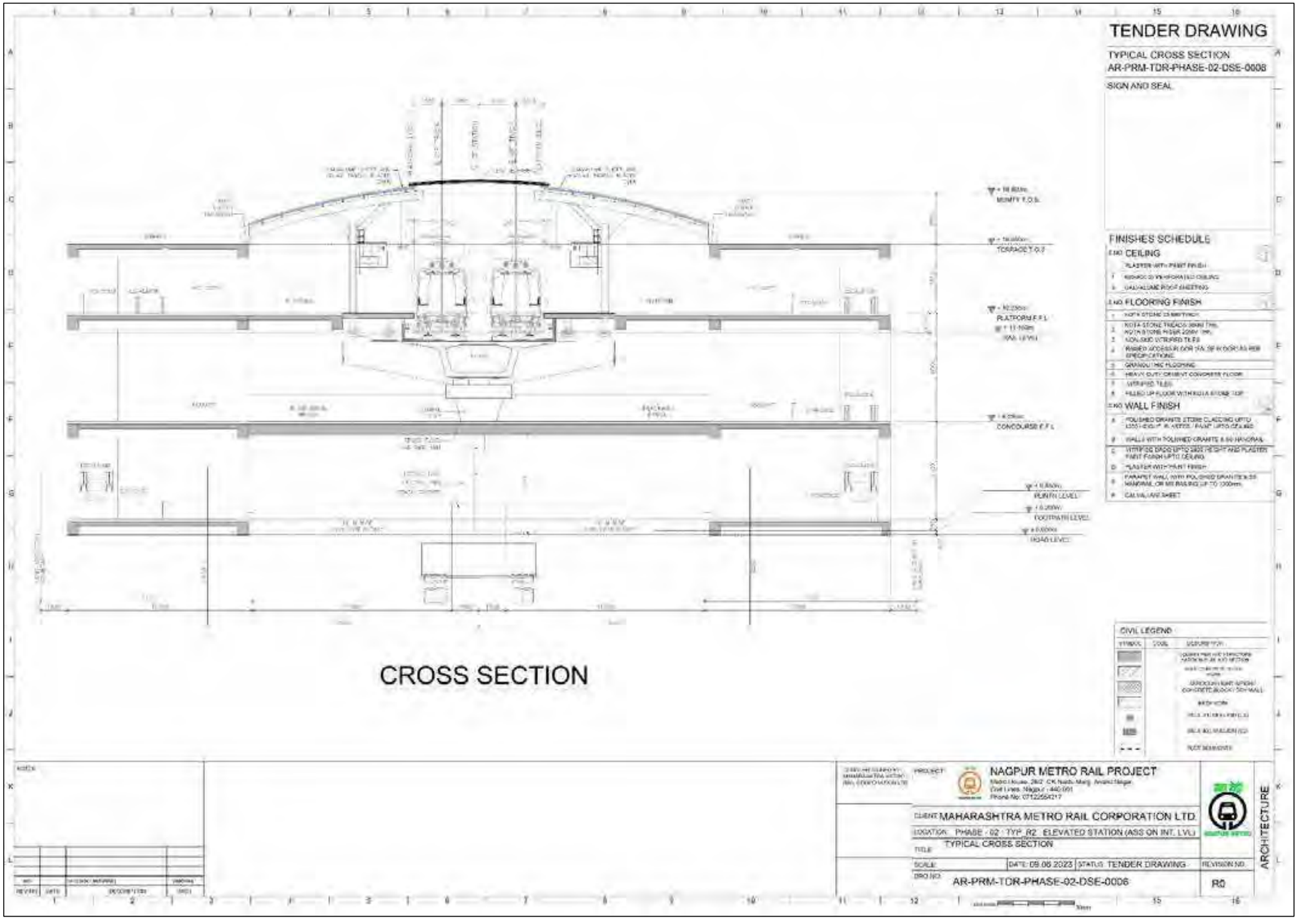

TENDER DRAWING
TYPICAL CROSS SECTION
AR-PRM-TDR-PHASE-02-DSE-0008
SIGN AND SEAL
FINISHES SCHEDULE
CEILING
FLOORING FINISH
WALL FINISH
CROSS SECTION
CIVIL LEGEND
NAGPUR METRO RAIL PROJECT
CLIENT MAHARASHTRA METRO RAIL CORPORATION LTD.
TYPICAL CROSS SECTION
DRG NO. AR-PRM-TDR-PHASE-02-DSE-0006
REVISION NO. R0
ARCHITECTURE

Figure L

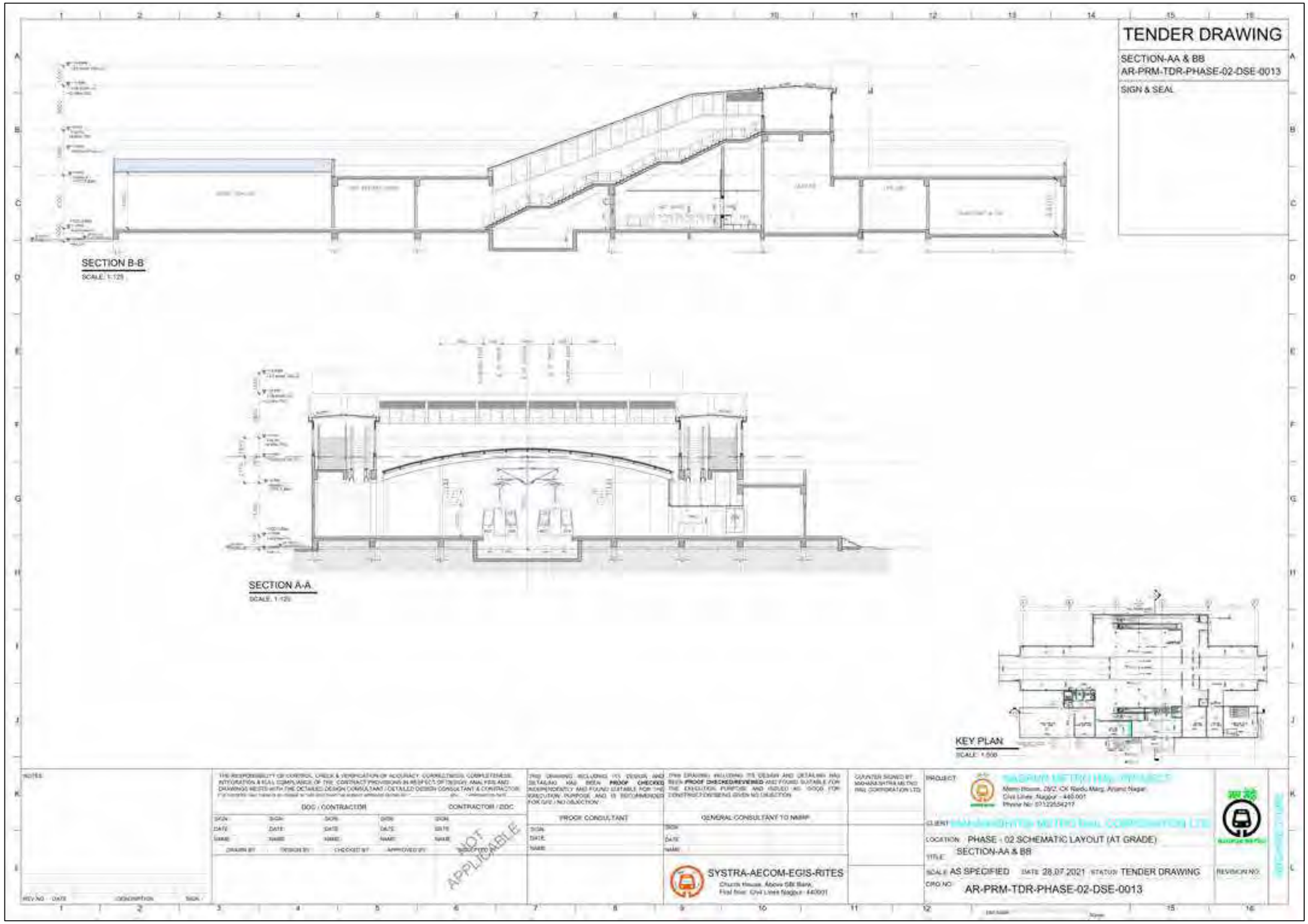

TENDER DRAWING
SECTION-AA & BB
AR-PRM-TDR-PHASE-02-DSE-0013
SIGN & SEAL
SECTION B-B
SCALE: 1:125
SECTION A-A
SCALE: 1:125
KEY PLAN
SCALE: 1:500
NOTES:
DOC / CONTRACTOR
CONTRACTOR / ZDC
PROOF CONSULTANT
GENERAL CONSULTANT TO NMRP
NOT APPLICABLE
SYSTRA-AECOM-EGIS-RITES
Church House, Above SBI Bank,
First floor, Civil Lines Nagpur - 440001
PROJECT:
Metro Bhawan, 29/2, CK Naidu Marg, Ajnara Nagar,
Civil Lines, Nagpur - 440 001
Phone No: 07122554217
CLIENT:
LOCATION: PHASE - 02 SCHEMATIC LAYOUT (AT GRADE)
TITLE: SECTION-AA & BB
SCALE: AS SPECIFIED
DATE: 28.07.2021
STATUS: TENDER DRAWING
DRG NO: AR-PRM-TDR-PHASE-02-DSE-0013
REVISION NO:

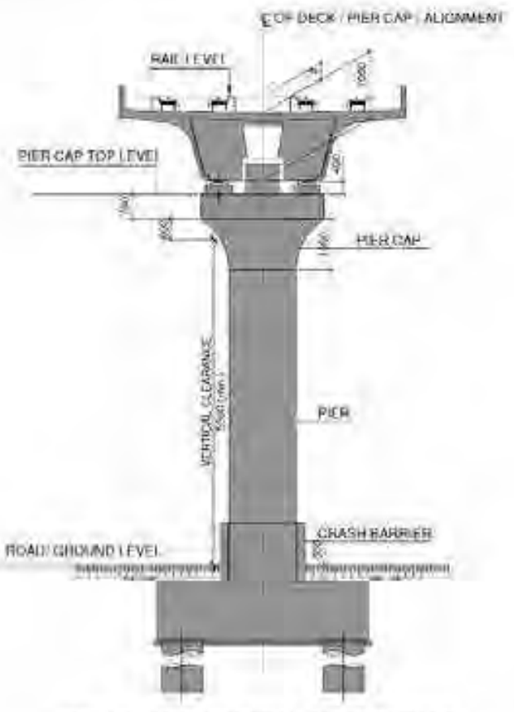
Figure M

TENDER DRAWING

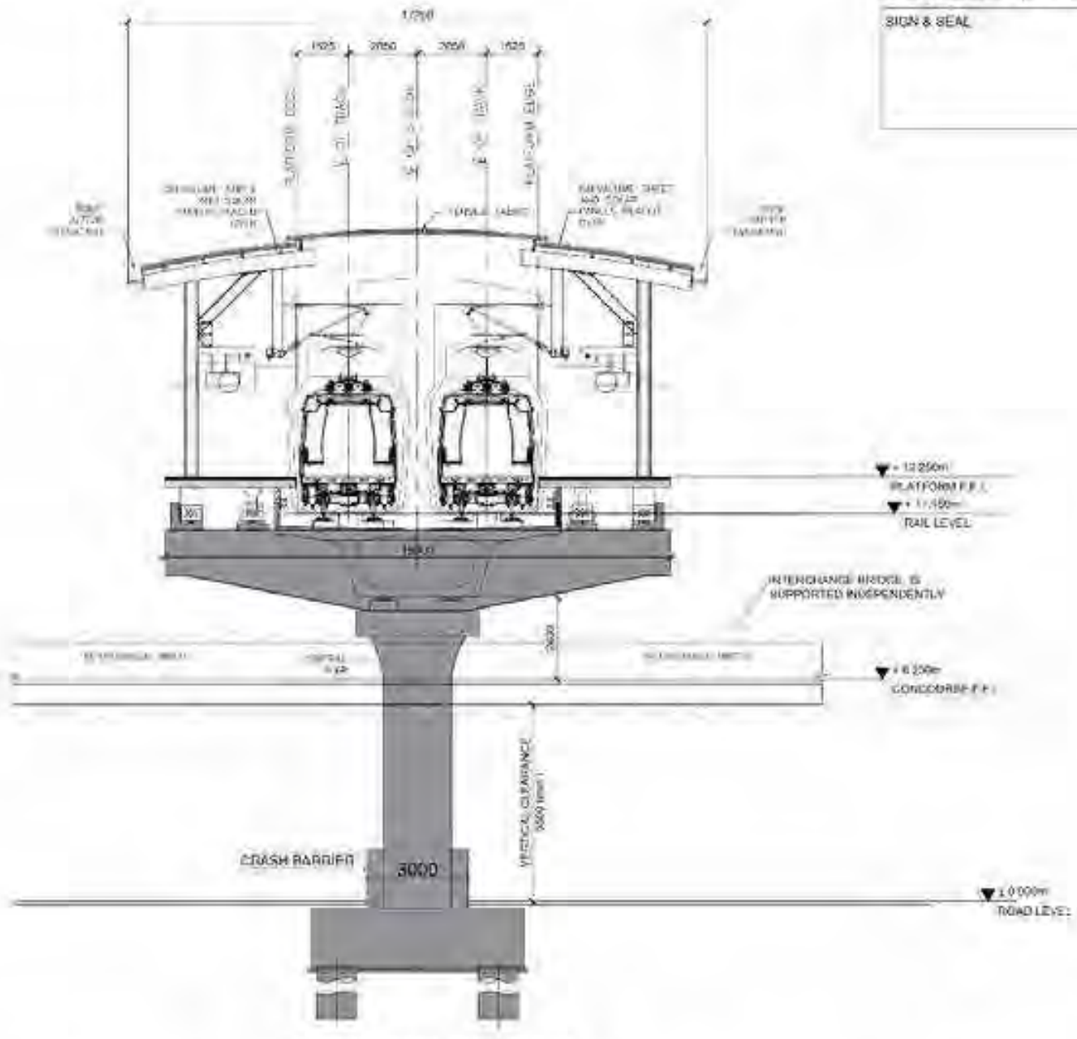
SIGN & SEAL

Additional Notes:

1. Bidders shall note that Scope of work under lumpsum contract in single decker stretch involves Design and Construction of substructure and Segmental Superstructure with necessary bearing pedestals, bearings, seismic restrainer and drainage arrangement as detailed in 2.1.1 & 2.1.2 of Employer's Requirements Functional (Section VII - B Part II) to the extent applicable.
2. Scope of work in this contract involves Design and Construction of the GREY color hatched portion only.
3. For single decker Stations, the Scope under lumpsum contract also includes Design and Construction of substructure and Segmental Superstructure with necessary bearing pedestals, bearings, seismic restrainer and drainage arrangement alongwith Piercaps at Track/ Platform level.



TYPICAL CROSS SECTION OF BOX GIRDER
VIADUCT WITH NORMAL PIER



TYPICAL CROSS SECTION FOR
METRO VIADUCT WITH PIER ARM FOR SUPPORTING PLATFORM (OTHER THAN CONNECTING BRIDGE) AND PEB
SINGLE DECKER PORTION

NOTES:- PAINTING TO BE DONE AS PER SPECIFICATION FOR PIER, PIERCAP AND SUPERSTRUCTURE.

NOT APPLICABLE

PROOFCONSULTANT

SYSTRA-AECOM-EGIS-RITES

PROJECT: NAGPUR METRO RAIL PROJECT

CLIENT: MAHARASHTRA METRO RAIL CORPORATION LTD.

LOCATION: PHASE - 02

TITLE: TYPICAL CROSS SECTIONS IN SINGLE DECKER PORTION (SHEET 1)

SCALE: AS SPECIFIED DATE: 18.02.2023 STATUS: TENDER DRAWING

DRG NO: CV-PRM-TDR-PHASE-02-DRP-0005

REVISION NO: R0

STRUCTURE

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Format No. EME/LAB/Format 7.8/TR

Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/1**
	Name of Sample	Surface water
	Sample Details	Pili Nadi 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	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	Test Methods
1	pH at 25 °C	7.23	-	APHA 4500 H+, A, 4 95, 23rd Ed.2017.
2	Temperature	28.3	°C	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	849.6	µS/cm	APHA 2510 B,2-56 to 2-58 ,23rd Ed.2017.
4	Turbidity	15.2	NTU	IS: 3025 Part-10 (Rev.1,RA:2012)
5	Total Dissolved Solids	570.0	mg/l	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	604.0	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 $CaCO_3$	187.9	mg/l	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
9	Total Hardness as $CaCO_3$	191.28	mg/l	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
10	Calcium as Ca	52.25	mg/l	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
11	Magnesium as Mg	32.14	mg/l	APHA 3500 Mg B, 3. 86 ,23rd Ed.2017.
12	Chloride as Cl^-	55.23	mg/l	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
13	Sulphates as SO_4	31.65	mg/l	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
14	Nitrate as NO3	8.87	mg/l	APHA 4500 NO3 - B 4-127 23rd Ed.2017.
15	Ammonical Nitrogen as NH_4-N	3.25	mg/l	APHA 4500 NH_3 F, 4-119 to 4-120 23rd Ed.2017.
16	Total Kjeldahl Nitrogen as NH3-N	4.15	mg/l	APHA 4500 N org B and 4500 N-NH_3 C
17	salinity	0.099	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_2	6.52	mg/l	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.
21	Sodium as Na	6.15	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
22	Potassium as K	1.73	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

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	28	mg/l	IS: 3025 Part-44-1993 (Rev.1, RA 2014)
34	Chemical Oxygen Demand	72	mg/l	APHA 5220 C,5-20 to 5-21 23rd Ed 2017
35	Dissolved Oxygen	2.0	mg/l	IS: 3025 (Part-38)-1989
36	Boron	<0.04	mg/l	APHA 4500 B-c 4-27 23rd Ed 2017
		Microbiological Parameters		
01	Total Coliforms	>1600	Per100 ml	IS: 15185:2016
02	E-coli	>1600	Per100 ml	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

MITCON CONSULTANCY & ENGINEERING SERVICES LTD. * PUNE *

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Format No. EME/LAB/Format 7.8/TR

Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/2**
	Name of Sample	Surface water
	Sample Details	Nallah near Lekha nagar station D/S
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	MITCON
	Method of sampling	IS 3025 (Part I)
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	Test Methods
1	pH at 25 °C	7.89	-	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	28.7	°C	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	997.7	µS/cm	APHA 2510 B,2-56 to 2-58 ,23rd Ed.2017.
4	Turbidity	20.1	NTU	IS: 3025 Part-10 (Rev.1,RA:2012)
5	Total Dissolved Solids	676.0	mg/l	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	898.0	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 $CaCO_3$	171.42	mg/l	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
9	Total Hardness as $CaCO_3$	212.4	mg/l	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
10	Calcium as Ca	80.12	mg/l	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
11	Magnesium as Mg	32.18	mg/l	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
12	Chloride as Cl	27.12	mg/l	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
13	Sulphates as SO_4	30.14	mg/l	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
14	Nitrate as NO3	7.43	mg/l	APHA 4500 NO3 - B 4-127 23rd Ed.2017.
15	Ammonical Nitrogen as NH_4-N	3.46	mg/l	APHA 4500 NH_3 F, 4-119 to 4 120 23rd Ed.2017.
16	Total Kjeldahl Nitrogen as NH3-N	7.52	mg/l	APHA 4500 N org B and 4500 N NH_3 C
17	salinity	0.049	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	1.15	mg/l	APHA 4500 P-C4-162, 23rd Ed.2017.
20	Silica as SiO_2	6.52	mg/l	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.
21	Sodium as Na	7.31	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
22	Potassium as K	1.112	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

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	9.0	mg/l	IS: 3025 Part-44-1993 (Rev.1, RA 2014)
34	Chemical Oxygen Demand	28.0	mg/l	APHA 5220 C,5-20 to 5-21 23rd Ed 2017
35	Dissolved Oxygen	3.0	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	110	Per100 ml	IS: 15185:2016
02	E-coli	90	Per100 ml	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/3**
	Name of Sample	Surface water
	Sample Details	NAG River at kamptee D/S
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	MITCON
	Method of sampling	IS 3025 (Part I)
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	Test Methods
1	pH at 25 °C	8.02	-	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	29.6	°C	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	1200.4	µS/cm	APHA 2510 B,2-56 to 2-58 ,23rd Ed.2017.
4	Turbidity	25.3	NTU	IS: 3025 Part-10 (Rev.1,RA:2012)
5	Total Dissolved Solids	814.0	mg/l	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	847.0	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 $CaCO_3$	200.6	mg/l	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
9	Total Hardness as $CaCO_3$	212.35	mg/l	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
10	Calcium as Ca	78.12	mg/l	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
11	Magnesium as Mg	32.16	mg/l	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
12	Chloride as Cl^-	45.16	mg/l	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
13	Sulphates as SO_4	78.13	mg/l	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
14	Nitrate as NO3	15.25	mg/l	APHA 4500 NO3 - B 4-127 23rd Ed.2017.
15	Ammonical Nitrogen as NH_4-N	2.25	mg/l	APHA 4500 NH_3 F, 4-119 to 4-120 23rd Ed.2017.
16	Total Kjeldahl Nitrogen as NH3-N	6 15	mg/l	APHA 4500 N org B and 4500 N-NH_3 C
17	salinity	0.081	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	3.25	mg/l	APHA 4500 P-C4-162, 23rd Ed.2017.
20	Silica as SiO_3	5.78	mg/l	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.
21	Sodium as Na	8.13	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
22	Potassium as K	2.12	mg/l	APHA 3111B, 3-20 to 3 21 , 23rd Ed.2017.(AAS)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

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	25	mg/l	IS: 3025 Part-44-1993 (Rev.1, RA 2014)
34	Chemical Oxygen Demand	75	mg/l	APHA 5220 C,5-20 to 5-21 23rd Ed 2017
35	Dissolved Oxygen	1.9	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	120.0	Per100 ml	IS: 15185:2016
02	E-coli	40.0	Per100 ml	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

Authorized Signatory
Dr. Sandeep Jadhav
[Senior Vice President]

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/4**
	Name of Sample	Surface water
	Sample Details	Kamptee Nallah 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	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	Test Methods
1	pH at 25 °C	8.057	-	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	28.6	°C	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	870.1	µS/cm	APHA 2510 B,2-56 to 2-58 ,23rd Ed.2017.
4	Turbidity	27.4	NTU	IS. 3025 Part-10 (Rev.1,RA:2012)
5	Total Dissolved Solids	545.0	mg/l	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	555.0	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 $CaCO_3$	189.25	mg/l	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
9	Total Hardness as $CaCO_3$	224.51	mg/l	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
10	Calcium as Ca	65.12	mg/l	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
11	Magnesium as Mg	29.14	mg/l	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
12	Chloride as Cl^-	42.13	mg/l	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
13	Sulphates as SO_4	34..08	mg/l	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
14	Nitrate as NO3	9.56	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	<1.0	mg/l	APHA 4500 N org B and 4500 N-NH_3 C
17	salinity	0.076	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	8.72	mg/l	APHA 4500 P-C4-162, 23rd Ed.2017.
20	Silica as SiO_2	5.28	mg/l	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.
21	Sodium as Na	9.13	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
22	Potassium as K	2.45	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)

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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	80.0	mg/l	IS: 3025 Part-44-1993 (Rev.1, RA 2014)
34	Chemical Oxygen Demand	259.0	mg/l	APHA 5220 C,5-20 to 5-21 23rd Ed 2017
35	Dissolved Oxygen	1.0	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	>1600	Per100 ml	IS: 15185:2016
02	E-coli	>1600	Per100 ml	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/5**
	Name of Sample	Surface water
	Sample Details	Kanhan River
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	MITCON
	Method of sampling	IS 3025 (Part 1)
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	Test Methods
1	pH at 25 °C	7.58	-	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	28.4	°C	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	855.0	µS/cm	APHA 2510 B,2-56 to 2-58 ,23rd Ed.2017.
4	Turbidity	1.7	NTU	IS: 3025 Part-10 (Rev.1,RA:2012)
5	Total Dissolved Solids	575	mg/l	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	589	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 $CaCO_3$	174.8	mg/l	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
9	Total Hardness as $CaCO_3$	220.3	mg/l	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
10	Calcium as Ca	73.13	mg/l	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
11	Magnesium as Mg	32.16	mg/l	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
12	Chloride as Cl^-	38.67	mg/l	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
13	Sulphates as SO_4	40.02	mg/l	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed 2017.
14	Nitrate as NO3	10.13	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	<1.0	mg/l	APHA 4500 N org B and 4500 N-NH_3 C
17	salinity	0.070	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	6.25	mg/l	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.
21	Sodium as Na	8.14	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
22	Potassium as K	1.19	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)

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Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

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	4.0	mg/l	IS: 3025 Part-44-1993 (Rev.1, RA 2014)
34	Chemical Oxygen Demand	16.0	mg/l	APHA 5220 C,5-20 to 5-21 23rd Ed 2017
35	Dissolved Oxygen	24	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	30	Per100 ml	IS: 15185:2016
02	E-coli	20	Per100 ml	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspath,Nagpur-440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/6**
	Name of Sample	Surface water
	Sample Details	Raipur Nala upstream
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	MITCON
	Method of sampling	IS 3025 (Part I)
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	Test Methods
1	pH at 25 °C	7.83	-	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	28.6	°C	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	1470.0	µS/cm	APHA 2510 B,2-56 to 2-58 ,23rd Ed.2017.
4	Turbidity	10.3	NTU	IS: 3025 Part-10 (Rev.1,RA:2012)
5	Total Dissolved Solids	1008.0	mg/l	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	1092.0	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 $CaCO_3$	212.7	mg/l	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
9	Total Hardness as $CaCO_3$	404.02	mg/l	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
10	Calcium as Ca	80.12	mg/l	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
11	Magnesium as Mg	42.08	mg/l	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
12	Chloride as Cl	55.17	mg/l	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
13	Sulphates as SO_4	101.25	mg/l	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
14	Nitrate as NO3	12.23	mg/l	APHA 4500 NO3 - B 4-127 23rd Ed.2017.
15	Ammonical Nitrogen as NH_4-N	2.43	mg/l	APHA 4500 NH_3 F, 4-119 to 4-120 23rd Ed.2017.
16	Total Kjeldahl Nitrogen as NH3-N	4.28	mg/l	APHA 4500 N org B and 4500 N-NH_3 C
17	salinity	0.0099	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	1.13	mg/l	APHA 4500 P-C4-162, 23rd Ed.2017.
20	Silica as SiO_3	6.02	mg/l	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.
21	Sodium as Na	13.2	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
22	Potassium as K	3.12	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)

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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	19.0	mg/l	IS: 3025 Part 44-1993 (Rev.1, RA 2014)
34	Chemical Oxygen Demand	54.0	mg/l	APHA 5220 C,5-20 to 5-21 23rd Ed 2017
35	Dissolved Oxygen	2.4	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	400	Per100 ml	IS: 15185:2016
02	E-coli	150	Per100 ml	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

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Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/7**
	Name of Sample	Surface water
	Sample Details	Vena River upstream
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	MITCON
	Method of sampling	IS 3025 (Part 1)
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	Test Methods
1	pH at 25 °C	7.12	-	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	28.5	°C	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	678.9	µS/cm	APHA 2510 B,2-56 to 2-58 ,23rd Ed.2017.
4	Turbidity	<1.0	NTU	IS: 3025 Part-10 (Rev.1,RA:2012)
5	Total Dissolved Solids	413.0	mg/l	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	433.0	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 $CaCO_3$	190.23	mg/l	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
9	Total Hardness as $CaCO_3$	204.23	mg/l	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
10	Calcium as Ca	70.12	mg/l	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
11	Magnesium as Mg	29.67	mg/l	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
12	Chloride as Cl^-	55.42	mg/l	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
13	Sulphates as SO_4	19.20	mg/l	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
14	Nitrate as NO3	9.81	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	<1.0	mg/l	APHA 4500 N org B and 4500 N-NH_3 C
17	salinity	0.10	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	<1.0	mg/l	APHA 4500 P-C4-162, 23rd Ed.2017.
20	Silica as SiO_2	5.23	mg/l	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.
21	Sodium as Na	5.15	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
22	Potassium as K	2.10	mg/l	APHA 3111B, 3 20 to 3-21 , 23rd Ed.2017.(AAS)

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Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

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	2 0	mg/l	IS: 3025 Part-44-1993 (Rev.1, RA 2014)
34	Chemical Oxygen Demand	8.0	mg/l	APHA 5220 C,5-20 to 5-21 23rd Ed 2017
35	Dissolved Oxygen	5.6	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	70.0	Per100 ml	IS: 15185:2016
02	E-coli	Absent	Per100 ml	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	Sample Code	MITCON/2023-24/April/144/8
	Name of Sample	Surface water
	Sample Details	Vena River 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	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

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	28.6	°C	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	751.9	µS/cm	APHA 2510 B,2-56 to 2-58 ,23rd Ed.2017.
4	Turbidity	<1	NTU	IS: 3025 Part-10 (Rev.1,RA:2012)
5	Total Dissolved Solids	442	mg/l	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	445	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 $CaCO_3$	185.23	mg/l	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
9	Total Hardness as $CaCO_3$	198.72	mg/l	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
10	Calcium as Ca	68.01	mg/l	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
11	Magnesium as Mg	28.15	mg/l	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
12	Chloride as Cl	62.12	mg/l	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
13	Sulphates as SO_4	21.20	mg/l	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
14	Nitrate as NO3	8.42	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	<1.0	mg/l	APHA 4500 N org B and 4500 N-NH_3 C
17	salinity	0.112	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	<1.0	mg/l	APHA 4500 P-C4 162, 23rd Ed.2017.
20	Silica as SiO_2	4.85	mg/l	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.
21	Sodium as Na	6.27	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.[AAS]
22	Potassium as K	1.95	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.[AAS]

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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	12	mg/l	IS: 3025 Part-44-1993 (Rev.1, RA 2014)
34	Chemical Oxygen Demand	43	mg/l	APHA 5220 C,5-20 to 5-21 23rd Ed 2017
35	Dissolved Oxygen	4.3	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	140.0	Per100 ml	IS: 15185:2016
02	E-coli	20	Per100 ml	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/9**
	Name of Sample	Surface water
	Sample Details	Vena River Downstream 2
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	MITCON
	Method of sampling	IS 3025 (Part I)
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	Test Methods
1	pH at 25 °C	7.23	-	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	28.4	°C	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	763.9	µS/cm	APHA 2510 B,2-56 to 2-58 ,23rd Ed.2017.
4	Turbidity	<1	NTU	IS: 3025 Part-10 (Rev.1,RA:2012)
5	Total Dissolved Solids	467	mg/l	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	471	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 $CaCO_3$	183.25	mg/l	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
9	Total Hardness as $CaCO_3$	193.25	mg/l	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
10	Calcium as Ca	65.45	mg/l	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
11	Magnesium as Mg	28.15	mg/l	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
12	Chloride as Cl	70.38	mg/l	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
13	Sulphates as SO_4	24.57	mg/l	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
14	Nitrate as NO3	10.12	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	<1.0	mg/l	APHA 4500 N org B and 4500 N-NH_3 C
17	salinity	0.127	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	<1.0	mg/l	APHA 4500 P-C4-162, 23rd Ed.2017.
20	Silica as SiO_2	7.14	mg/l	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.
21	Sodium as Na	7.02	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
22	Potassium as K	2.13	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)

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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	02	mg/l	IS: 3025 Part-44-1993 (Rev.1, RA 2014)
34	Chemical Oxygen Demand	06	mg/l	APHA 5220 C,5-20 to 5-21 23rd Ed 2017
35	Dissolved Oxygen	5.8	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	30	Per100 ml	IS: 15185:2016
02	E-coli	Absent	Per100 ml	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	MITCON/2023-24/April/144/10
	Name of Sample	Surface water
	Sample Details	Vena River upstream 2
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	MITCON
	Method of sampling	IS 3025 (Part 1)
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	Test Methods
1	pH at 25 °C	7.26	-	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	28.1	°C	APHA 2550 B,2-69 to 2 70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	767.3	µS/cm	APHA 2510 B,2-56 to 2-58 ,23rd Ed.2017.
4	Turbidity	<1.0	NTU	IS: 3025 Part-10 (Rev.1,RA:2012)
5	Total Dissolved Solids	413.0	mg/l	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	433.0	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 $CaCO_3$	190.23	mg/l	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
9	Total Hardness as $CaCO_3$	204.23	mg/l	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
10	Calcium as Ca	70.12	mg/l	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
11	Magnesium as Mg	29.67	mg/l	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
12	Chloride as Cl^-	55.42	mg/l	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
13	Sulphates as SO_4	19.20	mg/l	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
14	Nitrate as NO3	9.81	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	<1.0	mg/l	APHA 4500 N org B and 4500 N-NH_3 C
17	salinity	0.10	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	<1.0	mg/l	APHA 4500 P-C4-162, 23rd Ed.2017.
20	Silica as SiO_3	5.23	mg/l	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.
21	Sodium as Na	5.15	mg/l	APHA 3111B, 3 20 to 3-21 , 23rd Ed.2017.(AAS)
22	Potassium as K	2.10	mg/l	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
23	Hexavalent Chromium [as Cr6+]	<0.02	mg/l	APHA 3500 Cr-B 3-71 23rd Ed.2017.

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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	03	mg/l	IS: 3025 Part-44-1993 (Rev.1, RA 2014)
34	Chemical Oxygen Demand	11	mg/l	APHA 5220 C,5-20 to 5-21 23rd Ed 2017
35	Dissolved Oxygen	5.5	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	40.0	Per100 ml	IS: 15185:2016
02	E-coli	20.0	Per100 ml	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/11**
	Name of Sample	Surface water
	Sample Details	Wakeshwar Dam
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	MITCON
	Method of sampling	IS 3025 (Part I)
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	IS:10500:2012 Required Standards	Test Methods
CHEMICAL POTABILITY					
1	pH at 25 °C	7.32	-	6.50 to 8.50	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	28.2	°C	N.S.	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	359.4	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	185.0	mg/l	≤ 500	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	189.0	mg/l	N.S.	APHA 2540 C, 2-68 to 2-69, 23rd Ed.2017.
7	Acidity as $CaCO_3$	<5	mg/l	N.S.	IS 3025 (part 22),1986,(Rev 1R.A.2014)
8	Total Alkalinity as $CaCO_3$	95.44	mg/l	≤ 200	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
9	Total Hardness as $CaCO_3$	100.20	mg/l	≤ 200	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
10	Calcium as Ca	32.24	mg/l	≤ 75	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
11	Magnesium as Mg	14.12	mg/l	≤ 30	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
12	Chloride as Cl^-	13.25	mg/l	≤ 250	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
13	Sulphates as SO_4	<10.0	mg/l	≤ 200	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
14	Nitrate as NO3	3.27	mg/l	≤ 45	APHA 4500 NO3 - B 4-127 23rd Ed.2017.
15	Ammonical Nitrogen as NH4-N	<0.1	mg/l	N.S.	APHA 4500 NH_3 F, 4-119 to 4-120 23rd Ed.2017.
16	Total Kjeldahl Nitrogen as NH3-N	<1.0	mg/l	N S.	APHA 4500 N org B and 4500 N-NH_3 C
17	salinity	0.024	ppt	N.S.	By Calculation
18	Fluoride as F	<0.1	mg/l	≤ 1.0	APHA 4500 F-D 4-90 to 4-91 ,23rd Ed.2017.
19	Total Phosphorous	<1.0	mg/l	N.S.	APHA 4500 P-C4-162, 23rd Ed.2017.
20	Silica as SiO_3	6.12	mg/l	N.S.	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

21	Sodium as Na	2.10	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
22	Potassium as K	1.10	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
23	Hexavalent Chromium (as Cr6+)	<0.02	mg/l	N.S.	APHA 3500 Cr-B 3-71 23rd Ed.2017.
24	Iron (as Fe)	<0.05	mg/l	≤ 0.3	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
25	Copper (as Cu)	<0.04	mg/l	≤ 0.05	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
26	Nickel	<0.01	mg/l	≤ 0.01	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
27	Zinc as Zn	<0.05	mg/l	≤ 5	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
28	Manganese	<0.1	mg/l	≤ 0.1	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
29	Chromium	<0.03	mg/l	≤ 0.05	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
30	Lead	<0.01	mg/l	≤ 0.01	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
31	cadmium	<0.003	mg/l	≤ 0.003	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
32	Phenol	<0.001	mg/l	≤ 0.001	IS 3025 (Part 43)(Rev 1:R.A: 2014
33	Biochemical Oxygen Demand	<1.0	mg/l	N.S	IS: 3025 Part-44-1993 (Rev.1, RA 2014)
34	Chemical Oxygen Demand	<5.0	mg/l	N.S	APHA 5220 C,5-20 to 5-21 23rd Ed 2017
35	Dissolved Oxygen	5.8	mg/l	N.S	IS: 3025 (Part-38)-1989
36	Boron	<0.04	mg/l	≤ 0.5	APHA 4500 B-c 4 27 23rd Ed 2017
BACTERIOLOGICAL POTABILITY					
01	Total Coliforms	20.0	Per100 ml	Absent	IS: 15185:2016
02	E-coli	Absent	Per100 ml	Absent	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

MITCON CONSULTANCY & ENGINEERING SERVICES LTD.

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/12**
	Name of Sample	Surface water
	Sample Details	Nag River at Kamptee U/S
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	MITCON
	Method of sampling	IS 3025 (Part I)
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	IS:10500:2012 Required Standards	Test Methods
CHEMICAL POTABILITY					
1	pH at 25 °C	7.62	-	6.50 to 8.50	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	28.1	°C	N.S.	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	568.0	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	345.0	mg/l	≤ 500	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	347.0	mg/l	N.S.	APHA 2540 C, 2-68 to 2-69, 23rd Ed.2017.
7	Acidity as $CaCO_3$	<5	mg/l	N.S.	IS 3025 (part 22),1986,(Rev 1R.A.2014)
8	Total Alkalinity as $CaCO_3$	114.25	mg/l	≤ 200	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
9	Total Hardness as $CaCO_3$	167.25	mg/l	≤ 200	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
10	Calcium as Ca	42.13	mg/l	≤ 75	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
11	Magnesium as Mg	21.40	mg/l	≤ 30	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
12	Chloride as Cl	23.12	mg/l	≤ 250	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
13	Sulphates as SO_4	18.67	mg/l	≤ 200	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
14	Nitrate as NO3	10.44	mg/l	≤ 45	APHA 4500 NO3 - B 4-127 23rd Ed.2017.
15	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.
16	Total Kjeldahl Nitrogen as NH3-N	<1.0	mg/l	N.S.	APHA 4500 N org B and 4500 N-NH_3 C

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17	salinity	0.042	ppt	N.S.	By Calculation
18	Fluoride as F	<0.1	mg/l	≤ 1.0	APHA 4500 F-D 4-90 to 4-91 ,23rd Ed.2017.
19	Total Phosphorous	<1.0	mg/l	N.S.	APHA 4500 P-C4-162, 23rd Ed.2017.
20	Silica as SiO_2	8.45	mg/l	N.S.	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.
21	Sodium as Na	5.42	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
22	Potassium as K	1.03	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
23	Hexavalent Chromium (as Cr6+)	<0.02	mg/l	N.S.	APHA 3500 Cr-B 3-71 23rd Ed.2017.
24	Iron (as Fe)	<0.05	mg/l	≤ 0.3	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
25	Copper (as Cu)	<0.04	mg/l	≤ 0.05	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
26	Nickel	<0.01	mg/l	≤ 0.01	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
27	Zinc as Zn	<0.05	mg/l	≤ 5	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
28	Manganese	<0.1	mg/l	≤ 0.1	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
29	Chromium	<0.03	mg/l	≤ 0.05	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
30	Lead	<0.01	mg/l	≤ 0.01	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
31	cadmium	<0.003	mg/l	≤ 0.003	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
32	Phenol	<0.001	mg/l	≤ 0.001	IS 3025 (Part 43)(Rev 1:R.A: 2014
33	Biochemical Oxygen Demand	13	mg/l	N.S	IS: 3025 Part-44-1993 (Rev.1, RA 2014)
34	Chemical Oxygen Demand	42	mg/l	N,S	APHA 5220 C,5-20 to 5-21 23rd Ed 2017
35	Dissolved Oxygen	4.3	mg/l	N.S	IS: 3025 (Part-38)-1989
36	Boron	<0.04	mg/l	≤ 0.5	APHA 4500 B-c 4-27 23rd Ed 2017
BACTERIOLOGICAL POTABILITY					
01	Total Coliforms	90	Per100 ml	Absent	IS: 15185:2016
02	E-coli	30	Per100 ml	Absent	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

MITCON CONSULTANCY & ENGINEERING SERVICES LTD. PUNE

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project	Sample Code	MITCON/2023-24/April/144/13
	Name of Sample	Surface water
	Sample Details	Pili nadi nallah upstream
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	MITCON
	Method of sampling	IS 3025 (Part I)
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	IS:10500:2012 Required Standards	Test Methods
CHEMICAL POTABILITY					
1	pH at 25 °C	7.42	-	6.50 to 8.50	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	28.1	°C	N.S.	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	901.7	µS/cm	N.S.	APHA 2510 B,2-56 to 2-58 ,23rd Ed.2017.
4	Turbidity	17.1	NTU	≤ 1	IS: 3025 Part-10 (Rev.1,RA:2012)
5	Total Dissolved Solids	580.0	mg/l	≤ 500	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	613.0	mg/l	N.S.	APHA 2540 C, 2-68 to 2-69, 23rd Ed.2017.
7	Acidity as $CaCO_3$	<5	mg/l	N.S.	IS 3025 (part 22),1986,(Rev 1R.A.2014)
8	Total Alkalinity as $CaCO_3$	200.4	mg/l	≤ 200	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
9	Total Hardness as $CaCO_3$	208.7	mg/l	≤ 200	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
10	Calcium as Ca	54.36	mg/l	≤ 75	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
11	Magnesium as Mg	34.12	mg/l	≤ 30	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
12	Chloride as Cl	60.13	mg/l	≤ 250	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
13	Sulphates as SO_4	28.37	mg/l	≤ 200	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
14	Nitrate as NO3	11.26	mg/l	≤ 45	APHA 4500 NO3 - B 4-127 23rd Ed.2017.
15	Ammonical Nitrogen as NH_4-N	4.03	mg/l	N.S.	APHA 4500 NH_3 F, 4-119 to 4 120 23rd Ed.2017.
16	Total Kjeldahl Nitrogen as NH3-N	5.12	mg/l	N.S.	APHA 4500 N org B and 4500 N-NH_3 C
17	salinity	0.108	ppt	N.S.	By Calculation
18	Fluoride as F	<0.1	mg/l	≤ 1.0	APHA 4500 F-D 4-90 to 4-91 ,23rd Ed.2017.
19	Total Phosphorous	3.12	mg/l	N.S.	APHA 4500 P-C4-162, 23rd Ed.2017.
20	Silica as SiO_3	5.45	mg/l	N.S.	APHA 4500 SiO2, C 4-175 to 4-177 ,23rd Ed.2017.

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21	Sodium as Na	5.75	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
22	Potassium as K	1.27	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
23	Hexavalent Chromium (as Cr6+)	<0.02	mg/l	N.S.	APHA 3500 Cr-B 3-71 23rd Ed.2017.
24	Iron (as Fe)	<0.05	mg/l	≤ 0.3	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
25	Copper (as Cu)	<0.04	mg/l	≤ 0.05	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
26	Nickel	<0.01	mg/l	≤ 0.01	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
27	Zinc as Zn	<0.05	mg/l	≤ 5	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
28	Manganese	<0.1	mg/l	≤ 0.1	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
29	Chromium	<0.03	mg/l	≤ 0.05	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
30	Lead	<0.01	mg/l	≤ 0.01	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
31	cadmium	<0.003	mg/l	≤ 0.003	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
32	Phenol	<0.001	mg/l	≤ 0.001	IS 3025 (Part 43)(Rev 1:R.A: 2014
33	Biochemical Oxygen Demand	32	mg/l	N.S	IS: 3025 Part-44-1993 (Rev.1, RA 2014)
34	Chemical Oxygen Demand	82	mg/l	N.S	APHA 5220 C,5-20 to 5-21 23rd Ed 2017
35	Dissolved Oxygen	2.0	mg/l	N.S	IS: 3025 (Part-38)-1989
36	Boron	<0.04	mg/l	≤ 0.5	APHA 4500 B-c 4-27 23rd Ed 2017
BACTERIOLOGICAL POTABILITY					
01	Total Coliforms	>1600	Per100 ml	Absent	IS: 15185:2016
02	E-coli	>1600	Per100 ml	Absent	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

MITCON CONSULTANCY & ENGINEERING SERVICES LTD. * PUNE *

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/14**
	Name of Sample	Surface water
	Sample Details	Raipur Nalfah D/S
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	MITCON
	Method of sampling	IS 3025 (Part I)
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	IS:10500:2012 Required Standards	Test Methods
CHEMICAL POTABILITY					
1	pH at 25 °C	7.20	-	6.50 to 8.50	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	28.2	°C	N.S.	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	438.4	µS/cm	N.S.	APHA 2510 B,2-56 to 2-58 ,23rd Ed.2017.
4	Turbidity	10.1	NTU	≤ 1	IS: 3025 Part-10 (Rev.1,RA:2012)
5	Total Dissolved Solids	287.0	mg/l	≤ 500	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	314.0	mg/l	N.S.	APHA 2540 C, 2-68 to 2-69, 23rd Ed.2017.
7	Acidity as $CaCO_3$	<5	mg/l	N.S.	IS 3025 (part 22),1986,(Rev 18.A.2014)
8	Total Alkalinity as $CaCO_3$	101.41	mg/l	≤ 200	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
9	Total Hardness as $CaCO_3$	135.24	mg/l	≤ 200	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
10	Calcium as Ca	58.12	mg/l	≤ 75	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
11	Magnesium as Mg	25.14	mg/l	≤ 30	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
12	Chloride as Cl	43.12	mg/l	≤ 250	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
13	Sulphates as SO_4	18.37	mg/l	≤ 200	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
14	Nitrate as NO3	5.23	mg/l	≤ 45	APHA 4500 NO3 - B 4-127 23rd Ed.2017.
15	Ammonical Nitrogen as NH_4-N	3.37	mg/l	N.S.	APHA 4500 NH_3 F, 4-119 to 4-120 23rd Ed.2017.
16	Total Kjeldahl Nitrogen as NH3-N	4.02	mg/l	N.S.	APHA 4500 N org B and 4500 N-NH_3 C
17	salinity	0.077	ppt	N.S.	By Calculation
18	Fluoride as F	<0.1	mg/l	≤ 1.0	APHA 4500 F-D 4 90 to 4-91 ,23rd Ed.2017.
19	Total Phosphorous	2.92	mg/l	N.S.	APHA 4500 P-C4-162, 23rd Ed.2017.

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20	Silica as SiO_2	5.93	mg/l	N.S.	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.
21	Sodium as Na	3.27	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
22	Potassium as K	<1.0	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
23	Hexavalent Chromium (as Cr6+)	<0.02	mg/l	N.S.	APHA 3500 Cr-B 3-71 23rd Ed.2017.
24	Iron (as Fe)	<0.05	mg/l	≤ 0.3	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
25	Copper (as Cu)	<0.04	mg/l	≤ 0.05	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
26	Nickel	<0.01	mg/l	≤ 0.01	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
27	Zinc as Zn	<0.05	mg/l	≤ 5	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
28	Manganese	<0.1	mg/l	≤ 0.1	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
29	Chromium	<0.03	mg/l	≤ 0.05	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
30	Lead	<0.01	mg/l	≤ 0.01	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
31	cadmium	<0.003	mg/l	≤ 0.003	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
32	Phenol	<0.001	mg/l	≤ 0.001	IS 3025 (Part 43)(Rev 1:R.A: 2014
33	Biochemical Oxygen Demand	20	mg/l	N.S	IS: 3025 Part-44-1993 (Rev.1, RA 2014]
34	Chemical Oxygen Demand	65	mg/l	N,S	APHA 5220 C,5-20 to 5-21 23rd Ed 2017
35	Dissolved Oxygen	3.6	mg/l	N.S	IS: 3025 (Part-38)-1989
36	Boron	<0.04	mg/l	≤ 0.5	APHA 4500 B-C 4-27 23rd Ed 2017
BACTERIOLOGICAL POTABILITY					
01	Total Coliforms	600	Per100 ml	Absent	IS: 15185:2016
02	E-coli	300	Per100 ml	Absent	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

MITCON CONSULTANCY & ENGINEERING SERVICES LTD. PUNE

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/15**
	Name of Sample	Surface water
	Sample Details	Ambazari Lake
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	MITCON
	Method of sampling	IS 3025 (Part I)
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

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	28.1	°C	N.S.	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	337.1	µS/cm	N.S.	APHA 2510 B,2-56 to 2-58 ,23rd Ed.2017.
4	Turbidity	1.2	NTU	≤ 1	IS: 3025 Part-10 (Rev.1,RA:2012)
5	Total Dissolved Solids	215.0	mg/l	≤ 500	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	218.0	mg/l	N.S.	APHA 2540 C, 2-68 to 2-69, 23rd Ed.2017.
7	Acidity as $CaCO_3$	<5	mg/l	N.S.	IS 3025 (part 22),1986,(Rev 1R.A.2014)
8	Total Alkalinity as $CaCO_3$	104.37	mg/l	≤ 200	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
9	Total Hardness as $CaCO_3$	110.06	mg/l	≤ 200	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
10	Calcium as Ca	45.12	mg/l	≤ 75	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
11	Magnesium as Mg	20 14	mg/l	≤ 30	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
32	Chloride as Cl^-	32.12	mg/l	≤ 250	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
13	Sulphates as SO_4	18.70	mg/l	≤ 200	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
14	Nitrate as NO3	10.13	mg/l	≤ 45	APHA 4500 NO3 - B 4-127 23rd Ed.2017.
15	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.
16	Total Kjeldahl Nitrogen as NH3-N	<1.0	mg/l	N.S.	APHA 4500 N org B and 4500 N-NH_3 C
17	salinity	0.058	ppt	N.S.	By Calculation
18	Fluoride as F	<0.1	mg/l	≤ 1.0	APHA 4500 F-D 4-90 to 4-91 ,23rd Ed.2017.
19	Total Phosphorous	<1.0	mg/l	N.S.	APHA 4500 P-C4-162, 23rd Ed.2017.
20	Silica as SiO_3	3.93	mg/l	N.S.	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.

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21	Sodium as Na	<1.0	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
22	Potassium as K	<1.0	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
23	Hexavalent Chromium (as Cr6+)	<0.02	mg/l	N.S.	APHA 3500 Cr-B 3-71 23rd Ed.2017.
24	Iron (as Fe)	<0.05	mg/l	≤ 0.3	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
25	Copper (as Cu)	<0.04	mg/l	≤ 0.05	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
26	Nickel	<0.01	mg/l	≤ 0.01	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
27	Zinc as Zn	<0.05	mg/l	≤ 5	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
28	Manganese	<0.1	mg/l	≤ 0.1	APHA 3111B, 3-20 to 3-21 , 23rd Ed 2017.(AAS)
29	Chromium	<0.03	mg/l	≤ 0.05	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
30	Lead	<0.01	mg/l	≤ 0.01	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
31	cadmium	<0.003	mg/l	≤ 0.003	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
32	Phenol	<0.001	mg/l	≤ 0.001	IS 3025 (Part 43)(Rev 1:R.A: 2014
33	Biochemical Oxygen Demand	02	mg/l	N.S	IS: 3025 Part-44-1993 (Rev.1, RA 2014)
34	Chemical Oxygen Demand	07	mg/l	N.S	APHA 5220 C,5-20 to 5-21 23rd Ed 2017
35	Dissolved Oxygen	5.9	mg/l	N.S	IS: 3025 (Part-38)-1989
36	Boron	<0.04	mg/l	≤ 0.5	APHA 4500 B-c 4.27 23rd Ed 2017
BACTERIOLOGICAL POTABILITY					
01	Total Coliforms	40.0	Per100 ml	Absent	IS: 15185:2016
02	E-coli	Absent	Per100 ml	Absent	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

MITCON CONSULTANCY & ENGINEERING SERVICES LTD. * PUNE *

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/16**
	Name of Sample	Surface water
	Sample Details	Butibori MIDC Nallah
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	MITCON
	Method of sampling	IS 3025 (Part 1)
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	IS:10500:2012 Required Standards	Test Methods
CHEMICAL POTABILITY					
1	pH at 25 °C	6.92	-	6.50 to 8.50	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	28.1	°C	N.S.	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	614.4	µS/cm	N.S.	APHA 2510 B,2-56 to 2-58 ,23rd Ed.2017.
4	Turbidity	13.4	NTU	≤ 1	IS: 3025 Part-10 (Rev.1,RA:2012)
5	Total Dissolved Solids	378.0	mg/l	≤ 500	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	413.0	mg/l	N.S.	APHA 2540 C, 2-68 to 2-69, 23rd Ed.2017.
7	Acidity as $CaCO_3$	<5	mg/l	N.S.	IS 3025 (part 22),1986,(Rev 1R.A.2014)
8	Total Alkalinity as $CaCO_3$	135.2	mg/l	≤ 200	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
9	Total Hardness as $CaCO_3$	180.25	mg/l	≤ 200	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
10	Calcium as Ca	32.12	mg/l	≤ 75	APHA 3500 Ca B, 3-69 to 3-70,23rd Ed.2017.
11	Magnesium as Mg	13.18	mg/l	≤ 30	APHA 3500 Mg B, 3-86 ,23rd Ed.2017.
12	Chloride as Cl	52.13	mg/l	≤ 250	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
13	Sulphates as SO_4	18.24	mg/l	≤ 200	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
14	Nitrate as NO3	10.29	mg/l	≤ 45	APHA 4500 NO3 - B 4-127 23rd Ed.2017.
15	Ammonical Nitrogen as NH_4-N	3.73	mg/l	N.S.	APHA 4500 NH_3 F, 4-119 to 4-120 23rd Ed.2017.
16	Total Kjeldahl Nitrogen as NH3-N	8.58	mg/l	N.S.	APHA 4500 N org B and 4500 N-NH_3 C
17	salinity	0.094	ppt	N.S.	By Calculation
18	Fluoride as F	<0.1	mg/l	≤ 1.0	APHA 4500 F-D 4-90 to 4-91 ,23rd Ed.2017.
19	Total Phosphorous	5.26	mg/l	N.S.	APHA 4500 P-C4-162, 23rd Ed.2017.
20	Silica as SiO_3	7.13	mg/l	N.S.	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.

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21	Sodium as Na	5.12	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
22	Potassium as K	2.09	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
23	Hexavalent Chromium (as Cr6+)	<0.02	mg/l	N.S.	APHA 3500 Cr-B 3-71 23rd Ed.2017.
24	Iron (as Fe)	<0.05	mg/l	≤ 0.3	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
25	Copper (as Cu)	<0.04	mg/l	≤ 0.05	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
26	Nickel	<0.01	mg/l	≤ 0.01	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
27	Zinc as Zn	<0.05	mg/l	≤ 5	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
28	Manganese	<0.1	mg/l	≤ 0.1	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
29	Chromium	<0.03	mg/l	≤ 0.05	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
30	Lead	<0.01	mg/l	≤ 0.01	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
31	cadmium	<0.003	mg/l	≤ 0.003	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
32	Phenol	<0.001	mg/l	≤ 0.001	IS 3025 (Part 43)(Rev 1:R.A: 2014
33	Biochemical Oxygen Demand	25	mg/l	N.S	IS: 3025 Part-44-1993 (Rev.1, RA 2014)
34	Chemical Oxygen Demand	80	mg/l	N.S	APHA 5220 C,5-20 to 5-21 23rd Ed 2017
35	Dissolved Oxygen	1.9	mg/l	N.S	IS: 3025 (Part-38)-1989
36	Boron	<0.04	mg/l	≤ 0.5	APHA 4500 B-c 4-27 23rd Ed 2017
BACTERIOLOGICAL POTABILITY					
01	Total Coliforms	>1600	Per100 ml	Absent	IS: 15185:2016
02	E-coli	>1600	Per100 ml	Absent	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

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Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	Sample Code	**MITCON/2023-24/April/144/17**
	Name of Sample	Surface water
	Sample Details	Nag River Mahalgaon upstream
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	MITCON
	Method of sampling	IS 3025 (Part I)
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	IS:10500:2012 Required Standards	Test Methods
CHEMICAL POTABILITY					
1	pH at 25 °C	7.36	-	6.50 to 8.50	APHA 4500 H^+, A, 4-95, 23rd Ed.2017.
2	Temperature	28.0	°C	N.S.	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	555.8	µS/cm	N.S.	APHA 2510 B,2-56 to 2-58 ,23rd Ed.2017.
4	Turbidity	3.25	NTU	≤ 1	IS: 3025 Part-10 (Rev.1,RA:2012)
5	Total Dissolved Solids	368.0	mg/l	≤ 500	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	380.0	mg/l	N.S.	APHA 2540 C, 2-68 to 2-69, 23rd Ed.2017.
7	Acidity as $CaCO_3$	<5	mg/l	N.S.	IS 3025 (part 22),1986,(Rev 1R.A.2014)
8	Total Alkalinity as $CaCO_3$	172.0	mg/l	≤ 200	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
9	Total Hardness as $CaCO_3$	183.14	mg/l	≤ 200	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
10	Calcium as Ca	48.14	mg/l	≤ 75	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
11	Magnesium as Mg	23.24	mg/l	≤ 30	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
12	Chloride as Cl^-	30.13	mg/l	≤ 250	APHA 4500 Cl B,4 75 to 4-76,23rd Ed.2017.
13	Sulphates as SO_4	14.37	mg/l	≤ 200	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
14	Nitrate as NO3	6.52	mg/l	≤ 45	APHA 4500 NO3 - B 4-127 23rd Ed.2017.
15	Ammonical Nitrogen as NH_4-N	1.27	mg/l	N.S.	APHA 4500 NH_3 F, 4-119 to 4-120 23rd Ed.2017.
16	Total Kjeldahl Nitrogen as NH3-N	2.12	mg/l	N.S.	APHA 4500 N org B and 4500 N-NH_3 C
17	salinity	0.054	ppt	N.S.	By Calculation
18	Fluoride as F	<0.1	mg/l	≤ 1.0	APHA 4500 F-D 4-90 to 4-91 ,23rd Ed.2017.
19	Total Phosphorous	<1.0	mg/l	N.S.	APHA 4500 P-C4-162, 23rd Ed.2017.
20	Silica as SiO_3	5.37	mg/l	N.S.	APHA 4500 SiO2, C 4-175 to 4-177 ,23rd Ed.2017.

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21	Sodium as Na	7.16	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
22	Potassium as K	<1.0	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
23	Hexavalent Chromium (as Cr6+)	<0.02	mg/l	N.S.	APHA 3500 Cr-B 3-71 23rd Ed.2017.
24	Iron (as Fe)	<0.05	mg/l	≤ 0.3	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
25	Copper (as Cu)	<0.04	mg/l	≤ 0.05	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
26	Nickel	<0.01	mg/l	≤ 0.01	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
27	Zinc as Zn	<0.05	mg/l	≤ 5	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
28	Manganese	<0.1	mg/l	≤ 0.1	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
29	Chromium	<0.03	mg/l	≤ 0.05	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
30	Lead	<0.01	mg/l	≤ 0.01	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
31	cadmium	<0.003	mg/l	≤ 0.003	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
32	Phenol	<0.001	mg/l	≤ 0.001	IS 3025 (Part 43)(Rev 1:R.A: 2014
33	Biochemical Oxygen Demand	11	mg/l	N.S	IS: 3025 Part-44-1993 (Rev.1, RA 2014)
34	Chemical Oxygen Demand	47	mg/l	N,S	APHA 5220 C,5-20 to 5-21 23rd Ed 2017
35	Dissolved Oxygen	4.1	mg/l	N.S	IS: 3025 (Part-38)-1989
36	Boron	<0.04	mg/l	≤ 0.5	APHA 4500 B-c 4-27 23rd Ed 2017
BACTERIOLOGICAL POTABILITY					
01	Total Coliforms	300	Per100 ml	Absent	IS: 15185:2016
02	E-coli	110	Per100 ml	Absent	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

MITCON CONSULTANCY & ENGINEERING SERVICES LTD.

Authorized Signatory
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(Senior Vice President)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhooml,Ramdaspeth,Nagpur-440010 **Consultancy Services for carrying out EIA and Preparation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/18**
	Name of Sample	Surface water
	Sample Details	Nag River Pardi 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	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	IS:10500:2012 Required Standards	Test Methods
CHEMICAL POTABILITY					
1	pH at 25 °C	7.29	-	6.50 to 8.50	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	28.0	°C	N.S.	APHA 2550 B,2 69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	512.7	µS/cm	N.S.	APHA 2510 B,2-56 to 2-58 ,23rd Ed.2017.
4	Turbidity	2.72	NTU	≤ 1	IS: 3025 Part-10 [Rev.1,RA:2012)
5	Total Dissolved Solids	371.0	mg/l	≤ 500	'APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	384.0	mg/l	N.S.	APHA 2540 C, 2-68 to 2-69, 23rd Ed.2017.
7	Acidity as $CaCO_3$	<5	mg/l	N.S.	IS 3025 (part 22),1986,(Rev 1R.A.2014)
8	Total Alkalinity as $CaCO_3$	154.13	mg/l	≤ 200	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
9	Total Hardness as $CaCO_3$	165.13	mg/l	≤ 200	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
10	Calcium as Ca	45.04	mg/l	≤ 75	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
11	Magnesium as Mg	22.01	mg/l	≤ 30	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
12	Chloride as Cl^-	29.37	mg/l	≤ 250	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
13	Sulphates as SO_4	17.14	mg/l	≤ 200	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
14	Nitrate as NO3	8.02	mg/l	≤ 45	APHA 4500 NO3 - B 4-127 23rd Ed.2017.
15	Ammonical Nitrogen as NH_4-N	1.02	mg/l	N.S.	APHA 4500 NH_3 F, 4-119 to 4-120 23rd Ed.2017.
16	Total Kjeldahl Nitrogen as NH3-N	1.67	mg/l	N.S.	APHA 4500 N org B and 4500 N NH_3 C
17	salinity	0.053	ppt	N.S.	By Calculation
18	Fluoride as F	<0.1	mg/l	≤ 1.0	APHA 4500 F-D 4-90 to 4-91 ,23rd Ed.2017.
19	Total Phosphorous	<1.0	mg/l	N.S.	APHA 4500 P-C4-162, 23rd Ed.2017.
20	Silica as SiO_3	4.23	mg/l	N.S.	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.

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21	Sodium as Na	6.29	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
22	Potassium as K	<1.0	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
23	Hexavalent Chromium (as Cr6+)	<0.02	mg/l	N.S.	APHA 3500 Cr-B 3-71 23rd Ed.2017.
24	Iron (as Fe)	<0.05	mg/l	≤ 0.3	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017 (AAS)
25	Copper (as Cu)	<0.04	mg/l	≤ 0.05	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
26	Nickel	<0.01	mg/l	≤ 0.01	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
27	Zinc as Zn	<0.05	mg/l	≤ 5	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
28	Manganese	<0.1	mg/l	≤ 0.1	APHA 3111B, 3-20 to 3 21 , 23rd Ed.2017.(AAS)
29	Chromium	<0.03	mg/l	≤ 0.05	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
30	Lead	<0.01	mg/l	≤ 0.01	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
31	cadmium	<0.003	mg/l	≤ 0.003	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
32	Phenol	<0.001	mg/l	≤ 0.001	IS 3025 (Part 43)[Rev 1:R.A: 2014
33	Biochemical Oxygen Demand	23	mg/l	N.S	IS: 3025 Part-44-1993 (Rev.1, RA 2014)
34	Chemical Oxygen Demand	80	mg/l	N,S	APHA 5220 C,5-20 to 5-21 23rd Ed 2017
35	Dissolved Oxygen	4.3	mg/l	N.S	IS: 3025 (Part-38)-1989
36	Boron	<0.04	mg/l	≤ 0.5	APHA 4500 B-c 4-27 23rd Ed 2017
BACTERIOLOGICAL POTABILITY					
01	Total Coliforms	240	Per100 ml	Absent	IS: 15185:2016
02	E-coli	90	Per100 ml	Absent	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
[Mrs. Kadambari Deshmukh]

MITCON CONSULTANCY & ENGINEERING SERVICES LTD. * PUNE *

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west]of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/19**
	Name of Sample	Ground Water
	Sample Details	Dharmanand Nagar Ganesh Mandir handpump
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	MITCON
	Method of sampling	IS 3025 (Part I)
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

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	28.3	°C	N.S.	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	1190	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	710.0	mg/l	≤ 500	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	712.0	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 $CaCO_3$	151.23	mg/l	≤ 200	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
10	Total Hardness as $CaCO_3$	300.14	mg/l	≤ 200	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
11	Calcium as Ca	72.14	mg/l	≤ 75	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
12	Magnesium as Mg	35.12	mg/l	≤ 30	APHA 3500 Mg B, 3.-85 ,23rd Ed.2017.
13	Chloride as Cl^-	38.46	mg/l	≤ 250	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
14	Sulphates as SO_4	20.14	mg/l	≤ 200	APHA 4500 SO4 E,4-199 to 4-200 23rd Ed.2017.
15	Nitrate as NO3	6.73	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

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17	Total Kjeldahl Nitrogen as NH3-N	<1	mg/l	N.S.	APHA 4500 N org B and 4500 N-NH3 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.
21	Silica as SiO_3	4.13	mg/l	N.S.	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.
22	Sodium as Na	9.45	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
23	Potassium as K	<1.0	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: 15185:2016
02	E-coli	Absent	Per100 ml	Absent	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

MITCON CONSULTANCY & ENGINEERING SERVICES LTD. PUNE

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/20**
	Name of Sample	Ground Water
	Sample Details	Khasara Fata
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	MITCON
	Method of sampling	IS 3025 (Part I)
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	IS:10500:2012 Required Standards	Test Methods
CHEMICAL POTABILITY					
1.	pH at 25 °C	7.29	-	6.50 to 8.50	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	28.3	°C	N.S.	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	1810.0	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	980.0	mg/l	≤ 500	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	983.0	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 $CaCO_3$	189.25	mg/l	≤ 200	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
10	Total Hardness as $CaCO_3$	402.13	mg/l	≤ 200	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
11	Calcium as Ca	89.52	mg/l	≤ 75	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
12	Magnesium as Mg	43.25	mg/l	≤ 30	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
13	Chloride as Cl^-	120.24	mg/l	≤ 250	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
14	Sulphates as SO_4	78.13	mg/l	≤ 200	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
15	Nitrate as NO3	12.45	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	0.217	ppt	N.S.	By Calculation

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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.
21	Silica as SiO_3	6.92	mg/l	N.S.	APHA 4500 SIO2, C 4 175 to 4-177 ,23rd Ed.2017.
22	Sodium as Na	12.42	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
23	Potassium as K	2.25	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: 15185:2016
02	E-coli	Absent	Per100 ml	Absent	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

MITCON CONSULTANCY & ENGINEERING SERVICES LTD. PUNE

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/21**
	Name of Sample	Ground Water
	Sample Details	All India Radio Borewell
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	MITCON
	Method of sampling	IS 3025 (Part I)
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	IS:10500:2012 Required Standards	Test Methods
CHEMICAL POTABILITY					
1.	pH at 25 °C	7.65	-	6.50 to 8.50	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	28.3	°C	N.S.	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	1320	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	832.0	mg/l	≤ 500	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	835.0	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 $CaCO_3$	192.67	mg/l	≤ 200	APHA 2320 B, 2-37 to 2-3923rd Ed.2017.,
10	Total Hardness as $CaCO_3$	375.83	mg/l	≤ 200	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
11	Calcium as Ca	89.92	mg/l	≤ 75	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
12	Magnesium as Mg	48.37	mg/l	≤ 30	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
13	Chloride as Cl	119.52	mg/l	≤ 250	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
14	Sulphates as SO_4	94.35	mg/l	≤ 200	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
15	Nitrate as NO3	8.52	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	0.215	ppt	N.S.	By Calculation

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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.
21	Silica as SiO_3	3.52	mg/l	N.S.	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.
22	Sodium as Na	14.23	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
23	Potassium as K	1.12	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: 15185:2016
02	E-coli	Absent	Per100 ml	Absent	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	Sample Code	MITCON/2023-24/April/144/22
	Name of Sample	Ground Water
	Sample Details	Khairi Fata Borewell
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	MITCON
	Method of sampling	IS 3025 (Part I)
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	IS:10500:2012 Required Standards	Test Methods
CHEMICAL POTABILITY					
1.	pH at 25 °C	7.32	-	6.50 to 8.50	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	28.7	°C	N.S.	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	3520.0	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	1800.0	mg/l	≤ 500	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	1804.0	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 $CaCO_3$	241.25	mg/l	≤ 200	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
10	Total Hardness as $CaCO_3$	800.25	mg/l	≤ 200	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
11	Calcium as Ca	145.25	mg/l	≤ 75	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
12	Magnesium as Mg	89.52	mg/l	≤ 30	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
13	Chloride as Cl	198.25	mg/l	≤ 250	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
14	Sulphates as SO_4	158.12	mg/l	≤ 200	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
15	Nitrate as NO3	14.25	mg/l	≤ 45	APHA 4500 NO3 - B 4-127 23rd Ed.2017.
16	Ammonical Nitrogen as NH_3-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	0.35	ppt	N.S.	By Calculation

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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.
21	Silica as SiO_2	8.45	mg/l	N.S.	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.
22	Sodium as Na	24.12	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
23	Potassium as K	4.23	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: 15185:2016
02	E-coli	Absent	Per100 ml	Absent	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

MITCON CONSULTANCY & ENGINEERING SERVICES LTD. * PUNE *

Authorized Signatory
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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/23**
	Name of Sample	Ground Water
	Sample Details	Lokvihar dugwell
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	MITCON
	Method of sampling	IS 3025 (Part I)
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	IS:10500:2012 Required Standards	Test Methods
CHEMICAL POTABILITY					
1.	pH at 25 °C	7.52	-	6.50 to 8.50	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	28.4	°C	N.S.	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	2023	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	1215.0	mg/l	≤ 500	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	1218.0	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 $CaCO_3$	313.7	mg/l	≤ 200	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
10	Total Hardness as $CaCO_3$	585.12	mg/l	≤ 200	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
11	Calcium as Ca	167.36	mg/l	≤ 75	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
12	Magnesium as Mg	90.13	mg/l	≤ 30	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
13	Chloride as Cl^-	213.25	mg/l	≤ 250	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
14	Sulphates as SO_4	110.13	mg/l	≤ 200	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
15	Nitrate as NO3	14.46	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	0.385	ppt	N.S.	By Calculation

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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.
21	Silica as SiO_3	10.24	mg/l	N.S.	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.
22	Sodium as Na	17.23	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
23	Potassium as K	3.18	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: 15185:2016
02	E-coli	Absent	Per100 ml	Absent	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/24**
	Name of Sample	Ground Water
	Sample Details	Lekha nagar borewell
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	MITCON
	Method of sampling	IS 3025 (Part I)
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	IS:10500:2012 Required Standards	Test Methods
CHEMICAL POTABILITY					
1.	pH at 25 °C	7.83	-	6.50 to 8.50	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	28.1	°C	N.S.	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	1460	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	913.0	mg/l	≤ 500	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	916.0	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 $CaCO_3$	222.32	mg/l	≤ 200	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
10	Total Hardness as $CaCO_3$	402.12	mg/l	≤ 200	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
11	Calcium as Ca	64.12	mg/l	≤ 75	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
12	Magnesium as Mg	32.31	mg/l	≤ 30	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
13	Chloride as Cl	95.13	mg/l	≤ 250	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
14	Sulphates as SO_4	34.67	mg/l	≤ 200	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
15	Nitrate as NO3	14.28	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	0.17	ppt	N.S.	By Calculation

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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.
21	Silica as SiO_2	6.98	mg/l	N.S.	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.
22	Sodium as Na	8.12	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
23	Potassium as K	2.36	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: 15185:2016
02	E-coli	Absent	Per100 ml	Absent	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

MITCON CONSULTANCY & ENGINEERING SERVICES LTD. PUNE

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/25**
	Name of Sample	Ground Water
	Sample Details	Ganjke balaji temple near kamptee police 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	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	IS:10500:2012 Required Standards	Test Methods
CHEMICAL POTABILITY					
1.	pH at 25 °C	7.52	-	6.50 to 8.50	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	28.5	°C	N.S.	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	2280	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	1400.0	mg/l	≤ 500	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	1406.0	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 $CaCO_3$	187.25	mg/l	≤ 200	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
10	Total Hardness as $CaCO_3$	589.65	mg/l	≤ 200	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
11	Calcium as Ca	85.27	mg/l	≤ 75	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
12	Magnesium as Mg	40.13	mg/l	≤ 30	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
13	Chloride as Cl	180.12	mg/l	≤ 250	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
14	Sulphates as SO_4	240.13	mg/l	≤ 200	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
15	Nitrate as NO3	17.68	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

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18	salinity	0.325	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.
21	Silica as SiO_2	8.12	mg/l	N.S.	APHA 4500 SIO2, C 4 175 to 4-177 ,23rd Ed.2017.
22	Sodium as Na	18.32	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
23	Potassium as K	2.14	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: 15185:2016
02	E-coli	Absent	Per100 ml	Absent	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project	Sample Code	MITCON/2023-24/April/144/26
	Name of Sample	Ground Water
	Sample Details	Near sub district hospital kamptee
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	MITCON
	Method of sampling	IS 3025 (Part I)
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	IS:10500:2012 Required Standards	Test Methods
CHEMICAL POTABILITY					
1.	pH at 25 °C	7.29	-	6.50 to 8.50	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	27.9	°C	N.S.	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	1480.0	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	802.0	mg/l	≤ 500	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	804.0	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 $CaCO_3$	212.40	mg/l	≤ 200	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
10	Total Hardness as $CaCO_3$	368.25	mg/l	≤ 200	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
11	Calcium as Ca	145.62	mg/l	≤ 75	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
12	Magnesium as Mg	95.23	mg/l	≤ 30	APHA 3500 Mg B, 3. 86 ,23rd Ed.2017.
13	Chloride as Cl^-	168.14	mg/l	≤ 250	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
14	Sulphates as SO_4	95.45	mg/l	≤ 200	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
15	Nitrate as NO3	10.25	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	0.303	ppt	N.S.	By Calculation

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Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

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.
21	Silica as SiO_2	10.12	mg/l	N.S.	APHA 4500 SiO2, C 4-175 to 4-177 ,23rd Ed.2017.
22	Sodium as Na	18.67	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
23	Potassium as K	3.19	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: 15185:2016
02	E-coli	Absent	Per100 ml	Absent	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

MITCON CONSULTANCY & ENGINEERING SERVICES LTD. * PUNE *

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/27**
	Name of Sample	Ground Water
	Sample Details	Modi Padav Nagar borewell
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	MITCON
	Method of sampling	IS 3025 (Part I)
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	IS:10500:2012 Required Standards	Test Methods
CHEMICAL POTABILITY					
1.	pH at 25 °C	7.45	-	6.50 to 8.50	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	28.4	°C	N.S.	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	1950.0	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	980.0	mg/l	≤ 500	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	982.0	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 $CaCO_3$	249.8	mg/l	≤ 200	APHA 2320 B, 2-37 to 2-3923rd Ed.2017.,
10	Total Hardness as $CaCO_3$	300.21	mg/l	≤ 200	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
11	Calcium as Ca	108.37	mg/l	≤ 75	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
12	Magnesium as Mg	43.57	mg/l	≤ 30	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
13	Chloride as Cl^-	52.14	mg/l	≤ 250	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
14	Sulphates as SO_4	48.19	mg/l	≤ 200	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
15	Nitrate as NO3	11.55	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	0.094	ppt	N.S.	By Calculation

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Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

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.
21	Silica as SiO_3	7.52	mg/l	N.S.	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.
22	Sodium as Na	19.37	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
23	Potassium as K	1.10	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: 15185:2016
02	E-coli	Absent	Per100 ml	Absent	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

MITCON CONSULTANCY & ENGINEERING SERVICES LTD. * PUNE *

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/28**
	Name of Sample	Ground Water
	Sample Details	Sanjay nagar Bengali colony handpump
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	MITCON
	Method of sampling	IS 3025 (Part I)
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	IS:10500:2012 Required Standards	Test Methods
CHEMICAL POTABILITY					
1.	pH at 25 °C	7.24	-	6.50 to 8.50	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	28.3	°C	N.S.	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	1890.0	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	1204.0	mg/l	≤ 500	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	1207.0	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 $CaCO_3$	289.25	mg/l	≤ 200	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
10	Total Hardness as $CaCO_3$	375.80	mg/l	≤ 200	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
11	Calcium as Ca	72.14	mg/l	≤ 75	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
12	Magnesium as Mg	38.33	mg/l	≤ 30	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
13	Chloride as Cl^-	227.43	mg/l	≤ 250	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
14	Sulphates as SO_4	128.49	mg/l	≤ 200	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
15	Nitrate as NO3	11.35	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	0.410	ppt	N.S.	By Calculation

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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.
21	Silica as SiO_2	6.28	mg/l	N.S.	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.
22	Sodium as Na	18.67	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
23	Potassium as K	2.92	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: 15185:2016
02	E-coli	Absent	Per100 ml	Absent	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

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Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/29**
	Name of Sample	Ground Water
	Sample Details	Transport Nagar borewell
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	MITCON
	Method of sampling	IS 3025 (Part I)
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	IS:10500:2012 Required Standards	Test Methods
CHEMICAL POTABILITY					
1.	pH at 25 °C	7.56	-	6.50 to 8.50	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	28.4	°C	N.S.	APHA 2550 B,2-69 to 2 70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	1484.0	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	810.0	mg/l	≤ 500	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	812.0	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 $CaCO_3$	240.37	mg/l	≤ 200	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
10	Total Hardness as $CaCO_3$	301.83	mg/l	≤ 200	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
11	Calcium as Ca	101.13	mg/l	≤ 75	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
12	Magnesium as Mg	54.25	mg/l	≤ 30	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
13	Chloride as Cl	145.54	mg/l	≤ 250	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
14	Sulphates as SO_4	98.30	mg/l	≤ 200	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
15	Nitrate as NO3	14.23	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	0.262	ppt	N.S.	By Calculation

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Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

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.
21	Silica as SiO_2	7.42	mg/l	N.S.	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.
22	Sodium as Na	14.15	mg/l	N.S.	APHA 3111B, 3 20 to 3-21 , 23rd Ed.2017.(AAS)
23	Potassium as K	3.09	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: 15185:2016
02	E-coli	Absent	Per100 ml	Absent	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

MITCON CONSULTANCY & ENGINEERING SERVICES LTD. * PUNE *

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/30**
	Name of Sample	Ground Water
	Sample Details	Pardi Borewell
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	MITCON
	Method of sampling	IS 3025 (Part I)
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	IS:10500:2012 Required Standards	Test Methods
CHEMICAL POTABILITY					
1.	pH at 25 °C	7.24	-	6.50 to 8.50	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	28.3	°C	N.S.	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	951.3	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	478.0	mg/l	≤ 500	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	481.0	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 $CaCO_3$	137.28	mg/l	≤ 200	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
10	Total Hardness as $CaCO_3$	198.13	mg/l	≤ 200	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
11	Calcium as Ca	72.12	mg/l	≤ 75	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
12	Magnesium as Mg	27.14	mg/l	≤ 30	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
13	Chloride as Cl^-	85.12	mg/l	≤ 250	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
14	Sulphates as SO_4	101.40	mg/l	≤ 200	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
15	Nitrate as NO3	9.83	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	0.153	ppt	N.S.	By Calculation

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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.
21	Silica as SiO_2	10.14	mg/l	N.S.	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.
22	Sodium as Na	14.15	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
23	Potassium as k	3.09	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: 15185:2016
02	E-coli	Absent	Per100 ml	Absent	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

MITCON CONSULTANCY & ENGINEERING SERVICES LTD. * PUNE *

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/30**
	Name of Sample	Ground Water
	Sample Details	Pardi Borewell
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	MITCON
	Method of sampling	IS 3025 (Part I)
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	IS:10500:2012 Required Standards	Test Methods
CHEMICAL POTABILITY					
1.	pH at 25 °C	7.24	-	6.50 to 8.50	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	28.3	°C	N.S.	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	951.3	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	478.0	mg/l	≤ 500	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	481.0	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 $CaCO_3$	137.28	mg/l	≤ 200	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
10	Total Hardness as $CaCO_3$	198.13	mg/l	≤ 200	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
11	Calcium as Ca	72.12	mg/l	≤ 75	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
12	Magnesium as Mg	27.14	mg/l	≤ 30	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
13	Chloride as Cl^-	85.12	mg/l	≤ 250	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
14	Sulphates as SO_4	101.40	mg/l	≤ 200	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
15	Nitrate as NO3	9.83	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	0.153	ppt	N.S.	By Calculation

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Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

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.
21	Silica as SiO_2	10.14	mg/l	N.S.	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.
22	Sodium as Na	14.15	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
23	Potassium as K	3.09	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: 15185:2016
02	E-coli	Absent	Per100 ml	Absent	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
[Mrs. Kadambari Deshmukh]

MITCON CONSULTANCY & ENGINEERING SERVICES LTD. * PUNE *

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/31**
	Name of Sample	Ground Water
	Sample Details	Hingna Mount view borewell
	Container Details	2 llt Plastic Can + 100 ml Sterile bottle
	Sample Collected By	MITCON
	Method of sampling	IS 3025 (Part I)
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	IS:10500:2012 Required Standards	Test Methods
CHEMICAL POTABILITY					
1.	pH at 25 °C	7.18	-	6.50 to 8.50	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	28.1	°C	N.S.	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	743.2	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	402.0	mg/l	≤ 500	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	405.0	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 $CaCO_3$	141.4	mg/l	≤ 200	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
10	Total Hardness as $CaCO_3$	188.47	mg/l	≤ 200	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
11	Calcium as Ca	112.42	mg/l	≤ 75	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
12	Magnesium as Mg	31.14	mg/l	≤ 30	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
13	Chloride as Cl^-	80.13	mg/l	≤ 250	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
14	Sulphates as SO_4	54.23	mg/l	≤ 200	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
15	Nitrate as NO3	11.26	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	0.144	ppt	N.S.	By Calculation

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

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-E4-162, 23rd Ed.2017.
21	Silica as SiO_2	12.32	mg/l	N.S.	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.
22	Sodium as Na	12.25	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
23	Potassium as K	1.52	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: 15185:2016
02	E-coli	Absent	Per100 ml	Absent	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

MITCON CONSULTANCY & ENGINEERING SERVICES LTD. PUNE

Authorized Signatory
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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/32**
	Name of Sample	Ground Water
	Sample Details	Rajiv Nagar
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	MITCON
	Method of sampling	IS 3025 (Part I)
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	IS:10500:2012 Required Standards	Test Methods
CHEMICAL POTABILITY					
1.	pH at 25 °C	7.34	-	6.50 to 8.50	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	27.9	°C	N.S.	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	652.1	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	383.0	mg/l	≤ 500	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	386.0	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 $CaCO_3$	127.3	mg/l	≤ 200	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
10	Total Hardness as $CaCO_3$	181.25	mg/l	≤ 200	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
11	Calcium as Ca	45.13	mg/l	≤ 75	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
12	Magnesium as Mg	27.13	mg/l	≤ 30	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
13	Chloride as Cl^-	62.17	mg/l	≤ 250	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
14	Sulphates as SO_4	37.13	mg/l	≤ 200	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
15	Nitrate as NO3	7.41	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	0.112	ppt	N.S.	By Calculation

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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.
21	Silica as SiO_2	4.23	mg/l	N.S.	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.
22	Sodium as Na	6.0	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed 2017.(AAS)
23	Potassium as K	<1.0	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: 15185:2016
02	E-coli	Absent	Per100 ml	Absent	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

MITCON CONSULTANCY & ENGINEERING SERVICES LTD. PUNE

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/33**
	Name of Sample	Ground Water
	Sample Details	Wakegri Handpump
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	**MITCON**
	Method of sampling	IS 3025 (Part I)
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	IS:10500:2012 Required Standards	Test Methods
CHEMICAL POTABILITY					
1.	pH at 25 °C	7.26	-	6.50 to 8.50	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	28.2	°C	N.S.	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	905.8	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	520.0	mg/l	≤ 500	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	523.0	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 $CaCO_3$	183.9	mg/l	≤ 200	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
10	Total Hardness as $CaCO_3$	283.7	mg/l	≤ 200	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
11	Calcium as Ca	89.16	mg/l	≤ 75	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
12	Magnesium as Mg	45.13	mg/l	≤ 30	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
13	Chloride as Cl	75.14	mg/l	≤ 250	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
14	Sulphates as SO_4	55.32	mg/l	≤ 200	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
15	Nitrate as NO3	13.26	mg/l	≤ 45	APHA 4500 NO3 - B 4-127 23rd Ed.2017.
16	Ammonical Nitrogen as NH_3-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	0.135	ppt	N.S.	By Calculation

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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.
21	Silica as SiO_3	7.68	mg/l	N.S.	APHA 4500 SiO2, C 4-175 to 4-177 ,23rd Ed.2017.
22	Sodium as Na	11.20	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
23	Potassium as K	2.03	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: 15185:2016
02	E-coli	Absent	Per100 ml	Absent	IS: 15185:2016

For **MITCON Consultancy & Engineering Services Ltd.**

Checked By
(Mrs. Kadambari Deshmukh)

MITCON CONSULTANCY & ENGINEERING SERVICES LTD. PUNE

Authorized Signatory
Dr. Sandeep Jadhav
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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/34**
	Name of Sample	Ground Water
	Sample Details	Open Dug well hingna bus stand
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	**MITCON**
	Method of sampling	IS 3025 (Part I)
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	IS:10500:2012 Required Standards	Test Methods
CHEMICAL POTABILITY					
1.	pH at 25 °C	7.15	-	6.50 to 8.50	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	28.2	°C	N.S.	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	1235	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	825.0	mg/l	≤ 500	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017
6	Total Solids	828.0	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 $CaCO_3$	183.9	mg/l	≤ 200	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
10	Total Hardness as $CaCO_3$	371.7	mg/l	≤ 200	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
11	Calcium as Ca	111.8	mg/l	≤ 75	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
12	Magnesium as Mg	48.37	mg/l	≤ 30	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
13	Chloride as Cl^-	88.37	mg/l	≤ 250	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
14	Sulphates as SO_4	62.13	mg/l	≤ 200	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
15	Nitrate as NO3	10.45	mg/l	≤ 45	APHA 4500 NO3 - B 4-127 23rd Ed.2017.
16	Ammonical Nitrogen as NH_3-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	0.15	ppt	N.S.	By Calculation

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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.
21	Silica as SiO_2	11.24	mg/l	N.S.	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.
22	Sodium as Na	14.15	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
23	Potassium as K	3.17	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: 15185:2016
02	E-coli	Absent	Per100 ml	Absent	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/35**
	Name of Sample	Ground Water
	Sample Details	Hingna Hand pump
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	**MITCON**
	Method of sampling	IS 3025 (Part I)
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	IS:10500:2012 Required Standards	Test Methods
CHEMICAL POTABILITY					
1.	pH at 25 °C	7.32	-	6.50 to 8.50	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	28.0	°C	N.S.	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	792.5	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	467.0	mg/l	≤ 500	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	471.0	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 $CaCO_3$	161.8	mg/l	≤ 200	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
10	Total Hardness as $CaCO_3$	220.13	mg/l	≤ 200	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
11	Calcium as Ca	71.64	mg/l	≤ 75	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
12	Magnesium as Mg	29.53	mg/l	≤ 30	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
13	Chloride as Cl^-	84.13	mg/l	≤ 250	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
14	Sulphates as SO_4	48.16	mg/l	≤ 200	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
15	Nitrate as NO3	9.17	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	0.151	ppt	N.S.	By Calculation

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Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

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.
21	Silica as SiO_2	7.52	mg/l	N.S.	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.
22	Sodium as Na	6.72	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
23	Potassium as K	1.11	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: 15185:2016
02	E-coli	Absent	Per100 ml	Absent	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/36**
	Name of Sample	Ground Water
	Sample Details	Raipur Hand Pump
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	**MITCON**
	Method of sampling	IS 3025 (Part I)
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	IS:10500:2012 Required Standards	Test Methods
CHEMICAL POTABILITY					
1.	pH at 25 °C	7.02	-	6.50 to 8.50	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	28.2	°C	N.S.	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	751.3	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	492.0	mg/l	≤ 500	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	495.0	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 18.A.2014)
9	Total Alkalinity as $CaCO_3$	190.36	mg/l	≤ 200	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
10	Total Hardness as $CaCO_3$	240.17	mg/l	≤ 200	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
11	Calcium as Ca	58.64	mg/l	≤ 75	APHA 3500 Ca B, 3-69 to 3-70,23rd Ed.2017.
12	Magnesium as Mg	25.34	mg/l	≤ 30	APHA 3500 Mg B, 3-86 ,23rd Ed.2017.
13	Chloride as Cl^-	47.15	mg/l	≤ 250	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017
14	Sulphates as SO_4	37.20	mg/l	≤ 200	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
15	Nitrate as NO3	5.54	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	0.085	ppt	N.S.	By Calculation

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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.
21	Silica as SiO_2	5.15	mg/l	N.S.	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.
22	Sodium as Na	7.49	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
23	Potassium as K	<1.0	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: 15185:2016
02	E-coli	Absent	Per100 ml	Absent	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

MITCON CONSULTANCY & ENGINEERING SERVICES LTD. PUNE

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/37**
	Name of Sample	Ground Water
	Sample Details	Kapsi Khurd
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	**MITCON**
	Method of sampling	IS 3025 (Part I)
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	IS:10500:2012 Required Standards	Test Methods
CHEMICAL POTABILITY					
1.	pH at 25 °C	7.17	-	6.50 to 8.50	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	28.0	°C	N.S.	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	902.3	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	540.0	mg/l	≤ 500	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	543.0	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 $CaCO_3$	187.12	mg/l	≤ 200	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
10	Total Hardness as $CaCO_3$	260.13	mg/l	≤ 200	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
11	Calcium as Ca	95.02	mg/l	≤ 75	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
12	Magnesium as Mg	45.67	mg/l	≤ 30	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
13	Chloride as Cl^-	85.10	mg/l	≤ 250	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
14	Sulphates as SO_4	62.15	mg/l	≤ 200	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
15	Nitrate as NO3	11.25	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	0.15	ppt	N.S.	By Calculation

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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.
21	Silica as SiO_2	11.72	mg/l	N.S.	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.
22	Sodium as Na	12.37	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
23	Potassium as K	1.07	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: 15185:2016
02	E-coli	Absent	Per100 ml	Absent	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
[Mrs. Kadambari Deshmukh]

MITCON CONSULTANCY & ENGINEERING SERVICES LTD. PUNE

Authorized Signatory
Dr. Sandeep Jadhav
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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/38**
	Name of Sample	Ground Water
	Sample Details	Dongargaon
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	**MITCON**
	Method of sampling	IS 3025 (Part I)
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	IS:10500:2012 Required Standards	Test Methods
CHEMICAL POTABILITY					
1.	pH at 25 °C	7.09	-	6.50 to 8.50	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	28.3	°C	N.S.	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	1025.0	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	540.0	mg/l	≤ 500	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	543.0	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 $CaCO_3$	171.0	mg/l	≤ 200	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
10	Total Hardness as $CaCO_3$	274.0	mg/l	≤ 200	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
11	Calcium as Ca	79.14	mg/l	≤ 75	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
12	Magnesium as Mg	53.25	mg/l	≤ 30	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
13	Chloride as Cl	72.10	mg/l	≤ 250	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
14	Sulphates as SO_4	43.25	mg/l	≤ 200	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
15	Nitrate as NO3	7.62	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	0.13	ppt	N.S.	By Calculation

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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.
21	Silica as SiO_3	12.35	mg/l	N.S.	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.
22	Sodium as Na	11.89	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
23	Potassium as K	2.32	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: 15185:2016
02	E-coli	Absent	Per100 ml	Absent	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
[Mrs. Kadambari Deshmukh]

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Authorized Signatory
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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshebhoomi,Ramdaspeth,Nagpur-440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/39**
	Name of Sample	Ground Water
	Sample Details	Mohgaon Dugwell
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	**MITCON**
	Method of sampling	IS 3025 (Part I)
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	IS:10500:2012 Required Standards	Test Methods
CHEMICAL POTABILITY					
1.	pH at 25 °C	7.37	-	6.50 to 8.50	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	28.1	°C	N.S.	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	1038	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	555	mg/l	≤ 500	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	558	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 $CaCO_3$	182.16	mg/l	≤ 200	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
10	Total Hardness as $CaCO_3$	280.16	mg/l	≤ 200	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
11	Calcium as Ca	83.51	mg/l	≤ 75	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
12	Magnesium as Mg	55.17	mg/l	≤ 30	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
13	Chloride as Cl^-	78.12	mg/l	≤ 250	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
14	Sulphates as SO_4	41.14	mg/l	≤ 200	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
15	Nitrate as NO3	6.02	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	0.141	ppt	N.S.	By Calculation

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Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

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.
21	Silica as SiO_2	14.25	mg/l	N.S.	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.
22	Sodium as Na	12.52	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
23	Potassium as K	3.10	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: 15185:2016
02	E-coli	Absent	Per100 ml	Absent	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
[Mrs. Kadambari Deshmukh]

MITCON CONSULTANCY & ENGINEERING SERVICES LTD. PUNE

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/40**
	Name of Sample	Ground Water
	Sample Details	Meghdoot cidco
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	**MITCON**
	Method of sampling	IS 3025 (Part I)
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	IS:10500:2012 Required Standards	Test Methods
CHEMICAL POTABILITY					
1.	pH at 25 °C	7.24	-	6.50 to 8.50	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	28.2	°C	N.S.	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	604.3	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	398.0	mg/l	≤ 500	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	401.0	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 $CaCO_3$	175.12	mg/l	≤ 200	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
10	Total Hardness as $CaCO_3$	194.23	mg/l	≤ 200	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
11	Calcium as Ca	74.35	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^-	35.12	mg/l	≤ 250	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
14	Sulphates as SO_4	33.27	mg/l	≤ 200	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
15	Nitrate as NO3	7.14	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	0.063	ppt	N.S.	By Calculation

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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.
21	Silica as SiO_3	16.45	mg/l	N.S.	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.
22	Sodium as Na	8.12	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
23	Potassium as K	<1.0	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: 1S185:2016
02	E-coli	Absent	Per100 ml	Absent	IS: 1S185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

MITCON CONSULTANCY & ENGINEERING SERVICES LTD. PUNE

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/41**
	Name of Sample	Ground Water
	Sample Details	Butibori police 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	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No	Parameters	Results	Unit	IS:10500:2012 Required Standards	Test Methods
CHEMICAL POTABILITY					
1.	pH at 25 °C	7.81	-	6.50 to 8.50	APHA 4500 H+, A, 4-95, 23rd Ed.2017.
2	Temperature	28.1	°C	N.S.	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	506.2	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	290.0	mg/l	≤ 500	APHA 2540 C, 2-69 to 2-70, 23rd Ed.2017.
6	Total Solids	293.0	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 $CaCO_3$	131.02	mg/l	≤ 200	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
10	Total Hardness as $CaCO_3$	140.10	mg/l	≤ 200	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
11	Calcium as Ca	35.25	mg/l	≤ 75	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
12	Magnesium as Mg	23.15	mg/l	≤ 30	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
13	Chloride as Cl	30.46	mg/l	≤ 250	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017.
14	Sulphates as SO_4	31.25	mg/l	≤ 200	APHA 4500 SO4-E,4-199 to 4 200 23rd Ed.2017.
15	Nitrate as NO3	5.45	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	0.055	ppt	N.S.	By Calculation

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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.
21	Silica as SiO_2	9.55	mg/l	N.S.	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.
22	Sodium as Na	<1.0	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
23	Potassium as K	<1.0	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: 15185:2016
02	E-coli	Absent	Per100 ml	Absent	IS: 15185:2016

For **MITCON Consultancy & Engineering Services Ltd.**

Checked By
(Mrs. Kadambari Deshmukh)

MITCON CONSULTANCY & ENGINEERING SERVICES LTD. * PUNE *

Authorized Signatory
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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project	Sample Code	MITCON/2023-24/April/144/42
	Name of Sample	Ground Water
	Sample Details	Ashokwan
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
	Sample Collected By	MITCON
	Method of sampling	IS 3025 (Part I)
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

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	28.0	°C	N.S.	APHA 2550 B,2-69 to 2-70 ,23rd Ed.2017.
3	Electrical Conductivity at 25 °C	751.3	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	471.0	mg/l	≤ 500	APHA 2540 C, 2-69 to 2 70, 23rd Ed.2017.
6	Total Solids	474.0	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 $CaCO_3$	155.24	mg/l	≤ 200	APHA 2320 B, 2-37 to 2-3923rd Ed.2017..
10	Total Hardness as $CaCO_3$	193.36	mg/l	≤ 200	APHA 2340 C ,2-48 to 2-50,23rd Ed.2017.
11	Calcium as Ca	58.16	mg/l	≤ 75	APHA 3500 Ca B, 3.-69 to 3-70,23rd Ed.2017.
12	Magnesium as Mg	27.45	mg/l	≤ 30	APHA 3500 Mg B, 3.-86 ,23rd Ed.2017.
13	Chloride as Cl^-	48.16	mg/l	≤ 250	APHA 4500 Cl B,4-75 to 4-76,23rd Ed.2017
14	Sulphates as SO_4	33.20	mg/l	≤ 200	APHA 4500 SO4-E,4-199 to 4-200 23rd Ed.2017.
15	Nitrate as NO3	10.45	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	0.087	ppt	N.S.	By Calculation

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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
21	Silica as SiO_2	8.53	mg/l	N.S.	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.
22	Sodium as Na	4.17	mg/l	N.S.	APHA 3111B, 3-20 to 3-21 , 23rd Ed.2017.(AAS)
23	Potassium as K	<1.0	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: 15185:2016
02	E-coli	Absent	Per100 ml	Absent	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

MITCON CONSULTANCY & ENGINEERING SERVICES LTD. PUNE

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	Sample Code	MITCON/2023-24/April/144/43
	Name of Sample	Soil
	Sample Details	Rajiv Nagar
	Container Details	1 kg plastic bag
	Sample Collected By	MITCON
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No.	Parameters	Results	Unit	Test Method
01	Texture	Clay	-	IS 2720 (Part 4)
02	Percentage Of Different Components			
	sand Silt Clay	20 30 50	% % %	IS 2720 (Part 4)
03	Soil Moisture	2.32	%	IS 2720 Part II1973
04	Bulk Density	1.12	gm/cm³	IS 2720 (part XXIX)
05	Water Holding Capacity	53.2	%	:S 14767:2000
06	pH	8.02	-	IS 2720 (Part 26) 1987,Rev..2,Reaff 2011
07	Conductivity	979.2	µs/cm	IS 14767,2000,Reaff 2016
08	Organic Carbon	0.34	%	IS 2720 (Part 22)
09	Calcium (as Ca)	98.3	mg/kg	USEPA 3050 B,6010 C
10	Magnesium (as Mg)	42.3	mg/kg	USEPA 3050 B,6010 C
11	Available Nitrogen	112.3	kg/ha	IS 14684
12	Phosphorous (as P)	9.42	kg/ha	Laboratory methods for analysis of soils irrigation water and plants revised edition 2012 p.no 87-89
13	Potassium (as K)	135.7	kg/ha	USEPA 3050 B
14	Iron (as Fe)	0.92	mg/kg	USEPA 3050 B
15	Zinc (as Zn)	0.48	mg/kg	USEPA 3050 B
16	Copper (as Cu)	0.12	mg/kg	USEPA 3050 B
17	Sodium	74.7	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	1.07	-	EME/LAB/SOP/SAR

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

CONSULTANCY & ENGINEERING SERVICES LTD.

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/44**
	Name of Sample	Soil
	Sample Details	Hingna
	Container Details	1 kg plastic bag
	Sample Collected By	MITCON
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No.	Parameters	Results	Unit	Test Method
01	Texture	Silty Loam	-	IS 2720 (Part 4)
02	Percentage Of Different Components			
	sand Silt Clay	23 55 22	% % %	IS 2720 (Part 4)
03	Soil Moisture	3.13	%	IS 2720 Part II1973
04	Bulk Density	1.07	gm/cm³	IS 2720 (part XXIX)
05	Water Holding Capacity	50.5	%	IS 14767:2000
06	pH	7.90	--	IS 2720 (Part 26) 1987,Rev..2,Reaff 2011
07	Conductivity	513.8	µs/cm	IS 14767,2000,Reaff 2016
08	Organic Carbon	0.52	%	IS 2720 (Part 22)
09	Calcium (as Ca)	85.32	mg/kg	USEPA 3050 B,6010 C
10	Magnesium (as Mg)	20.12	mg/kg	USEPA 3050 B,6010 C
11	Available Nitrogen	110.5	kg/ha	IS 14684
12	Phosphorous (as P)	10.2	kg/ha	Laboratory methods for analysis of soils Irrigation water and plants revised edition 2012 p.no 87-89
13	Potassium (as K)	137.7	kg/ha	USEPA 3050 B
14	Iron (as Fe)	0.78	mg/kg	USEPA 3050 B
15	Zinc (as Zn)	0.29	mg/kg	USEPA 3050 B
16	Copper (as Cu)	0.18	mg/kg	USEPA 3050 B
17	Sodium	22.4	mg/kg	USEPA 3050 B
18	Manganese (as Mn)	0.32	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	1.25	-	EME/LAB/SOP/SAR

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

CONSULTANCY & ENGINEERING SERVICES LTD. MITCON PUNE

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	Sample Code	**MITCON/2023-24/April/144/45**
	Name of Sample	Soil
	Sample Details	Wanadongri
	Container Details	1 kg plastic bag
	Sample Collected By	MITCON
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No.	Parameters	Results	Unit	Test Method
01	Texture	clay	-	IS 2720 (Part 4)
02	Percentage Of Different Components			
	sand Silt Clay	30 20 50	% % %	IS 2720 (Part 4)
03	Soil Moisture	1.83	%	IS 2720 Part II1973
04	Bulk Density	1.12	gm/cm³	IS 2720 (part XXIX)
05	Water Holding Capacity	51.7	%	IS 14767:2000
06	pH	7.77	--	IS 2720 (Part 26) 1987,Rev. 2,Reaff 2011
07	Conductivity	673.4	µs/cm	IS 14767,2000,Reaff 2016
08	Organic Carbon	0.52	%	IS 2720 (Part 22)
09	Calcium (as Ca)	101.4	mg/kg	USEPA 3050 B,6010 C
10	Magnesium (as Mg)	52.1	mg/kg	USEPA 3050 B,6010 C
11	Available Nitrogen	103.8	kg/ha	IS 14684
12	Phosphorous (as P)	13.6	kg/ha	Laboratory methods for analysis of soils irrigation water and plants revised edition 2012 p.no 87-89
13	Potassium (as K)	151.5	kg/ha	USEPA 3050 B
14	Iron (as Fe)	0.42	mg/kg	USEPA 3050 B
15	Zinc (as Zn)	0.29	mg/kg	USEPA 3050 B
16	Copper (as Cu)	0.18	mg/kg	USEPA 3050 B
17	Sodium	20.1	mg/kg	USEPA 3050 B
18	Manganese (as Mn)	0.37	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	0.84		EME/LAB/SOP/SAR

For MITCON Consultancy & Engineering Services Ltd.

Checked By
[Mrs. Kadambari Deshmukh]

Authorized Signatory
Dr. Sandeep Jadhav
[Senior Vice President]

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Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/46**
	Name of Sample	Soil
	Sample Details	Raipur
	Container Details	1 kg plastic bag
	Sample Collected By	MITCON
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No.	Parameters	Results	Unit	Test Method
01	Texture	clay	-	IS 2720 (Part 4)
02	Percentage Of Different Components			
	sand Silt Clay	25 25 50	% % %	IS 2720 (Part 4)
03	Soil Moisture	3.02	%	IS 2720 Part II1973
04	Bulk Density	1.08	gm/cm³	IS 2720 (part XXIX)
05	Water Holding Capacity	50.1	%	IS 14767:2000
06	pH	7.89	--	IS 2720 (Part 26) 1987, Rev..2,Reaff 2011
07	Conductivity	740..3	µs/cm	IS 14767,2000,Reaff 2016
08	Organic Carbon	0.46	%	IS 2720 (Part 22)
09	Calcium (as Ca)	89.3	mg/kg	USEPA 3050 B,6010 C
10	Magnesium (as Mg)	24.3	mg/kg	USEPA 3050 B,6010 C
11	Available Nitrogen	108.9	kg/ha	IS 14684
12	Phosphorous (as P)	14.2	kg/ha	Laboratory methods for analysis of soils irrigation water and plants revised edition 2012 p.no 87-89
13	Potassium (as K)	187.5	kg/ha	USEPA 3050 B
14	Iron (as Fe)	0.87	mg/kg	USEPA 3050 B
15	Zinc (as Zn)	0.53	mg/kg	USEPA 3050 B
16	Copper (as Cu)	0.49	mg/kg	USEPA 3050 B
17	Sodium	21.5	mg/kg	USEPA 3050 B
18	Manganese (as Mn)	0.67	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	1.08	-	EME/LAB/SOP/SAR

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

MITCON CONSULTANCY & ENGINEERING SERVICES LTD. PUNE

Authorized Signatory
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Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	Sample Code	**MITCON/2023-24/April/144/47**
	Name of Sample	Soil
	Sample Details	Dongargaon
	Container Details	1 kg plastic bag
	Sample Collected By	MITCON
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No.	Parameters	Results	Unit	Test Method
01	Texture	loam	-	IS 2720 (Part 4)
02	Percentage Of Different Components			
	sand	45	%	IS 2720 (Part 4)
	Silt	25	%	
	Clay	30	%	
03	Soil Moisture	3.02	%	IS 2720 Part II1973
04	Bulk Density	1.08	gm/cm^3	IS 2720 (part XXIX)
05	Water Holding Capacity	42.3	%	IS 14767:2000
06	pH	7.89	-	IS 2720 (Part 26) 1987,Rev..2,Reaff 2011
07	Conductivity	740..3	µs/cm	.IS 14767,2000,Reaff 2016
08	Organic Carbon	0.28	%	IS 2720 (Part 22)
09	Calcium (as Ca)	89.3	mg/kg	USEPA 3050 B,6010 C
10	Magnesium (as Mg)	24.3	mg/kg	USEPA 3050 B,6010 C
11	Available Nitrogen	108.9	kg/ha	IS 14684
12	Phosphorous (as P)	14.7	kg/ha	Laboratory methods for analysis of soils irrigation water and plants revised edition 2012 p.no 87-89
13	Potassium (as K)	103.25	kg/ha	USEPA 3050 B
14	Iron (as Fe)	0.87	mg/kg	USEPA 3050 B
15	Zinc (as Zn)	0.53	mg/kg	USEPA 3050 B
16	Copper (as Cu)	0.49	mg/kg	USEPA 3050 B
17	Sodium	21.5	mg/kg	USEPA 3050 B
18	Manganese (as Mn)	0.62	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	1.08	-	EME/LAB/SOP/SAR

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

MITCON CONSULTANCY & ENGINEERING SERVICES LTD. PUNE

Authorized Signatory
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Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	Sample Code	MITCON/2023-24/April/144/48
	Name of Sample	Soil
	Sample Details	Mohgaon
	Container Details	1 kg plastic bag
	Sample Collected By	MITCON
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No.	Parameters	Results	Unit	Test Method
01	Texture	Clay loam	-	IS 2720 (Part 4)
02	Percentage Of Different Components			
	sand Silt Clay	35 35 30	% % %	IS 2720 (Part 4)
03	Soil Moisture	1.42	%	IS 2720 Part II1973
04	Bulk Density	1.12	gm/cm³	IS 2720 (part XXIX)
05	Water Holding Capacity	53.6	%	IS 14767:2000
06	pH	7.47	--	IS 2720 (Part 26) 1987,Rev.:2,Reaff 2011
07	Conductivity	572.6	µs/cm	IS 14767,2000,Reaff 2016
08	Organic Carbon	0.62	%	IS 2720 (Part 22)
09	Calcium (as Ca)	101.4	mg/kg	USEPA 3050 B,6010 C
10	Magnesium (as Mg)	40.3	mg/kg	USEPA 3050 B,6010 C
11	Available Nitrogen	152.7	kg/ha	IS 14684
12	Phosphorous (as P)	20.6	kg/ha	Laboratory methods for analysis of soils irrigation water and plants revised edition 2012 p.no 87-89
13	Potassium (as K)	195.4	kg/ha	USEPA 3050 B
14	Iron (as Fe)	1.02	mg/kg	USEPA 3050 B
15	Zinc (as Zn)	0.62	mg/kg	USEPA 3050 B
16	Copper (as Cu)	0.58	mg/kg	USEPA 3050 B
17	Sodium	19.3	mg/kg	USEPA 3050 B
18	Manganese (as Mn)	0.59	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	0.85	-	EME/LAB/SOP/SAR

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

CONSULTANCY & ENGINEERING SERVICES LTD.

Authorized Signatory
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(Senior Vice President)

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Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	Sample Code	MITCON/2023-24/April/144/49
	Name of Sample	Soil
	Sample Details	Meghdoot cidco
	Container Details	1 kg plastic bag
	Sample Collected By	MITCON
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No.	Parameters	Results	Unit	Test Method
01	Texture	clay	-	IS 2720 (Part 4)
02	Percentage Of Different Components			
	sand Silt Clay	20 35 45	% % %	IS 2720 (Part 4)
03	Soil Moisture	1.01	%	IS 2720 Part II1973
04	Bulk Density	1.16	gm/cm³	IS 2720 (part XXIX)
05	Water Holding Capacity	57.8	%	IS 14767:2000
06	pH	7.83	--	IS 2720 (Part 26) 1987,Rev..2,Reaff 2011
07	Conductivity	601.23	µs/cm	IS 14767,2000,Reaff 2016
08	Organic Carbon	0.54	%	IS 2720 (Part 22)
09	Calcium (as Ca)	120.6	mg/kg	USEPA 3050 B,6010 C
10	Magnesium (as Mg)	52.3	mg/kg	USEPA 3050 B,6010 C
11	Available Nitrogen	165.7	kg/ha	IS 14684
12	Phosphorous (as P)	23.3	kg/ha	Laboratory methods for analysis of soils irrigation water and plants revised edition 2012 p.no 87-89
13	Potassium (as K)	180.1	kg/ha	USEPA 3050 B
14	Iron (as Fe)	0.85	mg/kg	USEPA 3050 B
15	Zinc (as Zn)	0.40	mg/kg	USEPA 3050 B
16	Copper (as Cu)	0.72	mg/kg	USEPA 3050 B
17	Sodium	21.4	mg/kg	USEPA 3050 B
18	Manganese (as Mn)	0.27	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	0.85	-	EME/LAB/SOP/SAR

For **MITCON Consultancy & Engineering Services Ltd.**

Checked By
(Mrs. Kadambari Deshmukh)

CONSULTANCY & ENGINEERING SERVICES LTD. PUNE

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	Sample Code	MITCON/2023-24/April/144/50
	Name of Sample	Soil
	Sample Details	MIDC ESR
	Container Details	1 kg plastic bag
	Sample Collected By	MITCON
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No.	Parameters	Results	Unit	Test Method
01	Texture	clay	-	IS 2720 (Part 4)
02	Percentage Of Different Components			
	sand	20	%	IS 2720 (Part 4)
	Silt	20	%	
	Clay	60	%	
03	Soil Moisture	1.23	%	IS 2720 Part II1973
04	Bulk Density	1.05	gm/cm³	IS 2720 (part XXIX)
05	Water Holding Capacity	60.2	%	IS 14767:2000
06	pH	7.90	-	IS 2720 (Part 26) 1987,Rev..2,Reaff 2011
07	Conductivity	949.3	µs/cm	IS 14767,2000,Reaff 2016
08	Organic Carbon	0.30	%	IS 2720 (Part 22)
09	Calcium (as Ca)	95.3	mg/kg	USEPA 3050 B,6010 C
10	Magnesium (as Mg)	37.6	mg/kg	USEPA 3050 B,6010 C
11	Available Nitrogen	145.1	kg/ha	IS 14684
12	Phosphorous (as P)	16.2	kg/ha	Laboratory methods for analysis of soils irrigation water and plants revised edition 2012 p.no 87-89
13	Potassium (as K)	164.2	kg/ha	USEPA 3050 B
14	Iron (as Fe)	0.48	mg/kg	USEPA 3050 B
15	Zinc (as Zn)	0.60	mg/kg	USEPA 3050 B
16	Copper (as Cu)	0.51	mg/kg	USEPA 3050 B
17	Sodium	23.2	mg/kg	USEPA 3050 B
18	Manganese (as Mn)	0.42	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	1.07	-	EME/LAB/SOP/SAR

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

MITCON CONSULTANCY & ENGINEERING SERVICES LTD. PUNE

Authorized Signatory
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Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	Sample Code	MITCON/2023-24/April/144/51
	Name of Sample	Soil
	Sample Details	Kinhi MIDC(KFC)
	Container Details	1 kg plastic bag
	Sample Collected By	MITCON
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No.	Parameters	Results	Unit	Test Method
01	Texture	clay	-	IS 2720 (Part 4)
02	Percentage Of Different Components			
	sand Silt Clay	20 30 50	% % %	IS 2720 (Part 4)
03	Soil Moisture	0.83	%	IS 2720 Part II 1973
04	Bulk Density	1.09	gm/cm³	IS 2720 (part XXIX)
05	Water Holding Capacity	45.8	%	IS 14767:2000
06	pH	7.96	--	IS 2720 (Part 26) 1987,Rev..2,ReaH 2011
07	Conductivity	851.4	µs/cm	IS 14767,2000,Reaff 2016
08	Organic Carbon	0.42	%	IS 2720 (Part 22)
09	Calcium (as Ca)	80.2	mg/kg	USEPA 3050 B,6010 C
10	Magnesium (as Mg)	23.4	mg/kg	USEPA 3050 B,6010 C
11	Available Nitrogen	114.3	kg/ha	IS 14684
12	Phosphorous (as P)	12.80	kg/ha	Laboratory methods for analysis of soils irrigation water and plants revised edition 2012 p.no 87-89
13	Potassium (as K)	148.7	kg/ha	USEPA 3050 B
14	Iron (as Fe)	0.72	mg/kg	USEPA 3050 B
15	Zinc (as Zn)	0.84	mg/kg	USEPA 3050 B
16	Copper (as Cu)	0.48	mg/kg	USEPA 3050 B
17	Sodium	24.5	mg/kg	USEPA 3050 B
18	Manganese (as Mn)	0.50	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	1.27	-	EME/LAB/SOP/SAR

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	Sample Code	MITCON/2023-24/April/144/S2
	Name of Sample	Soil
	Sample Details	MHADA COLONY
	Container Details	1 kg plastic bag
	Sample Collected By	MITCON
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No.	Parameters	Results	Unit	Test Method
01	Texture	clay	-	IS 2720 (Part 4)
02	Percentage Of Different Components			
	sand Silt Clay	20 30 50	% % %	IS 2720 (Part 4)
03	Soil Moisture	0.83	%	IS 2720 Part II1973
04	Bulk Density	1.09	gm/cm³	IS 2720 (part XXIX)
05	Water Holding Capacity	45.8	%	IS 14767-2000
06	pH	7.96	--	IS 2720 (Part 26) 1987,Rev..2,Reaff 2011
07	Conductivity	851.4	µs/cm	IS 14767,2000,Reaff 2016
08	Organic Carbon	0.42	%	IS 2720 (Part 22)
09	Calcium (as Ca)	80.2	mg/kg	USEPA 3050 B,6010 C
10	Magnesium (as Mg)	23.4	mg/kg	USEPA 3050 B,6010 C
11	Available Nitrogen	114.3	kg/ha	IS 14684
12	Phosphorous (as P)	12.80	kg/ha	Laboratory methods for analysis of soils irrigation water and plants revised edition 2012 p.no 87-89
13	Potassium (as K)	148.7	kg/ha	USEPA 3050 B
14	Iron (as Fe)	0.72	mg/kg	USEPA 3050 B
15	Zinc (as Zn)	0.84	mg/kg	USEPA 3050 B
16	Copper (as Cu)	0.48	mg/kg	USEPA 3050 B
17	Sodium	24.5	mg/kg	USEPA 3050 B
18	Manganese (as Mn)	0.50	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	1.27	-	EME/LAB/SOP/SAR

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

CONSULTANCY & ENGINEERING SERVICES LTD. MITCON PUNE

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	Sample Code	**MITCON/2023-24/April/144/S2**
	Name of Sample	Soil
	Sample Details	Kapsi Khurd
	Container Details	1 kg plastic bag
	Sample Collected By	MITCON
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No.	Parameters	Results	Unit	Test Method
01	Texture	Clay loam	-	IS 2720 (Part 4)
02	Percentage Of Different Components			
	sand Silt Clay	40 20 40	% % %	IS 2720 (Part 4)
03	Soil Moisture	0.72	%	IS 2720 Part II1973
04	Bulk Density	1.04	gm/cm³	IS 2720 (part XXIX)
05	Water Holding Capacity	51.7	%	IS 14767:2000
06	pH	7.77	--	IS 2720 (Part 26) 1987,Rev..2,Reaff 2011
07	Conductivity	610.4	µs/cm	IS 14767,2000,Reaff 2016
08	Organic Carbon	0.38	%	IS 2720 (Part 22)
09	Calcium (as Ca)	69.1	mg/kg	USEPA 3050 B,6010 C
10	Magnesium (as Mg)	28.3	mg/kg	USEPA 3050 B,6010 C
11	Available Nitrogen	110.7	kg/ha	IS 14684
12	Phosphorous (as P)	13.45	kg/ha	Laboratory methods for analysis of soils irrigation water and plants revised edition 2012 p.no 87-89
13	Potassium (as K)	130.6	kg/ha	USEPA 3050 B
14	Iron (as Fe)	0.18	mg/kg	USEPA 3050 B
15	Zinc (as Zn)	0.32	mg/kg	USEPA 3050 B
16	Copper (as Cu)	0.10	mg/kg	USEPA 3050 B
17	Sodium	30.3	mg/kg	USEPA 3050 B
18	Manganese (as Mn)	0.13	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	1.62	-	EME/LAB/SOP/SAR

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

CONSULTANCY & ENGINEERING SERVICES LTD. PUNE

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/53**
	Name of Sample	Soil
	Sample Details	Transport Nagar
	Container Details	1 kg plastic bag
	Sample Collected By	MITCON
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No.	Parameters	Results	Unit	Test Method
01	Texture	Clay loam	-	IS 2720 (Part 4)
02	Percentage Of Different Components			
	sand Silt Clay	45 20 35	% % %	IS 2720 (Part 4)
03	Soil Moisture	0.52	%	IS 2720 Part II1973
04	Bulk Density	1.11	gm/cm³	IS 2720 (part XXIX)
05	Water Holding Capacity	47.7	%	IS 14767:2000
06	pH	7.49	--	IS 2720 (Part 26) 1987,Rev.,2,Reaff 2011
07	Conductivity	867.4	µs/cm	IS 14767,2000,Reaff 2016
08	Organic Carbon	0.22	%	IS 2720 (Part 22)
09	Calcium (as Ca)	104.25	mg/kg	USEPA 3050 B,6010 C
10	Magnesium (as Mg)	55.12	mg/kg	USEPA 3050 B,6010 C
11	Available Nitrogen	115.28	kg/ha	IS 14684
12	Phosphorous (as P)	10.71	kg/ha	Laboratory methods for analysis of soils irrigation water and plants revised edition 2012 p.no 87-89
13	Potassium (as K)	128.18	kg/ha	USEPA 3050 B
14	Iron (as Fe)	0.26	mg/kg	USEPA 3050 B
15	Zinc (as Zn)	0.23	mg/kg	USEPA 3050 B
16	Copper (as Cu)	0.13	mg/kg	USEPA 3050 B
17	Sodium	21.7	mg/kg	USEPA 3050 B
18	Manganese (as Mn)	0.20	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	0.89	-	EME/LAB/SOP/SAR

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

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Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	Sample Code	MITCON/2023-24/April/144/54
	Name of Sample	Soil
	Sample Details	Pili Nadi
	Container Details	1 kg plastic bag
	Sample Collected By	MITCON
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No.	Parameters	Results	Unit	Test Method
01	Texture	clay	-	IS 2720 (Part 4)
02	Percentage Of Different Components			
	sand Silt Clay	30 20 50	% % %	IS 2720 (Part 4)
03	Soil Moisture	1.23	%	IS 2720 Part II1973
04	Bulk Density	1.08	gm/cm³	IS 2720 (part XXIX)
05	Water Holding Capacity	50.1	%	IS 14767:2000
06	pH	8.00	-	IS 2720 (Part 26) 1987,Rev.,2,Reaff 2011
07	Conductivity	1013.4	µs/cm	IS 14767,2000,Reaff 2016
08	Organic Carbon	0.32	%	IS 2720 (Part 22)
09	Calcium (as Ca)	89.23	mg/kg	USEPA 3050 B,6010 C
10	Magnesium (as Mg)	41.6	mg/kg	USEPA 3050 B,6010 C
11	Available Nitrogen	121.8	kg/ha	IS 14684
12	Phosphorous (as P)	13.46	kg/ha	Laboratory methods for analysis of soils irrigation water and plants revised edition 2012 p.no 87-89
13	Potassium (as K)	167.25	kg/ha	USEPA 3050 B
14	Iron (as Fe)	0.12	mg/kg	USEPA 3050 B
15	Zinc (as Zn)	0.20	mg/kg	USEPA 3050 B
16	Copper (as Cu)	0.20	mg/kg	USEPA 3050 B
17	Sodium	19.6	mg/kg	USEPA 3050 B
18	Manganese (as Mn)	0.30	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	0.89	-	EME/LAB/SOP/SAR

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/55**
	Name of Sample	Soil
	Sample Details	All India Radio
	Container Details	1 kg plastic bag
	Sample Collected By	MITCON
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No.	Parameters	Results	Unit	Test Method
01	Texture	clay	-	IS 2720 (Part 4)
02	Percentage Of Different Components			
	sand Silt Clay	20 30 50	% % %	IS 2720 (Part 4)
03	Soil Moisture	1.19	%	IS 2720 Part II1973
04	Bulk Density	1.13	gm/cm^3	IS 2720 (part XXIX)
05	Water Holding Capacity	53.7	%	IS 14767:2000
06	pH	7.76	-	IS 2720 (Part 26) 1987,Rev..2,Reaff 2011
07	Conductivity	920.3	µs/cm	IS 14767,2000,Reaff 2016
08	Organic Carbon	0.23	%	IS 2720 (Part 22)
09	Calcium (as Ca)	45.7	mg/kg	USEPA 3050 B,6010 C
10	Magnesium (as Mg)	31 6	mg/kg	USEPA 3050 B,6010 C
11	Available Nitrogen	134.5	kg/ha	IS 14684
12	Phosphorous (as P)	14.7	kg/ha	Laboratory methods for analysis of soils irrigation water and plants revised edition 2017 p.no 87-89
13	Potassium (as K)	103.2	kg/ha	USEPA 3050 B
14	Iron (as Fe)	<0.05	mg/kg	USEPA 3050 B
15	Zinc (as Zn)	0.10	mg/kg	USEPA 3050 B
16	Copper (as Cu)	0.13	mg/kg	USEPA 3050 B
17	Sodium	27.4	mg/kg	USEPA 3050 B
18	Manganese (as Mn)	<0.05	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	1.59	-	EME/LAB/SOP/SAR

For MITCON Consultancy & Engineering Services Ltd.

Checked By
[Mrs. Kadambari Deshmukh]

MITCON CONSULTANCY & ENGINEERING SERVICES LTD. PUNE

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	Sample Code	MITCON/2023-24/April/144/56
	Name of Sample	Soil
	Sample Details	Lekha Nagar
	Container Details	1 kg plastic bag
	Sample Collected By	MITCON
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No.	Parameters	Results	Unit	Test Method
01	Texture	clay	-	IS 2720 (Part 4)
02	Percentage Of Different Components			
	sand Sirt Clay	23 30 47	% % %	IS 2720 (Part 4)
03	Soil Moisture	1.07	%	IS 2720 Part II1973
04	Bulk Density	1.17	gm/cm³	IS 2720 (part XXIX)
05	Water Holding Capacity	56.7	%	IS 14767:2000
06	pH	7.45	--	IS 2720 (Part 26) 1987,Rev..2,Reaff 2011
07	Conductivity	741.7	µs/cm	IS 14767,2000,Reaff 2016
08	Organic Carbon	0.32	%	IS 2720 (Part 22)
09	Calcium (as Ca)	87.3	mg/kg	USEPA 3050 B,6010 C
10	Magnesium (as Mg)	30.7	mg/kg	USEPA 3050 B,6010 C
11	Available Nitrogen	118.7	kg/ha	IS 14684
12	Phosphorous (as P)	19.1	kg/ha	Laboratory methods for analysis of soils irrigation water and plants revised edition 2012 p.no 87-89
13	Potassium (as K)	125.1	kg/ha	USEPA 3050 B
14	Iron (as Fe)	<0.05	mg/kg	USEPA 3050 B
15	Zinc (as Zn)	0.23	mg/kg	USEPA 3050 B
16	Copper (as Cu)	0.37	mg/kg	USEPA 3050 B
17	Sodium	29.6	mg/kg	USEPA 3050 B
18	Manganese (as Mn)	<0.05	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	1.45	-	EME/LAB/SOP/SAR

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	Sample Code	**MITCON/2023-24/April/144/57**
	Name of Sample	Soil
	Sample Details	Kanhan River
	Container Details	1 kg plastic bag
	Sample Collected By	MITCON
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No.	Parameters	Results	Unit	Test Method
01	Texture	clay	-	IS 2720 (Part 4)
02	Percentage Of Different Components			
	sand Silt Clay	27 30 43	% % %	IS 2720 (Part 4)
03	Soil Moisture	1.04	%	IS 2720 Part II1973
04	Bulk Density	1.09	gm/cm³	IS 2720 (part XXIX)
05	Water Holding Capacity	53.8	%	IS 14767:2000
06	pH	7.77	..	IS 2720 (Part 26) 1987,Rev..2,Reaff 2011
07	Conductivity	780.9	µs/cm	IS 14767,2000,Reaff 2016
08	Organic Carbon	0.28	%	IS 2720 (Part 22)
09	Calcium (as Ca)	100.3	mg/kg	USEPA 3050 B,6010 C
10	Magnesium (as Mg)	41.4	mg/kg	USEPA 3050 B,6010 C
11	Available Nitrogen	131.87	kg/ha	IS 14684
12	Phosphorous (as P)	14.3	kg/ha	Laboratory methods for analysis of soils irrigation water and plants revised edition 2012 p.no 87-89
13	Potassium (as K)	120.8	kg/ha	USEPA 3050 B
14	Iron (as Fe)	<0.05	mg/kg	USEPA 3050 B
15	Zinc (as Zn)	0.27	mg/kg	USEPA 3050 B
16	Copper (as Cu)	0.31	mg/kg	USEPA 3050 B
17	Sodium	32.4	mg/kg	USEPA 3050 B
18	Manganese (as Mn)	<0.05	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	1.43	-	EME/LAB/SOP/SAR

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

Authorized Signatory
Dr. Sandeep Jadhav
(Sen or Vice President)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	Sample Code	MITCON/2023-24/April/144/S8
	Name of Sample	Soil
	Sample Details	Ashokwan
	Container Details	1 kg plastic bag
	Sample Collected By	MITCON
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No.	Parameters	Results	Unit	Test Method
01	Texture	Clay loam	-	IS 2720 (Part 4)
02	Percentage Of Different Components			
	sand Silt Clay	40 20 40	% % %	IS 2720 (Part 4)
03	Soil Moisture	0.21	%	IS 2720 Part II1973
04	Bulk Density	1.04	gm/cm³	IS 2720 (part XXIX)
05	Water Holding Capacity	40.2	%	IS 14767:2000
06	pH	7.98	--	IS 2720 (Part 26) 1987, Rev.. 2,Reaff 2011
07	Conductivity	343.2	µs/cm	IS 14767,2000,Reaff 2016
08	Organic Carbon	0.14	%	IS 2720 (Part 22)
09	Calcium (as Ca)	70.2	mg/kg	USEPA 3050 B,6010 C
10	Magnesium (as Mg)	55.3	mg/kg	USEPA 3050 B,6010 C
11	Available Nitrogen	84.3	kg/ha	IS 14684
12	Phosphorous (as P)	7.37	kg/ha	Laboratory methods for analysis of soil, irrigation water and plants revised edition 2012 p.no 87-89
13	Potassium (as K)	89.34	kg/ha	USEPA 3050 B
14	Iron (as Fe)	<0.05	mg/kg	USEPA 3050 B
15	Zinc (as Zn)	0.33	mg/kg	USEPA 3050 B
16	Copper (as Cu)	0.18	mg/kg	USEPA 3050 B
17	Sodium	30.2	mg/kg	USEPA 3050 B
18	Manganese (as Mn)	<0.05	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	1.36	-	EME/LAB/SOP/SAR

For MITCON Consultancy & Engineering Services Ltd.

Checked By
[Mrs. Kadambari Deshmukh]

MITCON CONSULTANCY & ENGINEERING SERVICES LTD. PUNE

Authorized Signatory
Dr. Sandeep Jadhav
[Senior Vice President]

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Report Number : MITCON/2023-24/April/144 **Report Date:12/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/59**
	Name of Sample	Soil
	Sample Details	Wandongri
	Container Details	1 kg plastic bag
	Sample Collected By	MITCON
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No.	Parameters	Results	Unit	Test Method
01	Texture	loam	-	IS 2720 (Part 4)
02	Percentage Of Different Components			
	sand Silt Clay	45 10 45	% % %	IS 2720 (Part 4)
03	Soil Moisture	0.90	%	IS 2720 Part II1973
04	Bulk Density	1.33	gm/cm³	IS 2720 (part XXIX)
05	Water Holding Capacity	52 7	%	IS 14767:2000
06	pH	7.52	-	IS 2720 (Part 26) 1987,Rev..2,Reaff 2011
07	Conductivity	801.8	µs/cm	IS 14767,2000,Reaff 2016
08	Organic Carbon	0.43	%	IS 2720 (Part 22)
09	Calcium (as Ca)	95.67	mg/kg	USEPA 3050 B,6010 C
10	Magnesium (as Mg)	47.3	mg/kg	USEPA 3050 B,6010 C
11	Available Nitrogen	55.13	kg/ha	IS 14684
12	Phosphorous (as P)	4.52	kg/ha	Laboratory methods for analysis of soils irrigation water and plants revised edition 2012 p.no 87-89
13	Potassium (as K)	35.2	kg/ha	USEPA 3050 B
14	Iron (as Fe)	<0.05	mg/kg	USEPA 3050 B
15	Zinc (as Zn)	<0.05	mg/kg	USEPA 3050 B
16	Copper (as Cu)	<0.04	mg/kg	USEPA 3050 B
17	Sodium	14.1	mg/kg	USEPA 3050 B
18	Manganese (as Mn)	<0.05	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	0.61	-	EME/LAB/SOP/SAR

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

CONSULTANCY & ENGINEERING SERVICES PUNE

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/60**
	Name of Sample	Soil
	Sample Details	Khairi Phata
	Container Details	1 kg plastic bag
	Sample Collected By	MITCON
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No.	Parameters	Results	Unit	Test Method
01	Texture		-	IS 2720 (Part 4)
02	Percentage Of Different Components			
	sand Silt Clay	35 30 35	% % %	IS 2720 (Part 4)
03	Soil Moisture	0.52	%	IS 2720 Part II1973
04	Bulk Density	1.09	gm/cm³	IS 2720 (part XXIX)
05	Water Holding Capacity	56.8	%	IS 14767:2000
06	pH	7.89	--	IS 2720 (Part 26) 1987,Rev..2,Reaff 2011
07	Conductivity	745.8	µs/cm	IS 14767,2000,Reaff 2016
08	Organic Carbon	0.14	%	IS 2720 (Part 22)
09	Calcium (as Ca)	78.25	mg/kg	USEPA 3050 B,6010 C
10	Magnesium (as Mg)	25.8	mg/kg	USEPA 3050 B,6010 C
11	Available Nitrogen I	74.13	kg/ha	IS 14684
12	Phosphorous (as P)	5.28	kg/ha	Laboratory methods for analysis of soils irrigation water and plants revised edition 2012 p.no 87-89
13	Potassium (as K)	95.27	kg/ha	USEPA 3050 B
14	Iron (as Fe)	<0.05	mg/kg	USEPA 3050 B
15	Zinc (as Zn)	<0.05	mg/kg	USEPA 3050 B
16	Copper (as Cu)	<0.04	mg/kg	USEPA 3050 B
17	Sodium	18.6	mg/kg	USEPA 3050 B
18	Manganese (as Mn)	<0.05	mg/kg	USEPA 3050 B
19	Total Chromium (as Cr)	<0.05	mg/kg	USEPA 3050 B
20	Nickel (as Ni)	<0.07	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	0.97	-	EME/LAB/SOP/SAR

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

CONSULTANCY & ENGINEERING SERVICES LTD. PUNE

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/61**
	Name of Sample	Soil
	Sample Details	Hingna mount view
	Container Details	1 kg plastic bag
	Sample Collected By	MITCON
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No.	Parameters	Results	Unit	Test Method
01	Texture	loam	-	IS 2720 (Part 4)
02	Percentage Of Different Components			
	sand Silt Clay	30 30 40	% % %	IS 2720 (Part.4)
03	Soil Moisture	0.72	%	IS 2720 Part II1973
04	Bulk Density	1.02	gm/cm³	IS 2720 (part XXIX)
05	Water Holding Capacity	51.6	%	IS 14767:2000
06	pH	7.89	--	IS 2720 (Part 26) 1987,Rev..2,Reaff 2011
07	Conductivity	698 7	µs/cm	IS 14767,2000,Reaff 2016
08	Organic Carbon	0.48	%	IS 2720 (Part 22)
09	Calcium (as Ca)	85.6	mg/kg	USEPA 3050 B,6010 C
10	Magnesium (as Mg)	41.7	mg/kg	USEPA 3050 B,6010 C
11	Available Nitrogen	65 02	kg/ha	IS 14684
12	Phosphorous (as P)	7.13	kg/ha	Laboratory methods for analysis of soils irrigation water and plants revised edition 2012 p.no 87-89
13	Potassium (as K)	98.3	kg/ha	USEPA 3050 B
14	Iron (as Fe)	<0.05	mg/kg	USEPA 3050 B
15	Zinc (as Zn)	<0.05	mg/kg	USEPA 3050 B
16	Copper (as Cu)	<0.04	mg/kg	USEPA 3050 B
17	Sodium	70.4	mg/kg	USEPA 3050 B
18	Manganese (as Mn)	0.17	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	0.95	-	EME/LAB/SOP/SAR

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

MITCON CONSULTANCY & ENGINEERING SERVICES LTD. PUNE

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/62**
	Name of Sample	Soil
	Sample Details	Pardi
	Container Details	1 kg plastic bag
	Sample Collected By	MITCON
	Sample Collected On	24/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sr. No.	Parameters	Results	Unit	Test Method
01	Texture		-	IS 2720 (Part 4)
02	Percertage Of Different Components			
	sand Silt Clay	40 20 40	% % %	IS 2720 (Part 4)
03	Soil Moisture	3.11	%	IS 2720 Part II1973
04	Bulk Density	1.08	gm/cm³	IS 2720 (part XXIX)
05	Water Holding Capacity	55.6	%	IS 14767.2000
06	pH	7.49		IS 2720 (Part 26) 1987,Rev..2,Reaff 2011
07	Conductivity	767.1	µs/cm	IS 14767,2000,Reaff 2016
08	Organic Carbon	0.52	%	IS 2720 (Part 22)
09	Calcium (as Ca)	83.35	mg/kg	USEPA 3050 B,6010 C
10	Magnesium (as Mg)	51.3	mg/kg	USEPA 3050 B,6010 C
11	Available Nitrogen	71.7	kg/ha	IS 14684
12	Phosphorous (as P)	8.12	kg/ha	Laboratory methods for analysis of soils Irigation water and plants revised edition 2012 p.no 87-89
13	Potassium (as K)	83.2	kg/ha	USEPA 3050 B
14	Iron (as Fe)	<0.05	mg/kg	USEPA 3050 B
15	Zinc (as Zn)	<0.05	mg/kg	USEPA 3050 B
16	Copper (as Cu)	<0.04	mg/kg	USEPA 3050 B
17	Sodium	22.7	mg/kg	USEPA 3050 B
18	Manganese (as Mn)	<0.05	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	1.00	-	EME/LAB/SOP/SAR

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

Authorized Signatory
Dr. Sandeep Jadhav
(Senior Vice President)

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Report Number : MITCON/2023-24/April/144 **Report Date:2/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project	Sample Code	MITCON/2023-24/April/144/63
	Name of Sample	Ambient Air
	Location Name	AAQ 1
	Sampling Method	IS 5182
	Sample Collected By	MITCON
	Sample Collected On	27/04/2023
	Date of Sample Receipt	28/04/2023
	Analysis Start Date	28/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sampling Location	$PM_{2.5}$	PM_{10}	SO_2	Nox	CO
AAQ1	48.2	80.7	27.8	35.5	0.8
Methods	IS 5182 (Part 24) : 2019 (Reaffirmed 2019)	IS:5182(Part 23)-2006 (Reaffirmed 2017)	IS:5182(Part 2)-2001 (Reaffirmed 2017)	IS:5182(Part 6)-2006 (Reaffirmed 2017)	Instrumental Manual
Limits as per NAAQ	≤60	≤100.0	≤80.0	≤80.0	≤4.0

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadamban Deshmukh)

MITCON CONSULTANCY & ENGINEERING SERVICES LTD. * PUNE *

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:2/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project	Sample Code	MITCON/2023-24/April/144/64
	Name of Sample	Ambient Air
	Location Name	AAQ 2
	Sampling Method	IS 5182
	Sample Collected By	MITCON
	Sample Collected On	22/04/2023
	Date of Sample Receipt	28/04/2023
	Analysis Start Date	28/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sampling Location	$PM_{2.5}$	PM_{10}	SO_2	Nox	CO
AAQ2	50.1	92.5	29.1	38.7	0.7
Methods	IS 5182 (Part 24) : 2019 (Reaffirmed 2019)	IS:5182(Part 23)-2006 (Reaffirmed 2017)	IS:5182(Part 2)-2001 (Reaffirmed 2017)	IS:5182(Part 6)-2006 (Reaffirmed 2017)	Instrumental Manual
Limits as per NAAQ	≤60	≤100.0	≤80.0	≤80.0	≤4.0

For MITCON Consultancy & Engineering Services Ltd.

Checked By
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MITCON CONSULTANCY & ENGINEERING SERVICES LTD. PUNE

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Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/65**
	Name of Sample	Ambient Air
	Location Name	AAQ 3
	Sampling Method	IS 5182
	Sample Collected By	MITCON
	Sample Collected On	23/04/2023
	Date of Sample Receipt	28/04/2023
	Analysis Start Date	28/04/2023
	End Date of Analysis	05/05/2023

ANALYSIS RESULTS

Sampling Location	$PM_{2.5}$	PM_{10}	SO_2	Nox	CO
AAQ3	51.2	85.4	30.1	36.9	1.1
Methods	IS 5182 (Part 24) : 2019 (Reaffirmed 2019)	IS:5182(Part 23)-2006 (Reaffirmed 2017)	IS:5182(Part 2)-2001 (Reaffirmed 2017)	IS:5182(Part 6)-2006 (Reaffirmed 2017)	Instrumental Manual
Limits as per NAAQ	≤60	≤100.0	≤80.0	≤80.0	≤4.0

For MITCON Consultancy & Engineering Services Ltd.

Checked By
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Client's Name & Address	Sample Details	
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	Name of Sample	Ambient Air
	Location Name	AAQ 4
	Sampling Method	IS 5182
	Sample Collected By	MITCON
	Sample Collected On	23/04/2023
	Date of Sample Receipt	28/04/2023
	Analysis Start Date	28/04/2023
	End Date of Analysis	05/05/2023

Sampling Location	$PM_{2.5}$	PM_{10}	SO_2	Nox	CO
AAQ4	50.7	93.6	26.5	35.4	0.9
Methods	IS 5182 (Part 24) : 2019 (Reaffirmed 2019)	IS:5182(Part 23)-2006 (Reaffirmed 2017)	IS:5182(Part 2)-2001 (Reaffirmed 2017)	IS:5182(Part 6)-2006 (Reaffirmed 2017)	Instrumental Manual
Limits as per NAAQ	≤60	≤100.0	≤80.0	≤80.0	≤4.0

For MITCON Consultancy & Engineering Services Ltd.

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:2/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project	Sample Code	MITCON/2023-24/April/144/67
	Name of Sample	Ambient Air
	Location Name	AAQ 5
	Sampling Method	IS 5182
	Sample Collected By	MITCON
	Sample Collected On	24/04/2023
	Date of Sample Receipt	28/04/2023
	Analysis Start Date	28/04/2023
	End Date of Analysis	05/05/2023

Sampling Location	$PM_{2.5}$	PM_{10}	SO_2	Nox	CO
AAQ5	52.6	98.7	25.1	37.4	1.0
Methods	IS 5182 (Part 24) : 2019 (Reaffirmed 2019)	IS:5182(Part 23)-2006 (Reaffirmed 2017)	IS:5182(Part 2)-2001 (Reaffirmed 2017)	IS:5182(Part 6)-2006 (Reaffirmed 2017)	Instrumental Manual
Limits as per NAAQ	≤60	≤100.0	≤80.0	≤80.0	≤4.0

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

MITCON CONSULTANCY & ENGINEERING SERVICES LTD. PUNE

Authorized Signatory
Dr. Sandeep Jadhav
Quality Manager/HOD

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:2/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project	Sample Code	MITCON/2023-24/April/144/68
	Name of Sample	Ambient Air
	Location Name	AAQ 6
	Sampling Method	IS 5182
	Sample Collected By	MITCON
	Sample Collected On	25/04/2023
	Date of Sample Receipt	28/04/2023
	Analysis Start Date	28/04/2023
	End Date of Analysis	05/05/2023

Sampling Location	$PM_{2.5}$	PM_{10}	SO_2	Nox	CO
AA	56.7	85.8	28.2	38.2	1.2
Methods	IS 5182 (Part 24) : 2019 (Reaffirmed 2019)	IS:5182(Part 23)-2006 (Reaffirmed 2017)	IS:5182(Part 2)-2001 (Reaffirmed 2017)	IS:5182(Part 6)-2006 (Reaffirmed 2017)	Instrumental Manual
Limits as per NAAQ	≤60	≤100.0	≤80.0	≤80.0	≤4.0

For MITCON Consultancy & Engineering Services Ltd.

Checked-By
(Mrs. Kadambari Deshmukh)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:2/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project	Sample Code	MITCON/2023-24/April/144/69
	Name of Sample	Ambient Air
	Location Name	AAQ 7
	Sampling Method	IS 5182
	Sample Collected By	MITCON
	Sample Collected On	25/04/2023
	Date of Sample Receipt	28/04/2023
	Analysis Start Date	28/04/2023
	End Date of Analysis	05/05/2023

Sampling Location	$PM_{2.5}$	PM_{10}	SO_2	Nox	CO
AAQ7	59.5	92.7	26.9	33.1	1.1
Methods	IS 5182 (Part 24) : 2019 (Reaffirmed 2019)	IS:5182(Part 23)-2006 (Reaffirmed 2017)	IS:5182(Part 2)-2001 (Reaffirmed 2017)	IS:5182(Part 6)-2006 (Reaffirmed 2017)	Instrumental Manual
Limits as per NAAQ	≤60	≤100.0	≤80.0	≤80.0	≤4.0

For MITCON Consultancy & Engineering Services Ltd.

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:2/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	Sample Code	MITCON/2023-24/April/144/70
	Name of Sample	Ambient Air
	Location Name	AAQ 8
	Sampling Method	IS 5182
	Sample Collected By	MITCON
	Sample Collected On	26/04/2023
	Date of Sample Receipt	28/04/2023
	Analysis Start Date	28/04/2023
	End Date of Analysis	05/05/2023

Sampling Location	$PM_{2.5}$	PM_{10}	SO_2	Nox	CO
AAQ8	60.2	93.1	32.3	41.6	1.4
Methods	IS 5182 (Part 24) : 2019 (Reaffirmed 2019)	IS:5182(Part 23)-2006 (Reaffirmed 2017)	IS:5182(Part 2)-2001 (Reaffirmed 2017)	IS:5182(Part 6)-2006 (Reaffirmed 2017)	Instrumental Manual
Limits as per NAAQ	≤60	≤100.0	≤80.0	≤80.0	≤4.0

For MITCON Consultancy & Engineering Services Ltd.

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Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/71**
	Name of Sample	Ambient Air
	Location Name	AAQ 9
	Sampling Method	IS 5182
	Sample Collected By	MITCON
	Sample Collected On	24/04/2023
	Date of Sample Receipt	28/04/2023
	Analysis Start Date	28/04/2023
	End Date of Analysis	05/05/2023

Sampling Location	$PM_{2.5}$	PM_{10}	SO_2	Nox	CO
AAQ9	58.9	86.9	23.6	33.1	1.0
Methods	IS 5182 (Part 24) : 2019 (Reaffirmed 2019)	IS:5182(Part 23)-2006 (Reaffirmed 2017)	IS:5182(Part 2)-2001 (Reaffirmed 2017)	IS:5182(Part 6)-2006 (Reaffirmed 2017)	Instrumental Manual
Limits as per NAAQ	≤60	<100.0	≤80.0	≤80.0	≤4.0

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Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	Sample Code	MITCON/2023-24/April/144/72
	Name of Sample	Ambient Air
	Location Name	AAQ 10
	Sampling Method	IS 5182
	Sample Collected By	MITCON
	Sample Collected On	26/04/2023
	Date of Sample Receipt	28/04/2023
	Analysis Start Date	28/04/2023
	End Date of Analysis	05/05/2023

Sampling Location	$PM_{2.5}$	PM_{10}	SO_2	Nox	CO
AAQ10	53.2	88.1	31.3	37.8	1.2
Methods	IS 5182 (Part 24) : 2019 (Reaffirmed 2019)	IS:5182(Part 23)-2006 (Reaffirmed 2017)	IS:5182(Part 2)-2001 (Reaffirmed 2017)	IS:5182(Part 6)-2006 (Reaffirmed 2017)	Instrumental Manual
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Report Number : MITCON/2023-24/April/144 **Report Date:2/05/2023**

Client's Name & Address	Sample Details	
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	Name of Sample	Ambient Air
	Location Name	AAQ 11
	Sampling Method	IS 5182
	Sample Collected By	MITCON
	Sample Collected On	17/04/2023
	Date of Sample Receipt	22/04/2023
	Analysis Start Date	22/04/2023
	End Date of Analysis	27/04/2023

Sampling Location	$PM_{2.5}$	PM_{10}	SO_2	Nox	CO
AAQ11	51.4	83.7	28.9	35.4	0.8
Methods	IS 5182 (Part 24) : 2019 (Reaffirmed 2019)	IS:5182(Part 23)-2006 (Reaffirmed 2017)	IS:5182(Part 2)-2001 (Reaffirmed 2017)	IS:5182(Part 6)-2006 (Reaffirmed 2017)	Instrumental Manual
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Report Number : MITCON/2023-24/April/144 **Report Date:2/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	Sample Code	**MITCON/2023-24/April/144/74**
	Name of Sample	Ambient Air
	Location Name	AAQ 12
	Sampling Method	IS 5182
	Sample Collected By	MITCON
	Sample Collected On	17/04/2023
	Date of Sample Receipt	22/04/2023
	Analysis Start Date	22/04/2023
	End Date of Analysis	27/04/2023

Sampling Location	$PM_{2.5}$	PM_{10}	SO_2	Nox	CO
AAQ12	52.5	87.8	24.5	30.6	1.0
Methods	IS 5182 (Part 24) : 2019 (Reaffirmed 2019)	IS:5182(Part 23)-2006 (Reaffirmed 2017)	IS:5182(Part 2)-2001 (Reaffirmed 2017)	IS:5182(Part 6)-2006 (Reaffirmed 2017)	Instrumental Manual
Limits as per NAAQ	≤60	≤100.0	≤80.0	≤80.0	≤4.0

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Report Number : MITCON/2023-24/April/144 **Report Date:2/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project	Sample Code	MITCON/2023-24/April/144/75
	Name of Sample	Ambient Air
	Location Name	AAQ 13
	Sampling Method	IS 5182
	Sample Collected By	MITCON
	Sample Collected On	18/04/2023
	Date of Sample Receipt	22/04/2023
	Analysis Start Date	22/04/2023
	End Date of Analysis	27/04/2023

Sampling Location	$PM_{2.5}$	PM_{10}	SO_2	Nox	CO
AAQ13	52.9	85.4	26.1	32.5	0.9
Methods	IS 5182 (Part 24) : 2019 (Reaffirmed 2019)	IS:5182(Part 23)-2006 (Reaffirmed 2017)	IS:5182(Part 2)-2001 (Reaffirmed 2017)	IS:5182(Part 6)-2006 (Reaffirmed 2017)	Instrumental Manual
Limits as per NAAQ	≤60	≤100.0	≤80.0	<80.0	≤4.0

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:2/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/76**
	Name of Sample	Ambient Air
	Location Name	AAQ 14
	Sampling Method	IS 5182
	Sample Collected By	MITCON
	Sample Collected On	18/04/2023
	Date of Sample Receipt	22/04/2023
	Analysis Start Date	22/04/2023
	End Date of Analysis	27/04/2023

Sampling Location	$PM_{2.5}$	PM_{10}	SO_2	Nox	CO
AAQ14	55.6	90.1	25.6	33.1	1.0
Methods	IS 5182 (Part 24) : 2019 (Reaffirmed 2019)	IS:5182(Part 23)-2006 (Reaffirmed 2017)	IS:5182(Part 2)-2001 (Reaffirmed 2017)	IS:5182(Part 6)-2006 (Reaffirmed 2017)	Instrumental Manual
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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:2/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project	Sample Code	MITCON/2023-24/April/144/77
	Name of Sample	Ambient Air
	Location Name	AAQ 15
	Sampling Method	IS 5182
	Sample Collected By	MITCON
	Sample Collected On	19/04/2023
	Date of Sample Receipt	22/04/2023
	Analysis Start Data	22/04/2023
	End Date of Analysis	27/04/2023

Sampling Location	$PM_{2.5}$	PM_{10}	SO_2	Nox	CO
AAQ15	57.8	92.5	27.8	41.1	0.9
Methods	IS 5182 (Part 24) : 2019 (Reaffirmed 2019)	IS:5182(Part 23)-2006 (Reaffirmed 2017)	IS:5182(Part 2)-2001 (Reaffirmed 2017)	IS:5182(Part 6)-2006 (Reaffirmed 2017)	Instrumental Manual
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Report Number : MITCON/2023-24/April/144 **Report Date:2/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project	Sample Code	MITCON/2023-24/April/144/78
	Name of Sample	Ambient Air
	Location Name	AAQ 16
	Sampling Method	IS 5182
	Sample Collected By	MITCON
	Sample Collected On	19/04/2023
	Date of Sample Receipt	22/04/2023
	Analysis Start Date	22/04/2023
	End Date of Analysis	27/04/2023

Sampling Location	$PM_{2.5}$	PM_{10}	SO_2	Nox	CO
AAQ16	55.7	89.4	24.1	38.7	0.8
Methods	IS 5182 (Part 24) : 2019 (Reaffirmed 2019)	IS:5182(Part 23)-2006 (Reaffirmed 2017)	IS:5182(Part 2)-2001 (Reaffirmed 2017)	IS:5182(Part 6)-2006 (Reaffirmed 2017)	Instrumental Manual
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Client's Name & Address	Sample Details	
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	Name of Sample	Ambient Air
	Location Name	AAQ 17
	Sampling Method	IS 5182
	Sample Collected By	MITCON
	Sample Collected On	20/04/2023
	Date of Sample Receipt	22/04/2023
	Analysis Start Date	22/04/2023
	End Date of Analysis	27/04/2023

Sampling Location	$PM_{2.5}$	PM_{10}	SO_2	Nox	CO
AAQ17	57.1	90.2	26.3	40.3	1.1
Methods	IS 5182 (Part 24) : 2019 (Reaffirmed 2019)	IS:5182(Part 23)-2006 (Reaffirmed 2017)	IS:5182(Part 2)-2001 (Reaffirmed 2017)	IS:5182(Part 6)-2006 (Reaffirmed 2017)	Instrumental Manual
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Client's Name & Address	Sample Details	
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	Name of Sample	Ambient Air
	Location Name	AAQ 18
	Sampling Method	IS 5182
	Sample Collected By	MITCON
	Sample Collected On	20/04/2023
	Date of Sample Receipt	22/04/2023
	Analysis Start Date	22/04/2023
	End Date of Analysis	27/04/2023

Sampling Location	$PM_{2.5}$	PM_{10}	SO_2	Nox	CO
AAQ18	56.9	91.5	22.1	45.6	1.1
Methods	IS 5182 (Part 24) : 2019 (Reaffirmed 2019)	IS:5182(Part 23)-2006 (Reaffirmed 2017)	IS:5182(Part 2)-2001 (Reaffirmed 2017)	IS:5182(Part 6)-2006 (Reaffirmed 2017)	Instrumental Manual
Limits as per NAAQ	≤60	≤100.0	≤80.0	≤80.0	≤4.0

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

Authorized Signatory
Dr. Sandeep Jadhav
Quality Manager/HOD

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:2/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspath,Nagpur- 440010 Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project	Sample Code	MITCON/2023-24/April/144/81
	Name of Sample	Ambient Air
	Location Name	AAQ 19
	Sampling Method	IS 5182
	Sample Collected By	MITCON
	Sample Collected On	21/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

Sampling Location	$PM_{2.5}$	PM_{10}	SO_2	Nox	CO
AAQ19	54.1	87.4	23.2	46.1	0.9
Methods	IS 5182 (Part 24) : 2019 (Reaffirmed 2019)	IS:5182(Part 23)-2006 (Reaffirmed 2017)	IS:5182(Part 2)-2001 (Reaffirmed 2017)	IS:5182(Part 6)-2006 (Reaffirmed 2017)	Instrumental Manual
Limits as per NAAQ	≤60	≤100.0	<80.0	≤80.0	≤4.0

For **MITCON Consultancy & Engineering Services Ltd.**

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(Mrs. Kadambari Deshmukh)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:2/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/82**
	Name of Sample	Ambient Air
	Location Name	AAQ 20
	Sampling Method	IS 5182
	Sample Collected By	MITCON
	Sample Collected On	22/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

Sampling Location	$PM_{2.5}$	PM_{10}	SO_2	Nox	CO
AAQ20	52.3	82.1	25.7	44.2	0.7
Methods	IS 5182 (Part 24) : 2019 (Reaffirmed 2019)	IS:5182(Part 23)-2006 (Reaffirmed 2017)	IS:5182(Part 2)-2001 (Reaffirmed 2017)	IS:5182(Part 6)-2006 (Reaffirmed 2017)	Instrumental Manual
Limits as per NAAQ	≤60	≤100.0	≤80.0	≤80.0	≤4.0

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Report Number : MITCON/2023-24/April/144 **Report Date:2/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	Sample Code	MITCON/2023-24/April/144/83
	Name of Sample	Ambient Air
	Location Name	AAQ 21
	Sampling Method	IS 5182
	Sample Collected By	MITCON
	Sample Collected On	19/04/2023
	Date of Sample Receipt	22/04/2023
	Analysis Start Date	22/04/2023
	End Date of Analysis	27/04/2023

Sampling Location	$PM_{2.5}$	PM_{10}	SO_2	Nox	CO
AAQ21	50.9	86.3	28.4	45.2	0.6
Methods	IS 5182 (Part 24) : 2019 (Reaffirmed 2019)	IS:5182(Part 23)-2006 (Reaffirmed 2017)	IS:5182(Part 2)-2001 (Reaffirmed 2017)	IS:5182(Part 6)-2006 (Reaffirmed 2017)	Instrumental Manual
Limits as per NAAQ	≤60	≤100.0	≤80.0	≤80.0	≤4.0

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:2/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project	Sample Code	MITCON/2023-24/April/144/84
	Name of Sample	Ambient Air
	Location Name	AAQ 22
	Sampling Method	IS 5182
	Sample Collected By	MITCON
	Sample Collected On	21/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

Sampling Location	$PM_{2.5}$	PM_{10}	SO_2	Nox	CO
AAQ22	57.4	91.2	30.1	46.3	0.9
Methods	IS 5182 (Part 24) : 2019 (Reaffirmed 2019)	IS:5182(Part 23)-2006 (Reaffirmed 2017)	IS:5182(Part 2)-2001 (Reaffirmed 2017)	IS:5182(Part 6)-2006 (Reaffirmed 2017)	Instrumental Manual
Limits as per NAAQ	≤60	≤100.0	<80.0	≤80.0	≤4.0

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Report Number : MITCON/2023-24/April/144 **Report Date:2/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project	Sample Code	MITCON/2023-24/April/144/85
	Name of Sample	Ambient Air
	Location Name	AAQ 23
	Sampling Method	IS 5182
	Sample Collected By	MITCON
	Sample Collected On	21/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

Sampling Location	$PM_{2.5}$	PM_{10}	SO_2	Nox	CO
AAQ23	56.4	95.2	29.8	45.7	0.9
Methods	IS 5182 (Part 24) : 2019 (Reaffirmed 2019)	IS:5182(Part 23)-2006 (Reaffirmed 2017)	IS:5182(Part 2)-2001 (Reaffirmed 2017)	IS:5182(Part 6)-2006 (Reaffirmed 2017)	Instrumental Manual
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Report Number : MITCON/2023-24/April/144 **Report Date:2/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010 Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project	Sample Code	MITCON/2023-24/April/144/86
	Name of Sample	Ambient Air
	Location Name	AAQ 24
	Sampling Method	IS 5182
	Sample Collected By	MITCON
	Sample Collected On	19/04/2023
	Date of Sample Receipt	22/04/2023
	Analysis Start Date	22/04/2023
	End Date of Analysis	27/04/2023

Sampling Location	$PM_{2.5}$	PM_{10}	SO_2	Nox	CO
AAQ24	57.8	88.7	30.6	48.9	1.1
Methods	IS 5182 (Part 24) : 2019 (Reaffirmed 2019)	IS:5182(Part 23)-2006 (Reaffirmed 2017)	IS:5182(Part 2)-2001 (Reaffirmed 2017)	IS:5182(Part 6)-2006 (Reaffirmed 2017)	Instrumental Manual
Limits as per NAAQ	≤60	≤100.0	≤80.0	≤80.0	<4.0

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Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	Sample Code	**MITCON/2023-24/April/144/87**
	Name of Sample	Ambient Air
	Location Name	AAQ 25
	Sampling Method	IS 5182
	Sample Collected By	MITCON
	Sample Collected On	19/04/2023
	Date of Sample Receipt	22/04/2023
	Analysis Start Date	22/04/2023
	End Date of Analysis	27/04/2023

Sampling Location	$PM_{2.5}$	PM_{10}	SO_2	Nox	CO
AAQ25	55.9	86.5	31.2	47.5	1.0
Methods	IS 5182 (Part 24) : 2019 (Reaffirmed 2019)	IS:5182(Part 23)-2006 (Reaffirmed 2017)	IS:5182(Part 2)-2001 (Reaffirmed 2017)	IS:5182(Part 6)-2006 (Reaffirmed 2017)	Instrumental Manual
Limits as per NAAQ	≤60	≤100.0	≤80.0	≤80.0	≤4.0

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Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project	Sample Code	MITCON/2023-24/April/144/88
	Name of Sample	Ambient Air
	Location Name	AAQ 26
	Sampling Method	IS 5182
	Sample Collected By	MITCON
	Sample Collected On	18/04/2023
	Date of Sample Receipt	22/04/2023
	Analysis Start Date	22/04/2023
	End Date of Analysis	27/04/2023

Sampling Location	$PM_{2.5}$	PM_{10}	SO_2	Nox	CO
AAQ26	56.3	95.9	30.4	48.5	1.0
Methods	IS 5182 (Part 24) : 2019 (Reaffirmed 2019)	IS:5182(Part 23)-2006 (Reaffirmed 2017)	IS:5182(Part 2)-2001 (Reaffirmed 2017)	IS:5182(Part 6)-2006 (Reaffirmed 2017)	Instrumental Manual
Limits as per NAAQ	≤60	≤100.0	≤80.0	≤80.0	≤4.0

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Client's Name & Address	Sample Details	
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	Name of Sample	Ambient Air
	Location Name	AAQ 27
	Sampling Method	IS 5182
	Sample Collected By	MITCON
	Sample Collected On	18/04/2023
	Date of Sample Receipt	22/04/2023
	Analysis Start Date	22/04/2023
	End Date of Analysis	27/04/2023

Sampling Location	$PM_{2.5}$	PM_{10}	SO_2	Nox	CO
AAQ27	58.7	98.6	31.5	50.2	1.1
Methods	IS 5182 (Part 24) : 2019 (Reaffirmed 2019)	IS:5182(Part 23)-2006 (Reaffirmed 2017)	IS:5182(Part 2)-2001 (Reaffirmed 2017)	IS:5182(Part 6)-2006 (Reaffirmed 2017)	Instrumental Manual
Limits as per NAAQ	≤60	≤100.0	≤80.0	≤80.0	≤4.0

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Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/90**
	Name of Sample	Ambient Air
	Location Name	AAQ 28
	Sampling Method	IS 5182
	Sample Collected By	MITCON
	Sample Collected On	17/04/2023
	Date of Sample Receipt	22/04/2023
	Analysis Start Date	22/04/2023
	End Date of Analysis	27/04/2023

Sampling Location	$PM_{2.5}$	PM_{10}	SO_2	Nox	CO
AAQ28	57.9	97.9	30.7	50.8	1.2
Methods	IS 5182 (Part 24) : 2019 (Reaffirmed 2019)	IS:5182(Part 23)-2006 (Reaffirmed 2017)	IS:5182(Part 2)-2001 (Reaffirmed 2017)	IS:5182(Part 6)-2006 (Reaffirmed 2017)	Instrumental Manual
Limits as per NAAQ	≤60	≤100.0	≤80.0	≤80.0	≤4.0

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Report Number : MITCON/2023-24/April/144 **Report Date:2/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project	Sample Code	MITCON/2023-24/April/144/91
	Name of Sample	Ambient Air
	Location Name	AAQ 29
	Sampling Method	IS 5182
	Sample Collected By	MITCON
	Sample Collected On	17/04/2023
	Date of Sample Receipt	22/04/2023
	Analysis Start Date	22/04/2023
	End Date of Analysis	27/04/2023

Sampling Location	$PM_{2.5}$	PM_{10}	SO_2	Nox	CO
AAQ29	55.4	80.2	27.9	49.6	1.0
Methods	IS 5182 (Part 24) : 2019 (Reaffirmed 2019)	IS:5182(Part 23)-2006 (Reaffirmed 2017)	IS:5182(Part 2)-2001 (Reaffirmed 2017)	IS:5182(Part 6)-2006 (Reaffirmed 2017)	Instrumental Manual
Limits as per NAAQ	≤60	≤100.0	≤80.0	<80.0	≤4.0

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Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	Sample Code	MITCON/2023-24/April/144/92
	Name of Sample	Ambient Air
	Location Name	AAQ 30
	Sampling Method	IS 5182
	Sample Collected By	MITCON
	Sample Collected On	20/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

Sampling Location	$PM_{2.5}$	PM_{10}	SO_2	Nox	CO
AAQ30	57.2	86.3	26.7	47.6	0.9
Methods	IS 5182 (Part 24) : 2019 (Reaffirmed 2019)	IS:5182(Part 23)-2006 (Reaffirmed 2017)	IS:5182(Part 2)-2001 (Reaffirmed 2017)	IS:5182(Part 6)-2006 (Reaffirmed 2017)	Instrumental Manual
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Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project	Sample Code	MITCON/2023-24/April/144/93
	Name of Sample	Ambient Air
	Location Name	AAQ 31
	Sampling Method	IS 5182
	Sample Collected By	MITCON
	Sample Collected On	20/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

Sampling Location	$PM_{2.5}$	PM_{10}	SO_2	Nox	CO
AAQ31	58.2	88.1	25.2	45.6	1.2
Methods	IS 5182 (Part 24) : 2019 (Reaffirmed 2019)	IS:5182(Part 23)-2006 (Reaffirmed 2017)	IS:5182(Part 2)-2001 (Reaffirmed 2017)	IS:5182(Part 6)-2006 (Reaffirmed 2017)	Instrumental Manual
Limits as per NAAQ	≤60	≤100.0	≤80.0	≤80.0	≤4.0

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

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Authorized Signatory
Dr. Sandeep Jadhav
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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:2/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	Sample Code	MITCON/2023-24/April/144/94
	Name of Sample	Ambient Air
	Location Name	AAQ 32
	Sampling Method	IS 5182
	Sample Collected By	MITCON
	Sample Collected On	22/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

Sampling Location	$PM_{2.5}$	PM_{10}	SO_2	Nox	CO
AAQ32	60.3	98.3	24.1	48.2	1.2
Methods	IS 5182 (Part 24) : 2019 (Reaffirmed 2019)	IS:5182(Part 23)-2006 (Reaffirmed 2017)	IS:5182(Part 2)-2001 (Reaffirmed 2017)	IS:5182(Part 6)-2006 (Reaffirmed 2017)	Instrumental Manual
Limits as per NAAQ	≤60	≤100.0	≤80.0	≤80.0	≤4.0

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Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project	Sample Code	MITCON/2023-24/April/144/95
	Name of Sample	Ambient Air
	Location Name	AAQ 33
	Sampling Method	IS 5182
	Sample Collected By	MITCON
	Sample Collected On	22/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

Sampling Location	$PM_{2.5}$	PM_{10}	SO_2	Nox	CO
AAQ33	59.8	94.8	25.6	44.8	1.1
Methods	IS 5182 (Part 24) : 2019 (Reaffirmed 2019)	IS:5182(Part 23)-2006 (Reaffirmed 2017)	IS:5182(Part 2)-2001 (Reaffirmed 2017)	IS:5182(Part 6)-2006 (Reaffirmed 2017)	Instrumental Manual
Limits as per NAAQ	≤60	≤100.0	≤80.0	≤80.0	≤4.0

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Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010 **Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(noth south and east west)of Nagpur metro rail project**	**Sample Code**	**MITCON/2023-24/April/144/96**
	Name of Sample	Ambient Air
	Location Name	AAQ 34
	Sampling Method	IS 5182
	Sample Collected By	MITCON
	Sample Collected On	22/04/2023
	Date of Sample Receipt	25/04/2023
	Analysis Start Date	25/04/2023
	End Date of Analysis	05/05/2023

Sampling Location	$PM_{2.5}$	PM_{10}	SO_2	Nox	CO
AAQ34	61.6	100.9	26.3	50.2	1.2
Methods	IS 5182 (Part 24) : 2019 (Reaffirmed 2019)	IS:5182(Part 23)-2006 (Reaffirmed 2017)	IS:5182(Part 2)-2001 (Reaffirmed 2017)	IS:5182(Part 6)-2006 (Reaffirmed 2017)	Instrumental Manual
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	Name of Sample	Ambient Noise
	Date of Monitoring period	17/04/2023-27/04/2023

Sample No.	Locations (Village)	Category of Area / Zone	24 hourly Average Noise Level Values [in L_{eq} dB (A)]	
			Day	Night
NQ1	Ashokwan	Residential	50.1	36.1
NQ2	Dongargaon	Residential	47.2	30.6
NQ3	Mohgaon	Residential	51.6	40.5
NQ4	Meghdoot CIDCO	Commercial	62.7	49.4
NQ5	Butibori Police Station	Commercial	59.8	48.3
NQ6	MHADA Colony	Commercial	61.6	49.8
NQ7	MIDC KEC	Industrial	73.6	52.5
NQ8	MIDC ESR	Industrial	68.0	54.9
NQ9	Jijamata High School & Jr. College	Silence	51.6	44.7
NQ10	Rachana Hospital	Silence	54.2	45.6
NQ11	Pili Nadi	Commercial	60.3	51.3
NQ12	Khasara fata	Commercial	61.4	52.1
NQ13	All India Radio	Commercial	64.2	50.4
NQ14	Khairi fata	Commercial	60.9	51.9
NQ15	Lok Vihar	Residential	54.9	45.7
NQ16	Lekha Nagar Asha Hospital and Asharam College & School of Nursing	Residential / Silence	56.8	44.9
NQ17	Kamptee Police station	Commercial	59.8	50.1
NQ18	Kamptee Municipal Council	Residential	55.1	45.6

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NQ19	Dragon Palace	Residential	54.9	44.2
NQ20	Kanhan River	Residential	52.1	40.6
NQ21	Delhi Public School (DPS), Khairy, Kamptee Road, Nagpur	Silence	50.1	43.6
NQ22	Hingna Mount View	Residential	56.9	42.3
NQ23	Rajiv Nagar	Commercial	60.3	46.9
NQ24	Wanadongri	Commercial	59.8	44.8
NQ25	APMC	Commercial	61.2	55.1
NQ26	Raipur	Commercial	64.1	53.7
NQ27	Hingna Bus Station	Commercial	62.7	55.9
NQ28	Hingna	Commercial	67.4	52.1
NQ29	Rural Hospital - Hingna	Silence	53.2	46.8
NQ30	YCCE	Silence	55.4	43.9
NQ31	Shalinitai Meghe Hospital	Silence	56.6	47.8
NQ32	Pardi	Commercial	59.8	49.1
NQ33	Kapsi Kh.	Commercial	62.3	50.2
NQ34	Transport Nagar	Commercial	64.9	51.3

Remarks and observations:

Sr no	Area	Day Time limits	Night Time limits
1	Residential	≤55 dB(A)	≤45 dB(A)
2	Commercial	≤65 dB(A)	≤55 dB(A)
3	Silence	≤50d8(A)	≤40 dB(A)
4	Industrial	≤75 dB(A)	≤70 dB(A)

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

MITCON CONSULTANCY & ENGINEERING SERVICES LTD. PUNE

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Quality Manager/HOD

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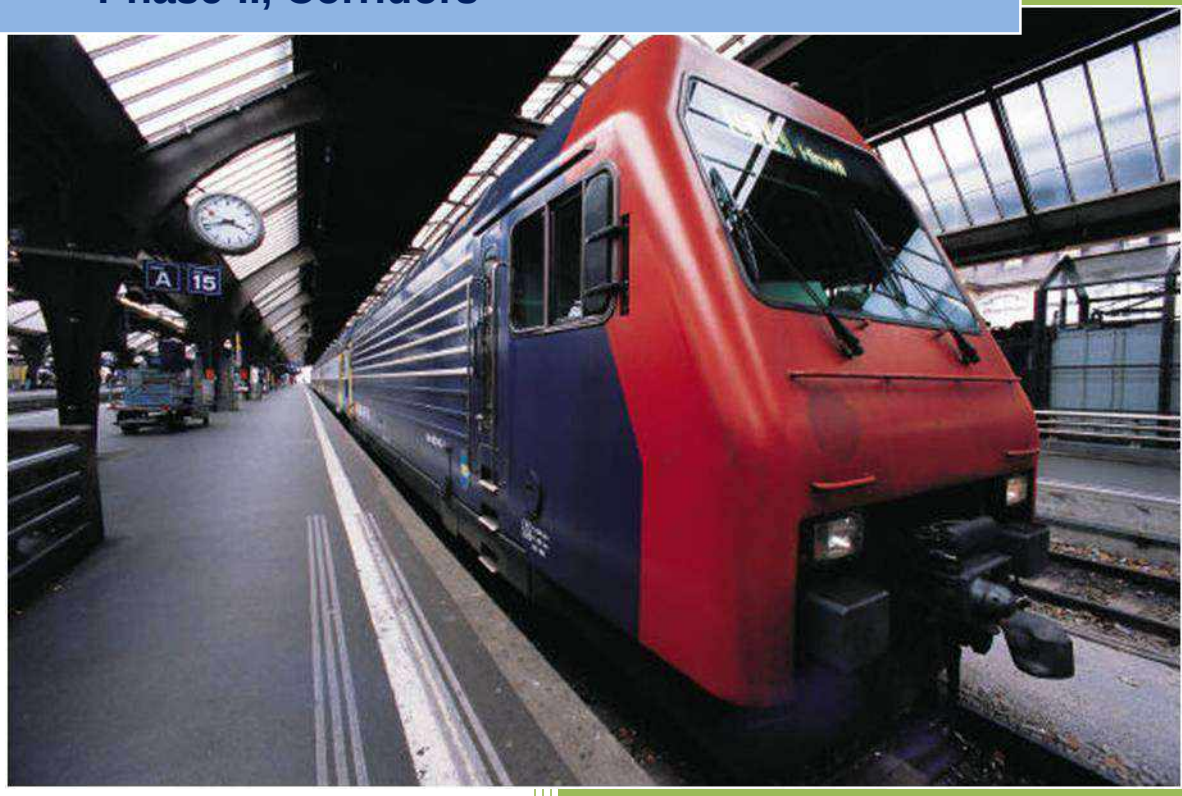
(Report)

Oct. -2023

Vibration Modelling for Extension of Nagpur Metro Rail Project Phase-II, Corridors



Submitted to:

MITCON Consultancy & Engineering Services Ltd, Pune

Submitted by:

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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 9 locations of proposed metro rail corridors of Phase-II. 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. Study the existing vibration monitoring data of 9 locations.
2. GIS mapping of all 9 location along the proposed metro rail corridors of Phase-II.
3. Data compiling for vibration modelling
4. Vibration modelling of all 9 locations using GIS software.
5. Vibration modelling analysis and validation.
6. 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

Nagpur Metro Rail Project (NMRP) was planned to construct in two phases. The Phase-1 consisting two corridors- the North-South corridor (Automotive Square to MIHAN) and the East-West corridor (Prajapati Nagar to Lokmanya Nagar) 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.

The field vibration monitoring was conducted at 9 locations, which are shown in figure 2.1

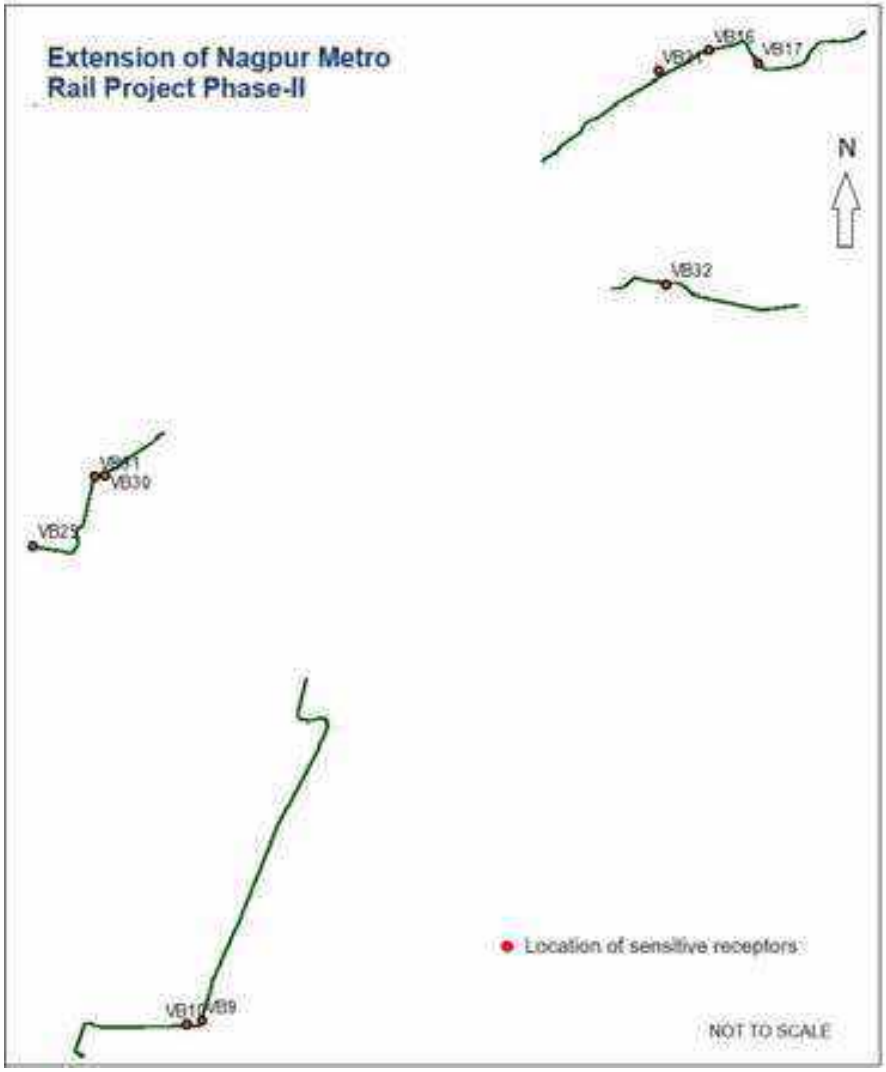


Figure 2. 1: Showing the location of Vibration monitoring on proposed phase-II extension of NMRP.

The coordinates of the vibration monitoring points are given in table 2.1 below:

Table 2.1: Details of vibration study locations.

Sample code	Location	Latitude	Longitude	Vibration Monitoring carried out at	Distance from Track in Meter	Baseline Vibration Levels: PPV (Maximum) in mm/s
VB9	Jijamata High School & Jr. College	20°55'46.79" N	79° 0'18.23" E	School	40	0.3
VB10	Rachana Hospital	20°55'43.79"N	78°59'59.7"E	Hospital	46	0.2
VB16	Asha Hospital and Asharam College & School of Nursing	21°13'8.52"N	79°10'36.74"E	Hospital & School	26	0.3
VB17	Girijadhar Balaji Hanuman Temple	21°12'52.41"N	79°11'31.24"E	Religious place	72	0.2
VB21	Delhi Public School (DPS), Khairy, Kamptee Road, Nagpur	21°12'43.34"N	79° 9'36.93"E	School	105	0.1
VB29	Rural Hospital - Hingna	21° 4'29.01"N	78°57'15.34"E	Hospital	42	0.2
VB30	YCCE	21° 5'43.55" N	78°58'41.26" E	Engineering college	92	0.5
VB31	Dr. Babasaheb Ambedkar Superspeciality Hospital	21° 5'42.41" N	78°58'29.12" E	Hospital	22	0.4
VB32	Pardi Residential area	21° 8'57.99" N	79° 9'37.53" E	NMRP2 station, (Residential Area)	16	0.3

2.2 Soil Condition at Study Area

The Geotechnical investigation work included drilling of 150mm diameter boreholes (BHs) in all kind of soil including gravels and cobbles & 76 mm dia. drilling in weathered rock, soft rock & hard Rock up to depths ranging from 6m to 30m. Boreholes have been terminated at shallower depths after completing at least 3m drilling in fresh and hard rock. Boreholes have been drilled at an interval of about 1000m distance along the alignment or at change of strata. In total, 50 BHs were drilled (up to 30 m depth each), along the lengths of all four proposed Metro alignments.

2.3 Section details

The proposed extensions of metro rail corridors are elevated structures over the existing roads. Typical design of elevated section is shown in figure 2.2. Since the stations are planned generally in the middle of the road, minimum vertical clearance of 5.50 m has been provided under the concourse. Concourse floor level is about 7.0 m above the road. Consequently, platforms are at a level of about 13.0 m from the road.

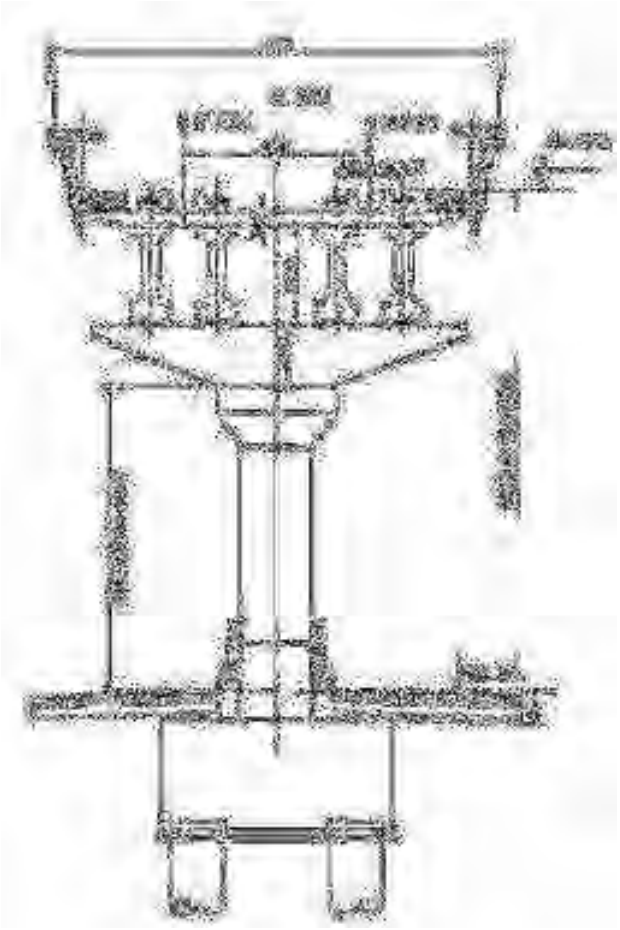


Figure 2.2: showing the cross-section of Box Girder Viaduct Section

The distance between the rail and ground level is 9 meters. During train operation, the

vibrations from the rails will transmit through pier into ground. Vibration in ground will move in three directions vertical, radial and horizontal. Since the building are located on ground levels, horizontal vibrations will create more impact than vertical and radial vibrations. Therefore, horizontal vibrations are predicted in the vibration modelling at these 9 locations.

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 equipment, 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

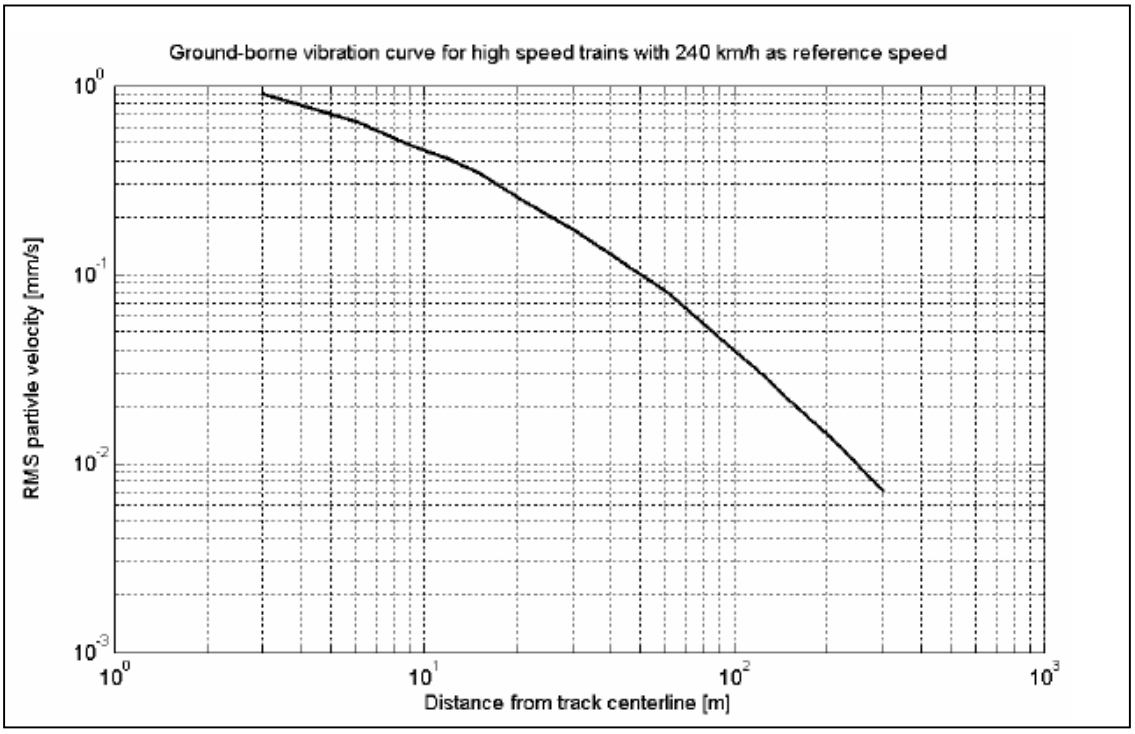


Figure 3.1: Generalized ground-borne vibration curve (DOT-293630-1, 1989).

3.2 Human perception of ground- Borne vibration

The background vibration velocity level in residential areas is usually 50 VdB or lower, well below the threshold of perception for humans which is around 65 VdB. Most perceptible indoor vibration is caused by sources within buildings such as operation of mechanical equipment, movement of people or slamming of doors. Typical outdoor sources of perceptible ground-borne vibration are construction equipment, steel- wheeled trains, and traffic on rough Rails. If the Railway is smooth, the vibration from train traffic is rarely perceptible.

The range of interest is from approximately 50 VdB to 100 VdB. Background vibration is usually well below the threshold of human perception and is of concern only when the vibration affects very sensitive manufacturing or research equipment. the perceptibility threshold is about 65 VdB, human response to vibration is not usually significant unless the vibration exceeds 70 VdB. Rapid transit or light Rail systems typically generate vibration levels of 70 VdB or more near their

tracks. Because of the heavy locomotives on diesel commuter Rail systems, the vibration levels average about 5 to 10 decibels higher than Rail transit vehicles. If there is unusually rough Rail or track, wheel flats, geologic conditions that promote efficient propagation of vibration, or vehicles with very stiff suspension systems, the vibration levels from any source can be 10 decibels higher than typical.

The figure 3.2 indicates common vibration source and the human and structural response to ground –borne vibration.

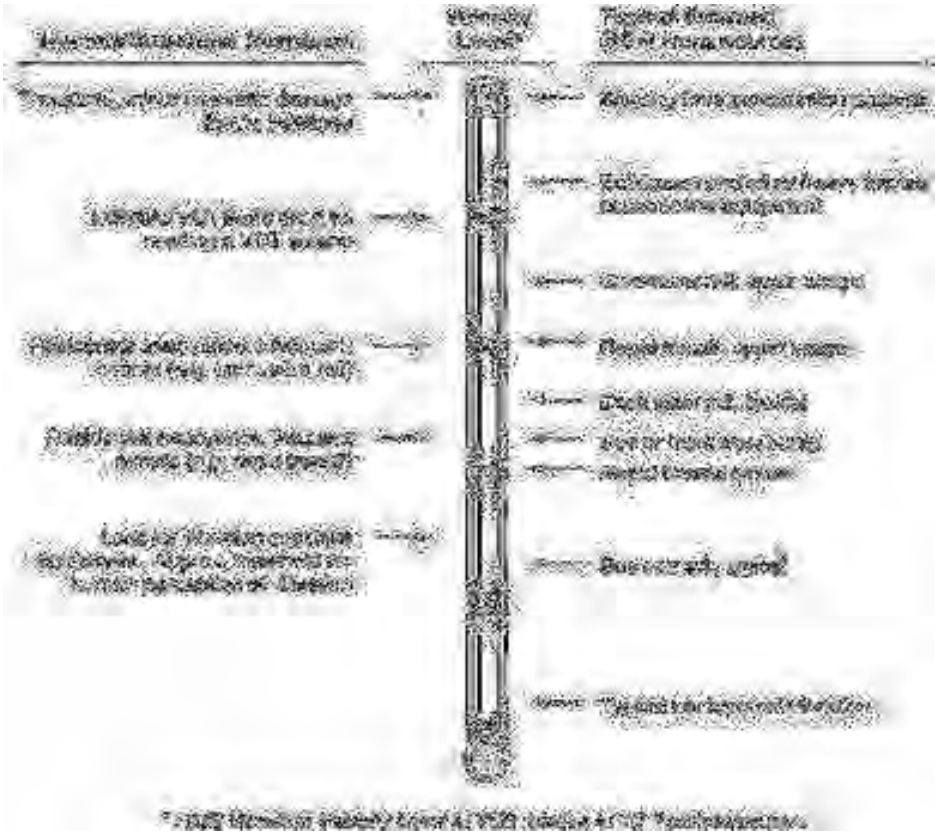


Figure 3.2 Typical levels of Ground-Borne Vibration

The vibration at 15.2 meters (50 feet), the upper range for rapid transit vibration is around 80 VdB and the high range for commuter Rail vibration is 85 VdB. If the vibration level in a residence reaches 85 VdB, most people will be strongly annoyed by the vibration.

Vibration of train operation was calculated at the section near to the sensitive receptors at 9 locations. The vibration was calculated with train movement equations in a homogeneous conduction considering the ground topography, soil condition and the source distance. The prediction of vibration is based on the concept that the train can be considered as a moving multi-punctual excitations source (due to train velocity), where each axes of the train is considered as appoint load that excites the sleepers of the track as the train is running over them. Therefore, each sleeper of the track can be considered as a static punctual source of vibration that transmits the vibration to the ground through piers.

Parameters considered for modeling:

Parameters	Values from DPR
Axle load (Max @8p/m2)	< 16 T
Maximum design speed	90kmph
Average speed	34kmph
Gross tonnage (T) of 3 car rake	184.58
Soil type	Silty clay
Conductivity of soil (1:2% Aq. Extract)	250.6
Elastic modulus of soil	550MN/m^2
Poisson's ration	0.5
Density of soil	1500 kg/m^3
Safe bearing capacity	260 to 300 T/M^2
Number of tracks	2
Height of train passing from ground level	9 m
Average train movement per Hour	17
Basic Unit	3 Car basic unit 2 DMC and 1 TC Every coach should be fully interchangeable with any other coach of same type
Train Composition	3 Car: DMC+TC+DMC
Rail spacing	1435 mm
Distance between the two tracks	4000 mm c/c

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 sensitive receptors where vibration monitoring was conducted. Vibration modelling was conducted at the center line of metro rail corridor for a stretch of 100 m at each location. 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. The vibration modelling results were validated with the actual measurements carried out at existing metro rail operations. Vibration modelling of all 9 locations is described below:

4.1 Location VB9: Jijamata High School &Jr. College,

Jijamata high school and & Jr. college is located in Butibori which is at outskirts of Nagpur city. The school is at a distance of 40 m from the center line of proposed metro rail alignment. Vibration modelling was conducted at a stretch of 100m at the center of the alignment.

The figure 4.1 is shows the predicted vibration contours that can be generated during operation of metro rail.

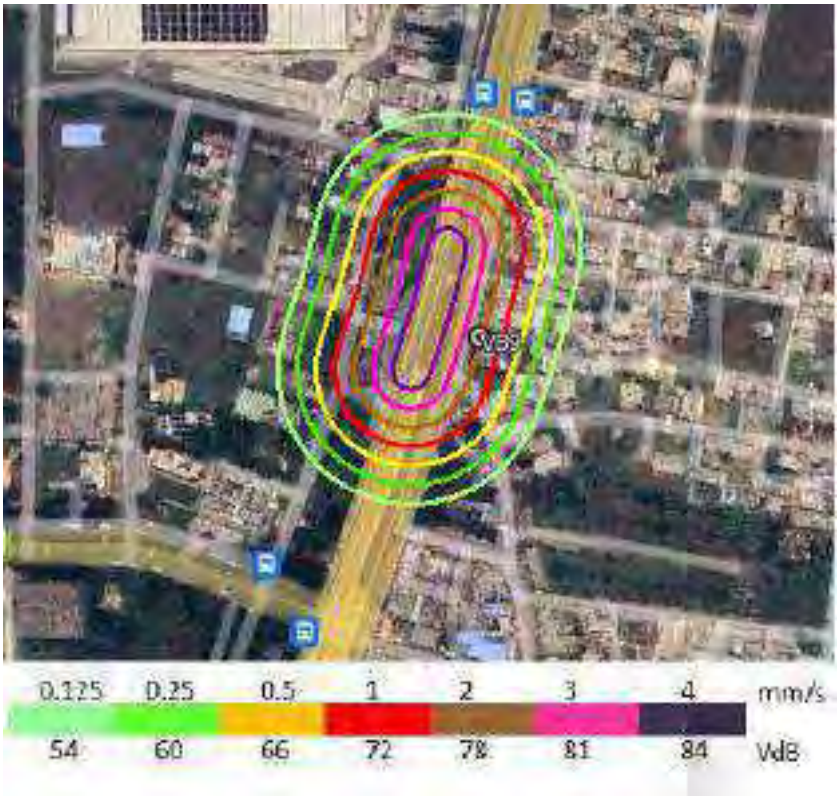


Figure 4.1: showing the predicted vibration contours due to train operation at Jijamatha High school location.

The minimum vibration of about 0.125 mm/s is at a distance of 95m from the center line of rail corridor. At the Jijamata school location the predicted vibration (Peak Particle Velocity) would be around 2 mm/s during train operation and the vibration of 2 mm/s will not cause any impact on the school building and the school building structures will be safe against vibration during metro rail operation.

4.2 Location VB10: Rachana Hospital & Research Centre

Rachana hospital is also located at Butibori. It is one of the top private hospitals in Nagpur. The hospital is at a distance of 46 m from the center line of proposed metro rail alignment. Vibration modelling was conducted at a stretch of 100m at the center of the alignment.

The figure 4.2 is shows the predicted vibration contours that can be generated during operation of metro rail at Rachana Hospital.

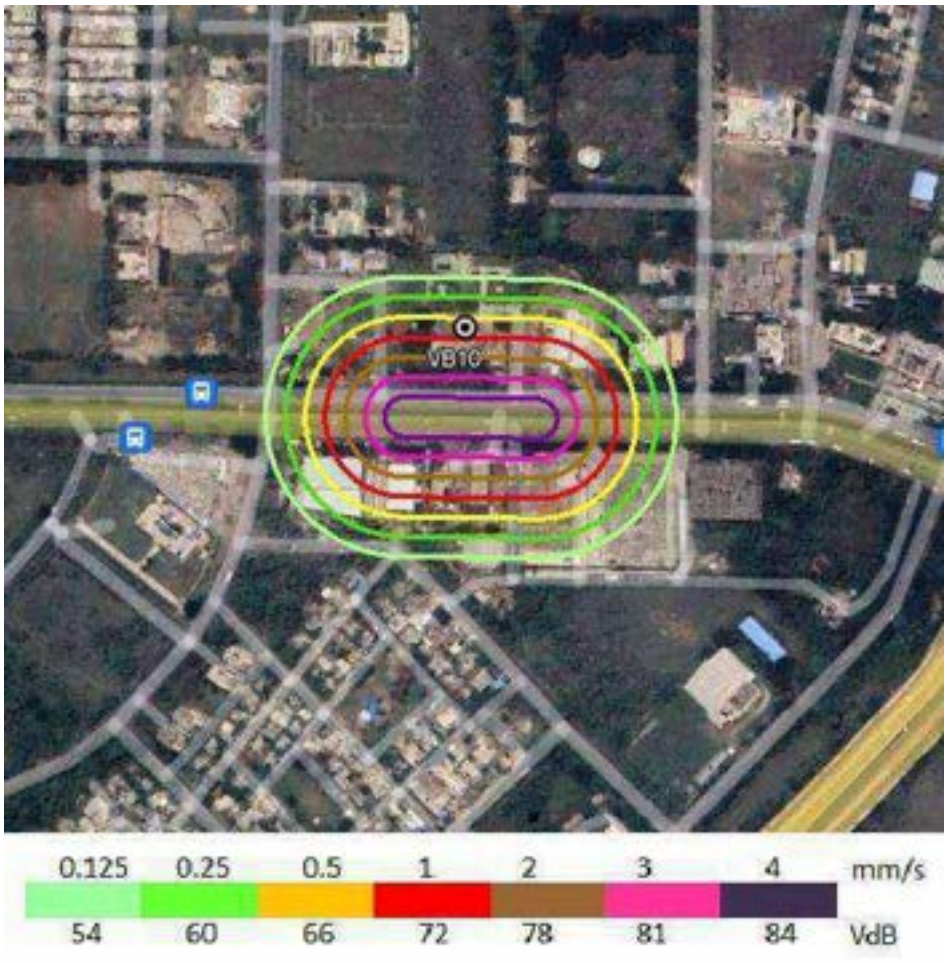


Figure 4.2: showing the predicted vibration contours due to train operation at Rachana Hospital location

The minimum vibration of about 0.125 mm/s is at a distance of 95m from the center line of rail corridor. At the Rachana Hospital location the predicted vibration (Peak Particle Velocity) would

be around 1.2 mm/s during train operation and the vibration of 1.2 mm/s will not cause any impact on the Hospital building and will be safe against vibration during metro rail operation.

4.3 Location VB16: Asha Hospital and Ashram College & School of Nursing

Asha Hospital and Asharam college & school of Nursing is located near Lekha nagar, Cantonment area. It is a private college affiliated to Maharashtra Nursing council.

The college is at a distance of 26 m from the center line of proposed metro rail alignment. Vibration modelling was conducted at a stretch of 100m at the center of the alignment.

The figure 4.3 is shows the predicted vibration contours that can be generated during operation of metro rail at Asharam college & school of Nursing.

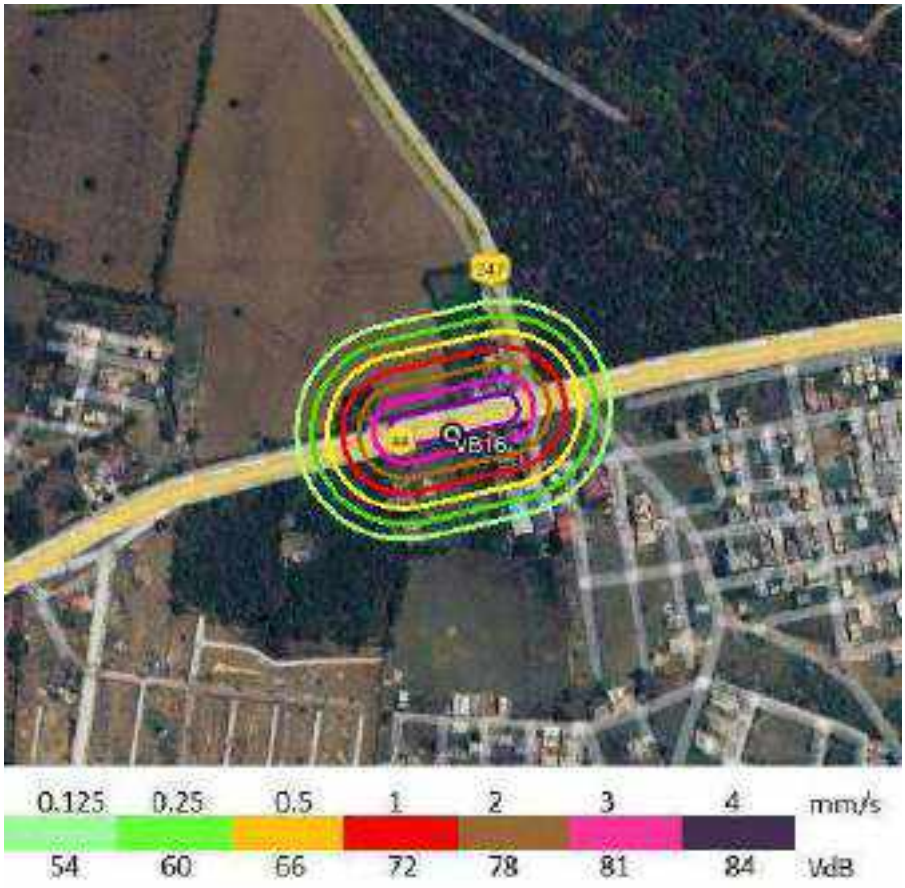


Figure 4.3: showing the predicted vibration contours due to train operation at Asha Hospital and Asharam College & School of Nursing

The minimum vibration of about 0.125 mm/s is at a distance of 95m from the center line of rail corridor. At the Asharam college location the predicted vibration (Peak Particle Velocity) would be around 3.7 mm/s during train operation and the vibration of 3.7 mm/s will not

cause any significant impact on the college building will be safe against vibration during metro rail operation.

4.4 Location VB17: Girijadhar Balaji Hanuman Temple

Shree Girijadhar Balaji Hanuman Temple is located in Bhim nagar residential area. It is very famous and lot of devotees come to the temple not only from Nagpur but also from other places.

This temple is located at a distance of 72 m from the center line of proposed metro rail alignment. Vibration modelling was conducted at a stretch of 100m at the center of the alignment.

The figure 4.4 is shows the predicted vibration contours that can be generated during operation of metro rail at Shree Girijadhar Balaji Hanuman Temple.

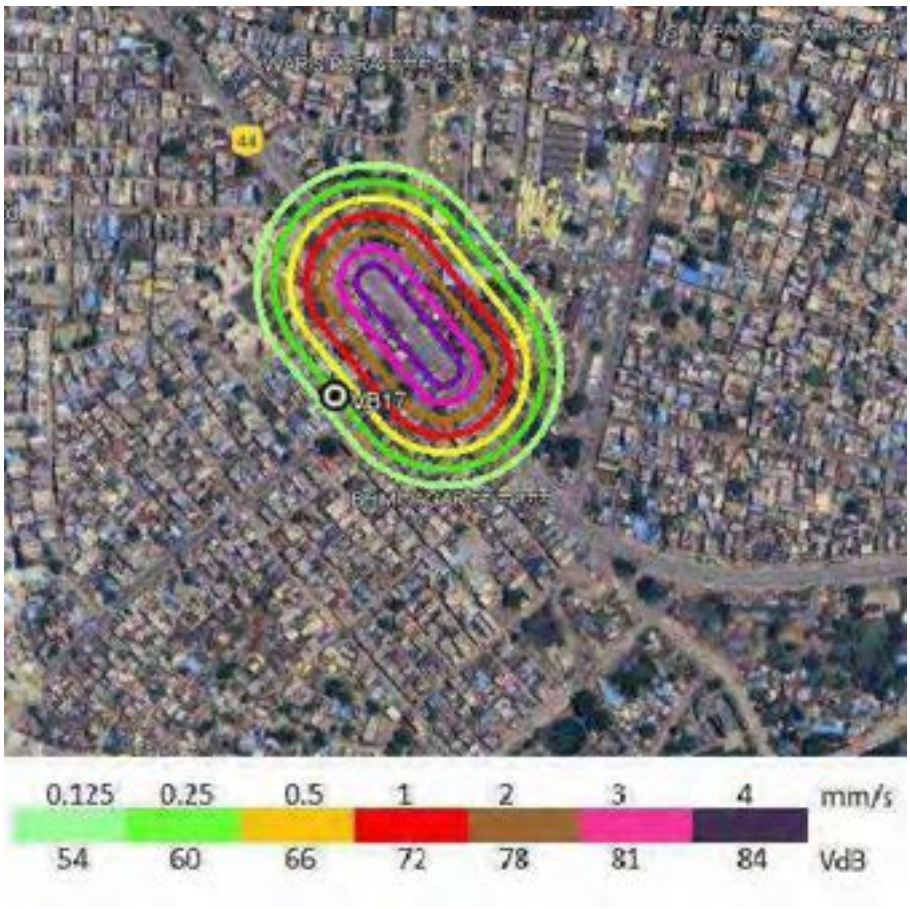


Figure 4.4: showing the predicted vibration contours due to train operation at Shree Girijadhar Balaji Hanuman Temple

The minimum vibration of about 0.125 mm/s is at a distance of 95m from the center line of rail corridor. At the Shree Girijadhar Balaji Hanuman Temple location the predicted vibration (Peak Particle Velocity) would be around 0.25 mm/s during train operation which will not cause any

significant impact on the temple structure, and will be safe against vibration during metro rail operation.

4.5 Location VB21: Delhi Public School (DPS), Khairy, Kamptee Road, Nagpur

Delhi Public School, Khairy, Kamptee road is a distance of 105 m from the center line of proposed metro alignment.

The figure 4.5 is shows the predicted vibration contours that can be generated during operation of metro rail at DPS Khairy.

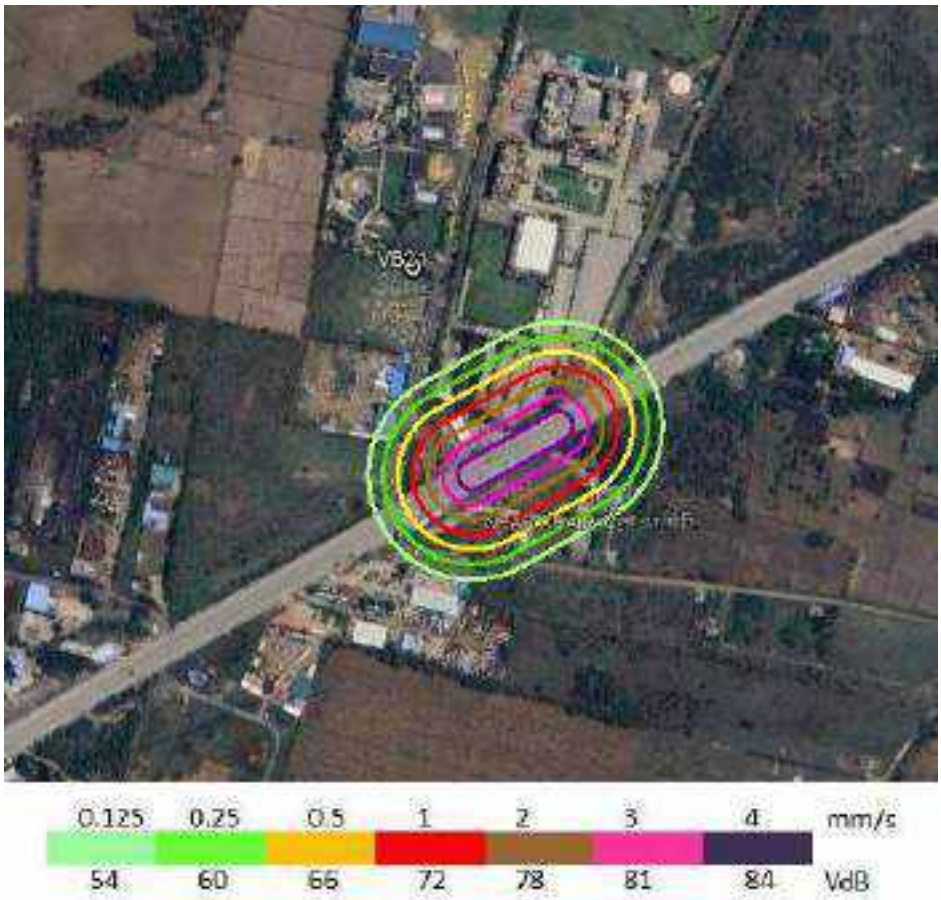


Figure 4.5: showing the predicted vibration contours due to train operation at DPS Khairy

The minimum vibration of about 0.125 mm/s is at a distance of 95m from the center line of rail corridor. At the DPS Khairy is located at a distance of 105 m from the metro rail corridor, therefore the vibration due to train operation is very minimum (beyond predictable level) and does not have any impact on the DPS structure.

4.6 Location VB29: Rural Hospital Hingna

Rural Hospital Hingna is located near Dangarpura, Nagpur. It is located at a distance of 42 m from the center line of proposed metro alignment.

The figure 4.6 is shows the predicted vibration contours that can be generated during operation of metro rail at Rural hospital Hingna.

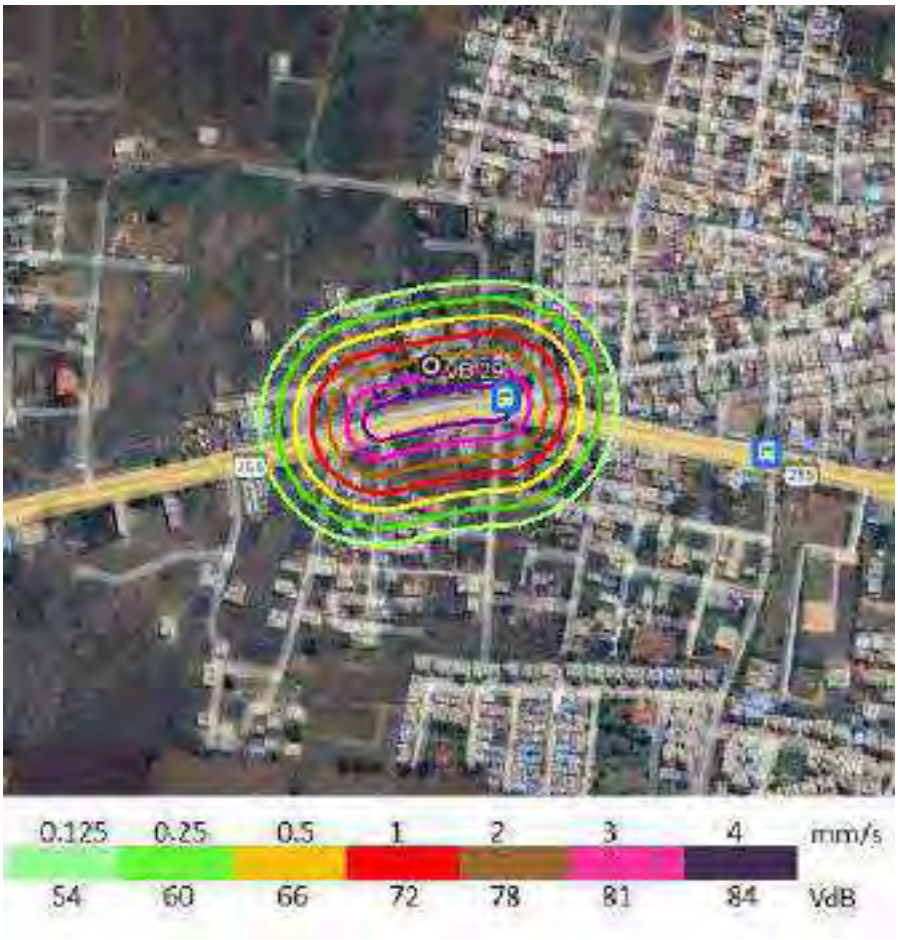


Figure 4.6: showing the predicted vibration contours due to train operation at Rural Hospital Hingna

The minimum vibration of about 0.125 mm/s is at a distance of 95 m from the center line of rail corridor. At the Rural Hospital Hingna location the predicted vibration (Peak Particle Velocity) would be around 1.8 mm/s during train operation and the vibration of 1.8 mm/s will not cause any impact on the Hospital building and will be safe against vibration during metro rail operation.

4.7 Location VB30: YCCE

Yeshwantrao Chavan College of Engineering (YCCE) was established in the year 1984 by Nagar Yuwak Shikshan Sanstha, Nagpur. It is located at a distance of 92 m from the center line of proposed metro alignment.

The figure 4.7 is shows the predicted vibration contours that can be generated during operation of metro rail at YCCE.

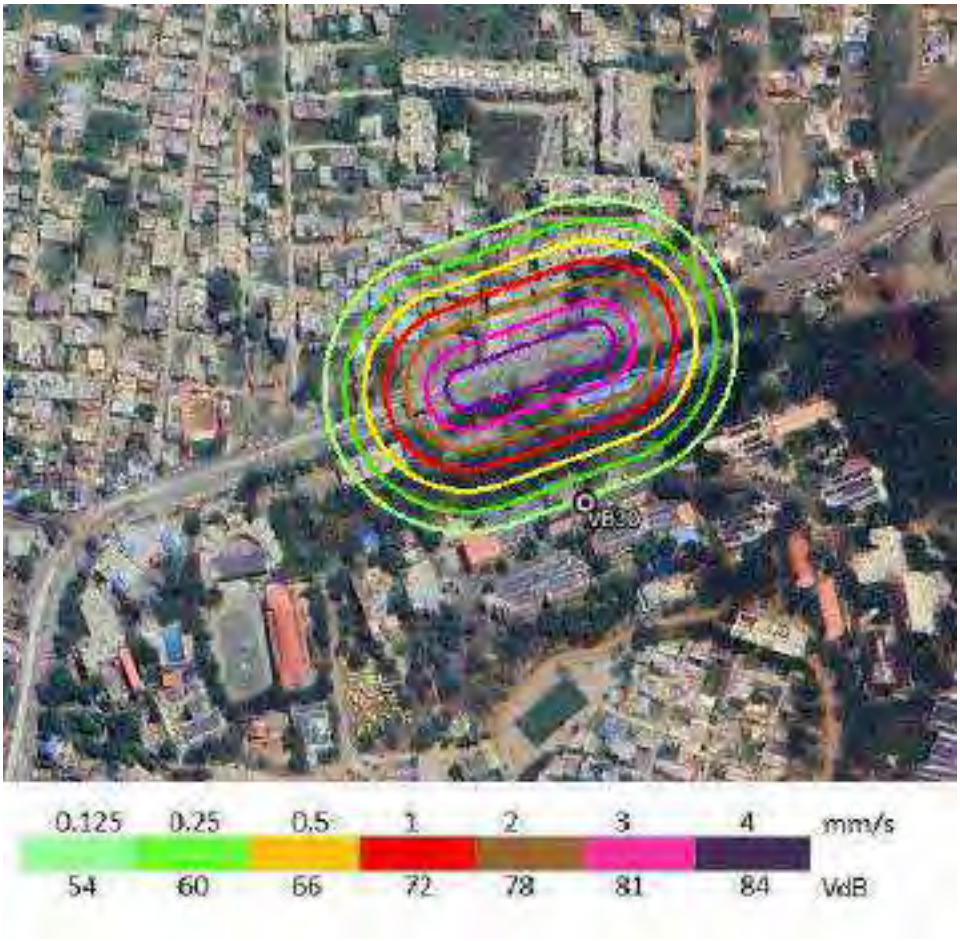


Figure 4.7: showing the predicted vibration contours due to train operation at YCCE

At the YCCE location, the predicted vibration (Peak Particle Velocity) would Be around 0.12 mm/s during train operation and the vibration of 0.12 mm/ s is very minimum and will not cause any impact on the YCCE building and it will be safe against vibration during metro rail operation.

4.8 Location VB31: Dr. Babasaheb Ambedkar Superspeciality Hospital

Dr. Babasaheb Ambedkar Superspeciality Hospital (DBASH) is about 500 beds capacity. It is It is located at a distance of 22 m from the center line of proposed metro alignment.

The figure 4.8 is shows the predicted vibration contours that can be generated during operation of metro rail at DBASH.

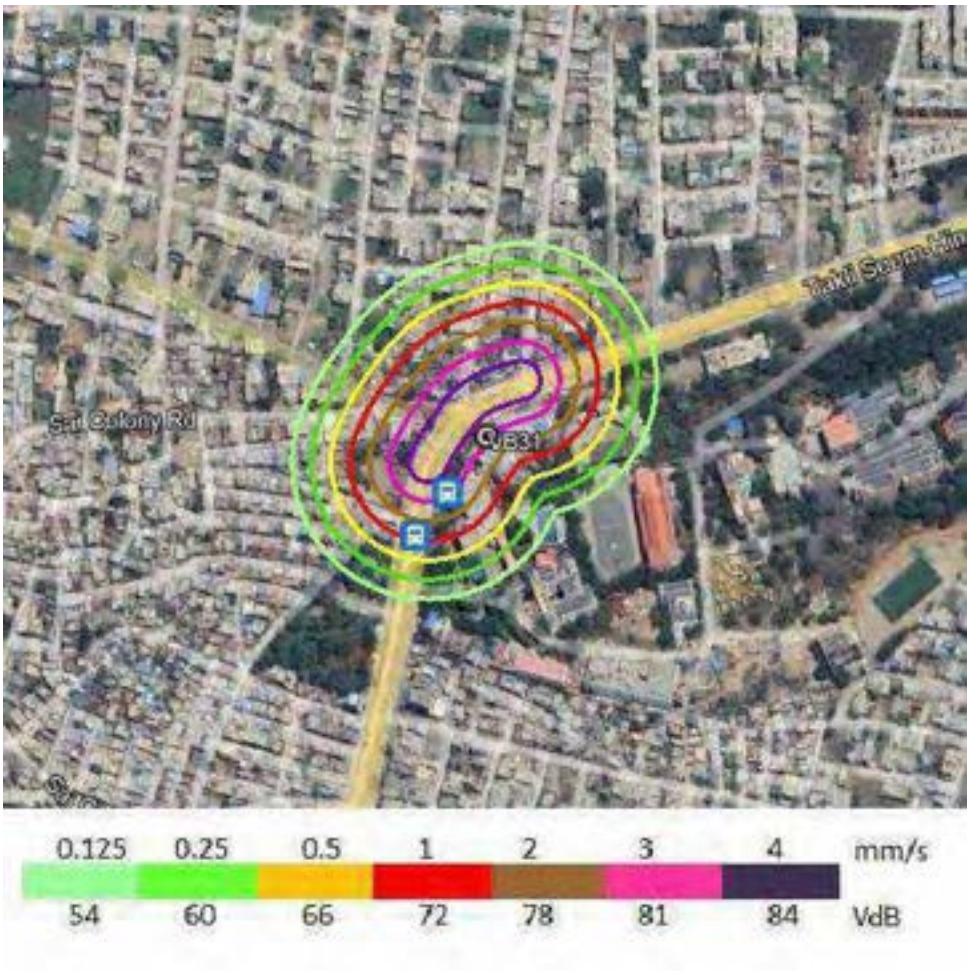


Figure 4.8: showing the predicted vibration contours due to train operation at DBASH

At the Dr. Babasaheb Ambedkar Superspeciality Hospital location, the predicted vibration (Peak Particle Velocity) would be around 3 mm/s during train operation and the vibration of 3 mm/ s is minimum and will not cause any impact on the DBASH structures and it will be safe against vibration during metro rail operation.

4.9 Location VB32: Pardi Residential area

Pardi Residential area is one of the old residential areas with many hotels, shopping complex and other commercial places. A residential apartment is selected as one of the locations for vibration monitoring and modelling to study the vibration impact due to proposed metro rail project. The selected location VB32 is at a distance of 16 m from the center line of proposed metro alignment.

The figure 4.9 is shows the predicted vibration contours that can be generated during operation of metro rail at residential area.

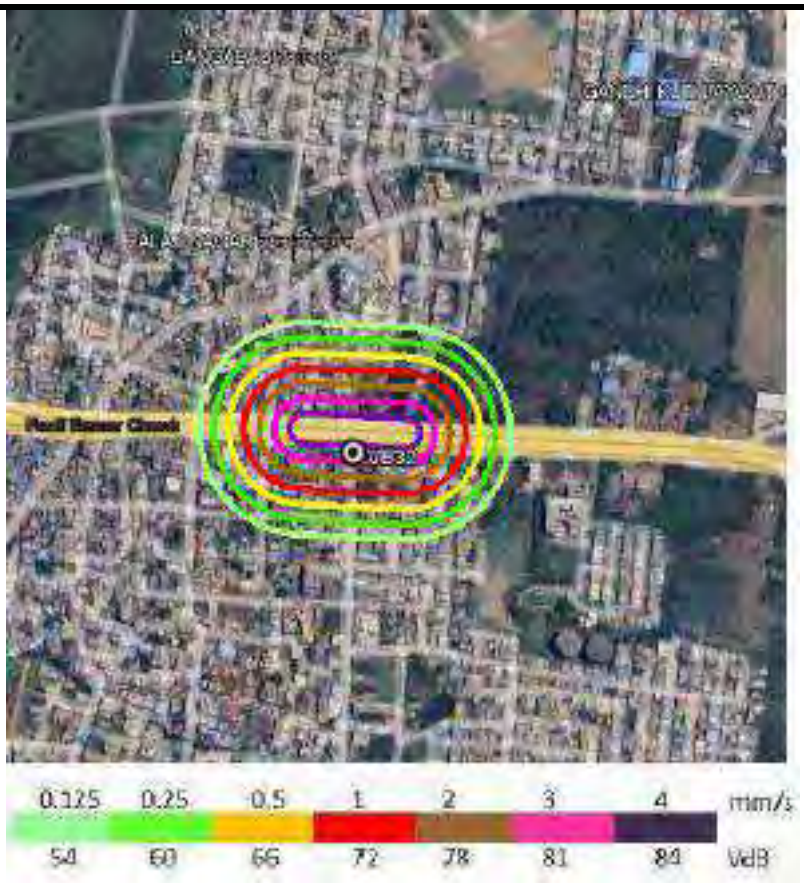


Figure 4.9: showing the predicted vibration contours due to train operation at Pardi residential area.

At the Pardi residential area location, the predicted vibration (Peak Particle Velocity) would be around 3.5 mm/s during train operation and the vibration of 3.5mm/ s is minimum and will not cause any significant impact on the residential building structures and it will be safe against vibration during metro rail operation.

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 were compared with the DGMS standards as shown in table 5.2:

Table 5.2: Vibration modelling results compared with standards

Location code.	Location	Results from vibration modelling (mm/s)	Results from vibration modelling (VdB)	Vibration standard in (mm/s)	Vibration standard in (VdB)
VB9	Jijamata High School & Jr. College	2	74	5	134
VB10	Rachana Hospital	1.2	72	5	134

VB16	Asha Hospital and Asharam College & School of Nursing	3.7	81	5	134
VB17	Girijadhar Balaji Hanuman Temple	0.25	60	5	134
VB21	Delhi Public School (DPS), Khairy, Kamptee Road, Nagpur	Below detectable level	nil	5	134
VB29	Rural Hospital - Hingna	1.8	72	5	134
VB30	YCCE	0.12	54	5	134
VB31	Dr. Babasaheb Ambedkar Superspeciality Hospital	3	81	5	134
VB32	Pardi Residential area	3.5	82	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.

5.2 Vibration results comparison with criteria mentioned in RDSO guidelines

According to Research Designs and Standards Organization, (RDSO), ministry of Railways, India, the criteria for environmental impact from ground-borne vibration is based on the maximum root-mean square vibration levels for repeated events of the same sources. The criteria for the Ground Borne Vibration is given in table below:

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

The limits for vibration vary in different countries. In the United States of America, the maximum limit is considered to be 65 VdB, whereas, as per ISO -2361-2, the maximum limit is up to 83 VdB depending on the frequency, location and type of structures.

The monitored vibration levels were compared with the criteria mentioned in RDSO guidelines, which is presented in the table 5.3:

Table 5.3: Comparison of measured vibration with the criteria of RDSO

Sl no.	Location	Vibration monitoring point	Vibration modelling results in PPV (VdB)	Vibration criteria as per RDSO in (VdB)
VB9	Jijamata High School & Jr. College	School	74	75
VB10	Rachana Hospital	Hospital	72	75
VB16	Asha Hospital and Asharam College & School of Nursing	Hospital & School	81	72
VB17	Girijadhar Balaji Hanuman Temple	Religious place	60	75
VB21	Delhi Public School (DPS), Khairy, Kamptee Road, Nagpur	School	nil	72
VB29	Rural Hospital - Hingna	Hospital	72	75
VB30	YCCE	Engineering college	54	72
VB31	Dr. Babasaheb Ambedkar Superspeciality Hospital	Hospital	81	75
VB32	Pardi Residential area	Residential Area	81	75

Note: As per RDSO guidelines, the hospitals, comes under land use Category-2 and the Temples, Church, schools and Masjid comes under land use Category-3. As mentioned in the RDSO guidelines, the vibration criteria for Category-2 buildings is 72 VdB and for Category-3 buildings is 75VdB respectively.

As the table 5.3, the predicted vibration levels at VB16, VB31 and VB32 locations is found to be higher than the criteria for ground vibration mentioned in the RDSO guidelines.

AIR MODELLING REPORT

FOR

EXTENSION OF NAGPUR METRO RAIL PHASE 2

BY

MAHARASHTRA METRO RAIL CORPORATION LIMITED

Submitted to

MITCON ENVIROTECH LIMITED

A wholly Owned subsidiary of

MITCON Consultancy & Engineering Services Ltd.

Submitted By

Envirosphere

Consultant & Engineers

Office No. 506, Shree Ganesha Ace Arcade, Kokane Chowk, Pimple Saudagar, Pune, Maharashtra – 411017

Contents

List of Tables

List of Figures

1. Introduction

Maharashtra Metro Rail Corporation Ltd. is a joint venture company of Govt. of India (GoI) and Government of Maharashtra (GoM) established under the companies act 2013 for the purpose of implementation of the project within Maharashtra excluding Mumbai metropolitan area. RITES Ltd has carried out the investigation and studies for Nagpur Metro Rail Project Phase-II and prepared a Detailed Project Report (DPR) in November, 2019 based on which the project is proposed to be implemented.

Nagpur, the Orange city of India, is third largest city in the state of Maharashtra and second capital of the state. It is the seat of annual winter session of the Maharashtra State Vidhan Sabha. Nagpur lies precisely at centre of the country with Zero Mile Marker indicating the geographical centre of India. It is a major commercial and political centre of the Vidarbha region of Maharashtra. The city is also considered as the second greenest city in India along with title 'Tiger Capital of India' as it connects to many tiger reserves in the country. Due to its proximity from various parts of country, the city is also emerging as one of economical hubs in recent times.

The city of Nagpur acts as the headquarter for the Nagpur district with a population of about 46 Lakh of which about 24 Lakh population accounts to Nagpur Municipal Corporation as per 2011 Census data. Nagpur has large number of technical institutes which can cater to the rising needs of the IT-ITES industry in the region by generating enough manpower resources. Nagpur, also considered as a low living cost city, has become a prime destination for Information Technology Enabled Services (ITES) and Business Process Outsourcing (BPO) units. In addition to establishment of Multi-modal International Cargo Hub & Airport (MIHAN), Nagpur is also expected to be established as one of the major IT sectors in the country.

Rapid urbanization and intense commercial developments in recent past have resulted in steep rise in travel demand putting Nagpur's transport infrastructure to stress. To relieve this stress MRTs system i.e., Nagpur Metro Phase-1 is already in operation.

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 corridors of Phase 1 in order to meet the future traffic demand. Nationally and globally, it is seen that the metro network expands progressively to cover entire city. Hence, it is essential that in Nagpur also, such expansion of Metro Rail network is taken up in time, extension of Phase-II is proposed.

2. Project Description

Two corridors have been finalized for implementation of Metro Rail Project in Nagpur. The salient features of the corridors are summarised in the following sections. These corridors will provide connectivity to all congested, important and densely populated areas of the city. Details of the length of corridors, elevated/underground length and number of stations is given in **Table 1**.

Table 1: Details of Nagpur Metro Rail Project - Phase 2 Corridors1

Corridor	Line/ Alignment	Description	Length (km)
North – South	Line 1A	MIHAN to MIDC ESR	18.77
	Line 2A	Automotive Square - Kanhan river	12.93
East – West	Line 3A	Lokmanya Nagar - Hingna	6.66
	Line 4A	Prajapati Nagar (Pardi) - Transport Nagar	5.44
Total			**43.80**

With a view of developing effective and efficient mass transit system in addition to the existing public transportation, the Maharashtra Metro Rail Corporation Ltd. intends to develop the proposed Nagpur Metro Rail Project – Phase 2 (NMRP-P2) having North-South and East-West Corridors. The proposed metro corridors in Nagpur city are shown in **Figure 1**.

[1] Source: Nagpur Metro Rail Project Phase II (NMRP-P2) Detailed Project Report (DPR), November 2019

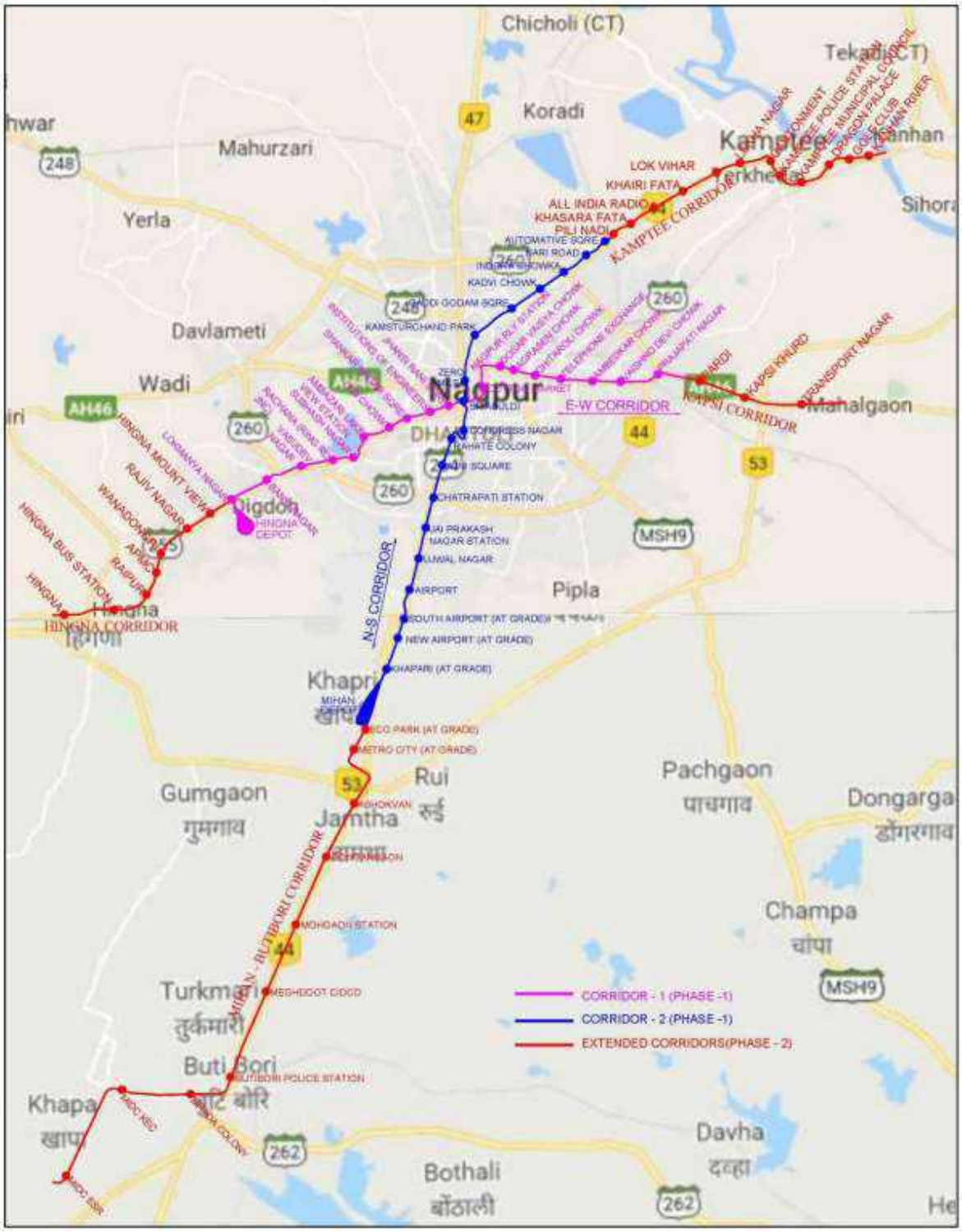


Figure 1: Routes of NMRP Phase II

2.1 North – South Corridor

2.1.1 Line 1A (MIHAN to MIDC ESR)

The proposed alignment of Line-1A is an extension of Reach 1 of Phase 1 and starts from Chainage 20200m before ECO Park Station and terminates near MIDC ESR at Chainage 38852m. The total length of the corridor is about 18.768 Km, out of which 1.25 Km is atgrade (up to Ch. 21450 m) and 17.518m elevated.

Total 10 stations (2 At-grade & 8 elevated) are proposed in this corridor, starting from ECO Park Station (Ch.: 20462 m) and terminating at MIDC ESR Station (Ch: 38352m). Details of Line 1A are summarized in **Table 2**, while Line 1A map if presented as **Figure 2**.

Table 2: Alignment Description of Corridor-1A

Description	Station	Chainage (m) **	Intermediate Distance (m)
Start Point	--	20200	--
Station	ECO Park (At Grade)	20462	262
	Metro City (At Grade)	21058	596
	Ashokwan	23843	2593
	Dongargaon	26693	2850
	Mohgaon	29878	3185
	Meghdoot CIDCO	32802	2924
	Butibori Police Station	33540	738
	MHADA Colony	34233	693
	MIDC KEC	37360	3127
	MIDC ESR	38352	992
Terminal Point		38852	500
Additional Length for Stabling Entry / Exits		--	116
Total		**18768 m**	

**** For the planning convenience, the chainages are in continuation with Phase-1 North-South corridors**

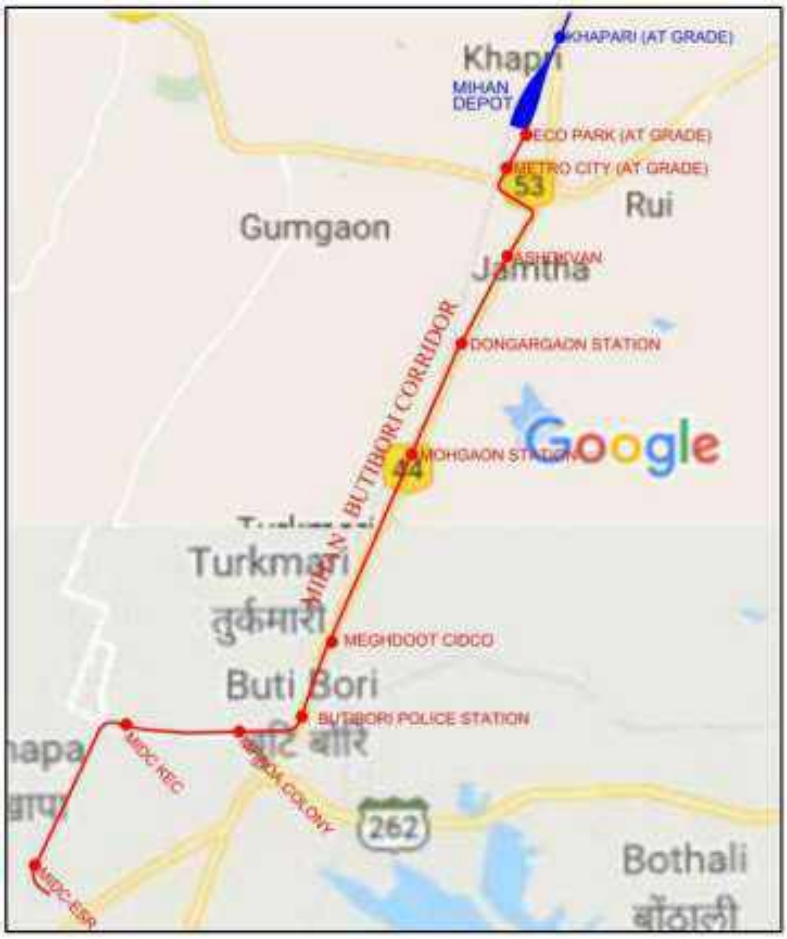


Figure 2: Alignment Map of Corridor-1A

2.1.2 Line 2A (Automotive Square to Kanhan river)

The proposed alignment of Corridor-2A is an extension of Reach 2 of Phase 1 and starts from Chainage (-) 575m beyond Automotive Square and terminates near Kanhan River at Chainage (-) 13500. The total length of the corridor is about 12.925 Km and is completely elevated. Total 12 elevated stations are proposed in this corridor, starting from Pili Nadi Station (Ch: -1409m) and terminating at Kanhan River Station (Ch: -13324m). Details of Line 2A are summarized as under in **Table 3**, while Line 2A map if presented as **Figure 3**.

Table 3: Alignment Description of Corridor-2A

Description	Station	Chainage (m) **	Intermediate Distance (m)
Start Point	--	-575	--
Station	Pili Nadi	-1409	834
	Khasara Fata	-2286	877
	All India Radio	-3314	1028
	Khairi Fata	-5250	1936
	Lok Vihar	-6176	926

	Lekha Nagar	-7199	1023
	Cantonment	-8681	1482
	Kamptee Police Station	-9410	729
	Kamptee Municipal Council	-10225	815
	Dragon Palace	-11196	971
	Golf Club	-12468	1272
	Kanhan River	-13324	856
Terminal Point		-13500	176
Total		**12925 m**	

**** For the planning convenience, the chainages are in continuation with Phase-1 North-South corridors**

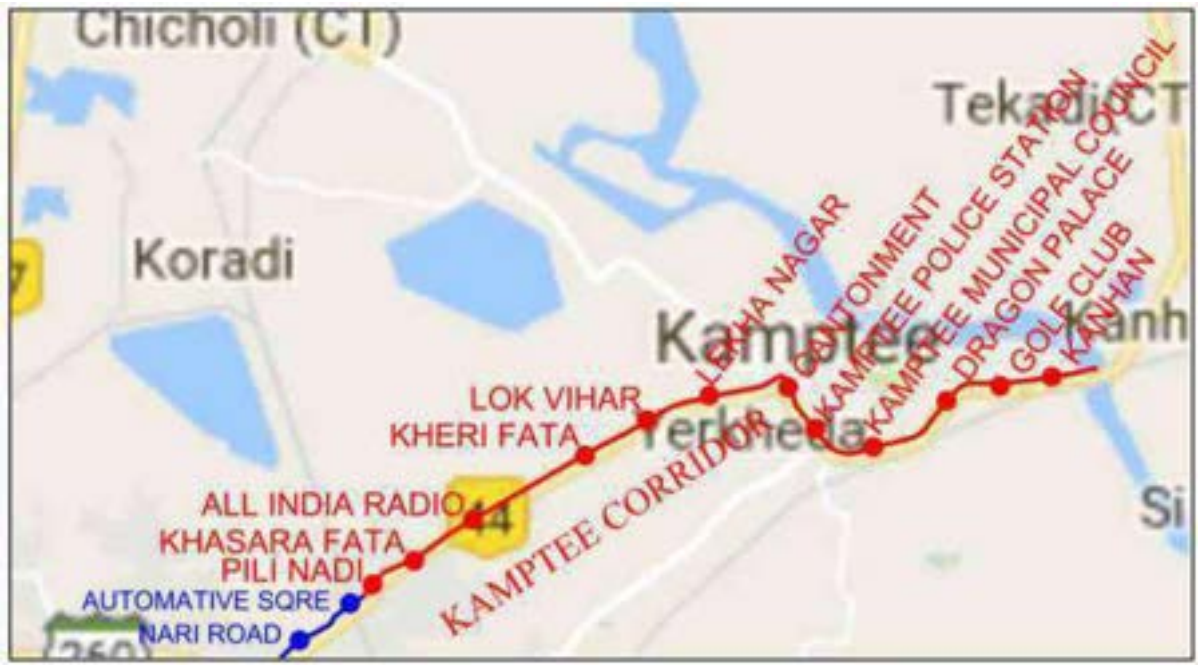


Figure 3: Alignment Map of Corridor-2A

2.2 East-West Corridor

2.2.1 Line 3A (Lokmanya Nagar to Hingna)

The proposed alignment of Corridor-3A is west extension of Reach 3 of Phase 1 and starts from Chainage 18218m beyond Lokmanya Nagar and terminates near Hingna at Chainage 24874.650m. The total length of the corridor is about 6.657 Km and is completely elevated. Total 7 elevated stations are proposed in this corridor, starting from Hingna Mount View Station (Ch.: 18761m) and terminating at Hingna Station (Ch.: 24504m). Details of Line 3A are summarized as under in **Table 4**, while Line 3A map if presented as **Figure 4**.

Table 4: Alignment Description of Corridor-3A

Description	Station	Chainage (m) **	Intermediate Distance (m)
Start Point	--	18218	--
Station	Hingna Mountview	18761	543
	Rajiv Nagar	19607	846
	Wanadongri	21006	1399
	APMC	21715	709
	Raipur	22823	1108
	Hingna Bus Stand	23625	802
	Hingna	24504	879
Terminal Point		24875	371
Total		**6657 m**	

**** For the planning convenience, the chainages are in continuation with Phase-1 North-South corridors**

Figure 4: Alignment Map of Corridor-3A

2.2.2 Line 4A (Prajapati Nagar to Transport Nagar)

The proposed alignment of Corridor-4A is extension of Reach 4 of Phase 1 and starts from Chainage (-) 580m beyond Prajapati Nagar and terminates near Transport Nagar at Chainage

(-) 6021m. The total length of the corridor is about 5.441 Km and is completely elevated. Total 3 elevated stations are proposed in this corridor, starting from Pardi Station (Ch: -1365m) and terminating at Transport Nagar Station (Ch: -5126m). Details of Line 4A are summarized as under in **Table 5**, while Line 4A map if presented as **Figure 5**.

Table 5: Alignment Description of Corridor-4A

Description	Station	Chainage (m) **	Intermediate Distance (m)
Start Point	--	-580	-
Station	Pardi	-1365	785
	Kapsi Khurd	-3200	1835
	Transport Nagar	-5126	1926
Terminal Point		-6021	895
Total		**5441 m**	

**** For the planning convenience, the chainages are in continuation with Phase-1 North-South corridors**

Figure 5: Alignment Map of Corridor-4A

3. Baseline Monitoring with respect to Air Environment

As part of the process, primary baseline data was collected for Ambient Noise during April to June 2023.

3.1 Methodology

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:

- Particulate Matter less than 10µm (PM10)
- Particulate Matter less than 2.5µm (PM2.5)
- Sulphur dioxide (SO2)
- Oxides of nitrogen (NOX)
- Carbon monoxide (CO)

3.2 Techniques for Measurement

The ambient air quality monitoring was undertaken once in the study period at all the proposed NMRP-P2 station locations on all 4 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 each of these locations. Measurement techniques used for Air quality analysis are presented in **Table 6**.

Table 6: 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

3.3 Sampling Period, Frequency and Parameters

Ambient air quality monitoring was conducted at a total of 34 locations in the project study area. 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 7**. Details of Sampling locations for each line are shown in **Table 8** whereas the same marked on google earth are shown in **Figure 6** to **Figure 10**

Table 7: Justification for selection of AAQ locations for NMRP-P2

Line	AAQ locations at NMRP-P2 Stations	AAQ locations at Sensitive Receptors	Crosswind Locations	Downwind Locations	Upwind Locations
1A	8	2	0	6	4
2A	9	2	3	4	4
3A	7	3	3	4	3
4A	3	0	0	3	0
Total	**27**	**7**	**6**	**17**	**11**

Table 8: Ambient Air Quality Stations monitored in Project Study Area

Line	Sampling Date	Machine Details	Sampling Code	Sampling Location	Significance	Latitude	Longitude	Wind type#
1A	27.04.2023	Combo	AAQ.1	Ashokwan	NMRP-P2 station	21° 0'47.21"N	79° 2'42.47"E	DW
1A	22.04.2023	FPS, RDS	AAQ.2	Dongargaon	NMRP-P2 station	20°59'13.84"N	79° 1'48.28"E	DW
1A	23.04.2023	Combo	AAQ.3	Mohgaon	NMRP-P2 station	20°57'34.55"N	79° 1'2.22"E	DW
1A	23.04.2023	FPS, RDS	AAQ.4	Meghdoot CIDCO	NMRP-P2 station	20°56'11.46"N	79° 0'26.81"E	DW
1A	24.04.2023	FPS, RDS	AAQ.5	Butibori Police Station	NMRP-P2 station	20°55'45.14"N	79° 0'13.97"E	DW
1A	25.04.2023	Combo	AAQ.6	MHADA Colony	NMRP-P2 station	20°55'42.22"N	78°59'56.08"E	UW

1A	25.04.2023	FPS, RDS	AAQ.7	MIDC KEC	NMRP-P2 station	20°55'46.66"N	78°58'11.74"E	UW
1A	26.04.2023	Combo	AAQ.8	MIDC ESR	NMRP-P2 station	20°55'24.58"N	78°57'51.47"E	UW
1A	24.04.2023	Combo	AAQ.9	Jijamata High School & Jr. College	Sensitive Receptor (School)	20°55'46.73"N	79° 0'18.04"E	DW
1A	26.04.2023	FPS, RDS	AAQ.10	Rachana Hospital	Sensitive Receptor (Hospital)	20°55'44.18"N	79° 0'0.43"E	UW
2A	17.04.2023	FPS, RDS	AAQ.11	Pili Nadi	NMRP-P2 station	21°11'31.78"N	79° 7'43.52"E	UW
2A	17.04.2023	Combo	AAQ.12	Khasara fata	NMRP-P2 station	21°11'49.19"N	79° 8'6.65"E	UW
2A	18.04.2023	Combo	AAQ.13	All India Radio	NMRP-P2 station	21°12'10.21"N	79° 8'37.93"E	UW
2A	18.04.2023	FPS, RDS	AAQ.14	Khairi fata	NMRP-P2 station	21°12'39.95"N	79° 9'33.83"E	UW
2A	19.04.2023	FPS, RDS	AAQ.15	Lok Vihar	NMRP-P2 station	21°12'56.59"N	79°10'3.96"E	CW
2A	19.04.2023	Combo	AAQ.16	Lekha Nagar	NMRP-P2 station	21°13'8.90"N	79°10'36.83"E	CW
				Asha Hospital and Asharam College & School of Nursing	Sensitive Receptor (School & Hospital)			
2A	20.04.2023	FPS, RDS	AAQ.17	Kamptee Police station**	NMRP-P2 station	21°12'57.05"N	79°11'30.05"E	DW
2A	20.04.2023	FPS, RDS	AAQ.18	Kamptee Municipal Council	NMRP-P2 station	21°12'46.36"N	79°11'56.90"E	DW
2A	21.04.2023	FPS, RDS	AAQ.19	Dragon Palace	NMRP-P2 station	21°13'1.64"N	79°12'29.2"E	DW
2A	22.04.2023	Combo	AAQ.20	Kanhan River	NMRP-P2 station	21°13'21.88"N	79°13'26.78"E	DW
2A	19.04.2023	Combo	AAQ.21	Delhi Public School (DPS), Khairy, Kamptee Road, Nagpur	Sensitive Receptor (School)	21°12'48.91"N	79° 9'35.83"E	CW
3A	21.04.2023	FPS, RDS	AAQ.22	Hingna Mount View	NMRP-P2 station	21° 6'12.70"N	78°59'24.86"E	DW
3A	21.04.2023	FPS, RDS	AAQ.23	Rajiv Nagar	NMRP-P2 station	21° 5'48.38"N	78°58'50.21"E	DW
3A	19.04.2023	FPS, RDS	AAQ.24	Wanadongri	NMRP-P2 station	21° 5'30.72"N	78°58'25.46"E	CW
3A	19.04.2023	FPS, RDS	AAQ.25	APMC	NMRP-P2 station	21° 5'9.26"N	78°58'18.62"E	CW
3A	18.04.2023	FPS, RDS	AAQ.26	Raipur	NMRP-P2 station	21° 4'38.63"N	78°58'6.9"E	CW

3A	18.04.2023	FPS, RDS	AAQ.27	Hingna Bus Station	NMRP-P2 station	21° 4'21.45"N	78°57'52.82"E	UW
3A	17.04.2023	FPS, RDS	AAQ.28	Hingna	NMRP-P2 station	21° 4'27.11"N	78°57'23.17"E	UW
3A	17.04.2023	FPS, RDS	AAQ.29	Rural Hospital - Hingna	Sensitive Receptor (Hospital)	21° 4'29.05"N	78°57'15.89"E	UW
3A	20.04.2023	FPS, RDS	AAQ.30	YCCE	Sensitive Receptor (Engg. College)	21° 5'43.60"N	78°58'42.68"E	DW
3A	20.04.2023	FPS, RDS	AAQ.31	Shalinitai Meghe Hospital	Sensitive Receptor (Hospital)	21° 5'42.14"N	78°58'28.75"E	DW
4A	22.04.2023	FPS, RDS	AAQ.32	Pardi	NMRP-P2 station	21° 8'58.03"N	79° 9'37.51"E	DW
4A	22.04.2023	FPS, RDS	AAQ.33	Kapsi Kh.	NMRP-P2 station	21° 8'38.86"N	79°10'35.17"E	DW
4A	22.04.2023	FPS, RDS	AAQ.34	Transport Nagar	NMRP-P2 station	21° 8'27.22"N	79°11'36.07"E	DW

*** No environmental monitoring could not be carried out in the vicinity of Cantonment station, as it is Defence area and permission is required from the Commanding Officer for same. MahaMetro / GC to kindly arrange the same*

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

Figure 6: Air Monitoring Locations for Line 1A

Figure 7: Air Monitoring Locations for Line 2A

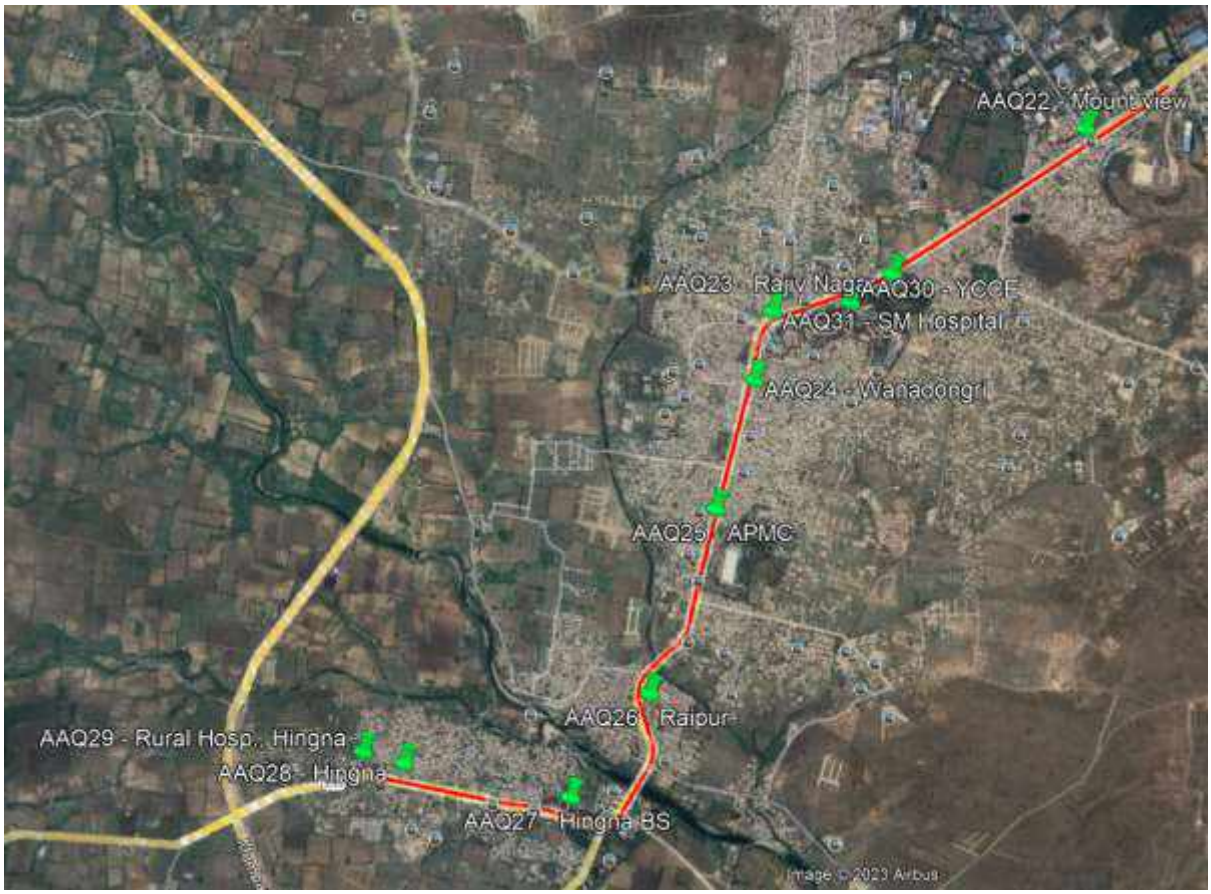


Figure 8: Air Monitoring Locations for Line 3A

Figure 9: Air Monitoring Locations for Line 4A

3.3 Air Quality Sampling Results

Summary of the results of Ambient Air monitoring carried out in the Project Study area are given in **Table 9**.

Table 9: Summary of Ambient Air Monitoring Results for NMRP-P2

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	48.2	80.7	27.8	35.5	0.8
AAQ2	50.1	92.5	29.1	38.7	0.7
AAQ3	51.2	85.4	30.1	36.9	1.1
AAQ4	50.7	93.6	26.5	35.4	0.9
AAQ5	52.6	98.7	25.1	37.4	1.0
AAQ6	56.7	85.8	28.2	38.2	1.2
AAQ7	59.5	92.7	26.9	33.1	1.1
AAQ8	60.2	93.1	32.3	41.6	1.4
AAQ9	58.9	86.9	23.6	33.1	1.0
AAQ10	53.2	88.1	31.3	37.8	1.2
AAQ11	51.4	83.7	28.9	35.4	0.8
AAQ12	52.5	87.8	24.5	30.6	1.0
AAQ13	52.9	85.4	26.1	32.5	0.9
AAQ14	55.6	90.1	25.6	33.1	1.0
AAQ15	57.8	92.5	27.8	41.1	0.9
AAQ16	55.7	89.4	24.1	38.7	0.8
AAQ17	57.1	90.2	26.3	40.3	1.1
AAQ18	56.9	91.5	22.1	45.6	1.1
AAQ19	54.1	87.4	23.2	46.1	0.9
AAQ20	52.3	82.1	25.7	44.2	0.7
AAQ21	50.9	86.3	28.4	45.2	0.6
AAQ22	57.4	91.2	30.1	46.3	0.9
AAQ23	56.4	95.2	29.8	45.7	0.9
AAQ24	57.8	88.7	30.6	48.9	1.1
AAQ25	55.9	86.5	31.2	47.5	1.0
AAQ26	56.3	95.9	30.4	48.5	1.0
AAQ27	58.7	98.6	31.5	50.2	1.1
AAQ28	57.9	97.9	30.7	50.8	1.2
AAQ29	55.4	80.2	27.9	49.6	1.0
AAQ30	57.2	86.3	26.7	47.6	0.9
AAQ31	58.2	88.1	25.2	45.6	1.2
AAQ32	60.3	98.3	24.1	48.2	1.2
AAQ33	59.8	94.8	25.6	44.8	1.1
AAQ34	61.6	100.9	26.3	50.2	1.2

4. Anticipated Impacts

4.1 During Construction Phase

The major activities during construction phase include,

- Site Development
- Civil Construction Work
- Movement of construction Vehicles
- Loading and unloading of construction material and machinery

The potential impacts on air quality due to the proposed project will be temporary rise in Particulate matter likely to result from:

- Fugitive dust emissions near the construction site;

During the construction phase, the excavation activity is anticipated to generate significant levels of particulate matter. These particular pollutants are expected to be of primary concern during the construction process. It should be noted that pollution emissions from this phase will be dispersed across the entire project site and categorized as area sources. Furthermore, it is worth mentioning that the land acquired for the project is relatively flat, and as a result, there is no anticipation of extensive earthmoving or terrain alteration work during this phase.

4.2 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.

5. Air Modelling

Air quality modelling study is carried out with an objective to estimate and analyse concentrations of air pollutants and their impact on nearby areas. It is used for determining and visualizing the significance and impact of emissions to the atmosphere. Air quality models estimate the air pollutant concentration at many locations which are referred to as receptors. These models provide a cost-effective way to analyze impacts over a wide spatial area where factors such as meteorology, topography and emissions from nearby sources are considered. The source data is evaluated in conjunction with meteorological information such as wind speed, wind direction, temperature etc. in the air quality model. The model examines all of these components together to characterize the state of the atmosphere and predict how pollutants are transported from the sources and estimates the concentration of these pollutants in the atmosphere.

Operation of D.G. Set is the main sources identified during the operation phase of the project and same is considered for modelling.

The results from modelling the emissions are used to ensure that the regional air quality does not exceed the NAAQS or deteriorate the air quality further. Therefore, it is important that the modelling method accurately estimate both the amount of pollutant proposed project will emit and the pollutants dispersion.

Urban background concentrations data is used from previous monitoring conducted by MPCB. Gaussian based air dispersion model AERMOD, is used to simulate the ground level concentrations of the selected pollutants.

5.1 Objectives of Air Modelling

The purpose of a dispersion model 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. However, predictive compliance with an ambient air quality objective is determined by the concentration of the substance at ground level. Air quality objectives refer to concentration in the ambient air, not in the emission source. In order to assess whether an emission meets the ambient air objective it is necessary to determine the ground-level concentrations that may arise at various distances from the source. This is the function of a dispersion model.

5.2 AERMOD

AERMOD was developed by the AERMIC (American Meteorological Society (AMS)/United States Environmental Protection Agency (EPA) Regulatory Model Improvement Committee). AERMOD model is applicable to rural and urban areas, flat and complex terrain, surface and elevated releases, and multiple sources (including, point, area and volume sources). AERMOD 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.

The AERMOD atmospheric dispersion modelling system is an integrated system that includes three modules:

- A steady-state dispersion model designed for short dispersion of air pollutant emissions from stationary industrial sources.
- A meteorological data pre-processor (AERMET) that accepts surface meteorological data, upper air soundings, and optionally, data from on-site instrument towers. It then calculates 20 atmospheric parameters needed by the dispersion model, such as atmospheric turbulence characteristics, mixing heights, friction velocity, Monin-Obukov length and surface heat flux.
- A terrain pre-processor (AERMAP) whose main purpose is to provide a physical relationship between terrain features and the behaviour of air pollution plumes. It generates location and height data for each receptor location. It also provides information that allows the dispersion model to simulate the effects of air flowing over hills or splitting to flow around hills.

The flow and processing of information in AERMOD has been presented in Figure 2. The modelling system consists of one main program (AERMOD) and two pre-processors (AERMET and AERMAP). The major purpose of AERMET is to calculate boundary layer parameters for use by AERMOD. The meteorological INTERFACE, internal to AERMOD, uses these parameters to generate profiles of the needed meteorological variables.

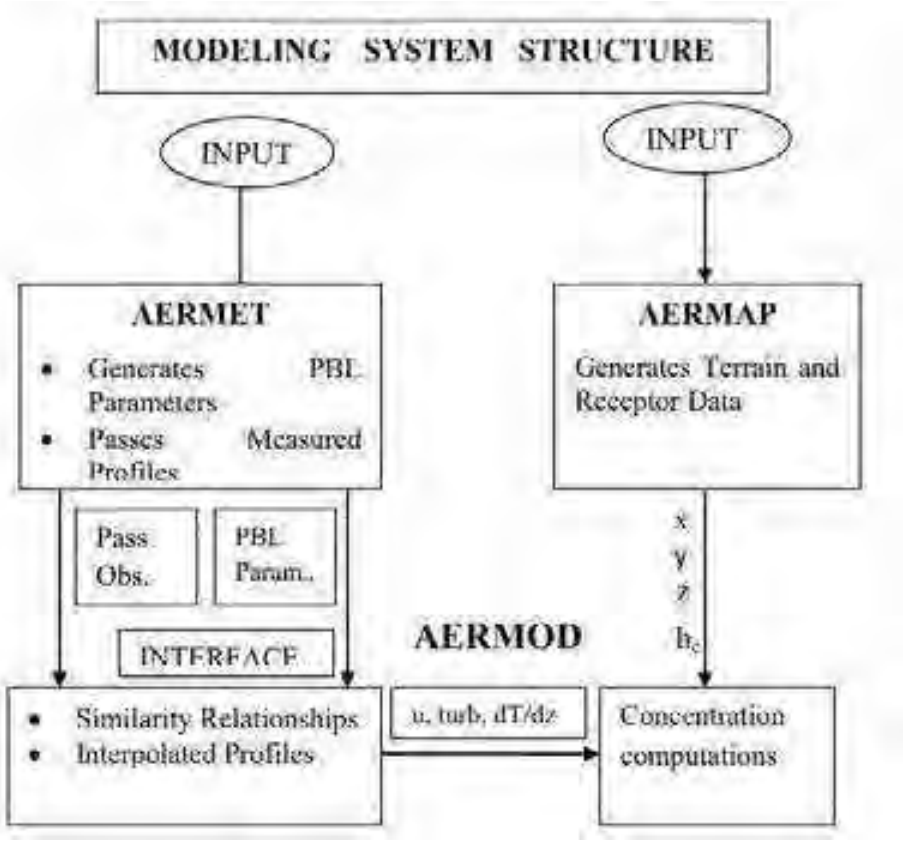


Figure 10: Dataflow in AERMOD modelling system

5.2.1 Input to the Model

5.2.1.1 Construction Phase

As per AP – 42, Fifth Edition, titled "Compilation of Air Pollutant Emission Factors – Volume I", Emission factor for Excavation depends upon soil properties, climatic conditions and area of pit. Empirical equation for calculation of open pit emission rate is given as follows –

$$E = \left[\{(100-m)/m\}^{0.1}\left\{\frac{s}{(100-s)}\right\}^{0.3} a^{1.6}\{u/(10+125u)\}\right]$$

Where,

E = Emission rate (g/sec)

m = Moisture content (%)

s = Silt content (%)

u = Wind speed (m/s)

a = Area (km^2)

In the absence of information regarding the quantity and type of construction equipment to be deployed at any particular time, emission factor $1.81X10^{-5}$ $g/m^2/sec$ (EPA 2006) for general construction activities is used for PM10 emissions estimates. The modelling area of 10 km radius from the project site is assumed.

Since in case of $PM_{2.5}$, one-year meteorological data is required. Hence $PM_{2.5}$ modelling is not carried out.

The depth of the pier is considered as 12 m whereas dimensions of the pier considered are 5.10 m x 5.10 m. A typical section of the column considered for modelling is shown in **Figure 11.**

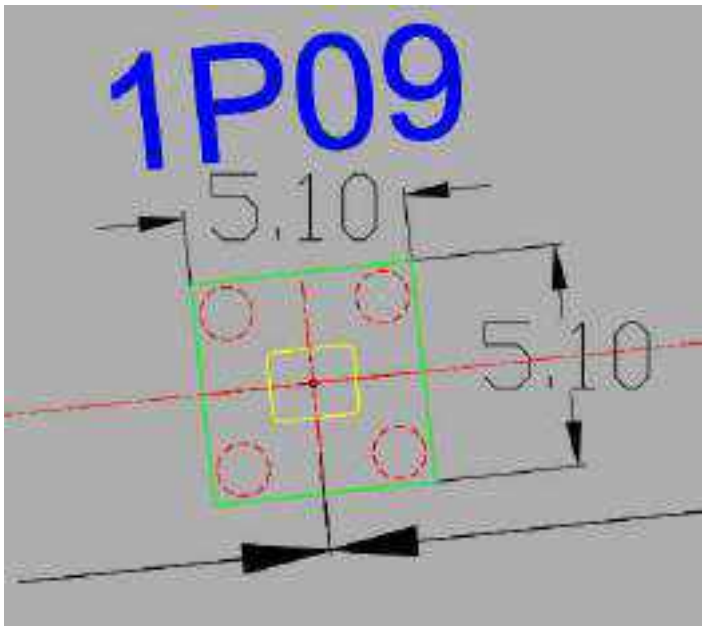


Figure 11: Typical plan of Pier considered for modelling

5.2.1.2 Operation Phase

The input parameters required for carrying out Air Modelling are presented in **Table 10.**

Table 10: Stack Details

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 (Nm^3/hr)	226.65
5	Height (m)	19
6	Stack dia.(m)	0.15
7	Exit velocity (m/s)	10
8	Emission Rate of PM_{10} (g/s) carried for impact Assessment	0.02
9	Emission Rate of SO_2 (g/s) carried for impact Assessment	0.07
10	Emission Rate of NO_x (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.

5.2.2 Study Area

10 km radius study area has been considered from the centre of each alignment and the contours are plotted accordingly.

5.2.3 Meteorological Data

Meteorology data from IMD for Nagpur Station (nearest IMD Station) for the period of 1st March, 2023 to 31st May 2023 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 from April 2023 to June 2023 to determine the present conditions of the site. The same results have been used a background concentration.

5.2.4 Results & Discussion

5.2.4.1 Construction Phase

The short-term ground level concentrations predicted for SPM within study area is presented below:

- **Line 1 A:**

The isopleths of incremental concentration for PM10 have been shown in **Figure 12**. Cumulative concentration at the receptors due to excavation activity is presented in **Table 11** below –

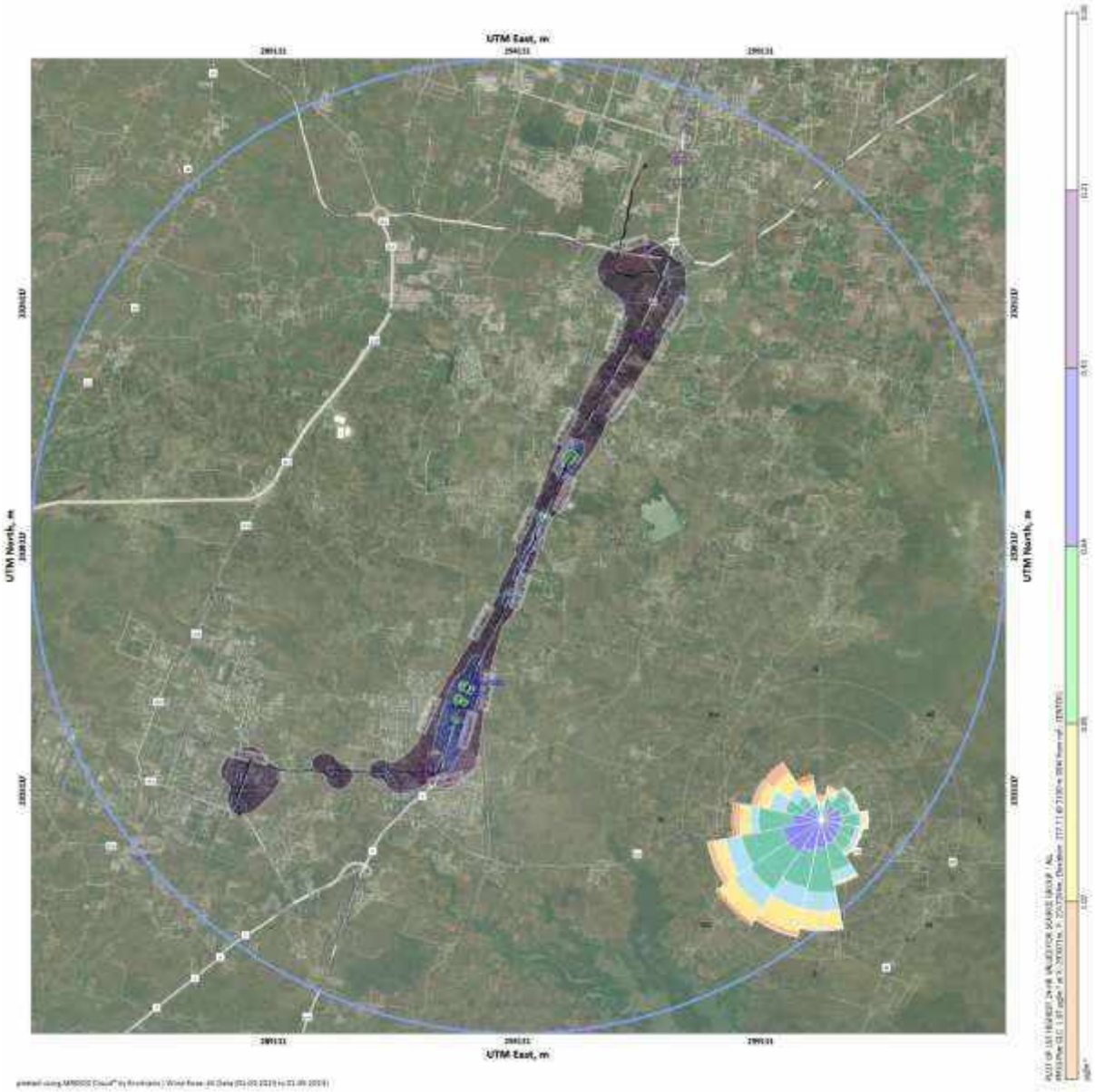


Figure 12: Isopleth of Incremental concentration of PM_{10} (Line 1A)

Table 11: Cumulative concentration of PM_{10} (Line 1A)

Sampling Code	Sampling Location	Baseline Concentration ($\mu g/m^3$)	Incremental Concentration ($\mu g/m^3$)	Total Concentration ($\mu g/m^3$)
AAQ.1	Ashokwan	80.7	0.27	80.97
AAQ.2	Dongargaon	92.5	0.81	93.31
AAQ.3	Mohgaon	85.4	0.55	85.95
AAQ.4	Meghdoot CIDCO	93.6	0.66	94.26
AAQ.5	Butibori Police Station	98.7	0.26	98.96
AAQ.6	MHADA Colony	85.8	0.36	86.16

AAQ.7	MIDC KEC	92.7	0.31	93.01
AAQ.8	MIDC ESR	93.1	0.35	93.45
AAQ.9	Jijamata High School & Jr. College	86.9	0.84	87.74
AAQ.10	Rachana Hospital	88.1	0.31	88.41

- **Line 2A**

The isopleths of incremental concentration for PM10 have been shown in **Figure 13**. Cumulative concentration at the receptors due to excavation activity is presented in **Table 12** below –

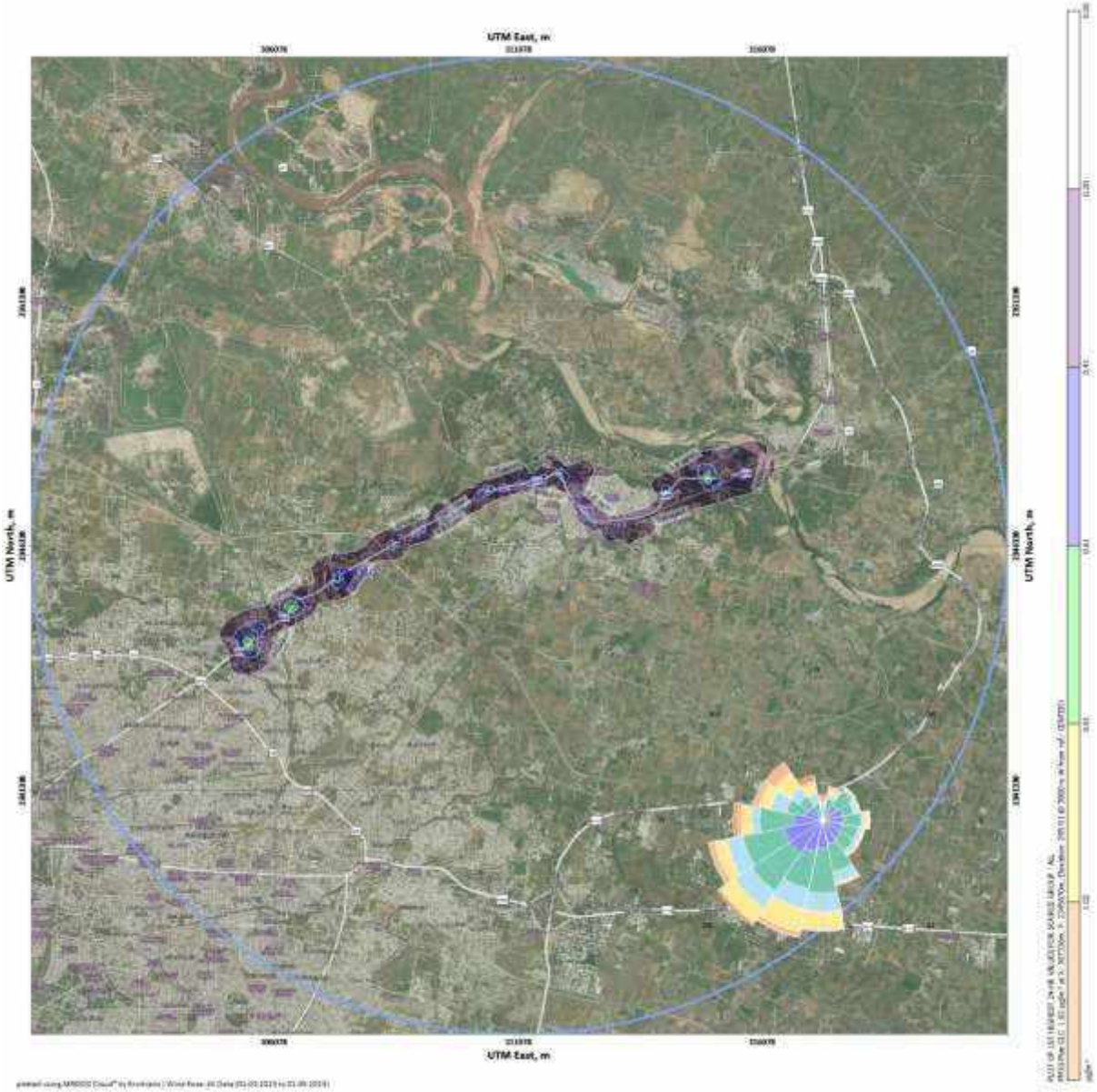


Figure 13: Isopleth of Incremental concentration of PM_{10} (Line 2A)

Table 12: Cumulative concentration of PM_{10} (Line 2A)

Sampling Code	Sampling Location	Baseline Concentration (µg/m³)	Incremental Concentration (µg/m³)	Total Concentration (µg/m³)
AAQ.11	Pili Nadi	83.7	0.52	84.22
AAQ.12	Khasara fata	87.8	0.71	88.51
AAQ.13	All India Radio	85.4	0.32	85.72
AAQ.14	Khairi fata	90.1	0.43	90.53
AAQ.15	Lok Vihar	92.5	0.79	93.29
AAQ.16	Lekha Nagar Asha Hospital and Asharam College & School of Nursing	89.4	0.49	89.89
AAQ.17	Kamptee Police station**	90.2	0.45	90.65
AAQ.18	Kamptee Municipal Council	91.5	0.30	91.8
AAQ.19	Dragon Palace	87.4	0.32	87.72
AAQ.20	Kanhan River	82.1	0.44	82.54
AAQ.21	Delhi Public School (DPS), Khairy, Kamptee Road, Nagpur	86.3	0.21	86.51

- **Line 3A**

The isopleths of incremental concentration for PM_{10} have been shown in **Figure 14**. Cumulative concentration at the receptors due to excavation activity is presented in **Table 13** below –

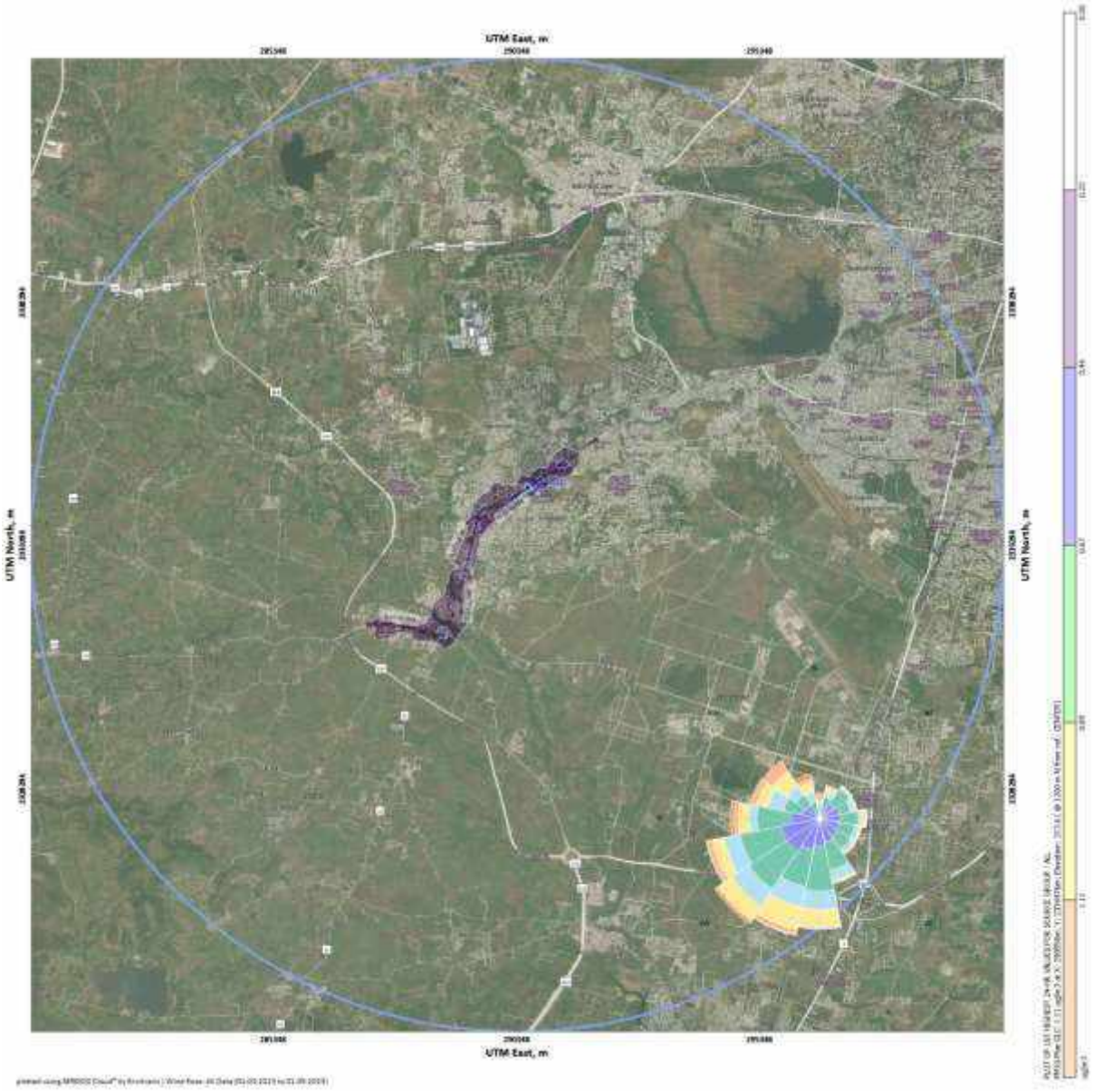


Figure 14: Isopleth of Incremental concentration of PM_{10} (Line 3A)

Table 13: Cumulative concentration of PM_{10} (Line 3A)

Sampling Code	Sampling Location	Baseline Concentration (µg/m³)	Incremental Concentration (µg/m³)	Total Concentration (µg/m³)
AAQ.22	Hingna Mount View	91.2	0.63	91.83
AAQ.23	Rajiv Nagar	95.2	0.68	95.88
AAQ.24	Wanadongri	88.7	0.82	89.52
AAQ.25	APMC	86.5	0.35	86.85
AAQ.26	Raipur	95.9	0.45	96.35
AAQ.27	Hingna Bus Station	98.6	0.35	98.95

AAQ.28	Hingna	97.9	0.39	98.29
AAQ.29	Rural Hospital - Hingna	80.2	0.23	80.43
AAQ.30	YCCE	86.3	0.38	86.68
AAQ.31	Shalinitai Meghe Hospital	88.1	0.50	88.6

- **Line 4A**

The isopleths of incremental concentration for PM10 have been shown in **Figure 15**. Cumulative concentration at the receptors due to excavation activity is presented in **Table 14** below –

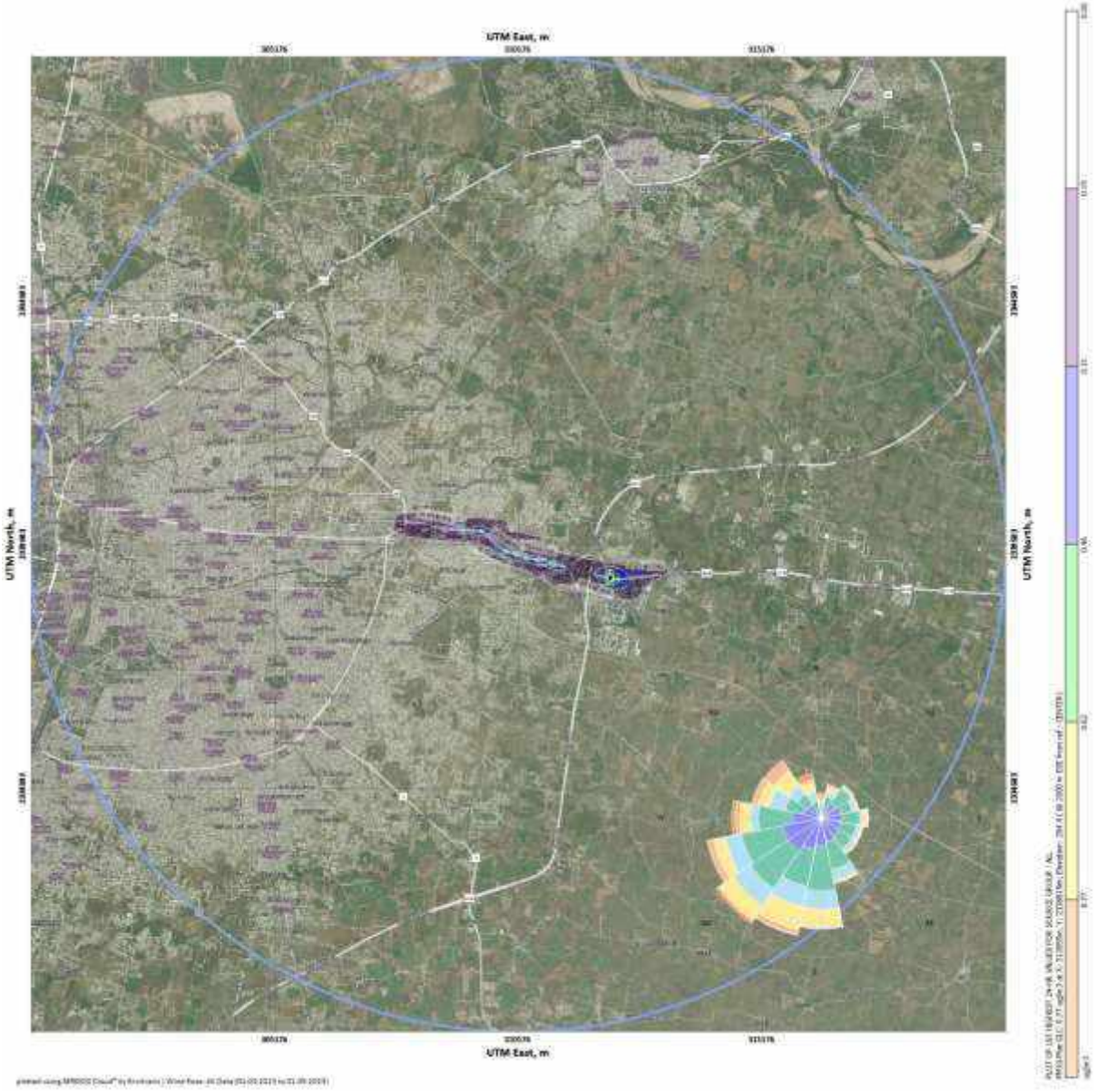


Figure 15: Isopleth of Incremental concentration of PM_{10} (Line 4A)

Table 14: Cumulative concentration of PM_{10} (Line 4A)

Sampling Code	Sampling Location	Baseline Concentration (µg/m³)	Incremental Concentration (µg/m³)	Total Concentration (µg/m³)
AAQ.32	Pardi	98.3	0.61	98.91
AAQ.33	Kapsi Kh.	94.8	0.40	95.2
AAQ.34	Transport Nagar	100.9	0.28	101.18

5.2.4.2 Operation Phase

The short-term ground level concentrations predicted for SPM within study area is presented below:

- **Line 1A:**

The isopleths of incremental concentration for PM10, SO2 & NOX have been shown in **Figure 16** to **Figure 18** below. Cumulative concentration at the receptors due to operation of DG sets for PM10, SO2 & NOX have been shown in **Table 15** to **Table 17** below -

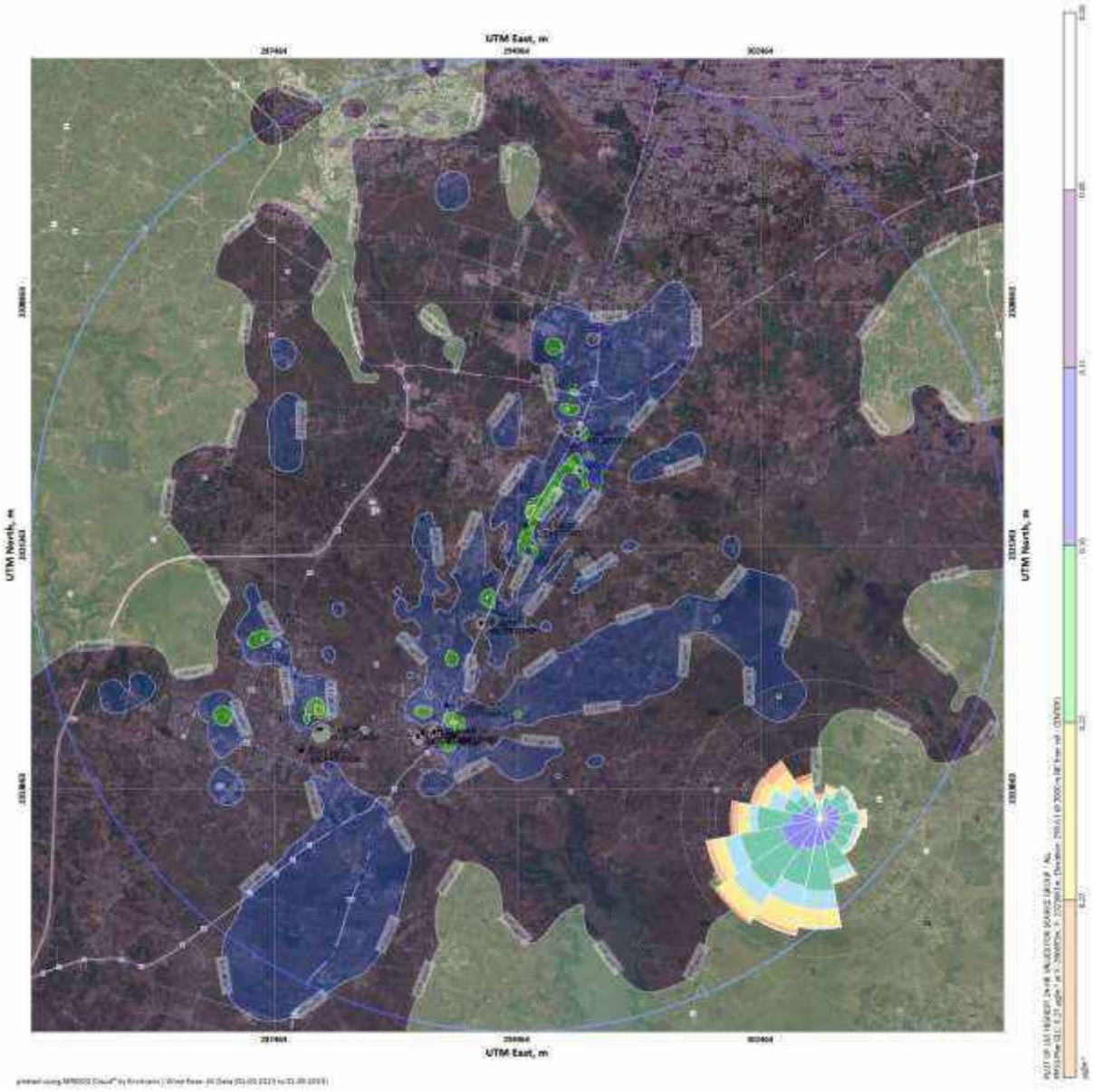


Figure 16: Isopleth of Incremental concentration of PM_{10}

Table 15: Cumulative concentration of PM_{10}

Sampling Code	Sampling Location	Baseline Concentration (µg/m³)	Incremental Concentration (µg/m³)	Total Concentration (µg/m³)
AAQ.1	Ashokwan	80.7	0	80.7
AAQ.2	Dongargaon	92.5	0.15	92.65
AAQ.3	Mohgaon	85.4	0	85.4
AAQ.4	Meghdoot CIDCO	93.6	0.14	93.74
AAQ.5	Butibori Police Station	98.7	0	98.7
AAQ.6	MHADA Colony	85.8	0	85.8
AAQ.7	MIDC KEC	92.7	0	92.7
AAQ.8	MIDC ESR	93.1	0.07	93.17

AAQ.9	Jijamata High School & Jr. College	86.9	0.11	87.01
AAQ.10	Rachana Hospital	88.1	0.09	88.19

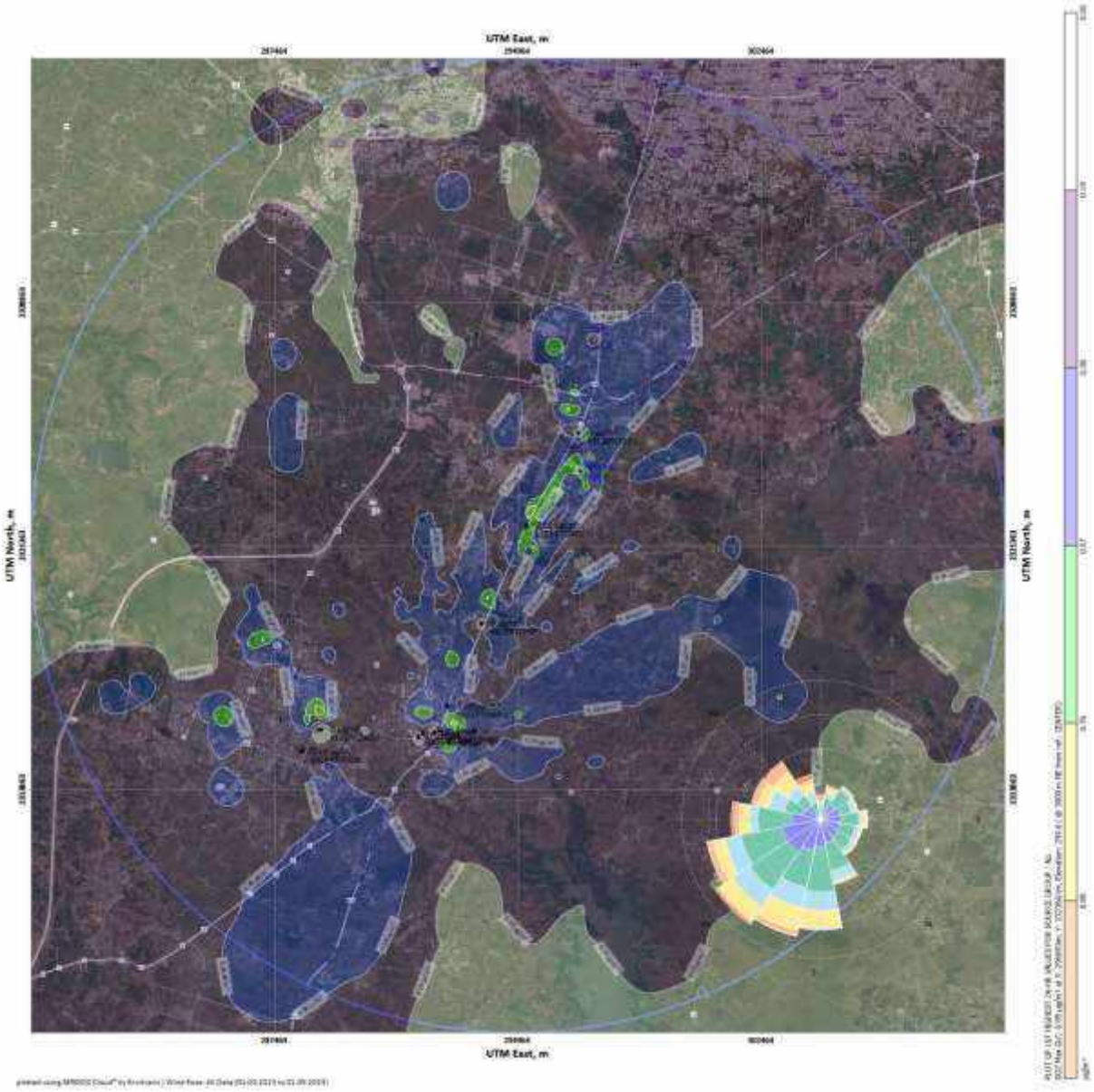


Figure 17: Isopleth of Incremental concentration of SO_2

Table 16: Cumulative concentration of SO_2

Sampling Code	Sampling Location	Baseline Concentration (µg/m³)	Incremental Concentration (µg/m³)	Total Concentration (µg/m³)
AAQ.1	Ashokwan	27.8	0	27.8
AAQ.2	Dongargaon	29.1	0.55	29.65

AAQ.3	Mohgaon	30.1	0	30.1
AAQ.4	Meghdoot CIDCO	26.5	0.49	26.99
AAQ.5	Butibori Police Station	25.1	0	25.1
AAQ.6	MHADA Colony	28.2	0	28.2
AAQ.7	MIDC KEC	26.9	0	26.9
AAQ.8	MIDC ESR	32.3	0.26	32.56
AAQ.9	Jijamata High School & Jr. College	23.6	0.39	23.99
AAQ.10	Rachana Hospital	31.3	0.33	31.63

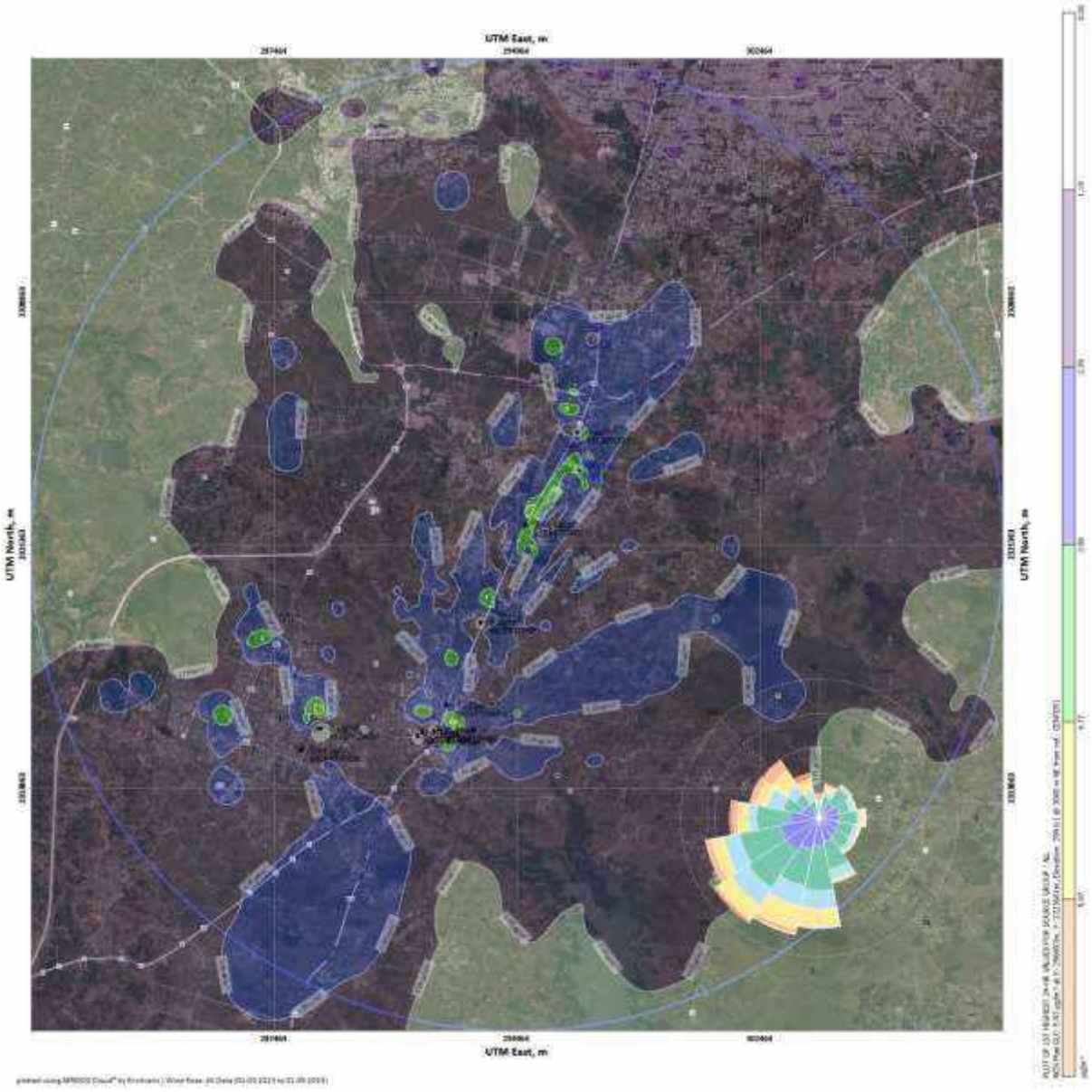


Figure 18: Isopleth of Incremental concentration of NO_x

Table 17: Cumulative concentration of NO_x

Sampling Code	Sampling Location	Baseline Concentration (µg/m³)	Incremental Concentration (µg/m³)	Total Concentration (µg/m³)
AAQ.1	Ashokwan	35.5	0	35.5
AAQ.2	Dongargaon	38.7	3.45	42.15
AAQ.3	Mohgaon	36.9	0	36.9
AAQ.4	Meghdoot CIDCO	35.4	3.10	38.5
AAQ.5	Butibori Police Station	37.4	0	37.4
AAQ.6	MHADA Colony	38.2	0	38.2
AAQ.7	MIDC KEC	33.1	0	33.1
AAQ.8	MIDC ESR	41.6	1.64	43.24
AAQ.9	Jijamata High School & Jr. College	33.1	2.46	35.56
AAQ.10	Rachana Hospital	37.8	2.13	39.93

- **Line 2A**

The isopleths of incremental concentration for PM10, SO2 & NOX have been shown in **Figure 19** to **Figure 21** below. Cumulative concentration at the receptors due to operation of DG sets for PM10, SO2 & NOX have been shown in **Table 18** to **Table 20** below -

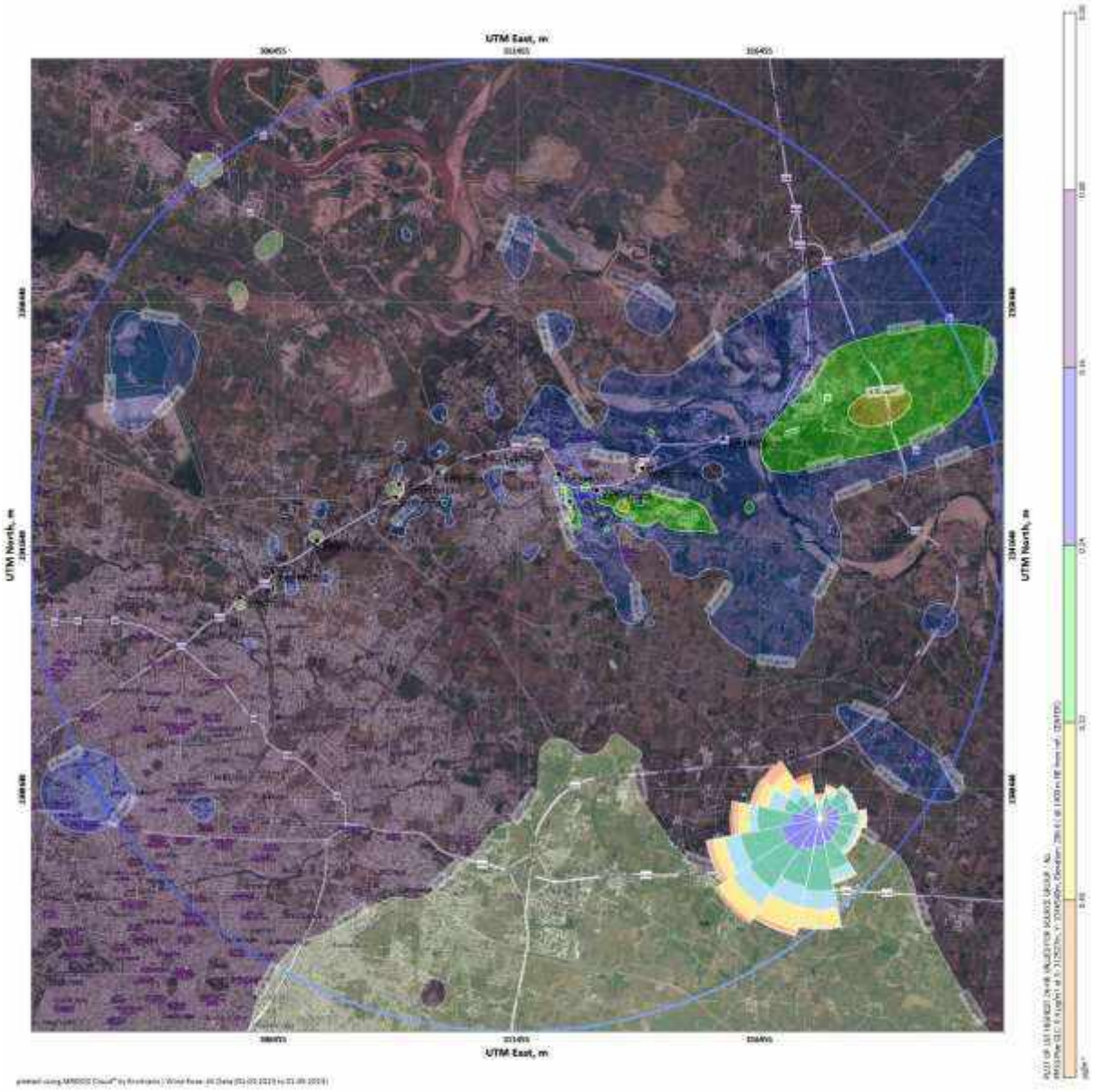


Figure 19: Isopleth of Incremental concentration of PM_{10}

Table 18: Cumulative concentration of PM_{10}

Sampling Code	Sampling Location	Baseline Concentration (µg/m³)	Incremental Concentration (µg/m³)	Total Concentration (µg/m³)
AAQ.11	Pili Nadi	83.7	0	83.7
AAQ.12	Khasara fata	87.8	0.14	87.94
AAQ.13	All India Radio	85.4	0	85.4
AAQ.14	Khairi fata	90.1	0	90.1
AAQ.15	Lok Vihar	92.5	0	92.5
AAQ.16	Lekha Nagar	89.4	0.14	89.54

	Asha Hospital and Asharam College & School of Nursing			
AAQ.17	Kamptee Police station**	90.2	0.15	90.35
AAQ.18	Kamptee Municipal Council	91.5	0	91.5
AAQ.19	Dragon Palace	87.4	0	87.4
AAQ.20	Kanhan River	82.1	0.2	82.3
AAQ.21	Delhi Public School (DPS), Khairy, Kamptee Road, Nagpur	86.3	0	86.3

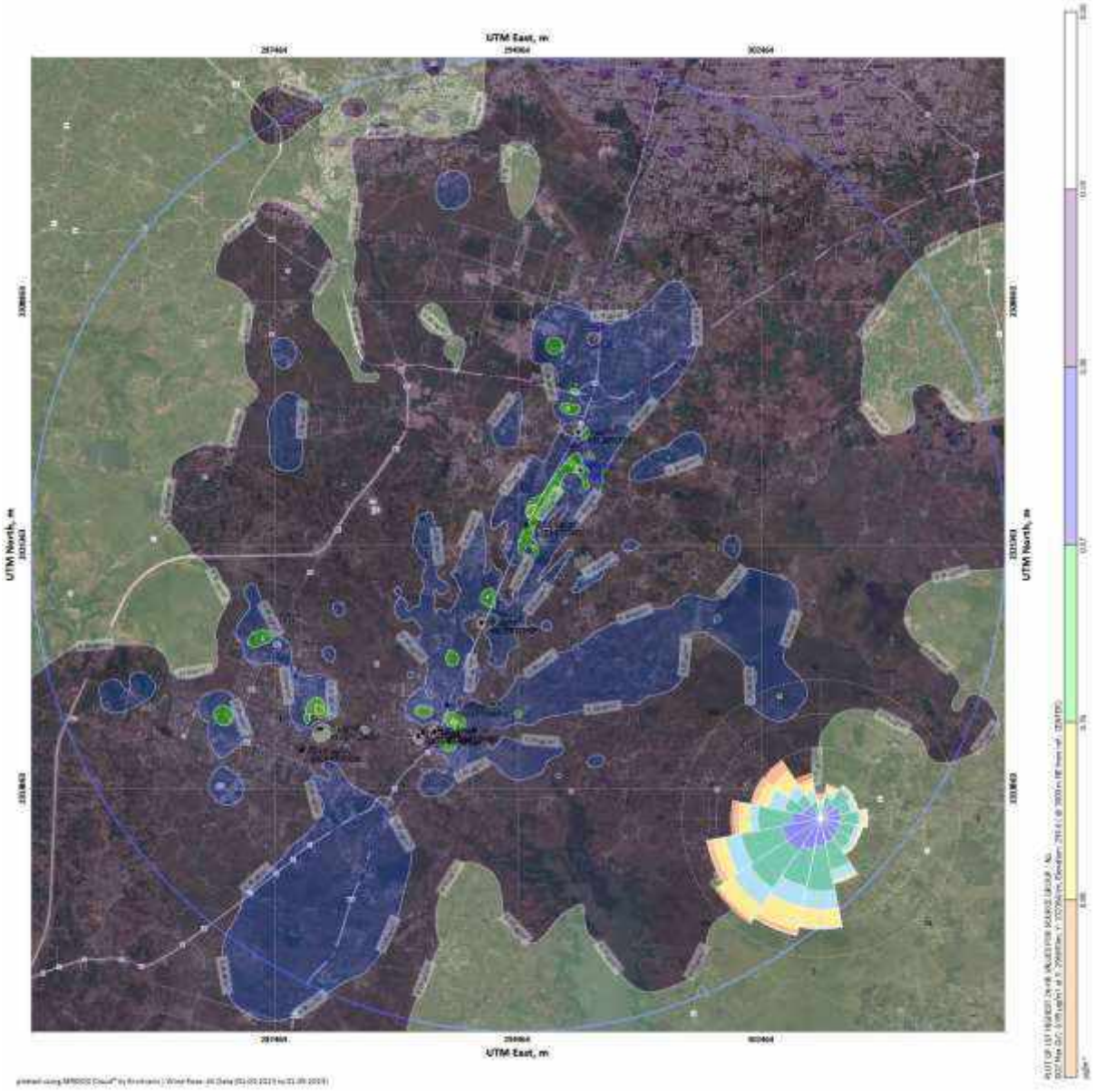


Figure 20: Isopleth of Incremental concentration of SO_2

Table 19: Cumulative concentration of SO_2

Sampling Code	Sampling Location	Baseline Concentration (µg/m³)	Incremental Concentration (µg/m³)	Total Concentration (µg/m³)
AAQ.11	Pili Nadi	28.9	0	28.9
AAQ.12	Khasara fata	24.5	0.50	25
AAQ.13	All India Radio	26.1	0	26.1
AAQ.14	Khairi fata	25.6	0	25.6
AAQ.15	Lok Vihar	27.8	0	27.8
AAQ.16	Lekha Nagar Asha Hospital and Asharam College & School of Nursing	24.1	0.50	24.6
AAQ.17	Kamptee Police station**	26.3	0.53	26.83
AAQ.18	Kamptee Municipal Council	22.1	0	22.1
AAQ.19	Dragon Palace	23.2	0	23.2
AAQ.20	Kanhan River	25.7	0.70	26.4
AAQ.21	Delhi Public School (DPS), Khairy, Kamptee Road, Nagpur	28.4	0	28.4

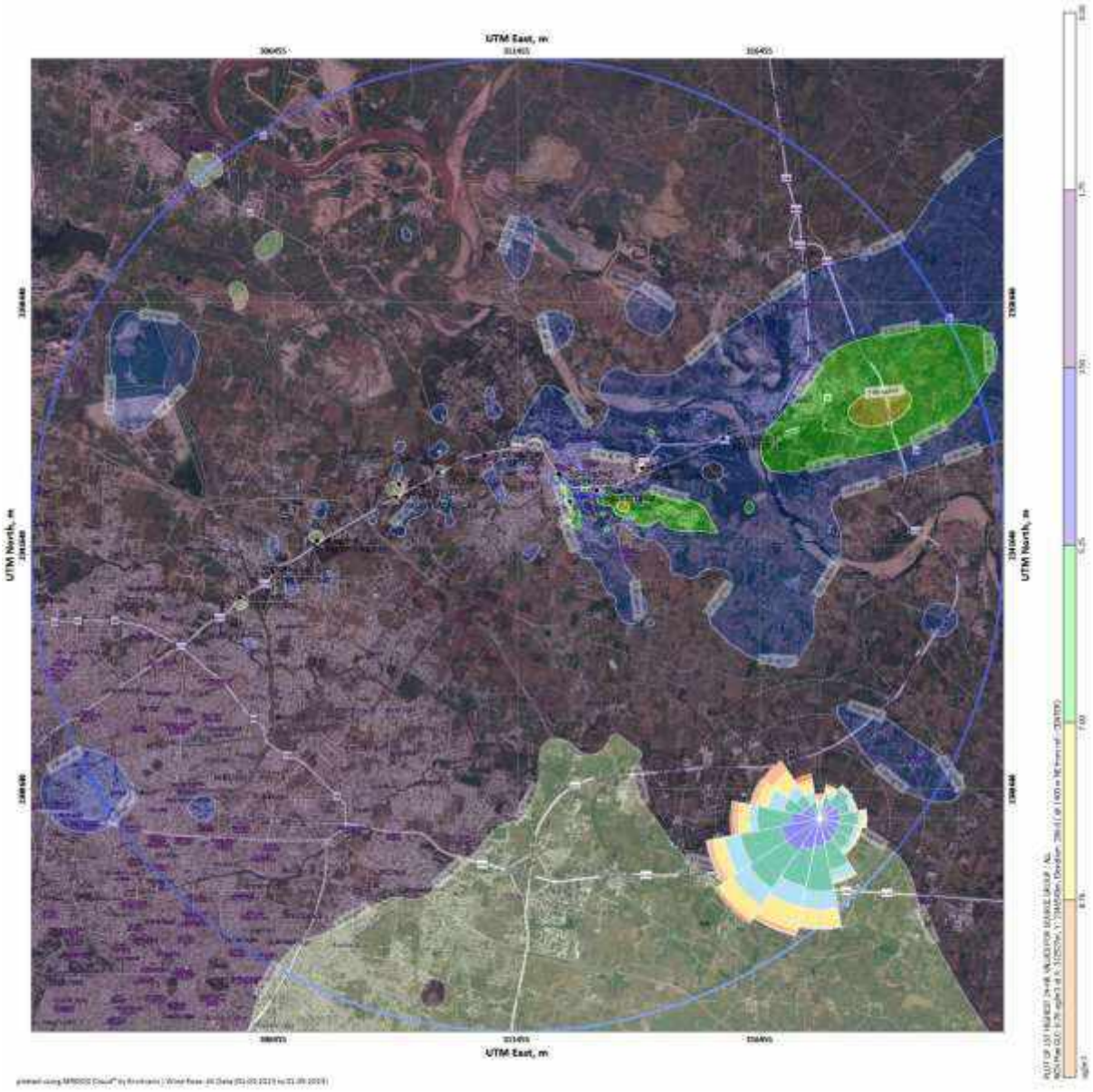


Figure 21: Isopleth of Incremental concentration of NO_x

Table 20: Cumulative concentration of NO_x

Sampling Code	Sampling Location	Baseline Concentration (µg/m³)	Incremental Concentration (µg/m³)	Total Concentration (µg/m³)
AAQ.11	Pili Nadi	35.4	0	35.4
AAQ.12	Khasara fata	30.6	3.15	33.75
AAQ.13	All India Radio	32.5	0	32.5
AAQ.14	Khairi fata	33.1	0	33.1
AAQ.15	Lok Vihar	41.1	0	41.1
AAQ.16	Lekha Nagar	38.7	3.15	41.85

	Asha Hospital and Asharam College & School of Nursing			
AAQ.17	Kamptee Police station**	40.3	3.34	43.64
AAQ.18	Kamptee Municipal Council	45.6	0	45.6
AAQ.19	Dragon Palace	46.1	0	46.1
AAQ.20	Kanhan River	44.2	4.41	48.61
AAQ.21	Delhi Public School (DPS), Khairy, Kamptee Road, Nagpur	45.2	0	45.2

- **Line 3A**

The isopleths of incremental concentration for PM10, SO2 & NOX have been shown in **Figure 22** to **Figure 24** below. Cumulative concentration at the receptors due to operation of DG sets for PM10, SO2 & NOX have been shown in **Table 21** to **Table 23** below -

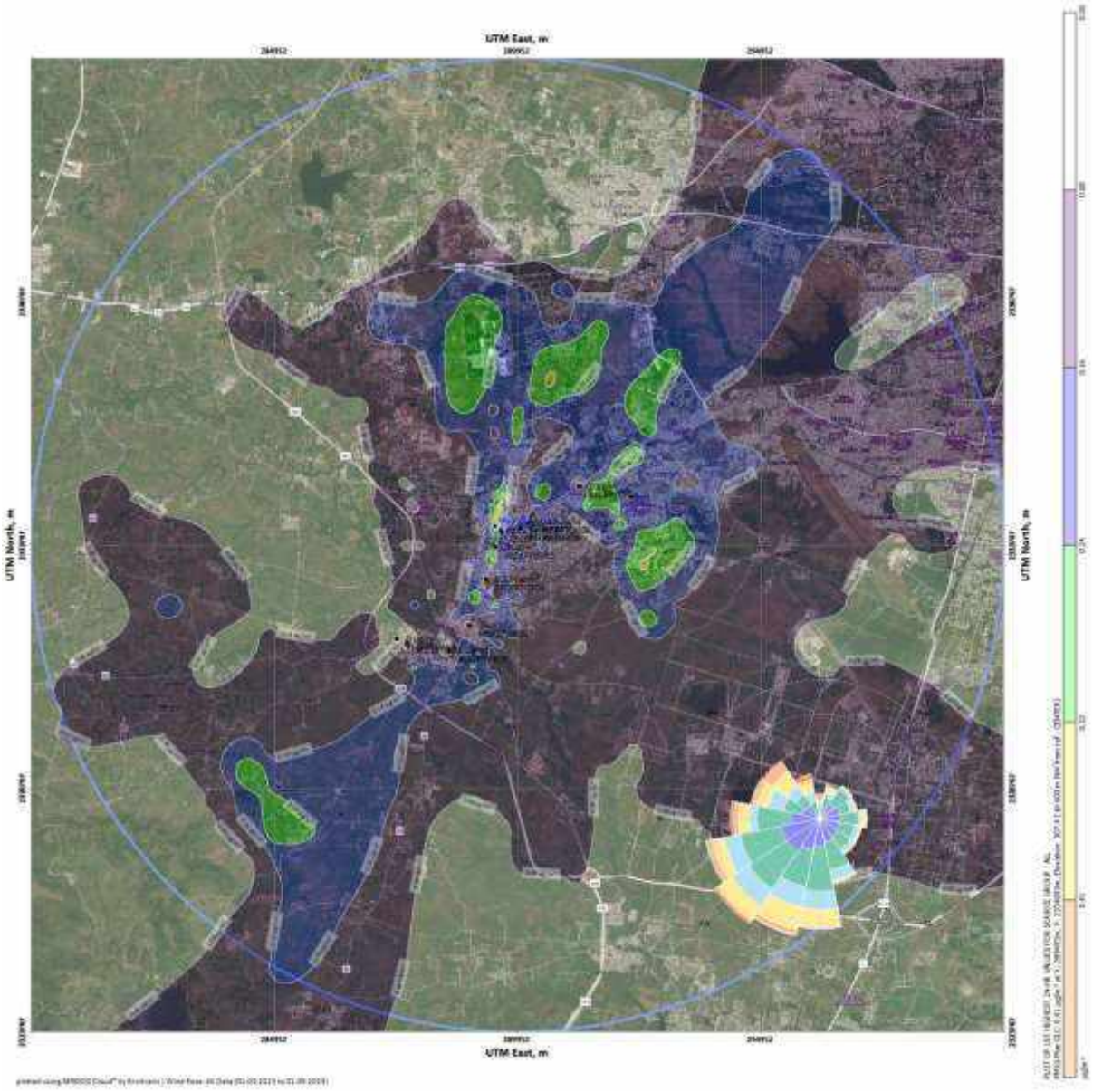


Figure 22: Isopleth of Incremental concentration of PM_{10}

Table 21: Cumulative concentration of PM_{10}

Sampling Code	Sampling Location	Baseline Concentration (µg/m³)	Incremental Concentration (µg/m³)	Total Concentration (µg/m³)
AAQ.22	Hingna Mount View	91.2	0	91.2
AAQ.23	Rajiv Nagar	95.2	0.16	95.36
AAQ.24	Wanadongri	88.7	0	88.7
AAQ.25	APMC	86.5	0.13	86.63
AAQ.26	Raipur	95.9	0	95.9
AAQ.27	Hingna Bus Station	98.6	0	98.6

AAQ.28	Hingna	97.9	0	97.9
AAQ.29	Rural Hospital - Hingna	80.2	0	80.2
AAQ.30	YCCE	86.3	0.19	86.49
AAQ.31	Shalinitai Meghe Hospital	88.1	0.21	88.31

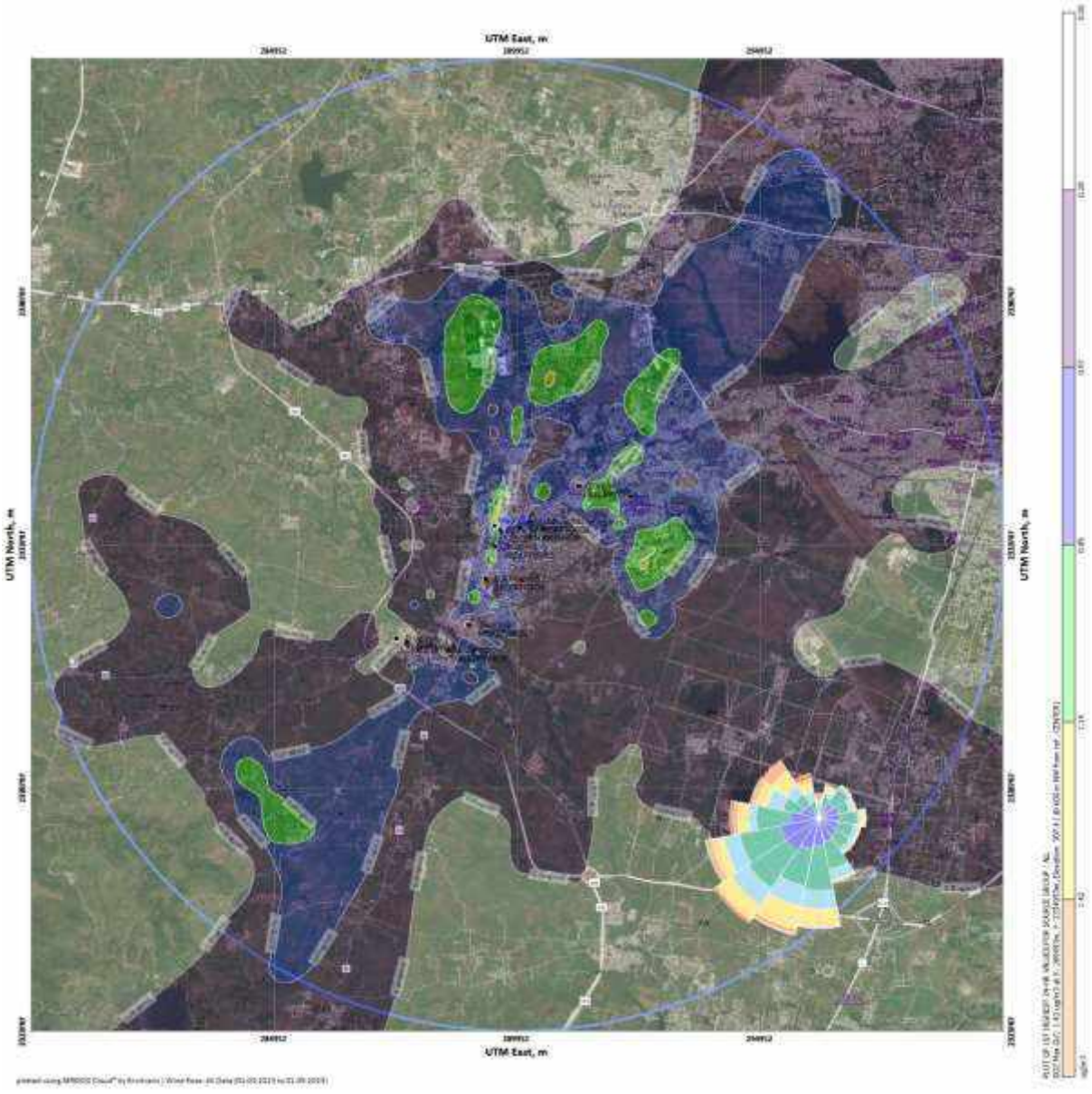


Figure 23: Isopleth of Incremental concentration of SO_2

Table 22: Cumulative concentration of SO_2

Sampling Code	Sampling Location	Baseline Concentration (µg/m³)	Incremental Concentration (µg/m³)	Total Concentration (µg/m³)
AAQ.22	Hingna Mount View	30.1	0	30.1

AAQ.23	Rajiv Nagar	29.8	0.58	30.38
AAQ.24	Wanadongri	30.6	0	30.6
AAQ.25	APMC	31.2	0.47	31.67
AAQ.26	Raipur	30.4	0	30.4
AAQ.27	Hingna Bus Station	31.5	0	31.5
AAQ.28	Hingna	30.7	0	30.7
AAQ.29	Rural Hospital - Hingna	27.9	0	27.9
AAQ.30	YCCE	26.7	0.68	27.38
AAQ.31	Shalinitai Meghe Hospital	25.2	0.75	25.95

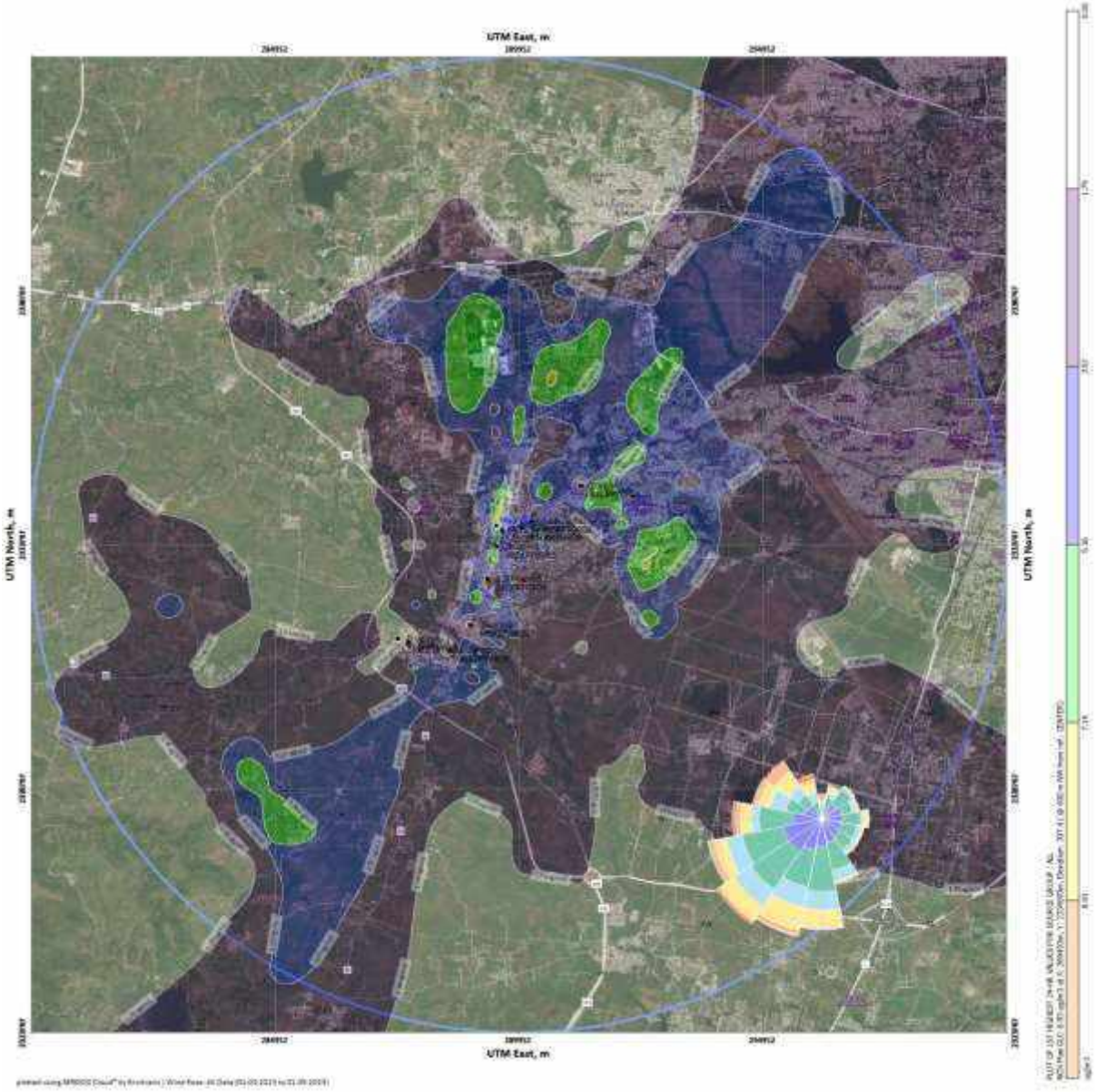


Figure 24: Isopleth of Incremental concentration of NO_x

Table 23: Cumulative concentration of NO_x

Sampling Code	Sampling Location	Baseline Concentration (µg/m³)	Incremental Concentration (µg/m³)	Total Concentration (µg/m³)
AAQ.22	Hingna Mount View	46.3	0	46.3
AAQ.23	Rajiv Nagar	45.7	3.66	49.36
AAQ.24	Wanadongri	48.9	0	48.9
AAQ.25	APMC	47.5	2.96	50.46
AAQ.26	Raipur	48.5	0	48.5
AAQ.27	Hingna Bus Station	50.2	0	50.2
AAQ.28	Hingna	50.8	0	50.8
AAQ.29	Rural Hospital - Hingna	49.6	0	49.6
AAQ.30	YCCE	47.6	4.28	51.88
AAQ.31	Shalinitai Meghe Hospital	45.6	4.75	50.35

- **Line 4A**

The isopleths of incremental concentration for PM10, SO2 & NOX have been shown in **Figure 25** to **Figure 27** below. Cumulative concentration at the receptors due to operation of DG sets for PM10, SO2 & NOX have been shown in **Table 24** to **Table 26** below -

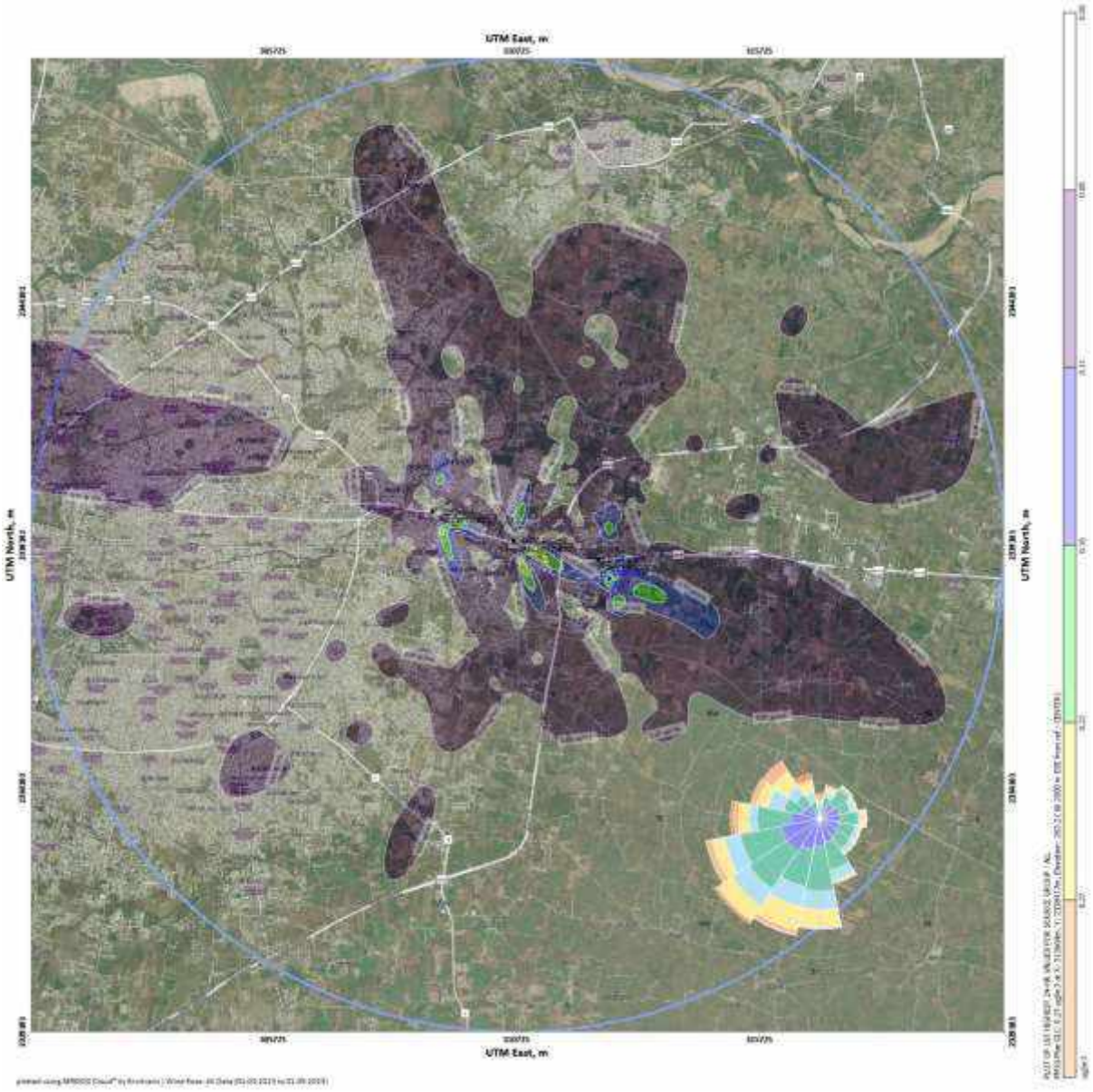


Figure 25: Isopleth of Incremental concentration of PM_{10}

Table 24: Cumulative concentration of PM_{10}

Sampling Code	Sampling Location	Baseline Concentration (µg/m³)	Incremental Concentration (µg/m³)	Total Concentration (µg/m³)
AAQ.32	Pardi	98.3	0	98.3
AAQ.33	Kapsi Kh.	94.8	0.06	94.86
AAQ.34	Transport Nagar	100.9	0.06	100.96

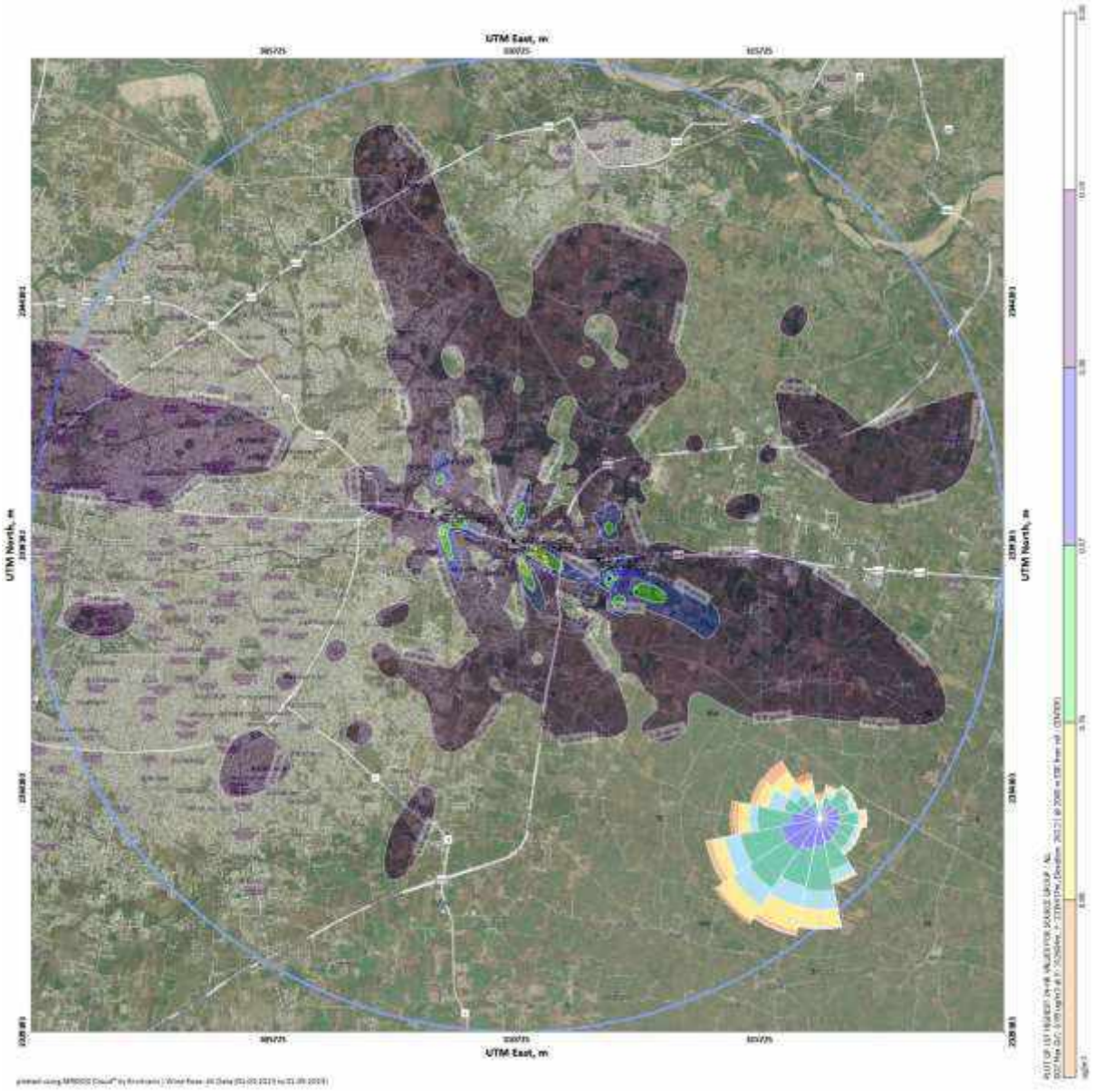


Figure 26: Isopleth of Incremental concentration of SO_2

Table 25: Cumulative concentration of SO_2

Sampling Code	Sampling Location	Baseline Concentration (µg/m³)	Incremental Concentration (µg/m³)	Total Concentration (µg/m³)
AAQ.32	Pardi	26.7	0	26.7
AAQ.33	Kapsi Kh.	25.2	0.23	25.43
AAQ.34	Transport Nagar	24.1	0.21	24.31

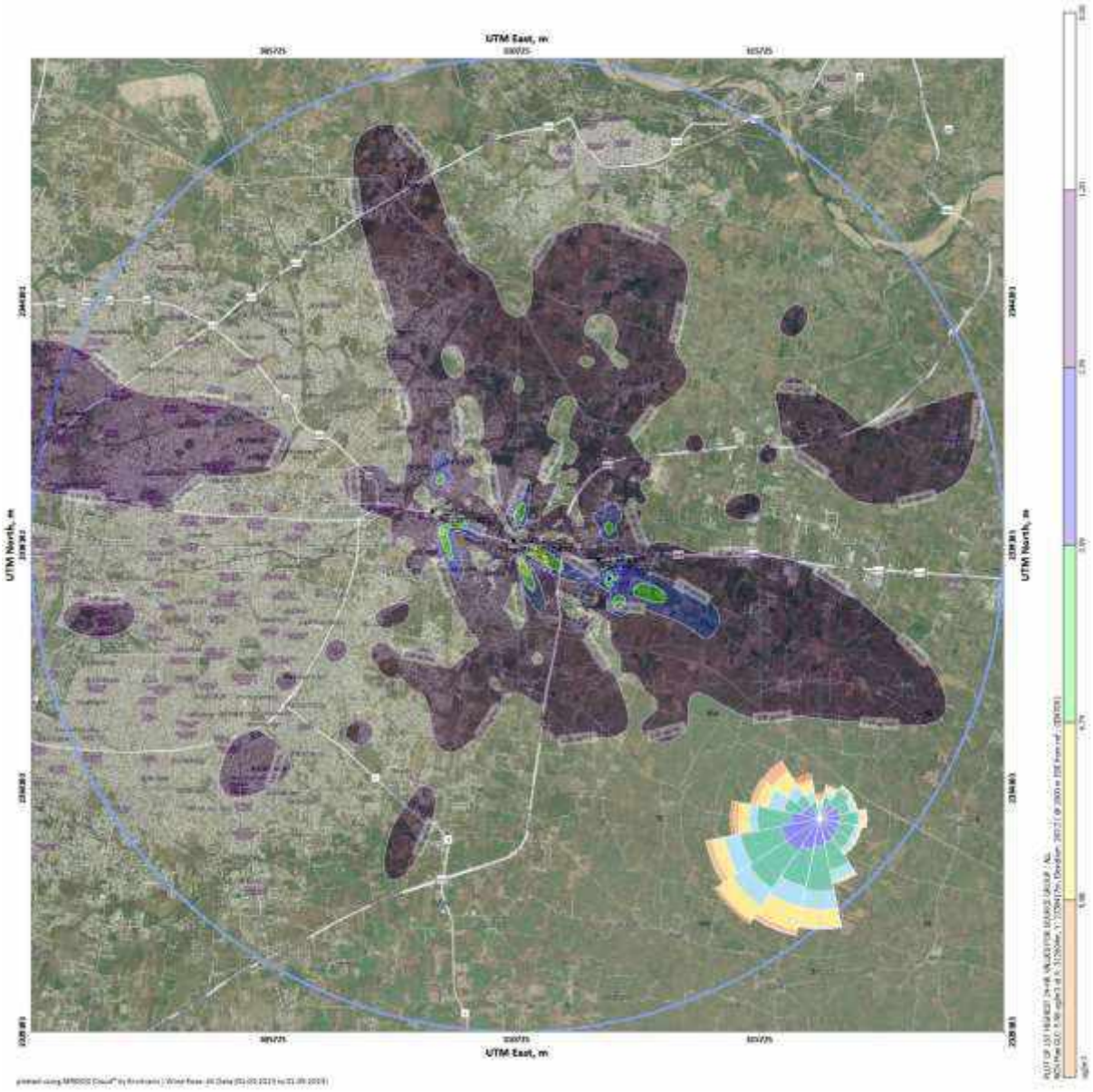


Figure 27: Isopleth of Incremental concentration of NO_x

Table 26: Cumulative concentration of NO_x

Sampling Code	Sampling Location	Baseline Concentration (µg/m³)	Incremental Concentration (µg/m³)	Total Concentration (µg/m³)
AAQ.32	Pardi	47.6	0	47.6
AAQ.33	Kapsi Kh.	45.6	1.47	47.07
AAQ.34	Transport Nagar	48.2	1.37	49.57

5.2.5 Conclusion

5.2.5.1 Construction Phase

- From the above modelling studies, it can be concluded that there is minimalistic impact on the baseline environmental values due to proposed excavation activity.
- Max incremental concentration for Line 1A is 1.07 µg/m^3 at 800 m North of Meghdoot CIDCO Station, for Line 2A is 1.02 µg/m^3 at 20 m South – East of All India Radio Station, for Line 3A is 1.11 µg/m^3 at 295 m North – East of Rajivnagar Station and for Line 4A is 0.77 µg/m^3 at 338 m West of Transport Nagar Station.
- Overall it can be concluded that PM values at all the receptors are well within the NAAQS Standards stipulated by CPCB except at Transport nagar as its baseline is exceeding the limit.

5.5.2.2 Operation Phase

- It can be concluded that no significant impacts due to operation of DG set are envisaged.

5.5.6 Mitigation Measures during Construction Phase

Though there are no significant impacts in the construction phase, some of the generalised mitigation measures suggested are –

- **Water Spraying:** One of the most effective ways to control dust during construction is to spray water onto the areas where dust is being generated. This will be done using water trucks or water cannons.
- **Covering Materials:** Using covers such as tarpaulins or plastic sheets will help to control dust generated from construction materials like sand, gravel, and cement.
- **Vacuum Sweeping:** Vacuum sweeping is an effective method to capture dust at its source before it can become airborne. This method shall be used on finished surfaces, such as floors or walls, to prevent dust from becoming airborne during cleaning.
- **Personal Protective Equipment:** Workers who are exposed to dust during construction activities will be provided with appropriate personal protective equipment (PPE), such as dust masks or respirators.
- **Enclosure:** Construction areas will be enclosed with minimum 10ft high metal sheets to contain dust, especially in sensitive locations such as hospitals and schools. Enclosures shall be created using dust barriers or by enclosing the entire construction site with a temporary fence.

- **Regular Site Cleaning:** Regular cleaning of the construction site can help to prevent the accumulation of dust. This can be done using brooms, shovels, or vacuums.
- **Wind Breaks:** Creating wind breaks, such as planting trees or constructing temporary walls, can help to reduce the amount of wind-blown dust.
- **Reduced Speed Limit:** Dust is often generated when vehicles are moving too fast on unpaved roads. Reducing the speed limit for construction vehicles can help to control dust emissions.
- **Covering of Trucks Carrying Excavated Material:** All the trucks carrying excavated material will be covered with tarpaulin sheets in order to prevent dust from getting air borne.
- **Cleaning of Vehicles:** Tyres of Trucks/ Dumpers carrying excavated materials will be cleaned regularly to avoid fugitive dust emission.
- **Tree Plantation:** Development of Green Belt which will include species having large canopy to prevent fugitive dust emission in neighbouring areas.

These measures can be implemented in combination to create an effective dust control plan for the construction site.

Environmental Impact Assessment

EXTERNAL
Version: Draft
Revision No. 2

December 2023

India: Nagpur Metro Urban Mobility Project

(Annex 6: Noise Modelling Report)

Prepared by the Maharashtra Metro Rail Corporation Limited for the Asian Development Bank.

ABBREVIATIONS

ADB	-	Asian Development Bank
CPCB	-	Central Pollution Control Board
EIA	-	environmental impact assessment
FTA	-	Federal Transit Administration
MMRCL	-	Maharashtra Metro Rail Corporation Limited
NMRP	-	Nagpur Metro Rail Project
RoW	-	right of way
SPL	-	sound pressure level
SPS	-	Safeguards Policy Statement 2009
YCCE	-	Yeshwantrao Chavan College of Engineering

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

A. INTRODUCTION

1. This is the noise assessment report prepared for the Phase 2 of the proposed Nagpur Metro Rail Project -(NMRP) located in Nagpur 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 Asian Development Bank (ADB).

2. An environmental impact assessment (EIA) has been carried out for the project in line with ADB's Safeguards Policy Statement (SPS 2009) 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 ADB's SPS 2009 requirements. This report will be annexed to the EIA report.

B. PROJECT DESCRIPTION

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 Nagpur Metro Rail Project – Phase 2 having North-South and East-West Corridors. Two corridors have been finalized for implementation of Metro Rail Project in Nagpur. Details of the corridors is given in Table 1. The proposed metro corridors in Nagpur city are shown in Figure 1.

Table 1: Details of Nagpur Metro Rail Project - Phase 2 Corridor

Corridor	Line/ Alignment	Description	Length (km)
North – South	Line 1A	MIHAN to MIDC ESR	18.77
	Line 2A	Automotive Square - Kanhan river	12.93
East – West	Line 3A	Lokmanya Nagar - Hingna	6.66
	Line 4A	Prajapati Nagar (Pardi) - Transport Nagar	5.44
		Total	**43.8**

Figure 1: Routes of NMRP Phase II project

C. BASELINE NOISE LEVELS AT SENSITIVE RECEPTORS

4. About 22 sensitive receptors have been found to be located within 100 m on either side of the project alignment. There are additional 3 sensitive receptors beyond 100 m offset considered in this study as they have direct exposure to the metro alignment. This includes educational institutes, hospitals and places of worship. The baseline noise levels at sensitive receptors are presented in Table 2 below.

Table 2: Baseline Noise Levels at Sensitive Receptors

Line	Receptor Description	Latitude Longitude	Offset from Centreline, meter	Existing 24 hr Day Equivalent	Existing 24 hr Night Equivalent
1A	Sharirik Shikshan Mahavidyalaya	21° 0'13.12"N 79° 2'26.53"E	45	50.1	36.1
1A	Rachana Hospital	20°55'43.41"N 79° 0'0.56"E	48	54.2	45.6
1A	Masjid and Dargah	20°58'40.38"N 79° 1'37.08"E	75	47.2	30.6
1A	Al Jamiatur Razvia Darululoom Amjadia School	20°58'34.95"N 79° 1'34.44"E	75	47.2	30.6
1A	Jijamata High School & Jr. College	20°55'46.75" N 79° 0'18.26" E	65	51.6	44.7
1A	St. Claire School	20°56'36.97"N 79° 0'38.53"E	125	62.7	49.4
1A	Datta Meghe College	20°55'45.25"N 78°59'36.82"E	50	61.6	49.8
1A	Ira International School	20°55'45.15"N 78°59'51.09"E	100	61.6	49.8
1A	KEC Training Centre	20°55'46.08"N 78°59'31.40"E	100	61.6	49.8
1A	Balbharti School	20°55'35.47"N 78°59'38.01"E	140	61.6	49.8
2A	Orange City Park - Residential area	21°13'10.70"N 79°10'48.91"E	25	56.8	44.9
2A	Asha Hospital and Asharam College & School of Nursing	21°13'9.11" N 79°10'35.50" E	40	56.8	44.9
2A	Christ Church	21°13'18.44"N 79°11'8.62"E	50	56.8	44.9
2A	Kamptee sub district hospital	21°12'47.51" N 79°11'56.43" E	30	55.1	45.6
2A	Buddha Vihar	21°12'41.46"N 79° 9'41.72"E	75	60.9	51.9
2A	Delhi Public School (DPS), Khairi	21°12'49.33"N 79° 9'39.19"E	95	50.1	43.6
2A	Girijadhar Balaji Hanuman Temple	21°13'15.86"N 79°11'3.71"E	2	56.8	44.9
3A	Yeshwantrao Chavan College of Engineering (YCCE), Nagpur	21° 5'43.27" N 78°58'41.14" E	90	55.4	43.9
3A	Rural Hospital Hingna	21° 4'29.18" N 78°57'16.31" E	40	53.2	46.8

Line	Receptor Description	Latitude Longitude	Offset from Centreline, meter	Existing 24 hr Day Equivalent	Existing 24 hr Night Equivalent
3A	Dr. Babasaheb Ambedkar Super Speciality Hospital	21° 5'42.38"N 78°58'29.78"E	8	56.6	47.8
3A	School of Scholars, Wanadongri	21° 5'42.82"N 78°58'32.22"E	30	56.6	47.8
4A	Nagpur City Hospital	21° 9'2.89"N 79° 8'56.81"E	20	59.8	49.1
4A	Tarangan Hospital	21° 9'4.84"N 79° 9'2.53"E	30	59.8	49.1
4A	Prakash Krishi Educational institute	21° 8'58.10" N 79° 9'38.54" E	30	59.8	49.1
4A	Pardi Residential area	21° 8'57.99"N 79° 9'37.53"E	5-10	59.8	49.1

D. OPERATION PHASE NOISE LEVEL PREDICTION

5. To estimate the operational noise level, the internationally recognized noise modelling software 'SoundPLAN' version 8.2 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:

$$SPL=PWL+D_i-(A_d+A_a+A_g+A_b+A_n+A_v)$$

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 analyzing 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. 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	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, theaters, 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 8.2, 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 and minimum distance between any two stations is 3.2km and 600m, respectively. Both of which are in line 1A.
- The metro train service timing for all routes is 5:00 AM till midnight, 19 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	Detail
Unit	3 car basic unit DMC+TMC+DMC
DMC dimension	21.64x2.9x3.9 (LxBxH)

<table>
<tr><th>Parameter</th><th>Detail</th></tr>
<tr><td>TMC dimension</td><td>21.34x2.9x3.9 (LxBxH)</td></tr>
<tr><td>Maximum coach length</td><td>22.6m</td></tr>
<tr><td>Axle Load</td><td>≤ 16T or 157kN</td></tr>
<tr><td>Number of axles</td><td>4</td></tr>
<tr><td>Normal braking system</td><td>Regenerative</td></tr>
<tr><td>Braking type</td><td>Disc brakes</td></tr>
<tr><td>Wheel diameter</td><td>860mm (assumption)</td></tr>
<tr><td>Track Gauge</td><td>1435mm</td></tr>
<tr><td>Track base</td><td>Ballast-less track with elastic and absorbent fittings</td></tr>
<tr><td>Rail joints</td><td>Minimum spacing (assumption)</td></tr>
<tr><td>Number of trains per hour</td><td><table><tr><td>Line</td><td>2024</td><td>2031</td><td>2041</td></tr><tr><td>1A</td><td>4</td><td>4</td><td>6</td></tr><tr><td>2A</td><td>10</td><td>10</td><td>11</td></tr><tr><td>3A</td><td>3</td><td>3</td><td>4</td></tr><tr><td>4A</td><td>8</td><td>10</td><td>14</td></tr></table></td></tr>
</table>

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, whereas it is 0.75m AGL for at-grade stations. All the stations in all the routes are elevated except two stations on route 1A.

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 receptors on four routes, along with the modelled noise values from the metro train, are as presented in Table 6. The daytime and night-time contour maps and the single-point maps for each receiver are provided in Annexure 1 to Annexure 4 for Line 1A to Line 4A respectively. The findings are summarised in following paragraphs.

25. For Line 1A the total noise levels during metro operation are within permissible limits for all the modelled locations except at two receptors Daruloom Amjadia School and Masjid & Dargah where total night-time noise levels increases by 6 dB(A) and 5.5 dB(A) respectively over the baseline levels. Both these sensitive receptors have landuse category of silent zone as per Central Pollution Control Board (CPCB) norms. However, there is no activity at these sensitive receptors during night time and metro will not be operational during whole night. Therefore, no mitigation measures are required at these receptors.

26. For Line 2A the total noise levels during metro operation are within CPCB permissible limits at all the modelled receptors. Maximum increment in noise is observed at Christ Church where daytime noise levels increases by 0.5 dB(A) and night-time levels are increased by 2.4 dB(A).

27. For Line 3A the total noise levels during metro operation are within CPCB permissible limits at all the modelled receptors except at Dr. Babasaheb Ambedkar Super Speciality Hospital where daytime noise levels increases by 1.4 dB(A) and night-time levels are increased by 3.2 dB(A).

28. For Line 4A the total noise levels during metro operation are within CPCB permissible limits at all the sensitive receptors. Maximum increment in noise is observed at Pardi Residential Area where daytime noise levels increases by 0.6 dB(A) and night-time levels are increased by 2 dB(A).

Table 6: Noise levels due to Metro Operation

Name of Receptor	Landuse Category as per CPCB	Baseline Noise Levels, dB(A)		Predicted Noise Levels, dB(A)		Projected Noise Levels, dB(A)		Increase over Baseline Noise Levels, dB(A)		Central Pollution Control Board Noise Standards (dBA)	Respective WB-EHS or IFC Standards (dBA)
		Day time	Night time	Day time	Night time	Day time	Night time	Day time	Night time		
Line 1A											
Sharirik Shikshan Mahavidyala	Silent Zone	50.1	36.1	39.7	35.5	50.5	38.8	0.4	2.7	Day: 50 Night: 40	Day: 55 Night: 45
Daruloom Amjadia School	Silent Zone	47.2	30.6	39.7	35.4	47.9	36.6	0.7	6.0	Day: 50 Night: 40	Day: 55 Night: 45
Masjid & Dargah	Silent Zone	47.2	30.6	39.0	34.7	47.8	36.1	0.6	5.5	Day: 50 Night: 40	Day: 55 Night: 45
St. Claire School	Silent Zone	62.7	49.4	38.0	33.7	62.7	49.5	0.0	0.1	Day: 50 Night: 40	Day: 55 Night: 45
Datta Meghe College	Silent Zone	61.6	49.8	35.9	31.6	61.6	49.9	0.0	0.1	Day: 50 Night: 40	Day: 55 Night: 45
Ira International School	Silent Zone	61.6	49.8	39.3	35.1	61.6	49.9	0.0	0.1	Day: 50 Night: 40	Day: 55 Night: 45
EC Training Centre	Silent Zone	61.6	49.8	38.6	34.3	61.6	49.9	0.0	0.1	Day: 50 Night: 40	Day: 55 Night: 45
Balbharti School	Silent Zone	61.6	49.8	37.7	33.5	61.6	49.9	0.0	0.1	Day: 50 Night: 40	Day: 55 Night: 45
Jijamata High School & College	Silent Zone	51.6	44.7	39.8	35.6	51.9	45.2	0.3	0.5	Day: 50 Night: 40	Day: 55 Night: 45
Rachana Hospital	Silent Zone	54.2	45.6	40.8	36.5	54.4	46.1	0.2	0.5	Day: 50 Night: 40	Day: 55 Night: 45
Line 2A											
Kamptee Sub-district Hospital	Silence	55.1	45.6	46.3	42	55.6	47.2	0.5	1.6	Day: 50 Night: 40	Day: 55 Night: 45
Christ Church	Silence	56.8	44.9	47.8	43.6	57.3	47.3	0.5	2.4	Day: 50 Night: 40	Day: 55 Night: 45
Asha hospital, Ashram school & college of Nursing	Silence	56.8	44.9	42.6	38.4	57	45.8	0.2	0.9	Day: 50 Night: 40	Day: 55 Night: 45

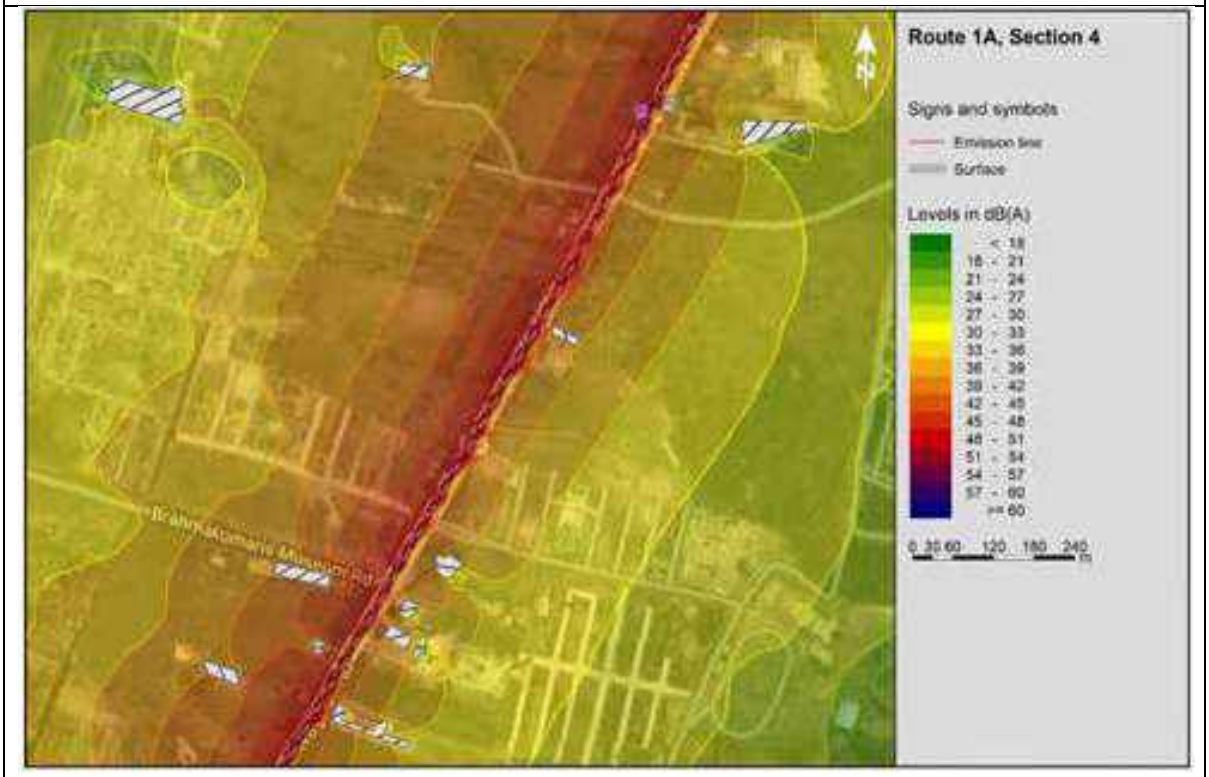
Name of Receptor	Landuse Category as per CPCB	Baseline Noise Levels, dB(A)		Predicted Noise Levels, dB(A)		Projected Noise Levels, dB(A)		Increase over Baseline Noise Levels, dB(A)		Central Pollution Control Board Noise Standards (dBA)	Respective WB-EHS or IFC Standards (dBA)
		Day time	Night time	Day time	Night time	Day time	Night time	Day time	Night time		
Orange City Park	Residential	54.9	45.7	45.6	41.4	55.4	47.1	0.5	1.4	Day: 55 Night: 45	Day: 55 Night: 45
Budhha Vihar	Silence	60.9	51.9	45.3	41	61	52.2	0.1	0.3	Day: 50 Night: 40	Day: 55 Night: 45
Girijadhar Balaji Hanuman Temple	Silence	56.8	44.9	46.6	42.3	57.2	46.8	0.4	1.9	Day: 50 Night: 40	Day: 55 Night: 45
Delhi Public School	Silence	50.1	43.6	39.9	35.7	50.5	44.3	0.4	0.7	Day: 50 Night: 40	Day: 55 Night: 45
Line 3A											
Yeshwantrao Chavan College of Engineering (YCCE)	Silence	55.4	43.9	38.1	33.8	55.5	44.3	0.1	0.4	Day: 50 Night: 40	Day: 55 Night: 45
School of Scholars, Wanadongri	Silence	56.6	47.8	44.4	40	56.9	48.5	0.3	0.7	Day: 50 Night: 40	Day: 55 Night: 45
Rural Hospital Hingna	Silence	53.2	46.8	38.8	34.5	53.4	47	0.2	0.2	Day: 50 Night: 40	Day: 55 Night: 45
Dr. Babasaheb Ambedkar Super Speciality Hospital	Silence	56.6	47.8	52.4	48.1	58	51	1.4	3.2	Day: 50 Night: 40	Day: 55 Night: 45
Line 4A											
Prakash Krishi Educational Institute	Silence	59.8	49.1	48.3	44	60.1	50.3	0.3	1.2	Day: 50 Night: 40	Day: 55 Night: 45
Tarangan Hospital	Silence	59.8	49.1	46	41.7	60	49.8	0.2	0.7	Day: 50 Night: 40	Day: 55 Night: 45
Nagpur City Hospital	Silence	59.8	49.1	36.5	32.2	59.8	49.2	0	0.1	Day: 50 Night: 40	Day: 55 Night: 45
Pardi Residential Area	Residential	59.8	49.1	51.2	46.9	60.4	51.1	0.6	2	Day: 55 Night: 45	Day: 55 Night: 45

F. CONCLUSION AND RECOMMENDATIONS

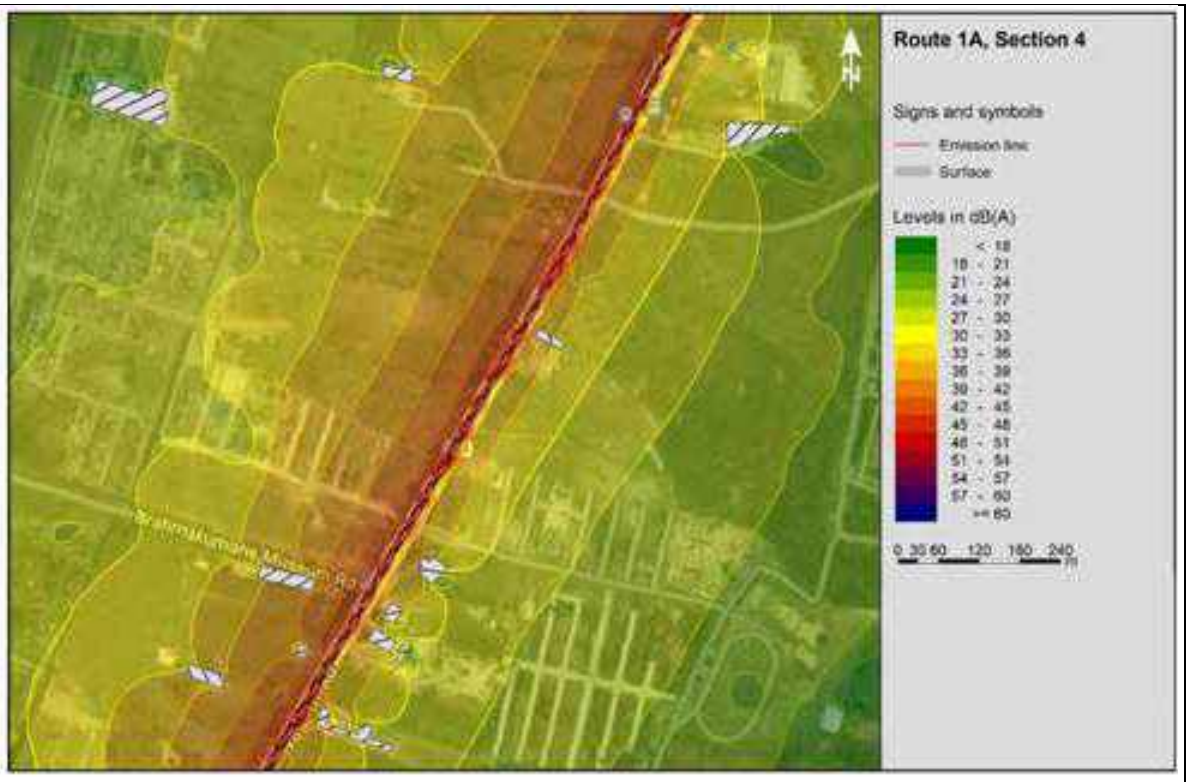
29. The noise from the operation of the metro is well within the permissible limits of CPCB as well as WB-EHS or IFC guidelines and do not exceed +3 dB(A) of the existing ambient noise levels except at two sensitive receptors along line 1A where noise levels are within permissible limits but exceeding the +3 dB(A) during night time. Since these two sensitive receptors i.e. Daruloom Amjadia School and Masjid & Dargah will be closed during night time and metro will not be running entire night time, no control measures are needed at this stage. The noise levels are also exceeded at Dr. Babasaheb Ambedkar Super Speciality Hospital along line 1A where night -time levels exceed by +3.2 dB(A). 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.

Annexure 1: Noise Level Contours at Sensitive Receptors for Line 1A

Noise levels at different floors (at different sides of building) at Sharirik Shikshan Mahavidhyalaya

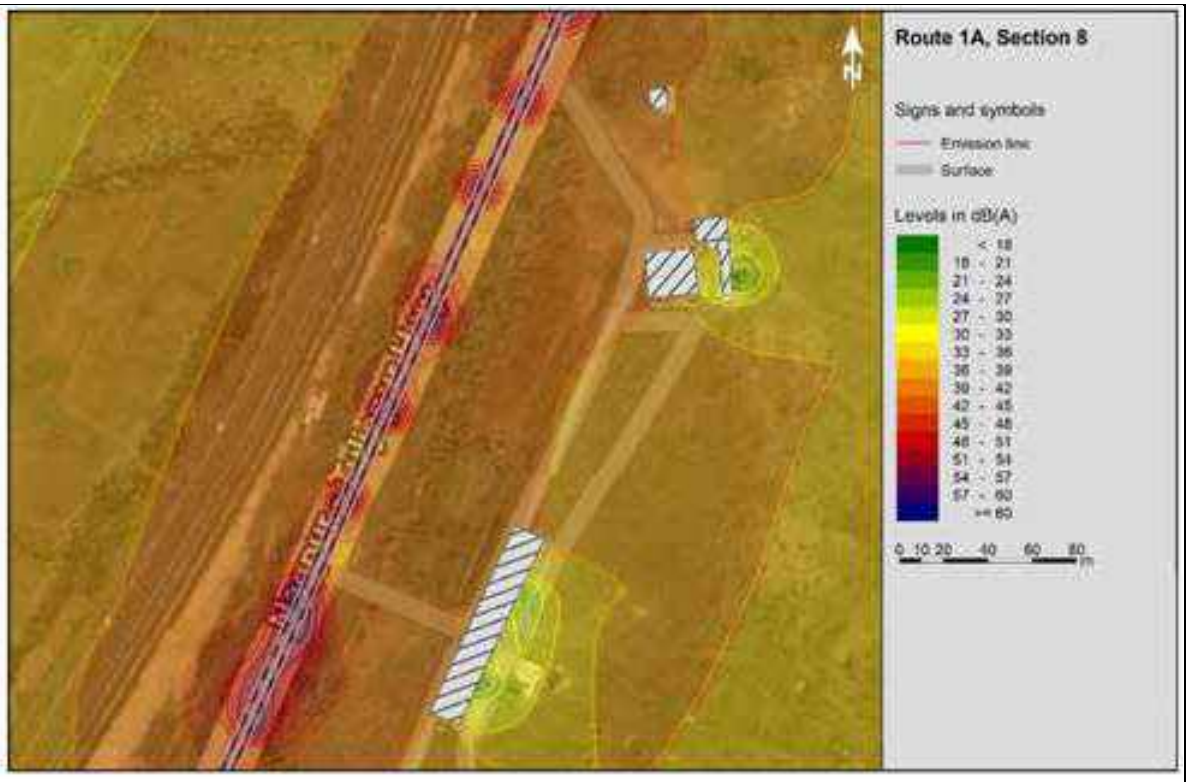


Daytime Noise Contours at Sharirik Shikshan Mahavidhyalaya



Nighttime Noise Contours at Sharirik Shikshan Mahavidhyalaya

Noise levels at different floors (at different sides of building) at Al Jamiatur Razvia School and Masjid



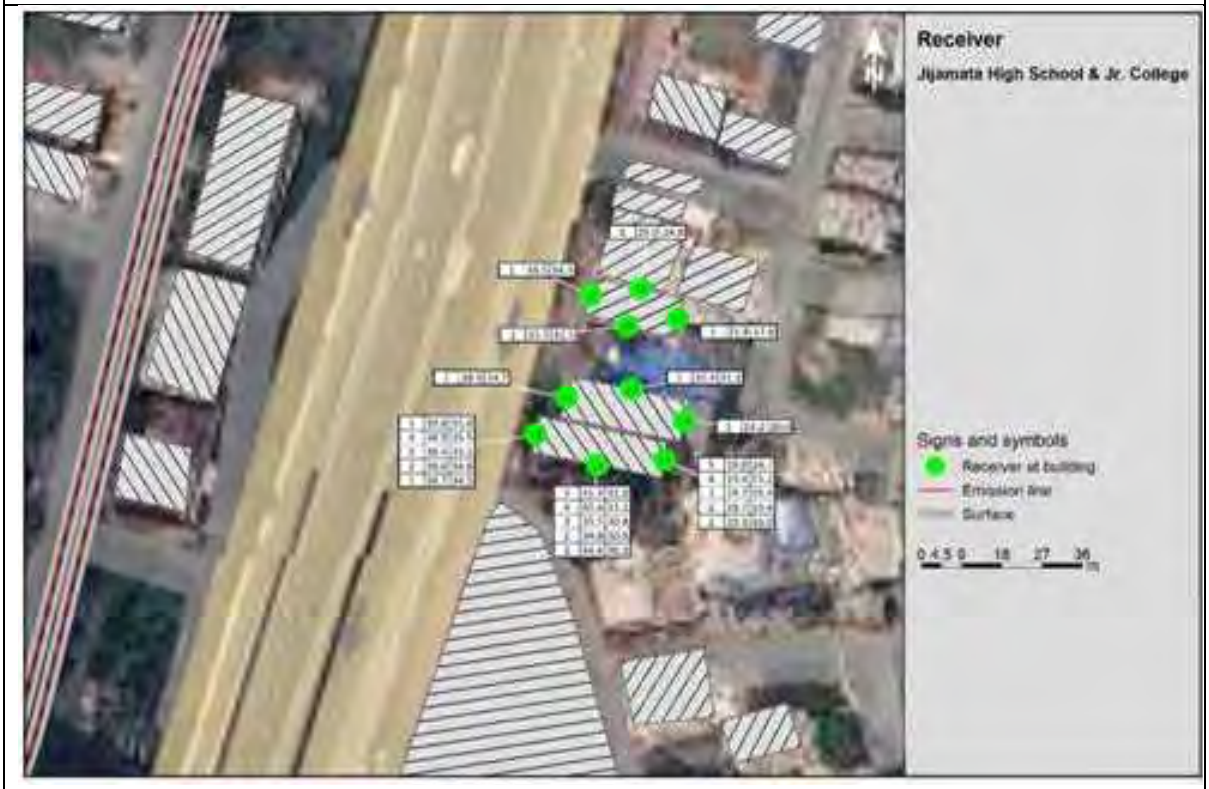
Daytime Noise Contours at Al Jamiatur Razvia School and Masjid

Nighttime Noise Contours at Al Jamiatur Razvia School and Masjid

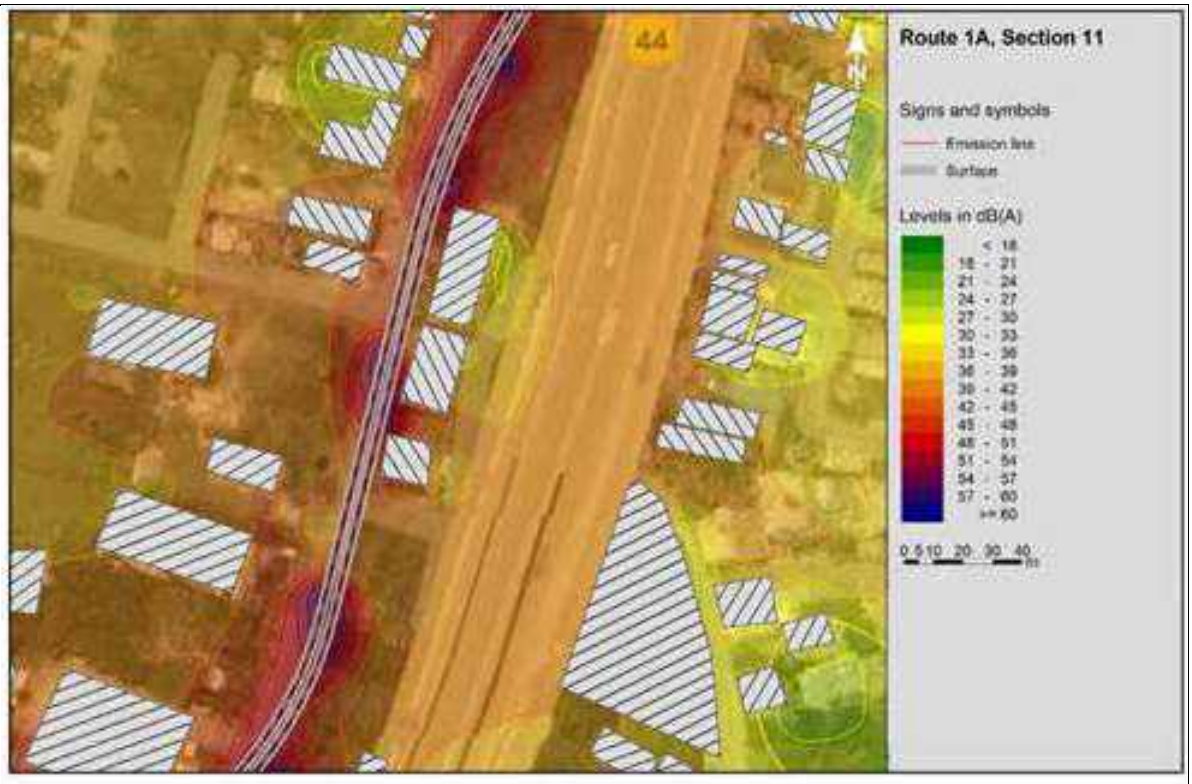
Noise levels at different floors (at different sides of building) at St. Claire School

Daytime Noise Contours at St. Claire School

Nighttime Noise Contours at St. Claire School



Noise levels at different floors (at different sides of building) at Jijamata High School and Jr. College

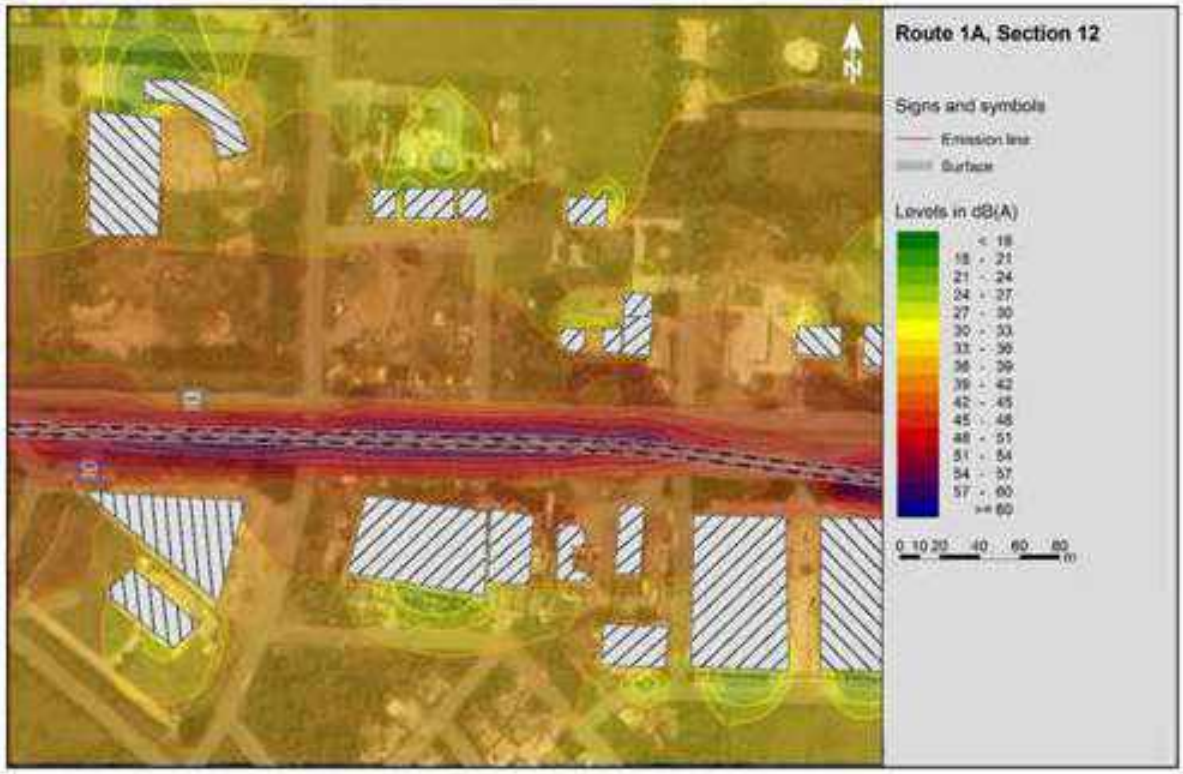


Daytime Noise Contours at Jijamata High School and Jr. College

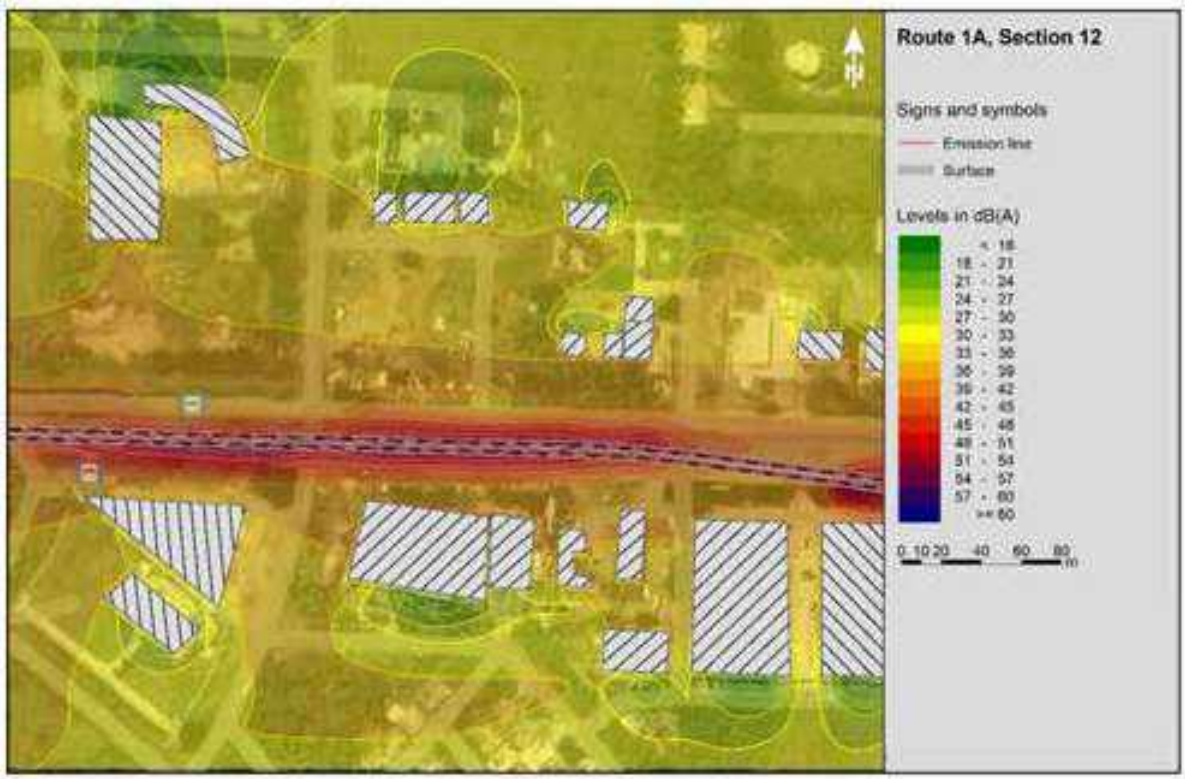
Nighttime Noise Contours at Jijamata High School and Jr. College

Noise levels at different floors (at different sides of building) at Rachna Hospital

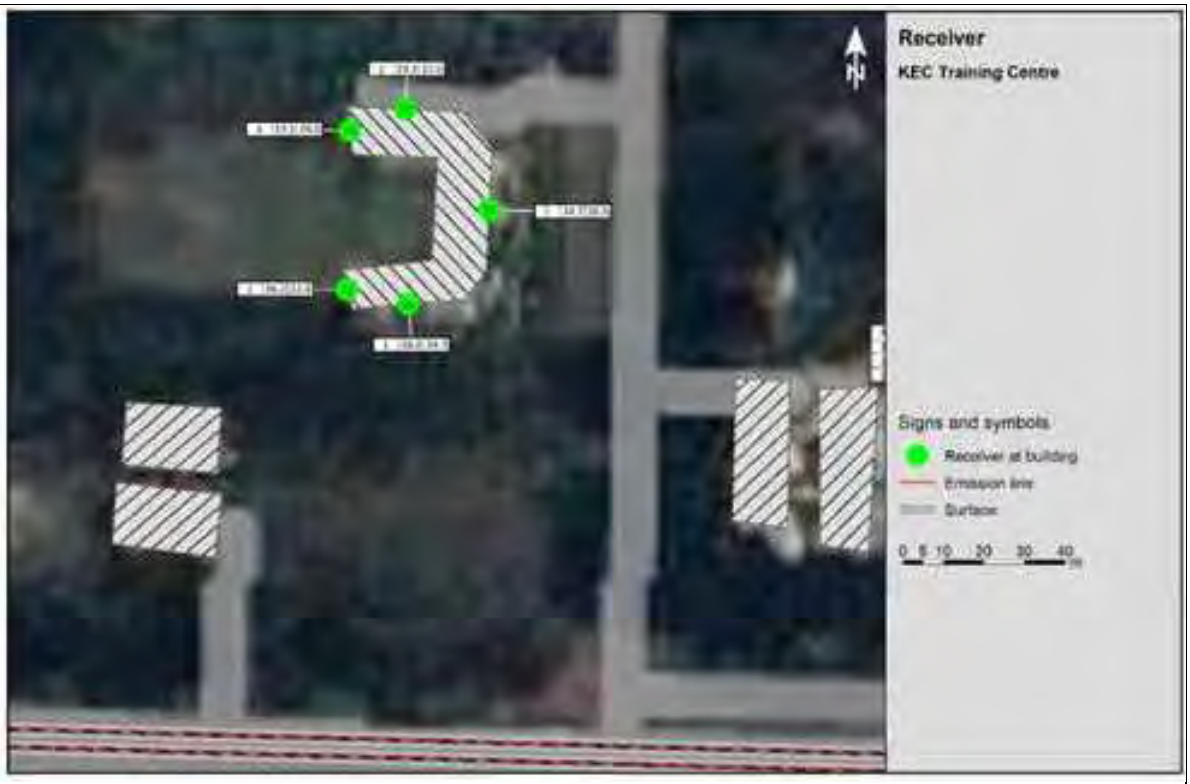
Noise levels at different floors (at different sides of building) at Ira International School



Daytime Noise Contours at Rachna Hospital and Ira International School

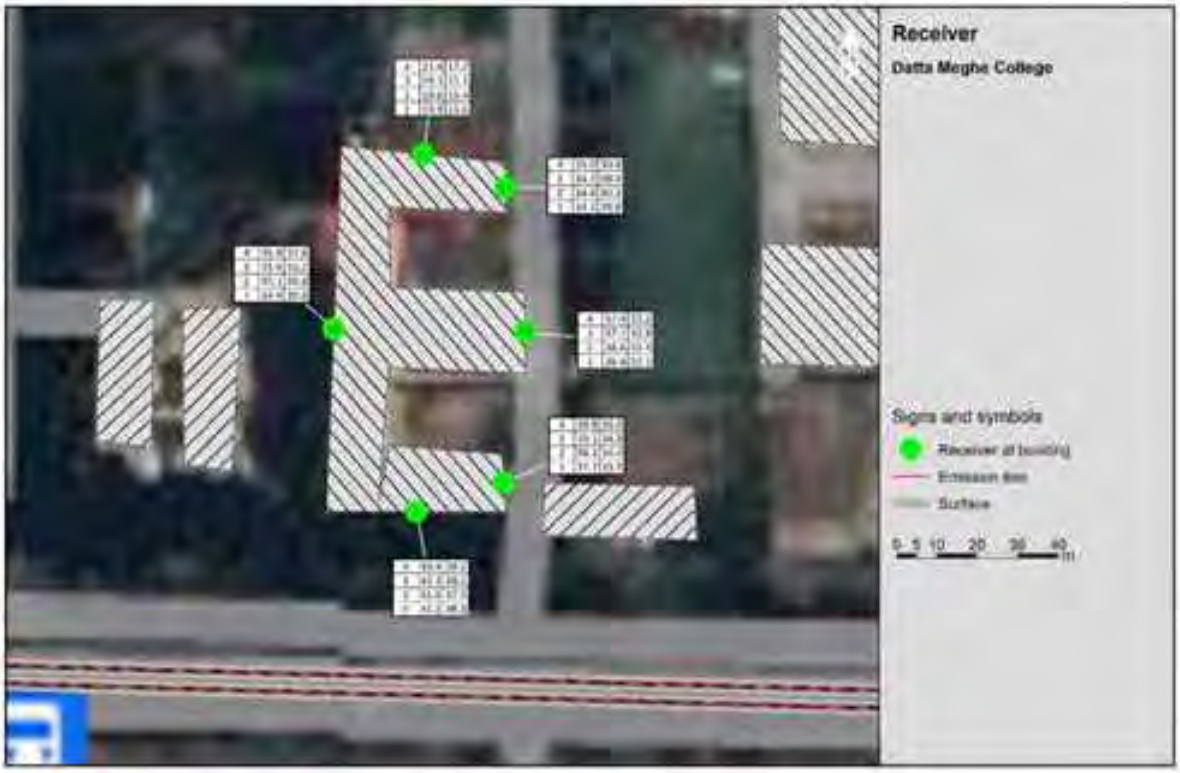


Nighttime Noise Contours at Rachna Hospital and Ira International School

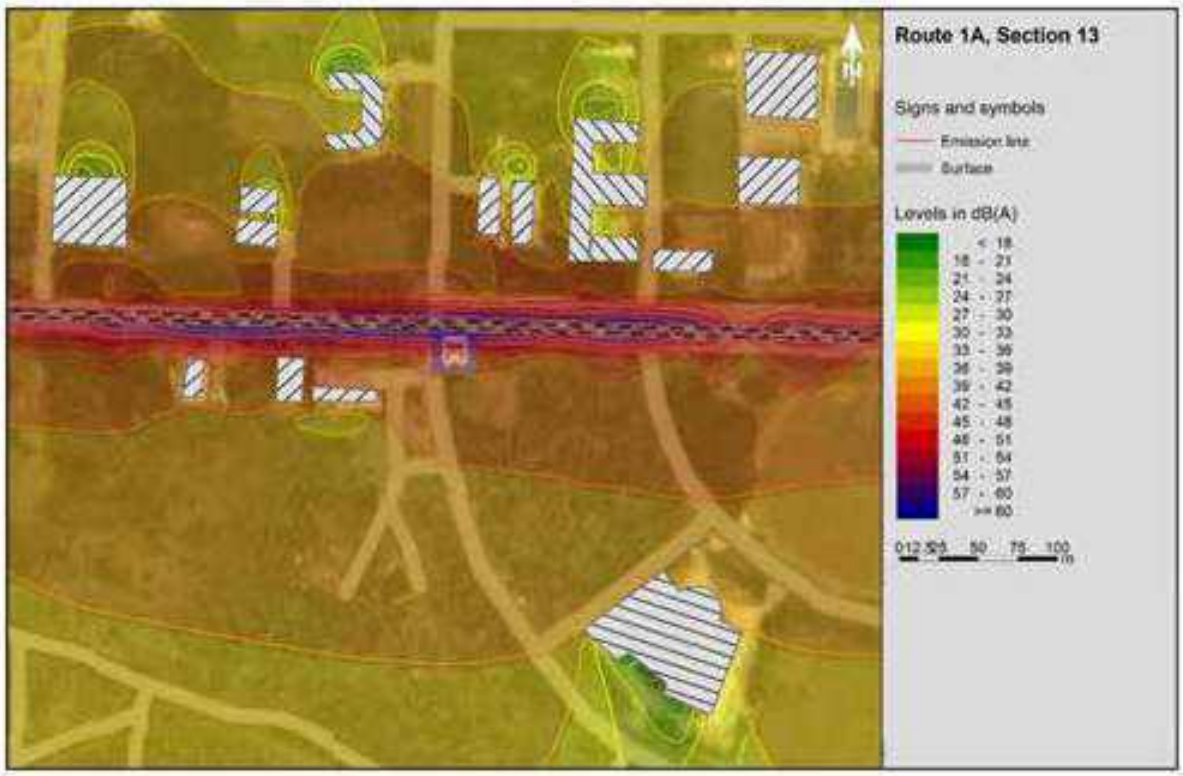


Noise levels at different floors (at different sides of building) at KEC Training Centre

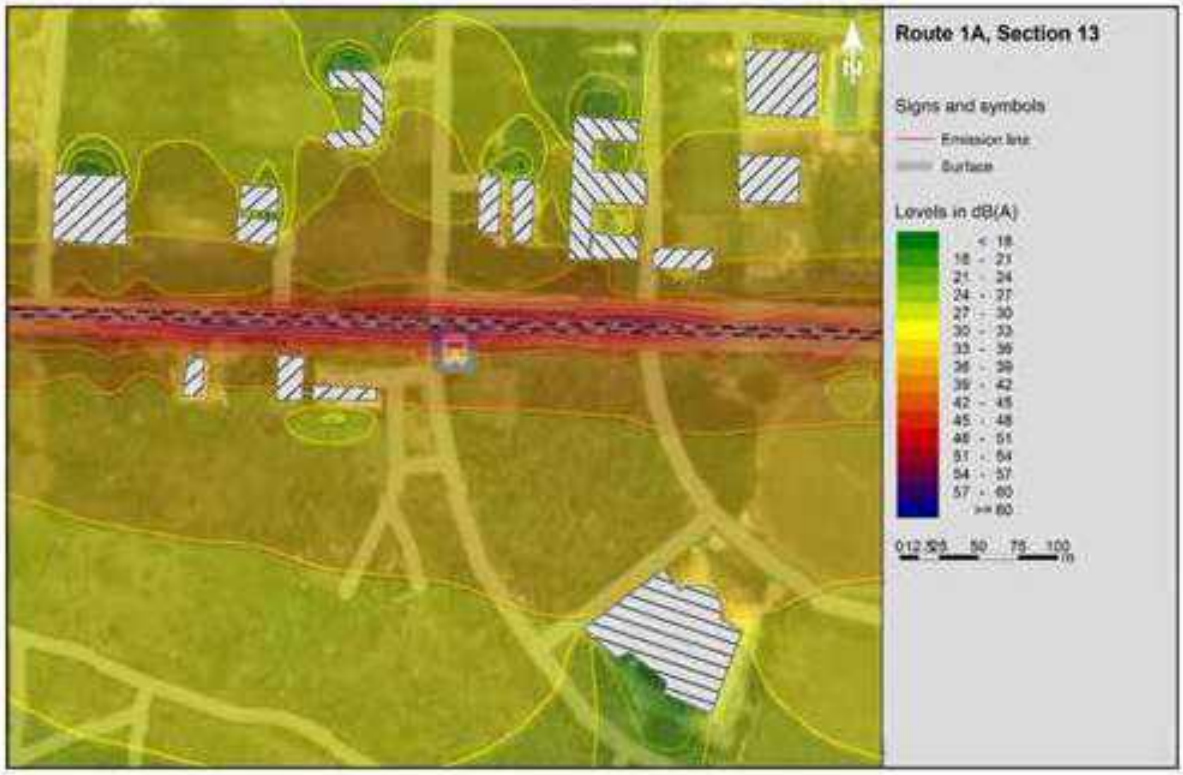
Noise levels at different floors (at different sides of building) at Balbharti School



Noise levels at different floors (at different sides of building) at Datta Meghe College



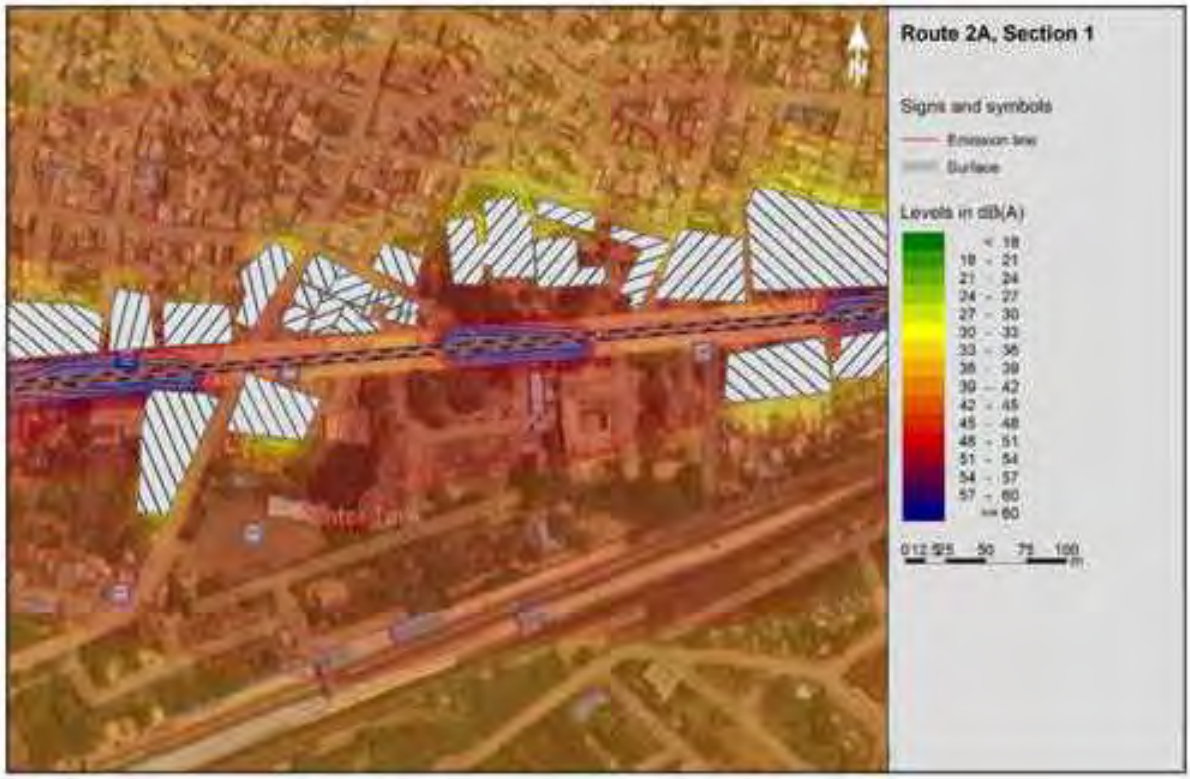
Daytime Noise Contours at KEC Training Centre, Balbharti School and Datta Meghe College



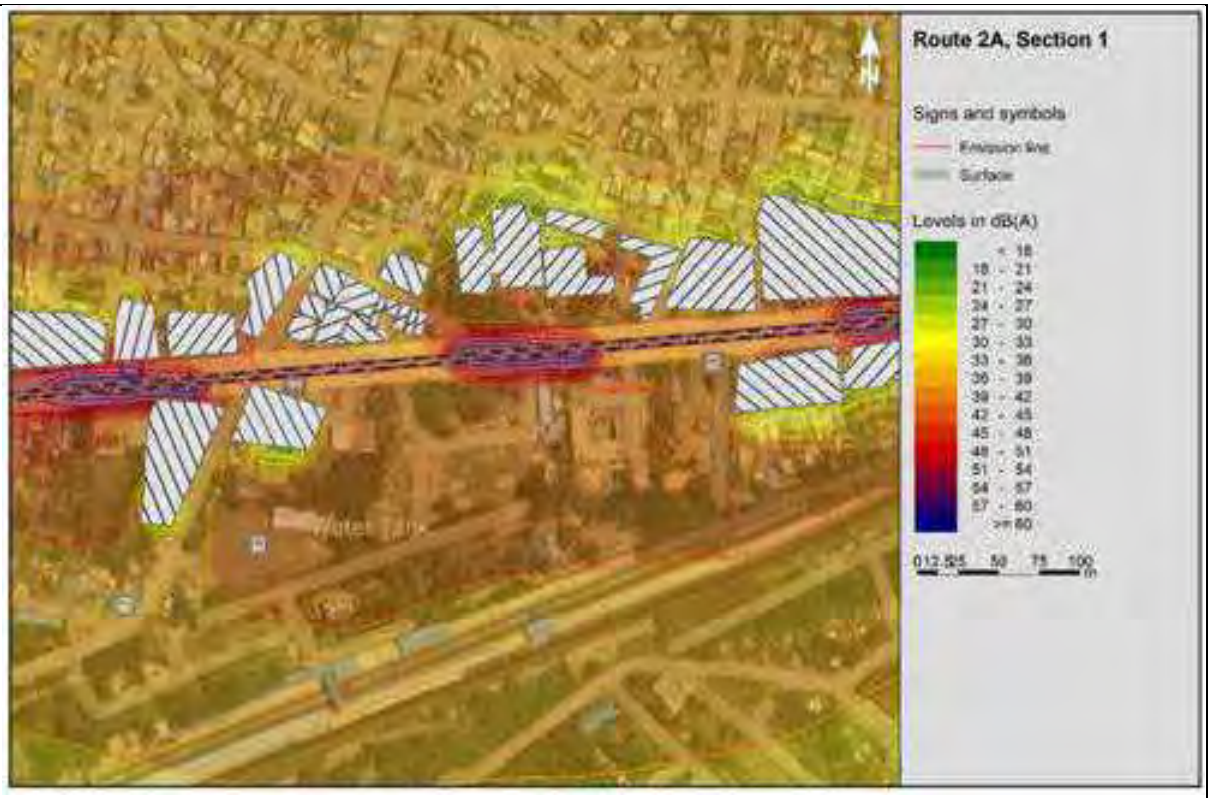
Nighttime Noise Contours at KEC Training Centre, Balbharti School and Datta Meghe College

Annexure 2: Noise Level Contours at Sensitive Receptors for Line 2A

Noise levels at different floors (at different sides of building) at Kamptee Sub-district Hospital

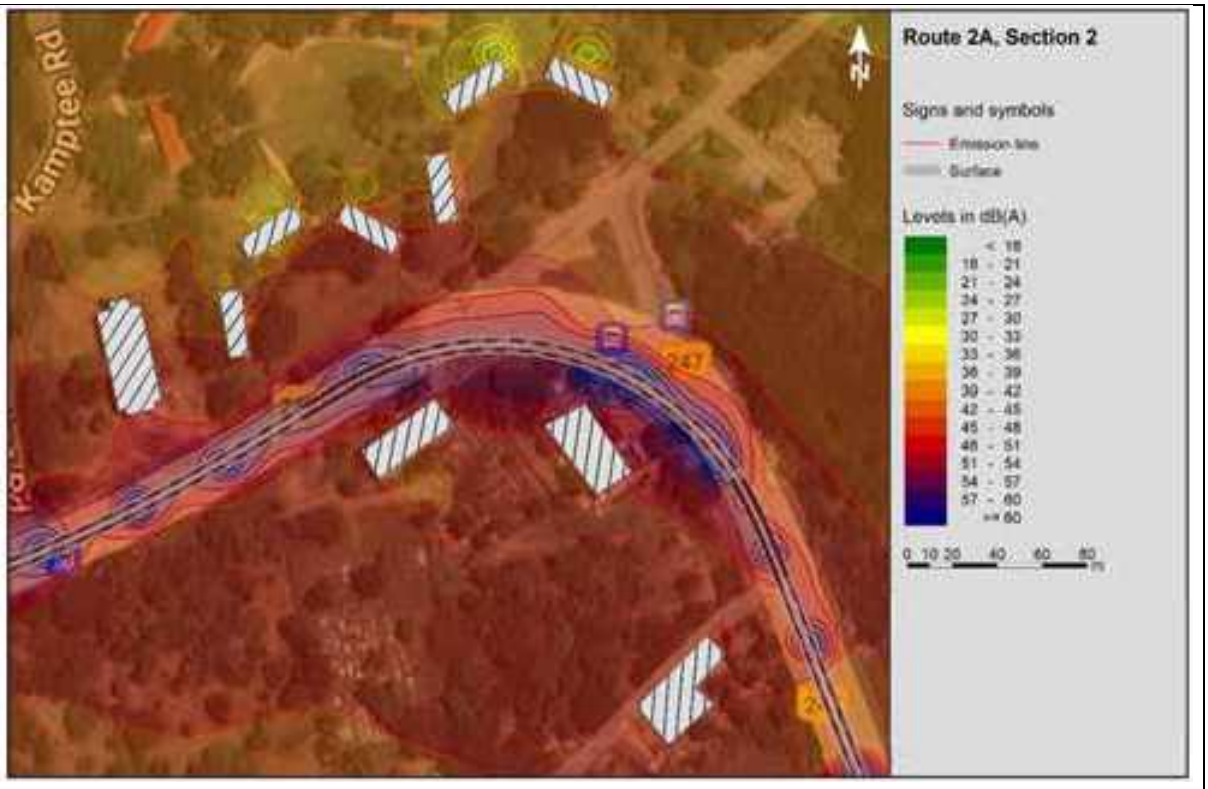


Daytime Noise Contours at Kamptee Sub-district Hospital

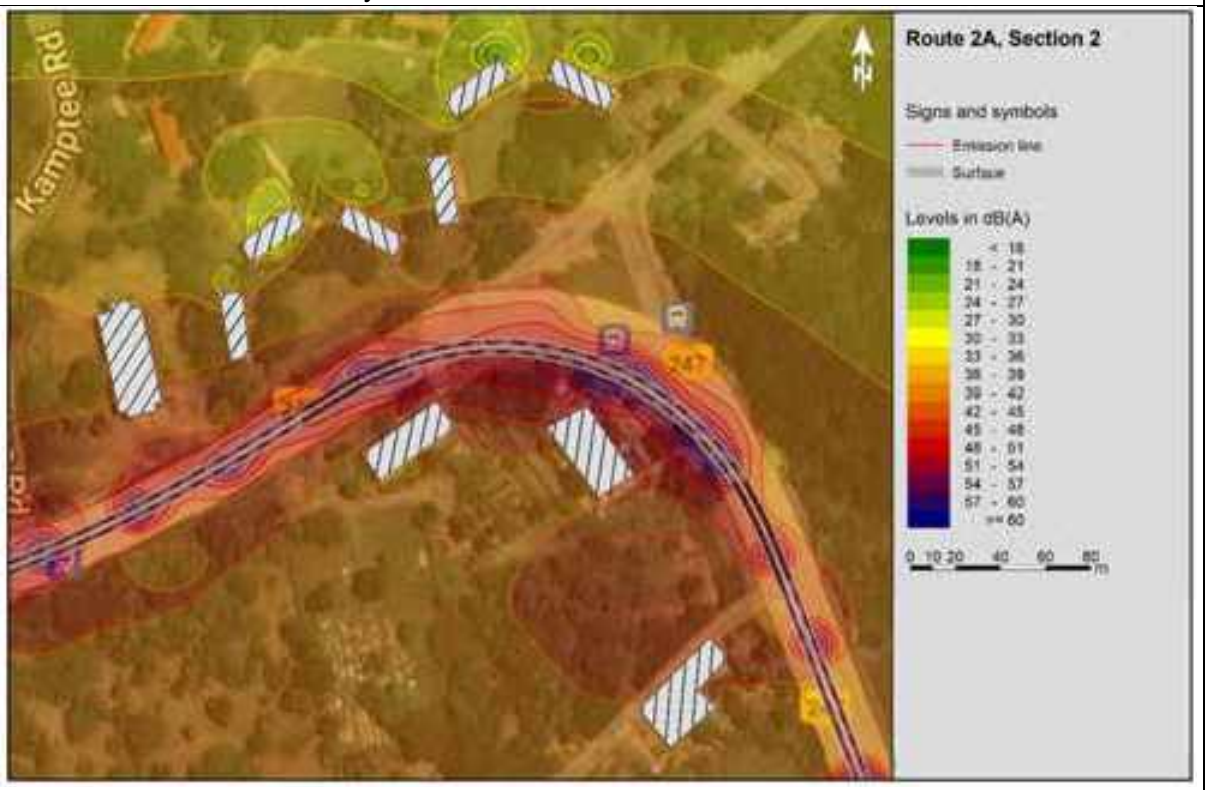


Nighttime Noise Contours at Kamptee Sub-district Hospital

Noise levels at different sides of Christ Church

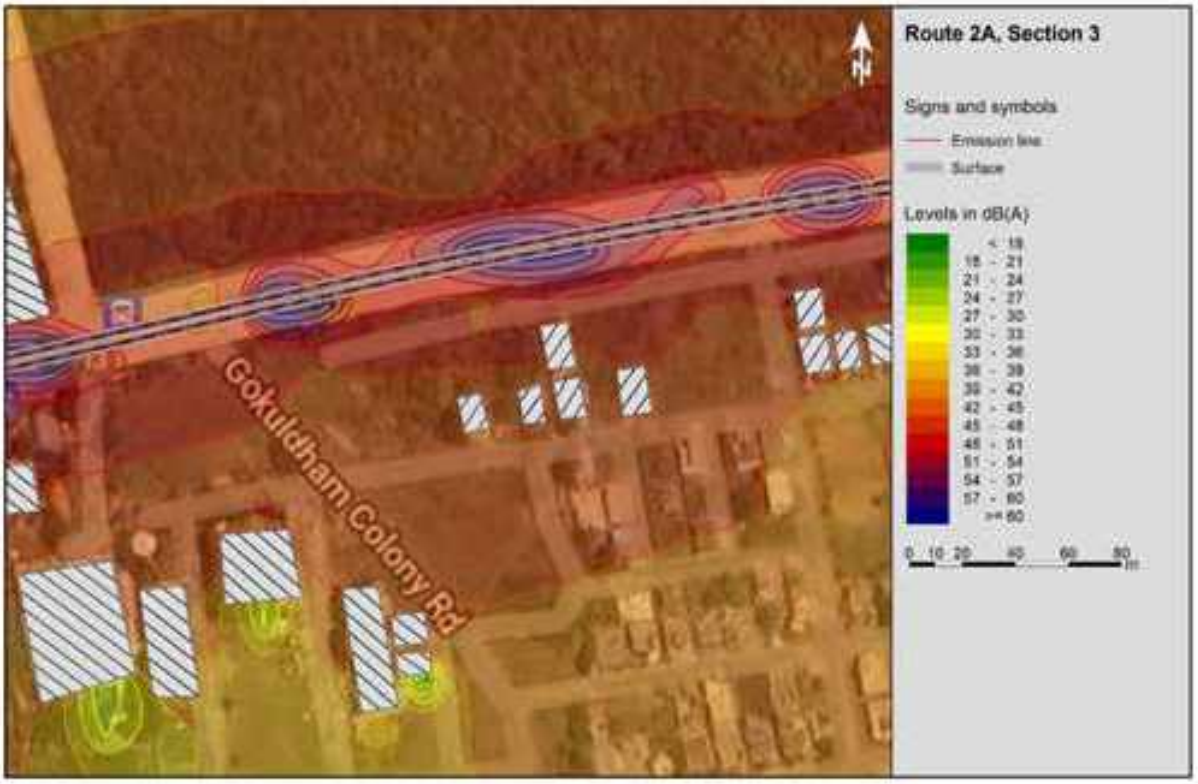


Daytime Noise Contours at Christ Church

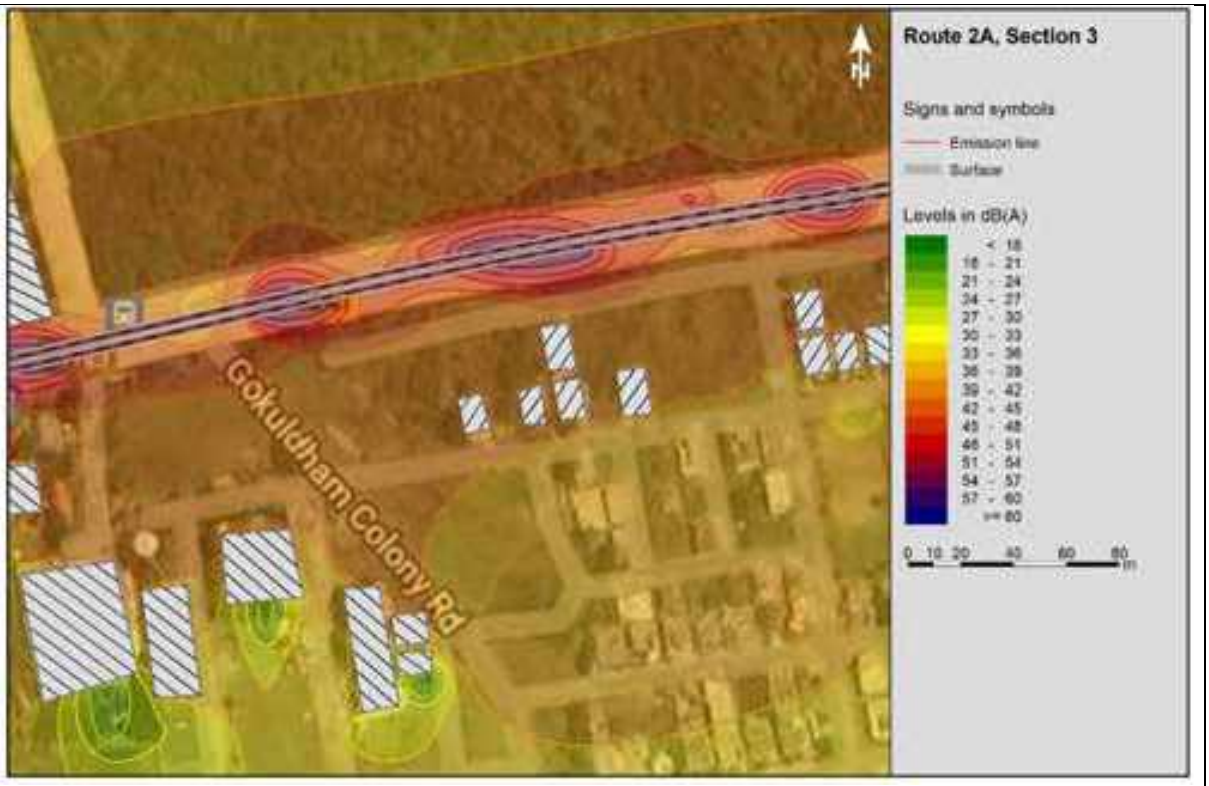


Nighttime Noise Contours at Christ Church

Noise levels at different floors (at different sides of building) at Asha Hospital, Asharam College & school of Nursing

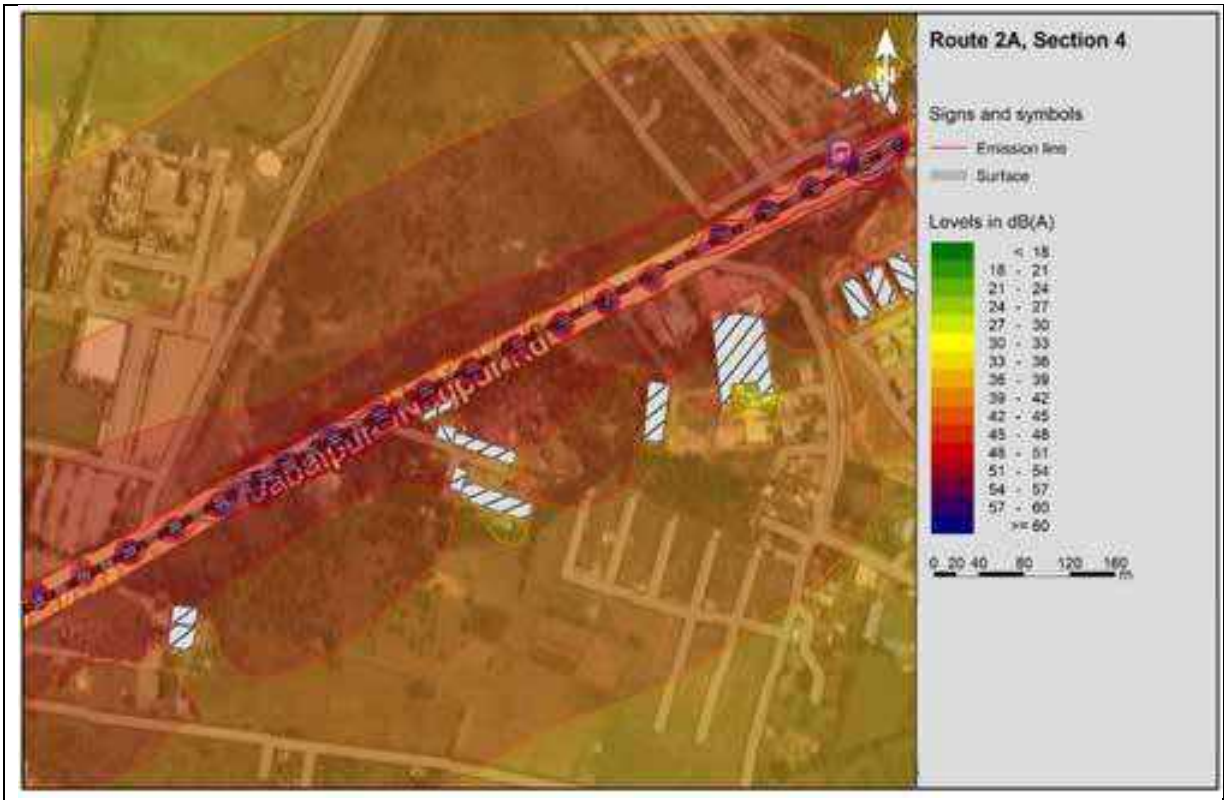


Daytime Noise Contours at Asha Hospital, Asharam College & school of Nursing

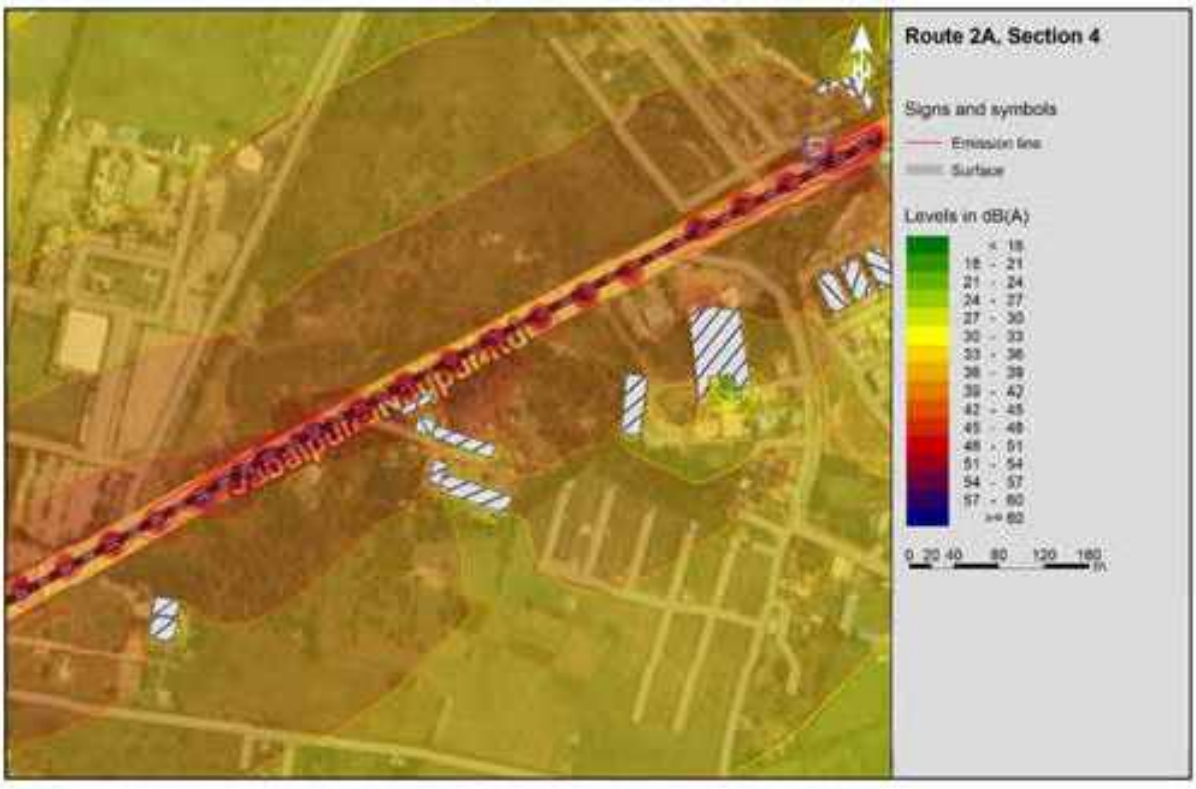


Nighttime Noise Contours at Asha Hospital, Asharam College & school of Nursing

Noise levels at different floors (at different sides of building) at Buddha Vihar

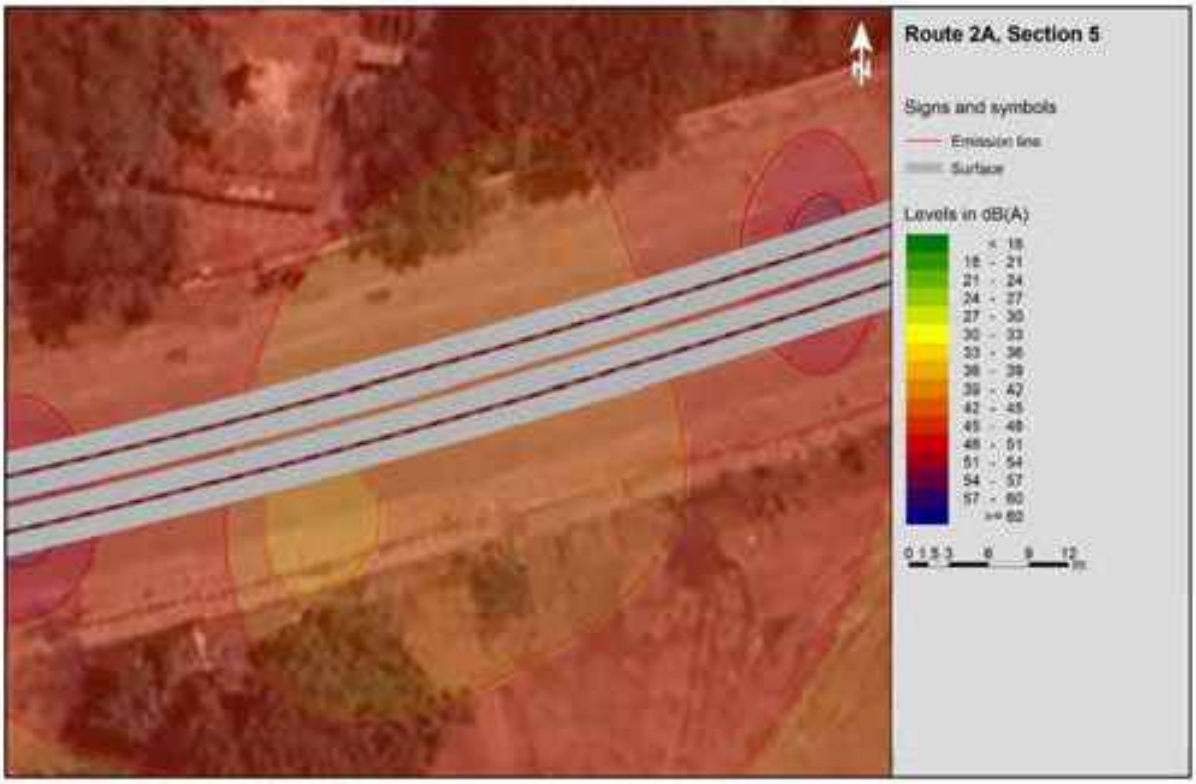


Daytime Noise Contours at Buddha Vihar



Nighttime Noise Contours at Buddha Vihar

Noise levels at different floors (at different sides of building) at Hanuman Mandir

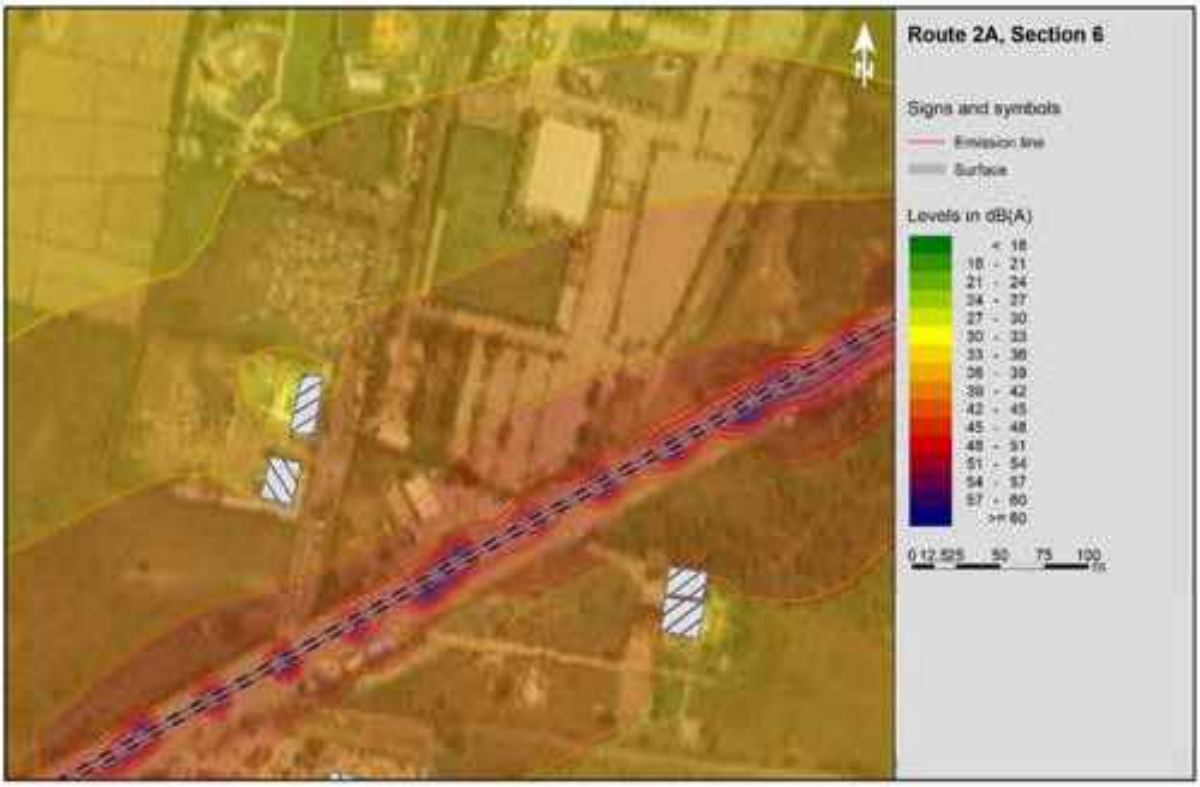


Daytime Noise Contours at Hanuman Mandir

Nighttime Noise Contours at Hanuman Mandir

Noise levels at different floors (at different sides of building) at Delhi Public School

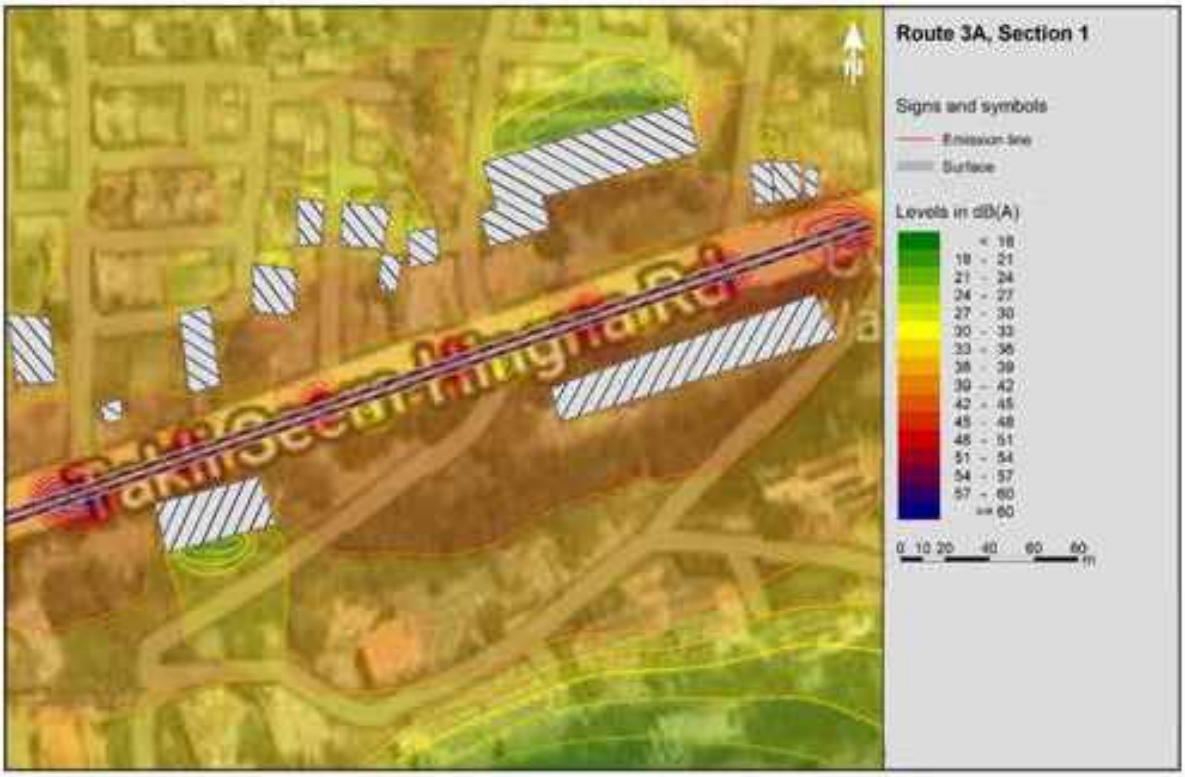
Daytime Noise Contours at Delhi Public School



Nighttime Noise Contours at Delhi Public School

Annexure 3: Noise Level Contours at Sensitive Receptors for Line 3A

Noise levels at different floors (at different sides of building) at Yeshwantrao Chavan College of Engineering (YCCE)



Daytime Noise Contours at Yeshwantrao Chavan College of Engineering (YCCE)

Nighttime Noise Contours at Yeshwantrao Chavan College of Engineering (YCCE)

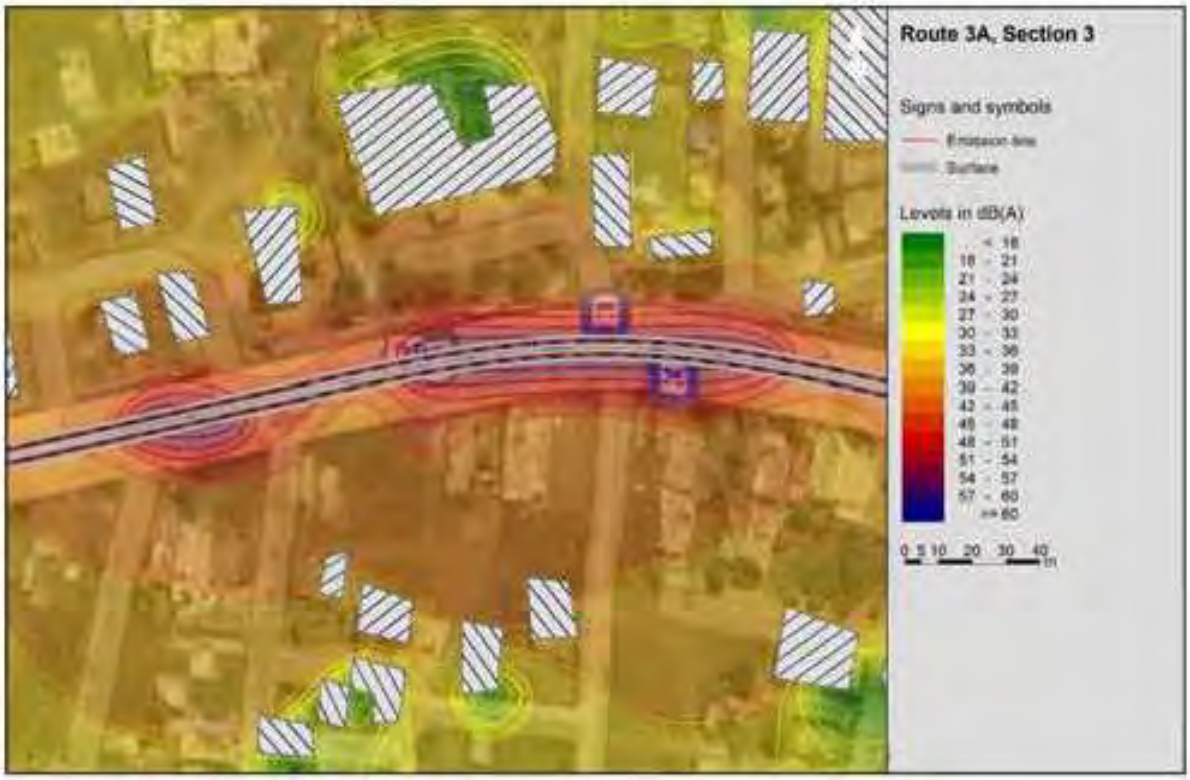
Noise levels at different floors (at different sides of building) at School of Scholars Wanadongri

Noise levels at different floors (at different sides of building) at Dr. Babasaheb Ambedkar Super Speciality Hospital

Daytime Noise Contours at School of Scholars Wanadongri and Dr. Babasaheb Ambedkar Super Speciality Hospital

Nighttime Noise Contours at School of Scholars Wanadongri and Dr. Babasaheb Ambedkar Super Speciality Hospital

Noise levels at different floors (at different sides of building) at Rural Hospital Hingna



Daytime Noise Contours at Rural Hospital Hingna

Nighttime Noise Contours at Rural Hospital Hingna

Annexure 4: Noise Level Contours at Sensitive Receptors for Line 4A

Noise levels at different floors (at different sides of building) at Praksah Krishi Educational Institute

Daytime Noise Contours at Praksah Krishi Educational Institute

Nighttime Noise Contours at Praksah Krishi Educational Institute

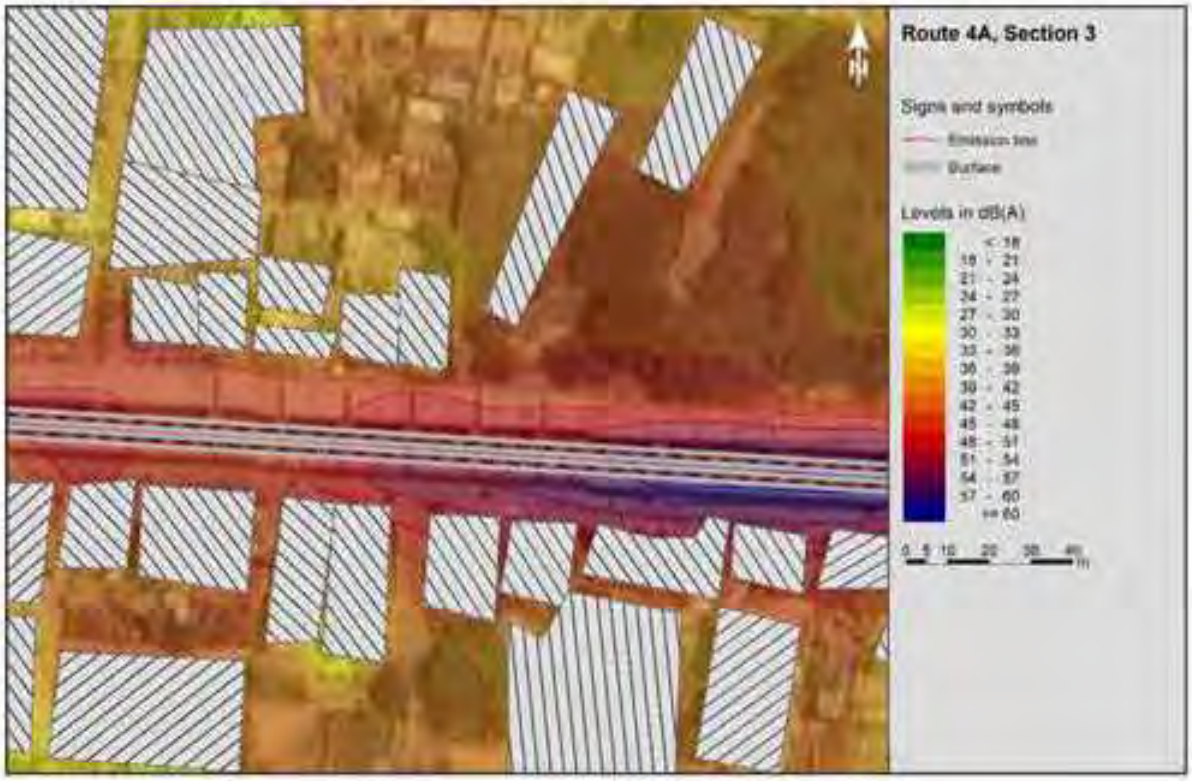
Noise levels at different floors (at different sides of building) at Tarangan Hospital

Noise levels at different floors (at different sides of building) at Nagpur City Hospital

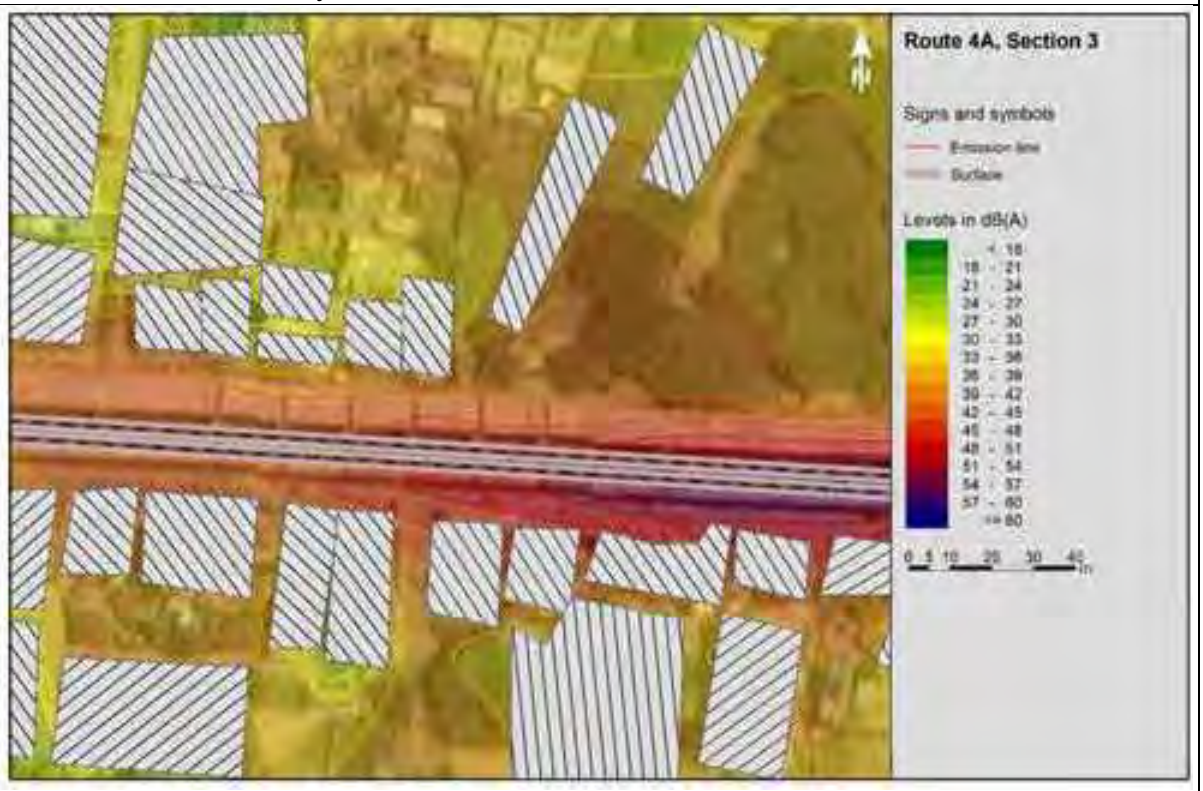
Daytime Noise Contours at Tarangan Hospital and Nagpur City Hospital

Nighttime Noise Contours at Tarangan Hospital and Nagpur City Hospital

Noise levels at different floors (at different sides of building) at Pardi Residential Area



Daytime Noise Contours at Pardi Residential Area



Nighttime Noise Contours at Pardi Residential Area

Annexure 7 - List of Affected trees

Corridor	Section	Side	Sr.No.	Botanical Name	Family	Common Name	GBH (cm)	Height (m)	Canopy (m)	Age in years (approx)	GPS Location	IUCN status
1A MIHAN to MIDC ESR	Ashokvan Station	LHS	1	*Azadirachta indica* A.Juss.	Meliaceae	Neem	197	11	7	41	21.0127475,79.0453897	LC
		RHS	2	*Azadirachta indica* A.Juss.	Meliaceae	Neem	71	6	4	9	21.0127982,79.0451114	LC
	Dongargaon Station	LHS	No Trees									
		RHS	3	*Azadirachta indica* A.Juss.	Meliaceae	Neem	41	5	3	7	20.9866686,79.0297859	LC
	Mohagaon Station	LHS	4	*Azadirachta indica* A.Juss.	Meliaceae	Neem	189	12	8	39	20.9603260,79.0181103	LC
			5	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Leguminosae	Siamese Cassia (*Kashid*)	151	13	7	35	20.9602502,79.0180623	LC
		RHS	6	*Bombax ceiba* L.	Malvaceae	Katesavar	66	7	4	9	20.9604490, 79.0178729	LC
			7	*Albizia procera* (Roxb.) Benth.	Fabaceae	Kinhai (White siris)	78	10	6	11	20.9604124, 79.0178541	LC
			8	*Albizia procera* (Roxb.) Benth.	Fabaceae	Kinhai (White siris)	53	8	4	8	20.9603748, 79.0178216	LC
			9	*Terminalia arjuna* (Roxb. ex DC.) Wight & Arn.	Combretaceae	Arjun	37	5	3	6	20.9603116, 79.0177931	-
			10	*Leucaena leucocephala* (Lam.) de Wit	Leguminosae	Subabul	35	6	4	6	20.9603425, 79.0177505	-
			11	*Albizia procera* (Roxb.) Benth.	Fabaceae	Kinhai (White siris)	69	7	5	10	20.9604681, 79.0178162	LC
			12	*Leucaena leucocephala* (Lam.) de Wit	Leguminosae	Subabul	50	6	5	9	20.9605, 79.0178437	-
			13	*Azadirachta indica* A.Juss.	Meliaceae	Neem	102	10	7	17	20.9605382, 79.0178793	LC
	Meghdoot Cidco Station	LHS	14	*Albizia saman* (Jacq.) Merr.	Leguminosae	Rain Tree	49	6	4	8	20.9370305, 79.0073509	-
			15	*Peltophorum pterocarpum (* DC.) K.Heyne	Leguminosae	Sonmohar (Copper Pod)	132	13	8	29	20.9369811, 79.0073633	-
			16	*Peltophorum pterocarpum (* DC.) K.Heyne	Leguminosae	Sonmohar (Copper Pod)	179	14	9	57	20.9368571, 79.0072772	-
			17	*Peltophorum pterocarpum (* DC.) K.Heyne	Leguminosae	Sonmohar (Copper Pod)	165	11	9	51	20.9368057, 79.0072443	-
			18	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	183	10	10	52	20.9367503, 79.0072228	LC
		RHS	19	*Erythrina variegata* L.	Fabaceae	Pangara	71	7	5	10	20.9370114, 79.0070183	LC
			20	*Azadirachta indica* A.Juss.	Meliaceae	Neem	109	10	7	15	20.9369764, 79.0070351	LC
			21	*Butea monosperma* (Lam.) Kuntze	Fabaceae	Palash	65	6	4	8	20.9368649, 79.0069942	LC
			22	*Azadirachta indica* A.Juss.	Meliaceae	Neem	108	9	8	15	20.9367872, 79.0069446	LC
	Butibori Station	LHS	No Trees									
		RHS	No Trees									
		Butibori Parking LHS	23	*Azadirachta indica* A.Juss.	Meliaceae	Neem	23	5	3	7	20.9295729, 79.0050439	LC
			24	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	45	6	4	8	20.929546, 79.005041	LC
			25	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Leguminosae	Siamese Cassia (*Kashid*)	46	6	4	8	20.929528, 79.005040	LC
			26	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	39	5	3	7	20.929520, 79.005042	LC
			27	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	51	5	5	9	20.9294862, 79.0050325	LC
		Butibori Police Station RHS	No Trees									
	Mhada Colony Metro Station	LHS	28	*Ficus amplissima* Sm.	Moraceae	Payar	179	9	7	83	20.928013, 78.998942	-
			29	*Albizia saman* (Jacq.) Merr.	Leguminosae	Rain Tree	195	6	5	74	20.928003, 78.999031	-
			30	*Albizia saman* (Jacq.) Merr.	Leguminosae	Rain Tree	89	8	4	21	20.928001, 78.999206	-
			31	*Albizia saman* (Jacq.) Merr.	Leguminosae	Rain Tree	103	6	4	34	20.928001, 78.999421	-
		RHS	32	*Albizia saman* (Jacq.) Merr.	Leguminosae	Rain Tree	231	10	8	71	20.9284205, 78.9986834	-
	MIDC KEC Metro Station	LHS	33	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	111	9	5	27	20.929434, 78.969408	LC
			34	*Pithecellobium dulce* (Roxb.) Benth.	Mimosaceae	Vilayati Chinch	23	4	3	5	20.929508, 78.969385	LC
			35	*Pithecellobium dulce* (Roxb.) Benth.	Mimosaceae	Vilayati Chinch	24	4	2	5	20.929503, 78.969321	LC
			36	*Pithecellobium dulce* (Roxb.) Benth.	Mimosaceae	Vilayati Chinch	40	5	4	6	20.929522, 78.969284	LC
			37	*Pithecellobium dulce* (Roxb.) Benth.	Mimosaceae	Vilayati Chinch	27	3	2	4	20.929455, 78.969267	LC
			38	*Pithecellobium dulce* (Roxb.) Benth.	Mimosaceae	Vilayati Chinch	25	4	3	5	20.929506, 78.969271	LC
			39	*Pithecellobium dulce* (Roxb.) Benth.	Mimosaceae	Vilayati Chinch	31	5	2	5	20.929481, 78.969227	LC
			40	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Leguminosae	Siamese Cassia (*Kashid*)	41	6	4	6	20.929500, 78.969163	LC
			41	*Peltophorum pterocarpum (* DC.) K.Heyne	Leguminosae	Sonmohar (Copper Pod)	231	12	8	36	20.929587, 78.969115	-
			42	*Peltophorum pterocarpum (* DC.) K.Heyne	Leguminosae	Sonmohar (Copper Pod)	167	11	7	30	20.929555, 78.969037	-
			43	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Leguminosae	Siamese Cassia (*Kashid*)	33	5	4	6	20.929631, 78.969024	LC
			44	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	150	10	7	34	20.929586, 78.968953	LC
			45	*Peltophorum pterocarpum (* DC.) K.Heyne	Leguminosae	Sonmohar (Copper Pod)	239	12	10	51	20.929647, 78.968866	-
		RHS	46	*Dalbergia sissoo* DC.	Leguminosae	Sissoo	78	8	6	13	20.9297972, 78.9691707	LC
			47	*Azadirachta indica* A.Juss.	Meliaceae	Neem	46	5	4	9	20.9298037, 78.9691435	LC
			48	*Dalbergia sissoo* DC.	Leguminosae	Sissoo	71	8	5	10	20.9298185, 78.9691371	LC
			49	*Dalbergia sissoo* DC.	Leguminosae	Sissoo	107	9	6	15	20.9298354, 78.9690966	LC

MIDC ECR Metro Station	LHS	50	*Acacia leucophloea* (Roxb.) Willd.	Fabaceae	Hivar	40	5	4	9	20.924172, 78.964946	-
		51	*Butea monosperma* (Lam.) Kuntze	Fabaceae	Palash	67	6	3	8	20.924133, 78.964927	LC
		52	*Butea monosperma* (Lam.) Kuntze	Fabaceae	Palash	81	7	5	16	20.924109, 78.964925	LC
		53	*Gliricidia sepium* (Jacq.) Steud.	Fabaceae	Giripushp	34	4	3	5	20.924094, 78.964962	LC
		54	*Peltophorum pterocarpum (* DC.) K.Heyne	Leguminosae	Sonmohar (Copper Pod)	89	7	5	12	20.924080, 78.964898	-
		55	*Acacia leucophloea* (Roxb.) Willd.	Fabaceae	Hivar	30	4	3	5	20.924049, 78.964918	-
		56	*Peltophorum pterocarpum (* DC.) K.Heyne	Leguminosae	Sonmohar (Copper Pod)	105	10	6	13	20.924033, 78.964878	-
		57	*Acacia leucophloea* (Roxb.) Willd.	Fabaceae	Hivar	57	5	4	10	20.924017, 78.964899	-
		58	*Dalbergia sissoo* DC.	Leguminosae	Sissoo	39	5	3	6	20.923990, 78.964870	LC
		59	*Dalbergia sissoo* DC.	Leguminosae	Sissoo	42	5	3	6	20.923959, 78.964896	LC
		60	*Dalbergia sissoo* DC.	Leguminosae	Sissoo	59	6	3	7	20.923935, 78.964848	LC
		61	*Peltophorum pterocarpum (* DC.) K.Heyne	Leguminosae	Sonmohar (Copper Pod)	113	10	7	15	20.923888, 78.964906	-
		62	*Dalbergia sissoo* DC.	Leguminosae	Sissoo	30	5	3	4	20.923879, 78.964817	LC
		63	*Dalbergia sissoo* DC.	Leguminosae	Sissoo	69	6	4	7	20.923858, 78.964870	LC
		64	*Leucaena leucocephala* (Lam.) de Wit	Leguminosae	Subabul	46	5	3	6	20.923824, 78.964821	-
		65	*Leucaena leucocephala* (Lam.) de Wit	Leguminosae	Subabul	67	6	2	8	20.923784, 78.964815	-
	RHS	66	*Eucalyptus globulus* Labil.	Myrtaceae	Nilgiri	134	11	5	39	20.9240754, 78.9646012	LC
		67	*Gliricidia sepium* (Jacq.) Steud.	Fabaceae	Giripushp	35	4	3	6	20.924084, 78.964558	LC
		68	*Gliricidia sepium* (Jacq.) Steud.	Fabaceae	Giripushp	29	4	2	5	20.924135, 78.964551	LC
		69	*Gliricidia sepium* (Jacq.) Steud.	Fabaceae	Giripushp	41	5	3	5	20.924185, 78.964620	LC
		70	*Gliricidia sepium* (Jacq.) Steud.	Fabaceae	Giripushp	34	4	3	6	20.924185, 78.964621	LC
		71	*Gliricidia sepium* (Jacq.) Steud.	Fabaceae	Giripushp	30	3	2	4	20.924171, 78.964620	LC
		72	*Gliricidia sepium* (Jacq.) Steud.	Fabaceae	Giripushp	24	3	1	4	20.924158, 78.964560	LC
		73	*Gliricidia sepium* (Jacq.) Steud.	Fabaceae	Giripushp	15	2	1	4	20.924247, 78.964645	LC
		74	*Gliricidia sepium* (Jacq.) Steud.	Fabaceae	Giripushp	26	3	2	5	20.924304, 78.964670	LC
		75	*Gliricidia sepium* (Jacq.) Steud.	Fabaceae	Giripushp	28	4	2	5	20.924351, 78.964697	LC
		76	*Gliricidia sepium* (Jacq.) Steud.	Fabaceae	Giripushp	39	4	3	5	20.924404, 78.964693	LC
		77	*Gliricidia sepium* (Jacq.) Steud.	Fabaceae	Giripushp	22	3	1	4	20.924453, 78.964712	LC
		78	*Gliricidia sepium* (Jacq.) Steud.	Fabaceae	Giripushp	40	5	4	6	20.924498, 78.964740	LC
		79	*Gliricidia sepium* (Jacq.) Steud.	Fabaceae	Giripushp	34	4	3	5	20.924498, 78.964694	LC
Along Line 1A	Median	80	*Butea monosperma* (Lam.) Kuntze	Fabaceae	Palash	105	9	6	13	20.9282185, 78.9863901	LC
		81	*Butea monosperma* (Lam.) Kuntze	Fabaceae	Palash	89	6	4	10	20.9282261, 78.9862936	LC
		82	*Azadirachta indica* A.Juss.	Meliaceae	Neem	56	5	3	8	20.928266, 78.986259	LC
		83	*Butea monosperma* (Lam.) Kuntze	Fabaceae	Palash	76	6	4	9	20.928257, 78.986208	LC
		84	***Tectona grandis* L.f.**	**Lamiaceae**	**Sag**	**69**	**5**	**3**	**8**	**20.928249, 78.986157**	**EN**
		85	*Azadirachta indica* A.Juss.	Meliaceae	Neem	113	9	5	15	20.9282474, 78.9861869	LC
		86	*Bombax ceiba* L.	Malvaceae	Katesavar	71	6	4	7	20.928275, 78.986118	LC
		87	*Azadirachta indica* A.Juss.	Meliaceae	Neem	57	5	4	6	20.928275, 78.986067	LC
		88	***Tectona grandis* L.f.**	**Lamiaceae**	**Sag**	**62**	**6**	**3**	**8**	**20.928268, 78.986030**	**EN**
		89	*Butea monosperma* (Lam.) Kuntze	Fabaceae	Palash	110	7	5	17	20.928258, 78.985991	LC
		90	***Tectona grandis* L.f.**	**Lamiaceae**	**Sag**	**45**	**6**	**4**	**8**	**20.928261, 78.985952**	**EN**
		91	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	159	10	7	43	20.9282589, 78.9857957	LC
		92	*Ficus racemosa* L.	Moraceae	Umbar	49	5	3	7	20.928267, 78.985905	LC
		93	*Azadirachta indica* A.Juss.	Meliaceae	Neem	88	7	5	11	20.9282524, 78.9855851	LC
		94	*Azadirachta indica* A.Juss.	Meliaceae	Neem	50	6	4	7	20.928267, 78.985719	LC
		95	*Ziziphus jujuba* Mill.	Rhamnaceae	Bor	32	4	2	6	20.928256, 78.985636	LC
		96	*Ziziphus jujuba* Mill.	Rhamnaceae	Bor	30	3	3	5	20.928241, 78.985525	LC
		97	*Ziziphus jujuba* Mill.	Rhamnaceae	Bor	27	4	2	5	20.928266, 78.985523	LC
		98	*Ziziphus jujuba* Mill.	Rhamnaceae	Bor	34	4	3	6	20.928263, 78.985482	LC
		99	*Azadirachta indica* A.Juss.	Meliaceae	Neem	56	7	5	9	20.928248, 78.985457	LC
		100	*Butea monosperma* (Lam.) Kuntze	Fabaceae	Palash	67	7	4	10	20.928284, 78.985432	LC
		101	*Butea monosperma* (Lam.) Kuntze	Fabaceae	Palash	79	8	5	16	20.928274, 78.985389	LC
		102	***Tectona grandis* L.f.**	**Lamiaceae**	**Sag**	**50**	**6**	**4**	**9**	**20.928248, 78.985373**	**EN**
		103	*Butea monosperma* (Lam.) Kuntze	Fabaceae	Palash	29	3	2	5	20.928278, 78.985335	LC
		104	*Acacia leucophloea* (Roxb.) Willd.	Fabaceae	Hivar	50	6	5	7	20.9282571, 78.9852445	-
		105	*Azadirachta indica* A.Juss.	Meliaceae	Neem	46	5	4	8	20.928282, 78.985228	LC
		106	*Azadirachta indica* A.Juss.	Meliaceae	Neem	40	3	2	6	20.928282, 78.985203	LC
		107	*Azadirachta indica* A.Juss.	Meliaceae	Neem	67	5	3	9	20.928253, 78.985212	LC

108	*Azadirachta indica* A.Juss.	Meliaceae	Neem	71	6	5	10	20.928279, 78.985169	LC
109	***Tectona grandis* L.f.**	**Lamiaceae**	**Sag**	**54**	**6**	**3**	**8**	**20.928245, 78.985160**	**EN**
110	***Tectona grandis* L.f.**	**Lamiaceae**	**Sag**	**49**	**5**	**4**	**8**	**20.928269, 78.984903**	**EN**
111	***Tectona grandis* L.f.**	**Lamiaceae**	**Sag**	**39**	**5**	**3**	**7**	**20.928280, 78.984952**	**EN**
112	*Azadirachta indica* A.Juss.	Meliaceae	Neem	65	7	6	13	20.928280, 78.984292	LC
113	*Azadirachta indica* A.Juss.	Meliaceae	Neem	87	8	5	19	20.928288, 78.984218	LC
114	*Butea monosperma* (Lam.) Kuntze	Fabaceae	Palash	40	6	4	9	20.928263, 78.984139	LC
115	*Ziziphus jujuba* Mill.	Rhamnaceae	Bor	32	5	3	7	20.928286, 78.984107	LC
116	*Butea monosperma* (Lam.) Kuntze	Fabaceae	Palash	117	10	7	29	20.9282392, 78.9839148	LC
117	***Tectona grandis* L.f.**	**Lamiaceae**	**Sag**	**56**	**6**	**4**	**9**	**20.928290, 78.983916**	**EN**
118	*Azadirachta indica* A.Juss.	Meliaceae	Neem	71	7	4	13	20.928282, 78.983787	LC
119	*Azadirachta indica* A.Juss.	Meliaceae	Neem	115	9	6	24	20.928241, 78.983675	LC
120	***Tectona grandis* L.f.**	**Lamiaceae**	**Sag**	**60**	**5**	**5**	**8**	**20.928255, 78.983610**	**EN**
121	*Acacia leucophloea* (Roxb.) Willd.	Fabaceae	Hivar	74	6	4	15	20.928284, 78.983551	-
122	***Tectona grandis* L.f.**	**Lamiaceae**	**Sag**	**36**	**4**	**3**	**7**	**20.928276, 78.983506**	**EN**
123	*Ailanthus excelsus* Roxb.	Simaroubaceae	Maharukh	56	7	5	10	20.928259, 78.983470	-
124	*Azadirachta indica* A.Juss.	Meliaceae	Neem	32	4	2	5	20.928285, 78.983460	LC
125	*Lannea coromandelica* (Houtt.) Merr.	Anacardiaceae	Shemat	43	5	4	6	20.9282546, 78.9834169	LC
126	*Ailanthus excelsus* Roxb.	Simaroubaceae	Maharukh	107	9	6	28	20.928300, 78.983280	-
127	*Azadirachta indica* A.Juss.	Meliaceae	Neem	125	10	7	37	20.9282862, 78.9833458	LC
128	*Ailanthus excelsus* Roxb.	Simaroubaceae	Maharukh	27	5	3	6	20.928277, 78.983198	-
129	*Ficus benghalensis* L.	Moraceae	Vad	120	9	7	28	20.9282508, 78.9831125	-
130	*Dalbergia sissoo* DC.	Leguminosae	Sissoo	129	11	8	34	20.928283, 78.983081	LC
131	*Ficus benghalensis* L.	Moraceae	Vad	159	11	10	61	20.9282611, 78.9829126	-
132	*Azadirachta indica* A.Juss.	Meliaceae	Neem	34	4	3	5	20.928291, 78.982953	LC
133	*Butea monosperma* (Lam.) Kuntze	Fabaceae	Palash	64	5	4	9	20.928287, 78.982991	LC
134	*Azadirachta indica* A.Juss.	Meliaceae	Neem	27	3	2	6	20.928255, 78.983003	LC
135	*Azadirachta indica* A.Juss.	Meliaceae	Neem	43	5	3	8	20.928279, 78.983037	LC
136	*Ailanthus excelsus* Roxb.	Simaroubaceae	Maharukh	55	6	4	9	20.928264, 78.983078	-
137	*Azadirachta indica* A.Juss.	Meliaceae	Neem	39	5	4	6	20.928288, 78.983106	LC
138	*Acacia leucophloea* (Roxb.) Willd.	Fabaceae	Hivar	108	8	5	21	20.928285, 78.982688	-
139	*Acacia leucophloea* (Roxb.) Willd.	Fabaceae	Hivar	97	9	5	16	20.928274, 78.982612	-
140	*Acacia leucophloea* (Roxb.) Willd.	Fabaceae	Hivar	112	10	6	26	20.9282790, 78.9824248	-
141	*Delonix regia* (Hook.) Raf.	Leguminosae	Gulmohar (Flame tree)	188	10	8	49	20.9298269, 78.9683895	LC
142	*Peltophorum pterocarpum (* DC.) K.Heyne	Leguminosae	Sonmohar (Copper Pod)	132	8	6	28	20.9298438, 78.9683865	-
143	*Delonix regia* (Hook.) Raf.	Leguminosae	Gulmohar (Flame tree)	105	9	7	26	20.929876, 78.968313	LC
144	*Delonix regia* (Hook.) Raf.	Leguminosae	Gulmohar (Flame tree)	109	8	5	24	20.929919, 78.968246	LC
145	*Pithecellobium dulce* (Roxb.) Benth.	Mimosaceae	Vilayati Chinch	112	8	5	26	20.929912, 78.968176	LC
146	*Delonix regia* (Hook.) Raf.	Leguminosae	Gulmohar (Flame tree)	143	10	6	38	20.9298570, 78.9682192	LC
147	*Peltophorum pterocarpum (* DC.) K.Heyne	Leguminosae	Sonmohar (Copper Pod)	98	6	5	19	20.929954, 78.967981	-
148	*Peltophorum pterocarpum (* DC.) K.Heyne	Leguminosae	Sonmohar (Copper Pod)	125	10	7	28	20.929992, 78.967906	-
149	*Delonix regia* (Hook.) Raf.	Leguminosae	Gulmohar (Flame tree)	158	11	9	44	20.9298585, 78.9681199	LC
150	*Delonix regia* (Hook.) Raf.	Leguminosae	Gulmohar (Flame tree)	50	6	4	9	20.930006, 78.967854	LC
151	*Peltophorum pterocarpum (* DC.) K.Heyne	Leguminosae	Sonmohar (Copper Pod)	114	8	6	23	20.930014, 78.967596	-
152	*Delonix regia* (Hook.) Raf.	Leguminosae	Gulmohar (Flame tree)	147	9	7	40	20.9299390, 78.9680612	LC
153	*Pithecellobium dulce* (Roxb.) Benth.	Mimosaceae	Vilayati Chinch	134	10	7	35	20.9299271, 78.9678041	LC
154	*Delonix regia* (Hook.) Raf.	Leguminosae	Gulmohar (Flame tree)	85	6	4	15	20.930035, 78.967426	LC
155	*Pithecellobium dulce* (Roxb.) Benth.	Mimosaceae	Vilayati Chinch	103	8	5	16	0.930014, 78.967485	LC
156	*Peltophorum pterocarpum (* DC.) K.Heyne	Leguminosae	Sonmohar (Copper Pod)	132	9	6	27	20.9300248, 78.9677639	-
157	*Delonix regia* (Hook.) Raf.	Leguminosae	Gulmohar (Flame tree)	126	7	5	21	20.929971, 78.967580	LC
158	*Delonix regia* (Hook.) Raf.	Leguminosae	Gulmohar (Flame tree)	88	6	4	15	20.930001, 78.967508	LC
159	*Pithecellobium dulce* (Roxb.) Benth.	Mimosaceae	Vilayati Chinch	120	11	6	28	20.930040, 78.967460	LC
160	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	131	10	6	29	20.930080, 78.967625	LC
161	*Peltophorum pterocarpum (* DC.) K.Heyne	Leguminosae	Sonmohar (Copper Pod)	119	9	7	21	20.9300868, 78.9674903	-
162	*Alstonia scholaris* (L.) R.Br.	Apocynaceae	Satvin	128	8	5	24	20.9299791, 78.9674581	LC
163	*Delonix regia* (Hook.) Raf.	Leguminosae	Gulmohar (Flame tree)	148	10	7	31	20.9299249, 78.9676398	LC
164	*Leucaena leucocephala* (Lam.) de Wit	Leguminosae	Subabul	56	6	4	10	20.9299879, 78.9674916	-
165	*Ceiba pentandra* (L.) Gaertn.	Malvaceae	Savar	179	10	8	43	20.9299349, 78.9672874	LC

			166	*Roystonea regia* (Kunth) O.F.Cook	Arecaceae	Royal Palm	231	10	6	34	20.9298385, 78.9672723	LC
			167	*Peltophorum pterocarpum (* DC.) K.Heyne	Leguminosae	Sonmohar (Copper Pod)	124	8	5	23	20.9297712, 78.96722	-
			168	*Peltophorum pterocarpum (* DC.) K.Heyne	Leguminosae	Sonmohar (Copper Pod)	110	9	6	21	20.9297389, 78.9671875	-
			169	*Azadirachta indica* A.Juss.	Meliaceae	Neem	66	7	5	10	20.9297564, 78.9672988	LC
			170	*Mangifera indica* L.	Anacardiaceae	Amba	79	7	5	16	20.9297990, 78.9672921	DD
			171	*Azadirachta indica* A.Juss.	Meliaceae	Neem	143	10	7	34	20.9296772, 78.9672006	LC
			172	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Leguminosae	Siamese Cassia (*Kashid*)	89	7	6	20	20.9298407, 78.967208	LC
			173	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Leguminosae	Siamese Cassia (*Kashid*)	49	5	4	6	20.9298376, 78.9672529	LC
			174	*Mangifera indica* L.	Anacardiaceae	Amba	283	13	11	71	20.9262942, 78.965607	DD
			175	*Albizia saman* (Jacq.) Merr.	Leguminosae	Rain Tree	144	10	9	38	20.9217880, 78.9639367	-
			176	*Albizia saman* (Jacq.) Merr.	Leguminosae	Rain Tree	89	7	6	24	20.921714, 78.963952	-
			177	*Albizia saman* (Jacq.) Merr.	Leguminosae	Rain Tree	189	10	8	53	20.921663, 78.963901	-
			178	*Syzygium cumini* (L.) Skeels	Myrtaceae	Jamun (Indian Blackberry)	109	9	5	26	20.9214620, 78.9640074	LC
			179	*Syzygium cumini* (L.) Skeels	Myrtaceae	Jamun (Indian Blackberry)	113	10	6	28	20.9213840, 78.9639927	LC
			180	*Albizia saman* (Jacq.) Merr.	Leguminosae	Rain Tree	100	8	6	21	20.9214742, 78.963882	-
			181	*Albizia saman* (Jacq.) Merr.	Leguminosae	Rain Tree	123	10	7	29	20.9213211, 78.963932	-
			182	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Leguminosae	Siamese Cassia (*Kashid*)	87	6	4	10	20.9213515, 78.9639843	LC
			183	*Azadirachta indica* A.Juss.	Meliaceae	Neem	94	8	5	23	20.9212876, 78.9639829	LC
			184	*Roystonea regia* (Kunth) O.F.Cook	Arecaceae	Royal Palm	119	8	6	23	20.9212152, 78.9639736	LC
			185	*Albizia lebbeck* (L.) Benth.	Leguminosae	Shirish (Indian siris)	175	10	10	51	20.9210436, 78.9641747	LC
			186	*Albizia lebbeck* (L.) Benth.	Leguminosae	Shirish (Indian siris)	163	10	8	43	20.9210217, 78.9642361	LC
			187	*Azadirachta indica* A.Juss.	Meliaceae	Neem	121	8	6	24	20.9283667, 78.9882439	LC
			188	*Terminalia bellirica* (Gaertn.) Roxb.	Combretaceae	Behada	189	13	8	45	20.9283328, 78.9911329	LC
			189	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Leguminosae	Siamese Cassia (*Kashid*)	90	7	5	18	20.9281449, 79.0032713	LC
			190	*Albizia saman* (Jacq.) Merr.	Leguminosae	Rain Tree	140	12	8	30	20.928133, 79.003343	-
			191	*Albizia saman* (Jacq.) Merr.	Leguminosae	Rain Tree	136	10	8	27	20.928111, 79.003560	-
			192	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Leguminosae	Siamese Cassia (*Kashid*)	59	6	5	14	20.928032, 79.003564	LC
			193	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Leguminosae	Siamese Cassia (*Kashid*)	64	7	5	10	20.9282138, 79.0034983	LC
			194	*Terminalia catappa* L.	Combretaceae	Deshi Badam	41	5	3	9	20.9282154, 79.0034346	LC
			195	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Leguminosae	Siamese Cassia (*Kashid*)	59	6	4	7	20.9282455, 79.0037407	LC
			196	*Albizia saman* (Jacq.) Merr.	Leguminosae	Rain Tree	143	10	6	29	20.9283855, 79.0039971	-
			197	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Leguminosae	Siamese Cassia (*Kashid*)	45	5	2	7	20.928385, 79.003946	LC
			198	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Leguminosae	Siamese Cassia (*Kashid*)	32	4	3	5	20.928454, 79.004016	LC
			199	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Leguminosae	Siamese Cassia (*Kashid*)	41	5	2	6	20.9284913, 79.0040743	LC
			200	*Albizia saman* (Jacq.) Merr.	Leguminosae	Rain Tree	98	7	5	15	20.9424415, 79.0088969	-
			201	*Dalbergia sissoo* DC.	Leguminosae	Sissoo	81	8	6	19	20.9427173, 79.0090317	LC
			202	*Mangifera indica* L.	Anacardiaceae	Amba	188	11	9	61	21.0192483, 79.0474171	DD
			203	*Limonia acidissima* Houtt.	Rutaceae	Kavath	195	12	7	59	21.0193440, 79.0473903	-
			204	*Terminalia catappa* L.	Combretaceae	Deshi Badam	65	6	4	9	21.025060, 79.039153	LC
			205	*Dalbergia sissoo* DC.	Leguminosae	Sissoo	117	10	6	24	21.024994, 79.039067	LC
			206	*Acacia chundra* (Roxb. ex Rottler) Willd.	Fabaceae	Khair	45	5	4	8	21.025134, 79.039196	-
2A Automotive Square to Kanhan River	**Pili Nadi Station**	**LHS**	207	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	97	7	5	12	21.192058, 79.127933	LC
			208	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	103	8	5	12	21.192082, 79.127953	LC
			209	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	33	4	3	6	21.192085, 79.127990	LC
			210	*Cassia fistula* L.	Fabaceae	Bahava	29	4	2	5	21.192116, 79.127963	LC
			211	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	56	5	4	7	21.192113, 79.128054	LC
			212	*Leucaena leucocephala* (Lam.) de Wit	Leguminosae	Subabul	80	7	4	9	21.192142, 79.128032	-
			213	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	69	6	5	7	21.192146, 79.128076	LC
			214	*Leucaena leucocephala* (Lam.) de Wit	Leguminosae	Subabul	26	3	2	4	21.192155, 79.128123	-
			215	*Cordia dichotoma* G.Forst.	Boraginaceae	Bhokar	30	4	3	6	21.192227, 79.128211	LC
			216	*Leucaena leucocephala* (Lam.) de Wit	Leguminosae	Subabul	38	5	2	4	21.192242, 79.128253	-
			217	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	37	4	3	5	21.192264, 79.128305	LC
			218	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	31	4	2	5	21.192296, 79.128323	LC
			219	*Cocos nucifera* L.	Arecaceae	Naral	78	7	5	10	21.192222, 79.128104	-
			220	*Syzygium cumini* (L.) Skeels	Myrtaceae	Jamun (Indian Blackberry)	40	6	3	7	21.192179, 79.128085	LC
		RHS	221	*Terminalia catappa* L.	Combretaceae	Deshi Badam	74	7	6	13	21.1920482, 79.1286116	LC
			222	*Azadirachta indica* A.Juss.	Meliaceae	Neem	47	6	4	8	21.1919926, 79.1285023	LC
			223	*Ficus benjamina* L.	Moraceae	Green ficus	30	4	4	6	21.1919926, 79.1285023	LC

Khasara Fata Station	**LHS**	224	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	30	4	3	5	21.196473, 79.134321	LC
		225	*Neolamarckia cadamba* (Roxb.) Bosser	Rubiaceae	Kadamb	27	4	2	5	21.196502, 79.134350	-
		226	*Pithecellobium dulce* (Roxb.) Benth.	Mimosaceae	Vilayati Chinch	31	5	3	6	21.196535, 79.134354	LC
		227	*Cordia dichotoma* G.Forst.	Boraginaceae	Bhokar	29	4	3	4	21.196512, 79.134366	LC
		228	*Ficus religiosa* L.	Moraceae	Pimpal	118	12	7	31	21.1969754, 79.1345835	LC
		229	*Ficus religiosa* L.	Moraceae	Pimpal	99	10	7	25	21.1970760, 79.1346338	LC
		230	*Azadirachta indica* A.Juss.	Meliaceae	Neem	102	11	8	22	21.1971514, 79.1347887	LC
	RHS	231	*Ficus religiosa* L.	Moraceae	Pimpal	168	13	9	55	21.196580, 79.134854	LC
		232	*Leucaena leucocephala* (Lam.) de Wit	Leguminosae	Subabul	69	8	3	10	21.196413, 79.134721	-
		233	*Prosopis juliflora* (Sw.) DC.	Fabaceae	Vilayati Babul	34	5	4	6	21.196375, 79.134667	-
All India Radio Station	**LHS**	234	*Leucaena leucocephala* (Lam.) de Wit	Leguminosae	Subabul	21	4	2	5	21.202509, 79.143370	-
		235	*Leucaena leucocephala* (Lam.) de Wit	Leguminosae	Subabul	29	3	2	5	21.202551, 79.143395	-
		236	*Leucaena leucocephala* (Lam.) de Wit	Leguminosae	Subabul	18	3	1	4	21.202571, 79.143422	-
		237	*Leucaena leucocephala* (Lam.) de Wit	Leguminosae	Subabul	23	4	2	4	21.202593, 79.143425	-
		238	*Pithecellobium dulce* (Roxb.) Benth.	Mimosaceae	Vilayati Chinch	40	5	4	6	21.202596, 79.143463	LC
		239	*Leucaena leucocephala* (Lam.) de Wit	Leguminosae	Subabul	21	4	2	3	21.202666, 79.143537	-
		240	*Leucaena leucocephala* (Lam.) de Wit	Leguminosae	Subabul	18	4	2	4	21.202678, 79.143572	-
		241	*Muntingia calabura* L.	Muntingiaceae	Singapore Cherry	55	6	6	8	21.202698, 79.143601	-
		242	*Pithecellobium dulce* (Roxb.) Benth.	Mimosaceae	Vilayati Chinch	31	5	3	4	21.202706, 79.143636	LC
		243	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	38	5	3	4	21.202728, 79.143665	LC
		244	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	30	4	2	4	21.202741, 79.143627	LC
		245	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	21	3	2	4	21.202733, 79.143652	LC
		246	*Acacia farnesiana* (L.) Willd.	Fabaceae	Devbabul	27	5	3	6	21.202744, 79.143701	-
		247	*Pithecellobium dulce* (Roxb.) Benth.	Mimosaceae	Vilayati Chinch	30	5	4	5	21.202698, 79.143664	LC
		248	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	22	4	2	3	21.202689, 79.143638	LC
	RHS	249	*Azadirachta indica* A.Juss.	Meliaceae	Neem	20	3	3	5	21.202547, 79.143991	LC
		250	*Leucaena leucocephala* (Lam.) de Wit	Leguminosae	Subabul	25	4	2	4	21.202524, 79.143954	-
		251	*Leucaena leucocephala* (Lam.) de Wit	Leguminosae	Subabul	31	5	2	4	21.202484, 79.143914	-
		252	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	18	3	1	4	21.202449, 79.143838	LC
		253	*Bombax ceiba* L.	Malvaceae	Katesavar	31	4	3	5	21.202429, 79.143812	LC
		254	*Acacia farnesiana* (L.) Willd.	Fabaceae	Devbabul	35	4	4	6	21.202407, 79.143791	-
		255	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	30	4	3	5	21.202390, 79.143728	LC
Khairi Phata Station	**LHS**	256	*Acacia farnesiana* (L.) Willd.	Fabaceae	Devbabul	21	4	2	5	21.210983, 79.158568	-
		257	*Acacia farnesiana* (L.) Willd.	Fabaceae	Devbabul	20	3	2	4	21.211020, 79.158655	-
		258	*Acacia farnesiana* (L.) Willd.	Fabaceae	Devbabul	29	4	3	4	21.211055, 79.158650	-
		259	*Acacia farnesiana* (L.) Willd.	Fabaceae	Devbabul	19	3	2	3	21.211087, 79.158741	-
		260	*Acacia farnesiana* (L.) Willd.	Fabaceae	Devbabul	17	3	1	3	21.211120, 79.158732	-
		261	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	39	4	3	5	21.211111, 79.158798	LC
		262	*Ailanthus excelsus* Roxb.	Simaroubaceae	Maharukh	22	3	2	5	21.211129, 79.158840	-
		263	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	23	4	1	5	21.211159, 79.158856	LC
		264	*Pithecellobium dulce* (Roxb.) Benth.	Mimosaceae	Vilayati Chinch	47	5	3	6	21.211167, 79.158895	LC
	RHS	**No Trees**									
Lok Vihar Station	**LHS**	265	*Ziziphus jujuba* Mill.	Rhamnaceae	Bor	45	6	3	7	21.2154834, 79.1672314	LC
		266	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	24	3	2	4	21.215481, 79.167195	LC
		267	*Ziziphus jujuba* Mill.	Rhamnaceae	Bor	15	3	1	4	21.215457, 79.167162	LC
		268	*Ficus hispida* L.f.	Moraceae	Kala Umbar	17	3	2	4	21.215431, 79.167142	LC
		269	*Phoenix sylvestris* (L.) Roxb.	Arecaceae	Shindi	90	6	4	13	21.215436, 79.167098	-
		270	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	26	4	3	4	21.215404, 79.167091	LC
		271	*Ziziphus jujuba* Mill.	Rhamnaceae	Bor	28	5	3	4	21.215409, 79.167055	LC
		272	*Prosopis juliflora* (Sw.) DC.	Fabaceae	Vilayati Babul	19	3	2	4	21.215376, 79.167050	-
		273	***Tectona grandis* L.f.**	**Lamiaceae**	**Sag**	**17**	**3**	**2**	**4**	**21.215410, 79.167001**	**EN**
		274	***Tectona grandis* L.f.**	**Lamiaceae**	**Sag**	**18**	**3**	**2**	**3**	**21.215342, 79.166947**	**EN**
		275	***Tectona grandis* L.f.**	**Lamiaceae**	**Sag**	**23**	**4**	**3**	**4**	**21.215342, 79.166916**	**EN**
		276	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	39	4	3	5	21.215317, 79.166887	LC
		277	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	20	3	2	4	21.215316, 79.166853	LC
		278	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	23	4	2	3	21.215288, 79.166828	LC
		279	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	29	3	2	4	21.215279, 79.166759	LC
		280	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	30	4	1	5	21.215154, 79.166589	LC

			281	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	25	3	2	3	21.2151218, 79.1665082	LC
		RHS	No Trees									
	Lekha Nagar Station	LHS	282	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	53	6	4	8	21.2193390, 79.1760424	LC
			283	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	19	3	2	4	21.219365, 79.176077	LC
			284	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	57	6	5	9	21.219371, 79.176102	LC
			285	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	40	4	3	5	21.219380, 79.176123	LC
			286	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	31	4	2	5	21.219396, 79.176163	LC
			287	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	77	7	5	11	21.219373, 79.176178	LC
			288	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	23	4	3	5	21.219406, 79.176240	LC
			289	*Prosopis juliflora* (Sw.) DC.	Fabaceae	Vilayati Babul	16	3	2	4	21.219411, 79.176287	-
			290	*Prosopis juliflora* (Sw.) DC.	Fabaceae	Vilayati Babul	18	4	2	4	21.219406, 79.176233	-
			291	*Prosopis juliflora* (Sw.) DC.	Fabaceae	Vilayati Babul	23	4	3	4	21.219380, 79.176219	-
			292	*Leucaena leucocephala* (Lam.) de Wit	Leguminosae	Subabul	30	3	2	4	21.219429, 79.176280	-
			293	*Lannea coromandelica* (Houtt.) Merr.	Anacardiaceae	Shemat	71	6	4	9	21.219403, 79.176302	LC
			294	*Leucaena leucocephala* (Lam.) de Wit	Leguminosae	Subabul	44	5	3	4	21.219446, 79.176359	-
			295	*Eucalyptus globulus* Labil.	Myrtaceae	Nilgiri	129	13	5	32	21.219425, 79.176332	LC
			296	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	85	8	6	13	21.219439, 79.176416	LC
		RHS	297	*Ficus hispida* L.f.	Moraceae	Kala Umbar	20	3	3	4	21.219158, 79.176566	LC
			298	*Leucaena leucocephala* (Lam.) de Wit	Leguminosae	Subabul	29	4	3	5	21.219135, 79.176539	-
			299	*Ziziphus jujuba* Mill.	Rhamnaceae	Bor	36	6	5	7	21.219105, 79.176449	LC
			300	*Ficus racemosa* L.	Moraceae	Umbar	40	5	4	8	21.219097, 79.176390	LC
			301	*Pithecellobium dulce* (Roxb.) Benth.	Mimosaceae	Vilayati Chinch	31	3	2	4	21.219119, 79.176373	LC
			302	*Leucaena leucocephala* (Lam.) de Wit	Leguminosae	Subabul	45	6	2	7	21.219092, 79.176321	-
	Cantonment Station	LHS	No Trees									
		RHS	303	*Bombax ceiba* L.	Malvaceae	Katesavar	179	14	8	53	21.220813, 79.188417	LC
			304	*Holoptelea integrifolia* (Roxb.) Planch.	Ulmaceae	Vavla	106	10	7	23	21.220739, 79.188406	-
			305	*Holoptelea integrifolia* (Roxb.) Planch.	Ulmaceae	Vavla	113	11	6	26	21.220706, 79.188468	-
			306	*Holoptelea integrifolia* (Roxb.) Planch.	Ulmaceae	Vavla	134	11	7	30	21.220666, 79.188511	-
			307	*Ficus amplissima* Sm.	Moraceae	Piparni	121	12	8	39	21.2204758, 79.1884939	-
	Kamptee Police Station	LHS	308	*Polyalthia longifolia* (Sonn.) Thw. var angustifolia	Annonaceae	Ashok	134	9	6	27	1.215406, 79.192587	-
			309	*Azadirachta indica* A.Juss.	Meliaceae	Neem	91	7	5	13	21.215194, 79.192734	LC
			310	*Azadirachta indica* A.Juss.	Meliaceae	Neem	106	8	6	19	21.215174, 79.192762	LC
		RHS	311	*Azadirachta indica* A.Juss.	Meliaceae	Neem	193	12	7	41	21.215169, 79.192437	LC
			312	*Ailanthus excelsus* Roxb.	Simaroubaceae	Maharukh	102	9	5	13	21.215032, 79.192507	-
			313	*Annona squamosa* L.	Annonaceae	Sitaphal	41	5	4	7	21.214969, 79.192578	LC
			314	*Moringa oleifera* Lam.	Moringaceae	Shevaga	67	5	3	10	21.214932, 79.192620	LC
	Kamptee Municipal Council Station	LHS	315	*Prosopis juliflora* (Sw.) DC.	Fabaceae	Vilayati Babul	83	7	5	11	21.213477, 79.198981	-
			316	*Ficus racemosa* L.	Moraceae	Umbar	102	8	5	24	21.213516, 79.198992	LC
			317	*Ficus religiosa* L.	Moraceae	Pimpal	91	7	6	14	21.213497, 79.199029	LC
			318	*Terminalia catappa* L.	Combretaceae	Deshi Badam	69	6	6	9	21.213496, 79.199079	LC
			319	*Ficus racemosa* L.	Moraceae	Umbar	70	5	4	8	21.213491, 79.199107	LC
			320	*Mitragyna parvifolia* Korth.	Rubiaceae	Kalamb	49	6	3	7	21.213482, 79.199216	-
			321	*Mitragyna parvifolia* Korth.	Rubiaceae	Kalamb	55	6	4	8	21.213495, 79.199305	-
			322	*Mitragyna parvifolia* Korth.	Rubiaceae	Kalamb	41	5	3	6	21.213478, 79.199306	-
		RHS	323	*Alstonia scholaris* (L.) R.Br.	Apocynaceae	Satvin	91	7	5	10	21.213213, 79.199493	LC
			324	*Ficus religiosa* L.	Moraceae	Pimpal	56	5	4	7	21.213193, 79.199387	LC
			325	*Ficus racemosa* L.	Moraceae	Umbar	63	6	4	8	21.213205, 79.199301	LC
			326	*Eucalyptus globulus* Labil.	Myrtaceae	Nilgiri	183	14	6	49	21.213152, 79.199098	LC
			327	*Eucalyptus globulus* Labil.	Myrtaceae	Nilgiri	206	14	5	62	21.213152, 79.199013	LC
3A Lokmanya Nagar - Hingna	Mount View Station	Mount View Parking 1 (LHS)	328	*Azadirachta indica* A.Juss.	Meliaceae	Neem	138	8	6	27	21.104100, 78.991205	LC
			329	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	83	7	5	12	21.1038783, 78.9908543	LC
			330	*Peltophorum pterocarpum (* DC.) K.Heyne	Leguminosae	Sonmohar (Copper Pod)	80	6	4	12	21.1038386, 78.9907065	-
			331	*Ficus religiosa* L.	Moraceae	Pimpal	43	4	3	7	21.1038386, 78.9907065	LC
			332	*Azadirachta indica* A.Juss.	Meliaceae	Neem	109	7	5	13	21.1039021, 78.9906931	LC
		RHS	333	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	69	6	4	8	21.1036834, 78.9905097	LC
			334	*Azadirachta indica* A.Juss.	Meliaceae	Neem	196	7	6	51	21.1035314, 78.9903705	LC
		LHS	335	*Azadirachta indica* A.Juss.	Meliaceae	Neem	299	14	9	67	21.1032168, 78.9901365	LC
			336	*Azadirachta indica* A.Juss.	Meliaceae	Neem	205	11	8	53	21.1034917, 78.9905757	LC

		337	*Azadirachta indica* A.Juss.	Meliaceae	Neem	199	11	8	49	21.1036697, 78.9908496	LC
		338	*Azadirachta indica* A.Juss.	Meliaceae	Neem	180	12	7	43	21.1039656, 78.9913341	LC
	Mount View Parking 2 (LHS)	339	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Leguminosae	Siamese Cassia (*Kashid*)	68	7	5	10	21.1033694, 78.9906458	LC
		340	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Leguminosae	Siamese Cassia (*Kashid*)	41	5	4	9	21.1033832, 78.9907122	LC
		341	*Acacia polyacantha* Willd.	Fabaceae	Sonkhair	66	7	5	8	21.1033219, 78.9907283	-
		342	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Leguminosae	Siamese Cassia (*Kashid*)	30	4	2	5	21.1033347, 78.9907547	LC
		343	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	109	8	6	14	21.1032483, 78.9907789	LC
		344	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Leguminosae	Siamese Cassia (*Kashid*)	45	6	3	7	21.1032552, 78.9907071	LC
	Mount View Parking (RHS)	345	*Alstonia scholaris* (L.) R.Br.	Apocynaceae	Satvin	15	3	2	**6**	21.103351, 78.990016	LC
		346	*Alstonia scholaris* (L.) R.Br.	Apocynaceae	Satvin	14	4	2	**6**	21.103322, 78.989978	LC
		347	*Alstonia scholaris* (L.) R.Br.	Apocynaceae	Satvin	17	4	3	**6**	21.103272, 78.989886	LC
		348	*Terminalia mantaly* H.Perrier	Combretaceae	China Almond Tree	27	4	3	**6**	21.103291, 78.989830	LC
		349	*Wodyetia bifurcata* A.K.Irvine	Arecaceae	Foxtail Palm	14	3	2	6	21.103323, 78.989807	CD
		350	*Wodyetia bifurcata* A.K.Irvine	Arecaceae	Foxtail Palm	20	3	2	6	21.103301, 78.989822	CD
		351	*Alstonia scholaris* (L.) R.Br.	Apocynaceae	Satvin	15	4	2	6	21.103359, 78.989830	LC
		352	*Alstonia scholaris* (L.) R.Br.	Apocynaceae	Satvin	19	4	3	6	21.103394, 78.989885	LC
		353	*Alstonia scholaris* (L.) R.Br.	Apocynaceae	Satvin	13	3	2	6	21.103406, 78.989906	LC
		354	*Alstonia scholaris* (L.) R.Br.	Apocynaceae	Satvin	10	3	1	6	21.103364, 78.989927	LC
		355	*Alstonia scholaris* (L.) R.Br.	Apocynaceae	Satvin	15	3	2	6	21.103335, 78.989946	LC
		356	*Azadirachta indica* A.Juss.	Meliaceae	Neem	117	11	6	19	21.1034232, 78.989941	LC
		357	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Leguminosae	Siamese Cassia (*Kashid*)	71	7	5	10	21.1030504, 78.9894354	LC
		358	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Leguminosae	Siamese Cassia (*Kashid*)	108	10	7	15	21.1029090, 78.9893422	LC
		359	*Ficus religiosa* L.	Moraceae	Pimpal	139	10	8	34	21.1028639, 78.9892889	LC
		360	*Azadirachta indica* A.Juss.	Meliaceae	Neem	94	7	5	13	21.1028639, 78.9892889	LC
		361	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	73	6	6	10	21.1028336, 78.989237	LC
		362	*Azadirachta indica* A.Juss.	Meliaceae	Neem	110	10	7	15	21.1028336, 78.989237	LC
		363	*Ficus religiosa* L.	Moraceae	Pimpal	115	10	6	17	21.1029875, 78.9892289	LC
		364	*Ficus benghalensis* L.	Moraceae	Vad	76	9	5	14	21.1029556, 78.989185	-
Rajiv Nagar Station	**LHS**	365	*Azadirachta indica* A.Juss.	Meliaceae	Neem	121	10	8	29	21.0974948, 78.9809134	LC
		366	*Azadirachta indica* A.Juss.	Meliaceae	Neem	116	9	7	24	21.0975824, 78.9810569	LC
		367	*Acacia leucophloea* (Roxb.) Willd.	Fabaceae	Hivar	137	8	6	27	21.0974688, 78.9810716	-
	RHS	**No Trees**									
Vandongari Station	**LHS**	368	*Azadirachta indica* A.Juss.	Meliaceae	Neem	100	9	5	13	21.0920757, 78.973829	LC
		369	*Alstonia scholaris* (L.) R.Br.	Apocynaceae	Satvin	58	5	4	7	21.092053, 78.973818	LC
		370	*Alstonia scholaris* (L.) R.Br.	Apocynaceae	Satvin	55	6	4	7	21.092026, 78.973806	LC
		371	*Azadirachta indica* A.Juss.	Meliaceae	Neem	61	5	3	8	21.091997, 78.973780	LC
		372	*Roystonea regia* (Kunth) O.F.Cook	Arecaceae	Royal Palm	89	6	4	9	21.091959, 78.973779	LC
		373	*Mangifera indica* L.	Anacardiaceae	Amba	37	4	3	5	21.091944, 78.973772	DD
	Parking LHS	374	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	16	4	2	5	21.0923125, 78.9740469	LC
	RHS	375	*Azadirachta indica* A.Juss.	Meliaceae	Neem	115	9	7	16	21.0919546, 78.9735336	LC
	Parking RHS	**No Trees**									
APMC Station	**LHS**	376	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Leguminosae	Siamese Cassia (*Kashid*)	120	8	6	22	21.0856169, 78.9719659	LC
	Parking LHS	377	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	23	4	2	6	21.0855693, 78.9722348	LC
		378	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	31	5	3	6	21.0855693, 78.9722348	LC
		379	*Pithecellobium dulce* (Roxb.) Benth.	Mimosaceae	Vilayati Chinch	33	2	1	5	21.0856156, 78.9720517	LC
	RHS	380	*Azadirachta indica* A.Juss.	Meliaceae	Neem	219	13	10	56	21.0857304, 78.971764	LC
		381	*Tamarindus indica* (L.) Skeels	Leguminosae	Chinch	164	12	10	53	21.0855027, 78.9717181	LC
		382	*Tamarindus indica* (L.) Skeels	Leguminosae	Chinch	159	11	9	51	21.0853960, 78.9716846	LC
	Parking RHS	383	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	57	7	5	9	21.0855327, 78.9714807	LC
Raipur Station	**LHS**	384	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	53	6	4	8	21.077851, 78.968471	LC
		385	*Ceiba pentandra* (L.) Gaertn.	Malvaceae	Savar	193	14	7	43	21.077774, 78.968492	LC
	Parking LHS	386	*Ailanthus excelsus* Roxb.	Simaroubaceae	Maharukh	156	11	7	40	21.077866, 78.968402	-
		387	*Neolamarckia cadamba* (Roxb.) Bosser	Rubiaceae	Kadamb	109	8	6	12	21.077865, 78.968459	-
		388	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	50	6	4	8	21.077852, 78.968504	LC
		389	*Prosopis juliflora* (Sw.) DC.	Fabaceae	Vilayati Babul	97	8	5	14	21.077799, 78.968394	-
		390	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	46	5	3	6	21.077781, 78.968409	LC
		391	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	53	6	4	7	21.077751, 78.968408	LC
		392	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	49	5	3	8	21.077692, 78.968396	LC

		393	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	58	6	4	9	21.077676, 78.968399	LC
		394	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	61	6	5	9	21.077656, 78.968390	LC
		395	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	39	4	3	5	21.077634, 78.968406	LC
		396	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	57	6	4	9	21.077609, 78.968394	LC
		397	*Prosopis juliflora* (Sw.) DC.	Fabaceae	Vilayati Babul	74	6	6	11	21.077578, 78.968391	-
		398	*Azadirachta indica* A.Juss.	Meliaceae	Neem	103	9	5	15	21.077519, 78.968381	LC
		399	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	31	4	3	5	21.077496, 78.968404	LC
		400	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	45	5	3	5	21.077442, 78.968402	LC
		401	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	60	7	5	8	21.077427, 78.968428	LC
		402	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	53	6	5	8	21.077377, 78.968418	LC
		403	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	45	4	3	6	21.077352, 78.968432	LC
		404	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	39	6	4	5	21.077177, 78.968454	LC
		405	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	59	5	4	7	21.077122, 78.968479	LC
		406	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	117	8	6	19	21.077055, 78.968518	LC
		407	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	54	6	4	7	21.0769579, 78.9685447	LC
		408	*Ficus racemosa* L.	Moraceae	Umbar	135	10	6	29	21.0768403, 78.9686979	LC
		409	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	40	5	3	8	21.0767242, 78.9686926	LC
		410	*Ficus hispida* L.f.	Moraceae	Kala Umbar	23	4	2	5	21.0766870, 78.9688196	LC
		411	*Lagerstroemia speciosa* Pers.	Lythraceae	Tamhan	30	5	3	5	21.0766641, 78.968877	-
		412	*Psidium guajava* L.	Myrtaceae	Common guava (*Peru*)	28	4	2	5	21.0766654, 78.9688616	LC
	RHS	**No Trees**									
Hingane Bus Station	**LHS**	413	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Leguminosae	Siamese Cassia (*Kashid*)	66	6	5	9	21.0723796, 78.9654223	LC
		414	*Holoptelea integrifolia* (Roxb.) Planch.	Ulmaceae	Vavla	20	4	3	5	21.0723796, 78.9654223	-
	Parking LHS	415	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Leguminosae	Siamese Cassia (*Kashid*)	23	4	2	**5**	21.0725107, 78.9650729	LC
		416	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Leguminosae	Siamese Cassia (*Kashid*)	18	3	2	4	21.0725289, 78.9650149	LC
		417	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	31	5	4	6	21.0725289, 78.9650149	LC
	RHS	418	*Ficus religiosa* L.	Moraceae	Pimpal	129	10	6	27	21.0721221, 78.9656962	LC
		419	*Ficus religiosa* L.	Moraceae	Pimpal	147	12	7	39	21.0720461, 78.9656744	LC
		420	*Ficus religiosa* L.	Moraceae	Pimpal	93	7	5	15	21.0720699, 78.9656476	LC
		421	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	70	6	4	11	21.0720574, 78.9656121	LC
		422	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Leguminosae	Siamese Cassia (*Kashid*)	102	13	6	17	21.0721356, 78.9656235	LC
		423	*Melia azedarach* L.	Meliaceae	Bakneem (Chinaberry)	109	10	5	23	21.0720927, 78.9655601	LC
		424	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Leguminosae	Siamese Cassia (*Kashid*)	132	10	6	27	21.0722004, 78.9655098	LC
		425	*Holoptelea integrifolia* (Roxb.) Planch.	Ulmaceae	Vavla	100	9	5	14	21.0721415, 78.9654256	-
		426	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Leguminosae	Siamese Cassia (*Kashid*)	85	6	4	15	21.0721231, 78.9654662	LC
		427	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Leguminosae	Siamese Cassia (*Kashid*)	130	8	5	24	21.0722388, 78.9653988	LC
		428	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Leguminosae	Siamese Cassia (*Kashid*)	49	6	3	7	21.072205, 78.965239	LC
		429	*Cordia dichotoma* G.Forst.	Boraginaceae	Bhokar	53	5	4	8	21.072219, 78.965054	LC
		430	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Leguminosae	Siamese Cassia (*Kashid*)	60	6	4	7	21.072220, 78.964993	LC
		431	*Cordia dichotoma* G.Forst.	Boraginaceae	Bhokar	98	7	5	12	21.072223, 78.964942	LC
		432	*Holoptelea integrifolia* (Roxb.) Planch.	Ulmaceae	Vavla	154	11	7	35	21.0723127, 78.9650652	-
	Parking RHS	433	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Leguminosae	Siamese Cassia (*Kashid*)	38	5	4	**6**	21.0722148, 78.9650438	LC
		434	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Leguminosae	Siamese Cassia (*Kashid*)	136	10	6	24	21.0722980, 78.9649871	LC
		435	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Leguminosae	Siamese Cassia (*Kashid*)	109	9	6	18	21.0723252, 78.9649563	LC
		436	*Pithecellobium dulce* (Roxb.) Benth.	Mimosaceae	Vilayati Chinch	69	7	5	10	21.0723440, 78.9647045	LC
		437	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Leguminosae	Siamese Cassia (*Kashid*)	85	7	4	11	21.0723299, 78.9646786	LC
		438	*Ficus benghalensis* L.	Moraceae	Vad	60	6	4	8	21.0723671, 78.964677	-
Hingana Metro Station	**LHS**	439	*Terminalia catappa* L.	Combretaceae	Deshi Badam	56	6	5	9	21.0742674, 78.9561583	LC
		440	*Polyalthia longifolia* (Sonn.) Thw. var angustifolia	Annonaceae	Ashok	40	5	2	6	21.074240, 78.956511	-
		441	*Psidium guajava* L.	Myrtaceae	Common guava (*Peru*)	25	3	3	5	21.074276, 78.956531	LC
	Parking 1 LHS	442	*Azadirachta indica* A.Juss.	Meliaceae	Neem	139	11	7	35	21.0743081, 78.9566085	LC
		443	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	30	4	3	5	21.0743234, 78.9565277	LC
		444	*Moringa oleifera* Lam.	Moringaceae	Shevaga	42	5	3	6	21.0742567, 78.9565133	LC
	Parking 2 LHS	445	*Azadirachta indica* A.Juss.	Meliaceae	Neem	89	6	5	15	21.0745371, 78.9539317	LC
		446	*Ficus benghalensis* L.	Moraceae	Vad	68	5	4	7	21.0744786, 78.9540155	-
		447	*Millingtonia hortensis* L.f.	Bignoniaceae	Akashneem	101	9	5	13	21.0744441, 78.9540377	-
		448	*Azadirachta indica* A.Juss.	Meliaceae	Neem	70	6	4	7	21.0744876, 78.9541292	LC
		449	*Azadirachta indica* A.Juss.	Meliaceae	Neem	43	4	3	6	21.0744955, 78.9541734	LC

			450	*Azadirachta indica* A.Juss.	Meliaceae	Neem	49	5	3	7	21.0745561, 78.9541483	LC
			451	*Millingtonia hortensis* L.f.	Bignoniaceae	Akashneem	102	8	4	12	21.0746728, 78.9541124	-
			452	*Millingtonia hortensis* L.f.	Bignoniaceae	Akashneem	116	10	5	15	21.0746500, 78.9540675	-
			453	*Leucaena leucocephala* (Lam.) de Wit	Leguminosae	Subabul	98	8	3	10	21.0746616, 78.9539662	-
		RHS	454	*Syzygium cumini* (L.) Skeels	Myrtaceae	Jamun (Indian Blackberry)	19	4	3	5	21.0739968, 78.9562558	LC
			455	*Syzygium cumini* (L.) Skeels	Myrtaceae	Jamun (Indian Blackberry)	33	6	4	5	21.0739993, 78.9562907	LC
		Parking RHS	456	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	23	4	3	**5**	21.0739477, 78.9563484	LC
			457	*Butea monosperma* (Lam.) Kuntze	Fabaceae	Palash	29	5	4	5	21.0738485, 78.9564604	LC
	Along Line 3A	**Median Trees**	458	*Delonix regia* (Hook.) Raf.	Leguminosae	Gulmohar (Flame tree)	136	10	7	34	21.0747251, 78.9686064	LC
			459	*Azadirachta indica* A.Juss.	Meliaceae	Neem	67	6	4	7	21.0734552, 78.967784	LC
			460	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	40	5	3	6	21.073355, 78.967671	LC
			461	*Azadirachta indica* A.Juss.	Meliaceae	Neem	69	6	5	9	21.073334, 78.967684	LC
			462	*Delonix regia* (Hook.) Raf.	Leguminosae	Gulmohar (Flame tree)	110	8	6	17	21.073284, 78.967609	LC
			463	*Azadirachta indica* A.Juss.	Meliaceae	Neem	59	5	4	7	21.0730914, 78.967506	LC
			464	*Alstonia scholaris* (L.) R.Br.	Apocynaceae	Satvin	40	4	3	6	21.0728883, 78.9673632	LC
			465	*Azadirachta indica* A.Juss.	Meliaceae	Neem	43	5	3	7	21.0728883, 78.9673632	LC
			466	*Delonix regia* (Hook.) Raf.	Leguminosae	Gulmohar (Flame tree)	101	8	6	14	21.0728173, 78.9672951	LC
			467	*Syzygium cumini* (L.) Skeels	Myrtaceae	Jamun (Indian Blackberry)	63	6	4	9	21.0725411, 78.9671258	LC
			468	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	31	5	3	5	21.0721231, 78.9667101	LC
			469	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	60	7	5	9	21.0720586, 78.9666172	LC
			470	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	57	6	4	8	21.0720123, 78.9664848	LC
			471	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Leguminosae	Siamese Cassia (*Kashid*)	110	9	6	24	21.0720652, 78.9661837	LC
4A Prajapati Nagar - Transport Nagar	**Pardi Metro Station**	**LHS**	472	*Azadirachta indica* A.Juss.	Meliaceae	Neem	76	7	5	14	21.1497461, 79.1605942	LC
			473	*Pithecellobium dulce* (Roxb.) Benth.	Mimosaceae	Vilayati Chinch	34	5	3	6	21.1498643, 79.1605406	LC
			474	*Polyalthia longifolia* (Sonn.) Thw. var angustifolia	Annonaceae	Ashok	119	8	3	22	21.1498802, 79.1607022	-
			475	*Albizia saman* (Jacq.) Merr.	Leguminosae	Rain Tree	80	7	4	15	21.1497939, 79.1607723	-
			476	*Ceiba pentandra* (L.) Gaertn.	Malvaceae	Savar	20	4	3	5	21.1498665, 79.1607947	LC
			477	*Tabebuia rosea* (Bertol.) Bertero ex A.DC.	Bignoniaceae	Pink Poui	32	5	3	6	21.1500697, 79.1607572	LC
			478	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	29	4	3	6	21.1502429, 79.1608115	LC
			479	*Ceiba pentandra* (L.) Gaertn.	Malvaceae	Savar	22	4	2	5	21.1503558, 79.1608708	LC
			480	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	28	4	3	5	21.1503233, 79.1608437	LC
			481	*Azadirachta indica* A.Juss.	Meliaceae	Neem	18	3	2	5	21.1504068, 79.1608692	LC
			482	*Azadirachta indica* A.Juss.	Meliaceae	Neem	22	4	2	5	21.1504227, 79.1608809	LC
			483	*Ficus religiosa* L.	Moraceae	Pimpal	149	13	9	61	21.1501713, 79.1608215	LC
			484	*Azadirachta indica* A.Juss.	Meliaceae	Neem	188	14	8	49	21.1501401, 79.1608591	LC
			485	*Albizia saman* (Jacq.) Merr.	Leguminosae	Rain Tree	219	13	9	53	21.1500988, 79.1608601	-
			486	*Mangifera indica* L.	Anacardiaceae	Amba	131	10	6	35	21.1501129, 79.1609349	DD
			487	*Albizia saman* (Jacq.) Merr.	Leguminosae	Rain Tree	205	14	8	60	21.1499318, 79.1609124	-
		RHS	488	*Plumeria rubra* L.	Apocynaceae	Lal Chapha	41	6	5	9	21.1493358, 79.1604638	LC
			489	*Albizia saman* (Jacq.) Merr.	Leguminosae	Rain Tree	39	5	3	6	21.1491954, 79.1605081	-
			490	*Albizia saman* (Jacq.) Merr.	Leguminosae	Rain Tree	52	5	4	7	21.1491892, 79.1605738	-
			491	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karanj	39	4	3	5	21.1491488, 79.1605986	LC
			492	*Azadirachta indica* A.Juss.	Meliaceae	Neem	179	13	7	38	21.1490725, 79.1606157	LC
			493	*Peltophorum pterocarpum* (DC.) K.Heyne	Leguminosae	Sonmohar (Copper Pod)	57	6	5	9	21.1491648, 79.1605037	-
			494	*Azadirachta indica* A.Juss.	Meliaceae	Neem	183	11	7	39	21.1490894, 79.1604859	LC
			495	*Azadirachta indica* A.Juss.	Meliaceae	Neem	30	4	2	5	21.1489053, 79.1604853	LC
			496	*Mimusops elengi* L.	Sapotaceae	Bakul	22	3	2	4	21.1488721, 79.160494	LC
	Kapasi Khurd	**LHS**	**No Trees**									
		Parking LHS	497	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Leguminosae	Siamese Cassia (*Kashid*)	48	6	4	9	21.144191, 79.176347	LC
			498	*Azadirachta indica* A.Juss.	Meliaceae	Neem	51	5	3	8	21.144176, 79.176406	LC
			499	*Azadirachta indica* A.Juss.	Meliaceae	Neem	83	6	4	11	21.144156, 79.176545	LC
		RHS	**No Trees**									
	Revised New Station	**LHS**	500	*Delonix regia* (Hook.) Raf.	Leguminosae	Gulmohar (Flame tree)	80	7	6	15	21.143229, 79.179939	LC
			501	*Pithecellobium dulce* (Roxb.) Benth.	Mimosaceae	Vilayati Chinch	77	6	6	12	21.143264, 79.179961	LC
			502	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	34	4	3	5	21.143309, 79.179963	LC
			503	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	30	5	3	5	21.143312, 79.180031	LC
			504	*Pithecellobium dulce* (Roxb.) Benth.	Mimosaceae	Vilayati Chinch	29	4	3	5	21.143289, 79.180017	LC
			505	*Pithecellobium dulce* (Roxb.) Benth.	Mimosaceae	Vilayati Chinch	37	6	5	7	21.143318, 79.180062	LC

			506	*Pithecellobium dulce* (Roxb.) Benth.	Mimosaceae	Vilayati Chinch	18	3	2	4	21.143292, 79.180082	LC
			507	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	29	4	3	5	21.143311, 79.180186	LC
			508	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	24	4	3	5	21.143239, 79.180165	LC
			509	*Prosopis juliflora* (Sw.) DC.	Fabaceae	Vilayati Babul	27	5	3	6	21.143284, 79.180244	-
			510	*Plumeria alba* L.	Apocynaceae	Pandhara chapha	22	4	2	5	21.143257, 79.180296	LC
			511	*Plumeria alba* L.	Apocynaceae	Pandhara chapha	19	4	3	4	21.143216, 79.180279	LC
			512	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	46	6	5	9	21.143192, 79.180350	LC
			513	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	53	6	4	9	21.143227, 79.180381	LC
			514	*Ziziphus jujuba* Mill.	Rhamnaceae	Bor	36	5	3	4	21.143266, 79.180376	LC
			515	*Ziziphus jujuba* Mill.	Rhamnaceae	Bor	20	3	2	4	21.143274, 79.180307	LC
		RHS	516	*Ziziphus jujuba* Mill.	Rhamnaceae	Bor	23	5	4	6	21.142872, 79.179768	LC
			517	*Ziziphus jujuba* Mill.	Rhamnaceae	Bor	17	4	3	5	21.142866, 79.179875	LC
			518	*Ziziphus jujuba* Mill.	Rhamnaceae	Bor	28	5	4	6	21.142784, 79.179742	LC
			519	*Leucaena leucocephala* (Lam.) de Wit	Leguminosae	Subabul	32	3	1	5	21.142792, 79.179766	-
	Transport Nagar Station	**LHS**	520	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Leguminosae	Siamese Cassia (*Kashid*)	65	7	5	9	21.1408579, 79.1942335	LC
			521	*Albizia procera* (Roxb.) Benth.	Fabaceae	Kinhai (White siris)	44	6	4	8	21.1408616, 79.1941805	LC
			522	*Albizia procera* (Roxb.) Benth.	Fabaceae	Kinhai (White siris)	20	4	3	6	21.1408407, 79.1940229	LC
			523	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Leguminosae	Siamese Cassia (*Kashid*)	59	7	5	8	21.1408294, 79.1939737	LC
			524	***Tectona grandis* L.f.**	**Lamiaceae**	**Sag**	**23**	**5**	**3**	**6**	**21.1408253, 79.1939153**	**EN**
		Parking LHS	525	*Acacia leucophloea* (Roxb.) Willd.	Fabaceae	Hivar	50	7	5	10	21.1409216, 79.1940166	-
			526	*Acacia farnesiana* (L.) Willd.	Fabaceae	Devbabul	19	3	2	5	21.1409216, 79.1940166	-
			527	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	23	5	3	6	21.140785, 79.193522	LC
			528	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	29	5	4	5	21.140825, 79.193517	LC
			529	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	31	5	3	6	21.140827, 79.193586	LC
			530	*Acacia nilotica* (L.) Delile	Leguminosae	Babul	40	5	3	7	21.140799, 79.193639	LC
			531	*Prosopis juliflora* (Sw.) DC.	Fabaceae	Vilayati Babul	35	4	2	5	21.140842, 79.193715	-
			532	*Prosopis juliflora* (Sw.) DC.	Fabaceae	Vilayati Babul	32	5	3	4	21.141025, 79.194184	-
			533	*Prosopis juliflora* (Sw.) DC.	Fabaceae	Vilayati Babul	25	5	4	6	21.140945, 79.194193	-
			534	*Prosopis juliflora* (Sw.) DC.	Fabaceae	Vilayati Babul	19	4	3	5	21.140937, 79.194280	-
			535	*Prosopis juliflora* (Sw.) DC.	Fabaceae	Vilayati Babul	26	5	4	6	21.141031, 79.194296	-
			536	*Leucaena leucocephala* (Lam.) de Wit	Leguminosae	Subabul	37	5	4	6	21.141054, 79.194248	-
			537	*Leucaena leucocephala* (Lam.) de Wit	Leguminosae	Subabul	49	6	3	7	21.141049, 79.194135	-
			538	*Leucaena leucocephala* (Lam.) de Wit	Leguminosae	Subabul	33	5	3	6	21.141002, 79.194353	-
		RHS	**No Trees**									

Annexure 8 – List of Utilities to be affected during construction of NMRP Phase II corridors

[Source: Nagpur Metro Rail Project Phase II (NMRP-P2) Detailed Project Report (DPR), November 2019]

WATER SUPPLY AND SEWER LINE UTILITIES

SI	Utility	From Chainage (m)	To Chainage (m)	Side	Affected Length (m)	Dia/Size	Position of Alignment	Remarks
Reach 2A – Automotive Square To Kanhan River								
1	SWD	-550	-750	RHS	-	Storm Water Drain RCC Slab, Depth=2.3’	Parallel	
2	SWD	-640	-950	LHS	-	Storm Water Drain RCC Slab, Depth=2.3’	Parallel	
3	SWD	-625	-855	LHS	475	Storm Water Drain RCC Slab, Depth=2.3’	Parallel	
4	SWD	-1125	-1564	RHS	100	Storm Water Drain RCC Slab, Depth=2.3’	Parallel	Way To Bhandara
5	SWD	-1268	-1496	RHS	375	Storm Water Drain RCC Slab, Depth=2.3’	Parallel	
6	Sewer Line	-1364	-1548	LHS	215	Sewer Line Depth=3.5’, Dia.=12”	Parallel	
7	Sewer Line	-1558	-2056	LHS Crossing		Sewer Line Depth=3.5’, Dia.=12”	Perpendicular	Way To Uppal Wadi
8	Sewer Line	-1658	-2589	RHS	200	Sewer Line Depth=3.5’, Dia.=12”	Parallel	
9	Sewer Line	-1868	-5426	RHS Crossing		Sewer Line Depth=3.5’, Dia.=12”	Perpendicular	Way To Bhandara
10	Sewer Line	Railway Tracks Near Pilli Nadi to Kamptee Nala (Cantonment Area); No Sewer Line Use Only Septic Tank Part By NMC Assi Nagar Area.						
Reach 4A – Prajapati Nagar To Transport Nagar								
1	SWD	364	904	RHS	540	Storm Water Drain Box Slab, Depth=2.5m	Parallel	
2	SWD	364	904	LHS	540	Storm Water Drain Box Slab, Depth=2.5m	Parallel	
3	Sewer Line	989	1114	LHS	125	Outlet Valve Sewer, Depth=15’-20’, Dia.=1.5’	Parallel	
4	Sewer Line	1494	1494	Road Crossing		Covered Drain with Sewer Line	Perpendicular	
5	Sewer Line	1504	1504	Road Crossing		Covered Drain with Sewer Line	Perpendicular	

6	Sewer Line	1504	1734	RHS	230	Covered Drain with Sewer Line	Parallel	Way To Mittal Enclave

** SWD - Storm Water Drain*

DETAILS OF HT CROSSING

SI	Utility	From Chainage (m)	To Chainage (m)	Side	Position of Alignment	Height (m)	Remarks
Reach 1A – MIHAN to MIDC ESR							
1	HT Line	31250		Across	Perpendicular	12.00	
Reach 3A – Lokmanya Nagar to Hingna							
3	HT Line	22143		Across	Perpendicular	8.00	
Reach 4A – Prajapati Nagar To Transport Nagar							
5	HT Line	5775		-	Perpendicular	11.00	

ELECTRICAL (MSEDCL) UTILITIES

SI	Utility	From Chainage (m)	To Chainage (m)	Side	Affected Length (m)	Dia./Size	Position of Alignment	Remarks
Reach 2A – Automotive Square To Kanhan River								
1	Electrical	-654	-789	Road Crossing		33KV (Bhilgaon New Feeder) Cable (2 Nos.) Depth=7’	Perpendicular	
2	Electrical	-687	-889	RHS	80	33KV (Bhilgaon New Feeder) Cable (2 Nos.) Depth=7’	Parallel	
3	Electrical	-688	-895	LHS	50	33KV Cable, Depth=7’	Parallel	
4	Electrical	-874	-1675	Road Crossing		33KV Cable, Depth=7’	Perpendicular	
5	Electrical	-1675	-1800	RHS	125	33KV Cable, Depth=7’	Parallel	
6	Electrical	-1760	-2000	LHS	240	11KV (Khusada Feeder) Cable, Depth=7’	Parallel	
7	Electrical	-2000	-2000	Road Crossing		11KV (Khusada Feeder) Cable, Depth=7’	Perpendicular	
8	Electrical	-2000	-2325	RHS	325	2 Nos. 33 KV Cable, 300 sq.mm, Depth=1m Bhilgaon Sub-Station	Parallel	
9	Electrical	-8450	-8460	RHS	10	11KV, 240 sq.mm Link Cable	Parallel	
10	Electrical	-8775		RHS		11KV, 240 sq.mm, Depth=1m	Parallel	Along the Road NC Office
Reach 3A – Lokmanya Nagar to Hingna								
1	MSEB Nagpur	18526	19584	RHS	380	11 KV U/G Cable	Parallel	

						300 sq.mm Double Circuit Depth=1.2m and O/H Line		
2	MSEB Nagpur	19568	19568	Road Crossing		11 KV U/G Cable 300 sq.mm Double Circuit Depth=1.2m and O/H Line	Perpendicular	
3	MSEB Nagpur	19854	20546	RHS	1295	1 KV U/G Cable 300 sq.mm Double Circuit, Depth=1.2m and 11KV O/H Line Double Circuit	Parallel	
4	MSEB Nagpur	19987	20054	RHS	120	LT U/G CABLE 25 sq.mm, Depth=3.5’	Parallel	
Reach 4A – Prajapati Nagar To Transport Nagar								
1	Electrical	114	604	LHS	490	Sonba Feeder 11KV	Parallel	
2	Electrical	114	604	LHS	490	Taragaon Transformer 11KV	Parallel	
3	Electrical	114	584	LHS	470	2×2 nos. Cable Bhandara 3 & 4, 11KV 300 sq.mm Feeder	Parallel	
4	Electrical	584	584	Road Crossing		2×2 nos. Cable Bhandara 3 & 4, 11KV 300sq.mm Feeder	Perpendicular	
5	Electrical	114	2454	RIGHT SIDE	2340	U/G 2×2 nos. Cable 33KV, 300sq.mm SNDL Electrical Cable, Depth=2m	Parallel	
6	Electrical	614	614	Road Crossing		11KV HB Town Feeder 300sq.mm	Perpendicular	
7	Electrical	614	614	Road Crossing		Gomati Feeder 11KV	Perpendicular	
8	Electrical	614	614	Road Crossing		OTC528	Perpendicular	
9	Electrical	614	1249	LHS	635	11KV Bhawani Feeder 300sq.mm Single Run	Parallel	
10	Electrical	614	1249	LHS	635	11KV Bhawani Feeder 300sq.mm Single Run	Parallel	
11	Electrical	889	889	Road Crossing		11KV HB Town Feeder 300sq.mm Single Run	Perpendicular	
12	Electrical	889	994	LHS	470	11KV Gomti Feeder 300sq.mm, Depth=1m	Parallel	
13	Electrical	994	994	Road Crossing		11KV Gomti Feeder 300sq.mm, Depth=1m	Perpendicular	

14	Electrical	1849	1849	Road Crossing		11KV Rajesh Costing Feeder 300sq.mm		
15	Electrical	2464	2464	Road Crossing		Subhan Nagar 1 & 2, 11KV-300sq.mm	Perpendicular	
16	Electrical	2464	2464	Road Crossing		Double × 2 Wardhaman Nagar 33KV, 300sq.mm	Perpendicular	
17	Electrical	314	2469	LHS	2155	Double × 2 Wardhaman Nagar 33KV, 300sq.mm	Parallel	
18	Electrical	2674	2674	Road Crossing		33KV, 300 SQMM 1NO,CABLE, DEPTH=2.0M	Perpendicular	
19	Electrical	3204	3204	*Nallah* Crossing		11KV, 300sq.mm 2 nos. Cable, Depth=2m	Perpendicular	
20	Electrical	3539	3539	Road Crossing		11KV, 300sq.mm 2 nos. Cable, Depth=2m	Perpendicular	
21	Electrical	4228	4229	Road Crossing		11KV, 300sq.mm 2 nos. Cable, Depth=2m	Perpendicular	
22	Electrical	4329	4414	LHS Fly-Over Crossing	85	33KV, 300sq.mm 2 nos. Cable, Depth=2m	Parallel	

*** U/G = Underground*
O/H = Over-head
LT = Low-Tension
HT = High-Tension

TELECOM (BSNL) UTILITIES

SI	Utility	From Chainage (m)	To Chainage (m)	Side	Affected Length (m)	Dia./Size	Position of Alignment	Remarks
Reach 2A – Automotive Square To Kanhan River								
1	BSNL Optical Fibre Cables (OFC)	-658	-889	RHS	100	22 nos. Duct (Concrete),12 Fibre & 24 Fibre OFC, Depth=1.65M	Parallel	NGP-NARI-KMPT-SSA Cable
2	BSNL Optical Fibre Cables (OFC)	-854	-1054	Road Crossing		22 nos. Duct (Concrete),12 Fibre & 24 Fibre OFC, Depth=1.65M	Diagonal	NGP-NARI-KMPT-SSA Cable
3	BSNL Optical Fibre Cables (OFC)	-985	-1256	LHS		22 nos. Duct (Concrete),12 Fibre & 24 Fibre OFC, Depth=1.65M	Parallel	NGP-NARI-KMPT-SSA Cable
4	BSNL Optical Fibre Cables (OFC)	-2546	-5698	RHS	250	22 nos. Duct (Concrete),12 Fibre & 24 Fibre OFC, Depth=1.65M	Parallel	NGP-NARI-KMPT-SSA Cable
5	BSNL Copper Cables	-1100	-1568	LHS		Duct No. 3, Copper Cable – 200 pairs /	Parallel	Copper Cable

						100 pairs - 2 nos., Depth=1mm		
6	BSNL Copper Cables	-5987	-1650	LHS	1650	Duct No. 7, Copper Cable – 200 pairs - 2 nos., Depth=1mm	Parallel	Copper Cable
7	BSNL Copper Cables	-3568	-1895	Road Crossing	-	Pillar No. 20, Copper Cable – 100 pairs, Depth=1m	Perpendicular	Copper Cable
8	BSNL Copper Cables	-1660	-1660	Road Crossing	-	Barred Crossing, Copper Cable – 50 pairs, Depth=1m	Perpendicular	Bhilgaon T Point
9	BSNL Copper Cables	-1650	-4075	LHS	1425	Duct No. 3, Copper Cable – 200 pairs / 100 pairs - 2 nos., Depth=1mm	Parallel	Copper Cable
10	BSNL Copper Cables	-6400	-7450	LHS	1050	Duct Copper Cable – 50 pairs, 1 no., Depth=1m	Parallel	Asha Hospital to Dragon Palace
11	BSNL Copper Cables	-6400	-7450	RHS	1050	Duct Copper Cable – 100 pairs, 1 no., Depth=1m	Parallel	
12	BSNL Copper Cables	-7450	-8200	RHS	750	Duct Copper Cable – 800 pairs, 1 no., Depth=1m	Parallel	
13	BSNL Copper Cables	-7750	-7750	RHS Crossing	-	Duct Copper Cable – 800 pairs, 1 no., Depth=1m	Perpendicular	
14	BSNL Copper Cables	-7775	-7775	Crossing	-	Duct Copper Cable – 800 pairs, 1 no., Depth=1m		Distribution Line
15	BSNL Copper Cables	-8200	-8475	RHS	275	Duct Copper Cable – 400 pairs, 1 no., Depth=1m		
16	BSNL Copper Cables	-8365	-8365	LHS		Duct Copper Cable – 400 pairs, 1 no., Depth=1m		Distribution Line
17	BSNL Copper Cables	-8465	-8465	LHS		Duct Copper Cable – 200 pairs, 1 no., Depth=1m		Distribution Line
18	BSNL Copper Cables	-8465		RHS		Duct Copper Cable – 100 pairs, 1 no., Depth=1m		Up to Dragon Palace RUB
19	BSNL Copper Cables	-8660	-8925	LHS	265	Duct Copper Cable – 100 pairs, 1 no., Depth=1m		Up to Cantonment Area
20	BSNL Copper Cables	-8660	-8660	Road Crossing		Duct Copper Cable – 100 pairs, 1 no., Depth=1m		Distribution Line
21	BSNL WTR (Long Distance Cable)	-659	-7500	LHS		Duct 22 nos. OFC (12 Fibre / 24 Fibre) Depth=4’	Parallel	NGP-KAMPTEE-RAMTEK Duct
Reach 3A – Lokmanya Nagar to Hingna								
1	BSNL Optical Fibre Cables (OFC)	18564	19700	RHS	4050	BSNL OFC (48 Fibre / 24 Fibre), Depth=1.2m	Parallel	OFC

2	BSNL Optical Fibre Cables (OFC)	20625	20625	RHS Crossing		BSNL OFC (48 Fibre / 24 Fibre), Depth=1.2m	Diagonal	OFC
3	BSNL Copper Cables	20854	20854	LHS	900	BSNL U/G Cable 2000 pairs Copper & 400 pairs U/G Copper Cable, Depth=1.65m	Parallel	Copper Cable
4	BSNL Copper Cables	21548	22548	LHS	1100	BSNL U/G Cable 800 pairs Copper, Depth=1.65m	Parallel	Copper Cable
5	BSNL Copper Cables	21645	21645	LHS	300	BSNL U/G Cable 100 pairs 1 no. Copper & 800 pairs 1 no. U/G Copper Cable, Depth=1.65m	Parallel	Copper Cable
6	BSNL Copper Cables	21849	21849	LHS	900	BSNL U/G Cable 100 pairs 1 no. Copper, Depth=1.65m		Optical Fibre
7	BSNL Copper Cables	22548	22548	Road Crossing	650	BSNL U/G Cable 50 pairs 1 no. Copper, Depth=1.65m		Optical Fibre
8	BSNL WTR (Long Distance Cable)	22654	22654	RHS	4050	BSNL WTR OFC Cable - 12 Fibre / 24 Fibre Depth=1m	Parallel	BSNL WTR
9	BSNL WTR (Long Distance Cable)	23564	23564	RHS Crossing		BSNL WTR OFC Cable - 12 Fibre / 24 Fibre Depth=1m	Diagonal	BSNL WTR
Reach 4A – Prajapati Nagar To Transport Nagar								
1	BSNL Copper Cables			RHS		BSNL U/G Cable 3 nos. (1200 pairs / 400 pairs / 100 pairs) Copper, Depth=1m	Parallel	Copper Cable
2	BSNL Copper Cables			Road Crossing		BSNL U/G Cable 3 nos. (1200 pairs / 400 pairs / 100 pairs) Copper, Depth=1m	Perpendicular	Copper Cable
3	BSNL Copper Cables			LHS		BSNL U/G Cable 3 nos. (1200 pairs / 400 pairs / 100 pairs) Copper, Depth=1m	Parallel	
4	BSNL Copper Cables			LHS Crossing		BSNL U/G Cable 1 no. (100 pairs Copper, Depth=1m	Perpendicular	P-23
5	BSNL Copper Cables			LHS		BSNL U/G Cable 2 nos. (800 pairs / 100 pairs) Copper, Depth=1m	Parallel	
6	BSNL Copper Cables	494	494	Road Crossing		BSNL U/G Cable 2 nos. (400 pairs /	Perpendicular	

						100 pairs) Copper, Depth=1m		
7	BSNL Copper Cables	114	114	Road Crossing		BSNL U/G Cable 3 nos. (200 pairs / 100 pairs / 100 pairs) Copper, Depth=1m	Perpendicular	P-34
8	BSNL Copper Cables	114	114	Road Crossing		BSNL U/G Cable 1 no. (100 pairs Copper, Depth=1m	Perpendicular	To Bhawani Temple
9	BSNL Copper Cables	114	114	RHS	1310	BSNL U/G Cable 4 nos. (100 pairs / 100 pairs / 200 pairs / 400 pairs) Copper, Depth=1m	Parallel	P-34 To Connected P-38
10	BSNL Copper Cables	114	114	Road Crossing		BSNL U/G Cable 1 no. (100 pairs Copper, Depth=1m	Perpendicular	
11	BSNL Copper Cables	114	114	LHS	960	BSNL U/G Cable 1 no. (100 pairs Copper, Depth=1m	Parallel	Up to NMC Naka
12	BSNL Copper Cables	114	114	RHS	660	BSNL U/G Cable 1 no. (50 pairs Copper, Depth=1m	Parallel	To MSEB Office
13	BSNL (OFC+WTR)	-650	-650	LHS Crossing		BSNL (WTR) OFC Cable 40mm Duct 8 nos., 24 Fibre. Depth=1.65m (Open Trench)	Perpendicular	From Kalamna BSNL Exchange
14	BSNL (OFC+WTR)	-650	-700	LHS	50	BSNL (WTR) OFC Cable 40mm Duct 8 nos., 24 Fibre. Depth=1.65m (Open Trench)	Parallel	WTR Cable
15	BSNL (OFC+WTR)	-650	-650	Road Crossing		BSNL (WTR) OFC Cable 40mm Duct 8 nos., 24 Fibre. Depth=1.65m (Open Trench)	Perpendicular	WTR Cable
16	BSNL (OFC+WTR)	-650	3650	RHS	3500	BSNL (WTR) OFC Cable 40mm Duct 8 nos., 24 Fibre. Depth=1.65m (Open Trench)	Parallel	WTR Cable
17	BSNL (OFC+WTR)	3314	4699	RHS	1335	BSNL (WTR) OFC Cable 40mm Duct 8 nos., 24 Fibre. Depth=1.65m (Open Trench)	Parallel	WTR Cable

*** RUB = Railway under Bridge*

Annexure 9A: 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 9B: Guidelines for Muck Disposal

Muck generated from tunnelling and excavation of any project component is required to be disposed in a planned manner so that it takes a least possible space and is not hazardous to the environment. An account of the same has been given in the following paragraphs.

1. Criteria for selection of Muck Disposal Sites:

Based on the geological nature of the rocks and engineering properties of the soil, a part of the muck can be used as construction material. The remaining muck is to be disposed of at muck disposal sites. The identification of muck disposal areas is done in line with the topographic and site specific conditions.

The following points will be considered and followed as guidelines for finalization of the areas to be used as muck disposal sites:

- The dumping sites have been selected as close as possible to the project area to avoid long distance transport of muck.
- The dumping sites are located in already modified habitat.
- The sites are free from possibility of toe erosion and slope instability.
- The dumping sites are either at higher level than the flood level or are away from the river course so that the possibility of muck falling into the river is avoided at all times.
- There is no active channel or stream flowing through the dumping sites.
- The sites are far away from human settlement areas.

The muck that needs disposal is expected to be comprised of fragmented rock mixed with soil and would be piled at an angle of repose less than 30° at the proposed dumping sites. For this, the slopes would be broken up by creating benches across the slope. This will be done to provide stability to the slopes and also to provide ample space for planting trees, which would further help in holding and consolidating the material stacked at different sites. The description regarding the stabilization of the stacked material along the proposed roads has been discussed in the following paragraphs.

The options like dumping muck in stages and allowing it to consolidate/settle through the monsoon, compacting the dumped muck with Dozer movement, zoning the dump judiciously to ensure the stability of 30° slope under all superimposed conditions will be utilised.

2. Methodology of Dumping

The main objectives of process of muck dumping and restoration of these muck disposal sites are:

- to protect and control soil erosion;
- to create greenery in the muck disposal areas;
- to improve and develop the sites into recreational sites;
- to ensure maximum utilization of muck for the construction purpose;
- to develop the muck disposal sites/ dumping yards to blend with the surrounding landscape; and,
- to minimise damages due to the spoilage of muck in the project area.

The generated muck will be carried in dumper trucks covered with heavy duty tarpaulin properly tied to the vehicle in tune with international practice. All precautionary measures will be followed during the dumping of muck. All dumpers will be well maintained to avoid any chances of loose soil from being falling during the transportation. All routes will be periodically wetted with the help of tanker prior to the movement of dump trucks. Dumping would be avoided during the high speed wind, so that suspended particulate matters (SPM) level could be maintained. Further, transportation will be avoided during heavy traffic. After the dumping the surface of dumps will be sprayed with water and then compacted.

A retaining wall shall be constructed prior to dumping of muck. Loose muck would be compacted layer-wise. The muck brought by dumpers will be spread in layers behind the wire crate walls and then compacted by rollers till the top level is achieved. The retaining wall shall be laid with proper berm and the muck dumped behind it in layers and compacted by rollers. The process shall be repeated up to 50 cm level below the desired height which shall be laid with good soil for providing grass cover. At a regular vertical interval of 1.5 m and 3.0 m c/c masonry drains (catch water drains) shall be provided to drain off the rain water. Proper fencing of the entire area will be done. The muck disposal area will ultimately be covered with fertile soil and suitable plants will be planted adopting suitable bio-technological measures. The project authorities would ensure that the dumping yards blend with the natural landscape by developing the site with gentle slope, patches of greenery in and around them. These sites can also be developed later as recreational parks and tourist spots with sufficient greenery by planting trees.

All measures would be adopted to ensure that the dumping of muck does not cause injury or inconvenience to the people or the property around the area. The spillage of muck into water bodies must be prevented at any site, if necessary by making concrete retaining walls to retain the muck pile. It shall be ensured that dumping is carried out at a minimum distance of 50 m away from any water body. The top surface would be levelled and graded after the capacity of any dumping site is exhausted. The top surface will be covered with soil and grass seeding will be ensured to promote vegetation cover.

Annexure 9C: Guidelines for Construction Waste Disposal

1. Purpose:

Solid waste will be generated from the construction site and labour camps during the construction phase. To maximize re-use of material generated during construction and to avoid environmental hazards due to improper disposal of construction waste material the following procedures should be followed for upkeep of storage and disposal sites.

2. Procedure:

- • Municipal waste will be generated from labour camp. Dustbins for recyclable and non-recyclable waste shall be provided in labour camp area. Recyclable waste shall be sold to authorized vendors on a regular basis and non-recyclable shall be disposed off through authorized agency in area responsible for waste collection and management;
- • Construction waste should be segregated into recyclable and non-recyclable waste. Recyclable waste shall be stored in the covered area and shall be sold to authorized vendors on a regular basis. Non-recyclable waste shall be disposed off at approved sites, transported in covered vehicles;
- • Disposal sites shall not contaminate ground water or any surface water sources, therefore the site should be located away from water body and disposal site should be lined properly to prevent infiltration of water;
- • Contractor shall maintain register for keeping records on kilometer-wise quantities of material generated during demolition, excavation and any other activity that generates debris;
- • Contractor shall re-use construction material to the extent possible based on engineering properties. Possible re-use areas are fill sections, embankment slope, approach roads etc. Debris without bitumen could be used for backfilling of quarry / borrow areas as recommended by the GC. At locations identified for dumping of residual bituminous wastes, the dumping shall be carried out over a 60mm thick layer of rammed clay so as to eliminate the possibility of the leaching of the wastes into the ground water. The contractor shall ensure that the filled area is covered with a layer of preserved topsoil.
- • Contractor shall prepare a plan including detailed lay out and cross-section for disposal of debris and bitumen waste and get approval of the same by the GC;
- • Bentonite slurry or similar debris generated from pile driving or other construction activities shall be disposed such that it does not flow into the surface water bodies or form mud puddles in the area;
- • Contractor and GC shall ensure that disposal areas are properly treated as per agreed plan;
- • Contractor and GC's representatives shall undertake joint weekly inspection to ensure compliance of various environmental requirements.
- • GC's representatives shall issue non-compliance if disposal site is not managed as per agreed plan;
- • All arrangement for transportation during construction including provision, maintenance, dismantling and clearing debris, where necessary will be considered incidental to the work and should be planned and implemented by the contractor as approved and directed by the GC.
- • 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. Contractor shall dispose of
- waste strictly at fully legally compliant and approved site/s only. Record of all such sites should be maintained along with the area of disposal site, type & quantity of material disposed of daily and capacity of disposal site.

Annexure 10 - 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

Environmental Impact Assessment

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India: Nagpur Metro Urban Mobility Project

Annexures 11–17

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Annexure 11 - Terms of Reference for Engaging External Monitoring Agency / Expert

A. Background

Project Description: The NMRP Phase II consists of extension of the Phase I corridors resulting in 4 alignments with a total length of around 43.80km, all elevated corridors, with total of 32 stations.

Project Category: The Project is assigned as category A for Environment and Involuntary Resettlement 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.

1MAHARASHTRA METRO RAIL CORPORATION LIMITED

(NAGPUR METRO RAIL PROJECT, PHASE-II)

BID DOCUMENTS

FOR

Name of the Work: ----------

TENDER NO. --------/2021

PART 3:
CONDITIONS OF CONTRACT AND CONTRACT FORMS
Section XI: SHE Manual

Maharashtra Metro Rail Corporation Limited

Metro Bhawan, East High Court Road (VIP Road),

Near Dikshabhoomi, Ramdaspeth, Nagpur-440010,

Maharashtra, INDIA

Website: www.metrorailnagpur.com

LIST OF CONTENTS

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 Nagpur 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:

(i) The land where work will be carried out, or

(ii) the land necessary for the implantation of Worksite facilities (work camp, workshops, offices, storage areas, concrete production plants) and including special access roads, or

(iii) quarries for aggregates, rock material and riprap, or

(iv) borrow areas for sand and other selected material, or

(v) stockpiling areas for backfill material or other demolition rubble, or

(vi) 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 Nagpur 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 all aspects 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.

1.4 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: 2004 Environmental Management Systems. Definition of key terms used in these requirements related to **ISO 45001-2018** and ISO 14001 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

(ii) National Building Code, 2005

(iii) Factories Act, 1948, Maharashtra Government Factories Rules, 1963

(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

(vi) Indian Road Congress Code IRC: SP: 55-2001 'Guidelines on Safety in Road Construction Zones'

(vii) The Petroleum Act, 1934 and Rules 1976

(viii) Gas Cylinder Rules, 2003

(ix) Indian Explosives Act, 1884, along with the Explosives substance Act 1908 and the Explosives Rules 1983

(x) The (Indian) Boilers Act, 1923

(xi) The Public Liability Insurance Act 1991 and Rules 1991

(xii) Minimum Wages Act, 1948 and The Minimum Wages (Maharashtra Rules) 1961

(xiii) The Contract Labour (Regulation & Abolition) Act 1970 & The Contract Labour (P&R) (Maharashtra) Rules, 1972

(xiv) The Child Labour (Prohibition & regulation) Act 1986 and Maharashtra Rules 1994

(xv) Environment Protection Act, 1986 and Rules 1986

(xvi) Air (Prevention and control of Pollution) Act, 1981

(xvii) Water (Prevention and Control of Pollution) Act, 1974

(xviii) The Noise Pollution (Regulation & Control) Rules, 2000

(xix) Notification on Control of Noise from Diesel Generator (DG) sets, 2002

(xx) Recycled Plastic Usage Rules, 1998

(xxi) Notification, Central Ground Water Board, Act January 1997

(xxii) The Manufacturing, Storage, and Import of Hazardous Chemical Rules, 1989

(xxiii) Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996

(xxiv) The Hazardous Waste (Management, Handling& Trans-boundary Movement) Rules, 2007

(xxv) Relevant Rules / Guidelines regarding Preservation of Trees

(xxvi) Batteries (Management and Handling) Rules

(xxvii) Fly ash utilization notification, Sept 1999 as amended in August 2003

(xxviii) Guidelines of Nagpur Urban Development Authority

(xxix) Guidelines of Maharashtra Pollution Control Board

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 clause 3.4.2 below.

3.4.2 The specialised international organisations affiliated to the United Nations referred to in Clause 9.2 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 14001-2004 : Environmental Management Systems.

3.4.4 The process of certification shall start immediately after the award of the work and complete within reasonable time. 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.

3.4.5 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 TwentyOne (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 SHE POLICY AND PLAN

4.1 The Contractor as per Section 39 of the BOCW Act shall formulate a SHE policy and get it approved by DG/CIIBC and display it at conspicuous places at work sites in Hindi and local languages understood by the majority of construction workers.

4.2 Within 4 weeks of the notification of acceptance of the tender, the Contractor shall submit a detailed and comprehensive Contract specific SHE Plan. The SHE Plan shall include detailed policies, procedures, and regulations which, when implemented, will ensure compliance of the contract provisions. The SHE Plan shall include the following but not be restricted to:

(i) A statement of the Contractor’s policy, organisation, and arrangements for SHE

(ii) The name(s) and experience of person(s) within the Contractor's proposed management who shall be responsible for co-ordinating and monitoring the Contractor's SHE performance;

(iii) The number of SHE staffs 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 SHE 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 SHE 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 SHE related matters, and

(xi) A statement of the Contractor's procedure for reporting and investigating accidents, dangerous occurrences, or occupational illnesses

4.3 The Contractor shall, from time to time and as necessary are required by the Employer to produce supplements to the SHE Plan such that it is at all times a detailed, comprehensive and contemporaneous statement by the Contractor of his site safety, industrial health and environment obligations, responsibilities, policies and procedures relating to work on Site. Any and all submissions of supplements to the SHE Plan shall be made to the Employer in accordance with the agreed procedures.

4.4 If at any time the SHE Plan is, in the Employer's opinion, insufficient or requires revision or modification to ensure the security of the Works and the safety of all workmen upon and visitors to the Site, the Employer may instruct the Contractor to revise the SHE plan and the Contractor shall within 7 days submit the revised plan to the Employer for review.

4.5 Any omissions, inconsistencies, and errors in the SHE Plan or the Employer's acceptance or rejection of the SHE Plan and/or supplements thereto shall be without prejudice to the Contractor's obligations with respect to site safety, industrial health and environment and shall not excuse any failure by the contractor to adopt proper and recognised safety practices throughout the execution of the Work.

4.6 The Contractor shall adhere to the SHE Plan and shall ensure, as far as practically possible, that all sub-contractors of all tiers require that contracting parties each have a copy of the Site SHE Plan and comply with its provisions.

4.7 The details of contents to be covered in the site SHE 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 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

5.3.1 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

5.4.1 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.

5.4.2 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

5.5.1 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 SHE personnel as prescribed in General Instruction MAHA-METRO/SHE/GI/001 (enclosed at the end) based upon the statutory requirement and establish the safety 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 full time Labour Welfare Officer duly qualified and experienced as per Clause 6.1.1.

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 56.0 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 Employer 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 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 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 Terms of Reference

7.2.1 The Terms of Reference for the committee shall be as follows:

(i) To establish company safety policies and practices

(ii) To monitor the adequacy of the contractor's site SHE Plan and ensure its implementation

(iii) To review SHE training

(iv) To review the Contractor's monthly, SHE report.

(v) To identify probable causes of accident and unsafe practices in building or other construction work and to suggest remedial measures

(vi) 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.

(vii) To go round the Construction Site with a view to check unsafe practices and detect unsafe conditions and to recommend remedial measures for their rectifications including first-aid medical and welfare facilities.

(viii) Committee team members should perform a site inspection before every committee meeting and to monitor SHE inspection reports.

(ix) 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

(x) To suggest measures for improving welfare amenities in the construction site and other miscellaneous aspect of safety, health, and welfare in building or other construction work.

(xi) To look into the health hazards associated with handling different types of explosives, chemicals, and other construction materials and to suggest remedial measures including personal protective equipment.

(xii) To review the last safety committee meeting minutes and to take action against persons/sub-contractors for non-compliance if any

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	SHE Manager (In-charge)
Members	i) Labour Welfare Officer ii) In charge of plant and machinery iii) In charge of site electrics iv) In charge of stores. v) Senior Managers/ Engineers heading different sub functions. vi) Sub – contractor's representative vii) Labour Contractor's representative viii) Workers' representative ix) Co-contractor representative. x) SHE staffs
Employer's Representatives	MAHA-METRO SHE 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	SHE Manager (In-charge)
Members	(i) Labour Welfare Officer (ii) In charge of plant and machinery (iii) In-charge of site electricity (iv) Senior Managers / Engineers heading different sub functions (v) Sub- Contractor's representative

	(vi)	Labour contractor's representative
	(vii)	Workers' representatives
	(viii)	All 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) Matters arising

(x) Any other business

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/fax 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

8.3 Contractor shall also issue a 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 TRAINING

9.1 The behaviour of people at all levels of the Contractor is critical for SHE performance.

9.2 The Contractor shall organise quality SHE training to engage Managers, supervisors and other personnel in behavioural change and improve safety performance.

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 SHE responsibilities

(ii) Specification of qualifications, competency, and training requirements for all personnel

(iii) Assessment and recording of training needs for all personnel, including subcontractors' employees in the workforce, vendor representatives and site visitors

(iv) A system for assessing new hirers e.g., previous training

(v) A means of confirming that the system is effective

(vi) A matrix and schedule of training requirements, covering general, task–specific and SHE-related training, showing the training frequency and interval between refresher courses

(vii) 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 Employer 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.

9.15 Records of all training conducted shall be maintained and made available for inspection and monitoring.

10.0 SHE INSPECTION

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 inspections 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 committee Inspection.

(ii) Weekly safety inspection by construction supervisors (Contractors and Sub-contractors)

(iii) Daily safety inspection by contractor site SHE 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) 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.

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 site SHE management team

10.3.5 The Contractor shall prepare all required safety inspection checklist for all activity operations and equipment. Checklists will be prepared based on the Indian standards, rules and regulations and Employer's requirements. The formats provided in the Project SHE manual may be referred.

10.3.6 All inspection records and reports will be properly kept and filed for audit purpose. Inspection reports of Planned General Inspection and Routine Inspection will be used for discussion during Safety Committee Meetings.

10.3.7 Safety Inspection report and its compliance shall be submitted to employer in given specific time without fail.

11.0 SHE AUDIT

11.1 General

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.

11.2 Monthly 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 SHE 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 SHE Audit

11.4.1 External SHE audits are to be conducted by external agencies that are competent with ISO qualified auditors 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 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 SHE audits shall be conducted on a quarterly basis throughout the currency of the Contract.

11.4.4 Targets of SHE Audit

The contents and coverage of the external audit shall include the following items

11.4.4.1 SHE management

(i) Organization
(ii) Communication and Motivation
(iii) Time office
(iv) Inspection
(v) Emergency preparedness
(vi) Budget allocation
(vii) Education and Training
(viii) Work permit system

11.4.4.2 Technical

(i) Building and Structure
(ii) Construction operational safety
(iii) Material safety
(iv) Hand tools and Power tools
(v) Electrical system
(vi) Safety Appliances
(vii) Fire prevention and control
(viii) Housekeeping

(ix) Maintenance and Machinery safety
(x) First-aid and Medical Facilities
(xi) Welfare measures
(xii) Environmental Management

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) SHE policy
(ii) SHE manual
(iii) SHE Rules and Regulation
(iv) SHE organization chart
(v) Annual SHE objectives / programs
(vi) Accident / near miss statistics and analysis
(vii) SHE Training program / records for all personnel
(viii) Operating manuals and maintenance manual of all equipments
(ix) Safe worthiness certificates of all lifting appliances and gears
(x) Medical fitness record for all personnel
(xi) Risk identification, assessment, and control details
(xii) Environmental management reports
(xiii) Emergency management records including mock drill

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.

11.4.10 Failure of Contractor to conduct External SHE Audit

11.4.10.1 If the Contractor fails to conduct the external, SHE audit in time, the Employer at the cost of Contractor shall get it done.

12.0 SHE COMMUNICATION

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, Englishand 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/008and 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 SHE Report (as given in Clause 13.3)
(iii) SHE Committee Meeting Minutes (as given in Clause 7.9.1)
(iv) SHE Inspection Reports
(v) SHE Audit Reports
  a. Monthly Audit Rating Score (MARS) report
  b. External SHE Audit
  c. Electrical Safety Audit
(vi) Air and Noise Quality monitoring report

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 7th of next month to the Employer as specified in the Project SHE Manual.

(i) Monthly man-hour details as specified in the Project SHE manual
(ii) Monthly accident / incident details as specified in the Project SHE manual
(iii) SHE committee details
(iv) Details of SHE training conducted in the month
(v) SHE Inspection
(vi) SHE internal audit details like electrical audit etc.
(vii) SHE Communication activities under taken in the month indicating the number of posters displayed and balance availability in stock.
(viii) Air quality
(ix) Toolbox talks details
(x) PPE details: Quantity purchased, issued to the workmen and stock available.
(xi) Details on IP 44 panel boards, lighting poles, welding and cutting equipments, Ladders, Hoists, tools & tackles.
(xii) Monthly Lux meter study results
(xiii) Housekeeping
(xiv) Barricade maintenance details
(xv) No of critical excavations
(xvi) Health & Welfare activities
(xvii) Safety walk conducted by Contractors' Project Manager in the month
(xviii) SHE Activities Planned for next month

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.

14.3.2 Procedure of incident investigation

14.3.2.1 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.

14.3.2.2 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.

14.3.2.3 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

16.1 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.

16.2 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

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:

(iii) a guard-rail, toe-board, barrier, or similar collective means of protection
(iv) a working platform
(v) a net, airbag, or other collective safe guard for arresting falls
(vi) personal fall protection system
(vii) 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 Clause18.15

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, where necessary to prevent injury to any person, 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.

18.10.3 theContractor 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.

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.

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 Nagpur 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

All Vehicles shall be fitted with audible reverse alarms and 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".

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 • 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) • Wide angle flood (fan shaped beam) • Medium or narrow angle flood (Conical beam)
3	Dispersive lighting	Lighting for indoor	• Dispersive (Mercury florescent) • Cargo cluster • Florescent trough
4	Walkway lighting	Lighting for stairways, ladder ways, corridors, scaffold access routes, etc.	• Well glass unit • Bulkhead unit (tungsten filament) • Bulk head unit (Florescent)
5	Local lighting	Lighting on sites and fittings are generally accessible to operatives	• PAR (Parabolic Aluminised Reflector) lamp cluster • Festoons (with or without shades) • Adjustable florescent work lamp • 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.

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.

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 The batching plant / casting yard shall be barricaded and made as a compulsory PPE zone

38.3 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.

38.4 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.

38.5 Drainage shall be effectively provided and waste water shall be disposed after proper treatment

38.6 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.

38.7 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.

38.8 The PPEs provided to cement handling workmen shall conform to international standards.

38.9 Access roads and internal circulation roads shall be well laid and maintained properly at all time.

38.10 Non-adherence to any of the above provision shall be penalised as per relevant penalty clause.

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: (a) Background in fluorescent orange-red in colour (b) Two vertical green strips of 5cm wide on front side, covering the torso at least 500 cm2 (c) Two diagonal strips of 5 cm wide on back in an 'X' pattern covering at least 570cm2	Hi-visibility jacket covering upper body and meeting the following requirements as per BS EN 471:1994: (a) Background in fluorescent orange-red in colour (b) 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

All employees of the Contractor including workmen	Traffic marshals
(d) Horizontal strips not less than 5cm wide running around the bottom of the vertical strip in front and 'X' pattern at back. (e) The bottom strip shall be at a distance of 5cm from the bottom of the vest. (f) Strips must be retro reflective and fluorescent (g) Waistcoat shall have a side adjustable fit and a side and front tear-away feature on vests made of nylon.	shall not be less than 5cm from the bottom of the sleeve. (c) Two vertical green strips of 5cm wide on front side, covering the torso at least 500 cm2 (d) Two diagonal strips of 5 cm wide on back in an 'X' pattern covering at least 570cm2 (e) Horizontal strips not less than 5cm wide running around the bottom of the vertical strip in front and 'X' pattern at back. (f) The bottom strip shall be at a distance of 5cm from the bottom of the vest. (g) 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.

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 As indicated earlier in this Manual, the Engineer shall undertake regular audits at quarterly intervals, of the Contractor's onsite practices and procedures as a means of assessing the ongoing performance of the Contractor.

40.5 The criteria against which the audits will be undertaken shall be derived from the clauses within the Environment Protection Requirements, contract-specific Site Environmental Plan and previous site inspection results.

40.6 In addition to the quarterly audits by the Engineer, site inspection shall be undertaken by the Contractor's staff to inspect the construction activities in order to ensure that appropriate environmental protection and pollution control measures are properly followed and implemented.

40.7 The frequency of site inspection shall be at least once a week.

40.8 The Contractor shall prepare an 'Environmental Inspection and Action Reporting System' and submit to the Engineer for approval and make amendments as suggested. It shall contain a contract specific comprehensive Environment Inspection checklist as requirement of Site Environmental Plan.

40.9 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.

40.10 Results of inspection shall be discussed with Engineer and his recommendations on better environmental protection shall be notified to the Contractor for taking immediate action and rapid resolution of identified non-compliance.

40.11 If significant environmental problems are identified or if there is an environmental complaint or as a part of investigation work, then the Engineer shall also carry out ad hoc site inspection which shall be attended by Contractor's Representative.

40.12 Reporting System

40.12.1 Reporting under the Environmental Management System will contain results of monitoring and inspection programs.

40.12.2 In Site Environmental Plan, the Contractor shall prepare and submit monthly Environmental Quality Management Reports in accordance with requirements as per Contract.

40.12.3 The monthly report shall include (but not limited to) the following:

a. Executive Summary

b. Brief mention of construction activities

c. Monitoring results under AMCP

d. Interpretation of monitoring results, significance and influencing factors

e. Graphical representation of monitored results over past four reporting periods.

f. Measures to control spill under Spill Prevention and Control Plan (SPCP).

g. Action taken on recommendations under site inspection programme or specific directions.

h. Summary of complaints, results of investigations and follow-up action

i. Future key issues

40.13 Complaint Response Process

40.13.1 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.

40.13.2 The objective of complaint process is to ensure that public and agency complaints are addressed and resolved consistently and expeditiously.

40.13.3 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.

40.13.4 Field investigation should determine whether the complaint has merit, and if so, action should be taken to address the impact.

40.13.5 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.

40.13.6 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.

40.14 Completion of the EQM Programme

40.14.1 The construction of Project will be undertaken as a series of individual construction contracts with necessarily different construction program and completion dates.

40.14.2 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.

40.14.3 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.

40.14.4 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.

43.0 NOISE

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. The noise levels at adjacent locations (at receiver) external to the stations/Viaduct shall meet the latest requirement of statutory standards of CPCB/SPCB/MoEFCC.

43.1.1 Without prejudice to the generality of the foregoing, noise level reduction measures shall include the following:

(i) 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.

(ii) 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 day-time and night-time shall not exceed the maximum permissible noise limits, whether continuously or intermittently, as given in the project SHE Manual. 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.

43.1.3 The noise monitoring requirements are given in the project SHE Manual and the monitoring locations shall be identified.

43.2 Noise Monitoring

43.2.1 The activities which are expected to cause noise during the construction of Project, include noise from construction equipment, construction activities such as portal construction, boring for piling, earthwork excavation, concreting, viaduct construction (including shifting of launching truss / girder)

and removal of spoil and movement of construction vehicles and delivery vehicles, travelling to and from the construction and disposal sites. The noise levels shall be monitored at each construction work site in every 15 days uniform intervals.

43.2.2 The level of impact of these noise sources depends upon the noise characteristics of the equipment and activities involved the construction schedule, and the distance from noise sensitive receptors.

43.2.3 The Noise Monitoring Control Plan (NMCP) will provide guidance for construction activity. It shall also address noise performance criteria used in the selection of construction equipment.

43.2.4 The Noise Control Plan shall provide for:

(i) Definition of noise-sensitive uses in the zones affected by construction;

(ii) Calculation of future noise levels at the closest noise-sensitive receptors to the construction activity based on construction activity and ambient noise levels;

(iii) Evaluation and specification of the noise abatement measures that can be applied to meet the noise objectives;

(iv) Monitoring construction activity and providing adjustments to noise abatement controls that may be required to increase their effectiveness;

(v) It shall specify the nighttime and daytime construction activities.

43.2.5 In defining the requirements of the NMCP, available measures for noise control, such as, the use of equipment with special exhaust silencers or enclosures, and the construction of temporary enclosures or noise barriers around specific construction site activity areas shall be considered. It should also specify the measures to be adopted to counter the impact of noise pollution for public and workers working at site during construction.

43.2.6 If the measured noise levels exceed the noise limits, the noise levels shall be reduced by appropriate abatement measures.

43.2.7 The Engineer shall monitor Contractor's performance of tasks specified, and will inspect the procedures related to the control of noise.

43.2.8 In no case shall the Contractor expose the public to construction noise levels exceeding 90dBA (slow) or to impulsive noise levels with a peak sound pressure level exceeding 140dB as measured on an impulse sound level meter.

43.2.9 Limit for construction noise is based on the existing ambient noise levels in areas adjoining the construction sites.

43.2.10 The noise levels emanating from any source during construction, shall not exceed 5 dBA or more above existing ambient pre-construction noise levels. The same may be varied from time to time by and at the sole discretion of the Engineer.

43.2.11 Where there are no ambient noise measurements, the construction activities shall be limited to levels at a distance of 200 feet from the construction limits or at the nearest affected building, whichever is closer, as given in Table-2.

Table 2: Allowable Construction Noise

Land Use	**Maximum Noise Level L_{max}dBA**	
	Day Time	**Night Time**
Residential	75	65
Commercial (all times)	85	
Industrial (all times)	90	

43.2.12 At the surface of the construction site during night time hours, the Contractor shall use only equipment that operating under full load meets the noise limits specified in Table3, if a sensitive receptor would be affected.

Table 3: Noise Emission Limits for Construction Equipment used during night hours (Measured at 50 feet from Construction Equipment)

SN	Equipment Category	L_{max} Level dBA
1.	Backhoe	80
2.	Bar Bender	75
3.	Chain Saw	81
4.	Compactor	80
5.	Compressor	80
6.	Concrete Mixer	85
7.	Concrete Pump	82
8.	Crane	85
9.	Dozer	85
10.	Front end loader	80
11.	Generator	82
12.	Gradall	85
13.	Grader	85
14.	Paver	85
15.	Pneumatic tools	85
16.	Scrapper	85
17.	Tractor	84

Noise emission limits apply to equipment used at surface of the construction site during night time hours of 9 pm to 6 am.

43.2.13 The adjustments for close-in equipment noise shall be made in accordance with Table4.

Table 4: Adjustments for Close-in Equipment Noise

Distance (Feet)	Level to Estimate Sound Level at 50 Feet dB (A)
19-21	8
22-23	7
24-26	6
27-29	5
30-33	4
34-37	3
38-42	2
43-47	1
48-50	0

Table 5: Construction Vibration Limits (Vibration Type and Permissible)

Aggregate Duration	Limit
Sustained (1 hour / day)	0.01 in/sec (80 VdB re 10^{-6} in/sec)
Transient (< 1 hour / day)	0.03 in/sec (90 VdB re 10^{-6} in/sec)
Transient (< 10 minutes / day)	0.10 in/sec (100 VdB re 10^{-6} in/sec)

43.2.14 When Diesel Generator (DG) Sets are used for operation of equipment and machinery, then 'Standards and Guidelines for control of Noise Pollution from Stationery DG Sets', under Environment (Protection) Act, 1986 shall apply.

43.2.15 Where the Engineer determines that the recorded Noise level is significantly greater than the acceptable levels, the Engineer may direct the Contractor to take effective remedial measures including, but not limited to, reviewing noise sources, and modifying working procedures.

43.2.16 The Contractor shall inform the Engineer of all steps taken to investigate cause of exceedance and immediate action taken to avoid further exceedance through written reports and proposals for action under an Event Contingency Plan.

43.3 Control Requirements

43.3.1 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.

43.4 Occupational Noise

(i) Protection against the effects of occupational noise exposure should be provided when the sound level exceeds the threshold values as provided in Project, SHE Manual.

(ii) When employees are subjected to sound levels exceeding those listed in the Table above, feasible administrative or engineering controls should be utilized as given in this document and MAHA-METRO’s Project SHE Manual.

(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 computations, as given in project SHE Manual.

43.5 Vibration Level

43.5.1 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.

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.

45.6 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

45.7 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 should be properly disposed.

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 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

47.1 Environmental Monitoring

47.1.1 The Contractor's Environmental Team shall carry out the monitoring of environmental impacts during construction. Representative sensitive receivers in the vicinity of the works shall be monitored for air quality impacts.

47.1.2 For carrying out impact monitoring for air, equipment shall be provided, operated, and maintained by the Contractor. The equipment shall be kept in a good state of repair in accordance with the manufacturer's recommendations and maintained in proper working order with sufficient spare equipment available in the event of breakdown to maintain the planned monitoring program.

47.1.3 The calibration of monitoring instruments and their respective calibrators shall be carried out in accordance with the manufacturer's requirements to ensure they perform to the same level of accuracy as stated in the manufacturer's specifications.

47.1.4 Environment Parameter (Air Quality) levels shall be monitored & measured as per Guidelines for Manual Sampling & Analyses (National Ambient Air Quality Series: NAAQMS/36/2012-13), CPCB

47.1.5 24-hour average PM concentration shall be measured by drawing air through a High-Volume Sampler (HVS) fitted with pre-weighted Glass Fibre filter paper at an average flow rate not less than 1.1m^3 per minute.

47.1.6 The minimum requirements to the specifications of sound level meter should be as given in IS: 9779-1981. (However, monitoring is deleted).

47.1.7 Engineer will undertake baseline monitoring to establish background levels. Action Level of the Contractor shall be based on the results of baseline monitoring program, which will be made available to him prior to start of construction.

47.1.8 The Contractor's monitoring program is summarized in Table 1.

Table 1: Summary of Contractor's Monitoring Programme

Parameter	**Air**
Sampling	PM10, PM2.5, SO2 & NOx 24-hours of the day CO: 12 hours from 0800 to 2000 hrs
Frequency at each location	Two 24-hour samples every 15 days at uniform intervals
Locations	To be determined by the Contractor in consultation with Envr. Expert/GC or Maha-Metro based on sensitive receptors
Number of locations	At every working site
Duration of Monitoring by Contractor	During civil construction
Additional Requirements	Ad hoc monitoring as required

Monitoring Reports should be submitted every month along with the Monthly SHE Report

47.2 Event Contingency Plan

The Contractor shall prepare an Event Contingency Plan under his Site Environmental Plan. The purpose is to provide, in addition to monitoring activities, procedures for ensuring that if any environmental exceedance of limiting values (either accidental or through inadequate implementation of mitigation measures on part of the Contractor) does occur, the cause is quickly identified and remedied, and that the risk of a similar event recurring is reduced.

47.3 Air Quality

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

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

47.3.3 If after commencement of construction activity, Employer believes that the Contractor's equipment or methods of working are causing unacceptable air pollution impacts then these shall be inspected and remedial proposals shall be drawn up by the Contractor, submitted for review to the Employer and implemented.

47.3.4 In developing these remedial measures, the Contractor shall inspect and review all dust sources that may be contributing to air pollution. Remedial measures include use of additional / alternative equipment by the Contractor or maintenance / modification of existing equipment of the Contractor.

In the event that approved remedial measures are not being implemented and serious impacts persist, the Employer may direct the Contractor to suspend work until the measures are implemented, as required under the Contract.

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

47.3.6 The Contractor shall establish and maintain records of routine maintenance program for internal combustion engine powered vehicles and equipment used on this project. He shall keep records available for inspection by Employer.

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

47.3.8 The Contractor shall promptly transport all excavation disposal materials of whatever kind so as not to delay work on the project. Stockpiling of materials will only be allowed at sites designated by the Employer. The Contractor shall place excavation materials in the dumping/disposal areas designated in the plans as given in the specifications.

47.3.9 The temporary dumping areas shall be maintained by the Contractor at all times until the excavate is re-utilised for backfilling or as directed by Employer. Dust control activities shall continue even during any work stoppage.

47.3.10 The Contractor shall place material in a manner that will minimize dust production. Material shall be minimized each day and wetted, to minimize dust production. During dry weather, dust control methods must be used daily especially on windy, dry days to prevent any dust from blowing across the site perimeter.

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

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

47.3.13 The Contractor shall design and implement his blasting techniques so as to minimise dust, noise, vibration generation and prevention fly rock.

47.3.14 Blasting technique should be consistent not only with nature and quaintly of rock to be blasted but also the location of blasting.

47.3.15 The Contractor shall give preference to explosives with better environmental characteristics.

47.3.16 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.

47.3.17 The Contractor shall submit to the Employer an Air Monitoring and Control Plan (AMCP) under contract specific Site Environmental Plan to guide construction activity insofar as it relates to monitoring, controlling and mitigating air pollution.

47.4 Air Monitoring

47.4.1 Construction activities that will generate dust impacts include excavation (including related activities), material handling and stockpiling, vehicular movement, and wind erosion of unpaved work areas.

47.4.2 The impact of fugitive dust on ambient air pollution depends on the quantity generated, as well as the drift potential of the dust particles injected into the atmosphere. Large dust particles will settle out near the source and smaller particles are likely to undergo dispersal over greater distance from the sources and impeded settling. SPM levels will be monitored to evaluate the dust impact during the construction phase of the Project.

47.4.3 The Air Quality Monitoring and Control Plan (AMCP) in contract-specific Site Environmental Plan prepared by the Contractor shall establish procedures to monitor impact air quality and measures to control air pollution including dust suppression due to construction activities at work sites. This plan shall contain description of activities that will cause degradation in air quality, environmental procedures to manage pollutants to minimise the air pollution, monitoring program, record keeping and reporting.

47.4.4 The Engineer shall monitor Contractor’s performance of tasks specified, and will inspect necessary records, reports and procedures related to the control of air quality given in AMCP.

47.4.5 Information gathered during the AMCP will be catalogued and maintained by the Contractor and shall be available for review by the Engineer.

47.4.6 The exact location of the air monitoring stations located near air sensitive receptors adjoining the construction sites, such as residences, schools, hotels and hospitals and placement of monitoring equipment thereat shall be agreed with the Engineer prior to commencement of air monitoring program.

47.4.7 Impact monitoring during the course of the Works shall be carried out at the monitoring stations for two days (continuous twenty-four hours) every fifteen days and where there is a perceived air quality problem.

47.4.8 The Contractor shall construct suitable fence, lockable gate, 220V AC power point and suitable access at each air monitoring station. Monitoring stations shall be free from local obstructions or sheltering.

47.4.9 Should impact monitoring record dust levels which are:

- indicative of a deteriorating situation such that closer monitoring is reasonably indicated, or

- when in the opinion of the Engineer additional measurements are required in view of deteriorating air quality,

Then the Engineer may require the Contractor to increase the frequency of impact monitoring at any one or more of the monitoring stations until the results indicate an improving and acceptable level of air quality.

47.4.10 The Contractor shall keep records of air quality monitoring (including location, date, time). The Contractor shall submit a copy of monitoring results to the Engineer. The results should represent a statistical evaluation of data by calculating maximum, minimum, mean, standard deviation, geometric mean, and percentile calculations for evaluation of frequency distribution, trends, and comparison with emission standards.

47.4.11 The National Ambient Air Quality Standards given in Air (Prevention and Control of Pollution) Act, 1981 may be referred by the Contractor for Limit Levels of SPM in ambient air which may be followed in estimating the pollution level caused by Contractor's activities.

47.4.12 Where the Engineer determines that the recorded dust level is significantly greater than the Limit levels, the Engineer may direct the Contractor to take effective remedial measures including, but not limited to, reviewing dust sources, and modifying working procedures.

47.4.13 Where the recorded baseline levels exceed the ambient air quality standards, then at such locations the action level is the recorded base line. 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 Engineer.

47.4.14 The Contractor shall inform the Engineer of all steps taken to investigate cause of accidence and immediate action taken to avoid further accidence through written reports and proposals for action under an Event Contingency Plan.

48.0 WATER QUALITY

48.1 The Contractor shall comply with the Indian Government legislation and other State regulations in existence in Nagpur insofar as they relate to water pollution control and monitoring. A drainage system should be constructed at the commencement of the Works, to drain off all surface water from the work site into suitable drain outlet.

48.2 The Contractor shall provide adequate precautions to ensure that no spoil 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 and drains within or adjacent to the site. In the event of any spoil or debris from construction works being deposited or any silt washed down to any area, then all such spoil, 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.

48.3 Due to lowering of potable water supplies in Nagpurand subsequent contamination of ground water, 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 and this water may subsequently be discharged to the drainage system or, if not re-used, recharged to the ground water at suitable aquifer levels. The Contractor must submit his proposals for approval of Employer, on his proposed locations of dewatering of excavation and collection of water for either construction re-use or recharge directly to aquifers. The Contractor's recharge proposals must be sufficient for recharging of the quantity of water remaining after deduction of water re-used for construction. During dewatering, the Contractor shall monitor ground water levels from wells to ensure that draw down levels do not exceed allowable limits. The Contractor will not be permitted to directly discharge, to the drainage system, unused

ground water obtaining from the excavation without obtaining approval of Employer or the Agency controlling the system.

48.4 The Contractor shall ensure that earth, bentonite, chemicals, and concrete agitator washings etc. are not deposited in the watercourses but are suitably collected and residue disposed off in a manner approved by local authorities.

48.5 All water and waste products (surface runoff and wastewater) arising on the site shall be collected and removed from the site via a suitable and properly designed temporary drainage system and disposed off at a location and in a manner that will cause neither pollution nor nuisance.

48.6 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, bentonite etc. The Contractor shall provide treatment facilities as necessary to prevent the discharge of contaminated ground water.

48.7 The Contractor shall discharge wastewater arising out of site office, canteen or toilet facilities constructed by him into sewers after obtaining prior approval of agency controlling the system. A wastewater drainage system shall be provided to drain wastewater into the sewerage system.

48.8 The bentonite mixing, treatment and handling system shall be established by the Contractor giving due regard to its environmental impacts. The disposal of redundant bentonite shall be carefully considered whether in bulk or liquid form. The disposal location will be advised and agreed with the relevant authorities.

48.9 The Contractor shall take measures to prevent discharge of oil and grease during spillage from reaching drainage system or any water body. Oil removal / interceptors shall be provided to treat oil waste from workshop areas etc.

48.10 The Contractor shall apply to the appropriate authority for installing bore wells for water supply at site.

49.0 ARCHAEOLOGICAL AND HISTORICAL PRESERVATION

49.1 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.

49.2 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.

49.3 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.

50.0 LANDSCAPE AND GREENERY

50.1 As far as is reasonably practicable, the Contractor shall maintain ecological balance by preventing deforestation and defacing of natural landscape. In respect of ecological balance, the Contractor shall observe the following instructions.

50.2 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.

50.3 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.

50.4 A suggested list of trees / shrubs suitable for planting and landscaping is found in Employer's Project SHE Manual.

51.0 FELLING OF TREES

51.1 The Contractor shall identify the number and type of trees that are require to be felled as a result of construction of works and facilities related to Project and inform the Employer.

51.2 All trees and shrubbery, which are not specifically require 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 Project except with the previous permission obtained from the Forest Department.

51.3 The Employer shall arrange permission from the forest department for trees to be felled or transplanted. The Employer will permit the removal of trees or shrubs only after prior approval.

51.4 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 used of protective barriers or other methods approved by the Employer. Trees shall not be used for anchorage.

52.0 FLY ASH

52.1 The Employer may require the Contractor to use fly ash as a percentage substitution of cement, in concrete for certain structures and works.

52.2 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.

52.3 The reporting details on consumption of Fly Ash are found in Employer's SHE Manual.

53.0 WASTE

53.1 The Contractor is required to develop, institute, and maintain a Waste Management Programme (WMP) during the construction of the project for his works, which may include:

(i) Identification of disposal sites
(ii) Identification of quantities to be excavated and disposed off
(iii) Identification of split between waste and inert material
(iv) Identification of amounts intended to be stored temporarily on-site location of such storage.
(v) Identification of intended transport means and route.
(vi) Obtaining permission, where required, for disposal.

53.2 Such a mechanism is intended to ensure that the designation of areas for the segregation and temporary storage of reusable and recyclable materials are incorporate into the WMP. The WMP should be prepared and submitted to the Engineer for approval.

53.3 The Contractor shall handle waste in a manner that ensures they are held securely without loss or leakage thus minimizing potential for pollution. The Contractor shall maintain and clean waste storage areas regularly.

53.4 The Contractor shall remove waste in a timely manner and disposed off at landfill sites after obtaining approval of the competent authorities namely Nagpur Municipal Corporation etc.

53.5 Burning of wastes is prohibited. The Contractor shall not burn debris or vegetation or construction waste on the site but remove it in accordance with Clause50.1 above.

53.6 The Contractor shall make arrangement to dispose of metal scrap and other saleable waste to authorized dealer and make available to the Employer on request, records of such sales.

53.7 The Contractor selects suppliers having a voluntary and documented policy to reduce the volume and weight of packaging, and to select recyclable or biodegradable packaging.

53.8 The Contractor establishes and maintains a waste register which is at the disposal of the Engineer. This register will record all waste management operations: production, collection, transport, treatment. The following aspects are documented in this register:

a) Type of waste, using the nomenclature specified in Clause 53.12.

b) Waste quantities

c) Name and address of the third-party waste management facilities receiving waste or parties taking possession of the substances no longer considered as waste.

d) Name and address of waste transport contractors.

e) Plannedwastetreatment.

53.9 The contractor files and maintains at the disposition of the Engineer the waste manifests for the collection, transport, treatment and/or elimination of waste.

53.10 The waste register is established and available as of the Contractors mobilisation to the Worksite. This register will be archived for at least 1 year after the provisional acceptance of the works.

53.11 The Contractor implements specific waste management practices adapted to the level of danger for human health or the natural environment. Three waste categories are identified for Worksites and in tracking documents:

a) Hazardous waste: any waste with one or several dangerous properties as listed in appendix 2 of these SHE specifications.

b) Non-hazardous waste: any waste with no properties rendering it hazardous. Non-hazardous waste contaminated by hazardous material will be considered as hazardous waste, unless indicated otherwise by the Engineer.

c) Inert waste: any waste unaffected by any significant physical, chemical or biological modifications, which does not decompose, burn, or produce any physical or chemical reaction, is not biodegradable and does not damage any substance with which it comes into contact in a manner likely to cause damage to the environment or human health.

53.12 The Contractor assesses, document and effectively implements any local recycling or re-use options for its waste.

53.13 Waste is categorised and stored separately prior to removal from the Worksites, depending on the level of danger, phase (liquid, solid or gas), the waste management solution to be applied and its potential in terms of recycling or reuse.

53.14 Waste is collected from each Worksite at the same rate that it is produced and is placed in temporary locations meeting the following criteria:

a) Located at a distance of over 100 m from any natural sensitive area and over 500 m from any socioeconomic sensitive area (school, market, healthcare centre, water well or catchment area), with the exception of waste storage area in camps.

b) Protected from moving machinery and vehicles, but easy to access for regular collection.

c) Located on a flat impervious surface to prevent infiltrations.

d) Under cover for non-inert waste.

e) Stored in containers of the appropriate size, tightness and level of resistance depending on the danger and phase (solid, liquid, gas) of the waste.

f) Liquid wastes storage is equipped with secondary retention with a volume at least equal to the volume of the waste contained in the containers.

g) Hazardous waste stored pursuant to Clause 30.4.7 of the present SHE specifications.

53.15 Waste is removed from Worksites and transported to recycling, treatment, and waste management facilities on a regular basis. The frequency of removal, approved by the Engineer, guarantees:

a) No overflowfrom containers.

b) No unpleasant odour or emissions which are dangerous for human health.

c) No proliferation of insects, rodents, dogs, or other animals which are harmful or dangerous for human health.

d) Regular cleaning of containers and surfaces on which they are located.

53.16 Unless otherwise specified in the Contract or instructed by the Engineer, waste incineration is prohibited on Worksites. Two exceptions are medical waste and green waste, which unless instructed to the contrary by the Engineer, are managed.

The use of third-party waste management services is subject to a documented prior audit of the treatment, storage, and recycling facilities by the Contractor, to guarantee the conformity with the provisions of the present ESHS specifications on waste.

53.17 The provisions applicable to the Contractor regarding waste management also apply to any third part waste management contractors. The Engineer reserves the right to inspect third party waste management facilities and prohibit the Contractor from using the facilities if considered unacceptable.

53.18 The management of non-hazardous waste complies with the following conditions:

53.18.1 Non contaminated inert waste is removed and can be disposed of to landfill with unused backfill material. The location, capacity, and environmental protection measures, particularly for water courses, implemented by the Contractor or subcontractor, will comply with the provisions of the present ESHS specifications.

53.18.2 Non-hazardous waste that cannot be recycled is disposed of to landfill, and complying with the following criteria:

a) Walls and base sealed by a geo-membrane or a layer of compacted clay with a permeability 10^{-7} cm/s.

b) Drained for the recovery of leachates, which are routed to a lagoon aerobic/anaerobic treatment prior to discharge into the natural environment or collected in a temporary storage prior to regular collection and transfer to a treatment unit (septic tank or wastewater treatment plant).

c) Regularly compacted and covered by earth to limit odours and the proliferation of insects.

d) When the landfill has reached full capacity, vents are installed to evacuate gases, and the landfill covered by a geo-membrane with a minimum thickness of 1 mm, or a layer of compacted clay, and a top layer of 1.5 m of topsoil, which is revegetated.

54.0 HAZARDOUS WASTE MANAGEMENT

54.1 If encountered or generated as a result of Contractor's activity, then waste classified as hazardous under the "Hazardous Waste (management, handling and trans-boundary movement) rules, 2007 and amendment 2008" shall be disposed off in a manner in compliance with the procedure given in the rules under the aforesaid act.

54.2 Chemicals classified as hazardous chemicals under "Manufacture, Storage, and Import of Hazardous Chemical Rules, 1989 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.

54.3 The Contractor shall identify the nature and quantity of hazardous waste generated as a result of his activities and shall file a 'Request for Authorisation' with State Pollution Control Committee along with a map showing the location of storage area.

54.4 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.

54.5 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.

54.6 The Contractor shall approach only Authorised Recyclers of Hazardous Waste for disposal of Hazardous Waste, under intimation to the Employer.

54.7 Submittal of all environment related documents and records pertaining to monitoring and trend analysis on key parameters such as but not limited to consumption/efficient use of resources such as energy, water, material such as cement, fly ash, iron and steel, recycle/reuse of waste etc. that shall have demonstrated continual improvement in the implementation of Environmental management System. In case of failure to do so, the Employer shall impose appropriate penalty as indicated under penalty clause.

55.0 ENERGY MANAGEMENT

55.1 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.

55.2 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

55.3 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.

PART - V: PENALTY AND AWARDS

56.0 PENALTIES TO BE CHARGED/RECOVERED FROM THE CONTRACTOR FOR UNSAFE CONDITION OR UNSAFE ACT

56.1 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).

56.2 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.

56.3 The following table indicates the Safety, Health and Environment 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**. 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. 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. 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 4.2,4.7)		
		b) Delay in submission (Clause 4.2, 4.4)		
		c) Not updated as per Employer's instruction as per Clause 4.4		
		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. 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)		L1- Rs 50,000 for first month and Rs 1,00,000 for subsequent months. 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/012 (Clause 6.9.2)		L1- Rs 25000 for first violation and Rs 50000 for subsequent violations. 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. 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. 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 (viii))		L1-Rs 25,000 for first violation and Rs 50,000 for subsequent violations. 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. 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. L2- Rs 1,00,000 for first violation on and Rs 2,00,000 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		
		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. L2- Rs 1,00,000 for first violation on and Rs 2,00,000 for subsequent violations.
		ii) Non-compliance of clause 10.3.6 and Clause 10.3.7		
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. 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)		L1-Rs 1,00,000 for first violation and Rs 2,00,000 for subsequent violations. 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)		
		iii) Action not taken for any quarter (Clause 11.4.9)		
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. 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 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. 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. 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). 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. L3-Rs 2,00,000 for first violation and Rs 4,00,000 for subsequent violations.
		Non-compliance of the Clause 14.4	L2→L3	L2- Rs 50,000 for first violation on and Rs 1,00,000 for subsequent violations. 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. 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. 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. 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. 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. 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. 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. 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. 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. 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. 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. 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. 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. 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	L2-Rs 50,000 per first violation and Rs 1,00,000 for subsequent violations. L3-Rs 1,50,000 per first violation and Rs 3,00,000 for subsequent violations.
		Non-compliance of Clause 36.8.3		
		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 ii) Unfit drivers or operators iii) Unlicensed vehicles iv) Absence of traffic marshals v) Absence of reversing alarm vi) Absence of fog light (at winter) 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. 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. 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. 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. 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. 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. L2-Rs 10,000 per single violation Compounded to a maximum of Rs 1,00,000 at any single instance. 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. 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)		
28	Environmental Management	Tyre wash facility not provided (Clause 47.12)	L1→L2	L1-Rs 10,000 per single violation Compounded to a maximum of Rs 50,000 at any single instance. L2-Rs 20,000 per single violation Compounded to a maximum of Rs 1,00,000 at any single instance.
		Spillage from vehicles not arrest (Clause 48.9)		
		Air monitoring not practiced (Clause 47.17)		
		The values of air monitoring not within acceptable limits (Clause 47.17, 43.2.1)		
		Dust control measures at sites not practiced (Clause 47.13)		
		Improper disposal of debris / residues		
		Non compliance of Clause 53.0 & 54.0		

56.4 Without limiting to the unsafe acts and or conditions mentioned above in Clause 56.3 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 56.3.

56.5 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:

56.5.1 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.

56.5.2 **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.

56.5.3 **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.

56.5.4 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.

57.0 STOPPAGE OF WORK

57.1 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.

57.2 The Contractor shall not proceed with the work until he has complied with each direction to the satisfaction of Employer.

57.3 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.

58.0 AWARDS

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.

	NAGPUR METRO RAIL CORPORATION LIMITED
APPENDIX NO.: 1	

Memorandum of Understanding between MAHA-METRO and the Contractor for safe execution of contract work

This Memorandum of Understanding is made and executed by and between **Nagpur 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 and assigns) of the one party

AND

M/s _____ having its registered office at _____ 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:

	NAGPUR METRO RAIL CORPORATION LIMITED
APPENDIX NO.: 2	

Safety, Welfare and Occupational Health requirements as per BOCW Act 1996 and Rules 1998 and Maharashtra BOCW Rules 2003

(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, R – 23 to 27
2.	Display of registration certification at workplace	R – 26 (5)
3.	Hours of work	S – 28 R – 234 to 237
4.	Register of overtime	S – 28; S – 29 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 R – 238
8.	Notice of commencement and completion	S – 46 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 R – 243
21.	Accommodation	S – 34
22.	Creches	S – 35
23.	First-aid boxes	S – 36 R – 231 and Schedule III
24.	Canteens	S – 37 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

SN	Items	Relevant Sections / Rules in BOCWA and BOCWR and MBOCWR 2003
27.	Food charges on no loss no profit basis	R – 247
28.	BOCWR 2003 welfare Board Rules	
29.	Safety committee	S – 38 R – 208
30.	Safety officer	S – 38 R – 209 and Schedule VII
31.	Reporting of accidents and dangerous occurrences	S – 39 R – 210
32.	Procedure for inquiry in to the causes of accidents	R – 211
33.	Responsibility of employer	S - 44 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

SN	Items	Relevant Sections / Rules in BOCWA and BOCWR and MBOCWR 2003
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
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 MaharashtraState Rules

	NAGPUR METRO RAIL CORPORATION LIMITED
APPENDIX NO.: 3	

SITE SHE PLAN

Contract No	
Contractor Name	
Project Name	

1.	**Project Highlights** i) Title of the content ii) Contractor Number iii) Brief scope of work iv) Location map/ key plan v) Period of the project
2.	**SHE Policy**
3.	**Site Organisation Chart** Chart indicating reporting of SHE personnel
4.	**Roles & Responsibility** Individual responsibility of the: i) Project Manager ii) Construction Manager iii) Construction Supervisors iv) SHE Committee Members v) SHE In charge vi) Site Engineers vii) First Line Supervisors viii) Sub-contractors
5.	**SHE Committee** i) Details - Chairman, Members, Secretary and Employer's representative 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** i) Work at Height ii) Structural Steel Erection iii) Launching of segments iv) Floor, Wall Openings and Stairways v) Welding, Cutting and Bracing vi) Lifting appliances vii) Work Permit Systems viii) Electrical Equipments ix) Mechanical Equipments x) Excavation xi) Fire Prevention xii) Hazardous Chemicals and Solvents xiii) Ionising Radiation xiv) Lighting 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**

	NAGPUR METRO RAIL CORPORATION LIMITED
APPENDIX NO.: 4	

WORKPLACE POLICY ON HIV/AIDS PREVENTION & CONTROL FOR WORKMEN ENGAGED BY CONTRACTORS

"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

	NAGPUR METRO RAIL CORPORATION LIMITED
General Instruction: MAHA-METRO/SHE/GI/001	

MINIMUM MANPOWER REQUIREMENTS OF SHE ORGANIZATION BASED ON CONTRACT VALUE

	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	**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 support staff**	**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.

Note 2: 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 3: 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.

	NAGPUR METRO RAIL CORPORATION LIMITED
General Instruction: MAHA-METRO/SHE/GI/002	

MINIMUM QUALIFICATION AND EXPERIENCE FOR (SHE) SAFETY, ELECTRICAL, ENVIRONMENTAL, TRAFFIC ENGG. AND OCCUPATIONAL HEALTH 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: i) Post Graduate Diploma in Industrial Safety & Environmental Management (PGDISEM) from National Institute of Industrial Engineering, Mumbai ii) M.E. in Industrial Safety from NIT, Trichy, Tamil Nadu iii) M.E. in Industrial Safety from MepcoSchlenk Engineering College, Sivakasi, Tamil Nadu iv) B.E. in Fire and Safety Engg. From Cochin University of Science and Engg. Cochin, Kerala v) B.E. with advanced Safety Management Diploma from CLI / RLI Mumbai / Chennai / Kolkata and Kanpur. vi) B.E / B.Arch., with one-year Full Time advanced Safety diploma from NICMAR, Hyderabad. vii) B.E / B.Tech with any other equivalent State and Central Govt. recognized full time Degree / Diploma in Safety. viii) International qualifications like CSP (Certified Safety Professional), NEBOSH, MIOSH, MSISO etc.	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: i) B.Sc. (Physics/Chemistry/Maths) with one-year Full Time advanced Safety diploma from NICMAR, Hyderabad ii) B.Sc. / Diploma in Engg with advanced Safety Management Diploma from CLI / RLI / Mumbai / Chennai / Kolkata and Kanpur. 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. 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	2 {for category (i), (ii) and (iii) only}
3	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.	2 (for category (i) only)

SN	Designation	Qualification	Experience (in years)
		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	
4	Safety Steward	Any basic qualification with any SHE related certificate courses.	2
5	Senior SHE (Electrical) Manager	Degree in Electrical Engineering + Govt. recognized Electrical Licence holder	2
6	Junior SHE (Electrical) Manager	Diploma in Electrical Engineering + Govt. recognized Electrical Licence holder	1
7	Senior SHE (Fire) Manager	i) B.E. (Fire) from National Fire Service College, Nagpur ii) B.E (Fire & Safety) from Cochin University iii) Graduate with any Govt. recognized diploma in Fire Safety with 5 years of experience	2 (for category (i) and (ii) only)
8	Junior SHE (Fire) Manager	Any Diploma holder with any Govt. recognized diploma in Industrial Fire Safety.	1
9	Occupational Health Officer	MBBS with Govt. recognized degree/diploma in Industrial/ occupational health	1
10	Environment Manager	Govt. recognized PG Degree / PG Diploma / Degree in Environmental Engineering / Science	2
11	Senior SHE (Traffic) Engineer	Govt. recognized PG Degree / Degree / Diploma in Traffic/Transportation Engineering or Planning	1
12.	House Keeping Cum Barricade Manager	Any Diploma in Engineering	1
13	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.

	NAGPUR METRO RAIL CORPORATION LIMITED
General Instruction: MAHA-METRO/SHE/GI/003	

MINIMUM REQUIREMENTS OF SHE MONITORING AND AUDIO-VISUAL EQUIPMENTS

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				

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
b)	Measuring tape for measuring Flexible tape – 2m length Metal Foot long scale and Metal tape – 30m				
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				

	NAGPUR METRO RAIL CORPORATION LIMITED
General Instruction: MAHA-METRO/SHE/GI/004	

Topics for First day at work SHE orientation training of Workmen

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

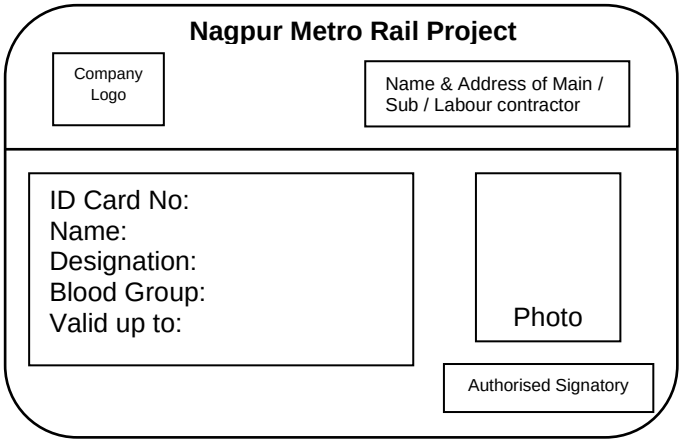
- Brief outline of responsibilities of employee under law
- Explanation of how new employees fit into the Contractor's plan for accident prevention. (Induction and orientation).

	NAGPUR METRO RAIL CORPORATION LIMITED
General Instruction: MAHA-METRO/SHE/GI/005	

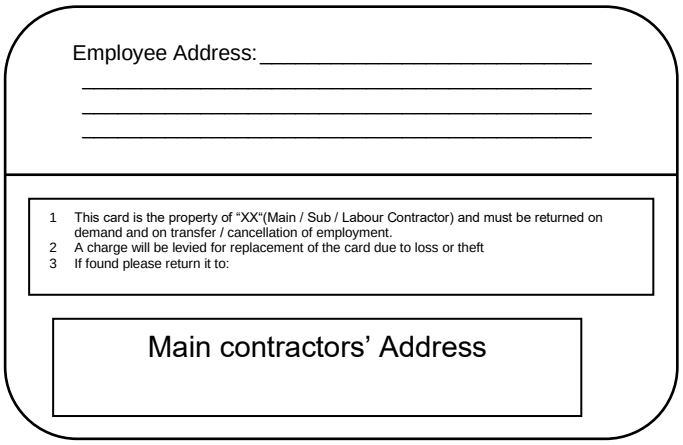
ID Card Format

(85 mm x 55mm)

Front side of ID card:



Backside of ID card:



माझी मेट्रो NAGPUR METRO	**NAGPUR 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 Appropriate regulations Duties of employer and employee	Effect of incentive on accident prevention Human relations Consultation Safety Officer: duties, aims, objectives
3. Safety and the Supervisor	**4. Principles of Accident Prevention**
Safety and efficient production go together Accidents affect morale and public relations	Attitudes of management, supervision, and operations Methods of achieving safe operations Accident and injury causes
5. Site Inspection	**6. Human Behaviour**
The role of management Hazard Identification Procedure Records results Follow-up procedures Feedback	Motivating agencies Individual behaviour Environmental effects Techniques of persuasion
7. Site housekeeping	**8. Health**
Site organization Relationship of site housekeeping to accident occurrence Site access Equipment storage Material stacking Materials handling	Medical examination Hazard to health on site Sanitation and welfare Protective clothing First Aid/CPR
9. Personal Protective Equipment	**10. Electricity**
Eye, face, hands, feet and legs Respiratory protective equipment Protection against ionizing radiation	Appreciation of electrical hazards Power tools Arc welding Low voltage system Lighting and power system on sites ELCB, RRCB, Grounding/Ground fault circuit interrupters (GFCIs)
11. Oxygen and Acetylene Equipment	**12. Equipment**
Cylinder storage and maintenance Condition and maintenance of valves, regulators, and gauges Condition and maintenance of hoses and fittings Pressures	Accidents related to moving parts of machinery Appreciation of principles of guarding Importance of regular maintenance
13. Transportation	**14. Excavations**
Transport to and from site Hazard connected with site transport Competent drivers Dumpers Tipping trucks Movement near excavations	Method of shoring Precautions while shoring Precautions at edge of excavations Removal of shoring Sheet steel piling
15. Working platforms, Ladders, and Scaffolding	**16. Cranes and other Lifting Machines**
Hazards connected with the use of ladders Maintenance and inspection Type of scaffold	Licensing, certification, and training required for operation of cranes Slinging methods

Overloading Work on roofs Fragile material Openings in walls and floors Use of safety belts and nets	Signalling Access to crane(s) Maintenance and examination Ground conditions Hazards and accident prevention methods connected with the use of different types of cranes/heavy equipment Crane Lift Plan for all lifts
17. Lifting Tackle	**18. Fire Prevention and Control**
Slings - single and multi-legged Safe working loads (SWLs) Safety hooks and eyebolts Cause of failure Maintenance and examination	Principle causes determining fire Understanding fire chemistry Fire fighting equipment Fire fighting training
19. Communications	**20. Manual Handling**
Effective methods of communication (particular interest to non-English speaking workers) Method and preparation of reports Safety committees Safety meeting	Body posture and procedure for lifting, pushing, pulling, dragging, sitting and walking Ergonomics Stretching exercises

NAGPUR METRO RAIL CORPORATION LIMITED

General Instruction: MAHA-METRO/SHE/GI/007

SHE Training Matrix

Types of training	Management																			Supervisor										Specific																	
	SHE Orientation	SHE Leadership	SHE Plan	SHE Improvement Plan	Management of Change	SHE Audit & Inspection	SHE Emergency Response & Preparedness	Incident/Accident Investigation & Reporting	SHE Communication	SHE Promotion & Incentives	Traffic Management	Hazard Identification & Risk	Permit to work system	Confined space entry	Scaffolding	Waste Management	Environment Monitoring	Labour welfare measures	Behavioural Based Safety Management (BBSM)	Job/Task Safety Analysis (JSA)	Safety Training Observation Programme (STOP)	Industrial First Aid & CPR	Incident / Accident Investigation &	Fire fighting	Confined Space Testing &	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. SHE Managers		•					•								•		•					•																						
Jr. SHE Managers	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
SHE Supervisors	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•

	NAGPUR 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

माझी मेट्रो NAGPUR METRO	**NAGPUR METRO RAIL CORPORATION LIMITED**
General Instruction: MAHA-METRO/SHE/GI/009	

Minimum Requirements of SHE Communication Posters / Signages / Video

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,	5 types of sizes made up of metal sheet to be mounted at	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
	FIT FOR USE, AVOID USE etc.	different locations				
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
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 limit, safe crossing and working within barricaded area etc.)	5	Each 25	Each 50	Each 75	Each 200
17.	Environmental Monitoring (Spillage of Muck, hazardous material, Improper drainage, water spray for dust containment 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.	Safety Handbook	6”x4”
6.	Signages	Small: 12”x6” 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

	NAGPUR 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., B-21 & 22, First Floor, Sector-16, NOIDA-201 301 (U.P.) Phone: 0120 - 2515055 Fax: 0120 - 2515248 E-mail: enp.delhi@in.bureauveritas.com	• External SHE Audit • SHE Management / Technical Training
2.	Central Labour Institute Post box no: 17851, NSMonkikarMarg Sion, Mumbai- 400 022 Tel.: 022- 4092203 Fax: 022 – 4071986 E-mail: cli@dgfasli.nic.in	SHE Management / Technical Training
3.	Construction Industry Development Council 801, 8th Floor, Hemkunt Chambers, 89, Nehru Place, New Delhi – 110 019 E-mail: cidc@vsnl.com	SHE Management / Technical Training
4.	Delhi Productivity Council 1E/10, Swami Ramtirath Nagar New Delhi – 110 055 Tel.: 23522835	SHE Management / Technical Training
5.	Det Norske Veritas AS, 203, SavitriSadan 1, 11 PreetVihar Community Centre, New Delhi-110 092 Phone: 011-22531502/2253/1503, 22427688/22531278 Fax: 011-2253 0247 Website: www.dnv.com	• External SHE Audit • SHE Management / Technical Training
6.	Dr AV Baliga Memorial trust Link House, Bagadur Shah ZafarMarg Press Area New Delhi – 110 002 Phone: 011 – 23311119	HIV / AIDS awareness
7.	Dr. Cris Research Centre for Occupational Health & Safety 306, Guru ArjunaDevBhawan, Ranjit Nagar Complex, New Delhi – 110 008 Phone: 9810040406 Fax: 011 – 25702929 E-mail: team@drcris.com Website: www.drcris.com	• Ambulance Room & Van • Communication Materials • First-aid box • First-aid Training • HIV / AIDS awareness • ID Card • Medical Facilities • SHE Orientation Training
8.	DuPont Safety Resources, E.I. DuPont India Private Limited, ArihantNitco Park 6th Floor, 90, Dr. Radhakrishnan Salai, Mylapore, Chennai-600 004	SHE Management Training

SN	Organisation	Services
	Phone: 044-2847 2800, 2847 3752 Fax: 044-2847 3800 Mobile: 9381201040 Website: in.dupont.com	
9.	EQMS INDIA PVT. LTD. 304 & 305, 3rd Floor, Rishabh Towers, Plot No. 16, Community Centre, Karkardooma, Delhi - 110092. Phone: 011 - 22374729 / 22374775 Fax: 011- 22374662 E-mail: eqms@eqmsindia.org Website: www.eqmsindia.com	• ISO Certification • SHE Management / Technical Training
10.	Green Cross Consultants 59, 7th Cross, 1st Floor, Jai Bharath Nagar, Banglore-560 033 Phone: 080-2549 6782 E-mail: etgrangan@yahoo.com	SHE Management / Technical Training
11.	HSRTC, PENTASAFE, 201, 2nd Floor, Town Centre, AndheriKurla Road, Marol, Andheri (East), Mumbai-400 059 Phone: 022-2850 2210/20/50 Fax: 022-2850 2260 E-mail: training@penta-safe.com	SHE Practical Field Training for Height Safety
12.	Institute of Driving Training & Research, Wazirabad Road, Adjoining Loni Road flyover. New Delhi – 110 094 Phone: 011 – 22813474, 22815833 Fax: 011 - 22811131	SHE Technical Training for Vehicle Drivers.
13.	Institute for Research, Development & Training of Construction Trades & Management, An Educational Institute, Society and Trust, 1st Floor, UVCE Alumni Association Building, K.R. Circle, Bangalore-560 001 Phone: 080-22294291/22243257 Fax: 080-22243257 E-mail: ubrco@vsnl.com Website: www.instructindia.org	SHE Technical /Field Training
14.	International Engineering Company K – 10, South Extension, Part – 2, New Delhi – 110 049 Phone: 011 – 26254761, 26258130 Mobile: 9312260130 E-mail: ashok@intenco.net	• Crane and Lifting appliances and Gears Certification • SHE Practical Field Training for Crane Safety
15.	L & T Eutectic 32, SivajiMarg, New Delhi – 110 015 Phone: 011 - 51419538, 51419539 Fax: 011 - 51419600 Website: www.lnteutecticwelding.com	SHE Practical Field Training for Welding Safety
16.	Loss Prevention Association of India Ltd. Warden House, Sir P.M. Road, Mumbai – 400 001 Website: www.lpaindia.org	SHE Management / Technical Training
17.	MFA Crucial Moments Healthcare Pvt. Ltd., 42, Okhla Industrial Estate, Phase – II New Delhi – 110 020 Phone: 011 – 55624000 Fax: 011 – 55624010 E-mail: contact@crucialmoments.net	First-aid Training

SN	Organisation	Services
18.	Modicare Foundation 4 Community Centre, New Friends Colony, New Delhi – 110 065 Phone: 011 – 5167235059 Fax: 011 – 26915469 E-mail: nivedita@modi.com nivedita@gmavil.com Website: www.modicarefoundation.org	HIV / AIDS awareness
19.	National Safety Council HQ and Institute Building 98A, Sector 15, industrial Area C.B.D Belapur, Navi Mumbai – 400614 Phone: 27579924	SHE Management / Technical Training
20.	NICMAR (National Institute of Construction Management and Research) 910,9th Floor, Hemkunt Chambers, 89, Nehru Place, New Delhi – 110 019 Phone: 011 – 51618415, 51618417, 51618418 Fax: 011 – 51618416	SHE Management / Technical Training
21.	Quality Growth Services Pvt. Ltd. H-13, Kirti Nagar, New Delhi – 110 015 Fax: 011 – 25431737 / 25438598 / 25918332 E-mail: qgs@qgspl.com Website: www.qgspl.com	ISO Certification
22.	Safety Engineers Association / Safety Educational Trust – India 2/257, First Floor, Dr.Ambedkar Nagar, Manapakkam, Chennai – 600 116 Phone: 044 – 22523461 E-mail: safetrustindia@rediffmail.com	SHE Management / Technical Training
23.	SHE Management Consultancy & Support Services, 145 A, Pocket-VI, (DDA Flats), KondliGharoli, MayurVihar-II, Delhi-110 096 Fax: 011-2262 5015 Mobile: 9811153873 E-mail: r_k_p@vsnl.net	SHE Management / Technical Training
24.	St. Johns' Ambulance Red Cross Road New Delhi – 110 001	First-aid Training
25.	Vexil Business Process Services Pvt. Ltd. 208, A/4, Savitri Nagar, New Delhi – 110 017 Mobile: 9350232714, 98102832201, 9350232716 E-mail: info@vexilbps.com Website: www.vexilbps.com	• Emergency Preparedness Mock drill • SHE Management / Technical Training
26.	Welding Research Institute Bharat Heavy Electricals Ltd. (BHEL) Trichirappalli, Tamil Nadu – 620 014 Phone: 0431 – 2577029, 2577283 Fax: 0431 – 2520770 E-mail: wri@bheltry.co.in	SHE Practical Field Training for Welding Safety

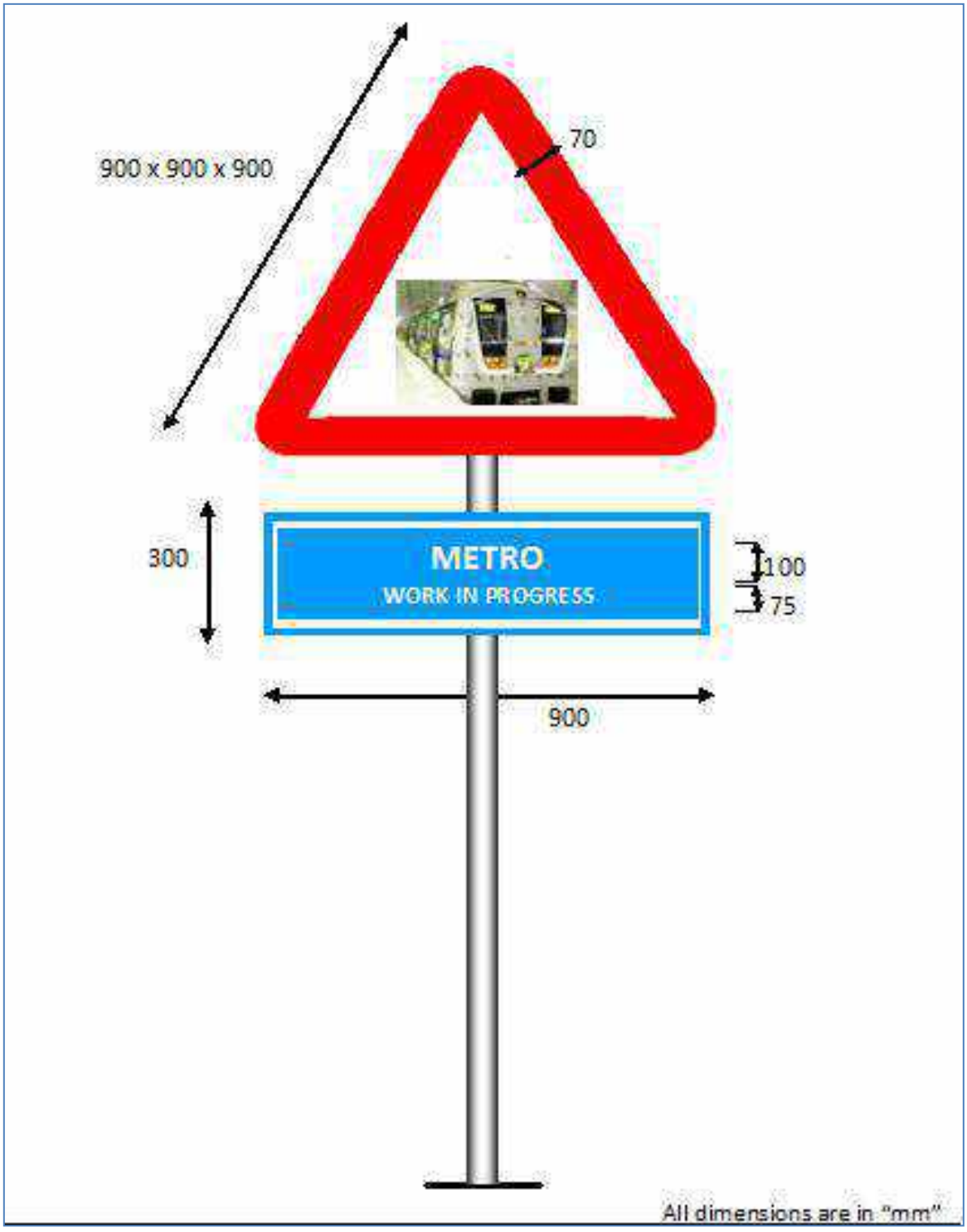
	NAGPUR METRO RAIL CORPORATION LIMITED
General Instruction: MAHA-METRO/SHE/GI/011	

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** • general indoor • general outdoor • tunnel and general underground work areas (minimum 110 lux required at tunnel and shaft heading during drilling, mucking and scaling)	 55 (5) 33 (3) 55 (5)
3.	**Access ways** • exit ways, walkways, ladders, stairs	 110 (10)
4.	**Maintenance / Operating areas / shops** • vehicle maintenance shop • carpentry shop • outdoors field maintenance area • refueling area, outdoors • shops, fine details work • shops, medium detail work • welding shop	 325 (30) 110 (10) 55 (5) 55 (5) 540 (50) 325 (30) 325 (30)
5.	Mechanical/electrical equipment rooms	110 (10)
6.	Hoists, Elevators, freight and passenger	215 (20)
7.	**Warehouses and storage rooms/area** • indoor stockroom, active/bulk storage • indoor rack storage • outdoor storage	 110 (10) 270 (25) 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)

	NAGPUR METRO RAIL CORPORATION LIMITED
General Instruction: MAHA-METRO/SHE/GI/012	

Warning Traffic Sign



	NAGPUR 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

	NAGPUR 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			

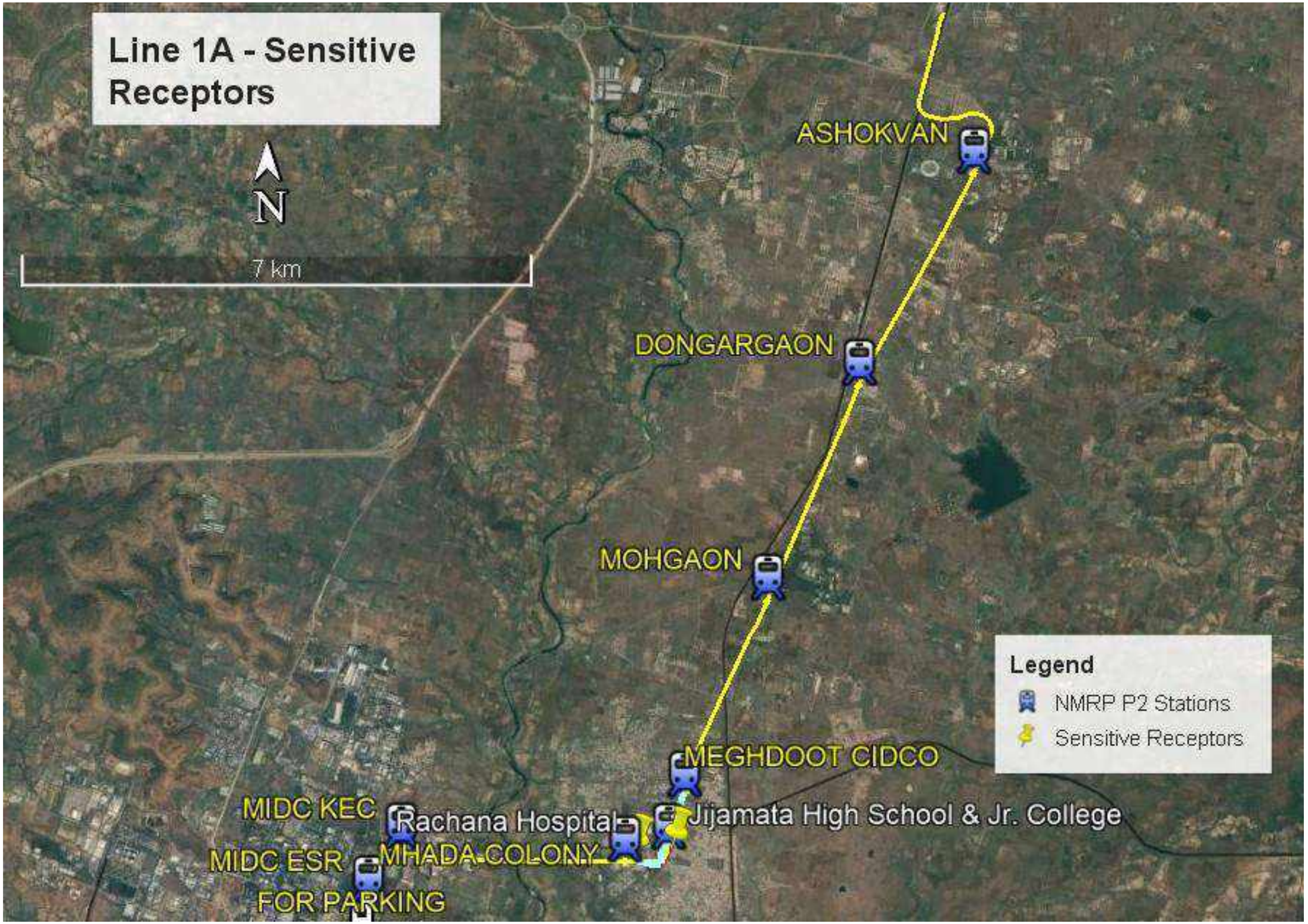
Item No.	Description of Discussion	Action By	Target	Remarks
9	Need for any specific system / training / PPE's / resources			
10	Observation of SHE committee during last walk down			

Next, SHE Meeting is scheduled on:

Date: **Chief SHE Manager** **(Signature & Name)**
Date: **Project Manager** **(Signature & Name)**

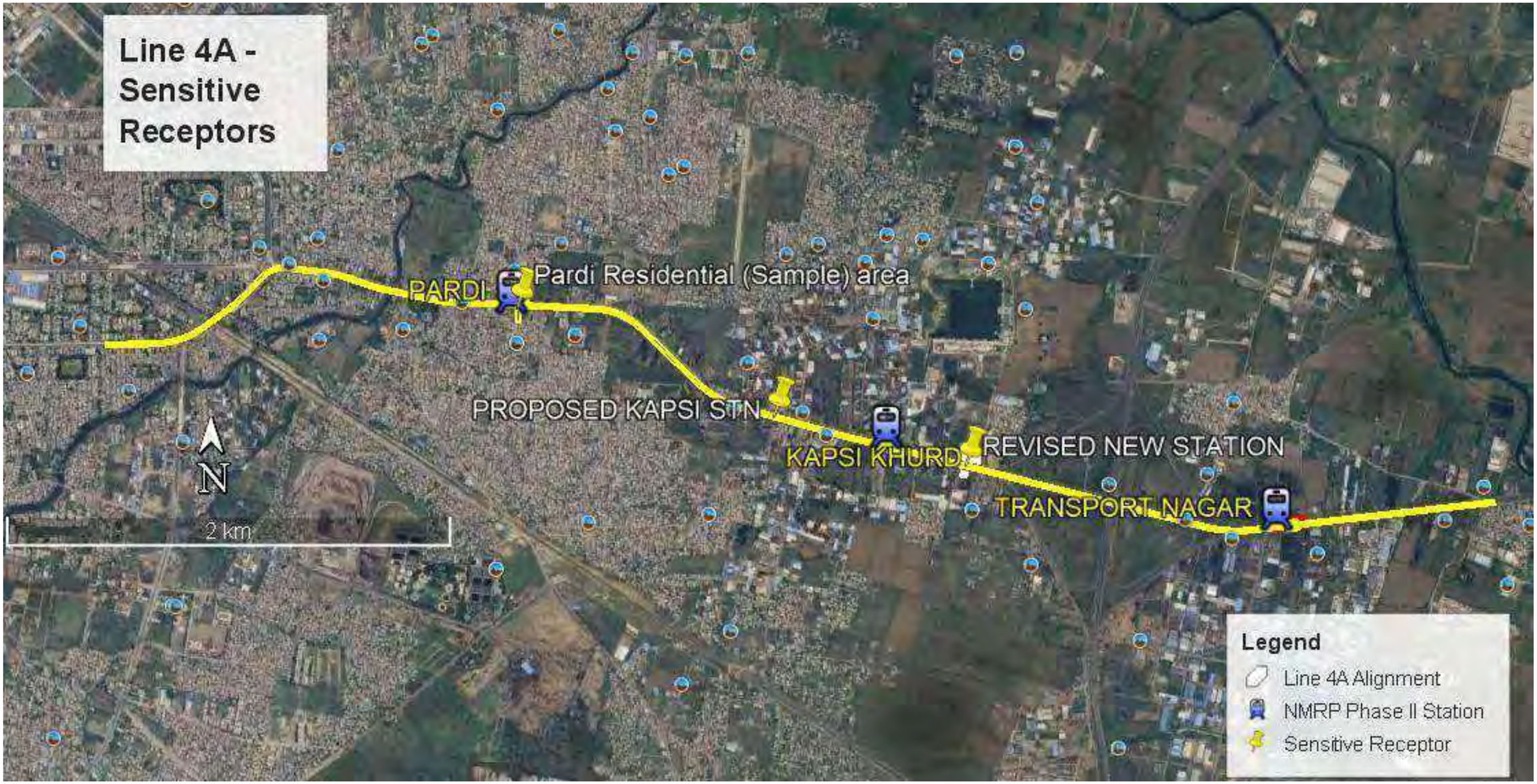
Annexure 13 – List of Sensitive Receptors

Sr. No.	Line / Reach	Name of Sensitive Receptor	Type of Sensitive Receptor	Side of Alignment	Distance from the ROW (m)	Latitude	Longitude
1	1A	Jijamata High School & Jr. College	Educational	LHS	22	20°55'46.79" N	79° 0'18.23" E
2	1A	Rachana Hospital	Medical	RHS	60	20°55'43.79"N	78°59'59.7"E
3	2A	Asha Hospital and Asharam College & School of Nursing	Educational and Medical	RHS	65	21°13'7.45"N	79°10'38.01"E
4		Girijadhar Balaji Hanuman Temple	Temple (PCR)	LHS	2		
5	2A	Delhi Public School (DPS), Khairi	Educational	LHS	95	21°12'49.33"N	79° 9'39.19"E
6	3A	Rural Hospital - Hingna	Medical	RHS	36	21° 4'29.01"N	78°57'15.34"E
7	3A	Yeshwantrao Chavan College of Engineering (YCCE), Nagpur	Educational	LHS	78	21° 5'43.55" N	78°58'41.26" E
8	3A	Dr. Babasaheb Ambedkar Superspeciality Hospital	Medical	LHS	5	21° 5'41.63"N	78°58'28.68"E
9	4A	Pardi residential area	Residential area (sample area)	RHS	5-10	21° 8'57.99"N	79° 9'37.53"E


Line 1A - Sensitive Receptors
N
7 km
ASHOKVAN
DONGARGAON
MOHGAON
MEGHDOOT CIDCO
MIDC KEC
Rachana Hospital
Jijamata High School & Jr. College
MHADA COLONY
MIDC ESR
FOR PARKING
Legend
NMRP P2 Stations
Sensitive Receptors


Line 2A - Sensitive Receptors
N
4 km
LEKHA NAGAR
Asha Hospital
CANTONMENT FOR PARKING -1
KAMPTEE POLICE STATION
GOLF CLUB
KANHAN RIVER
DRAGON PALACE
KAMPTEE MUNICIPAL COUNCIL
DPS Khairi
LOK VIHAR
KHAIRI FATA
ALL INDIA RADIO
KHASARA FATA
PILI NADI
Legend
NMRP P2 Stations
Sensitive Receptors


Line 3A - Sensitive Receptors
N
2 km
HINGNA MOUNT VIEW
FOR PARKING-1
RAJIV NAGAR
Dr. B. Ambedkar Hospital
YCCE, Nagpur
WANADONGRI
APMC
RAIPUR
Rural Hospital - Hingna
FOR PARKING-2
HINGNA
HINGNA BUS STATION
Legend
Line 3A Alignment
NMRP P2 Station
Sensitive Receptor


Line 4A - Sensitive Receptors
PARDI
Pardi Residential (Sample) area
PROPOSED KAPSI STN
KAPSI KHURD
REVISED NEW STATION
TRANSPORT NAGAR
N
2 km
Legend
Line 4A Alignment
NMRP Phase II Station
Sensitive Receptor

Integrated Biodiversity Assessment Tool

PROXIMITY REPORT
REACH_1A_23_08_23 CENTERLINE-0

Country: India

Location: [21, 79]

Date of analysis: 17 October 2023 (GMT)

Buffers applied: 10 km | 20 km

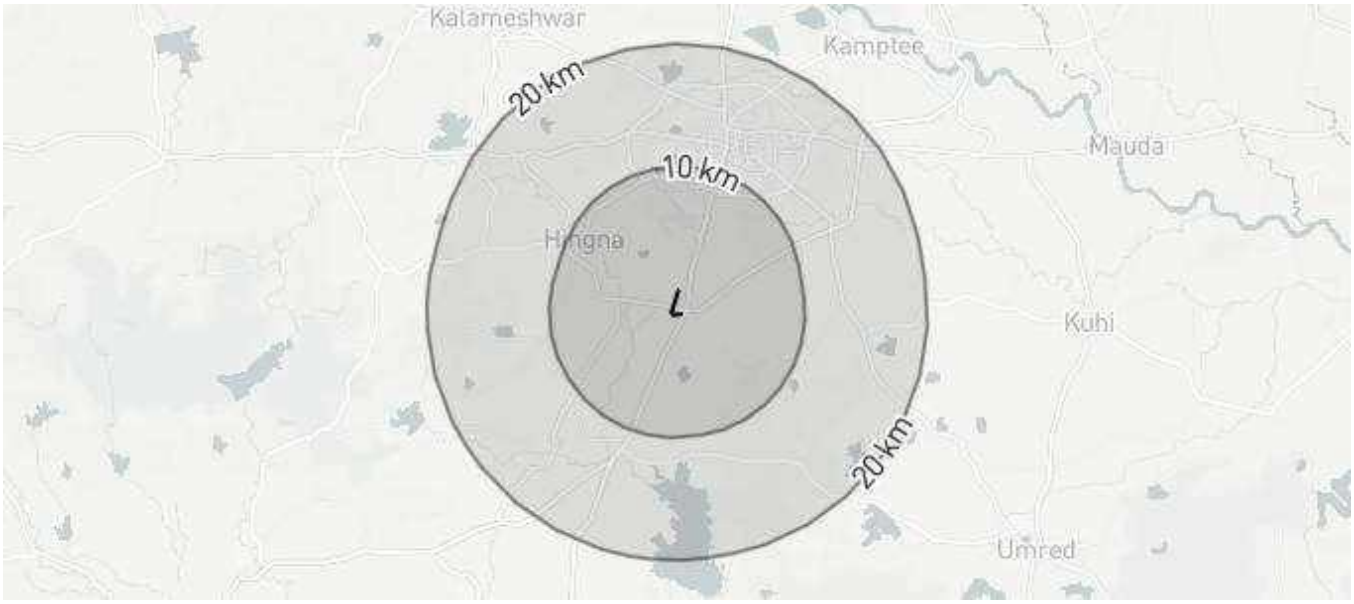
IUCN Red List Biomes: Marine, Terrestrial, Freshwater

Generated by: Suvalaxmi Sen

Organisation: ADB

Overlaps with:

Protected Areas	0
Key Biodiversity Areas	0
IUCN Red List	37



Displaying project location and buffers: 10 km, 20 km

About this report

This report presents the results of [6775-50035] proximity analysis to identify the biodiversity features and species which are located within the following buffers: 10 km, 20 km.

This report is one part of a package generated by IBAT on 17 October 2023 (GMT) that includes full list of all species, protected areas, Key Biodiversity Areas in CSV format, maps showing the area of interest in relation to these features, and a 'How to read IBAT reports' document.

WARNING: IBAT aims to provide the most up-to-date and accurate information available at the time of analysis. There is however a possibility of incomplete, incorrect or out-of-date information. All findings in this report must be supported by further desktop review, consultation with experts and/or on-the-ground field assessment. Please consult IBAT for any additional disclaimers or recommendations applicable to the information used to generate this report.

Please note, sensitive species data are currently not included in IBAT reports in line with the Sensitive Data Access Restrictions Policy for the IUCN Red List. This relates to sensitive Threatened species and KBAs triggered by sensitive species.

Data used to generate this report

- UNEP-WCMC and IUCN, 2023. Protected Planet: The World Database on Protected Areas (WDPA)[On-line], Cambridge, UK: UNEP-WCMC and IUCN. Available at: www.protectedplanet.net - October 2023.
- BirdLife International (on behalf of the KBA Partnership), 2023. Key Biodiversity Areas - October 2023.
- IUCN, 2022. IUCN Red List of Threatened Species - December 2022.
- IUCN. The IUCN Red List of Threatened Species. Version 2019-3. (2019). https://www.iucnredlist.org
- IUCN. Threats Classification Scheme (Version 3.2). (2019)
- Strassburg, B.B.N., Iribarrem, A., Beyer, H.L. et al. Global priority areas for ecosystem restoration. Nature 586, 724–729 (2020). https://doi.org/10.1038/s41586-020-2784-9

Protected Areas

The following protected areas are found within 10 km, 20 km of the area of interest.
For further details please refer to the associated csv file in the report folder.

No protected areas within buffer distance

Key Biodiversity Areas

The following key biodiversity areas are found within 10 km, 20 km of the area of interest.
For further details please refer to the associated csv file in the report folder.

No KBAs within buffer distance

IUCN Red List of Threatened Species

The following threatened species are potentially found within 50km of the area of interest.

For the full IUCN Red List please refer to the associated csv in the report folder.

Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
Nilssonia leithii	Leith's Softshell Turtle	REPTILIA	CR	Decreasing	Terrestrial, Freshwater
Sypheotides indicus	Lesser Florican	AVES	CR	Decreasing	Terrestrial
Vanellus gregarius	Sociable Lapwing	AVES	CR	Decreasing	Terrestrial
Gyps bengalensis	White-rumped Vulture	AVES	CR	Decreasing	Terrestrial
Sarcogyps calvus	Red-headed Vulture	AVES	CR	Decreasing	Terrestrial
Gyps indicus	Indian Vulture	AVES	CR	Decreasing	Terrestrial

Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
Cuon alpinus	Dhole	MAMMALIA	EN	Decreasing	Terrestrial
Manis crassicaudata	Indian Pangolin	MAMMALIA	EN	Decreasing	Terrestrial
Panthera tigris	Tiger	MAMMALIA	EN	Decreasing	Terrestrial
Silonia childreni		ACTINOPTERYGII	EN	Decreasing	Freshwater
Ammannia nagpurensis		MAGNOLIOPSIDA	EN	Unknown	Freshwater
Rynchops albicollis	Indian Skimmer	AVES	EN	Decreasing	Terrestrial, Freshwater
Sterna acuticauda	Black-bellied Tern	AVES	EN	Decreasing	Terrestrial, Freshwater
Neophron percnopterus	Egyptian Vulture	AVES	EN	Decreasing	Terrestrial, Freshwater
Aquila nipalensis	Steppe Eagle	AVES	EN	Decreasing	Terrestrial
Acinonyx jubatus	Cheetah	MAMMALIA	VU	Decreasing	Terrestrial
Bos gaurus	Gaur	MAMMALIA	VU	Decreasing	Terrestrial
Crocodylus palustris	Mugger	REPTILIA	VU	Stable	Terrestrial, Freshwater
Lutrogale perspicillata	Smooth-coated Otter	MAMMALIA	VU	Decreasing	Terrestrial, Marine, Freshwater
Melursus ursinus	Sloth Bear	MAMMALIA	VU	Decreasing	Terrestrial
Panthera pardus	Leopard	MAMMALIA	VU	Decreasing	Terrestrial

Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
Tetracerus quadricornis	Four-horned Antelope	MAMMALIA	VU	Decreasing	Terrestrial
Rusa unicolor	Sambar	MAMMALIA	VU	Decreasing	Terrestrial
Wallago attu		ACTINOPTERYGII	VU	Decreasing	Freshwater
Aythya ferina	Common Pochard	AVES	VU	Decreasing	Terrestrial, Marine, Freshwater
Grus antigone	Sarus Crane	AVES	VU	Decreasing	Terrestrial, Freshwater
Sterna aurantia	River Tern	AVES	VU	Decreasing	Terrestrial, Marine, Freshwater
Clanga clanga	Greater Spotted Eagle	AVES	VU	Decreasing	Terrestrial, Freshwater
Aquila rapax	Tawny Eagle	AVES	VU	Decreasing	Terrestrial, Freshwater
Leptoptilos javanicus	Lesser Adjutant	AVES	VU	Decreasing	Terrestrial, Marine, Freshwater
Schoenicola striatus	Bristled Grassbird	AVES	VU	Decreasing	Terrestrial, Freshwater
Amandava formosa	Green Avadavat	AVES	VU	Decreasing	Terrestrial
Clanga hastata	Indian Spotted Eagle	AVES	VU	Decreasing	Terrestrial
Oryza malampuzhaensis		LILIOPSIDA	VU	Decreasing	Terrestrial

Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
Lissemys punctata	Indian Flapshell Turtle	REPTILIA	VU	Decreasing	Terrestrial, Freshwater
Schizothorax plagiostomus	Snow Trout	ACTINOPTERYGII	VU	Decreasing	Freshwater
Bagarius bagarius		ACTINOPTERYGII	VU	Decreasing	Freshwater

Recommended citation

IBAT Proximity Report. Generated under licence 6775-50035 from the Integrated Biodiversity Assessment Tool on 17 October 2023 (GMT). www.ibat-alliance.org

How to use this report

This report provides an indication of the potential biodiversity-related features - protected areas, key biodiversity areas and species - close to the specified location. It provides an early indication of potential biodiversity concerns, and can provide valuable guidance in making decisions. For example, this information can be helpful when assessing the potential environmental risk and impact of a site, categorising investments/projects, preparing the terms of reference for an impact assessment, focusing attention on key species of conservation concern and sites of known conservation value, and reviewing the results of an impact assessment.

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Integrated Biodiversity Assessment Tool

PROXIMITY REPORT
REACH_2A_23_08_23 CENTERLINE-0

Country: India

Location: [21.2, 79.2]

Date of analysis: 17 October 2023 (GMT)

Buffers applied: 1 km | 10 km | 25 km

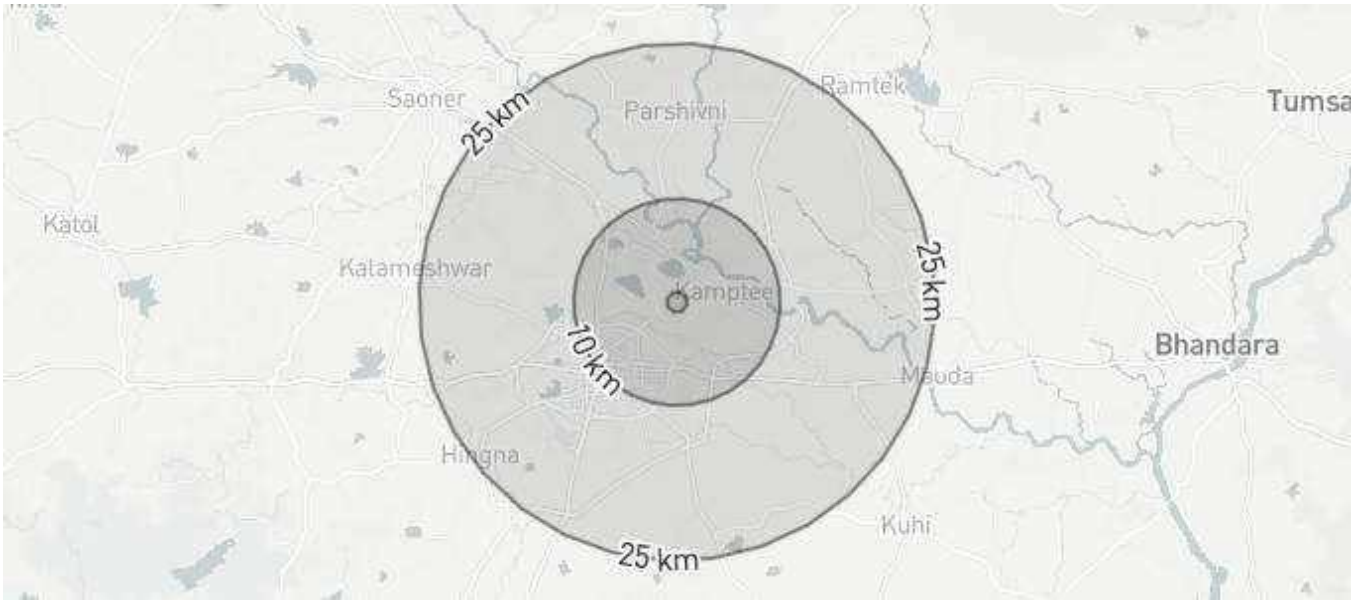
IUCN Red List Biomes: Marine, Freshwater, Terrestrial

Generated by: Suvalaxmi Sen

Organisation: ADB

Overlaps with:

Protected Areas	0
Key Biodiversity Areas	0
IUCN Red List	38



Displaying project location and buffers: 1 km, 10 km, 25 km

About this report

This report presents the results of [6775-50036] proximity analysis to identify the biodiversity features and species which are located within the following buffers: 1 km, 10 km, 25 km.

This report is one part of a package generated by IBAT on 17 October 2023 (GMT) that includes full list of all species, protected areas, Key Biodiversity Areas in CSV format, maps showing the area of interest in relation to these features, and a 'How to read IBAT reports' document.

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Data used to generate this report

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- IUCN. The IUCN Red List of Threatened Species. Version 2019-3. (2019). https://www.iucnredlist.org
- IUCN. Threats Classification Scheme (Version 3.2). (2019)
- Strassburg, B.B.N., Iribarrem, A., Beyer, H.L. et al. Global priority areas for ecosystem restoration. Nature 586, 724–729 (2020). https://doi.org/10.1038/s41586-020-2784-9

Protected Areas

The following protected areas are found within 1 km, 10 km, 25 km of the area of interest.
For further details please refer to the associated csv file in the report folder.

No protected areas within buffer distance

Key Biodiversity Areas

The following key biodiversity areas are found within 1 km, 10 km, 25 km of the area of interest.
For further details please refer to the associated csv file in the report folder.

No KBAs within buffer distance

IUCN Red List of Threatened Species

The following threatened species are potentially found within 50km of the area of interest.

For the full IUCN Red List please refer to the associated csv in the report folder.

Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
Nilssonia leithii	Leith's Softshell Turtle	REPTILIA	CR	Decreasing	Terrestrial, Freshwater
Sypheotides indicus	Lesser Florican	AVES	CR	Decreasing	Terrestrial
Vanellus gregarius	Sociable Lapwing	AVES	CR	Decreasing	Terrestrial
Gyps bengalensis	White-rumped Vulture	AVES	CR	Decreasing	Terrestrial
Sarcogyps calvus	Red-headed Vulture	AVES	CR	Decreasing	Terrestrial
Gyps indicus	Indian Vulture	AVES	CR	Decreasing	Terrestrial
Cuon alpinus	Dhole	MAMMALIA	EN	Decreasing	Terrestrial

Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
Manis crassicaudata	Indian Pangolin	MAMMALIA	EN	Decreasing	Terrestrial
Panthera tigris	Tiger	MAMMALIA	EN	Decreasing	Terrestrial
Silonia childreni		ACTINOPTERYGII	EN	Decreasing	Freshwater
Ammannia nagpurensis		MAGNOLIOPSIDA	EN	Unknown	Freshwater
Rynchops albicollis	Indian Skimmer	AVES	EN	Decreasing	Terrestrial, Freshwater
Sterna acuticauda	Black-bellied Tern	AVES	EN	Decreasing	Terrestrial, Freshwater
Neophron percnopterus	Egyptian Vulture	AVES	EN	Decreasing	Terrestrial, Freshwater
Aquila nipalensis	Steppe Eagle	AVES	EN	Decreasing	Terrestrial
Acinonyx jubatus	Cheetah	MAMMALIA	VU	Decreasing	Terrestrial
Bos gaurus	Gaur	MAMMALIA	VU	Decreasing	Terrestrial
Crocodylus palustris	Mugger	REPTILIA	VU	Stable	Terrestrial, Freshwater
Hipposideros durgadasi	Durga Das's Leaf-nosed Bat	MAMMALIA	VU	Decreasing	Terrestrial
Lutrogale perspicillata	Smooth-coated Otter	MAMMALIA	VU	Decreasing	Terrestrial, Marine, Freshwater
Melursus ursinus	Sloth Bear	MAMMALIA	VU	Decreasing	Terrestrial
Panthera pardus	Leopard	MAMMALIA	VU	Decreasing	Terrestrial

Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
Tetracerus quadricornis	Four-horned Antelope	MAMMALIA	VU	Decreasing	Terrestrial
Rusa unicolor	Sambar	MAMMALIA	VU	Decreasing	Terrestrial
Wallago attu		ACTINOPTERYGII	VU	Decreasing	Freshwater
Aythya ferina	Common Pochard	AVES	VU	Decreasing	Terrestrial, Marine, Freshwater
Grus antigone	Sarus Crane	AVES	VU	Decreasing	Terrestrial, Freshwater
Sterna aurantia	River Tern	AVES	VU	Decreasing	Terrestrial, Marine, Freshwater
Clanga clanga	Greater Spotted Eagle	AVES	VU	Decreasing	Terrestrial, Freshwater
Aquila rapax	Tawny Eagle	AVES	VU	Decreasing	Terrestrial, Freshwater
Leptoptilos javanicus	Lesser Adjutant	AVES	VU	Decreasing	Terrestrial, Marine, Freshwater
Schoenicola striatus	Bristled Grassbird	AVES	VU	Decreasing	Terrestrial, Freshwater
Amandava formosa	Green Avadavat	AVES	VU	Decreasing	Terrestrial
Clanga hastata	Indian Spotted Eagle	AVES	VU	Decreasing	Terrestrial
Oryza malampuzhaensis		LILIOPSIDA	VU	Decreasing	Terrestrial

Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
Lissemys punctata	Indian Flapshell Turtle	REPTILIA	VU	Decreasing	Terrestrial, Freshwater
Schizothorax plagiostomus	Snow Trout	ACTINOPTERYGII	VU	Decreasing	Freshwater
Bagarius bagarius		ACTINOPTERYGII	VU	Decreasing	Freshwater

Recommended citation

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Integrated Biodiversity Assessment Tool

PROXIMITY REPORT
REACH_3A_23_08_23 CENTERLINE-0

Country: India

Location: [21.1, 79]

Date of analysis: 17 October 2023 (GMT)

Buffers applied: 1 km | 10 km | 20 km

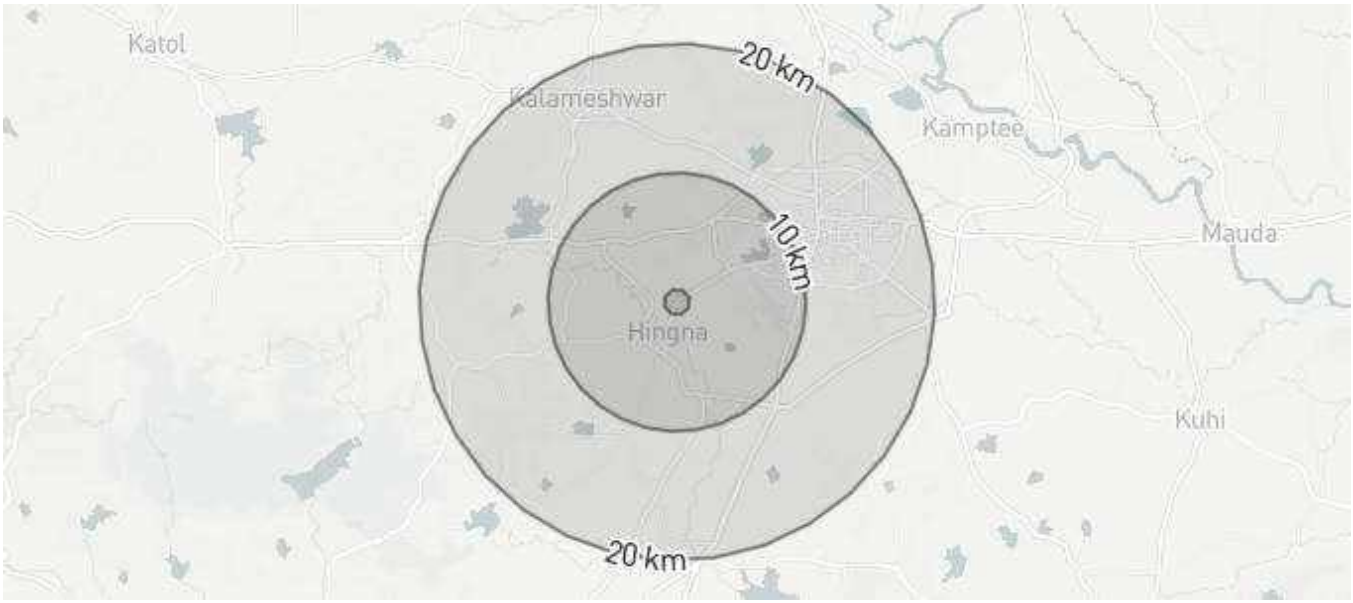
IUCN Red List Biomes: Terrestrial, Freshwater, Marine

Generated by: Suvalaxmi Sen

Organisation: ADB

Overlaps with:

Protected Areas	0
Key Biodiversity Areas	0
IUCN Red List	37



Displaying project location and buffers: 1 km, 10 km, 20 km

About this report

This report presents the results of [6775-50037] proximity analysis to identify the biodiversity features and species which are located within the following buffers: 1 km, 10 km, 20 km.

This report is one part of a package generated by IBAT on 17 October 2023 (GMT) that includes full list of all species, protected areas, Key Biodiversity Areas in CSV format, maps showing the area of interest in relation to these features, and a 'How to read IBAT reports' document.

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- IUCN. The IUCN Red List of Threatened Species. Version 2019-3. (2019). https://www.iucnredlist.org
- IUCN. Threats Classification Scheme (Version 3.2). (2019)
- Strassburg, B.B.N., Iribarrem, A., Beyer, H.L. et al. Global priority areas for ecosystem restoration. Nature 586, 724–729 (2020). https://doi.org/10.1038/s41586-020-2784-9

Protected Areas

The following protected areas are found within 1 km, 10 km, 20 km of the area of interest.
For further details please refer to the associated csv file in the report folder.

No protected areas within buffer distance

Key Biodiversity Areas

The following key biodiversity areas are found within 1 km, 10 km, 20 km of the area of interest.
For further details please refer to the associated csv file in the report folder.

No KBAs within buffer distance

IUCN Red List of Threatened Species

The following threatened species are potentially found within 50km of the area of interest.

For the full IUCN Red List please refer to the associated csv in the report folder.

Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
Nilssonia leithii	Leith's Softshell Turtle	REPTILIA	CR	Decreasing	Terrestrial, Freshwater
Sypheotides indicus	Lesser Florican	AVES	CR	Decreasing	Terrestrial
Vanellus gregarius	Sociable Lapwing	AVES	CR	Decreasing	Terrestrial
Gyps bengalensis	White-rumped Vulture	AVES	CR	Decreasing	Terrestrial
Sarcogyps calvus	Red-headed Vulture	AVES	CR	Decreasing	Terrestrial
Gyps indicus	Indian Vulture	AVES	CR	Decreasing	Terrestrial

Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
Cuon alpinus	Dhole	MAMMALIA	EN	Decreasing	Terrestrial
Manis crassicaudata	Indian Pangolin	MAMMALIA	EN	Decreasing	Terrestrial
Panthera tigris	Tiger	MAMMALIA	EN	Decreasing	Terrestrial
Silonia childreni		ACTINOPTERYGII	EN	Decreasing	Freshwater
Ammannia nagpurensis		MAGNOLIOPSIDA	EN	Unknown	Freshwater
Rynchops albicollis	Indian Skimmer	AVES	EN	Decreasing	Terrestrial, Freshwater
Sterna acuticauda	Black-bellied Tern	AVES	EN	Decreasing	Terrestrial, Freshwater
Neophron percnopterus	Egyptian Vulture	AVES	EN	Decreasing	Terrestrial, Freshwater
Aquila nipalensis	Steppe Eagle	AVES	EN	Decreasing	Terrestrial
Acinonyx jubatus	Cheetah	MAMMALIA	VU	Decreasing	Terrestrial
Bos gaurus	Gaur	MAMMALIA	VU	Decreasing	Terrestrial
Crocodylus palustris	Mugger	REPTILIA	VU	Stable	Terrestrial, Freshwater
Lutrogale perspicillata	Smooth-coated Otter	MAMMALIA	VU	Decreasing	Terrestrial, Marine, Freshwater
Melursus ursinus	Sloth Bear	MAMMALIA	VU	Decreasing	Terrestrial
Panthera pardus	Leopard	MAMMALIA	VU	Decreasing	Terrestrial

Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
Tetracerus quadricornis	Four-horned Antelope	MAMMALIA	VU	Decreasing	Terrestrial
Rusa unicolor	Sambar	MAMMALIA	VU	Decreasing	Terrestrial
Wallago attu		ACTINOPTERYGII	VU	Decreasing	Freshwater
Aythya ferina	Common Pochard	AVES	VU	Decreasing	Terrestrial, Marine, Freshwater
Grus antigone	Sarus Crane	AVES	VU	Decreasing	Terrestrial, Freshwater
Sterna aurantia	River Tern	AVES	VU	Decreasing	Terrestrial, Marine, Freshwater
Clanga clanga	Greater Spotted Eagle	AVES	VU	Decreasing	Terrestrial, Freshwater
Aquila rapax	Tawny Eagle	AVES	VU	Decreasing	Terrestrial, Freshwater
Leptoptilos javanicus	Lesser Adjutant	AVES	VU	Decreasing	Terrestrial, Marine, Freshwater
Schoenicola striatus	Bristled Grassbird	AVES	VU	Decreasing	Terrestrial, Freshwater
Amandava formosa	Green Avadavat	AVES	VU	Decreasing	Terrestrial
Clanga hastata	Indian Spotted Eagle	AVES	VU	Decreasing	Terrestrial
Oryza malampuzhaensis		LILIOPSIDA	VU	Decreasing	Terrestrial

Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
Lissemys punctata	Indian Flapshell Turtle	REPTILIA	VU	Decreasing	Terrestrial, Freshwater
Schizothorax plagiostomus	Snow Trout	ACTINOPTERYGII	VU	Decreasing	Freshwater
Bagarius bagarius		ACTINOPTERYGII	VU	Decreasing	Freshwater

Recommended citation

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Integrated Biodiversity Assessment Tool

PROXIMITY REPORT
REACH_4A_23_08_23 CENTERLINE-0

Country: India

Location: [21.1, 79.2]

Date of analysis: 17 October 2023 (GMT)

Buffers applied: 1 km | 10 km | 20 km

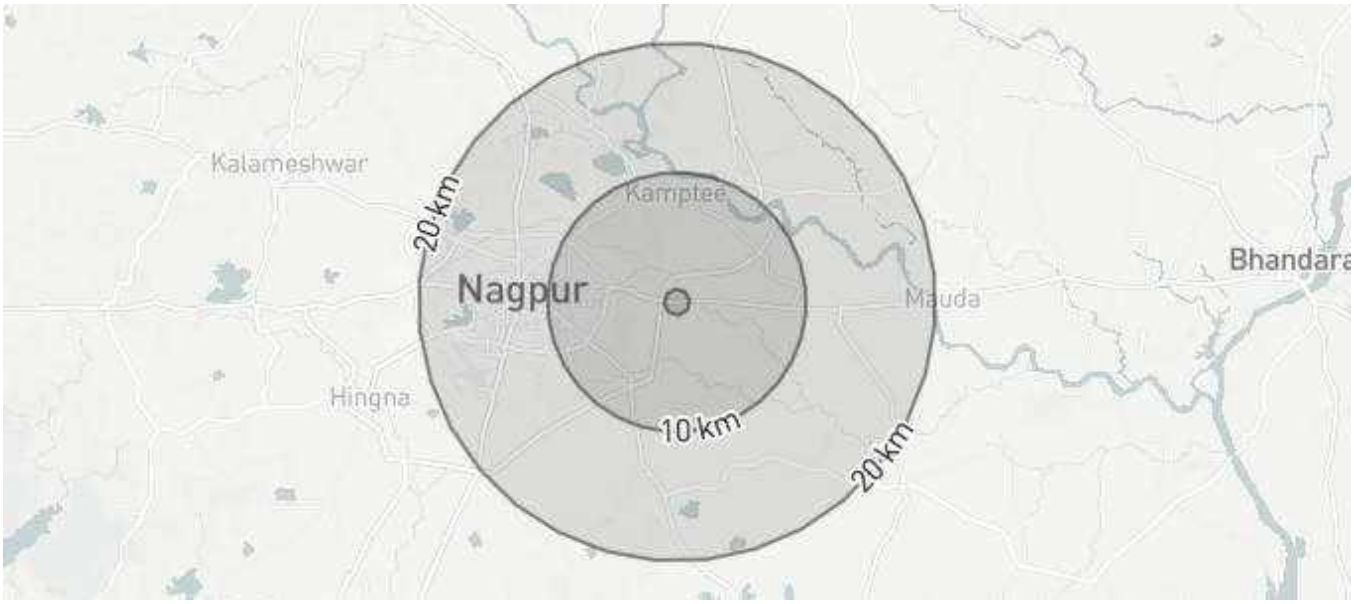
IUCN Red List Biomes: Terrestrial, Freshwater, Marine

Generated by: Suvalaxmi Sen

Organisation: ADB

Overlaps with:

Protected Areas	0
Key Biodiversity Areas	0
IUCN Red List	37



Displaying project location and buffers: 1 km, 10 km, 20 km

About this report

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Protected Areas

The following protected areas are found within 1 km, 10 km, 20 km of the area of interest.
For further details please refer to the associated csv file in the report folder.

No protected areas within buffer distance

Key Biodiversity Areas

The following key biodiversity areas are found within 1 km, 10 km, 20 km of the area of interest.
For further details please refer to the associated csv file in the report folder.

No KBAs within buffer distance

IUCN Red List of Threatened Species

The following threatened species are potentially found within 50km of the area of interest.

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Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
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Sypheotides indicus	Lesser Florican	AVES	CR	Decreasing	Terrestrial
Vanellus gregarius	Sociable Lapwing	AVES	CR	Decreasing	Terrestrial
Gyps bengalensis	White-rumped Vulture	AVES	CR	Decreasing	Terrestrial
Sarcogyps calvus	Red-headed Vulture	AVES	CR	Decreasing	Terrestrial
Gyps indicus	Indian Vulture	AVES	CR	Decreasing	Terrestrial

Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
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Manis crassicaudata	Indian Pangolin	MAMMALIA	EN	Decreasing	Terrestrial
Panthera tigris	Tiger	MAMMALIA	EN	Decreasing	Terrestrial
Silonia childreni		ACTINOPTERYGII	EN	Decreasing	Freshwater
Ammannia nagpurensis		MAGNOLIOPSIDA	EN	Unknown	Freshwater
Rynchops albicollis	Indian Skimmer	AVES	EN	Decreasing	Terrestrial, Freshwater
Sterna acuticauda	Black-bellied Tern	AVES	EN	Decreasing	Terrestrial, Freshwater
Neophron percnopterus	Egyptian Vulture	AVES	EN	Decreasing	Terrestrial, Freshwater
Aquila nipalensis	Steppe Eagle	AVES	EN	Decreasing	Terrestrial
Acinonyx jubatus	Cheetah	MAMMALIA	VU	Decreasing	Terrestrial
Bos gaurus	Gaur	MAMMALIA	VU	Decreasing	Terrestrial
Crocodylus palustris	Mugger	REPTILIA	VU	Stable	Terrestrial, Freshwater
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Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
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Rusa unicolor	Sambar	MAMMALIA	VU	Decreasing	Terrestrial
Wallago attu		ACTINOPTERYGII	VU	Decreasing	Freshwater
Aythya ferina	Common Pochard	AVES	VU	Decreasing	Terrestrial, Marine, Freshwater
Grus antigone	Sarus Crane	AVES	VU	Decreasing	Terrestrial, Freshwater
Sterna aurantia	River Tern	AVES	VU	Decreasing	Terrestrial, Marine, Freshwater
Clanga clanga	Greater Spotted Eagle	AVES	VU	Decreasing	Terrestrial, Freshwater
Aquila rapax	Tawny Eagle	AVES	VU	Decreasing	Terrestrial, Freshwater
Leptoptilos javanicus	Lesser Adjutant	AVES	VU	Decreasing	Terrestrial, Marine, Freshwater
Schoenicola striatus	Bristled Grassbird	AVES	VU	Decreasing	Terrestrial, Freshwater
Amandava formosa	Green Avadavat	AVES	VU	Decreasing	Terrestrial
Clanga hastata	Indian Spotted Eagle	AVES	VU	Decreasing	Terrestrial
Oryza malampuzhaensis		LILIOPSIDA	VU	Decreasing	Terrestrial

Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
Lissemys punctata	Indian Flapshell Turtle	REPTILIA	VU	Decreasing	Terrestrial, Freshwater
Schizothorax plagiostomus	Snow Trout	ACTINOPTERYGII	VU	Decreasing	Freshwater
Bagarius bagarius		ACTINOPTERYGII	VU	Decreasing	Freshwater

Recommended citation

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Annexure - 15

Minutes of Meeting (MoM) of Public Consultations held during ADB Fact Finding Mission (FFM) dated 26th and 27th October 2023 for Extension of Nagpur Metro Phase II

Prepared by,
MAHARASHTRA METRO RAIL CORPORATION LIMITED
Nagpur Metro Rail Project (NMRP) – Phase II

Introduction:

Maharashtra Metro Rail Corporation Limited (Maha-Metro) a joint venture company of Government of India (GoI) and Government of Maharashtra (GoM), is developing the Nagpur Metro Rail Project (NMRP) Phase-II consisting of proposed 4 corridors with length 43.8 kms and 30 elevated station, 2 are at grade. This Phase-II metro rail network will strengthen and augment the transport infrastructure within the city and suburban thus will address constrained public transport infrastructure issues. This Phase – II metro project is an extension of existing Phase – I.

For land acquisition, total 51 Titleholders who owns the private land and 47 Kiosk and 3 CPR have been identified[1] in the baseline socio economic survey. For private land acquisition the Direct Purchase through Negotiation method as per Government of Maharashtra Circular No. Misc.03/2015/C. N34/A-2 dated 12th May 2015, 30th Sept. 2015 & LQN-01/2017/CN-12/A-2 dated 25th Jan 2017 of Revenue Forest Department, GoM has been adopted. If by any reason this method fails then The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act (LARRA), 2013 will be applicable. Further, R&R shall be implemented as per Notification No. NMR-3318/Pra.Kra.145/Navi-7 dt. 12th May 2023 as directed to use Mumbai Urban Transport Project (MUTP) – R & R Policy, 2000. Since the Involuntary Resettlement is reversible, hence it is categorised as category – B for Social, whereas for Environment project category is A.

ADB desired to conduct the formal Public Consultation at each corridor during their fact-finding mission dated from 26 Oct. to 27 Oct. 2023. Accordingly, Maha-Metro (NMRP) organised Public Consultations at following four locations:

- **Reach 1A:** Dongargaon, Gram panchayat office on 26th October 2023
- **Reach 2A:** Kamptee Municipal Council office on 27th October 2023
- **Reach 3A:** Raipur Nagar panchayat office on 26th October 2023
- **Reach 4A:** Prakash Krushi Vidyalay High School, Pardi on 27th October 2023

Objectives of Public Consultation:

1. The main objective of this public consultation was to understand the awareness about Phase II project and to gather opinion on the Environmental and Social Impact due to Phase – II project and its mitigation measures from public.
2. To discuss the resettlement or compensation opinion from NTH about their loss.
3. To informed them about availability of GRM and GRC at NMRP for their complaint's registration.
4. To informed public about availability of ADB's Accountability Mechanism which provides rights to DPs for registering their grievance directly on ADB website.

[1] The number of TH and NTH will be chances to change as there will be any modification in the designs.

General Discussion held in Public Consultation:

1. Vikas Tambe, Sr. Social Expert, GC opened the meeting by welcoming all the participants and explained briefly about the aim of consultation and described the project in brief.
2. Ms. Suvalaxmi, Environment Specialist, ADB further asked about the public awareness of Phase II project and past consultations conducted. The people replied they were aware about the Phase II project and said that Maha-Metro has informed them through the meeting about the Phase II project periodically.
3. During earlier consultations the people were made aware that village weekly market may go under acquisition for the project, and they had demanded the construction of new market on alternative land with basic amenities like water, electricity, road etc.
4. Ms. Suvalaxmi, informed people about availability of Grievance Redressal Committee (GRC) at NMRP where they can register their social and environment complaints, if any.
5. If, due to any reason, the complaint has not been satisfactorily resolved with appropriate reply or complainant does not get any reply from NMRP, then the people can also reach directly to ADB's official website https://www.adb.org/ where under the ADB Accountability Mechanism, DPs can register their complaint directly with ADB.
6. The Sarpanch Smt. Kalpana Koram said that running of metro up to MIDC in the future, will boost the local entrepreneurial activities, especially their weekly market. Since the [prposed NMRP Phase II station is coming nearby their market the footfall to the market will increase, thus improving the financial status of poor. Further, travelling to Nagpur city through metro will be safes especially for women and also become financially affordable with reduced pollution. Overall, the people were happy for the Phase – II project and does not have any major complainant on the project.

Reach 1A (MIHAN to MIDC ESR)

Date: 26.10.2023
Location: Dongargaon, Gram panchayat (Reach 1A)
Star time: 12.00 pm
End time: 1.30 pm
Officials Presents:

Sr No	Name of Officials	Designation
1	Lawreen Laurito	Social Development Specialist, ADB
2	Suvalaxmi Sen	Environment Specialist, ADB
3	Marco Sprong	Environment Specialist, ADB
4	Ajay Ramteke	DGM/Land, NMRP
5	Pratish Nitey	AGM/Environment, NMRP
6	Vishal Hazare	Jr. Executive Surveyor, NMRP
7	Mr. Suhagpure	Jr. Executive, Land, NMRP
8	Aditya Athavale	Environment Expert, MITCON
9	Arvind Singh	Social Expert, CMRSD
10	Vikas Tambe	Sr. Social Expert, GC

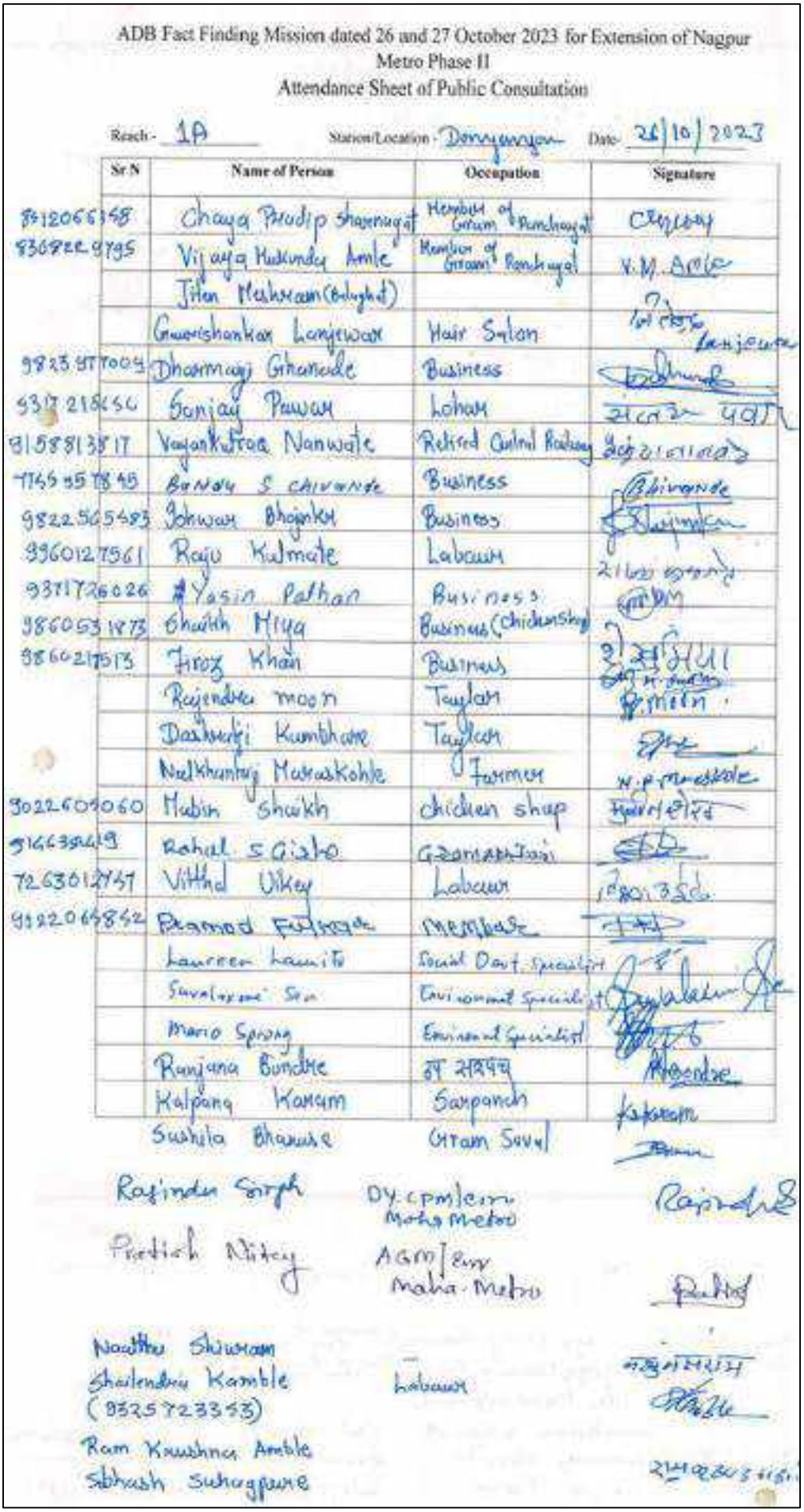
Following are some of the major points raised by the Public and discussed during the PC:

Srn	Name of the Person	Issue raised/ Point of Discussion	NMRP official reply
1	Shri Devendrasingh Thakur	The people were asking about plan for the relocation of weekly market and demanded any land identified by the NMRP for relocation.	The market will be relocated at suitable and accessible location near by their village. The NMRP has asked them to suggest any location where market can be relocated.
2.	Mobin Shaikh 9022604060	Any shop is going apart from the weekly market.	No, only land where is the market is located is going under acquisition.
3	Raju Kamthe 9960127561	There should be basic amenities like water, electricity, road, and drainage facilities provide to the new build market by the NMRP.	All the necessary facilities will be provided by the NMRP.
4	Kalpana Koram 8308209652	The progress of the Phase – II project and relocation should be informed to the local villagers timely.	The project progress will be intimate by villager through public consultation periodically.
5	Vyankatrao Nalavade 9158813817	What is the timeline to complete the project and when will the relocation of market commence?	The timeline to complete the whole project is minimum 5 years but the

			NMRP will try to complete before timeline. The relocation of market will be start after finalization of alternative land.

Photos of Public Consultaion:

Attendance Sheet:



ADB Fact Finding Mission dated 26 and 27 October 2023 for Extension of Nagpur Metro Phase II

Attendance Sheet of Public Consultation

Reach - 1A Station/Location - Dongargaon Date 26/10/2023

	Sr.N	Name of Person	Occupation	Signature
8412066148		Chaya Pradip Shamnagat	Member of Gram Panchayat	Chaya
8308226795		Vijaya Mukundrao Amle	Member of Gram Panchayat	V.M. Amle
		Jiten Meshram (Balghat)		
		Gwerishankar Langewar	Hair Salon	Langewar
9823977004		Dhanraj Ghanade	Business	
9371218456		Sanjay Pawar	Lohar	
8158813817		Vaijankutrao Nanwate	Retired Guard Railway	
7745957845		Bapu S Chivande	Business	Chivande
9822565485		Jaiswal Bhojraj	Business	
9960127561		Raju Kulmate	Labourer	
9371726026		Yasin Pathan	Business	
9860531873		Shaikh Miya	Business (Chickenshop)	
9860217513		Firoz Khan	Business	
		Rajendra Meen	Taylor	Meen
		Dashrathji Kumbhare	Taylor	
		Nilkhanthraj Mahorkohle	Farmer	N.P. Mahorkohle
9022609060		Mubin Shaikh	chicken shop	
9146384419		Rahul S Gajbe	Gramsabhasadasya	
7263012747		Vitthal Vikey	Labourer	
9122064842		Pramod Fulzele	Mechanic	
		Laureen Lamito	Social Dev. Specialist	
		Sivalingam Sen	Environment Specialist	
		Mario Spring	Environment Specialist	
		Ranjana Bundele	ग्रा.पं.सदस्य	Bundele
		Kalpana Kanam	Sarpanch	Kalpana Kanam
		Sushila Bhaware	Gram Sevak	
		Rajinder Singh	Dy. CPM/Engr. Maha Metro	Rajinder S
		Pratish Nitey	AGM/Engr Maha Metro	
		Nandkishor Shivram Shelendra Kamble (9325723353)	Labourer	
		Ram Krushna Amble		
		Subhash Suhagpure		

Reach 2A (Automotive Square to Kanhan River)

Date: 27.10.2023
Location: Kamptee Municipal Councill (Reach 2A)
Star time: 11.00 pm
End time: 2.30 pm
Officials Presents:

Sr No	Name of Officials	Designation
1	Lawreen Laurito	Social Development Specialist, ADB
2	Suvalaxmi Sen	Environment Specialist, ADB
3	Marco Sprong	Environment Specialist, ADB
4	Ajay Ramteke	DGM/Land, NMRP
5	Pratish Nitey	AGM/Environment, NMRP
6	Vishal Hazare	Jr. Executive Surveyor, NMRP
7	Mr. Suhagpure	Jr. Executive, Land, NMRP
8	Aditya Athavale	Environment Expert, MITCON
9	Arvind Singh	Social Expert, CMRSD
10	Vikas Tambe	Sr. Social Expert, GC

Following are some of the major points raised by the Public and discussed during the PC:

Srn	Name of the Person	Issue raised/ Point of Discussion	NMRP official reply
1	Sanjay Meshram 9890236893 Legal document shop	These squatters were demanded an alternative location for their shop nearby the Kamptee municipal council so that their livelihood will not disturb.	The authority said, the NMRP will assist them to relocate their shop in possible nearby location, if possible, at Kamptee municipal council by ensuring there will be no income loss.
2.	Anmol Dongare 7304055693 Food Centre	These kioks / Street venders have asked about the nearby alternative location for loss of livelihood after acquisition of land.	The authority said, the NMRP will assist them to relocate their kiosk in possible nearby location with local competent authority by ensuring there will be no income loss.
3	Prashant V. Kale 9923597025	The NPRM must provide the Jobs during the construction period in Metro.	The NPRM will request the contractor to provide temporary as and when required.
4	Manish Dhanade 8805652790	The relocation of their kiosk must be done to nearby location so that there will be no loss of income.	NMRP will try to relocate nearby place if land is available in coordination with local government authority.

5	Sunil A. Thakare 8551883420	What is the timeline to complete the project and when will the relocation commence?	The timeline to complete the whole project is minimum 5 years but the NMRP will try to complete before timeline. The relocation of market will be start before land acquisition.

Photos of Public Consultaion:

Attendance Sheet:

ADB Fact Finding Mission dated 26 and 27 October 2023 for Extension of Nagpur Metro Phase II

Attendance Sheet of Public Consultation

Reach - 2A Station/Location - Kamptee m.c. Date- 27/10/23

Sr N	Name of Person	Occupation	Signature
1	Rajkishor P. Bobde	Chandrapur-Nagpur	
2	[illegible]	8208495643	
3	[illegible]	9960493658	
4	[illegible]	9370855817	
5	[illegible]	7304055695	
6	[illegible]	[illegible]	
7	[illegible]	8531883420	
8	[illegible]	9923597025	
9	[illegible]	9763250552	
10	[illegible]	8928587774	
11	[illegible]	9370530069	
12	[illegible]	9881751904	
13	[illegible]	9890236893	
14	[illegible]	8855488890	
15	Manish Dharak	9850697870	
16	Madhuri Vikay	8905852740	
17	V.P. Manwatkar	9765965212	
18	Aditya Ahuvale (MITCON)	9850248597	
19	Jawadamuthan (ADB)	9096780015	
20	Marco Spinelli (ADB)		
21	Laurien Lauria		
22	Arvind Singh	SIA Consultant	
23	Jyoti Moelewar	9623651168	

Reach 3A (Lokmanya Nagar to Hingna)

Date: 26.10.2023
Location: Raipur Nagar panchayat (Reach 3A)
Star time: 3.00 pm
End time: 4.30 pm
Officials Presents:

Sr No	Name of Officials	Designation
1	Lawreen Laurito	Social Development Specialist, ADB
2	Suvalaxmi Sen	Environment Specialist, ADB
3	Marco Sprong	Environment Specialist, ADB
4	Ajay Ramteke	DGM/Land, NMRP
5	Pratish Nitey	AGM/Environment, NMRP
6	Vishal Hazare	Jr. Executive Surveyor, NMRP
7	Mr. Suhagpure	Jr. Executive, Land, NMRP
8	Aditya Athavale	Environment Expert, MITCON
9	Arvind Singh	Social Expert, CMRSD
10	Vikas Tambe	Sr. Social Expert, GC

Following are some of the major points raised by the Public and discussed during the PC:

Srn	Name of the Person	Issue raised/ Point of Discussion	NMRP official reply
1	Sudhir Bakare 9011642827 Saloon Shop and others	These kioks / Street venders have asked about the nearby alternative location to relocate them after acquisition of land.	The authority said, the NMRP will assist them to relocate their kiosk in possible nearby location with local competent authority by ensuring there will be no income loss.
2.	Manish N. Choudhari 8806991106 Chinese Food Centre	Apart from alternative location is there any cash compensation will be provided by the NMRP for loss of income?	The cash compensation if any, will be decided and informed them in the next meeting.
3	Dilip B. Kedkar 9823912132	The NPRM must provide the Jobs during the construction period in Metro.	The NPRM will request the contractor to provide temporary as an when required.
4	Nitesh D. Ghatode 9373054632	The relocation of their kiosk must be done to nearby location so that there will be no loss of income.	NMRP will try to relocate nearby place if land is available in coordination with local government authority.

Photos of Public Consultation:

Attendance Sheet:

ADB Fact Finding Mission dated 26 and 27 October 2023 for Extension of Nagpur Metro Phase II

Attendance Sheet of Public Consultation

Reach - 3A Station/Location - Raipur M.P. Date- 26/10/23

	Sr N	Name of Person	Occupation	Signature
7709713113		Shridep Dhandekar	Pan Thela	
8806991106		Manish Chawdhari	Chinese Centre	
—		Narendra Rakhunde	Pan Thela	
7038082510		Baban Laxman Chauhan		
9361950368		Ranjana Nannaware	General Store	
9208651883		Ganesh Gajanan Bhasle	Business	
7745936383		Prabhakar Dhodke	Panthela	
9765185560		Mangesh Khose	water purifier	
9018642827		Sudhir Bhakne	Salone	
7038619767		Vinod Vaidya.	Cycle Shop	
9158913661		Nitish Dhatode	Garage	
9823912192		Dilip Khedkar	Garage	
9765751566		Pankaj Deshmukh	Business	
9373756311		Sanket Kunakar	—	
8830100305		Nikhil Ambule	—	
8[illegible]		Rajendra Kapse	— Service	
		Lavkeen	Social Devt. Specialist	
		Suvalaxmi Sen	Environment Specialist	
		Mako Spsong	Environment Specialist	
9860997651		Shubhash Subhanpure	Consultant Metro	
9422933835		Anand Singh	SIA Consultant	
(9096[illegible])		Aditya Alhawat	RITES (Consultant)	
		[illegible]		

Reach 4A (Prajapati Nagar to Transport Nagar)

Date: 27.10.2023
Location: Prakash Krushi School, Pardi (Reach 4A)
Star time: 2.30 pm
End time: 4.30 pm
Officials Presents:

Sr No	Name of Officials	Designation
1	Lawreen Laurito	Social Development Specialist, ADB
2	Suvalaxmi Sen	Environment Specialist, ADB
3	Marco Sprong	Environment Specialist, ADB
4	Ajay Ramteke	DGM/Land, NMRP
5	Pratish Nitey	AGM/Environment, NMRP
6	Vishal Hazare	Jr. Executive Surveyor, NMRP
7	Mr. Suhagpure	Jr. Executive, Land, NMRP
8	Aditya Athavale	Environment Expert, MITCON
9	Arvind Singh	Social Expert, CMRSD
10	Vikas Tambe	Sr. Social Expert, GC

Following are some of the major points raised by the Public and discussed during the PC:

Srn	Name of the Person	Issue raised/ Point of Discussion	NMRP official reply
1	Gangabai Chavhan (Cobbler shop owner)	These kioks / Street venders have asked about to relocate nearby alternative location after acquisition of land.	The authority said, the NMRP will assist them to relocate their kiosk, if possible, nearby location with local competent authority by ensuring there will be no income loss.
2.	P.G.Choudhari 9765964255	What is the timeline to complete the project?	The timeline to complete the whole project is minimum 5 years but the NMRP will try to complete before timeline.
3	Tanmay Panchbudhe 9359736213	The relocation of their kiosk must be done to nearby location so that there will be no loss of income.	NMRP will try to relocate nearby place if land is available in coordination with local government authority.
4	Nitin A. Raut 8888441300	School authority was concern about the demarcation done by NMRP, they said they need more clarity on the demarcation done.	NMRP informed about the demarcation and area of land to be acquire.

Photos of Public Consultation:

Attendance Sheet:

ADB Fact Finding Mission dated 26 and 27 October 2023 for Extension of Nagpur Metro Phase II

Attendance Sheet of Public Consultation

Reach - 4A Station/Location - Prakash Krushi Pardi School Date- 27/10/23

Sr N	Name of Person	Occupation	Signature
(1)	सुनील नारायण ढोरे	J60 H727370	सुनील ढोरे
(2)	किशोर देवराव [illegible]	9923394407	[signature]
(3)	उदय पंचभुते	8055049813	[signature]
(4)	वसंत फुलबांधे	7080358321	[signature]
(5)	नंदमय पंचभुते	9850736213	[signature]
(6)	अनंत ना. लोकडे	9422578927	[signature]
(7)	नितीन अण्णाजी राऊत	8888441300	[signature]
(8)	अण्णाजी देवराव [illegible]	9372232539	[signature]
(9)	रंगराव बाई चक्रोण		
(10)	पंढरी महादेवराव शेंडगारे	9421776451	[signature]
(11)	सौ. मिना किशोर कोडे	9763173053	[signature]
(12)	श्री. व्ही. एस. [illegible]	9588434125	[signature]
(13)	Sau Po G o Chaudhari	9765964255	[signature]
(14)	Sau. Hemlata G. Gondane	7875425139	[signature]
	Aditya Athawale	9096780015	[signature]

LABOUR MANAGEMENT PLAN- OUTLINE

Contents

11. Primary Supply Workers

12. Management, Monitoring & Evaluation
12.1 Training and Awareness
12.2 General Monitoring Activities
12.3 Assessments
12.4 Audits
12.5 Performance Indicators

NAGPUR METRO RAIL CORPORATION LIMITED

CONSULTING SERVICES FOR "CONDUCTING"
ENVIRONMENTAL IMPACT ASSESSMENT (EIA) STUDY AND
ENVIRONMENT MITIGATION PLAN (EMP)
FOR NAGPUR METRO RAIL PROJECT

EIA & EMP REPORT

Consultant

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September 2016

CONTENTS

List of Tables

List of Figures

LIST OF ABBREVIATIONS

AAQM	Ambient Air Quality Monitoring
ADB	Asian Development Bank
ADT	Average Daily Traffic
AFC	Automatic Fare Collection
ASI	Archaeological Survey of India
ATP	Automatic Train Protection
BGL	Below Ground Level
BIS	Bureau of Indian Standards
BOD	Biochemical Oxygen Demand
BoQ	Bill of Quantities
CBI	Computer Based Interlocking
CBTC	Communications-Based Train Control
CCITT	International Consultative Committee On Telecommunications and Telegraphy
CFE	Consent For Establishment
CFO	Consent For Operation
CGWB	Central Ground Water Board
CO	Carbon Monoxide
CO_2	Carbon Di Oxide
COD	Chemical Oxygen Demand
CPCB	Central Pollution Control Board
CPHEEO	Central Public Health and Environmental Engineering Organization
CPSEs	Central Public Sector Enterprise s
CPWD	Central Public Works Department
CSR	Corporate Social Responsibility
dB	Decibels
DCC	Digital Command Centre
DFID	Department For International Development
DG	Diesel Generator
DMP	Data Management Platform
DMRC	Delhi Metro Rail Corporation Limited
DO	Dissolved Oxygen
DPR	Detailed Project Report
DRDO	Defence Research and Development Organization
EIA	Environmental Impact Assessment
EMC	Environmental Management Cell
EMP	Environment Management Plan
EP	Environment (Protection) Act
E-W	East West
FHWA	Federal Highways Noise Administration
FIRR	Financial Internal Rate of Return

ft	Feet
FRP	Fibre-Reinforced Plastic
gm	gram
GoI	Government of India
GI	Galvanised Iron
GW	Ground Water
GWQ	Groundwater Quality
HC	Hydrocarbon
I	Importance
IGBC	Indian Green Building Council
IMD	Indian Meteorology Department
in	inch
IRC	Indian Road Congress
IS	Indian Standards
ISO	International Organization for Standardization
JICA	Japan International Cooperation Agency
Kg	Kilo gram
KL	KiloLitre
Km	Kilometre
Km/h	Kilometere per hour
L S	Lump Sum
LARRA	Land Acquisition & Rehabilitation and Resettlement Act
LC	Labour Camps
LT	Long Term
Ltd	Limited
M	Magnitude
m	metre
M/s	Messrs
MADC	Maharashtra Airport Development Company
MIHAN	Multi-Modal International Cargo Hub and Airport At
mg	Milligram
mm	Millimetre
MoEF & CC	Ministry of Environment and Forest and Climate Change
MoUD	Ministry of Urban Development
MPCB	Maharashtra Pollution Control Board
MPN	Most Probable Number
MSL	Mean Sea Level
MSRTC	Maharashtra State Road Transport Corporation
MW	Mega Watts
NAAQMS	National Ambient Air Quality Series
NABET	National Accreditation Board For Education and Training
NEERI	National Environmental Engineering and Research

NGO	Non Government Organization
NH	National Highways
NHAI	National Highways Authority of India
NIT	Nagpur Improvement Trust
NMC	Nagpur Municipal Corporation
NMRCL	Nagpur Metro-Rail Corporation Limited
NOC	No Objection Certificates
NO_X	Oxides of Nitrogen
Nos	Numbers
N-S	North South
OBC	Other Backward Caste
OCC	Operation Control Center
OHL	Over Head Line
P Way	Permanent Way
PAPs	Project Affected People
PAT	Profit After Tax
PCU	Passenger Car Unit
PHPDT	Peak Hour Peak Direction Traffic
PM	Particulate Matter
PPEs	Personal Protection Equipments
PV	Photovoltaic
PWD	Public Works Department
QCI	Quality Council of India
R&R	Resettlement and Rehabilitation
RAP	Resettlement Action Plan
RBI	Reserve Bank of India
RCC	Reinforced Cement Concrete
RDS	Respirable Dust Samplers
RMC	Ready Mix Concrete
RMS	Root Mean Square
ROB	Rail Over Bridge
RSPM	Respirable Suspended Particulate Matter
S & T	Signal and Telegraph
SC	Scheduled Caste
SEZ	Special Economic Zone
SIA	Social Impact Assessment
SOx	Oxides of Sulphur
SQ	Soil Quality
sq	square
SRP	State Reserve Police
ST	Short Term

STP	Sewage Treatment Plants
SW	Surface Water
TDP	Traffic Diversion Plan
TDS	Total Dissolved Solids
TOD	Transit Oriented Development
TOR	Terms of Reference
TSS	Total Suspended Solids
µs	Micro Siemens
µm	Micro metre
VdB	Velocity Decibels
WB	World Bank

EXECUTIVE SUMMARY

0.1 INTRODUCTION

Nagpur is the third largest city of Maharashtra and also the winter capital of the state with a population of approximately 25 lakhs. Nagpur Metropolitan Area is the 13th largest urban conglomeration in India. It has also recently been ranked as the cleanest city and the second greenest city of India. It is also known as "Orange City" for being a major trade center of oranges that are cultivated in the region. Nagpur lies precisely at the center of the country with the Zero Mile Marker indicating the geographical center of India.

The city has recently become a home for a Multi-Modal International Cargo Hub and Airport termed as MIHAN. The project is considered as a mile stone in the economic development of the country. Keeping in purview of the various economic activities being planned in and around the city, the transportation system of the city is expected to change dynamically in coming decades. In addition to above, increase in urban agglomerates and interaction between various land uses make the Transport System planning as the need of the hour. For this purpose provision of Rail-based Metro system in the city has been considered.

DMRC provided Consultancy Services for preparation of a Detailed Project Report for Metro Rail System in Nagpur, and finalised DPR on November, 2013. The total length of the alignment is 38.215 Kms and the same is bifurcated into North-South & East-West Corridor.

- *Line 1 – North-South Corridor*: Automotive Square to MIHAN (19.658 km). The corridor is again sub-classified into two reaches namely:
  - Reach 1 - From Khapri to Sitaburdi
  - Reach 2 - From Sitaburdi to Automotive square
- *Line 2 – East West Corridor:* Prajapati Nagar to Lokmanya Nagar (18.557 km). The East - West Corridor is again sub-classified into two reaches namely:
  - Reach 3 - From Lokmanya Nagar to Sitabudi
  - Reach 4 - From Sitaburdi to Prajapati Nagar

Nagpur Metro Rail Corporation Limited (NMRCL) intends to implement the Nagpur Metro Rail Project with international/multilateral funding from funding agencies like KfW/AfD.

The objective of the study is to assess the significant environmental impact arising on account of the project during construction and operational phases and to propose mitigation measures, monitoring plan for significant impacts. The scope of EIA includes the impacts resulting from pre-construction, construction and operation phases of E-W & N-S corridor and Depot. The EIA is based on detailed field reconnaissance surveys, inventories and available secondary information.

The MoEF, Government of India, Notification of 14th September 2006 and its amendment enlist projects in Schedule that require environmental clearance. However as per the said notification a metro project does not require environmental clearance from MoEF. As per KfW Development Bank Sustainable Guidelines, 2014, preliminary appraisal (Screening) is performed to NMRCL Project. The proposed project is falling under the Category -B and the project may have potentially adverse risks and impacts upon the environment and on the social conditions of those concerned. However, the impacts and risks may have a lesser extent than these of Category –A.

0.2 PROJECT DESCRIPTION

The project North-South corridor runs from Automotive Square to MIHAN and South-West corridor runs from Prajapati Nagar to Lokmanya Nagar.

Line -1: North-South Corridor from Automotive Square to KHAPRI Depot: A total of 17 Stations have been planned along the proposed N-S Corridor. This corridor originates from Automotive square and runs southwards on NH-7 through Nari Road, Indora chowk, Gaddi Godam Square, Kastrurchand Park, Zero Mile, Sitabardi, Congress Nagar, Rahate colony, Ajni Square Station, Chhatrapati Square Station, Jaiprakash Nagar, Ujjawal Nagar, Airport Station, New Airport Station and Khapri Station. The Corridor is partly elevated and partly at grade. Total Length of the corridor is 19.658 Km of which approximately 15.058 is elevated and 4.6 km is at grade. There are 17 stations on this corridor of which 15 stations are elevated and 2 stations are at grade. Sitabardi Station is an Inter-change station. The depot is planned at MIHAN near Khapri. The proposed Metro Corridor is expected to have a daily ridership of 2,77,704 with Maximum PHPDT of 15729 by 2041. The completion cost of the project with all taxes, escalation & private land comes to Rs 8683 Crores.

Line -2: East-West Corridor from Prajapati Nagar to Lokmanya Nagar: A total of 19 Stations have been planned along the proposed E-W Corridor This corridor originates from Prajapati Nagar and runs westwards, through Vaishnodevi Chowk, Ambedkar Chowk, Telephone Exchange, Chittar Oli Chowk, Agrasen Chowk, Doser Vaisya Chowk, Nagpur Railway Station, Sitabardi, Jhansi Rani Square, Institute of Engineers, Shankar Nagar Square, LAD chowk, Dharmpeth College, Subhash Nagar, Rachna (Ring road Junction), Vasudev Nagar, Bansi Nagar to Lomanya Nagar. The entire corridor is elevated. The total length of the corridor is 18.266 kilometer. All stations are elevated stations and Sitabardi station is an Interchange Station. The depot is planned at Hingna near prajapati Nagar. The proposed Metro Corridor is expected to have a daily ridership of 2,86,031 with Maximum PHPDT of 11882 by 2041.

The design speed and scheduled speed of the metro rail will be 85 km/h and 30 km/h respectively. The power demand in 2016 will be about 12MVA and substation will be planned at Uppalwadi and Butibori grid sub-station for Line-1 and at Pardi and Hingna for Line-2. The train carrying capacity for 3 car train is 764 passengers @ 6 standee/sqm. Automatic train Control system with Automatic Train Protection (ATP) will be adopted. Fare collection system will be proposes as Automatic Fare Collection System with POM and smart card.

0.3 BASELINE STATUS OF PROJECT SITE

Base line studies were carried out in the study area. Environmental attributes such as air, noise, water, land, biological and socio-economic environment have been identified and the study was conducted generally conforms to the requirements of the EIA Notification, 2006 and subsequent amendments.

Ambient Air Quality: The prime objective of baseline air quality survey was to assess the ambient air quality of the area. Air quality monitoring was carried out at E-W and N-E corridor by collecting 24 hourly samples at 6 locations for parameters PM_{10}, $PM_{2.5}$, SO_2, NO_2, and HC; and 8 hourly samples for 1 day at 12 locations for Parameters CO and O_3. All values were found to be well within the stipulated standards except for Sitaburdi location where PM_{10} exceeded the limit.

Noise Environment: The identified twenty (20) ambient noise monitoring locations are falling under the commercial and sensitive categories. The day and night noise levels are observed to be in the range of 68.5 to 84.3 dB (A) & 42.5 to 58.8 dB(A) as against the CPCB Standard of 65 & 55 dB(A) respectively. The day & night noise levels are found to

be higher than the stipulated values in almost all locations. At locations near Saibaba Mandir & Gurudwara Mandir which falls under sensitive locations day and night noise levels are observed to be in the range of 74.4 to 75.8 dB (A) & 48.5 to 51.8 dB(A) as against the CPCB Standard of 50 & 40 dB(A) respectively. The main source of noise in the project area is the traffic movement on the road.

Vibration Analysis: Twenty two (22) locations are identified for carrying out Ambient Vibration Monitoring in the study area covering different category of buildings viz. residential, commercial/industrial and sensitive zone like Archaeological/ Historical buildings along the metro alignment.
North - South Corridor the monitored vibration levels are given for existing in inhabitant area. The values are monitored at major locations floor-wise. The values are observed at ground level and are ranging from 0.0060 inch/sec to 0.126 inch/sec as against the national standard of 0.20-0.40 inch/sec. The minimum values are observed at Kasturchand Park, Bharadwaj Apartment (Congress nagar), Hyatt Enclave (congress nagar) and Khullerchand (Sitaburdi) locations. Higher values are observed at RBI, Sai temple (Khapri), Sarvodhaya apartment (Pulia chowk) and Durgamata mandir (near automotive square) locations.

East-West Corridor the monitored vibration levels are given for existing in inhabitant area. The values are monitored at major locations floor-wise. The values are observed at gound level and are ranging from 0.012 inch/sec to 0.125 inch/sec as against the national standard of 0.20-0.40 inch/sec. The minimum values are observed at Kalinga Arcade (Shankar nagar square), Suryalok apartment (Viashnodevi chowk), Towry market (Chittar Oli chowk), and Girls hostel (Ambazari lake) locations. Higher values are observed at Chanderlok building, Rattan plaza (opp. Railway station), Subhash nagar chowk and Residential building (Ambedkar nagar chowk) locations. The monitored values at different floors of the locations are gradually reducing or increasing depends upon the material used for the construction and age of the building. However, all the monitored values at different floors of the locations are well within stipulated national standards.

Surface Water Quality: The surface water collected from various sources are analysed for physico-chemical and bacteriological parameters. The results are compared with BIS-2296 Class C Limit (Drinking water source after conventional treatment). Data on physical characteristics indicated pH ranged between 6.62 – 7.14, total hardness is in the range of 201.6 to 464.2 mg/l, calcium values are in the range 21.38-149.6 mg/l and magnesium values are in the range 13.01-142.6 mg/l. Dissolved solids are in the range between 286 mg/l to 1152 mg/l. Chlorides ranged between 35.41 – 54.96 mg/l. The Nitrates and Sulphates are ranged between 2.08 – 8.47 mg/l and 8.48 – 25.76 mg/l. Dissolved Oxygen in the sources is ranging between 5.0 to 6.3 mg/l as against the minimum requirement limit 4 mg/l. Bio-chemical Oxidation Demand (BOD) is observed to be high and ranged between 1.9–108 mg/l as against the specified limit of 3 mg/l except locations near Ambazari lake and Stream near Nildoh. An exceeding the limit is mainly due to entry of domestic wastewater from near townships and other commercial area in to the near-by surface water bodies.

Ground Water Quality: Physical characteristics indicated variations in pH ranged between 7.14 – 7.95 as against IS standard of 6.5 – 8.5. Total Hardness is in the range of 142.56 to 477.18 mg/l. All the values are well within the permissible limit 600 mg/l. Total Dissolved Solids observed to be ranged between 319 mg/l to 1141 mg/l as against the standard of 500-2000 mg/l. All the samples are well within the permissible limit. Chlorides are ranged between 26.22 – 398.23 mg/l, all the samples are well the permissible limit of 1000mg/l. The Nitrates and Sulphates values observed to be low and are ranged between 1.9 – 28.64 mg/l and 2.54 – 55.13 mg/l as against the desirable limit of 45 mg/l and 200 mg/l respectively.

Soil Characteristics: Six (06) samples were selected from different locations in the study area to understand the Physico-chemical properties of the soil. The soil along the study area is classified as silty-clay in nature and characterized by pH, the values are in the range of 6.10 – 7.87. The available Nitrogen in the soil is 68.51 – 96.17 Kg/ha, found to be average/sufficient requirement for the plantation. The available Phosphorous in the soil is 21.73 – 129.86 Kg/ha, found to be sufficient requirement for the plantation. The available Potassium in the soil is 23.99 – 1069.67 Kg/ha, found to be sufficient.

Ecological Environment: An ecological study of the ecosystem is essential to understand the impact due to project development activities on the existing flora and fauna of the area.

Flora: Trees survey has been conducted along the proposed alignment, at station locations and at depot area. The proposed alignment of metro rail is in urban/ city area and not passing through any forest area. Total number of trees observed along the alignment, station & depots is around 639. The type of species observed are Subabul, Neem, Gulmohar, Peepal, Coconut Palms, Ashoka, Mango, Karanj etc. There are no endangered or rare species present in the project impact area.

Fauna: No wildlife envisages in the project area. The domestic animals in the project area consist of cows, bullocks, sheep, goats and dogs.

0.4 POTENTIAL NEGATIVE IMPACTS

i) Impacts during Construction

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

Soil erosion: Though the project may not have significant impact on soil erosion, however, minor impact on soil erosion due to runoff from unprotected excavated areas may result in soil erosion, especially when erodibility of soil is high. Problems could arise from dumping of construction soils (concrete, bricks), waste materials (from contractor's camp) etc. causing surface and ground water pollution.

Traffic diversion: During construction period, partial traffic diversions on road will be required, as most of the construction is to be carried out on the middle of the road.

Spoil /Muck Disposal: During construction the major share of spoil/ muck estimated in the project is from excavation of the foundations of the piers is 2.40 Lakh Cum and Depots are generating 1.19 Lakh Cum. The construction & demolition waste is also considerable in the project which is estimated to be 0.24 Lakh Cum and others estimated to be 0.126 Lakh Cum. Overall spoil/ muck generation estimated in the project is 3.96 Lakh Cum.

The Contractor has identified the barren private land of 4.05 ha near Jamtha for excavated soil disposal and the agreement has been made with the owner. The land is located near Jamtha area, Nagpur which is about 2.0 km away from the Jamtha casting yard. All necessary precautions will be undertaken by contractor to ensure proper dumping within the identified area. No hazardous/chemicals is being used during piling operation and hence no ground contamination is anticipated. If required water quality within the area will be tested for any contamination.

Dust Generation: Protective measures shall be undertaken during construction phase for transportation of earth and establishment of the material due to use of heavy

machinery like compactors, rollers, water tankers, and dumpers. This activity is machinery intensive resulting in dust generation. However, this activity will be only short-term. The total amount of muck has to be transported through trucks. However, the sprinkling of water will be made in the construction areas throughout the construction period.

Ground and Surface Water: Construction activities may have an adverse impact on water bodies due to disposal of waste. The waste could be due to: the spillage of construction materials, dumping of used water from the stone crusher, oils and greases and workers camp. But the quantities of such spills are very negligible. Care, however, needs to be taken to provide adequate sanitary facilities and drainage in the temporary colonies of the construction workers. Provision of adequate washing and toilet facilities with septic tanks and appropriate refuse collection and disposal system should be made obligatory. Contamination of ground water can take place, if the dump containing above substances gets leached and percolates into the ground water table. This is not the case with the present project, as the activity does not involve usage of any harmful ingredients. Moreover, activities are of short duration. Hence, no adverse impact on either ground or surface water quality is anticipated in the present project. The debris, solid waste, wastewater from campsites etc generated from the project shall not be disposed/ discharged close to the 25 nos. of identified rivers, lakes, ponds, nallas etc.

Workers Camp: About 1200 persons are likely to work during peak construction activity for one reach. Water requirement at camp in the reach where construction is happening will be around 44.80 KLD, from which wastewater generation will be around 35.84 KLD & Municipal solid waste generation will be 288 Kg per day. The workers camp shall be provided with the Bio-digesters size of 100 KLD.

Loss of Historical and Cultural Monuments: No historical/cultural monuments will be affected/ damaged as a result of the proposed development.

Air Pollution: Potential impacts on existing air quality during the construction phase would be due to dust generated during excavation, earth work, vehicles movement, loading and unloading of the construction materials. Fugitive emissions generated due to vehicular movement are not expected to travel beyond a distance of 50 to 100 m from the point of their origin. Since, the proposed NMRCL project is proposed in the middle of the existing road, the habitation is present within 20 to 30m from the centre line of the road. The impact on air environment during the construction phase is temporary and localized in nature. However, sprinkling of water will be made in the construction areas throughout the construction period.

Impact on Noise: During the construction phase, noise will be generated due to movement of vehicles, and operation of light & heavy construction machinery including pneumatic tools (dozers, tippers, loaders, excavators, graders, roller, concrete mixer, generators, concreting pumps, vibrators, cranes, compressors, etc). The construction activities are expected to produce noise levels in the range of 104 – 109 dB (A) at source which decreases with increase in distance. Provision of construction noise barrier will reduce noise level up to 10-15 dB(A).

Vibration Impact: Construction activities can result in varying degrees of ground vibration, depending on the equipment and methods employed. Ground vibrations from construction activities do not often reach the levels that can damage structures, but they can achieve the audible and feelable ranges in buildings very close to the site. The construction activities that typically generate the most severe vibrations are blasting and impact pile.

North - South Corridor the predicted vibration levels are given for existing in inhabitant area, reference distance at 25' and other varying distances of 75', 125',175', 225', 275'and 325'. The predicted values for the existing scenario is ranging from 1.0 to 10.2 mm/sec as against the standard of 5-10mm/sec. The vibration values predicted other distances are gradually reducing and well below the standards.

East - West Corridor the predicted vibration levels are given for existing in inhabitant area, reference distance at 25' and other varying distances of 75', 125',175', 225' 275'and 325'. The predicted values for the existing scenario is ranging from 2.0 to 2.5 mm/sec as against the standard of 10mm/sec. The vibration values predicted other distances are gradually reducing and well below the standards.

ii) Impacts due to Project Operation

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

Noise Pollution: Noise levels prediction for the years 2021,2031 and 2041 was carried out taking 2016 noise levels monitored at different locations as the base value. The monitored base line data was compared with the predicted noise levels of 2021, 2031 and 2041 at day and at night time at distance of 50'. When the day time noise was predicted for different years at stations like Indira Chowk, Sai Baba Mandir, Khapri Depot, Gurudwara Mandir, Dosar Viasya Chowk and Hadas high school have showed more increase in noise levels (more than 1.5 dB(A) for 2021) while stations like Sitha burdi and Prajapathi Nagar shows less increase. Station near to Munje chowk is found to have predicted values more than the base values by nearly 5 dB(A) in 2021 and subsequent years, this trend of increase in values is due to the proposed high frequency of trains passing this location.

For the night time noise levels were predicted for different years at all stations where noise monitoring was conducted. Stations like Airport Station, Khapri Depot, GurudwaraMandir, Congress Nagar to Rahate Chowk, Dosar Viasya Chowk, Ambazari Lake and Hadas high school have shown significant increase in noise levels (more than 20 dB(A) for 2021). Remaining stations also are showing a substantial increase in noise levels in the predicted years of 2021, 2031 and 2041. For distances of 100m and 150m away from monitored location noise levels are found to be less than the base values for both day and night time.

Vibration Impact due to train: Predicted vibration levels during operation phase are given for existing in inhabitant area, reference distance at 25' and other varying distances of 75', 125',175', 225', 275'and 325'. The values assessed for the existing scenario is ranging from 0.50 to 15.2 mm/sec as against the standard of 5 to 10 mm/sec. The vibration values predicted other distances are gradually reducing and well below the standards.

It is observed that the vibration is ranging from 29 VdB to 60 VdB along the project corridor. High vibrations (78VdB-84.7VdB) were recorded along the sections which are passing through existing NH7 and Hingna Road. It is due to movement of heavy vehicles on the highway. It is expected that vibration levels are likely to be increased due to operation of the Metro. Past studies have shown that the vibrations have been recorded between 60VdB and 72VdB due to operation of the Metro. It is also recorded that vibration levels have reached up to 95VdB when metro is running at a high speed 75-80Km/h.

Medical equipment are sensitive to vibration only in operating stage. Negligible impact will be anticipated during operation stage as the vibration levels are well within standard of 0.20 inch/sec. Drop hammer piling will be avoided and hence negligible vibration impact during construction. Due consideration will be undertaken in the traffic diversion plan in close proximity of hospital.

Water Supply and Sanitation: The water demand for each station will be approximately 50m^3 per day. The proposed NMRCL project is having 36 stations and the total quantity of the water requirement is estimated to be 1800 m^3 per day.

iii) Impacts due to Depot

It is proposed to establish one depot- cum- workshop near Khapri Station in MADC Land for North South Corridor and one depot- cum- workshop in the land belonging to SRP near Lokmanya Nagar for East West Corridor. The area at depot is vegetated with no habitation near Lokmanya Nagar, and at Khapri land is vegetated open land of MIHAN industrial area.

Water Supply & Waste Water: About 118.03 KLD of water will be required at Depots for different uses. This will be collected from ground water/ municipal water supply through tankers. About 37.30 KLD of sewage is expected to be generated at Depots.

Noise Pollution: The main source of noise from depot is during operation of workshop. The roughness of the contact surfaces of rail, wheel and train speed is the factors, which influence the magnitude of rail-wheel noise. The vibration of concrete structures also radiates noise. To reduce these noise levels as a part of afforestation Greenbelt have to be provided along the Periphery of Depot area of 20-50 m thickness.

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

Solid waste: About 1.8 tonne per month of solid waste will be generated from the depot.

Trees: About 300 numbers of trees are observed at both the depot. The details of tree likely to be cut are given in the Environmental Management Plan.

0.5 POTENTIAL POSITIVE IMPACTS OF THE PROJECT

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

Employment Opportunities: About 3,000 persons are likely to work during peak period of construction activities. In operation phase about 30 persons/Km length of the corridor will be employed for operation and maintenance of the proposed system.

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

Safety: Operation of Nagpur Metro Rail will provide improved safety and lower the number of accidental deaths.

Traffic Noise Reduction: An introduction of Nagpur Metro Rail substantially reduces the vehicular traffic which ultimately reduces noise level.

Traffic Congestion Reduction: The proposed development will reduce journey time and hence congestion and delay.

Reduced Air Pollution: The metro is least polluting and can be classified as an environment friendly technology since no air emissions are involved in running and operating the metro trains. Reduction in traffic on Nagpur roads due to proposed metro rail could lead to reduce air pollution.

Carbon Credits: The reduction in CO_2 assessed for the project and the details of the carbon credits (tCO_2e/year) may obtained in the project are 47866, 57995 and 71125 for the horizon years 2021, 2031and 2041 respectively. Carbon credit revenue with present price (INR) will be 13.08 lakh, 14.30 lakh, 15.73 lakh and 17.33 lakh in year 2016, 2021, 2026 and 2036 respectively by considering approximate 53 gm of carbon-di-oxide (CO_2e) for every trip of 1 Km.

i) Green Initiatives Proposed in NMRCL

Under other project features, the NMRCL has taken completely green initiatives by introducing **Solar power generation, Bio-digesters and Green Building i**n the project. Mission of NMRCL is to develop an energy efficient, environment friendly mass rapid transit system using maximum energy from the renewable sources.The details of the same are described below:

Solar Photovoltaic Systems: NMRCL plans to install solar PV panels in two phases. In the first phase solar PV panels will be installed on the rooftops of stations and ground mount in the depot area. Solar panels having total capacity of **14.5 MWp** would be installed in the first phase. After completion of **Phase -I**, NMRCL plans to install to solar PV panels on depot and track boundary walls and on the viaduct structures under Phase -II. The total capacity of solar power which is likely to harnessed is about **23.1 MWp** after completion of **Phase II**. NMRCL has also planned to install solar panels on the roof of Metro Bhavan with a capacity of 260 Kwp and 1000 units/day. This green initiative will reduce the load on conventional sources for power production and also reduce carbon emissions.

Bio-digesters: In general, this technology has 2 components – (i) The anaerobic microbial consortium which is formulated from group of bacteria that are very efficient to perform the biodegradation of the human waste in wide range of temperature and in presence of toxic chemicals. (ii) The vessel in which fermentation is carried out with the help of bacteria is called bio-digester. The process of bio-degradation of human waste used in the present technology is carried out in strict anaerobic environment (devoid of oxygen) by anaerobic microbial consortium. It involves multiple biochemical steps and is of complex nature. These steps are sequential in nature and interdependent.

NMRCL will install eco-friendly bio-digesters at 36 stations and 2 Depots for on site disposal of human waste. A memorandum of understanding (MoU) in this regard was signed with Defence Research and Development Organization (DRDO), which had developed this technology. The bio-digestors based Eco-friendly sanitation technology will convert human faecal waste into water and gas. Ultimately, treated water is proposed to use for landscaping in Depots and parking areas.

Green Building: Green buildings can have tremendous benefits, both tangible and intangible. The most tangible benefits are the reduction in water and energy consumption right from day one of occupancy. The energy savings could range from 20 - 30 % and water savings around 30 - 50%. The intangible benefits of green new buildings include enhanced air quality, excellent day lighting, health & well-being of the occupants, safety benefits and conservation of scarce national resources. Green Building design strives to balance environmental responsibility, resource efficiency, occupant comfort and health and community sensitivity.

NMRCL also proposes eco-friendly and sustainable construction techniques to construct **Metro Bhavan office building** in Nagpur with a total built-up area of 10000 sq.m. NMRCL is having keen interest to make this project in accordance with green building norms and also aimed for obtaining the prestigious green building rating from Indian green building council (IGBC).

0.6 ENVIRONMENTAL MANAGEMENT PLAN

Soil Erosion Control: Prior to the start of the construction, the Contractor shall submit his schedules to the NMRCL for carrying out temporary and permanent erosion/sedimentation control works. The construction of temporary berms, dikes, sediment basins, slope drains and use of temporary mulches, fabrics, mats, seeding, or other control devices or methods will help to control erosion and sedimentation. Careful planning, timing of cut-and-fill operations and re-vegetation will help to control soil erossion. It is also proposed to have Ready Mix Concrete (RMC) directly from batching plant for use at site. The construction material such as steel, bricks, etc. will be housed in a fenced stored yard. The balance material from store yards will be removed for use/disposal at the end of work.

Traffic Diversion/ Management: Traffic Diversion Plans are required in order to look for options and remedial measures so as to mitigate any traffic congestion situations arising out due to acquisition of road space during Metro construction. It will be advisable to make these roads as one way to allow for operation of traffic together with construction activities. Advance traffic updates/information on communication systems will be an advantage to users of affected roads.

Muck Disposal: Overall spoil/ muck generation estimated in the project is 3.96 Lakh Cum. Spoil/ Muck shall be disposed at dumping sites.

Compensatory Afforestation: The objective of the afforestation program should be to develop natural areas in which ecological functions could be maintained on a sustainable basis. The Nagpur Municipal Corporation (NMC) & Revenue Department, Nagpur is responsible for giving the permission for the tree cutting in the project area.The Maximum number of trees is getting affected only at stations, Parking lots and at depot location are about 639 nos. However, NMRCL has planting 5000 nos. of trees as compensatory afforestation.

Water Supply, Sanitation and Solid Waste Management: The water demand for each station will be approximately 50m^3 per day. The proposed NMRCL project is having

36 stations and the total quantity of the water requirement is estimated to be 1800 m3 per day. Adequate provisions for meeting the water demand at each station have been taken. Platform washing requirement has been worked out at metro stations has been taken at the rate of 0.50liter per m^2. Fire fighting requirement has been taken as per the existing norms of Maharashtra Government. This could be developed from existing ground water source or municipal water supply through tankers. Solid waste generated at all stations is about 36 cum/day. Wastewater at station will be treated by eco-friendly bio-digestors. Solid waste generated during and after construction will be disposed in accordance with relevant National and State laws and Regulations.

Labour Camp: The Contractor during the progress of work will provide, erect and maintain necessary (temporary) living accommodation and ancillary facilities for labour to standards and scales. Safe drinking water should be provided to the dwellers of the construction camps. The labour camps cleanliness and worker's hygiene will be monitored as a part of Labour Laws of the Country during construction of proposed project. The labour camps will have facilities like Shelter at Workplace, Canteen Facilities, First aid facilities, Day Crèche Facilities, Sanitation Facilities and Solid Waste Management.

Air Pollution Control Measures: During the construction period, the impact on air quality will be mainly due to increase in Particulate Matter (PM) along haul roads and emission fro m vehicles and construction machinery. All the vehicles, machinery and equipment to be engaged for the construction work shall be attached with the latest, advanced pollution control measures available in the country and those shall conform to the relevant Indian standards. Contractor shall install barriers around the open construction sites before commencing the work. The Contractor shall sprinkle water at construction sites to suppress dust.

Noise Control Measures: There will be an increase in noise level due to construction of the proposed Metro corridors. The increases in levels are marginal; hence local population will not be adversely affected. However the exposure of workers to high noise levels especially, near the engine, vent shaft etc, need to be minimized. This could be achieved by: Job rotation to the extent possible, Automation, Construction of permanent and temporary noise barriers, Acoustic enclosures should be provided for individual noise generating construction equipment and the workers exposed to noise should be provided with protective devices. Rubber pads to reduce track noise and ground vibrations. Noise barriers arrangement at sharp curves and at closely located areas will be provided so as to reduce sound levels. About 950 m noise barriers proposed in N-S Corridor and 1350 m length proposed in E-W Corridor.

Vibration Control Measures: The impact piling is avoided at identified sensitive location viz., hospitals & schools. Drill pile will be employed to reduce the vibration impact. However, the vibration impact is on surrounding buildings/ habitat is temporary and localised in nature. By adopting good construction practices, generation of vibration will be controlled during construction. It is expected that vibration levels are likely to be increased due to operation of the Metro. Past studies have shown that the vibrations have been recorded between 60VdB and 72VdB due to operation of the Metro. It is also recorded that vibration levels have reached up to 95VdB when metro is running at a high speed 75-80Km/h.

Environmental Safeguard: The Contractor shall constitute a special group of environmental sanitation personnel. This group shall ensure daily cleaning at work sites and surrounding areas and maintain a register as per the approved format by the NMRCL.

Hazardous Waste Management: It shall be the responsibility of the contractor to ensure that hazardous wastes are stored, based on the composition, in a manner

suitable for handling, storage and transport. The contractor shall identify the nature and quantity of hazardous waste generated as a result of the project activities. Hazardous Waste will be handled and disposed as per the Hazardous waste (M&H) Rules, 2008 and shall be authorized with Maharashtra Pollution Control Board (MPCB). The contractor shall approach only Authorized Recyclers with MPCB for disposal of Hazardous Waste, under intimation to the NMRCL.

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

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

0.7 MANAGEMENT PLANS FOR DEPOT

Water supply: About 118.03 KLD of water will be required for operation and functioning of depots. This could be either met from Municipal Corporation or through boring tube well into the ground. The ground water will need treatment depending upon its use. Domestic and some of the industrial application, a Reverse Osmosis (RO) plant of 8 liter/ minute capacity will be appropriate.

Oil Pollution Control: The oil tends to form scum in sedimentation chambers, clog fine screens, interfere with filtration and reduce the efficiency of treatment plants. Hence oil and grease removal tank has to be installed at initial stage of effluent treatments. Such tanks usually employ compressed air to coagulate the oil and grease and cause it to rise promptly to the surface. Compressed air may be applied through porous plates located in bottom of the tank. Hence oil & grease removal tank having size of 3x2x1.5 m shall be installed at initial stage of effluent treatments in each depot area. The tank may be designed for a detention period of 5 to 15 minutes. This accumulated oil and grease will be disposed off through approved re-cyclers.

Sewage/Effluent Pollution Control: About 37.30 KLD of sewage/effluent is likely to be generated at depots. Waste water at depot will be treated by Eco-friendly bio-digestors. This has to be treated as per the requirement of regulatory pollution control agency of the state (MPCB).

Solid Waste Disposal: About 1.8 tonne per month of solid waste will be generated from the Depot which will be disposed to the Nagpur Municipal Corporation waste disposal sites in accordance with relevant National and State laws and regulations. Waste will be collected at separate dustbin system. Dustbins will be provided at appropriate locations.

Green belt development: The greenbelt development / plantation in the depot area not only functions as landscape features resulting in harmonizing and amalgamating the physical features with surrounding environment but also acts as pollution sink / noise barrier. In addition to augmenting present vegetation, it will also check soil erosion, make the ecosystem more diversified and functionally more stable, make the climate more conducive and restore balance. Treated sewage and effluent in the best combination should be used for green belt development.

Rain water harvesting: To conserve and augment the storage of groundwater, it has been proposed to construct roof top rainwater harvesting structure at the constructed depot site. Depot cum workshop area of 35,281 sq.m is available at both depots for roof top rain water harvesting. An annual average rainfall is 1112.7 mm, 287 KLD rain water will be harvested. The total recharge pit area of 10x10x3 will be required.

0.8 ENVIRONMENTAL MONITORING PLAN

Environmental monitoring will be carried out during construction and operational phase of the project. The environmental parameters i.e water, soil, air, noise and vibration needs to be carried out as per the environmental monitoring plan as outlined in the report.

Construction Period: It is proposed to complete the project in a time period of 48 months.

0.9 ENVIRONMENTAL COST ESTIMATES

Costs Towards Implementation of Environment Management Plan: The design and construction of the project involves a number of items such as erosion prevention, rehabilitation of Burrow areas, safety signage, etc., which are included in the contract cost. Only those items that are not covered under the budget for construction are given in the EMP implementation budget. The total budget for EMP works out to **Rs. 16.24 Crores (2.17 Million Euros as on 22/9/2016).**

Budget components under the purview of Contractor: From Table -10.1 of EIA Report, Budget for Workers camps, health and other services (Component 2); Solid waste management at campsite (Component 3); Muck/ Spoil disposal from the site (Component 4); Construction of noise barriers (Component 5); Green belt development (Component 6); Rainwater harvesting (Component 7); Bio-digesters (Component 8); Disaster Management Plan (Component 9); Tree plantation (Component 10); Monitoring for Construction Phase (Components 11, 12, 13, 14 & 15) and Awareness Programmes (Component 16) come under the purview of Contractor and already included in the tender document. Total cost for these components is estimated to be **Rs. 14.52 Crores.**

Budget components under the purview of NMRCL: From Table -10.1 of EIA Report, Budget for Third party/Independent Environmental Engineer monitoring and supervision of EMP implementation during construction phase (Component 1) and Monitoring costs-Operation phase (Components 17, 18, 19, 20 & 21 only) come under the purview of NMRCL. Total cost for these components is estimated to be **Rs. 1.72 Crores**

CHAPTER -01
INTRODUCTION

1.0 Background of the NMRCL Project

Nagpur is the third largest city of Maharashtra and also the winter capital of the state with a population of approximately 25 lakhs. Nagpur Metropolitan Area is the 13th largest urban conglomeration in India. It has also recently been ranked as the cleanest city and the second greenest city of India. In addition to being the seat of annual winter session of Maharashtra state assembly "Vidhan Sabha", Nagpur is also a major commercial and political center of the Vidarbha region, It is also known as "Orange City" for being a major trade center of oranges that are cultivated in the region.

Nagpur lies precisely at the center of the country with the Zero Mile Marker indicating the geographical center of India. The city was founded by the Gonds but later became part of the Maratha Empire under the Bhonsles. The British East India Company took over Nagpur in the 19th century and made it the capital of the Central Provinces and Berar. After the first reorganization of states, the city lost its capital status but according to the informal "Nagpur Pact" between political leaders, it was made the second capital of Maharashtra. Nagpur is also declared, "Tiger Capital of India " as it connects many Tiger Reserves in India to the world.

Nagpur lies on the Deccan plateau of the Indian Peninsula and has a mean altitude of 310 meters above sea level. The underlying rock strata are covered with alluvial deposits resulting from the flood plain of the Kanhan River. Nagpur city is dotted with natural and man-made lakes with Ambazari lake being the largest. Other natural lakes include Gorewada Lake and Telangkhedi lake. Sonegaon lake and Gandhisagar lake are man-made lakes created by the city's historical rulers. Nag river, Pilli nadi along with nallas form the natural drainage pattern for the city. Nagpur is known for its greenery, and was judged as the cleanest and second greenest in India. Recently, Government of India selected Nagpur as a Model City for *National Clean Air Mission* by allocating Rupees 25 Crores for the plan. This project will be handled by Nagpur's own National Environmental Engineering and Research Institute (NEERI).

Nagpur has a tropical wet and dry climate with dry conditions prevailing for most of the year. It receives an annual rainfall of 1,205 mm (47.44 in) from monsoon rains during June to September. The highest recorded rainfall was 304 mm on 14 July 1994. Summers are extremely hot lasting from March to June, with maximum temperatures occurring in May. Winter lasts from November to January, during which temperatures can drop below 10 °C (50 °F). The highest ever recorded temperature in the city was 49°C, while the lowest was 3°C.

The current transportation system of Nagpur city is being maintained and operated by Maharashtra State Road Transport Corporation (MSRTC). The existing Public Transport system of the city is quite robust, yet inadequate in meeting the transport demand of the commuters. The effectiveness of the Public Transport system mainly depends on its spread and network coverage. Whereas the Nagpur's public transport network mainly seems to concentrate on certain routes which limits its utility**.** Currently there are various kinds of buses being operated in the city. The seating capacity of the buses ranges from 28 to 44 seats. The buses are operated on all major routes and many of them are centrally connected to the Sitabardi Station which acts as a central terminal for the passengers to commute to various parts of the city.

The city has recently become a home for a Multi-Modal International Cargo Hub and Airport termed as MIHAN. The project is considered as a mile stone in the economic development of the country. It provides an added advantage of not only being connected to various corners of the country by air, but also being integrated with Rail and Road networks. Keeping in purview of the various economic activities being planned in and around the city, the transportation system of the city is expected to change dynamically in coming decades. In addition to above, increase in urban agglomerates and interaction between various land uses make the Transport System planning as the need of the hour.

Study Area:

In early 2012 Nagpur Improvement Trust (NIT) requested DMRC to provide Consultancy services for preparation of a Detailed Project Report for Metro Rail System in Nagpur, Maharashtra initially for 30 Km which was revised to 42 Km in July 2012. Thereafter, DMRC conducted Traffic Surveys, Topographical Surveys, Geo-technical Investigations and Environment Impact Assessment Survey. The study area consisted of Nagpur Municipal Corporation Area. The study area totaled to approximately 217 sq km.

Based on the different types of surveys done by DMRC, metro alignments were finalized after repeated inspection of the road network, intersections, passenger traffic flow, traffic congestion, connectivity to important land uses. Alignment of routes proposed by DMRC are given in Table -1.1.

Table -1.1: Alignment Proposed by DMRC in July 2013

Alignment (Proposed by DMRC)	Detail Route
Alignment-1 North-South Corridor (21.833 Km, 17 stations)	Automotive Square, along Kamptee Road, Wardha Road,Variety Square to Abhyankar Road, along Nag River alignment will fall on Humpyard Road, Rahate Colony Road, Wardha Road, Khamla Road, Airport, MIHAN Area
Alignment-2 East – West Corridor (18.266 Km, 19 stations)	From Prajapati Nagar, along Central Avenue Road, Railway Feeder Road, Munje Chowk, Jhansi Ranee Chowk, North Ambajhari Road, Hingna Road, Lokmanya Nagar

Source: NMRCL DPR, November, 2013

Final Alignment:

On 03.08.2013, a meeting presided by Shri S K Lohia, JS-MoUD,GoI was held at Nagpur to discuss the DPR. In that meeting, JS-MoUD,GoI expressed that the FIRR of the project should be at least 8%. Recently, MoUD has also issued advisory that FIRR of Metro Project should not be below 8%.

On 1.10.2013, a presentation on the DPR was made by M/s NIT to The Chief Minister, Government of Maharashtra. He was of the opinion to avoid underground alignment in MIHAN and also construct Maintenance Depot in the land belonging to State Govt Land. Subsequently, on 21.10.2013, a joint inspection of the NS corridor was done by VC&MDMADC, Chairman-NIT, and Director Business Development -DMRC.

The original alignment of Corridor-I proposed was passing through Khamla Road, Airport Area after Sahakar Nagar and finally was ending at MIHAN. The alignment up to Old Airport Station was elevated, then for a length of 3.30 km, it was underground with one underground station named as New Airport Station and again elevated in MIHAN Area. Since

the cost of underground section of the alignment is much more than the elevated section or the section at grade, alternative alignment was suggested for cost reduction, enhancement in PHPDT and to increase FIRR so that project becomes financially and economically viable.

The new proposed alignment suggested in the above inspection, was to pass through a 24m wide road adjacent to London Street after Sehkar Nagar Junction and was proposed to be taken to the east along 24m wide road and London Street up to Wardha Road. From the intersection at Wardha road, the elevated alignment was proposed to be on the central divider on the Wardha Road. After crossing existing intersection point of Wardha Road & Airport Road, the alignment was to be shifted to the MIHAN area. Alignment in this portion was proposed to be at grade and to run parallel to Wardha road upto ROB and abutting railway line thereafter up-to proposed Car depot.

But, while working on this modification of alignment, it was noticed that a very large number of properties were falling along the alignment due to sharp curve at the junction of Sahakar Nagar & 24 m wide road and also at the junction of 24m wide road & Wardha Road. Acquiring of these properties will be very tough and may delay the whole project. Hence to avoid all such situation, it has been decided to take the alignment on Wardha Road only without going on Khamla Road.

Finally, NS Corridor will pass through Wardha Road after Congress Nagar Metro Station. After crossing existing intersection point of Wardha Road & Airport Road, the alignment will be shifted to the MIHAN area. Alignment in this portion will be at grade and will run parallel to Wardha road upto ROB and parallel to railway line thereafter up-to proposed Car depot. 14m wide stretch of land between the railway boundary line and the road near proposed Container Depot of Container Corporation of India Ltd. will be affected by this proposed alignment of the Metro Rail as the proposed alignment passes through this stretch of land. 73 Ha land is available on the west side of railway line and south of existing flyover near khapari station. Average width of this land is about 80m and is about 1800m long. This MADC land may be utilized for Car Depot. Similarly, Depot of EW Corridor has also been shifted to SRP Land near proposed Lokmanya Nagar Metro Station. The final alignment is given in Table -1.2.

Table -1.2: Final Alignment

Alignment	Detail Route
Alignment-1 North-South Corridor (19.658 km, 17 Stations)	Automotive Square, along Kamptee Road, Wardha Road,Variety Square to Abhyankar Road, along Nag River alignment will fall on Humpyard Road, Rahate Colony Road, Wardha Road, Parallel to Railway Line, Khapri Station and finally in MIHAN Area near concor depot.
Alignment-2 East – West Corridor (18.557 km, 19 Stations)	From Prajapati Nagar, along Central Avenue Road, Railway Feeder Road, Munje Chowk, Jhansi Ranee Chowk, North Ambajhari Road, Hingna Road, Lokmanya Nagar

Source: NMRCL DPR, November, 2013

Nagpur Metro-rail Corporation Limited (NMRCL):

NMRCL Is a Special Purpose Vehicle (SPV) created for the smooth implementation and operations of the Nagpur Metro Rail Project and is a joint venture of Government of India & Government of Maharashtra, with 50:50 equity. NMRCL shall be solely responsible for the successful and timely completion of the project & its operations subsequently. Nagpur Metro Rail Corporation Limited is Incorporated by Govt. of India- Ministry of Corporate affairs on 18th February 2015.

With this background, M/s. Nagpur Metro Rail Corporation Limited (NMRCL) has entrusted the service to M/s. Aarvee Associates Architects Engineers & Consultants Pvt. Ltd., Hyderabad Vide LoA No: NMRCL/Civil (Consul)/06-2015/159, Dated: 27.01.2016 for Conducting Environmental Impact Assessment (EIA) Study and Environmental Mitigation / Monitoring & Management Plan for the Proposed Metro-Rail Project.

1.1 Objectives and Scope of Study

The objective of KfW Development Bank/ AFD Bank Environmental Impact Assessments (EIA) and climate change assessments is to anticipate and appraise any foreseeable impact a project may have on the environment, the climate and/or on social factors (including human rights), and to identify and prevent any negative impact, or limit it to a tolerable level and (provided that the negative impact is inevitable but still tolerable) introduce compensation measures.

In addition, the assessments should identify, monitor and manage any residual risks. The objective of the climate change assessment is also to recognize climate change impacts that may impair the achievement of objectives in due time so that, if applicable, required adaptation measures can be taken into consideration in the project conception.

By aligning EIAs with internationally recognized environmental and social standards (e.g. World Bank Safeguard Policies, IFC Performance Standards, Environmental, Health and Safety Guidelines of the World Bank Group, ILO Core Labour Stand- c ards, EU Environmental Legislation), KfW Development Bank/ AFD Bank aims to improve donor harmonization in accordance with the Paris Declaration.

The objective of the study is to facilitate the M/s. Nagpur Metro Rail Corporation ltd. (NMRCL) in the preparation EIA & EMP report as per requirements KfW Development Bank/ AFD Bank Sustainable Guidelines, 2014. The scope of EIA includes the impacts resulting from design/ pre-construction, construction and operation phases of Line I & Line II of Metro corridor, Depot and sub-stations.

1.1.1 Objectives

The principle objectives of Environmental Impact Assessment (EIA) and Environment Management Plan (EMP) are:

- EIAs and climate change assessments are a core element of the assessment procedure of KfW Development Bank/ AFD Bank. They are, first and foremost, intended as a management tool to steer and shape projects over their entire life cycle (i.e. from planning to completion).
- To carryout EIA study and preparation of Environmental Mitigation/ Monitoring & Management Plan in accordance to the Guidelines of the KfW Bank sustainable Guidelines/ AFD Bank/ MoEF & CC/ WB Guidelines and Appraisal of the same.
- To describe the proposed project and associated works together with the requirements for carrying out proposed metro rail development;
- To identify and describe the elements of the environment likely to be affected by the proposed metro rail developments;
- To establish the baseline environmental and social scenario of the project area (The baseline values are extracted from the NMRCL DPR, 2013);
- To identify and quantify emission sources and determine the significance of impacts

on sensitive receptors;

- To identify, predict and evaluate environmental and social impacts expected during the construction and operation phases of the project;
- To develop mitigation measures so as to minimize pollution, environmental disturbance and nuisance during construction and operations of the development;
- To design and specify the environmental management plan for the impacts identified; and
- To work out the cost of environmental mitigation, monitoring and management requirements.

1.1.2 Scope of the EIA Study

The scope of the environmental report is given below:

- ✓ Reconnaissance survey of the proposed route alignment;
- ✓ Review of National, state and local environmental regulatory requirements on environmental aspects and available standards besides requirement of Funding Agencies like WB/ KfW Bank Sustainable Guidelines /AFD Bank Guidelines.
- ✓ An environmental screening and categorization framework for the proposed project to identify the environmental analysis and planning aspects of the project.
- ✓ Identification of hot spots like involvement of forests, roads, rail crossing, bridges, rivers, nallahs, surface drainage as well as hydro geological conditions including aquifer geometry and groundwater flow etc.;
- ✓ Location of the project stretch with respect to environmentally sensitive areas, and community concerns.
- ✓ Assessment of existing land use pattern and feasibility of the entire rail link route with respect to availability of natural resources within the statutory frame work;
- ✓ Description on all applicable laws and regulations for the project.
- ✓ Establish the baseline status of the study area with reference to the air, noise/ vibration, water, soil quality, biological and social aspects along the section;
- ✓ Detailed Ecological and Biodiversity Impact Assessment, prediction and suggesting mitigation plan.
- ✓ Identification and suitability of sites for disposal of muck/waste soil material generated from cutting for roads, design of retaining structures and any other related works.
- ✓ Identification and assessment of habitation coming under entire section especially

with respect to noise/vibration impacts, resettlement and rehabilitation requirements;

- ✓ Incorporation of TOD studies and its impacts.
- ✓ Study the possible impacts of the project on land use pattern and suggesting alternative land use for environmental sustainability;
- ✓ Suggest suitable measures for restoration of the drainage net work
- ✓ Suggest suitable measures separately for mitigating the impact of noise and vibration in surrounding environment and habituated area that is likely to be generated from the speed of the train;
- ✓ Project specific Risk and Hazardous management studies & suggesting construction Workers management plan (Occupational health and safety).
- ✓ Preparing and suggesting project specific environmental management plan duly following MoEF & CC /KfW /AFD guidelines for environmental sustainability, including budget for implementation.

1.2 Need for Environmental Impact Assessment

Metro Rail projects are generally undertaken to improve the economic and social welfare of the people. At the same time, they may also create an adverse impact on the surrounding environment. People and property in the direct path of the Metro works are affected. The environmental impact of Metro Rail projects include damage to sensitive Eco-systems, soil erosion, changes to drainage pattern and thereby drop in groundwater level, interference with animal and plant life, resettlement of people, disruption of local economic activities, demographic changes, accelerated urbanization and increase in pollution noise levels. Metro Rail development and operation should, therefore, be planned with careful consideration of the environmental impact. To minimize these adverse effects that may be created by Metro Rail development projects, the techniques of Environmental Impact Assessment (EIA) become necessary. Identification and assessment of potential environmental impacts should be an integral part of the project cycle. However, the proposed project does not comes under the purview of EIA Notification. The total length of the proposed Metro Rail project is 38.215 km.

1.3 Approach and Methodology

The proposed alignment has been fixed based on Technical Feasibility, Socioeconomic

acceptability, and Environmental sustainability for Metro Corridors. The preliminary environmental study is carried out for the final alignment proposed by M/s. NMRCL. The approach is to follow the sequence of steps adopted in an EIA study. The basic concept is to ascertain the existing baseline conditions and assess the impacts as a result of construction and operation of the project. The changes likely to occur in different components of the environment viz. physical, biological / ecological, environmental and socioeconomic etc. have been studied, analyzed and quantified, wherever possible. The identification of parameters for data generation and impact assessment are important. The accurate analysis of assessment depends upon the reliable data generated/ available on environmental attributes. The baseline data for various parameters of physical (physio-graphic and soils), ecological (forestry, fisheries and wildlife), and environmental pollution (air, water, noise, and solid waste) are extracted from the NMRCL DPR Report, 2013. In addition to that an additional data on trees, sensitive locations (schools, hospitals, temples, archaeological sites etc.), validation of the above said environmental attributes are given in the report. Keeping in view of the KfW Development Bank/ AFD Bank Sustainable Guidelines, 2014, the impacts are assessed by M/s. **Aarvee Associates, Hyderabad** for various phases of project cycle namely:

- Impacts due to project Alignment/ Design/ Pre-Construction
- Impacts due to project construction, and
- Impacts due to project operation.

The impacts are categorized as negative and positive. The approach for EIA study is presented in Figure-1.1.

The standard methodology for the data collection, impact assessment and formulation of management plans is adopted. The National Acts, Legislation and Laws along with KfW Development Bank and AFD Bank guidelines were consulted with a view to ensure compliance with various requirements. The consultant collected and compiled the environmental baseline data for environmental attributes from primary and secondary sources. The primary sources include site visits, visual inspection, field studies, monitoring and analysis. The secondary sources include the books, reports, maps and documents from various government and non-government organizations on subject matter.

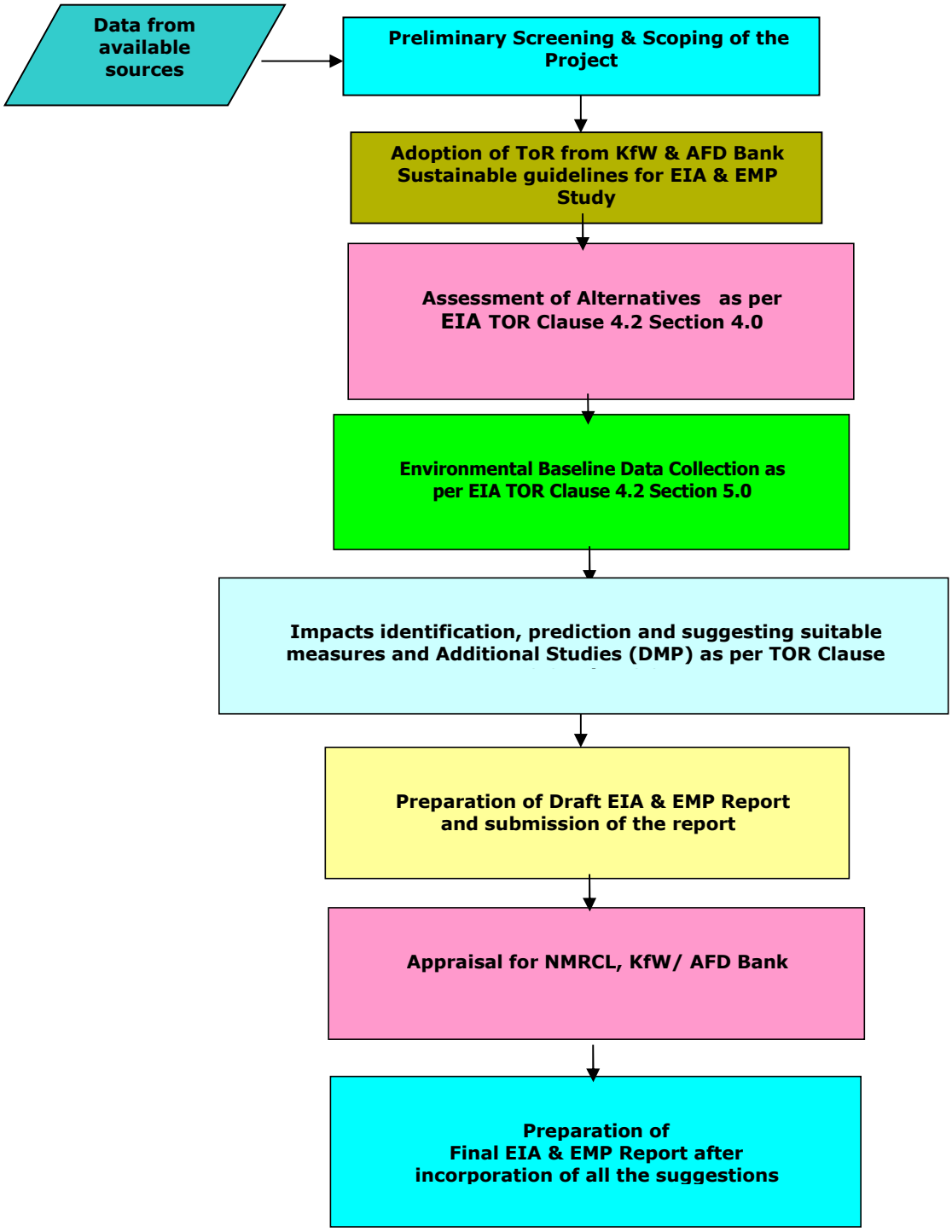


Figure -1.1: Flow Chart Showing the EIA Process

1.4 Generic Structure of Environmental Impact Assessment Document

In terms of the EIA notification of the MoEF dated 14th September 2006, the generic structure of the EIA document shall be as under:

1. Introduction
2. Project Description
3. Review of Environmental Regulatory Requirements, Policies & Guidelines
4. Analysis of Alternatives (Technology and Site)
5. Description of the Environment
6. Negative Impacts
7. Positive Impacts
8. Environmental Management Plan
9. Environmental Monitoring Plan
10. Environmental Cost Estimates
11. Summary & Conclusions
12. Disclosure of Consultants engaged

CHAPTER -02
PROJECT DESCRIPTION

2.0 PROJECT DESCRIPTION

2.1 Project Location

In early 2012 Nagpur Improvement Trust (NIT) requested DMRC to provide Consultancy services for preparation of a Detailed Project Report (DPR) for Metro Rail System in Nagpur, Maharashtra initially for 30 Km which was revised to 42 Km in July 2012. The study area covers of Nagpur Municipal Corporation Area which is total of approximately 217 sq km.

Based on the different types of surveys done by DMRC, metro alignments were finalized after repeated inspection of the road network, intersections, passenger traffic flow, traffic congestion, connectivity to important land uses. Alignments of final route proposed by DMRC, 2016 is given in Table -2.1 & the map showing the same is given in Figure-2.1.

Table-2.1: Alignment of final route proposed, 2016

Description	chainage	Detail Route
Line 1 – North-South Corridor: Automotive Square to MIHAN	0.000 km to 18.4606 km	Automotive Square, along Kamptee Road, Wardha Road, Variety Square to Abhyankar Road, along Nag River alignment will fall on Humpyard Road, Rahate Colony Road, Wardha Road, Parallel to Railway Line, Khapri Station and finally in MIHAN Area near concor depot
Line 2 – East West Corridor: Prajapati Nagar to Lokmanya Nagar	0.000 km to 17.7926 km	From Prajapati Nagar, along Central Avenue Road, Railway Feeder Road, Munje Chowk, Jhansi Ranee Chowk, North Ambazari Road, Hingana Road, Lokmanya Nagar

Source: NMRCL DPR, November, 2013

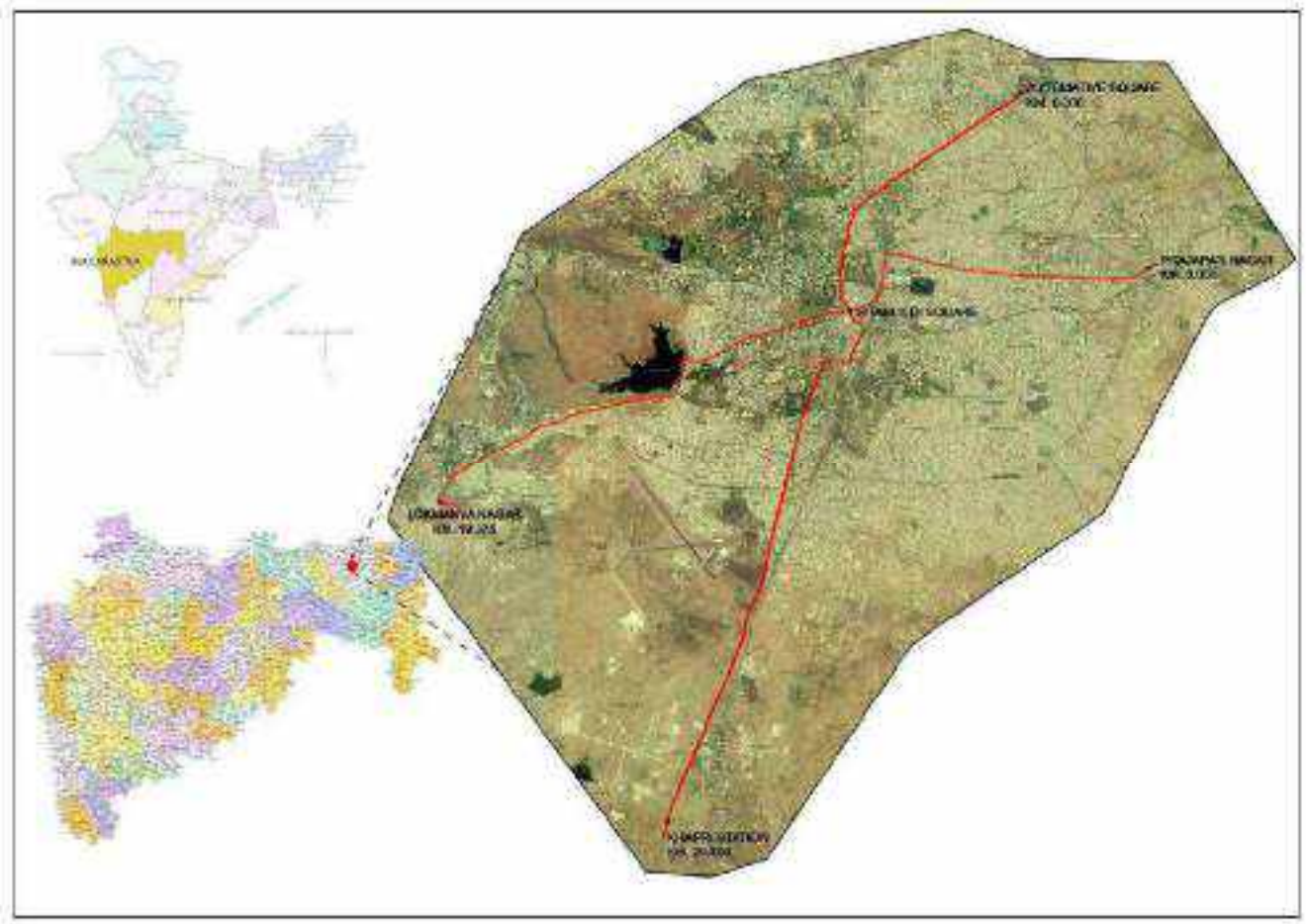


Figure -2.1: Location Map Showing the Proposed Project Stretches

2.2 Description of the Proposed Project Corridor

The project North-South corridor runs from Automotive Square to MIHAN and East-West corridor runs from Prajapati Nagar to Lokmanya Nagar. The section of North-South Corridor of the project starts near Automotive Square at km 0.00 km and extends upto Kasthurchand Park at km 5.1486, Chatrapathi Square at km 11.1463 and ends at Khapari at km 18.4606. In East West Corridor stretch zero chainage starts at Prajapati Nagar and passes through Telephone Exchange, Jhansi rani square, Lad chowk stations and ends at Lokmanya Nagar at km 17.7926. Sitabardi Station is an Inter-change station. The total length of the proposed stretch of both the corridors is about 38 km. Description of the Proposed Project Corridor is given in Table -2.2.

Table -2.2: Description of the Project Corridor

Description	Route Length (End to End of the Station)			Number of Stations	
	Elevated (km)	At Grade (km)	Total (km)	Elevated	At Grade
Line 1 – North-South Corridor: Automotive Square to MIHAN	15.058	4.600	19.658	15	2
Line 2 – East West Corridor: Prajapati Nagar to Lokmanya Nagar	18.557	0.00	18.557	19	0
Total	33.615	4.600	38.215	34	2

Source: NMRCL DPR Prepared by DMRC, 2013

2.3 Salient and Engineering Features of the Project

Salient and Engineering features of the Proposed Metro Rail Project are given in Table-2.3**.**

Table -2.3: Salient and Engineering features of the Project

S. No	Parameter(s)	Line 1 – North-South Corridor: Automotive Square to MIHAN	Line 2 – East-West Corridor: Prajapati Nagar to Lokmanya Nagar
1	Design Speed	85 km/h	
2	Scheduled speed	- Automotive Sqre to Congress Nagar section: 32 kmph. - Congress Nagar to Khapri Station section: 34 kmph.	30 kmph
3	Power Demand (MVA)	12.04 (2016)	12.58 (2016)
4	Sub Station	Uppalwadi Grid Sub-station. Butibori Grid Sub-station.	Pardi-Jattarodi ckt Hingana – Lendra Ckt
5	Train Carrying Capacity of 3 Car Train	764 passengers @6 standee/sqm	

S. No	Parameter(s)	Line 1 – North-South Corridor: Automotive Square to MIHAN	Line 2 – East-West Corridor: Prajapati Nagar to Lokmanya Nagar
6	Signaling & Train Control	Cab signaling and continuous automatic train control with Automatic Train Protection (ATP)	
7	Fare Collection	Automatic Fare collection system with POM and Smart card etc	
8	Depot location	Khapri Station (MADC Land)	Lokmanya Nagar Station (SRP Land)
9	Train operation	19 hours of the day (5 AM to 12 PM, i.e. midnight)	
10	Headway	- 4 min (Automotive Square to Congress Nagar) - 8 min (Congress Nagar to Khapri) (2031)	- 9 min (Prajapati Nagar to Agrasen Chowk) - 4.5 min (Agrasen Chowk to Subhash Nagar) - 9 min (Subhash Nagar to Lokmanya Nagar) (2031)
11	Max. Peak Hour Peak Direction Traffic (PHPDT)	12934(2031)	9906(2031)
12	Project Cost (Rs.)	8680 Crores	
13	Power requirement (MVA)	12.04 (2016), 12.85 (2021), 14.98 (2031), 18.65 (2041)	12.58 (2016), 13.03 (2021), 15.61 (2031), 19.49 (2041)

Source: DPR Prepared for NMRCL by DMRC, 2013

2.4 Details of Civil Engineering structures in NMRCL

The important civil engineering structures in the metro rail project are Viaducts, Piers, Foundation, Stations and Depots. Viaducts and piers form the superstructure and substructure respectively. Two level stations are constructed as elevated and at-grade stations. 2 depots have been provided in the project to facilitate maintenance of rakes.

2.4.1 Viaducts

Elevated viaducts are constructed with Pre-stressed concrete "Box" shaped Girders/Double U-Girder and will be supported on single cast-in-place RC pier. The superstructure of a

large part of the viaduct comprises of simply supported spans. However at major crossing/over or along existing bridge, special steel or continuous unit will be provided.

The normal viaduct structure of elevated Metro is about 10 m (edge to edge) wide. Ideally the required right of way is 10m. However, for reasons of safety a clean marginal distance / setback of about 5 m is necessary from either edge of the viaduct (or 10 m on both sides of the centre line) wherein no structures are to be located. Normally the U-Channel girder having a soffit width of 9.0 m (approx) accommodates the two tracks situated at 3.7m (tangent & upto 150m curvature) to 4.0m (90m curvature) c/c. The U-Channel superstructure for almost all the simply supported standard spans will be constructed by pre-cast pre-stressed segmental construction with epoxy bonded joints. Standard span up to 28.0m will be provided throughout the viaduct as far as possible. At crossings, where spans requires to be increased upto 31.0m, simply supported spans will be provided. The usual segments shall be 3.0m in length. Depth of the superstructure is so chosen that top of flange of U-Channel will be used as an evacuation walkway in case of an emergency.

2.4.2 Piers

The viaduct superstructure will be supported on single cast-in-place RC pier. The shape of the pier follows the flow of forces. The pier dimensions typically used in the project are 2*1.5 m2 or 2.2*1.7 m2 for most of its height. For the standard spans, the pier gradually widens at the top to support the bearing under the box webs. To prevent the direct collision of vehicle to pier, a Jersey Shaped crash barrier of 1.0 m height above existing road level has been provided all around the pier. A gap of 25 mm has also been provided in between the crash barrier and outer face of pier. The shape of upper part of pier has been so dimensioned that a required clearance of 5.5 m is always available on road side beyond vertical plane drawn on outer face of crash barrier. In such a situation, the minimum height of rail above the existing road is 8.4 m. The longitudinal center to center spacing of elastomeric/pot bearing over a pier would be about 2m. The space between the elastomeric bearings will be utilized for placing the lifting jack required for the replacement of elastomeric bearing. An outward slope of 1:200 will be provided at pier top for the drainage due to spilling of rainwater, if any. The transverse spacing between bearings would be 2.6 m (to be studied in more details). The orientation and dimensions of the piers for the continuous units or steel girder (simply supported span) have to be carefully selected to ensure minimum occupation at ground level traffic. Since the vertical and

horizontal loads will vary from pier to pier, this will be catered to by selecting the appropriate structural dimensions.

2.4.3 Foundation

Geo-technical investigation work at site was carried out to determine the existing subsoil strata, proposed type & depth of foundations and safe bearing capacity of foundations required for the proposed two Metro Corridors in Nagpur based on the results of 80 boreholes. Bore holes were driven in Automotive Square to MIHAN alignment & in Lokmanya Nagar to Prajapati Nagar alignment. Depending on the nature of soil, type of proposed structure and expected loads on foundations, the recommended type of foundation is generally pile foundation except for a few locations where hard strata was located close to ground level. Pile capacities have been calculated as per IS 2911 Part 2 and IRC 78 while allowable bearing capacity for shallow open footing has been computed from the equation as per IS: 6403 – 1981. The most feasible soil-foundation system is recommended as normal bored cast in situ R.C.C. piles foundations of 0.80m & 1.0m diameter at different depths with cut-off level at 1.50m to 2.0m depth below existing ground level. Auger boring will be conducted to install piles keeping in mind the densely populated region and to reduce the effect of vibrations on the surrounding structures. Settlement shall be determined for unit pressure for a specified width of footing based on corrected SPT values between the level of base of footing and the depth equal to 1.5 to 2.0 times the width of footing. Corrections shall be applied as applicable. Refer; IS: 8009 (Part-1).

Figure –2.2a : Elevated station

Figure- Fig 2.2 b At Grade Station.pdf

Figure –2.3: Piers, Viaducts and Piling

2.4.4 Stations Planning

NMRCL project has taken every care while selection of the stations, connecting staircases, escalators and parking areas. Mostly Stations are proposed at open or barren Government Lands and under unavoidable circumstances private properties are preferred. The NMRCL Project is classified into two type namely North-South Corridor and East-West Corridor. These corridors are further sub-classified into Reaches for an easy construction process as given below:

The North - South Corridor is again sub-classified into two reaches namely:

- ✓ Reach 1 - From Khapri to Sitaburdi
- ✓ Reach 2 - From Sitaburdi to Automotive square

The East - West Corridor is again sub-classified into two reaches namely:

- ✓ Reach 3 - From Lokmanya Nagar to Sitabudi
- ✓ Reach 4 - From Sitaburdi to Prajapati Nagar

The map showing the North-South Corridor & East-West Corridor along with Reaches and Stations is given in Figure -2.4.

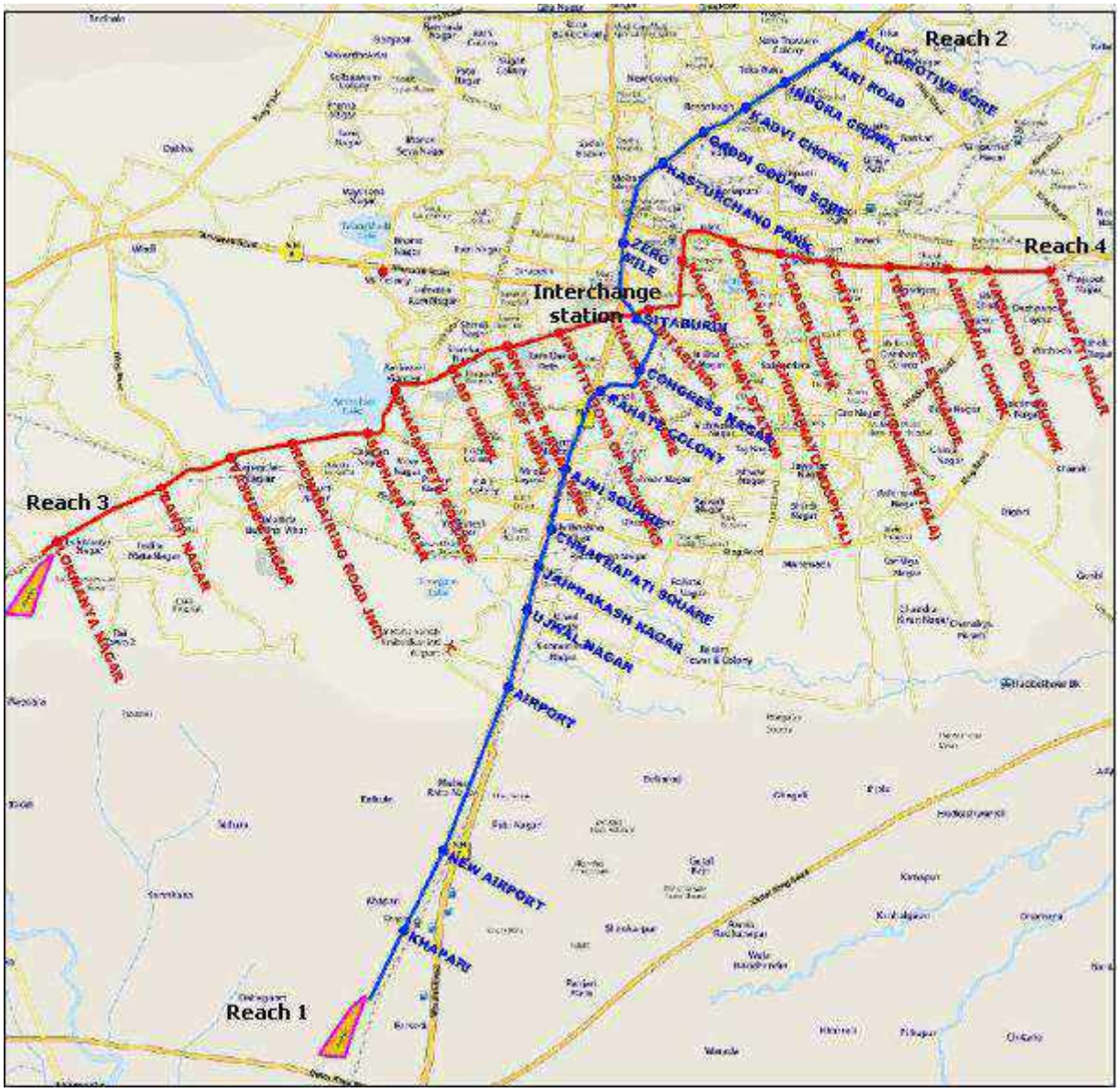


Figure -2.4: Map showing N-S & E-W Corridors along with Reaches and Stations

The detailed description of the North-south and East-west corridors is given below.

Line -1: North-South Corridor from Automotive Square to KHAPRI Depot: A total of 17 Stations have been planned along the proposed NS Corridor. This corridor originates from Automotive square and runs southwards on NH-7 through Nari Road, Indora chowk, Gaddi Godam Square, Kastrurchand Park, Zero Mile, Sitabardi, Congress Nagar, Rahate

colony, Ajni Square Station, Chhatrapati Square Station, Jaiprakash Nagar, Ujjawal Nagar, Airport Station, New Airport Station and Khapri Station. The Corridor is partly elevated and partly at grade. Total Length of the corridor is 19.658 Km of which approximately 15.058 is elevated and 4.6 km is at grade. There are 17 stations on this corridor of which 15 stations are elevated and 2 stations are at grade. Sitabardi Station is an Inter-change station. Average inter-station distance is 1.20km approximately varying from 0.54km to 2.4km depending upon the site, operational and traffic requirements. The details of the North-south Corridor Stations are given in Table -2.6. The proposed station locations with parking are given in Figures – 2.5.

Table -2.6: Details of the North-south Corridor Stations

S. No.	Name of the Station	Chainage (m)	Distance from Previous Station (m)	Rail level (m)	Platform type	Alignment
	Dead End	-145.0	-	-	-	-
1	Automotive Square	0.00	408.2	303.900	Side	Elevated
2	Nari Road	975.8	975.8	308.900	Side	Elevated
3	Indora Chowk	2139.7	1163.9	314.100	Side	Elevated
4	Kadvi Chowk	3181.2	1041.5	318.400	Side	Elevated
5	Gaddi Godam Sqre	4399.0	1217.8	323.200	Side	Elevated
6	Kasturchand Park	5148.6	749.6	326.300	Side	Elevated
7	Zero Mile	6175.5	1026.9	319.600	Side	Elevated
8	Sitabardi	6709.2	533.7	310.900	Side	Elevated
9	Congress Nagar	7897.2	1188.0	317.900	Side	Elevated
10	Rahate Colony	8682.6	785.4	321.500	Side	Elevated
11	Ajni Square	10104.7	1422.1	315.300	Side	Elevated
12	Chhatrapati Square	11146.3	1041.6	319.500	Side	Elevated
13	Jaiprakash Nagar	11811.5	665.2	320.000	Side	Elevated
14	Ujwal Nagar	12846.6	1035.1	311.000	Side	Elevated
15	Airport	13784.9	938.3	313.300	Side	Elevated
16	New Airport	16184.4	2399.5	299.000	Side	At-Grade
17	Khapari	18460.6	2276.2	308.700	Side	At-Grade
	Dead End	19250.0	-	-	-	-

Source: DPR prepared for NMRCL by DMRC, 2013

Figure -2.5: Photographs Showing the Stations (Zero mile & New Aiport) of North-South Corridor

Line -2: East-West Corridor from Prajapati Nagar to Lokmanya Nagar: A total of 19 Stations have been planned along the proposed EW Corridor This corridor originates from Prajapati Nagar and runs westwards, through Vaishnodevi Chowk, Ambedkar Chowk, Telephone Exchange, Chittar Oli Chowk, Agrasen Chowk, Doser Vaisya Chowk, Nagpur Railway Station, Sitabardi, Jhansi Rani Square, Institute of Engineers, Shankar Nagar Square, LAD chowk, Dharmpeth College, Subhash Nagar, Rachna (Ring road Junction), Vasudev Nagar, Bansi Nagar to Lomanya Nagar. The entire corridor is elevated. The total length of the corridor is 18.266 kilometer. All stations are elevated stations and Sitabardi station is an Interchange Station. Average inter-station distance is 1.00km approximately varying from 0.65km to 1.29km depending upon the site, operational and traffic requirements. The details of the East -West Corridor is given in Table -2.7. The proposed stations locations with parking areas are given in Figure -2.6.

Table -2.7: Details of the East-West Corridor Stations

S. No.	Name of the Station	Chainage (m)	Distance from Previous Station(m)	Rail level (m)	Platform type	Alignment
	Dead End	-392.0	-	-	-	-
1	Prajapati Nagar	0.00	392.0	301.0	Side	Elevated
2	Vaishno Devi Chowk	1229.3	1229.3	305.3	Side	Elevated

S. No.	Name of the Station	Chainage (m)	Distance from Previous Station(m)	Rail level (m)	Platform type	Alignment
3	Ambedkar Chowk	1947.9	718.6	308.3	Side	Elevated
4	Telephone Exchange	3137.4	1189.5	311.6	Side	Elevated
5	Chittar Oli Chowk	3950.2	812.8	311.5	Side	Elevated
6	Agarsen Chowk	4759.8	809.6	319.5	Side	Elevated
7	Dosar Vaisya Chowk	5590.4	830.6	321.9	Side	Elevated
8	Nagpur Railway station	6464.4	874.0	319.7	Side	Elevated
9	Sitabardi (Interchange)	7707.7	1243.3	320.1	Side	Elevated
10	Jhansi Rani Square	8354.0	646.3	313.9	Side	Elevated
11	Institute Of Engineers	9117.2	763.2	315.4	Side	Elevated
12	Shankar Nagar Square	10074.9	957.7	316.9	Side	Elevated
13	Lad Chowk	10873.1	798.2	319.1	Side	Elevated
14	Dharmpeth College	12020.7	1147.6	329.5	Side	Elevated
15	Subhash Nagar	12947.1	926.4	336.0	Side	Elevated
16	Rachna Ring Road Jn.	14201.1	1254.0	338.8	Side	Elevated
17	Vasdev Nagar	15173.9	972.8	345.2	Side	Elevated
18	Bansi Nagar	16131.6	957.7	336.3	Side	Elevated
19	Lokmanya Nagar	17792.6	1661.0	330.4	Side	Elevated
	Dead End	18165.0	372.4	-	-	-

Source: DPR prepared for NMRCL by DMRC-2013.

Figure- 2.6: Photographs Showing the Stations (Telephone Exchange & Chittaroli Chowk) of East-West Corridor

A. Planning and Design Criteria followed for Stations:

1. The stations can be divided into public and non-public areas (the areas where access is restricted). The public areas can be further subdivided into paid and unpaid areas.
2. The platform level has adequate assembly space for passengers for both normal operating conditions and a recognized abnormal scenario.
3. The platform level at elevated stations is determined by a critical clearance of 5.5-m under the concourse above the road intersection, allowing 3.5-m for the concourse height, about 1-m for concourse floor and 2.2-m for structure of tracks above the concourse. Further, the platforms are 1.09-m above the tracks. This would make the rail level in an elevated situation at least 13.4 m above ground.
4. The concourse contains automatic fare collection system in a manner that divide the concourse into distinct areas. The 'unpaid area' is where passengers gain access to the system, obtain travel information and purchase tickets. On passing through the ticket gates, the passenger enters the 'paid area', which includes access to the platforms.
5. The arrangement of the concourse is assessed on a station-by-station basis and is determined by site constraints and passenger access requirements. However, it is planned in such a way that maximum surveillance can be achieved by the ticket hall

supervisor over ticket machines, automatic fare collection (AFC) gates, stairs and escalators. Ticket machines and AFC gates are positioned to minimise cross flows of passengers and provide adequate circulation space.

6. Sufficient space for queuing and passenger flow has been allowed at the ticketing gates.
7. Station entrances are located with particular reference to passenger catchment points and physical site constraints within the right-of-way allocated to the MRTS.
8. Office accommodation, operational areas and plant room space is required in the non-public areas at each station.
9. The DG set, bore well pump houses and ground tank would be located generally in one area on ground.
10. The system is being designed to maximize its attraction to potential passengers and the following criteria have been observed:

- ✓ Minimum distance of travel to and from the platform and between platforms for transfer between lines.
- ✓ Adequate capacity for passenger movements.
- ✓ Convenience, including good signage relating to circulation and orientation.
- ✓ Safety and security, including a high level of protection against accidents.

11. Following requirements have been taken into account:

- ✓ Minimum capital cost is incurred consistent with maximising passenger attraction.
- ✓ Minimum operating costs are incurred consistent with maintaining efficiency and the safety of passengers.
- ✓ Flexibility of operation including the ability to adapt to different traffic conditions changes in fare collection methods and provision for the continuity of operation during any extended maintenance, repair period, etc.
- ✓ Provision of good visibility of platforms, fare collection zones and other areas, thus aiding the supervision of operations and monitoring of efficiency and safety.
- ✓ Provision of display of passenger information and advertising.

12. The numbers and sizes of staircases/escalators are determined by checking the capacity against AM and PM peak flow rates for both normal and emergency conditions such as delayed train service, fire etc.

13. In order to transfer passengers efficiently from street to platforms and vice-versa, station planning has been based on established principles of pedestrian flow and arranged to minimise unnecessary walking distances and cross-flows between incoming and outgoing passengers.

14. Passenger handling facilities comprise of stairs/escalators, lifts and ticket gates required to process the peak traffic from street to platform and vice-versa (these facilities must also enable evacuation of the station under emergency conditions, within a set safe time limit).

B. Details of a typical station:

Stations can be classified as Elevated station, At grade station and interchange station. There are 36 stations in total out of which one is an interchange station, two are at-grade and 33 stations are elevated stations. A brief description of the three types are given below.

Elevated Stations: The station is generally located on the road median. In order to keep the land acquisition to minimum, alignment is planned generally in middle of the road and a two level station design has been proposed. Total length of the station is ~140m. The concourse is planned along the whole length of the platform with staircases leading from either side of the road. The maximum width of the station at concourse is ~22m. Passenger facilities like ticketing, information, etc as well as operational areas are provided at the concourse level. Typically, the concourse is divided into public and non-public zones. The non-public zone or the restricted zone contains station operational areas such as Station Control Room, Station Master's Office, Waiting Room, Meeting Room, UPS & Battery Room, Signalling Room, Train Crew Room & Supervisor's Office, Security Room, Station Store Room, Staff Toilets, etc. The public zone is further divided into paid and unpaid areas. Auxiliary Service station is provided on the ground under the entry/ exit structure.

Since the station is in the middle of the road, minimum vertical clearance of 5.5-m has been provided under the concourse. Platforms are at a level of about 14.5m from the road. Platforms would be protected from the heat and rains by providing an overhang of the roof and sidewalls are avoided, thereby enhancing the transparent character of the station

building. In order to allow unhindered traffic movement below the stations, the station structure is supported on a single column, which lies unobtrusively on the central verge.

In elevated stations, 3.5m wide side platforms have been proposed. In Interchange station the platform width is kept as 5.0m in order to cater to a large number of interchanging passengers. These platform widths also have been checked for holding capacity of the platform for worst-case scenario.

At grade Stations: At grade stations are provided at Khapri and New Airport. The platforms proposed are of 4m wide and 3.5m wide at Khapri and New Airport respectively. At both stations concourse and platforms are at the same level.

Typical Interchange Station: The Sitaburdi Station is located at the intersection of the Line-1 and Line-2 of the Nagpur Metro System. The station has an interchange type configuration, and many passengers will change from one line to the other. This interchange will provide great utility and flexibility for the system as a whole, and it will decrease the time required for travel within the city.

Passengers traveling on both lines have the option to change their direction of travel at Sitaburdi, thus requiring larger concourses and platforms in the station for pedestrian movements. In addition to providing interchange connections between Line-1 and Line-2, the station accommodates a busy area of the city next to the Stadium, which will generate large numbers of passengers during special events. The station is composed of a Concourse Level 8.00 meters above the ground. Above the Concourse is the Line Platform at an elevation of 14.5 meters, and Line-2 Platform passes over Line-1 at the height of 23.9 meters.

Passengers entering Sitaburdi Station may go directly to either Line-1 or Line-2 platform from which they may board a train in any of four directions. Passengers entering the station on a train on either Line-1 or Line-2 may transfer between lines in a direct manner by means of convenient escalators and stairs that lead to trains in the other three directions.

Grouping of Stations: Stations have been grouped based on the available road width, site conditions as given below. Stations have also been grouped into different reaches.

Grouping of stations

Type-1 Stations:- These stations may be constructed on approx. road width of 18m. Concourse will be on the First floor and it shall be over the road and below track slab. So approximate size of the concourse may be around 78m x 18m. Floor area of each such station is approximately 6200 sqm. e.g. Congress Nagar Station.
Type-2 Stations:- These stations have been planned where approx. road width available is 22m. Concourse will be on the First floor with approximate size = 78 x 22m. Floor area of each such station is approximately 5400 sqm. eg. Ajani Square station.
Type-3 Stations:- These stations are planned with split concourse and shall be on each side of the road. The concourse shall be joined by a connecting bridge. Generally, the height of rail level from the ground level shall be in the range of 20m. These stations are expected to be constructed where flyover or double decker arrangement will be below the station track or viaduct. Operational rooms shall be constructed on 1st, 2nd and 3rd floors. Floor area of each such station is approximately 5800 sqm. e.g. Chhatrapati Square Station

The typical Stations viz., Type -1: Congress Nagar, Type -2: Ajani Square and Type -3: Chhatrapati Square are shown in Figure -2.7. 2.8 & 2.9 respectively. Reach wise grouping of the Stations are given in Tables -2.8 to 2.11.

Table -2.8: Reach 1 – From Khapri to Sitaburdi

Sl. No	Station Name	Road width excluding footpath	Flyover	Station Group	Remarks
1	Khapari		-		At grade station
2	New Airport		-		At grade station
3	Airport	22m	-	Type 2	22m
4	Ujwal Nagar	22m	yes	Type 3	Concourse on either side of flyover
5	Jaiprakash Nagar	22m			Concourse over the flyover
6	Chhatrapati Square	22m			No viaduct, concourse over flyover
7	Ajni Square	22m	-	Type 2	Road width More than 22m

Sl. No	Station Name	Road width excluding footpath	Flyover	Station Group	Remarks
8	Rahate Colony	25.109m	-	Type 2	No Viaduct in the station, 3 railway lines
9	Congress Nagar	16.945m	-	Type 1	No Viaduct in the station, Road width less than 22m
10	Sitaburdi	--	-		Interchange Station

Source: NMRCL, May-2016

Table -2.9: Reach 2- From Kasturchand Park to Automotive square

S. No	Station Name	Road width excluding footpath	Flyover	Station Group	Remarks
11	Sitaburdi towards Zero Mile		-		Interchange Station
1	Kasturchand Park	19.7	-	Type 1	
2	Gaddi Godam Square	19.2	-	Type 1	
3	Kadvi Chowk	21.9	Yes	Type 3	Station and viaduct over the flyover
4	Indora Chowk	29.4			
5 5	Nari Road	29.3			
6	Automotive Square	15+8.5			

Source: NMRCL, May-2016

Table -2.10: Reach 3 – From Jhansi Rani Square to Lokmanya Nagar

S. No	Station Name	Road width excluding footpath	Flyover	Station Group
1	Jhansi Rani Square	-	-	Type 3
2	Institute Of Engineers	-	-	Type 3
3	Shankar NagarSquare	-	-	Type 3
4	Lad Chowk	-	-	Type 3
5	Dharmpeth College	-	-	Type 3

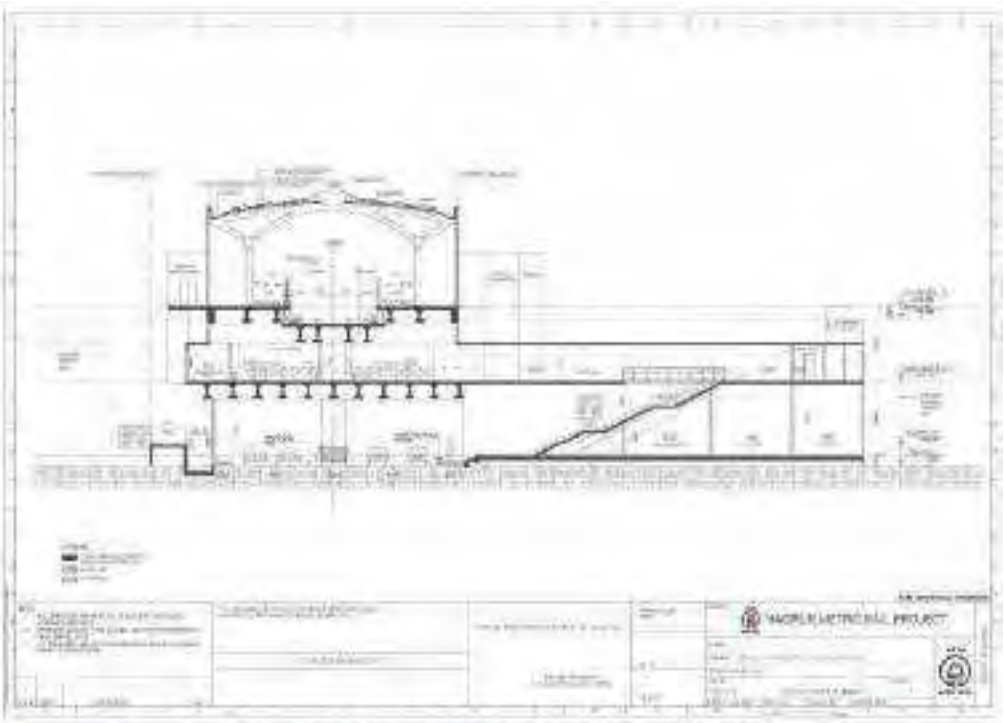
6	Subhash Nagar	-	-	Type 3
7	Rachna Ring Road Jn.	--	-	Type 3
8	Vasdev Nagar	-	-	Type 3
9	Bansi Nagar	-	-	Type 3
10	Lokmanya Nagar	-	-	Type 3

Source: NMRCL, May-2016

Table -2.11: Reach 4- From Nagpur Railway station to Prajapati Nagar

S. No	Station Name	Road width excluding footpath	Flyover	Station Group	Remarks
1	Nagpur Railway station	19.9*	-	Type 2	* Additional space on each side is available at site. Hence Type 2 station may be planned
2	Dosar Vaisya Chowk	22.6#	-	Type 1	#Building line of adjacent commercial properties shall almost touch stations if type 2 stations are planned. Hence, type 1 stations may be planned.
3	Agarsen Chowk	23.3#	-		
4	Chittar Oli Chowk	24#	-		
5	Telephone Exchange	24.4	-	Type 2	
6	Ambedkar Chowk	25.2	-	Type 2	
7	Vaishno Devi Chowk	25.1	-	Type 2	
8	Prajapati Nagar	27.46	yes	Type 1	Station & viaduct parallel to the flyover

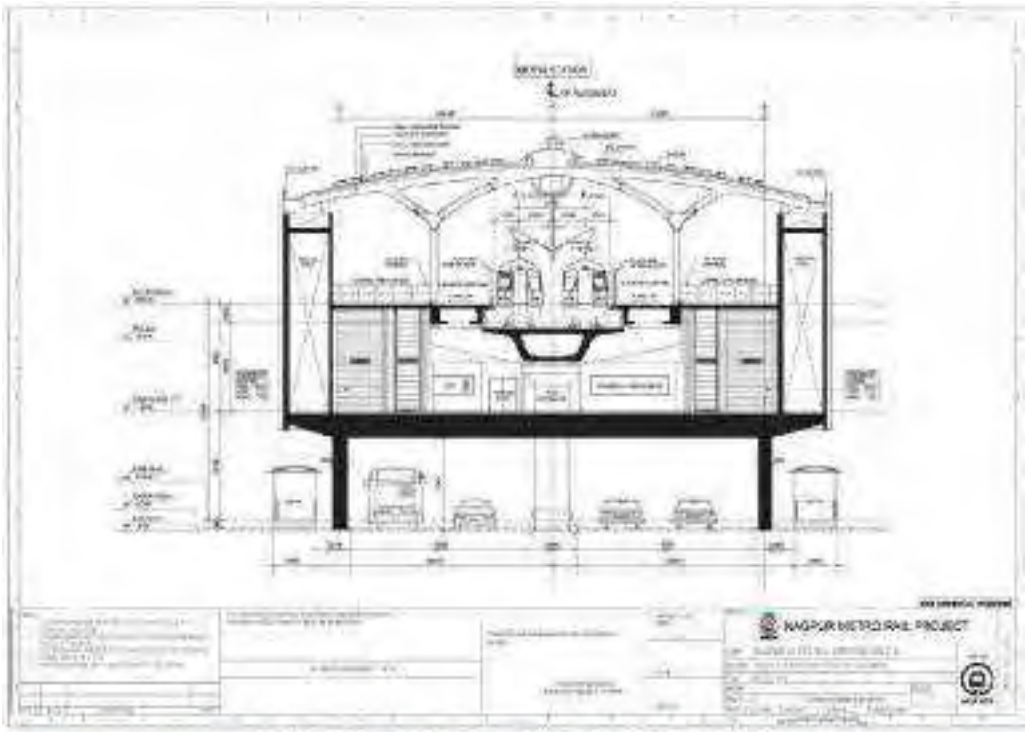
Source: NMRCL, May-2016



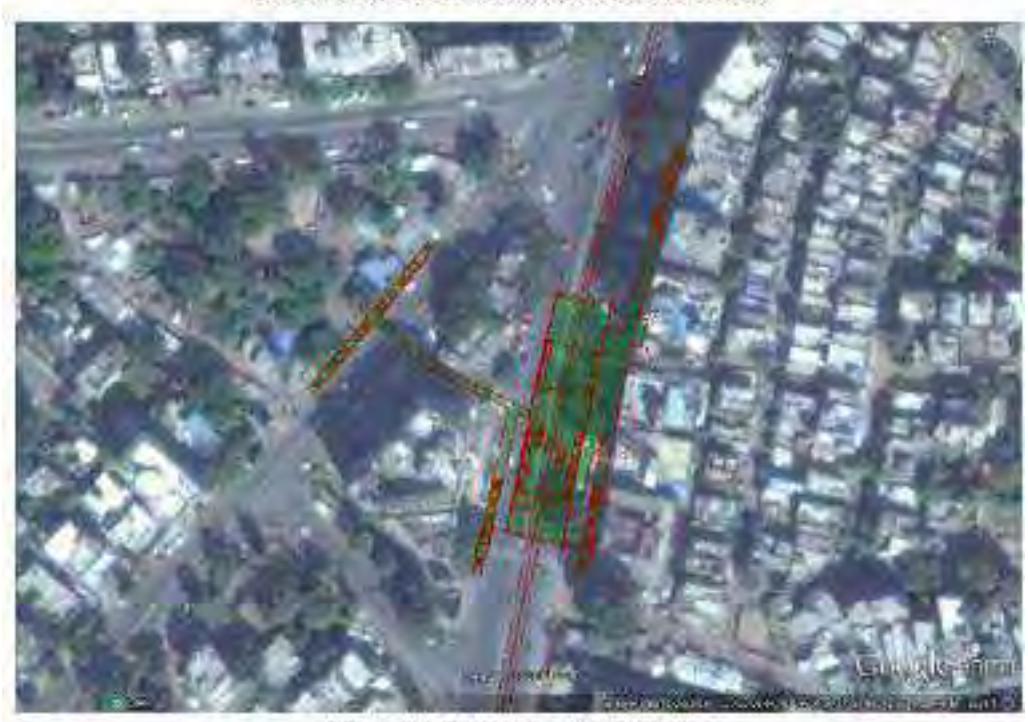
CONGRESS NAGAR METRO STATION CROSS SECTION

CONGRESS NAGAR METRO STATION PLAN

Figure -2.7: Typical Type -1 Station - Congress Nagar

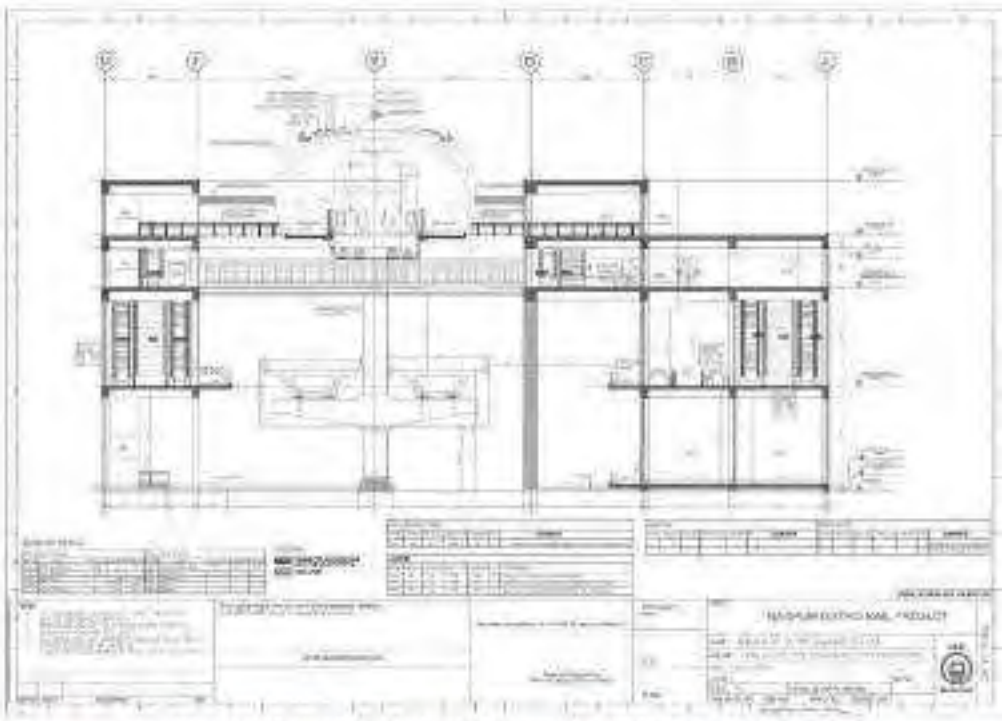


AJNI SQUARE METRO STATION CROSS SECTION



AJNI SQUARE METRO STATION PLAN

Figure -2.8: Typical Type -2 Station - Ajni Square



TYPE-3 STATION: CHATRAPATI METRO STATION CROSS SECTION

CHATRAPATI METRO STATION PLAN

Figure -2.9: Typical Type -3 Station - Chatrapati Square

2.4.5 Depot Planning

The proposed corridor requires a dedicated depot for the maintenance of the rakes. The inspection, overhauling and all maintenance facilities for P Way, S & T, OHE etc will also be provided at the depot cum maintenance workshop. As per the preliminary assessment, train operation on Proposed corridor will require about 20 rakes of 3 cars to meet the traffic projection in the horizon year 2041. Depot cum workshop shall have necessary facilities viz stabling lines, schedule inspection lines, workshop for overhaul, unscheduled maintenance including major repairs, wheel profiling, and heavy interior/under frame/roof cleaning etc.

In addition, the Depot will also house for Operation Control Center (OCC), administrative building, maintenance facilities for civil-track, electrical-traction, E&M; signaling & telecommunication; Water Supplies, Drainage & Sewerage etc. Two depots are planned at NMRCL Project namely:

1. MIHAN near Khapri (North South Direction) and
2. Hingna near Prajapati Nagar (East West Direction).

The photographs showing the proposed depot area is given Figure -2.10.

Figure -2.10: Photographs Showing the Proposed Depot Areas (Hingna Road & MIHAN Area)

Hingna Depot: Hingna Depot is located in Western side of the E-W Corridor near Prajapati nagar. The total Extent of land available is 25.960 Ha and the entire land

belongs to Government of Maharashtra. The depot area is plain and rolling terrain. The proposed site is also very close to the alignment.There should not be any obstruction to movement of rakes in either direction. Various facilities at the depot are Main building, Administrative building, Maintenance office, Inspection bay, Control room, Auto coach washing plant, P-way room, stabilizing line, pit wheel lathe, workshop and bio-digesters. The Google imagery overlaying of the Depot plan is given in Figure -2.11.

Figure - 2.11: Google Imagery Overlaying the Hingna Depot plan

MIHAN Depot: MIHAN Depot is located in Southern side of the N-S Corridor near Khapri area. The total Extent of land available is 33.90Ha and the entire land belongs to Government of Maharashtra. The depot area is mostly plain terrain. The proposed site is also very close to the alignment.There should not be any obstruction to movement of rakes in either direction. Various facilities at the depot are Main building, Administrative building, Maintenance office, Inspection bay, Control room, Auto coach washing plant, P-way room, stabilizing line, pit wheel lathe, workshop and bio-digesters. The Google imagery overlaying of the Depot plan is given in Figure -2.12.

Figure - 2.12: Google Imagery Overlaying the MIHAN Depot plan

2.4.6 Construction Methodology

For the elevated sections it is recommended to have precast segmental construction for super structure for the viaduct. For stations also the superstructure is generally of precast members.

2.4.7 Construction Strategy

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

2.4.8 Construction Period

It is proposed to complete the project in a time period of 48 months.

2.5 Ridership on Proposed Metro Corridor

Estimation of trips on metro line is done by using a special computer program which scans routes between each zone-pair which are generated from traffic assignment model during incremental loading traffic assignment algorithm.

The proposed Metro Corridor is expected to have a daily ridership of 2,77,704 on LINE-1, 2,86,031 on LINE-2 and Maximum PHPDT of 15729 on LINE-1, 11882 on LINE-2 by 2041. These are shown in Table -2.12.

Table -2.12: Maximum PHPDT and Daily Ridership

Year	MAXIMUM PHPDT		DIAILY RIDERSHIP (IN LAKH)	
	LINE 1 North-South Corridor	**LINE 2 East-West Corridor**	**LINE 1 North-South Corridor**	**LINE 2 East-West Corridor**

Year	MAXIMUM PHPDT		DIAILY RIDERSHIP (IN LAKH)	
	LINE 1 North-South Corridor	**LINE 2 East-West Corridor**	**LINE 1 North-South Corridor**	**LINE 2 East-West Corridor**
2016	10089	7746	1.68	1.84
2021	10936	8460	1.85	1.97
2031	12934	9906	2.24	2.34
2041	15729	11882	2.77	2.86

Source: NMRCL DPR Prepared by DMRC, 2013

2.6 Rolling Stock, Traction and Signaling

The salient features of proposed Metro Corridor (underground) in respect of rolling stock, power supply, traction system and signaling are summarized in DPR and reproduced below:

- A short train consisting of 3 cars with high frequency service which can be increased to 4-cars and 6-car for increasing the Passenger Carrying Capacity of Trains with the consideration of matching the growing traffic demand.
- The rolling stock shall be Nominal 1435 mm track gauge Section having maximum width of 2.9 m, Axle load of 16 tonnes and capacity of 3 coach unit as 764 passengers. Seating arrangement will be longitudinal.
- 25 KV AC Traction system is proposed to fulfill the power demand of 25 MVA in 2016.
- The system, under normal operating conditions, will be an automatically operated system utilizing Automatic Train Control and Automatic Train Protection (ATP) under the overall control of a train driver and OCC operators.
- Computer Based Interlocking (CBI) signaling and continuous automatic train control with Automatic Train Protection (ATP) is proposed, while telecommunication system is integrated with Optical Fiber Cable, LED/LCD based boards, Mobile Radio, Mobile system etc.
- Fare collection system is provided with automation in association with Contact less Smart Card and Retractable Flap Type Control Gates, Ticket Office Machine, POM etc.

2.7 Passenger Carrying Capacity

In order to maximize the passenger carrying capacity, longitudinal seating arrangement

shall be adopted. Criteria for the calculation of standing passengers are 3 persons per square meter of floor area in normal state, 6 persons in crush state of peak hour. Therefore, Driving Trailer with 21.64 m car body length, 2.9 m car body width and longitudinal seat arrangement conceptually have the capacity of 43 seated, 204 standing, thus a total of 247 passengers while a Motor car with 21.34 m car body length, 2.9 m car body width and longitudinal seat arrangement conceptually have the capacity of 50 seated, 220 standing, thus a total of 270 passengers for a car is envisaged considering a standee area of 6 persons per square meter. These are shown in Table -2.13.

Table -2.13: Carrying Capacity of a Car

Particulars	Driving Motor car		Trailer car / Motor car		3 Car Train	
	Normal	Crush	Normal	Crush	Normal	Crush
Seated	43	43	50	50	136	136
Standing	102	204	110	220	314	628
Total	145	247	160	270	450	764

Source: DPR Prepared for NMRCL by DMRC, 2013

2.8 Maintenance at Depot -Electrical, signaling & Telecommunication

The maintenance of depot along with full workshop facilities have been proposed at Khapri Station for North South Corridor and one depot- cum- workshop in SRP Land near Lokmanya Nagar Station for East West Corridor. The facilities include for the maintenance of the Rakes, Track, Electrical – Traction (OHE), E & M, Signaling & Telecom, Automatic Fare Collection etc. It will house Operation Control Center (OCC) and Administrative Building. All the systems at depot have been designed to cater for 20 rakes of 3 Car composition to take care of requirement beyond the horizon year 2041.

2.9 Power Requirements

Electricity is required for operation of Metro system for running of trains, station services (e.g. lighting, lifts, escalators, signaling & telecommunications, fire fighting etc) workshops, depots & other maintenance infrastructure within premises of metro system. The power requirements of a metro system are determined by peak-hour demands of power for traction and auxiliary applications. Broad estimation of auxiliary and traction power demand

is made based on the following requirements:

- Specific energy consumption of rolling stock: 75 KWh per 1000 GTKM
- Regeneration by rolling stock – 30%
- Train operation design: 6 min (Automotive Sqre to Congress Nagar), 12 min (Congress Nagar to Khapri), 13 min (Prajapati Nagar to Agrasen Chowk), 6.5 min (Agrasen Chowk to Subhash Nagar), 13 min (Subhash Nagar to Lokmanya Nagar) (2016)
- Depot auxiliary: Design load 2000 kW (2016), 2500 kw (2041)
- Power factor of load: 0.9 and Transmission losses @ 5%

Keeping in view the above norms, designed load and power requirement projected are depicted in Table -2.14.

Table -2.14: Power Demand Estimation (MVA)

Corridor		Year			
		2016	2021	2031	2041
North-South Corridor – 1 Automotive Sqre to Depot Station. [19.658 kms; 15 elevated Stations & 2 at Grade Station].	Traction	4.32	5.01	5.84	7.16
	Auxiliary	7.72	7.84	9.14	11.49
	Total	12.04	12.85	14.98	18.65
East-West Corridor – 2 Prajapati Nagar to Lokmanya Nagar [18,557 kms; 19 Elevated Stations].	Traction	4.24	4.57	5.73	7.01
	Auxiliary	8.34	8.46	9.88	12.48
	Total	12.58	13.03	15.61	19.49

Source: DPR Prepared for NMRCL by DMRC, 2013

2.10 Sub Stations

The high voltage power supply network of Nagpur City has only 220kV and 132kV network on the periphery of the city to cater to various types of demand in vicinity of the proposed corridor. 220/132 kV sub stations are far away from the alignment and therefore, it involves substantial cable and it's laying cost. Keeping in view the reliability requirements, two input

sources of 220 kV or 132KV Voltage level are normally considered for each corridor. Therefore, to achieve the desired reliability, two Receiving Sub Stations (132/33/25 kV or 220/33/25 KV) are proposed to be set up for each Corridor – 1 & Corridor – 2. The intersection of the two corridors will be at Sitabardi station (Elevated station of Corridor – 1). It is proposed to avail power supply for traction as well as auxiliary services from the following grid sub-stations at 220/132kV through cable feeders. Sources of Power Supply are depicted as in Table -2.15**.**

Table -2.15: Sources of Power Supply

Corridor	Grid sub-station (with Input voltage)	Receiving Sub-Station	Cables
North-South Corridor – 1 Automotive Sqre to Depot Station. [19.658 kms; 15 elevated Stations & 2 at Grade Station]	1. 132 KV Uppalwadi Grid Sub-station	2×132 KV bays near Automotive station	7 route km, 132 kV (Double Circuit cables).
	2. Proposed 220 KV Butibori Grid Sub-station.	2×220 KV bays at Khapri Station	4 route km, 220kV (Double Circuit cables).
East-West Corridor – 2 Prajapati Nagar to Lokmanya Nagar [18,557 kms; 19 Elevated Stations]	3. LILO of proposed 132 KV Pardi-Jattarodi ckt.	2 X132 KV bays near Prajapati Nagar station	4 route km, 132 kV (Double Circuit Cables).
	LILO of proposed 132 KV Hingana – Lendra Ckt.	2×132 KV bays near Suhash Nagar station	10 route km, 132 kV (Double Circuit Cables).

Source: DPR Prepared for NMRCL by DMRC, 2013

2.11 Other Project Features

Under other project features, the NMRCL has taken completely green initiatives by introducing **Solar power generation, Bio-digesters and Green Building i**n the project. Mission of NMRCL is to develop an energy efficient, environment friendly mass rapid transit system using maximum energy from the renewable sources.The details of the same are described below:

2.11.1 Solar Photo-voltaic Systems

Solar power is becoming a positive energy source for many people who are looking to reduce their carbon footprint. Solar Photo-voltaic (PV) systems enables direct conversion of sunlight into electricity. NMRCL plans to install solar PV panels in two phases. In the first phase solar PV panels will be installed on the rooftops of stations and ground mount in the depot area. Solar panels having total capacity of 14.5 MWp would be installed in the first phase. After completion of phase I, NMRCL plans to install to solar PV panels on depot and track boundary walls and on the viaduct structures under phase II. The total capacity of solar power which is likely to harnessed is about 23.1 MWp after completion of phase II.

NMRCL has also planned to install solar panels on the roof of metro bhavan with a capacity of 260 Kwp and 1000 units/day. This green initiative will reduce the load on conventional sources for power production and also reduce carbon emissions.

Table -2.16 Table -2.17 below gives the sources employed for harnessing solar energy in Phase -I& Phase -II and Reach wise respectively.

Table –2.16: Sources &Estimated capacity of solar power to be generated under Phase 1

Name of Reach	No. of stations	No of Depots	Estimated Capacity (Kwp) (Station + Depot)		Per day Generation (units)		Annual Generation (mill units)	
			Station	Depot	Station	Depot	Station	Depot
Reach 1	10	1	1667	4250	6940	18500	2.5	6.75
Reach 2	7	0	1167	0	4865	0	1.75	0
Reach 3	10	1	1667	4250	6940	18500	2.5	6.75
Reach 4	9	0	1500	0	6255	0	2.25	0
Total	36	2	6000	8500	25000	37000	9	13.5
Grand Total			**14520 = (14.52 MWp)**		**62000**		**22.5**	

Source: NMRCL, August-2016

Table -2.17: Sources and Estimated capacity of solar power to be generated under Phase II

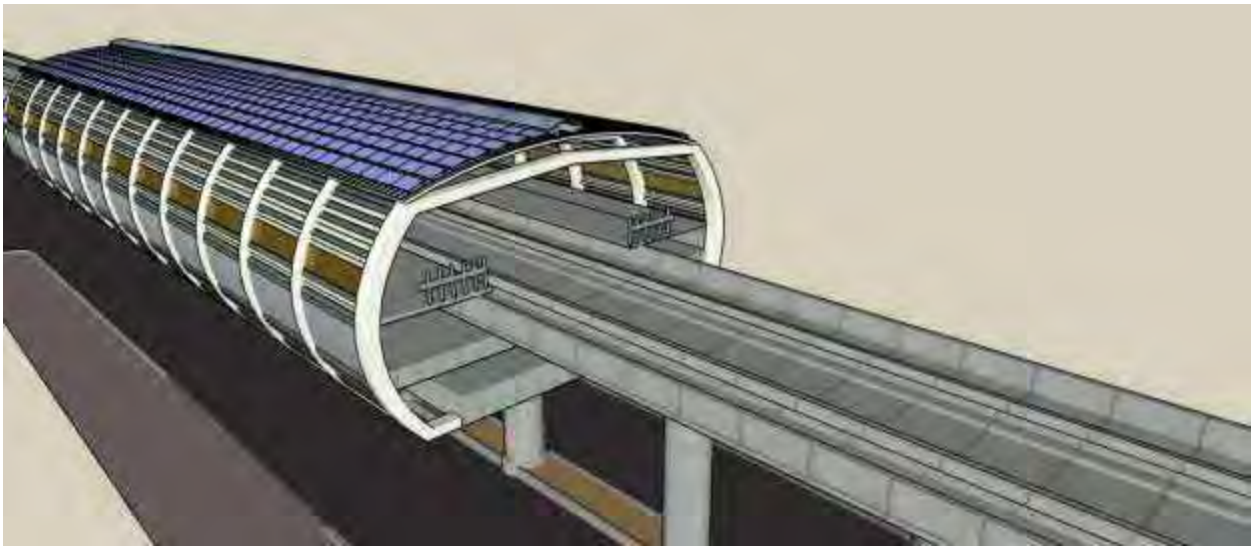
Name of Reach	Length of Viaduct Km	Depot and track boundary wall Km	Estimated Capacity (Kwp) (Viaduct + Boundary wall)		Per day Generation (units)		Annual Generation (mill units)	
			Viaduct	Boundary wall	Viaduct	Boundary wall	Viaduct	Boundary wall
Reach 1	7.94	5	1407	1375	5605	5125	2.04	1.875
Reach 2	6.86	0	1216	0	4843	0	1.77	0
Reach 3	10.46	5	1853	1375	7385	5125	2.70	1.875
Reach 4	8.01	0	1419	0	5655	0	2	0
Total	33.26	10	5895	2750	23300	10250	8.51	3.75
Grand Total			**8645**		**33550**		**12.25**	

Source: NMRCL, August-2016

Images showing the typical Views of Solar Panels installation over station roof tops in Figure -2.13.

Images showing the Solar PV Panels on Track and Depot Boundary Walls & Solar PV panels likely to be installed on viaduct in Figure -2.14.

Images showing the Proposed Solar panels on Depot Area & Solar panel installation on Metro Bhavan in Figure -2.15.



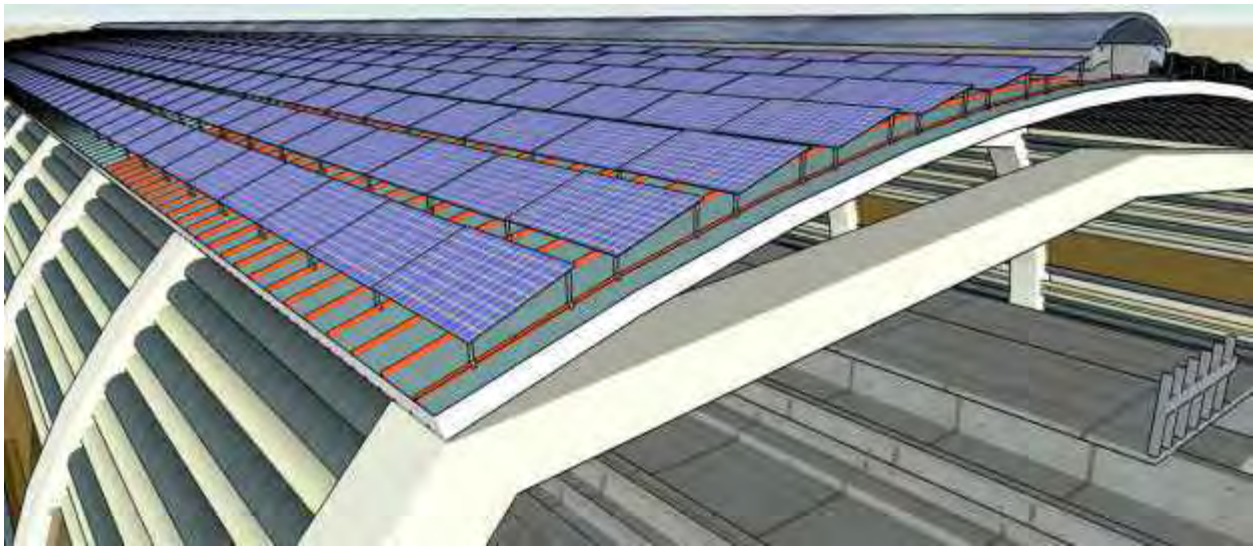


Figure -2.13: Typical Views of Solar Panels installation over station roof tops

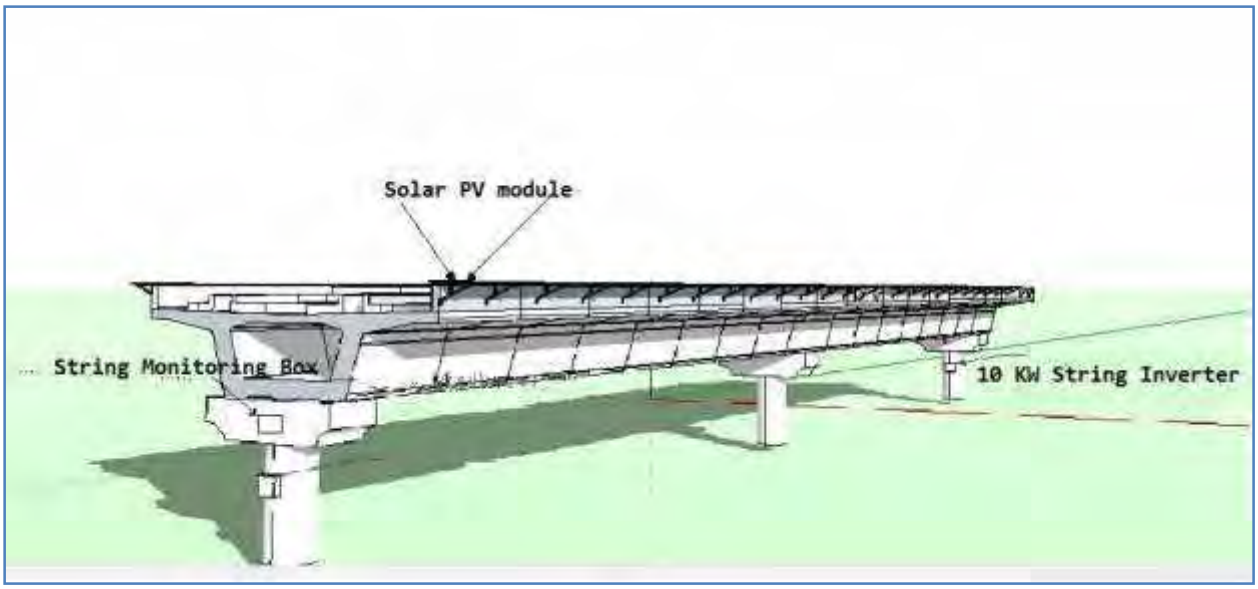


Figure -2.14: Images showing the Solar PV Panels on Track and Depot Boundary Walls (Top) & Solar PV panels likely to be installed on viaduct (Bottom)

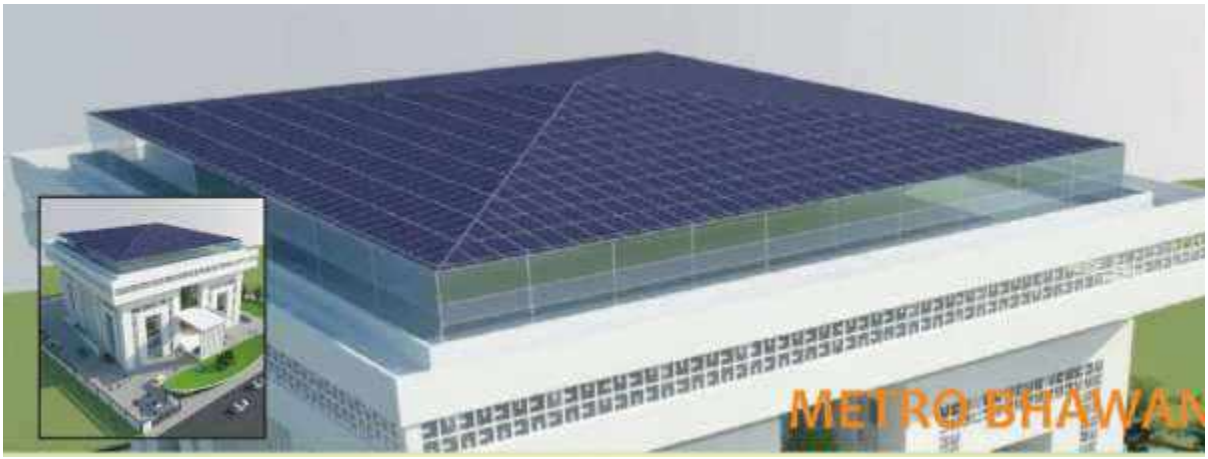


Figure –2.15: Images showing the Proposed Solar panels on Depot Area (Top) & Solar panel installation on Metro Bhavan (Bottom)

2.11.2 Bio-digesters

NMRCL will install eco-friendly bio-digesters at 36 stations and 2 Depots for on site disposal of human waste. A memorandum of understanding (MoU) in this regard was signed with Defence Research and Development Organization (DRDO), which had developed this technology. The bio-digester based eco-friendly sanitation technology will convert human faecal waste into water and gas. This technology was developed to solve the sanitation problem faced by soldiers in high altitude.

In general, this technology has 2 components – (i) The anaerobic microbial consortium which is formulated from group of bacteria that are very efficient to perform the bio-degradation of the human waste in wide range of temperature and in presence of toxic chemicals. (ii) The vessel in which fermentation is carried out with the help of bacteria is called bio-digester. The process of bio-degradation of human waste used in the present technology is carried out in strict anaerobic environment (devoid of oxygen) by anaerobic microbial consortium. It involves multiple biochemical steps and is of complex nature. These steps are sequential in nature and interdependent.

Bio-digester technology treats human waste at the source. A collection of anaerobic bacteria that has been adapted to work at temperatures as low as -5°C and as high as 50°C act as inocula (seed material) to the bio-digesters and convert the organic human waste into water, methane, and carbon-dioxide. The anaerobic process inactivates the pathogens responsible for water-borne diseases and treats the fecal matter without the use of an external energy source. The only by-products of the waste treatment process are pathogen-free water, which is good for gardening, and bio-gas, which can be used for cooking. Bio-toilets do not require sewage connectivity and because the process is self-contained, bio-toilets are also maintenance-free. Anticipated influent & effluent wastewater quality parameters from the bio-digesters are given in Table -2.18.

Table -2.18: Wastewater Quality Parameters (Influent & Effluent)

S.no.	Parameter	Unit	In-fluent Sewage	Effluent characteristics
1	pH	--	7.0 – 7.5	7.0 – 7.5
	Turbidity	NTU	70 - 90	2 -5
2	Total Suspended Solids	mg/l	90 -120	50 -80
3	Total Dissolved Solids	mg/l	350 - 450	100 - 300

S.no.	Parameter	Unit	In-fluent Sewage	Effluent characteristics
4	Biochemical Oxygen Demand @ 5 days and 20 ^{0}C	mg/l	70 – 120	2 -4
5	Chemical Oxygen Demand	mg/l	250 - 300	15 -25
6	Coliforms	MPN/100 ml	300 - 350	0 - 12

Source: DRDO Website

Bio-digester Proposed at Stations and Depots: There are 10 no. of bio-digesters suggested for each station and 8 no. of bio-digesters in each depot. The bio-digester tank may be constructed with FRP/RCC/ stainless steel material. Table -2.19 shows the number of bio-digesters planned to install according to each reach. A typical cross section of Bio-digester is given in Figure -2.16.

Table –2.19: Reach wise installation of Bio-digesters at Stations & Depots

Name of Reach	No. of stations	No of Depots	No. of Bio-digesters to be provided
Reach 1	10	1	108
Reach 2	7	0	70
Reach 3	10	1	108
Reach 4	9	0	90
Total	36	2	376

Source; DRDO, Govt. of India

Figure -2.16: A Typical Cross section of Bio-digester

2.11.3 Green Building

Several metros in India have adopted to green building designs for its stations and offices. All the nine Metro stations of the Badarpur – Escorts Mujesar (Faridabad) section of Delhi Metro's Phase 3, have been awarded the highest possible rating (platinum) for adherence to green building norms, by the Indian Green Building Council (IGBC), which has devised a rating mechanism for Metro stations and buildings on a scale of platinum, gold, silver etc. for following the green building specifications. NMRCL also proposes eco-friendly and sustainable construction techniques to construct Metro Bhavan office building in Nagpur with a total built-up area of 10000 sq.m. NMRCL is having keen interest to make this project in accordance with green building norms and also aimed for obtaining the prestigious green building rating from Indian green building council (IGBC).

Green buildings can have tremendous benefits, both tangible and intangible. The most tangible benefits are the reduction in water and energy consumption right from day one of occupancy. The energy savings could range from 20 - 30 % and water savings around 30 - 50%. The intangible benefits of green new buildings include enhanced air quality, excellent day lighting, health & well-being of the occupants, safety benefits and conservation of scarce national resources. Green Building design strives to balance environmental responsibility, resource efficiency, occupant comfort and health and community sensitivity.

Image showing the 3-D view of proposed Metro Bhavan Green Building is given in Figure - 2.17. The green initiatives to be adopted by NMRCL for the Metro Bhavan building are given in Table -2.20.

Figure -2.17: 3-D view of proposed Metro Bhavan Green Building

Table - 2.20: Green Initiatives to be adopted by NMRCL for Metro Bhavan Construction

Sl.No	Green Initiatives to be adopted by NMRCL for Metro Bhavan Construction
I	**Issues Relating to Site and Water** ✓ More than 15 % of the Natural Topography is being preserved ✓ 100% of Existing Trees are preserved ✓ On Site Soil and Erosion Control ✓ Site in Vicinity of Basic amenities ✓ Provision for Electric Car and Bike Charging ✓ 75 % of the parking is underground ✓ Roof With SRI Paint to reduce heat Island effect ✓ Design to minimize exterior light pollution ✓ Handicapped Friendly design ✓ Proper health and safety facility for construction workers ✓ 100 % Rainwater Harvesting ✓ Water efficient Plumbing Fixtures to achieve 30 % savings ✓ Native Landscape with efficient irrigation system ✓ Waste Water Treatment ✓ Water metering for various usage
II	**Issues Relating to Energy Efficiency** ✓ High Performance Glass with Shaded façade along with roof Insulation ✓ More than 4 COP VRV based HVAC System ✓ LED Lighting Fixtures with Occupancy and daylight Controls ✓ More than 5 % of the total annual energy consumption being met by on site solar PV ✓ Off site Solar PV installation to meet more than 50 % of annual energy consumption ✓ Energy Metering for various energy end use e.g. HVAC, Lighting , Pumps etc ✓ Third Party Commissioning of HVAC and Lighting Systems
III	**Issues Relating to Material and Indoor Air Quality** ✓ Segregation of Waste ✓ Use of Local and Recycled Materials ✓ 100 % of Construction waste being reused/ sent for recycling ✓ Fresh air design as per ASHRAE 62-1-2010 ✓ CO2 monitoring within occupied space ✓ More than 75 % of the area meeting day lighting ✓ Use of Low emitting Adhesives and Paints

2.12 Drainage Pattern

The existing storm water drainage in the city covers three major storm water-carrying rivers, i.e., the Pilli River, the Nag River, and the Pora River which fall outside NMC's boundaries. The Nag river starts from the Ambazari lakes' overflow weir at the western end of the city and flows towards the east. The final disposal of storm water from parts of west Nagpur, south Nagpur, and central and east Nagpur is into this river through major and minor nallahs. Storm water for the southern part of the city drains into the Pora river. These are pucca closed drains and run along the major road networks of the city. There is about 40% of storm water drainage facility available in the city when compared with Ministry of Urban Development (MoUD) benchmark of 100%. The drainage map of Nagpur city is shown in Figure -2.18.

Figure -2.18: Drainage Map of Nagpur City

2.13 Spoils / Muck Generation

The major sources of spoil/ muck in NMRCL Project are excess earth from excavation foundations for piers, clearances near parking locations, stations, depot areas and construction demolition waste of the buildings etc. Reach wise spoil / muck generation during construction phase of the project is given in Table -2.21.

Table -2.21: Reach wise Spoil/ Muck generation during construction phase

S. No	Activity	Spoil /Muck Generation (m^3)				Total (m^3)
		North-south corridor		East-west corridor		
		Reach 1	Reach 2	Reach 3	Reach 4	
1	During foundation & piers Construction	60000	60000	60000	60000	240000
2	During construction of stations	831	582	618	557	2588
3	At Parking locations	4863	3404	1076	968	10311
4	At Depot locations	67800	-	51800	-	119600
5	Structures demolition waste for Metro-line & stations construction	6527	3568	7867	6094	24056
	Total *(including construction material waste)*	140021	67554	121361	67619	3,96,555 (m^3)

The major share of spoil/ muck estimated in the project is from excavation of the foundations of the piers is 2.40 Lakh Cum and Depots are generating 1.19 Lakh Cum. The construction & demolition waste is also considerable in the project which is estimated to be 0.24 Lakh Cum and others estimated to be 0.126 Lakh Cum. Overall spoil/ muck generation estimated in the project is 3.96 Lakh Cum.

2.14 Traffic Management Plan

Nagpur Metro Rail Corporation Limited, Nagpur intends to Carrying out Classified traffic volume count and detailed Traffic Management Plan from Cargo Terminal gate to Hotel Pride Junction and from Hotel Pride Junction to Somalwada Junction on Wardha Road for Metro Nagpur Rail Project. NMRCL had appointed the M/s. UTES Consultancy Pvt. Ltd., Nagpur for Technical & Traffic Management plan at two critical locations of Project Corridor:

1. Cargo Terminal Gate to Hotel Pride Junction

2. Somalwada Junction

The proposed Road alignment is a four lane Nagpur-Wardha Section of NH-7 in the State of Maharashtra. The proposed Road alignment has 4-lane divided configuration. The locations of the traffic management survey carried out are given in Figures-2.19 & 2.20.

Figure 2.19: Location of the Proposed Traffic Management Road (Cargo Terminal Gate to Hotel Pride Junction)

Figure 2.20: Location of the Proposed Traffic Management Road (Somalwada Junction)

2.14.1 Classified Traffic Volume Counts

Volume count location has been selected near Hotel Pride and near Somalwada Junction at proposed Metro alignment of Nagpur-Wardha of NH-7, as per the scope of work. While choosing the survey locations, the following have been considered.

- The selected site to be safe, with adequate shoulders, having good visibility and a straight section to the extent available,
- The location shall be such that, wherever possible and required, lighting and open space is available on either side at the same location so that the supervisors can effectively monitor the traffic surveys,
- Away from median openings (where considerable u-turn traffic exists), and Sufficiently close to a place, where minimum facilities for supervisors and survey coordinators are available.

2.14.2 Analysis of Volume Count Data

This section presents findings from the analysis of classified traffic volume observed at count location. Analysis has been carried out for:

- Traffic volume and ADT (Average Daily Traffic)
- Traffic composition
- Hourly variation
- Directional Distribution

2.14.3 Average Daily Traffic

Traffic was counted for continuous 24 Hours between 10:00am to 10:00am Seven (7) days. Volume of traffic covering all categories of vehicles was counted. The Survey was carried out on following days.

Date	Days
05-12-2015	Saturday
06-12-2015	Sunday
07-12-2015	Monday
08-12-2015	Tuesday
09-12-2015	Wednesday
10-12-2015	Thursday
11-12-2015	Friday

The following PCU factor of each vehicle has been consider for evaluation the total capacity of the project stretch. As per IRC 106-1990

Category of Vehicle	PCU Factor
Car	1
LCV	1.4
Bus/ Truck	2.2
MAV	4
Two Wheeler	0.75
Auto Rickshaw/ 6 Seater	1.2
Bicycle	0.4
Cycle Rickshaw	1.5
Hand Driven Vehicle	1.5
Bullock Carts/ Animal Driven Vehicle	2.0

The average daily traffic estimated at various legs of Cargo Terminal Gate to Hotel Pride Junction and at various legs of Somalwada Junction are given in Table -2.22. The source of these information is extracted from Traffic Management Plan prepared for NMRCL during construction phase of the project.

Table 2.22: Average 24 Hours Traffic volume count at various locations (in PCUs)

Car	LCV	Bus/ Truck	MAV	Two Wheeler	Auto Rickshaw/ 6 Seater	Bicycle	Cycle Rickshaw	Hand Driven Vehicle	Bullock Carts/ Animal Driven Vehicle
1. Cargo Terminal Gate to Hotel Pride (in PCUs)									
8079	1457	5117	1959	8449	348	128	12	5	1
2. Hotel Pride to Cargo Terminal Gate (in PCUs)									
8299	2009	4357	1915	8084	343	183	15	12	0
3. Chhatrapati Junction at Somalwada Junction (in PCUs)									
8285	1661	4965	1807	10097	637	376	102	4	1
4. Khapari at Somalwada Junction (in PCUs)									
7851	1981	4121	1763	7761	450	266	55	10	0
5. Manish Nagar at Somalwada Junction (in PCUs)									
1166	176	465	189	2252	63	70	8	1	0
6. Sudarshan colony at Somalwada Junction (in PCUs)									
512	66	135	38	1300	34	24	1	1	0

Source: NMRCL Traffic Management Plan (2015-2016)

2.14.4 Traffic Management Plan

I) Purpose of Overall Traffic Management Plan:

The overall traffic management plan is designed and intended to specify adequate safety measures in advance against identified hazards and stipulated implementation of the said safety measures to ensure safe movement of traffic during the construction operations of Cargo Terminal gate to Hotel Pride Junction on Wardha Road and Hotel Pride Junction to Somalwada Junction on Wardha Road for Nagpur Metro Rail Corporation Ltd. Project. The objective of safety standards is to provide safe travel to the drivers of vehicles plying on the Project Highway at all times of the day, throughout the year and provide protection to the Project workers when they are on the work. This overall traffic management plan delineates the safety standards in terms of Construction zones, Signs and Safety measures in work zones and during normal operations.

ii) Construction Zone:

Construction Zones are an integral part of any road construction system. The safety practices in construction will, therefore, be oriented towards reducing conditions, which lead to such hazards and consequent stress whereby risk of accident increases. Safety measures will be aimed at avoiding hazardous conditions especially in work sub zones where major construction activities are going on. For all purposes, the entire stretch will be treated as work sub zone.

iii) Signage:

The construction and maintenance signs fall into the three major categories viz. regulatory signs, warning signs and guide signs as other traffic signs do. Ref: IRC: 67-2001 (Code of Practice for Road Signs). These signs will be placed on the left hand side of the road. Some other signboards will also be used to regulate the Traffic, which have not been standardized. Ref:- IRC:SP:55-2014 (Guidelines on Traffic Management in Work Zones) However they confirm with the general requirement of shape and color, and their message is brief, legible and clearly understandable, i.e., CAUTION- Men and Machinery at work Go Slow, CAUTION- Work in Progress Go Slow etc. Typical signage to be used in the project are given in Figure -2.14.

The location, frequency and type of signboards will be governed by the kind of traffic situations arising during the construction. Signboards of the type 'men at work' and 'speed

limit' will be provided at locations wherever required on a case-to-case basis.

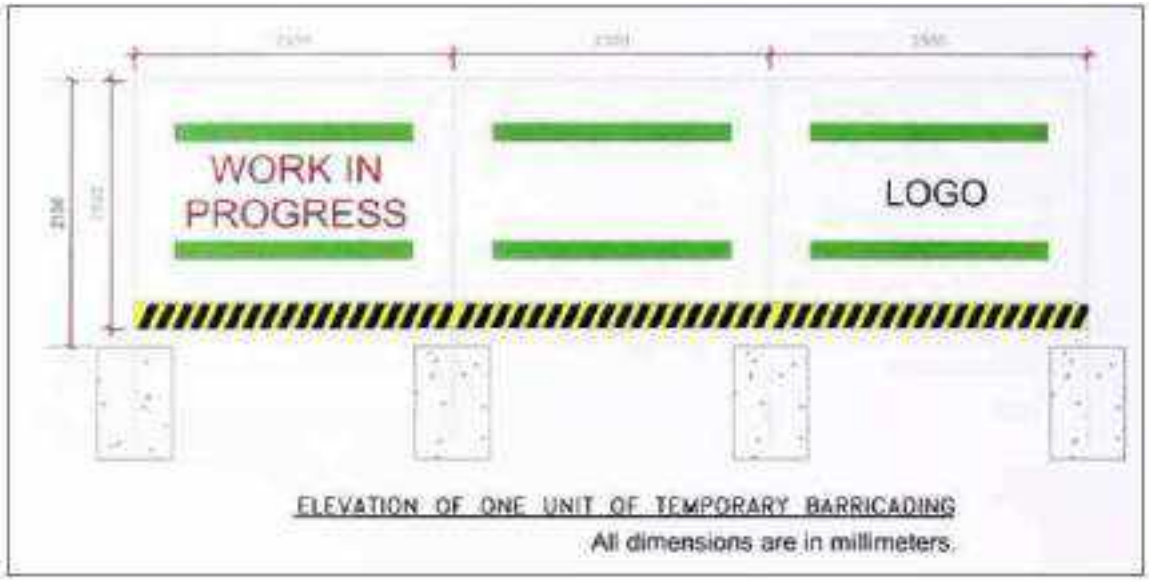


Figure -2.21: Typical signage to be used during construction phase

iv) Traffic Management Practices

The traffic management strategies include the following fundamental principles:

i. Making the traffic safety an integral and high priority element of the project.
ii. Avoid inhibiting traffic as much as possible.

iii. Guide Drivers in a clear and positive way.

iv. Routine inspection of traffic control element and traffic operations

v. Protection to Project workers on work site

v) Traffic Control Devices

- **Warning Signs**:
  - The advance warning for the construction operation ahead will be provided by the warning sign 'Men at Work' about 100 m earlier to the work zone.
  - It will be followed by 'Over Taking Prohibited' signboard. These signs will be placed on the left hand side of the road.

'Men at Work' and 'Overtaking Prohibited' signboards will be as per IRC67: 2001.

- **Barricading:**

Barricade using the CGI sheets would be on vertical steel post. The horizontal members of barricades would be of metal. These should be 200 mm-300 mm wide and should be painted in alternate yellow and black stripes of 150 mm width. The stripes should slope away at an angle of 45° in the direction traffic is to pass. Where the barricades extend entirely across the carriageway, the stripes should slope downward towards the direction the traffic must turn in detour.

The main intention of the barricading is to restrict the entering of the traffic in work area and protecting main carriageway traffic from falling in excavated or lower level area. These barricading will be provided at regular interval as per the site requirement. Height of Barricade would be 1.5 m.

- **Flagman:**

To avoid collision between construction vehicle and traffic; Flagmen with flags will be effectively used at the exit/entry points of working stretch.The flags for signaling will be 0.60 m x 0.60 m size, made of a good red cloth and securely fastened to a staff of approximately 1m in length.

2.14.5 Traffic Management/ Operation on Khapri Rail Over Bridge

After installation of Traffic signal post at Cargo Terminal Gate T-Point on Nagpur- Wardha Road, the traffic coming from Wardha road towards Nagpur over the Khapri Bridge will be managed by Traffic Marshal through Walky-Talky at both end of approach road to Khapari Bridge. The Traffic management will be such a way that there will be not a single vehicle to be stop over the bridge during Traffic red signal at proposed Cargo Terminal gate Traffic signal.

2.14.6 Traffic Management at Somalwada Junction

- Somalwada junction has already Traffic Signal Post for regulating the Traffic at this junction during the construction.

- The sign board should place 100m. before the Somalwada junction on Wardha Road both sides, showing vehicle driver keep their vehicle at proper lane i.e. on left side if wish to turn left, at right side if wish to turn right and at middle if want to go straight. The traffic police also enforce the driver for keeping correct lane before 100m.

- U-Turn should not be allowed at Somalwada Junction for the Vehicular Traffic from Chhatrapati Junction and the vehicular traffic from Khapri.

- Traffic signal synchronization (i.e. Cycle time of Red, Green and Amber light) shall be need for all the four legs coming at Somalwada junction as per the Traffic flow.

2.14.7 Safety Of Project Workmen At Site

- Safety of the Project Workers at site during duty hours will be ensured. Safety measures appropriate (as per Project Safety Plan) for the job will be adopted.
- The job specific PPEs i.e. Helmets and Safety jackets will be provided to workmen at site and it will be compulsory for them to wear the same.
- Site engineers will ensure the use of Personal Protection Equipments (PPEs) by workmen.
    - ✓ Use of Safety Jacket will be compulsory for the workmen engaged for

roadwork.

- ✓ Use of Safety helmet will be compulsory for all workmen including the staff.

- Labour Laws in force will be followed.

2.14.8 Maintenance of traffic control devices

For maintenance of installed traffic control devices, a separate gang consisting of 15 labors, two painters and two supervisors will be engaged. They will be provided with two vehicles for transportation of materials and workers. This group will periodically check for disturbed devices and maintain them accordingly.

Permanent Barricade:

Permanent barricades provided along the construction work of road will channelize the vehicles along the existing road. Main intention of this barricade is to make traffic aware about the construction work in progress. This is a psychological barrier preventing vehicles from going astray in to construction area.

Permanent barricade will be made of GI sheets fixed with properly anchored with steel. GI wire will be used to fasten the sheets for better stability. These sheets will be painted with alternate yellow and black inclined strips or red and white vertical strips. For night visibility red reflective sheets will be fixed on barricades.

Pavement barricade:

The finished kerb on the median side of carriageway will be pavement barricade preventing the vehicles from entering into the area under construction. The portion of kerb above the finished asphalt top will prevent vehicles from crossing the median under construction, and its further entry into construction area. In eccentric and concentric widening situations kerb will be the pavement barricade wherever its casting has been completed.

Delineators:

Delineators will be of cylindrical shape and will be made of concrete. They will be painted with black and white circumferential strips. Red colored reflectors or retro reflective sheet

will be fixed to the delineator so as to make it visible to the traffic from either direction during night. These delineators will be placed at a suitable spacing to guide the drivers along a safe path and control the flow of traffic.

Flashing Beacons/ Road blinkers:

Flashing beacons/ blinkers will be provided during night at places where construction activities will obstruct the main flow of traffic or at diversions where a switching of traffic occurs.

Construction Entry/ Exit points:

Construction entry/ exit points will be clearly identified and marked. Construction traffic will be allowed to enter/ exit the construction area through these openings only. These will be marked with signboards or red colored flag.

The typical barricading arrangement at Pride Junction is given in Figure -2.22 and at Somalwada Junction is given in Figure -2.23.

A Typical flowchart showing the Traffic Management in NMRCL Project is given in Figure -2.24.

Figure 2.22- Typical barricading (Cargo to Pride)

Figure 2.23- Typical barricading at Somalwada Junction

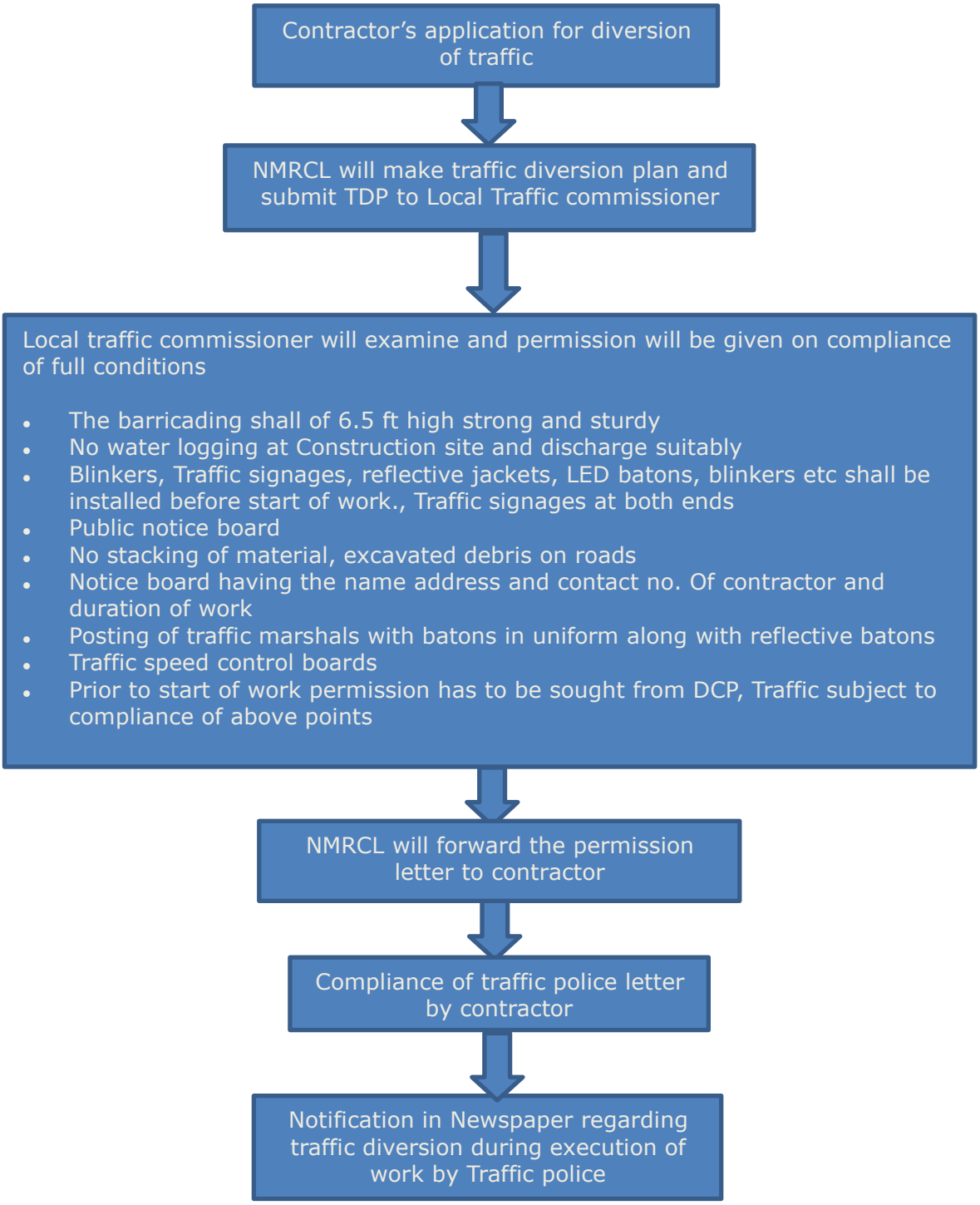


Figure -2.24: Flow Chart Showing the Typical Traffic Management in NMRCL Project

2.15 DPR Redesign/Method/Actions

Nagpur Metro Rail Project is sanctioned based on the DPR prepared by DMRC in November 2013. The DPR has been revised progressively in order to reduce cost of the project and to implement the project in more effective manner in terms of sanction and within time frame before going ahead with implementation to ensure sustainability of the project. NMRCL has also taken inputs from other on going metro projects in the country namely DMRC, CMRL, Kochi, Jaipur, Lucknow, Mumbai and Kolkata for the DPR revision.

Keeping in view the above, review of the following aspects of DPR in addition to anything further considered necessary, is required.

1. Review of adoption of 25KV AC OHE Traction: DPR envisages adoption of 25 KVA OHE for Nagpur Metro Rail project, however no detailed analysis towards relative merits and demerits of various other alternatives, such as 750 V DC third rail, etc is not available in DPR. Recently Kochi Metro has adopted 750 V DC third rail traction. Like Kochi Metro the ridership estimates of Nagpur Metro are on lighter side between 7000 to 10000 Peak Hour Peak Direction Traffic (PHPDT) on either lines. It is therefore proposed to review the decision on adoption of the type of the traction.

2. Review of adoption of type of superstructure as envisaged in DPR: DPR envisages adoption of segmental box construction or double U-girder for the construction of elevated structure/viaduct, however no detailed analysis towards relative merits of various other alternative is available in the DPR. Keeping in view of the typical situation of Nagpur i.e. availability of of soft rock at shallow dept, available space, etc , techno analysis of other alternatives such as 'Pre-stressed pre-cast beams with cast in-situ diaphragms and deck slab", pre-stress precast spine with precast ribs and cast in-situ, continuous portal with no bearing/articulation etc is required, which has been kept in the proposed scope of work of Interim Consultant.

3. Rationalization of Length of Station and Stabling Lines in Maintenance Depots: Currently in the DPR, it envisages running of 3 coach trains and adoption of Rolling stock with coach width of 2.90m, without a detailed analysis of relative merits and demerits of various alternative, such as coach width of 3.2m, etc. The length of the stations (about 140m) and stabling lines in depots have been planned for trains with 6 coaches.

The ridership forecast for 2041, the Peak Hour Peak Direction Traffic (PHPDT) which will be available with 3 cars is sufficient in E-W corridor and falls short marginally by about 3% on N-S corridor with 6 persons per sq.m of standee area during crush state of peak hour and 3 minutes headway. Though if 8 persons per sq.m is adopted, PHPDT will be sufficient but it has been found to be uncomfortable for the riders. Alternately, to increase capacity, 3.2 m car width instead of 2.9 m, as in DMRC can be considered. This will increase capacity of standing passengers by 10% (taking 6 persons per sq.m area only) and a 3 coach cars train will have capacity of 818, an increase of 54 commuters. This, with 3 mins headway , can give an increase of PHPDT by 1080.

Track centre, width of deck ,etc may increase marginally if coach with wider width is considered, but savings in construction cost and time duration can be achieved. The required stations will be hardly 70 to 80 m long and disturbance and inconvenience to the road users will get reduced considerably during construction period. It is also planned to reduce the length of depot stabling lines which have been considered for 6 cars, even though the train unit is of 3 cars. In the event of increase in traffic in future, Communications-based train control (CBTC) can be used to reduce headway. Which can be to 2 minutes, which will increase the no. of services by ten more compared to 3 minutes headway which means an increase of PHPDT by 7640 as one train capacity with 6 persons per sq.m standee area is 764.

2.16 Construction Programme

The detailed project plan including the various activities carried out during construction and commissioning phase is given in Table -2.23

Table -2.23: Construction Programme

2.17 Civil Works Packaging Description

The details of the civil works packaging description adopted in NMRCL Project is given below:

S.No	Name of works
1	Construction Of Bridges (Including Rail Over Bridge Over Concor Siding At Khapari), Retaining Walls,Boundry Walls And Earth Work In Depot Area At-Grade Section Between Ch.14200-Ch.21604.5 In Airport-Khapari-Mihan Depot Section On North-South Corridor Of Nagpur Rail Project.(Ps)
2	Design And Construction Of Viaduct In Reach-1 Between New Airport And Sitabuldi Stations From CH 6790m-14400m Including Viaduct In Five Elevated Station Portions, On The North-South Corridor Of Nagpur Metro Rail Project.
3	Construction Of Seven Elevated Metro Stations And Three At Grade Stations (North South Corridor) Viz. Congress Nagar To Khapri And Viaducts Between CH: 7/850 To 8/030 And CH: 8/574 To 9/692 In Reach-1.
4	Construction Of Interchange Station (TTMC Area) And Zero Mile Station.
5	Design And Construction Of Viaduct Reach-2 From Sitabuldi Interchange Station To Automotive Square On East –West Corridor.
6	Construction Of Six Number Elevation Metro Stations Viz Kasturchand Park, Kadvi Chowk , Gaddi Godam Sq. , Indora Sq. Nari Road, Automotive Sq. On East -West Reach-2
7	Design And Construction Of Viaduct In Reach-3 Between Jhasi Rani Square To Lokamanya Nagar Stations From CH: 7825 M To CH: 17866 M Including Viaduct Also In Ten Elevated Stations, On East West Corridor.
8	Construction Of 10 No. Of Elevated Metro Stations Viz Lokmanay Nagar, Bansi Nagar, Vasudeo Nagar, Rachana (Ring Road)Jn, Subhash Nagar, Dharampeth Collage, LAD Sq, Shankar Nagar Sq, Instituted Of Engineering, Jhasi Rani Sq On East-West Corridor In Reach – 3 Of Nagpur Metro Rail Project.
9	Design And Construction Of Elevated Viaduct Of Length 6.836 Kms From CH: 590 To CH: 5809, CH: 6000 To CH: 7100 And CH: 7183 To CH: 7700 Between Prajapati Nagar To Sitaburdi. And ROR Near Anand Talkies, Viaduct &Ramp Near Ramjhula, Ror Near Prajapati Nagar And Viaduct Of Length 1.050 Kms From CH:(-)496 To CH: 90.962 And CH: 126.962to CH: 590 On Boq Basis.(Reach-4)
10	Construction Of Eight Number Of Elevated Metro Stations Viz Prajapati Nagar, Vaishno Devi Square, Telephone Exchange, Chitter Oil Square, Agrasen Square, Dosar Vaisya Square & Nagpur Railway Station On The East – West Corridor (Reach-4) Of Nagpur Metro Rail Project.
11	Construction Of Metro Train Depot At Mihan (North-South Corridor) And Hingna (East-West Corridor).
12	Supply Of 10,000 MT 60E1 (UIC 60), 1080 Grade Head Hardened (HH) Rails As Per IRS T-12, 2009 For Nagpur Metro Rail Project.
13	Design, Manufacturing & Supply Of Standard Gauge 60E 1 (UIC 60) Turnouts For Nagpur Metro Rail Project.
14	Supply Of Fastening System For Ballast Less Track For North-South Corridor And East-West Corridor Including Connectivity To Depot.
15	Supply Of 2000 MT 90 UTS Rails, UIC 60, IRS-T-12-2009, 880 Grade For Nagpur Metro Rail Project.
16	Supply, Installation, Testing And Commissioning Of Ballasted Track In At Grade

S.No	Name of works
	Section Of North-South Corridor Along With Ballasted/ Embedded Track In Mihan & Hingna Depots Of Nagpur Metro Rail Project.
17	Supply, Installation, Testing And Commissioning Of Ballastless Track Of Standard Gauge Phase-1, North-South Corridor (Reach-1 Sitaburdi – Khapari) And East West Corridor (Reach-3 Sitaburdi-Lokmanya Nagar)Section Of Ballastless Track Nagpur Metro Rail Project.
18	Supply, Installation, Testing And Commissioning Of Ballastless Track Of Standard Gauge Phase-1, North-South Corridor (Reach-2 Sitaburdi – Automotive) And East-West Corridor (Reach-4 Sitaburdi - Prajapati Nagar)Section Of Ballastless Track Nagpur Metro Rail Project.

2.18 Economic & Financial Assessment of the Project

Year wise details of the Economic and financial aspects of the Project is given in Table - 2.24. and the details of the KfW Funding components and their cost is given in Table - 2.25.

Table - 2.24: Year Wise Outlay Required for all Works all Figures (Rs. Crs.)

S. No.	Particulars	Funding	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	Total Rs. in Crs.
1	Detailed GT Investigation	Equity	0.8						0.8
2	Interim Consultant (I/C) RITES	Equity	5.0						5.0
3	PMC (RITES) at Grade	Equity	0.6	3.4					4.0
4	Const - Priority Section (EW & Br) (Khapri-Old Airport)	Equity	31.6	54.4					86.0
5	Interim Consultant (I/C) DMRC	Equity	3.1	1.9					5.0
6	General Consultant	Equity	0.0	37.5	58.3	58.3	58.3	37.5	250.0
7	OSO 5D BIM	Equity	0.0	44.7	58.3	6.5	6.5	9.0	125.0
8	Construction of Corporate office	Equity	5.4	24.2	5.4				35.0
9	D&C-Viaduct-1 (Old Airport - Congress Nagar-Sitaburdi) Reach-1	Equity	12.1	45.8	70.0	144.8			272.7
10	D&C-Viaduct-2 (Sitaburdi-Zero Mile - Auto Motive) Reach -2	KFW			12.6	74.9	162.0	62.7	312.2
11	D&C-Viaduct-3 (Lokmanya Ngr - Rani Jhansi-Sitaburdi) Reach-3	Equity		44.0	108.0	115.9	106.3		374.3
12	D&C-Viaduct-4 (Sitaburdi-Dosar Vaishya-Prajapati) Reach-4	KFW			13.7	94.6	100.0	54.6	262.8

Table - 2.24: Year Wise Outlay Required for all Works all Figures (Rs. Crs.)

S. No.	Particulars	Funding	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	Total Rs. in Crs.
13	DDC for Sitabuldi Interchange Stn, Zero Mile	Equity		1.5	0.7	0.8			3.1
14	DDC for Stations Pkg-1 (Khapri - Congress Nagar) Reach-1	Equity	1.1	4.8	3.5				9.4
15	DDC for Stations Pkg-2 (Kasturchand Park - Auto Motive) Reach-2	Equity		1.2	2.0	3.1			6.2
16	DDC for Stations Pkg-3 (Lokmanya Ngr - Rani Jhansi) Reach - 3	Equity		4.3	6.1				10.4
17	DDC for Stations Pkg-4 (Railway Station-Prajapati)	Equity		1.8	2.7	3.7			8.3
18	Construction-Sitabuldi Interchange Stn and Zero Mile with viaduct & TTMC at sitabuldi	KFW		7.8	79.9	87.1			174.8
19	Construction-Station Pkg-1 (Khapri - Congress Nagar) Reach-1	Equity		65.6	134.9	117.9			318.5
20	Construction-Station Pkg-2 (Kasturchand Park - Auto Motive) Reach-2	KFW			5.6	60.7	69.7	75.9	211.9
21	Construction-Station Pkg-3 (Lokmanya Ngr - Rani Jhansi) Reach-3	Equity		24.3	139.7	122.6	66.6	0.0	353.2
22	Construction-Station Pkg-4 (Railway Station-Prajapati) Reach-4	KFW		10.5	14.3	64.1	81.2	112.5	282.5
23	Appointment of DDC for Depots	Equity		8.1	2.5	2.0			12.7
24	Construction-Depots (2 no.) - Civil, E&M works	Equity		53.5	61.8	92.3	92.8		300.4
25	Construction-Depots (2 no.) - M&P	Equity		12.0	40.7	37.5	31.8		122.0
26	Track Laying Elevated	KFW		23.2	38.7	44.2	48.0		154.1
27	Track Laying At-Grade section	Equity		20.8	8.7				29.5
28	Supply of Track Mtls (Rail, fitting etc)	KFW							
29	a) Rails - For Elevated Section	KFW		12.5	24.1	28.4			65.0
30	b) Rails - For At-Grade Section	Equity		17.1					17.1
31	c) Turnouts	KFW		13.1	23.5	13.6			50.2
32	d) Fastenings	KFW		11.4	18.7	21.6			51.7
33	DDC Traction	Equity		9.3	10.7	9.4			29.4

Table - 2.24: Year Wise Outlay Required for all Works all Figures (Rs. Crs.)

S. No.	Particulars	Funding	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	Total Rs. in Crs.
34	Traction and auxilary power supply-Supply, Erection & Commissioning	KFW		75.0	189.8	134.8	129.3	60.2	589.1
35	Overhead Traction (Elevated section)-Supply, Erection & Commissioning	KFW		35.0	133.4	99.8	83.2	6.6	358.0
36	Overhead Traction (At-Grade Section)-Supply, Erection & Commissioning	Equity		34.5					34.5
37	Signalling & Train Control System-Supply, Erection & commissioning	AFD		84.0	97.2	85.1	91.6	62.2	420.1
38	Platform Screen Door-Supply, Installation, Testing & Commissioning	KFW		0.0	32.0	40.0	35.8	5.2	113.0
39	Telecom-Supply,Erection & Commissioning	AFD		57.4	67.8	75.5	86.3		287.0
40	Rolling Stock-Supply,Testing & Commissioning	KFW	0.2	169.5	289.9	224.0	164.1		847.7
41	Automatic Fare Collection (AFC) & E&M Works -Lifts & Escalators	AFD			64.0	26.9	103.9	62.6	257.4
42	Consultancy charges for AFC & Alternate Revenue Models	Equity		3.0					3.0
43	Fire Prevention & Control	KFW		5.2	25.0	25.0	14.3	0.0	69.5
44	Serveillance equipment	Equity			5.2	5.2	10.9	7.6	28.9
45	Salaries and Establishment	Equity	6.0	14.0	18.0	24.0	31.0	37.2	130.2
46	Construction of Staff Quarters	Equity	13.4	0.0	11.7	18.0	21.9		65.0
47	Utility Shifting	Equity	13.0	41.0	94.6	124.8			273.4
48	Feeder bus/Contingency Provision	KFW	0.0		14.0	94.5	31.7		140.2
49	Contingency	Equity	13.0	34.0	36.0	64.8	2.5	0.1	150.4
KFW Loan (Rs. In Crores)			**0**	**363**	**915**	**1107**	**919**	**445**	**3750**
AFD Loan (Rs. In crores). Incl. AFC			**0.0**	**141**	**229**	**187**	**282**	**135**	**975**
Total Loan				**505**	**1144**	**1295**	**1201**	**580**	**4725**
50	Contingency Provision KfW Loan for other items to be Included	KFW						67.3	67.3

Table - 2.24: Year Wise Outlay Required for all Works all Figures (Rs. Crs.)

S. No.	Particulars	Funding	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	Total Rs. in Crs.
51	Contingency Provision AFD Loan for other items to be Included	AFD						10.4	10.4
Annual Expenditure Total			**105.3**	**1111**	**2024**	**2247**	**1630**	**661**	**7789**
Land Cost Contribution from NIT/NMC & Grant from NMC				**350**	**279**			**73**	**702**
R&R Cost to be borne by NMC/NIT				**50**	**50**	**50**	**24**		**174**
Other Adjustments									**18**
Total Project Cost									**8683**

Table -2.25: Details of the KfW Funding components and their cost

Details	Amount (All Fig in Crs.)	Euro (Crs)
D&C-Viaduct-2 (Sitaburdi-Zero Mile - Auto Motive) Reach -2	312	41.6
D&C-Viaduct-4 (Sitaburdi-Dosar Vaishya-Prajapati) Reach-4	263	35
Construction-Sitabuldi Interchange Stn and Zero Mile with viaduct & TTMC at sitabuldi	175	23.3
Construction-Station Pkg-2 (Kasturchand Park - Auto Motive) Reach-2	211.9	28.3
Construction-Station Pkg-4 (Railway Station-Prajapati) Reach-4	282.5	37.7
Track Laying Elevated	154.1	20.5
Supply of Track Mtls (Rail, fitting etc)		0
a) Rails - For Elevated Section	65	8.7
c) Turnouts	50.2	6.7
d) Fastenings	51.7	6.9
Traction and auxilary power supply-Supply, Erection & Commissioning	589.1	78.5
Overhead Traction (Elevated section)-Supply, Erection	358	47.7

Details	Amount (All Fig in Crs.)	Euro (Crs)
& Commissioning		
Platform Screen Door-Supply, Installation, Testing & Commissioning	113	15.1
Rolling Stock-Supply,Testing & Commissioning	847.7	113
Fire Prevention & Control	69.5	9.3
Feeder bus/Contingency Provision	140.2	18.7
Contingency Provision KFW loan for other items to be included	67.3	9
Total	**3750**	**500**

2.18.1 Cost Estimates

The completion cost of the project with all taxes, escalation & private land comes to Rs.8683 Crores including EMP Cost.

CHAPTER -3
REVIEW OF ENVIONMENTAL REGULATORY REQUIREMENTS, POLICIES & GUIDELINES

3.0 REVIEW OF ENVIRONMENTAL REGULATIORY REQUIREMENTS, POLICIES & GUIDELINES

3.1 Applicability of National, State and Local environmental norms

The proposed Metro Rail project of Nagpur in the state of Maharashtra is attracting various National, State, regional and World Bank guidelines, environmental laws, rules and regulations. These regulations and rules are helpful in impact mitigation and improvement of the environment. The environmental assessment study will be carried out as per the requirement of the National/State/KfW/AFD Bank environmental guidelines. The regulations and guidelines require that a description of the environmental baseline Integration and mapping to expedite project approvals for licensing and funding. The applicability of the regulatory norms are given in Table – 3.1.

Table – 3.1: Applicability of Environmental Regulatory Norms for NMRCL Project

Project	Project Components	Applicability of Environmental Laws, Policies and Notifications	Remarks
Nagpur Metro Rail Project in Maharashtra	• Right of Way • Land Acquisition • Pile installation • Sensitive Locations • Archaeological Sites • Forest Stretch • Quarries • Operation of heavy construction	The Environment (Protection) Act, 1986 and further notifications issued under this Act.	Any act during implementation causing damage to environment. As per the Environment (Protection) Act (EP) 1986, ambient air quality and noise levels are to be maintained as stipulated by the Central Pollution Control Board (CPCB). Noise levels are to be comply with CPCB standards for different categories of areas like, commercial, residential and silence zones, etc., during sub-project construction and operation., Section -3 (2)(iii & iv).

Project	Project Components	Applicability of Environmental Laws, Policies and Notifications	Remarks
	equipments	Water (Prevention and Control of Pollution) Cess Act, 1977 including Rules	Applicable to all activities, which discharge effluents as a result of process or operations. Section 3 (2)(a) of the Act and Cess to the Govt. of India as per Table -I & II for consumption of water for domestic, commercial and industrial purposes.
		Water (Prevention and Control of Pollution) Act, 1974 – as amended in 1978 &1988.	
		Forest (Conservation) Act, 1980 – as amended Rules 2004.	Applicable if the project involves any activities in the reserved forests, village forests, protected forests and other areas as declared by the state government. Forest Conservation Act – Chapter – 2.5(ii).
		Wildlife Protection Act, 1972, amended thereof. The Wildlife (Protection) Rules, 1995.	The act prohibits picking, uprooting, damaging, destroying, acquiring any specified plant from any forest land. It bans the use of injurious substances, chemicals, explosives that may cause injury or endanger any wildlife. MM-1 -IA Nos. 147, 148 & 149 of 2011 in WP (C) No. 337 of 1995 MM-2-IA No. 316 in WP (C) No. 1309/1985 and 301 to 333.
		The Hazardous Wastes (Management And Handling) Rules, 1989 and subsequent amendments thereof till date.	Materials such as heavy metals, toxic inorganic, oils, emulsions, spent chemicals and Metal-finishing wastes emanating during construction and operation shall be stored and disposed off as per the Rules. Rule 17, 18 & 19 of the Act.

Project	Project Components	Applicability of Environmental Laws, Policies and Notifications	Remarks
		The Public Liability Insurance Act, 1991.	Act enables the people to access legal aid to claim compensation in the event of an accident occurred while handling any hazardous substance. So insurance needs to be taken up by the project implementing agencies or contractors. PLI Act: Act 6 of 1991 as amended by Act 11 of 1992.
		World Bank Operational Directive and Operational Policies for Environmental Impact Assessment (4.01), Operational Policy on cultural property (4.11) and forestry (4.36) for water supply improvement project.	Applicable in preparation of Environmental assessment report, protection of cultural property, forest clearances etc. WB OD and OP – 4.01, 411 & 4.36
		Ministry of Environment & Forests (MoEF) EIA Notification (New) issued on 14th September, 2006 and subsequent amendments thereof.	Not Applicable
		Noise Pollution (Regulation and Control) Rules, 2000	Applicable Under Rule 3(1) & 4 (1) - Clause 2, 3 & 6.
		Land Acquisition Act 1894/ RTFCTLARA, 2013 (Land Acquisition Act 2013)	Applicable. To set out rules for the acquisition of land by Government.

Project	Project Components	Applicability of Environmental Laws, Policies and Notifications	Remarks
		The Metro Railway (Amendment) Act, 2009 Metro Railway (Construction of Works) Act, 1978 Delhi Metro Railway (Operation and Maintenance) Act, 2002	Applicable. To enforce Metro Rail codes during construction and operation.
		KfW Development Bank Sustainable Guidelines, 2014 AFD Bank Environmental & Social risk management guidelines.	Applicable Screening, Scoping, Field studies, Public Consultation, Appraisal of the project as per the Clause -3.0 to Clause 9.0. Applicable

3.2 KfW Bank Requirements

For more than five decades, the business area KfW Development Bank of the KfW Group referred to hereinafter as KfW Development Bank), has financed measures in numerous areas to protect the environment and the climate and to support social development. Central to its activities are the principles of environmental and social compatibility as well as sustainability. Therefore, all the Financial Cooperation measures (referred to hereinafter as "FC measures") financed by KfW Development Bank have long been subject to a comprehensive and systematic assessment by KfW Development Bank to ensure they are compatible with environmental and social aspects as well as other crucial development policies.

Mission: The priority areas of KfW's promotional activities in developing countries include social development, environmental and climate protection and the conservation of

natural resources. Its work also encompasses FC measures which make a crucial contribution to implementing international agreements on environmental and climate protection and on the conservation of natural resources such as the United Nations Framework Convention on Climate Change (UNFCC), the Convention on Biological Diversity (UNCBD) and the Convention to Combat Desertification (UNCCD). Whenever the main goal of Financial Cooperation (FC) measures is not geared to environmental, climate or resource protection, KfW Development Bank seeks to incorporate climate and/or environmental objectives into the scope of the FC measure.

Aim: With the aim of sustainability and avoiding adverse environmental, social and climate impacts and risks, KfW Development Bank pursues in particular the following principles for its FC measures that are financed:

- ✓ to avoid, reduce or limit environmental pollution and environmental damage including climate-damaging emissions and pollution;
- ✓ to preserve and protect biodiversity and tropical rain forests and to sustainably manage natural resources;
- ✓ to consider probable and foreseeable impacts of climate change including utilising the potential to adapt to climate change. In this context climate change is understood as climate variability and long-term climate change;
- ✓ to avoid adverse impacts upon the living conditions of communities, in particular indigenous people and other vulnerable groups, as well as to ensure the rights, living conditions and values of indigenous people;
- ✓ to avoid and minimise involuntary resettlement and forced eviction of people and their living space as well as to mitigate adverse social and economic impacts through changes in land use by reinstating the previous living conditions of the affected population;
- ✓ to ensure and support health protection at work and the occupational health and safety of people working within the framework of a FC measure;
- ✓ to condemn forced labour and child labour, ban discrimination in respect of employment as well as occupation and support the freedom of association and the right to collective bargaining;
- ✓ to protect and preserve cultural heritage;

- ✓ to support the executing agency in the management and monitoring of possible adverse environmental, social and climate impacts as well as risks within the framework of the implement FC measure.

Scope and Objectives: This Guideline describes principles and procedures to assess the environmental, social and climate impacts during the preparation and implementation of FC measure financed by KfW Development Bank. In this context, this Guideline pursues the following objectives, in particular:

- ✓ to define a common binding framework to incorporate environmental, social and climate standards into the planning, appraisal, implementation, and monitoring of FC measures;

- ✓ to enhance transparency, predictability and accountability in the decision-making processes of the internal environmental & social impact assessment and climate assessments;

3.2.1 Appraisal (Screening) of the Project as per KfW Development Bank Guidelines, 2014:

The preliminary appraisal (Screening) is performed on the basis of KfW Development Bank Sustainable Guidelines, 2014, Appendix-2:Questionnaire for preliminary appraisal of the project as per the checklist and consideration of existing and additional, easily accessible information. The checklist is given as Table -3.2.

Table -3.2: Checklist for Preliminary Appraisal of the NMRCL Project

Description of the Environmental Attributes	Applicable to the Project	
Environmental Assessment	**No**	**Yes**
Does the measure potentially have a substantial negative impact on one or more of the following subjects of protection? ✓ Humans, including human health ✓ Animals, plants and biological diversity ✓ Soil, water, air and landscape ✓ Cultural goods and other assets ✓ interdependence between the above-mentioned protected resources	√	x

Description of the Environmental Attributes	Applicable to the Project	
Does the measure have considerable potential to improve environmental quality, resource protection or strengthen ecological sustainability?	x	√
Is an environmental assessment required by the national law of the partner country?	√	x
Climate adaptation assessment (Climate Proofing):	**No**	**Yes**
Are the intended developmental impacts of the measure sub-substantially dependent on climatic parameters such as temperature, rainfall, wind, etc?	√	x
Does the measure present the possibility of substantially increasing the adaptation capacity of the target groups or ecosystems?	√	x
Climate change reduction assessment (Emission Saving):	**No**	**Yes**
Is the measure expected to make a substantial contribution to greenhouse gas emissions?	x	√
Can it be assumed that the measure will have the potential to considerably reduce emissions of greenhouse gases or increase CO_2 sequestration in soil?	x	√

If one or more of the questions are answered with "Yes", then an in-depth environmental and/or climate change impact assessment should certainly be carried out. The in-depth assessment can be limited to the sub-areas or protected resources for which an impact is affirmed. The following criteria should be used to judge relevance:

- ✓ extent of the expected impacts (e.g. number of affected persons),
- ✓ frequency, duration and expected time of the expected impacts,
- ✓ sensitivity of the affected natural spaces, population groups and economic activities as well as their adaptation capacity, irreversibility of changes,
- ✓ requirements in legal regulations (e.g. threshold values for pollutants).

Appendix -1 (5) of KfW Sustainable Guidelines, 2014 illustrative list of projects which may have severe negative environmental, social, and climate change impacts. The proposed NMRCL Project is also falling under the Category -B of their guidelines in view of the above conditions stated in Table -3.1. Category -B may have potentially adverse risks and impacts upon the environment and on the social conditions of those concerned. However, the impacts and risks may have a lesser extent than these of category A, FC measures and can usually be mitigated through state-of-the-art mitigation measures or

standard solutions are used and prepared the report. The same are discussed in detail in subsequent Chapters of EIA / EMP Report.

The proposed NMRCL project will show potential positive impact on environmental quality, resource protection or strengthening of ecological sustainability by way of reduction of fuel consumption followed by reduction of the greenhouse gas (CO_2) and it also reduces the air pollution levels in the project impact area. The details of the same are given in EIA/EMP report.

3.3 Other Permissions/Clearances

The project proposes to construct Metro Rail in Nagpur city in the state of Maharashtra, where the investments intervene with various other utilities already in place. In such areas the project implementing agency will ensure the following clearances before initiating the works.

- Permissions from Nagpur Municipal Corporation (NMC)/ Nagpur Improvement Trust (NIT) to cut the trees falling under right of way.
- Identification of low lying barren private areas to dispose solid waste & muck generated during construction and getting the permission from the concerned authority/ Private owners.
- NOC from Heritage Conservation Committee (HCC) for acquiring about 408.45 Sq.M area of Kasthurchand park. Accordingly, NMRCL already obtained the NoC from HCC dated on 18.08.2016.
- Permission from Water Resources Department for construction of elevated metro -rail project and to draw water during the construction period.
- Permissions from NHAI, PWD and NMC for the construction of the elevated metro-rail project in the Nagpur city.
- Permission for breaking or shifting of public utilities like sewer lines or water pipe lines from water supply and sewerage boards.
- Permission and clearance from electricity board for shifting/ moving of streetlights and transformers during construction of elevated metro-rail or construction of fly over or pedestrian ways or any other likely sub projects.
- All the quarries and sand mines proposed to be utilized in the project shall get the permissions from respective Departments /owners.

CHAPTER -04
ANALYSIS OF ALTERNATIVES

4.1 ANALYSIS OF ALTERNTIVES

The Nagpur Municipal Corporation (NMC) had awarded the project titled "Preparation of Master Plan/Perspective Plan for Transportation System of Nagpur City 2031" to L&T-Ramboll Consulting Engineers Limited in June 2007. The study aims to update the long-term transportation strategy for NMC and identify a practicable and effective investment programme up to 2031. L&T Ramboll Consulting Engineers Limited had carried out the Comprehensive Traffic and Transportation Study and prepared Transportation Master Plan for Nagpur city commissioned by NMC.

Transportation Improvement proposals (L&T-Ramboll study) are broadly classified into three categories based on the time horizon:

- ✓ Short Term Improvement Proposals (2008-2009)
- ✓ Medium Term Improvement Proposals (2009-2021)
- ✓ Phase-I (2009-2011)
- ✓ Phase-II (2012-2016)
- ✓ Phase-III (2017-2021)
- ✓ Long Term Improvement Proposals (2022-2031)

Some of the important proposals recommended by L&T-Ramboll Consulting Engineers Limited are:

Improved bus system with a fleet comprising of Standard buses and Mini-buses. Standard buses will serve the major corridors whereas mini-bus services act as a feeder services and low demand corridors. Construction of MRTS in phases 2012-16 and 2017-2021. It is envisaged 65 km of MRTS and 20 km commuter rail by 2031.

4.2 Alignments Proposed By DMRC for Metro Rail System In July-2013 DPR

In early 2012 Nagpur Improvement Trust (NIT) requested DMRC to provide Consultancy services for preparation of a Detailed Project Report for Metro Rail System in Nagpur, Maharashtra. DMRC has conducted Traffic Surveys, Topographical Surveys, Geo-

technical Investigations and Environment Impact Assessment Survey. Based on the different types of surveys done by DMRC, metro alignments has been finalized after repeated inspection of the road network, intersections, passenger traffic flow, traffic congestion, connectivity to important land uses. Alignment of routes proposed by DMRC were given in Table -4.1.

Table -4.1 Alignment Proposed by DMRC

Alignment	Detail Route
Alignment-1 North-South Corridor (21.833 km, 17 Stations)	Automotive Square, along Kamptee Road, Wardha Road, Variety Square to Abhyankar Road, along Nag River alignment will fall on Humpyard Road, Rahate Colony Road, Wardha Road, Khamla Road, Airport, MIHAN Area
Alignment-2 East – West Corridor (18.266 km, 19 Stations)	From Prajapati Nagar, along Central Avenue Road,Railway Feeder Road, Munje Chowk, Jhansi Ranee Chowk, North Ambajhari Road, Hingna Road, Lokmanya Nagar

4.3 Final Alignment for Proposed NMRCL

On 03.08.2013, a meeting presided by Shri S K Lohia, JS-MoUD,GoI was held at Nagpur to discuss the DPR. In that meeting, JS-MoUD,GoI expressed that the FIRR of the project should be at least 8%. Recently, MoUD has also issued advisory that FIRR of Metro Project should not be below 8%.

On 1.10.2013, a presentation on the DPR was made by M/s NIT to The Chief Minister, Government of Maharashtra. He was of the opinion to avoid underground alignment in MIHAN and also construct Maintenance Depot in the land belonging to State Govt Land. Subsequently, on 21.10.2013, a joint inspection of the NS corridor was done by VC&MDMADC, Chairman-NIT, and Director Business Development-DMRC.

The original alignment of Corridor-I proposed was passing through Khamla Road, Airport Area after Sahakar Nagar and finally was ending at MIHAN. The alignment up to Old Airport Station was elevated, then for a length of 3.30 km, it was underground with one underground station named as New Airport Station and again elevated in MIHAN Area. Since the cost of underground section of the alignment is much more than the elevated section or the section at grade, alternative alignment was suggested for cost reduction,

enhancement in PHPDT and to increase FIRR so that project becomes financially and economically viable.

The new proposed alignment suggested in the above inspection, was to pass through a 24m wide road adjacent to London Street after Sehkar Nagar Junction and was proposed to be taken to the east along 24m wide road and London Street up to Wardha Road. From the intersection at Wardha road, the elevated alignment was proposed to be on the central divider on the Wardha Road. After crossing existing intersection point of Wardha Road & Airport Road, the alignment was to be shifted to the MIHAN area. Alignment in this portion was proposed to be at grade and to run parallel to Wardha road

upto ROB and abutting railway line thereafter up-to proposed Car depot.

But, while working on this modification of alignment, it was noticed that a very large number of properties were falling along the alignment due to sharp curve at the junction of Sahakar Nagar & 24 m wide road and also at the junction of 24m wide road & Wardha Road. Acquiring of these properties will be very tough and may delay the whole project.

Hence to avoid all such situation, it has been decided to take the alignment on Wardha Road only without going on Khamla Road.

Finally, NS Corridor will pass through Wardha Road after Congress Nagar Metro Station. After crossing existing intersection point of Wardha Road & Airport Road, the alignment will be shifted to the MIHAN area. Alignment in this portion will be at grade and will run parallel to Wardha road upto ROB and parallel to railway line thereafter up-to proposed Car depot.This has caused deletion of few earlier proposed metro stations on NS Corridor and addition of new stations on the same.

Final alignment considered for NMRCL for both the corridors are given in Table -4.2. The salient features of the alignment are given in Table -4.3.

Table -4.2: Final Alignment

Alignment	Detail Route
Alignment-1 North-South Corridor (19.658 km, 17 Stations)	Automotive Square, along Kamptee Road, Wardha Road, Variety Square to Abhyankar Road, along Nag River alignment will fall on Humpyard Road, Rahate Colony Road, Wardha Road, Parallel to Railway Line, Khapri Station and finally in MIHAN Area near concor depot
Alignment-2	From Prajapati Nagar, along Central Avenue Road, Railway Feeder Road, Munje Chowk, Jhansi

Alignment	Detail Route
East – West Corridor (18.557 km, 19 Stations)	Ranee Chowk, North Ambajhari Road, Hingna Road, Lokmanya Nagar

Table -4.3: Detail Description of the Alignments

S.NO.	Description	North-South Corridor	East-West Corridor	Total
1	Route Length (km) Elevated Grade	19.658 15.058 4.600	18.557 18.557 0.00	38.215 33.615 4.600
2	No. of stations Elevated At Grade	17 15 2	19 19 0	36 34 2
3	Schedule Speed (kmph)	32-34	29-30	
4	Power Demand (MVA)(2016) Traction Auxiliary	12.04 4.32 7.72	12.58 4.24 8.34	24.62
5	Max. Peak Hour Peak Direction Traffic (PHPDT) (2031)	12934	9906	22840
6	Land used(sq m) Govt. Land Private Land	540184.7 502167.10 38017.60	289568.1 274652.20 14915.90	829752.8 776819.30 52933.50
7	No. of structures affected Private Government Community	194 80 107 7	336 192 134 10	530 272 241 17

S.NO.	Description	North-South Corridor	East-West Corridor	Total
8	Compensatory Plantation Parking Areas Depot areas Station locations	 @ 8 locations, 1-2 Rows of plantation @ Khapri Depot 2-3 Rows of plantation @ 17 nos., of stations wherever possible	 @ 5 locations, 1-2 Rows of plantation @ Lokamanya nagar Depot 2-3 Rows of plantation @ 19 nos., of stations wherever possible	500-600 700-800 200-300
9	No. of Bio-digesters to be installed Stations Depot	178 170 8	198 190 8	376 360 16

4.4 Environmental Perspective of Proposed NMRCL Alignment

- ✓ The project alternative routes are not limited to the impacts of the project on the physical environment such as natural resources and biological life, but also include the impacts on socioeconomic, political affairs as well as financial and economics. Hence the present Nagpur Metro line alignment is finalized such that, the impact of alignment on the above mentioned Environmental & Social attributes is minimum, than all other possible alternatives.
- ✓ The alignment is planed in such way that it should be efficiently reduce the prevailing traffic problems and should serve as long term solution for development of transportation facility in the Nagpur city area. At the same time alignment should not compromise on Social, Environmental, Political & Physical aspects of the project area and should be Economically feasible.

- ✓ The total affected properties as per the alignment map is 269 out of which 127 properties belong to lease holders properties on the government land, 59 properties own by government and the 83 are private properties. This shows that maximum i.e., about 70% of land to be acquired is Govt., land there by having a minimal impact on loss of private property.
- ✓ Except in few small stretches & Depot areas the proposed metro alignment is passing through the center line of the existing road alignment there by requiring minimal number of tress to be cut. The total number of tress to be cut/ lost at proposed station locations and along the alignment is estimated to be 1000 nos.
- ✓ There is no forest area need to be acquired for the project and no archeological/ historical location is affected by the project stretch. The project acquired No Objection for alignment passing close to historical Kasturchand Park. Accordingly, the NMRCL obtained the NoC from Kasturchand Park Heritage Conservation Committee, Nagpur for the diversion of 408.45 sq.m land dated on 18th August, 2016. Political impacts such as Infrastructure development (region wise); Reaction from locals; Interests of the public; Political leaders support; Political rift / legal snags etc., due to proposed alignment is mostly positive.

CHAPTER -05
DESCRIPTION OF THE ENVIRONMENT

5.0 DESCRIPTION OF THE ENVIRONMENT

This chapter describes the existing environmental settings in the study area. The objective of Environmental Impact Assessment (EIA) is to ascertain the baseline environmental conditions and then assess the impacts as a result of the proposed project during various phases of the project cycle. The data on different environmental components along the project corridor is being collected, followed by site reconnaissance in order to establish environmental condition of the project area. The study area will cover 10 km on either side of the project stretch. The baseline data generation is of two types i.e., Secondary data collection through various sources and Primary data through field studies. Information about geology, hydrology, prevailing natural hazards like earthquakes, etc have been collected from literature reviews and authenticated information made available by government departments. Climatological data was collected from Indian Meteorological Department. The methodology adopted for data collection is highlighted wherever necessary.

(A) Secondary Data Collection: Secondary data will be collected from secondary sources like publishes, literature from various Government and private agencies, NGOs, or institutions on physical, biological and social components of environment. The data will be reviewed for establishing existing environmental and ecological status within the project area. The details of secondary data type, source and use is given in Table -5.1. The data furnished by the NMRCL/ Contractors is given in Table -5.2.

Table -5.1: Secondary Data Collection

S. No.	Type	Source	Use	Data Collected from Source
i.	Micro metereology	IMD, Nagpur	To Correlate the field data & in Analysis of the metereology of the study area	Mean and extreme monthly Metrological data of Nagpur city during the period 1969 to 2010 is collected from IMD, Nagpur.
ii.	Air and Water pollution data	CPCB / MPCB/ NEERI	To Correlate the field data, & to incorporation of suggestions given by CPCB/ MPCB/ NEERI.	Air Quality data (1st January 2015 to 5th February 2016) at four locations namely Civil Lines, North Ambazari road, Hingana road and Sadar is collected from CPCB.
iii.	Sensitive Archaeological/ Temple sites	Archaeological survey of India (ASI)	To demarcate sensitive locations in mapping & to incorporation of	Collected from ASI and Town Planning Department, Nagpur

S. No.	Type	Source	Use	Data Collected from Source
			suggestions given by ASI.	
iv.	Ecology and Biodiversity	Forest Department/ MoEF	To get information on existing flora and fauna.	Information on forest areas and type of Flora & Fauna present in study region collected from Forest Department and NMC.
v.	Socio Economic Data	Census of India	To incorporate the Data in Socio-Economic Report.	Census data for the study region collected from statistical Department Govt. of India
vi.	Ground Water Data	Central Groundwater Board (CGWB)	To Correlate the field data & in Analysis of the Condition of GW in the study area.	Piezometric levels of Groundwater in the city area for Pre & Post Monsoon season (Last 3 Years) was collected from CGWB regional office, Nagpur

Table -5.2: Data furnished by NMRCL/ Contractor

S. No.	Type	Source	Use
i.	Traffic Studies/Diversion & Management plan	NMRCL / Contractor	Impacts identification, prediction and to workout Reduction in carbon Emissions.
ii.	Transit orient Development (TOD) studies	NMRCL / Contractor	Impacts identification, prediction and to workout Reduction in carbon Emissions.
iii.	Existing Drainage network data	NMRCL / Contractor	To use in Drainage Network Restoration Studies.
iv.	Information on Waste Management disposal sites;	NMRCL / Contractor	To Use in Solid Waste management Studies.
v.	Information on Risk & Hazardous Management	NMRCL / Contractor	To Use in Project specific Risk and Hazardous management Studies.
vi.	Soil Investigation Report	NMRCL / Contractor	To assess and predict the Vibration studies and its impact on the project.

(B) Field Studies: The Field studies are initiated before Report preparation, for identification of the environmental sensitive zones within the study area along with the physical verification of all the identified sensitive zones with respect to the location of the project alignment and activities proposed are carried out for Summer season viz., March 2016 to June 2016 through M/s. Anacon Labs, Nagpur, (Recognized by Ministry of Environment & Forests (MoEF) vide Notification No. D.L-33004/99 dt.24.10.2007– under EPA. act http://moef.gov.in/legis/env/so1811e.pdf. M/s. Aanacon Labs, Nagpur also certified by NABL and NABET). The field studies include monitoring of environmental quality in terms of ambient air quality, water quality, soil quality, background noise level and ecology (flora, fauna and roadside trees, etc.) along the existing alignment. The

procedure for measurement of environmental quality surveys will be carried-out as per guidelines of the Ministry of Environment and Forests, Government of India.

Team of QCI-NABET approved experts from M/s. Aarvee Associates, Hyderabad visited the site during last week of March 2016 towards collection/generation & monitoring of environmental baseline (Primary & Secondary) data. The photographs showing the experts visited the site is given in Fig-5.1

Fig-5.1: Site visit by QCI-NABET approved experts & other staff from Aarvee Associates

5.1 Site and Its Environs

The Project area is situated in Nagpur, third largest city of Maharashtra and also the winter capital of the state. The average elevation of Nagpur plains is 310.5 m above the mean sea level (a-MSL). It is situated at latitude between 20°35'N and 21°44'N and longitude between 78°15'E and 79°40'E. Parameters involved in land environment are, physiography, geology and soils, and seismicity. These are discussed in the following paragraphs.

5.1.1 Physiography

Nagpur district lies between 20.35 to 21.44 North Latitude and 78.15 to 79.40 East Longitude., in the plain to which it gives its name at the southern base of the Satpuda Hills. It has an area of 9,892 Sq. km. The district is bounded on the north by the Chhindwada and Seoni districts of the Madhya Pradesh, on the east by Bhandara, on the south and west by Chanda and Wardha, respectively, and along a small strip on the northwest by the Amravati district. The northern range of hills extends along the whole border, being pierced only in two places where the Kanhan and Pench rivers have broken through. On the west it consists merely of the outlying foothills of the Satpudas, the plateau proper lying behind them in Chhindwada. But from the Kanhan to the Pench, it is

the major range of the Satpudas themselves which dominates the landscape, and the ascent of the Khamarpani plateau is made in Nagpur. Along this length the hills are well wooded and picturesque, and there is some striking scenery on the Pench river. Nag River a tributary of Kanhan river flows through the project alignment.

5.1.2 Geology and Soils

The city of Nagpur lies on the basaltic flow known geologically as Deccan Traps. The parent basalt is very dark Grey in colour, compact, dense and very hard in nature. It is very difficult to break this rock and it breaks up with sharp conchoidal fractures confirming to be of igneous origin. Nagpur city lies in the neighborhood of the classical geological areas of India. More than half of the whole district of Nagpur is covered by basaltic and doleritic lava flows known as Deccan Traps. The main soil types present in the region are kali soils, morand soils, khardi soils, bardi soils, kachchar soils and wardi soils.

i) Kali soils: These are black cotton soils which are fine grained clayey in texture and varies in depth from 1 m to 6 m or more and retain moisture. They are found around Kalmeshwar, Saoner and Nagpur.

ii) Morand soils: These are predominant in the district. They are black cotton soils with higher percentage of lime than the Kali soils. They are black, Grey or light to dark brown in colour, clayey in texture and have a depth of about 1 to 3 m.

iii) Khardi soils: They are shallow soils mixed with sand and found mainly in hills. These are Grey in colour, clay loam in texture.

iv) Bardi soils: They are red gravel covered with boulders found on summits and slopes of trap hills and are less fertile in nature.

v) Kachchar soils: They are mainly found in the banks of Kanhan river and are alluvial soils, loamy in nature and vary in depth from 1 to 3 m.

vi) Wardi soils: They are red soils with a large amount of sand. They are shallower and clayey loam in nature. They are mainly found in the paddy tracts in the eastern part of the district.

5.1.3 Hydro-geology

Archeans and the Deccan trap basalts are the two consolidated formations, which form the Hard rock aquifers occurring in the study area.

a) **Archaean**- The crystalline rocks comprising of gneiss, schist, pegmatite and quartzite are the main formations occurring in north-eastern and south eastern parts of the district. In these rocks, weathered zone which is down to a depth of 25 m. BGL, forms

the important shallow aquifer for dug wells. In unweathered crystalline rocks, the occurrence of ground water is mainly controlled by joints and fractures. Higher yields are generally associated with lineaments. Ground water at places occurs in fractured zones at depth in semi-confined to confined conditions.

b) **Deccan Traps**- Basalt is the main formation of the study district and occupies an area of about 4300 sq. km. Ground water occurs under phreatic conditions in the exposed lava flows and in semi-confined to confined state in the subsurface flows. Ground water is present in pore spaces in the vesicular unit of each flow and in the jointed and fractured portions of massive unit. However, secondary porosity and permeability developed on account of weathering, fracturing and joints play a very important role in the storage and movement of ground water. This has given rise to good aquifers. Weathering not only produces granular materials but also widens the fractures, joint and shear zones.

The depth of the ground water level in the study area is between 10-20 m BGL during pre-monsoon season and the ground water level during post-monsoon season is between 5-10 m BGL.

5.1.4 Seismicity

The country has been classified into different zones indicating the intensity of damage or frequency of earthquake occurrences. These zoning maps indicate broadly the seismic coefficient that could generally be adopted for design of buildings in different parts of the country.

As per the Bureau of Indian Standards (BIS), The project area falls in Zone-II of Seismic Zoning Map of India. This is a least active zone from seismic point of view. Nagpur has close to zero chances of getting a major earthquake which may cause huge devastation. Recent history also supports the fact that Nagpur region is relatively very safe as far as earthquakes are concerned. But still, as per the Seismic Zoning Map of India (IS 1893, Part-I, 2002) necessary seismic factors suggested by Indian Meteorology Department (IMD) shall be incorporated suitably while designing the structures to safeguard against earthquake risks.

5.2 Meteorology of the Region

The climate of Nagpur can be broadly divided into three important seasons of summer, winter and monsoon. Almost throughout the summer (March-June), the maximum temperature remains beyond 40 degree Celsius. Sometimes it may be as high as 48

degree Celsius. Monsoons (July-September) take its charge in the month of June. It showers maximum in the months of July and August. The minimum temperature recorded around 12 degree Celsius in winters (October-January) and sometimes even dips down below that level in the month of February. Mean and extreme monthly data of Nagpur during the period from 1969 to 2010 is given in Table -5.3 (A&B).

Table 5.3 (A): Mean and Extreme monthly data of Nagpur (1969-2010)

Month	Highest Max Temp	Lowest Min Temp	Rainfall mm	Heaviest monthly R/F mm	Wind Speed	Mean Evaporation mm.
Jan	28.9	6.4	15.3	129.3	5.5	3.5
Feb	31.8	7.4	20.8	151.5	6.6	4.4
Mar	36.5	10.1	18.1	99.6	6.8	5.9
April	40.7	16.2	8.6	60.8	7.5	7.4
May	42.7	20.4	18.2	76.5	9.9	8.7
June	37.8	21.0	163.4	398.8	10	6.3
July	31.7	19.5	304.0	677.5	8.3	3.8
Aug	30.6	19.8	275.0	557.7	7.8	3.4
Sept	32.2	16.6	170.1	406.8	6.5	4.1
Oct	33.0	12.6	61.2	363.1	5.6	4.3
Nov	30.9	7.0	16.8	100.2	5.6	3.7
Dec	28.8	5.7	11.7	126.5	5.0	3.3

Source: "Climate of Nagpur" report given by Regional Meteorological Center Airport, Nagpur (2011)

Table 5.3 (B): Mean and Extreme monthly data of Nagpur (1969-2010)

Month	Number of days with				
	Hailstorm	Thunder	Fog	Dust storm	Squall
Jan	0.5	1	0.6	0.0	0.1
Feb	0.0	1.6	0.1	0.0	0.3
Mar	0.1	3.0	0.0	0.1	0.5
April	0.0	4.1	0.1	0.1	0.6
May	0.0	6.1	0.0	0.2	1.9
June	0.0	10.7	0.0	0.0	2.3
July	0.1	8.8	0.1	0.0	0.7
Aug	0.1	7.2	0.1	0.0	0.4
Sept	0.0	8.5	0.0	0.0	0.5
Oct	0.0	2.8	0.1	0.0	0.1
Nov	0.0	0.8	0.2	0.0	0.0
Dec	0.0	0.3	0.5	0.0	0.0

Source: "Climate of Nagpur" report given by Regional Meteorological Center Airport, Nagpur (2011)

i) Temperature: The temperature generally rises from the beginning of March till June, which is the hottest month of the year with mean minimum and maximum temperatures of 20.3°C and 36.7°C respectively. With the onset of monsoons by the end of June, temperature begins to fall. The drop in day temperature is much more than the drop in night temperature. The night temperature falls rapidly after the withdrawal of monsoons by mid- September. The month of December is coolest month with the mean maximum and minimum temperatures being 28.3°C and 12.1°C respectively. Sky is generally clear with light surface winds blow from North or Northeasterly direction. The normal minimum temperature is 12.0°C to 14.0°C with slight rise in the mean daily minimum

temperature. The mean maximum temperature is around 29.0°C.

ii) Humidity: Except during monsoon months humidity is generally low throughout the year. During summer season, humidity is lowest (20.7%). During monsoon months, it goes as high as 80- 90%. The highest level of humidity (88%) is observed in the month of August.

iii) Rainfall: At Nagpur, the annual rainfall is 1250.7 mm. About 60 to 70 % of the annual rainfall is reviewed in the monsoon months. The rain in Nagpur is heavily dominated by the south-westerly monsoon winds. Precipitation in form of rain is received during monsoon months. The number of rainy days in a year is about 56.9 at Nagpur.

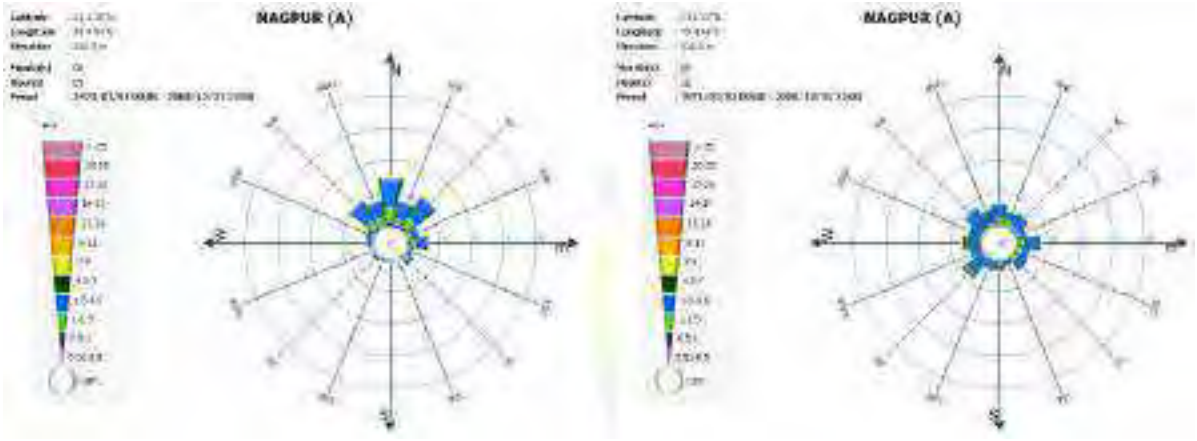
iv) Wind Speed: Nagpur city experiences a low pressure in the end of May month resulting in the wind blowing at a speed of 6 m/s or more and for the rest part of the year; the speed remains 2 to 3 m/s. The season wise diagrams for the period of 1969 to 2010 is given in Figure -5.3 to 5.6.

5.2.1 On site Meteorological Conditions

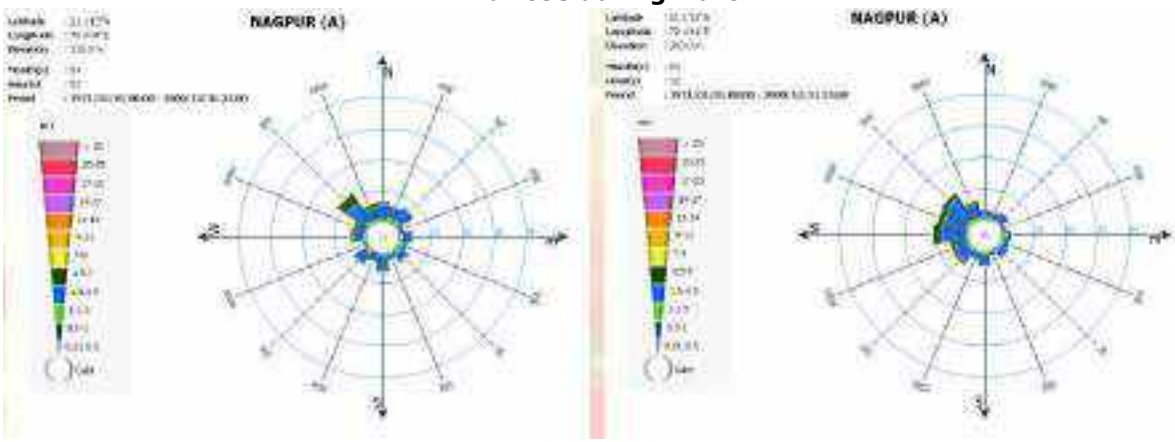
As a part of the EIA study, an automatic weather station has been installed and monitored for the months of March to June 2016 at Ramnagar. The micro-meteorological parameters observed are Temperature, Relative Humidity, Wind speed, Wind direction and Rainfall. The summary & conclusions of micro-meteorological conditions of the study area are described in this EIA report. Figure 5.2 -shows the micro-meteorological station installed at Ramnagar.

Figure-5.2: Micro-Meteorological station installed at Ramnagar.

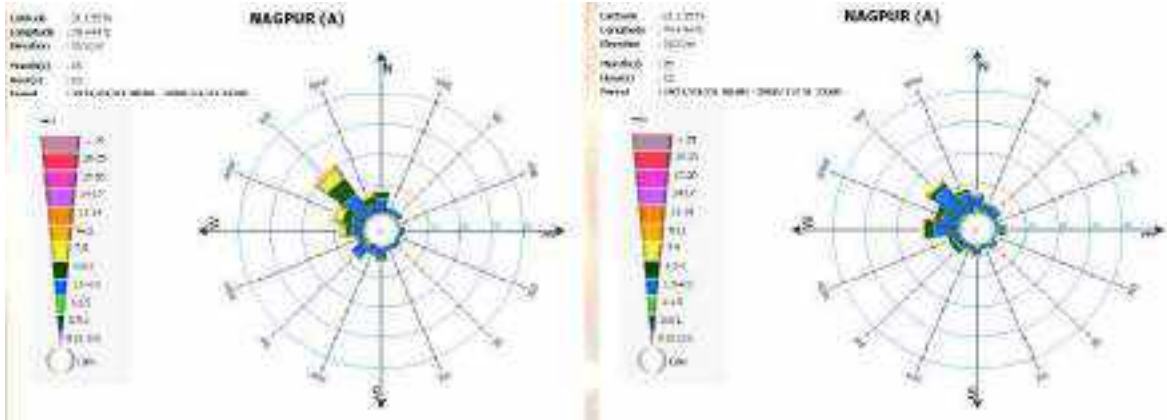
Mean Temperature during the study period is 21.1°C to 39.5°C and the humidity is recorded to be 24.5%. The wind speed 2 to 4.5 m/s and the predominant wind direction is blowing from North-West, Northern, North-East and South-West. The cumulative rainfall occured is <4 mm. The study period meteorology is in line with the regional meterology.



Wind rose during March



Wind rose during April



Wind rose during May

Figure -5.3: Wind rose obtained during Summer Season drawn at 08.30 & 17.30 hours I.S.T (March, April & May for the Year 1969 to 2000)

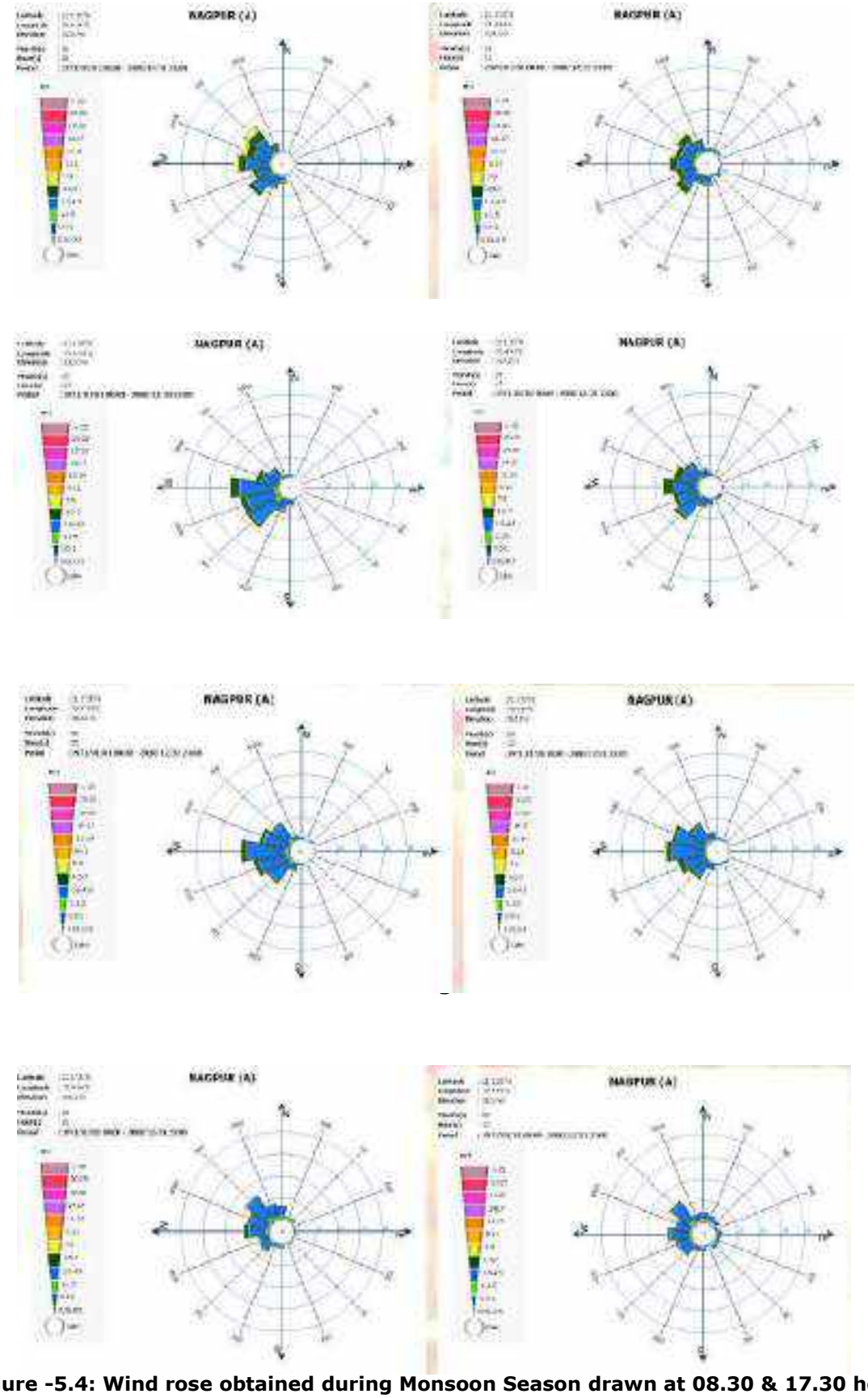
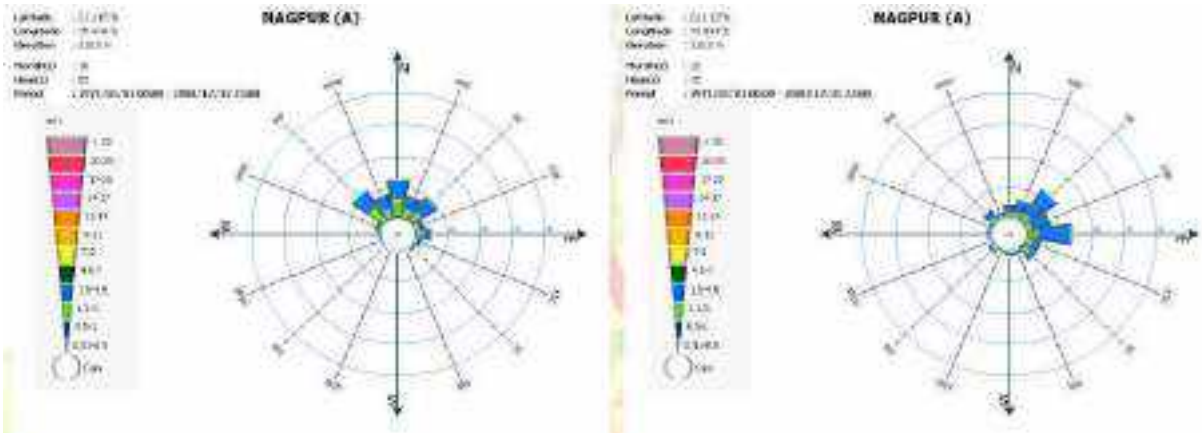
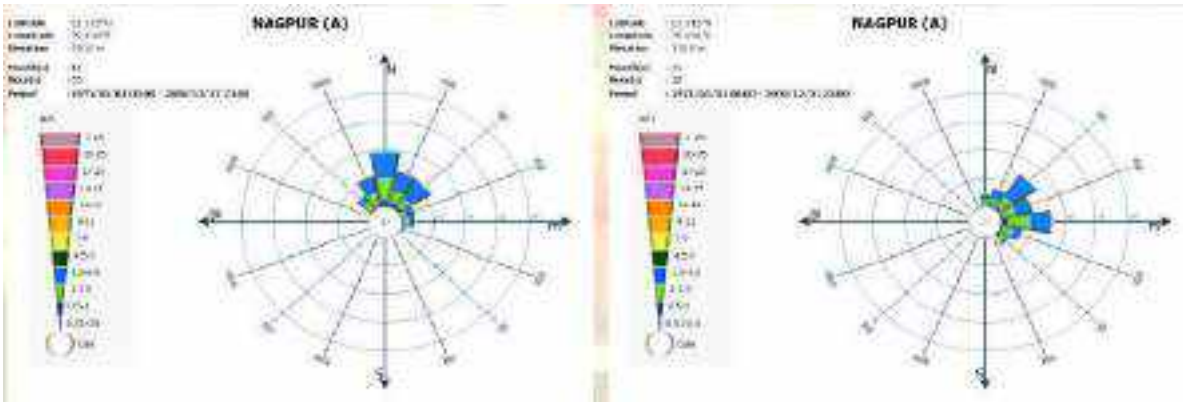


Figure -5.4: Wind rose obtained during Monsoon Season drawn at 08.30 & 17.30 hours I.S.T (June to September for the Year 1969 to 2000)

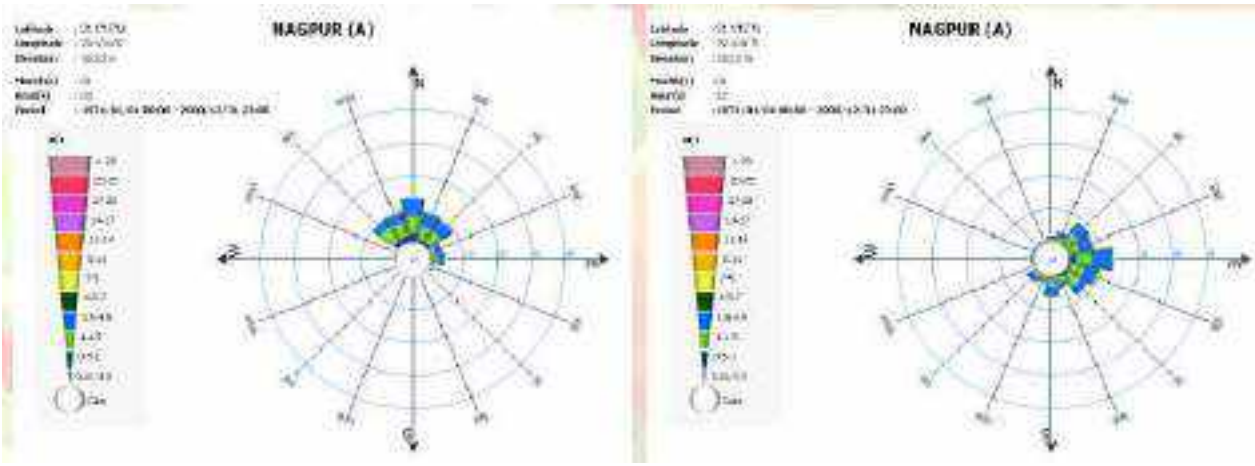


Wind rose during October

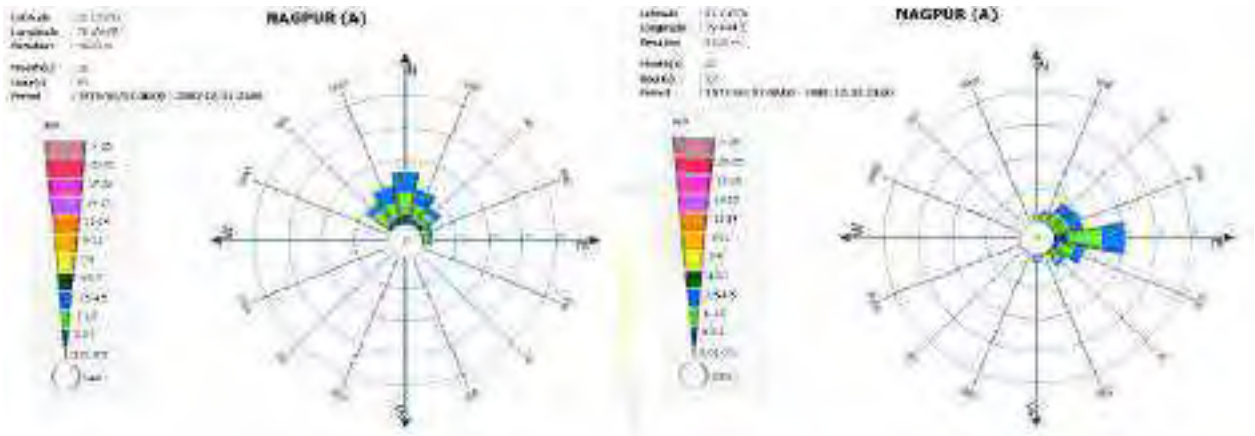


Wind rose during November

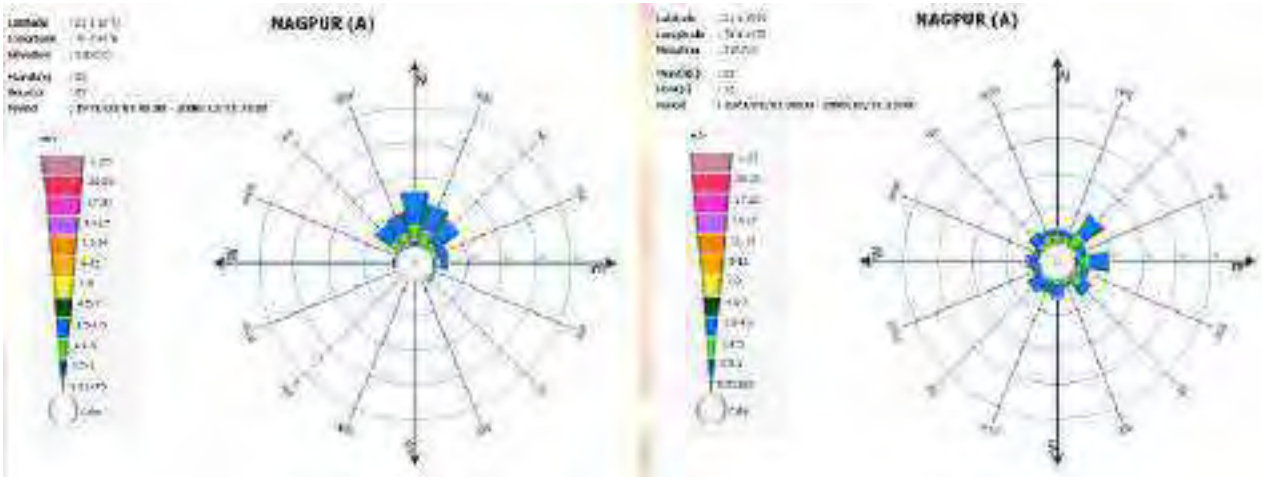
Figure -5.5: Wind rose obtained during Post-monsoon Season drawn at 08.30 & 17.30 hours I.S.T (October to November for the Year 1969 to 2000)



Wind rose during December



Wind rose during January



Wind rose during February

Figure -5.6: Wind rose obtained during Winter Season drawn at 08.30 & 17.30 hours I.S.T (December to February for the Year 1969 to 2000)

5.3 Air Environment

In order to understand the present condition of the air environment, monitoring of ambient air quality was carried out at different locations. After a preliminary reconnaissance of the study region and taking into account the meteorological (predominant wind directions, wind speed) & topographic conditions and details on existing industrial activities in the study region, six (06) stations were identified for carrying out Ambient Air Quality Monitoring (AAQM) in the study area covering different category of land use, viz. residential, commercial/industrial and sensitive zone like schools, colleges and hospitals along the road. The ambient air quality monitoring is being carried out with respect to Particulate Matter (size less than 10µm) or PM_{10}, Particulate Matter (size less than 2.5 µm) or $PM_{2.5}$, Sulphur dioxide (SO_2), Oxides of Nitrogen (NO_X), Carbon Monoxide, and Hydrocarbons by following the MoEF&CC guidelines. The details of the ambient air quality monitoring locations in the study area are given in Table -5.4. The photographs showing the AAQ Monitoring in the study area are shown in Figure- 5.7 and the basemap showing the AAQ locations are given in Figures -5.8.

Table -5.4: Details of Ambient Air Quality Monitoring Locations

S. No.	Station code	Location of Monitoring
1	AAQ1	Automotive Square
2	AAQ2	Sitabardi Square
3	AAQ3	Khapri station
4	AAQ4	Prajapathi Nagar
5	AAQ5	Lokamanya Nagar
6	AAQ6	Chatrapathi Square

Figure -5.7: Photographs showing the AAQ Monitoring in Sitabardi & Prajapathi nagar

Figure -5.8 (a): Map showing the Environmental Baseline Monitoring Locations of Micro meteorological station, Air, Water and Soil

Figure -5.8 (b): Map showing the Environmental Baseline Monitoring Locations of Noise and Vibration

In assessing the environmental impact, collection and interpretation of baseline data is of prime importance. The primary data for the study period is to be collected for 24 hours basis, twice in a week for three months period as per national guidelines. Monitoring was done as per the guidelines for Ambient Air Quality Monitoring, National Ambient Air Quality Series NAAQMS/25/2003-04. The criteria followed for selecting the AAQM stations is recommended by IS: 5182 and CPCB.

They are

- The sampling station had free exposure so that it did not collect air from stagnant pockets.
- It was not obstructed by large structures including hills.
- The sampling point was not directly influenced by any local source of emission.
- It was located at a minimum height of 1.5 m from the ground level.

Monitoring and analytical procedure:

Ambient air quality was monitored for the presence of contaminants existing in the air. In order to evaluate and quantify the air pollution problem, measurements were carried out for various air pollutants. This data was used not only to evaluate the air quality in the study region but also as the basis to develop programs aiming at preventing the spread of pollutants leading to a risk to human health and general environment. Respirable Dust Samplers (RDS) were used for ambient air sampling of selected parameter.

Selection of monitoring parameters:

The parameters selected for analysing ambient air quality status were Sulphur dioxide (SO_2), Nitrogen dioxide (NO_2), Respirable Particulate Matter (PM_{10}), Fine Particulate Matter ($PM_{2.5}$), Carbon Monoxide (CO) and Hydro carbon (HC).

Data analysis

The observed concentrations of various pollutants at all the sampling stations were processed for analysis of different statistical parameters like arithmetic mean, minimum concentration, and maximum concentration and percentile values (75^{th} & 98^{th}). The existing baseline levels obtained during the study period at six monitored locations are presented in Table -5.5.

All of the Ambient Air Quality Monitoring (AAQM) stations where AAQM was carried out falls under commercial category. The recorded concentrations are compared with the National Ambient Air Quality Standards as notified on 16.11.2009 by MoEF.

Table -5.5: Ambient air quality during study period

Location/Category	Min.	Max.	Mean	75 Percentile	98 Percentile	CPCB Standard
PM_{10} ($\mu g/m^3$)						
Automotive Square	55.96	98.52	68.72	70.66	98.52	100
Sitabardi Square	69.12	104.78	78.73	81.02	104.78	100
Khapri station	43.73	56.98	50.63	52.34	56.98	100
Prajapathi Nagar	61.52	76.96	69.29	71.12	76.96	100
Lokamanya Nagar	51.05	78.33	64.77	69.01	78.33	100
Chatrapathi Square	66.03	78.86	71.45	74.21	78.86	100
$PM_{2.5}$ ($\mu g/m^3$)						
Automotive Square	29.75	38.11	33.72	37.27	38.11	60
Sitabardi Square	36.02	54.57	42.19	44.7	54.57	60
Khapri station	28.32	36.62	32.23	34.32	36.62	60
Prajapathi Nagar	33.49	42.56	38.00	39.27	42.56	60
Lokamanya Nagar	29.15	37.59	33.23	34.98	37.59	60
Chatrapathi Square	30.45	41.08	36.76	40.58	41.08	60
SO_2 ($\mu g/m^3$)						
Automotive Square	11.1	18.9	14.99	16.78	18.9	80
Sitabardi Square	12.43	21.16	17.24	18.53	21.16	80
Khapri station	7.53	11.13	9.26	9.94	11.13	80
Prajapathi Nagar	12.02	18.32	15.38	16.24	18.32	80
Lokamanya Nagar	13.47	19.46	16.91	18.02	19.46	80
Chatrapathi Square	19.47	22.26	20.80	21.92	22.26	80
NO_2 ($\mu g/m^3$)						
Automotive Square	32.24	39.02	35.75	37.15	39.02	80
Sitabardi Square	39.95	55.56	48.91	51.34	55.56	80
Khapri station	25.76	31.74	28.71	29.68	31.74	80
Prajapathi Nagar	31.15	43.42	38.82	40.97	43.42	80

Location/Category	Min.	Max.	Mean	75 Percentile	98 Percentile	CPCB Standard
Lokamanya Nagar	32.28	37.81	34.16	35.06	37.81	80
Chatrapathi Square	45.02	58.48	53.12	56.99	58.48	80
CO (mg/m³)						
Automotive Square	0.62	0.81	0.71	0.73	0.81	4
Sitabardi Square	0.67	0.81	0.73	0.77	0.81	4
Khapri station	0.34	0.41	0.37	0.39	0.41	4
Prajapathi Nagar	0.50	0.76	0.62	0.67	0.76	4
Lokamanya Nagar	0.45	0.69	0.58	0.62	0.69	4
Chatrapathi Square	0.61	0.79	0.72	0.75	0.79	4

Source: Baseline study carried out by M/s. Aarvee Associates for Summer season

The following observations can be made from the above Table:

- The mean Respirable Particulate Matter (PM_{10}) values observed in the range between 50.63-81.38 µg/m³ as against the CPCB standard of 100 µg/m³ for residential / industrial category. All values were found to be well within the stipulated standards except for Sitaburdi location where PM_{10} exceeded the limit. The maximum and 98th percentile values found to be well within the stipulated standards for all the locations except sitaburdi square location.
- The mean Fine Particulate Matter ($PM_{2.5}$) values were found in the range between 32.23-42.41 µg/m³ as against the CPCB standard of 60 µg/m³ for residential/industrial category. The maximum and 98th percentile values found to be well within the stipulated standards for all the locations.
- The mean Sulfur dioxide values were observed in the range between 9.26–17.24 µg/m³ against the CPCB standard of 80 µg/m³ for residential / industrial category. The maximum and 98th percentile values found to be well within the stipulated standards for all the locations.
- The mean Dioxides of Nitrogen (NO_2) values were observed in the range between 28.71 – 50.06 µg/m³ against the CPCB standard of 80 µg/m³ for residential / industrial category. The maximum and 98th percentile values found to be well within the stipulated standards for all the locations.
- The mean carbon monoxide (CO) levels observed in the range between 0.37 – 0.74 mg/m³ as against the CPCB standard of 4mg/m³ for residential / industrial

category. The maximum and 98th percentile values found to be well within the stipulated standards for all the locations.

- The Hydro carbon levels observed in the range <0.01 µg/m3.

In general, the ambient air quality in the study area is satisfactory. It is envisaged that due to proposed metro project traffic may come down and ease the vehicles movement and reduce traffic congestion, which will lead to reduction of pollution levels. The PM_{10}, PM $_{2.5}$, SO_2 & NO_2 concentrations are shown in the figures 5.9, 5.10, 5.11 & 5.12

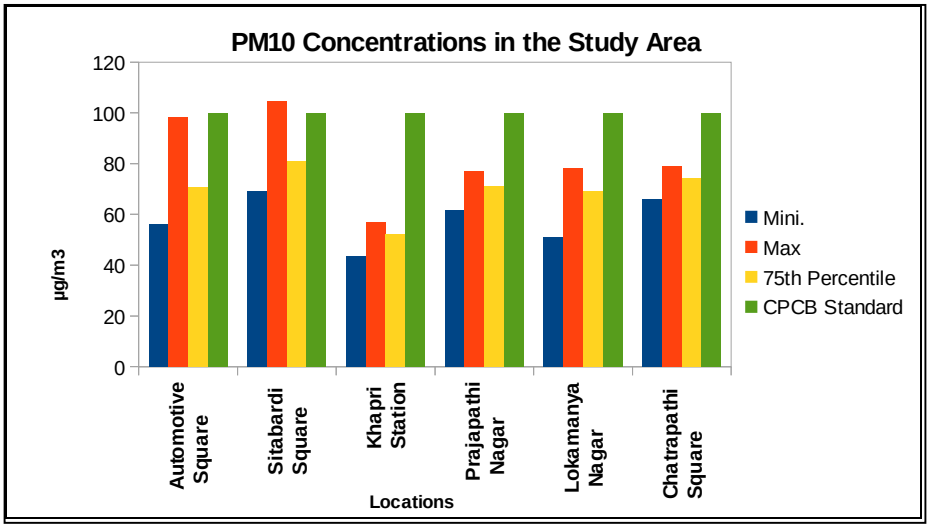


Figure-5.9: PM_{10} at different locations

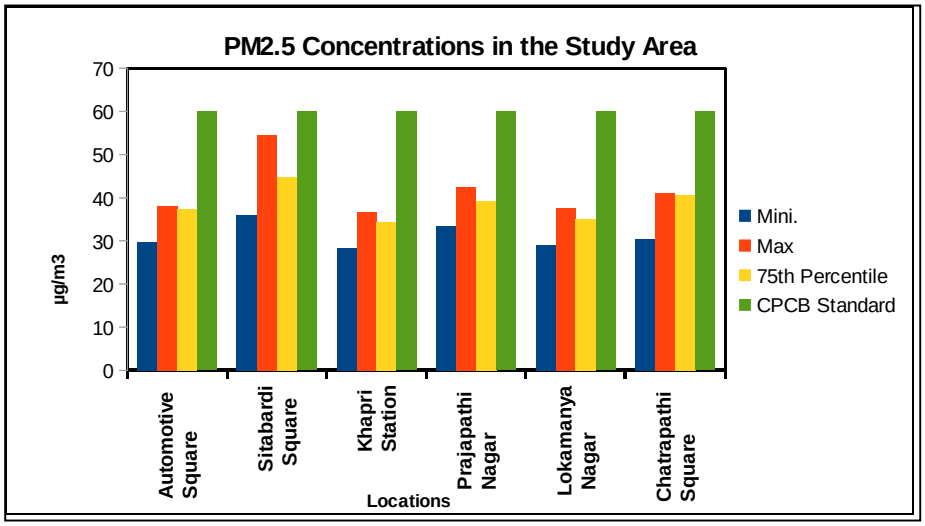


Figure-5.10: $PM_{2.5}$ at different locations

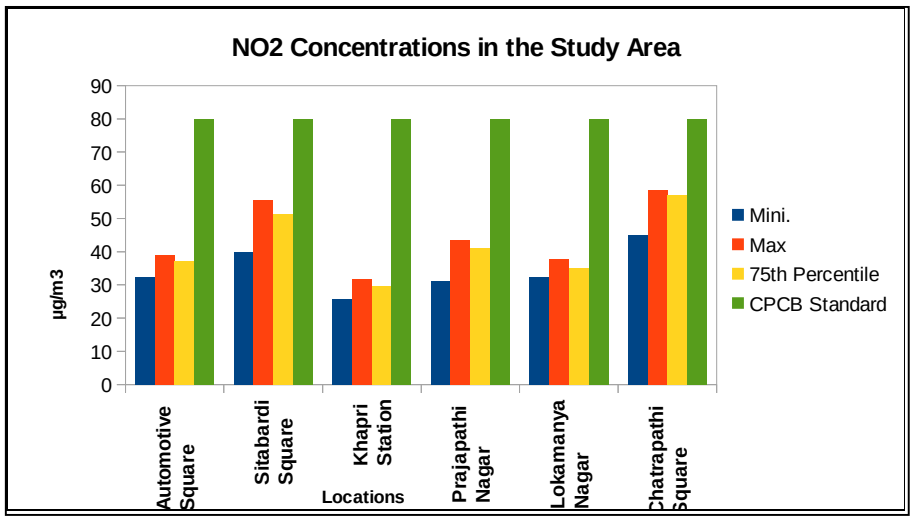


Figure-5.11: NO_2 at different locations

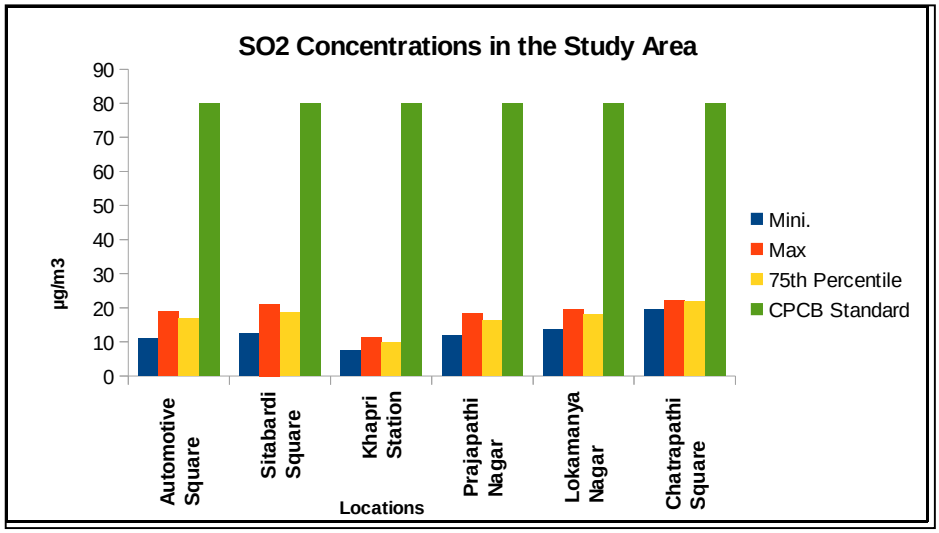


Figure-5.12: SO_2at different locations

5.3.1 Air Quality of Nagpur

Air quality assessed by Maharashtra State Pollution Control Board (MPCB) at 4 locations namely Civil lines, North Ambhajhari Road, Hingna Road and Sadar areas of the Nagpur under State Ambient Air Quality Monitoring Programme (SAMP). Almost, all of the locations are falling within the study area of 10 Km radius of the proposed NMRCL Project. The air quality data collected and compiled for the last 18 months (January 2015 to June 2016). The criteria pollutants covered under the monitoring are PM_{10}, SO_2, & NO_X. The details of the same are given in Table -5.6.

Table -5.6: Ambient Air Quality Monitored at Nagpur

Month	Civil Lines Nagpur			North Ambazani Road			Hingana Road			Sadar		
	SO_2	Nox	RSPM	SO_2	Nox	RSPM	SO_2	Nox	RSPM	SO_2	Nox	RSPM
January, 2015	10.77	34.46	57.46	10.56	31.33	90.22	11.78	38.67	137.33	12.11	40.89	90.44
February	10.33	31.96	54.46	11	36.88	114.63	11.63	38.13	149.5	10.5	32.88	98.63
Mar	10.59	79.44	47.12	11.44	27.5	22.72	11.25	35.5	117.25	13.13	36.56	75.44
April	8	57.1	42.56	8.33	25.56	113.11	7.75	25	123.38	9.33	29.78	111.11
May	7.6	68.88	60.92	78	23.6	116.6	9	27.8	148.8	8.25	48.54	113.11
June	8.11	66	48.54	8.38	26.13	116.5	64	193	86.6	11.11	34.38	116.6
July	8.27	54.4	34.38	9	27.43	91.29	9.13	27.38	100.25	12.1	56	116.5
August	8.08	78.13	56	8.18	23.91	86.09	8.3	24.1	101.4	12.4	47.56	91.29
September	8.88	81.22	47.56	9.3	28.7	87.8	8.75	27.25	88.38	10.77	45.35	86.09
October	9.28	54.08	45.35	11.11	40.78	86.78	10.7	36.9	94.9	10.33	27.38	87.8
November	11.31	34.72	54.21	12.1	42.4	120.1	11.78	42.56	100	10.59	24.1	86.78
December	9.83	31.7	58.7	12.4	44.2	93	12	42.78	127.67	12.1	45	100.1

Month	Civil Lines Nagpur			North Ambazani Road			Hingana Road			Sadar		
	SO_2	**Nox**	**RSPM**	**SO_2**	**Nox**	**RSPM**	**SO_2**	**Nox**	**RSPM**	**SO_2**	**Nox**	**RSPM**
January, 2016	11.75	41.32	51.61	--	--	--	--	--	--	--	--	--
February	9.33	30.33	53	--	--	--	--	--	--	--	--	--
March	8.69	24.73	46.73	9.33	27.56	89.33	10.11	31.11	101.78	9.2	28.1	92.1
April	8.4	24.4	46.72	9.8	31.5	89.2	10.1	34.1	95.7	9.11	27.44	77.56
May	7.41	20.22	44.41	9.8	31.5	89.2	10.1	34.1	95.7	9.11	27.44	77.56
June	7.83	21.83	43.12	9.67	30.78	89.44	10.1	34.1	95.7	10.1	-	95.7
CPCB Standards	**80**	**80**	**100**	**80**	**80**	**100**	**80**	**80**	**100**	**80**	**80**	**100**

Source: MPCB website for the year January 2015 to June 2016.

Analysis of the Data:

- ✓ PM_{10} values at Civil lines locations was well below the standard value, but at North Ambazari Road and Sadar locations RSPM values were found to be slightly exceeding the stipulated value during the months of February, April, May, June, July and November of 2015. At Hingna road PM_{10} values were found to be considerably exceeding the stipulated value during February 2015, it was found to be 149 µg/m^3 as against the stipulated standard of 100 µg/m^3.
- ✓ It was found that SO_2 values for these locations ranged from 7.41 to 64 µg/m^3 and all values are well below the stipulated value 80 µg/m^3.
- ✓ NOx values for these monitored locations were found to range from 20.22 to 81.22 µg/m^3 . All values were found to be well below the stipulated value of 80µg/m^3 except at Civil lines on September 2015 which exceeded slightly than the stipulated value.

The primary data collected by M/s. Aarvee Associates are in line with the MPCB air quality data.

5.4 Water Environment

5.4.1 Surface Water Quality

Surface water quality is being studied by collecting surface water samples from seven (07) locations with in study area. The details of the Sampling locations is given in Table-5.7. The Photographs showing the Surface water sampling in the study area is shown in Figure- 5.13.

Table -5.7: The Details of Surface Water Quality Sampling Locations

S. No.	Station code	Location of Monitoring
1	SW-1	Stream Near Automotive Square
2	SW-2	Stream Near Kammal Chowk
3	SW-3	Nag Nadhi stream confluence near Sitabuldi Square
4	SW-4	Stream Near Karve Nagar
5	SW-5	Nag Nadhi Stream Near Prajapati Nagar
6	SW-6	Ambazari Lake
7	SW -7	Stream Near Nildoh

Figure -5.13: Photographs showing the Surface water sampling near Ambazari Lake & Stream near Prajapathi Nagar

In order to understand existing surface water quality status in the study area, surface water samples at seven different locations were tested for various parameters and results of the same is presented in Table -5.8.

Table 5.8: Surface Water Quality along the project corridor

S.No	Parameter	Units	BIS:2296 Class D Limit	BIS:2296 Class C Limit	SW-1	SW-2	SW-3	SW-4	SW-5	SW-6	SW-7
1	pH value @ 25^{0}C	-	6.5 to 8.5	6.5 to 8.5	7.10	6.62	7.10	7.01	7.14	7.05	7.11
2	Electrical Conductivity at 25^{0}C	µS/cm	1000	2000	821.0	662.3	823.8	1996	964.1	493.6	940.7
3	Turbidity	NTU	---	---	58	48	4.0	2.0	16	0.9	99
4	Dissolved Oxygen	mg / l	4.0	4.0	5.0	5.2	5.7	5.2	5.2	6.2	6.3
5	Total dissolved solids (TDS)	mg / l	---	1500	477	384	479	1152	560	286	546
6	Total suspended solid (TSS)	mg / l	---	---	218	123	80	54	73	<4	< 10
7	Total alkalinity (as $CaCO_3$)	mg / l	---	---	247.2	201.6	254.4	464.2	297.6	204	275
8	Total hardness (as $CaCO_3$)	mg / l	---	---	164.34	158.4	178.2	690	190.08	112.86	176
9	Sodium (as Na)	mg / l	---	---	72.7	55.6	64.7	59.7	86.2	50.8	48.0
10	Potassium (as K)	mg / l	---	---	11.5	7.6	11.6	9.53	13.6	5.6	12.8
11	Magnesium (as Mg)	mg / l	---	---	13.01	13.49	30	142.6	16.39	14.46	21.43
12	Calcium (as Ca)	mg / l	---	---	44.35	41.18	45.14	149.6	49.10	21.38	35.2
13	Sulphate (as SO_4)	mg / l	---	400	12.72	12.72	8.48	25.76	19.51	11.87	21.37
14	Nitrate	mg / l	---	50	8.47	4.87	3.61	3.872	6.87	3.07	2.08
15	Fluoride (as F)	mg / l	---	1.5	0.41	0.23	0.37	0.72	0.42	0.18	0.62
16	Chlorides (as Cl)	mg / l	---	600	50.14	39.53	48.21	48.81	50.14	54.96	35.41
17	Total Nitrogen	mg / l	---	---	10.04	6.81	5.41	5.88	9.08	5.01	3.18
18	Oil and Grease	mg / l	0.1	0.1	< 4	< 4	< 4	7	< 4	< 4	< 4
19	COD	mg / l	---	---	279.36	182.36	116.84	364.56	196	<4	< 4
20	BOD	mg / l	---	3.0	93	55	38.66	108	62.0	<2	< 2
21	Free Residual Chlorine	mg / l	---	---	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
22	Total Phosphate	mg / l	---	---	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
23	Arsenic (as As)	mg / l	---	0.2	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
24	Cadmium (as Cd)	mg / l	---	0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
25	Total Chromium (as Cr)	mg / l	---	---	<0.03	<0.03	<0.03	0.03	0.06	0.06	0.06
26	Copper (as Cu)	mg / l	---	1.5	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
27	Lead (as Pb)	mg / l	---	0.1	<0.001	<0.001	0.02	<0.001	<0.001	<0.001	<0.001

S.No	Parameter	Units	BIS:2296 Class D Limit	BIS:2296 Class C Limit	SW-1	SW-2	SW-3	SW-4	SW-5	SW-6	SW-7
28	Iron (as Fe)	mg / l	---	50	0.20	0.21	0.28	0.29	0.32	0.16	0.38
29	Manganese (as Mn)	mg / l	---	---	0.17	0.32	0.18	0.21	0.26	<0.05	0.27
30	Zinc (as Zn)	mg / l	---	15	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
31	Nickel (as Ni)	mg / l	---	---	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
32	Cobalt (as CO)	mg / l	---	---	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
33	Total coliform	MPN/100 ml	---	5000	1600	1600	1600	1600	1600	1600	1600
34	Faecal Coliform	100 ml	---	---	Absent	Present	Present	Absent	Absent	Present	Absent
35	E. coli	100 ml	---	---	Absent	Absent	Absent	Absent	Absent	Absent	Absent

Note: Primary surface water data collected by M/s. Aarvee Associates, Hyderabad.

Data analysis

The surface water collected from various sources are analysed for physico-chemical and bacteriological parameters. The results are compared with BIS- 2296 Class C Limit (Drinking water source after conventional treatment). The detail description of sample analysed is given as below:

- Data on physical characteristics indicated variations in pH ranged between 6.62 – 7.14 as against BIS standard of 6.5 – 8.5. pH and all were found to be well within the stipulated value.
- Data on chemical characteristics:
    - The total hardness observed to be constant in all samples and is in the range of 201.6 to 464.2 mg/l. The calcium values are in the range 21.38-149.6 mg/l and magnesium values are in the range 13.01-142.6 mg/l. The contribution of calcium is more than magnesium to the total hardness, which is reflected clearly from calcium and magnesium values.
    - The total dissolved solids observed to be ranged between 286 mg/l to 1152 mg/l. All the values observed to be consistent in the stud area and well within the standards.
    - The chlorides ranged between 35.41 – 54.96 mg/l. All the values observed to be consistent in the stud area and well within the standard of 600 mg/l.
    - The Nitrates and Sulphates are ranged between 2.08 – 8.47 mg/l and 8.48 – 25.76 mg/l. The analysed values values found to be consistent in Nitrates and Sulphates in the study area.
    - The Fluoride values found to be in the range of 0.18 to 0.72 mg/l as against the general standard of 1.5 mg/l. In all the analysed samples Fluoride found to be consistent in the study area.
    - The Dissolved Oxygen in the sources is ranging between 5.0 to 6.3 mg/l as against the minimum requirement limit 4 mg/l. All the locations were are found to have higher values of dissolved oxygen than the stipulated value.
    - Bio-chemical Oxidation Demand (BOD) is observed to be high and ranged between 1.9–108 mg/l as against the specified limit of 3 mg/l. Except locations near Ambazari lake and Stream near Nildoh BOD was found to be very high than the stipulated value. All the monitored locations are exceeding the limit mainly due to entry of domestic wastewater from near townships and other commercial area in to the near by surface water bodies.
    - Bacteriological samples were analyzed for all the surface water sampling locations, the coliform organism values are observed in the range of around 1600 against the standard 5000 MPN/100 ml, indicates the coliforms are well within the standard.
    - Data on metals i.e., Fe and Zn concentrations are well within the strandards.

Graphs for BOD & DO, COD, TDS and Total Coliform are given in Figures 5.14, 5.15, 5.16 and 5.17 respectively

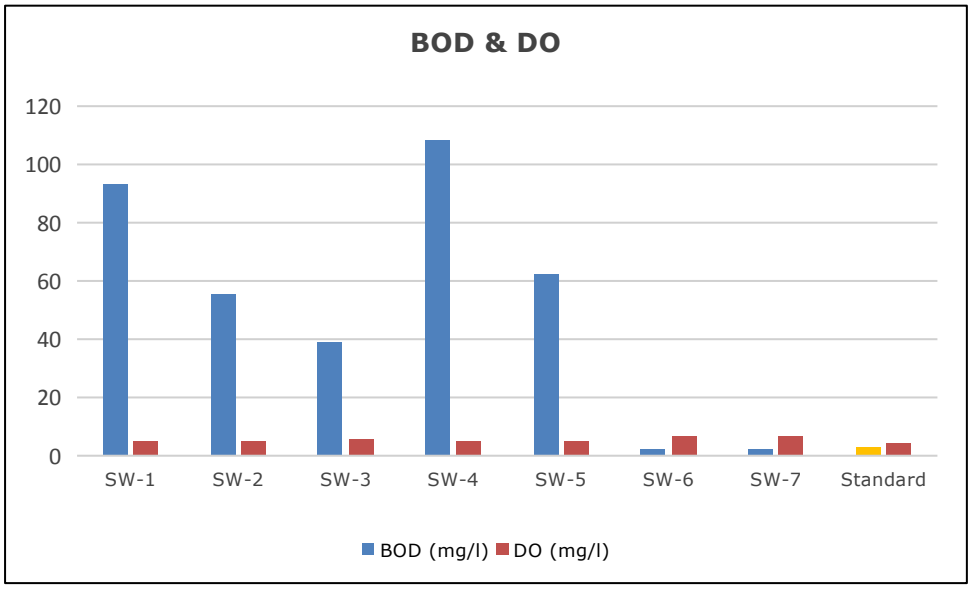


Figure 5.14-BOD & DO Concentrations

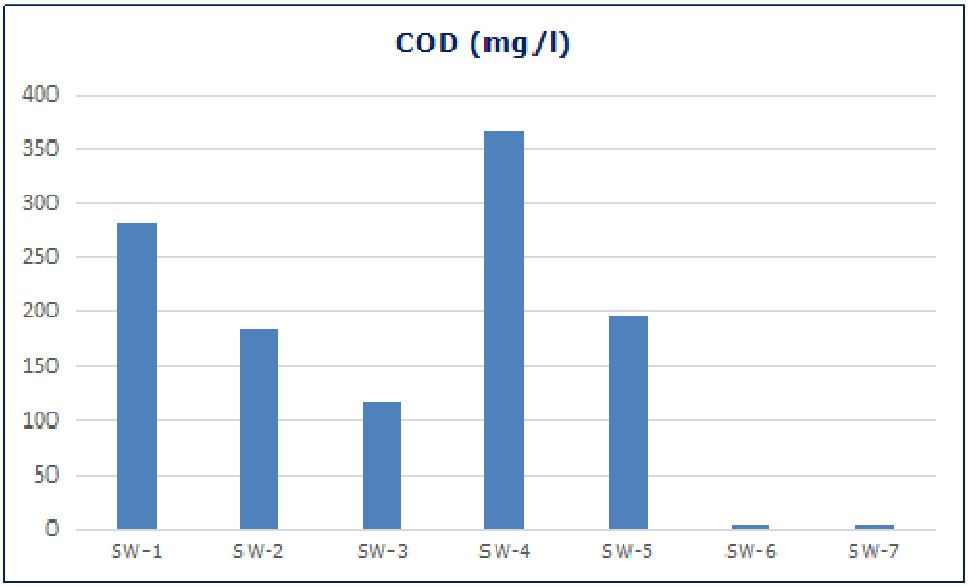


Figure 5.15-COD Concentrations

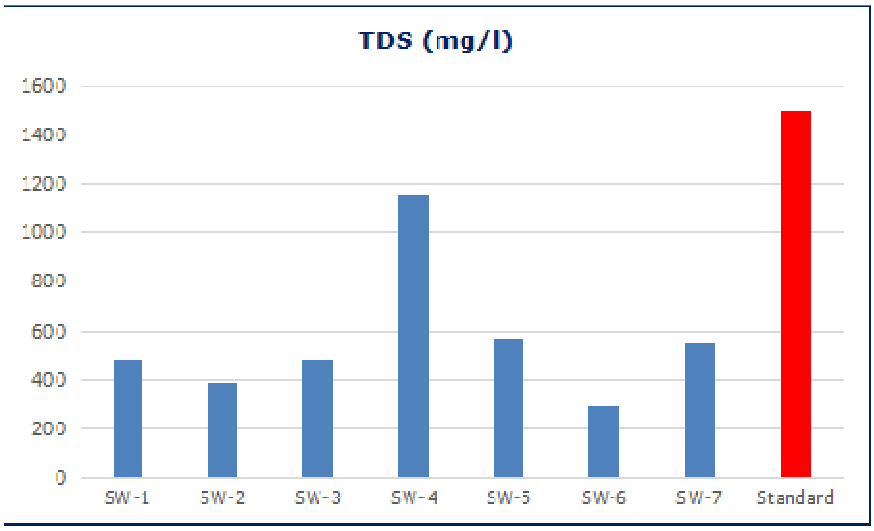


Figure 5.16-TDS Concentrations

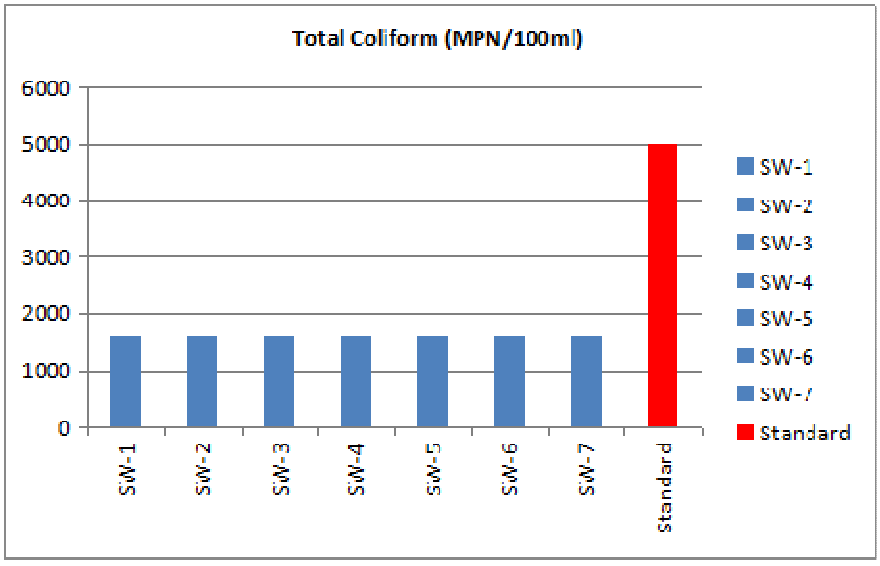


Figure 5.17-Total Coliform

5.4.2 Groundwater Quality (GWQ)

Ground water is also one of the main source for domestic usage purposes in the study area. The depth of the ground water level in Nagpur City is between 10-20 m bgl during pre-monsoon season and the ground water level during post-monsoon season is between 5-10 m bgl as per the Central Ground Water Board (CGWB), New Delhi. Keeping in view of the importance usage of the ground water, eight (08) Ground water samples are collected covering the whole study area and analysed for the various

physico-chemical parameters as per IS:10500 Standards. The details of the Sampling locations is given in Table-5.9. The Photographs showing the Groundwater sampling in the study area is shown in Figure- 5.18.

Table -5.9: The Details of Ground Water (GW) Quality Sampling Locations

S. No	Station code	Location of Monitoring
1	GW-01	Near Automotive Sqaure
2	GW-02	Near Sitabuildi square
3	GW-03	Near Karve Nagar
4	GW-04	Near MIHAN Depot
5	GW-05	Near Prajapati Nagar
6	GW-06	Near Chota Loharpura
7	GW-07	Near Adityaapak Layout near Ambazari Lake
8	GW-08	Near Lokamanya Nagar

Figure -5.18: Photographs showing the GW sampling near Khapri depot & sitabuldi

In order to understand existing Groundwater quality status in the study area, groundwater samples at eight different locations were tested for various parameters and results of the same is presented in **Table -5.10**.

Table -5.10: Groundwater Quality Status in the Study Area

S.No	Parameter	Units	BIS: 10500		GW-1	GW-2	GW-3	GW-4	GW-5	GW-6	GW-7	GW-8
			Desirable Limit	Permissible Limit								
1	pH value @ 25^{0}C	-	6.5 to 8.5	6.5 to 8.5	7.50	7.14	7.81	7.95	7.28	7.40	7.26	7.43
2	Electrical Conductivity at 25^{0}C	µS/cm	1000	2000	620	924.7	1206	1967	712.8	549.8	915.3	1491
3	Turbidity	NTU	---	---	4.3	0.3	1.5	4.5	4.2	0.7	64	0.9
4	Dissolved Oxygen	mg / l	4.0	4.0	6.3	5.9	5.7	5.4	6.2	6.2	5.9	5.7
5	Total dissolved solids (TDS)	mg / l	---	1500	360	538	701	1141	413	319	540	865
6	Total suspended solid (TSS)	mg / l	---	---	<10	<10	<10	<10	<10	<10	<10	<10
7	Total alkalinity (as $CaCO_3$)	mg / l	200	600	140.8	340.6	345.8	75.4	154	169	265.2	257.4
8	Total hardness (as $CaCO_3$)	mg / l	200	600	166	261.36	144.54	25.74	178	142.56	320.76	477.18
9	Sodium (as Na)	mg / l	---	---	29.8	87.7	167.5	242.5	34.6	49.1	31.6	49.3
10	Potassium (as K)	mg / l	---	---	3.42	1.5	2.7	2.3	4.2	11.1	0.5	0.6
11	Magnesium (as Mg)	mg / l	---	---	18.50	25.07	8.19	2.41	19.96	12.05	26.03	29.89
12	Calcium (as Ca)	mg / l	---	---	36	63.36	44.35	6.33	38.4	37.22	85.8	141.76
13	Sulphate (as SO_4)	mg / l	---	400	24.76	9.33	44.95	45.80	37.99	6.78	2.54	55.13
14	Nitrate	mg / l	---	50	< 2	<2	13.79	28.64	< 2	<2	<2	9.18
15	Fluoride (as F)	mg / l	---	1.5	0.34	0.38	0.34	0.58	0.26	0.21	0.28	0.53
16	Chlorides (as Cl)	mg / l	---	600	62.21	35.93	78.67	398.23	56.26	26.22	57.30	170.95
17	Total Nitrogen	mg / l	---	---	1.84	<0.1	15.54	30.34	1.81	1.72	<0.1	11.23
18	Oil and Grease	mg / l	0.1	---	< 4	< 4	<4	< 4	< 4	< 4	< 4	< 4
19	COD	mg / l	---	---	<4	<4	<4	<4	<4	<4	<4	<4
20	BOD	mg / l	---	3.0	<2	<2	<2	<2	<2	<2	<2	<2
21	Free Residual Chlorine	mg / l	---	---	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
22	Total Phosphate	mg / l	---	---	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
23	Arsenic (as As)	mg / l	---	---	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
24	Cadmium (as Cd)	mg / l	---	---	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
25	Total Chromium (as Cr)	mg / l	---	---	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
26	Copper (as Cu)	mg / l	0.05	1.5	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
27	Lead (as Pb)	mg / l	0.01	--	0.017	<0.001	<0.001	0.023	<0.001	<0.001	0.03	0.01
28	Iron (as Fe)	mg / l	---	---	0.29	0.22	0.46	0.34	0.20	0.21	1.86	0.08
29	Manganese (as Mn)	mg / l	0.1	0.3	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
30	Zinc (as Zn)	mg / l	5	15	<0.1	<0.1	0.48	<0.1	<0.1	<0.1	<0.1	<0.1

S.No	Parameter	Units	BIS: 10500		GW-1	GW-2	GW-3	GW-4	GW-5	GW-6	GW-7	GW-8
31	Nickel (as Ni)	mg / l	---	---	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
32	Cobalt (as CO)	mg / l	---	---	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01
33	Total coliform	MPN/100 ml	---	<5000	<2	1600	<2	<2	<2	900	<2	348
34	Faecal Coliform	100 ml	---	---	Absent	Present	Absent	Absent	Absent	Present	Absent	Present
35	E. coli	100 ml	---	---	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent

Note: Primary ground water data collected by M/s. Aarvee Associates, Hyderabad.

Data analysis:

The Groundwater collected from various sources are analysed for physico-chemical and bacteriological parameters. The results are compared with BIS: 10500 Drinking Water Standards. The detail description of sample analysed is given as below:

- Data on physical characteristics indicated variations in pH ranged between 7.14 – 7.95 as against IS standard of 6.5 – 8.5.
- Data on chemical characteristics:
  - The Total Hardness observed to be varying in all samples and is in the range of 142.56 to 477.18 mg/l as against the standard limits of 200 -600 mg/l. All the values are well within the permissible limit 600 mg/l.
  - The Total Dissolved Solids observed to be ranged between 319 mg/l to 1141 mg/l as against the standard of 500-2000 mg/l. All the samples are well within the permissible limit.
  - The chlorides are ranged between 26.22 – 398.23 mg/l, all the samples are well the permissible limit of 1000mg/l.
  - The Nitrates and Sulphates values observed to be low and are ranged between 1.9 – 28.64 mg/l and 2.54 – 55.13 mg/l as against the desirable limit of 45 mg/l and 200 mg/l respectively. All the nitrate samples are well within the desirable limits.

Graphs for Total Hardness & total alkalinity, Flourides and Chlorides, Sulphates & Nitrates are given in Figures 5.19, 5.20 & 5.21

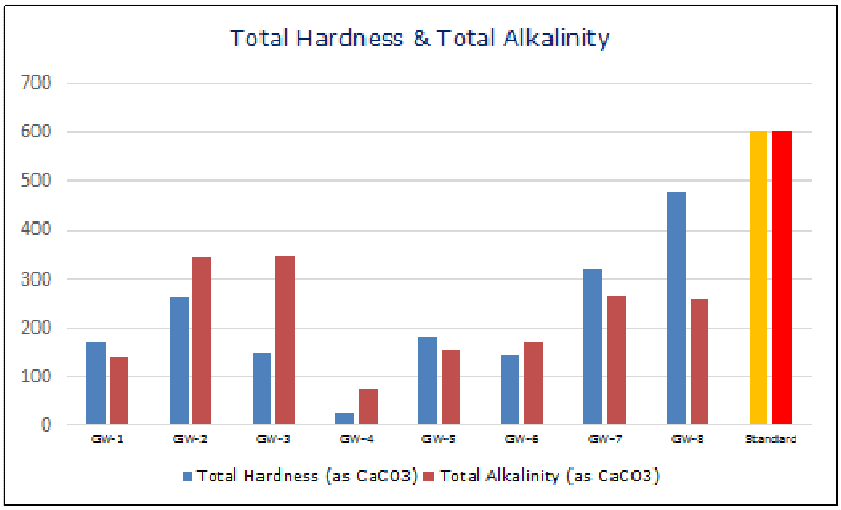


Figure 5.19: Total Hardness & Total Alkalinity

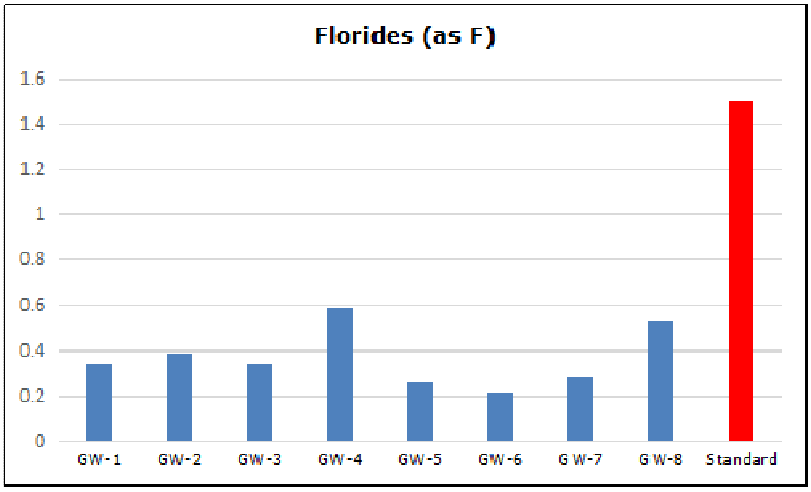


Figure 5.20: Florides (as F)

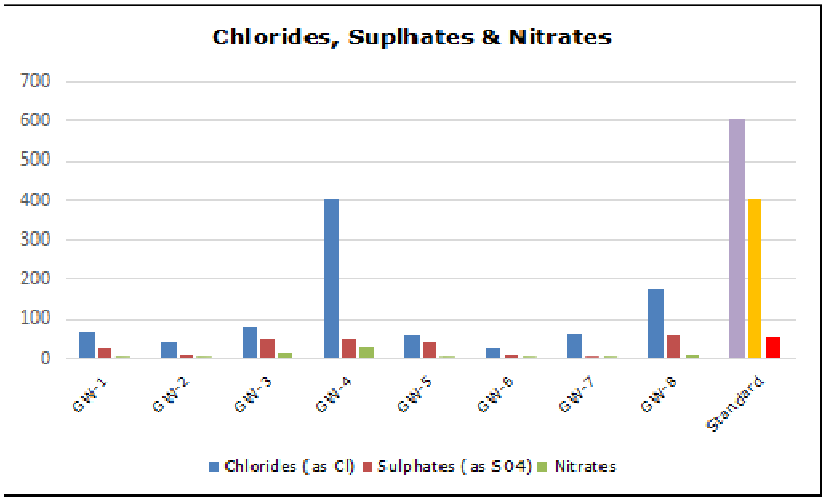


Figure 5.21: Chlorides, Sulphates & Nitrates

5.5 Noise Environment

Noise pollution is caused by an unwanted sound that is produced by various natural or man-made sources such as oceans, construction, industrial, transportation etc. Noise can have any adverse affects such as hearing impairment; sleep disturbance, interference with speech communication, reduced performance, annoyance and harming physiological functions.

Noise pollution is regarded as a public nuisance under Sections 268, 290 and 291 of the Indian Penal Code. There are several other Legislations relating to noise pollution such

as The Factories Act, 1948 (under which 'noise induced hearing loss' is notified as a disease); Motor Vehicles Act, 1988 (which specifies rules for horns and silencers); Law of Torts (civil suits can be filed for claiming damages); The Air (Prevention and Control of Pollution) Act, 1981 (ambient noise standards have been given), The Environment (Protection) Act, 1986; Noise Pollution (Regulation and Control) Rules, 2000 and regulations in respect of Loudspeakers/Public Address System. Further, there are standards and guidelines for ambient noise quality, automobiles, domestic appliances and construction equipment, generator sets, and firecrackers as notified under the Environment (Protection) Act, 1986. In general, continued exposure to noise levels above 85 dB would cause hearing loss over time. However, noise above 140 dB could cause aural damage after just one exposure. As a safeguard against harmful noise level, the CPCB has specified standards (National Ambient Noise Standards) for various categories of areas as given below in Table 5.11.

National Noise Standards:

The Central Pollution Control Board has specified ambient noise levels for different land use for day and night times. Importance was given to the timing of exposure and areas designated as sensitive. The National ambient noise level standards are given below.

Table -5.11: National ambient noise level standards

Area Code	Category	Limits in Decibels (dB(A))	
		Day Time	Night Time
A	Industrial	75	70
B	Commercial	65	55
C	Residential	55	45
D	Silence Zones	50	40

Note:

- Day Time is recorded in between 6 a.m. and 9 p.m.
- Night time is recorded in between 9 p.m. to 6 a.m.
- Silence zone is defined as areas upto 100 meters around such premises as hospitals, educational institutions and courts. The silence zones are to be declared by the Competent Authority. Use of vehicular horns, loudspeakers and bursting of crackers shall be banned in these zones.
- Mixed categories of areas should be declared as one of the four above mentioned categories by the Competent Authority and the corresponding standards shall apply.

Noise level survey conducted along the alignment with an objective to establish the baseline noise levels and assess the impacts of total noise expected due to the proposed metro. Noise monitoring was carried out at twenty (20) representative locations as presented in Table-5.12. The Photographs showing the Noise Monitoring in the study area is shown in Figure- 5.22.

Table -5.12: Details of Noise Quality Monitoring Locations

Station code	Location of Monitoring
NQ01	Junction near Automotive Square
NQ02	Indora Chowk
NQ03	Near Gurudwara Mandir
NQ04	Kasthurchand Park
NQ05	RBI square
NQ06	Munje Chowk
NQ07	Between Congress Nagar to Rahate Chowk
NQ08	Sai baba Mandir
NQ09	Near Proposed Airport Station
NQ10	MIHAN Depot
NQ11	Junction near Prajapathi Nagar
NQ12	Junction near Agrasen chowk
NQ13	Dosar Viasya chowk
NQ14	Masjid Near cable bridge
NQ15	Sitha buildi
NQ16	Near Hadas high school
NQ17	Junction near Sankar Nagar
NQ18	Junction near Ambazari lake
NQ19	Junction near Rachna Ring road
N20	Junction near Hingna Depot

Figure -5.22: Photographs showing the Noise Monitoring near Sitabardi Station locations (N-S Corridor, E-W corridor)

Hourly Noise levels will be recorded at 2 m away from source as per standard practice. Sampling duration to be taken on hourly basis in the time bracket of 08-10, 12-14, 16-18, 20-22 & 24- 02 hours in order to have an assessment of the Day and Night time noise levels. The results of the noise quality obtained are presented below in table 5.13.

Table -5.13: Noise Quality Monitoring Status in the Study Area

Station No.	Location	Category	Leq day dB(A)	Leq Night dB(A)
N-1	Junction near Automotive Square	Commercial	82.6	52.4
N-2	Indora Chowk	Commercial	79.8	54.1
N-3	Sitha bardi	Commercial	84.3	55.6
N-4	Sai baba Mandir	sensitive	75.8	51.8
N-5	Near Proposed Airport Station	Commercial	79.2	48.7
N-6	MIHAN Depot	Commercial	68.7	45.2
N-7	Junction near Prajapathi Nagar	Commercial	81.5	51.6
N-8	Near Gurudwara Mandir	Sensitive	74.4	48.5
N-9	Kasthurchand Park	Commercial	80.2	53.7
N-10	RBI square	Commercial	82.9	54.8
N-11	Munje Chowk	Commercial	75.4	56.8
N-12	Between Congress Nagar to Rahate Chowk	Commercial	78.0	50.8
N-13	Junction near Agrasen chowk	Commercial	80.5	52.2
N-14	Dosar Viasya chowk	Commercial	76.2	49.7
N-15	Masjid Near cable bridge	Commercial	82.9	58.8
N-16	Junction near Sankar Nagar	Commercial	80.8	50.3
N-17	Junction near Ambazari lake	Commercial	68.5	42.5
N-18	Near Hadas High school	Commercial	71.6	45.0
N-19	Junction near Rachna Ring road	Commercial	82.7	52.7
N-20	Junction near Hingna Nagar Depot	Commercial	81.5	54.5

Note: Primary data on noise monitoring was carried out by M/s. Aarvee Associates, Hyderabad.

Data analysis

As is seen from Table -5.13, noise monitoring was carried out twenty locations. Among the monitored locations, all locations are falling under the commercial category except two locations which comes under sensitive category.

Commercial Category:

The locations where ambient noise monitoring was conducted falls under the commercial and sensitive category. The day and night noise levels are observed to be in the range of 68.5 to 84.3 dB (A) & 42.5 to 58.8 dB(A) as against the CPCB Standard of 65 & 55 dB(A) respectively. The day & night noise levels are found to be higher than the stipulated values in almost all locations. At locations near Saibaba Mandir & Gurudwara Mandir which falls under sensitive locations day and night noise levels are observed to be in the range of 74.4 to 75.8 dB (A) & 48.5 to 51.8 dB(A) as against the CPCB Standard of 50 & 40 dB(A) respectively.

5.6 Vibration Studies

The noise of passing train can also induce vibrations, especially if buildings are close to the track. These airborne vibrations occur at higher frequencies than soil-borne vibrations and mostly cause rattling of windows and loose objects in front facing rooms of affected buildings. Building vibrations caused by rail are not only a health and safety concern; they are more a problem of annoyance. Monitoring of Ambient Vibration will be done on the Both sides of all critical turning points as follows:

- X,Y,Z directional vibration will be monitored on the Both sides of all critical turning locations -Floor wise / at ground
- Acceleration/Velocity
- RMS / Peak Value with different reference values (as your requirement) in X,Y,Z directional.
- Prediction of the vibration impact on nearest inhabited areas during construction phase due to piling machinery being used for foundation and existing traffic.
- Prediction of the vibration impact on nearest inhabited areas during operation phase due to movement of the metro vehicle as well as existing traffic.
- The graphical representation of the existing and predicted impacts (Construction & operation phases) shall be presented.
- Suggesting Vibration impact mitigation measures and management plan with budgetary provision.
- Prediction of Vibration during construction stage (Piling etc) as well as operation

stage is carried out and the same is presented in EIA report.

Instrument/software will be used in this study:

Instruments:

- Soundbook- for vibration on building floor wise, Sonogrammes Analysis etc.
- Tri axial Vibration meter (Crystal) - tri directional (X, Y, Z) vibration monitoring.

Software:

- Samurai- for Sonogramme, waterfall, frequency Analysis.
- Nwwin- noise level analysis.

After a preliminary reconnaissance of the study region and taking into account the meteorological (predominant wind directions, wind speed) & topographic conditions, settlement characteristics along the alignment and all critical turning locations in the study region, Twenty two (22) locations are identified for carrying out Ambient Vibration Monitoring in the study area covering different category of buildings viz. residential, commercial/industrial and sensitive zone like Archaeological/ Historical buildings along the metro alignment. The vibration monitoring is done using Tri axial Vibration meter at all the selected locations. The recorded values processed using above mentioned softwares. The details of the monitoring locations is given below in Table-5.14. The Photographs showing the Noise Monitoring in the study area is shown in Figure- 5.23.

Table -5.14: Vibration Monitoring Locations

Station code	Location of Monitoring (N-S Corridor)	Station code	Location of Monitoring (E-W Corridor)
V-01	Durga-Mata Mandir (Towards Automotive)	V-12	H.P town (Shradda) (Commercial)
V-02	Sadodya Appartment, Pulia Chowk	V-13	6,Suryalok Appartment, Veshnodevi Chowk
V-03	Bindra Plaza (Residential)	V-14	257, Residential Building, Ambedkar Chowk
V-04	Gurudwara, Kampi Road	V-15	MAHESHWARI MILLS STORE,Towry Market,Chitar Oli Chowk (Commercial)
V-05	Reserve Bank Of India	V-16	Chanderlok Building
V-06	Kasturchand Park	V-17	Rattan Plaza (Opp. Rly. Station)
V-07	Khullar Chamber, Sitaburdi (Commercial)	V-18	Saraswati Vidhya Mandir (school)
V-08	Hotel Green city (Turning Point)	V-19	World of Titan, Shankar nagar, (Commercial)
V-09	Hyaat Enclave, Congress Nagar (Residential Building near turning point)	V-20	Girls Hostel, Opp. Ambasari Lake (Residential building)
V-10	Bhardwaj Appartment,Oppsite School, Congress Nagar (Residential)	V-21	New Construction, Subhash Nagar (Residential)
V-11	Sai Temple (Towards Khapri)	V-22	Shubham Appartment, Near Rachna Ring Road Metro Station (Residential)

Figure -5.23: Photographs showing the Vibration Monitoring near Sitabuldi & Kasthurchand park

5.6.1 Vibrational levels along the Project Corridor

The project comprises two sections North-South Corridor and East-West Corridor. The total Length of the North-South Corridor is 19.658 Km of which approximately 15.058 is elevated and 4.6 km is at grade. There are 17 stations on this corridor of which 15 stations are elevated and 2 stations are at grade. The East West Corridor stretch is 18.557 km of length and runs between Prajapati nagar and Lokamanya nagar. There are 19 stations on this corridor.

Design Phase Vibrational levels were monitored at selected locations along North-South and East-West Corridors and the result is given in Tables -5.15 and 5.16 respectively.

Table 5.15: Design Phase/ Baseline Vibrational Levels (PPV in inch/sec.) at selected Locations along the North South Corridor

S.No.	Description of Vibration Monitoring/ Sensitive Location		Vibration level (PPV in inch/sec.)
1	Durga-Mata Mandir (Towards Automotive)		0.041
2	Sarvodya Appartment,Pulia Chowk	Ground Floor	0.039
		I Floor	0.035
		II Floor	0.016
		III Floor	0.018
3	Bindra Plaza (Residential)	Ground Floor	0.013
		I Floor	0.012
		II Floor	0.018
		III Floor	0.011
		IV Floor	0.011
4	Gurudwara, Kampi Road	Ground Floor	0.018
		I Floor	0.015
5	Reseve Bank Of India		0.126
6	Kasturchand Park		0.006

S.No.	Description of Vibration Monitoring/ Sensitive Location		Vibration level (PPV in inch/sec.)
7	Khullar Chamber, Sitaburdi (Commercial)	Ground Floor	0.007
		I Floor	0.006
		II Floor	0.005
		III Floor	0.006
		IV Floor	0.004
8	Hotel Green City (Turning Point)	Ground Floor	0.007
		I Floor	0.0068
		II Floor	0.0062
		III Floor	0.006
		IV Floor	0.004
9	Hyaat Enclave, Congress Nagar (Residential Building near turning point)	Ground Floor	0.0069
		I Floor	0.008
		II Floor	0.0068
		III Floor	0.0072
		IV Floor	0.0062
10	Bhardwaj Appartment,Oppsite School,Congress Nagar	Ground Floor	0.0063
		I Floor	0.015
		II Floor	0.0070
		III Floor	0.017
		IV Floor	0.011
11	SAI Temple (Towards Khapri)		0.016

From the above Table, in North - South Corridor the monitored vibration levels are given for existing in inhabitant area. The values are monitored at major locations floor-wise. The values are observed at ground level and are ranging from 0.0060 inch/sec to 0.126

inch/sec as against the national standard of 0.20-0.40 inch/sec. The minimum values are observed at Kasturchand Park, Bharadwaj Apartment (Congress nagar), Hyatt Enclave (congress nagar) and Khullerchand (Sitaburdi) locations. Higher values are observed at RBI, Sai temple (Khapri), Sarvodhaya apartment (Pulia chowk) and Durgamata mandir (near automotive square) locations.

The monitored values at different floors of the locations are gradually reducing or increasing depends upon the material used for the construction and age of the building. However all the monitored values at different floors of the locations are well within stipulated national standards.

Table 5.16: Design Phase/ Baseline Vibrational Levels (PPV in inch/sec.) at selected Locations along the East West Corridor

S.No.	Description of Vibration Monitoring/ Sensitive Location		Vibration level (PPV in inch/sec.)
1	Murli Industries Building (Commercial)	Ground Floor	0.0128
		I Floor	0.017
		II Floor	0.012
		III Floor	0.010
2	6,Suryalok Appartment, Veshnodevi Chowk	Ground Floor	0.012
		I Floor	0.012
		II Floor	0.014
		III Floor	0.00414
		IV Floor	0.0126
3	257, Residential Building, Ambedkar Chowk	Ground Floor	0.016
		I Floor	0.0068
		II Floor	0.015
		III Floor	0.044
		IV Floor	0.004

S.No.	Description of Vibration Monitoring/ Sensitive Location		Vibration level (PPV in inch/sec.)
4	Commercial Building,Towry Market,Chitar Oli Chowk	Ground Floor	0.0125
		I Floor	0.019
		II Floor	0.011
5	Chanderlok Building	Ground Floor	0.125
		I Floor	0.125
		II Floor	0.090
		III Floor	0.039
		IV Floor	0.089
		V Floor	0.041
6	Rattan Plaza (Opp. Rly. Station)	Ground Floor	0.016
		I Floor	0.0818
		II Floor	0.0068
		III Floor	0.0063
7	Saraswati School	Ground Floor	0.015
		I Floor	0.0125
8	Kalinga Arcade, shankar nagar square (Commercial)	Ground Floor	0.012
		I Floor	0.006
		II Floor	0.0069
9	Girls Hostel (Opp. Ambasari Lake)	Ground Floor	0.012
		I Floor	0.016
10	New Construction, Subhash Nagar (Residential)	Ground Floor	0.016
		I Floor	0.012
		II Floor	0.006

S.No.	Description of Vibration Monitoring/ Sensitive Location		Vibration level (PPV in inch/sec.)
		III Floor	0.0068
11	Shubham Appartment,Near Rachna Ring Road Metro Station	Ground Floor	0.015
		I Floor	0.011
		II Floor	0.012
		III Floor	0.012
		IV Floor	0.011

From the above Table, in East-West Corridor the monitored vibration levels are given for existing in inhabitant area. The values are monitored at major locations floor-wise. The values are observed at ground level and are ranging from 0.012 inch/sec to 0.125 inch/sec as against the national standard of 0.20-0.40 inch/sec. The minimum values are observed at Kalinga Arcade (Shankar nagar square), Suryalok apartment (Viashnodevi chowk), Towry market (Chittar Oli chowk), and Girls hostel (Ambazari lake) locations. Higher values are observed at Chanderlok building, Rattan plaza (opp. Railway station), Subhash nagar chowk and Residential building (Ambedkar nagar chowk) locations.

The monitored values at different floors of the locations are gradually reducing or increasing depends upon the material used for the construction and age of the building. However all the monitored values at different floors of the locations are well within stipulated national standards.

In the case of historical building PPV values 2mm/s is the upper level. During piling operations, 28m is the safe distance especially in soils of clayey and sandy.

5.7 Land Environment

Secondary Data (Source: NMRCL DPR,2013)

The soil samples in the study area were analyzed for physico-chemical and parameters during the past studies carried out in the year 2013 as part of NMRCL -DPR. The detail description of samples analyzed are given below:

i) Physical properties

- Results indicate that the clay content is 22% at Automotive Square (SQ1), 29% at New Airport Area (SQ2), 19% in the area between Prajapati Nagar and Vaishno Devi Chawk (SQ3) and 54% in the area between Subhash Nagar & Rachana Ring Road (SQ4). The sand content varies from 34-52% while silt content is varying from 12-39%. The porosity is ranging from 7.4% by mass to 10.5% by mass. Lower values of bulk density varying from 1.17 to 1.24gm/cc. indicate good soil structure.
- Texture of SQ1(Automotive Square) is classified as Sandy Clay Loam, SQ2 as Medium Loam, SQ3 as Sandy Loam and SQ4 as Clayey. The soils varied in moisture content from dry through moist to wet types. Moisture content varies from 3.7% to 31.3%.

ii) Chemical Properties:

- The collected soil samples were analyzed for various chemical properties. The parameters selected were pH, electrical conductivity, Organic Matter, Nitrogen, Exchangeable Potassium, Phosphorus, Sulphate and Sodium. pH is an important factor which indicates the alkaline and acidic nature of soil and gives the idea of nutrient availability, microbial activity and physical condition of the soil.
- The soil in the study area is alkaline in nature as the pH value is varying from 7.75 to 8.58. Conductivity is ranging from 80 to 175µS/cm. The total Nitrogen in the soil samples in the study area varies from 728mg/100g to 1784mg/100g. The substantial amount of the nitrogen in the soils of the study area is contributed by nitrogen fixing bacteria of the genus *Rhizobium* associated with the leguminous plants of the area which constitute an appreciable proportion of the plant species.
- Organic matter is an important soil health indicator as it contributes to the biological, chemical, and physical properties of the soil. Organic matter serves as a reservoir of nutrients and water in the soil, aids in reducing compaction and surface crusting, and increases water infiltration into the soil. The organic matter in the soil samples is ranging from 1.5% to 2.6%. It is also responsible for the stability of soil aggregates.
- The phosphorus concentrations ranged from 33mg/100g to 94mg/100g. The total content of the basic chemicals like K, gives the extent of leaching of the soil where the concentration of exchangeable Potassium varies from 77.1mg/1000g to 251.9mg/1000g.

However to understand the existing conditions of land environment six (06) samples were collected covering the whole study area, to know the Physico-chemical properties of the soil. The activities around the sampling sites are also taken into consideration to understand the sources of pollution if any and all other factors governing the Physico-chemical properties of the soil. Meticulous attention was be paid to collect adequate amount of composite soil samples at three depths for analysis. The samples collected in dependable, waterproof containers marking the samples accurately, distinctly and brought to the laboratory for analysis. The details of the Soil Quality Sampling locations are given below in Table-5.17. The Photographs showing the Soil sampling in the study area is shown in Figure- 5.24.

Table -5.17: Soil Quality Sampling locations details

Station code	Location of Monitoring
S-01	Automotive Square
S-02	Sitabuldi Square
S-03	MIHAN Station
S-04	Prajapathi Nagar
S-05	Near Ambazari Lake
S-06	Lokamanya Nagar

Figure -5.24: Photographs showing the Soil sampling near Prajapathi nagar & subash nagar

The results of soil sampling at the above mentioned monitoring locations are presented below in table 5.20.

Table -5.18: Results of soil monitoring samples

S. No.	Test Parameter	Measurement Unit	S1	S2	S3	S4	S5	S6
Physical Characteristics								
1.	Bulk Density	g/cc	1.14	1.13	1.17	1.13	1.14	1.06
2.	Particle size distribution	-	-	-	-	-	-	-
	Sand	%	10	18	8	13	12	22
	Silt	%	48	45	49	46	47	30
	clay	%	42	37	43	41	41	48
3.	Texture	-	Silty Clay	Silty Clay	Silty Clay	Silty Clay	Silty Clay	Silty Clay
4.	Water Holding Capacity	%	42.18	45.69	48.71	43.17	46.87	48.32
5.	Infiltration Rate	cm/min	20.22	18.62	23.79	21.69	25.07	21.97
Chemical Characteristics (Soil : Water Extract)								
6.	pH	-	7.05 at 25^{0}C	6.20 at 25 ^{0} C	6.10 at 25^{0}C	7.04 at 25^{0}C	7.10 at 25^{0}C	7.87 at 26^{0}C
7.	Electrical Conductivity at 25^{0}C	µS/cm	110.2	48.96	40.33	159.3	132.4	531.4
8.	Ca	mg/kg	237.57	237.45	158.35	237.52	237.55	95.94
9.	Mg	mg/Kg	240.97	96.34	144.55	47.98	144.57	38.77
10.	Na	mg/kg	311.96	77.95	63.96	179.94	529.89	68.81
11.	K	mg/kg	53.99	53.96	45.98	1069.67	23.99	53.81
12.	Chloride	mg/kg	192.78	192.68	192.74	192.74	289.14	57.36
13.	Sulphate	mg/kg	118.72	42.81	59.63	53.81	52.02	120.12
Fertility status (Available)								
14.	N	Kg/Ha	78.16	82.17	96.17	86.18	68.51	87.77
15.	P	Kg/Ha	28.69	26.91	22.81	28.83	21.73	129.86

S. No.	Test Parameter	Measurement Unit	S1	S2	S3	S4	S5	S6
16.	K	mg/kg	53.99	53.96	45.98	1069.67	23.99	53.81
17.	Organic Matter	%	1.68	1.089	1.123	1.169	1.107	3.68
18.	Organic Carbon	%	0.97	0.63	0.65	0.68	0.64	2.14
19.	CEC	meq/100g	15.1	12.9	14.2	0.39	13.8	9.80
Exchangeable Cations								
20.	Na	mg/Kg	218.6	48.91	35.78	115.2	328.62	33.26
21.	K	mg/kg	16.81	21.62	18.97	872.3	18.60	26.11
22.	Ca	mg/kg	110.21	116.42	78.41	117.21	117.10	45.26
23.	Mg	mg/kg	118.22	45.62	70.11	22.07	70.21	17.53
24.	SAR	--	20.16	14.68	5.19	15.06	38.34	14.32
Heavy Metals (Digested Soil)								
25.	As	mg/kg	ND	ND	ND	ND	ND	ND
26.	B	mg/kg	ND	0.03	ND	ND	0.16	0.039
27.	Cd	mg/kg	ND	ND	ND	ND	0.0032	0.0014
28.	Cr	mg/kg	ND	0.092	ND	0.031	0.058	ND
29.	Cu	mg/kg	0.004	0.02	<0.03	0.02	0.044	0.004
30.	Pb	mg/kg	0.13	0.09	0.09	ND	0.033	0.052
31.	Ni	mg/kg	ND	ND	ND	ND	ND	ND
32.	Co	mg/kg	0.03	0.044	0.03	0.024	0.038	0.0085
33.	Fe	mg/kg	3.27	2.07	10.02	3.51	1.11	70.11
34.	Mn	mg/kg	0.03	0.07	0.35	0.052	0.087	1.38
35.	Zn	mg/kg	ND	ND	<0.1	ND	0.027	0.048
36.	Se	mg/kg	ND	ND	ND	ND	ND	ND

Data analysis:

As it can be seen from the above Table -5.20, the soil along the study area is classified as silty- clay in nature. Characterized by pH, the values are in the range of 6.10 – 7.87. If the soil's Electrical Conductivity (EC) falls below 1000 micro Siemens, it is good; the soil can be classified as normal. In analyzed samples EC found to be in the range between 40.33 – 531.4 µS/cm hence, the soil is classified as normal. The Organic Carbon ranged from 0.64% to 2.14%. The available Nitrogen in the soil is 68.51 – 96.17 Kg/ha, found to be average/sufficient requirement for the plantation. The available Phosphorous in the soil is 21.73 – 129.86 Kg/ha, found to be sufficient requirement for the plantation. The available Potassium in the soil is 23.99 – 1069.67 Kg/ha, found to be sufficient.

5.8 Biological Environment

5.8.1 Land use Pattern

The land use/land cover pattern of a region is an outcome of natural and socio – economic factors and their utilization by man in time and space. Hence, information on land use / land cover is essential for the selection, planning and implementation of land use which can be further used to meet the increasing demands for basic human needs and welfare. Land use pattern along both the alignment is generally residential and commercial, with some part of the alignment having plantation, Institutions, water bodies etc. The different categories of land use of the study region are given in the Table 5.19 below:

Table – 5.19: Land Utilization Pattern of the Study District (Km^2)

S. No.	Land Utilization Particulars	Area (sq. km)	Area Percentage (%)
1	Agricultural/ Open Lands	11.34	14.52
2	Built-up Area	38.85	49.75
3	Open Area	7.31	9.36
4	Plantation	8.25	10.56
5	Institute	0.51	0.65
6	Industry	6.79	8.70

S. No.	Land Utilization Particulars	Area (sq. km)	Area Percentage (%)
7	Lake	1.57	2.01
8	Water body	0.42	0.54
9	Canal	0.23	0.29
10	Ground	0.19	0.24
11	Wasteland	2.63	3.37
Total		**78.09**	**100.00**

Source: Agriculture contingency plans of Nagpur, Maharashtra State (2008-09)

Figure -5.25: Land use map for the study area

5.8.2 Forests, Sanctuaries and Bio-spheres

The project site is located in city area and no forests, sanctuaries and bio-spheres present in the study area. The project study area is having mostly urban forestry, urban fauna.

5.8.3 Field Report on Flora in the Study Area

Trees survey has been conducted along the proposed alignment, stations and depot areas. The type of species observed in the project impact area are Subabul, Neem, Gulmohar, Peepal, Coconut Palms, Ashoka, Mango, Karanj etc. As per the information given by the NMRCL, there are about 639 nos., of trees have been falling & need to be cut along the project alignment as well as Depot areas. As per Forest (Conservation) Act, 1980 (amended Rules 2004), Chapter 2.5 (ii), minimum of Two plants are to be planted for every tree cut. However, NMRCL is agreed for more number of plantation ratio of 1:5, i.e., total 5000 trees for 639 nos., or presumed 1000 nos. of trees cut/affected. The tress present in the study area are mostly native in nature and no rare and endangered species identified in the project impact area. The plantation shall be done with same kind of species or appropriate species suitable for the site condition in the ensuing planting season. The photographs showing the trees to be cut during construction phase are given in Figure -5.26.

Figure -5.26: Photographs showing the Floral species along the project stretch

5.8.4 Survey of Fauna of the study area:

A variety of domestic animals can be seen in the study area are i.e., monkeys, buffaloes, cows, sheep, goats, poultry animals and fishes are cultivated in this region.

5.9 Sensitive Receptor

The sensitive receptor such as school, colleges, hospitals, place of worship, monuments/Statue structures etc. within 100 m on either side of proposed NMRCL Project is captured from the primary surveys. The list of the sensitive receptors and location marked on the map is given in this EIA/EMP report. The summary of the sensitive receptors identified along the project corridor are given in Table -5.20. Photographs of Sensitive Receptors along project corridor are shown in Figure-5.27. The sensitive receptors within 100m of East-West corridor and North-South corridor are shown in Figure-5.28 & Figure-5.29 respectively.

Table -5.20: Summary of Identified Sensitive & Other Receptors

S. No	Description of Sensitive areas	Within 100 m on Either side	
		East-West corridor	North-South corridor
1	School, colleges, technical institutes etc.	48	30
2	Hospital	28	15
3	Temple	45	30
4	Mosque/ Darga	5	1
5	Church	0	2
	Total	126	78
S. No	**Description of Other areas**	**Within 100 m on Either side**	
		East-West corridor	**North-South corridor**
1	Others (Industries, water bodies, petrol pumps, recreational places etc.)	43	46
Total		43	46

Source: Primary Surveys carried out by M/s. Aarvee Associates, Hyderabad

Figure -5.27: Photographs showing the Sensitive Receptors along project corridor

Figure-5.28: Sensitive receptors within 100m of East-West corridor

Figure-5.29: Sensitive receptors within 100m of North-South corridor

5.10 Social & Cultural Impact Assessment

5.10.1 Demographic Details

Nagpur located on the eastern parts of Maharashtra is a Municipal Corporation. It is also second capital of Maharashtra. As it is located at the centre of the Indian peninsula far from Bay of Bengal and Arabian Sea, Nagpur has a tropical wet and dry climate with dry conditions prevailing for most of the year.

Nagpur is the main center of commerce for Vidarbha region. The city is important for the banking sector as it hosts the regional office of Reserve Bank of India, which was opened on September 10, 1956. Sitabuldi market in central Nagpur, known as the Heart of the city, is the major commercial market area of city. Nagpur is also emerging as an important industrial town. Butibori Industrial area, which is one of the largest industrial areas is located in Nagpur. This area mainly includes synthetic polyester manufacturing units, Koradi Thermal Power Plant and Khaparkheda Thermal Power Plant. Nagpur is witnessing an economic boom as the "Multi-Modal International Cargo Hub and Airport at Nagpur (MIHAN)" is being developed. MIHAN will be used for handling heavy cargo coming from South-East Asia and the Middle East.

Nagpur City	Total	Male	Female
City Population	**2,405,665**	1,225,405	1,180,260
Literates	**1,984,123**	1,036,097	948,026
Average Literacy (%)	**91.92 %**	94.44 %	89.31 %
Sex ratio	**963/1000**		
Source: Census, 2011			

As of the 2011 census, Nagpur municipality has a population of 2,405,665. The total population constitute, 1,225,405 males and 1,180,260 females. The total children (ages 0–6) are 247,078, of whom 128,290 are boys and 118,788 are girls. Children form 10.27% of total population of Nagpur. The total number of slums number 179,952, in which 859,487 people reside. This is around 35.73%

of the total population of Nagpur. The municipality has a sex ratio of 963 females per 1,000 males and child sex ratio of 926 girls per 1,000 boys. 1,984,123 people are literate, of whom 1,036,097 are male and 948,026 are female. Average literacy rate of Nagpur city are 91.92%. Men are 94.44% and women are 89.31% literate.

The methodology for the study entails the following tasks:

- ✓ Collection and review of project literature and implementation arrangements
- ✓ Rapid reconnaissance survey to familiarize field activities
- ✓ Scoping and other research design
- ✓ Field Survey
- ✓ Consultations with proposed project beneficiary, NGOs and NMRCL Staff
- ✓ Data Analysis and reporting.

Various social research tools have been employed to ensure that, all issues relating to social economic conditions assessment are adequately addressed so that a meaningful objective of impact assessment can be undertaken.

A household survey questionnaire has administered to the sample households of the project beneficiaries in Nagpur city. In addition to the household profile, the comprehensive questionnaire incorporates all relevant questions related to the project impact indicators such as changes in Demographic characteristics, migration pattern, employment, standard of living, water availability, changes in the commercial activities and net income. The sample represented in metro project areas of Nagpur city.

At the minimum the following have been collected during the survey.

- Socio-economic conditions of beneficiary persons
- Family structure and number of family members
- Education levels
- Impacts on family occupation, Socio-economic status
- Perceptions on present transport system and improvement in accessibility after the construction of metro rail

Details of the final SIA Report is given in separate volume.

5.10.2 Project level public consultation:

As part of the study a sample household survey was carried out to find out the Socio-economic conditions of the project area. A randomly household survey was done at veracious locations of Nagpur city and collected the information on socio-economic status and perceptions on metro rail project. The below tables gives the details of socio-economic conditions of the samples families.

- The details of the family pattern of the sample survey, around 69 % families are nuclear type families followed by 19% are joint families 9 % are individual and 3 % are living with extended family culture.
- There are around 93% of the surveyed families belongs to Hindu community 4.76% Muslim and 2.38% belongs to Christian community from the sample house holds. The below tables gives the details of social category of the sample surveyed families, around 59% of the families of belongs of Other Backward Caste (OBC), followed by 26% general, 12 % are Scheduled Caste(SC) and one family belong to Scheduled Tribe.
- To understand the status of living standards in the project area, collected information various socio-economic indicators. One of the indicator is usage of ration card. It is observed only 33 % of the surveyed population have ration cards and remaining households are not availing benefits from public distribution system. From the 64 % of sample families have AAY card followed by 27 % BPL cards, 10% sample households have White ration card and only 2 % have saffron.
- Information on type of house owned by sample population has been collected, around 57 % of the families owned permanent structures followed by 35 % with semi-permanent structure and 5% have kutcha structures with mud wall and thatched roof. 3 households who are residing in the temporary structures are migrated from the various parts of the district for non-farm labour work.

- 88 % families depended for drinking water source is piped water supply by Nagpur Municipal Corporation, 7 % households depended on public stand post and 5 % of the sample holds have own bore well facility for drinking water purpose. The survey also covered the status of drainage system provided by Nagpur Municipal Corporation in the sample household locations,

Around 62 % of the household informed that NMC provided with closed drainage system in their colonies and 38% of the households stated that they have only open drainage system.

- Around 41 % of the sample household has shop keeping is the main source of income, 21% of the families involved in non farm wage labour work, 14 % household involved in private service, 12 % families source of income though professional activities like engineer, lawyers, doctors etc. 10% of the families rendering their services in government sector and only 2% households main source of income is by doing artisan activities. Majority of the households falls under 50000 to 1 lakh category, 33% families income falls under between 2 to 3 lakh category, 16.67 % falls under below 50000 category and families whose income is more than 3 lakhs are around 12%.

As part the study important component covered is local transportation systems are being used by the sample households in the Nagpur city for their daily activities. It is observed that majority (62%) of the households depended on own transportation system by arrangements like, two wheelers & cars. Around 26 % of the surveyed households used public transportation system provided by NMC and 12 % of the households used auto as their local transportation facility. All the surveyed households welcomed the metro rail project and appreciated the alignment which is covering major area of the Nagpur city.

Table 5.21 gives the perceptions on project benefits from the sample survey. The survey results shows that majority of the surveyed population opined multiple benefits from the project. About 57 % of the population expressed that metro rail is more safety than the road transpiration and accidents can be reduced, followed by 52.38 % of the population expected traffic problems will be reduced, 35.7 % informed that both traffic problems and accidents can be reduced, 33 % stated that easy access for local labour than the present local transportation facility, around 36 % are in the opinion of transportation charges will be less when compared with road transportation and 21 % expressed that pollution will be reduced as well as traffic problems. All the families are appreciated the project and requested for on-time completion. No negative impacts observed from the sample household survey. Photographs of Socioeconomic sample survey along project corridor are given in Figure-5.30.

Table-5.21: Perception on project Benefits

Project benefits	%
Traffic problems will be reduced	52.38
Accidents can be reduced and more safety than road transportation	57.14
Air Pollution will be reduced	19.05
Traffic problems and accidents will be reduced	35.71
Easy access for workers	33.33
Transportation charges will be less	35.71

Figure-5.30: Photographs of Socioeconomic sample survey along project corridor

CHAPTER -6
NEGATIVE ENVIRONMENTAL IMPACTS

6.1 General

The primary function of an environmental impact assessment study is to predict and quantify the magnitude of impacts, evaluate and assess the importance of the identified changes and formulate plans to monitor and mitigate the actual changes. Environmental impacts could be positive or negative, direct or indirect, local, regional or global, reversible or irreversible. The process begins by identifying the development and operational activities resulting from the proposed project as contained in Chapter-2 and Chapter-5 is dedicated for providing information on the baseline environmental conditions for various parameters. Attempts have been made to predict the impacts due to proposed project. The pollutants generated due to the proposed project premises during construction and operation phases are solid, liquid and gaseous in nature. This section identifies and appraises the negative impacts on various aspects of the environment likely to result from the proposed development.

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

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

6.2 Impacts due to Project Location

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

- Change of Land use;
- Loss of trees/forest;
- Utility/Drainage Problems,
- Impact on Historical and Cultural Monuments, and
- Impact on Local Transport Facilities

6.2.1 Change of Land Use

Development of proposed Nagpur Metro involves acquisition of land for stations, Depot, TSS, Cut & Cover station and for other facilities. The details of land requirement for different components of the project of East-West and North-South corridors are given in Table 6.1. Acquisition of the private land may cause social disruption and economic loss for the project affected families/people. While implementing the project, there is a need to take into account these disturbances and losses due to the project, their impact on socio-economic condition of the people and plan for their mitigation measures to minimise any negative impacts

Table 6.1: Land Requirement details for Nagpur Metro Rail Project

LAND DETAILS	EAST-WEST CORRIDOR		NORTH-SOUTH CORRIDOR	
	Govt. Land (in sq.m)	Pvt. Land (in sq.m)	Govt. Land (in sq.m)	Pvt. Land (in sq.m)
Stations Exit/Entry	3644.80	7769.40	7525.30	13812.50
Running Section	3255.30	5680.80	101882.00	19025.90
Depot Area	258973.00		339000.00	
Traffic Integration/Parking	8779.10	1465.70	53759.80	5179.20
Total	**274652.20**	**14915.90**	**502167.10**	**38017.60**
Total Govt Land	**776819.30**	**Say 77.68 Hectares**		
Total Pvt Land	**52933.50**	**Say 5.3 Hectares**		

From the data it could be concluded that out of total permanent land requirement, about 93.6% land is to be acquired from Government and 6.4% from Private sector for both corridors. The compensation for land is included in Social Impact Assessment Study Report.

6.2.2 Loss of Trees/Forests

The proposed alignment of metro rail is in urban/ city area and not passing through any forest area. The alignment will mostly pass through mid of the road, stations & Depot areas are mostly identified in urban-barren with sparsely presence of plantation. The Maximum number of trees is getting affected only at stations, Parking lots and at depot location. There are about 639 nos/ presumed 1000 nos. of trees observed along the alignment, stations, depot areas and are proposed to be removed. With removal of these trees, the process of CO_2 absorption and O_2 production will get affected and the losses are reported in Table -6.2. The loss of tree will have short term Heat-Island Phenomenon and would be mitigated after construction due to afforestation.

Table 6.2: Oxygen Deficit due to Tree loss

S. No	Description	Quantity
1	Total no. of Trees to be cut/ affected	1000*
2	Increase in CO_2 @ 21.8 Kg/year/ tree	21800
3	Decrease in Oxygen production @ 49 Kg/year/ tree	49000

* Higher side value of actual trees affected/cut of 639 nos. has taken for estimations.

According to Clean Development Mechanism one tonne of CO_2 decrease will yield one Carbon credit and 0.40 Euros (1Euro = Rs.76.00) is earned by one carbon credit. Increase in CO_2 content will be 21.8 ton per year due to cutting of 1000 trees. About 49,000 kg of Oxygen production will get reduced because of tree loss and loss of Rs. 27.22 lakh (49000 (Kg of O_2) X 55.55 (Rs./Kg of O_2) is anticipated. Five trees will be planted by NMRCL for every tree cut in other suitable location to minimize the pollution load due to tree loss.

6.2.3 Severance of Utilities/Drainage Problems

There will be considerable impact on utility and drainage on the running section area since the proposed metro rail alignment is elevated. Construction of metro station, alignment will affect utilities and drainage of the area. The sub-surface, surface and overhead utility services may be sewer, water mains, storm water drains, telephone cables, electric lines, etc. These utilities services are essential

and have to be maintained in working order during different stages of construction by temporary/permanent diversions or by supporting in position. Since these affect construction and project implementation time schedule/ costs for which necessary planning/ action needs to be initiated in advance.

6.2.4 Impact on Historical and Cultural Monuments

- ✓ The proposed metro rail project will affect residential and commercial structures near to some of the proposed metro stations where construction will be made by cut and cover method whereas no Archaeological Monuments are likely to be affected. Some of the historical structures are close to the proposed metro alignment and due to unavoidable circumstances, NMRCL is proposing ramps in Kasturchand Park open area of 408.45 sq.m. In this regards, NMRCL conducted series of meetings with Kasturchand Park heritage conservation committee and obtained the NoC on 18th August, 2016. Utmost care will be taken so that no significant impact is anticipated on the historical structures due to project activities during construction and operation.

6.2.5 Impact on Local Transport Facilities

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

6.3 Impacts due to Project Design

Considered impacts, due to project designs are:

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

6.3.1 Platform inlets and outlets

In the elevated section, stations are also being planned with side platforms to avoid the viaduct structure from flaring in and out at stations, which obstructs the road traffic below. Care has been taken to locate stations on straight alignment. However, in some stations site, constraints have become the deciding criteria and a curve of 1000 meter radius has been introduced.

The platform level has adequate assembly space for passengers for both normal operating conditions and a recognized abnormal scenario. The platform level at elevated stations is determined by a critical clearance of 5.5m under the concourse above the road intersection, allowing 3.5m for the concourse height, about 1m for concourse floor and 2.2m for structure of tracks above the concourse. Further, the platforms are 1.09m above the tracks. This would make the rail level in an elevated situation at least 13.4m above ground.

Lifts will be provided one each on either platform, to provide access for elderly and disabled. These stairs and escalator together provide an escape capacity adequate to evacuate maximum accumulated passengers in emergency from platforms to concourse in 5.5 minutes.

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

6.3.2 Metro Station Refuse

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

- Garbage,
- Rubbish, and
- Floor Sweepings.

As per the available data from Delhi Metro Phase I and II, the solid waste generation is about 0.5-1.0 cum/day at stations. Thus about 36 Cum of solid

waste will be generated from all metro stations of NMRCL per day. The maintenance of adequate sanitary facilities for temporarily storing refuse on the premises is considered as a responsibility of the NMRCL project authorities. The storage containers for this purpose need to be designed. However, it is suggested that the capacity of these containers should not exceed 50 litres and should be equipped with side handles to facilitate handling. To avoid odour and the accumulation of fly-supporting materials, garbage containers should be washed at frequent intervals.

6.3.3 Risk Due to Earthquake

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

6.4 Impacts Due to Project Construction

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

- Soil erosion,
- Traffic management and Risk to existing buildings
- Muck disposal,
- Dust Generation,
- Increased water demand,
- Impact due to workers camp
- Loss of Archaeological, Historical and Cultural Monuments,
- Impact on Ground and Surface Water,
- Air Pollution,
- Noise Pollution,
- Impact due to Vibration,
- Health risk at construction site,
- Tree plantation
- Impact of proposed road improvement works
- Impact on sensitive receptors

6.4.1 Soil erosion

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

6.4.2 Traffic management and Risk to existing buildings

The objective of safety standards is to provide safe travel to the drivers of vehicles plying on the Project Highway at all times of the day, throughout the year and provide protection to the Project workers when they are on the work. The overall traffic management plan is to design and specify adequate safety measures in advance against identified hazards and stipulated implementation of the said safety measures to ensure safe movement of traffic during the construction and operation operation of metro rail.

Traffic Management plan should be prepared for each construction stretch/ segment well before the commencement of construction, the Management plan should assess & present the following as per specified codes/ guidelines and practices.

- Baseline Traffic characteristics in that stretch
- Analysis of present road stretch capacity and level of service
- Proposal for Traffic management plan
- Construction Zone
- Signs
- Traffic Management Practices
- Traffic Control Devices
- Safety of project workmen at site

Advance traffic updates/information on communication systems will be an advantage to users of affected roads. The rail corridor does not pose any serious risk to existing buildings. Still it will be appropriate to carry out stability and ground settlement analysis for proceeding further during construction.

6.4.3 Spoil/Muck Disposal

The major sources of spoil/ muck in NMRCL Project are excess earth from excavation foundations for piers, clearances near parking locations, stations, depot areas and construction demolition waste of the buildings etc. Reach wise spoil / muck generation during construction phase of the project is given in Table -6.3.

Table -6.3: Reach wise Spoil/ Muck generation during construction phase

S. No	Activity	Spoil /Muck Generation (m^3)				Total (m^3)
		North-south corridor		East-west corridor		
		Reach 1	Reach 2	Reach 3	Reach 4	
1	During foundation & piers Construction	60000	60000	60000	60000	240000
2	During construction of stations	831	582	618	557	2588
3	At Parking locations	4863	3404	1076	968	10311
4	At Depot locations	67800	-	51800	-	119600
5	Structures demolition waste for Metro-line & stations construction	6527	3568	7867	6094	24056
	Total *(including construction material waste)*	140021	67554	121361	67619	3,96,555 (m^3)

The major share of spoil/ muck estimated in the project is from excavation of the foundations of the piers is 2.40 Lakh Cum and Depots are generating 1.19 Lakh Cum. The construction & demolition waste is also considerable in the project which is estimated to be 0.24 Lakh Cum and others estimated to be 0.126 Lakh Cum. Overall spoil/ muck generation estimated in the project is 3.96 Lakh Cum.

The Contractor has identified the barren private land of 4.05 ha near Jamtha for excavated soil disposal and the agreement has been made with the owner. The land is located near Jamtha area, Nagpur which is about 2.0 km away from the Jamtha casting yard. All necessary precautions will be undertaken by contractor to ensure proper dumping within the identified area. No hazardous/chemicals is

being used during piling operation and hence no ground contamination is anticipated. If required water quality within the area will be tested for any contamination.

6.4.4 Dust Generation

Protective measures shall be undertaken during construction phase for transportation of earth and establishment of the material due to use of heavy machinery like compactors, rollers, water tankers, and dumpers. This activity is machinery intensive resulting in dust generation. However, this activity will be only short-term. The total 0.396 Mm^3 of muck has to be transported through trucks. The truck movement required for transporting the muck/ earth will be about 15 truck trips per day for the entire length. On an average a truck is anticipated to move about 10 km per trip. Hence total distance traveled would be 150 km per day. Provision shall be made to carry the muck generated during night time so that traffic is not disturbed. Being the good road condition in Nagpur, the dust generation due to transportation of muck will be insignificant. However, sprinkling of water will be made in the construction areas throughout the construction period.

6.4.5 Increased water demand

The water demand will increase during construction phase. Sufficient water for construction purpose will be made available by digging borehole/borewell within the vicinity of the project site during the construction phase. Hence, proper care shall be taken while deciding the location of these activities or drawing water from public facilities. Appropriate permissions from the Groundwater Department shall be taken for the project.

6.4.6 Impact due to Workers camp

About 1200 persons are likely to work during peak construction activity for one reach. The skilled workers associated with Pile installation and fabrication work are supposed to stay at workers camp while the local workers will be employed for other associated work like earthwork and concreting. About 200 skilled workers will stay at workers camp. The semiskilled/skilled workers expected to be working in the project are 200 nos. Considering that 80% of them are married, in 80% of married families both husband and wife will be working and taking

average family size as 4, total workforce in the workers camps will be about 640. The workers camps can be installed at suitable location in each reach. The details of the water requirement, wastewater generation and municipal solid waste generation is given Table-6.4

Table 6.4: Details of the water requirement/wastewater & solid waste generation in Workers Camp of each Reach

S.No.	Description	Details	References /Remarks.
1	Water Supply	640x70 lit/day =44.80 KLD	Recommended water supply as per CPHEEO – Status of the Water Supply, Sanitation and Solidwaste Management in Urban Areas for urban areas provided with piped water without sewerage system (Clause -2.4.1)
2	Wastewater Generation	80% of the water supply =35.84 KLD	Recommended sewerage as per CPHEEO – Status of the Water Supply, Sanitation and Solidwaste Management in Urban Areas (Clause -3.3.1)
3	Solid Waste Generation	640x0.45 Kg/day =288 Kgs/day	Recommended solid waste as per CPHEEO – Status of the Water Supply, Sanitation and Solidwaste Management in Urban Areas (Clause -4.3.4)
4	Wastewater Treatment	Bio-digesters to be provided	Since the NMRCL has alreaday made MoU with DRDE lab under the umbrella of DRDO on installation bio-digesters, contractor or concessionnaire may also adopt the same in their premises.

Water requirement at camp in the reach where construction is happening will be around 44.80 KLD, from which wastewater generation will be around 35.84 KLD & Municipal solid waste generation will be 288 Kg per day. The workers camp shall be provided with the Bio-digesters size of 100 KLD.

Construction workers are more prone to infectious diseases like HIV/AIDS due to migration and lack of education. The three main transmission routes of HIV are sexual contact, exposure to infected body fluids or tissues and from mother to foetus or child during prenatal period. Training and awareness programme will be conducted during construction to avoid the spread of infected diseases and maintain good sanitation in workers camp. After construction, operation of metro will not have significant impact on spreading of infectious diseases. An amount of Rs. 19.2 Lakh is provided for Bio-digesters in workers camp of each reach. An amount of Rs. 40 Lakh is allotted for setting up health and other services at workers camp.

6.4.7 Loss of Archaeological, Historical and Cultural Monuments

There are 3 archaeological/historical sites present in the corridor such as Kasturchand Park, Zero mile and British library. No Archaeological, Historical & Cultural monuments will be lost or affected during construction. Some of the historical structures are close to the proposed metro alignment. NMRCL is proposing ramps in Kasturchand Park open area of 408.45 sq.m. In this regards, NMRCL conducted series of meetings with Kasturchand Park heritage conservation committee and the committee and got NOC from them dated on 18th August 2016. Utmost care needs be taken so that no significant impact is anticipated on the historical structures due to project activities during construction and operation. Area acquired by NMRCL is shown in the Figure -6.1b.

Figure -6.1: Area acquired by NMRCL in Kasthurchand Park

6.4.8 Impact on Ground and Surface Water

There are several natural water bodies within the city limits including 12 lakes, two rivers and five nallahs. The lakes (Gorewada, Futala, Ambazari, Sonegaon, Sakkardara, Gandhisagar, Lendi Talao, Naik Talao, Dob Talao, Pandrabodi, Sanjay Nagar Khadan and Pardi) cover an area of about 3.13 sq. km.. The Nag and Pili Rivers cut across the city and are 15.73 km. and 12.11km. in length, respectively. Besides these, Chamar Nallah, Shakti Nagar Nallah, Hudkeshwar Nallah, Swawalabmi Nagar Nallah and Sahakar Nagar Nallah also flow through the city.

Construction activities may have an adverse impact on water bodies due to disposal of waste. The waste could be due to: the spillage of construction materials, dumping of used water from the stone crusher, oils and greases and waste from workers camp. But the quantities of such spills are very negligible. However, care needs to be taken to provide adequate sanitary facilities and drainage in the temporary colonies of the construction workers. Provision of adequate washing and toilet facilities (Bio-digesters) and appropriate refuse collection and disposal system should be made obligatory. Contamination of ground water can take place, if the dump containing above substances gets leached and percolates into the ground water table. This is not the case with the present project, as the activity does not involve usage of any harmful ingredients. Moreover, activities are of short duration. Hence, no adverse impact on either ground or surface water quality is anticipated in the present project.

The debris, solid waste, waste-water from campsites etc generated from the project shall not be disposed/ discharged close to the identified rivers, lakes, ponds, nallahs etc present in the core study area of 500m. The details of the same are given in Table -6.5.

Table -6.5: Details of the Rivers, Lakes/Ponds, Nallahs etc., in Core Study Area

S.No	Chainage	Side	Name Of The Water Body
North-South Corridor			
1	2750.00 to 2775.00	right/left	Nallah
2	6800.00 to 7250.00	Left	Nallah
3	8450.00 to 8900.00	Left	Pond
4	9350.00 to 9925.00	Left	Drain
5	10000.00 to 10250.00	Left to right	Nallah
6	10925.00 to 10950.00	Both	Nallah
7	13125.00 to 13150.00	Both Side	Nallah
8	15600.00 to 15650.00	Left	Nallah
9	16275.00 to 16325.00	Both Side	Nallah
10	17675.00 to 17700.00	both	Nallah
11	19075.00 to 19100.00	Right	Drain

S.No	Chainage	Side	Name Of The Water Body
12	20210.00 to 20400.00		Nallah
East-West Corridor			
1	5950.00 to 5975.00	Right	Nallah
2	6400.00 to 6425.00	Left	Nallah
3	9800.00 to 10200.00	Left	Nag River
4	11750.00 to 12750.00	Right	Ambazari Lake
5	12075.00 to 12200	Left	Nallah
6	12200 to 12275.00	Left	Nalah
7	15200	Right	Drain
8	16100.00 to 16350.00	Right	Nalla
9	16600.00 to 16625.00	Left	Nalah
10	17300.00 to 17350.00	Left	Nallah
11	17500	both	nalah
12	17550.00 to 17575.00	Right	Nallah
13	18225.00 to 18500	Right	Nallah

The photographs showing the river, lake/ponds, nallahs present in the project impact area is given in Figure -6.2.

Figure -6.2: Photographs showing the Streams abutting the RoW

6.4.9 Air Pollution

Potential impacts on existing air quality during the construction phase would be due to dust generated during excavation, earth work, vehicles movement, loading and unloading of the construction materials.

Fugitive emissions generated due to vehicular movement are not expected to travel beyond a distance of 50 to 100 m from the point of their origin. Since, the proposed NMRCL project is proposed in the middle of the existing road, the habitation is present within 20 to 30m from the centre line of the road. The impact on air environment during the construction phase is temporary and localized in nature. However, sprinkling of water will be made in the construction areas throughout the construction period.

6.4.10 Noise Pollution

During the construction phase, noise will be generated due to movement of vehicles, and operation of light & heavy construction machinery including pneumatic tools (dozers, tippers, loaders, excavators, graders, roller, concrete mixer, generators, concreting pumps, vibrators, cranes, compressors, etc). The construction activities are expected to produce noise levels in the range of 80-100 dB (A) at a distance of 50 feet from the source, which is the likely inhabitants area of the study region. Similarly, the construction activities are expected to produce noise levels in the range of 60.0 – 80.0 dB(A) at 150 feet distance.

Mitigation Measures:

- ✓ Construction of noise barriers, such as temporary walls or piles of excavated material, between noisy activities and identified noise sensitive receptors of 172 nos. (East – West Corridor: 126 and North-south corridor: 78 nos.)
- ✓ Construct walled enclosures around cluster of noisy equipment activities. For example, shields can be used around pavement breakers and loaded vinyl curtains can be draped under elevated structures.
- ✓ Re-routing of the truck traffic away from the residential streets as much as possible in co-ordination with the traffic police, Nagpur City.

The construction works will be carried out during the day time near residential areas. The impact of noise produced during the construction will, however, be limited to a distance of about 75 meters at which the noise level of various equipment will come down below 55 dB(A). It could therefore be concluded that the construction activities would not have a significant impact on existing ambient noise levels. People working at noisy areas may be affected (if they do not use ear muffs/plugs), if actual exposures exceeds the prescribed safety limits (8-hour long limit of 90 dB (A)) as per Factories Act / BOCW Act 1996. The overall noise during construction will be for short-term.

6.4.11 Impact due to Vibration

Construction activities can result in varying degrees of ground vibration, depending on the equipment and methods employed. Ground vibrations from construction activities do not often reach the levels that can damage structures, but they can achieve the audible and feeble ranges in buildings very close to the site. The construction activities that typically generate the vibrations are blasting and piling. There are 22 locations in the project, where vibration impact has been predicted using appropriate Logarithm Formulae as given in Federal Transit Administration Manual, 2006.

The existing frequency is varying with time because of passage of different type of vehicles. Overall the average frequency considered for this project is in the range 8-25 Hz. Continuous effect of vibration on the buildings can cause damage to the buildings. Building subjected to the vibration effect with more than 10 mm/s would receive structural damage. Historic buildings are more susceptible to vibration effect with more than 5 mm/s.

Old structures generally lose structure strength over the period. Therefore, it is more important to study the effect of vibration on the historic buildings especially the structures that comes under heritage category. As per the permissible vibration value for India it is 5 mm/s for Objects of historical importance and sensitive structures and 10 mm/s for Domestic houses/ structures (Kuchcha, bricks and Cement) is given in Table -6.6.

Table -6.6: Permissible limits of Ground Vibration in India

Type of Structures	Dominant Excitation Frequency (Hz)		
	<8 Hz	8-25 Hz	>25 Hz
A) Buildings/ Structures not belong to the Owner			
1. Domestic houses/ structures (Kuchcha, bricks and Cement)	5 mm/s or 0.20 inch/s	10 mm/s or 0.40 inch/s	15 mm/s or 0.60 inch/s
2. Industrial building	10 mm/s or 0.40 inch/s	20 mm/s or 0.79 inch/s	25 mm/s or 0.98 inch/s
3. Objects of historical importance and sensitive structures	2 mm/s or 0.08 inch/s	5 mm/s or 0.20 inch/s	10 mm/s or 0.40 inch/s
B) Buildings belonging to the Owner with limited life span			
1.Domestic houses/ structures	10 mm/s or 0.40 inch/s	15 mm/s or 0.60 inch/s	20 mm/s or 0.79 inch/s
2. Industrial buildings	15 mm/s or 0.60 inch/s	25 mm/s or 0.98 inch/s	50 mm/s or 1.97 inch/s

Source: Director of Mines,Govt. of India

Construction activities have the potential to produce vibration levels that may be annoying or disturbing to humans living nearby. The ground borne vibration impacts may be somewhat perceptible to people who are outdoors, it is almost never annoying and does not cause a strong adverse human reaction. In the case of predicted construction phase human perceptible vibrational noise levels are in the range 72 to 92 VdB for N-S Corridor and 78 to 80 VdB for E-W Corridor which are slightly exceeding the prescribed vibrational velocity levels as per Table -6.7.

Table -6.7: Vibration Criteria for different Building Usage

Building Use	Vibration Velocity level (VdB)	Vibration Velocity (rms amplitude in inch/sec)
Workshop	90	0.030
Office	84	0.016
Residence	78 day/ 75 night	0.008
Hospital	72	0.004

Source: ISO 2631-II Vibration Criteria

The predicted vibration levels during construction phase for N-S & E-W Corridors are given Table -6.8 & 6.9 respectively.

Table -6.8: Vibration Levels in mm/sec during Construction Phase at selected Locations along the North - South Corridor

Location code	Location (description)	Distance from PCR (feet)	Predicted Vibration Value		Distance From PCR						
			in/sec	mm/sec	Reference Value (25')	75'	125'	175'	225'	275'	325'
V1	Durga-Mata Mandir (Towards Automotive)	18.3	0.04	1.0	0.6	0.1	0.1	0.0	0.0	0.0	0.0
V2	Sadodya Appartment,Pulia Chowk	49.9	0.3	7.6	21.5	4.1	1.9	1.2	0.8	0.6	0.5
V3	Bindra Plaza (Residential)	63.7	0.24	6.1	24.8	4.8	2.2	1.3	0.9	0.7	0.5
V4	Gurudwara, Kampi Road	52.8	0.25	6.4	19.5	3.8	1.7	1.1	0.7	0.5	0.4
V5	Reserve Bank of India	85.6	0.23	5.8	37.0	7.1	3.3	2.0	1.4	1.0	0.8
V6	Kasturchand Park	40	0.2	5.1	10.3	2.0	0.9	0.6	0.4	0.3	0.2
V7	Khullar Chamber, Sitaburdi (Commercial)	40.4	0.4	10.2	20.9	4.0	1.9	1.1	0.8	0.6	0.4
V8	Hotel Green City (Turning Point)	49.2	0.23	5.8	16.1	3.1	1.4	0.9	0.6	0.4	0.3
V9	Hyaat Enclave, Congress Nagar (Residential Building near turning point)	41	0.18	4.6	9.6	1.8	0.9	0.5	0.4	0.3	0.2
V10	Bhardwaj Appartment,Oppsite School,Congress Nagar	45.3	0.3	7.6	18.6	3.6	1.7	1.0	0.7	0.5	0.4
V11	Sai Temple (towards Khapri)	50.9	0.19	4.8	14.0	2.7	1.3	0.8	0.5	0.4	0.3

Source: Assessed by Aarvee Associates according to FTA (Chapter 6).
Note: All the predicted values are expressed in mm/sec.

In North - South Corridor the predicted vibration levels are given for existing in inhabitant area, reference distance at 25' and other varying distances of 75', 125',175'225' 275'and 325'. The predicted values for the existing scenario is

ranging from 1.0 to 10.2 mm/sec as against the standard of 5-10mm/sec. The vibration values predicted other distances are gradually reducing and well below the standards. However, an adequate mitigation measures are suggested to further mitigate the vibration levels during construction phase of the project.

Location wise analysis and vibrational level contours for all the stations of N-S Corridor are given below:

Durga Matha Mandir (V1): This location falls towards Left hand side of the North South Corridor. The Madir is located 18.3' away from the corridor at ch:1125.000. The monitored vibrational value at this location is 1.0 mm/sec. As the location is very close to the project alignment and is of religious importance, necessary care should be taken during construction and operational phases of the project. The vibrational contour map is given in Figure -6.3.

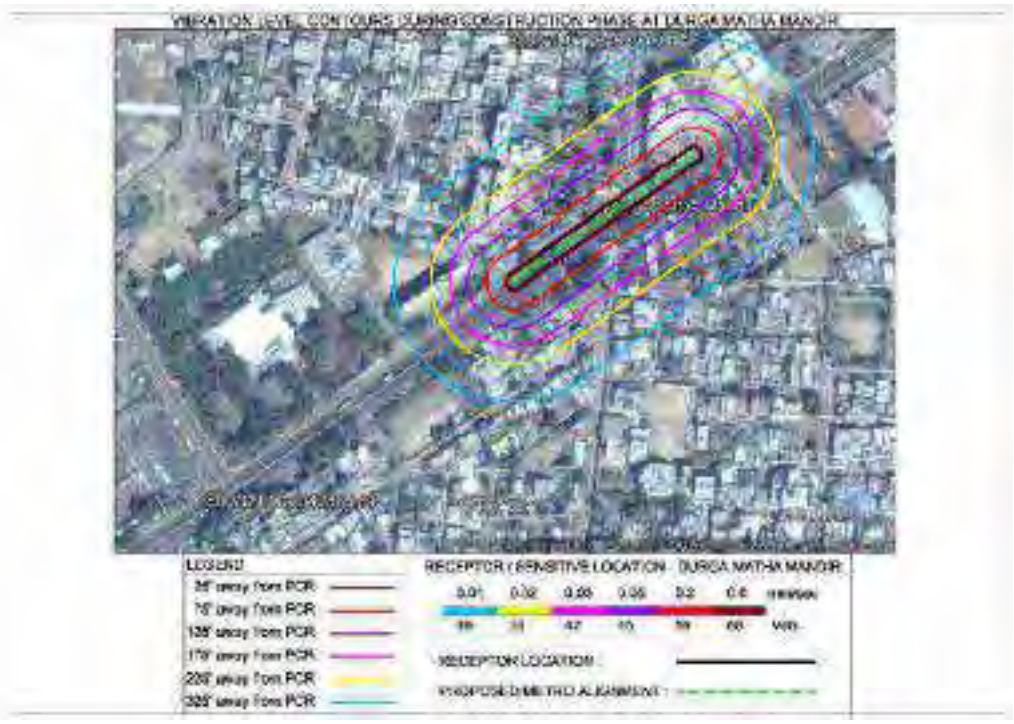


Figure -6.3: Vibration level Contours during construction phase at Durga Matha Mandir

Sarvodaya Apartments (V2): This location falls towards Left hand side of the North South Corridor. The Apartments are meant for residential purpose and are located 49.9' away from the corridor at ch:2525.000. The monitored vibrational value at this location is 7.6 mm/sec. As the location is close to the project alignment, necessary care should be taken during construction and operational phases of the project.

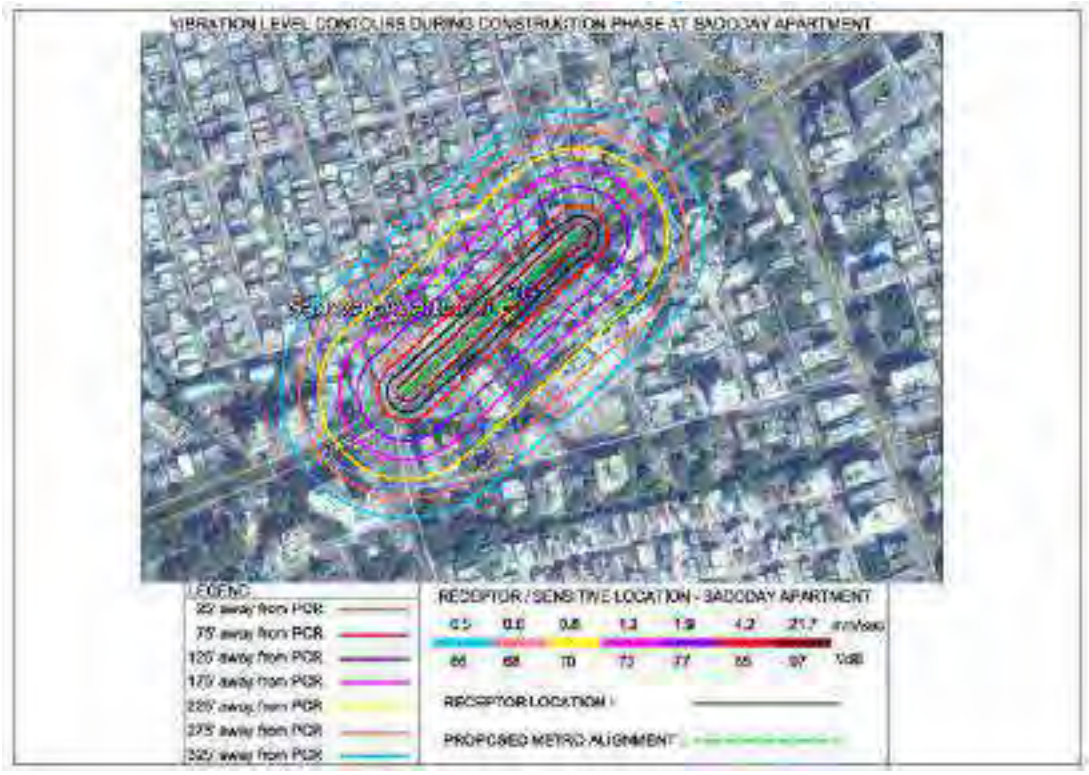


Figure -6.4: Vibration level Contours during construction phase at Sarvodaya Apartments

Bindra Plaza (V3): This location falls towards Right hand side of the North South Corridor. The plaza is used for residential purpose which is situated 63.7' away from the NS corridor at ch:3250.000. The monitored vibrational value at this location is 6.1 mm/sec. As the location is very close to the project alignment, necessary care should be taken during construction and operational phases of the project.

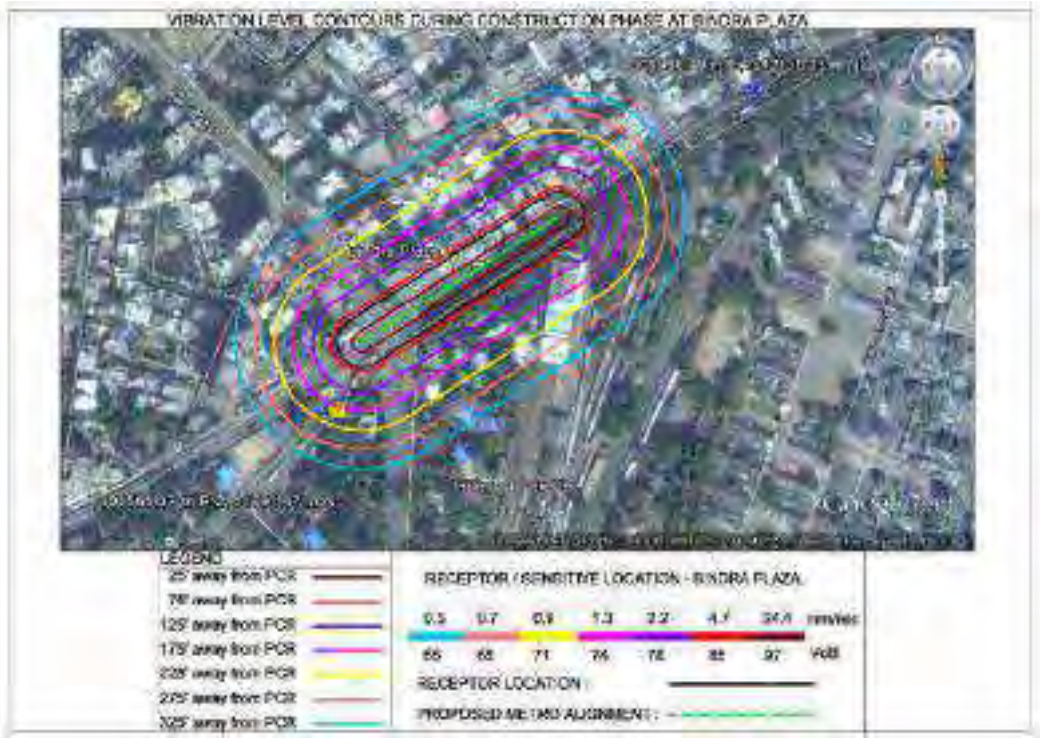


Figure -6.5: Vibration level Contours during construction phase at Bindra Plaza

Gurudwara (V4): This location falls towards Right hand side of the North South Corridor. The Madir is located 52.8' away from the corridor at ch:3950.000. The monitored vibrational value at this location is 6.4 mm/sec. As the location belongs to religious importance, hence it falls under environmental sensitive location, necessary care should be taken during construction and operational phases of the project.

Figure -6.6: Vibration level Contours during construction phase at Gurudwara

Reserve Bank of India (V5): This location falls towards Right hand side of the North South Corridor. It is an historically important and old building structure which is situated 85.6' away from the corridor at ch:5325.000. The monitored vibrational value at this location is 5.8 mm/sec which shows relatively higher when compared with the values at other locations. As the location falls under category of old structure/ building, stringent precautionary measures to be taken during construction and operational phases of the project.

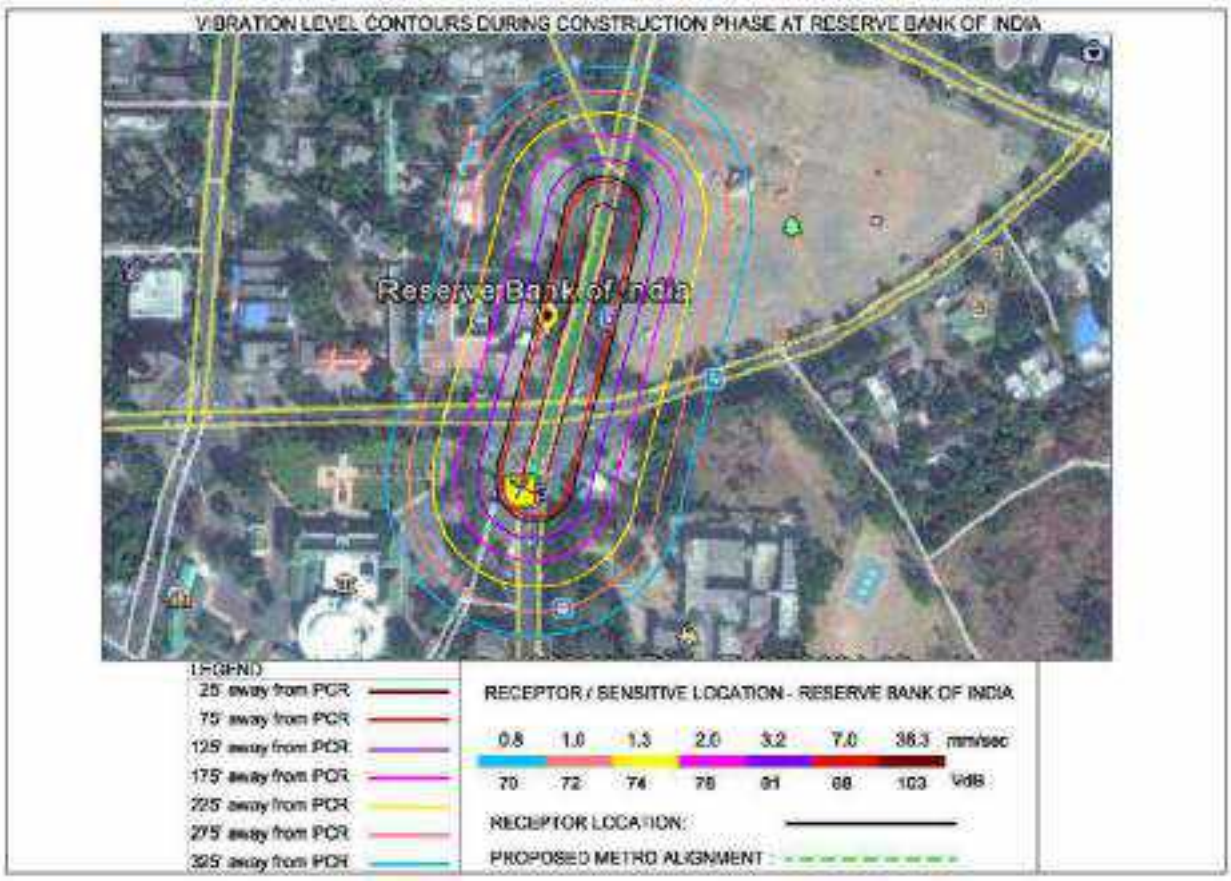


Figure -6.7: Vibration level Contours during construction phase at Reserve Bank of India

Kasturchand Park (V6): This location falls towards Right hand side of the North South Corridor. The park is located 40.0' away from the corridor at ch:5100.000 to 5350.000. The monitored vibrational value at this location is 5.1 mm/sec. The park comprises an Archeological important structure which falls under environmental sensitive category. Hence Rigorous precautionary measures to be adopted during construction and operational phases of the project.

Figure -6.8: Vibration level Contours during construction phase at Kasturchand Park

Khullar Chamber (V7): This location falls towards Right hand side of the North South Corridor. The chamber is located 40.4' away from the corridor at ch:6675.000 to 6700.000. The monitored vibrational value at this location is 102 mm/sec. The chamber is located in densely populated urban area, hence many people will be get affected. Rigorous precautionary measures to be adopted during construction and operational phases of the project.

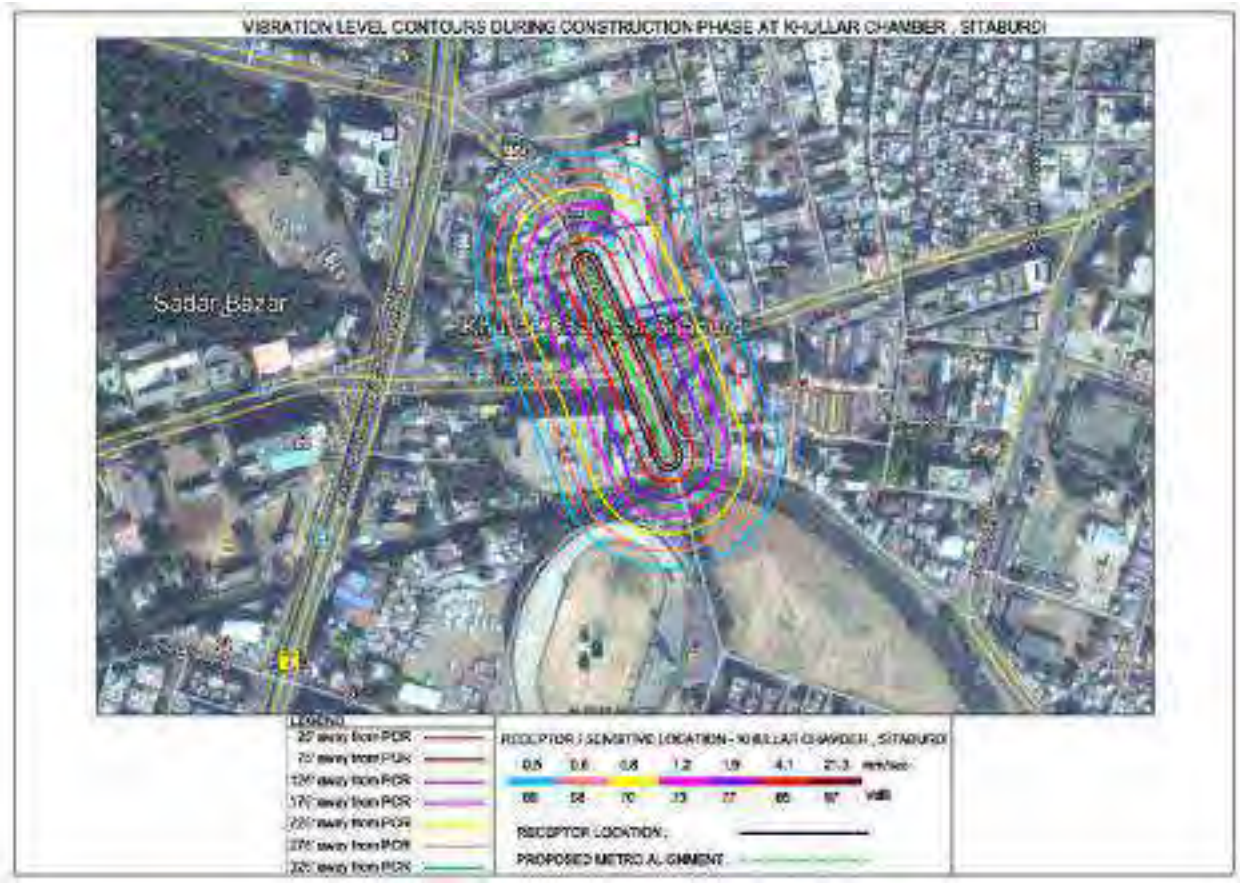


Figure -6.9: Vibration level Contours during construction phase at Khullar Chamber

Hotel Green City (V8): This location falls towards Right hand side of the North South Corridor. The hotel is located 49.2' away from the corridor at ch:7350.000 to 7375.000. The monitored vibrational value at this location is 5.8 mm/sec. The hotel is located in thickly populated area in the city. Rigorous precautionary measures to be adopted during construction and operational phases of the project.

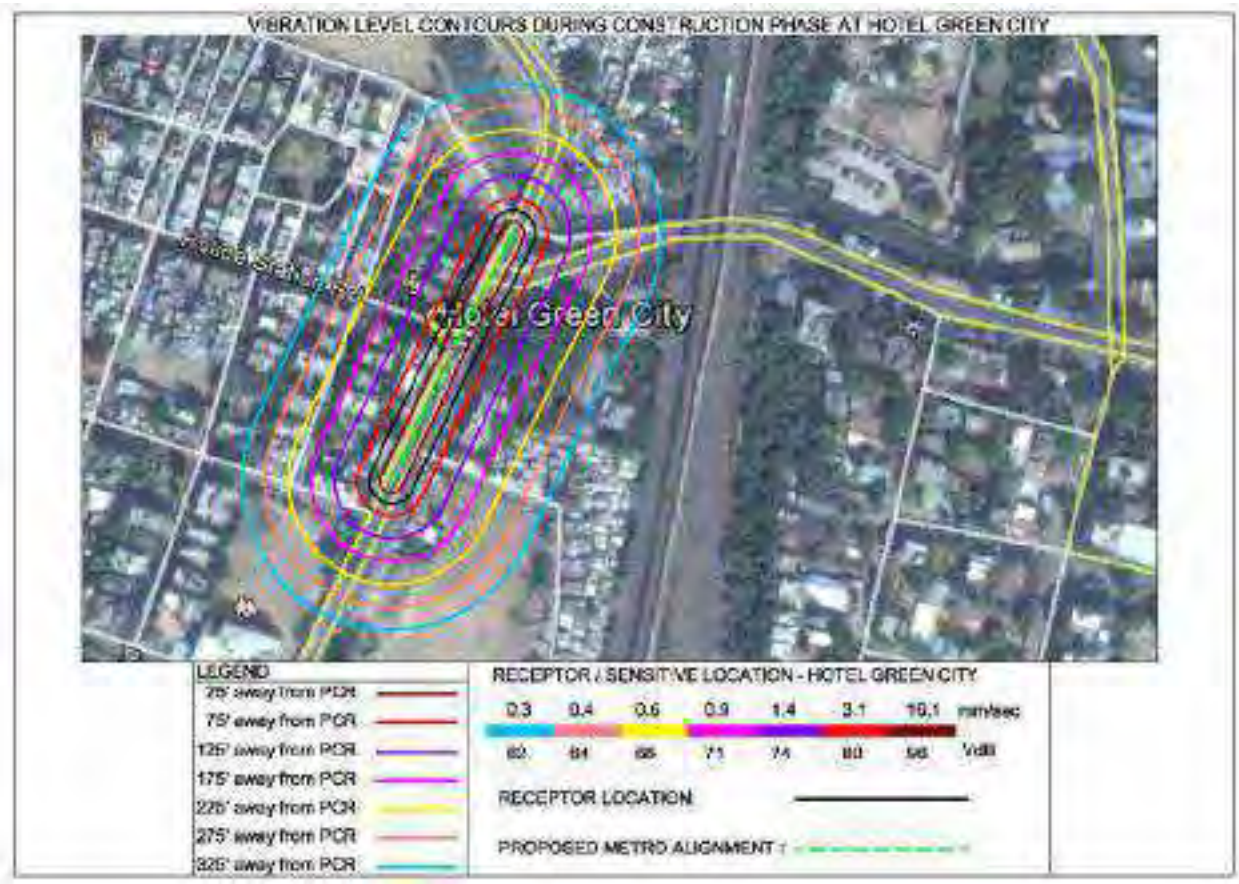


Figure -6.10: Vibration level Contours during construction phase at Hotel Green City

Hyaat Enclave (V9): This location falls towards Right hand side of the North South Corridor. The enclave is located 41.0' away from the corridor at ch:7625.000. The building is used for residential purpose. The monitored vibrational value at this location is 4.6 mm/sec. The building is located in thickly populated area in the city. Rigorous precautionary measures to be adopted during construction and operational phases of the project.

Figure -6.11: Vibration level Contours during construction phase at Hyaat Enclave

Bhardwaj Appartment (V10): This location falls towards Right hand side of the North South Corridor. The apartment is located 45.2' away from the corridor at ch:8200.000. The apartment is used for residential purposes. The monitored vibrational value at this location is 7.6 mm/sec. The building is located in thickly populated area in the city. Hence rigorous precautionary measures to be adopted during construction and operational phases of the project.

Figure -6.12: Vibration level Contours during construction phase at Bhardwaj Appartment

Sai Temple (V11): This location falls towards Right hand side of the North South Corridor. The temple is located 50.9' away from the corridor at ch:10750.000 to 10775.000. The monitored vibrational value at this location is 4.8 mm/sec. The temple is located in thickly populated area in the city. Hence rigorous precautionary measures to be adopted during construction and operational phases of the project.

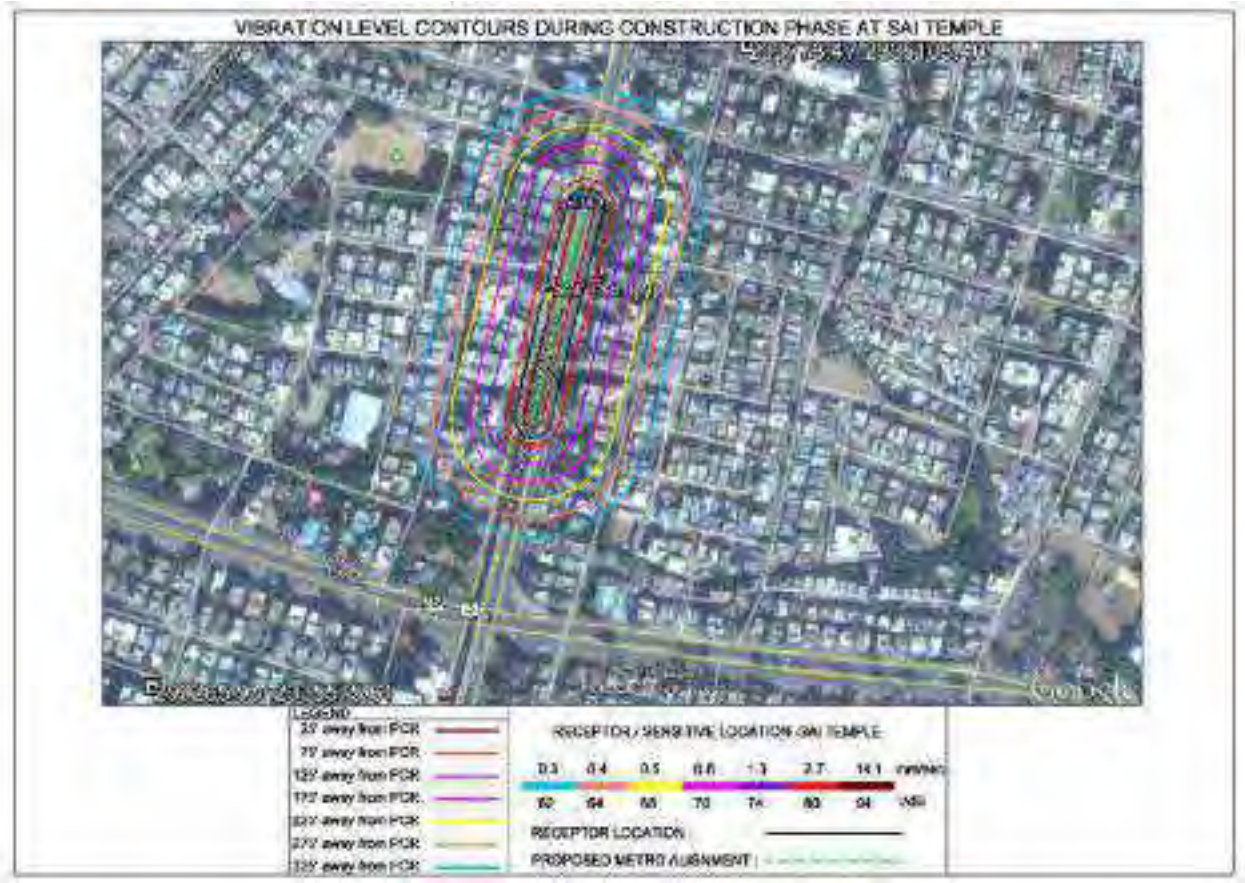


Figure -6.13: Vibration level Contours during construction phase at Sai Temple

Table -6.9: Vibration Levels in mm/sec during Construction Phase at selected Locations along the East - West Corridor

Location code	Location (description)	Distance from PCR (feet)	Predicted Vibration Value		Distance From PCR						
			in/sec	mm/sec	Reference Value (25')	75'	125'	175'	225'	275'	325'
V12	H.P town (Shradda) (Commercial)	98.4	0.10	2.5	19.5	3.8	1.7	1.1	0.7	0.5	0.4
V13	Suryalok Appartment, Veshnodevi Chowk	47.2	0.08	2	5.2	1.0	0.5	0.3	0.2	0.1	0.1
V14	257, Residential Building, Ambedkar Chowk	40.7	0.08	2.1	4.4	0.8	0.4	0.2	0.2	0.1	0.1
V15	Commercial Building,Towry Market,Chitar Oli Chowk	54.1	0.09	2.3	7.3	1.4	0.7	0.4	0.3	0.2	0.2
V16	Chanderlok Building	114.8	0.09	2.3	22.6	4.4	2.0	1.2	0.8	0.6	0.5
V17	Rattan Plaza (Opp. Rly. Station)	33	0.09	2.3	3.5	0.7	0.3	0.2	0.1	0.1	0.1
V18	Saraswati School	27.8	0.09	2.2	2.6	0.5	0.2	0.1	0.1	0.1	0.1
V19	World Titan (Commercial), Shankar nagar	55.7	0.08	2	6.7	1.3	0.6	0.4	0.2	0.2	0.1
V20	Residential building (Opp. Ambasari Lake)	41.3	0.08	2.1	4.5	0.9	0.4	0.2	0.2	0.1	0.1
V21	New Construction, Subhash Nagar (Residential)	61.8	0.08	2	7.8	1.5	0.7	0.4	0.3	0.2	0.2
V22	Shubham Appartment,Near Rachna Ring Road Metro Station	68.9	0.09	2.4	11.0	2.1	1.0	0.6	0.4	0.3	0.2

Source: Assessed by Aarvee Associates according to FTA (Chapter 6).
Note: All the predicted values are expressed in mm/sec.

In East - West Corridor the predicted vibration levels are given for existing in inhabitant area, reference distance at 25' and other varying distances of 75', 125',175'225' 275'and 325'. The predicted values for the existing scenario is ranging from 2.0 to 2.5 mm/sec as against the standard of 10mm/sec. The vibration values predicted other distances are gradually reducing and well below the standards. However, an adequate mitigation measures are suggested to further mitigate the vibration levels during construction phase of the project. The location wise analysis and the vibrational level contours for all the stations E-W Corridor are given below:

H.P Town (Shradda) (V12): This location falls towards Right hand side of the East West Corridor. The building is located 98.4' away from the corridor at ch:-250.000. The building is used for residential purposes. The monitored vibrational value at this location is 2.5 mm/sec. The building is located in thickly populated area in the city. Hence rigorous precautionary measures to be adopted during construction and operational phases of the project.

Figure -6.14: Vibration level Contours during construction phase at H.P Town

Suryalok Apartments (V13): This location falls towards Left hand side of the East West Corridor. The Apartment is located 98.4' away from the corridor at ch:1150.000 to 1200.000. The Apartment is used for residential purposes. The monitored vibrational value at this location is 2.0 mm/sec. The building is located in thickly populated area in the city. Hence necessary precautionary measures to be adopted during construction and operational phases of the project.

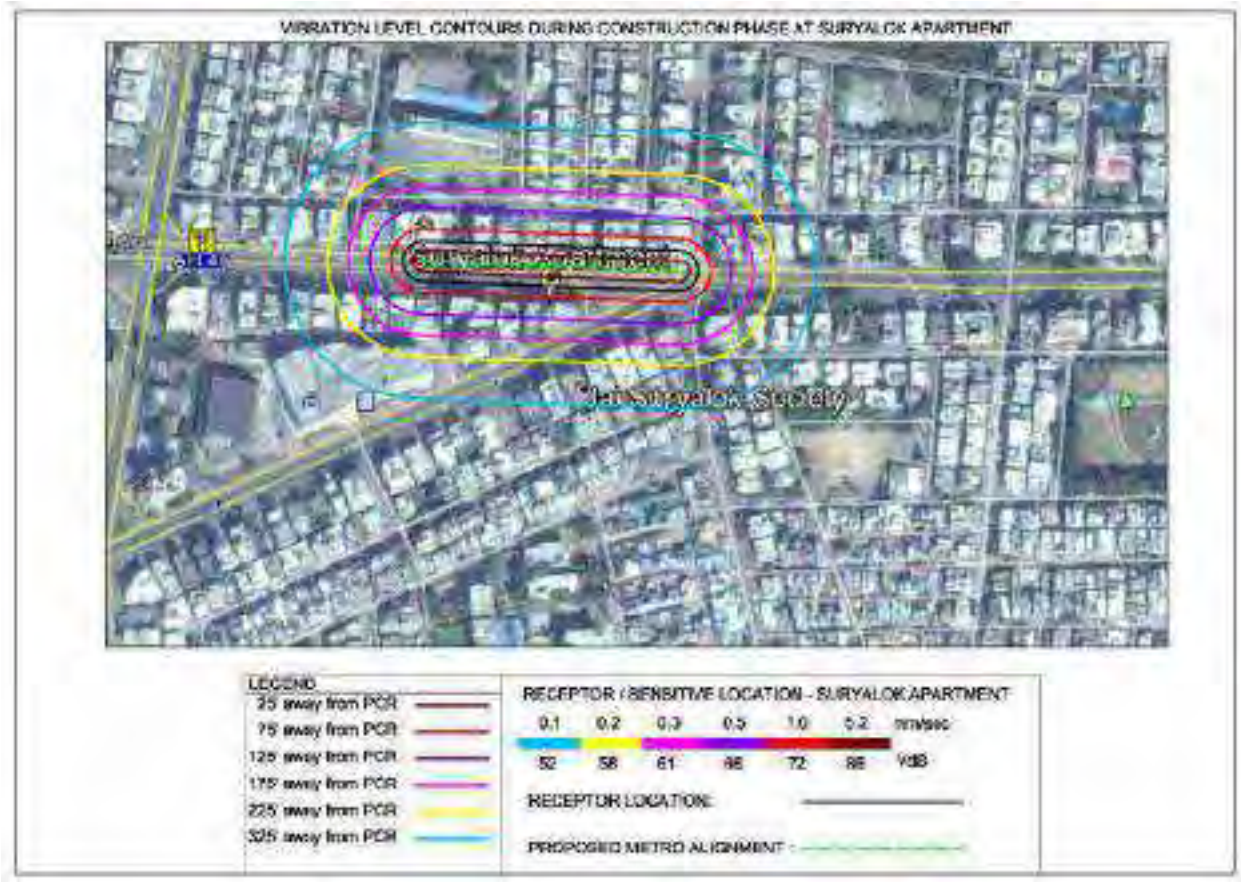


Figure -6.15: Vibration level Contours during construction phase at Suryalok Apartments

257, Residential Building (V14): This location falls towards Right hand side of the East West Corridor. The Apartment is located 40.7' away from the corridor at ch:1800.000. The Apartment is used for residential purposes. The monitored vibrational value at this location is 2.1 mm/sec. The building is located in thickly populated area in the city. Hence necessary precautionary measures to be adopted during construction and operational phases of the project.

Figure -6.16: Vibration level Contours during construction phase at 257, Residential Building

Maheswari Mills Stores (V15): This location falls towards Right hand side of the East West Corridor. The building is located 54.1' away from the corridor at ch:3850.000 to 3900.000. The building is used for commercial purposes. The monitored vibrational value at this location is 2.3 mm/sec. The building is located in a thickly populated area in the city. Hence necessary precautionary measures to be adopted during construction and operational phases of the project.

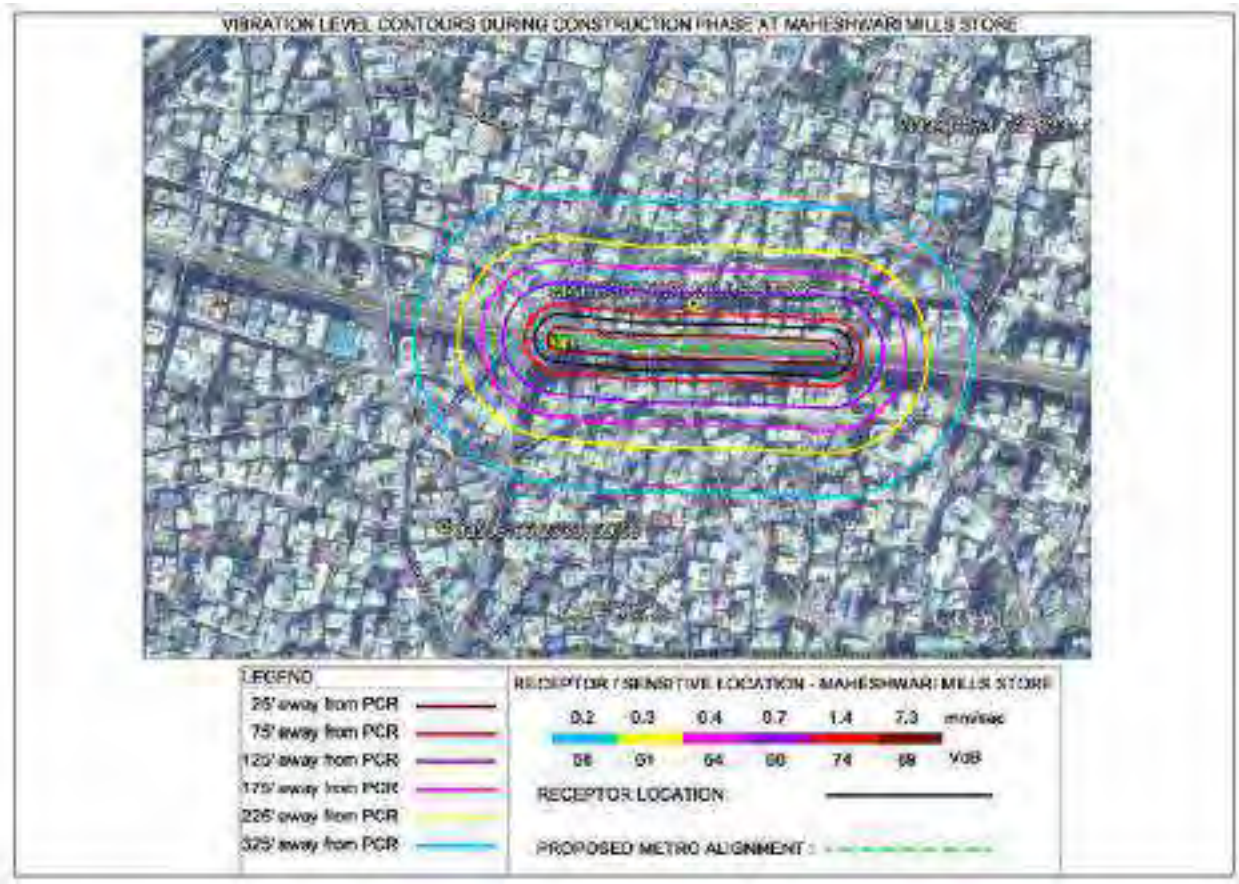


Figure -6.17: Vibration level Contours during construction phase at Maheswari Mills Stores

Chanderlok building (V16): This location falls towards Right hand side of the East West Corridor. The building is located 114.8' away from the corridor at ch:5600.000 to 5650.000. The building is used for commercial purposes. The monitored vibrational value at this location is 2.3 mm/sec. The relatively higher value may be due to the nature of local soil strata. As the building is located in a thickly populated area in the city, it is advisable to adopt necessary precautionary measures during construction and operational phases of the project.

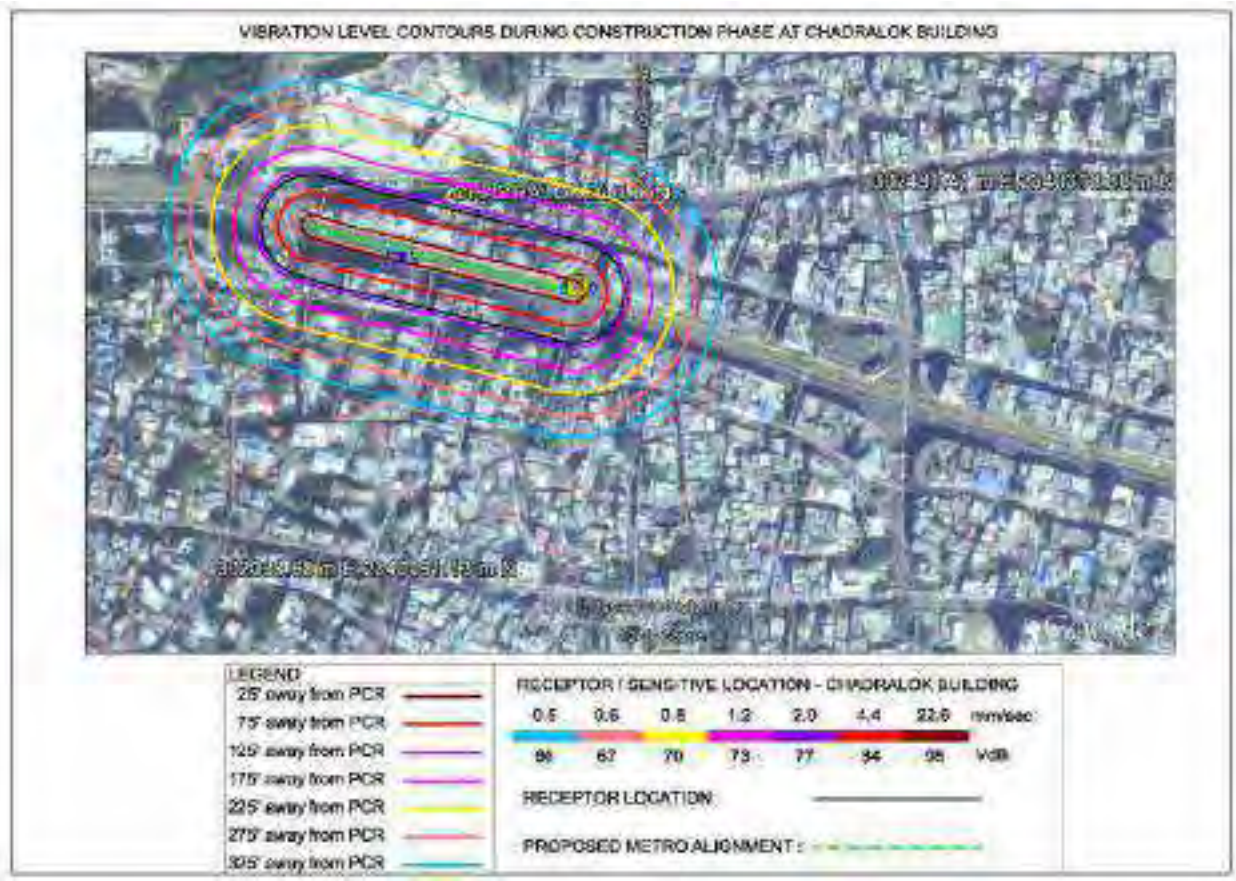


Figure -6.18: Vibration level Contours during construction phase at Chanderlok building

Rattan Plaza (V17): This location falls towards Right hand side of the East West Corridor. The building is located 33.0' away from the corridor at ch:6350.000. The building is used for commercial purposes. The monitored vibrational value at this location is 2.3 mm/sec. The relatively higher value may be due to the nature of local soil strata. As the building is located in a thickly populated area in the city, it is advisable to adopt necessary precautionary measures during construction and operational phases of the project.

Figure -6.19: Vibration level Contours during construction phase at Rattan Plaza

Saraswati School (V18): This location falls towards Right hand side of the East West Corridor. The building is located 27.8' away from the corridor at ch:7650.000. The building is used for educational purposes. The monitored vibrational value at this location is 2.2 mm/sec. As the building is located in a thickly populated area in the city, it is advisable to adopt necessary precautionary measures during construction and operational phases of the project.

Figure -6.20: Vibration level Contours during construction phase at Saraswati School

Kalinga Arcade (V19): This location falls towards Right hand side of the East West Corridor. The building is located 55.7' away from the corridor at ch:10000.000. The building is used for educational purposes. The monitored vibrational value at this location is 2.0 mm/sec. As the building is located in a thickly populated area in the city, it is advisable to adopt necessary precautionary measures during construction and operational phases of the project.

Figure -6.21: Vibration level Contours during construction phase at Kalinga Arcade

Building Near Ambasari Lake (V20): This location falls towards Right hand side of the East West Corridor. The building is located 41.3' away from the corridor at ch:10050.000 to 10075.000. The building is used for residential purposes. The monitored vibrational value at this location is 2.1 mm/sec. As the building is located in a thickly populated area in the city, it is recommended to adopt necessary precautionary measures during construction and operational phases of the project.

Figure -6.22: Vibration level Contours during construction phase at Building Near Ambasari Lake

New Construction in Subhash nagar (V21): This location falls towards Left hand side of the East West Corridor. The building is located 61.8' away from the corridor at ch:12600.000 to 12650.000. The building is used for residential purposes. The monitored vibrational value at this location is 2.0 mm/sec. As the building is located in a thickly populated area in the city, it is recommended to adopt necessary precautionary measures during construction and operational phases of the project.

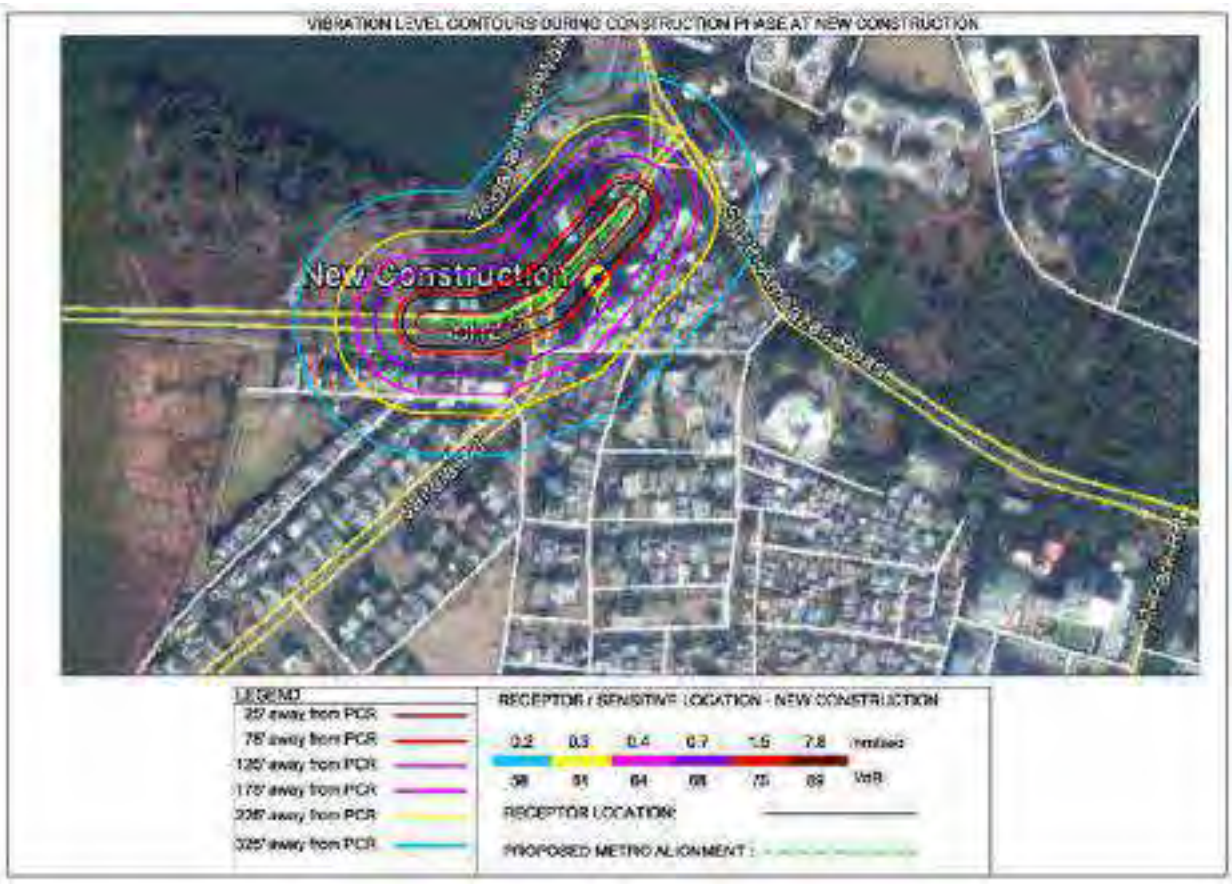


Figure -6.23: Vibration level Contours during construction phase at New Construction in Subhash nagar

Shubham Apartments (V22): This location falls towards Left hand side of the East West Corridor. The building is located 68.9' away from the corridor at ch:12600.000 to 12650.000. The building is used for residential purposes. The monitored vibrational value at this location is 2.4 mm/sec. As the building is located in a thickly populated area in the city, it is recommended to adopt necessary precautionary measures during construction and operational phases of the project.

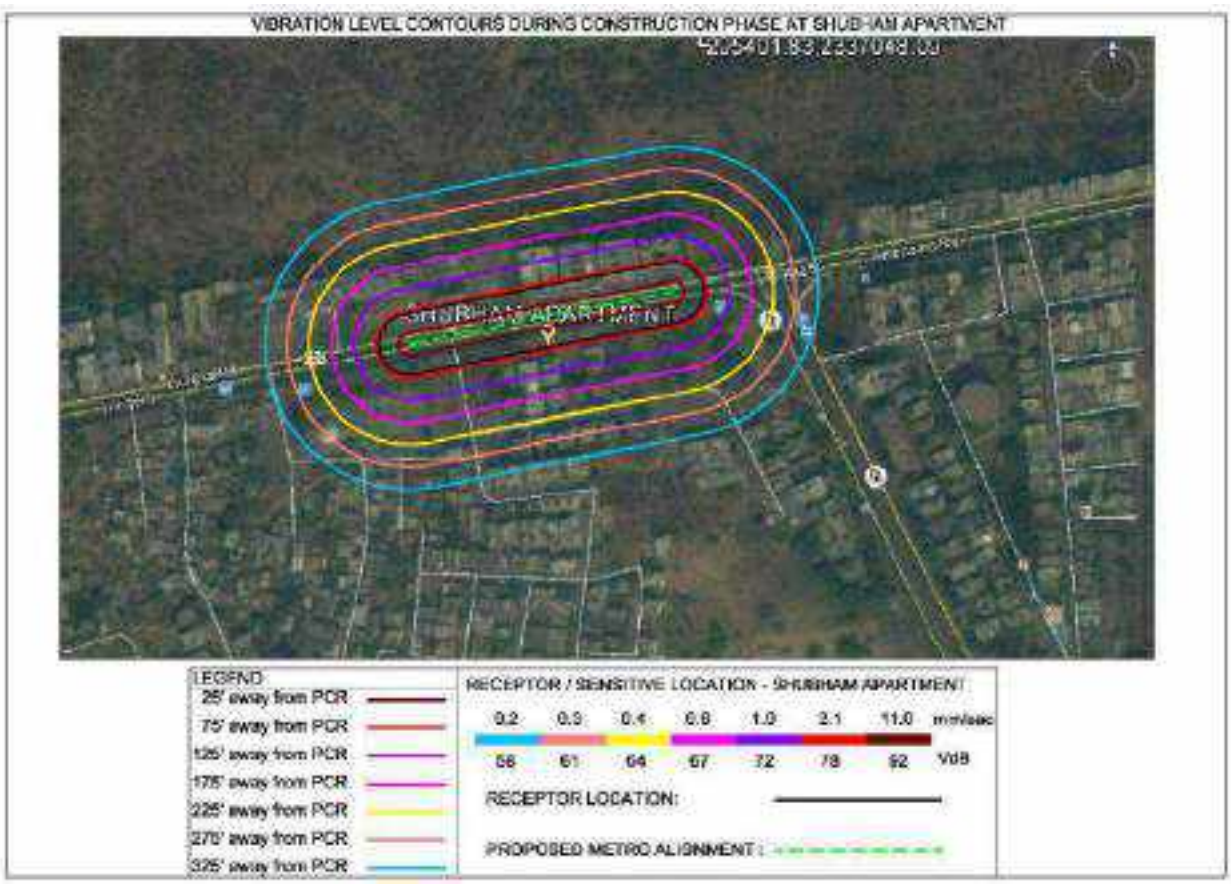


Figure -6.24: Vibration level Contours during construction phase at Shubham Apartments

6.4.12 Health risk at Construction site

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

6.4.13 Tree Plantation

There are about 639 nos., of trees been falling & need to be cut along the project alignment as well as Depot areas during construction. However it is presumed that there are about 1000 no. of trees falling on the project alignment and need to be cut during construction phase of the project. As per Forest (Conservation) Act, 1980 (amended Rules 2004), Chapter 2.5 (ii), minimum of Two plants are to be planted for every tree cut. However, NMRCL has agreed for more number of plantation ratio of 1:5, i.e., total 5000 trees for presumed 1000 nos. of trees cut. The type of plants to be removed are Subabul, Neem, Gulmohar, Peepal, Coconut Palms, Ashoka, Mango, Karanj etc. The short-term impact due to felling of trees will be compensated in long term through the proposed plantation programme. The local plant varieties will be identified and the same will be planted along the 36nos. of Station, 2nos. of Depot areas and surrounding areas. Details of Compensatory Plantation are given in Table -6.10.

Table-6.10:- Compensatory Plantation

S. No		North-South Corridor	East-West Corridor	Total Plantation
1	Parking Areas	@ 8 locations, 1-2 Rows of plantation	@ 5 locations, 1-2 Rows of plantation	500-600
2	Depot areas	@ Khapri Depot 2-3 Rows of plantation	@ Lokamanya nagar Depot 2-3 Rows of plantation	700-800
3	Station locations	@ 17 nos., of stations wherever possible	@ 19 nos., of stations wherever possible	200-300

6.5 Impacts Due to Project Operation

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

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

6.5.1 Noise pollution

Noise levels prediction for the years 2021,2031 and 2041 was carried out taking 2016 noise levels monitored at different locations as the base value. The monitored base line data was compared with the predicted noise levels of 2021, 2031 and 2041 at day and at night time.

i) Predicted Noise Levels at 5O Feet Distance:

When the day time noise was predicted for different years' stations like Indira Chowk, Sai Baba Mandir, Khapri Depot, Gurudwara Mandir, Dosar Viasya Chowk and Hadas high school have showed more increase in noise levels (more than 1.5 dB(A) for 2021) while stations like Sitha burdi and Prajapathi Nagar shows less increase. Station near to Munje chowk is found to have predicted values more than the base values by nealy 5 dB(A) in 2021 and subsequent years, this trend of increase in values is due to the proposed high frequency of trains passing this location. Predicted noise levels at 50 feet distance are given in Table -11. Figure 6.25 shows Noise level prediction for day time at different station - 50 feet distance

For the night time noise levels were predicted for different years at all stations where noise monitoring was conducted. Stations like Airport Station, Khapri Depot, Gurudwara Mandir, Congress Nagar to Rahate Chowk, Dosar Viasya Chowk, Ambazari Lake and Hadas high school have shown significant increase in noise levels (more than 15 dB(A) for 2021). Remaining stations also are showing a substantial increase in noise levels in the predicted years of 2021, 2031 and 2041. Predicted noise levels at 50 feet distance are given in Table -12. Figure 6.26 shows Noise level prediction for night time at different station - 50 feet distance.

Table -6.11: Prediction of Noise levels at day time at 50 feet

Station name	Base Value	2021	2031	2041
Automotive square	82.6	83.0	83.1	83.3
Indira Chowk	79.8	80.6	80.7	81.0
Sitha bardi	84.3	84.6	84.7	84.8
Sai Baba Mandir	75.8	76.8	77.0	77.4
Airport Station	79.2	79.8	80.0	80.2
Khapri Depot	68.7	73.2	73.8	74.7
Prajapathi Nagar	81.5	81.7	81.8	81.9
Gurudwara Mandir	74.4	76.6	77.0	77.6
Kasthurchand Park	80.2	80.9	81.1	81.3
RBI Square	82.9	83.3	83.4	83.5
Congress Nagar to Rahate Chowk	78	79.1	79.3	79.7
Agrasen Chowk	80.5	81.0	81.2	81.3
Dosar Viasya Chowk	76.2	77.5	77.8	78.2
Cable bridge	82.9	83.2	83.3	83.4
Shankar nagar	80.8	81.3	81.4	81.6
Ambazari Lake	68.5	73.2	74.1	74.9
Hadas high school	71.6	74.5	75.2	75.8
Rachna ring road	82.7	82.9	82.9	83.0
Lokmanya nagar Depot	81.5	81.7	81.8	81.9
Munje Chowk	75.4	80.1	80.4	80.9

Table -6.12: Predictions of noise at night time at 50 feet

Station name	Base Value	2021	2031	2041
Automotive square	52.4	69.2	70.2	71.4
Indira Chowk	54.1	69.2	70.2	71.4
Sitha bardi	55.6	69.3	70.2	71.4
Sai Baba Mandir	51.8	66.6	67.6	68.8
Airport Station	48.7	67.8	68.7	70.0
Khapri Depot	45.2	67.7	68.7	70.0
Prajapathi Nagar	51.6	65.1	66.3	67.4
Gurudwara Mandir	48.5	69.2	70.1	71.4
Kasthurchand Park	53.7	69.2	70.2	71.4
RBI Square	54.8	69.3	70.2	71.4
Congress Nagar to Rahate Chowk	50.8	69.2	70.1	71.4
Agrasen Chowk	52.2	68.0	69.3	70.3
Dosar Viasya Chowk	49.7	68.0	69.2	70.3
Cable bridge	58.8	68.4	69.6	70.6
Shankar nagar	50.3	68.0	69.2	70.3
Ambazari Lake	42.5	67.9	69.2	70.3
Hadas high school	45.0	67.9	69.2	70.3
Rachna ring road	52.7	65.2	66.4	67.4
Lokmanya nagar Depot	54.5	65.3	66.4	67.5
Munje Chowk	56.8	71.8	71.7	74.0

Source: Assessed by Aarvee Associates according to FTA (Chapter 6)

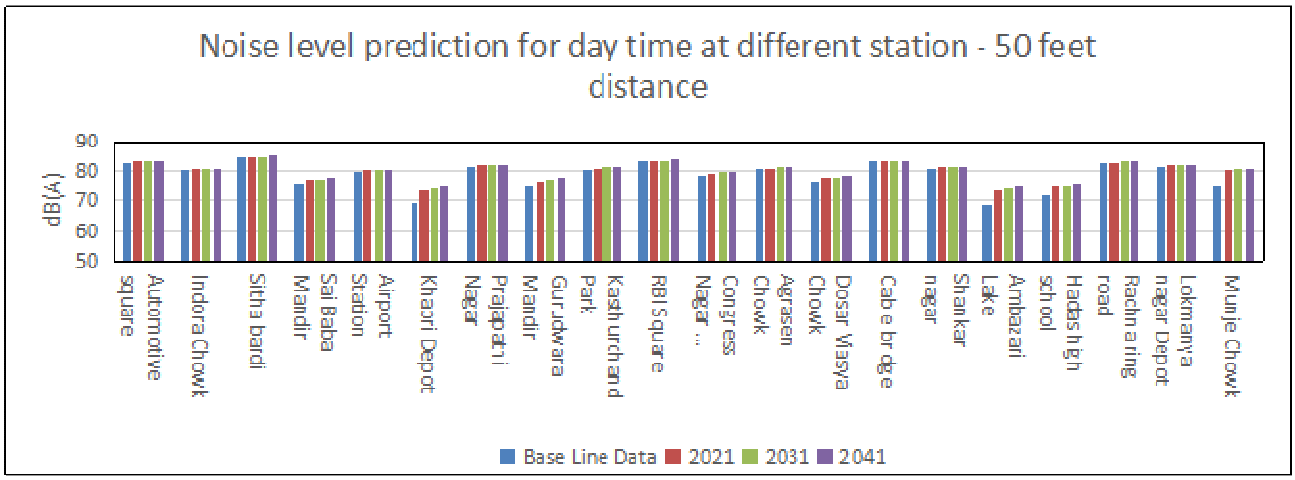


Figure 6.25- Noise level prediction for day time at different station - 50 feet distance

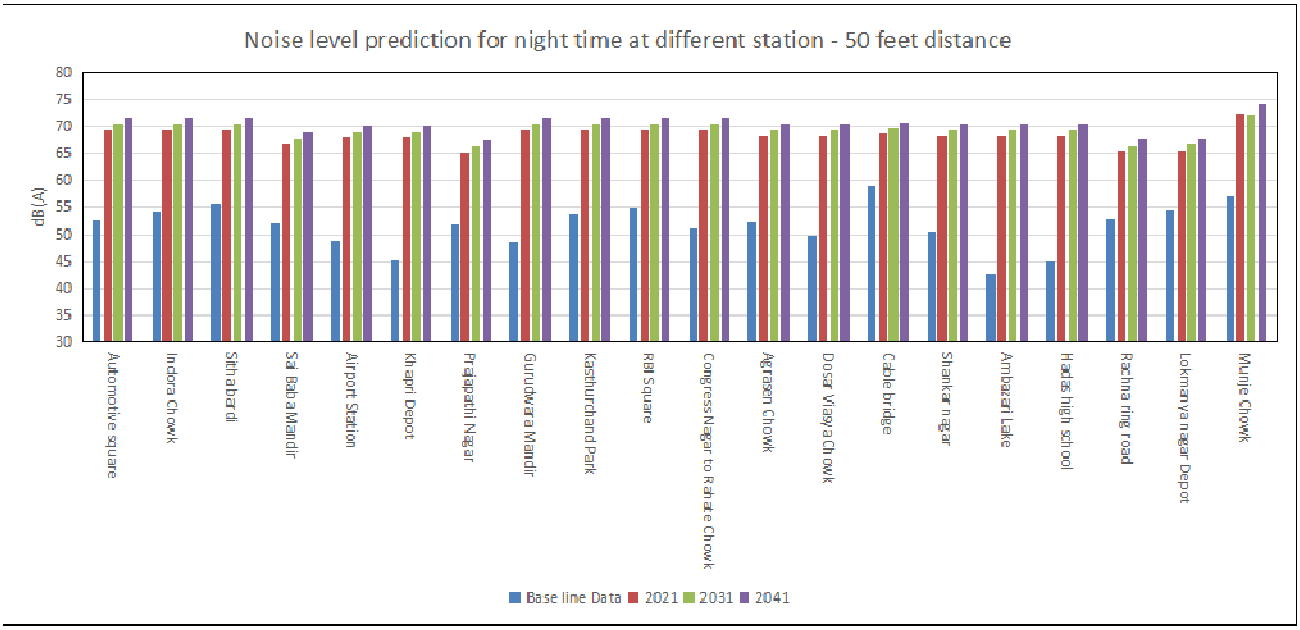


Figure 6.26- Noise level prediction for night time at different station - 50 feet distance

ii) Predicted Noise Levels at 10O Feet Distance:

Predictions of noise at day time at a distance of 100 feet is shown in Table - 6.13. Predicted noise levels at day time for different years at monitored stations was found to have a significant decline when compared with the noise levels at a distance of 50 feet and also showed less values when compared with the base noise level values. Stations like Airport Station, Indira Chowk, Sai Baba Mandir, Khapri Depot, Gurudwara Mandir, Munje Chowk, Dosar Viasya Chowk and Hadas high school showed less decrease in the noise levels (around 10 to 15 dB(A) for 2021) while stations like Munje Chowk, RBI Square, Agrasen Chowk and Prajapathi Nagar showed more decrease in the noise levels. Figure 6.27 shows Noise level prediction for day time at different station - 100 feet distance

Predictions of noise at night time at a distance of 100 feet is shown in Table -6.14. When the night time noise was predicted for different years noise levels at all stations was found to have a slight increase in the value when compared with the monitored base valves. Night time noise levels was predicted for different years at stations and it was found that locations like Airport Station, Khapri Depot, Gurudwara Mandir, Congress Nagar to Rahate Chowk, Dosar Viasya Chowk, Ambazari Lake and Hadas high school are showing increase in noise levels as compared to other stations. Figure 6.28 shows Noise level prediction for night time at different station - 100 feet distance

Table-6.13: Predictions of noise at day time at 100 feet

Station name	Base Value	2021	2026	2031
Automotive square	82.6	70.7	70.8	70.9
Indora Chowk	79.8	68.2	68.4	68.7
Sitha bardi	84.3	72.2	72.3	72.4
Sai Baba Mandir	75.8	64.5	64.7	65.0
Airport Station	79.2	67.5	67.6	67.9
Khapri Depot	68.7	60.8	61.5	62.4
Prajapathi Nagar	81.5	69.4	69.4	69.5
Gurudwara Mandir	74.4	64.3	64.7	65.3
Kasthurchand Park	80.2	68.6	68.7	69.0
RBI Square	82.9	70.9	71.0	71.2
Congress Nagar to Rahate Chowk	78	66.8	67.0	67.4
Agrasen Chowk	80.5	68.7	68.8	69.0
Dosar Viasya Chowk	76.2	65.1	65.5	65.8
Cable bridge	82.9	70.9	71.0	71.1
Shankar nagar	80.8	68.9	69.1	69.2
Ambazari Lake	68.5	60.9	61.8	62.6
Hadas high school	71.6	62.2	62.8	63.5
Rachna ring road	82.7	70.5	70.6	70.6
Lokmanya nagar Depot	81.5	69.4	69.4	69.5
Munje Chowk	75.4	67.7	68.1	68.6

Source: Assessed by Aarvee Associates according to FTA (Chapter 6)

Table-6.14: Predictions of noise at night time at 100 feet

Station name	Base Value	2021	2031	2041
Automotive square	52.4	56.9	57.8	59.0
Indora Chowk	54.1	56.9	57.8	59.1
Sitha bardi	55.6	57.0	57.9	59.1
Sai Baba Mandir	51.8	54.3	55.2	56.4
Airport Station	48.7	55.4	56.4	57.6
Khapri Depot	45.2	55.4	56.4	57.6
Prajapathi Nagar	51.6	52.8	54.0	55.0
Gurudwara Mandir	48.5	56.8	57.8	59.0
Kasthurchand Park	53.7	56.9	57.8	59.1
RBI Square	54.8	56.9	57.9	59.1
Congress Nagar to Rahate Chowk	50.8	56.8	57.8	59.0
Agrasen Chowk	52.2	55.7	56.9	58.0
Dosar Viasya Chowk	49.7	55.6	56.9	58.0
Cable bridge	58.8	56.1	57.2	58.2
Shankar nagar	50.3	55.7	56.9	58.0
Ambazari Lake	42.5	55.6	56.8	57.9
Hadas high school	45	55.6	56.8	57.9
Rachna ring road	52.7	52.8	54.0	55.1
Lokmanya nagar Depot	54.5	52.9	54.1	55.1
Munje Chowk	56.8	59.5	60.5	61.7

Source: Assessed by Aarvee Associates according to FTA (Chapter 6)

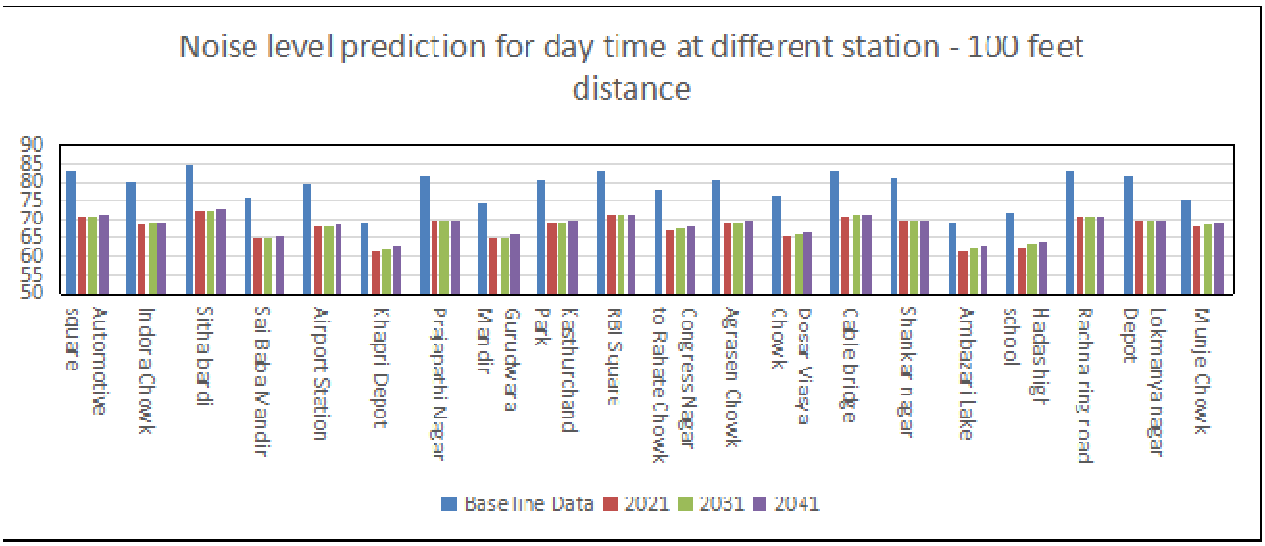


Figure 6.27-Noise level prediction for day time at different station - 100 feet distance

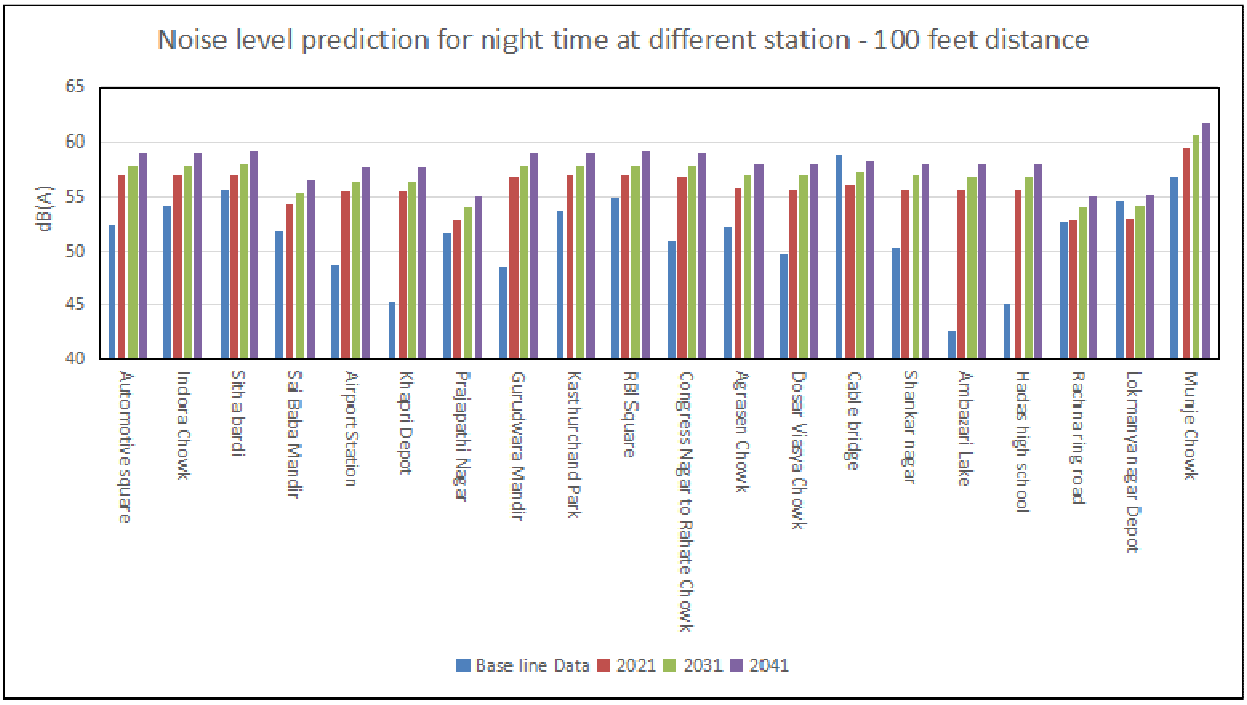


Figure 6.28- Noise level prediction for night time at different station - 100 feet distance

iii) Predicted Noise Levels at 15O Feet Distance:

When the day time noise was predicted for different years it was found that value predicted values were about 10 to 15 dB(A) lesser than the base noise levels. Stations like Airport Station, Indira Chowk, Sai Baba Mandir, Khapri Depot, Gurudwara Mandir,Munje Chowk, Dosar Viasya Chowk and Hadas high school showed less decrease in the noise levels (around 10 to 15 dB(A)) while stations like Munje Chowk,RBI Square, Agrasen Chowk and Prajapathi Nagar showed higher decrease in the noise levels. Predictions of noise levels at day time at a distance of 150 feet is shown in Table -6.15. Figure 6.29 shows the graph of Noise level prediction for day time at different station - 150 feet distance

Decrease in noise levels for the predicted years was found when compared with the base noise levels at a distance of 150 feet for night time. Locations like Khapri Depot, Gurudwara Mandir, Congress Nagar to Rahate Chowk, Dosar Viasya Chowk, Ambazari Lake and Hadas high school showed increase in noise levels while stations like Automotive square, Indora Chowk, Sitha bardi, Kasthurchand Park and Rachna ring road are showing slight increase in noise level. Table -6.16 shows Predictions of noise levels at night time at a distance of 150 feet. Figure 6.30 shows the graph of Noise level prediction for night time at different station - 150 feet distance

Table-6.15: Predictions of noise at day time at 150 feet

Station name	Base Value	2021	2031	2041
Automotive square	82.6	63.5	63.6	63.7
Indora Chowk	79.8	61.0	61.2	61.4
Sitha bardi	84.3	65.0	65.1	65.2
Sai Baba Mandir	75.8	57.3	57.5	57.8
Airport Station	79.2	60.3	60.4	60.7
Khapri Depot	68.7	53.6	54.2	55.2
Prajapathi Nagar	81.5	62.1	62.2	62.3
Gurudwara Mandir	74.4	57.1	57.5	58.1
Kasthurchand Park	80.2	61.3	61.5	61.8
RBI Square	82.9	63.7	63.8	64.0
Congress Nagar to Rahate Chowk	78	57.7	58.0	58.6
Agrasen Chowk	80.5	61.4	61.6	61.8
Dosar Viasya Chowk	76.2	57.9	58.2	58.6
Cable bridge	82.9	63.6	63.7	63.8
Shankar nagar	80.8	61.7	61.9	62.0
Ambazari Lake	68.5	53.7	54.5	55.3
Hadas high school	71.6	55.0	55.6	56.3
Rachna ring road	82.7	63.3	63.3	63.4
Lokmanya nagar Depot	81.5	62.1	62.2	62.3
Munje Chowk	75.4	60.5	60.9	61.4

Source: Assessed by Aarvee Associates according to FTA (Chapter 6)

Table-6.16: Predictions of noise at night time at 150 feet

Station name	Base Value	2021	2031	2041
Automotive square	52.4	63.5	63.6	63.7
Indora Chowk	54.1	61.0	61.2	61.4
Sitha bardi	55.6	65.0	65.1	65.2
Sai Baba Mandir	51.8	57.3	57.5	57.8
Airport Station	48.7	60.3	60.4	60.7
Khapri Depot	45.2	53.6	54.2	55.2
Prajapathi Nagar	51.6	62.1	62.2	62.3
Gurudwara Mandir	48.5	57.1	57.5	58.1
Kasthurchand Park	53.7	61.3	61.5	61.8
RBI Square	54.8	63.7	63.8	64.0
Congress Nagar to Rahate Chowk	50.8	57.7	58.0	58.6
Agrasen Chowk	52.2	61.4	61.6	61.8
Dosar Viasya Chowk	49.7	57.9	58.2	58.6
Cable bridge	58.8	63.6	63.7	63.8
Shankar nagar	50.3	61.7	61.9	62.0
Ambazari Lake	42.5	53.7	54.5	55.3
Hadas high school	45	55.0	55.6	56.3
Rachna ring road	52.7	63.3	63.3	63.4
Lokmanya nagar Depot	54.5	62.1	62.2	62.3
Munje Chowk	56.8	60.5	60.9	61.4

Source: Assessed by Aarvee Associates according to FTA (Chapter 6)

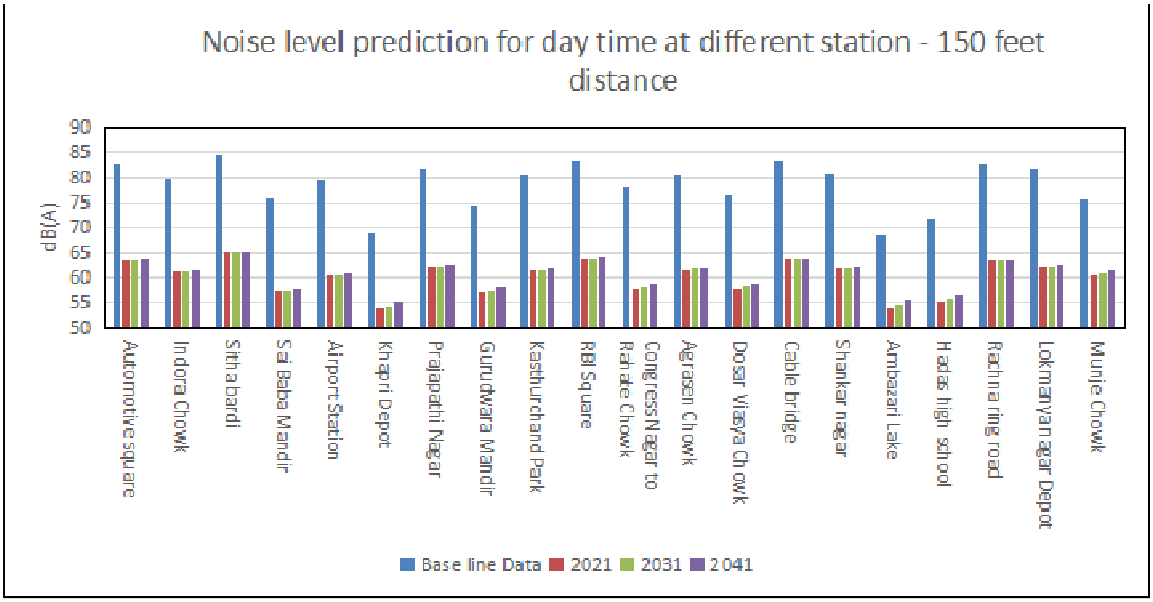


Figure 6.29-Noise level prediction for day time at different station - 150 feet distance

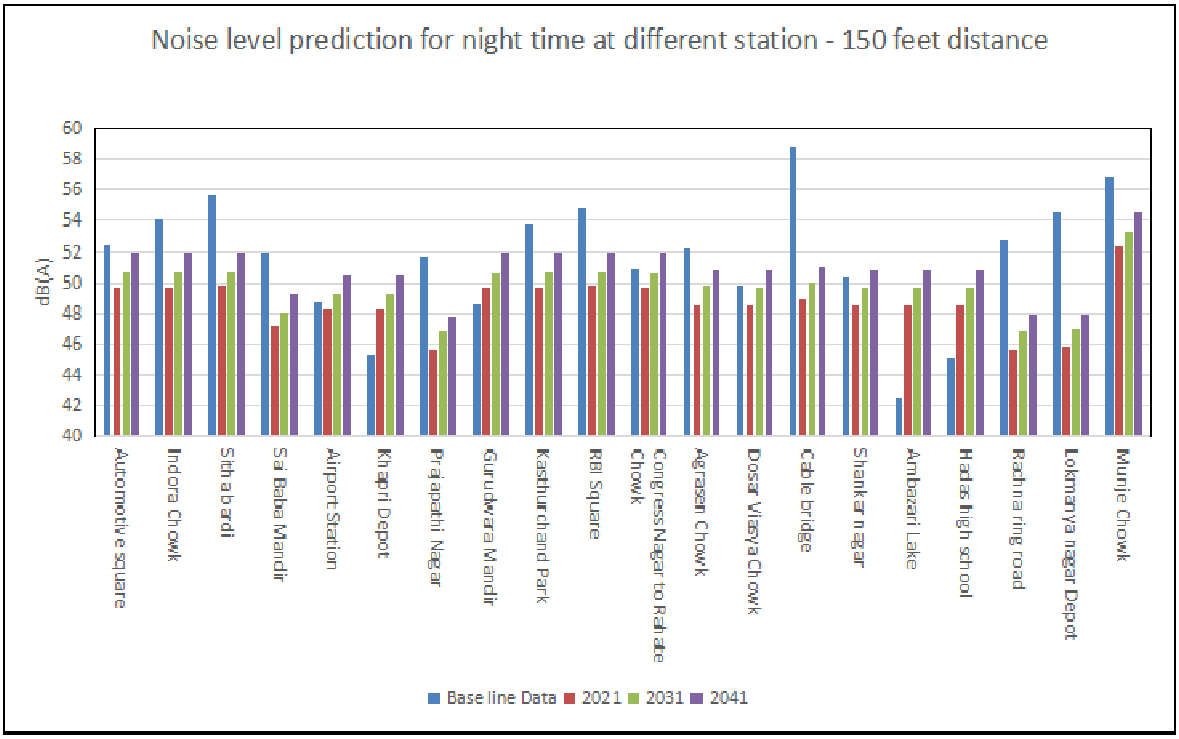


Figure 6.30-Noise level prediction for night time at different station - 150 feet distance

6.5.2 Noise Barriers

Keeping in view of the sensitive locations in the project,there is a length of 950 m noise barriers proposed in N-S Corridor and 1350 m length proposed in E-W Corridor. The details of the noise barriers proposed are given in Table -6.17. Noise barrier locations for both the corridors are given in Figures 6.31 & 6.32.

Table -6.17: Provision of Noise Barriers in Different Stretches

S. No	Chainage	Name of the sensitive location	Length (in m)
North – South Corridor:			
1	6200.000 to 6350.000	Latha Mangeshkar hospital	150
2	2625.000 to 2725.000	Turning, Pulia chowk	100
3	3275.000 to 3375.000	Turning, Kadbi square	100
4	6350.000 to 6500.000	Variety square	150
5	6550.000 to 6700.000	Bank of Baroda,Munji square,(Sitabuldi)	150
6	6725.000 to 6825.000	Bank of Maharastra, Munji square	100
7	8000.000 to 8200.000	Near congress nagar Turning point	200
		Total	**950**
East – West Corridor:			
1	5900.000 to 6100.000	Ramzula Cable bridge (turning)	200
2	7650.000 to 7800.000	Tulsi Hindi Primary School	150
3	11700.000 to 11850.000	Lake turning	150
4	2600.000 to 2700.000	Netaji Subhash Chandra Bose Square	100
5	5650.000 to 5900.000	MAYO Govt Hospital, Shahid Uccha Primary school, Temples	250
6	6400.000 to 6600.000	Govardan das Rawal high school, SMR Hindi Bashi sangh	200
7	10150.000 to 10450.000	Saraswathi Vidyalaya Higher secondary school, Wockhardt	300
		Total	**1350**

These Stretches are identified after preliminary analysis, detail site inspection and by studying the surrounding environment. Final length of the Noise Barriers is fixed and along with Noise Barriers it is also Proposed to have at least 2 rows of green belt around the Proposed Metro-Rail Stations/ parking areas depends upon the availability of the land.

Mitigation Measures:

Mitigation of noise impact from Nagpur Metro-rail project may involve treatments at the three fundamental components of the noise problem: (1) at the noise source, (2) along the source-to-receiver propagation path

1. Source Treatment: Among the most effective noise mitigation treatment is noise control at the outset, during the specification and design of the transit vehicle. By enforcing stringent but achievable noise specifications in Rolling Stock. Rolling stock exterior and individual systems and equipment noise measurements are to be made in accordance with ISO 3095, and interior noise measurements are to be made in accordance with ISO Standard 3381, except where otherwise specified. The same is already adopted in NMRCL project as given below:

Interior Noise Levels (ISO: 3381)

Location	Noise Measurements (L_{Aeq} in dBA as per ISO 3381)	
	Stationary	Running (80kmph)
All cars except in driving cab (elevated & at grade)	72	75
Driving Cab (Elevated & At grade)	72	75

Exterior Noise Levels (ISO: 3095)

Location	Noise Measurements (L_{Aeq} in dBA as per ISO 3095)	
	Stationary	Running (80kmph)
Platform (elevated & at grade)	67	84

2. Path Treatments:

- Sound 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 such factors as the source height and the distance from the source to the barrier.
- Noise barrier proposed in North-south corridor is 950 m and East-west corridor is 1350m covering the major hospitals, schools, colleges, turnings etc. As per Chapter -6, Table-6.12 of Transit Noise & Vibration by FTA, 2006, noise transmission loss due to these barriers will be about 6 -15 dB(A).
- These Stretches are identified after preliminary analysis, detail site inspection and by studying the surrounding environment. Final length of the Noise Barriers is fixed and along with Noise Barriers it is also Proposed to have at least 2 rows of green belt around the Proposed Metro-Rail Stations/ parking areas depends upon the availability of the land.

Conclusion:

All necessary precautions will be taken during operation stage to control the noise impact as per the stipulated standard norms. Provision of rubber pads below track fittings will help to reduce noise due to wheel interaction. Detailed noise modeling will be undertaken at sharp curves and at major hospitals along Right of Way (RoW) edge during operation stage to understand the noisy pockets within the corridor. Exterior and individual systems and equipment noise measurements are to be made in accordance with ISO 3095.

Figure 6.31: Noise barriers in East-West Corridor

Figure 6.32: Noise barriers in North-South Corridor

6.5.3 Vibration impact due to train

Vibration levels are assessed using Federal Transit Administration Manual. 2006 and the movement of vehicle and movement of the train predicted and given in Table -6.18.

Table -6.18: Vibration During Operation Phase

Location code	E-W Corridor	Distance from PCR (feet)	Predicted Vibration Value (in/sec) (mm/sec)		Distance from PCR (Feet)						
					Reference Value (25')	75'	125'	175'	225'	275'	325'
V12	H.P town (Shradda) (Commercial)	98.4	0.1	2.5	19.8	3.8	1.8	1.1	0.7	0.5	0.4
V13	Suryalok Appartment, Veshnodevi Chowk	47.2	0.3	7.6	19.8	3.8	1.8	1.1	0.7	0.5	0.4
V14	257, Residential Building, Ambedkar Chowk	40.7	0.07	1.8	3.7	0.7	0.3	0.2	0.1	0.1	0.1
V15	Commercial Building,Towry Market,Chitar Oli Chowk	54.1	0.08	2.0	6.5	1.2	0.6	0.3	0.2	0.2	0.1
V16	Chanderlok Building	114.8	0.08	2.0	20.0	3.8	1.8	1.1	0.7	0.5	0.4
V17	Rattan Plaza (Opp. Rly. Station)	33	0.02	0.5	0.8	0.1	0.1	0.0	0.0	0.0	0.0
V18	Saraswati School	27.8	0.07	1.8	2.1	0.4	0.2	0.1	0.1	0.1	0.0
V19	World Titan (Commercial), Shankar nagar	55.7	0.1	2.5	8.4	1.6	0.8	0.5	0.3	0.2	0.2
V20	Residential building (Opp. Ambasari Lake)	41.3	0.05	1.3	2.7	0.5	0.2	0.1	0.1	0.1	0.1
V21	New Construction, Subhash Nagar (Residential)	61.8	0.6	15.2	59.2	11.4	5.3	3.2	2.2	1.6	1.3

Location code	E-W Corridor	Distance from PCR (feet)	Predicted Vibration Value (in/sec)	(mm/sec)	Distance from PCR (Feet) Reference Value (25')	75'	125'	175'	225'	275'	325'
V22	Shubham Appartment,Near Rachna Ring Road Metro Station	68.9	0.09	2.3	10.5	2.0	0.9	0.6	0.4	0.3	0.2

Source: Assessed by Aarvee Associates according to FTA (Chapter 6).
Note: All the predicted values are expressed in mm/sec.

the predicted vibration levels during operation phase are given for existing in inhabitant area, reference distance at 25' and other varying distances of 75', 125',175'225' 275'and 325'. The values assessed for the existing scenario is ranging from 0.50 to 15.2 mm/sec as against the standard of 5 to 10 mm/sec. Maximum value observed at Subhash Nagar is obtained due to presence of hard rock underneath and the same is confirmed from geo-technical values (Table 5.5, Pg. No. 179 of DPR). The vibration values predicted other distances are gradually reducing and well below the standards.

H.P Town (Shradda) (V12): This location falls towards Right hand side of the East West Corridor. The building is located 98.4' away from the corridor at ch:-250.000. The building is used for residential purposes. The monitored vibrational value at this location is 2.5 mm/sec. The building is located in thickly populated area in the city. Hence rigorous precautionary measures to be adopted during construction and operational phases of the project.

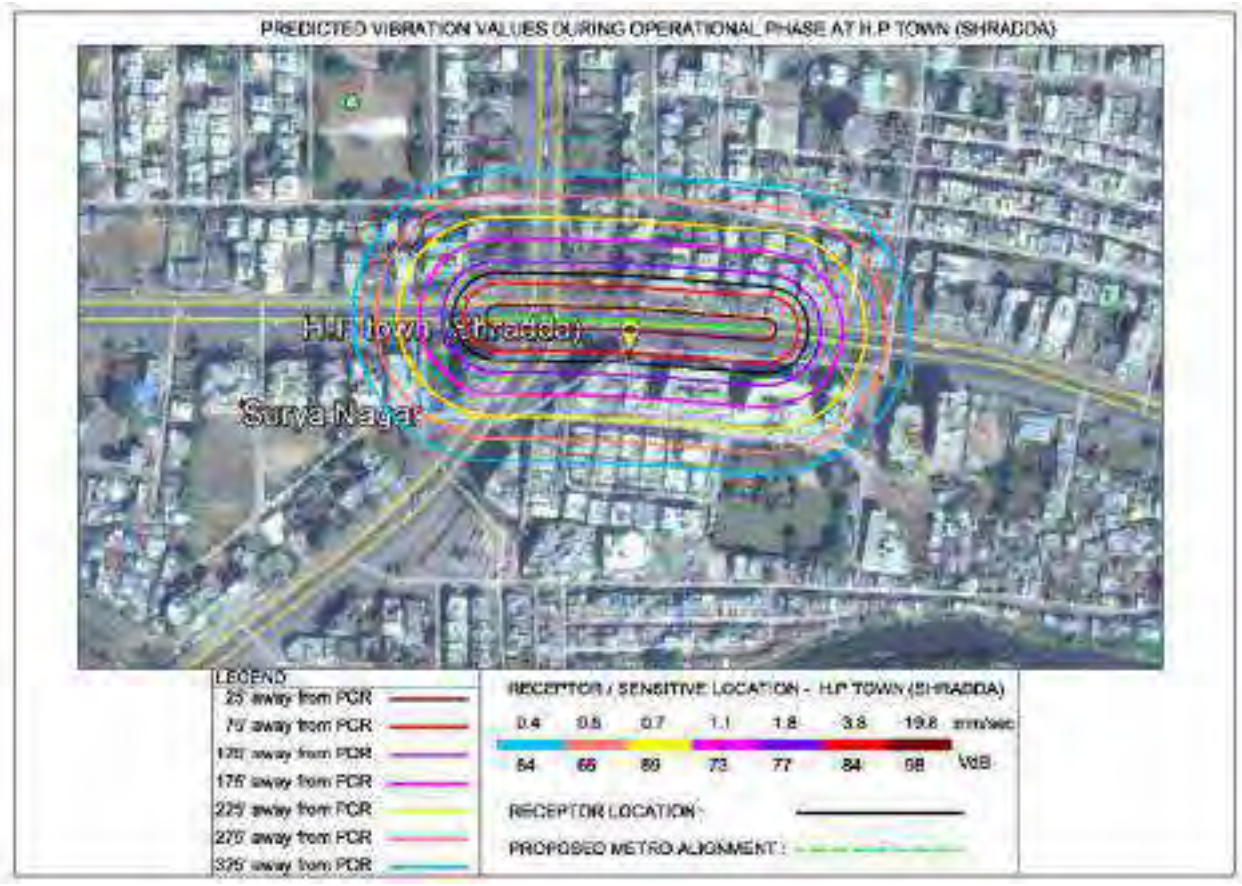


Figure 6.33- Predicted vibration values during Operation Phase at H.P. Town

Suryalok Apartments (V13): This location falls towards Left hand side of the East West Corridor. The Apartment is located 98.4' away from the corridor at ch:1150.000 to 1200.000. The Apartment is used for residential purposes. The monitored vibrational value at this location is 7.6 mm/sec. The building is located in thickly populated area in the city. Hence necessary precautionary measures to be adopted during construction and operational phases of the project.

Figure 6.34- Predicted vibration values during Operation Phase at Suryalok Apartments

Residential Building (V14): This location falls towards Right hand side of the East West Corridor. The Apartment is located 40.7' away from the corridor at ch:1800.000. The Apartment is used for residential purposes. The monitored vibrational value at this location is 1.8 mm/sec. The building is located in thickly populated area in the city. Hence necessary precautionary measures to be adopted during construction and operational phases of the project.

Figure 6.35- Predicted vibration values during Operation Phase at Residential Building

Maheswari Mills Stores (V15): This location falls towards Right hand side of the East West Corridor. The building is located 54.1' away from the corridor at ch:3850.000 to 3900.000. The building is used for commercial purposes. The monitored vibrational value at this location is 2.0 mm/sec. The building is located in a thickly populated area in the city. Hence necessary precautionary measures to be adopted during construction and operational phases of the project.

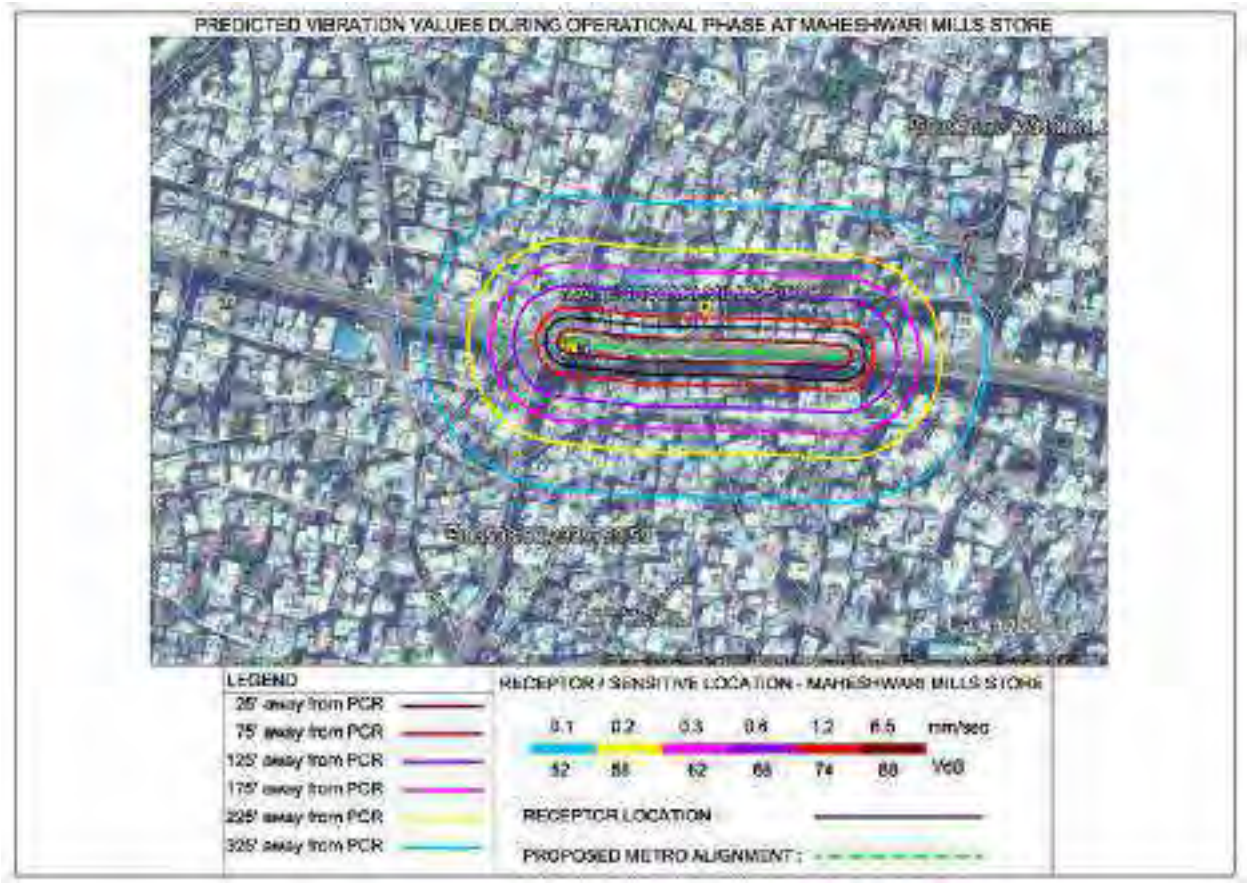


Figure 6.36- Predicted vibration values during Operation Phase at Maheswari Mills Stores

Chanderlok building (V16): This location falls towards Right hand side of the East West Corridor. The building is located 114.8' away from the corridor at ch:5600.000 to 5650.000. The building is used for commercial purposes. The monitored vibrational value at this location is 2.0 mm/sec. The relatively higher value may be due to the nature of local soil strata. As the building is located in a thickly populated area in the city, it is advisable to adopt necessary precautionary measures during construction and operational phases of the project.

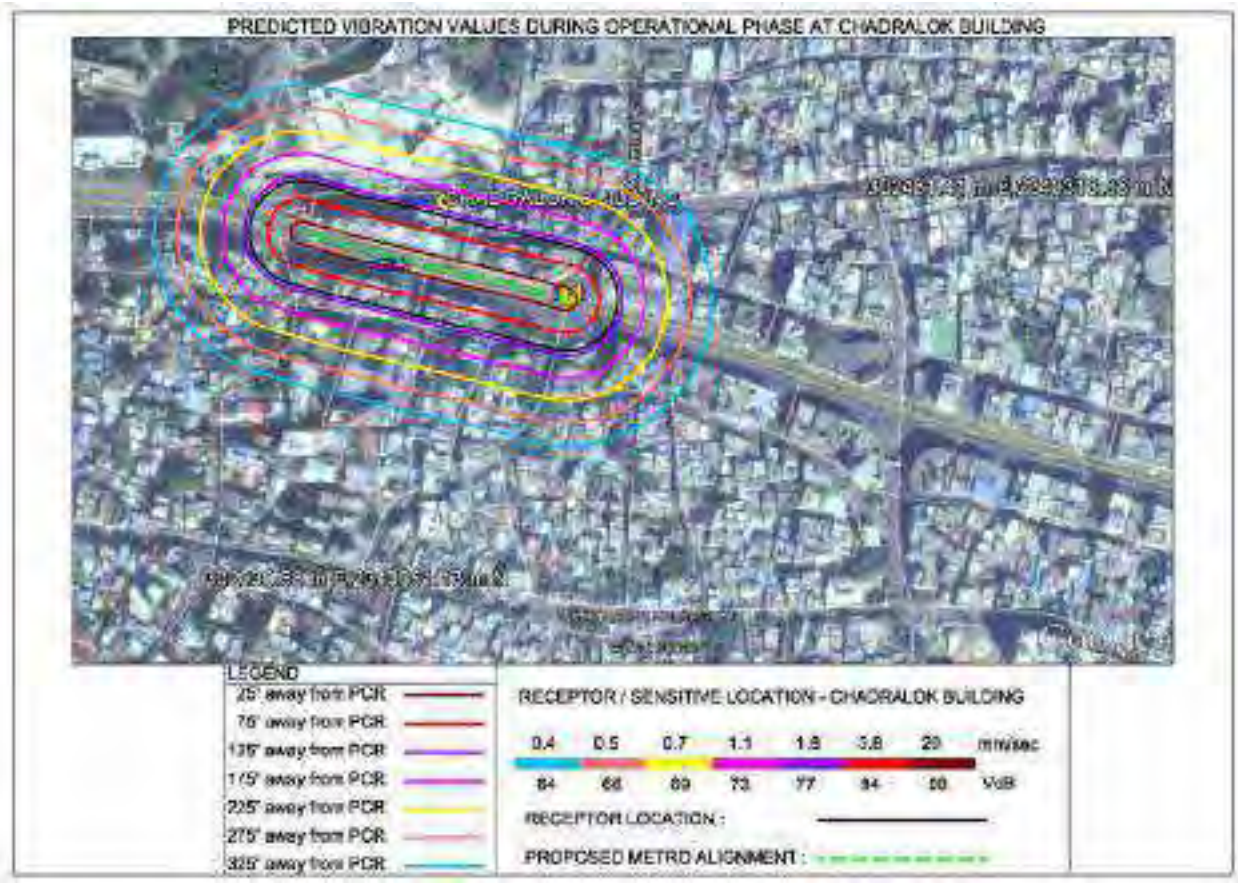


Figure 6.37- Predicted vibration values during Operation Phase at Chanderlok building

Rattan Plaza (V17): This location falls towards Right hand side of the East West Corridor. The building is located 33.0' away from the corridor at ch:6350.000. The building is used for commercial purposes. The monitored vibrational value at this location is 0.5 mm/sec. The relatively higher value may be due to the nature of local soil strata. As the building is located in a thickly populated area in the city, it is advisable to adopt necessary precautionary measures during construction and operational phases of the project.

Figure 6.38- Predicted vibration values during Operation Phase at Rattan Plaza

Saraswati School (V18): This location falls towards Right hand side of the East West Corridor. The building is located 27.8' away from the corridor at ch:7650.000. The building is used for educational purposes. The monitored vibrational value at this location is 1.8 mm/sec. As the building is located in a thickly populated area in the city, it is advisable to adopt necessary precautionary measures during construction and operational phases of the project.

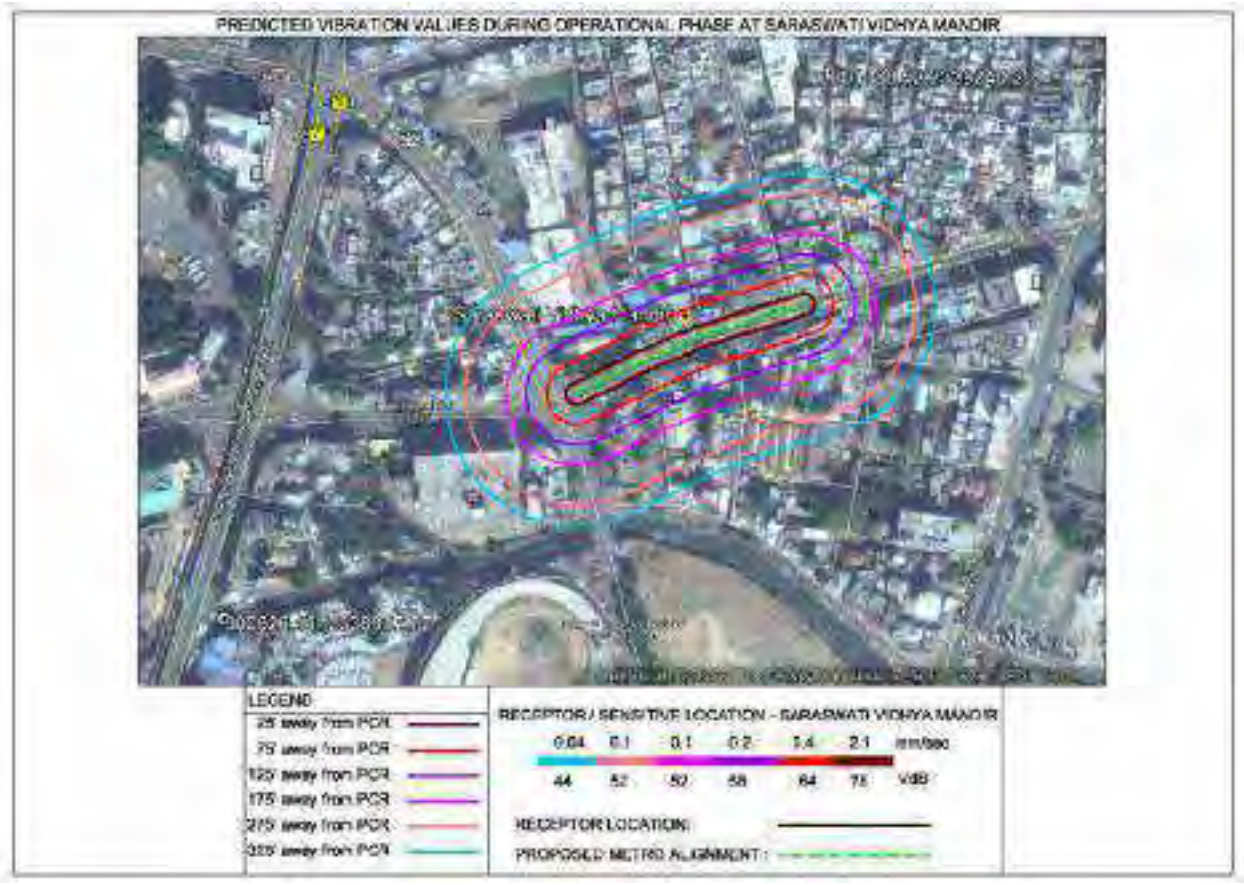


Figure 6.39- Predicted vibration values during Operation Phase at Saraswati School

Kalinga Arcade (V19): This location falls towards Right hand side of the East West Corridor. The building is located 55.7' away from the corridor at ch:10000.000. The building is used for educational purposes. The monitored vibrational value at this location is 2.5 mm/sec. As the building is located in a thickly populated area in the city, it is advisable to adopt necessary precautionary measures during construction and operational phases of the project.

Figure 6.40- Predicted vibration values during Operation Phase at Kalinga Arcade

Building Near Ambasari Lake (V20): This location falls towards Right hand side of the East West Corridor. The building is located 41.3' away from the corridor at ch:10050.000 to 10075.000. The building is used for residential purposes. The monitored vibrational value at this location is 1.3 mm/sec. As the building is located in a thickly populated area in the city, it is recommended to adopt necessary precautionary measures during construction and operational phases of the project.

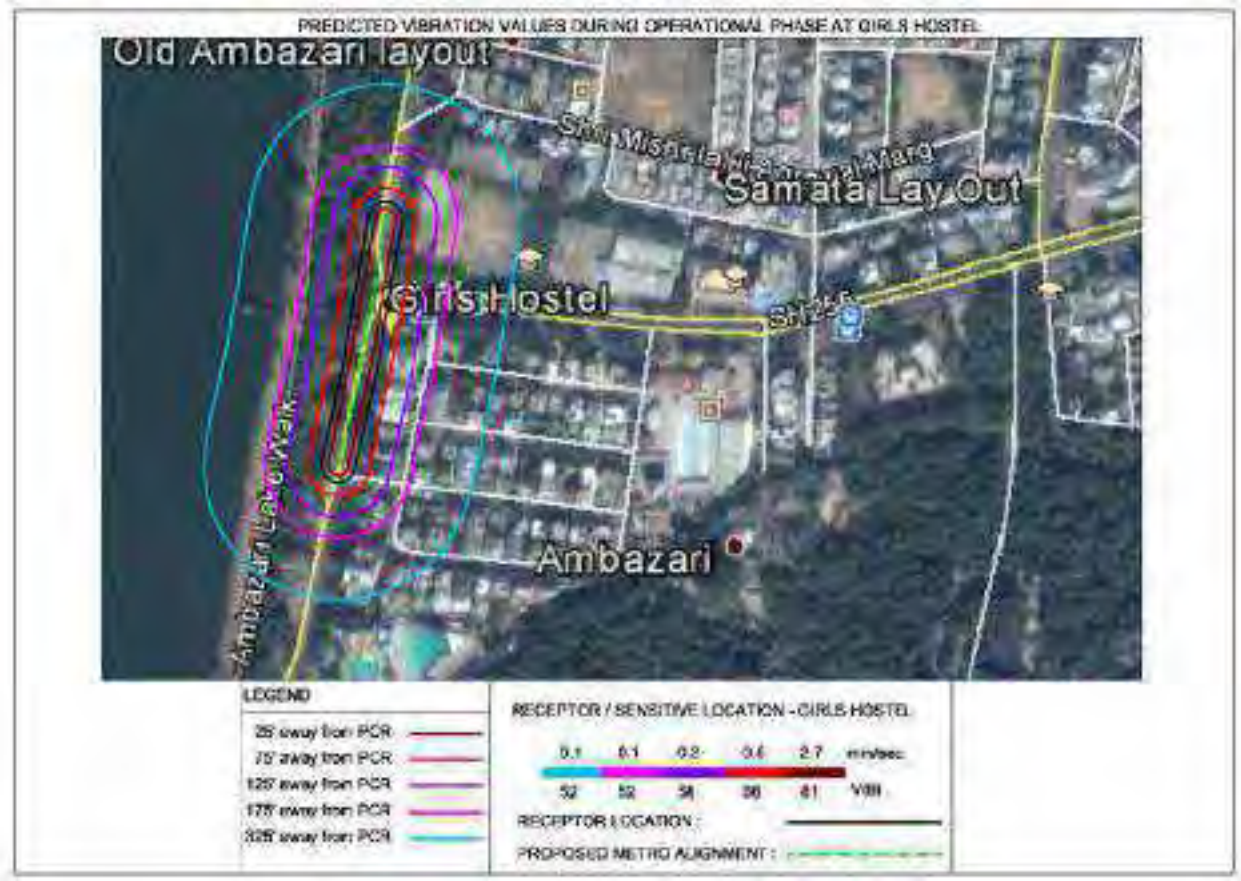


Figure 6.41- Predicted vibration values during Operation Phase at Building Near Ambasari Lake

New Construction in Subhash nagar (V21): This location falls towards Left hand side of the East West Corridor. The building is located 61.8' away from the corridor at ch:12600.000 to 12650.000. The building is used for residential purposes. The monitored vibrational value at this location is 15.2 mm/sec. As the building is located in a thickly populated area in the city, it is recommended to adopt necessary precautionary measures during construction and operational phases of the project.

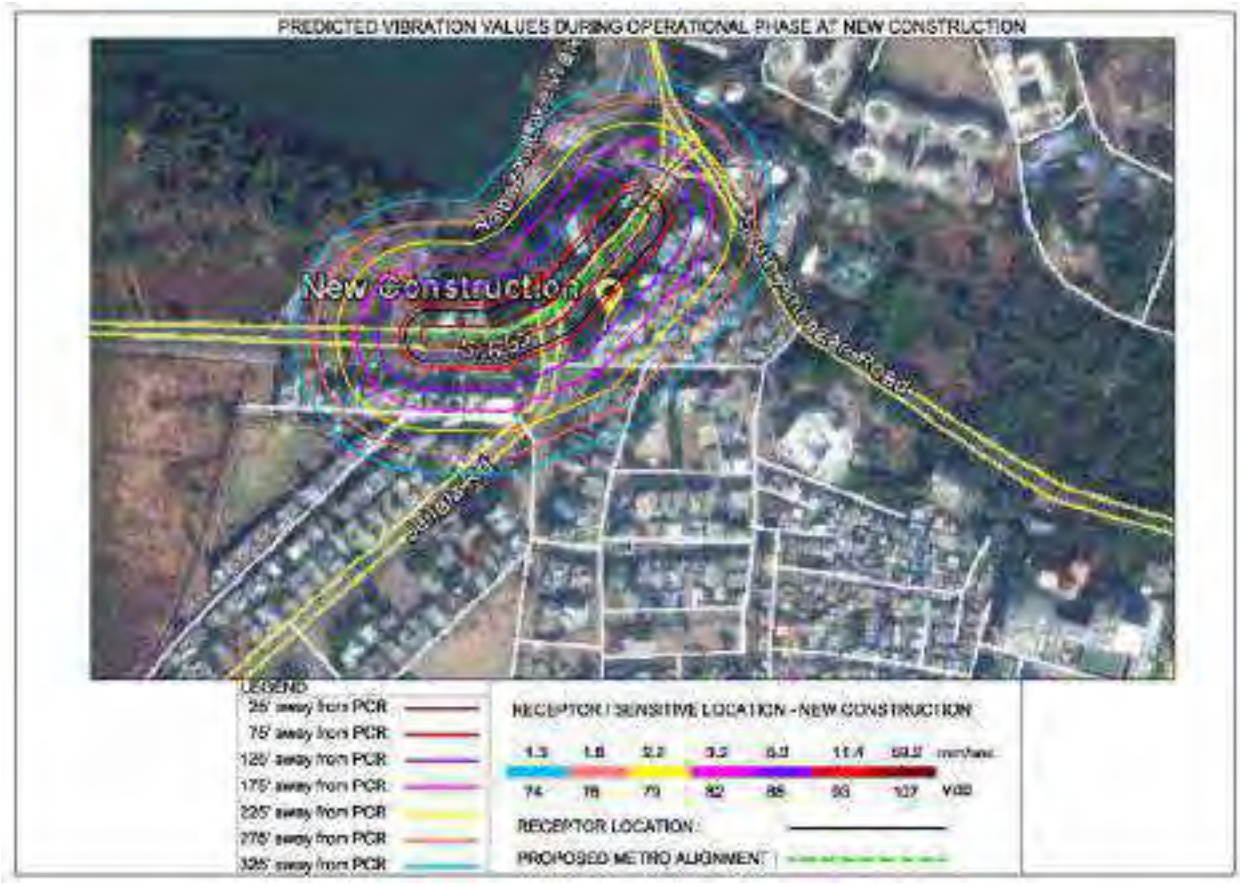


Figure 6.42- Predicted vibration values during Operation Phase at New Construction in Subhash nagar

Shubham Apartments (V22): This location falls towards Left hand side of the East West Corridor. The building is located 68.9' away from the corridor at ch:12600.000 to 12650.000. The building is used for residential purposes. The monitored vibrational value at this location is 2.3 mm/sec. As the building is located in a thickly populated area in the city, it is recommended to adopt necessary precautionary measures during construction and operational phases of the project.

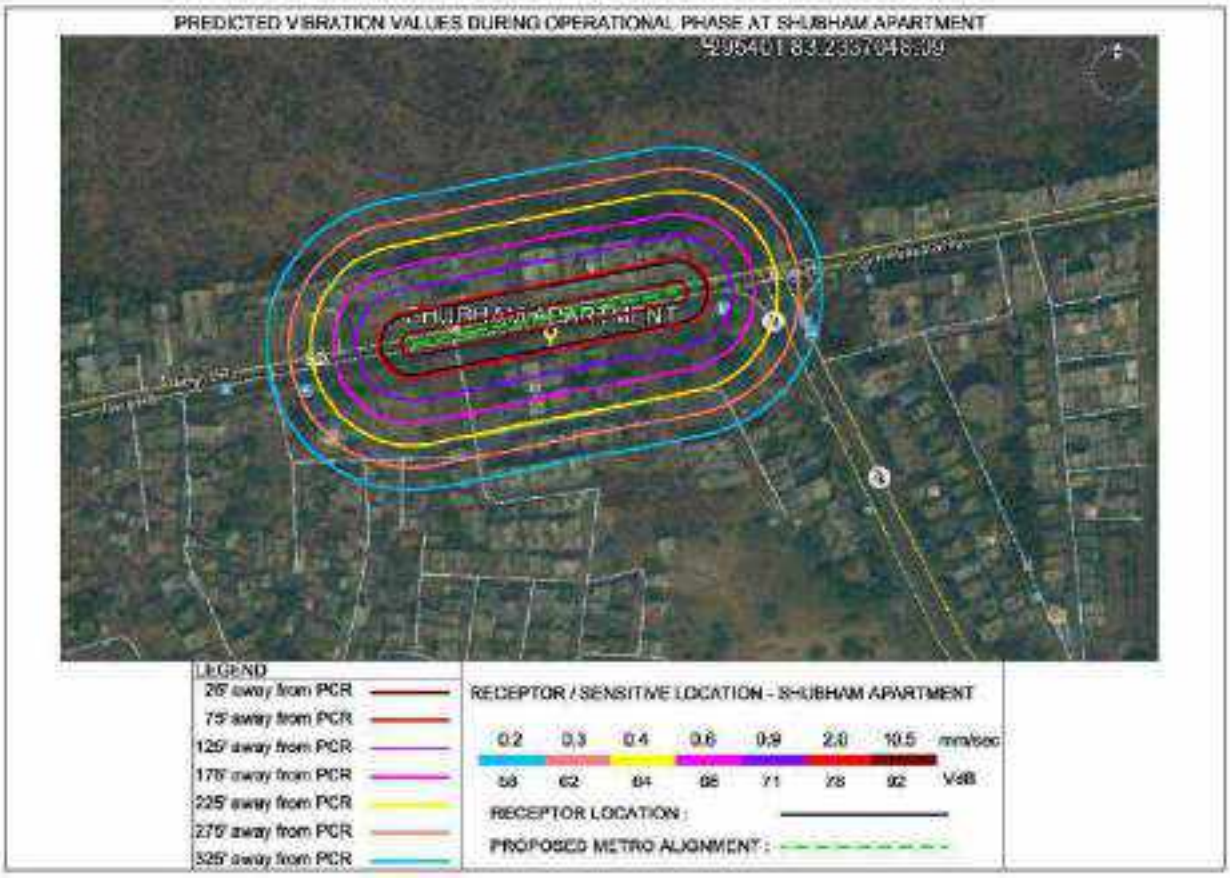


Figure 6.43- Predicted vibration values during Operation Phase at Shubham Apartments

It is observed that the vibration is ranging from 29 VdB to 60 VdB along the project corridor. High vibrations (78VdB-84.7VdB) were recorded along the sections which are passing through existing NH7 and Hingna Road. It is due to movement of heavy vehicles on the highway. It is expected that vibration levels are likely to be increased due to operation of the Metro. Past studies (Source: http://indiatoday.intoday.in/story/delhi-metro-line-tremors-every-threeminutes/

1/158027.html) have shown that the vibrations have been recorded between 60 VdB and 72 VdB due to operation of the metro. It is also recorded that vibration levels have reached up to 95 VdB when metro is running at a high speed 75-80Km/h. However, the operation speed of the metro-rail anticipated in the project is between 30-35 Kmph. Hence, the vibrations level may not reach to the higher level.

Mitigation Measures:

- Vibration emanates from rail-wheel interaction and the same can be reduced by minimizing surface irregularities of wheel and rail, improving track geometry, providing elastic fastenings with insertion of resilient and shock absorbing pad.
- While designing the track structure for Mass Rapid Transit System all the above points have been taken into consideration in the following ways:

  · Rails will be continuously welded and also will be laid to fine tolerances so that any noise/vibration on account of track geometry could be reduced.

  · The vibration generated from rail-wheel interaction will be greatly absorbed by the elastic fastening system proposed to be used.

- Lubrication of rail by vehicle mounted lubricator have been contemplated.

6.5.3.1 Impact on sensitive equipment at Hospitals

There are three major hospitals falling within 150 ft distance on either side of the right of way. These hospitals are Wockhardt Super Speciality Hospital, Wockhardt Heart Hospital and Lata Mangeshkar Hospital. The Wockhardt Super Speciality Hospital, Wockhardt Heart Hospital and Lata Mangeshkar hospital are located at distances of 90 ft, 85 ft and 300 ft (Main building) respectively away from the centre line of the alignment. The predicted vibration levels at these locations are 0.019 inch/sec & 0.0118 inch/sec which are well within the National standard of 0.20 inch/sec.

Opinions have been taken from these hospitals administration/Centre heads to understand measures to be adopted by NMRCL to mitigate noise & Vibration.

Project details briefed to them along with likely impact during construction & operation phase. The following points come out during discussion:

- Unanimous positive response to Metro Rail from the administration so that City will get better connectivity; Hospital staff, patients & attendants can reach the hospital quicker and safer than without Metro. All of them welcomed the Metro Rail Project in Nagpur.
- Ventilator machines and 2D ECHO machine are sensitive to vibration and hence avoid the major piling activity between 2 to 5 pm during day time and 10 pm to 5 am during night time.
- Traffic diversion and management shall be done effectively in close proximity of the hospitals.

Medical equipment are sensitive to vibration only in operating stage. Negligible impact will be anticipated during operation stage as the vibration levels are well within standard of 0.20 inch/sec. Drop hammer piling will be avoided and hence negligible vibration impact during construction. Due consideration will be undertaken in the traffic diversion plan in close proximity of hospital.

6.5.4 Water supply and sanitation at stations

Public Health facilities such as water supply, sanitation and toilets are very much needed at the stations, CPHEEO has recommended 70 litres per day (including drinking, toilets flushing etc.), water supply to persons working at stations. The people working at stations will be about 30 and assumed that 25% of riders are drinking the water. The water demand in stations will be for following components:

- Personal use of Railway staff,
- Cleaning
- Toilets flushing
- Fire demands, and
- Wastage

As per the available data, the water demand for each station will be approximately 50m^3 per day. The proposed NMRCL project is having 36 stations and the total quantity of the water requirement is estimated to be 1800 m^3 per day. Adequate provisions for meeting the water demand at each station have

been taken. Platform washing requirement has been worked out at metro stations has been taken at the rate of 0.5 liter per m^2. Fire fighting requirement has been taken as per the existing norms of Maharashtra Government. This could be developed from existing ground water source or municipal water supply through tankers. The construction and operation of the proposed project will not have any major impact on the surface/ ground water quality in the area. But the quantities of such spills are very negligible.

Water should be treated before use up to IS:10500 drinking water standards. Ground water shall be used for this purpose.

Sanitation:

NMRCL has made MoU with Defence Research & Development Establishment (DRDE) Laboratory (An umbrella unit of DRDO, Government of India) to install eco-friendly bio-digesters at all the 36 stations and 2 depot areas. At each station, there are about 10 bio-toilets /digesters are proposed x 36 station. Total of 360 nos. of Bio-digesters are proposed in the project. The cost of pre-fabricated structure of FRP/HDPE Bio-digesters is Rs. 30,000/unit. An amount of Rs. 108.0 Lakhs provision made in the EMP.

Transit-oriented development

Transit-oriented development is a mixed-use residential and commercial area for maximizing access to public transport and often incorporates features to encourage transit ridership. A TOD neighborhood typically has a centre with a transit (train/ metro) station or stop and residential as well as commercial development around it. Many cities around the world like San Francisco, Vancouver, Hong Kong, Melbourne, Paris, etc. have developed, and continue to write policies and strategic plans, with an aim to reduce automobile dependency and increase the use of public transit.

6.6 Impacts Due to Depot

It is proposed to establish one depot- cum- workshop near Khapri Station in MADC Land for North South Corridor and one depot- cum- workshop in the land belonging to SRP near Lokmanya Nagar for East West Corridor. The area at depot is vegetated with no habitation near Lokmanya Nagar, and at Khapri land is a

vegetated open land of MIHAN industrial area. The depot will have following facilities:

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

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

- Water supply,
- Effluent Treatment (Bio-digesters),
- Oil Pollution,
- Noise Pollution,
- Surface drainage,
- Solid Waste,
- Cutting of trees.

6.6.1 Water Supply

The water supply will be required for the following purpose in the depot. The demands are summarised in Table -6.19.

Table -6.19: Water Demands at Depots

S.no.	Purpose	Demand	Nos.	Total (m^3)
1	Water Supply facilities -for Two Depots	70 lpcd	200 nos.	14.00
2	Washing of Trains(Car washing -15 cars/day/Depot x 2 Depot = 30Nos.)	500 Lts/car	30 nos.	15.00
3	Floor Washing Demand	0.5 lit/sqm	16605 sqm	8.30
4	Fire fighting and replacement	L.S	--	20.00
5	Horticulture	L.S	--	50.00
6	Wastage/Losses	@ 10%	--	10.73
	Total			**118.03**

About 118.03 m^3 of water will be required at Depots for different uses per day. This will be collected from ground water/ municipal water supply through tankers.

6.6.2 Bio-digesters

About 37.30 m^3 of sewage is expected to be generated in the project. The provision of Bio-digesters having capacity of 40 m^3 is made in the BoQ. As per the DRDO, the Inlet and Outlet characteristics of Bio-digesters could be as reported in Table -6.20.

Table – 6.20: Inlet and Outlet Characteristics of Bio-digesters

S.no.	Parameter	Unit	Influent Sewage	Outlet characteristics
1	pH	--	7.0 – 7.5	7.0 – 7.5
2	Turbidity	NTU	70 - 90	2 -5
3	Total Suspended Solids	mg/l	90 -120	50 -80
4	Total Dissolved Solids	mg/l	350 - 450	100 - 300
5	Biochemical Oxygen Demand @ 5 days and 20 ^0C	mg/l	70 – 120	2 -4
6	Chemical Oxygen Demand	mg/l	250 - 300	15 -25
7	Coliforms	MPN/100 ml	300 - 350	0 - 12

Source: DRDO Website

There are 8Nos of Bio-digesters are proposed at each Depot area x 2 Depot areas, cumulative Bio-digesters proposed in the project are 16 nos. Total cost provision made in the EMP for Rs. 4.8 Lakh.

Necessity permissions such as NOC from Maharashtra State Pollution Control Board will be obtained for the Bio-digesters as applicable. The treated effluent will be used for horticulture and flushing purposes. As far as possible "Zero Discharge Rule" may be adopted for disposal of treated wastewater. The sludge generated shall be used as manure.

6.6.3 Oil Pollution

Oil spillage during change of lubricants, cleaning and repair processes, in the maintenance Depot cum workshop for maintenance of rolling stock, is very

common. The spilled oil should be trapped in oil and grease trap. The collected oil would be disposed off to authorised collectors, so as to avoid any underground/ surface water contamination.

Auto Train Wash Plant will be installed at washing plant of Depots for cleaning of the rail cars of 15 nos.per day. The water recycle module will be provided to minimize the water consumption of the depots. Used water from the first & final rinse station & second stage water brush station will be collected in underground reinforced concrete recycling tanks after proper screening. The final recycled water will be reused for work stations of wash plant or depot horticulture. Wastewater generated in cleaning process at each depot is estimated to be 7.5 Cum/day with a total of 15.0 Cum/day in the project. The treatment of the same shall be carried out using Oil & Grease Skimmers /Separators.

Oil & Grease Skimmers/ Separators: The oil & grease tends to form scum in sedimentation chambers, clog fine screens, interfere with filtration and reduce the efficiency of treatment plants. Hence oil & grease removal tank having size of 3x2x1.5 m shall be installed at initial stage of effluent treatments in each depot area. Such tanks usually employ compressed air to coagulate the oil and grease and cause it to rise promptly to the surface. Compressed air may be applied through porous plates located in bottom of the tank. The tank may be designed for a detention period of 5 to 15 minutes. This accumulated oil & grease will be skimmed-off and the same will be disposed through Maharashtra Pollution Control Board (MPCB) approved re-cyclers.

6.6.4 Noise Pollution

The main source of noise from depot is during operation of workshop. The roughness of the contact surfaces of rail, wheel and train speed are the factors, which influence the magnitude of rail – wheel noise. The vibration of concrete structures also radiates noise. To reduce these noise levels, as a part of afforestation Greenbelt will be provided along the Periphery of Depot area of 20-50 m thickness.

6.6.5 Surface Drainage

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

6.6.6 Solid Waste

As per available data, it is estimated that about 1.8 Ton per month of solid waste will be generated from the Depot.

6.6.7 Cutting of Trees

About 300 numbers of trees are observed at both the Depot areas. The details of tree likely to be cut and transplanted are given in the Environmental Management Plan.

6.7 Evaluation of Impacts

Evaluation of cumulative impacts by considering project activities and their impact on various environmental attributes (land,air, water,noise & vibration, biological, socio-economic etc.) assessed in the project using simple checklist method and Matrix method.

6.7.1 Checklist Method

Checklist method is a quick method of evaluation of "negative, positive and no impact" with respect to major project activities during design, construction and operation phases of the project. The anticipated checklist of Environmental Impacts in NMRCL Project is given in Table -6.21.

Table -6.21: Anticipated Checklist of Environmental Impacts

S. No.	Parameter	Negative Impact	Positive Impact	No Impact
A.	**Impacts due to Project Location**			
i	Displacement of People	√		
ii	Change of Land use	√		
iii	Loss of Trees	√		

S. No.	Parameter	Negative Impact	Positive Impact	No Impact
iv	Loss of Cultural and Historical Structures			√
v	Loss of Cultural and Historical land	√		
vi	Drainage & Utilities Problems	√		
vii	Loss of Water Bodies or Water Spread area			√
viii	Impact on Local Transport Utilities	√		
B.	**Impact due to Project Design**			
i	Platforms -Inlets & Outlets	√	√	
ii	Ventilation & Lighting		√	
iii	Railway Station Refuse	√		
iv	Risk due to Earthquakes and other natural calamities			√
C.	**Impact due to Project Construction**			
i	Soil Erosion	√		
ii	Traffic Diversion and Risk to Existing Buildings	√		
iii	Air Pollution	√		
iv	Noise Pollution	√		
v	Impact due to Vibration			√
vi	Health risk at construction site	√		
vii	Impact on Sensitive Receptor	√		
viii	Problem of excavated soil disposal	√		
ix	Dust Generation	√		
x	Muck / Excess soil Disposal	√		
xi	Workers Camps	√		
xii	Generation of the construction and its allied services based employment		√	
xiii	Benefit to Economy	√		
D.	**Impact due to Project Operation**			
i	Noise & Vibration	√		
ii	Water Demands	√		
iii	Refuse disposal and Sanitation	√		
iv	Electro-magnetic Interference	√		

S. No.	Parameter	Negative Impact	Positive Impact	No Impact
v	Employment Opportunities		√	
vi	Benefit to Economy		√	
vii	Mobility		√	
viii	Safety		√	
ix	Traffic Congestion Reduction		√	
x	Reduction of Fuel Consumption		√	
xi	Reduced Air Pollution		√	
xii	Reduction of Green House Gas (CO_2)		√	
xiii	Reduction of Traffic Noise		√	
xiv	Reduction of Local Traffic		√	
xv	Reduction in infrastructure		√	

6.7.2 Matrix Method

The matrix used for EIA consists of project activities on the x-axis and the environmental attributes likely to be affected by these activities on the y-axis. Each cell of the matrix represents a subjective evaluation of the impacts of a particular activity on a particular attribute in terms of magnitude and importance. A blank cell indicates no impact of the activity on the component. The magnitude (M) is represented by a number from 1 to 4,

Where,

1 = minimal 2 = appreciable

3 = significant 4 = severe

Positive sign (or no sign) indicates beneficial impact and negative sign indicates adverse impact. The importance (I) of the impact is given on a scale of 1 to 4 in each cell. This number indicates relative importance of the impact of the activity on the concerned attribute for this project. The magnitude and importance are multiplied to get a score of each cell. The score of individual cells in each row are added to determine the total impact of the project activities on each attribute. Similarly, the score in individual cells in each column are added to determine the total impact of each activity on all the environmental attributes likely to be

affected. The grand total of all cells indicates the total project impact.

Since both 'M' and 'I' vary from 1 to 4, the total score in each cell can theoretically vary between –16 to +16. Therefore the total project impact can vary between (-16 x total number of cells in the matrix) and (16 x total number of cells in the matrix). To compare score from matrices containing different number of cells, the total project scores can be normalized to a scale of 100 as follows

Total project impact scale of 100 = ((Total project impact computed by matrix)/ (16 x total number of cells in the matrix)) X100 . On this scale, the overall impact is classified in Table -6.22.

Table -6.22: Classification of the Overall Impact

Total project impact (Scale of 100)	Magnitude of impact
-100 to –75	Severely adverse
-75 to –50	Significantly adverse
-50 to –25	Appreciably adverse
-25 to 0	Minimally adverse
0 to 25	Minimally beneficial
25 to 50	Appreciably beneficial
50 to 75	Significantly beneficial
75 to 100	Extremely beneficial

Evaluation for Alternative Scenarios:

EIA without EMP

This scenario was based upon the assumption that the proposed development would go ahead without any environmental management options being implemented. The total project impact for the scenario, as can be seen in Table -6.23, was found to be -64. The score on a scale of (+/-) 100 for this scenario was found to be –5.4, which is on the **minimally adverse side**. This shows that if the project goes ahead without an EMP, the adverse impact on the existing environment would be several times that of the impact without the project. Thus, the EMP described in Chapter -6 will have to be implemented to minimize the potential negative impact due to the proposed activity.

EIA with EMP:

If the environmental management strategies discussed in Chapter-6 is fully implemented, the adverse impact of the project would be reduced, and there will be an overall improvement in physical, chemical, biological and socio-economic environment of the region. This is reflected in the total project impact score of +85, as shown in the Table -6.24 below, for this scenario. The score on a scale of (+/-) 100 for this scenario was found to be +6.3, which is on the **beneficial side**. Therefore, the proposed activity will be beneficial for the environment of the area, provided the EMP is in place.

It is clear from the above, that the proposed metro project would have negative effect without implementing certain environmental management strategies. If EMP, as discussed in the Chapter-6, is strictly adopted and implemented, the adverse impacts will be reduced and the overall environmental quality of the area would improve.

Table -6.23: Impact Assessment for the Proposed Project (EIA WITHOUT EMP)

Environmental components likely to be affected	Project activities likely to affect environmental components							
		Site preparation/ Resettlement and Rehabilitation	Construction /other activities	Transportation construction materials	Solid waste generation and its handling	Waste water generation	Post construction and operational phase	Total impact component
Air quality	M	-1	-2	-1	-1		-1	**-8**
	I	1	2	1	1		1	
Noise and Vibration	M	-1	-3	-1	-1		-3	**-19**
	I	1	3	2	1		2	
Surface water quality	M	-1	-1	-1	-1	-2	-2	**-14**
	I	1	2	2	1	2	2	
Ground water quality	M		-1		-1	-1	-1	**-4**
	I		1		1	1	1	
Soil quality / erosion	M	-2	-2	-1	-1	-1	-2	**-11**
	I	1	2	1	1	1	1	
Land use pattern	M	-1	-3	-1	-1		-2	**-12**
	I	2	2	1	1		1	
Flora and Fauna	M	-2	-2	-1	-1		-1	**-12**
	I	2	2	1	1		2	

Environmental components likely to be affected		Project activities likely to affect environmental components						
		Site preparation/ Resettlement and Rehabilitation	Construction /other activities	Transportation construction materials	Solid waste generation and its handling	Waste water generation	Post construction and operational phase	Total impact component
Aesthetics	M	-1	-2	-1	-1		-1	**-11**
	I	1	2	2	2		2	
Safety	M		-2	-2	-1		-1	**-11**
	I		2	2	1		2	
Human health	M	-1	-1	-2	-1	-1	-1	**-10**
	I	1	2	2	1	1	1	
Socio-economic status	M	1	2	1	1		**3**	**20**
	I	1	2	2	1		4	
Economy, trade and commerce	M	2	2	2	2		**3**	**30**
	I	2	3	2	2		4	
Total Action Impact		**-8**	**-30**	**-12**	**-6**	**-7**	**1**	**-62**

I = Importance, M = Magnitude; Impact scale: 1 = Minimal, 2 = Appreciable, 3 = Significant, 4 = Severe. Positive sign (or no sign) indicates beneficial impact, Negative sign indicates adverse impact, Blank indicates no impact

Table -6.24: Impact Assessment for the Proposed Project (EIA WITH EMP)

Environmental components likely to be affected		Project activities likely to affect environmental components							
		Site preparation/ Resettlement and Rehabilitation	Construction /other activities	Transportation construction materials	Solid waste generation and its handling	Waste water generation	Green belt development	Post construction / Operational phase	Total impact component
Air quality	M	-1	-1	-1	-1		2	3	**11**
	I	1	1	1	1		3	3	
Noise and Vibration	M	-1	-1	-1	-1		2	-2	**-4**
	I	1	1	1	1		2	2	
Surface water quality	M	-1	-1	-1	-1	-1	1	-1	**-5**
	I	1	1	1	1	1	1	1	
Ground water quality	M		-1		-1	-1		-1	**-4**
	I		1		1	1		1	
Soil quality / erosion	M	-1	-1	-1	-1	-1	2	-1	**-2**

Environmental components likely to be affected		Project activities likely to affect environmental components							
		Site preparation/ Resettlement and Rehabilitation	Construction /other activities	Transportation construction materials	Solid waste generation and its handling	Waste water generation	Green belt development	Post construction / Operational phase	Total impact component
	I	1	1	1	1	1	2	1	
Land use pattern	M	-2	-1	-1	-1		2	1	**-4**
	I	2	2	1	2		2	1	
Flora and Fauna	M	-2		-1	-1		2	2	**4**
	I	2		1	1		3	2	
Aesthetics	M	-1	-1	-1	-1		2	1	**2**
	I	1	1	1	1		2	2	
Safety	M		-1	-1				3	**7**
	I		1	1				3	
Human health	M	-1	-1	-1	-1	-1	2	2	**5**
	I	1	1	1	1	1	2	3	
Socio-economic status	M	2	3	2	2		2	4	**36**
	I	2	2	2	2		3	3	
Economy, trade and commerce	M	2	3	2	2		2	4	**39**
	I	2	3	2	2		3	3	
Total Action Impact		**-6**	**4**	**-1**	**-2**	**-4**	**46**	**48**	**85**

I = Importance, M = Magnitude; Impact scale: 1 = Minimal; 2 = Appreciable; 3 = Significant; 4 = Severe. Positive sign (or no sign) indicates beneficial impact, Negative sign indicates adverse impact, Blank indicates no impact.

CHAPTER -07

POSITIVE ENVIRONMENTAL IMPACTS

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

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

7.1 Employment Opportunities

The project is likely to be completed in a period of about 4 years. During this period manpower will be needed to take part in various activities. About 4,800 persons are likely to work during peak period of construction activities in all reaches. In operation phase of the project about 30 persons per kilometer length of the corridor, will be employed for operation and maintenance of the proposed

system. Thus the project would provide substantial direct employment; besides, more people would be indirectly employed in allied activities and trades.

7.2 Benefit to Economy

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

7.3 Mobility

The proposed Nagpur Metro network was estimated to carry 3.52 lakh passengers per day, in the year 2016. The maximum PHPDT on any section will be more than 10089 by year 2016 and more than 12934 by year 2031. Passenger average time saved will be about 13.54 minutes per Kilometer.

7.4 Safety

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

7.5 Traffic Congestion Reduction

To meet the forecast transport demand in the year 2041, it is estimated that the number of buses will have to be more. During this period personalised vehicles may also grow. Together, they will compound the existing problems of congestion and delay. The proposed development will reduce journey time and hence congestion and delay.

7.6 Less fuel Consumption Due to reduction in Vehicle

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

7.7 Reduced Air Pollution

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

7.8 Saving in Road Infrastructure

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

7.9 Traffic Noise Reduction

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

7.10 Climate Change

International concern about the climate change has led to the kyoto protocol, negotiated in 1997 and came into force on 16th February, 2005. It contains legally binding emission targets for developed countries to limit or reduce greenhouse gas emission. It is an international agreement to curtail emission of green house gases (GHGs) which is responsible for global warming. Green house gas in atmosphere absorbs and emits radiations within the thermal infrared range. The 6 greenhouse gases are responsible : Carbon-di-Oxide (CO_2), Methan (CH_4), Nitrous

Oxide (N_2O), Hydrofluoro Carbons (*HFCs*), Per Fluoro Carbons (*PFCs*) and Sulphur Hexa fluoride (SFI_6). The objective of the protocol was the stabilization of GHG concentration in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Carbon market is the brain child of the Kyoto protocol for controlling GHG emissions. The protocol agreed 'caps' or quotas on the maximum amount of GHG for developed and developing countries. The protocol makes it mandatory for the commercial entities emitting above the permitted limit of Carbon dioxide to cut down their emissions to prescribed levels or they should buy Carbon Credits Certificates which can be transacted in the market, or alternatively pay a charge for the emissions, which is referred to as Carbon Tax.

7.10.1 Carbon Credit

Each Carbon Credit represents one ton of CO_2 either removed from atmosphere or saved from being emitted.

7.10.2 Carbon Trading

The mechanism of buying and selling carbon credit is known as carbon trading. The developed countries with emission reduction targets are the buyers of the carbon credits. The developing and least developed countries with no emission targets (at present) are the sellers or suppliers of the carbon credits. The non-polluting companies from developing countries sell carbon credits to buyers and earned extra money in this process. The environmental carbon trading is done on the basis of the carbon credits earned. These credits are maintained in the form of electronic certificates. In carbon market two types of trading occur:

(a) Cap and trade (emission trading)

(b) Offset trading (project based carbon credits)

Kyoto Protocol worked out three mechanism of the emission reduction for developed countries to reduce GHG at target level.

(i) International Emission Trading (IET) : It allows countries to sell their surplus permitted emissions (which are not used) to those countries which

are over their targets these credits can be sold with quantified emission limits and reduction commitments under protocol. Countries can trade in the international carbon credit market.

(ii) Joint Implementation (JI) : Under this mechanism a developed country (invest party) with a relatively high cost of domestic GHG reduction, sets up a emission reduction or removal project in another developed country (host party) that has relatively low cost of GHG reduction, to achieve their Kyoto targets. JI offers parties a flexible and cost-efficient means of fulfilling a part of their Kyoto commitments, while the host country benefits from the foreign investment and the technology transfer. The credits generated out of JI is called as Emission Reduction Units (ERU).

(iii) Clean Development Mechanism (CDM) : It is a market driven mechanism and offers an opportunity to contribute towards environmental sustainability through business operations while at the same time helps to generate revenues by selling carbon credits. Under the United National Frame Work Convention on Climate Change (UNFCCC) charter, any company from a developed country can take up a emission reduction project activity with a company in the developing country that is signatory to the Kyoto protocol. In these developing countries cost of emission reduction project activity is usually much lower. These developed country companies must adopt new advance technologies and finance these projects to earn carbon credits in developing countries. The credit in CDM is termed as Certified Emission Reduction (CERs). Such credit has to be certified by an appropriate authority under the protocol. After certification, only a part of CERs can be transferred to the companies of developed countries to meet their emission reduction requirements. Thus CER is a 'certificate' just like a stock.

Two types of carbon market occur:

(a) The voluntary market in which the trade of carbon credit is on a voluntary basis.

(b) The Regulatory Compliance Market : It is used by companies and government that have to account for their GHG emissions. It is regulated by mandatory national and international carbon reduced regimes.

The market works as financial market and carbon credits are used as a currency in these markets. The elimination cost of an additional unit of pollution may differ for different countries. In order to find a common unit for this commodity, all GHGs are converted to CO_2 equivalent. The CO_2 (equ.) are traded in carbon markets.

Different types of carbon projects: Carbon credits can be generated from various projects including.

(a) Renewable energy : A switch from fossil fuels to a 'clean' energy. e.g. wind and solar energy.
(b) Forestation and Afforestation : The planting of new trees ad trees sequester and store CO_2 e.g. forest regeneration.
(c) Energy Efficiency : Reducing emission through an increase in energy efficiency e.g. installation of energy efficiency machinery.
(d) Methane Capture : Avoiding methane emissions through capture and burning to create energy e.g. landfill methane capture.
(e) **Transport** : Improvement in vehicle fuel efficiency with new technologies switch to transport mode. e.g. changing to less carbon intensive means of transport like Trains, Metro in Delhi and other cities of India.

Project eligibility for carbon credits depends on whether a project follows one of the Kyoto protocol's project based mechanisms or an independent voluntary standard.

Accounting Issues and Carbon Credit Accounting:

There is a unclear picture of recording of carbon credits because at present no authoritative accounting guidelines are available under generally accepted accounting principles of India and at International level. India is a huge supplier of CERs in global market. But a separate accounting standard has not been issued to measure and disclose income and expenditure from carbon reducing projects in India. To overcome the situation a significant step is taken by the Institute of Chartered Accountants of India (ICAI). ICAI issued guidance note on accounting for self-generated CERs in February, 2012, which has been effective on or after 1st

April, 2012. The Guidance Note (GN) provides guidance on accounting for carbon credits but does not deal with purchased CER's or with the use of CER's in own business.

(i) As per GN the CER cannot be recognized as an asset till it is certified by UNFCCC and its credit is being received by the generating entity. Thus CER's cannot be recognized at various stages of project.

(ii) During the period prior to issuance of CER's to generating entity, CER's has to be treated as contingent asset because CER's will actually arise or not with carbon projects, depends upon future certification by UNFCCC.

(iii) When CER's are actually issued to entity then these are recognized as an asset because now these become resource which is controlled by entity and it leads to future economic benefits in form of cash and cash equivalents on future sale of these with certainty.

(iv) As per AS-26 : An intangible asset is an identifiable non-monetary asset without physical existence held for use in the production or supply of goods and services, for rental to others or for administrative purposes.

As per AS-2 : Inventories are assets held for sale in ordinary course of business or in process of production for such sale or in the form of materials/suppliers to be consumed in the production process or in rendering of services.

Although CER's have no physical existence and are held for sale in normal course of business but they are not held for use in production or supply of goods or services. So they do not meet the criteria of being taken as an intangible asset. They should be accounted for as per requirements for AS-2 as inventory.

(v) Treated as an inventory the CER should be measured at the cost or net realizable value (NRV) whichever is less.

(vi) Here cost includes expenses made to setup a CDM project activity, operate the CDM project and generate CERs. Thus

Cost = Cost of Purchase + Cost of Conversion + Other Cash incurred to bring the inventory to present location and condition.

(vii) But expenses which do not give rise to CERs, like research and development should be accounted as per AS-26.

(viii) Capital assets used for generating CER's, should be accounted for as per AS-10 like pollution control devices, boilers etc.

(ix) Net Realisable Value (NRV) is the difference between estimated selling price in the ordinary course of business and the summation of estimated costs of completion and estimated costs necessary to make the sale.

NRV = Estimated Selling Price – (Estimated Cost of Completion + Estimated Selling Cost)

(x) AS-9 should be applied by entities with AS-2, to recognize revenues in respect of sales of CERs.

7.10.3 Carbon Credits in NMRCL Project

India has a large potential to earn carbon credits. India is currently the fourth largest GHG emitter in the world, although its per capita emissions are less than half of the world's average. India has generated 1,77,360,206 CER's through CDM till 2014 and India stands second in the world in terms of CDM projects registered and issuance of CER's next to China.

i) Carbon Credit Calculations

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

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

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

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

Establishment and description of baseline scenario: The baseline for the proposed project activity has been arrived at using the methodology specified in the applicable project category for small-scale CDM projects. Indicative simplified

baseline and monitoring methodologies for selected small-scale CDM project activity categories for Type-III C defines the baseline as: "The baseline is the energy use per unit of service for the vehicle that would otherwise have been used times the average annual units of service per vehicle times the number of vehicles affected times the emission coefficient for the fuel used by vehicle that would otherwise have been used. If electricity is used by the vehicles, the associated emissions shall be estimated in accordance with paragraphs of category I.D".

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

Thus in the baseline scenario for the project activity, rolling stocks without regenerative braking system would have been used and total electricity consumption of rolling stocks would have been met from MHEB.
For the project activity, the baseline and project emissions are from the total electrical energy (kWh) consumed in running the rolling stock during the project activity. The associated emissions are estimated as follows:

$ERy = BEy - PEy - LEy$ ……..(1)

Where:

ERy Emission reductions in year y (t CO2/y)-Calculated as in equation 1

BEy Baseline Emissions in year y (t CO2/y)- Calculated as in equation 2

PEy Project emissions (t CO2/y)

LEy Leakage emissions in year y (t CO2/y) – Not applicable as per methodology used

Baseline emission and Project emissions are calculated as follows:

$BEy=EGy*EFy$……...(2)

$PEy=PGy*EFy$…….(2)

Where,

BEy = Baseline emissions in year *y* (tCO2).

EGy = Total electrical energy regenerated with regenerative braking in year y (MWh). The data will be monitored ex-post.

PGy = Electrical energy consumed by the operational rolling stock in year y (MWh). The data will be monitored ex-post.

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

Methodology: Name of the Methodology Used: ACM0016: Mass Rapid Transit Projects. The tool referenced in this methodology is given in the reference documents.

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

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

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

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

However users of the metro may potentially realize in the baseline or in the

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

Baseline emissions are calculated per passenger surveyed. For each passenger surveyed the individual baseline emissions are calculated and multiplied with the individual expansion factor thus getting the baseline emissions of all passengers of the specific week surveyed.

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

Formula Used:

ER_y= (53*DR*DP*365)/ (10^6)

53 Emission per person per km per day

ER_y Emission reductions in year y (tCO_2e)

DR Daily ride per passenger (km)

DP Daily number of passengers

EF_y Emission factor (tCO_2e/MWh)

CER Revenue = ER_y * CER Price of one unit

Table 7.1 is showing the estimation of Carbon Credits in NMRCL Project.

Table -7.1: Carbon Credits in NMRCL Project

	Year	CER Rate (Euro/CER)	2016	2021	2026	2031	2036	2041
Daily ridership	Trip length per Passenger (km)		6.419	6.453	6.494	6.533	6.521	6.522
	Daily Ridership (No. of Passengers)		352442	383439	419135	458893	508656	563735
Carbon Credit Calculation	Carbon Credits (tCO_2e/year)		43765	47866	52654	57995	64166	71125
Carbon Credit Revenue	Revenue with Present Price (INR)	0.40	13,08,223	14,30,810	15,73,933	17,33,586	19,18,050	21,26,068
	Revenue with Highest ever CER Rate (INR)	18	5,88,70,052	6,43,86,471	7,08,27,001	7,80,11,394	8,63,12,253	9,56,73,082
	Revenue with Lowest ever CER Rate (INR)	0.10	3,27,056	3,57,703	3,93,483	4,33,396	4,79,512	5,31,517

Please note that above revenue is calculated for one year and this can be availed at least for 10 years.
Note: Trip length per passenger, Daily Ridership are taken from DPR (Pg. No. 5)
Source: Assessed by Aarvee Associates

CHAPTER -08
ENVIRONMENTAL MANAGEMENT PLAN

8.0 ENVIRONMENT MANAGEMENT PLAN

The Environmental Management Plan (EMP) states the procedure in which the project proponent would carry out the implementation of the mitigation measures and ensure compliance with environmental regulations that are binding on the project. This plan also specifies the organizational requirements and institutional strengthening necessary for sound environmental management of the project. Nagpur metro alignment has been classified into four reaches and the Environment Management Plan (EMP) has been prepared keeping in view the reaches classification as and when required. NMRCL Project Reach wise details is given in Table -8.1.

Table -8.1: NMRCL Project Reach Wise Details

Name	Corridor	Station wise details	Length (in km)
Reach 1	North-South	Sitaburdi station to Khapri station	12.54
Reach 2	North-South	Sitaburdi station to Automotive square station	6.85
Reach 3	East-West	Sitaburdi station to Lokmanya Nagar	10.45
Reach 4	East-West	Sitaburdi station to Prajapati Nagar	8.09

8.1 Approvals/Clearances Requirement

On the basis of baseline study and impacts, issues like tree cutting, development near Archaeological Monuments and muck disposal etc needs necessary approvals/clearance from the relevant concerned authorities. NMRCL will ensure that all necessary approvals/clearances are in place before implementation. Before commencement of the construction the necessary permission required for the project is given in Table -8.2.

Table -8.2: Necessary Approvals/Clearances Requirement

S. No.	Issues	Provisions of Laws & Regulations	Due Date	Approving Authority	Remarks
Pre-Construction Stage					
1.	Permission for felling of trees	Tree removal will be guided as per state government rules	Before construction	Nagpur Municipal Corporation & Revenue Department, Nagpur	Online form for Felling of trees is available at Garden Department, NMC at 203.129.203.6: 9180/grnp/
2.	Construction within the regulated area of Archaeological monuments	The Ancient Monuments and Archaeological Sites and Remains (Amendment and Validation) Act, 2010	Before construction	Heritage Conservation Committee, Kasturchand Park	Already obtained NoC from Kasturchand Heritage Conservation Committee dated on 18th August, 2016
Implementation Stage					
3.	Consent to operate hot mix plant, crushers, batching plant	Air (Prevention and Control of Pollution) Act, 1981	Before construction	Maharashtra state pollution control board	-
4.	Permission for withdrawal of groundwater for construction	Environment (Protection) Act, 1986	Before construction	Central Ground Water Board, Nagpur	-
5.	Authorization for Disposal of Hazardous Waste	Hazardous Waste (Management and Handling and trans-boundary movement) Rules 2008	Before construction	Maharashtra state pollution control board	-
6.	Employing workers	The Building and other Construction workers (Regulation of Employment and Conditions of Service) Act, 1996	Before construction	District Labor Commissioner	-
7.	Muck disposal permission	-	Before construction	State Govt./ Local Govt.	-

S. No.	Issues	Provisions of Laws & Regulations	Due Date	Approving Authority	Remarks
Operation Stage					
8.	Environmental statement form	-	During operation, every year	MPCB/ MoEF&CC	-

8.2 Environment Management Plans

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

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

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

- Funding,
- Management and Training, and
- Monitoring

The purpose of the first link is to ensure that proposed actions are adequately financed. The second link helps in embedding training, technical assistance, staffing and other institutional strengthening items in the mitigation measures to implement the overall management plan. The third link provides a critical path for

implementation and enables sponsors and the funding agency to evaluate the success of mitigation measures as part of project supervision, and as a means to improve future projects. This chapter has been divided into three sections:

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

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

8.3 Mitigation Measures

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

- Compensatory Afforestation
- Safety Management Measures during the construction period
- Workers Camp
- Energy Management
- Hazardous Waste Management
- Environmental Sanitation
- Utility Plan
- Archaeological and Historical Preservation
- Air Pollution Control Measures
- Noise Control Measures
- Vibration Control Measures
- Traffic Diversion/Management
- Soil Erosion Control
- Muck Disposal
- Water Supply, Sanitation and Solid Waste Management
- Sensitive Receptors
- Management plans for Depot
- Training and Extension

8.3.1 Compensatory Afforestation

The objective of the afforestation program should be to develop natural areas in which ecological functions could be maintained on a sustainable basis. The Nagpur Municipal Corporation (NMC) & Revenue Department, Nagpur is responsible for giving the permission for the tree cutting in the project area. An application along with the location map of trees to be removed should be submitted to the concerned Departments for permission. As mentioned in section 6.4.13 about 639 trees are observed at alignment and Depot locations. The detail of tree likely to be removed is given in the Table -8.3.

Table -8.3: Details of Trees cut

S. No	Particulars	Number of trees to be cut
1	Reach 1	112
2	Reach 2	61
3	Reach 3	93
4	Reach 4	72
5	Khapri depot	100
6	Hingna depot	200

The trees which are cut will be compensated by planting five times the number of trees. As per estimation, 639 trees are likely to be cut for which 5000 trees are required to be planted. Details of trees to be planted, reach wise, are given in **Table -8.4.** The compensation for loss of these trees works out to **Rs. 40 Lakhs** @ Rs. 800 per tree. The total area required for afforestation of these trees comes out to about 9 ha. It is presumed that Government land will be provided for afforestation; hence no land cost will be involved. Land for plantation of trees will be identified by the project proponent in consultation with NMC/Revenue Department of Nagpur. The native plant species recommended for afforestation by NMC with their botanical names to be planted are indicated in the **Table -8.5**.

Table -8.4: Details of trees to be planted

S. No	Particulars	Number of trees to be planted
1	Reach 1	1651
2	Reach 2	899
3	Reach 3	1384
4	Reach 4	1066

Table -8.5:Scientific Names of Tree for Plantation

S. No	Local Name	Botanical Name
1	Neem	Azadirachta indica
2	Blue Berry	Vaccinium corymbosum
3	Subabul	Leucaena leucocephala
4	Gulmohar	Delonix regia
5	Karanj	Millettia pinnata
6	Peepal	Ficus religiosa
7	Imli	Tamarindus indica
8	Babul	Vachellia nilotica
9	Mango	Mangifera indica
10	Coconut palms	Cocos nucifera

8.3.2 Safety Management Measures

Prior to the construction, identification of safety hazard would be made by Project Authority to establish the safety programmes following rules, regulations and guidelines. These would help to avoid and reduce the accidents. The comprehensive safety programmes will include deployment of a full time safety engineer who will prepare safety plan/schedule for their implementation during construction and operation. The personnel working would wear protective headgear, footwear and other special garments that applicable code requires. The specific working areas in underground construction can have their own unique hazards that personnel requires to be made aware of by providing training and displaying the instruction wherever it requires. The weatherproof first aid boxes will be made available at appropriate locations.

8.3.3 Workers Camp

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

and worker's hygiene will be monitored as a part of Labour Laws of the Country during construction of proposed project. Deployment of worker at the construction site will be made by following the fairer process as mentioned in civil contract agreement.

Shelter at Workplace: At every workplace, shelter shall be provided free of cost, separately for use of men and women workers. The height of shelter shall not be less than 3m from floor level to lowest part of the roof. Sheds shall be kept clean and the space provided shall be on the basis of at least 0.5m2 per head.

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

First aid facilities: At every workplace, a readily available first-aid unit will be provided. Suitable transport will be provided to facilitate transportation of injured and ill persons to the nearest hospital.

Day Crèche Facilities: At every construction site, provision of a day crèche shall be worked out so as to enable women to leave behind their children. At construction sites, where the number of women workers is more than 25 but less than 50, the contractor shall provide with at least one hut and one maidservant to look after the children of women workers. Size of crèches shall vary according to the number of women workers employed.

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

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

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

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

Water Supply and Waste water Treatment Facility for Workers Camps: It is estimated that about 44.80 KLD water will be required daily for the camps, which will be taken from bore well/Municipal Water Supply. Bore well water will be chlorinated for use as drinking water. About 80% of the water supply will be generated as sewage/waste water, which is estimated to be 35.84 KLD. Wastewater needs to be treated before disposal or may be connected to nearby sewerage network.

As per the Contract Labour (Regulation & Abolition) Act, 1970, there shall be at least one latrine for every 25 male. The sewage from the community water closet would be treated through bio-digesters. The drinking water facilities and sewage disposal sites should be located away from each other. A provision of **Rs. 76.8 Lakh** would be made for these facilities as reported in **Table -8.6**.

Table -8.6: Cost of water supply and sanitation facilities

S. No	Description	Rate (Rs/Unit)	Numbers					Cost (Lakh)				
			R1	R2	R3	R4	Total	R1	R2	R3	R4	Total
1	Bio-digesters	30,000/- per unit for 10 members	64	64	64	64	256	19.2	19.2	19.2	19.2	76.8
Total												**76.8**

Note: R1-Reach 1; R2-Reach 2; R3-Reach 3; R4-Reach 4

Above cost is included in Tender document and shall be taken care by contractor.

Solid Waste Management:

It is estimated that about 288 Kg per day municipal solid waste will be generated from the workers camp. The collection, conveyance and disposal facilities shall be made available by providing 20 litres capacity bin with handle and cover for 8 workers. In addition, one community bins would be provided for effective collection of the waste. The disposal of the waste will be at municipal corporation landfill site. The cost of these facilities including maintenance for 5 years works out to be about **Rs. 30.32 Lakh** as summarized in **Table -8.7**.

Table -8.7: Cost of domestic solid waste management facilities for workers camp in one reach

S. No	Description	Numbers	Rate (Rs/Unit)	Cost (Lakh)
1	Solid waste collection bins @ Rs. 200/bin Community bin 4 no. @Rs 15,000/bin	60 4	200 15000	0.72
2	Transportation	-	Lump sum	20.00
3	Manpower cost of 4 persons @5000 per person per month for 4 years	4	4*48*5000	9.60
			Total	**30.32**

8.3.4 Energy Management

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

In order to contain the energy cost to make the metro operations environment-friendly and sustainable, the NMRC is integrating solar energy generation right from the project planning and design stage to meet its energy requirements to the tune of 65 per cent, which will make it the one of "greenest" metros in the

world. All station rooftops, depots, boundary walls, depot shed rooftops and vacant ground spaces will be mounted with solar photovoltaic panels. In Phase-I, about 14 Mw solar power is proposed to be integrated which will rise to 36 Mw in future.

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

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

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

8.3.5 Hazardous Waste Management

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

8.3.6 Environmental Safeguard

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

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

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

Team of environmental sanitation squad shall carry out:

- Full height fence, barriers, barricades etc. shall be erected around the site in order to prevent the surrounding area from excavated soil, rubbish etc, which may cause inconvenience and endanger to the public. The barricade especially those exposed to public shall be aesthetically maintained by regular cleaning and painting as directed by the Employer. These shall be maintained in one line and level.
- The structural dimension of the barricade, material and composition, its colour scheme, NMRCL logo and other details.
- All stairways, passageways and gangways shall be maintained without any blockages or obstructions. All emergency exits passageways, exit fire doors, break-glass alarm points, fire-fighting equipment, first aid stations, and other emergency stations shall be kept clean, unobstructed and in good working order.
- All surplus earth and debris are removed/disposed off from the working areas to officially designated dump sites. Trucks carrying sand, earth and any pulverized materials etc. shall be covered while moving in order to avoid dust or odour impact.
- No parking of trucks/trolleys, cranes and trailers etc. shall be allowed on roads, which may obstruct the traffic movement.
- Roads shall be kept clear and free movement of road traffic shall not be obstructed by placing materials like pipes, steel, sand, boulders, concrete, chips and brick etc on the roads.
- Water logging on roads shall not be allowed.

- Turbid water from construction area shall be treated by sedimentation tank as required.
- Proper and safe stacking of material is of paramount importance at yards, stores. The storage area shall be well laid out with easy access and material stored / stacked in an orderly and safe manner.
- Flammable chemicals / compressed gas cylinders shall be safely stored.
- Unused/surplus cables, steel items and steel scrap lying scattered at different places within the working areas shall be removed to pre-identified locations(s).
- All wooden scrap, empty wooden cable drums and other combustible packing materials, shall be removed from work place to pre-identified location(s).
- Empty cement bags and other packaging material shall be properly stacked and removed.

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

8.3.7 Utilities

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

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

- Utility services have to be kept operational during the entire construction period and after completion of project. All proposals should therefore, ensure their uninterrupted functioning.
- Sewer lines and water supply lines are mainly affected in underground cut and cover construction. These services are proposed to be maintained by temporarily replacing them with CI/Steel pipelines and supporting them during construction, these will be encased in reinforced cement concrete after completion of construction and retained as permanent lines.

- Where permanent diversion of the affected utility is not found feasible, temporary diversion with CI/Steel pipes without manholes is proposed during construction. After completion of construction, these will be replaced with conventional pipes and manholes.
- The elevated viaduct does not pose much of a difficulty in negotiating the underground utility services, especially those running across the alignment. The utilities infringing at pier location can be easily diverted away from the pile cap location.
- In case a major utility is running along/across the alignment which cannot be diverted or the diversion of which is difficult, time consuming and uneconomical, the spanning arrangement of the viaduct and layout of piles in the foundation may be suitably adjusted to ensure that no foundation needs be constructed at the location, where utility is crossing the proposed alignment. The utility service can also be encased within the foundation piles.

The Organizations / Departments responsible for concerned utility services are reported in **Table -8.8.**

Table -8.8: Organizations responsible for Utilities and Services

S. No	Organization/ Department	Utility/Services
1	Nagpur Municipal Corporation	Sewerage and drainage lines. Water mains and their service lines, including hydrants and fountains etc, water treatment plants, pumping stations, Roads, surface water drains, nallahs, sewer lines, street lights, high mast lights etc.
2	Public Works Department	Roads, surface water drains, nallahs etc.
3	NHAI	Roads
4	Maharashtra Electricity Regulation Commission appointed power distribution franchise M/s. SNDPL	Power cables and their appurtenances, pole mounted transformer and HT line
5	Bharat Sanchar Nigam Limited (BSNL), Vodafone, Idea, Bharati Airtel, Aircel, Etisalat DB Telecom, Videocon and Uninor	Telecommunication cables, junction boxes, telephone posts, O.H. lines etc.
6	Office of Commissioner of Police, Nagpur	Traffic signal posts, junction boxes and cable connections etc.

8.3.8 Archaeological and Historical Structure Preservation

The proposed metro rail project will affect residential and commercial structures near to some of the proposed metro stations where construction will be made by cut and cover method whereas no Archeological Monuments are likely to be affected. Some of the historical structures are close to the proposed metro alignment and due to unavoidable circumstances, there is a need to acquire about 408.45 sq.m area of Historical Kasthurchand park. Accordingly, NMRCL obtained NoC from Kasturchand Park Heritage Conservation Committee dated on 18.08.2016. Utmost care will be taken so that no significant impact is anticipated on the historical structures due to project activities during construction and operation.

8.3.9 Air Pollution Control Measures

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

- The Contractor shall take all necessary precautions to minimize fugitive dust emissions from operations involving excavation, grading, and clearing of land and disposal of waste. He shall not allow emissions of fugitive dust from any transport during handling of materials, construction or storage activity. The emission should not remain visible in atmosphere beyond the property line of emission source for any prolonged period of time without notification to the Employer.
- The Contractor shall use construction equipment to minimise or control of air pollution. He shall maintain evidence of design and equipment to make these available for inspection by Employer.
- Contractor's transport vehicles and other equipment shall conform to emission standards fixed by Statutory Agencies of Government of India or the State Government from time to time. The Contractor shall carry out periodical checks and undertake remedial measures including replacement, if required, so as to operate within permissible norms.
- The Contractor shall use cover for materials of dust generating like debris and soil being transported from construction sites. All trucks carrying loose

material should be covered and loaded with sufficient free board to avoid spills through the tailboard or sideboards.

- Contractor shall install barriers around the open construction sites before commencing the work.
- The temporary dumping areas shall be maintained by the Contractor at all times until excavated material is re-utilized for backfilling wherever necessary or as directed by Employer. Dust control activities shall continue even during any work stoppage/public holidays.
- The Contractor shall place material in a manner that will minimize dust production. Material shall be wetted each day, to minimize dust production. During dry weather, dust control measures must be used daily especially on windy, dry days to prevent any dust from blowing across the site perimeter.
- The Contractor shall sprinkle water at construction sites to suppress dust, during handling of excavation soil or debris or during demolition. The Contractor will make water sprinklers, water supply and water delivering equipment available at any time that it is required for dust control use. Dust screens will be used, as feasible when additional dust control measures are needed especially where the work is near sensitive receptors.

8.3.10 Noise Control Measures

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

- Job rotation to the extent possible,
- Automation,
- Construction of permanent and temporary noise barriers,
- Re-route and regulate the traffic, a main source of noise,
- Use electric equipment instead of diesel powered equipment,
- Use hydraulic tools instead of pneumatic tools,
- Acoustic enclosures should be provided for individual noise generating construction equipment,
- Scheduling of truck loading, unloading and hauling operation,

- Proper operation and maintenance of the construction vehicles and equipments would keep them within noise limit,
- Schedule work to avoid simultaneous activities,
- Low speed compressor, blower and air conditioner,
- Mounting of under frame equipments on anti-vibration pad,
- Provision of rubber pads below track fittings to reduce noise due to wheel interaction
- Smooth and gradual control of door,
- Provision of GRP baffle on the via-duct for elimination of noise transmission,
- Provision of sound absorbing material in the supply duct and return grill of air conditioner,

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

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

The ballast-less track is supported on two layers of rubber pads to reduce track noise and ground vibrations. Reach wise noise barriers provision in NMRCL Project as given below:

- ✓ North - South Corridor (R-1: 300 m & R-2: 650m)
- ✓ East - West Corridor (R-3: 600m & R-4: 750m)

The cost for noise barriers is workout as **Rs. 138.00 Lakh**. Regular greasing of tracks on sharp curves can reduce noise. An amount of **Rs. 25.00 Lakh** provision is made in the EMP towards detailed noise modeling at sharp curves and at major hospitals along Right of Way (RoW) edge during operation phase of the project.

8.3.11 Vibration Control Measures

Construction activities can result in varying degrees of ground vibration, depending on the equipment and methods employed. Ground vibrations from construction activities do not often reach the levels that can damage structures, but they can achieve the audible and feelable ranges in buildings very close to the site. Especially in Hospitals, Medical equipment are sensitive to vibration only in operating stage. Negligible impact will be anticipated during operation stage as the vibration levels are well within standard of 0.20 inch/sec. The following mitigation measures will be adopted to reduce the degree of impact due to vibration during construction phase.

- Drill pile or sonic piling will be employed in selected areas to reduce the impacts on nearby buildings.
- Vibration monitoring will be undertaken as suggested in the environmental monitoring plan and a plan shall be prepared by the contractor to control the damage due to vibration.
- Near hospitals, avoid the major piling activity between 2 to 5 pm during day time and 10 pm to 5 am during night time.

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

- Rails will be continuously welded and also will be laid to fine tolerances so that any noise/vibration on account of track geometry could be reduced.
- The vibration generated from rail-wheel interaction will be greatly absorbed by the elastic fastening system proposed to be used
- The lower vibration will be achieved by providing of bolster less type bogies having secondary air spring.

- Lubrication of rail by vehicle mounted lubricator have been contemplated.

8.3.12 Traffic Diversion/ Management

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

- In 'Cut-and-Cover' method, the stretch between two points will have to be blocked during construction. However, temporary decking may be provided by blocking the road carriageway partially to permit traffic movement along the same stretch if possible.
- Wherever the stations are isolated, areas available around it should be utilized for road diversion purposes such as lay-byes and service roads.

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

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

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

All construction workers should be provided with high visibility jackets with reflective tapes. The conspicuous of workmen at all times shall be increased so as to protect from speeding vehicular traffic.

- Warn the road user clearly and sufficiently in advance.
- Provide safe and clearly marked lanes for guiding road users.
- Provide safe and clearly marked buffer and work zones
- Provide adequate measures that control driver behavior through construction zones.
- The primary traffic control devices used in work zones shall include signs, delineators, barricades, cones, pylons, pavement markings and flashing lights.

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

8.3.13 Soil Erosion Control

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

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

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

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

8.3.14 Muck/ Spoil Disposal

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

The construction activities involve excavation of soil for installation of piles & for construction of piers etc., and also involves demolition of existing structures for construction of Metro-line & Stations. Considerable amount of muck/soil will also be generated during land preparation for Parking & Depot areas. All these activities will generate Approx., 3,96,555 m^3 quantity of muck, in which Approx., 24,056 m^3 will be structure demolition waste which will be handled as per solid waste (Management and Handling) rules.

Remaining portion of muck can be utilized as the top soil to be used in the project for plantation, landscaping works & in road widening projects which are already in the process of construction. Solid waste/ Muck generation details during construction phase are given in **Table -8.9**

Table-8.9: Muck /Spoil generation during construction phase

S. No	Activity	Muck/Soil generated (m^3)				Total (m^3)
		North-south corridor		East-west corridor		
		Reach 1	Reach 2	Reach 3	Reach 4	
1	During foundation & piers Construction	60000	60000	60000	60000	240000
2	During construction of stations	831	582	618	557	2588
3	At Parking locations	4863	3404	1076	968	10311
4	At Depot locations	67800	-	51800	-	119600
5	Structures demolition waste for Metro-line & stations construction	6527	3568	7867	6094	24056
	Total *(including construction material waste)*	**140021**	**67554**	**121361**	**67619**	**3,96,555 (m^3)**

Accordingly cost estimate for muck disposal has been prepared and given in **Table -8.10**. The use can be decided only after thorough geo-technical investigation and testing of the muck. Muck will be monitored/ analyzed for heavy metals prior to their disposal at dumping site and monitoring programme is given in the Environmental Monitoring Plan.

Table -8.10: Cost of Muck/ Spoil Disposal

S. No	Particulars	Cost (Lakh)				Total Cost (Lakh)
		North-south corridor		East-west corridor		
		Reach 1	Reach 2	Reach 3	Reach 4	
1	Transportation cost	210	102	182	102	596

2	Plantation & Beautification works (Rs. 1.20 Lakhs/Ha)	3.6	2	3	2.4	11
	Total	**213.6**	**104**	**185**	**104.4**	**607**

Note:As per enquiry made at site, each truck can carry 9m^3 of Spoil/Muck and loading, unloading & carting to site upto 5 kms may charge Rs. 1350/-. Accordingly, cost per m^3 estimated to be Rs. 150/-.

8.3.15 Water Supply, Sanitation and Solid Waste Management

The public health facilities, such as water supply, sanitation and toilets are much needed at the stations. Water should be treated before use up to WHO drinking water standards. The collection and safe disposal of human wastes are among the most important problems of environmental health. The safe sewage disposal systems would be provided.

Requirements of drinking water supply at station are about 6 KL/day. Raw water requirement for station is about 50 m^3/Day. The water requirement at Depot will be 123 KLD. This shall be provided from municipal/ground water source.

Sanitation:

NMRCL has made MoU with Defence Research & Development Establishment (DRDE) Laboratory (An umbrella unit of DRDO, Government of India) to install eco-friendly bio-digesters at all the 36 stations and 2 depot areas. At each station, there are about 10 bio-toilets /digesters are proposed x 36 station and 8 bio-digesters are proposed x 2 Depots. Total of 376 nos. of Bio-digesters are proposed in the project and reach-wise details are given in **Table .11**. The cost of pre-fabricated structure of FRP/HDPE Bio-digesters is Rs. 30,000/unit. An amount of **Rs. 112.80 Lakhs** provision made in the EMP.

Table -8.11: No of Bio-digesters to be installed in each reach

Name of Reach	No. of stations	No of Depots	No. of Bio-digesters to be provided
Reach 1	10	1	108
Reach 2	7	0	70
Reach 3	10	1	108
Reach 4	9	0	90
Total	**36**	**2**	**376**

Solid waste generated at each station is about 37.6 cum/day. The maintenance of adequate sanitary facilities for temporarily storing refuse on the premises is

considered a responsibility of the NMRCL project authorities. The storage containers for this purpose need to be designed. However it is suggested that the capacity of these containers should not exceed 50 litres and these should be equipped with side handles to facilitate handling. To avoid odour and the accumulation of fly-supporting materials, garbage containers should be washed at frequent intervals. This should be collected and transported to local municipal bins for onward disposal to disposal site by municipality. Waste generated during and after construction will be disposed in accordance with relevant National and State laws and Regulations.

8.3.16 Sensitive Receptors

As discussed in section 5.9, the impact on sensitive receptors is anticipated due to noise and vibration during construction work of stations. The management plan for noise & vibration control mentioned at section 8.3.11 & 8.3.12 will reduce the noise & vibration level substantially. The noise & vibration due to construction activities will be monitored and recorded at sensitive receptors. Construction contractor must provide a mechanism for receiving and responding to complaints arising due to impacts on sensitive receptors. Avoid nighttime construction activities near sensitive receptors if possible.

8.3.17 Management Plans for Depot

Two depots are planned at MIHAN near Khapri (North South Direction) and at Hingna near Prajapati Nagar (East West Direction). The management plans for depot site includes:

- Water Supply,
- Oil Pollution Control,
- Sewage/Effluent Pollution Control,
- Solid Waste
- Surface Drainage,
- Green belt development,
- Rain water harvesting, and
- Recycling of treated waste water

Water supply: About 118.03 m^3 of water will be required for operation and functioning of depots per day. This could be either met from Municipal Corporation or through boring tube well into the ground. The ground water will need treatment depending upon its use. Domestic and some of the industrial

application, a Reverse Osmosis (RO) plant of 8 liter/ minute capacity will be appropriate.

Oil Pollution Control: The oil tends to form scum in sedimentation chambers, clog fine screens, interfere with filtration and reduce the efficiency of treatment plants. Hence oil & grease removal tank having size of 3x2x1.5 m shall be installed at initial stage of effluent treatments in each depot area. Such tanks usually employ compressed air to coagulate the oil and grease and cause it to rise promptly to the surface. Compressed air may be applied through porous plates located in bottom of the tank. The tank may be designed for a detention period of 5 to 15 minutes. This accumulated oil and grease will be disposed off through approved re-cyclers.

Sewage/Effluent Pollution Control: About 37.3 KLD of sewage/effluent is likely to be generated at depots. The sewage could be treated up to the level so that it could be used for horticulture purpose in the campus and can also be discharged into the nearby drainage system of NMC. The estimated cost of Bio-digesters (2 Depots* 8 bio-digesters in one depot* Rs. 30,000/unit) is about **Rs.4.8 Lakh**. This has to be treated as per the requirement of regulatory pollution control agency of the state (MPCB).

Solid Waste Disposal: As per available depot, about 1.8 Ton per month of solid waste will be generated from the Depot which will be disposed to the Nagpur Municipal Corporation waste disposal sites in accordance with relevant National and State laws and regulations. Waste will be collected at separate dustbin system. Dustbins will be provided at appropriate locations. Cost for solid waste management facilities for one depot is given in **Table -8.12**

Table -8.12: Cost for Solid waste management facilities at one Depot

S. No.	Description	Numbers	Rate (Rs./Unit)	Cost (Lakh)
1	Solid waste collection bins @Rs 200/bin	30	200	0.21
	Community bin 4 no. @Rs. 15000/bin	1	15000	
2	Transportation	-	Lump sum	20.00

S. No.	Description	Numbers	Rate (Rs./Unit)	Cost (Lakh)
3	Manpower cost of 2 persons @6000 per person per month for 10 years	2	2*120*6000	14.40
Total				**34.61**

Surface Drainage: The Storm water of the depot will be collected through the drain. Rain water harvesting pits are provided at different locations in the drains and for surplus storm water, the drainage system is connected to a nearby disposal site. The drainage costs have been included in project cost.

Green belt development: The greenbelt development / plantation in the depot area not only functions as landscape features resulting in harmonizing and amalgamating the physical features with surrounding environment but also acts as pollution sink / noise barrier. In addition to augmenting present vegetation, it will also check soil erosion, make the ecosystem more diversified and functionally more stable, make the climate more conducive and restore balance. It is recommended to have a provision of **Rs. 40 Lakh** in the cost estimate for the green belt development. Treated sewage and effluent in the best combination should be used for green belt development.

Rain water harvesting: To conserve and augment the storage of groundwater, it has been proposed to construct roof top rainwater harvesting structure at the constructed depot site. Depot cum workshop area of 35,281 sq.m is available at both depots for roof top rain water harvesting. An annual average rainfall is 1112.7 mm, 287 KLD rain water will be harvested. The total recharge pit area of 10x10x3 m will be required. A provision of **Rs. 15 Lakh** has been kept in the cost estimate. The cost of the same shall be distributed to Reach -1 for Rs. 7.5 Lakh and Reach-3 for Rs. 7.5 Lakh. Other reaches are not having Depot areas.

Recycling of treated waste water: Waste water generated at depot is proposed to be collected at ETP for treatment and recycled for horticulture work of the depot.

8.3.18 Training Programmes

The training programmes need to be conducted by the experts, for MRTS officers. These programmes could be extended for the local population for their active participation in the project implementation. Apart from training, such programme should include guidelines for safety, methods of disaster prevention, action required in case of emergency, fire protection, environmental risk analysis etc.

8.4 EMP Reporting Arrangement and Institutional Strengthening

Supervision involves periodic checking to ascertain whether activities are going according to the plans. It provides necessary feedback for project management team to keep the program on schedule. The supervision and reporting process with respect to implementation status of mitigation measures during construction will initiate from the contractor at the lowest rung who will report to the NMRCL through the project management consultant.

During construction phase of the project, the EMP implementation comprises of the following key activities:

- Implementing various mitigation and enhancement measures within the time frame recommended
- Overseeing the implementing various mitigation and enhancement measures and fine tuning/advocating more measures, if needed, depending on site conditions;
- Project level monitoring of key performance indicators to evaluate the implementation of EMP measures at the recommended intervals.
- Periodical reporting of status of EMP implementation and monitoring results and key performance indicators and
- Constant evaluation of EMP measures implemented based on the data available from project level monitoring and status reports and providing directions accordingly.

These activities to be carried out by various agencies that will be involved in the implementation of Metro project. It is also to be noted that all these activities will be carried out concurrently or at regular intervals and at different duration and location. This makes it pertinent that all agencies involved work within a predefine setup. The coordination model proposed during construction and operation phases is presented in **Figure -8.1** and **Figure -8.2** respectively. The identified agencies and their sphere of work are presented in following section.

Project Implementation Agency (PIA):

The responsibility of implementing environmental mitigation measures lies with the Nagpur Metro Rail Corporation Limited (NMRCL).

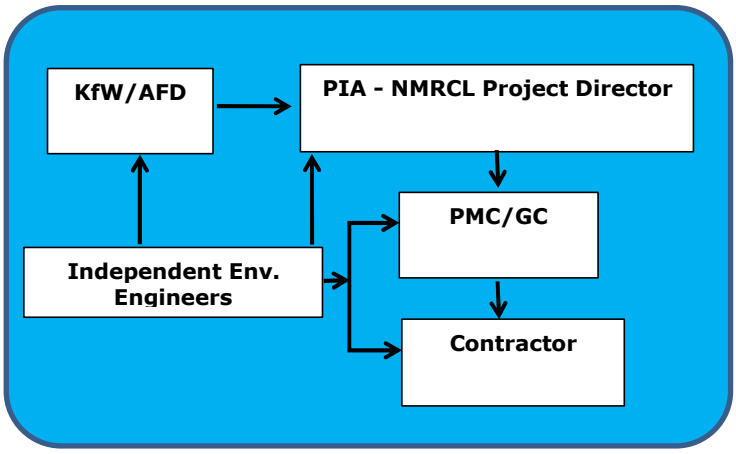


Figure 8.1: Institutional Mechanism For EMP Implementation (Construction Phase)

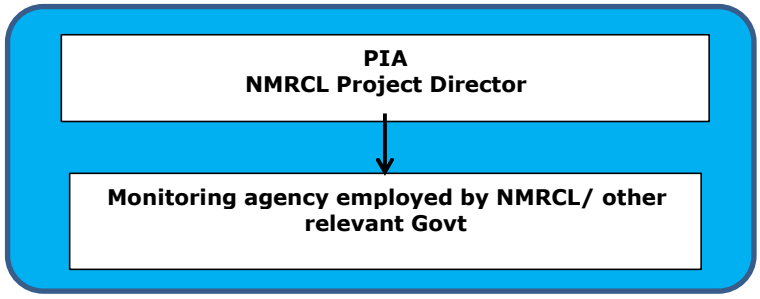


Figure -8.2:Institutional Mechanism for EMP Implementation (Operation Phase)

Project Management Consultant (PMC)

The PIA (NMRCL) will get the EMP implemented through the Project Management Consultant (PMC)/GC appointed for managing engineering and construction related activity. NMRCL will deliver the responsibility of supervising the implementation of project as per the contract agreement. In order to effectively discharge the duties PMC/GC will have an environmental officer/expert in the project management unit. The environmental officer will work for a full time basis at the site office. The officer must possess experience in the environmental management of metro projects.

Project Contractor

Project contractor will implement the EMP measures, enhancement measures and measures as directed by PIA (NMRCL) and PMC/GC. The responsibility to implement the EMP measures will be built in to the contractual agreement. The contractor shall submit a report on compliance of environmental mitigation measures periodically to the PMC/GC. The PMC/GC will review and approve the environmental compliance report (ECR) submitted by the contractor and forward the ECR to PIA (NMRCL) after approval. The PIA (NMRCL) will then submit the ECR to Independent Monitoring Panels through the Project Director, NMRCL. The Project Director accordingly submits report to the KfW & AFD.

NMRCL:

NMRCL as an apex organization shall initiate coordinate process among the concern organization for EMP implementation. NMRCL shall take lead in:

- Reviewing the progress of the project for the subsequent year-institution wise
- Reviewing and discussing the salient features of the report in the year on environmental aspects and their violations
- Organizing and coordinating training programs for all member organization

Environmental Monitoring Division needs to be set up by the NMRCL for implementation of EMP and EMoP. The Environmental Monitoring Division comprises following staff as per Figure 8.3.

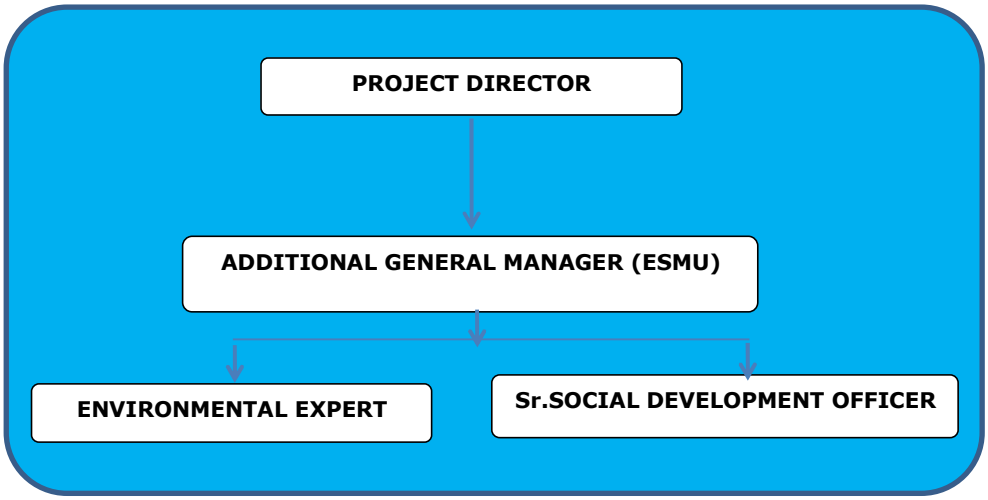


Figure -8.3: EMP Monitoring Structure

8.5 Disaster Management

Disaster is an unexpected event due to sudden failure of the system, external threats, internal disturbances, earthquakes, fire and accidents. As per the disaster management act, 2005 "disaster" means a catastrophe, mishap, calamity or grave occurrence in any area, arising from natural or manmade causes, or by accident or negligence which results in substantial loss of life or human suffering or damage to, and destruction of, property, or damage to, or degradation of, environment, and is of such a nature or magnitude as to be beyond the coping capacity of the community of the affected area".

A disaster is a tragic event, be it natural or manmade, which brings sudden and immense agony to humanity and disrupts normal life. It causes large scale human suffering due to loss of life, loss of livelihood, damages to property and persons and also brings untold hardships. It may also cause destruction to infrastructure, buildings, communication channels essential services, etc.

8.5.1 Need for Disaster Management Measures

The effect of any disaster spread over in operational area of Nagpur Metro is likely to be substantial as NMRCL deals with thousands of passengers daily in viaducts and stations. Disaster brings about sudden and immense misery to humanity and disrupts normal human life in its established social and economic patterns. It has the potential to cause large scale human suffering due to loss of life, loss of livelihood, damage to property, injury and hardship. It may also cause destruction or damage to infrastructure, buildings and communication channels of Metro. Therefore there is an urgent need to provide for an efficient disaster management plan.

The first step is to identify the causes which develop/ pose unexpected danger to the structural integrity due to construction. The potential causes are excessive load, cracks, failure and malfunctioning of sensing instruments, accident, etc. These need to be looked into with care.

8.5.2 Objectives

The main objectives of this Disaster Management Measures are as follows:

- Save life and alleviate suffering.

- Provide help to stranded passengers and arrange their prompt evacuation.
- Instill a sense of security amongst all concerned by providing accurate information.
- Protect Metro Rail property.
- Expedite restoration of train operation.
- Lay down the actions required to be taken by staff in the event of a disaster in NMRCL in order to ensure handling of crisis situation in coordinated manner.

To ensure that all officials who are responsible to deal with the situation are thoroughly conversant with their duties and responsibilities in advance. It is important that these officials and workers are adequately trained in anticipation to avoid any kind of confusion and chaos at the time of the actual situation and to enable them to discharge their responsibilities with alertness and promptness.

8.5.3 Provisions under Disaster Management Act, 2005

A. The National Disaster Management Authority (NDMA)

Establishment of National Disaster Management Authority:-

1. With effect from such date as the Central Government may, by notification in the Official Gazette appoint in this behalf, there shall be established for the purposes of this Act *(The Disaster Management Act, 2005),* an authority to be known as the National Disaster Management Authority.
2. The National Authority shall consist of the Chairperson and such number of other members, not exceeding nine, as may be prescribed by the Central Government and, unless the rules otherwise provide, the National Authority shall consist of the following:-

(a) The Prime Minister of India, who shall be the Chairperson of the National Authority, ex officio;

(b) Other members, not exceeding nine, to be nominated by the Chairperson of the National Authority.

3. The Chairperson of the National Authority may designate one of the members nominated under clause (b) of sub-section (2) to be the Vice- Chairperson of the National Authority.

The term of office and conditions of service of members of the National Authority shall be such as may be prescribed.

B. State Disaster Management Authority:

Establishment of State Disaster Management Authority:-

1. Every State Government shall, as soon as may be after the issue of the notification under sub-section (1) of section 3, by notification in the Official Gazette, establish a State Disaster Management Authority for the State with such name as may be specified in the notification of the State Government.

2. A State Authority shall consist of the Chairperson and such number of other members, not exceeding nine, as may be prescribed by the State Government and, unless the rules otherwise provide, the State Authority shall consist of the following members, namely:-

(a) The Chief Minister of the State, who shall be Chairperson, ex officio;

(b) Other members, not exceeding eight, to be nominated by the Chairperson of the State Authority;

(c) The Chairperson of the State Executive Committee, ex officio.

3. The Chairperson of the State Authority may designate one of the members nominated under clause (b) of sub-section (2) to be the Vice- Chairperson of the State Authority.

4. NMRCL would abide by the constitutional delegation stated under para 3 as above.

5. The term of office and conditions of service of members of the State Authority shall be such as may be prescribed.

C. Command & Control at the National, State & District Level

The mechanism to deal with natural as well as man made crisis already exists and that it has a four tier structure as stated below:-

1. National Crisis Management Committee (NCMC) under the chairmanship of Cabinet Secretary
2. Crisis Management Group (CMG) under the chairmanship of Union Home Secretary.
3. State Level Committee under the chairmanship of Chief Secretary.
4. District Level Committee under the Chairmanship of District Magistrate.

All agencies of the Government at the National, State and district levels will function in accordance with the guidelines and directions given by these committees

D. Plans by Different Authorities at District Level and their Implementation

Every office of the Government of India and of the State Government at the district level and the local authorities shall, subject to the supervision of the District Authority:-

(a) Prepare a disaster management plan setting out the following, namely:-

(i) Provisions for prevention and mitigation measures as provided for in the District Plan and as is assigned to the department or agency concerned;

(ii)Provisions for taking measures relating to capacity-building and preparedness as laid down in the District Plan;

(iii)The response plans and procedures, in the event of, any threatening disaster situation or disaster;

(b) Coordinate the preparation and the implementation of its plan with those of the other organizations at the district level including local authority, communities and other stakeholders;

(c) Regularly review and update the plan; and

(d) Submit a copy of its disaster management plan, and of any amendment thereto, to the District Authority.

8.6 Provisions at Metro Stations/Other Installations

8.6.1 Preventive Action

Once the likelihood of a disaster is suspected, action has to be initiated to prevent a failure. Engineers responsible for preventive action should be aware of availability of repair equipment, materials, workers and expertise for use during emergency

8.6.2 Reporting Procedures

The level at which a situation will be termed a disaster shall be specified. This shall include the stage at which the surveillance requirements should be increased both in frequency and details. The Engineer-in-Chief should notify the officer for the following information:

- Exit points for the public,
- Safety areas in the tunnel, and
- Nearest medical facilities.

8.6.3 Communication System

An efficient communication system is absolutely essential for the success of any disaster management plan. This has to be worked out in consultation with local authorities. More often, the entire communication system gets disrupted when a disaster occurs. The damage areas need to be clearly identified and provided with temporary and full proof communication system.

8.6.4 Emergency Action Committee

To ensure coordinated action, an Emergency Action Committee should be constituted. Chairman cum Director, NMRCL will be the Chairman of this Committee. The committee may comprise of:

- ✓ Head of operations,
- ✓ Head of technical services,

- ✓ Head of security,
- ✓ Fire brigade,
- ✓ Police representatives, and
- ✓ NGO

Emergency Action Committee will prepare the evacuation plan and procedures for implementation based on local needs and facilities available. The plan should include:

- ✓ Demarcation of the areas to be evacuated with priorities,
- ✓ Safe route to be used, adequacy of transport for evacuation, and traffic control,
- ✓ Safe area and shelters,
- ✓ Security of property left behind in the evacuated areas,
- ✓ Functions and responsibilities of various members of evacuation teams, and
- ✓ Setting up of Joint Control Room.

All personnel involved in the Emergency Action Plan should be thoroughly familiar with all the elements of the plan and their responsibilities. They should be trained through mock drills for the Emergency Action Plan. The staff at the site should be trained for problem detection, evaluation and emergency remedial measures. Individual responsibility to handle the segments in emergency plan must be allotted.

Success of an emergency plan depends on public participation, their response to warning notifications and timely action. Public has to be educated on the hazards and key role in disaster mitigation by helping in the planned evacuation and rescue operations.

It is essential to communicate by whom and how a declared emergency will be terminated. There should be proper notification to the public on de-alert signals regarding termination of the emergency. The notification should be clear so that the evacuees know precisely what to do when re-entering or approaching the affected areas.

8.7 Emergency Measures

The emergency measures are adopted to avoid any failure in the system such as lights, fire, means of escape, ventilation shafts etc. The aim of Emergency Action Plan is to identify areas, population and structures likely to be affected due to a catastrophic event of accident. The action plan should also include preventive action, notification, warning procedures and co-ordination among various relief authorities. These are discussed in following sections.

8.7.1 Emergency Lighting

The emergency lights operated on battery power should be provided at each station. The battery system should supply power to at least 25% of the lights at the station, platforms, tunnels/viaducts for a period of 2 hours. The underground station should have transformer at each end of the platform. Both the transformers need to be kept energized and should feed independently alternate rows of lights so that in case of failure of one transformer, there will not be complete darkness. The tunnels need to be provided with fluorescent incandescent lamps at a spacing of 20 m.

8.7.2 Fire Protection

The building materials should be of appropriate fire resistance standard. For underground structures the fire resistance period should be at least 4 hours, and 2 hours for surface or over head structures. Wood shall not be used for any purpose, excluding artificial wood products, which are flame resistant. The materials which have zero surface burning characteristics need to be used. The electrical systems shall be provided with automatic circuit breakers activated by the rise of current as well as activated by over current. The design of a station will include provision for the following:

- Fire prevention measures
- Fire control measures,
- Fire detection systems,
- Means of escape,
- Access for fireman, and
- Means of fire fighting

Accumulations of refuse of inflammable material like paper, plastic cartons constitute a major fire hazards and should not be permitted. Smoking should be strictly prohibited at all locations of Metro.

All aspects of fire prevention and control will be dealt in close collaboration with the city fire fighting authority. Smoke control will be achieved by the following means:

- Downstand bulkheads of a minimum depth of 600 mm to provide smoke containment. These will be provided around openings for escalators, lifts and stairs in underground stations, and
- In underground stations the ventilation system will be designed to extract smoke in the event of fire

A minimum of 30 minutes supply of water is to be assured in the case of fire. The pumps/overhead tanks shall have the capacity to discharge the water at the rate of 1100 litres per minute at a head of 21 m at nozzle mouth.

The storage capacity in an underground or overhead tank may be divided into two parts i.e. dead storage and running storage. Fire fighting pumps shall be provided with a diesel pump as a standby arrangement, in case of power failure.

Fire of electrical origin, water cannot be used until the electric system has been made dead and earthen. For electrical fires, non-aqueous extinguishers like chemical dry powder or CO2 gas are utilized for fire fighting. Fire extinguishers with these agents shall be liberally provided at static installations and on the rolling stock.

Generally there are often more casualties from smoke inhalation than from burning. Smoke needs to be transported away from the site of the fire. In order to achieve this, fresh air has to be introduced into the underground section and exhaust gases should be sucked out from other section.

Openings, including ducts and passages, between Metro property and any adjoining structures which allow free access into the Metro property will be protected by fire doors, fire shutters, fire dampers etc. as appropriate. Fire detection and alarm systems will be provided as per the prevailing state of art technology.

A. Fire Prevention and Safety Measures

Fire prevention measures will be designed and implemented to minimize the risk of outbreak of fire by appropriate choice, location and installation of various materials and equipment. In stations planning, potential sources of fire can be reduced by:

i. Fire Prevention

- Use of non-combustible or smoke retardant materials where possible,
- Rolling stock is provided with fire retarding materials, low smoke zero halogen type electric cable is also provide,
- Provision of layout which permits ease of maintenance for equipment and cleaning of the station premises,
- Provision of special storage spaces for combustible materials such as paint and oil,
- Prohibition of smoking in fire prone areas,
- Good housekeeping.

ii. Safety

Following provisions will be required from fire safety point of view:

- Automatic sprinkler/detection system to be provided if floor area exceeds 750 sq.m
- One wet riser-cum-down comer per 1000 sq.m floor area with static underground storage tank, overhead tanks and pumps of suitable capacity with hydrants, first-aid reel, etc.
- Portable fire non-aqueous extinguishers of Carbon dioxide, chemical dry powder etc. at suitable places.
- Automatic smokes venting facilities.
- Two separate means of exit shall be provided, if more than 10 persons are working and the area exceeds 1400 sq.m.
- Fire resisting doors shall be provided at appropriate places along the escape routes to prevent spread of fire and smoke.

- The travel distance for fire escape shall not exceed 20 m where escape is available in more than one direction; the distance could be upto 40 m.

B. Fire Alarm and Detection System

A complete fire detection system with equipment complying with the requirements of Nagpur Fire Services shall be provided through out each station and ancillary buildings including entrance passageways etc. to give visual and audible indication of alarm conditions actuated by the operation of break glass contact or fire sensors e.g. detector heads, linear heat detecting cables etc. The system shall be operated from 24 V DC Power sources.

Manually operated call points shall be provided at every hydrant and nose reel points, station head wall, tail wall and other locations. Alarm bells shall be installed in each plant room complex at both platform and concourse level and shall be clearly audible at all points in the room/area. Heat detector shall be installed at roof level, ceiling and floor cavity.

Smoke probe units shall be installed in rooms/compartments. When an alarm point is operated, the fire pump shall start to operate automatically. A station fire control and indicating panel shall be provided/ installed in the station controllers room, for the control, indication and monitoring of the whole detection and fire fighting systems. While designing the fire fighting system, the zone of Nagpur Fire Services shall be taken into account for linking with the same.

C. Fire Control Measures

Control of the spread of fire and smoke will be achieved by partition of fire risk areas, planning for smoke extraction, and arrangement for smoke containment. Partition is aimed at limiting the extent of a fire. The openings must be capable of being sealed in the event of fire. With the exception of station public areas, a fire compartment will not exceed 1500 m2. Partition of the public areas in stations is not practicable for operational reasons. The fire resistance period of this separated area should be about 3 hours.

D. Access for Fireman

A secondary access to the station, not used by passengers for evacuation, shall be available to fireman when the need arises. The entry point shall be easily accessible from the road. Access shall be available to all levels of the station. The minimum width of the stairs is 1.0 m and maximum height should not exceed 60 cm.

8.7.3 Emergency Door

The rolling stock is provided with emergency doors at both ends of the cab to ensure directed evacuation of passengers in case of any emergency including fire in the train.

8.8 Grievance Redressal Mechanism

Efficient grievance redressal mechanism will be setup to assist the stakeholders to resolve their queries and complaints. Grievances will be submitted to the Grievance Redressal Committee (GRC). The organizational structure of Environmental and Social Management Unit (ESMU) is shown in Figure-8.4. The main responsibilities of the GRC are to:

- Maintaining a database of all complaints related to environmental issues and forwarding them to the consultants
- Assisting the stakeholders to submit their environment-related complaints directly to the contractor
- Maintaining a list of stakeholders who are directly or indirectly affected by construction, operations, and maintenance work, and monitoring the implementation of mitigation plans.
- Record stakeholders grievances, categorize, and prioritize grievances and resolve them;
- Immediately inform the SMU about serious cases; and
- Report to stakeholders on developments regarding their grievances and decisions of the GRC.

GRC will meet every month, determine the merit of each grievance, and resolve grievances within a reasonable time. Records will be kept of all grievances received including: contact details of complaint, date the complaint was received,

nature of grievance, agreed corrective actions and the date these were effected, and final outcome.

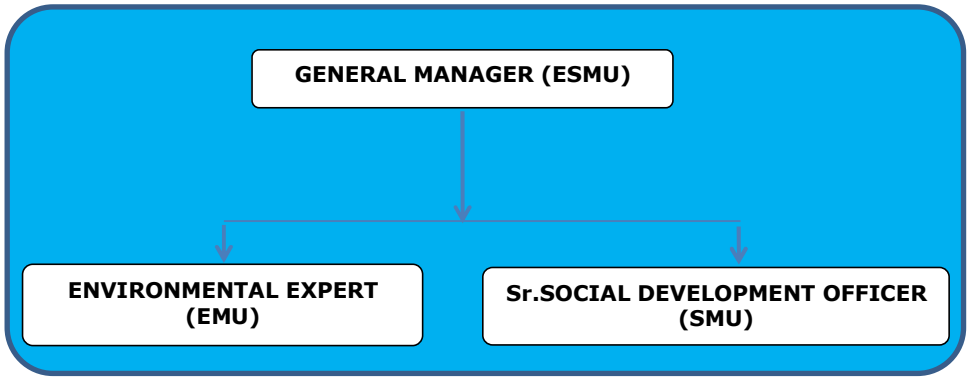


Figure-8.4: Organizational structure of ESMU

8.9 Information Disclosure

During social survey, meetings and discussions were conducted to get wider public input from the primary and secondary stakeholders. Information disclosure is persuaded for information and transparency in work. Executive summary of EIA study in local language will be disclosed on NMRCL website.

8.10 Summary of Environmental Management Plan (EMP)

The negative environmental impacts stemming out of the proposed project can be mitigated with simple set of measures, dealing with careful planning and designing of the metro alignment and structures. Adequate provision of environmental clauses in work contracts and efficient contract management will eliminate or reduce significantly all possible problems. A common problem encountered during implementation of environmental management plans of such projects is lack of environmental awareness among engineers and managers concerned with day to day construction activities, which can be solved through regular environmental training programs. A set of EMP for Reach Wise is presented in **Tables -8.13, 8.14, 8.15 & 8.16** which defines actions to be undertaken during pre-construction, construction and operation stage of the project. The effectiveness of environmental considerations will, however, depend on appropriate inclusion of these in the work contracts.

The major concern during the construction stage is that the contractors, due to lack of enforcement, would not practice good environmental sanitation

(housekeeping), may intend to get unauthorized use of the easily available natural resources and other available infrastructure like roads and water resources. This would result in degradation of ambient air quality, water resources and land environment around the construction sites and workers camp. Improper management of earthwork activities would disrupt the natural drainage and increase soil erosion. Improper management may result in spillage of explosives into the hands of unsocial elements. Finally the implementation of the mitigation actions requires that the project implementation unit would record an end-of-construction mitigation checklist, before releasing the final payment of any work contract.

In addition to that NMRCL, should prepare and establish Environmental and Health Policy and Procedures and that should become an integral part of contract document.

Operational phase mitigation would involve good environmental sanitation (housekeeping) practice at metro establishments including effective solid waste collection and disposal, wastewater disposal, upbringing of plantations and green area. During the operation period, the metro operating unit will be required to confirm receipt of the construction period mitigation report through the PIU and prepare and follow on timetable of actions.

Table -8.13: ENVIRONMENT MANAGEMENT ACTION PLAN FOR REACH -1

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
	DESIGN PHASE						
1.	Alignment	The selected alignment is covering all the important locations such as commercial hubs, corporate hubs, residential colonies etc. of Nagpur Town. The total length of the Reach 1 alignment is 12.5408 km. NMRCL is proposing 10 stations and 1 Depot in this reach. The alignment will not pass through any archaeological sites, temples and other environmentally sensitive areas.	Monthly	Design Consultant	NMRCL	-	Detailed Engineering
2.	Soil Erosion	Temporary and permanent drainage systems are mostly available in the project area. Hence, the soil erosion in the stretch is not anticipated much in this reach. The impact on the water bodies will be minimized by avoiding dumping of the excavated soil or waste soil near water bodies.	Monthly	Design Consultant	NMRCL	-	Detailed Engineering
3.	Cultural Relics	No protected Areas under international conventions, national or local legislation for their Archaeological importance, landscape, cultural or other related valuable are envisaged in the proposed alignment of Reach 1.	Quarterly	Design Consultant	Archaeological dept.	-	Detailed Engineering
4.	Flood	No major bridges and culverts are present at the project site. However, every care will been taken for the purpose of free flow of flood discharge in this reach.	Quarterly	Design Consultant	NMRCL	-	Detailed Engineering

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
5.	Inadequate design provision for safety against seismological hazard	Even though reach area falls under seismic zone II, NMRCL shall ensure that design provides for safety of structures against worst combination of forces in the probability of an earthquake.	Quarterly	Design Consultant	PIU	-	Detailed Engineering
6.	Water requirement	The requirement of water for construction purpose etc., shall be planned and arranged from Municipal water supply/ Ground water .	Quarterly	Design consultant	PIU/EMP Implementing Agency	-	Responsibility of Contractor and should be a part of Civil Contract
7.	Disposal of final treated effluent from treatment plant	Different options for final disposal shall be studied and the suitable disposal route shall be decided carefully to minimize the impact of receiving bodies. As far as possible Zero Effluent Discharge Rule may be adopted.	Quarterly	Contractor	NMRCL	Bio-digesters at workers camp are proposed	Responsibility of Contractor and should be a part of Civil Contract
CONSTRUCTION PHASE							
1.	Environmental Management and Monitoring	This will include institutional requirements, training, environmental management and monitoring for reach 1.	During and after construction	**Contractor**	PIU/EMP Implementing Agency		Chapter 8 & Chapter 9

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
2.	Tree cutting and plantation	• Prepare an action plan for an estimated 212 nos. of trees to be affected/felled in this reach and trees proposed to be planted about 1651 nos. along the reach including Stations and Depot Area. • Intimate Nagpur Municipal Corporation & Revenue Department, Nagpur before cutting trees and Prepare action plan for avenue plantation. • The indigenous plants to be planted in the project area such as Neem, Blue berry, Subabul, Gulmohar, Karanj, Pipal, Imli, Babul, Mango, Coconut palms etc. An amount of Rs. 13.21 Lakh is allocated in the EMP.	Monthly	Concessionaire / Contractor	NMRCL/NMC/ Revenue Department	13.21	Section 6.4.13
3.	Burrow pits and Quarry sites (stone & sand).	• Firm up contract with mining department for obtaining the quarry material • Quarrying will be carried out at approved and licensed quarries only. • Resurfacing and landscaping of the pits. • Borrow areas shall be carried out up to depth of 2.0m in non-cultivable & elevated lands, 0.45 m in productive lands etc. with a slope of not steeper than 1 vertical to 4 horizontal. • Borrow areas shall be 15 m away from the water bodies identified along the project corridor. • The borrow areas shall be located at least 800 m away from the villages/towns. • Resurfacing and landscaping of the borrow pits utilized in the project.	Monthly	Contractor or Concessionaire	NMRCL/ Mines & Geology Department	-	Responsibility of Contractor & should be part of Civil contract

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
4.	Equipment selection maintenance and operation	• Construction plants and equipment will meet recognized international standards for emissions and will be maintained and operated in a manner that ensures relevant air, noise, and discharge regulations are met.	Monthly	Contractor or Concessionaire	PIU/EMP Implementing Agency	Depend on construction methodology	Responsibility of Contractor & should be part of Civil contract
5.	Site for storage and construction camp.	• Land for temporary construction of yards/ depot is identified near KHAPRI Depot Land • The project Contractor shall select and construct a Campsite which is duly confirming the labour laws. Storage of construction materials such as cement, steel, bricks, pre-cast blocks etc will be expected as per the stipulated guidelines. Besides these, emergency response plan will be in place towards meeting unforeseen emergencies. Trained personnel will be deployed for handling such materials and care will be taken so that spills are abated and in case of spills, immediately they are contained.	Monthly	Contractor or Concessionaire	NMRCL	-	Responsibility of contractor and should be part of Civil contract

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
6.	Sewerage and solid waste disposal.	• Proper sanitation facilities at the construction workers camp shall be provided as per the IS:2470-1985 • Provision of Bio-digesters having capacity of 100m^3 for 640 people to achieve the desired on land discharage. 19.2 lakh provision shall be included in Tender documet and shall be taken care by contractor for workers camp in this reach. • The municipal solid wastes generated in construction & workers camp will be about 288 Kg/Day and the same will be disposed off at nearest identified location of disposal / landfill sites of local authority with payments in environmentally acceptable manner. Domestic refuse shall be collected separately for bio-degradable waste as well as the inert waste and the same shall be sent for the disposal as per the MSW (Management & Handling) Rules, 2000 and subsequent amendments thereof. An amount of Rs. 30.32 Lakh provision is made in the EMP for this reach.	Monthly	Contractor or Concessionaire	NMRCL /MPCB	19.2 (Bio-digesters at Workers camp) 30.32 (SW)	Responsibility of Contractor and should be part of Civil contractor Sections 6.4.6, 8.3.3
7.	Sanitation and Waste Disposal in Construction Camps	• Sufficient measures will be taken in the construction camps, i.e. provision of garbage tank and sanitation facilities. • Drinking water will meet Indian National Standards. • Garbage will be collected in a tank and disposed of daily. Camps will be located at a minimum distance of 200 m from water sources.	Monthly	Contractor or Concessionaire	PIU/EMP Implementing Agency	-	Responsibility of Contractor and should be part of Civil contractor

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
8.	Wastage of water	• Measures shall be taken to avoid misuse of water i.e awareness among the workers and posters. Construction agency shall be instructed accordingly to follow strict procedures while using the water for construction and drinking purpose.	Monthly	Contractor or Concessionaire	PIU/EMP Implementing Agency	-	Responsibility of Contractor and should be part of Civil contractor
9.	Traffic management	• The project stretch passes through City Area having Major junctions and Habitations like Sitaburdi, Chhatrapati square, Ujjwal nagar, Khapari, Airport etc in the project impact area of reach 1. • Secure assistance from local police for traffic control during the construction • Safety measures shall also be undertaken by installing road signs and markings for safe and smooth movement of traffic as per IRC SP:55.	Monthly	Contractor or Concessionaire	NMRCL /NHAI /Traffic Department	-	Responsibility of Contractor and should be part of Civil contractor
10.	Dust suppression	• Water should be sprinkled during construction phase once in 6 hours or 3times in a day, wherever it is required to avoid dust.	Daily	Contractor or Concessionaire	NMRCL /MPCB	-	Responsibility of Contractor and should be part of Civil contractor

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
11.	Noise level	• Stationary equipment shall be placed as far as possible from residential areas to minimize noise impacts on the near inhabitants. • Provision of ear plugs to workers exposed to high noise levels in the project. • Noise quality monitoring shall be carried out at 7 baseline locations of the project in all the seasons and compared with the baseline levels. Adequate measures shall be adopted time to time close to identified sensitive locations (38 nos) such as schools, hospitals, temples, recreation places etc. • An amount of 5.04 Lakh shall be allotted for Noise monitoring during construction period of 4 years, once in a month • On-site low cost noise protection barriers/traffic safety barriers to be provided to mitigate construction noise.	Monthly	Contractor or Concessionaire	NMRCL /MPCB	5.04 (for noise quality monitoring)	Responsibility of Contractor and should be part of Civil contractor
12.	Vibration	• The detailed vibration investigation shall be required during construction. Awareness about vibration impact to the public residing near to the alignment during construction and operation is proposed. • An amount of 16.80 Lakh shall be allotted for Vibration monitoring during construction period of 4 years, once in a month	Monthly	Contractor or Concessionaire	NMRCL /MPCB	16.80	Responsibility of Contractor and should be part of Civil contractor

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
13.	Air Quality	• Vehicles carrying construction material shall be covered to avoid spilling. • Mixing equipment shall be seated and equipped with dust removal device. • Air quality monitoring shall be carried out at 3 baseline monitored locations of the reach in all the seasons and compared with the baseline levels. Adequate mitigation measures such as water sprinkling during the construction phase at 6 hours interval or 3 times in a day at the construction yard and the unpaved sections of the road. • An amount of Rs. 5.4 Lakh provision is made for Air Quality Monitoring at 3 locations during construction period of 4 years for once in a month of 3 seasons (other than monsoon season)	Monthly	Contractor or Concessionaire	NMRCL /MPCB	5.4	Responsibility of Contractor and should be part of Civil contractor

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
14.	Water Quality & Muck /spoil waste	• There are 10 nos. of rivers/ lake / water bodies/ nalas / Canals present within the core area of this Reach. Hence, care needs to be take to deposit the muck or waste earth close to these locations to prevent the water pollution. • Prior permission of the concerned engineer and regulatory authorities shall be taken regarding the discharge or disposing of any material arising from the execution of the works. • During construction it will be ensured that contractor does not dispose off debris in water bodies. • Soil laden run off will not be diverted to water bodies. Provision of waste disposal site for waste from construction and storage yards shall be made. • Vehicle maintenance and refueling will be confined to areas under construction yard to trap discarded lubricant and fuel spills. • An amount 1.92 Lakh is allotted for Water Quality Monitoring at 4 locations during construction period of 4 years, once in 3 months (other than monsoon season) • Spoil/Muck generated in the reach is about 1,40,021 Cum and the same shall be disposed in the barren private land of 4.05 ha near Jamtha which is about 2.0 km away from the Jamtha casting yard. An amount of Rs. 213.6 Lakh provision is made in the EMP.	Quarterly	Contractor or Concessionaire	NMRCL /MPCB	213.6 (for Solid waste/Muck/ Spoil) 1.92 (for water quality Monitoring)	Responsibility of Contractor and should be part of Civil contractor
15.	Quarrying	• Quarrying will be carried out at approved and licensed quarries only	Monthly	Contractor or Concessionaire	NMRCL /MPCB	-	Responsibility of Contractor and should be part of Civil contractor

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
16.	Soil quality	• Periodic monitoring of water quality at suggested sensitive locations (2 locations) through out the 12.54 Kms stretch of reach. • An amount of 0.96 Lakh shall be allotted for water quality monitoring during construction phase (of 4 year), once every 3 months other than monsoon season	Quarterly	Contractor or Concessionaire	NMRCL /MPCB	0.96	Responsibility of Contractor and should be part of Civil contractor
17.	Water logging and stagnation of water in the Borrow pits	• Uncontrolled exploration of quarries / burrow pits will be avoided to prevent water accumulation which results in breeding of vectors.	Monthly	Contractor or Concessionaire	NMRCL	-	Responsibility of Contractor and should be part of Civil contractor
18.	Occupation Health & Safety and Safety with vehicles, people and livestock and signage	• Workers shall be equipped with proper safety gears like helmets, gloves and gum boots. • Periodic health checkup of construction workers. • Safety education and fines. • Allow for adequate traffic flow around construction areas • Provide adequate signage, barriers and flag persons for safety precautions. • Communicate to the public through radio, TV & newspaper announcements regarding the scope and timeframe of projects, as well as certain construction activities causing disruptions or access restrictions		Contractor or Concessionaire	NMRCL	-	Responsibility of Contractor and should be part of Civil contractor

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
19.	Basic amenities and sanitation facilities for Workers	• Workers shall be equipped with proper safety wears like helmets, gloves, gum boots etc. • Periodic health checkup of construction workers shall be carried out.	Monthly	Contractor or Concessionaire	NMRCL	-	Responsibility of Contractor and should be part of Civil contractor
20.	Fuel for workers	Adequate supply of fuel (LPG/Kerosene) shall be provided to the workers to avoid felling of trees for cooking and other domestic chores.	Monthly	Contractor or Concessionaire	NMRCL	-	Responsibility of Contractor and should be part of Civil contractor
21.	Drainage system	• Providing adequate drainage structure • Construction of toe drain along the road on both the sides • Avoiding obstruction of existing drainage during filling	Monthly	Contractor or Concessionaire	NMRCL	-	Responsibility of Contractor and should be part of Civil contractor
22.	Conservation of Eco-resources	• Arable lands should not be used as earth borrowing whenever possible. If needed, the topsoil (30cm) should be kept and refilled after construction is over to minimize the impact on ecosystem and agriculture. • Construction materials carrying vehicles should run at temporary accesses to avoid damaging arable lands and cattle-grazing lands.	Monthly	Contractor or Concessionaire	NMRCL	-	Responsibility of Contractor and should be part of Civil contractor
23	Rain Water Harvesting (RWH)	• There is about 143.5 KLD of rain water can be harvested by roof top harvesting method for which recharge pit area of 10x10x3 m will be required in MIHAN Depot. An amount of Rs. 7.5 Lakh is allotted in EMP.	Monthly	Contractor or Concessionaire	NMRCL	7.5	Responsibility of Contractor and should be part of Civil contractor

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
24	Energy Management/ Conservation	• Contractor shall try and reduce the direct consumption of fossil fuels on site through use of energy efficient equipment at their project office and at construction sites; • Construction Equipment shall be duly serviced to ensure that they are operated at optimum level of fuel efficiency DGs shall be regularly serviced for energy efficient outputs; • Only Five star labeled equipment by Bureau of Energy Efficiency (BEE)/or its equivalent shall be used at project offices. Maximum use of grid power shall be planned at construction sites and at project offices • Monthly consumption of diesel and power units shall be compiled and submitted to GC/NMRCL	Quarterly	Contractor or Concessionaire	Project Manager/PME Head/SHE Personnel	-	-
OPERATION PHASE							

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
1.	Noise level	• The cumulative impact of the noise due to metro-rail is envisaged between 75 to 80 dB (A). Construction of noise barriers for about 0.30 Kms in this reach is proposed using 6mm thick Poly-carbonated solid Plate may be provided. The noise transmission loss due to these barriers will be about 10-15 dB (A) as per FTA Manual, 2006 (Chapter 6). An amount of Rs. 18.00 Lakh provision is made in the tender document and shall be taken care by contractor. • An amount of 6.25 Lakh provision is made for detailed noise modeling at sharp curves and at major hospitals along Right of Way (RoW) edge during operation phase of the project. • Periodic monitoring of ambient noise levels at suggested sensitive locations (4 locations) through out the 12.54 Kms stretch of reach. • An amount of 0.72 Lakh shall be allotted for Noise monitoring during operation phase (of 3 year), once in 3 months • There are two rows of avenue plants proposed along the periphery of Metro stations and at Depots. 20-50m thick Green Belt will be provided along the periphery of Depots.	Quarterly	Contractor or Concessionaire	PIU/EMP Implementing Agency	18.0 (for Noise barriers) 6.25 (for Noise study) 0.72 (for noise quality monitoring)	Section 6.5.2
2.	Vibration level	• Periodic monitoring of ambient vibration levels at suggested sensitive locations (4 locations) through out the 12.54 Kms stretch of reach. • An amount of 3.36 Lakh shall be allotted for Noise monitoring during operation phase (of 3 year), once in 3 months	Quarterly	Contractor or Concessionaire	PIU/EMP Implementing Agency	3.36	Section 6.4.11

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
3.	Air Quality	• The average PCUs estimated in the project are 29,099 among them 30% of the PCUs will be diverted to the proposed metro-rail project. Based on the same, the fuel reduction assessment is carried out and the equivalent cost of the fuel will also be saved due to the project. The average fuel reduction is estimated in the project is 1932.83 KL/Year and the same is converted into money works out to be Rs. 11.20 Crores/Year. • In addition to the above, an attempt has been made for the assessment of the reduction of the criteria air pollutants such as CO_2, CO, NOx, SO_2, PM and HC in the proposed metro-rail project. The considerable reduction in greenhouse gas (CO_2) is estimated to be 14469 tonnes/year in the project and equivalent amount of Carbon credits will also be anticipated in the project. • Periodic monitoring of ambient air quality at 3 baseline monitored locations for comparison and control. • An amount of 1.35 Lakh shall be allotted for Air Quality monitoring for Operation phase (3 year), once in 3 months other than monsoon season.	Quarterly	Contractor or Concessionaire	NMRCL /MPCB	1.35	Section 6.4.9
4.	Water quality	• Periodic monitoring of water quality at suggested sensitive locations (4 locations) through out the 12.54 Kms stretch of reach. • An amount of 1.44 Lakh shall be allotted for water quality monitoring during operation phase (of 3 year), once in 3 months other than monsoon season	Quarterly	Contractor or Concessionaire	NMRCL /MPCB	1.44	Section 6.4.8

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
5.	Soil quality	• Periodic monitoring of soil quality at suggested sensitive locations (2 locations) through out the 12.54 Kms stretch of reach. • An amount of 0.72 Lakh shall be allotted for water quality monitoring during operation phase (of 3 year), once in 3 months (other than monsoon season)	Quarterly	Contractor or Concessionaire	NMRCL /MPCB	0.72	Section 8.3.14
6.	Road safety and traffic management	• Prepare and administer a monitoring system on road accidents. • Adequate number of road signs with clear visibility shall be installed. • In case of spill of hazardous materials, report to the relevant departments at once and deal with it in accordance with the emergency plan. • Drivers and Public will be educated about the Safety regulations.	Quarterly	Contractor or Concessionaire	NMRCL /NHAI/ Traffic Police dept.	-	-
7.	Oil and Grease pollution	• Suitable treatment shall be taken for treatment of oil and grease before discharging the wastewater especially in depot areas. **or** • Oil & Grease (O&G) traps shall be constructed at depots. The generated O&G shall be sold in secondary market. • Oil & Grease (O&G) removal tank having size of 3x2x1.5 m shall be installed at initial stage of effluent treatments in each depot area.	Quarterly	Contractor or Concessionaire	NMRCL	-	Section 8.3.17
8.	Maintenance of storm water drainage system.	• The project area is having adequate urban drainge facilities and the drainage systems will be periodically checked and cleared so as to ensure adequate storm water flow.	Quarterly	Contractor or Concessionaire	NMRCL	-	-

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
9.	Water supply, sanitation and final disposal of waste.	• Sufficient quantity of water to be supplied at Stations and Depot for various purposes i.e., drinking, canteen, washing of trains, horticulture, firefighting, and sanitation etc. either from Municipal Corporation or supplied through tankers. • Provision of Bio-digesters 108 nos. at stations & MIHAN Depot. The cost made for the same is Rs.32.40 Lakhs. • Option for final disposal shall be studied and the suitable disposal route shall be decided carefully to minimise the impact of receiving bodies. As far as possible Zero Discharge Rule may be adopted.	Quarterly	Contractor or Concessionaire	NMRCL /MPCB	32.40(Bio-digesters at stations & MIHAN Depot)	-
10.	Safety and noise disturbances.	• New buildings should be prohibited within 50 m of the edge of carriageway. No new schools and hospitals should be allowed within 200 m of carriageway.	Quarterly	Contractor or Concessionaire	NMRCL	-	-

Table 8.14: ENVIRONMENT MANAGEMENT ACTION PLAN FOR REACH -2

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
	DESIGN PHASE						
1.	Alignment	The selected alignment of reach 2 is covering all the important locations such as commercial hubs, corporate hubs, residential colonies etc. of Nagpur Town. The total length of the Reach 2 alignment is 6.8542 km. NMRCL is proposing 7 stations and 0 Depot in this reach. The alignment will not pass through any archaeological sites, temples and other environmentally sensitive areas.	Monthly	Design Consultant	NMRCL	-	Detailed Engineering
2.	Soil Erosion	Temporary and permanent drainage systems are mostly available in the project area. Hence, the soil erosion in the stretch is not anticipated much in this reach. The impact on the water bodies will be minimized by avoiding dumping of the excavated soil or waste soil near water bodies.	Monthly	Design Consultant	NMRCL	-	Detailed Engineering
3.	Cultural Relics	No protected Areas under international conventions, national or local legislation for their Archaeological importance, landscape, cultural or other related valuable are envisaged in the proposed alignment of Reach 2.	Quarterly	Design Consultant	Archaeological dept.	-	Detailed Engineering
4.	Flood	No major bridges and culverts are present at the project site. However, every care will been taken for the purpose of free flow of flood discharge in this reach.	Quarterly	Design Consultant	NMRCL	-	Detailed Engineering

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
5.	Inadequate design provision for safety against seismological hazard	Even though reach area falls under seismic zone II, NMRCL shall ensure that design provides for safety of structures against worst combination of forces in the probability of an earthquake.	Quarterly	Design Consultant	PIU	-	Detailed Engineering
7.	Water requirement	The requirement of water for construction purpose etc., shall be planned and arranged from Municipal water supply/ Ground water .	Quarterly	Design consultant	PIU/EMP Implementing Agency	-	Responsibility of Contractor and should be a part of Civil Contract
8.	Disposal of final treated effluent from treatment plant	Different options for final disposal shall be studied and the suitable disposal route shall be decided carefully to minimize the impact of receiving bodies. As far as possible Zero Effluent Discharge Rule may be adopted.	Quarterly	Contractor	NMRCL	Bio-digesters at workers camp are proposed	Responsibility of Contractor and should be a part of Civil Contract
CONSTRUCTION PHASE							
1.	Environmental Management and Monitoring	This will include institutional requirements, training, environmental management and monitoring for reach 2.	During and after construction	Contractor	PIU/EMP Implementing Agency	5	Chapter 8 & Chapter 9

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
2.	Tree cutting and plantation	• Prepare an action plan for an estimated 61 nos. of trees to be affected/felled in this reach and trees proposed to be planted about 899 nos. along the reach including Stations. • Intimate Nagpur Municipal Corporation & Revenue Department, Nagpur before cutting trees and Prepare action plan for avenue plantation. • The indigenous plants to be planted in the project area such as Neem, Blue berry, Subabul, Gulmohar, Karanj, Pipal, Imli, Babul, Mango, Coconut palms etc. An amount of Rs. 7.19 Lakh is allocated in the EMP.	Monthly	Concessionaire / Contractor	NMRCL/NMC/ Revenue Department	7.19	Section 6.4.13
3.	Burrow pits and Quarry sites (stone & sand).	• Firm up contract with mining department for obtaining the quarry material • Quarrying will be carried out at approved and licensed quarries only. • Resurfacing and landscaping of the pits. • Borrow areas shall be carried out up to depth of 2.0m in non-cultivable & elevated lands, 0.45 m in productive lands etc. with a slope of not steeper than 1 vertical to 4 horizontal. • Borrow areas shall be 15 m away from the water bodies identified along the project corridor. • The borrow areas shall be located at least 800 m away from the villages/towns. • Resurfacing and landscaping of the borrow pits utilized in the project.	Monthly	Contractor or Concessionaire	NMRCL/ Mines & Geology Department	-	Responsibility of Contractor & should be part of Civil contract

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
4.	Equipment selection maintenance and operation	• Construction plants and equipment will meet recognized international standards for emissions and will be maintained and operated in a manner that ensures relevant air, noise, and discharge regulations are met.	Monthly	Contractor or Concessionaire	PIU/EMP Implementing Agency	Depend on construction methodology	Responsibility of Contractor & should be part of Civil contract
5.	Site for storage and construction camp.	• Land for temporary construction of yards shall be identified at suitable locations with minimal adverse impact on Environment • The project Contractor shall select and construct a Campsite which is duly confirming the labour laws. Storage of construction materials such as cement, steel, bricks, pre-cast blocks etc will be expected as per the stipulated guidelines. Besides these, emergency response plan will be in place towards meeting unforeseen emergencies. Trained personnel will be deployed for handling such materials and care will be taken so that spills are abated and in case of spills, immediately they are contained.	Monthly	Contractor or Concessionaire	NMRCL	-	Responsibility of contractor and should be part of Civil contract

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
6.	Sewerage and solid waste disposal.	• For sewerage disposal, Proper sanitation facilities at the construction workers camp shall be provided as per the IS:2470-1985 • Provision of Bio-digesters having capacity for 640 people to achieve the desired on-land discharge standards of CPCB. An amount of Rs. 19.2 lakh provision shall be made in the tender document and shall be taken care by contractor for this reach. • The municipal solid wastes generated in construction & workers camp will be about 288 Kg/Day and the same will be disposed off at nearest identified location of disposal / landfill sites of local authority with payments in environmentally acceptable manner. Domestic refuse shall be collected separately for bio-degradable waste as well as the inert waste and the same shall be sent for the disposal as per the MSW (Management & Handling) Rules, 2000 and subsequent amendments thereof. An amount of Rs. 30.32 Lakh provision is made in the EMP for this reach.	Monthly	Contractor or Concessionaire	NMRCL /MPCB	19.2 (Bio-digesters for workers camp) 30.32 (SW)	Responsibility of Contractor and should be part of Civil contractor Section 6.4.6, 8.3.3
7.	Sanitation and Waste Disposal in Construction Camps	• Sufficient measures will be taken in the construction camps, i.e. provision of garbage tank and sanitation facilities. • Drinking water will meet Indian National Standards. • Garbage will be collected in a tank and disposed of daily. Camps will be located at a minimum distance of 200 m from water sources.	Monthly	Contractor or Concessionaire	PIU/EMP Implementing Agency	-	Responsibility of Contractor and should be part of Civil contractor

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
8.	Wastage of water	• Measures shall be taken to avoid misuse of water i.e awareness among the workers and posters. Construction agency shall be instructed accordingly to follow strict procedures while using the water for construction and drinking purpose.	Monthly	Contractor or Concessionaire	PIU/EMP Implementing Agency	-	Responsibility of Contractor and should be part of Civil contractor
9.	Traffic management	• The project stretch passes through City Area having Major junctions and Habitations like Automotive square, Nari road, Indora square, Kasturchand park, Prajapati nagar, etc in the project impact area of reach 2. • Secure assistance from local police for traffic control during the construction • Safety measures shall also be undertaken by installing road signs and markings for safe and smooth movement of traffic as per IRC SP:55.	Monthly	Contractor or Concessionaire	NMRCL /NHAI /Traffic Department	-	Responsibility of Contractor and should be part of Civil contractor
10.	Dust suppression	• Water should be sprinkled during construction phase once in 6 hours or 3times in a day, wherever it is required to avoid dust.	Daily	Contractor or Concessionaire	NMRCL /MPCB	-	Responsibility of Contractor and should be part of Civil contractor

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
11.	Noise level	• Stationary equipment shall be placed as far as possible from residential areas to minimize noise impacts on the near inhabitants. • Provision of ear plugs to workers exposed to high noise levels in the project. • Noise quality monitoring shall be carried out at 4 baseline locations of the project in all the seasons and compared with the baseline levels. Adequate measures shall be adopted time to time close to identified sensitive locations (40 nos) such as schools, hospitals, temples, recreation places etc. • An amount of 2.88 Lakh shall be allotted for Noise monitoring during construction period of 4 years, once in a month • On-site low cost noise protection barriers/traffic safety barriers to be provided to mitigate construction noise.	Monthly	Contractor or Concessionaire	NMRCL /MPCB	2.88 (for noise quality monitoring)	Responsibility of Contractor and should be part of Civil contractor
12.	Vibration	• The detailed vibration investigation shall be required during construction. Awareness about vibration impact to the public residing near to the alignment during construction and operation is proposed. • An amount of 23.52 Lakh shall be allotted for Vibration monitoring (at 7 locations) during construction period of 4 years, once in a month	Monthly	Contractor or Concessionaire	NMRCL /MPCB	23.52	Responsibility of Contractor and should be part of Civil contractor

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
13.	Air Quality	• Vehicles carrying construction material shall be covered to avoid spilling. • Mixing equipment shall be seated and equipped with dust removal device. • Air quality monitoring shall be carried out at 3 baseline monitored locations of the reach in all the seasons and compared with the baseline levels. Adequate mitigation measures such as water sprinkling during the construction phase at 6 hours interval or 3 times in a day at the construction yard and the unpaved sections of the road. • An amount of Rs. 5.4 Lakh provision is made for Air Quality Monitoring at 3 locations during construction period of 4 years for 3 seasons, once in a month (other than monsoon season)	Monthly	Contractor or Concessionaire	NMRCL /MPCB	5.4	Responsibility of Contractor and should be part of Civil contractor

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
14.	Water Quality & Muck/ spoil waste	• There are 2 nos. of rivers/ lake / water bodies/ nalas / Canals present within the core area of this Reach. Hence, care needs to be take to deposit the muck or waste earth close to these locations to prevent the water pollution. • Prior permission of the concerned engineer and regulatory authorities shall be taken regarding the discharge or disposing of any material arising from the execution of the works. • During construction it will be ensured that contractor does not dispose off debris in water bodies. • Soil laden run off will not be diverted to water bodies. Provision of waste disposal site for waste from construction and storage yards shall be made. • Vehicle maintenance and refueling will be confined to areas under construction yard to trap discarded lubricant and fuel spills. • An amount of 1.44 Lakh shall be allotted for Water Quality Monitoring at 3 locations during construction period of 4 years, once in 3 months (other than monsoon season). • Spoil/Muck generated in the reach is about 67,554 Cum and the same shall be disposed in identified barren private lands like the one in Jamtha area of reach 1. An amount of Rs. 104 Lakh provision is made in the EMP.	Quarterly	Contractor or Concessionaire	NMRCL /MPCB	104 (for Muck/Spoil) 1.44 (for water quality Monitoring)	Responsibility of Contractor and should be part of Civil contractor
15.	Quarrying	• Quarrying will be carried out at approved and licensed quarries only	Monthly	Contractor or Concessionaire	NMRCL /MPCB	-	Responsibility of Contractor and should be part of Civil contractor

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
16.	Soil quality	• Periodic monitoring of water quality at suggested sensitive locations (1 locations) through out the 6.85 Kms stretch of reach. • An amount of 0.48 Lakh shall be allotted for water quality monitoring during construction phase (of 4 year), once every 3 months other than monsoon season	Quarterly	Contractor or Concessionaire	NMRCL /MPCB	0.48	Responsibility of Contractor and should be part of Civil contractor
17.	Water logging and stagnation of water in the Borrow pits	• Uncontrolled exploration of quarries / burrow pits will be avoided to prevent water accumulation which results in breeding of vectors.	Monthly	Contractor or Concessionaire	NMRCL	-	Responsibility of Contractor and should be part of Civil contractor
18.	Occupation Health & Safety and Safety with vehicles, people and livestock and signage	• Workers shall be equipped with proper safety gears like helmets, gloves and gum boots. • Periodic health checkup of construction workers. • Safety education and fines. • Allow for adequate traffic flow around construction areas • Provide adequate signage, barriers and flag persons for safety precautions. • Communicate to the public through radio, TV & newspaper announcements regarding the scope and time frame of projects, as well as certain construction activities causing disruptions or access restrictions		Contractor or Concessionaire	NMRCL	-	Responsibility of Contractor and should be part of Civil contractor

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
19.	Basic amenities and sanitation facilities for workers	• Workers shall be equipped with proper safety wears like helmets, gloves, gum boots etc. • Periodic health checkup of construction workers shall be carried out.	Monthly	Contractor or Concessionaire	NMRCL	-	Responsibility of Contractor and should be part of Civil contractor
20.	Fuel for workers	Adequate supply of fuel (LPG/Kerosene) shall be provided to the workers to avoid felling of trees for cooking and other domestic chores.	Monthly	Contractor or Concessionaire	NMRCL	-	Responsibility of Contractor and should be part of Civil contractor
21.	Drainage system	• Providing adequate drainage structure • Construction of toe drain along the road on both the sides • Avoiding obstruction of existing drainage during filling	Monthly	Contractor or Concessionaire	NMRCL	-	Responsibility of Contractor and should be part of Civil contractor
22.	Conservation of Eco-resources	• Arable lands should not be used as earth borrowing whenever possible. If needed, the topsoil (30cm) should be kept and refilled after construction is over to minimize the impact on ecosystem and agriculture. • Construction materials carrying vehicles should run at temporary accesses to avoid damaging arable lands and cattle-grazing lands.	Monthly	Contractor or Concessionaire	NMRCL	-	Responsibility of Contractor and should be part of Civil contractor

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
23	Energy Management/ Conservation	• Contractor shall try and reduce the direct consumption of fossil fuels on site through use of energy efficient equipment at their project office and at construction sites; • Construction Equipment shall be duly serviced to ensure that they are operated at optimum level of fuel efficiency DGs shall be regularly serviced for energy efficient outputs; • Only Five star labeled equipment by Bureau of Energy Efficiency (BEE)/or its equivalent shall be used at project offices. Maximum use of grid power shall be planned at construction sites and at project offices • Monthly consumption of diesel and power units shall be compiled and submitted to GC/NMRCL	Quarterly	Contractor or Concessionaire	Project Manager/PME Head/SHE Personnel	-	-
OPERATION PHASE							

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
1.	Noise level	• The cumulative impact of the noise due to metro-rail is envisaged between 75 to 80 dB (A). Construction of noise barriers for about 0.65 Kms in this reach is proposed using 6mm thick Poly-carbonated solid Plate may be provided. The noise transmission loss due to these barriers will be about 10-15 dB (A) as per FTA Manual, 2006 (Chapter 6). An amount of Rs. 39.00 Lakh provision is made in the tender document and shall be taken care by contractor. • An amount of 6.25 Lakh provision is made for detailed noise modeling at sharp curves and at major hospitals along Right of Way (RoW) edge during operation phase of the project. • Periodic monitoring of ambient noise levels at suggested sensitive locations (3 locations) through out the 6.85 Kms stretch of reach. • An amount of 0.54 Lakh shall be allotted for Noise monitoring during operation phase (of 3 year), once in 3 months • There are two rows of avenue plants proposed along the periphery of Metro stations.	Quarterly	Contractor or Concessionaire	PIU/EMP Implementing Agency	39.0 (for noise barriers) 6.25 (for noise study) 0.54 (for noise quality monitoring)	Section 6.5.2
2.	Vibration level	• Periodic monitoring of ambient vibration levels at suggested sensitive locations (4 locations) through out the 6.85 Kms stretch of reach. • An amount of 3.36 Lakh shall be allotted for Noise monitoring during operation phase (of 3 year), once in 3 months	Quarterly	Contractor or Concessionaire	PIU/EMP Implementing Agency	3.36	Section 6.4.11

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
3.	Air Quality	• The average PCUs estimated in the project are 29,099 among them 30% of the PCUs will be diverted to the proposed metro-rail project. Based on the same, the fuel reduction assessment is carried out and the equivalent cost of the fuel will also be saved due to the project. The average fuel reduction is estimated in the project is 1055.81 KL/Year and the same is converted into money works out to be Rs. 6.12 Crores/Year. • In addition to the above, an attempt has been made for the assessment of the reduction of the criteria air pollutants such as CO2, CO, NOx, SO2, PM and HC in the proposed metro-rail project. The considerable reduction in greenhouse gas (CO2) is estimated to be 7903 tonnes/year in the project and equivalent amount of Carbon credits will also be anticipated in the project. • Periodic monitoring of ambient air quality at 3 baseline monitored locations for comparison and control. • An amount of 1.35 Lakh shall be allotted for Air Quality monitoring for Operation phase (3 year), once in 3 months other than monsoon season.	Quarterly	Contractor or Concessionaire	NMRCL /MPCB	1.35	Section 6.4.9
4.	Water quality	• Periodic monitoring of water quality at suggested sensitive locations (3 locations) through out the 6.85 Kms stretch of reach. • An amount of 1.08 Lakh shall be allotted for water quality monitoring during operation phase (of 3 year), once in 3 months other than monsoon season	Quarterly	Contractor or Concessionaire	NMRCL /MPCB	1.08	Section 6.4.8

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
5.	Soil quality	• Periodic monitoring of soil quality at suggested sensitive locations (1 locations) through out the 6.85Kms stretch of reach. • An amount of 0.36 Lakh shall be allotted for water quality monitoring during operation phase (of 3 year), once in 3 months other than monsoon season	Quarterly	Contractor or Concessionaire	NMRCL /MPCB	0.36	Section 8.3.14
6.	Road safety and traffic management	• Prepare and administer a monitoring system on road accidents. • Adequate number of road signs with clear visibility shall be installed. • In case of spill of hazardous materials, report to the relevant departments at once and deal with it in accordance with the emergency plan. • Drivers and Public will be educated about the Safety regulations.	Quarterly	Contractor or Concessionaire	NMRCL /NHAI/ Traffic Police dept.	-	-
7.	Oil and Grease pollution	• Suitable treatment shall be taken for treatment of oil and grease before discharging the wastewater	Quarterly	Contractor or Concessionaire	NMRCL	-	Section 8.3.17
8.	Maintenance of storm water drainage system.	• The project area is having adequate urban drainge facilities and the drainage systems will be periodically checked and cleared so as to ensure adequate storm water flow.	Quarterly	Contractor or Concessionaire	NMRCL	-	-

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
9.	Water supply, sanitation and final disposal of waste.	• Sufficient quantity of water to be supplied at Stations and Depot for various purposes i.e., drinking, canteen, washing of trains, horticulture, firefighting, and sanitation etc. either from Municipal Corporation or supplied through tankers. • Provision of Bio-digersters 70nos. at stations. The cost made for the same is Rs.21.00 Lakhs • Option for final disposal shall be studied and the suitable disposal route shall be decided carefully to minimise the impact of receiving bodies. As far as possible Zero Discharge Rule may be adopted.	Quarterly	Contractor or Concessionaire	NMRCL /MPCB	21.0 (bio-digesters at stations)	-
10.	Safety and noise disturbances.	• New buildings should be prohibited within 50 m of the edge of carriageway. No new schools and hospitals should be allowed within 200 m of carriageway.	Quarterly	Contractor or Concessionaire	NMRCL	-	-

Table 8.15: ENVIRONMENT MANAGEMENT ACTION PLAN FOR REACH -3

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
	DESIGN PHASE						
1.	Alignment	The selected alignment of reach 3 is covering all the important locations such as commercial hubs, corporate hubs, residential colonies etc. of Nagpur Town. The total length of the Reach 3 alignment is 10.4573 km. NMRCL is proposing 10 stations and 1 Depot in this reach. The alignment will not pass through any archaeological sites, temples and other environmentally sensitive areas.	Monthly	Design Consultant	NMRCL	-	Detailed Engineering
2.	Soil Erosion	Temporary and permanent drainage systems are mostly available in the project area. Hence, the soil erosion in the stretch is not anticipated much in this reach. The impact on the water bodies will be minimized by avoiding dumping of the excavated soil or waste soil near water bodies.	Monthly	Design Consultant	NMRCL	-	Detailed Engineering
3.	Cultural Relics	No protected Areas under international conventions, national or local legislation for their Archaeological importance, landscape, cultural or other related valuable are envisaged in the proposed alignment of Reach 3.	Quarterly	Design Consultant	Archaeological dept.	-	Detailed Engineering
4.	Flood	No major bridges and culverts are present at the project site. However, every care will been taken for the purpose of free flow of flood discharge in this reach.	Quarterly	Design Consultant	NMRCL	-	Detailed Engineering

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
5.	Inadequate design provision for safety against seismological hazard	Even though reach area falls under seismic zone II, NMRCL shall ensure that design provides for safety of structures against worst combination of forces in the probability of an earthquake.	Quarterly	Design Consultant	PIU	-	Detailed Engineering
7.	Water requirement	The requirement of water for construction purpose etc., shall be planned and arranged from Municipal water supply/ Ground water .	Quarterly	Design consultant	PIU/EMP Implementing Agency	-	Responsibility of Contractor and should be a part of Civil Contract
8.	Disposal of final treated effluent from treatment plant	Different options for final disposal shall be studied and the suitable disposal route shall be decided carefully to minimize the impact of receiving bodies. As far as possible Zero Effluent Discharge Rule may be adopted.	Quarterly	Contractor	NMRCL	Bio-digesters at workers camp are proposed	Responsibility of Contractor and should be a part of Civil Contract
CONSTRUCTION PHASE							
1.	Environmental Management and Monitoring	This will include institutional requirements, training, environmental management and monitoring for reach 3.	During and after construction	Contractor	PIU/EMP Implementing Agency	5	Chapter 8 & Chapter 9

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
2.	Tree cutting and plantation	• Prepare an action plan for an estimated 293 nos. of trees to be affected/felled in this reach and trees proposed to be planted about 1384 nos. along the reach including Stations. • Intimate Nagpur Municipal Corporation & Revenue Department, Nagpur before cutting trees and Prepare action plan for avenue plantation. • The indigenous plants to be planted in the project area such as Neem, Blue berry, Subabul, Gulmohar, Karanj, Pipal, Imli, Babul, Mango, Coconut palms etc. An amount of Rs. 11.07 Lakh is allocated in the EMP.	Monthly	Concessionaire / Contractor	NMRCL/NMC/ Revenue Department	11.07	Section 6.4.13
3.	Burrow pits and Quarry sites (stone & sand).	• Firm up contract with mining department for obtaining the quarry material • Quarrying will be carried out at approved and licensed quarries only. • Resurfacing and landscaping of the pits. • Borrow areas shall be carried out up to depth of 2.0m in non-cultivable & elevated lands, 0.45 m in productive lands etc. with a slope of not steeper than 1 vertical to 4 horizontal. • Borrow areas shall be 15 m away from the water bodies identified along the project corridor. • The borrow areas shall be located at least 800 m away from the villages/towns. • Resurfacing and landscaping of the borrow pits utilized in the project.	Monthly	Contractor or Concessionaire	NMRCL/ Mines & Geology Department	-	Responsibility of Contractor & should be part of Civil contract

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
4.	Equipment selection maintenance and operation	• Construction plants and equipment will meet recognized international standards for emissions and will be maintained and operated in a manner that ensures relevant air, noise, and discharge regulations are met.	Monthly	Contractor or Concessionaire	PIU/EMP Implementing Agency	Depend on construction methodology	Responsibility of Contractor & should be part of Civil contract
5.	Site for storage and construction camp.	• Land for temporary construction of yards shall be identified at suitable locations with minimal adverse impact on Environment • The project Contractor shall select and construct a Campsite which is duly confirming the labour laws. Storage of construction materials such as cement, steel, bricks, pre-cast blocks etc will be expected as per the stipulated guidelines. Besides these, emergency response plan will be in place towards meeting unforeseen emergencies. Trained personnel will be deployed for handling such materials and care will be taken so that spills are abated and in case of spills, immediately they are contained.	Monthly	Contractor or Concessionaire	NMRCL	-	Responsibility of contractor and should be part of Civil contract

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
6.	Sewerage and solid waste disposal.	• For sewerage disposal, Proper sanitation facilities at the construction workers camp shall be provided as per the IS:2470-1985 • Provision of Bio-digesters having capacity of 100m^3 for 640 people to achieve the desired on land discharge standards of CPCB. An amount of Rs. 19.2 lakh provision is made in tender document and shall be taken care by contractor for this reach. • The municipal solid wastes generated in construction & workers camp will be about 288 Kg/Day and the same will be disposed off at nearest identified location of disposal / landfill sites of local authority with payments in environmentally acceptable manner. Domestic refuse shall be collected separately for bio-degradable waste as well as the inert waste and the same shall be sent for the disposal as per the MSW (Management & Handling) Rules, 2000 and subsequent amendments thereof. An amount of Rs. 30.32Lakh provision is made in the EMP for this reach.	Monthly	Contractor or Concessionaire	NMRCL /MPCB	19.2 (for Bio-digesters at workers camp) 30.32 (SW)	Responsibility of Contractor and should be part of Civil contractor Sections 6.4.6, 8.3.3
7.	Sanitation and Waste Disposal in Construction Camps	• Sufficient measures will be taken in the construction camps, i.e. provision of garbage tank and sanitation facilities. • Drinking water will meet Indian National Standards. • Garbage will be collected in a tank and disposed of daily. Camps will be located at a minimum distance of 200 m from water sources.	Monthly	Contractor or Concessionaire	PIU/EMP Implementing Agency	-	Responsibility of Contractor and should be part of Civil contractor

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
8.	Wastage of water	• Measures shall be taken to avoid misuse of water i.e awareness among the workers and posters. Construction agency shall be instructed accordingly to follow strict procedures while using the water for construction and drinking purpose.	Monthly	Contractor or Concessionaire	PIU/EMP Implementing Agency	-	Responsibility of Contractor and should be part of Civil contractor
9.	Traffic management	• The project stretch passes through City Area having Major junctions and Habitations like Jhansi rani square, Subash nagar, Vasudev nagar etc in the project impact area of reach 3. • Secure assistance from local police for traffic control during the construction • Safety measures shall also be undertaken by installing road signs and markings for safe and smooth movement of traffic as per IRC SP:55.	Monthly	Contractor or Concessionaire	NMRCL /NHAI /Traffic Department	-	Responsibility of Contractor and should be part of Civil contractor
10.	Dust suppression	• Water should be sprinkled during construction phase once in 6 hours or 3times in a day, wherever it is required to avoid dust.	Daily	Contractor or Concessionaire	NMRCL /MPCB	-	Responsibility of Contractor and should be part of Civil contractor

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
11.	Noise level	• Stationary equipment shall be placed as far as possible from residential areas to minimize noise impacts on the near inhabitants. • Provision of ear plugs to workers exposed to high noise levels in the project. • Noise quality monitoring shall be carried out at 4 baseline locations of the project in all the seasons and compared with the baseline levels. Adequate measures shall be adopted time to time close to identified sensitive locations (58 nos) such as schools, hospitals, temples, recreation places etc. • An amount of 2.88 Lakh shall be allotted for Noise monitoring during construction period of 4 years, once in a month • On-site low cost noise protection barriers/traffic safety barriers to be provided to mitigate construction noise.	Monthly	Contractor or Concessionaire	NMRCL /MPCB	2.88 (for noise quality monitoring)	Responsibility of Contractor and should be part of Civil contractor
12.	Vibration	• The detailed vibration investigation shall be required during construction. Awareness about vibration impact to the public residing near to the alignment during construction and operation is proposed. • An amount of 16.80 Lakh shall be allotted for Vibration monitoring (at 5 locations) during construction period of 4 years, once in a month	Monthly	Contractor or Concessionaire	NMRCL /MPCB	16.80	Responsibility of Contractor and should be part of Civil contractor

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
13.	Air Quality	• Vehicles carrying construction material shall be covered to avoid spilling. • Mixing equipment shall be seated and equipped with dust removal device. • Air quality monitoring shall be carried out at 3 baseline monitored locations of the reach in all the seasons and compared with the baseline levels. Adequate mitigation measures such as water sprinkling during the construction phase at 6 hours interval or 3 times in a day at the construction yard and the unpaved sections of the road. • An amount of Rs. 5.4 Lakh provision is made for Air Quality Monitoring at 3 locations during construction period of 4 years for 3 seasons, once in a month (other than monsoon season)	Monthly	Contractor or Concessionaire	NMRCL /MPCB	5.4	Responsibility of Contractor and should be part of Civil contractor

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
14.	Water Quality & Spoil /Muck	• There are 11 nos. of rivers/ lake / water bodies/ nalas / Canals present within the core area of this reach. Hence, care needs to be take to deposit the muck or waste earth close to these locations to prevent the water pollution. • Prior permission of the concerned engineer and regulatory authorities shall be taken regarding the discharge or disposing of any material arising from the execution of the works. • During construction it will be ensured that contractor does not dispose off debris in water bodies. • Soil laden run off will not be diverted to water bodies. Provision of waste disposal site for waste from construction and storage yards shall be made. • Vehicle maintenance and refueling will be confined to areas under construction yard to trap discarded lubricant and fuel spills. • An amount of 1.92 Lakh shall be allotted for Water Quality Monitoring at 4 locations during construction period of 4 years, once in 3 months (other than monsoon season). • Spoil /Muck generated in the reach is about 1,21,361 Cum and the same shall be disposed in identified barren private lands like the one in Jamtha area of reach 1. An amount of Rs. 185 Lakh provision is made in the EMP.	Quarterly	Contractor or Concessionaire	NMRCL /MPCB	185(for Muck/Spoil) 1.92 (for water quality Monitoring)	Responsibility of Contractor and should be part of Civil contractor
15.	Quarrying	• Quarrying will be carried out at approved and licensed quarries only	Monthly	Contractor or Concessionaire	NMRCL /MPCB	-	Responsibility of Contractor and should be part of Civil contractor

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
16.	Soil quality	• Periodic monitoring of water quality at suggested sensitive locations (2 locations) through out the 10.45 Kms stretch of reach. • An amount of 0.96 Lakh shall be allotted for water quality monitoring during construction phase (of 4 year), once every 3 months other than monsoon season	Quarterly	Contractor or Concessionaire	NMRCL /MPCB	0.96	Responsibility of Contractor and should be part of Civil contractor
17.	Water logging and stagnation of water in the Borrow pits	• Uncontrolled exploration of quarries / burrow pits will be avoided to prevent water accumulation which results in breeding of vectors.	Monthly	Contractor or Concessionaire	NMRCL	-	Responsibility of Contractor and should be part of Civil contractor
18.	Occupation Health & Safety and Safety with vehicles, people and livestock and signage	• Workers shall be equipped with proper safety gears like helmets, gloves and gum boots. • Periodic health checkup of construction workers. • Safety education and fines. • Allow for adequate traffic flow around construction areas • Provide adequate signage, barriers and flag persons for safety precautions. • Communicate to the public through radio, TV & newspaper announcements regarding the scope and timeframe of projects, as well as certain construction activities causing disruptions or access restrictions		Contractor or Concessionaire	NMRCL	-	Responsibility of Contractor and should be part of Civil contractor

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
19.	Basic amenities and sanitation facilities for workers	• Workers shall be equipped with proper safety wears like helmets, gloves, gum boots etc. • Periodic health checkup of construction workers shall be carried out.	Monthly	Contractor or Concessionaire	NMRCL	-	Responsibility of Contractor and should be part of Civil contractor
20.	Fuel for workers	Adequate supply of fuel (LPG/Kerosene) shall be provided to the workers to avoid felling of trees for cooking and other domestic chores.	Monthly	Contractor or Concessionaire	NMRCL	-	Responsibility of Contractor and should be part of Civil contractor
21.	Drainage system	• Providing adequate drainage structure • Construction of toe drain along the road on both the sides • Avoiding obstruction of existing drainage during filling	Monthly	Contractor or Concessionaire	NMRCL	-	Responsibility of Contractor and should be part of Civil contractor
22.	Conservation of Eco-resources	• Arable lands should not be used as earth borrowing whenever possible. If needed, the topsoil (30cm) should be kept and refilled after construction is over to minimize the impact on ecosystem and agriculture. • Construction materials carrying vehicles should run at temporary accesses to avoid damaging arable lands and cattle-grazing lands.	Monthly	Contractor or Concessionaire	NMRCL	-	Responsibility of Contractor and should be part of Civil contractor
23	Rain Water Harvesting (RWH)	• There is about 143.5 KLD of rain water can be harvested by roof top harvesting method for which recharge pit area of 10x10x3 m will be required in Hingna Depot. An amount of Rs. 7.5 Lakh is allotted in EMP.	Monthly	Contractor or Concessionaire	NMRCL	7.5	Responsibility of Contractor and should be part of Civil contractor

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
24	Energy Management/ Conservation	• Contractor shall try and reduce the direct consumption of fossil fuels on site through use of energy efficient equipment at their project office and at construction sites; • Construction Equipment shall be duly serviced to ensure that they are operated at optimum level of fuel efficiency DGs shall be regularly serviced for energy efficient outputs; • Only Five star labeled equipment by Bureau of Energy Efficiency (BEE)/or its equivalent shall be used at project offices. Maximum use of grid power shall be planned at construction sites and at project offices • Monthly consumption of diesel and power units shall be compiled and submitted to GC/NMRCL	Quarterly	Contractor or Concessionaire	Project Manager/PME Head/SHE Personnel	-	-
OPERATION PHASE							

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
1.	Noise level	• The cumulative impact of the noise due to metro-rail is envisaged between 75 to 80 dB (A). Construction of noise barriers for about 0.6 Kms in this reach is proposed using 6mm thick Poly-carbonated solid Plate may be provided. The noise transmission loss due to these barriers will be about 10-15 dB (A) as per FTA Manual, 2006 (Chapter 6). An amount of Rs. 36.00 Lakh provision is made in the tender document and shall be taken care by contractor. • An amount of 6.25 Lakh provision is made for detailed noise modeling at sharp curves and at major hospitals along Right of Way (RoW) edge during operation phase of the project. • Periodic monitoring of ambient noise levels at suggested sensitive locations (3 locations) through out the 10.45 Kms stretch of reach. • An amount of 0.54 Lakh shall be allotted for Noise monitoring during operation phase (of 3 year), once in 3 months • There are two rows of avenue plants proposed along the periphery of Metro stations and at Depots. 20-50m thick Green Belt will be provided along the periphery of Depots.	Quarterly	Contractor or Concessionaire	PIU/EMP Implementing Agency	36(for noise barriers) 6.25 (for noise study) 0.54(for noise quality monitoring)	Section 6.5.2
2.	Vibration level	• Periodic monitoring of ambient vibration levels at suggested sensitive locations (2 locations) through out the 10.45 Kms stretch of reach. • An amount of 1.68 Lakh shall be allotted for Noise monitoring during operation phase (of 3 year), once in 3 months	Quarterly	Contractor or Concessionaire	PIU/EMP Implementing Agency	1.68	Section 6.4.11

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
3.	Air Quality	• The average PCUs estimated in the project are 29,099 among them 30% of the PCUs will be diverted to the proposed metro-rail project. Based on the same, the fuel reduction assessment is carried out and the equivalent cost of the fuel will also be saved due to the project. The average fuel reduction is estimated in the project is 1610.69 KL/Year and the same is converted into money works out to be Rs.9.33 Crores/Year. • In addition to the above, an attempt has been made for the assessment of the reduction of the criteria air pollutants such as CO2, CO, NOx, SO2, PM and HC in the proposed metro-rail project. The considerable reduction in greenhouse gas (CO2) is estimated to be 12057 tonnes/year in the project and equivalent amount of Carbon credits will also be anticipated in the project. • Periodic monitoring of ambient air quality at 3 baseline monitored locations for comparison and control. • An amount of 1.35 Lakh shall be allotted for Air Quality monitoring for Operation phase (3 year), once in 3 months other than monsoon season.	Quarterly	Contractor or Concessionaire	NMRCL /MPCB	1.35	Section 6.4.9
4.	Water quality	• Periodic monitoring of water quality at suggested sensitive locations (4 locations) through out the 10.45 Kms stretch of reach. • An amount of 1.44 Lakh shall be allotted for water quality monitoring during operation phase (of 3 year), once in 3 months (other than monsoon season)	Quarterly	Contractor or Concessionaire	NMRCL /MPCB	1.44	Section 6.4.8

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
5.	Soil quality	• Periodic monitoring of soil quality at suggested sensitive locations (2 locations) through out the 10.45 Kms stretch of reach. • An amount of 0.72 Lakh shall be allotted for water quality monitoring during operation phase (of 3 year), once in 3 months (other than monsoon season)	Quarterly	Contractor or Concessionaire	NMRCL /MPCB	0.72	Section 8.3.14
6.	Road safety and traffic management	• Prepare and administer a monitoring system on road accidents. • Adequate number of road signs with clear visibility shall be installed. • In case of spill of hazardous materials, report to the relevant departments at once and deal with it in accordance with the emergency plan. • Drivers and Public will be educated about the Safety regulations.	Quarterly	Contractor or Concessionaire	NMRCL /NHAI/ Traffic Police dept.	-	-
7.	Oil and Grease pollution	• Suitable treatment shall be taken for treatment of oil and grease before discharging the wastewater especially in depot areas. **Or** • Oil & Grease (O&G) traps shall be constructed at depots. The generated O&G shall be sold in secondary market. • Oil & Grease (O&G) removal tank having size of 3x2x1.5 m shall be installed at initial stage of effluent treatments in each depot area.	Quarterly	Contractor or Concessionaire	NMRCL	-	Section 8.3.17
8.	Maintenance of storm water drainage system.	• The project area is having adequate urban drainge facilities and the drainage systems will be periodically checked and cleared so as to ensure adequate storm water flow.	Quarterly	Contractor or Concessionaire	NMRCL	-	-

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
9.	Water supply, sanitation and final disposal of waste.	• Sufficient quantity of water to be supplied at Stations and Depot for various purposes i.e., drinking, canteen, washing of trains, horticulture, firefighting, and sanitation etc. either from Municipal Corporation or supplied through tankers. • Provision of Bio-digersters 108 nos. at stations & Hingna Depot. The cost made for the same is Rs.32.40 Lakhs • Option for final disposal shall be studied and the suitable disposal route shall be decided carefully to minimise the impact of receiving bodies. As far as possible Zero Discharge Rule may be adopted.	Quarterly	Contractor or Concessionaire	NMRCL /MPCB	32.40 (for bio-digesters at stations and Hingna Depot)	-
10.	Safety and noise disturbances.	• New buildings should be prohibited within 50 m of the edge of carriageway. No new schools and hospitals should be allowed within 200 m of carriageway.	Quarterly	Contractor or Concessionaire	NMRCL	-	-

Table -8.16: ENVIRONMENT MANAGEMENT ACTION PLAN FOR REACH -4

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
	DESIGN PHASE						
1.	Alignment	The selected alignment of reach 4 is covering all the important locations such as commercial hubs, corporate hubs, residential colonies etc. of Nagpur Town. The total length of the Reach 4 alignment is 8.09 km. NMRCL is proposing 9 stations in this reach. The alignment will not pass through any archaeological sites, temples and other environmentally sensitive areas.	Monthly	Design Consultant	NMRCL	-	Detailed Engineering
2.	Soil Erosion	Temporary and permanent drainage systems are mostly available in the project area. Hence, the soil erosion in the stretch is not anticipated much in this reach. The impact on the water bodies will be minimized by avoiding dumping of the excavated soil or waste soil near water bodies.	Monthly	Design Consultant	NMRCL	-	Detailed Engineering
3.	Cultural Relics	No protected Areas under international conventions, national or local legislation for their Archaeological importance, landscape, cultural or other related valuable are envisaged in the proposed alignment of Reach 4.	Quarterly	Design Consultant	Archaeological dept.	-	Detailed Engineering
4.	Flood	No major bridges and culverts are present at the project site. However, every care will been taken for the purpose of free flow of flood discharge in this reach.	Quarterly	Design Consultant	NMRCL	-	Detailed Engineering

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
5.	Inadequate design provision for safety against seismological hazard	Even though reach area falls under seismic zone II, NMRCL shall ensure that design provides for safety of structures against worst combination of forces in the probability of an earthquake.	Quarterly	Design Consultant	PIU	-	Detailed Engineering
7.	Water requirement	The requirement of water for construction purpose etc., shall be planned and arranged from Municipal water supply/ Ground water .	Quarterly	Design consultant	PIU/EMP Implementing Agency	-	Responsibility of Contractor and should be a part of Civil Contract
8.	Disposal of final treated effluent from treatment plant	Different options for final disposal shall be studied and the suitable disposal route shall be decided carefully to minimize the impact of receiving bodies. As far as possible Zero Effluent Discharge Rule may be adopted.	Quarterly	Contractor	NMRCL	Bio-digesters at workers camp are proposed	Responsibility of Contractor and should be a part of Civil Contract
CONSTRUCTION PHASE							
1.	Environmental Management and Monitoring	This will include institutional requirements, training, environmental management and monitoring for reach 4.	During and after construction	Contractor	PIU/EMP Implementing Agency	5.0	Chapter 8 & Chapter 9

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
2.	Tree cutting and plantation	• Prepare an action plan for an estimated 72 nos. of trees to be affected/felled in this reach and trees proposed to be planted about 1066 nos. along the reach including Stations. • Intimate Nagpur Municipal Corporation & Revenue Department, Nagpur before cutting trees and Prepare action plan for avenue plantation. • The indigenous plants to be planted in the project area such as Neem, Blue berry, Subabul, Gulmohar, Karanj, Pipal, Imli, Babul, Mango, Coconut palms etc. An amount of Rs. 8.52 Lakh is allocated in the EMP.	Monthly	Concessionaire / Contractor	NMRCL/NMC/ Revenue Department	8.52	Section 6.4.13
3.	Burrow pits and Quarry sites (stone & sand).	• Firm up contract with mining department for obtaining the quarry material • Quarrying will be carried out at approved and licensed quarries only. • Resurfacing and landscaping of the pits. • Borrow areas shall be carried out up to depth of 2.0m in non-cultivable & elevated lands, 0.45 m in productive lands etc. with a slope of not steeper than 1 vertical to 4 horizontal. • Borrow areas shall be 15 m away from the water bodies identified along the project corridor. • The borrow areas shall be located at least 800 m away from the villages/towns. • Resurfacing and landscaping of the borrow pits utilized in the project.	Monthly	Contractor or Concessionaire	NMRCL/ Mines & Geology Department	-	Responsibility of Contractor & should be part of Civil contract

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
4.	Equipment selection maintenance and operation	• Construction plants and equipment will meet recognized international standards for emissions and will be maintained and operated in a manner that ensures relevant air, noise, and discharge regulations are met.	Monthly	Contractor or Concessionaire	PIU/EMP Implementing Agency	Depend on construction methodology	Responsibility of Contractor & should be part of Civil contract
5.	Site for storage and construction camp.	• Land for temporary construction of yards shall be identified at suitable locations with minimal adverse impact on Environment • The project Contractor shall select and construct a Campsite which is duly confirming the labour laws. Storage of construction materials such as cement, steel, bricks, pre-cast blocks etc will be expected as per the stipulated guidelines. Besides these, emergency response plan will be in place towards meeting unforeseen emergencies. Trained personnel will be deployed for handling such materials and care will be taken so that spills are abated and in case of spills, immediately they are contained.	Monthly	Contractor or Concessionaire	NMRCL	-	Responsibility of contractor and should be part of Civil contract

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
6.	Sewerage and solid waste disposal.	• For sewerage disposal, Proper sanitation facilities at the construction workers camp shall be provided as per the IS:2470-1985 • Provision of Bio-digesters having capacity of 100m^3 for 640 people to achieve the desired on land discharge standards of CPCB. An amount of Rs. 19.20 lakh provision is made in tender document and shall be taken care by contractor for this reach. • The municipal solid wastes generated in construction & workers camp will be about 288 Kg/Day and the same will be disposed off at nearest identified location of disposal / landfill sites of local authority with payments in environmentally acceptable manner. Domestic refuse shall be collected separately for bio-degradable waste as well as the inert waste and the same shall be sent for the disposal as per the MSW (Management & Handling) Rules, 2000 and subsequent amendments thereof. An amount of Rs. 30.32 Lakh provision is made in the EMP for this reach.	Monthly	Contractor or Concessionaire	NMRCL /MPCB	19.2 (for Bio-digesters at workers camp) 30.32 (SW)	Responsibility of Contractor and should be part of Civil contractor Sections 6.4.6, 8.3.3
7.	Sanitation and Waste Disposal in Construction Camps	• Sufficient measures will be taken in the construction camps, i.e. provision of garbage tank and sanitation facilities. • Drinking water will meet Indian National Standards. • Garbage will be collected in a tank and disposed of daily. Camps will be located at a minimum distance of 200 m from water sources.	Monthly	Contractor or Concessionaire	PIU/EMP Implementing Agency	-	Responsibility of Contractor and should be part of Civil contractor

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
8.	Wastage of water	• Measures shall be taken to avoid misuse of water i.e awareness among the workers and posters. Construction agency shall be instructed accordingly to follow strict procedures while using the water for construction and drinking purpose.	Monthly	Contractor or Concessionaire	PIU/EMP Implementing Agency	-	Responsibility of Contractor and should be part of Civil contractor
9.	Traffic management	• The project stretch passes through City Area having Major junctions and Habitations like Vaishnodevi square, Ambedkar square, Telephone exchange, Agrasen square, Gandhi bagh basta, Railway station, Cotton market, Ramjhula etc in the project impact area of reach 4. • Secure assistance from local police for traffic control during the construction • Safety measures shall also be undertaken by installing road signs and markings for safe and smooth movement of traffic as per IRC SP:55.	Monthly	Contractor or Concessionaire	NMRCL /NHAI /Traffic Department	-	Responsibility of Contractor and should be part of Civil contractor
10.	Dust suppression	• Water should be sprinkled during construction phase once in 6 hours or 3times in a day, wherever it is required to avoid dust.	Daily	Contractor or Concessionaire	NMRCL /MPCB	-	Responsibility of Contractor and should be part of Civil contractor

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
11.	Noise level	• Stationary equipment shall be placed as far as possible from residential areas to minimize noise impacts on the near inhabitants. • Provision of ear plugs to workers exposed to high noise levels in the project. • Noise quality monitoring shall be carried out at 5 baseline locations of the project in all the seasons and compared with the baseline levels. Adequate measures shall be adopted time to time close to identified sensitive locations (68 nos) such as schools, hospitals, temples, recreation places etc. • An amount of 3.6 Lakh shall be allotted for Noise monitoring during construction period of 4 years, once in a month • On-site low cost noise protection barriers/traffic safety barriers to be provided to mitigate construction noise.	Monthly	Contractor or Concessionaire	NMRCL /MPCB	3.6 (for noise quality monitoring)	Responsibility of Contractor and should be part of Civil contractor
12.	Vibration	• The detailed vibration investigation shall be required during construction. Awareness about vibration impact to the public residing near to the alignment during construction and operation is proposed. • An amount of 23.52 Lakh shall be allotted for Vibration monitoring (at 7 locations) during construction period of 4 years, once in a month	Monthly	Contractor or Concessionaire	NMRCL /MPCB	23.52	Responsibility of Contractor and should be part of Civil contractor

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
13.	Air Quality	• Vehicles carrying construction material shall be covered to avoid spilling. • Mixing equipment shall be seated and equipped with dust removal device. • Air quality monitoring shall be carried out at 3 baseline monitored locations of the reach in all the seasons and compared with the baseline levels. Adequate mitigation measures such as water sprinkling during the construction phase at 6 hours interval or 3 times in a day at the construction yard and the unpaved sections of the road. • An amount of Rs. 5.4 Lakh provision is made for Air Quality Monitoring at 3 locations during construction period of 4 years for 3 seasons, once in a month (other than monsoon season)	Monthly	Contractor or Concessionaire	NMRCL /MPCB	5.4	Responsibility of Contractor and should be part of Civil contractor

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
14.	Water Quality & Spoil /Muck	• There are 2 nos. of rivers/ lake / water bodies/ nalas / Canals present within the core area of this reach. Hence, care needs to be take to deposit the muck or waste earth close to these locations to prevent the water pollution. • Prior permission of the concerned engineer and regulatory authorities shall be taken regarding the discharge or disposing of any material arising from the execution of the works. • During construction it will be ensured that contractor does not dispose off debris in water bodies. • Soil laden run off will not be diverted to water bodies. Provision of waste disposal site for waste from construction and storage yards shall be made. • Vehicle maintenance and refueling will be confined to areas under construction yard to trap discarded lubricant and fuel spills. • An amount of 1.92 Lakh shall be allotted for Water Quality Monitoring at 4 locations during construction period of 4 years, once in 3 months other than monsoon season • Spoil/ Muck generated in the reach is about 67,619 Cum and the same shall be disposed in identified barren private lands like the one in Jamtha area of reach 1. An amount of Rs. 104.4 Lakh provision is made in the EMP.	Quarterly	Contractor or Concessionaire	NMRCL /MPCB	104.4(for Muck/Spoil) 1.92 (for water quality Monitoring)	Responsibility of Contractor and should be part of Civil contractor
15.	Quarrying	• Quarrying will be carried out at approved and licensed quarries only	Monthly	Contractor or Concessionaire	NMRCL /MPCB	-	Responsibility of Contractor and should be part of Civil contractor

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
16.	Soil quality	• Periodic monitoring of water quality at suggested sensitive locations (1 locations) through out the 8.09 Kms stretch of reach. • An amount of 0.48 Lakh shall be allotted for water quality monitoring during construction phase (of 4 year), once every 3 months other than monsoon season	Quarterly	Contractor or Concessionaire	NMRCL /MPCB	0.48	Responsibility of Contractor and should be part of Civil contractor
17.	Water logging and stagnation of water in the Borrow pits	• Uncontrolled exploration of quarries / burrow pits will be avoided to prevent water accumulation which results in breeding of vectors.		Contractor or Concessionaire	NMRCL	-	Responsibility of Contractor and should be part of Civil contractor
18.	Occupation Health & Safety and Safety with vehicles, people and livestock and signage	• Workers shall be equipped with proper safety gears like helmets, gloves and gum boots. • Periodic health checkup of construction workers. • Safety education and fines. • Allow for adequate traffic flow around construction areas • Provide adequate signage, barriers and flag persons for safety precautions. • Communicate to the public through radio, TV & newspaper announcements regarding the scope and timeframe of projects, as well as certain construction activities causing disruptions or access restrictions	Monthly	Contractor or Concessionaire	NMRCL	-	Responsibility of Contractor and should be part of Civil contractor

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
19.	Basic amenities and sanitation facilities for Workers	• Workers shall be equipped with proper safety wears like helmets, gloves, gum boots etc. • Periodic health checkup of construction workers shall be carried out.	Monthly	Contractor or Concessionaire	NMRCL	-	Responsibility of Contractor and should be part of Civil contractor
20.	Fuel for Workers	Adequate supply of fuel (LPG/Kerosene) shall be provided to the Workers to avoid felling of trees for cooking and other domestic chores.	Monthly	Contractor or Concessionaire	NMRCL	-	Responsibility of Contractor and should be part of Civil contractor
21.	Drainage system	• Providing adequate drainage structure • Construction of toe drain along the road on both the sides • Avoiding obstruction of existing drainage during filling	Monthly	Contractor or Concessionaire	NMRCL	-	Responsibility of Contractor and should be part of Civil contractor
22.	Conservation of Eco-resources	• Arable lands should not be used as earth borrowing whenever possible. If needed, the topsoil (30cm) should be kept and refilled after construction is over to minimize the impact on ecosystem and agriculture. • Construction materials carrying vehicles should run at temporary accesses to avoid damaging arable lands and cattle-grazing lands.	Monthly	Contractor or Concessionaire	NMRCL	-	Responsibility of Contractor and should be part of Civil contractor

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
23	Energy Management/ Conservation	• Contractor shall try and reduce the direct consumption of fossil fuels on site through use of energy efficient equipment at their project office and at construction sites; • Construction Equipment shall be duly serviced to ensure that they are operated at optimum level of fuel efficiency DGs shall be regularly serviced for energy efficient outputs; • Only Five star labeled equipment by Bureau of Energy Efficiency (BEE)/or its equivalent shall be used at project offices. Maximum use of grid power shall be planned at construction sites and at project offices • Monthly consumption of diesel and power units shall be compiled and submitted to GC/NMRCL	Quarterly	Contractor or Concessionaire	Project Manager/PME Head/SHE Personnel	-	-
OPERATION PHASE							

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
1.	Noise level	• The cumulative impact of the noise due to metro-rail is envisaged between 75 to 80 dB (A). Construction of noise barriers for about 0.75 Kms in this reach is proposed using 6mm thick Poly-carbonated solid Plate may be provided.The noise transmission loss due to these barriers will be about 10-15 dB (A) as per FTA Manual, 2006 (Chapter 6). An amount of Rs. 45.00 Lakh provision is made in the tender document and shall be taken care by contractor. • An amount of 6.25 Lakh provision is made for detailed noise modeling at sharp curves and at major hospitals along Right of Way (RoW) edge during operation phase of the project. • Periodic monitoring of ambient noise levels at suggested sensitive locations (3 locations) through out the 8.09 Kms stretch of reach. • An amount of 0.54 Lakh shall be allotted for Noise monitoring during operation phase (of 3 year), once in 3 months • There are two rows of avenue plants proposed along the periphery of Metro stations.	Quarterly	Contractor or Concessionaire	PIU/EMP Implementing Agency	45(for noise barriers) 6.25 (for noise study) 0.54(for noise quality monitoring)	Section 6.5.2
2.	Vibration level	• Periodic monitoring of ambient vibration levels at suggested sensitive locations (4 locations) through out the 8.09 Kms stretch of reach. • An amount of 3.36 Lakh shall be allotted for Noise monitoring during operation phase (of 3 year), once in 3 months	Quarterly	Contractor or Concessionaire	PIU/EMP Implementing Agency	3.36	Section 6.4.11

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
3.	Air Quality	• The average PCUs estimated in the project are 29,099 among them 30% of the PCUs will be diverted to the proposed metro-rail project. Based on the same, the fuel reduction assessment is carried out and the equivalent cost of the fuel will also be saved due to the project. The average fuel reduction is estimated in the project is 1246.94 KL/Year and the same is converted into money works out to be Rs. 7.22 Crores/Year. • In addition to the above, an attempt has been made for the assessment of the reduction of the criteria air pollutants such as CO2, CO, NOx, SO2, PM and HC in the proposed metro-rail project. The considerable reduction in greenhouse gas (CO2) is estimated to be 9334 tonnes/year in the project and equivalent amount of Carbon credits will also be anticipated in the project. • Periodic monitoring of ambient air quality at 3 baseline monitored locations for comparison and control. • An amount of 1.35 Lakh shall be allotted for Air Quality monitoring for Operation phase (3 year), once in 3 months other than monsoon season.	Quarterly	Contractor or Concessionaire	NMRCL /MPCB	1.35	Section 6.4.9
4.	Water quality	• Periodic monitoring of water quality at suggested sensitive locations (4 locations) through out the 8.09 Kms stretch of reach. • An amount of 1.44 Lakh shall be allotted for water quality monitoring during operation phase (of 3 year), once in 3 months other than monsoon season	Quarterly	Contractor or Concessionaire	NMRCL /MPCB	1.44	Section 6.4.8

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
5.	Soil quality	• Periodic monitoring of soil quality at suggested sensitive locations (1 locations) through out the 8.09 Kms stretch of reach. • An amount of 0.36 Lakh shall be allotted for water quality monitoring during operation phase (of 3 year), once in 3 months (other than monsoon season)	Quarterly	Contractor or Concessionaire	NMRCL /MPCB	0.36	Section 8.3.14
6.	Road safety and traffic management	• Prepare and administer a monitoring system on road accidents. • Adequate number of road signs with clear visibility shall be installed. • In case of spill of hazardous materials, report to the relevant departments at once and deal with it in accordance with the emergency plan. • Drivers and Public will be educated about the Safety regulations.	Quarterly	Contractor or Concessionaire	NMRCL /NHAI/ Traffic Police dept.	-	-
7.	Oil and Grease pollution	• Suitable treatment shall be taken for treatment of oil and grease before discharging the waste water	Quarterly	Contractor or Concessionaire	NMRCL	-	Section 8.3.17
8.	Maintenance of storm water drainage system.	• The project area is having adequate urban drainge facilities and the drainage systems will be periodically checked and cleared so as to ensure adequate storm water flow.	Quarterly	Contractor or Concessionaire	NMRCL	-	-

S. No	Project related Issues	Action to be taken	Frequency	Implementation Agency / Authority	Supervision Agency	Cost (Rs. Lakh)	Remarks
9.	Water supply, sanitation and final disposal of waste.	• Sufficient quantity of water to be supplied at Stations for various purposes i.e., drinking, canteen, washing of trains, horticulture, firefighting, and sanitation etc. either from Municipal Corporation or supplied through tankers. • Provision of Bio-digesters of 90 nos. Is made in all the stations and the cost for the same is Rs. 27.0 Lakhs. • Option for final disposal shall be studied and the suitable disposal route shall be decided carefully to minimise the impact of receiving bodies. As far as possible Zero Discharge Rule may be adopted.	Quarterly	Contractor or Concessionaire	NMRCL /MPCB	27.0 (for bio-digesters at stations)	-
10.	Safety and noise disturbances.	• New buildings should be prohibited within 50 m of the edge of carriageway. No new schools and hospitals should be allowed within 200 m of carriageway.	Quarterly	Contractor or Concessionaire	NMRCL	-	-

CHAPTER -09
ENVIRONMENTAL MONITORING PLAN

9.1 Pre-Construction Phase

The environmental monitoring programme is a vital process of any Environmental Management Plan (EMP) of development project for review of indicators and take immediate preventive action. This helps in signaling the potential problems resulting from the proposed project activities and will allow for prompt implementation of corrective measures. Historically, environmental monitoring has been integral part of works of NMRCL towards better environmental management of air, noise, vibration, water quality etc both during construction and in operation. Generation of dust and noise are two main issues during any large construction activity. Degradation of water quality is another. During construction, management of dust was carried out by monitoring Suspended Particulate Matter. Now, the same is being done by monitoring Particulate Matter (size less than 10microns).Similarly, for example, noise and vibration monitoring is carried out by recording dB(A) and mm/s values respectively. Monitoring of specific environmental parameters has also been driven by requirements of KfW. The parameters are monitored in pre-construction, construction and operation phase and are based on the need to evaluate the deviation of environmental conditions from baseline environmental conditions due to construction and operation of the Metro. If it is observed that environmental conditions are deteriorating, then proper mitigation measures will be taken. The monitoring parameters are thus those that are generally impacted during construction activities. Impact monitoring during construction help to discipline the contractors and assist them in meeting their contractual obligations. Construction phase monitoring data is also intended to evaluate the efficacy of some control mechanisms found in the environmental manual which are then either modified, upgraded or deleted. Monitoring is also extended to the operational phase, to ascertain the impacts over a long term period. These parameters are also of immediate public concern. Over a period of time, much environmental monitored data has been generated and is also of academic interest. The data is much sought after by Institutions, NGOs and interested public. The environmental monitoring will be required during both construction and operational phases. The following parameters are proposed to be monitored:

- Water Quality,
- Air Quality,
- Noise and Vibration,
- Soil Quality
- Environmental Sanitation and Waste Disposal,
- Ecological monitoring and afforestation
- Workers health and safety

Environmental monitoring during pre-construction phase is important to know the baseline data and to predict the adverse impacts during construction and operations phases. Pre-construction phase monitoring has been done for the proposed project for air, noise, water, soil quality and ecology. The results so obtained are documented in **Chapter -5**.

9.2 Construction Phase

During construction stage environmental monitoring will be carried out for air quality, noise levels, vibrations, water quality, and ecology. Environmental monitoring has to be carried out at the locations where baseline monitoring was carried-out). These number could be modified based on need when the construction actually commences.

9.2.1 Water Quality

Since water contamination leads to various water related diseases, the project authorities shall establish a procedure for water quality surveillance and ensure safe water for the consumers. The water quality parameters are to be monitored during the entire period of project construction. Monitoring should be carried out by NABL certified private or Government agency. Water quality should be analyzed following the procedures given in the standard methods. Parameters for monitoring will be as per BIS: 10500(for drinking and ground water) & BIS: 2296 (for surface water quality). The monitoring points could be ground and surface water.

9.2.2 Air Quality

Air quality is regularly monitored by Central/State Pollution Control Boards at number of places in Nagpur. In addition to these, air quality should be monitored

at the locations of baseline monitoring as reported in Chapter 5. The parameters recommended is Particulate Matter (PM_{10}), $PM_{2.5}$, SO_2, NO_2 and CO. The contractor will be responsible for carrying out air monitoring during the entire construction phase under the supervision of NMRCL.

9.2.3 Noise and Vibration

The noise will be monitored at construction sites for entire phase of construction by the site contractor and under the supervision of NMRCL. The parameters to be monitored in noise are Leq_{day} & Leq_{night} and the parameters to be monitored in vibration are PPV (in mm/sec).

9.2.4 Soil Quality

Soil quality should be monitored at the locations of baseline monitoring as reported in **Chapter -5**. The physico-chemical parameters to be monitored as specified in baseline.

9.2.5 Ecological Monitoring

The project authority in coordination with the NMC shall monitor the status of ecology/trees along the project corridors during construction phase in order to maintain the ecological environment.

9.2.6 Workers health and safety

Monitoring of health risk issues that might arise throughout the project life time will be done. Epidemiological studies at construction sites and workers camp will be performed to monitor the potential spread of diseases. Regular inspection and medical checkups shall be carried out to workers health and safety monitoring. Any reoccurring incidents such as irritations, rashes, respiratory problems etc shall be recorded and appropriate mitigation measures shall be taken. Contractor will be the responsible person to take care health and safety of workers during the entire period of the construction. The monitoring Schedule for Air, noise, vibration, and water are presented in **Table -9.1.**

Table -9.1: Construction Stage Monitoring Schedule

Parameter	Frequency	Locations				Years
		Reach 1	Reach 2	Reach 3	Reach 4	
Air (PM10)	24 hours, once a month other than monsoon season	3	3	3	3	4
Noise	24 hours, once a month	4	3	3	3	4
Vibration	24 hours, once a month	2	5	3	2	4
Water	Once in 3 months other than monsoon season	4	3	4	4	4
Soil	Once in 3 months other than monsoon season	2	1	2	1	4

Note: Suggested by M/s. Aarvee Associates, Hyderabad

The base map showing the construction phase monitoring is given in Figure -9.1 a & b.

The monitoring schedule during construction & operation phase of the project is given in Figure -9.2.

9.3 Operation Phase

Even though the environmental hazards during the operation phase of the project are minimal, the environmental monitoring will be carried out for air, noise, vibration, water, waste water, solid waste and ecology during operation phase of the project. The parameters monitored during operation will be PM10 for air, heavy metals for solid waste, pH, TSS, BOD, COD, oil and grease for waste water. However water quality parameters that will be monitored will be as per BIS 10500. The monitoring schedule is presented in **Table -9.2**. The monitoring program shall be conducted by an external agency certified by NABL under the supervision of NMRCL. Project proponent (NMRCL) is responsible for successful environmental monitoring of the proposed project during operation phase.

Table -9.2: Operation Stage Monitoring Schedule

Parameter	Frequency	Locations				Years
		Reach 1	**Reach 2**	**Reach 3**	**Reach 4**	
Air (PM10)	24 hours, once in 3 months other than monsoon season	3	3	3	3	3
Noise	24 hours once in 3 months	4	3	3	3	3
Vibration	24 hours once in 3 months	2	5	3	2	3
Water	Once a 3 months other than monsoon season	4	3	4	4	3
Soil	Once in 3 months other than monsoon season	2	1	2	1	3
Wastewater	Once in 4 months	At Depot	-	At Depot	-	3
Solid waste	Once in a year	At Depot	-	At Depot	-	3

Note: Suggested by M/s. Aarvee Associates, Hyderabad

The results of Air quality, water quality, waste water, vibration will be submitted to management quarterly during construction phase and semi annually during operation phase. All monitoring to be carried out at all baseline locations, wherever not mentioned follow the directions of the Environmental Expert/ Engineer In-charge.

9.4 Establishment of an Environmental Division

It is recommended that NMRCL establishes an Environment Division at the initial stage of the project itself. The division should be staffed with an Environmental Engineer/Officer. The task of the division would be to supervise and coordinate studies, environmental monitoring and implementation of environmental mitigation measures, and it should report directly to GM/Project Director of the NMRCL. Organizational setups for Environmental Monitoring during construction and operation phase are shown in **Figure -9.3 and Figure -9.4**.

9.5 Implementation of EMP by Third party/ Independent Environmental Engineer

As per the requirement of KfW and AFD Banks, an Independent Environment Engineer/ Third party engineer shall be deployed at site during construction phase of the project for an effective Implementation of EMP.

Figure -9.1a: Environmental Base map for Construction Phase

Figure -9.1b: Environmental Base map for Operation Phase

Figure -9.2: Environmental Monitoring Schedule during Construction & Operation Phase

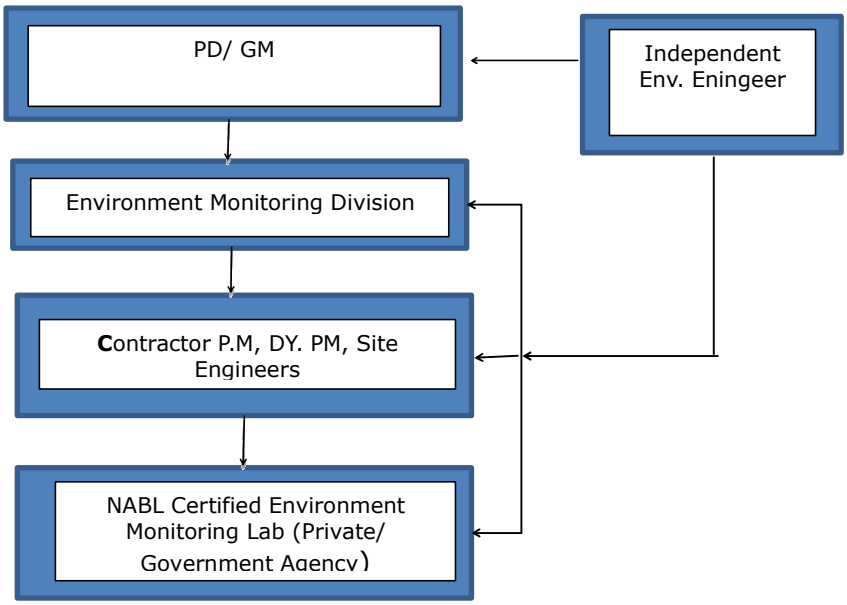


Figure -9.3: Organizational Setup During Construction Phase

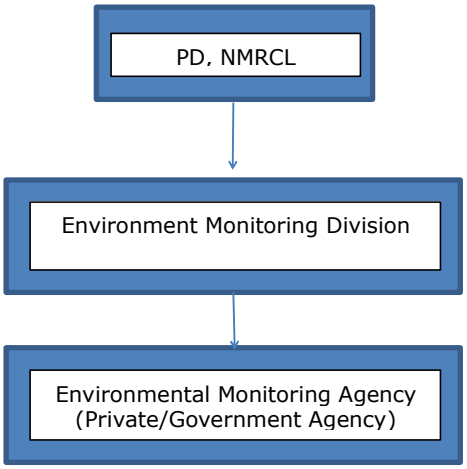


Figure -9.4: Organizational Setup During Operation Phase

CHAPTER -10
ENVIRONMENTAL COST ESTIMATES

10.1 Budget for EMP Implementation

The design and construction of the project involves a number of items such as erosion prevention, rehabilitation of Burrow areas, safety signage, etc., which are included in the contract cost. Only those items that are not covered under the budget for construction are shown in the EMP implementation budget. The total budget for EMP works out to **Rs. 16.24 Crores** as given in Table -10.1.

The main components are:

- Tree plantation / Transplantation
- Environmental monitoring during construction and operation phase
- Training during construction and operation phase
- Initiatives to be undertaken as part of Corporate Social Responsibilities.
- Dust Suppression systems
- Construction of Noise Barriers

Table 10.1: Budget for Environmental Management Plan

S.No.	Item	Unit cost/ Lump sum cost (Rs.)	Reach 1 (in Lakh)	Reach 2 (in Lakh)	Reach 3 (in Lakh)	Reach 4 (in Lakh)	Total cost (Rs. In Lakh)
I. Construction costs							
1.	Third party/Independent Environmental Engineer monitoring and supervision of EMP implementation during construction phase (4 years)	For 48 months @Rs. 2,50,000/month	30.00	30.00	30.00	30.00	120.00
2.	Workers camps, health and other services (Included in project cost)	Lump sum	30.00	30.00	30.00	30.00	120.00
3.	Solid waste management at campsites (Included in project cost)						
	Solid waste collection bins (60) @ Rs. 200/bin Community bin 4 no. @Rs 15,000/bin	200/bin 15,000/bin	0.72	0.72	0.72	0.72	2.88
	Transportation	Lump sum	20.00	20.00	20.00	20.00	80.00
	Manpower cost of 4 persons @5000 per person per month for 4 years	5000/month	9.60	9.60	9.60	9.60	38.40
4.	Muck/ Spoil Disposal from the site (Approx. 3,96,555 Cum @ Rs.250/Cum) (Included in Project cost)						
	Transportation cost (considering lead of 5 kms)	Lump sum	213.60	104.00	185.00	104.40	607.0
	Plantation & Beautification works (Rs. 1.20 Lakhs/Ha)	1.2 Lakhs/Ha	3.60	2.00	3.00	2.40	11.00
5.	Construction of noise barriers for about 2.3 Kms using using 6mm thick Poly-carbonated solid Plate may be provided. (2300 m x 2 sides x Rs 6000/m, including fixing & manpower charges) - Included in Project cost	6000/metre	18.00	39.00	36.00	45.00	138.00
6.	Green belt development-Included in project cost	Lump sum	18.0	-	22.0	-	40.00
7.	Rain water harvesting-Included in project cost	Lumpsum	7.5	-	7.5	-	15.00
8.	Bio-digesters (Rs. 30,000/unit) Workers camp - 64 nos. * 4 reaches Stations – 10 nos. * 36 stations	30,000/unit	51.6	40.2	51.6	46.2	189.60

S.No.	Item	Unit cost/ Lump sum cost (Rs.)	Reach 1 (in Lakh)	Reach 2 (in Lakh)	Reach 3 (in Lakh)	Reach 4 (in Lakh)	Total cost (Rs. In Lakh)
	Depot – 8 nos. * 2 depot -Included in project cost						
9..	Disaster Management Plan-Included in project cost	Lump sum	6.0	6.0	6.0	6.0	24.00
II. Tree plantation and compensatory afforestation							
10.	Tree plantation including 3 years maintenance - around 5000 nos. of trees (Rs. 800/tree)	800/tree	13.208	7.192	11.072	8.528	40.00
III. Monitoring costs: Construction Phase (4 years)							
11.	Air Quality Monitoring (12 Monitoring locations for 4 reaches) (Once in a month other than monsoon season)	No. of monitoring locations* 36months*Rs.5,000 per station	5.40	5.40	5.40	5.40	21.60
12	Noise level Monitoring (20 monitoring locations for 4 reaches) (once in a month)	No. of monitoring locations* 48months *Rs.1500 per station	5.04	2.88	2.88	3.60	14.40
13.	Water Quality Monitoring (15 Monitoring stations) (once in three months in a year other than monsoon season)	No. of monitoring locations*8months *Rs.4000 per station	1.92	1.44	1.92	1.92	7.20
14.	Soil Quality Monitoring (6 monitoring stations) (once every 3 months other than monsoon season)	No. of monitoring locations*12months *Rs.4000 per station	0.96	0.48	0.96	0.48	2.88
15.	Vibration Quality Monitoring (20 monitoring locations for 4 reaches)(once every month in a year)	No. of monitoring locations* 48 months*Rs.7000 per station	16.80	23.52	16.80	23.52	80.64
16.	Awareness programmes (Lump sum)-Included in project cost	5,00,000	5.00	5.00	5.00	5.00	20.00
IV. Monitoring costs: Operation Phase (3 years)							
17.	Air Quality Monitoring (12 Monitoring locations for 4 reaches) (once in three months other than monsoon season)	No. of monitoring locations* 9 months*Rs.5,000 per station	1.35	1.35	1.35	1.35	5.40
18.	Noise level Monitoring (13 monitoring locations for 4 reaches) (once in three months)	No. of monitoring locations* 9months *Rs.1500 per station	0.72	0.54	0.54	0.54	2.34
19.	Water Quality Monitoring (15 Monitoring stations) (once in three months other than monsoon season)	No. of monitoring locations*9months *Rs.4000 per station	1.44	1.08	1.44	1.44	5.40
20.	Vibration Quality Monitoring(12 monitoring locations for 4	No. of monitoring locations*	3.36	3.36	1.68	3.36	11.76

S.No.	Item	Unit cost/ Lump sum cost (Rs.)	Reach 1 (in Lakh)	Reach 2 (in Lakh)	Reach 3 (in Lakh)	Reach 4 (in Lakh)	Total cost (Rs. In Lakh)
	reaches)(once in three months)	9months*Rs.7000 per station					
21.	Soil Quality Monitoring (6 monitoring stations) (once in three months other than monsoon season)	No. of monitoring locations*9months *Rs.4000 per station	0.72	0.36	0.72	0.36	2.16
22	Detailed Noise Modeling study at Sharp Curves and Major Hospitals along the Right of Way (RoW) edge	Lump sum	6.25	6.25	6.25	6.25	25.00
Total			470.788	340.372	457.432	356.068	1624.66
Say			**INR 16.24 Crores (2.17 Million Euros as on 22/9/2016)**				

10.1.1 Budget components under the purview of Contractor:

Budget for Workers camps, health and other services (Component 2); Solid waste management at campsite (Component 3); Muck/ Spoil disposal from the site (Component 4); Construction of noise barriers (Component 5); Green belt development (Component 6); Rainwater harvesting (Component 7); Bio-digesters (Component 8); Disaster Management Plan (Component 9); Tree plantation (Component 10); Monitoring for Construction Phase (Components 11, 12, 13, 14 & 15) and Awareness Programmes (Component 16) come under the purview of Contractor and already included in the tender document. Total cost for these components is estimated to be **Rs. 14.52 Crores.**

10.1.2 Budget components under the purview of NMRCL:

Budget for Third party/Independent Environmental Engineer monitoring and supervision of EMP implementation during construction phase (Component 1); Detailed Noise Modeling study (Component 5) and Monitoring costs-Operation phase (Components 17, 18, 19, 20 & 21 only) come under the purview of NMRCL. Total cost for these components is estimated to be **Rs. 1.72 Crores**

CHAPTER -11
SUMMARY AND CONCLUSIONS

The proposed metro rail project can harmonize with the surrounding environment with the direct and indirect benefits. The following are the crucial conclusions drawn and recommendations developed as part of the Environmental Impact Assessment Report:

- There are 639 nos. (presumed 1000 nos.) of trees to be affected/felled in the project stretch and 5000 no.s trees are proposed to be planted along the project stretch including Parking areas of the Stations and Depot Areas. Tree cutting permission shall be taken from Nagpur Municipal Corporation (NMC) and Revenue Department, Nagpur . The indigenous plants proposed to be planted in the project area are Neem, Subabul, blue berry, Gulmohar, Karanj, Pipal, Imli, Babul, Mango, Coconut palms etc. An amount of Rs.40 Lakh is allocated for these plantations in the EMP.
- The major share of spoil/ muck estimated in the project is from excavation of the foundations of the piers is 2.40 Lakh Cum and Depots are generating 1.19 Lakh Cum. The construction & demolition waste is also considerable in the project which is estimated to be 0.24 Lakh Cum and others estimated to be 0.126 Lakh Cum. Overall spoil/ muck generation estimated in the project is 3.96 Lakh Cum. Cost towards the same is Rs. 6.18 Crores for all reaches.
- Provision of Bio-digesters shall be made at Construction camps (256 nos.), Stations (360 nos.) and Depots (16 nos.) to achieve the desired on land discharge standards of CPCB. An amount of Rs. 1.89 Crores provision shall be made during Construction and operation phases of the project.
- An adequate mitigation measures such as water sprinkling during the construction phase at 6 hours interval or 3 times in a day at the construction yard and the unpaved sections of the road.
- Keeping in view of the sensitive locations in the project,there is a length of 950 m noise barriers proposed in N-S Corridor and 1350 m length proposed in E-W Corridor. Noise barriers for about 2.3 Kms using 6mm thick Poly-carbonated solid Plate may be provided in all the identified sensitive locations of the project. An amount of Rs. 1.38 Crores provision is made in the EMP for this purpose.
- Rain Water Harvesting & Surface Drainage : To conserve and augment the storage of groundwater, it has been proposed to construct roof top rainwater

harvesting structure at the constructed depot site. Depot cum workshop area of 35,281 sq.m is available at both depots for roof top rain water harvesting. An annual average rainfall is 1112.7 mm, 287 KLD rain water will be harvested for which recharge pit area of 10x10x3 m will be required.

- An amount of Rs. 16.24 Crores (2.17 million Euros as on 22/9/2016) is allocated towards the implementation of the EMP in the project. Among them the budget that comes under the purview of Contractor is Rs. 14.52 Crores and the budget under the purview of NMRCL is Rs. 1.72 Crores.
- By creating awareness among the local public on effective utilization of Metro rail project, the pollution levels may further reduced.
- There will be an improvement of the economic growth in the surrounding places due to establishment of more IT Parks, SEZs, Educational Institutions, MNCs and other organizations.

Green Initiatives Proposed in NMRCL Project

Under other project features, the NMRCL has taken completely green initiatives by introducing **Solar power generation, Bio-digesters and Green Building i**n the project. Mission of NMRCL is to develop an energy efficient, environment friendly mass rapid transit system using maximum energy from the renewable sources.The details of the same are described below:

Solar Photo-voltaic Systems: NMRCL plans to install solar PV panels in two phases. In the first phase solar PV panels will be installed on the rooftops of stations and ground mount in the depot area. Solar panels having total capacity of **14.5 MWp** would be installed in the first phase. After completion of **Phase -I**, NMRCL plans to install to solar PV panels on depot and track boundary walls and on the viaduct structures under Phase -II. The total capacity of solar power which is likely to harnessed is about **23.1 MWp** after completion of **phase II**. NMRCL has also planned to install solar panels on the roof of metro bhavan with a capacity of 260 Kwp and 1000 units/day. This will reduce the load on conventional sources for power production and also reduce carbon emissions.

Green Building: NMRCL proposes eco-friendly and sustainable construction techniques to construct **Metro Bhavan office building** in Nagpur with a total built-up area of 10000 sq.m. NMRCL is having keen interest to make this project in accordance with green building norms and also aimed for obtaining the prestigious green building rating from Indian green building council (IGBC).

In view of the above benefits, the metro rail project will be taken up for the sustainable development of the society.

CHAPTER -12
DISCLOSURE OF THE CONSULTANT ENGAGED

12.0 DISCLOSURE OF THE CONSULTANT ENGAGED

Aarvee Associates is a premier, ISO 9001:2008 certified multidisciplinary engineering consulting company, established in 1989 and based at Hyderabad in India. We have a pan-India presence, with branch offices in New Delhi, Ahmadabad and Bhubaneshwar, and project offices in all the major states across the country. We also have a wholly-owned Australian subsidiary, Aarvee Associates Pty Ltd, based at Brisbane, Queensland.

In addition to over 1,000 successful assignments in India, we have carried out projects in Australia, Bangladesh, Ethiopia, Gabon, Mozambique, Nigeria, South Africa, Sri Lanka, and Uganda. We have worked on projects funded by various international agencies including the World Bank, the Asian Development Bank (ADB), the Department for International Development (DFID), and Japan International Cooperation Agency (JICA).

M/s. Aarvee Associates Architects Engineers and Consultants Pvt., Ltd., Hyderabad is Accredited by QCI-NABET in their Vide letter no. NABET/EIA/SA091/254 Dated: 12th December 2013 for doing EIA and EMP Studies including "Metro Rails, Railways, Transport Terminals, and Mass Rapid Transport Systems".

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Annexure - 18

Social Impact Assessment (SIA) Study and Preparation of Social Management Implementation Plan, Rehabilitation & Resettlement (R&R Policy) Plan for

Extension of Nagpur Metro Rail Project Phase-I

FINAL REPORT (MAY - 2024)

MAHARASHTRA METRO RAIL CORPORATION LIMITED

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ABBREVIATIONS

ADM	Additional District Magistrate
ADB	Asian Development Bank
AP	Affected Persons
EM	Entitlement Matrix
CPM	Chief Project Manager
CPR	Common Property Resource
DC	District Collector
DM	District Magistrate
DH	Displaced Households
DP	Displaced People
DPR	Detailed Project Report
FGD	Focus Group Discussion
GRC	Grievance Redressal Mechanism
GoI	Government of India
GoM	Government of Maharashtra
LA	Land Acquisition
LAA	Land Acquisition Act
MMRC	Maha Metro Rail Corporation
PMC	Project Management Consultancy
NMRP	Nagpur Metro Rail Project
NGO	Non-Government Organization
NTH	Non-Title holders
PIU	Project Management Unit
R&R	Resettlement & Rehabilitation
RP	Resettlement Plan
RPF	Resettlement Policy Framework
RFCTLARRA	Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013
SEMU	Social and Environment Management Unit
SIA	Social Impact Assessment
PWD	Person With Disability
SC	Schedule Caste
ST	Schedule Tribes
WHH	Women Headed Household
BPL	Below Poverty Line
RoW	Right of Way
VOC	Vehicle Operating Costs

CONTENT

List of Tables

List of Annexures

List of Figure

Executive Summary

1. Maharashtra Metro Rail Corporation Limited (Maha-Metro), a joint venture company of Government of India (GoI) and Government of Maharashtra (GoM), is developing the Nagpur Metro Rail Project (NMRP) Phase-II consisting of proposed 4 Reaches. The proposed NMRP Phase-II project is an extension of existing corridors of Phase-I project. Maha-Metro is the implementing agency of NMRP Phase-II project and will be responsible for execution of the project.

2. The total length of the proposed corridor in Phase-II project is 43.8 km. A total of 32 metro stations have been proposed along the four corridors of which 30 stations are elevated and 2 are at-grade. The Phase II corridor mostly follows median of the road at some locations the alignment is away from the road. Efforts have been made in modifying the engineering design and alignment of Phase-II metro line at various locations to minimize the resettlement impact and land acquisition.

3. The NMRP Phase-II project will undertake land acquisition by Direct Purchase Method through negotiation with the landowners as per GoM resolution dated 12 May 2015 and 30 September 2015. 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 (RFCTLARR), 2013. The compensation in Direct Purchase Method will have 25% additional amount on the compensation calculated as per section 26 to 36 of RFCTLAAR Act, 2013.

4. A total of 9.3089 Ha land will be required for the Phase II project, out of which 5.5749 Ha is Private Land and 3.734 Ha is Government Land. The private land will be acquired mainly for construction of station entry and exit purpose, viaduct, and parking purpose.

5. A total of 98 households would be displaced by this project. This includes 51 title holders (TH) losing the land only and 47 temporary structures owned by 47 non-title holder (NTH) households. A total of three CPRs will be affected by the project. The social stratification of DHs indicates that majority of the DHs belongs to Other Backward Caste (OBC) followed by general category. Most (81.82%) of the DHs belong to Hindu religion. This is followed by Muslim (12.50%). There are 57 DHs enumerated as vulnerable households in this project. There are 6.56% DPs who are illiterate. Most of the DPs are engaged in small business activities. There is no loss of livelihood among affected landowners as TH lands are barren. Also, no physical displacement of any residential structures. For NTH, provision of one-time assistance of Rs. 5000/- is kept in the EM.

6. Total 13 Public Consultations have been carried out during SIA study. Focus Group Discussions (FGDs) and individual discussions were held with the primary and secondary stakeholders to get wider public input on Phase II project. A total 162 male members and 34 women members participated. Other stakeholders in Phase II project such as officials of Implementing Agency (Maha-Metro), the relevant District administration and revenue officials were also consulted on various issues.

7. To receive and facilitate resolution of the DPs and general public concern and complaints in a transparent manner, the NMRP shall constitute two-tier GRC with representative from implementing agency, community and representative of DPs etc. The NMRP will maintain grievance registers at site offices and at head office. The decision of GRC will be documented and communicated to the concerned person in a transparent manner. In case the complainant is dissatisfied with the verdict of GRC, the complainant can approach the Court of Law.

8. The legal framework and principles adopted to address the resettlement issues of the Phase II project is guided by the existing legislation and policies of Government of India (GoI), Government of Maharashtra, and the SPS, 2009 of ADB & EIB Guidelines. Prior to the preparation of the PAP, a detailed analysis of the existing national and state policies was undertaken. A comparison of ADB-EIB and National Act has been done and measures to fill the gaps are presented in table no. 1.4 of the chapter 1.

9. The resettlement cost estimated for the Phase II project includes land compensation, resettlement and relocation assistance, reconstruction of CPRs and support cost for resettlement plan implementation. The support cost which includes staffing, monitoring, and reporting, and other administrative expenses are part of the overall project cost. Contingency provisions have been made to consider variation from this estimate.

10. During interaction with the villagers of the project area, it was found that they are very well conversant with the positive impact of the phase-II project. However, they expect a reasonable and adequate compensation for loss of their assets in the process of land acquisition. Therefore, adequate, and satisfactory monetary arrangement is must to compensate the people in lieu of their loss of land and emotional attachment.

I. PROJECT DESCRIPTION

A Project Background

Maharashtra Metro Rail Corporation Limited (Maha-Metro) a joint venture company of Government of India (GoI) and Government of Maharashtra (GoM), is developing the Nagpur Metro Rail Project (NMRP) Phase-II consisting of proposed 4 corridors. Based on the proposals from Comprehensive Mobility Plan (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 corridors of Phase-I to meet the future traffic demand. The proposed NMRP Phase-II project is an extension of existing Phase-I project. The Phase-II metro rail network will strengthen and augment the transport infrastructure within the city and will address constrained public transport infrastructure issues. Also, the peoples who are living & working in suburban and outskirts of the Nagpur city finds difficult to travel towards city. Hence, the demand to extend all the four Reach of existing metro Phase-I is growing continuously. Construction of rail metro would entail acquisition of land and structures as well as impacts other assets and Common Property Resources and may disrupt livelihood.

The NMRP Phase-I project is operational from the last 2 years with providing facilities to all kind of passengers including women and person with disabilities. The footfalls of Phase-I metro rail are steadily increase. The Maharashtra Metro Rail Corporation Limited (Maha-Metro) is an implementing agency will be responsible for execution of NMRP Phase-II project. This Phase-II project will benefit the people in Nagpur city socially and financially. The Phase II metro rail transportation will not only reduce the time travel but also cheaper to the passengers. It will also provide safe and secure transportation to vulnerable section of society. Due to increase in the transportation movement in the city, the business and financial activities will also be boost, thereby enhance the financial status of people. It will reduce the traffic congestion on road, reduces sound and air pollution and help in reducing global warming for creating sustainable environment.

For land acquisition and to mitigate the negative impact of the Phase II project. The NMRP has framed the Resettlement Action Plan (RAP) to provide guidance to deal with social adverse impacts associated with land acquisition and relocation. It also provides applicable measures to minimize or reduce the adverse impacts of the project. Recognizing the need to address involuntary displacement of people and their properties, this RAP has been developed in consistence with the relevant Indian National laws, RFCTLARR, 2013, and the policies and resolutions of Government of Maharashtra, International multilateral Funding Institutes- Asian Development Bank (ADB). This document serves to define procedures, principles and applicable legal regulations, institutional arrangements for dealing Land Acquisition (LA) and Resettlement for the Nagpur Metro Rail Project Phase-II covering length of 43.8 Kms of North – South (N-S) and East – West (E-W) corridor.

The NMRP Phase-II will offer a sustainable urban transport system, smart and healthy Nagpur city to increase the quality of life and better access to goods, services, creating employment opportunities and sustainable development, climate change mitigation resulting in livable city environment in Nagpur.

B. Rationale for the Project

The main aim of the Phase-II project is to decongest Nagpur city providing an option for the population of Nagpur to settle in surrounding areas and being able to travel to Nagpur city. It will promote social inclusion and development through improved accessibility to places that provide education and job opportunities. The proposed project will also enhance the regional transport system and provide inter-connection between Nagpur and settlements to relieve pressure on the existing transport routes converging at Nagpur.

The Phase-II project will offer a rail based Sustainable Urban Transport System, Smart and Healthy Cities to increase the quality of life and better access to goods, services, creating employment opportunities and sustainable development, climate change mitigation resulting in a liveable city environment i.e. health supportive environment with more allocation of road space to people rather than vehicles. This can be viewed as boosting overall substantial social and economic development to the region. The social benefits arising due to the project will be triggered due to improved accessibility to various services such as to markets, health facilities, schools, workplace and connectivity to rail, bus and airport, which in turn increases the income of the local residents, and ultimately elevating their standard of living.

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

1. The immediate benefits of Phase-II Metro Rail project will come in the form of direct employment opportunities for the roadside communities and specially those who are engaged as wage labourers, petty contractors, and suppliers of raw materials.
2. Improved metro rail network will provide for improved linkages between the suburban areas and Nagpur city, which provides wider work, marketing facilities and business opportunities. People can travel from Nagpur city to Industrial zone line Butibori MIDC, MIHAN, Hingna MIDC and Transport Nagar etc. to work.

3. Rail network will not only link the communities to better markets, but also open wider work opportunities in distant places. People can shuttle to distant work sites and towns and engage in construction, factories, business as well as domestic works.
4. Metro rail will also help people building strong institutional network with outside agencies. Essential and emergency services like schools, health centre, public distribution system etc. can be availed faster.
5. Increased frequency of interaction with outsiders will increase the awareness level of the people in the region regarding their health and nutrition, living style, value of education and proper utilization of available resources.
6. Interaction with the government, non-government and other development agents will help people gain new knowledge on improved farming, land development, development and maintenance of natural resources through the formation of various economic and social development groups.

Maha-Metro rail systems have an advantage over other modes of transportation because they provide higher carrying capacity, faster, smoother, and safer travel, occupy less space, and are non- polluting and energy-efficient. To summarize the benefits, a metro rail system:

a) Requires 1/5th energy per passenger km compared to road-based system
b) Causes no air pollution in the city
c) Causes lesser noise level
d) Occupies no road space as the majority of corridor is going from median of road with viaduct 8.5 meter
e) Is more reliable, comfortable and safer than road-based system.
f) Reduces travel time by 50% and 75% depending on road conditions.

Based on all above, it can be said the project will be beneficial to the community residing along the route alignment and provide relief to all including those who are losing their land for Phase II project which is this much awaited transport system.

The possible adverse impact of the Phase-II project estimated may be:

(i) **Loss of Private land:** As per Baseline socio-economic survey, a total of 5.5749 Ha of private land required for the project. This land will be acquired mainly for construction of station for entry exit purpose on either side, viaduct and parking purpose. There are 51 legal Titleholders (TH) identified whose private land is to be acquired.
(ii) **Loss of commercial land if any**: As per Baseline socio-economic survey found that no any commercial land is to be acquired for this project.
(iii) **Loss of CPR:** Total 3 Common Property Resource (CPR) includes two public toilet and one weekly market at Dongangao.
(iv) **Loss of livelihood if any:** Temporary loss of livelihood is anticipated for the non-titled holder due to relocation to outside the corridor of impact.

The measures to address these adverse impacts are described in the subsequent sections of this report.

Acquisition of land for public purpose as defined in Section 2 (1) of the Act RFCTLARR Act 2013 or Maharashtra Govt. GR in 2015 and 2017 is undertaken by invoking the provisions of

the Act with an objective to ensure a participative, informed and transparent process of speedy land acquisition for the public purpose. This social impact assessment is in accordance with the Act provision to assess the social impacts prior to the acquisition.

C. Details of the Project Size

The total length of the proposed corridor stretches in Phase-II project is 43.8 km. This entire stretch is extension of the existing Phase-I and is divided into four Reaches viz; Reach-1A (Khapari to MIDC ESR -18.5 km), Reach-2A (Automotive Square to Kanhan -13 km), Reach-3A (Lokmanya Nagar to Hingna - 6.7 km) and Reach-4A (Prajapati Nagar to Transport Nagar - 5.6 km). A total of 32 metro stations have been proposed along the four corridors of which 30 stations are elevated and 2 are at-grade. The details are given below in **Table – 1.1**

Table 1.1: Key Features of NMRP Phase-II

Extension of Phase-I	Corridor	Length in Km.	Elevated	At grade	Land Use (Stations)
Reach-1A	Khapri to MIDC ESR (Mihan Butibori Corridor)	18.5	08	2	(Mixed) Commercial & Industrial
Reach-2A	Automotive Square to Kanhan (Kamptee Corridor)	13	12	0	(Mixed) Commercial, barren & unculturable
Reach-3A	Lokmanya Nagar to Hingna (Hingna Corridor)	6.7	07	0	(Mixed) Commercial & Industrial
Reach-4A	Prajapati Nagar to Transport Nagar (Kapasi Corridor)	5.6	03	0	Commercial
Total		**43.80**	**30**	**2**	

Source: DPR, NMRP Phase-II

1. Location and General Profile of the Project Area

The Nagpur district consists of Nagpur Municipal Corporation, 10 Municipalities, 13 Panchayat Samitis and 778 Gram Panchayats. The total area covered is about 9897 sq. km. of which Nagpur city accounts for 217.65 sq. km. (2.2%).

Nagpur city is governed by Municipal Corporation which comes under Nagpur Metropolitan Region. As 2011 census, population of Nagpur city is 2,405,665; of which male and female are 1,225,405 and 1,180,260 respectively. Although Nagpur city has population of 2,405,665; its urban / metropolitan population is 2,497,870 of which 1,274,138 are males and 1,223,732 are females.

The municipality has a sex ratio of 963 females per 1,000 males and child sex ratio of 926 girls per 1,000 boys. 1,984,123 people are literate, of whom 1,036,097 are male and 948,026 are female. Average literacy rate of Nagpur city is 91.92%. The literacy rate of male is 94.44% and female is 89.31%.

Population

The current estimate population of Nagpur city in 2023 is 3,316,000. The last census was conducted in 2011 and the 2021 census for Nagpur city was postponed due to COVID-19. The current estimates of Nagpur city are based on past growth rate. The details are given below in **Table 1.2.**

Table 1.2: Population Growth in Nagpur

Year	Population	±%
1981	1,219,500	–
1991	1,664,000	+36.4%
2001	2,052,066	+23.3%
2011	2,405,665	+17.2%

Source: Census of India 2011

Total children (0-6) in Nagpur city are 247,078 as per figure from Census India report on 2011. There were 128,290 boys while 118,788 are girls. The child forms 10.27 % of total population of Nagpur City.

Hinduism is the majority religion in Nagpur city with 69.46% followers. Buddhism is the second most popular religion in Nagpur city with 15.57% following it. Nagpur is popular for the Buddhist monument of Deeksha Bhoomi. In Nagpur city, Islam is followed by 11.95%, Christianity by 1.15%, Jainism by 0.90% and Sikhism by 0.68%. Schedule Caste (SC) constitutes 19.8% while Schedule Tribe (ST) were 7.7% of total population in Nagpur.

Education

Nagpur is a major education hub in Central India. Nagpur has four state universities: Rashtrasant Tukadoji Maharaj Nagpur University (founded in 1923 as Nagpur University, one of the oldest in the country and having more than 600 affiliated colleges), Maharashtra Animal and Fishery Sciences, University, Kavikulaguru Kalidas Sanskruti University and Maharashtra National Law University.

Nagpur has four government medical colleges: Government Medical College, Indira Gandhi Government Medical College, Nagpur, Government Dental College and Government Ayurvedic College. All India Institute of Medical Sciences has been established in 2018 and it has started its classes from GMCH campus temporarily until its own campus gets constructed. Nagpur has two major management institutes, Indian Institute of Management established in 2015 and Institute of Management Technology, a private management college, established in 2004. Government Chitrakala Mahavidyalaya is also a premier institute in the city. Nagpur also has an IGNOU and YCMOU regional centre.

Employment

In Nagpur Municipal Corporation, out of total population, 843,771 were engaged in work activities. 92.4% of workers describe their work as Main Work (Employment or Earning more

than 6 Months) while 7.6% were involved in Marginal activity providing livelihood for less than 6 months. Of 843,771 workers engaged in Main Work, 3,424 were cultivators (owner or co-owner) while 5,683 were Agricultural labourers. The details are given below in **Table 1.3**.

Table 1.3: Employment Status in Nagpur

Type of Workers	Total	Male	Female
Main Workers	779,259	620,325	158,934
Cultivators	3,424	2,728	696
Agriculture Labourer	5,683	4,164	1,519
Household Industries	26,731	18,144	8,587
Other Workers	743,421	595,289	148,132
Marginal Workers	64,512	39,138	25,374
Non-Working	1,561,894	565,942	995,952

Source: Census 2011

Economy

Nagpur is an emerging metropolis. Nagpur's nominal GDP was estimated to be around ₹ 1,406,860 million in 2019–20, making it the largest economic centre in entire central India. Nagpur district has a per-capita GDP of ₹ 270,617 as of 2019-20 financial year, being the highest in the central India. In 2004, it was ranked the fastest-growing city in India in terms of the number of households with an annual income of ₹10 million or more. Nagpur has been the main centre of commerce in the region of Vidarbha since its early days and is an important trading location.

For centuries, Nagpur has been famous for its orange farms in the country, hence the name "Orange City". Orange cultivation has been expanding and it is the biggest marketplace for oranges in the country. The Maharashtra Argo Industrial Development Corporation has its multi fruit processing division called Nagpur Orange Growers Association (NOGA) which has an installed capacity of 4,950 MT of fruits per annum. Orange is also exported to various regions in the country as well to other countries. Nagpur is also famous for the cotton and silk which is woven by its large Koshti population of handloom weavers which are around 5,000.

Nagpur and the Vidarbha region have a very prominent power sector as compared to the rest of Maharashtra. Koradi Thermal Power station and Khaparkheda Thermal Power station are two major thermal power stations located near Nagpur and operated by MSPGCL. NTPC has a super thermal power plant called Mauda Super Thermal Power Station in Mauda around 40 km from Nagpur and Vidarbha Industries Power Limited (a subsidiary of Reliance Power) is situated at Butibori. The Multi-modal International Hub Airport at Nagpur (MIHAN) is an ongoing project for the Dr. Babasaheb Ambedkar International Airport, Nagpur. The government of Maharashtra formed a special purpose entity, Maharashtra Airport Development Company For the development of MIHAN apart of MIHAN SEZ the city has three prominent MIDC areas nearby of MIHAN.

Owing to rich natural resources in the region, mining is a major activity. Several government organizations related to the mining industry are based in Nagpur, which includes Western Coalfields Limited (one of the eight fully owned subsidiaries of Coal India Limited), MOIL and Indian Bureau of Mines.

2. Corridor of Impact (CoI)

The viaduct width of Nagpur metro is 8.5 meters. As per the land acquisition policy for Nagpur Metro Project, the requirement of corridor width for the purpose of land acquisition for private land is kept as 15 meters (which is optimally sufficient to carry out the construction work of viaduct). The official circular of Maha-Metro for CoI is attached at **Annexure-1**.

D. Examination of Alternatives

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.

The inventory data and typical cross-sections formed the basis of determining the widening requirement at stations and depots. Based on this information along with presence of buildings, trees, utility services along the project corridor, the centreline of the alignment is designed so as to cause minimum disturbance / impact to existing features. The existing ROW, as available on ground in most of the section (30-45m) along the existing road will be utilized for the construction of stations/viaduct. The proposed centreline is designed such that minimum land acquisition is required.

Attempts have been made in modifying the engineering design and alignment of Phase-II metro line at various locations to minimize the land acquisition, resettlement, and adverse impacts on the people in the project area. The maps of minor adjustment of alignments are provided at **Annexure -2.**

Reach-3A: At curve between Raipur & APMC Metro station- The alignment is slightly shifted to avoid demolition of existing structures.
Reach-2A: Near Kamptee police station alignment has been shifted to avoid demolition of the Kamptee Municipal Council wall and some kiosks (stamp vendors)
Reach-1A: Between Metro city station to Ashokvan Metro station- Near Ashokvan Metro station two commercial structures have been avoided by shifting alignment.

The NMRP 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.

E. Minimizing resettlement:

Though the Phase-II corridor mostly follows median of the road at some locations the alignment is away from the road. Efforts have been made in modifying the engineering design and alignment of Phase-II metro line at various locations to minimize the resettlement impact and land acquisition.

F. Resettlement Action Plan (RAP) for the Project

A Resettlement Action Plan (RAP) has been prepared under the Phase II project to mitigate all such unavoidable negative impacts caused due to the project and resettle the affected persons and restore their livelihoods. The RAP is prepared on the basis of project census survey findings and consultation with various stakeholders. The RAP covered the following aspects.

- Type and extent of loss of land and non-land assets, loss of livelihood, loss of common property resources.
- Impacts on vulnerable groups like poor, women and other disadvantaged sections of society
- Public consultation and people's participation in the project;
- Existing legal and administrative framework and formulation of resettlement policy for the project;
- Preparation of entitlement matrix, formulation of relocation strategy and restoration of businesses/income;
- R&R cost estimate including provision for fund and;
- Institutional framework for the implementation of the plan, including grievance redress mechanism, monitoring & reporting.

II. LEGAL FRAMEWORK

A. Introduction

The legal framework and principles adopted for Phase II project is to address the resettlement issues and compensation and this has been guided by the existing legislation and policies of Government of India (GoI) and Resolutions of Government of Maharashtra state and Safeguard Policy Statement, 2009 of Asian Development Bank prior to the preparation of the SIA, a detailed analysis of the existing national and state policies was undertaken. This section provides the details of various national and state level legislations, resolutions, and their applicability for the Phase II project. This SIA is prepared based on the review and analysis of all applicable legal and policy framework of the county, Asian Development Bank (ADB) policy requirement.

1. Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, (RFCTLARR, Act 2013)

This RFCTLARR, 2013 replaced the Land Acquisition Act, 1984 and is applicable to all states in India. RFCTLARR, 2013 is the first national/central law that addresses land acquisition and rehabilitation and resettlement. This Act provides an enhanced framework for providing compensation and resettlement and rehabilitation assistance through a participative and transparent process for land acquisition in the public interest. The Act lays down procedures for estimating fair compensation of the displaced persons (and not just the titleholders) due to land acquisition, rehabilitation, and resettlement. Some of the key features are as follows.

(i) Preliminary investigations/preparation of Social Impact Assessment (SIA) and preparation of Social Impact Management Plan (SIMP) or Resettlement Action Plan (RAP)
(ii) Preliminary Notification stating project/ public purpose; reasons necessitating land acquisition; summary of SIA; and particulars of the Administrator appointed for the purpose of rehabilitation and resettlement; receipt of Objections and Hearing after the approval of SIA and within 12 months from the date of SIA approval.
(iii) Preparation of Rehabilitation and Resettlement Scheme and its declaration by the District Collector after the same is approved by the Commissioner-Rehabilitation and Resettlement.
(iv) Public notice and award of compensation and R&R assistance by District Collector within a period of twelve months from the date of the Award publication.

Salient features of the RFCTLARR Act, 2013 are listed below:

(i) The Act provides for land acquisition as well as rehabilitation and resettlement. It replaces the Land Acquisition Act, 1894 and National Rehabilitation and Resettlement Policy, 2007**.**
(ii) The Act provides for the baseline for compensation and has devised a sliding scale which allows States to fix the multiplier (which will determine the final award) depending on distance from urban centers.
(iii) The affected communities shall be duly informed and consulted at each stage,

including public hearings in the affected areas for social impact assessment, wide dissemination of the details of the survey to be conducted for R&R plan or scheme.

(iv) Compensation in rural areas & urban areas would be calculated by multiplying market value by up to two and one respectively.

(v) The Collector shall take possession of land only after ensuring that full payment of compensation as well as rehabilitation and resettlement entitlements are paid or tendered to the entitled persons; families will not be displaced from land till their alternative R&R sites are ready for occupation.

(vi) The benefits to be offered to the affected families include - financial support to the affected families for construction of cattle sheds, shops, and working sheds, transportation costs.

(vii) Rehabilitation and resettlement benefits to which they are entitled in monetary terms along with a one-time entitlement of fifty thousand rupees.

(viii) For ensuring transparency, provision has been made for mandatory dissemination of information on displacement, rehabilitation, and resettlement, with names of the affected persons and details of the rehabilitation packages. Such information shall be placed in the public domain on the Internet as well as shared with the concerned Gram Sabha's and Panchayats, etc. by the project authorities.

(ix) No income tax shall be levied, and no stamp duty shall be charged on any amount that accrues to an individual as a result of the provisions of this law (section 96).

2. The Metro Railways (Construction of Works) Act, 1978 (33of 1978)

For construction of Metro Railway and any other work connected therewith, the Metro Railways (Construction of Works), Act, 1972 empowers metro rail administration to acquire:

(i) Any land, building, street, road, or passage or,

(ii) Any right of user or any right in easement, therein for construction of work

Power to acquire land: The central government, on receipt of an application from metrorail administration, may declare its intention to acquire the land, building, street, road, or passage for public purpose by notification in the Official Gazette.

Publication of notification for acquisition: After the issue of notification the metro railway administration or any officer or other employee of the metro railway has legal right (a) to enter upon and survey and take level of the land, building, street, road or passage (b) to dig or bore into the sub-soil, (c) to set out the intended work (d) to mark level/boundariI(e) to do all other works found necessary for preliminary examination of metro rail construction.

Hearing of objection: A person interested in land, building, road, street or passage may file an objection within 21 days of publication of notification under sub-section 3 of section 7. The Competent Authority (a) judicial officer in the rank of a subordinate judge appointed by the Central Government will have right to publish a public notice-inviting claim from all persons interested in the land, building, street, road or passages, or the right of user or the right in easement therein to be acquired. The Competent Authority or the Appellate Authority will determine the compensation amount taking into consideration (a) the market value of the

land, building, street, road, or passage on the date of notification under section 7, (b) the damage, if any sustained by the person interested, (c) person interested is compelled to change his residence or place of business.

3. Maharashtra Government Decision No. NMREACH-3318/Pra.Kra.145/Navi-7 dated 12th May 2023 of Urban Development Department, GoM – Regarding provision of R&R

The Urban Development Department, Government of Maharashtra has issued Notification No. NMREACH-3318/Pra.Kra.145/Navi-7 on 12th May 2023 for implementation of NMRP Phase-II project. Wherein, Mumbai Urban Transport Project (MUTP) – R & R Policy, 2000 for Resettlement and Rehabilitation of PAPs for Nagpur Phase – II project has been made applicable.

4. Government Decision No. SANKIRNA-03/2015/Para.Kra.34/A-2/ dated 12 May 2015 and SANKIRNA-03/2015/Para.Kra.34/A-2/ dated 30 September, 2015 of Revenue & Forest Department, GoM – Regarding Acquisition of private land for irrigation and other projects by negotiation through direct purchase method

Revenue and Forest Department of Maharashtra Government issued Government Resolution No: Misc.-03/2015/C.N.34/A-2 on 12th May 2015 and 30th September 2015 in the context of acquiring land of private sector by method of direct purchase through private negotiations for irrigation and other projects. Direct purchase method ensures that the property owners are negotiated directly for purchase of land by giving them an amount amicably accepted by the affected person which is 250% of the market value. In the process the concerned person is getting better price for the involved land and structure. The amount paid includes all the components of resettlement and rehabilitation.

Generally, for a different project, the private land required is acquired as per the prevailing Land Acquisition Act by the concerned Land Acquiring Institution. However, if the land required by Land Acquiring Institution is acquired by direct purchase method instead of acquiring as per Land Acquisition Act, which is not prohibited in Land Acquisition Act, it shall be done considering following directive principles:

(a) **Directive Principle** – Land required for new projects other than irrigation project. While acquiring land through direct purchase method, land shall be acquired for the entire project.

District level committee for deciding compensation – A committee shall be constituted under the Chairmanship of Collector to decide the rate of land being acquired through direct purchase method. The committee shall comprise the following:

i. District Collector – Chairman
ii. Superintending Engineer Irrigation – Member
iii. Superintending Engineer PWD – Member
iv. District Government Pleader – Member
v. Assistant Director of Town Planning – Member
vi. Competent Authority of acquiring body – Member

vii. Concerned Deputy Collector (Land Acquisition) – Member

(i) In addition to this as per requirement for exercising valuation of trees/ fruit trees/ forest trees/ standing crops, construction & other amenities, competent person, or specialist of the related subject from Agriculture, Forest, Gardening etc. shall be included as invitee member.

(ii) Above mentioned committee, before deciding the compensation of land, will verify the valuation of land as per the land acquisition act in force, documentation regarding the original owner of land & legal search repot of land through Govt. Pleader

(b) Procedure for deciding compensation – For projects while acquiring the land through direct purchase method, the amount of compensation shall be calculated as per the provision of Section No. 26 to 30 of Land Acquisition Act 2013 & Schedule I, including other related features, then 25% shall be added to the above-calculated compensation.

Options to farmers while accepting the compensation – Following two options shall be offered to farmers while acquiring the land through direct purchase method for a project.

1) Paying complete compensation as calculated (c) above at one time.
2) (a) while purchasing land/ taking over land 50% amount will be paid at the first stage out of whole compensation.
   (b) Remaining 50% amount will be paid as annuity.

5. Applicable Laws to NMRP – Phase II

As per RFCTLARR Act, 2013, Section 107 states that “Power of Legislature to enact any law more beneficial to affected families” and Section 108 states that “Option to affected families to avail better compensation and rehabilitation and resettlement”. Henceforth, where a state law or a policy framed by the Government of a state offers more beneficial rehabilitation and resettlement provisions under that Act or policy than under this Act, the affected persons or his family or member of his family may at his option opt to avail such rehabilitation and resettlement provisions under such state law or such policy of the state instead of under this Act.

The guidelines and circulars of the Government of Maharashtra will be applicable for land acquisition, rehabilitation, and resettlement compensation for NMRP Phase-II. The direct purchase method ensures that the property owners are negotiated directly for purchase of land by giving them an amount amicably accepted by the affected person which is 250% of the market value. In the process the concerned person is getting a better price for the involved land and structure. The amount to be paid includes all the components of resettlement and rehabilitation. This process of land acquisition was implemented for NMRP Phase-I also and for Phase-II, this has been recommended in DPR too. However, due to unforeseen condition,

if any one of the affected persons do not agree with applicable act/rule, compensation shall be paid as per Schedule-I & II of RFCTLARR Act, 2013.

A) EIB's Environmental and Social Standards (Feb 2022)

Standard 1: Environmental and Social Impacts and Risks
Standard 2: Stakeholder Engagement
Standard 3: Resource Efficiency and Pollution Prevention
Standard 4: Biodiversity and Ecosystems
Standard 5: Climate Change
Standard 6: Involuntary Resettlement
Standard 7: Vulnerable Groups, Indigenous Peoples and Gender
Standard 8: Labour Rights
Standard 9: Health, Safety and Security
Standard 10: Cultural Heritage

B) ADB's Safeguard Policy Statement (SPS), 2009 on Involuntary Resettlement

The objectives of ADB's SPS (2009) regarding involuntary resettlement are: (i) to avoid involuntary resettlement wherever possible; (ii) to minimize involuntary resettlement by exploring project and design alternatives; (iii) to enhance, or at least restore, the livelihoods of all displaced persons in real terms relative to pre-project levels; and (iv) to improve the standards of living of the displaced poor and other vulnerable groups.

ADB's SPS (2009) covers physical displacement (relocation, loss of residential land, or loss of shelter) and economic displacement (loss of land, assets, access to assets, income sources, or means of livelihoods) because of; (i) involuntary acquisition of land, (ii) involuntary restrictions on land use or on access to legally designated parks and protected areas. It covers displaced persons whether such losses and involuntary restrictions are full or partial, permanent, or temporary.

The three important elements of ADB's SPS (2009) are: (i) compensation at replacement cost for lost assets, livelihood, and income prior to displacement; (ii) assistance for relocation, including provision of relocation sites with appropriate facilities and services; and (iii) assistance, for rehabilitation to enhance, or at least restore, the livelihoods of all displaced persons relative to national minimum standard of living.

B Comparison of RFCTLARR Act, 2013 and ADB Policies

The new Act 'The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013', which has integrated provisions of National Rehabilitation and Resettlement Policy (2007) with that of The Land Acquisition Act (LAA) of 1894 (as amended in 1984), recognizes titleholders and non-titleholders affected by land acquisition. The RFCTLARR Act, 2013 came into effect from January 1, 2014. This Act both complement the revision of the NRRP (2007) and significantly decreases the gaps between the LA Act 1894 and ADB's SPS, 2009 & EIB Safeguard Standards. The Act also expands compensation coverage of the principal Act by requiring that the value of trees, plants, or

standing crops damaged must also be included and solatium being 100% of all amounts inclusive. The Act furthermore meets ADB & EIB requirements for all compensation to be paid prior to project taking possession of any land and provision of R&R support including subsistence grant and transportation cost.

Therefore, the RFCT in LARR Act – 2013 has established near equivalence of the government's policies with those of ADB's SPS, 2009 & EIB. Adoption of the below principles for the project has ensured that both are covered in their application to this project. A comparison of ADB, EIB and RFCTLARR Act, 2013 and measures to fill the gaps is presented below **Table 2.1.**

Table 2.1: Comparison of RFCTLARR Act, 2013, ADB & EIB

S.N	Aspect	EIB Safeguard Requirement	ADB Safeguard Requirement	RFCTLARR Act, 2013	Measures to bridge the GAP
1	Screen the project	In order to identify the extent and complexity of the potential social impacts and risks, the project should screen the project as early as possible.	Screen the project to identify past, present, and future involuntary resettlement impacts and risks. Conduct survey and/or census of displaced persons, including a gender analysis, specifically related to resettlement	4 (I) it is obligatory for the appropriate Government intends to acquire land for a public purpose to carry out a Social Impact Assessment study in consultation with concern panchayat, Municipality or Municipal Corporation at village level or ward level in the affected area. The Social Impact Assessment study report shall be made available to the public inthe manner prescribed under section 6.	Screening of project in line with the IR checklist of ADB, towards Enabling identification of the Potential Resettlement impacts and associated risks.14
2	Consultation with stake holders and establish grievance redress mechanism	Consultation shall be carried out proportionate to the nature and scale of the project and its potential impacts and risks, involving, at a minimum: (i) the identification and analysis of the stakeholders; and (ii) the establishment and/or maintenance of a grievance mechanism; as well as some (iii) disclosure of information; (iv) meaningful consultation.	Carryout consultations with displaced persons, host communities and concerned NGOs. Inform all displaced persons of their entitlements and resettlement options	Whenever a Social Impact Assessment is required to be prepared under section 4, the appropriate Government. shall ensure that a public hearing is. held at the affected area, after giving adequate publicity about the date, time and venue for the public hearing, to ascertain the views of the affected. families to be recorded and included in the Social Impact Assessment Report. The Land Acquisition Rehabilitation and Resettlement Authority shall be established in each State by the concerned State	No gap between ADB SPS, EIB and RFCTLARR, 2013

S.N	Aspect	EIB Safeguard Requirement	ADB Safeguard Requirement	RFCTLARR Act, 2013	Measures to bridge the GAP
				Government to hear disputes arising out of projects where land acquisition has been initiated by the State Government or its agencies.	
3	Improve, or at least restore, the livelihoods of all displaced, and payment at replacement cost	To avoid or, when unavoidable, minimise involuntary resettlement by exploring alternative projects, project designs and locations; provide timely compensation for a loss of assets at the full replacement cost;	Improve or restore the livelihoods of all displaced persons the: (i) land- based resettlement strategies. (ii) prompt replacement of assets with access to assets of equal or higher, (iii) prompt compensation at full replacement cost for assets that cannot be restored (iv) additional revenues and services through benefit sharing schemes were possible.	The Collector having determined the market value of the land to be acquired shall calculate the total amount of compensation to be paid to the landowner (whose land has been acquired) by including all assets attached to the land. Livelihood losers are eligible for various rehabilitation grants.	No gap between SPS, EIB and RFCTLARR- 2013 Assets to be compensated at replacement cost without depreciation and other Livelihood assistances a nd income restoration measures will be included.
4	Assistance for displaced persons	To improve displaced persons' livelihoods and/or living standards, or at least restore them to pre-project levels;	Provide physically and economically displaced persons with needed assistance	Schedule-I, provides market value of the land and value of the assets attached to land. Schedule II provides R&R package for TH and for livelihood losers including landless and special provisions for Scheduled Tribes.	No gap between SPS, EIB and RFCTLARR - 2013 Entitlement Matrix outlines compensation and assistance for DPs
5	Right of users	The acquisition or restriction of land rights or land-use rights through expropriation or other compulsory procedures in accordance with national law;	Provide legal and affordableaccess to land and resources in rural areas and appropriate income sources and legal and affordable access to adequate housing in urban area	No specific measures are found	The Metro Railways Act, 1978 acquire the right of users under sub-section. (2) of Section 13 by compensating their loss at 10% of amount determined under sub-section (1) for that land, building, street, road or passage.
6	Improve	Improve the	Improve the standards	RFCTLARR- 2013 only	Provisions outlined

S.N	Aspect	EIB Safeguard Requirement	ADB Safeguard Requirement	RFCTLARR Act, 2013	Measures to bridge the GAP
	standard of living of displaced vulnerable groups	standards of living of the displaced poor and other vulnerable groups, including women- headed families, to at least national minimum standards.	of living of the displaced poor and other vulnerable groups, including women-headed families, to at least national minimum standards.	provides special provisions scheduled tribe.	in ADB SPS & EIB will be followed for the project
7	Negotiated Settlement	The acquisition or restriction of land rights or land-use rights through negotiated settlements, However, if negotiations fail, there have provisions in place for expropriation or other compulsory procedures to initiate the acquisition process;	Develop procedures in a transparent, consistent, and equitable manner if land acquisition is through negotiated settlement to ensure that those people who enter negotiated settlements will maintain the same or better income and livelihood status	RFCTLARR only apply in case of land acquired / purchased for PPP projects and for Private Companies. Section: 2.(2), and 46.	Provisions outlined in ADB SPS & EIB will be followed for project. The EM provisions which are in compliance with the SPS requirement will fully apply for all modes of land procurement i.e. direct purchase and compulsory acquisition.
8	Compensation for Non-Title Holders	The displacement of persons, such as kiosk/small vendors, that are occupying land or assets without a formal title, the promoter shall compensate in compliance with the Standard.	Ensure that displaced persons without titles to land or any recognizable legal rights to land are eligible for resettlement assistance and compensation for loss of non-land assets.	Non-titleholders on acquired land area is only included but not clear about NTH in existing govt. land	The NMRP will resettle or relocate the Street Vendor / Kiosks (NTH) in proper coordination with local govt. authority.
9	Requirement of Resettlement Plan	A resettlement plan, is required for projects leading to significant physical displacement. The promoter shall develop an RAP covering, at a minimum, the applicable requirements of this Standard.	Prepare a resettlement plan / indigenous peoples plan elaborating on DPs entitlements, the income. and livelihood restorationstrategy, institutional arrangements, monitoring,and reporting framework, budget, and time-bound implementation schedule.	Preparation of Rehabilitation and Resettlement Scheme including timeline for implementation. *Section: 16. (1) and (2).* Separate development plans to be prepared. *Section 41*	No gap between SPS , EIB and RFCTLARR, 2013 Resettlement planwill be prepared for project with impact.
10	Public Disclosure	Disclose the final resettlement plan in a form and local language	Disclose a draft RAP, including documentation of the consultation process in	Under clause 18, the Commissioner shall cause the approved Rehabilitation and	No gap between SPS , EIB and RFCTLARR, 2013 Resettlement planwill

S.N	Aspect	EIB Safeguard Requirement	ADB Safeguard Requirement	RFCTLARR Act, 2013	Measures to bridge the GAP
		understandable to DP's and other stakeholders.	a timely manner, before project appraisal, in an accessible place and a formand local language understandable to DP and other stakeholders. Disclose the final resettlement plan and its updates to DPs and otherstakeholders	Resettlement Scheme to be made available in the local language to the *Panchayat*, Municipality or Municipal Corporation. As the case may be, and the offices of the District Collector, the Sub-Divisional Magistrate, and the *Tehsil,* and shall be published in the affected areas, in such manner as may be prescribed and uploaded on the website of the appropriate Government.	be prepared for project with impact.
11	Cost of resettlement	Include & provide the full costs of measures proposed in the resettlement plan.	Include the full costs of measures proposed in the resettlement plan as part of project's costs and benefits. For a project with significant involuntary resettlement impacts and / or indigenous peoples plan, consider implementing the involuntary resettlement component of the project as a stand-alone operation.	16. (I) Upon the publication of the preliminary notification under sub section (I) of section I by the collector, the administrator of R&R shall conduct a survey and undertake a census of the affected families, in such manner and within such time as may be Prescribed, which shall include: (a) particulars of lands and immovable properties being acquired of each affected family; (b) livelihoods lost in respect of land losers and landless whose livelihoods are primarily dependent on the lands being aired. (c) a list of public utilities and Government building which are affected or likely to e affected, where resettlement of affected families if involved: (d) details of the amenities &infrastructural facilities which are affected or likely to be affected, where resettlement of affected families invited; and (e) details of any CPR being acquired	No gap between SPS, EIB–and RFCTLARR. - 2013 Cost of resettlement will be covered by NMRP implementing agency.

S.N	Aspect	EIB Safeguard Requirement	ADB Safeguard Requirement	RFCTLARR Act, 2013	Measures to bridge the GAP
12	Taking over possession before Payment of compensatio n	Pay compensation and provide other resettlement entitlements before physical or economic displacement.	Pay compensation and provide other resettlement entitlements before physical or economic displacement. Implement the RP under cost supervision throughout the project implementation.	38 (I) The Collector shall take possession of land after ensuring that full payment of compensation as well as rehabilitation and resettlement entitlements are paid or tendered to the entitled persons within a period of three months for the compensation and a period of six months for the monetary part of rehabilitation and resettlement entitlements listed in the Second Schedule commencing from the date ofthe award made under section 30.	No gap between SPS , EIB and RFCTLARR, 2013.
13.	Monitoring	The promoter shall set up a monitoring system. Monitor and assess the resettlement outcomes in Monitoring reports.	Monitor and assess the resettlement outcomes, their impacts on the standards of living of displaced persons, and whether the objectives of the resettlement plan havebeen achieved and the results of resettlement monitoring. Disclose monitoring the reports.	48 (I)The Central Government may, whenever necessary for national or inter-State projects, constitute a National Monitoring Committee for reviewing and monitoring the implementation of rehabilitation and resettlement schemes or plans underthis Act.	For project, Monitoring mechanism and frequency will follow ADB SPS based on categorization.

III. APPROACH AND METHODOLOGY

A. The Objectives of SIA

The aim of this SIA study is to insure that the project addresses the adverse impact on due to their land and structure acquisition and loss of livelihood of the people and that nobody is left worse off after land acquisition and those affected have access to project benefits, both during the project construction as well as operation. The objectives is to undertake preliminary investigation for determination of social impacts and public purpose in relation to proposed acquisition of land required for development construction of the projects and for preparation of Social Impacts Management Plan in order to establish that the potential benefits and the public purpose for the proposed acquisition shall outweigh the social costs and adverse social impact as determined by the Social Impact Assessment.

Following are the broad objectives of the SIA;

- To carry out a socio-economic, cultural and political/institutional analysis to identify the project stakeholders and social Issues associated with the phase-II project;
- A detailed assessment of the socio-economic conditions of the people who may be negatively affected,
- To assess the extent of asset loss and undertake the census of potential displaced people;
- To develop a Social Impact Management Plan (SIMP) in consultation with the affected people and project Implementation authorities – A detailed plan to mitigate these Impacts and an assessment of the costs of such measures.

B Approach

The Socio- Economic Studies are important to ensure that social aspects are considered during decision making – by influencing design to avoid /minimize, and where unavoidable mitigating the residual adverse impacts and/or enhancing positive impacts of a project. It also provides a platform for getting views from stakeholders including the directly affected population to improve the design. The Feasibility Reports, Social Impact Assessment Reports and Resettlement Plan Reports are main outcomes of the socio –economic studies.

The parameters of impacts proposed to be covered under this SIA are as follows-

(i) Socio-economic and Cultural parameters

- **Demographic details -** Age, sex, caste, religion and Literacy, health and nutritional status
- **Poverty levels and Vulnerability**- especially among the women, children, the elderly, women-headed households, person with disability
- Kinship patterns and women's role in the family
- Social and cultural organization
- Civil society organizations and social movements

- **Land use and livelihood**
  - Agricultural and non-agricultural use
  - Quality of land - soil, water, trees etc.
  - Formal and informal work and employment
  - Household division of labour and women's work
  - Migration
  - Household income levels
  - Livelihood preferences
  - Food Security

- **Local economic activities**
  - Formal and informal, local industries
  - Access to credit
  - Wage rates
  - Specific women involved livelihood activities

- **Factors that contribute to local livelihoods**
  - Access to natural resources
  - Common property resources
  - Private assets Roads, transportation
  - Street vendors, Kiosks
  - Irrigation facilities
  - Access to markets
  - Tourist sites
  - Livelihood promotion programs
  - Co-operatives and other livelihood-related associations

- **Quality of the living environment**
  - Perceptions, aesthetic qualities, attachments and aspirations
  - Settlement patterns
  - Houses
  - Community and civic spaces
  - Sites of religious and cultural meaning
  - Physical infrastructure (including water supply, sewage systems etc.)
  - Public service infrastructure (schools, health facilities, anganwadi centres, public distribution system) Safety, crime, violence
  - Social gathering points for women

C. Methodology

The process of SIA has been followed with a dedicated team of investigators and enumerators. The team headed by a team leader having relevant experience of conducting SIA and the work was conducted and supervised in close coordination with requiring body.

1. Reconnaissance Survey

A reconnaissance survey (a preliminary survey) was conducted from 2nd March to 30th April, 2023

2. Collection and Review of Secondary Data, Literature and Other Relevant Documents

Documents such as District Census Handbook, District Gazetteer, District Statistics, maps and information on existing livelihood projects, government employment schemes and services in which people in the concerned districts/ blocks are largely involved was collected from government and non-government sources and reviewed. This pertinent data was collected mainly to develop understanding about the socio-economic conditions of the proposed affected station and viaduct area and availability of infrastructure facilities, and service delivery system.

3. Preparation of Questionnaire Formats

For a good resettlement planning, implementation and monitoring is important to collect quality baseline socio-economic data of DPs. For this purpose, sample socio-economic survey has been conducted by using a questionnaire containing structured and semi-structured questions. The questionnaire has covered a wide range of information. Through questionnaire, survey socio-economic conditions of the project affected families was ascertained. Besides, some qualitative information also be collected to substantiate the quantitative information. A draft questionnaire was developed and submitted to the project implementation authority (NMRP) for suggestions and modification. Thereafter, pre-testing of questionnaire was undertaken so as to incorporate further modifications. The questionnaire format used for the social survey is enclosed at **Annexure-3.**

4. Site Visit and Field Surveys

The questionnaire was administered by the professional surveyors/enumerators who are trained by the consultants. They visited all four Reaches of project sites for knowing the project area/alignments. The emphasis was laid on quality of the data so that the conclusion arrived authentic and reliable. Data generated from the surveyed, entered into computer in Micro-soft Excel for tabulation and analysis.

Broad information collected through this census and socio-economic survey includes: details of the head of household/family, social category, religion, sources of income, occupation, land holdings, ownership and type of structures, property and assets owned, details of assets belong to the family, details of family members etc. the extent of impact on common property resources (CPR) also observed during the surveys.
The primary data will be generated using both quantitative and qualitative techniques:

5. Quantitative Techniques

Pre—tested structured questionnaires was canvassed among different category of DPs (TH & NTH).

6. Qualitative techniques

The qualitative techniques will consist of Participatory Rural Appraisal (PRA) techniques such as social mapping, resource mapping, seasonality, livelihood analysis, In-depth interview, preference ranking, group discussion, focus group discussion (FGDs) public consultations etc.

7. Supervision of Data collection and Ground Verification

Supervision of data collection was undertaken by the consultant's team and simultaneously ground verification also conducted to the households/ families covered for the administration of socio-economic survey. Survey data was bring out the socio-economic conditions of the project affected households/ families. Analysis of data was segregate by social category, gender, Income category, possession of assets and consumer items, etc.

8. Public Hearings and Consultations with Stakeholders

One of the most important aspects of the study is identification and consultations with stakeholders, people's representatives, and community leaders. Consultations open up the line of communication between various stakeholders and the project implementing authority, thereby aiding the process of resolving conflicts, if any, at an early stage of the project. Participation of community leaders, people's representatives, TH and NTH in consultations helps in resolving the conflicts mutually. Public Consultations have been initiated from planning stage and will continue till the completion of the Phase II project to ensure people's participation during the entire phase of the project. The detailing of Public Consultations has been shown in chapter V (Stakeholder Consultations).

9. Social Impact Assessment & Mitigation Measures

The SIA and SIMP is prepared to address the social issues in the project area or along the four Reaches on impact on private / common / business/ cultural properties (TH, NTH & CPR) and on the people residing or doing business/ work in the area. Project affected area includes the area in which property/assets affected or from where land was acquired for the project.

The Maha Metro has suggested cost-effective measures for minimizing or eliminating adverse impact of the proposed Phase-II project. Measures for enhancing beneficial impacts also be recommended. The cost of implementing these measures is estimated and presented wherever possible. If compensation is recommended as one form of mitigation, the Maha Metro has identified all the names and physical addresses of TH. The details of compensation are shown in chapter VII (Social Impact Management Plan).

IV. LAND ASSESSMENT

A. Land Acquisition Requirement

The proposed construction of four corridors of Nagpur Metro Rail Project – Phase II is confined to almost entirely on the median of an existing right-of-way (RoW) of the road connecting East – West and North – South Corridor. Land is mainly required for construction of stations, viaducts & parking purposes. It is confirmed that the existing RoW of the roads are owned by Public Work Department (PWD), NHAI & MIDC. For the land required in the existing RoW like NHAI, State Highways, MIDC etc, necessary permissions/NOC are sought from the concerned department before starting the work physically at site. The ownership of land in the RoW is not sought by Maha-Metro as being government land. In case of requirement of government lands which is out of RoW, the transfer of these government lands will be done as per Maharashtra state government, Revenue and Forest Department GR dated 1st June 2017.

In Phase-II project, the construction of stations (32), entry/exits and parking facility will result in acquisition of private land. Since the existing Phase-I depot will be utilized for the Phase-II project, hence no separate land acquisition will be needed for depot. The total land requirement for Phase-II project is 9.3089 Ha. **Table 4.1** shows the land requirement as per socio-economic survey.

Table 4.1 - Land Requirements as per physical verification

Corridor	Length (Km.)	Number of DPs	Requirement Land (Ha)		
			Pvt. Land	Govt. Land	Total
MIHAN to MIDC ESR (Reach-1A)	18.7	26	3.3573	1.2897	4.6470
Automotive Square to Kanhan River (Reach-2A)	13.0	11	1.0548	1.2005	2.2553
Lokmanya Nagar to Hingna (Reach-3A)	6.6	11	0.8156	0.9625	1.7781
Prajapati Nagar to Transport Nagar (Reach-4A)	5.5	03	0.3472	0.2813	0.6285
Total	**43.8**	**51**	**5.5749**	**3.7340**	**9.3089**

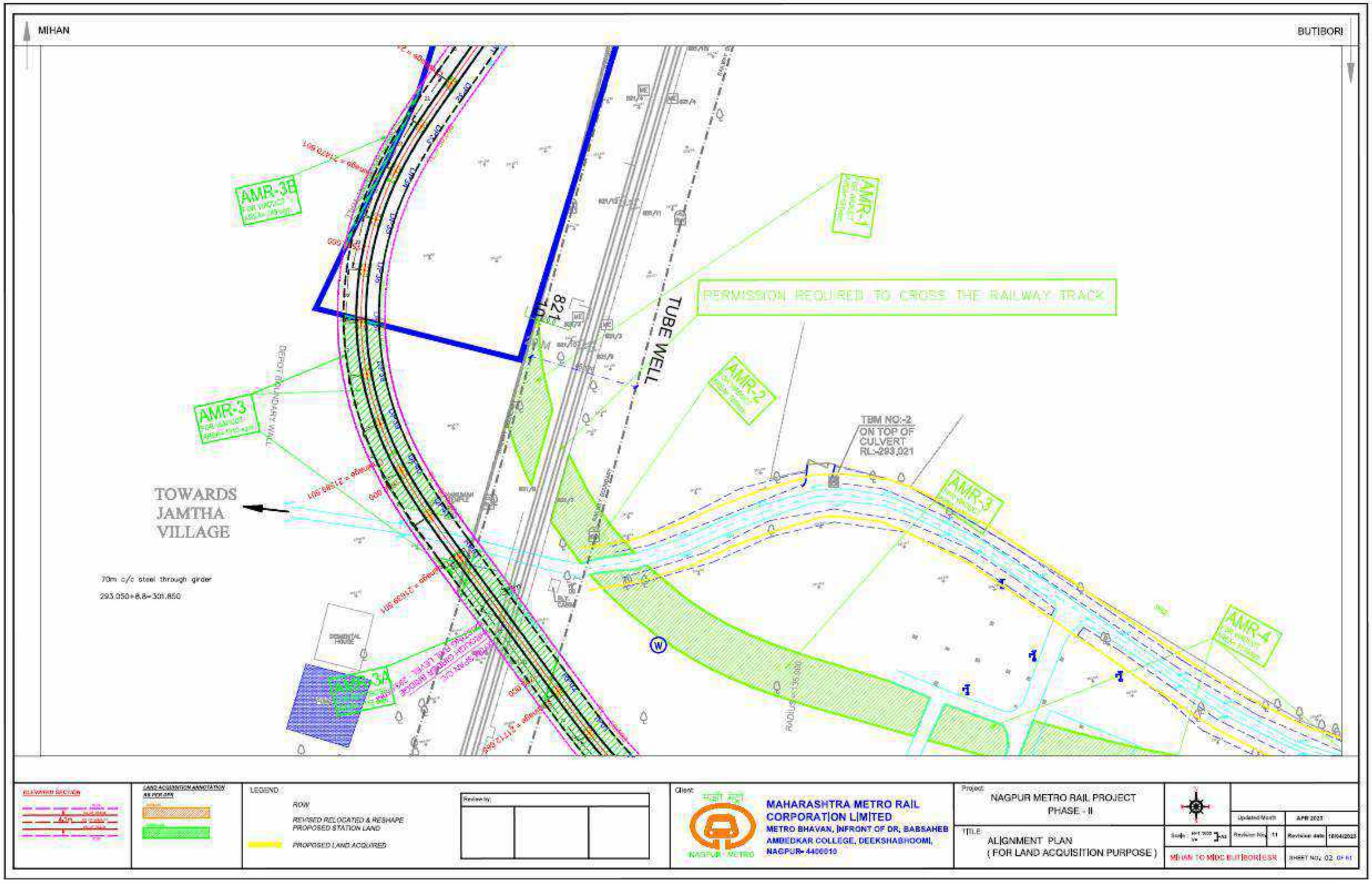
B. (B1) Land Requirement for the Viaduct & Associated Facilities in Reach- 1A, 2A, 3A, 4A

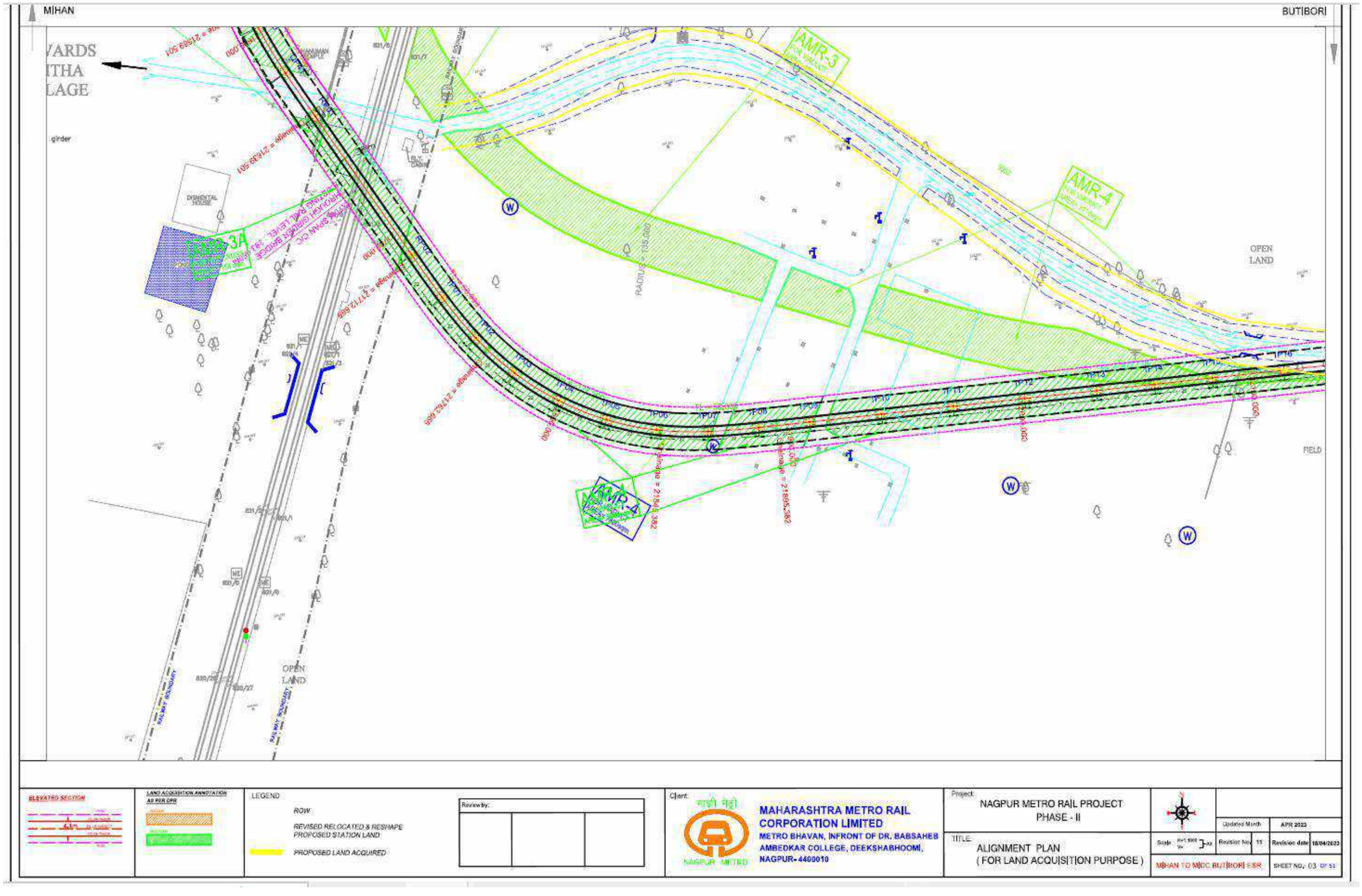
The land area for piers of elevated alignment, elevated stations falling over the existing road and entry/exit falling on road / State Government land, has not been accounted for in the land requirement and costing as present land use is not getting affected by these facilities. The RSS land in reach 2A is barren and details are provided in the **Annexure-4** and therefore, no impact has been anticipated.

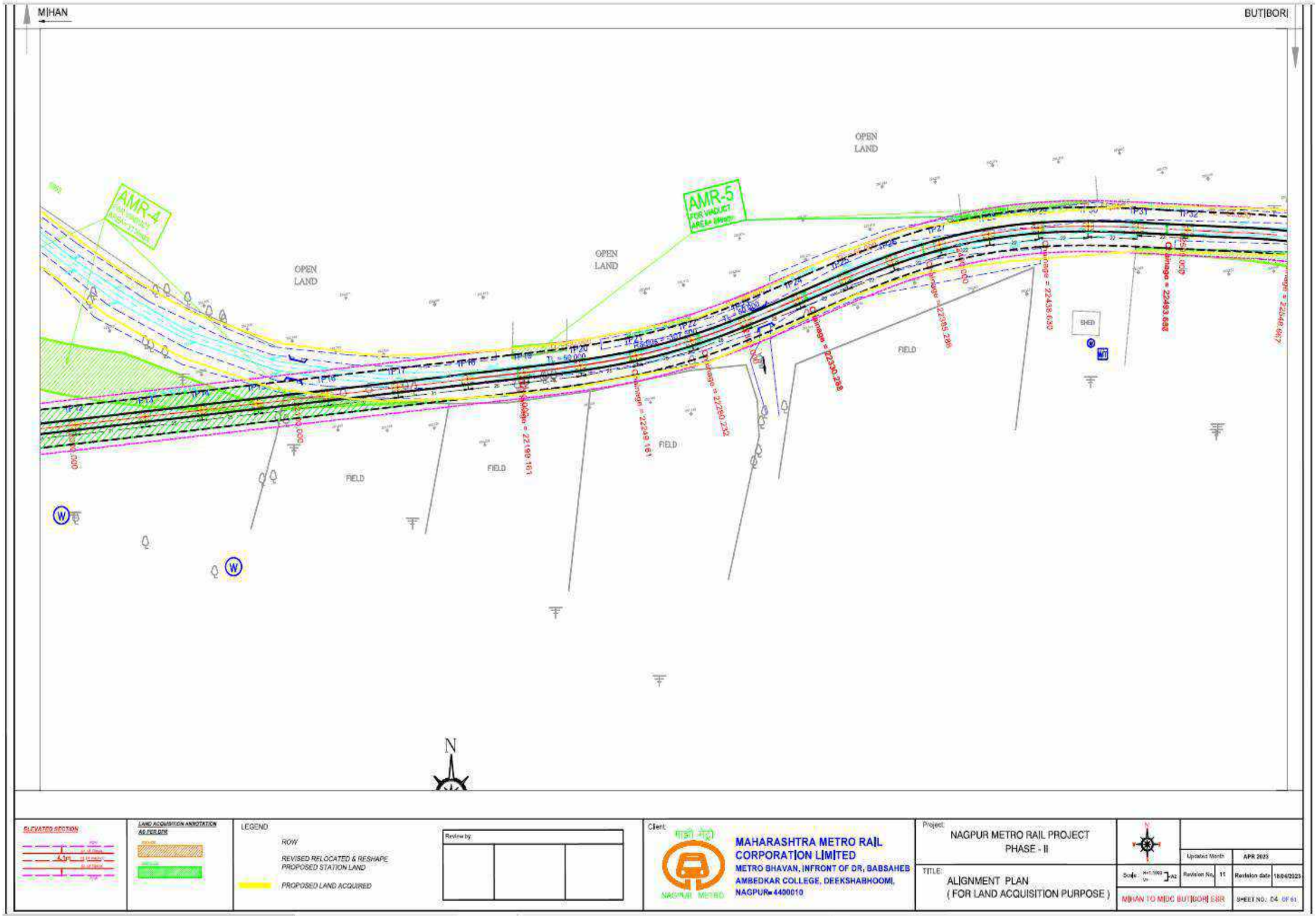
(B2) Land Requirement for the Stations in Corridor 1A, 2A, 3A, 4A

As per the LAP prepared for the all reaches and the area notified by the Maha-Metro for construction of exit and entry points of the stations the minimum land requirement was estimated as 9.3089 hectare. The LAP is given in figure-4.1 to 4.9.

Figure 4.1: Land Acquisition Plan for Metro City to Ashokvan in Corridor REACH-1A




MIHAN
BUTIBORI
AMR-3
AMR-3A
AMR-4
AMR-4
OPEN LAND
OPEN LAND
FIELD
RADIUS = 735.000
RAILWAY BOUNDARY
RAILWAY BOUNDARY
ELEVATED SECTION
LAND ACQUISITION ANNOTATION AS PER DPR
LEGEND
ROW
REVISED RELOCATED & RESHAPE PROPOSED STATION LAND
PROPOSED LAND ACQUIRED
Review by:
Client:
MAHARASHTRA METRO RAIL CORPORATION LIMITED
METRO BHAVAN, INFRONT OF DR. BABSAHEB AMBEDKAR COLLEGE, DEEKSHABHOOMI, NAGPUR- 4400010
Project:
NAGPUR METRO RAIL PROJECT PHASE - II
TITLE:
ALIGNMENT PLAN
(FOR LAND ACQUISITION PURPOSE)
Updated Month
APR 2023
Revision No.
11
Revision date
18/04/2023
MIHAN TO MIDC BUTIBORI ESR
SHEET NO.- 03 OF 51


MIHAN
BUTIBORI
AMR-4
AMR-5
FOR VIADUCT
OPEN LAND
OPEN LAND
OPEN LAND
FIELD
FIELD
FIELD
SHED
N
ELEVATED SECTION
LAND ACQUISITION ANNOTATION AS PER DPR
LEGEND
ROW
REVISED RELOCATED & RESHAPE PROPOSED STATION LAND
PROPOSED LAND ACQUIRED
Review by:
Client:
MAHARASHTRA METRO RAIL CORPORATION LIMITED
METRO BHAVAN, INFRONT OF DR, BABSAHEB AMBEDKAR COLLEGE, DEEKSHABHOOMI, NAGPUR- 440010
Project:
NAGPUR METRO RAIL PROJECT PHASE - II
TITLE:
ALIGNMENT PLAN
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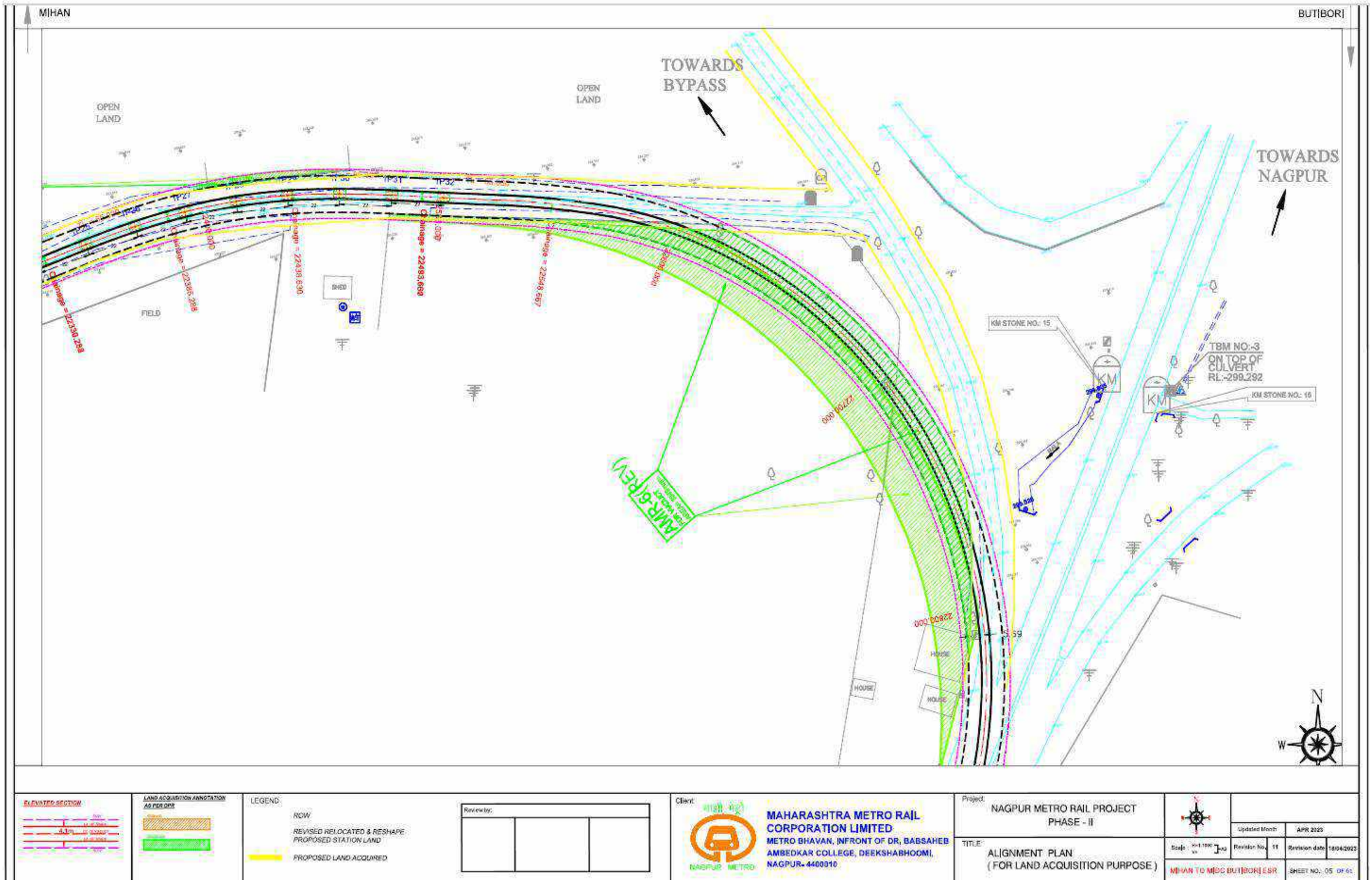
Updated Month
APR 2023
Revision No.
11
Revision date
MIHAN TO MIDC BUTIBORI ESR
SHEET NO. 04 OF 61


MIHAN
BUTIBORI
TOWARDS BYPASS
TOWARDS NAGPUR
OPEN LAND
OPEN LAND
FIELD
SHED
HOUSE
HOUSE
HOUSE
KM STONE NO.: 15
KM STONE NO.: 16
TBM NO.:-3
ON TOP OF CULVERT
RL:-299.292
AMR-6(REV)
ELEVATED SECTION
LAND ACQUISITION ANNOTATION AS PER DPR
LEGEND
ROW
REVISED RELOCATED & RESHAPE PROPOSED STATION LAND
PROPOSED LAND ACQUIRED
Review by:
Client:
MAHARASHTRA METRO RAIL CORPORATION LIMITED
METRO BHAVAN, INFRONT OF DR, BABSAHEB AMBEDKAR COLLEGE, DEEKSHABHOOMI, NAGPUR- 440010
Project:
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11
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18/04/2023
MIHAN TO MIDC BUTIBORI ESR
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Figure 4.2: Land Acquisition Plan for Ashokvan Stations in Corridor REACH-1A

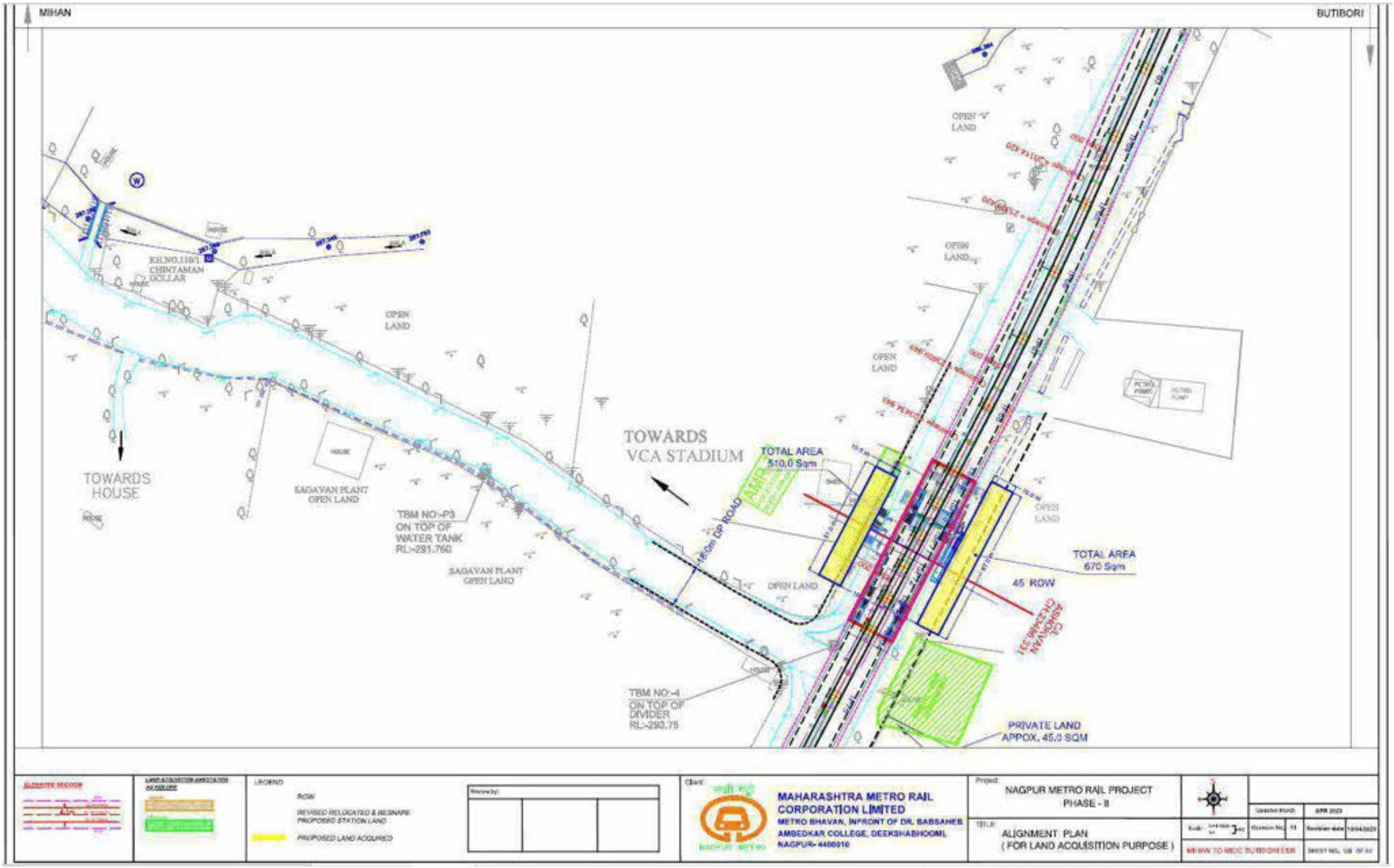


Figure 4.3: Land Acquisition Plan for Dongargaon Stations in Corridor REACH-1A

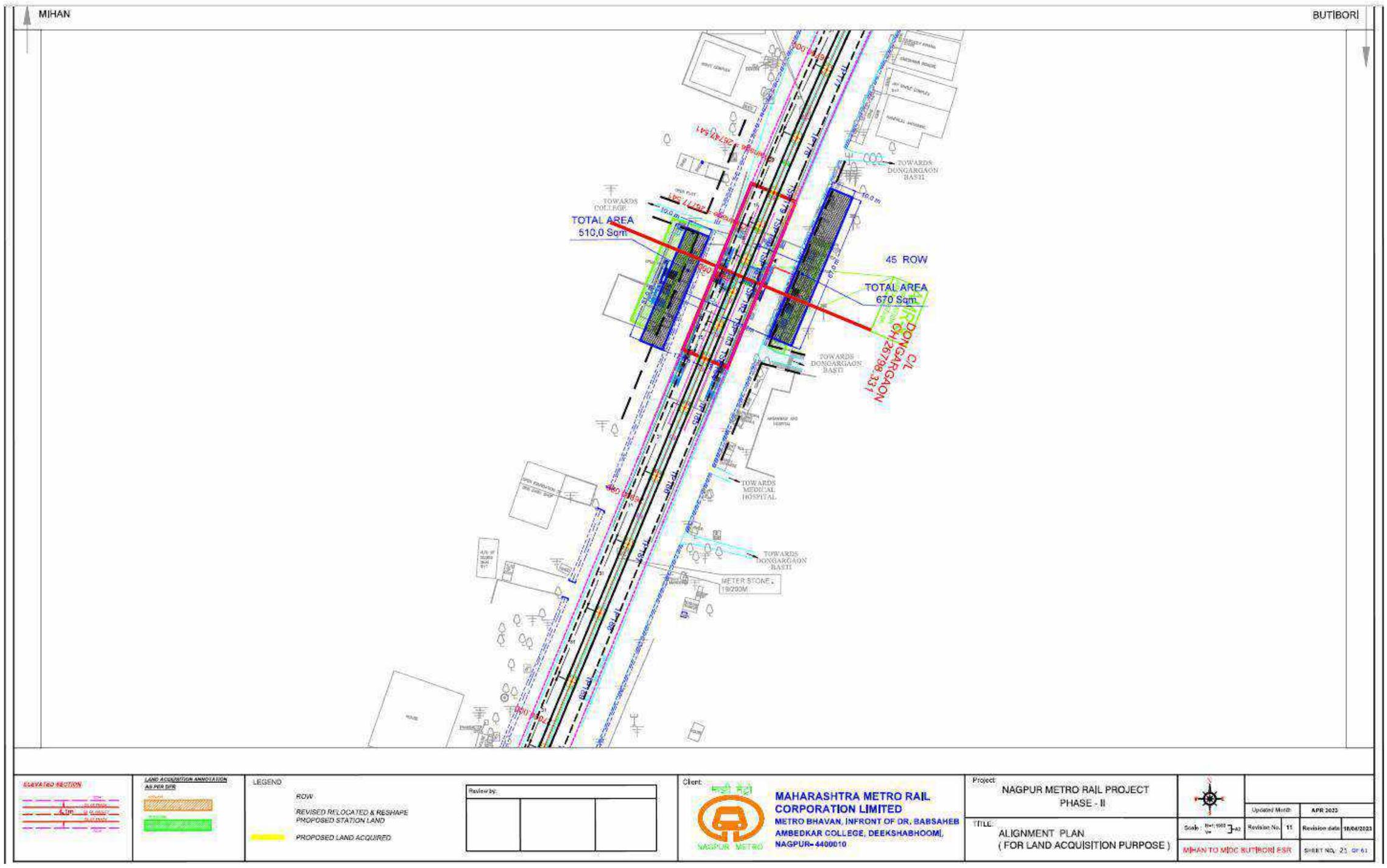


Figure 4.4: Land Acquisition Plan for Mohagaon Stations in Corridor REACH-1A

Figure 4.5: Land Acquisition Plan for Meghdoot CIDCO Stations in Corridor REACH-1A

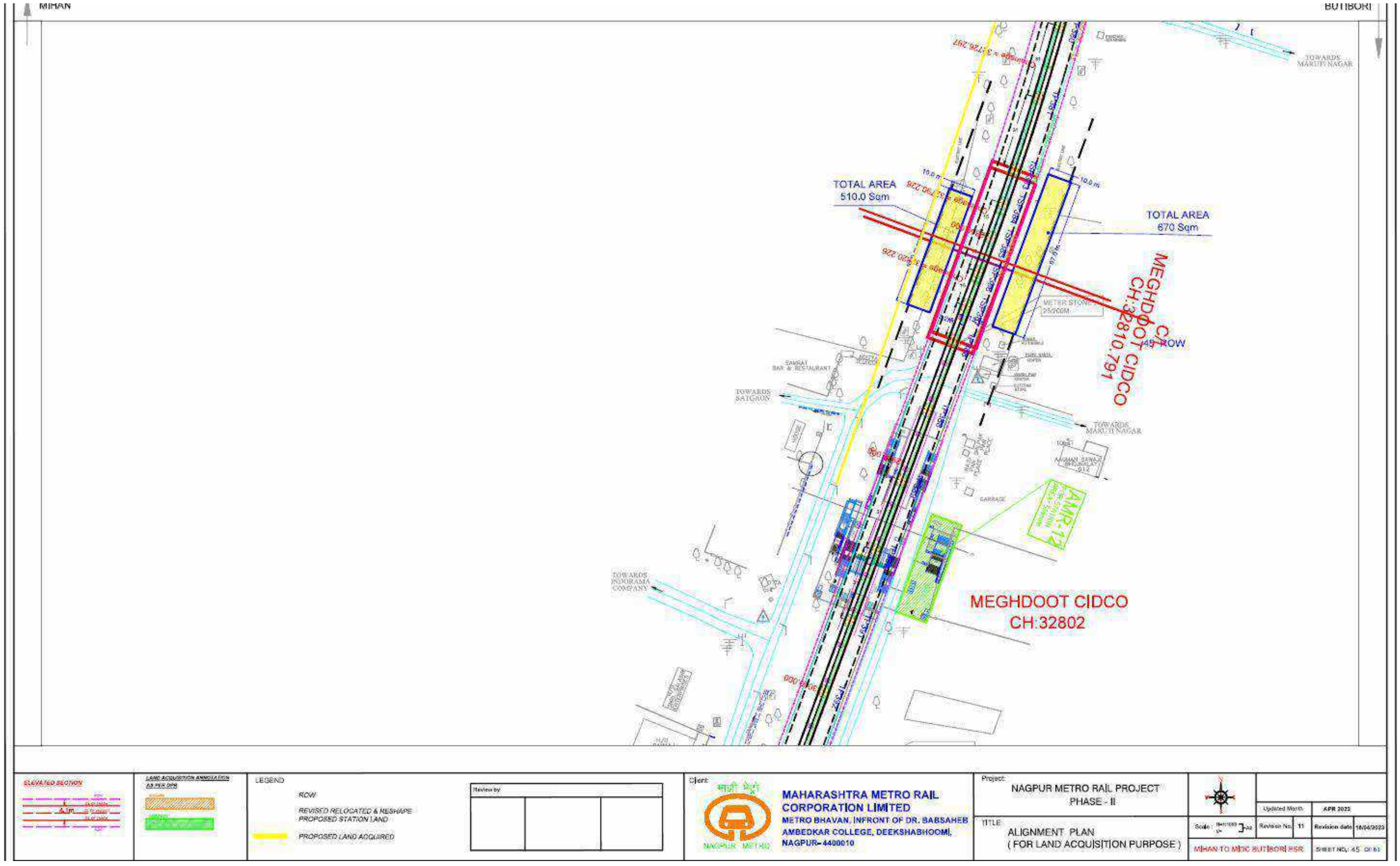


Figure 4.6: Land Acquisition Plan for Butibori Police Station Stations in Corridor REACH-1A

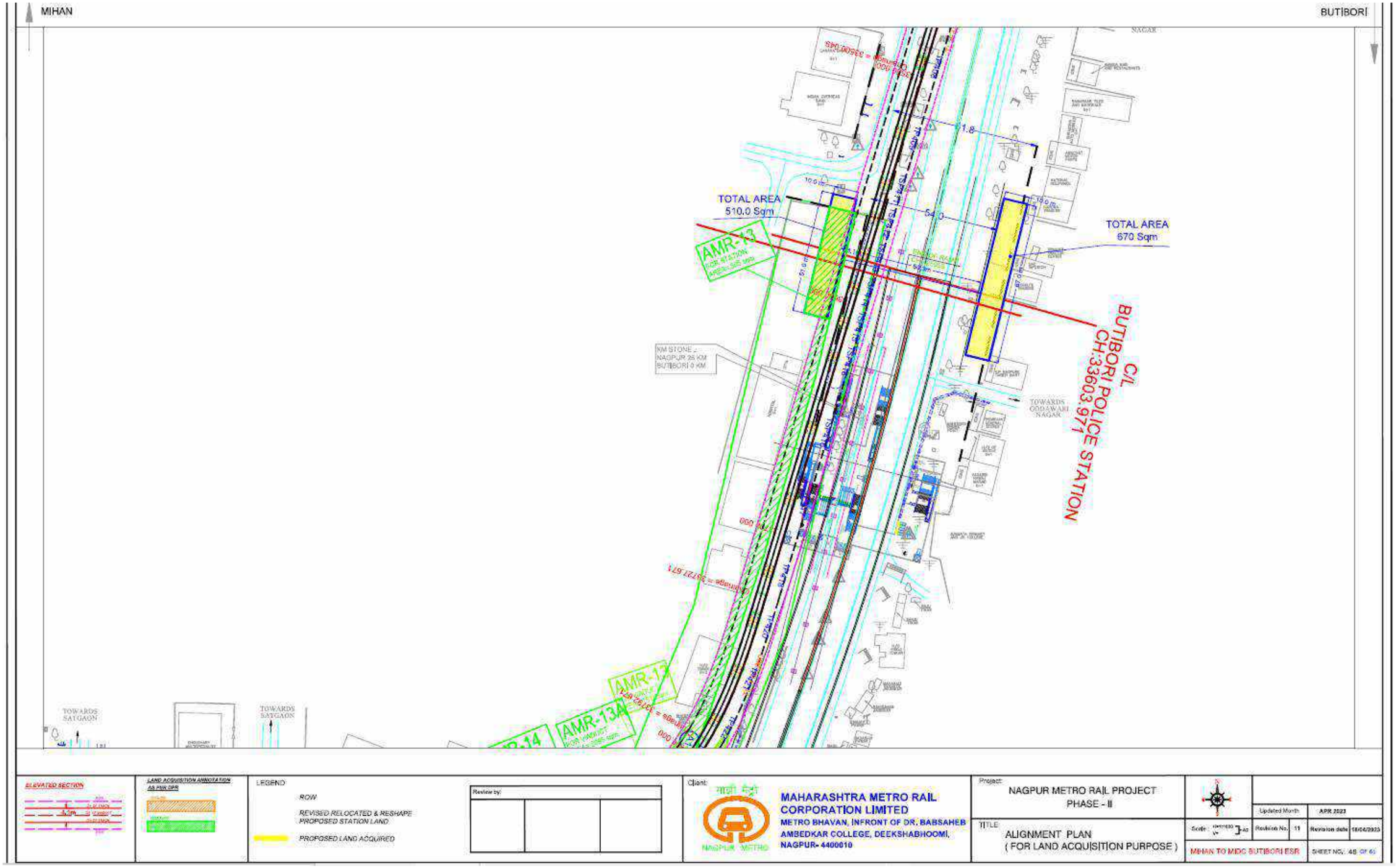


Figure 4.7: Land Acquisition Plan for MHADA Colony Stations in Corridor REACH-1A

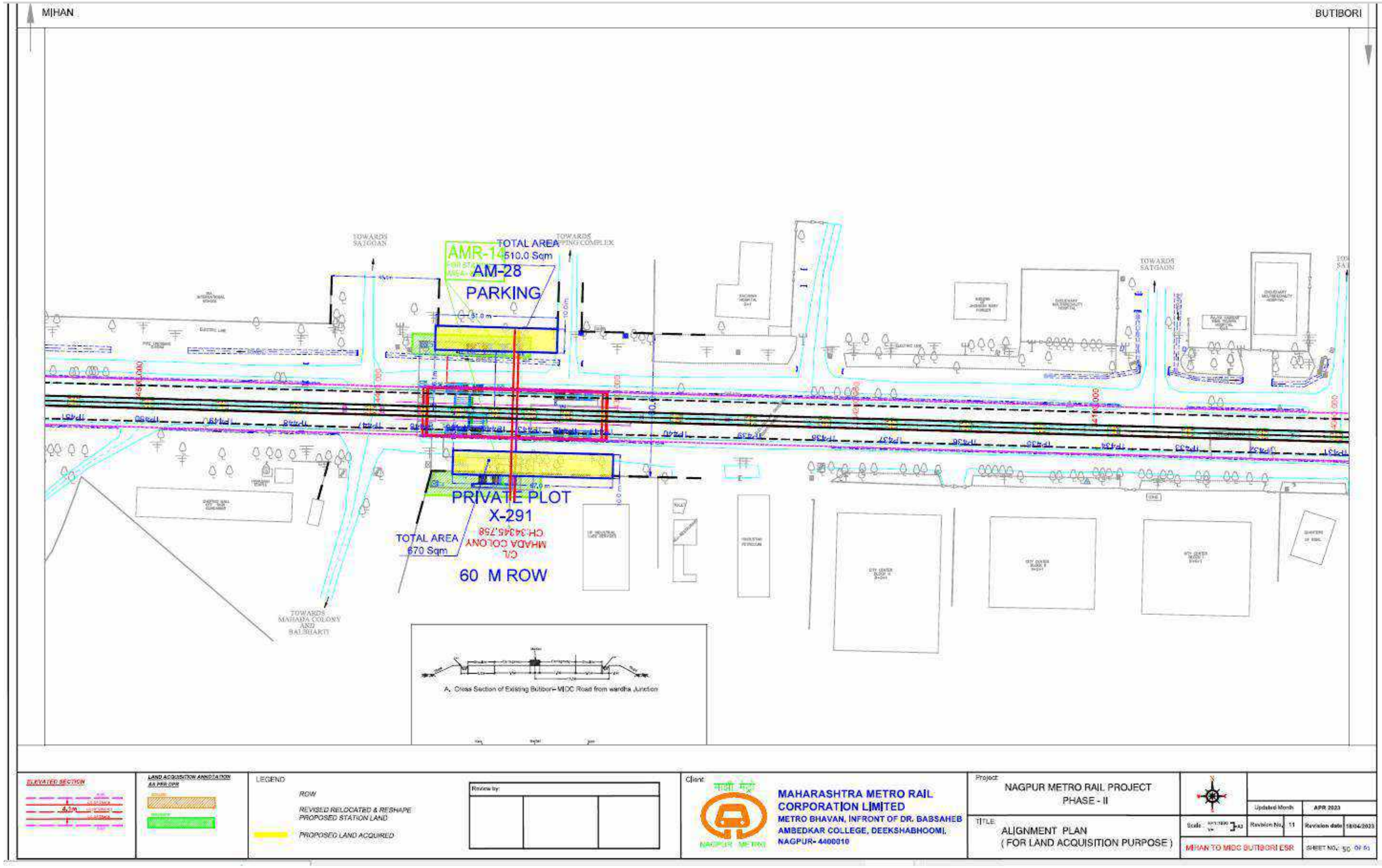
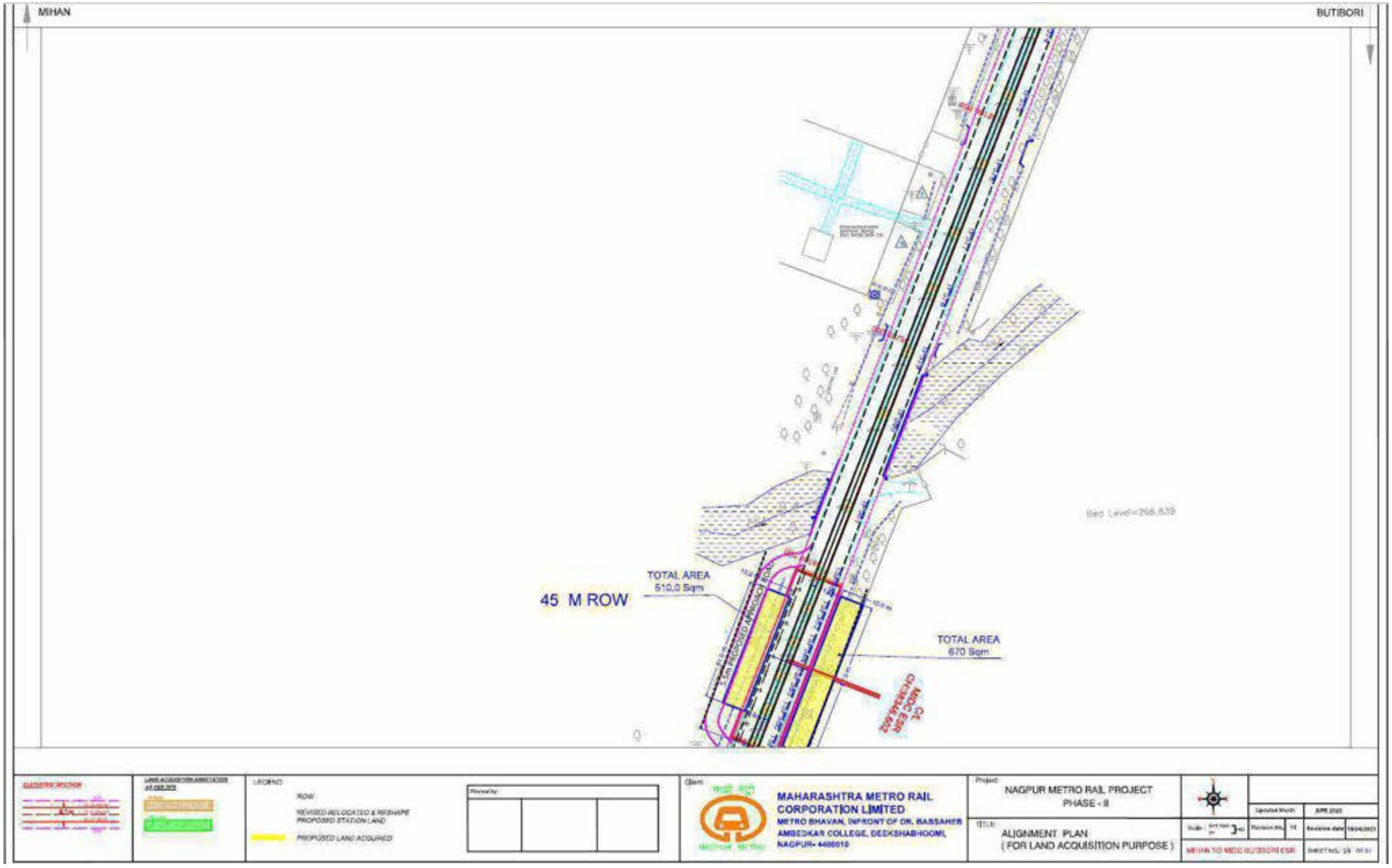
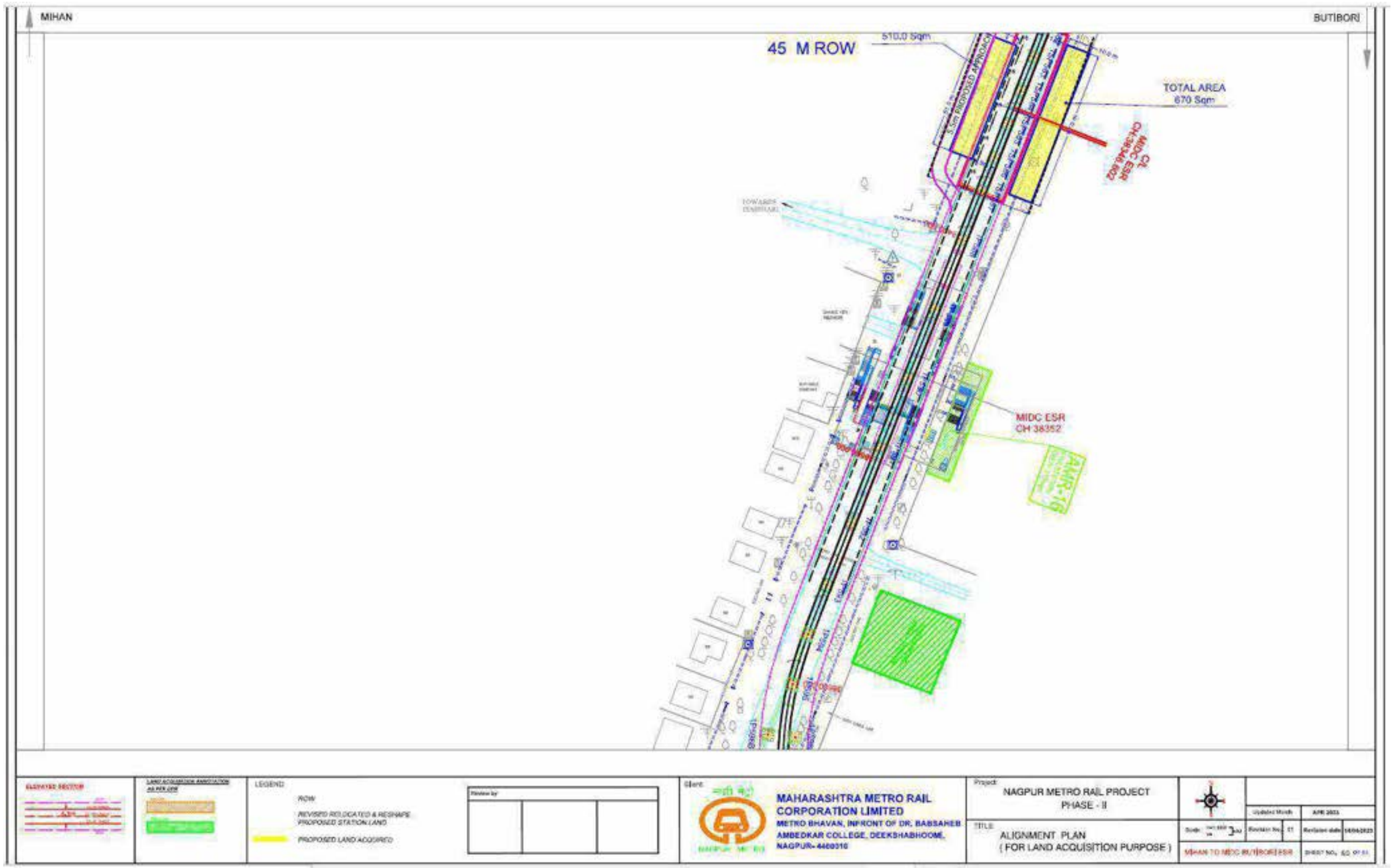
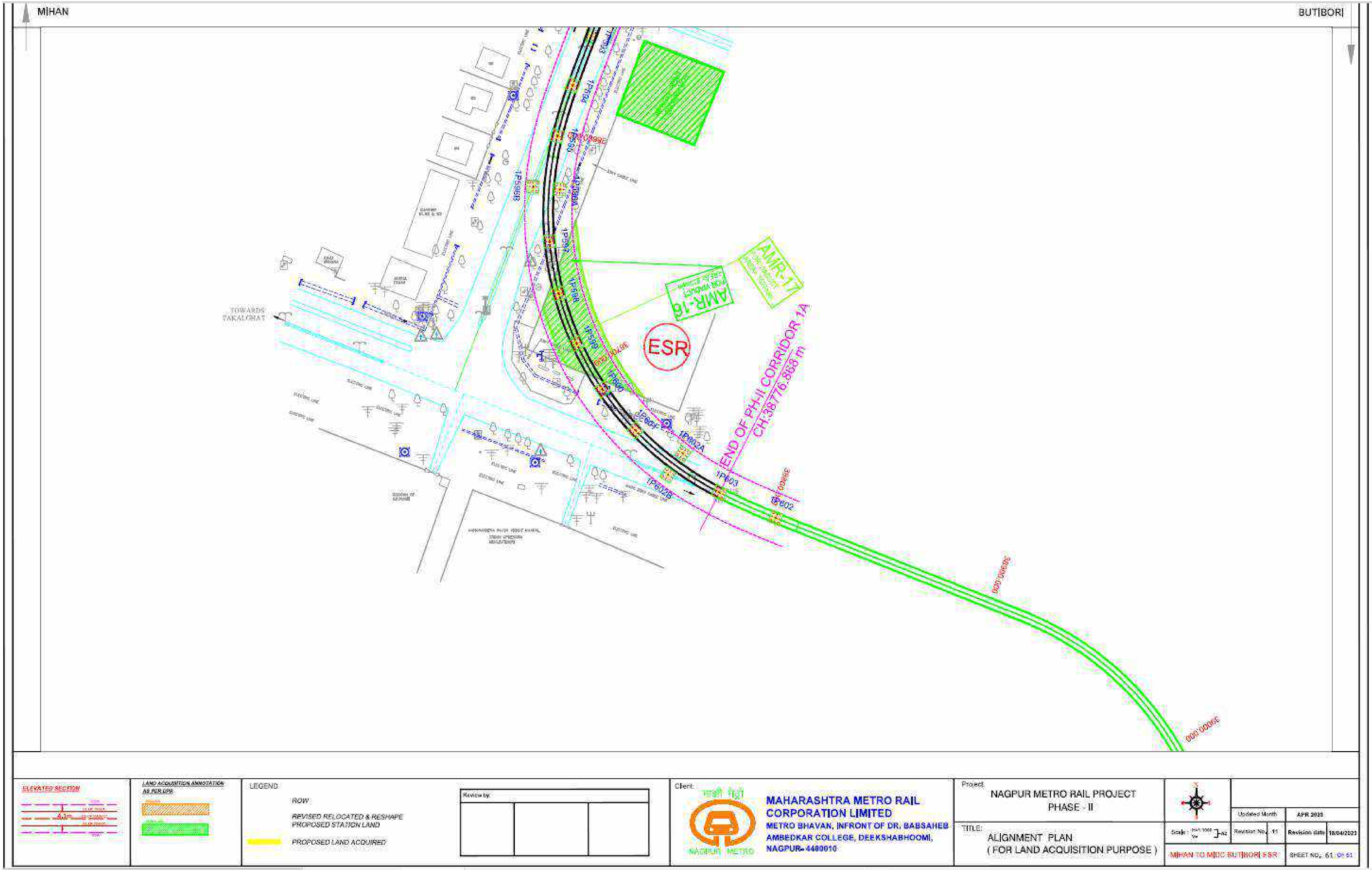


Figure 4.8: Land Acquisition Plan for MIDC KEC Stations in Corridor REACH-1A

Figure 4.9: Land Acquisition Plan for MIDC ESR Stations in Corridor REACH-1A




MIHAN
BUTIBORI
45 M ROW
510.0 Sqm
TOTAL AREA
670 Sqm
MIDC ESR
CH 38352
LEGEND:
ROW
REVISED RELOCATED & RESHAPE PROPOSED STATION LAND
PROPOSED LAND ACQUIRED
Client:
MAHARASHTRA METRO RAIL CORPORATION LIMITED
METRO BHAVAN, INFRONT OF DR. BABSAHEB AMBEDKAR COLLEGE, DEEKSHABHOOMI, NAGPUR- 440010
Project:
NAGPUR METRO RAIL PROJECT PHASE - II
TITLE:
ALIGNMENT PLAN
(FOR LAND ACQUISITION PURPOSE)


MIHAN
BUTIBORI
TOWARDS TAKALGHAT
AMR-16
AMR-17
ESR
END OF PH-II CORRIDOR 1A
CH:38776.868 m
1P603
1P602
1P602A
1P602B
ELEVATED SECTION
LAND ACQUISITION ANNOTATION AS PER DPR
LEGEND
ROW
REVISED RELOCATED & RESHAPE PROPOSED STATION LAND
PROPOSED LAND ACQUIRED
Review by:
Client:
MAHARASHTRA METRO RAIL CORPORATION LIMITED
METRO BHAVAN, INFRONT OF DR. BABSAHEB AMBEDKAR COLLEGE, DEEKSHABHOOMI, NAGPUR- 4400010
NAGPUR METRO
Project:
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Updated Month
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Revision No. 11
Revision date 18/04/2023
MIHAN TO MIDC BUTIBORI ESR
SHEET NO. 61 OF 61

(2) Land Requirement for the Stations and Viaduct in Corridor 2A – AUTOMOTIVE SQUARE TO KANHAN RIVER

As per the LAP prepared for the **Corridor 2A** project and the area notified by the MMRCL for construction of exit and entry points of the 12 stations the minimum land requirement was estimated as 2.2553 hectare. The LAP is given in figure-4.10 to 4.15.

Figure 4.10: Land Acquisition Plan for Pili Nadi Stations in Corridor REACH-2A

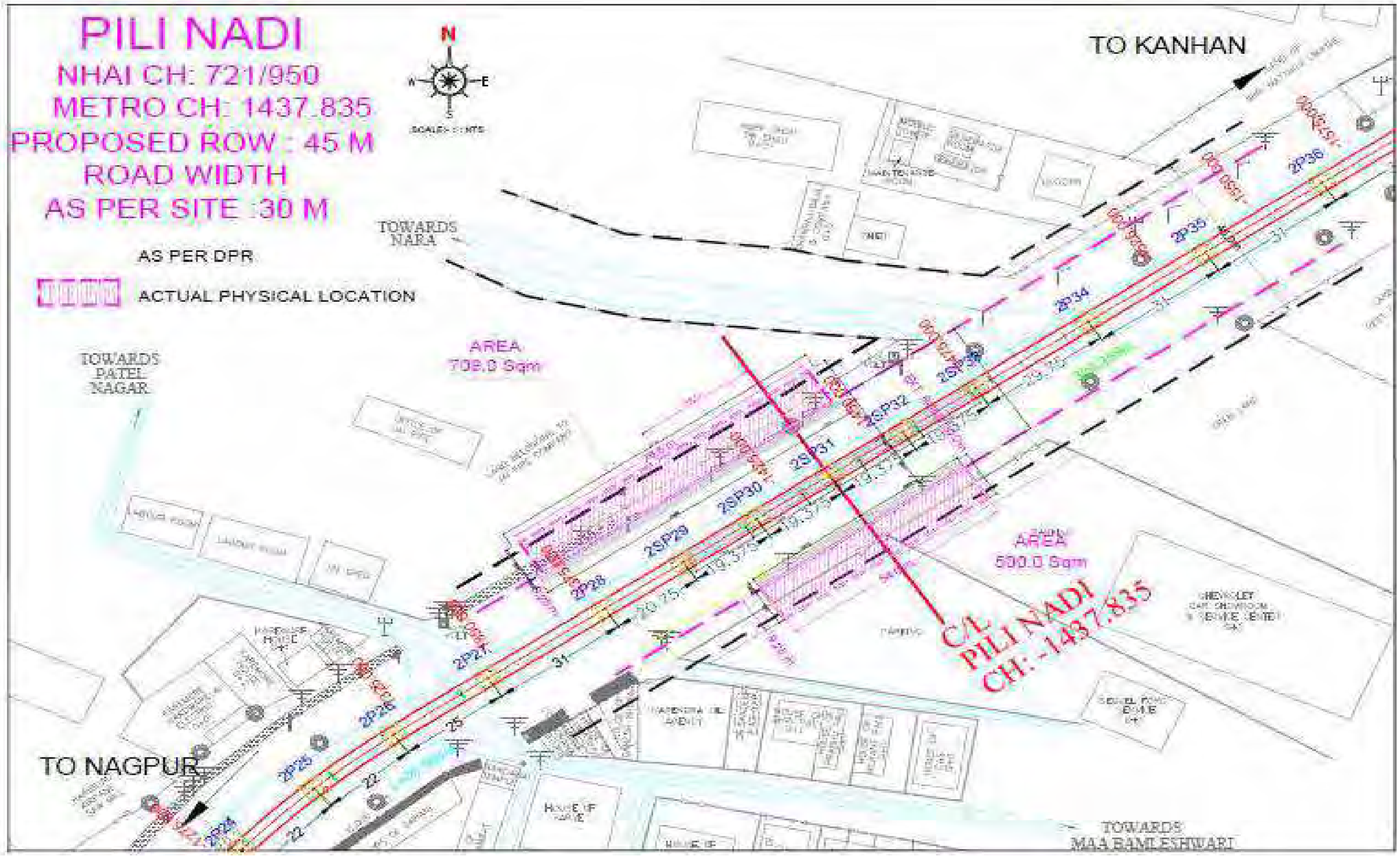


Figure 4.11: Land Acquisition Plan for Khasara Fata Stations in Corridor REACH-2A

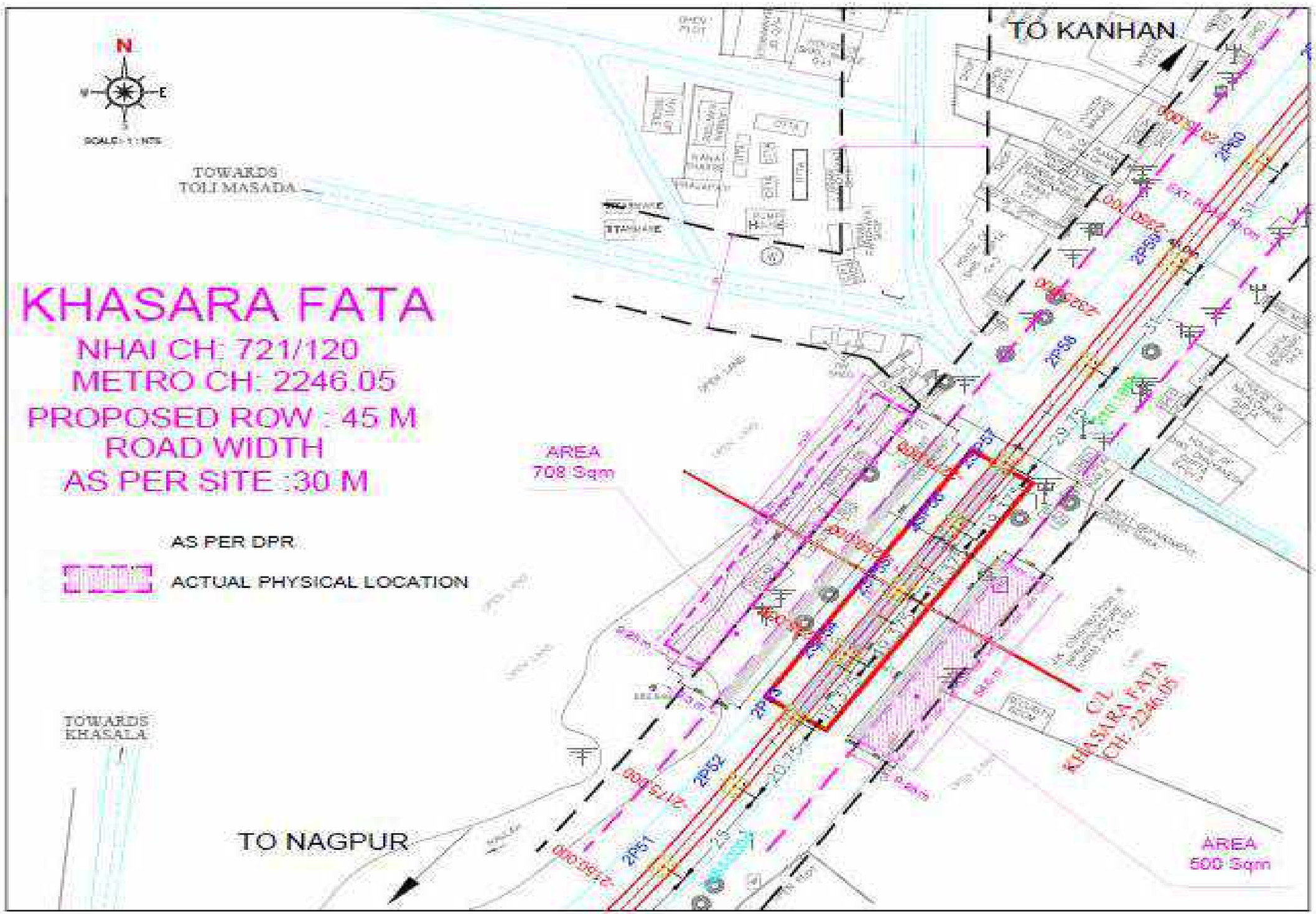


Figure 4.12: Land Acquisition Plan for All India Radio Stations in Corridor REACH-2A

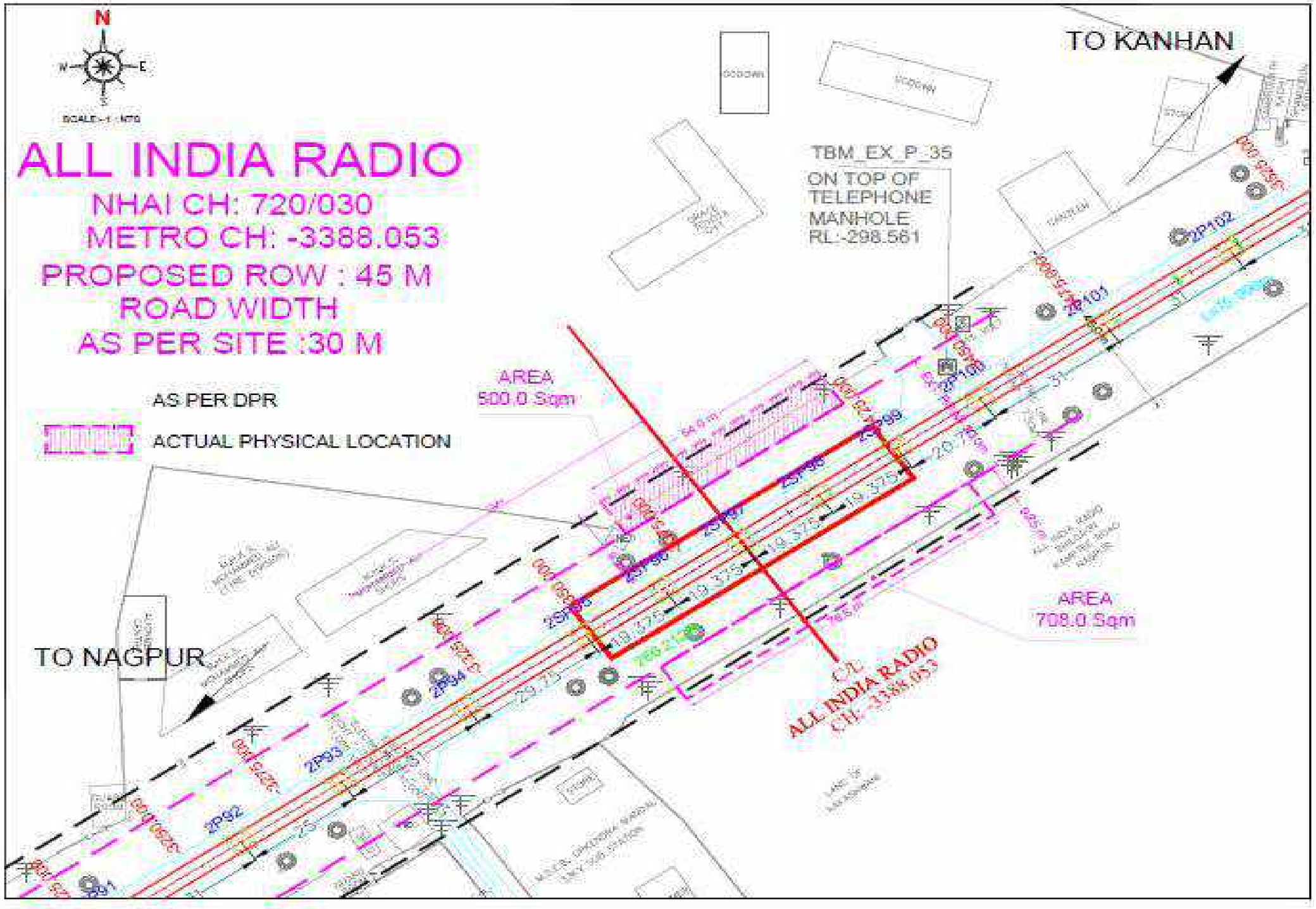


Figure 4.13: Land Acquisition Plan for Khairi Fata Stations in Corridor REACH-2A

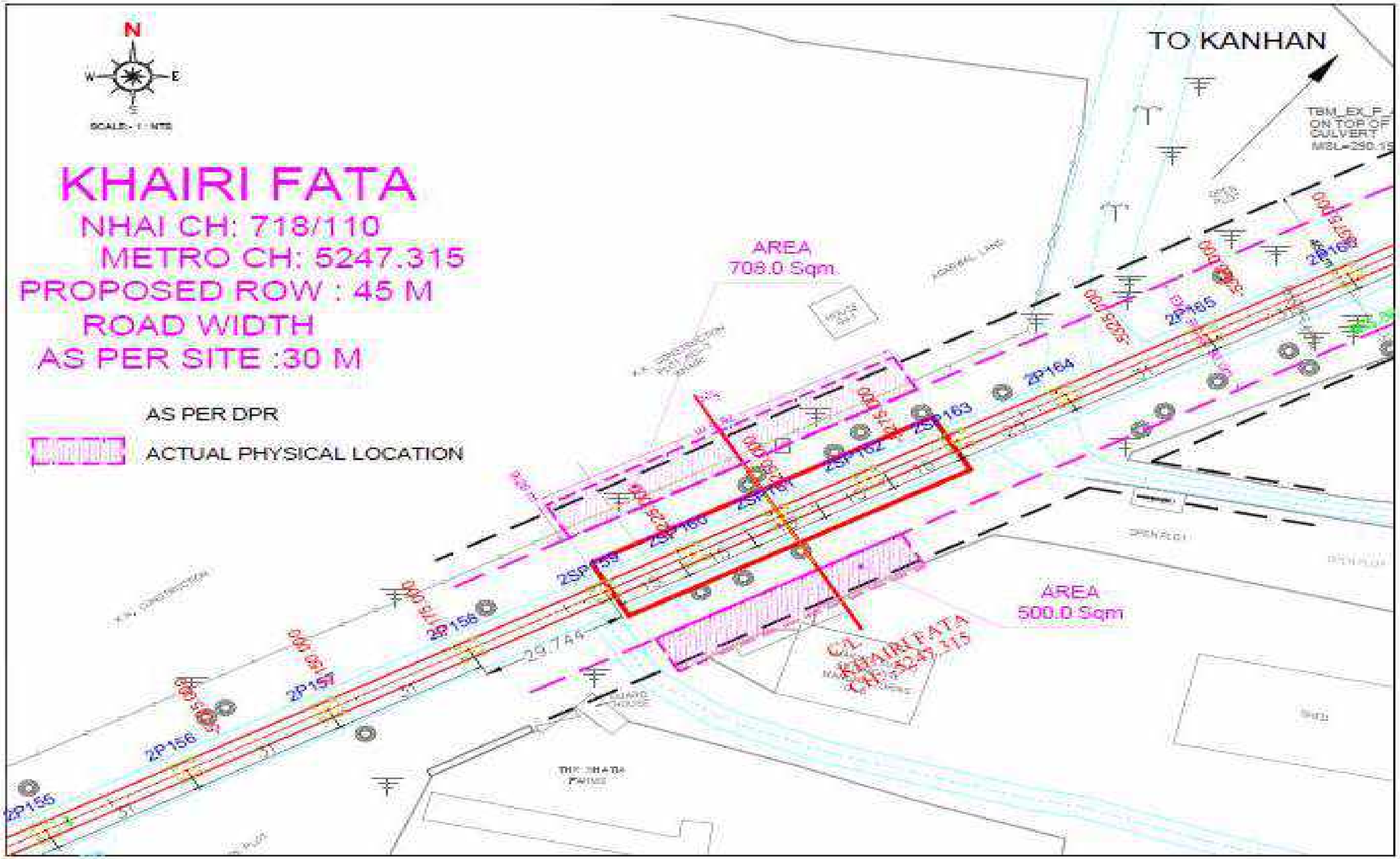


Figure 4.14: Land Acquisition Plan for Lok Vihar Stations in Corridor REACH-2A

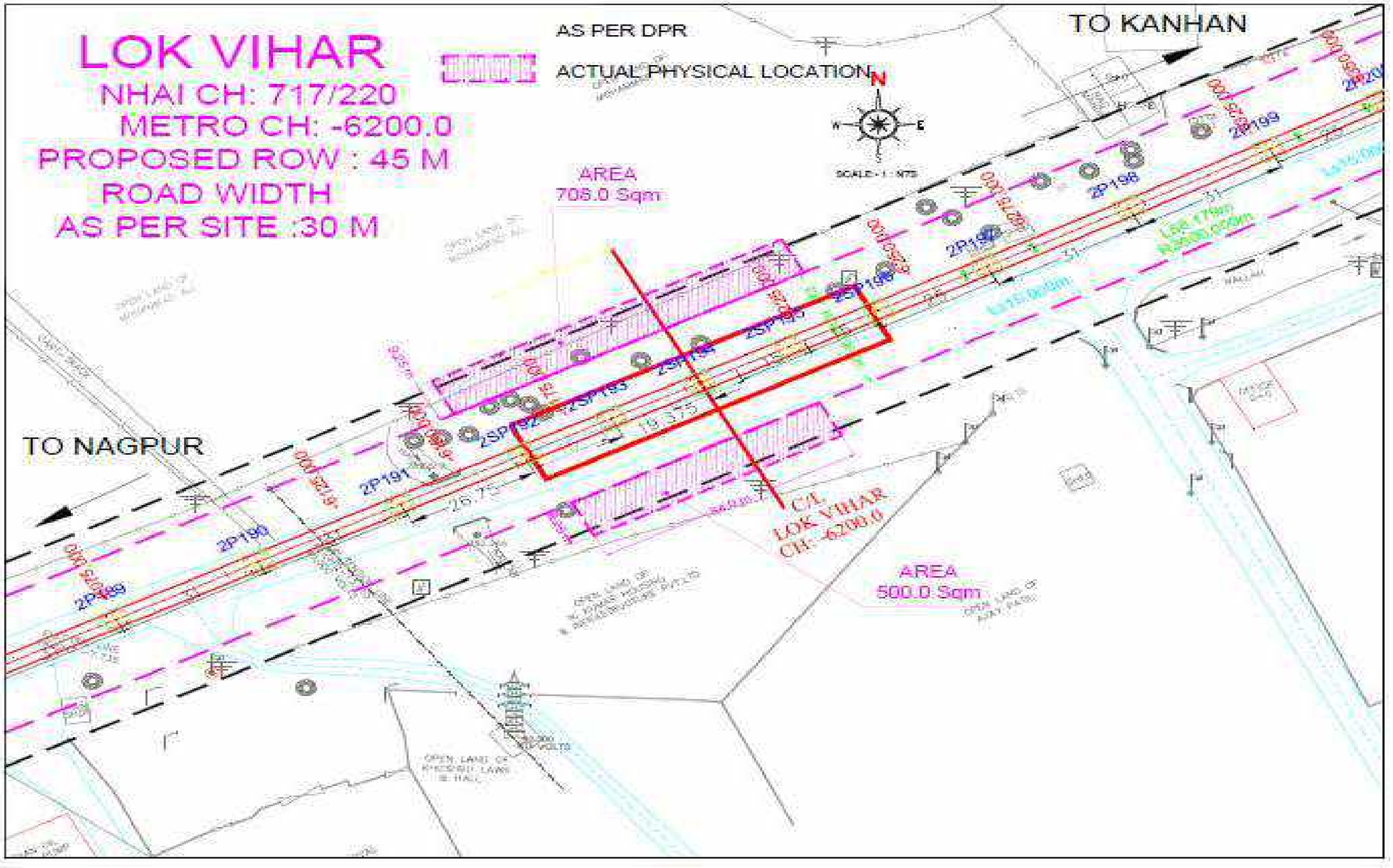
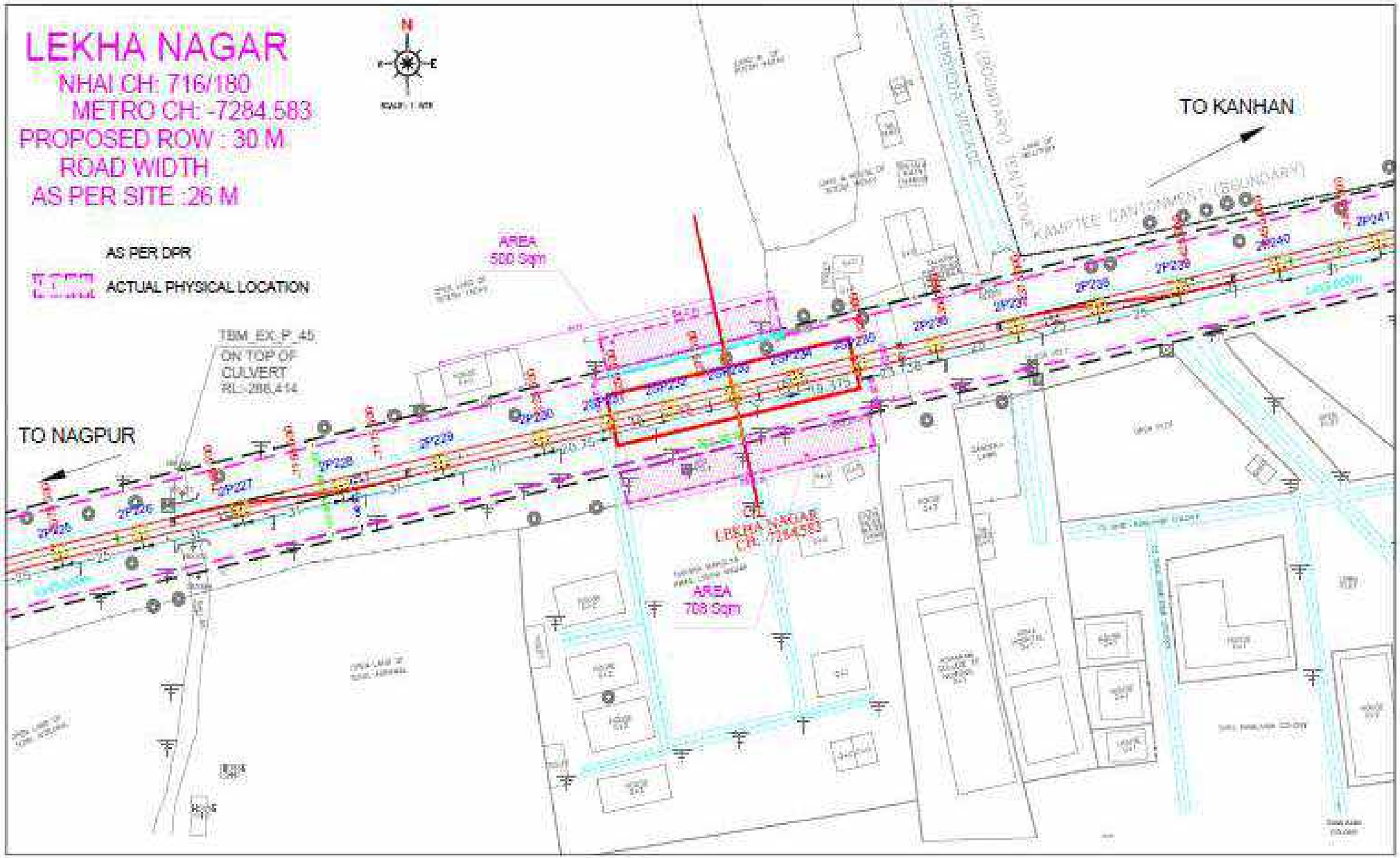


Figure 4.15: Land Acquisition Plan for Lekha Nagar Stations in Corridor REACH-2A



(3) Land Requirement for the Stations and Viaduct in Corridor 3A – LOKMANYA NAGAR TO HINGNA

As per the LAP prepared for the **Corridor 3A** project and the area notified by the MMRCL for construction of exit and entry points of the 7 stations the minimum land requirement was estimated as 1.7781 hectare. The LAP is given in figure-4.16 to 4.22.

Figure 4.16: Land Acquisition Plan for Hingna Mount View Stations in Corridor REACH-3A

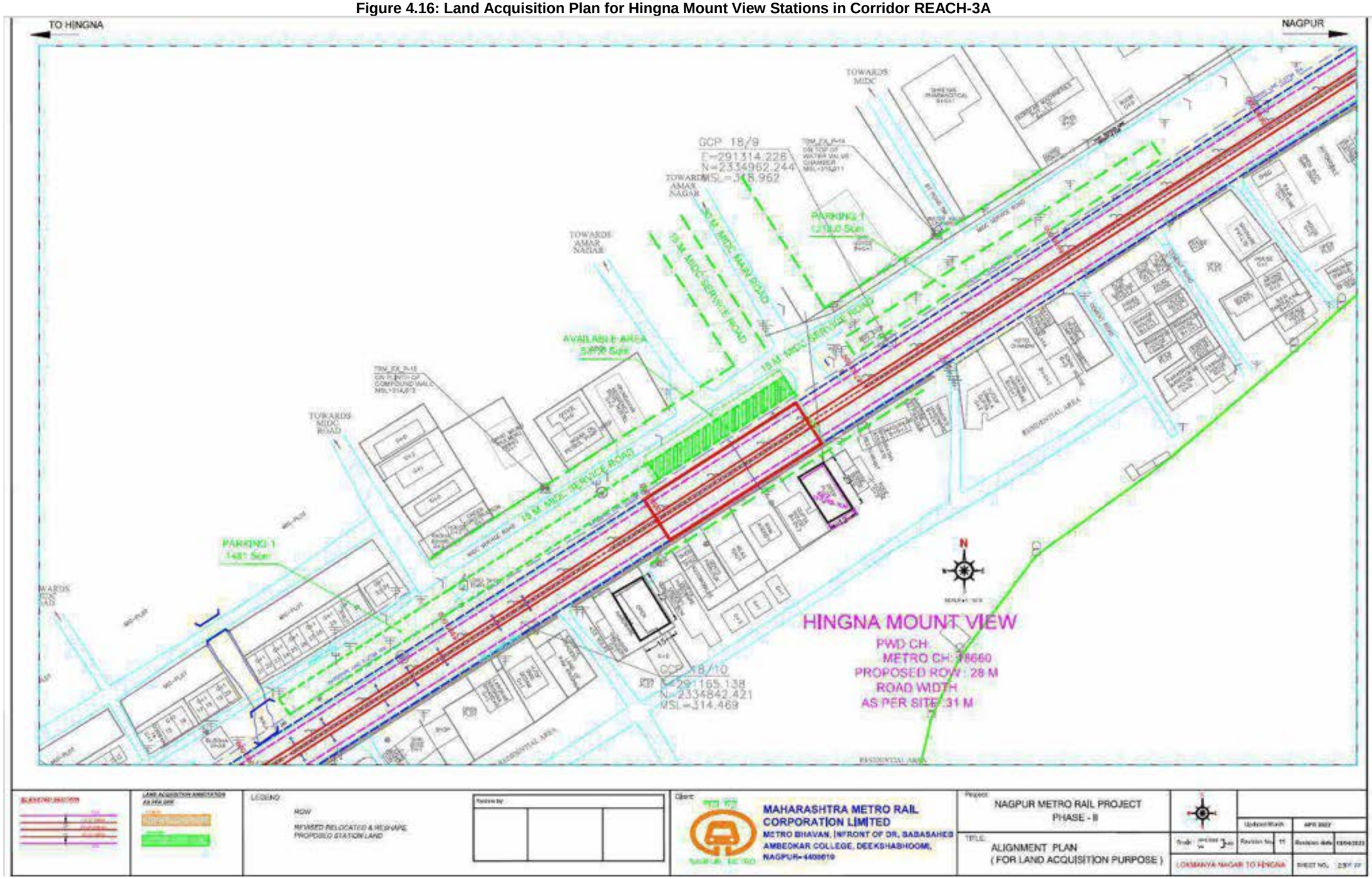


Figure 4.17: Land Acquisition Plan for Rajiv Nagar Stations in Corridor REACH-3A

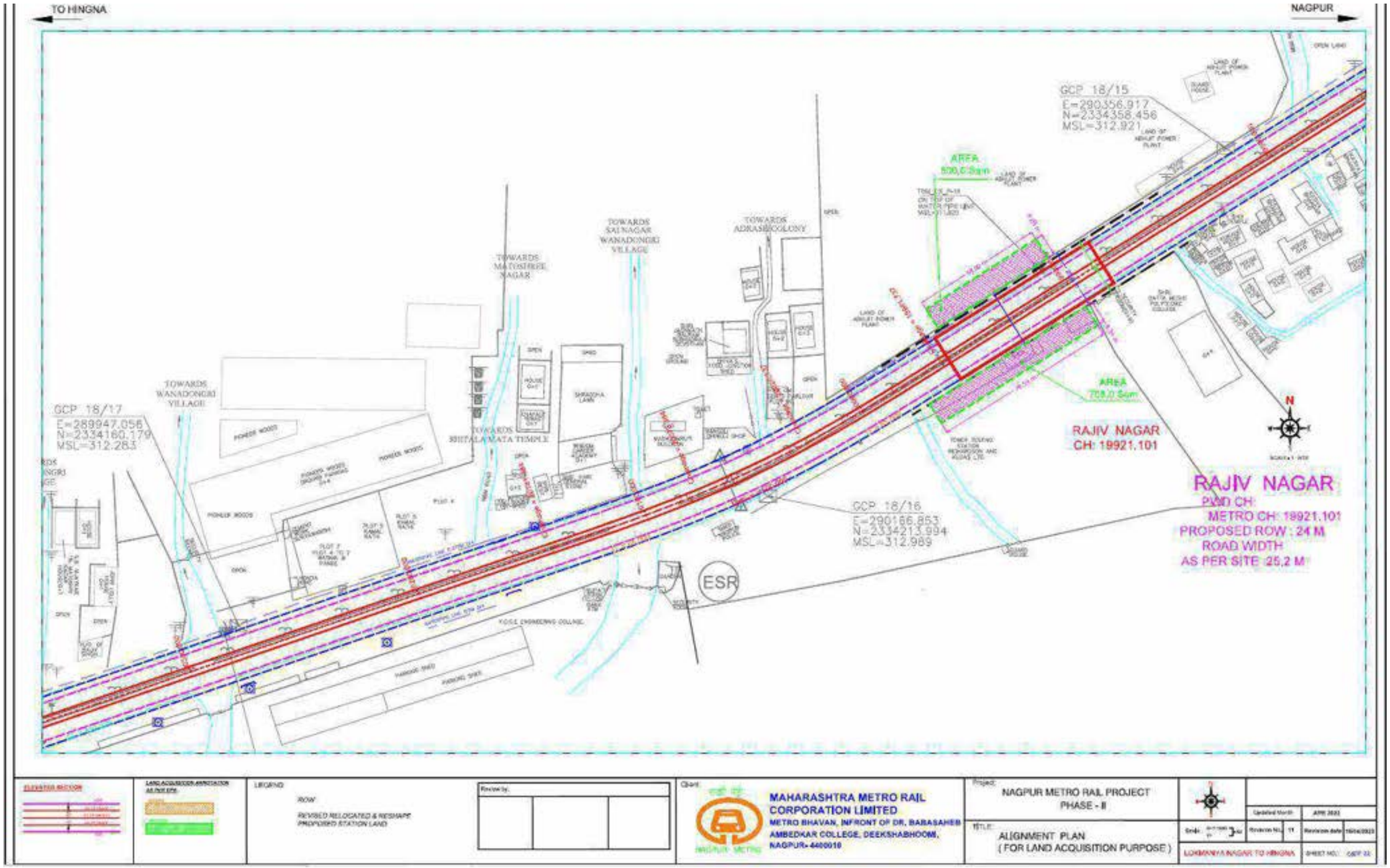


Figure 4.18: Land Acquisition Plan for Wanadongri Stations in Corridor REACH-3A

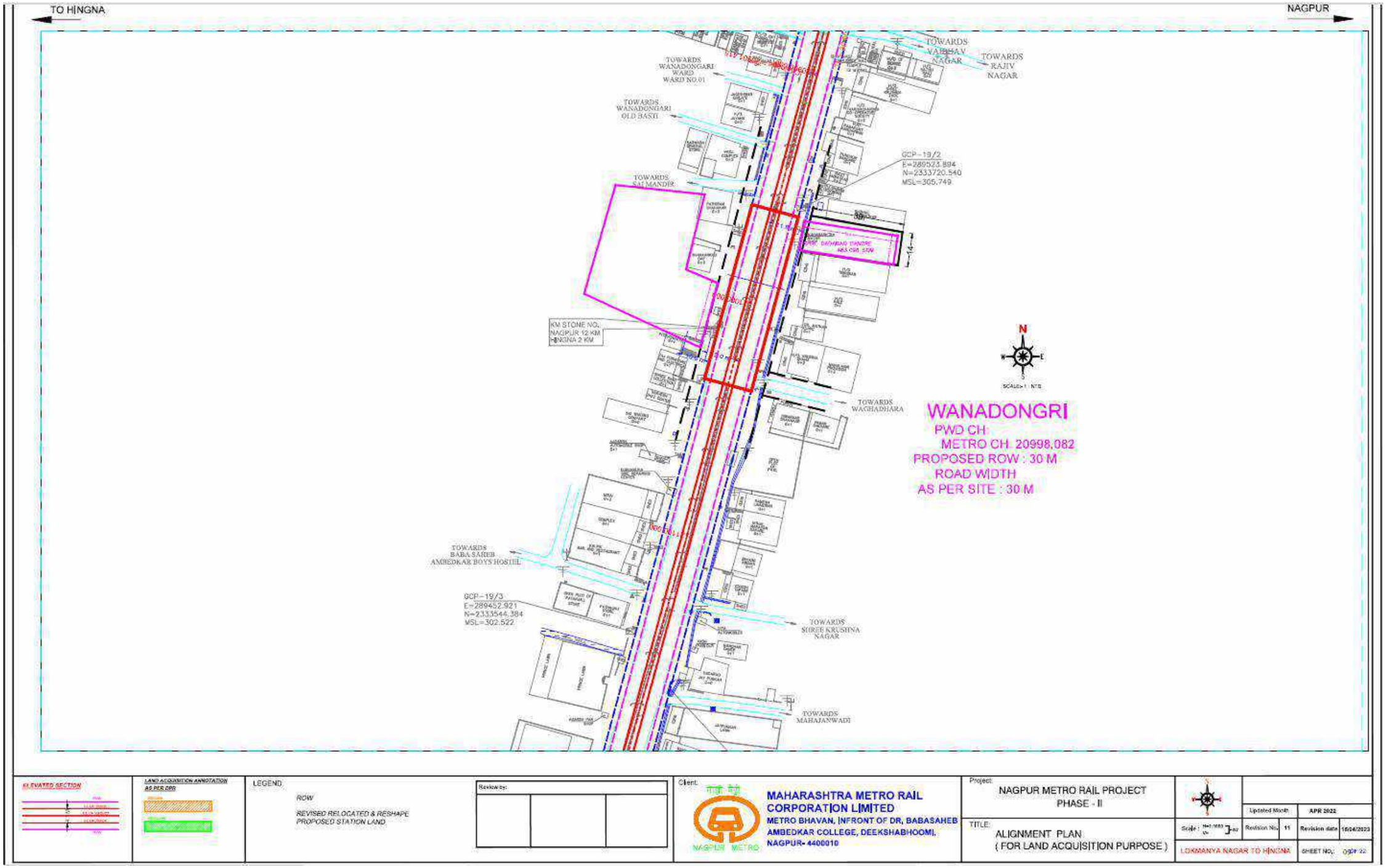


Figure 4.19: Land Acquisition Plan for APMC Stations in Corridor REACH-3A

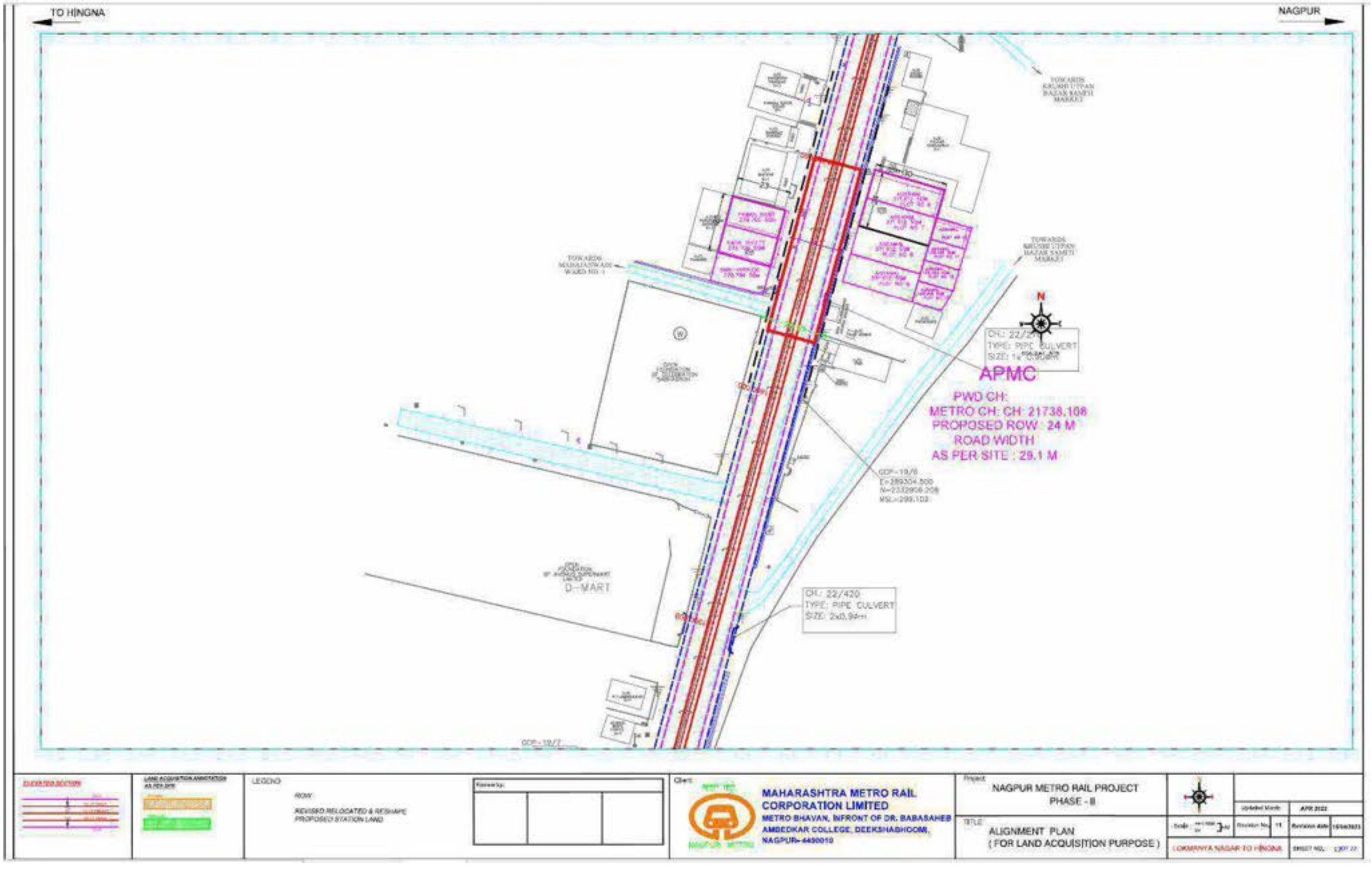


Figure 4.20: Land Acquisition Plan for Raipur Stations in Corridor REACH-3A

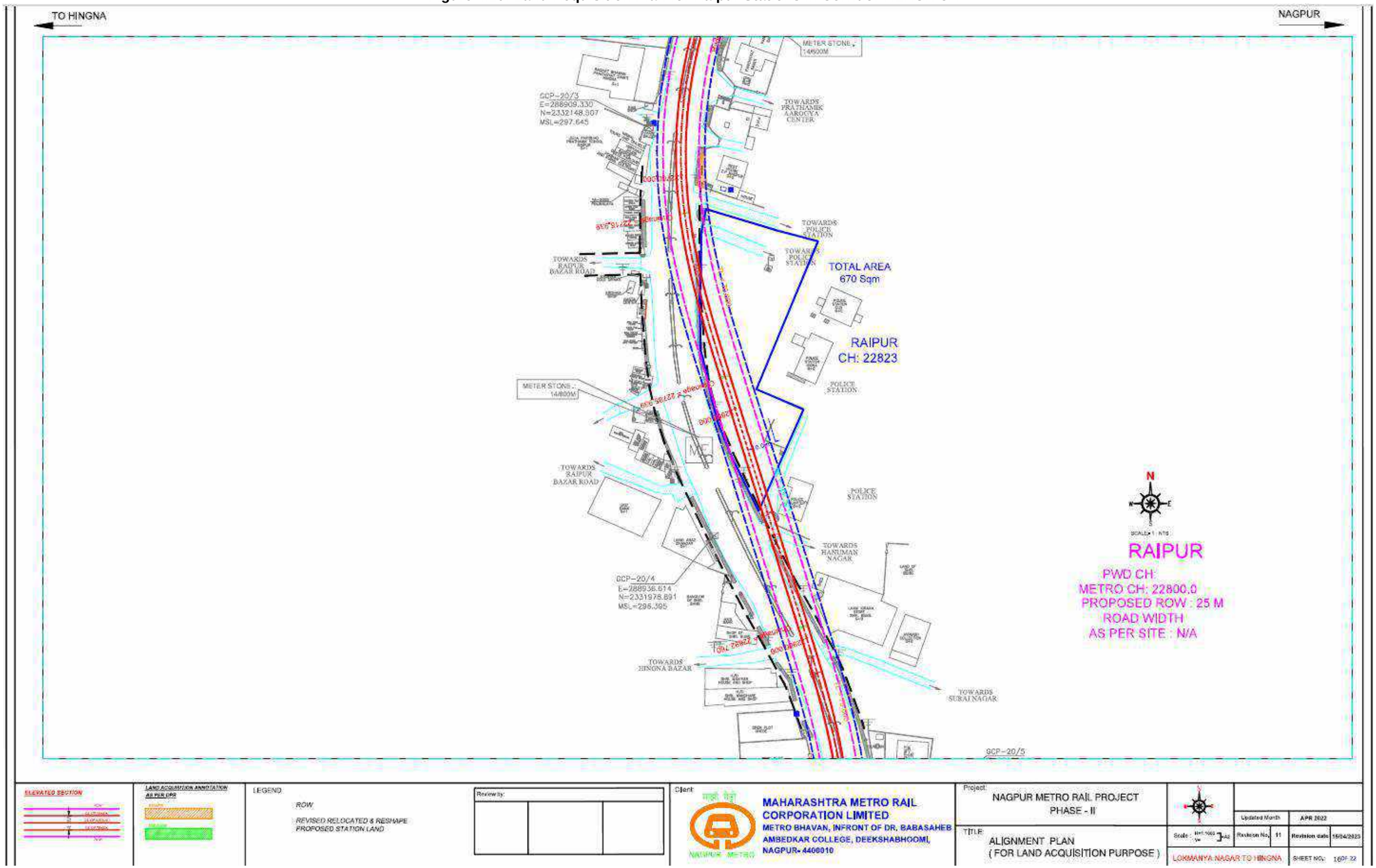


Figure 4.21: Land Acquisition Plan for Hingna Bus Station Stations in Corridor REACH-3A

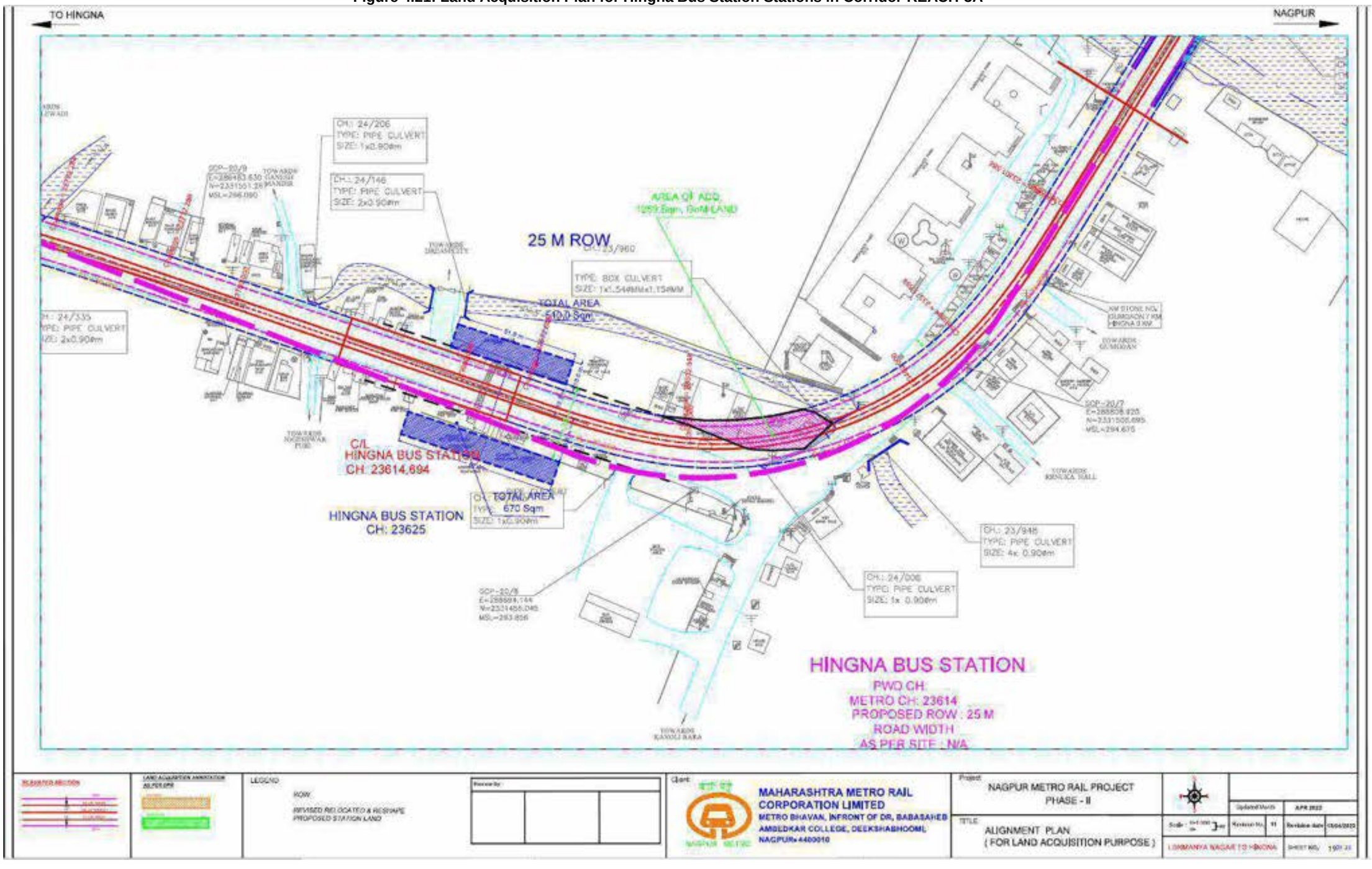
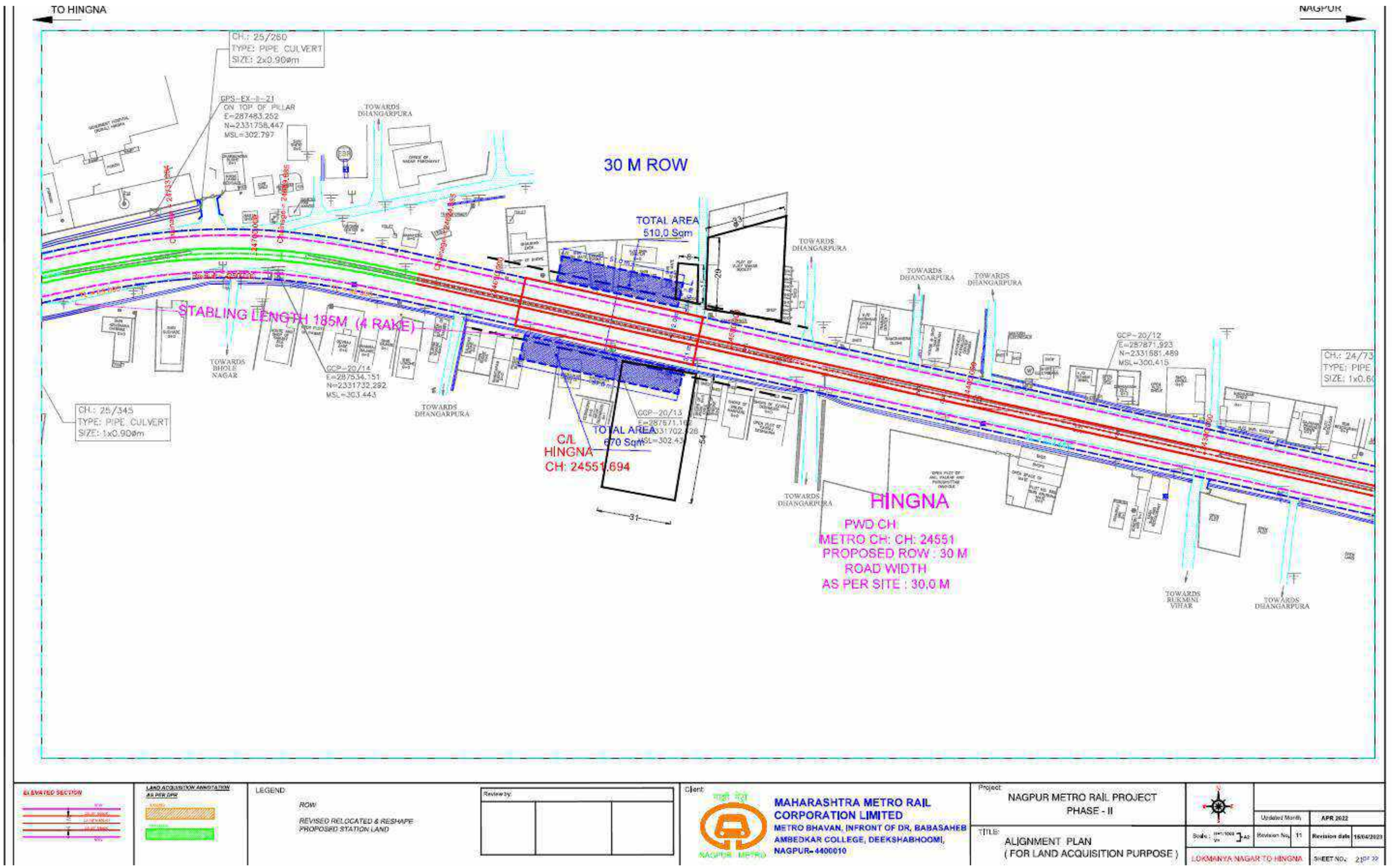


Figure 4.22: Land Acquisition Plan for Hingna Stations in Corridor REACH-3A



(4) Land Requirement for the Stations and Viaduct in Corridor REACH-4A – PRAJAPATI NAGAR TO TRANSPORT NAGAR

As per the LAP prepared for the **Corridor REACH-4A** project and the area notified by the MMRCL for construction of exit and entry points of the 7 stations the minimum land requirement was estimated as 0.6285 hectare. The LAP is given in figure-4.23 to 4.25

Figure 4.23: Land Acquisition Plan for Transport Nagar Stations in Corridor REACH-4A

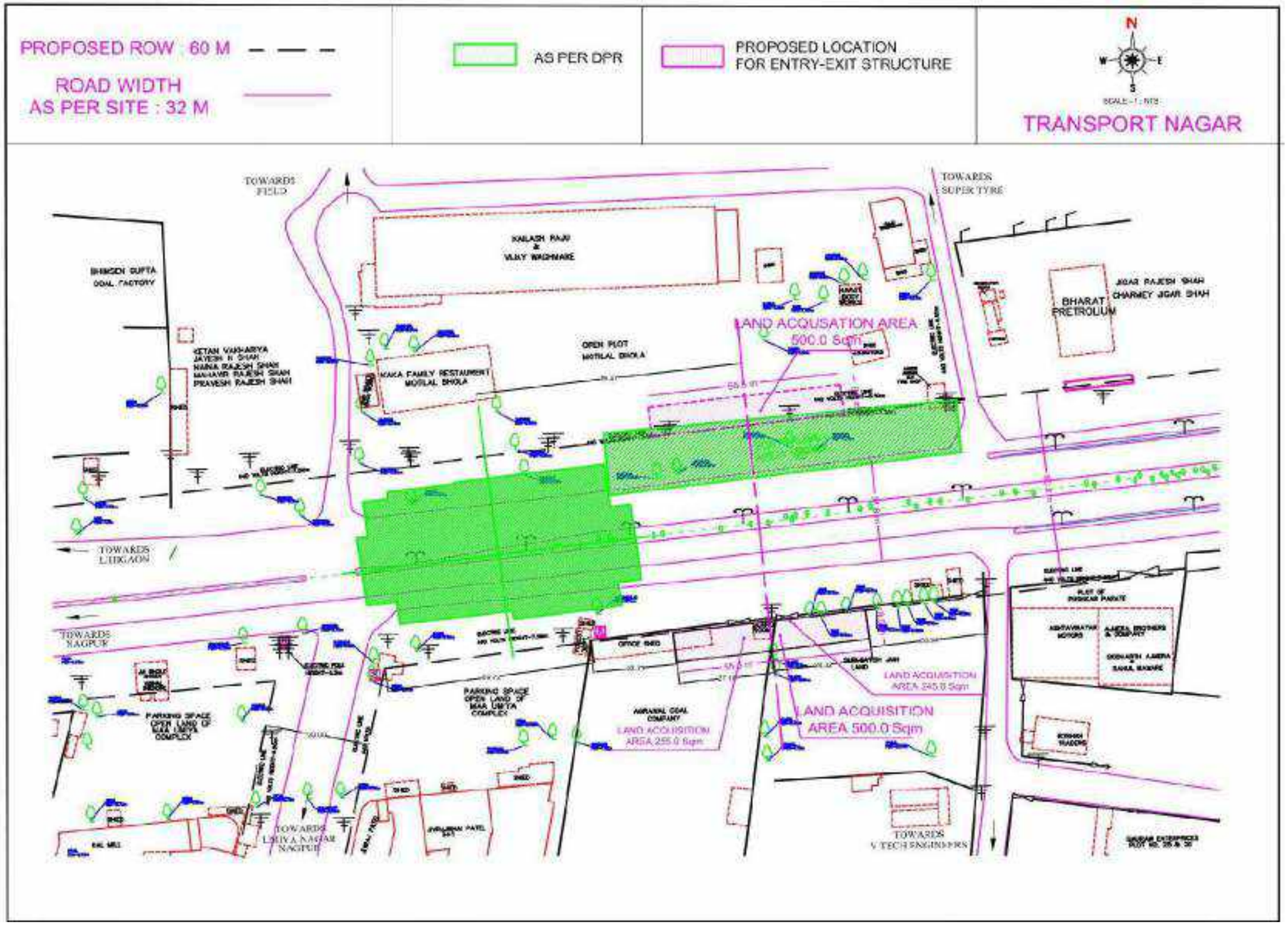


Figure 4.24: Land Acquisition Plan for Pardi Stations in Corridor REACH-4A

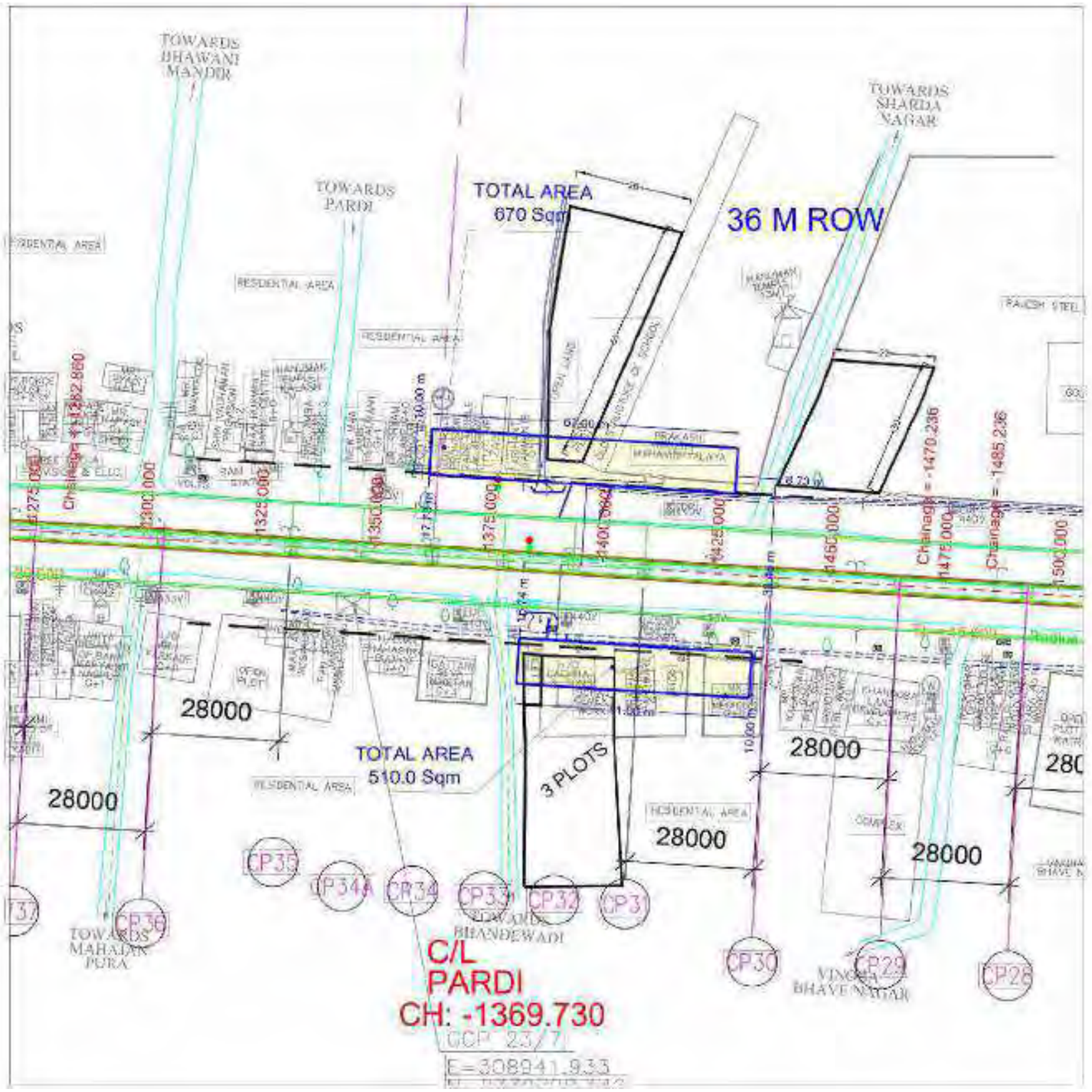
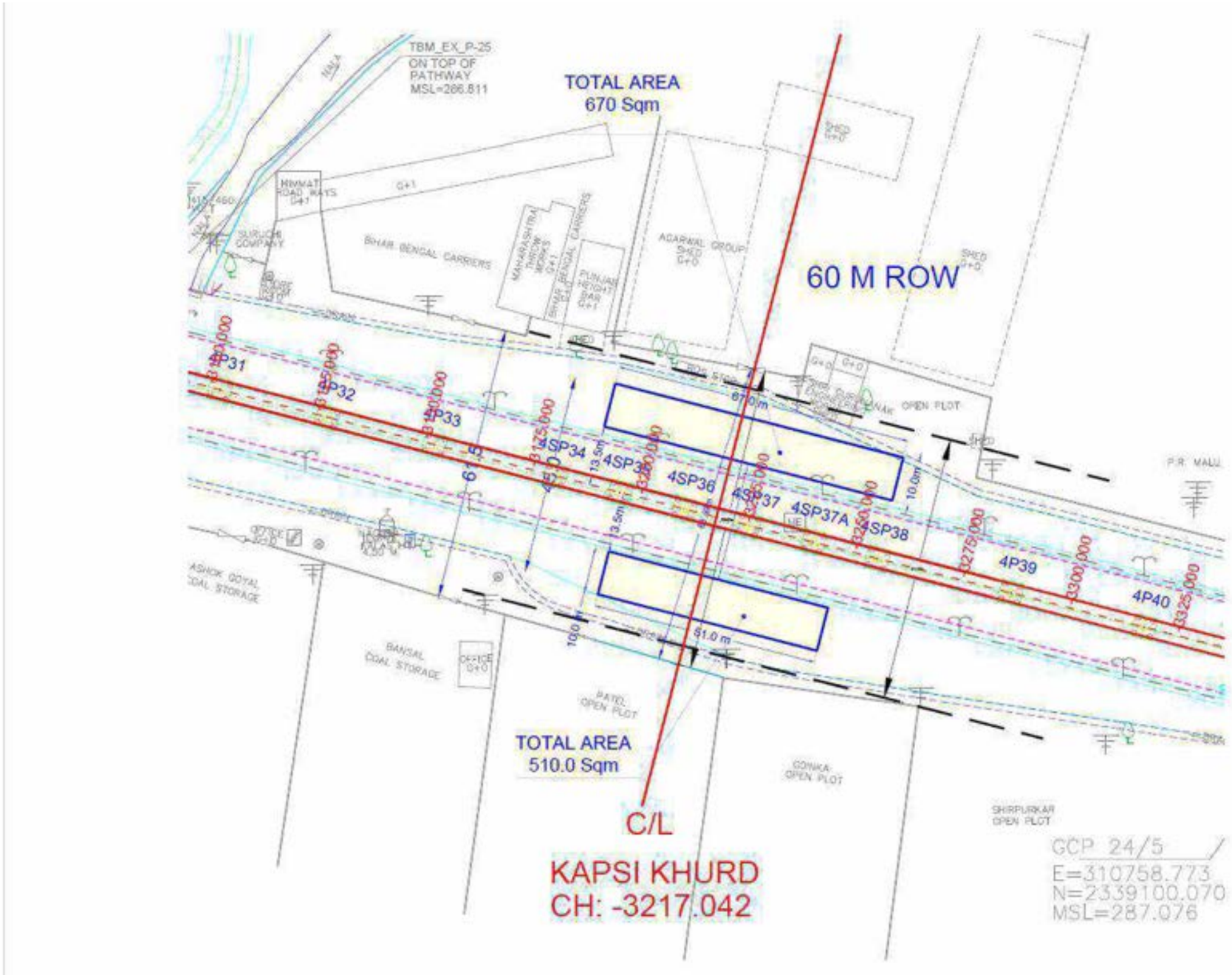


Figure 4.25: Land Acquisition Plan for Kapsi Khurd Stations in Corridor REACH-4A



C. Bare Minimum Land Assessment

The land proposed to be acquired in 21 villages for construction of exit and entry points of stations cannot be avoided due the technical nature of stations with elevated viaduct. While, stations are constructed on the existing RoW the exit/entry points are opened in the private land which is proposed to be acquired. Since, there is no option available the land can be termed as the bare minimum requirement for the construction of the proposed Phase-II Project.

D. Loss of Private Land

As per project census survey, the land acquisition of 5.5749 Ha of private land will affect 51 titleholders HHs. This land will be acquired mainly for construction of station entry and exit purpose, viaduct and parking purpose. All the landowners have purchased these lands for investment purpose, and they live in the city or nearby vicinity. The use of these lands to be acquired is barren at present. Below **Table 4.2** shows Reach wise loss of private land.

Table 4.2: Reach wise Private Land

Sr. No	Corridor	TH	Private land	Loss of Property
1	MIHAN to MIDC ESR (Reach-1A)	26	3.3573	Land only
2	Automotive Square to Kanhan River (Reach-2A)	11	1.0548	Land only
3	Lokmanya Nagar to Hingna (Reach-3A)	11	0.8156	Land only
4	Prajapati Nagar to Transport Nagar (Reach-4A)	03	0.3472	Land only
	Total	**51**	**5.5749**	

E. Loss of Government Land:

Total 3.3740 Ha Government land will be going under acquisition. These Government land belongs to MHADA, MIDC, MSRTC, GoM, Kamptee Municipal Council, Hingna Nagar Panchayat, Center Railway, Southeastern Railway, Kamptee Cantonment and NHAI. These State and Central Government land will be transfer from respective authority to NMRP. Below **Table 4.3** shows the Reach wise Government land acquisition.

Table-4.3: Reach wise Government Land

Sr. No	Corridor	NTH	Government land	NTH using type of Land
1	MIHAN to MIDC ESR (REACH-1A)	13	1.2897	
2	Automotive Square to Kanhan River (REACH-2A)	08	1.2005	
3	Lokmanya Nagar to Hingna (REACH-3A)	22	0.9625	
4	Prajapati Nagar to Transport Nagar (REACH-4A)	04	0.2813	
	Total	**47**	**3.7340**	**Kiosks/street vendors**

F. Loss of Trees:

The details of project affected trees in the private land is given below in **Table No. 4.4**

Table No: 4.4 - Total number of Trees

Sr.No.	Reach	Particulars of trees	Number of Trees
1	1A	Timber Tree	20
		Non-Timber Tree	0
		Fruit Bearing Tree	0
2	2A	Timber Tree	35
		Non-Timber Tree	5
		Fruit Bearing Tree	2
3	3A	Timber Tree	7
		Non-Timber Tree	0
		Fruit Bearing Tree	0
4	4A	Timber Tree	4
		Non-Timber Tree	1
		Fruit Bearing Tree	0
	Total		**74**

Source: NMRP II Project Census Survey

G. Loss of Private Structure:

Total 47 structures, owned by 47 non-titleholder households will be impacted due to the project. All these affected structures are temporary in nature. The details of loss of private structures are presented in the **Table 4.5**.

Table 4.5: Loss of Private Structures in the Project[1]

Sl. No	Ownership Status	No. of Structure	No. of displaced HHs	No. of displaced persons	%
1	Titleholder	0	0	0	0.00
2	Leaseholder	0	0	0	0.00
3	Non-titleholder	47	47	235	100.00
Total		**47**	**47**	**235**	**100.00**

Source: NMRP II Project Census Survey

H. Loss of Common Property Resource:

A total of three CPRs will be affected by the project. These includes two public toilets and one weekly market at Dongargaon. The Dongargaon weekly market land belongs to Maruti Devasthan Trust, and they have provided this land to Gram panchayat on mutual understanding for market purpose. The Gram panchayat has developed 16 platforms for weekly market purpose, out of which 8 platforms are being affected due to the proposed phase-II project. The detailed information, location and photographs of CPR is given in **Annexure-5.** The list of affected CPRs is presented in **Table 4.6**

[1] All the land requirement of TH are barren in nature. All the NTH are commercial kiosks. The detailed information is given at Annexure-6 &7. (Barren land:- No major crops are grown as the land is purchased from the owners only for investment purpose)

Table: 4.6 - CPRs affected by the Project

Sl. No.	Type of CPR	Number of affected CPR
1	Public toilets	2
2	Community structure (Dongargaon weekly market)	1
	Total	**3**

I. Extent of Impact

The proposed land to be acquired for all four Reach corridor of Phase-II project. There are no any private residential or commercial structures have been found during survey in an impacted plots. During survey it was also found that, all 51 landowners have purchased such lands for investment purposes and all are barren and vacate land, at present they do not use these lands for any purposes and they live in the city or nearby vicinity. The portion of the land that is affected does not exceed 10% of the total existing available land and no such impact on their livelihood from these plots.

J. Loss of Livelihoods

There is no loss of livelihood among affected landowners as lands are barren. Also, no physical displacement of any residential structures. Their livelihood is not depending on this land. The 47 affected temporary structures of NTHs will be relocated to the nearby place after proper consultation and with coordination by local authority. All the affected NTHs have kiosks which includes tea stall, pan shop, small eateries, cobbler shop, automobile repair shop etc. The livelihood of all these small kiosks holders will not be affected as they will continue to engage with the same activity in the place of relocation. However, these kiosk holders will experience temporary loss of income during the period of relocation to the new place.

K. Land Prices in the Project Affected Area

This Phase II Project Land Price is based on the provisions of the Entitlement Matrix and impact identified in SIA study. The project is proposed to acquire land through direct purchase method. The compensation amount will be 250% of land value (which includes 100% solatium and 25% direct purchase consent grant).

L. Land Acquisition Process as per Maharashtra Government Resolution – Direct Purchase Method

The NMRP team will ensure issuing timely notices and implementing necessary procedures for land acquisition as per Government of Maharashtra Orders. The following procedure will be followed for land acquisition under direct purchase method.

(i) Authorized person from Land cell of Maha Metro along with representative of CPM office will visit the property for verification to be acquired as per DPR.
(ii) The list of affected persons will be prepared by the authorized person of Land cell.
(iii) Notices to the affected persons will be issued for hearing and submission of ownership documents and consent letter to Maha Metro.
(iv) On submission of ownership document and consent letter by affected persons, the demarcation will be done by authorized person from the Land cell/nominated agency by

Maha Metro.

(v) The nominated agency will carry out the demarcation as per the DPR and same will be superimposed on city survey map.

(vi) The case is prepared and sent to the nominated Advocate of Maha Metro for submission of search report.

(vii) The complete case is sent to the nominated engineer of Land Cell, Maha Metro along with a search report and relevant documents for valuation. The Engineer from the respective Section as nominated by CPM will submit to DGM (Land).

(viii) Record for last three years sale/purchase for the area from the Registrar of Stamp Duty will be obtained and submitted along with the documents.

(ix) 7/12 of the land will be obtained from Patwari of that area and the property card is obtained from the Land Record Department.

(x) On obtaining all the data as above, the compilation will be done by land cell of Maha Metro and will be submitted to DGM Finance for its scrutiny before submission to the District Collector.

(xi) District Level Committee will be formed under the chairmanship of Collector for fixing the amount of compensation of the land to be acquired for direct purchase. The Committee will fix the amount on compensation as per guidelines of GOM.

(xii) The Collector passes the order for compensation of the land to be procured by direct purchase.

(xiii) The committee will review and process for execution of sale deed will be initiated by the land cell.

(xiv) Sale deed will be prepared and executed between Maha-Metro and private landowner.

(xv) Finally, the Possession of land will be taken from private landowner by NMRP. The **Fig-4.1** shows the step of Direct Purchase Method of land acquisition.

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 (RFCTLARR), 2013. The process for land acquisition in the context of this project will be as follows:

(i) Submission of requisition for land acquisition along with other required document to concerned District Authority.

(ii) Notification by Government for commencement of consultation and SIA.

(iii) Completion of SIA study culminating in SIA report.

(iv) Conduct public hearing for SIA

(v) Constitution of SIA Group to appraise SIA study report

(vi) Submission of appraisal of SIA report and recommendations by expert group.

(vii) Preliminary notification for acquisition of land under section 11 of the Act.

(viii) Updation of land records by LA Authority.

(ix) Hearing of objection under section 15 of the Act.

(x) Preparation of R&R Scheme and disclosure.

(xi) Declaration that land is required for public purpose u/s 19.

(xii) Hearing of objection under section 23 of the Act.

(xiii) Declaration of final award by collector.

(xiv) Payment of full amount of compensation

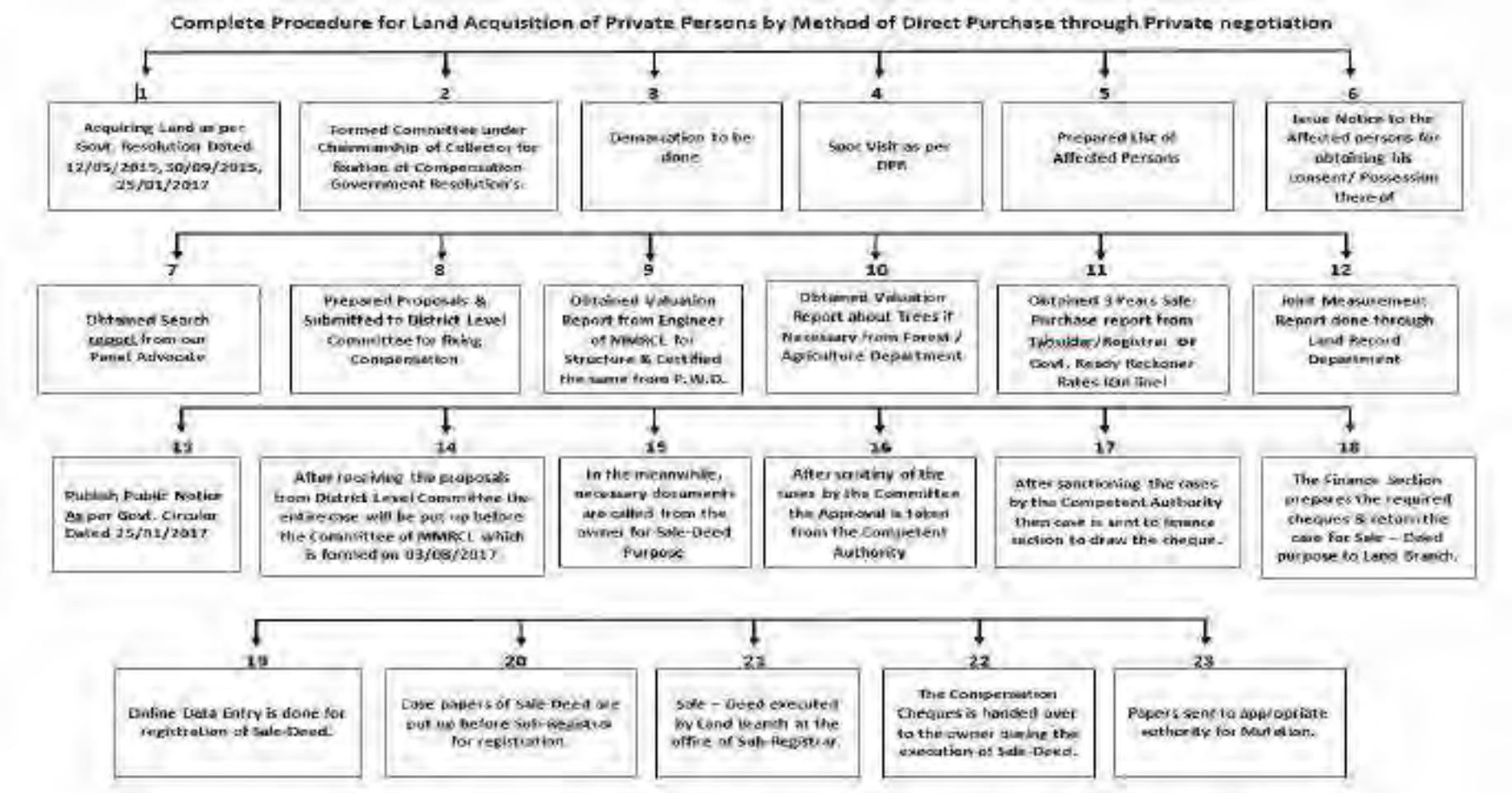
(xv) Payment of monetary part of R&R

(xvi) Taking possession of land acquired

(xvii) Infrastructural component of R&R package to be provided

(xviii) Displacement of affected families.

FIG 4.26: Describes the process of Direct Purchase Method of LA



V. SOCIO-ECONOMIC AND CULTURAL PROFILE

A. Profile of the Project Affected Area

According to the census 2011, Nagpur City had population of 2,405,665 with 1,225,405 males and 1,180,260 females. The urban / metropolitan population is 2,497,870 of which 1,274,138 are males and 1,223,732 are females. Children are 10.27% of total population of Nagpur. The municipality has a sex ratio of 963 females per 1,000 males and child sex ratio of 926 girls per 1,000 boys. 1,984,123 people are literate, of whom 1,036,097 are male and 948,026 are female. Average literacy rate of Nagpur city is 91.92%. Men are 94.44% and women are 89.31% literate. In Nagpur, 36% of the population lives in slums, making it the fourth largest city in terms of slum population. The sex ratio of Nagpur city is 963 per 1000 males and child sex ratio is girls are 926 per 1000 boys.

B. Profile of the Project Affected Villages

The metro alignment of NMRP Phase-II is passing from Municipality area and 21 villages outside the city limit. The details and metro alignment location and affected villages are provided in the **Table 5.1** below.

Table 5.1: List of Affected Village

Station	Village	Station	Village
REACH-1A – MIHAN TO MIDC ESR		**REACH-3A - LOKMANYA NGR - HINGNA**	
Eco Park City	Parsodi	Hinga Mount View	Nildoha
Metro City	Jamtha	Rajeev Nagar	Wanadongari
Ashokvan	Jamtha	Wanadongri	Wanadongari
Dongargaon	Dongargaon	APMC	Wanagondari
Mohagaon	Mohagaon	Raipur	Raipur
Meghdoot CIDCO	Borkhedi	Hingna Bus Stn.	Hingna
Butibori P. Station	Rengapar	Hingna Hospital	Hingna
MAHDA Colony	Kinhi		
MIDC KEC	Kinhi		
MIDC ESR	Kinhi		
REACH-2A (AUTOMOTIVE KANHAN RIVER)		**REACH-4A (PRAJAPATI -TRANSPORT Ngr)**	
Pili Nadi	Wanjara	Pardi	Bhandewadi
Khasara Fata	Wanjara	Kapsi Khurd	Kapsi Khurd
All India Radio	Bhilgaon	Transport Nagar	Kapsi Budruk
Khairi Fata	Khairi		
Lok Vihar	Yerkheda		
Lekha Nagar	Yerkheda		
Contonment	Yerkheda		
Kamptee P. Station	Kamptee (Nazul)		
Kamptee M. Council	Kamptee (Nazul)		
Dragon Palace	Ajani,Gada		
Golf Club	Kamptee		
Kanhan River	Kamptee		

Source: *Census and Socio-Economic Survey, April - May 2023*

These villages are located both side of the proposed corridor of Nagpur city and are urban agglomeration type. Apart from having good road connectivity, amenities like drinking water, sanitation, electricity and means of communication are available within the villages/towns. Due to urban agglomeration people of all religion and caste are found in floating population. The

project will impact 98 households with 486 persons. These 486 includes owners of land (TH), and 47 (NTH) Kiosk / street vendors.

C. Socio-economic Profile of Affected Households and Families

Total 51 TH and 47 NTH (98 DHs) will be affected due to proposed Phase II project. Out of this, socio-economic survey has been undertaken in 88 DHs. In the remaining 10 DHs (THs) survey could not possible because of various reasons such as, some of them are not available and residing outside of Nagpur City. The list of affected Title Holders (TH) & Non-Title Holders (NTH) are presented in **Annexure-6** & **Annexure-7** respectively. The THs who are not available during the census survey, is highlighted in TH database of **Annexure-8.** Based on Socio economic survey of TH and NTH, total 486 persons (Family Members) have been impacted due to the Project. Corridor wise number of DHs and Total Household Members is presented in **Table 5.2**.

Out of 98 Affected/Displaced Households 52.04% are in category of TH and 47.96% are in NTH category. This NTH category includes kiosks and street vendors. These street vendors/kiosks are temporary structures without legal documents located within or closer to the RoW. Some of them are mobile vendors, where their locations are not fixed. Theses street vendors/kiosks are very small in structures hence NMRP will relocate them in close vicinity, or they can be shifted by themselves also. The shifting distance is not more than 100 mtrs either side of the station location. This shifting can be done within 1-2 hours only. Loss of income due to such circumstances are not arise neither anticipated. No employees & tenants were noticed during the survey. Kiosk owners cannot afford to hire staff as they are very small vendors. The detailed Reach wise and DHs / DPs data of TH, NTH are given in **Table 5.2.**

Table 5.2 Reach wise impact on TH & NTH

Sl. No.	Corridor	Title Holders		Non-Titleholders		Total	
		DHs	DPs	DHs	DPs	DHs	DPs
1	Mihan Butibori	26	100	13	52	39	152
2	Kamptee	11	70	08	51	19	121
3	Hingna	11	62	22	113	33	175
4	Kapasi	03	19	04	19	07	38
	Total	**51**	**251**	**47**	**235**	**98**	**486**

Source: Census and Socio-Economic Survey, April - May 2023

1. Number of Affected Persons

The sex ratio is a vital indicator to know the participatory share of male and female, which is also one of the important indicators for the human development index. Among the surveyed TH and NTH it is observed that about 247 (46.34%) are male and the remaining 286 (53.66%) are female. The details of total male and female in TH & NTH are presented in the **Table 5.3.**

Table 5.3: Total number of male and female in TH & NTH

Sl. No.	Categories	Title Holders (APs)	Non-title Holders (APs)	Total Number of APs	Percentage
1	Male	132	115	247	46.34
2	Female	166	120	286	53.66
	Total	**298**	**235**	**533**	**100**

Source: Census and Socio-Economic Survey, April - May 2023

2. Social Stratification of Affected Persons

The social stratification of DHs indicates that majority of the DHs belongs to Other Backward Caste (OBC) followed by general category. About 12.5% DHs belong to scheduled caste and 4.5% DHs are from scheduled tribe category. The detail of social categories of DHs is presented in the **Table 5.4**.

Table 5.4: Social Categories of the DHs

Sl. No	Social categories of DHs	Total	Percentage
1	Scheduled Caste	11	12.50
2	Scheduled Tribe	4	4.55
3	Other Backward Caste	47	53.40
4	Higher Caste	26	29.55
	Total	**88**	**100**

Source: Census and Socio-Economic Survey, April - May 2023

3. Religious Categories of the DHs

Most (81.82%) of the DHs belong to Hindu religion. This is followed by Muslim (12.50%), Sikh (2.27%) and Buddhist (2.27%) and Jain (1.14%) The religious categories of DHs are given below in **Table 5.5**.

Table 5.5: Religious Categories of the DHs

Sl. No	Religion of DHs	No. of DHs	Percentage
1	Hindu	72	81.82
2	Muslim	11	12.50
3	Sikh	2	2.27
4	Jain	1	1.14
5	Buddhist	2	2.27
	Total	**88**	**100**

Source: Census and Socio-Economic Survey, April - May 2023

4. Vulnerable Households of DHs

There are 57 DHs enumerated as vulnerable households in this project. As per the latest Planning Commission, Government of India estimate, a person having monthly per capita consumption expenditure (MPCE) below Rs. 1,126 in the urban area of Maharashtra is considered to be living below poverty line. Based on this calculation of poverty line figure, average annual household consumption expenditure in urban area of Maharashtra is estimated as Rs. 67,560. One DH from the TH category and one DH from NTH category earning less than the average MPCE are considered as vulnerable households in the project. Below **Table 5.7** describes the vulnerability category of DHs.

Table 5.6: Vulnerable category of DHs

Sl. No	Categories of Vulnerability	TH	NTH	Total DHs	Percentage
1	BPL	0	2	2	3.51
2	SC	4	7	11	19.30
3	ST	1	3	4	7.02
4	PwD	1	1	2	3.51
5	Women headed	3	3	6	10.53
6	Household below MPCE	1	1	2	3.51

7	NTH not falling under any other criteria	0	30	30	52.62
	Total	**10**	**47**	**57**	**100**

Source: Census and Socio-Economic Survey, April - May 2023

5. Number of DHs considered as Separate family as per LA Act

There are various categories of DPs summarized in **Table 5.7** who are treated as separate family under Right to Fair Compensation in Land Acquisition and Resettlement Act-2013**.**

Table 5.7: Number of DHs Separate family as per LA Act

Sl. No.	Categories of DHs	Total DHs	Percentage
1	Unmarried Son > 30 years	4	11.76
2	Unmarried Daughter/Sister > 30 years	2	5.88
3	Physically/Mentally Challenged Person	2	5.88
4	Divorcee/Widow	25	77.53
	Total	**34**	**100**

Source: Census and Socio-Economic Survey, April - May 2023

6. Educational Status of Displaced Persons

The educational status of DPs above 6 years shows that there are 6.56% DPs who are illiterate. About13.79% of DPs are completed Primary education, 27.79% have done Secondary education and 40.48% have completed graduation. The gender segregated details of educational status of DPs are presented in the **Table 5.8**.

Table 5.8: Educational Status of DHs

Sl. No	Educational status	Male	%	Female	%	Total	%
1	Illiterate	8	3.76	22	9.02	30	6.56
2	Primary	24	11.27	39	15.98	63	13.79
3	Secondary	64	30.05	63	25.82	127	27.79
4	Graduation	85	39.91	100	40.98	185	40.48
5	Technical	32	15.02	20	8.20	52	11.38
6	Vocational	0	0	0	0	0	0
	Total	**213**	**100**	**244**	**100**	**457**	**100**

Source: Census and Socio-Economic Survey, April - May 2023

7. Occupational Status of DHs

The occupational profile of DPs above 6 years shows that 27.35% DPs are engaged in small business activities, 9.41% are in service sector. The students are 27.35% and housewife is 29.32%. The details of occupational status of DPs are summarized in **Table 5.9**.

Table 5.9: Occupational Status of DHs

Sl. No	Occupational status	Male	%	Female	%	Total	%
1	Service	33	15.49	10	4.10	43	9.41
2	Small business	106	49.77	19	7.79	125	27.35
3	Agriculture	9	4.23	1	0.41	10	2.19
4	Labour	5	2.35	0	0	5	1.09
5	Unemployed	9	4.23	3	1.23	12	2.63
6	Housewife	0	0	134	54.92	134	29.32
7	Student	50	23.47	75	30.74	125	27.35

8	Professional	1	0.47	2	0.82	3	0.66
	Total	**213**	**100**	**244**	**100**	**457**	**100**

Source: Census and Socio-Economic Survey, April - May 2023

8. Annual Income level of DHs

The survey reveals that there are 2 DHs having the income below the average MPCE (Rs. 67,560). There are 4 DHs who are earning above Rs. 67,560 and below Rs. 1 lakh; 29 DHs are earning between Rs. 1 lakh to Rs. 2 lakhs; 19 DHs are earning between Rs. 2 lakhs to Rs. 5 lakhs. A maximum 34 DHs are earning more than Rs. 5 lakh per year. The average income level of DHs in the project area is summarized in **Table-5.10.**

Table 5.10: Annual Income Level of DHs

Sl. No.	Annual Income Categories in (Rs)	Total DHs	Percentage
1	Below 67560	2	2.27
2	Above 67560 and up to 100000	4	4.55
3	Above 100000 and up to 200000	29	32.95
4	Above 200000 and up to 500000	19	21.59
5	Above 500000	34	38.64
	Total	**88**	**100**

Source: Census and Socio-Economic Survey, April - May 2023

9. Family Assets

Survey data reveals the household assets of the project affected families. The mobile phone, television, refrigerator, cooking gas, motorbike and car are the common property assets found in most of the displaced households. The material base of consumable good among the DHs has a significant presence. It is observed that most of the DHs have owned these items in their households. Only owners of the kiosk are without vehicles although the owners of kiosk have mobile phones, television, cooking gas, etc. The DHs consider that their consumable material base, that they have in their households, as need of day and necessary to survive in cities like Nagpur.

10. Project Impact on Indigenous People

There are 4 DHs who belongs to ST category are affected under the project. Of the total, 3 ST HHs belong to the NTH category and 1 ST HH is from TH category. The 4 ST HHs found impacted under this project are scattered all along the project corridors and not confined to any distinct habitat. They are integrated well in mainstream population.

11. Project Impact on Women

The Phase II Project will bring several benefits to women and girls. Direct benefits include a decrease in travel time and access to reliable, convenient and safety transport services. Indirect benefits include faster access to services such as health, education, as well as other government services. During the construction phase, women will also benefit from the increased employment opportunities in technical and non-technical staff at contractor project site office. However, there could be negative impacts such as the spread of STIs (sexually transmitted infections), trafficking, and road safety issues etc. Considering the importance and priority of women safety, the NMRP

will make suitable plan and take action to mitigate women safety issues. The contractor will carry out HIV/AIDS awareness program among worker camps and nearby community.

12. Role of women in decision making

Women were asked about their role in decision making on various matters of the household. The women in most of the HHs (82 DHs) responded that they play a role in decision making on several matters of the household. **Table 5.11** presents the findings on role of women in decision making on various matters.

Table 5.11: Role of Women in Decision Making

Sl No	Response	Various matters					Number of DHs	%
		Day to day activities	Education of Child	Health care of child	Purchase of assets	Social functions		
1	Yes	82	82	82	82	82	82	93.18
2	No	6	6	6	6	6	6	6.82
	Total	**88**	**88**	**88**	**88**	**88**	**88**	**100**

Source: Census and Socio-Economic Survey, April - May 2023

D. Project Impact on Women

The Phase II Project will bring great benefits to women and girls. Direct benefits include a decrease in travel time and an increase in reliable, convenient and safety transport services. Other Indirect benefits include improved access to products and services, including social services such as health, education, as well as other government services. During the construction phase, women will also benefit from the increased employment opportunities in technical and non-technical staff at contractor project site office ensuring participation of women in workforce. However, there could be negative impacts such as the spread of STIs (sexually transmitted infections), trafficking, and road safety issues etc. Considering the importance and priority of women safety, the NMRP will take suitable plan and action to mitigate negative impacts, also take necessary steps to addressed women safety issues through community awareness raising sessions. As per the findings of consultation with women group, the perceived benefit from the projects includes:

- Improved access to social facilities like health, education
- Increase in income generating activities
- Frequent, safe and affordable transport
- Management of emergency situation
- Improved community relations
- Increased frequency of health workers, extension workers visits
- Improved access to market
- Increased Leisure time
- Reduced time spent on transportation of goods and services

E. Project Awareness

During the socio-economic survey, some questions were asked to the DHs regarding the awareness, source of information and opinion about the proposed phase II project. The findings of the survey with regards to awareness, source of information and opinion about the proposed project. Out of the total surveyed DHs, 84.27% respondents are aware of the proposed Phase II project and most of them (33.33%) got information from Newspaper followed by Television

(25.33), Govt. Officials (22.67%), Community Members (12%), and Metro Staff (6.67%). The respondents were asked to give their perception on the anticipated positive and negative impacts of the project. All the respondents were found positive with the view that due to this Phase II project the employment opportunities and income sources and opportunities will increased in catchment area of station and Nagpur City.

VI. STAKEHOLDERS CONSULTATION

A. Stakeholders in the Project

Consultations with various stakeholders were carried out during SIA of the project. The primary stakeholders are project Displaced Persons (DPs), project beneficiaries and implementing agency. The secondary stakeholders include the revenue officials, village heads, gram panchayat, NGOs, and business communities in the area.

B. Public Consultation in the Project

Public Consultations have been initiated from planning stage of the project and will continue during various stages till the completion of the Phase II project. Public consultations are important to ensure people's participation, identifying the local issues and needs and capturing the views and opinions of various stakeholders during various phases of the project. Various sections of DPs and other stakeholders were consulted through focus group discussions (FGDs) and individual interviews/discussion.

C. Methods of Public Consultation

FGDs and individual discussions were held with the primary and secondary stakeholders to get wider public input on Phase II project. The DPs, public transporter and commuters were consulted during the project preparation stage. The public consultations were held in all the four Reaches. Women members participated in the consultations to express their views and opinions especially with respect to safety and security. **Table 6.1** mentioned the methods used in consultation**.**

Table 6.1: Methods of Public Consultations

Stakeholders	Method of PC
Displaced Person	Census and socio-economic survey involving head of the household as respondent.
Local community	Through Focus Group Discussion (FGD) at proposed station locations.
Public Transporter	Through Focus Group Discussion (FGD) at proposed station locations.
Implementing Agency	Individual interview, discussion
Line Department Agencies	Individual meeting, discussion.

D. Scope of Consultation and Issues

The consultation meetings were held in a free environment and after giving prior intimation to the DPs and other participants. During the consultation process, efforts were made by the team to:

- Ascertain the views of the DPs with reference to NMRP Phase II alignment and minimization of impact;
- Understand the views of the community on land acquisition and relocation options;
- Identify and assess the major socio-economic characteristics of the DHs to enable effective planning and implementation;
- Obtain opinion of the community on impacts on community property resources and relocation options;

- Identify local people's needs and expectations from Phase II project;

E. Findings of Public Consultation

Total 13 public consultations (FGDs) have been held in which 162 male members and 34 women members participated. Below **Table 6.2** presents the number of public consultations conducted and number of male and female participants at various Reaches**.**

Table 6.2: Reach wise public consultations

Sr No	Particulars of Public Consultation	No. of Public Consultation				No. of Participants	
		REACH-1A	REACH-2A	REACH-3A	REACH-4A	M	F
1	General Public	1	3	2	1	88	18
2	Rickshaw drivers	0	2	0	1	37	0
3	Traders	1	1	0	0	25	7
4	Students	0	0	1	0	12	9
	Total	**2**	**6**	**3**	**2**	**162**	**34**

The main issues discussed by the participants in the public consultations and measures to address the same are summarized in **Table 6.3.** The detailed findings of each Public Consultation including the attendance sheet and photographs are presented in **Annexure-9.**

Table 6.3: Summary of Public Consultation

Sr. No	Location & Date	Participants	Discussion/suggestion by Participants	Measures to be taken by Maha-Metro
1	Dongargaon weekly market traders and Grampanchayat (REACH-1A) 28.04.2023	10	a) The weekly market traders were in favor of Phase II project, and they wanted to complete the project as early as possible. People demanded alternative place for relocation of weekly market. b) They also concerned about arrangement of safety precaution during civil activity as they are located near station.	a) The suggestions will be considered by concerned officer of NMRP for planning and implementation of the project. b) The necessary safety precaution will be taken during the civil work.
2	MIDC Colony (REACH-1A) 28.04.2023	11	a) All the kiosk holders were concerned about alternative locations. b) People wanted to start the work early and complete within the time so that there will be no	a) They will be relocated to nearby feasible location without affecting their livelihood. b) Suggestion noted

			traffic congestion during civil work.	
3	Pili Nadi, (REACH-2A) 11.04.2023	13	a) People were in favor of Phase II project, and they wanted project to be completed as early as possible. b) Some people were concerned about dust formation during civil work.	a) The Project will be completed as per the scheduled timeline. b) Necessary precaution will be taken by the NMRP to mitigate the environmental impact. Regular water sprinkling will be done during construction activities.
4	Khasara Fata, (REACH-2A) 11.04. 2023 (traders)	15	a) Proper care of safety of people should be considered during execution of civil work. b) Compensation for the loss of land should be paid more than market rate.	a) All types of safety measures will be adopted during the execution of the project. b) The compensation against loss of land will be decided by the Committee under the chairmanship of District Collector, Nagpur.
5	All India Radio, (REACH-2A) 12.04. 2023	10	a) The participants wanted to know the actual rate of compensation against acquisition of land. b) People wanted basic amenities like wider roads during the implementation of Project. c) Peoples are keen to know the date of commencement of work.	a) The compensation against loss of land will be decided by the Committee under the chairmanship of District Collector, Nagpur. b) During work execution it will be ensured that no traffic will be affected. Also, for this purpose coordination shall be done on day-to-day basis with traffic police. c) The civil work will start in the year 2024.
6	Khairi Fata, (REACH-2A) 12.04. 2023	15	a) Proper care of safety of people should be considered during execution of civil work.	a) All types of safety measures will be adopted during the execution of the project.
7	Lok Vihar, (REACH-2A) 12.04. 2023	12	a) Participants demanded for job during construction of metro stations. People wanted	a) The suggestion of the participants has been noted and every effort will be made to recruit

			wider roads during the implementation of Project.	local people during the construction phase of the project.
8	Lekha Nagar, (REACH-2A) 12.04.2023	13	a) Proper safety of people should be considered during execution of civil work. b) Compensation for the loss of land should be paid more than market rate. c) Some people asked about where to give complaint for Phase II project.	a) All types of safety measures will be adopted during the execution of the project. b) The compensation against loss of land will be decided by the Committee under the chairmanship of Collector, Nagpur. c) The Grievance Redress Committee (GRC) will be constituted by NMRC, and Grievance register will be kept at site location during civil work to record complaint.
9	Hingna bus stop (REACH-3A) 06.04. 2023	14	a) Proper safety of people should be considered during execution of civil work. b) compensation for the loss of land should be paid more than market rate.	a) All types of safety measures will be adopted during the execution of the project. b) The compensation against loss of land will be decided by the Committee under the chairmanship of District Collector, Nagpur.
10	Raipur, (REACH-3A) 06.04.2023	10	a) People are in favor of Phase II project, and they wanted to complete the project as early as possible. b) People wanted basic amenities like wider roads during the implementation of Project.	a) The Project will be completed as per the scheduled timeline. b) During execution of Work it will be ensured that no traffic will be affected. Also, for this purpose coordination shall be done on day-to-day basis with traffic police.
11	Pardi, (REACH-4A) 10.04.2023	15	a) People are in favor of Phase-II project, and they wanted to complete the project as early as possible. b) People wanted basic amenities like wider	a) The Project will be completed as per the scheduled timeline. b) During execution of Work it will be ensured that no traffic will be affected. Also, for this purpose coordination

			roads during the implementation of Project. c) Some of the kiosk holders (NTH) expressed concern about their relocation.	shall be done on day-to-day basis with traffic police. c) The kiosk holders will be relocated to nearby feasible location without affecting their livelihood.
12	Transport Nagar, (REACH-4A) 10.04.2023	12	a) There should be fair compensation against loss of land. b) Participants demanded for job during the construction of metro stations. c) The rickshaw drivers were concerned about loss of passenger due to running of proposed Phase II metro.	a) The compensation against loss of land will be decided by the Committee under the chairmanship of Collector, Nagpur. b) The suggestion of the participants has been noted and every effort will be made to recruit local people in the construction phase of the project. c) After commencement of Phase II metro at Transport Nagar metro station, passengers will increase and they opt rickshaws to Reach their destination.
13	Consultation with Student 08.05.2023	12	a) All the students are happy for proposed Phase II project as majority of them are travelling long distance by use of road transport to Reach the college. b) They suggested that the fare should be minimum.	b) Suggestion noted

F Consultation with Officials and Other Stakeholders

The other stakeholders in Phase II project such as officials of Implementing Agency (Maha-Metro), the concern District administration and revenue officials were also consulted on various issues. The details of consultation with officials is summarized in **Table 6.4**

Table 6.4: Consultation with EA Officials

Sr No	Name & Designation	Issue discussed

1	Shri. Atul Gadgil (Director Project)	Project details and optimization and modification of alignment for minimization of resettlement impact.
2	Shri. Anand Kumar (Executive Director/Planning & Land) and Shri. C Dekate (Sr.AGM/Plng)	Alignment finalization. The Project shall be implemented within the planned time frame. The safety during the construction activities will be priority of Maha Metro.
3	Shri. Ajay Ramteke (DGM/Land)	Discussed in detail about the process of private land acquisition through negotiation. Discussion on transfer of Govt. land, time required to accomplish the Land Acquisition process
4	Shri. Pratish Nitey (AGM/Environment)	Discussed in detail the possible impacts that could be arises due to the proposed project. Discussed impact on environment, safety provision during the construction activities.
5	Shri. G D Nishankar (Consultant/Land Dept.)	Discussed and visited along the alignment for affected land. Discussed about CPR and relocation options
6	Shri. Vishal Hazare (Jr. Executive Survey)	Verify on ground about the actual land acquisition and land plan. Modification of alignment to minimize the Land acquisition and impact.
7	Shri. Piyush Chivande (Dy. Collector/Land)	Discussed in detail about the process and procedure of acquisition of Private and Government Land.
8	Smt. Kalpana S. Koram Sarpanch/Grampanchayat, Dongargaon	Discussed about the shifting of weekly market. Women safety during the construction activities

Figure 6.1: Photographs of Consultation with Stakeholder

G Outcome of Public Consultation:

Most participants are happy to hear about the proposed NMRP Phase II project. They said that Phase II will cater majority of the sub-urban population of the city and connects to the heart of the Nagpur city in very less time. They are interested to know about the compensation package against their loss of land. The team replied that it will be decided by the concerned District level Committee under the chairmanship of Collector, Nagpur and Implementing agency and will provide the best compensation package for the loss of land. They have also requested to

complete the work within the timeline so that the benefit of the metro network will be start at earliest. They are also concerned about the safety component to be implemented during the civil construction phase. Furthermore, they are very happy with provision of women safety measures adopted in existing NMRP Phase-I and requested same needs to be followed in NMRP Phase-II. Overall, the public consultations were found very fruitful and positive.

VII. SOCIAL IMPACT MANAGEMENT PLAN

A. Background

Social Impact Assessment of the Phase-II project is an important component of project preparation. The Right to Fair Compensation and Transparency in Land Acquisition and Rehabilitation and Resettlement Act, 2013 require social impact assessment during the design stage to avoid, reduce and mitigate potential negative impacts of project action and enhance positive impacts, sustainability and development benefits.

Assessment results are based on the technical design prepared by DPR consultant. The main objective of the study is to ensure that the project addresses the adverse impacts on the livelihood of the people, if any and that nobody is left worse off after implementing SIMP and those affected have access to project benefits, both during project construction as well as operation. In specific, the objectives of the study are:

- To carry out a socio-economic, cultural and political/institutional analysis to identify the project stakeholders and social Issues associated with the project;
- A detailed assessment of the socio-economic conditions of the people who may be negatively affected,
- To assess the extent of asset loss and undertake the census of potential project affected people;
- To develop a Social Impact Management Plan (SIMP) in consultation with the affected people and project authorities – A detailed plan to mitigate these Impacts and an assessment of the costs of such measures.

The study followed both quantitative and qualitative approach for data collection. Social impact assessment and resettlement planning component has three main elements:

- Screening/reconnaissance survey as part of inception report;
- Social Impact Assessment; Census and baseline socio-economic survey of potentially affected population, and;
- Preparation of the Social Impact Management Plan

Social screening was undertaken in conjunction with project inception report and following the all four Reach alignment map prepared by DPR Consultant.

A census of affected households has been undertaken according to the design and affected plot numbers TH and NTH provided by NMRP to register and document the status of the potentially affected population within the project impact area, their assets, and sources of livelihood. The primary notification for SIA provides the basis for establishing a cut-off date (3rd April 2023) for non-title holders in order to determine who may be entitled to assistance or other benefits from the project.

Socio-economic survey was also carried out on census basis. This survey provides a baseline against which mitigation measures and support will be measured and includes comprehensive examination of people's assets, incomes, important cultural or religious networks or sites, and other sources of support such as common property resources.

Analyses of survey results cover the needs and resources of different groups and individuals, including intra-household and gender analysis.

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 DHs and its integration in the Social Impact Management Plan.

For local level consultations (Primary Stakeholders), the DPs were invited at project site level. It was ensured that information regarding consultations is disseminated in the concerned DPs at least one day prior to consultations. The participants included community representatives, displaced persons. The targeted segments included men and women affected by loss of land and kiosks. .

B. Mitigation Measures Adopted for the Project

In keeping with the layout design of proposed section of Phase-II project prepared by the DPR Consultant, the census survey was undertaken April - May 2023. 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
- Loss of temporary structures (Kiosk/street vendors)
- Loss of private fruit bearing and timber trees

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 Negotiation under Maharashtra Government Resolution No. LQN-01/2017/CN 12/A-2 dated 25th January 2017 and Misc.-03/2015/CN 34/A-2 dated 12th May 2015 & 30th September 2015.

C. Valuation of Assets

The valuation of affected land and structures will be governed by the following process:

- Land surveys for determining the payment of compensation would be conducted on the basis of updated official records and ground facts. The land records containing information like legal title, and classification of land will be updated expeditiously for ensuring adequate cost compensation. Records as they are on the cut-off date will be taken into consideration while determining the current use of land. The economically unviable residual land remaining after the land acquisition will be acquired as per the provisions of RFCT in LARR Act, 2013 or through direct purchase negotiation rules of Maharashtra Govt. Rules.

- The methodology for verifying the cost for each type of loss will calculate as per the provision made in the RFCT in LARR Act, 2013 or through direct purchase negotiation rules of Maharashtra Govt. Rules.

1. Valuation of Land

Initially the Direct Purchase Method under Government of Maharashtra Resolution No: Misc.-03/2015/C.N.34/A-2 on 12th May 2015 and 30th September 2015 will be adopted for acquisition of private land affected by NMRP Phase II. For any reason if any one of the affected persons do not agree with this regulation, then land acquisition will be done as per RFCTLAAR, Act – 2013.

2. Valuation of Trees

Compensation of trees will be based on their full replacement cost. The District Collector or concern forest department of similar authority or agriculture department or horticulture department is the authority for the purpose of determining the market value of trees and plants attached to the land acquired.

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D Key Impact Area

Table 7.1: Indicative List of Social Impacts

1	**Impacts on land, livelihoods and income**	• Level and type of employment • Intra-household employment patterns • Income levels • Standard of living Access and control over productive resources • Economic dependency or vulnerability • Disruption of local economy • Impoverishment risks • Women's access to livelihood alternatives
2	**Impacts on physical / natural resources**	• Impacts on natural resources, soil, air, water, forests • Pressures on land and common property resources
3	**Impacts on private assets, public services and utilities**	• Capacity of existing health and education facilities • Capacity of housing facilities • Pressure on supply of local services • Adequacy of electrical and water supply, roads, sanitation and waste management system • Impact on private assets like bore wells & temporary sheds
4	**Health / safety impacts**	• Health impacts due to in-migration of labor and worker. • Health and safety impact on local community and worker. • Health impacts due to project activities with a special emphasis on women's health & Impact on the elderly
5	**Impacts on culture and social cohesion**	• Transformation of local political structures • Demographic changes • Shifts in the economy • Ecology balance • Impacts on the norms, beliefs, values and cultural life • Crime and illicit activities • Stress of dislocation • Impact of separation of family cohesion • Violence against women

E Impacts at different stages of the project cycle

The type, timing, duration, and intensity of social impacts will depend on and relate closely to the stages of the project cycle. Below is an indicative list of impacts:

Table 7.2: Impacts at different stages of Project Cycle

1	**Pre-construction Phase**	• Interruption in the delivery of services • Drop in Productive investment • Land speculation • Stress of uncertainty
2	**Construction Phase**	• Displacement and relocation of NTH • Influx of migrant construction workforce • Health impacts on those who continue to live close to the construction site • Traffic diversions and risk to existing structures • Temporary land requirement[2] • Dust generation • Noice generation
3	**Operation phase**	• Reduction in employment opportunities compared to the construction phase • Impact on Elderly and PwD • Economic benefits of the Project • Benefits on new infrastructure - New patterns of social organisation.
4	**De-commissioning Phase**	• Loss of economic opportunity • Environmental degradation and its impact on livelihoods
5	**Others**	**Direct and indirect impacts** • Direct impacts" will include all impacts that are likely to be experienced by the DPs • Indirect impacts" will include all impacts that may be experienced by those not directly affected by the acquisition of t*a (i.e. TH and NTH), but those living in the project area as general public.
		Differential Impacts • Impact on women, children, the elderly and the PwD • Impacts identified through tools such as Gender Impact Assessment Checklists, and Vulnerability and Resilience Mapping
		Cumulative impacts • Measureable and potential impacts of other projects in the area along with the identified impacts for the Project in question' • Impact on those not directly in the project area but based locally or even regionally.

[2] Temporary land will be required for the workers camps & parking area near sites, etc. Contractors will make leasing transactions with private owners in order to minimize permanent land acquisition. It is part of the contract document.

F Social Impacts during Construction & Operation and its Management Plan

1 Social Impacts during Construction Phase

Major part of the alignment runs along the central verge of the roads. 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. The likely social impacts during construction phase have been discussed in the following sections.

1.1 Traffic Diversions and Risk to Existing Buildings

During construction period, complete/partial traffic diversions on road will be required, as most of the construction activities are on the central verge of road. Barricades would be installed for the safety of public by segregating the working area and the area accessible by public. Traffic would get affected on the roads. Most of the roads in Nagpur city are two lanes either side hence one lane would be available for smooth flow of traffic. Advance traffic updates/information on communication systems will be an advantage to users of affected roads. The metro rail corridor does not pose any serious risk to existing buildings since there is safe distance between buildings and proposed corridor. Special care has to be taken for safety of the structures during construction.

1.2 Dust Generation

Transportation of earth and construction material will involve use of significant number of trucks and dumpers. Heavy machinery like compactors, rollers, water tankers, and dumpers etc. will be used for the construction activities. This activity is machinery intensive resulting in dust generation. However, this activity will be only short-term. Protective measures shall be undertaken during construction phase. Movement of trucks and other heavy equipment's and machinery would generate dust at construction site during construction period.

1.3 Noise Generation

Noise would be generated during construction due to use of heavy machinery for construction specially piling operations. The major sources of noise pollution during construction are movement of vehicles for transportation of construction material to the construction site and the noise generating activity at the construction site itself. The Metro construction is equipment intensive. Thus, the populace in the vicinity of the metro alignment would face the less problem of noise generated during construction.

1.4 Employment Opportunities

The project is likely to be completed in a period of about 4 years. During this period manpower will be needed to take part in various activities. About 1000 persons are likely to work during peak construction activity for one Reach. Thus, the project would provide substantial direct employment. Besides, more people would be indirectly employed in allied activities and trades. It involves significant movement of materials for construction generating direct employment opportunities. Such a large project would also lead to significant secondary and tertiary employment generation in the material supply industries, transport sector and others.

1.5 Loss of Trees: The construction of NMRP Phase-II will likely to be cut 74 numbers of trees on private land. Maha-Metro will make an utmost effort to save the trees by pruning or other feasible adjustment. The compensation for these is given in the R&R budget.

2. Social Impacts during Operations

During operation of the proposed Nagpur Metro project there would be significant positive impacts.

2.1 Impacts on Elderly and Disabled People

There could be severe impacts on elderly and people with disability if proper attention is not given and appropriate mitigating measures are not taken up while developing the metro rail system in Nagpur. The elderly people with disabled and otherwise vulnerable people were contacted and interacted to take their views and reactions to the metro project coming up in Nagpur city. They raised their concern about the facilities which may be specific for elderly and people with different type of disabilities. They were explained about the provisions about elderly and disabled people in the project design and the measures to be adopted by NMRCL during operations.

Adequate support staff will be placed as part of operations of the metro to support the elderly, women and disabled people. Following provisions have been made for Elderly and people with disability. The mitigating measures for disabled and elderly people have been discussed in social management plan.

2.2 Employment Opportunities

In operation phase of the project about 30 persons per kilo meter length of the corridor will be employed for operation and maintenance of the proposed system in shifts. Thus, the project would provide substantial direct employment. Besides, more people would be indirectly employed in allied activities and trades.

2.3 Enhancement of Economy

The proposed transport facility of Nagpur Metro project will facilitate sub-urban population to move quickly. With the development of this project, it is likely that more people will be involved in trade, commerce and allied services. NMRP will, however, make it convenient for more people to move in the present suburban areas. This will reduce population pressure on transport facilities in the urban area.

2.4 Mobility Safety and Reduced Accidents

The metro network increases the mobility of people at faster rate. The proposed corridor will provide more people connectivity to other parts of the city. Metro journey is safe and result in reduced accidents on roads.

2.5 Traffic Congestion Reduction

To meet the forecast transport demand in the year 2031, it is estimated that the number of buses and private vehicles like cars and two wheelers would increase significantly. The proposed development will reduce journey time and hence congestion and delay.

2.6 Reduced Noise Pollution

It is estimated that introduction of metro system in Nagpur would substitute a mix of vehicles from the roads. Since the vehicular movement and more particularly engine operation, use of horns, honking etc. leads to heavy noise along the corridor. The noise level is proportional to the number of vehicles. Noise level is already significantly higher along the corridor. Practically, the demand for vehicles on Nagpur roads will increase significantly in future due to increased population and developmental activities. The substitution of vehicles from roads will reduce the noise significantly.

2.7 Reduced Fuel Consumption and Air Pollution

On implementation of the project, it is estimated that both petrol and diesel consumption will get reduced. The saving will be due to two factors namely Reduction in vehicles and decongestion on roads. The reduced number of vehicles on road will further reduce the emissions from vehicular traffic thereby resulting in significant improvement in air quality of Nagpur city along the Metro corridors. Thus, the Nagpur metro will have positive social impacts during operations.

3 Social Management Plan

The social management plan is meant to minimize the adverse impacts and maximize the positive impacts of the Nagpur Metro Project. It has been proposed to purchase the land from the land owners through Direct Purchase method as per the Government Resolution of Maharashtra Government dated 12th May 2015 wherein the property owner is being paid 250% of market value of the land to be acquired. 51 TH land would be purchased directly through consent as per Maharashtra Government Resolution by paying 250% of market value. There would be no stamp duty or any other transaction charge. Stamp duty, if any applicable, would be borne by the Implementing organization.

Community structures will be shifted in consultation with local authority & people. NMRP will relocate the CRP as a part of rehabilitation plan.

3.1 Labour Camp:

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

NMRP through the GC shall time to time be monitoring whether the contractor is providing proper facilities at Labour camps and if found not being done properly would be penalised.

Influx of non-local labours will create a social issue, to avoid or minimize the impact following measures shall be adopted.

- Mixing of skilled non-local labours with local unskilled people will reduce social frictions.
- To avoid labor influx risk, sensitizing of local community and the non-local workers separately as well as jointly shall be done regularly.

3.2 Sanitation Facilities:

Construction sites and camps shall be provided sanitary latrines and urinals. Sewerage drains shall be provided for the flow of used water outside the camp. Drains and ditches should be treated with bleaching powder on a regular basis. The sewage system for the camp must be properly designed, built and operated so that no health hazard occurs and no pollution to the air, ground or adjacent watercourses takes place. Garbage bins must be provided in the camp and regularly emptied and the garbage disposed-off in a hygienic manner. NMRP through the GC shall time to time be monitoring whether the contractor is providing proper sanitation facilities and if found not being done properly would be penalised.

3.3 Shelter at Workplace:

At every workplace, shelter shall be provided free of cost, separately for use of men and women labourers. Sheds shall be maintained in proper hygienic conditions. NMRCL through the GC shall time to time be monitoring whether the contractor is providing proper shelter facilities and if found not being done properly would be penalised.

3.4 First aid facilities:

At every workplace, a readily available first-aid unit including an adequate supply of sterilized dressing materials and appliances shall be provided. Suitable transport shall be provided to facilitate taking injured and ill persons to the nearest hospital. NMRP through the GC shall time to time be monitoring whether the contractor is providing proper first aid facilities and if found not being done properly would be penalised.

3.5 Housekeeping

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. Contractor shall understand and accept that improper housekeeping is the primary hazard in any construction site and ensure that a high degree of environmental sanitation is always maintained. Environmental sanitation is the responsibility of all site personnel, and line management commitment shall be demonstrated by the continued efforts of supervising staff towards this activity. NMRP through the GC shall time to time be monitoring whether the contractor is providing house-keeping and if found not being done properly would be penalised. General housekeeping shall be carried out by the contractor and at all times at Work Site, Construction Depot, Batching Plant, Labour Camp, Stores, Offices and toilets/urinals. The contractor shall employ a special group of housekeeping personnel to carry out following activities:

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.

The structure dimension of the barricade, material and composition, its colour scheme, NMRP logo and other details.

- 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.
- All surplus earth and debris are removed/disposed-off from the working areas to designated dumpsites. Trucks carrying sand, earth and any pulverized materials etc. in order to avoid dust or odour impact shall be covered while moving.
- No parking of trucks/trolleys, cranes and trailers etc. shall be allowed on roads, which may obstruct the traffic movement.
- Roads shall be kept clear and 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.
- Water logging or spillage on roads shall not be allowed.
- 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.
- Flammable chemicals / compressed gas cylinders shall be safely stored.
- Unused/surplus cables, steel items and steel scrap lying scattered at different places within the working areas shall be removed to identified locations.
- All wooden scrap, empty wooden cable drums and other combustible packing materials, shall be removed from work place to identified location(s).
- Empty cement bags and other packaging material shall be properly stacked and removed.

3.6 Traffic Diversion/ Management

During construction, traffic is likely to be affected. Hence Traffic Diversion Plans are required in order to look for options and remedial measures so as to mitigate any traffic congestion situations arising out due to acquisition of road space during Metro construction of the corridor. Any reduction of road space during Metro construction results in constrained traffic flow. In order to retain satisfactory levels of traffic flow during the construction period, traffic management and engineering measures need to be taken. They can be road widening exercises, traffic segregation, one-way movements, traffic diversions on influence area roads etc. Maintenance of diverted roads in good working condition to avoid slow down and congestion shall be a prerequisite during construction period. Only temporary diversion plans will be required during construction of the proposed Metro corridor. Keeping in view the future traffic growth and reduction of carriageway due to Metro construction, implementation of traffic management/diversion plans shall become inevitable for ensuring smooth traffic movement and similar traffic diversion plans shall be formulated and followed during the execution stage.

3.7 Traffic Management Guidelines:

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

- All construction workers shall be provided with high visibility jackets with reflective tapes to protect from speeding vehicular traffic as most of viaduct and station works are on the right-of-way.
- Warn the road user clearly and sufficiently in advance.
- Provide safe and clearly marked lanes for guiding road users. Provide safe and clearly marked buffer and work zones.
- Provide adequate measures that control driver behaviour through construction zones.
- The primary traffic control devices used in work zones shall include signs, delineators, barricades, cones, pylons, pavement markings and flashing lights.
- NMRCL through the GC shall be monitoring always whether the contractor is managing traffic plans properly. NMRP along with the GC would also be regularly coordination with the traffic police and via apps and constant advertisements in local media updating citizens of Nagpur regarding work plans work flows areas affected and regarding slow movement of traffic if any. In case of need NMRP shall also seek additional support from the local police authorities to deploy additional man-power to avoid major traffic jams at work place. NMRCL is also open to deploying additional work force if required for proper traffic manning and implementing the entire traffic diversion plan in a systematic and proper manner.

3.8 Water Supply, Sanitation and Solid Waste Management

During Construction

The public health facilities, such as water supply, sanitation and toilets are much needed at the labour camps. Water shall be treated before use up to national drinking water standards. The collection and safe disposal of human wastes are among the most important problems of environmental health. The water carried sewerage solves the excreta disposal problems. The sewerage disposal systems shall be adopted for sewage disposal. The water for domestic consumption shall be sourced from public water supply. Solid waste shall be stacked at designated place and when sufficient quantity accumulates it shall be disposed-off through covered trucks to land fill site designated and authorized by NMRP/NIT.

During Operations

Practically, public facilities at stations have to be operated by regular staff. The sewage will be treated with eco-friendly Bio-digestors at all stations. Regular Public interaction will be maintained by NMRP during construction as well as operations of the Nagpur Metro Rail Project.

Internal Monitoring of project implementation will be undertaken by NMRP for proper implementation of project and policies. NMRP through the GC shall time to time be monitoring whether the contractor is supervising things and implementing the plans properly and if found not being done properly would be penalised.

3.9 Provisions for Elderly and people with Disability

An effort has been made to create a user-friendly mass transport system which can ensure accessibility to persons with disabilities, people travelling with small children or are carrying luggage, as well as people with temporary mobility problems (e.g. a leg in plaster) and the elderly persons. The design standards for universal access to Public Transport Infrastructure including related facilities and services, information, etc. would benefit people using public transport.

- Stations for all rail travel shall be fully accessible with extra wide turnstiles where possible alongside wheelchair accessible doorways
- All new railway stations shall be designed to be fully accessible.
- For persons with hearing impairments, an electronic sign board (digital display) should be displayed on each platform at conspicuous location for all announcements made by the railways.
- The gap between the car doors and the platform shall preferably as per design;
- Identification signage shall be provided on the doors of wheelchair accessible coach;
- If the car door and the platform cannot be at the same level, then at least one car doors shall have apparatus such as a hydraulic lift or pull-out ramp installed in the doorway for wheelchair users.
- Space for a wheel chair shall 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.
- An appropriate number of designated seats for passengers with disabilities and elderly people should be provided near the doors.
- Approach route shall not have level differences. If the station is not on the same level as the walkway or pathway, it should a ramp.
- Walkway surfaces should be non-slippery.
- Approach walkway shall have tactile pavements for persons with visual impairments.
- There shall be at least one low counter for visually impaired persons.

3.9 The Platforms should:

- Have non-slip and level flooring;
- Have seating areas for people with ambulatory / orthopaedic disabilities;
- There shall be no gap or difference in level between the train entry door and the platform.
- All platforms shall be inter-connect by means of an accessible routes or lifts.
- Provide accessible level entrance to the train coach.
- Colour can be used to identify routes and provide assistance in locating doors, walls and hazards.
- In addition to identifying hazards or warnings, tactile floor surfaces can also be used to inform that there is a change in area (e.g. leaving a corridor and entering a boarding area).
- Tactile systems should be consistent throughout the building.
- Good lighting assists those with a visual disability to see better and allows people who have a hearing impairment to lip read easier. However, care should be taken to properly direct lighting and to use matte finishes on floors, walls and signage.

- Blinds can be used to adjust lighting levels in areas where the natural lighting changes significantly throughout the day.
- Lifts shall have Braille buttons and audio announcement system for persons with vision impairments.
- Information or help desks shall be close to the terminal entrance, and highly visible upon entering the terminal
- Staff manning the counters shall know sign language.

The social Management Plan for Design, Construction and Operation phase is given in **Table 7.3.**

Table 7.3- Social Management Plan – Design, Construction & Operation Phase

Sl	Project-related E&S issues	Action to be taken	Frequency	Implementation Agency/ Authority	Supervision Agency	Remarks
Design Phase						
1	**Acquisition of Land from Land and structure owners**	Land and structures to be acquired by direct purchase method by paying 250% of Market value as per Maharashtra State Govt. GR.	Once	Revenue Department of State Govt.	NMRP	As given in DPR
2	**Elders and peoples with disability**	It shall be ensured that train contains fully accessible carriages. Staff shall be trained in methods of assistance and be at hand on request. Stations for all levels should be fully accessible with wide entrances and shall be accessible by wheelchair 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 The gap between the car doors and the platform shall be less than 12 mm Identification signage shall be provided on the	Once	Contractor	GC/ NMRP	Part of DPR

Sl	Project-related E&S issues	Action to be taken	Frequency	Implementation Agency/ Authority	Supervision Agency	Remarks
		doors of wheelchair accessible coach 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 An appropriate number of designated seats for passengers with disabilities and elderly people shall be provided near the doors. 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. 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. 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. There shall be at least one unisex accessible toilet At least one of the ticket gates shall be for disable person (low level counter) to allow a				

Sl	Project-related E&S issues	Action to be taken	Frequency	Implementation Agency/ Authority	Supervision Agency	Remarks
		wheelchair user through and have a continuous line of guiding paver for people with visual impairments The Platforms shall: Have seating areas for people with ambulatory disabilities All platforms shall inter-connect by means of an accessible routes or lifts and way finding references shall be available at decision points. Color shall be used to identify routes and provide assistance in locating doors, walls and hazards. Structural elements such as columns shall be color contrasted or brightly marked to assist visually impaired.				
		Construction Phase				
1	**Labor Camps Providing safe habitation to workers.**	Providing safe habitation to workers. Contractor shall make sufficient arrangements as given in ***SHE Volume 8 Clause 51.4*** for drinking water facilities for construction workers Worker camps and canteen facilities shall be protected from airborne and soil born insects and pests by taking suitable measures as described in ***SHE Volume 8 Clause 56. & Clause 57.0*** and its subsections	Continuous throughout construction	Project Manager/PME Head/SHE Personnel	GC and NMRP	
2	**Sanitation, Sewerage and waste disposal in worker's camp.**	In compliance to ***Clause 40.5 of SHE Volume 8***, for disposal of sanitary waste generated at worker camps at batching plant, casting	Continuous throughout construction	Project Manager/PME Head/SHE Personnel	GC and NMRP	

Sl	Project-related E&S issues	Action to be taken	Frequency	Implementation Agency/ Authority	Supervision Agency	Remarks
	Providing hygienic conditions in Labor camps and adequate Housekeeping in Labor camps	yards, sanitary facilities developed by Defense Research Development Organization (DRDO), with bio-digester technology shall be adopted. Mobile sanitary facilities shall be deployed at construction sites for workers Authorized agencies shall be deployed for disposal of sewage and other solid waste generated at worker camps and construction sites				
3	**General Housekeeping**	Contractor shall provide sufficient resources (personnel and equipment) for general housekeeping at sites, utilities, and labor camps. Barricades 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 All stairways, passageways and walkways shall be maintained without any blockages or obstructions. All emergency exits passageways, exits fire	Continuous throughout construction	Project Manager/PME Head/SHE Personnel	GC and NMRP	

Sl	Project-related E&S issues	Action to be taken	Frequency	Implementation Agency/ Authority	Supervision Agency	Remarks
		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 Water logging or spillage on roads shall not be allowed Proper and safe stacking of material at sites shall be ensured				
4	**Wastage of water. To ensure that best practices are adopted during construction phase to optimize water consumption**	Contractor shall try and reduce the water consumption through use of water efficient sanitary fixtures at sites and project offices Leakage of water shall not be allowed through pipes and valves Reuse of water for dust suppression and plantation shall be planned	Continuous throughout construction	Project Manager/PME Head/SHE Personnel	GC and NMRP	
5	**Traffic management Avoid and minimize inconvenience to public due to congestion and traffic jams during construction**	Location specific Traffic management plan shall be prepared to handle traffic flow particularly during peak hours. Co-ordination with traffic control shall be done for securing assistance from local police Traffic marshals shall be available at construction sites/ barricade openings to manage and assist traffic and movement of site vehicles Safety measures shall be undertaken by installing road signs and markings for safe and smooth movement of traffic. Communication shall be done with public through radio, TV & newspaper	Continuous throughout construction	Project Manager/PME Head/SHE Personnel	GC and NMRP	

Sl	Project-related E&S issues	Action to be taken	Frequency	Implementation Agency/ Authority	Supervision Agency	Remarks
		announcements regarding the construction activities causing disruptions or access restrictions in advance to minimize public inconvenience and smooth construction activities.				
6	**Occupation Health & Safety and Safety with vehicles, people and livestock and signage**	Workers shall be equipped with proper safety gears like helmets, gloves and gum boots. Periodic health checkup shall be conducted for construction workers Contractor shall take adequate precautions as per ***part I clauses 4,*** and its subsections of SHE Manual	Continuous throughout construction	Project Manager/PME Head/SHE Personnel	GC and NMRP	
7	**Gender Action Plan**	Safe lighting at work place and worker's colony along with separate access to female/male toilets and waiting areas shall be ensured; First aid medical facilities at the working sites for pregnant women, elderly women and children shall be ensured; Adherence to provision of labor law shall be ensured for civil contracts Information shall be disseminated on potential negative impacts of construction activities through awareness building programs Secluded sanitary facilities shall be provided for women workers working onsite	Continuous throughout construction	Project Manager/PME Head/SHE Personnel	GC and NMRP	
Operation Stage						

Sl	Project-related E&S issues	Action to be taken	Frequency	Implementation Agency/ Authority	Supervision Agency	Remarks
1	**Sanitation and Housekeeping at Stations**	Public facilities shall be provided at Stations and shall be maintained through enough number of regular/contractual housekeeping Municipal solid wastes generated at stations shall be collected in color coded bins with suitable sizes for dry wastes (recyclable) and bio-degradable wastes and disposed/handled accordingly. Bio-digesters shall be provided for onsite treatment of sewage and grey water generated at stations, depots and other related utilities. As far as possible 'Zero Discharge Rule' shall be adopted.	Continuous during Operations	Station Manager	NMRP	
2	**Gender Action Plan**	It will be ensured that women, children and elderly people accessible facilities shall be provided at stations. Separate seating for women and, priority seating for pregnant women and elderly citizens will be provided in the coaches. Emergency intercom and video surveillance shall be part of metro operating system Separate toilets for men and women at stations shall be provided; Patrolling of platforms after sunset hours by security personnel shall be ensured	Continuous during Operations	Station Manager	NMRP	

Sl	Project-related E&S issues	Action to be taken	Frequency	Implementation Agency/ Authority	Supervision Agency	Remarks
		Ladies security personnel to be deployed for frisking women passengers; Proactively encourage and promote women's employment in the metro services sector Secluded sanitary facilities shall be provided for women workers working onsite				
3	**Elders and peoples with disability**	Staff shall be trained in methods of assistance and shall be available at hand on request Good illumination shall be ensured at stations to ensure the comfort of visually impaired Braille buttons and audio announcement system shall be ensured for persons with vision impairments. It will be ensured that station operations shall be easy to understand and operate for persons with learning disabilities, intellectual disabilities, and elderly persons. Information or help desks shall be close to the station entrance, and highly visible upon entering the station. In addition, they should be clearly identifiable and accessible to wheelchairs bound and normal users Help desks shall have a	Continuous during Operations	Station Manager	NMRP	

Sl	Project-related E&S issues	Action to be taken	Frequency	Implementation Agency/ Authority	Supervision Agency	Remarks
		map of the facility and attendants can view with passengers, when providing information Staff manning the counters shall know sign language Lighting shall be positioned to illuminate the receptionist/person manning the counter and the desk top without creating glare				

VIII. Entitlements, Assistance and Benefits

A Introduction

This NMRP – Phase II project will have two type of Displaced Persons one is person with formal legal title holder (TH) and person who does not have formal legal rights i.e., non-Title holders (NTH). There are no residential and commercial structures of legal titleholders (TH) identified during the survey. The NTH are the kiosk holders with no permanent structure and exists within the RoW land. These are the street vendors kiosk with no formal legal title found during the base line socio economic survey. The 3 CPR have been identified during baseline socio economic survey. There are no residential or commercial structures in the required land parcel as almost all titleholders have taken the land for investment purpose. The land will be acquired from the legal titleholders (TH) only. The Resettlement Plan describes provisions of all Displaced Persons including TH, NTH and CPR.

(i) Loss of land, and trees as per provision.
(ii) Assistance in lieu of the loss of business / wage income and income assistance.
(iii) Assistance for shifting and provisions for the relocation.
(iv) Rebuilding and / or restoration of community resources / facilities

B Cut – off Date for Entitlement:

For titleholders in case of land acquisition under direct purchase through negotiation, the cut-off date shall be date of individual notification of land acquisition by the committee headed by Land Acquisition Officer. For non-titleholders, the cut-off date will be the start date of the census survey which is 3rd April 2023. DPs who settle in the affected areas after the cut-off date will not be eligible for compensation. They, however, will be given sufficient advance notice, requested to vacate premises and dismantle affected structures prior to project implementation. Their dismantled structures /materials will not be confiscated, and they will not pay any fine or suffer any sanction.

C Entitlements Matrix

An Entitlement Matrix has been developed, that summarized the types of losses and the corresponding nature and scope of entitlements and in compliance with Government of Maharashtra GR No Misc.-03/2015/C.N.34/A-2 dated 12 May 2015 and 30 September 2015 on Direct Purchase through Negotiation method, RFTCLAAR, Act – 2013 and ADB SPS, 2009. All compensation and assistance will be paid prior to any physical or economic displacement. **Table 8.1** presents the Entitlement Matrix for NMRP Phase II project. The Social Impacts for this project are concern with Sr.no.1, 7, 8,9 & 10 as mentioned in the Table 8.1. The R & R Budget for the above-mentioned categories are presented in Table No. 12.1.

Table 8.1: Entitlement Matrix

Sr. No.	Categories	Entitlements	Responsible Agency
1	Loss of land only[3]	Land will be acquired on payment of compensation as per RFCTLARR Act 2013. Or, Compensation as per Govt of Maharashtra's GR No: Misc.-03/2015/C.N.34/A-2 (May 12, 2015, and September 30, 2015).	District Collector and NMRP
2 a	Loss of land and residential structure for owner only.	a) Land will be acquired on payment of compensation as per RFCTLARR Act 2013. b) One-time subsistence allowance of Rs.36,000/- per affected family who require to relocate due to project. + SC/CT will get Rs. 50,000 in addition. c) One-time Resettlement Allowance of Rs.50,000/- for affected family. d) Transportation- Physical assistance or a maximum of Rs.50,000/- per affected family will be provided based on following criteria of relocation site: (i) 1km-5km – Rs. 10,000/- (ii) 5km-10 km – Rs. 20,000/- (iii) 10km-15km – Rs. 30,000/- (iv) 15 km and above– Rs 50,000/- e) The owner is entitled to a 50 sq mtr house at outskirts of the city or alternatively in the vicinity of their area, the following will be offered: 1) 50 sq ft-100 sq ft = 150 sq ft 2) 101 sq ft-200 sq ft = 300 sq ft 3) 201 sq ft-400 sq ft = 450 sq ft 4) 401 sq ft-550 sq ft= 550 sq ft 5) 551 sq ft and above= existing carpet area Or, The cash in lieu of house will be Rs.5,50,000/- f) Right to salvage affected materials. Note: Stamp duty and registration charges will be born in case of new houses or sites Or,	District Collector, PWD dept., and NMRP

[3] The residual part of land if found useless or inaccessible by the owner or if the owner desired so, shall also be acquired as per project requirement.

Sr. No.	Categories	Entitlements	Responsible Agency
		Compensation as per Govt of Maharashtra's GR No: Misc.-03/2015/C.N.34/A-2 (May 12, 2015, and September 30, 2015).	
2b	Loss of land and residential structure for owner and tenant staying in the same premises.	Owner: a) Land will be acquired on payment of compensation as per RFCTLARR Act 2013. Tenant & Owner Both Owner and Tenant will get the following compensation: b) One-time subsistence allowance of Rs.36,000/- per affected family who require to relocate due to project. c) One-time Resettlement Allowance of Rs.50,000/- for affected family. d) Transportation- Physical assistance or a maximum of Rs.50,000/- per affected family will be provided based on following criteria of relocation site: a. 1km-5km – Rs. 10,000/- b. 5km-10 km – Rs. 20,000/- c. 10km-15km – Rs. 30,000/- d. 15 km and above– Rs 50,000/- e) The owner is entitled to a 50 sq meter house at outskirts of the city or, in the vicinity of their area on ownership basis. The tenant will be entitled to a house of equivalent area of lease basis only. Following criteria will be used for determining the size of house. 1) 50 sq ft-100 sq ft = 150 sq ft 2) 101 sq ft-200 sq ft = 300 sq ft 3) 201 sq ft-400 sq ft = 450 sq ft 4) 401 sq ft-550 sq ft= 550 sq ft 5) 551 sq ft and above= existing carpet area Or, The cash in lieu of house will be Rs.5,50,000/- f) Right to salvage affected materials. Note: Stamp duty and registration charges will be born in case of new houses or sites	District Collector, PWD dept., and NMRP

Sr. No.	Categories	Entitlements	Responsible Agency
		Or, Compensation as per Govt of Maharashtra's GR No: Misc.-03/2015/C.N.34/A-2 (May 12, 2015, and September 30, 2015). In the absence of mutual agreement between Owner and tenant the collector will decide the apportionment.	
2c	Loss of land and residential structure partially but continues to remain in the balance portion of the same premises.	Same as 2a for acquired land area only. However, structure value for complete structure may be taken in total if remaining structure will be left in not accessible condition.	NMRP
2d	Loss of land and residential structure partially and willing to surrender the same completely to Project Authority.	As per section 94 owner can do this. He must request in writing. Compensation is same as 2a.	NMRP
2e	Loss of land and residential structure. Owner not residing at the premises.	**Owner:** a) Land will be acquired on payment of compensation as per RFCTLARR Act 2013. b) In lieu of Loss of rental income (livelihood) suitable compensation will determine and given. **Tenant will get below compensation**: c) One-time subsistence allowance of Rs.36,000/- per affected family who require to relocate due to project. SC/ST (if displaced from schedule area) will get Rs. 50,000 in addition to the above. d) One-time Resettlement Allowance of Rs.50,000/- for affected family. e) Transportation- Physical assistance or a maximum of Rs.50,000/- per affected family will	NMRP

Sr. No.	Categories	Entitlements	Responsible Agency
		be provided based on following criteria of relocation site: a. 1km-5km – Rs. 10,000/- b. 5km-10 km – Rs. 20,000/- c. 10km-15km – Rs. 30,000/- d. 15 km and above– Rs 50,000/- f) Right to salvage affected materials. g) The tenant is entitled to a 50 sq mtr house on the outskirts of the city or in the vicinity of their area on lease basis only. Alternately the tenant will be encouraged to buy the premises by paying the difference in cost, on mutually agreed basis with Maha Metro. Following criteria will be used for determining the size of house. 1) 50 sq ft-100 sq ft = 150 sq ft 2) 101 sq ft-200 sq ft = 300 sq ft 3) 201 sq ft-400 sq ft = 450 sq ft 4) 401 sq ft-550 sq ft= 550 sq ft 5) 551 sq ft and above= existing carpet area It must be noted that the tenant will be entitled only for the area for which they have the lease. Or, The cash in lieu of house will be Rs.5,50,000/- Note: Stamp duty and registration charges will be born in case of new houses or sites Or, Compensation as per Govt of Maharashtra's GR No: Misc.-03/2015/C.N.34/A-2 (May 12, 2015, and September 30, 2015). In the absence of mutual agreement between Owner and tenant the collector will decide the apportionment.	
3a	Loss of land and commercial structure for owner only.	a) Land will be acquired on payment of compensation as per RFCTLARR Act 2013. Or,	NMRP

Sr. No.	Categories	Entitlements	Responsible Agency
		An alternate build up commercial structure of area 10% above the existing area will be provided in the vicinity. b) Transportation- Physical assistance or a maximum of Rs.50,000/- per affected unit will be provided based on following criteria of relocation site: (i) 1km-5km – Rs. 10,000/- (ii) 5km-10 km – Rs. 20,000/- (iii) 10km-15km – Rs. 30,000/- (iv) 15 km and above– Rs 50,000/- c) Right to salvage affected materials. Or, Compensation as per Govt of Maharashtra's GR No: Misc.-03/2015/C.N.34/A-2 (May 12, 2015, and September 30, 2015).	
3b	Loss of partial land and commercial structure but continues to run business in the same premises.	Same as 3a for land area to be acquired only.	NMRP
3c	Loss of partial land and commercial structure but owner willing to surrender complete property.	As per section 94 of RFCTLARR Act 2013 owner can do this. DPs must request in writing. Compensation is same as 3a for the entire property.	NMRP
3d	Loss of land and commercial structure owner not on premises. Tenants on property.	**Owner**: a) Land will be acquired on payment of compensation as per RFCTLARR Act 2013. b) If the Loss of rental income (livelihood) suitable compensation will determine. **Tenant**: c) An alternate built up commercial structure of area 10% above the existing area. This commercial structure will be on Tenancy basis only.	NMRP

Sr. No.	Categories	Entitlements	Responsible Agency
		Or, Alternately the tenant will be encouraged to buy the premises by paying the difference in cost, on mutually agreed basis with Maha Metro. d) Transportation- Physical assistance or a maximum of Rs.50,000/- per affected unit will be provided based on following criteria of relocation site: (i) 1km-5km – Rs. 10,000/- (ii) 5km-10 km – Rs. 20,000/- (iii) 10km-15km – Rs. 30,000/- (iv) 15 km and above– Rs 50,000/- e) Right to salvage affected materials. Note: Stamp duty and registration charges will be born in case of new houses or sites Or, Compensation as per Govt of Maharashtra's GR No: Misc.-03/2015/C.N.34/A-2 (May 12, 2015, and September 30, 2015). In the absence of mutual agreement between Owner and tenant the collector will decide the apportionment.	
3f	Loss of land and commercial structure for owner and tenant.	The following compensation package will be offered: **Owner**: a) Land will be acquired on payment of compensation as per RFCTLARR Act 2013. Or, An alternate build up commercial structure of area 10% above the existing area will be provided in the vicinity. b) Transportation- Physical assistance or a maximum of Rs.50,000/- per affected unit will be provided based on following criteria of relocation site: (i) 1km-5km – Rs. 10,000/- (ii) 5km-10 km – Rs. 20,000/- (iii) 10km-15km – Rs. 30,000/- (iv) 15 km and above– Rs 50,000/-	NMRP

Sr. No.	Categories	Entitlements	Responsible Agency
		Tenant: c) An alternative builds up commercial structure of area 10% above the existing area. This commercial structure will be on Tenancy basis only. Or, Alternately the tenant will be encouraged to buy the premises by paying the difference in cost, on mutually agreed basis with Maha Metro. d) Transportation- Physical assistance or a maximum of Rs.50,000/- per affected unit will be provided based on following criteria of relocation site: (v) 1km-5km – Rs. 10,000/- (vi) 5km-10 km – Rs. 20,000/- (vii) 10km-15km – Rs. 30,000/- (viii) 15 km and above– Rs 50,000/- e) Right to salvage affected materials. Note: Stamp duty and registration charges will be born in case of new houses or sites Or, Compensation as per Govt of Maharashtra's GR No: Misc.-03/2015/C.N.34/A-2 (May 12, 2015, and September 30, 2015). In the absence of mutual agreement between Owner and tenant the collector will decide the apportionment.	
4	Loss of land and residential cum commercial structure for owner only	Land will be acquired as per RFCTLARR Act and commercial unit in accordance with 2a and 3a guidelines will be considered with mutual agreement. Or, Compensation as per Govt of Maharashtra's GR No: Misc.-03/2015/C.N.34/A-2 (May 12, 2015, and September 30, 2015).	NMRP
5	Tenant – Residential cum Commercial	a) Compensation package will be worked out on above guidelines (Sr. 3a to 3f whichever applicable) with mutual discussion.	NMRP
6a	Squatters-Residential	a) One-time Resettlement Allowance of Rs.50,000/- for affected family.	NMRP

Sr. No.	Categories	Entitlements	Responsible Agency
		b) One time subsistence allowance of Rs. 36000/- and SC/ST will get Rs. 50,000 in addition. c) Transportation- Physical assistance or a maximum of Rs.50,000/- per affected unit will be provided based on following criteria of relocation site: a. 1km-5km – Rs. 10,000/- b. 5km-10 km – Rs. 20,000/- c. 10km-15km – Rs. 30,000/- d. 15 km and above– Rs 50,000/- d) DPs losing residential units shall be offered SRA (Slum Rehabilitation Authority) housing unit of (25 or 30 sq meter) with the formation of cooperative societies. e) Right to salvage the affected materials.	
6b	Squatters-Commercial	a) Replacement cost of lost structure and other applicable allowances (as per Mumbai Urban Transport Project (MUTP)- R&R Policy, 2000 issued by GoM GR dated 12 May 2023)	NMRP
7	Loss of trees and crops	a. Advance notice to harvest crops, fruits, and timbers. b. Compensation for standing crops in case of such loss, based on an annual crop cycle at market value. c. Compensation for trees based on timber value at market price, and compensation for perennial crops and fruit trees at annual net product market value multiplied by remaining productive years; to be determined in consultation with the Forest Department/NMC for timber trees and the Horticulture Department for other trees/crops.	NMRP
8.	Vulnerable Household	-One adult member of the vulnerable HH will be provided skill upgradation training for employability. Vulnerability allowance of INR 50,000/- to each vulnerable affected HH. Guidance in case legal assistance required.	NMRP

Sr. No.	Categories	Entitlements	Responsible Agency
9.	Owners of Kiosks (NTH)	The NMRP will relocate the Kiosks (NTH) to a nearby feasible location in proper coordination with local govt. authority[4]. In case of self-relocation opted by the kiosk owner, one-time shifting allowance of Rs. 5000/ will be provided to the kiosk owner. For temporary loss income during relocation of the kiosk to the new place, cash assistance based on the daily earning from the kiosk for 5 days* will be provided to kiosk owner (NTH).	NMRP
10.	Common Property resources	CPRs will be relocated / resettled in consultation with the community / local bodies. Civic infrastructure and community services with basic amenities would be provided in consultation with the affected community and the District/Urban/Rural administration.	NMRP
11.	Any other impact not identified	Any unforeseen impact would be mitigated as per the RFCTLARR Act 2013 or as per MUTP – R&R Policy, 2000 directed GoM GR dated 12 May 2023.	NMRP

[4] The kiosks have temporary structures and located within the corridor of impact.

* The kiosks will be relocated to the nearby place. The relocation of kiosks including running of the usual business activities will be completed within a maximum of 5 days. Hence temporary income loss for the kiosk owner will be limited to a maximum 5 days.

IX. Institutional Arrangement

A Institutional Requirement

The implementation of RP requires involvement of various institutions at various levels and stages of project cycle. This section deals with roles and responsibilities of various institutions for a successful implementation of the RP. The institutions to be involved in the process are as follows:

i) Maha Metro Rail Corporation Limited (MMRCL) – HQ level
- General Manager (Design)/AGM LA& R&R
- Deputy General Manager (Land)
- Deputy General Manager (R&R)
- Assistant Manager (Land) and R&R

ii) Contractor

iii) General Consultant (GC)

iv) ADB

B Implementation Arrangement

Project Implementation Unit at HQ level: Maha Metro, is responsible for the technical aspects and overall execution of the Phase-II project. The Executive Director will have the overall responsibility to supervise the project.

For execution of the project Maha metro has appointed general consultants who are technical experts for project implementation. The General Consultants shall be the project implementation unit which shall include Livelihood restoration specialist.

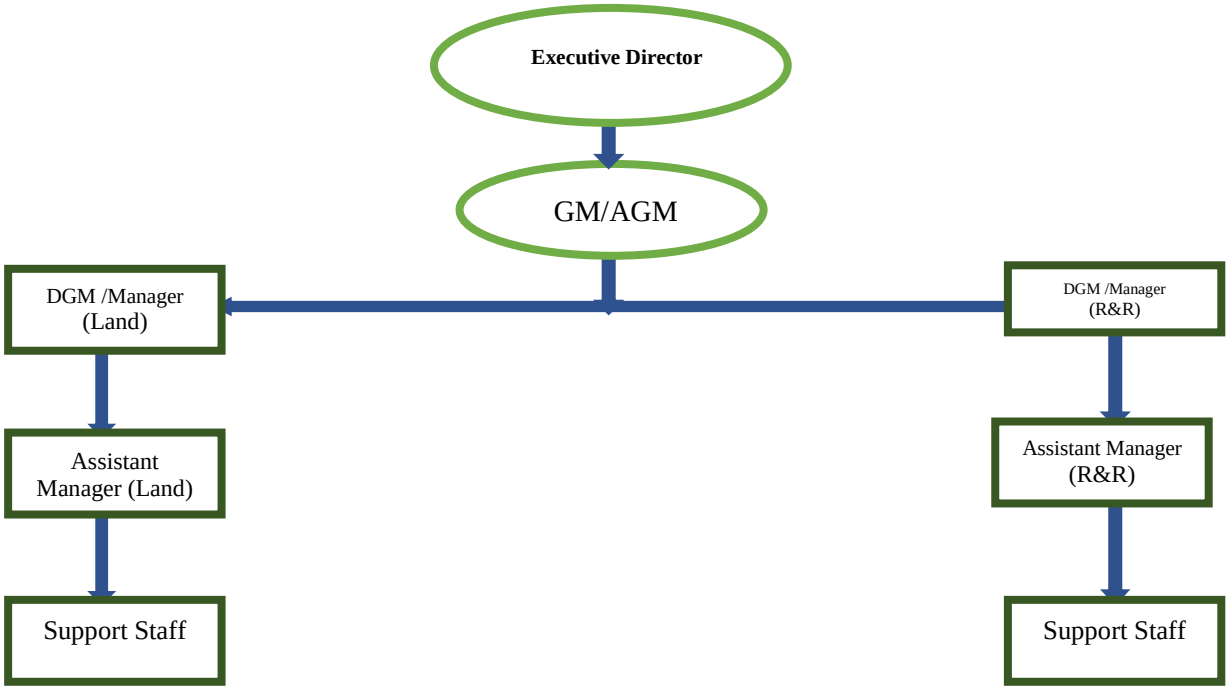
The Institutional setup for implementation of RP is given in below **Fig.9.1.** The role and responsibilities of implementing agency and General Consultants for implementation of resettlement activities are summarized in **Table 9.1**.

Table 9.1: Responsibility of Resettlement Plan Implementation

S.No	Institutions	Responsibility
1.	Executive Director/CPMs, NMRP	• Overall responsibility for implementing LA and relocation of NTH as per RP. • Review on progress of activities on RP implementation. • Resolve any implementation issues that may need intervention. • Ensure that the project comply with the provisions of ADB& EIB and GoI's policies and regulations
2.	General Manager /AGM / DGM, (Land)	• He will be responsible for processing the land acquisition proposals which will involves interfering with State Govt Agencies such as Revenue, PWD, NHAI determining compensations as per the laid down procedure, disbursal of compensation etc.

S.No	Institutions	Responsibility
		• Oversee and coordinate with R&R and LA Teams on regular basis. • Develop RAP implementation plans with the teams. • Ensure establishment of Grievance Redress Committee Resolve issues related to R&R implementation.
3	Deputy General Manager (R&R)	• He will be responsible for all issues related with PAH. His role will involve interfering with PAH and assisting them in transition and livelihood restoration. He will be also be responsible for ensuring that the PAH get assistance in time. He will be co-ordinate with General Consultant (Who are the Project Executing Authority) for smooth implementation of PAH rehabilitation plan. • Ensure timely disbursement of compensation amounts. • Oversee and ensure implementation of R&R. • Ensure timely disbursement of R&R assistance. • Ensure developing relocation sites and relocating CPRs as required. • Ensure that public consultations are held with the DPs during the RP implementation. • Ensure preparation of semi-annual safeguards monitoring reports.
4	Assistant Manager (Land and R&R), NMRP	• Supports the GM, DGM and ensures land acquisition for the project. Supports the GM, DGM and implementation of R&R.
5	Contractor	• Commence construction only when alignment is free of encumbrance. • Ensure safety of labor and other staff working at site location. • Maintain a grievance register to record grievances of DPs at each site. • Provide required data and information to PIU for development of semi-annual safeguards monitoring reports.
6	General Consultant / NMRP	• Coordinate with DPs and Implementing Agency (NMRP) for relocation of NTH. • Maintain records of land acquisition status, grievances and other R&R data. • Preparation of semi-annual Social Safeguard Monitoring Report. • Undertake Public Consultation with DPs periodically. • Disclosure of resettlement documents.

Fig. 9.1: Institutional Setup for Resettlement Plan Implementation



X. IMPLEMENTATION SCHEDULE

A. Introduction

The implementation schedule of the resettlement plan mainly consists of a timeline for compensation to be paid to DHs and R&R activities. The implementation of the resettlement plan will be scheduled as per the overall project implementation. All activities related to the land acquisition and resettlement must be planned to ensure that compensation is paid prior to displacement and commencement of civil works. The implementing agency will ensure that no physical or economic displacement of DHs will occur until: (i) compensation at full replacement cost has been paid to each DHs for project components or sections that are ready to be constructed; (ii) other entitlements listed in the resettlement plan are provided to the DHs; and (iii) a comprehensive income and livelihood restoration program, supported by adequate budget, is in place to help DHs, improve, or at least restore, their incomes and livelihoods. Public consultation, monitoring and grievance redress will be undertaken throughout the project duration. The schedule is subject to modification depending on the progress of the project activities. The civil work in a section will commence only after all compensation and relocation has been completed and rehabilitation measures are in place. However, the section that does not require land acquisition and Resettlement can be taken up for construction.

B. Schedule for Project Implementation

The proposed project R&R activities are divided into three broad categories based on the stages of work and process of implementation. The details of activities involved in these three phases- Project Preparation phase, RP Implementation phase, Monitoring and Reporting are discussed in the following paragraphs.

C. Project Preparation Phase

The major activities to be performed in this phase include preparation and submission of RP for ADB approval; establishment of GRM etc. The public consultation will be a process initiated from this stage and will go on till the end of the project.

D. Implementation Phase

In implementation of RP which includes issues like verification and award of compensation by implementing agency/revenue department; payment of all eligible assistance; relocation of DPs; initiation of economic rehabilitation measures; site preparation for delivering the site to contractors for construction and finally starting the civil work.

The internal monitoring will be the responsibility of the Project Implementation Unit of Maha Metro and will start when the implementation of the resettlement plan starts and will continue till the completion of the project. The General Consultant will provide the necessary support for monitoring RP implementation.

E. Resettlement Implementation Schedule

An implementation schedule for R&R activities in Phase II project, including various sub-tasks and timelines matching with the civil work schedule, is prepared and presented in **Table 10**. However, the sequence may change, or delays may occur due to circumstances beyond the control of the project. Accordingly, the time can be adjusted for the implementation of the plan. Table 10 presents the R&R implementation schedule.

Table 10: R&R Implementation Schedule

Sl. No.	Activity	2023				2024				2025				2026				2027			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Project Preparation																					
1	Conduct census survey																				
2	Preparation of LAP/resettlement plans																				
3	ADB and Maha Metro approval of RP																				
4	Procurement of civil works																				
Land Acquisition																					
5	Payment of Compensation																				
6	Relocate shops, businesses																				
7	Clear the RoW																				
Income Restoration																					
8	Income Restoration																				
9	Restoration of Community Resources																				
Construction																					
10	Issue notice for start of civil works																				
11	Civil works																				
Ongoing Activities																					
12	Grievance Redressal																				
13	Consultations with DPs																				
14	Internal Monitoring																				

Note:- The civil work for NMRP Phase-II was initiated in the third quarter of 2023.

F. MONITORING AND REPORTING

Monitoring and Reporting

Monitoring and reporting is important activities in the RP implementation. The monitoring involves periodic assessment to ascertain whether R&R actives are progressing as per the schedule. Monitoring is the crucial mechanism for measuring project performance and fulfilment of the resettlement objectives.

Monitoring in Phase II project

The RP implementation of Phase II project will be closely monitored by the implementing agency with support from GC staff. One of the main roles of Maha Metro will be to see proper and timely implementation of all activities of RP. Maha Metro with support from GC staff will collect information from the project site and compile it in the form of monthly report to assess the progress and results of RP implementation and adjust work plan where necessary, in case of delays or any implementation problems. This monitoring will form part of regular activity and reporting on this will be extremely important to undertake mid-way corrective steps. The monitoring by Maha Metro will include:

(i) Administrative monitoring: daily planning, implementation, DH database maintenance, and preparation of progress reports.
(ii) Socio-economic monitoring: progress of the R&R activities will be monitored on a regular basis by GC and Maha Metro staff.
(iii) Impact monitoring: Income standards restored/improved, and socio-economic conditions of the displaced persons.
(iv) Third party monitoring of negotiated settlements
(v) Semi-annual Social Monitoring reports documenting progress on RP implementation and compliance status of approved RP will be provided by the Maha Metro for review and approval from ADB.

Monitoring Indicators

The important components/indicators to be monitored are following kinds:

(i) Physical indicators including change in quantum of land required for execution of project activities, number of TH, NTH and CPR affected by the project etc.
(ii) Financial indicators including the disbursement of compensation to DHs.
(iii) Impact indicators related to the longer-term effect of the project on people's lives.
(iv) Grievances/complaint received and addressed.

Table 11: Indicators for monitoring the Resettlement Plan implementation.

Indicators	Parameter
Physical	Number of TH
	Number of NTH
	Number of vulnerable HHs
	Number of DHs eligible for compensation/assistance
	Number of DPs eligible for shifting allowance
Financial	Amount of compensation paid to TH
	Amount of assistance paid to NTH for loss of temporary income
Social	DPs awareness about their entitlement
	Number of Grievances/complaints recorded by site level GRM register
	Number of Public Consultation including number of participants
Grievance	Number of GRC meetings held
	Number of Grievances disposed by GRC to the satisfaction of DPs

Indicators	Parameter
	Number of Grievance received and addressed by GRC.
Process	Relocation of NTH as per schedule
	Land Acquisition and compensation
	Grievance Redressal process
Impact	Ensure better relocation/facilities
	Improvement in socio-economic status of vulnerable HHs
	DPs benefiting from the project

Reporting Requirement

The Maha Metro, responsible for supervision and implementation of the resettlement plan, will prepare monthly progress reports on resettlement activities with support from GC staff. The preparation of semi-annual Social Safeguard Monitoring Report will be done by GC staff which will determine whether resettlement goals have been achieved.

XI. Grievance Redress Mechanism

A. Introduction

The Grievance Redressal Mechanism (GRM) is an arrangement for receiving, documenting, and resolving grievances and complaints of DPs pertaining to social and environmental issues of the Phase II project. It is a time bound transparent mechanism to resolve any concern of DPs. The implementing agency will constitute the project specific GRM intended to address the DPs complaints. The Grievance Redressal Committee (GRC) will be constituted at two levels by NMRP to address the grievances.

B. Constitution of Grievance Redress Committee (GRC)

To receive and facilitate resolution of the DPs concern and complaints in a transparent manner the NMRP shall constitute two-tier GRC with representative from implementing agency, community, representative of DPs etc. for Phase II project. The Grievance from the DPs will be received by following ways:

i) Letter to GRC or by email.
ii) Telephonic grievance.
iii) Grievance communicated to field staff or NMRP/GC/Contractor.

The grievances of the DPs will be recorded by the field/site staff in a GRM register and will be communicated to the GRC. The phone numbers and communication address of GRC members shall be displayed at prominent location near construction site. This GRC will be at two levels, site level (Tier 1) and HQ level (Tier 2). The GRC working mechanism shall be as follows:

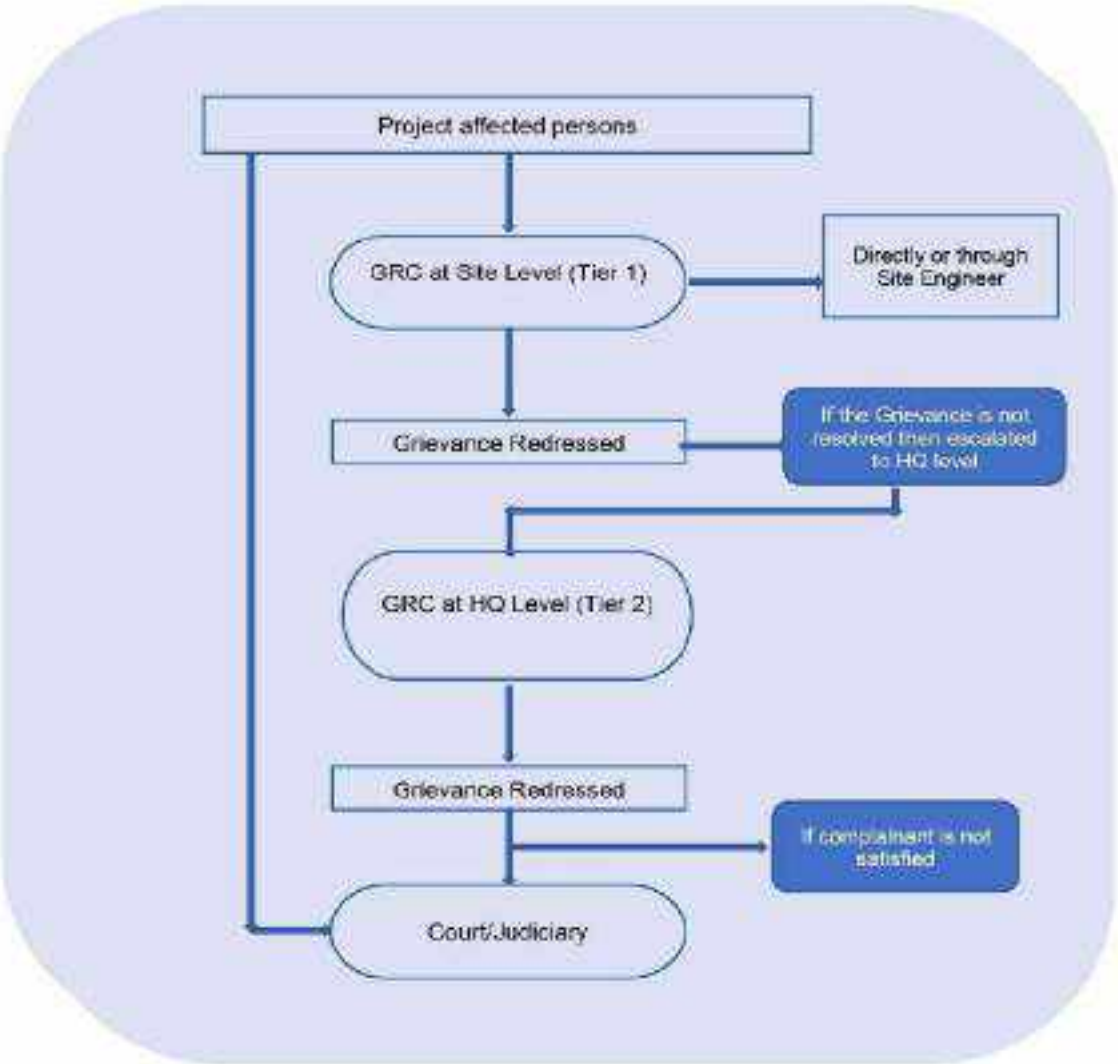
Grievances of DPs will be first brought to the attention of field level staff (Site Engineer). Then Site Engineer will forward the received grievance to Dy. CPM and Chief Project Manager (CPM) for consideration and redressal. The CPM (Tier 1) to the extent possible will address the complaint. The Grievance addressed (Tier 1) at site level, the copy of the compliance will be sent to the head office for record. If the Grievance is not redressed at Tier -1, then the Grievance will be forwarded to Tier -2 level at NMRP head office. The Tier -2 GRC members will include competent authority from land department of NMRP, designated officers from Revenue Department of Government of Maharashtra along with representative from DPs and Social Expert. The NMRP will maintain grievance registers both at site offices and at head office. The GRC will address only social and resettlement issues, and environmental issues both for TH and NTH. The decision of GRC will be documented and communicated to the concerned person in a transparent manner. In case the complainant is dissatisfied with the verdict of GRC, the complainant can approach the Court of Law[5].

When any grievance is brought to the field level staff (Site Engineers), it shall be resolved within 30 days from the date of complaint. The time taken to redress the grievance will be 2 weeks at Tier 2 level. NMRP will maintain a log of grievances documenting at respective site and HQ level. A flow chart of grievances redressal is indicated in Grievance Redressal Mechanism Figure 11.1.

[5] All land related matters fall under the jurisdiction of the State and therefore land ownership rights related disputes are dealt with and resolved in honourable court only.

People may also submit complaint to Funding Agencies (ADB/EIB) Accountability Mechanism. The Accountability Mechanism provides an independent forum and process whereby people adversely affected by ADB-assisted projects can voice, and seek a resolution of their problems, as well as report alleged violations of ADB's operational policies and procedures. Before submitting a complaint to the Accountability Mechanism, affected people should make a good faith effort to solve their problems by working with the concerned ADB operations department. Only after doing that, and if they are still dissatisfied, they approach the Accountability Mechanism. The information regarding the project GRM will be disclosed to public through public consultation process. In addition, awareness about the GRC and the process of registering a complaint will be disseminated through display boards at the site office. The records of all complaints including the status of redressal of complaint will be compiled in the semi-annual Social Monitoring Report.

Figure 11.1 – Grievance Redressal Mechanism



XII. Resettlement Budget and Financing Plan

A Introduction

The resettlement cost estimated for the Phase II project includes land compensation, resettlement and relocation assistance and support cost for resettlement plan implementation. The support cost which includes staffing, monitoring and reporting, and other administrative expenses are part of the overall project cost. The cost of land acquisition of private and government land and relocation assistance of NTHs has been derived through consultation with DPs, relevant officials of revenue and land department and other local authorities and reference from old practices. Contingency provisions have been made to consider variation from this estimate. Some of the major items for this resettlement budget is listed below.

i) Compensation for land (private and government)
ii) Compensation for trees.
iii) in lieu of temporary loss of income of kiosk owners
iv) Shifting allowance to kiosk owners.
v) Assistance to vulnerable HHs for livelihood strengthening.
vi) Cost for implementation of resettlement plan.

B R&R Budget

The project is proposed to acquire private land through direct purchase method. The compensation for acquisition of private land reflects compensation amount under the direct purchase method which will be 250% of market value. The R&R budget for the proposed Phase – II project is given in **Table 12.1.**

Table 12.1: R&R Budget

Sr.No	Items	Unit	Rate	Amount in Rs/-	Remark
A	**Compensation of Land**				
1	Private Land	5.57 Ha	Varied	120 Cr.	
	Government Land	3.7 Ha	Varied	22 Cr.	
	Subtotal A			**142 Cr.**	
B	**Compensation for Commercial & Residential Structure**				
	Items	**Nos**	**Rate**	**Amount**	
1	Permanent Structure	Nil	--	----	No permanent structures
2	Semi-Permanent Structure	Nil	--	----	No semi-permanent structures
3	Temporary Structure	Nil	---	----	No temporary structure of TH on their land.
4	CPR	03		0.77 Cr.	
	Subtotal B			**0.77 Cr.**	

Sr.No	Items	Unit	Rate	Amount in Rs/-	Remark
	Relocation Assistance				
C	**Items**	**Number**	**Rate**	**Amount**	
1	One-time Shifting allowance of Rs. 5000/ to kiosk owners in case of self-relocation	47	5000	2,35,000/-	Maha Metro through Urban local body will assist shifting of kiosks and all the logistics will be provided by Maha Metro
2	One-time assistance of Rs. 5000/ to each kiosk owner	47	5000/*	2,35,000/-	
3	Subsistence allowance to DHs losing livelihood	Nil	4500/-	--	No DH losing livelihood.
4	Assistance to vulnerable DHs	29	50,000/-	14,50,000/-	
5	Compensation for private trees on private land (including cutting & valuation) Timber trees-66 no's Non-timber trees-6 no's Fruit trees-2 no's	74	Timber tree-13500/- Non-timber tree-Rs. 7000/- Fruit Trees-Rs. 25,500/-	9,84,000/-	Cutting-As per PWD schedule of rates year 2021-22. Valuation-Rates of standing trees-Forest Dept & Hort. dept. of NMC
	Subtotal C			**29,04,000/-**	---
	RAP implementation support				
D	**Items**	**Number**	**Rate**	**Amount**	
1	Cost of R&R implementation	---	--	---	Not required as IA will do the R&R implementation
2	GRM cost	lumpsum	---	5,00,000/-	This cost includes the Public Consultation expenses also.
			Subtotal D	**5,00,000/**	
			Grant Total (A+B+C+D)	**143,11,04,000/-**	
			Contingency (10%)	**14,31,10400/-**	
			GRAND TOTAL	**157,42,14,400/-**	

Note: *As per the project census survey, the average daily earning of kiosk owners is around Rs. 500/. One-time assistance of Rs. 5000/ to each kiosk owner will compensate the loss of average daily earning for 10 days.

XIII. ANNALYSIS OF COSTS AND BENEFITS AND RECOMMENDATIONS ON ACQUISITION

A. Cost and Benefits of Project

- The commissioning of the proposed Phase-II project is expected to result in both direct and indirect benefits to the users. Keeping in view the benefits of the project is termed as the most preferred option for new generation. The project costs and benefits are distributed among the project beneficiaries including vehicle owners, passengers, the labour force, and government and private entities. It is expected that society will gain multiple benefits from this Phase-II project such as savings in vehicle operating costs (VOCs), fuel, and travel time, as well as decreased pollution.

- It is expected that there will be savings in travel time for passengers who shift from road to the metro. This will be because of a higher average speed on the metro (84 kilometres per hour [km/h]) than by road (26 km/h).

- It is expected that there will be time savings for passengers who continue to use roads after the metro is commissioned. This is attributable to an increase in their average speed because of reduced congestion.

- There will be fuel savings because of a reduction in the number of vehicles on the road after a shift of passengers from road to metro.

- Due to the lesser number of vehicles on road due to metro, lesser road capacity will be required. This will result in savings of highway construction cost and less vehicle noice

- Acquisition of private land has been minimised as far as possible. For the land needed to construct the metro alignment, stations, depots and power sub stations, the land requirement has been kept to the bare minimum. For elevated alignment, no land is proposed to be acquired permanently, except small areas for locating entry/ exit structures, traffic Integration etc. Elevated alignment is proposed to be located on the central verge of the road wherever possible.

- The project will benefit the poor and vulnerable in various ways. First, the benefit from the project directly from saved time and boost economically. A certain share of the drivers (e.g., owners of two-wheelers) who are poor will also enjoy reduced VOCs. The labour demand directly generated by the investment project is also likely to benefit low-income workers. Secondly, there will be indirect economic benefits generated by the investment project that will provide better access to jobs and education and promote structural transformation. These induced effects will, on a wider scale, help the poor and vulnerable.

- Regarding benefits of the proposed metro project, a very large section of people expect that it will lead to enhancement in land prices, more employment opportunities, comfortable commuting, and a lot of business opportunities for the local people. Overall, landholders are hoping more benefits from the project in comparison to likely negatives.

B. Recommendations

- During interaction with the villagers of the project area, it was found that they are very well conversant with the positive impact of the phase-II project. However, they expect a reasonable and adequate compensation for loss of their assets in the process of land acquisition. Therefore, adequate and satisfactory monetary arrangement is must to compensate the people in lieu of their loss of land and emotional attachment.

- The outcome of public consultation indicates mainly three kinds of apprehensions by the affected people like – loss of access to residual part of affected plot, loss of business and income source, and case of multiple displacements. It is commits to that the residual part of land if found useless or inaccessible by the owner or if the owner desired so, shall also be acquired as per project requirement. In case of multiple displacements additional compensation shall be paid to the affected families as per the provision laid down under Section 39 of RFCTLARR Act. 2013/Maharashtra GR.

- Preference shall be given in providing employment through the contractors for works especially to those belonging to vulnerable groups.

- The project implementation agency shall ensure the appropriate technology to reduce land requirements, and ensure involuntary resettlement is avoided or minimized.

- Consultations shall always be carried out with affected persons, and concerned local social organizations. Inform all affected persons of their entitlements.

- Particular attention shall be given to the needs of vulnerable groups, especially those below the poverty line, the landless, the elderly, women and children.

- There shall be a grievance redress mechanism at project level to receive and facilitate resolution of the concerns of affected persons. The social and cultural institutions of affected persons need to be supported.

- Transitional/transportation support and development assistance, such as land development, employment opportunities; and civic infrastructure and community services, as required shall be provided to the affected persons.

- The project shall improve the standards of living of the affected poor and other vulnerable groups, including women, to at least national minimum standards.

- The project shall provide non-monetary support measures and gender sensitive compensation approach including Legal assistance as needed; financial training to ensure proper administration of cash compensation for vulnerable households; skills up gradation programmes for vulnerable groups; relocation/moving assistance or allowance; right to salvage materials.

- Since, the project is being funded by the ADB & EIB (Funding Institutions) the implementing agency is required to ensure that all components of resettlement plan prepared under the project are implemented as per the provisions.

- The compensation and other assistance shall be provided to the affected persons before acquisition of land.

- Construction of metro may also lead to potential negative impacts such as the spread of STIs (Sexually Transmitted Infections), trafficking, and road safety issues. Potential negative impacts need to be addressed through community awareness raising sessions on health and safety issues.

ANNEXURE- 1: LAND ACQUISITION CIRCULAR FOR CORRIDOR OF IMPACT

CIN: U60100MH2015SGC265064 Website : www.metrorail.co.in

नागपूर मेट्रो रेल कॉर्पोरेशन लिमिटेड

NAGPUR METRO RAIL CORPORATION LIMITED

(A Joint Venture of Govt. of India & Govt. of Maharashtra)

CIRCULAR

No.NMRCL/Plg/A/Land Policy/2016/153/2356 **Dated: 01/09/2016**

Sub: Land acquisition policy for Nagpur Metro Project.

As per the approved DPR, the width of Metro Rail Corridor is 20m and therefore the land in this corridor was considered for acquisition. Although, the metro rail corridor mostly follows median of the roads, at some locations the alignment is away from the road. At such location, the need for optimisation of land acquisition was felt.

After optimisation of the width of viaduct, the requirement of corridor width for the purpose of land acquisition has been critically reviewed and the competent authority has approved the corridor width as under:

Sr. No.	Owner	ROW (in meters)
1	Government Ownership (GoM, GoI, NIT, MHC, MADC, AAI, Railways, etc.)	20
2	Private Ownership	15

Land Cell should modify land acquisition proposal accordingly. Planning Cell shall provide the modified plans.

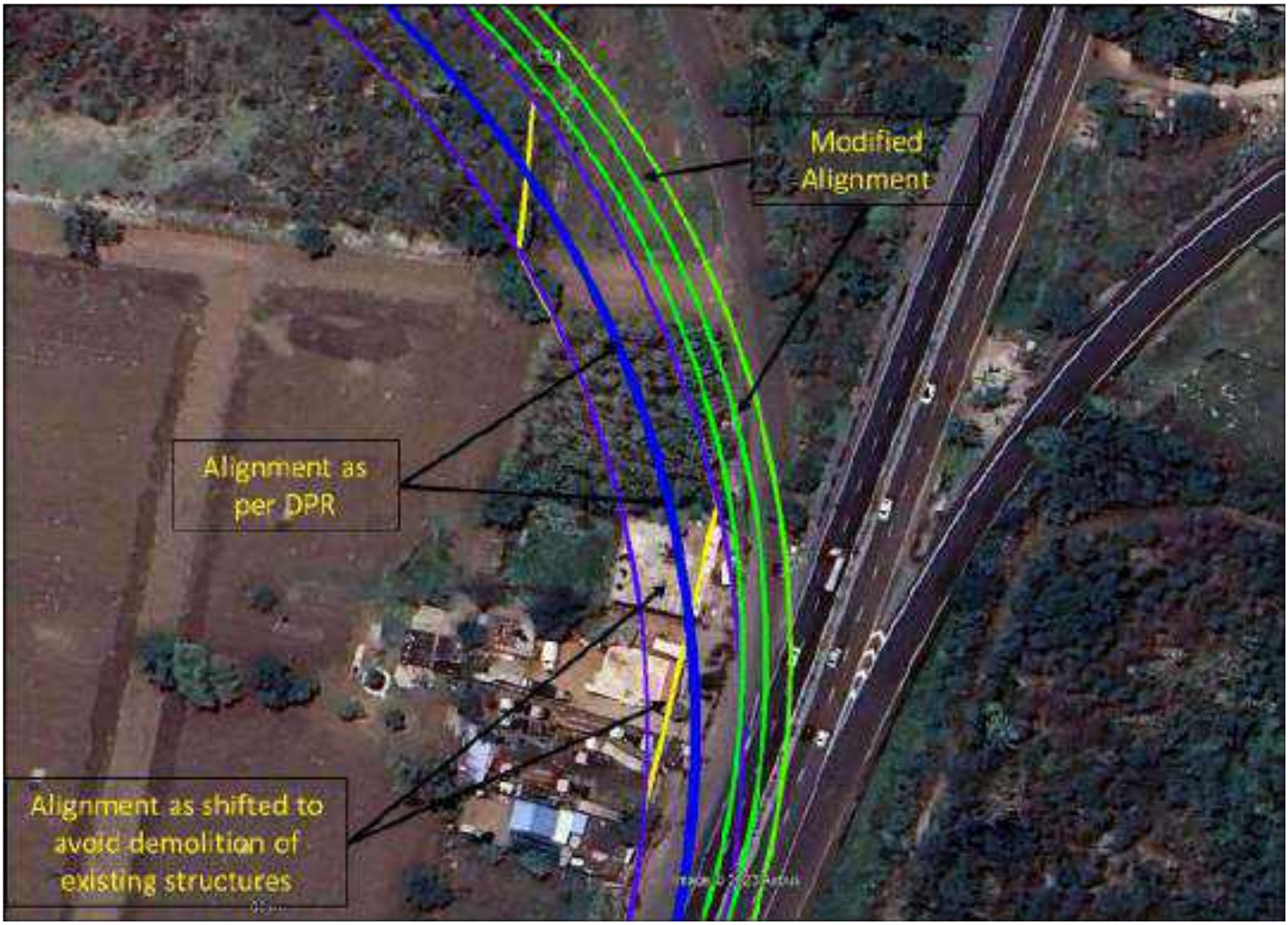
8-9-2016

(J.K. Nandanwar)
General Manager (Plg)

Copy to:

1. DP – For kind information please.
2. D(RS&S) – For kind information please.
3. PA to MD – For kind information of MD please.
4. GM (Land) – For information and necessary action.
5. All HOD'S/ Dy. HOD's – For kind information please.
6. All Notice Board of NMRCL's Offices.

ANNEXURE-2: MINIMIZATION OF IMPACTS: REACH-1A



Minimization of Impacts: Reach-2A

Minimization of Impacts: Reach-3A

ANNEXURE- 3: CENSUS AND SOCIO-ECONOMIC SURVEY

Maharashtra Metro Rail Corporation Limited
(महाराष्ट्र मेट्रो रेल कॉर्पोरेशन लिमिटेड)
Nagpur Metro Rail Corporation Limited
(नागपूर मेट्रो रेल कॉर्पोरेशन लिमिटेड)
Metro Bhawan, Nagpur – 440010
(मेट्रो भवन, नागपूर - 440010)

Census and Socio Economic Survey Questionnaire
(जनगणना आणि सामाजिक आर्थिक सर्वेक्षण प्रश्नावली)

Corridor No. [कॉरिडॉर क्रमांक]	Nearest Station [स्टेशन जवळचे]	Side (Left/Right) [बाजू (डावी/उजवी)]	Date [तारीख]

1-0	General Identification [सामान्य ओळख]		
1-1	Name of Affected Person [बाधित व्यक्तीचे नाव]	:	
1-2	Address [पत्ता]	:	Village [गाव] Ward [प्रभाग] Block [तालुका] District [जिल्हा] State [राज्य]
1-3	Name of Head Family Member [कुटुंब प्रमुखाचे नाव]	:	
1-4	Respondent's Name [प्रतिसादकर्त्याचे नाव]	:	
1-5	Contact Number [संपर्क क्रमांक]	:	
1-6	Type of Property [मालमत्तेचा प्रकार]	:	1. Title Holder [शीर्षक धारक] 2. Government [सरकार] 3. Community [समुदाय] 4. Others [इतर] .....
1-7	Ownership of Property [मालमत्तेची मालकी]	:	1. Title Holder [शीर्षक धारक] 2. Non Title Holder [नसलेले शीर्षक धारक]
1-8	If Non Title Holder [नसलेले शीर्षक धारक असल्यास]	:	1. Encroacher [अतिक्रमण करणारा] 2. Squatter [स्क्वाटर] 3. Tenant [भाडेकरू]
1-9	Uses of Land [जमिनीचा उपयोग]	:	1. Agriculture [शेती] 2. Residential [निवासी] 3. Commercial [व्यावसायिक] 4. Residential cum Commercial [निवासी आणि व्यावसायिक] 5. Garden [बाग] 6. Vacant/no use [रिकामे/उपयोग नाही] 7. Others [इतर]
1-10	Type of Land [जमिनीचा प्रकार]	:	1. Irrigated [सिंचन केले] 2. Unirrigated [सिंचन नसलेले] 3. Others [इतर] .....
1-11	How long have you been living in the land/house? [तुम्ही जमिनीत/घरात किती दिवस राहत आहात?)]	:	

2-0	Household Details [घरगुती तपशील]				
2-1	Religion [धर्म]	:	1. Hindu [हिंदू] 4. Christen [ख्रिश्चन]	2. Muslim [मुसलमान] 5. Others [इतर]	3. Sikh [शीख]
2-2	Caste [जात]	:	1. SC [अनुसूचित जाती] 3. OBC [इतर मागासवर्गीय] 5. Others [इतर]	2. ST [अनुसूचित जमाती] 4. General [सामान्य]	
2-3	Economic status of the family [कुटुंबाची आर्थिक स्थिती]	:	1. BPL [दारिद्र्यरेषेखालील] 3. Antodya [अंत्योदय] 6. Nothing [काहीही नाही]	2. APL [दारिद्र्यरेषेच्या वर] 4. Annapurna [अन्नपूर्णा]	
2-4	Vulnerability Status [असुरक्षितता स्थिती]	:	1. BPL [दारिद्र्यरेषेखालील] 3. Differently [दिव्यांग] 5. Others [इतर]	2. WHH [स्त्रिया घरच्या प्रमुख होत्या] 4. Widow/ [विधवा]	
2-5	Type of Family [कुटुंबाचा प्रकार]	:	1. Nuclear [अणु] 4. Sibling [भावंड]	2. Joint [संयुक्त] 3. Extended [विस्तारित] 5. Live in [सहजीवन]	
2-6	No. of Persons in HH [घरातील व्यक्तींची संख्या]	:	Above 18 Years [18 वर्षांपेक्षा जास्त]	Male [पुरुष]	Female [स्त्री]
			Below 18 Years [18 वर्षांखालील]	Male [पुरुष]	Female [स्त्री]
2-7	The main source of the family income [कौटुंबिक उत्पन्नाचा मुख्य स्त्रोत]	:			
2-8	Total monthly income of the family [कुटुंबाचे एकूण मासिक उत्पन्न]	:			
2-9	Total monthly Expenses of the family [कुटुंबाचा एकूण मासिक खर्च]	:			

Details of family members [कुटुंबातील सदस्यांचा तपशील]

Sl. No. [क्रमांक]	Name of Family Member [कुटुंबातील सदस्यांचे नाव]	Relationship [नाते]	Age [वय]	Sex [लिंग]	Marital Status [वैवाहिक स्थिती]	Education [शिक्षण]	Occupation [व्यवसाय]
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

Codes (संहिता)

Relationship (नाते)							
Head of Household (घरातील व्यक्ती)	1	Wife (बायको)	2	Husband (नवरा)	3	Son (मुलगा)	4
Daughter (मुलगी)	5	Son-in-law (जावई)	6	Daughter in Law (सून)	7	Grand father (आजोबा)	8
Grand Mother (आजी)	9	Grand son (नातू)	10	Grand Daughter (नात)	11	Grand son in Law (नातू जावई)	12
Grand Daughter-in-law (नातसून)	13	Brother (भाऊ)	14	Sister (बहीण)	15	Brother in Law (मेहुणा)	16
Sister in Law (वहिनी)	17	Father (वडील)	18	Mother (आई)	19	Father in Law (सासरे)	20
Mother in Law (सासू)	21	Uncle (काका)	22	Aunt (काकी)	23	Cousin (चुलत भाऊ)	24
Nephew (भाचा)	25	Niece (भाची)	26	Any Other (इतर कोणतेही)			
Sex (लिंग)							
Male (पुरुष)	1	Female (स्त्री)	2	Transgender (तृतीयपंथी)	3		
Marital Status (वैवाहिक स्थिती)							
Married (विवाहित)	1	Unmarried (अविवाहित)	2	Divorced (घटस्फोटित)	3	Widow/Widower (विधवा/विधुर)	4
Education (शिक्षण)							
Illiterate (निरक्षर)	1	Primary (प्राथमिक) (1-5)	2	Secondary (माध्यमिक) (6-10)	3	Higher/Graduation (उच्च पदवी)	4
Technical (तांत्रिक)	5	Vocational (व्यवसायिक)	6				
Occupation (व्यवसाय)							
Service (सेवा)	1	Business (धंदा)	2	Agriculture (शेती)	3	Labour (मजूर)	4
Unemployed (बेरोजगार)	5	Housewife (गृहिणी)	6	Student (विद्यार्थी)	7	Professional (व्यावसायिक)	8

2-10	Have you availed any benefit under Central or State Govt. Scheme [तुम्ही केंद्र किंवा राज्य सरकारच्या योजनेअंतर्गत काही लाभ घेतला आहे का?	Yes / No होय / नाही]

Scheme [योजना]	Purpose [उद्देश]	Remarks [टिप्पण्या]

2-11 Please indicate you borrowings during last one year [कृपया मागील एका वर्षातील तुमच्या कर्जाचा उल्लेख करा]

Source [स्रोत]	Amount taken (in Rs.) [काढलेली रक्कम (रु. मध्ये)]	Purpose of Loan [कर्जाचा उद्देश]	Amount returned (in Rs.) [परत केलेली रक्कम (रु. मध्ये)]	Balance [पैशाची बाकी]
Bank [बँक]				
Private money lender [खाजगी सावकार]				
Others (specify) [इतर (निर्दिष्ट करा)]				

2-12 Income and Expenditure (Yearly) [उत्पन्न आणि खर्च (वार्षिक)]

Income [उत्पन्न]		Expenditure [खर्च]			
Source [स्रोत]	In Rupees [रु. मध्ये]	Items [वस्तू]	In Rupees [रु. मध्ये]	Items [वस्तू]	In Rupees [रु. मध्ये]
Agriculture [शेती]		Food [अन्न]		Electricity / Utilities [वीज/उपयुक्तता]	
Commercial [व्यावसायिक]		Cooking Fuel [स्वयंपाक इंधन]		Water [पाणी]	
Service (Pvt./Govt.) [सेवा (खाजगी/सरकारी)]		Clothing [कपडे]		Social Events [सामाजिक कार्यक्रम]	
Livestock [पशुधन]		Transport [वाहतूक]		Agriculture (labour/tools) [शेती (मजूर/साधने)]	
Remittance (Money order etc.) [पैसे पाठवणे (मनी ऑर्डर इत्यादि)]		Healthcare Medicines [आरोग्यसेवा औषधे]		Seeds/fertilizers /pesticides [बियाणे/खते/ कीटकनाशके]	
Other Specify [इतर निर्दिष्ट करा]		Education [शिक्षण]		Other Specify [इतर निर्दिष्ट करा]	

2-13 Livestock Details [पशुधन तपशील]

Type [प्रकार]	Cow [गाय]	Buffalo [म्हैस]	OX [बैल]	Goat [शेळी]	Pig [डुकर]	Poultry [पोल्ट्री]	Others [इतर]
Numbers [संख्या]							

2-14 Assets available with affected family [बाधित कुटुंबाकडे उपलब्ध मालमत्ता]

S.No [क्रमांक]	Productive Assets [उत्पादक मालमत्ता]	Yes-1 No-2 [होय-1/नाही-2]	S.No [क्रमांक]	Other Assets [इतर मालमत्ता]	Yes-1 No-2 [होय-1/नाही-2]
1	Vehicle (four wheelers) [चारचाकी वाहन]		1	Refrigerator [रेफ्रिजरेटर]	
2	Vehicle (two wheelers) [दुचाकी वाहन]		2	Washing Machine [वॉशिंग मशीन]	
3	Tractor [ट्रॅक्टर]		3	Ceiling Fan [छताचा पंखा]	
4	Truck [ट्रक]		4	Television [दूरदर्शन]	
5	Machine if any [मशीन असल्यास]		5	Computer [संगणक]	
6	Others (specify) [इतर (निर्दिष्ट करा)]		6	Cell phone [सेल फोन]	

3-0	Asset Details [मालमत्ता तपशील]				
3-1	Measurement of the Land (In mts.) [जमिनीचे मोजमाप (मीटर मध्ये)]			Total [एकूण]	Affected [प्रभावित]
			Length [लांबी]		
			Width [रुंदी]		
			Area [क्षेत्रफळ]		
3-2	Measurement of the Structures (In mts.) [संरचनेचे मोजमाप (मीटर मध्ये)]			Total [एकूण]	Affected [प्रभावित]
			Length [लांबी]		
			Width [रुंदी]		
			Area [क्षेत्रफळ]		
3-3	Type of Construction [बांधकामाचा प्रकार]		Roof [छत]		
			Wall [भिंत]		
			Floor [फरशी]		
			Boundary [सीमा भिंत]		
3-4	Typology of Construction [बांधकामाची टायपोलॉजी]		1. Permanent [स्थायी] 2. Semi Permanent [अर्ध-स्थायी] 3. Temporary [तात्पुरता]		
3-5	Number of Rooms [खोल्यांची संख्या]				

Typology of the structure [संरचनेचे टायपोलॉजी]

Roof [छत]		Wall [भिंत]		Floor [फरशी]		Boundary [सीमा भिंत]	
RCC/ RBC [आर.सी.सी./आर.बी.सी.]	1	Brick [वीट]	1	Concrete [कॉंक्रिट]	1	Brick [वीट]	1
Thatched [गवत]	2	Wood [लाकूड]	2	Mud [चिखल]	2	Barbed Wire [काटेरी तार]	2
Mud [चिखल]	3	Mud [चिखल]	3	Stone [दगड]	3	Wood [लाकूड]	3
GI/Asbestos [लोखंड/एस्बेस्टोस]	4	Asbestos [एस्बेस्टोस]	4	Wood [लाकूड]	4	Others (Specify) [इतर (विशिष्ट करा)]	4
Bamboo [बांबू]	5	Plastic [प्लास्टिक]	5	Others (Specify) [इतर (विशिष्ट करा)]	5		
Others (Specify) [इतर (विशिष्ट करा)]	6	Others (Specify) [इतर (विशिष्ट करा)]					

3-6	Estimated cost of structure (in INR) [संरचनेची अंदाजे किंमत (रु. मध्ये)]						
3-7	In case of Commercial use, details of Business [व्यावसायिक वापराच्या बाबतीत, व्यवसायाचा तपशील]						
3-8	Ownership [मालकी]		Yes [होय]	1	No [नाही]	2	
3-9	If No. How many partners ? [असल्यास, किती भागीदार आहेत?]						
3-10	How many people have you employed [तुम्ही किती लोकांना रोजगार दिला आहे]		Male [पुरुष]		Female [स्त्री]		
4-0	**For land owners only [फक्त जमीन मालकांसाठी]**						
4-1	Khasra / Survey No. [खसरा/सर्वे नं.]						
4-2	Khata / Plot No. [खाता/प्लॉट नं.]						
4-3	Total Area of Land [जमिनीचे एकूण क्षेत्रफळ]						

4.4	Affected Area [प्रभावित क्षेत्र]						
4.5	Land Rate [जमिनीचा दर]		Market Rate [बाजार दर] : Circle Rate [मंडळ दर]				
4.6	What should be the total loss amount (in INR) [एकूण नुकसानीची रक्कम किती असावी (रु. मध्ये)]						
4.7	Compensation Received [भरपाई मिळाली]		Yes [होय]	1	No [नाही]	2	
5.0	**Rehabilitation Options [पुनर्वसन पर्याय]**						
5.1	Ready for Change [बदलासाठी सज्ज]		1. Self Decision [स्वतःचा निर्णय] 2. Rehabilitation Required [पुनर्वसन आवश्यक]				
5.2	Compensation options for Land or Structures [जमीन किंवा संरचनांसाठी भरपाई पर्याय]		1. Equivalent / Better productive land for land and construction allowance for any structure [जमिनीसाठी समतुल्य/उत्तम उत्पादक जमीन आणि कोणत्याही संरचनेसाठी बांधकाम भत्ता] 2. Cash compensation at replacement value [बदली मूल्यावर रोख भरपाई] 3. Rehabilitation Grant [पुनर्वसन अनुदान] 4. Other [इतर] Specify [निर्दिष्ट करा] ...				
5.3	Compensation options for Commercial Structures [व्यावसायिक संरचनांसाठी भरपाई पर्याय]		1. Cash compensation at replacement value [बदली मूल्यावर रोख भरपाई] 2. Shifting and rental allowance [स्थलांतरण आणि भाडे भत्ता] 3. Training for income restoration [उत्पन्न पुनर्संचयित करण्यासाठी प्रशिक्षण] 4. Other [इतर] (Specify) [निर्दिष्ट करा]				
6.0	**Project Related Information [प्रकल्प संबंधित माहिती]**						
6.1	Are you aware of the proposed project [तुम्हाला प्रस्तावित प्रकल्पाची माहिती आहे का]	:	Yes [होय]	1	No [नाही]	2	
6.2	If yes, what is the source [जर होय, तर स्त्रोत काय आहे]		TV [दूरदर्शन]	1	Newspaper [वृत्तपत्र]	2	Radio [रेडिओ] 3
			Community Memmess [समुदाय सदस्य]	4	Govt. Officials [सरकारी अधिकारी]	5	Other [इतर] (Specify) [निर्दिष्ट करा] 6
6.3	What is the impacts envisaged from this project [या प्रकल्पाचे काय परिणाम अपेक्षित आहेत]						
Positive Impacts perceived [सकारात्मक परिणाम जाणवले]			**Other Perceived Impacts [इतर समजलेले प्रभाव]**				
Increase in employment opportunities due to better access facilities [चांगल्या सुविधांमुळे रोजगाराच्या संधींमध्ये वाढ]		1	Loss of productive land for agriculture and own land for dwelling units [शेतीसाठी उत्पादक जमीन आणि निवासस्थानासाठी				1

		स्थलांची जमीन गमावणे]	
Increase in movement in terms of facilities [सुविधांच्या बाबतीत हालचाल वाढेल]	2	Pressure on existing infrastructure [विद्यमान पायाभूत सुविधांवर दबाव]	2
Increase in economic and business opportunities [आर्थिक और व्यावसायिक संधींमध्ये वाढ]	3	More influx of outside population and loss if privacy [बाहेरील लोकसंख्येचा अधिक ओघ आणि गोपनीयता असल्याचे नुकसान]	3
Increase in land price [जमीनीच्या किमतीत वाढ]	4	Conflict with outsiders [बाहेरील लोकांशी संघर्ष]	4
Improvement in the real estate sector [रिअल इस्टेट क्षेत्रात सुधारणा]	5	Increase in density around the metro [मेट्रोजवळची घनता वाढली]	5
Better reach/access to larger town for health [आरोग्यासाठी मोठ्या शहरात चांगली पोहोच/प्रवेश]	6	Spread of HIV/AIDs due to increase in unsafe sexual [असुरक्षित लैंगिक संबंधात वाढ झाल्यामुळे एच.आय.व्ही /एड्सचा फैलाव]	6
Higher income from rental due to this infrastructure development [या पायाभूत सुविधांच्या विकासामुळे भाड्याने मिळणारे अधिक उत्पन्न]	7	Increase rentals for tenants for both residential / commercial properties [निवासी/व्यावसायिक दोन्ही मालमत्तांसाठी भाडेकरूंचे भाडे वाढवा]	7
Other [इतर] (Specify) [निर्दिष्ट करा]	8	Other [इतर] (Specify) [निर्दिष्ट करा]	8

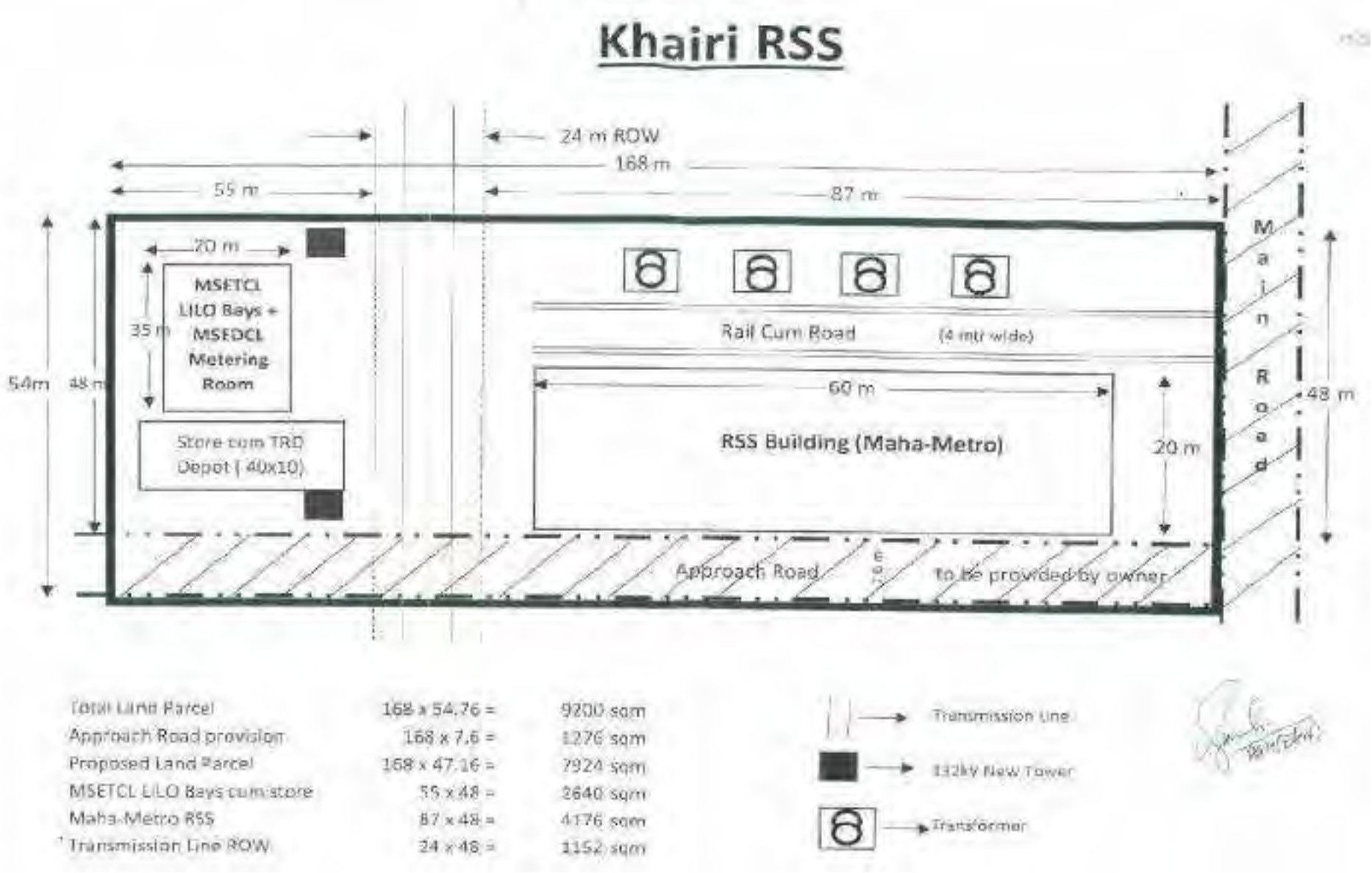
7.0	Gender Status [लिंग स्थिती]					
7-1	Does the women have titled to land of houses ? [महिलांना जमीन किंवा घरे यांचे नाव आहे का?]	Yes [होय]	1	No [नाही]	2	
7-2	Do your women members have any say to decision making of household matters ? [तुमच्या महिला सदस्यांना घरातील निर्णय घेण्याबाबत काही म्हणायचे आहे का?]	Yes [होय]	1	No [नाही]	2	
	If yes, give the following details [होय असल्यास, खालील तपशील द्या]	Financial Matter [आर्थिक बाब]		Yes [होय]	No [नाही]	
		Education of Child [मुलाचे शिक्षण]				
		Health care of child [मुलाची आरोग्य काळजी]				
		Purchase of assets [मालमत्तेची खरेदी]				
		Social functions [सामाजिक कार्ये]				
		Day to day activities [दैनंदिन क्रियाकलाप]				
		Others [इतर]				

(Signature of Supervisor)
[पर्यवेक्षकाची स्वाक्षरी]
Date [तारीख] .....

(Signature of investigator)
[अन्वेषकाची स्वाक्षरी]

(Signature of Respondent)
[प्रतिवादीची स्वाक्षरी]

ANNEXURE 4: LOCATION OF RSS LAND, BATCHING PLANT (REACH-2A)


Khairi RSS
24 m ROW
168 m
55 m
87 m
20 m
35 m
MSETCL LILO Bays + MSEDCL Metering Room
Store cum TRD Depot (40x10)
54m
48 m
Rail Cum Road
(4 mtr wide)
60 m
RSS Building (Maha-Metro)
20 m
Approach Road
6 m
To be provided by owner
Main Road
48 m
Total Land Parcel 168 x 54.76 = 9200 sqm
Approach Road provision 168 x 7.6 = 1276 sqm
Proposed Land Parcel 168 x 47.16 = 7924 sqm
MSETCL LILO Bays cum store 55 x 48 = 2640 sqm
Maha-Metro RSS 87 x 48 = 4176 sqm
Transmission Line ROW 24 x 48 = 1152 sqm
Transmission Line
132kV New Tower
Transformer

ANNEXURE 5: DETAILS OF DONGARGAON WEEKLY MARKET (CPR)

The NMRP Phase-II project will affect 3 CPRs. One of the CPR is a weekly market at Dongargaon, held on every Friday. The land of weekly market belongs to Maruti Devasthan Trust and they have provided this land to Gram Panchayat on mutual understanding for market purpose. The Gram panchayat has developed 16 platforms for weekly market purposes, out of which about 8 platforms are going to be affected due to NMRP Phase II project.

This is weekly vegetable market and no permanent space for anyone. They accommodate their spaces on the basis of their commodities (Vegetables) requirement. This is considered as Common Property Resource (CPR), hence consideration of TH & NTH not raise.

CPR- Platforms at weekly market at Dongargaon (Reach-1A)

Public Consultation: The Public consultation was held on 28.04.2023 at this CPR location along with stakeholders. Also, a formal public consultation was conducted by Maha-Metro along with ADB Social & Envr Expert team on 26.10.2023 at this CPR location.

Metro Phase II

Attendance Sheet of Public Consultation

Reach - 1A Station/Location - Dongargaon Date- 26/10/2023

Sr N	Name of Person	Occupation	Signature
8312066155	Chaya Pradip Shanmugat	Member of Gram Panchayat	
8308224795	Vijaya Mukunda Amle	Member of Gram Panchayat	V.M. Amle
	Jiten Masaram (Onlighat)		
	Gaurishankar Lanjewar	Hair Salon	
9823977009	Dharmaji Ghanode	Business	
9371215450	Sanjay Pawar	Lohar	
9158813817	Vayankutrao Nanwate	Retired Central Railway	
7745957848	Banay S Chivande	Business	
9822.5655483	Johwar Bhojnkr	Business	
9960127561	Raju Kulmate	Labour	
9371726026	Yasin Pathan	Business	
9860531873	Shaikh Miya	Business (Chickenshop)	
9850217613	Firoz Khan	Business	
	Rajendra moon	Taylor	
	Dashrathji Kumbhare	Taylor	
	Nilkhanthaji Maraskohle	Farmer	
3022605060	Mubin Shaikh	chicken shop	
9146384619	Rahul. S Gajbe	Grampanchayat	
7263012737	Vitthal Uikey	Labour	
9822065852	Pramod Fulzele	Member	
	Laureen Lamita	Social Dev. Specialist	
	Suvalaxmi Sen	Environment Specialist	
	Mario Sprong	Environment Specialist	
	Ranjana Bondre	ग्रा.पं.सदस्य	
	Kalpana Kavam	Sarpanch	
	Sushila Bhanuse	Gram Sevak	
	Aditya Akhavale	MITCON	

ANNEXURE 6: LIST OF AFFECTED TITLE HOLDER

Sl. No.	Name of the Village/ Town	Station location /viaduct	Side	Distance from Center line in meter	Chain age	Khasra / Survey No. (Land)	Name of the Landowner	Age (In Yr)	Religion	Social Category	Type of Land	Ownership Status	Affected Area of the Plot (in Sq. Mtr)	Intensity of Impact	Vulnerable group other than SC/ST	Literacy Level	Annual Income (in Rs.)
1	Jamtha	Metro City to Ashokvan for Viaduct	C	7.5	21500 to 22900	59/2	Ishwar Nathu Dhage	60	Hindu	OBC	Barren	Private	1310	Non-Significant	MPCE	Secondary	60000
2	Jamtha	Metro City to Ashokvan for Viaduct	C	7.5	21500 to 22900	59/1	Vaman Dhage	49	Hindu	OBC	Barren	Private	249	Non-Significant		Graduate	600000
3	Jamtha	Metro City to Ashokvan for Viaduct	C	7.5	21500 to 22900	92	Hemraj Ganpati Hinge	87	Hindu	OBC	Barren	Private	2520	Non-Significant		Primary	144000
4	Gavasi Manapur	Metro City to Ashokvan for Viaduct	C	7.5	21500 to 22900	7	Hariram Namji Warade	67	Hindu	OBC	Barren	Private	100	Non-Significant		Graduate	540000
5	Gavasi Manapur	Metro City to Ashokvan for Viaduct	C	7.5	21500 to 22900	5/2 and 5/3	Paras Devraj Gundecha (Vevej Hotel & Estate Pvt.ltd)	35	Jain	General	Barren	Private	2268	Significant		Graduate	1200000
6	Jamtha	Metro City to Ashokvan for Viaduct	C	7.5	21500 to 22900	91 PART (Plot No. 21)	Pawan Kumar Laxman Patil	36	Hindu	General	Barren	Private	135	Significant		Technical	1200000
7	Jamtha	Metro City to Ashokvan for Viaduct	C	7.5	21500 to 22900	91 PART (Plot No. 22)	Manish Girdhardas Kothari	42	Hindu	General	Barren	Private	135	Significant		Technical	600000
8	Jamtha	Metro City to Ashokvan for Viaduct	C	7.5	21500 to 22900	91 (Plot No. 29)	Sachin Lamsonge	57	Budhist	SC	Barren	Private	135	Significant		Technical	300000
9	Jamtha	Metro City to Ashokvan for Viaduct	C	7.5	21500 to 22900	91 (Plot No. 30)	Sachin Lamsonge	57	Budhist	SC	Barren	Private	135	Significant		Technical	300000

Sl. No.	Name of the Village/ Town	Station location /viaduct	Side	Distance from Center line in meter	Chainage	Khasra / Survey No. (Land)	Name of the Landowner	Age (In Yr)	Religion	Social Category	Type of Land	Ownership Status	Affected Area of the Plot (in Sq. Mtr)	Intensity of Impact	Vulnerable group other than SC/ST	Literacy Level	Annual Income (in Rs.)
10	Jamtha	Metro City to Ashokvan for Viaduct	C	7.5	21500 to 22900	91 (Plot No. 59)	Sushma Vijay Wankhede	61	Hindu	SC	Barren	Private	135	Significant		Graduate	600000
11	Jamtha	Metro City to Ashokvan for Viaduct	C	7.5	21500 to 22900	91 PART (Plot No. 43)	Deepak Bapurao Pendam	55	Hindu	ST	Barren	Private	135	Significant		Graduate	960000
12	Jamtha	Metro City to Ashokvan for Viaduct	C	7.5	21500 to 22900	91 PART (Plot No. 44)	Ashish Krishna Rao Godghate	43	Hindu	SC	Barren	Private	135	Significant		Graduate	588000
13	Jamtha	Metro City to Ashokvan for Viaduct	C	7.5	21500 to 22900	91 PART (Plot No. 45)	Amit Anantrao Adhulkar	36	Hindu	OBC	Barren	Private	135	Significant		Technical	480000
14	Jamtha	Metro City to Ashokvan for Viaduct	C	7.5	21500 to 22900	91 (Plot No. 59)	Pankuri Laxman Wanjari	60	Hindu	OBC	Barren	Private	150	Significant		Graduate	600000
15	Jamtha	Metro City to Ashokvan for Viaduct	C	7.5	21500 to 22900	91 PART (Plot No. 61)	Sandhya Prabhakar Carple	61	Hindu	OBC	Barren	Private	158	Significant	WHH	Graduate	480000
16	Jamtha	Metro City to Ashokvan for Viaduct	C	7.5	21500 to 22900	91 PART (Plot No. 62)	Sukhant Namderao Ninave	42	Hindu	OBC	Barren	Private	141	Significant		Technical	3600000
17	Jamtha	Metro City to Ashokvan for Viaduct	C	7.5	21500 to 22900	91	Shri. Anil R. Jambhulkar- Not available during census				Barren	Private	85	Significant			
18	Jamtha	Metro City to Ashokvan for Viaduct	C	7.5	21500 to 22900	91	Shri. Atul Pazare – Not available during census				Barren	Private	85	Significant			
19	Jamtha	Metro City to Ashokvan for Viaduct	C	7.5	21500 to 22900	91	Shri. Pradip Jadhav –Not available during census				Barren	Private	2162	Non-Significant			

Sl. No.	Name of the Village/ Town	Station location /viaduct	Side	Distance from Center line in meter	Chainage	Khasra / Survey No. (Land)	Name of the Landowner	Age (In Yr)	Religion	Social Category	Type of Land	Ownership Status	Affected Area of the Plot (in Sq. Mtr)	Intensity of Impact	Vulnerable group other than SC/ST	Literacy Level	Annual Income (in Rs.)
20	Jamtha	Metro City to Ashokvan for Viaduct	C	7.5	21500 to 22900	93	Shri. Dilip Motiram Hinge –Not available during census				Barren	Private	200	Non-Significant			
21	Gavasi Manapur	Metro City to Ashokvan for Viaduct	C	7.5	21500 to 22900	30	Shri. Shyam Sambhar –Not available during census				Barren	Private	168	Non-Significant			
22	Jamtha	Ashokvan	R	19.6	24000	143	Dilip Mase	43	Hindu	General	Barren	Private	500	Non-Significant		Graduate	2400000
23	Jamtha	Ashokvan	R	22.7	24000	111	Gurpreet Singh and Gurjeet Singh	40	Sikh	General	Barren	Private	500	Significant		Secondary	1800000
24	Jamtha	Ashokvan	L	22.5	24000	114/1, ञ	Prabhakar Bitthalrao Warhade	57	Hindu	OBC	Barren	Private	708	Non-Significant		Technical	540000
25	Jamtha	Dongargaon	R	22.5	26800	5 (PLOT NO 8 & 9)	Madhuri Amritrao Deotale	61	Hindu	OBC	Barren	Private	500	Significant	WHH	Graduate	120000
26	Mohagaon	Mohagaon	R	22.5	30010	5/2/B	Smt Sandhya Asthankar–Not available during census				Barren	Private	500	Non-Significant			
	CorridoReach-2A- Automotive Square to Kanhan River (Kamptee Corridor)																
27	Wanjara	Pili Nadi	R	18.6	-1425	KH NO. 39, CTS NO 80/2, SHEET NO 25-484	Vikas Garg	49	Hindu	General	Barren	Private	707.5	Non-Significant		Graduate	1200000
28	Wanjara	Pili Nadi	R	19.2	-1425	KH NO. 44, CTS NO 107, SHEET NO 25-484	Shabir Wali	58	Muslim	General	Barren	Private	511	Non-Significant		Graduate	2400000

Sl. No.	Name of the Village/ Town	Station location /viaduct	Side	Distance from Center line in meter	Chainage	Khasra / Survey No. (Land)	Name of the Landowner	Age (In Yr)	Religion	Social Category	Type of Land	Ownership Status	Affected Area of the Plot (in Sq. Mtr)	Intensity of Impact	Vulnerable group other than SC/ST	Literacy Level	Annual Income (in Rs.)
29	Wanjara	Khasara Fata	L	20.5	-2250	KH NO. 66, CTS NO 99, SHEET NO 14-492	Ulash Laxman Rao Ghate	74	Hindu	General	Barren	Private	708	Non-Significant		Secondary	540000
30	Wanjara	Khasara Fata	R	21.01	-2250	68/2, CTS-256	Shri Uday Singh Shreya–Not available during census		Hindu	General	Barren	Private	500	Non-Significant			
31	Bhilgaon	All India Radio	L	19.1	-3350	KH NO 181 /1 & 2	Dr. Roshan Dhore (Narayana Vidyalaya)	48	Hindu	General	Barren	Private	220	Non-Significant		Technical	6000000
32	Bhilgaon	All India Radio	L	15	-3350	KH NO 180/2	Zozer Mufaddal Amin	41	Muslim	OBC	Barren	Private	94	Non-Significant		Technical	10200000
33	Khairi	Khairi Fata	L	17.04	-5250	KH NO: 14/3	Paras Pramod Agrawal	32	Hindu	General	Barren	Private	708	Non-Significant		Illiterate	2400000
34	Khairi	Khairi Fata	R	17.05	-5250	KH No. 36	Savita Keshar	64	Hindu	General	Barren	Private	500	Non-Significant	WHH	Graduate	960000
35	Yerkheda	Lok Vihar	L	21.45	-6250	KH NO 66/4	Mufaddal Amin	41	Muslim	OBC	Barren	Private	164	Non-Significant		Technical	10200000
36	Yerkheda	Lok Vihar	R	15.02	-6250	KH NO 46,47/1/2/2/1/2/3/20 T0 27	Sanjay Ganpatrao Patil (M/s. Maitraiya Developers)	54	Hindu	General	Barren	Private	653	Non-Significant		Graduate	6000000
37	Yerkheda	Lekha Nagar	L	15.02	-7275	KH NO 100/1, GLR NO. 46 CLASS-B2	Mansing Fulchand Choudhary	42	Hindu	OBC	Barren	Private	500	Non-Significant		Graduate	384000
	CorridoReach-3A- Lokmanya Nagar to Hingna (Hingna Corridor)																
38	Nildoha	Hingna Mount View	L	18.02	18750	27	Vishal Kale	46	Hindu	OBC	Barren	Private	304	Significant		Graduate	600000

Sl. No.	Name of the Village/ Town	Station location /viaduct	Side	Distance from Center line in meter	Chainage	Khasra / Survey No. (Land)	Name of the Landowner	Age (In Yr)	Religion	Social Category	Type of Land	Ownership Status	Affected Area of the Plot (in Sq. Mtr)	Intensity of Impact	Vulnerable group other than SC/ST	Literacy Level	Annual Income (in Rs.)
39	Wana dongri	Rajiv Nagar	R	12.08	19925	205	M/s Abhijeet Power–Not available during census		Hindu	General	Barren	Private	708	Non-Significant			
40	Wan adongri	Wanadongri	R	28.652	20975	341	Naman Balmukund Agrawal	34	Hindu	General	Barren	Private	679	Significant		Technical	840000
41	Wana dongri	Wanadongri	L	14.475	20975	285/2B	Dada Rao Bandre	44	Hindu	OBC	Barren	Private	546	Significant		Graduate	6000000
42	Wana dongri	Wanadongri	R	17.49	20975	341/2	Shri Arun Patil –Not available during census		Hindu	General	Barren	Private	120	Significant			
43	Wana dongri	APMC	R	16.03	21750	334/2	Pawan Kumar Bang	34	Hindu	General	Barren	Private	279	Non-Significant		Technical	300000
44	Wana dongri	APMC	R	16.02	21750	334/2	Gani Abdul Shaikh	58	Muslim	OBC	Barren	Private	279	Significant	PwD	Graduate	600000
45	Wana dongri	APMC	L	16.03	21750	288/6	Nakul Balmukund Agrawal	30	Hindu	General	Barren	Private	743	Significant		Technical	840000
46	Wana dongri	APMC	R	16.04	21750	334/2	Shri Yadavrao Yerpude –Not available during census		Hindu	General	Barren	Private	279	Significant			
47	Hingna	Hingna	L	14.65	24525	113	Arun Dhole - Vinkar / Dhangar Society	74	Hindu	OBC	Barren	Private	573	Non-Significant		Graduate	900000
48	Hingna	Hingna	R	15.1	24525	114/8	Shesh Rao Sita Ram Budhe	81	Hindu	OBC	Barren	Private	398	Non-Significant		Graduate	720000
	CorridoReach-4A- Prajapati Nagar to Transport Nagar (Kapsi Corridor)																
49	Bhandewadi	Pardi	L	22.04	-1400	CTS NO 222	Prateek Gupta [Construction & Developers (Housing Scheme Business)]	35	Hindu	General	Barren	Private	777	Significant		Graduate	5040000
50	Bhandewadi	Pardi	R	18.07	-1400	CTS NO 289	Tarun Kacha (Kacha & Sons Firm)	49	Hindu	General	Barren	Private	278	Significant		Technical	504000

Sl. No.	Name of the Village/ Town	Station location /viaduct	Side	Distance from Center line in meter	Chain age	Khasra / Survey No. (Land)	Name of the Landowner	Age (In Yr)	Religion	Social Category	Type of Land	Ownership Status	Affected Area of the Plot (in Sq. Mtr)	Intensity of Impact	Vulnerable group other than SC/ST	Literacy Level	Annual Income (in Rs.)
51	Kapsi Khurd	Kapsi Khurd	L	15	-3250	53/3	Jagrup Singh Kalse (Shri Gurunanak Engineering)	45	Sikh	General	Barren	Private	900	Significant		Graduate	600000

Note: Total TH = 51, Out of that 10 are non-responsive

ANNEXURE 7: LIST OF AFFECTED NON-TITLE HODERS

Sl. No.	Name of the Village	Location	Proposed Station	Side	Distance from Centre Line in meter	Name of head of the Household	Occupation	Use of structure / Property	Ownership of Status	Type of Structure	Intensity of Impact	Family Type	Religion	Social Category	Vulnerable group other than SC/ST	Literacy Level	Annual Income
1	Kinhi	Butibori, Nagpur	Mhada Colony	LHS	16.5	Raju Shivankar	Small Business	Kiosk	NTH	Temporary	Non-Significant	Nuclear	Hindu	OBC	BPL	Secondary	120000
2	Kinhi	Satgaon, Butibori, Nagpur	Mhada Colony	LHS	17.4	Dinesh Rodle	Small Business	Kiosk	NTH	Temporary	Non-Significant	Nuclear	Hindu	OBC		Secondary	240000
3	Kinhi	Butibori, Ward No. 3, Nagpur	Mhada Colony	LHS	17	Pradeep Nanaji Raut	Small Business	Kiosk	NTH	Temporary	Non-Significant	Joint	Hindu	ST		Secondary	144000
4	Kinhi	Butibori, Nagpur	Mhada Colony	LHS	15	Avinash Balbudhe	Small Business	Kiosk	NTH	Temporary	Non-Significant	Nuclear	Hindu	OBC		Secondary	120000
5	Kinhi	Butibori Dream Five Colony, Bal Bharti, Nagpur	Mhada Colony	LHS	15.6	Prafool Thakur	Small Business	Kiosk	NTH	Temporary	Non-Significant	Nuclear	Hindu	SC		Secondary	180000
6	Kinhi	Mhada Colony, Nagpur	Mhada Colony	LHS	16.5	Pandu Sadashiv Panduran g	Small Business	Kiosk	NTH	Temporary	Non-Significant	Nuclear	Hindu	OBC		Secondary	600000
7	Kinhi	Satgaon, Butibori, Nagpur	Mhada Colony	RHS	19.5	Md. Firoz	Small Business	Kiosk	NTH	Temporary	Non-Significant	Nuclear	Muslim	OBC		Secondary	180000
8	Kinhi	Butibori, Ward No. 3, Nagpur	Mhada Colony	RHS	20.5	Ravi Ramteke	Small Business	Kiosk	NTH	Temporary	Non-Significant	Nuclear	Hindu	SC		Graduate	180000
9	Kinhi	Butibori, Nagpur	Mhada Colony	RHS	21.5	Kishor Bitthal	Small Business	Kiosk	NTH	Temporary	Non-Significant	Nuclear	Hindu	OBC		Primary	144000
10	Kinhi	Satgaon, Butibori, Nagpur	Mhada Colony	RHS	22.6	Nilkanth Choudhar y	Small Business	Kiosk	NTH	Temporary	Non-Significant	Joint	Hindu	OBC	BPL	Secondary	360000
11	Kinhi	Butibori, Ward No. 2, Nagpur	Mhada Colony	RHS	16.5	R. Mohd. Tahir	Small Business	Kiosk	NTH	Temporary	Non-Significant	Nuclear	Muslim	OBC		Graduate	144000

12	Kinhi	Satgaon, Ward No. 5, Nagpur	Mhada Colony	RHS	22	Gaurav	Small Business	Kiosk	NTH	Temporary	Non-Significant	Nuclear	Hindu	SC		Graduate	180000
13	Kinhi	188 Virsawarkar Nagar, Butibori, Nagpur	Mhada Colony	RHS	21.5	Krisna Soni	Small Business	Kiosk	NTH	Temporary	Non-Significant	Nuclear	Hindu	OBC		Graduate	180000
14	Bhilgaon	Bhilgaon, Nagpur	All India Radio	LHS	21.5	Mirja Shadaab Baig	Small Business	Kiosk	NTH	Temporary	Non-Significant	Joint	Muslim	OBC		Secondary	240000
15	Yerkheda	Bharat Town, Nagpur	Lok Vihar	LHS	21	Rakesh Sharma	Small Business	Kiosk	NTH	Temporary	Non-Significant	Nuclear	Hindu	General		Secondary	108000
16	Kamptee	Hazi Nagar, Near Masjid, Yedkheda, Sunrise Lawn (Opposite), Nagpur	Kamptee Police Station	LHS	16.5	Deen Ali	Small Business	Kiosk	NTH	Temporary	Non-Significant	Nuclear	Muslim	OBC		Secondary	180000
17	Kamptee	Hazi Nagar, Near Masjid, Yedkheda, Sunrise Lawn (Opposite), Nagpur	Kamptee Police Station	LHS	16.5	Anwar Ali	Small Business	Kiosk	NTH	Temporary	Non-Significant	Nuclear	Muslim	OBC		Graduate	180000
18	Kamptee	Kamptee, Ganj Ke Balaji Temple, Near Axis Bank, Nagpur	Kamptee Police Station	RHS	23.5	Raju Mangal Prasad Gupta	Small Business	Kiosk	NTH	Temporary	Non-Significant	Joint	Hindu	OBC		Secondary	144000
19	Kamptee	B.B. Colony, Yerkheda, Near Dr. Maksud, Nagpur	Kamptee Police Station	RHS	22.5	Mohd. Sadik Mumtaj Ahmed	Small Business	Kiosk	NTH	Temporary	Non-Significant	Joint	Muslim	OBC		Secondary	144000
20	Kamptee	Kamptee Police Station, Nagpur	Kamptee Police Station	RHS	23	Dharmendra Ramanand Tiwari	Small Business	Kiosk	NTH	Temporary	Non-Significant	Joint	Hindu	General	PwD	Graduate	96000

21	Kamptee	Hazi Building near Lakadganj, Nagpur	Kamptee Police Station	RHS	18.5	Fuzail Ahmad Ansari	Small Business	Kiosk	NTH	Temporary	Non-Significant	Joint	Muslim	OBC		Primary	144000
22	Nildoha	Gajanan Nagar, Hingna Road, Nagpur	Hingna Mount View	RHS	16.5	Chandraban Bhuraji Sonekar	Small Business	Kiosk	NTH	Temporary	Non-Significant	Joint	Hindu	SC		Primary	300000
23	Nildoha	Gajanan Nagar, Hingna Road, Nagpur	Hingna Mount View	RHS	18	Ridhi Bhola Prasad	Small Business	Kiosk	NTH	Temporary	Non-Significant	Nuclear	Hindu	General		Illiterate	216000
24	Nildoha	Gajanan Nagar, Hingna Road, Nagpur	Hingna Mount View	RHS	15	Sunita Chandrana Swami	Small Business	Kiosk	NTH	Temporary	Non-Significant	Nuclear	Hindu	General	WHH	Primary	240000
25	Nildoha	Gajanan Nagar, Hingna Road, Nagpur	Hingna Mount View	RHS	16.4	Ashish Ramesh Tandekar	Small Business	Kiosk	NTH	Temporary	Non-Significant	Joint	Hindu	SC		Graduate	216000
26	Nildoha	Mhada Colony, Electric Chouk, Ward No. 72, Nagpur	Hingna Mount View	RHS	15.8	O. P. Singh	Small Business	Kiosk	NTH	Temporary	Non-Significant	Joint	Hindu	General		Graduate	180000
27	Wanadongri	Sai Colony, Sangam Road, Nagpur	Wanadongri	RHS	19.5	Moreshvar Bhoir	Small Business	Kiosk	NTH	Temporary	Non-Significant	Nuclear	Hindu	OBC		Secondary	120000
28	Wanadongri	Wanadongri, Hingna Road, Nagpur	Wanadongri	RHS	15	Mirabai Vamanrao Asole	Small Business	Kiosk	NTH	Temporary	Non-Significant	Joint	Hindu	OBC	WHH	Illiterate	312000
29	Wanadongri	Hanuman Mandir, Ward No. 9, Wanadongri, Hingna	Wanadongri	RHS	16.8	Kapil Anil Thakare	Small Business	Kiosk	NTH	Temporary	Non-Significant	Nuclear	Hindu	OBC		Secondary	216000

		Road, Nagpur															
30	Wanadongri	Wanadongri, Hingna Road, Nagpur	Wanadongri	RHS	19.8	Ram Kumar Kushwah	Small Business	Kiosk	NTH	Temporary	Non-Significant	Nuclear	Hindu	OBC		Secondary	144000
31	Hingna	Mahajan Wadi, Hingna, Nagpur	Hingna Bus Station	LHS	20	Nitin Ganesh Bharti	Small Business	Kiosk	NTH	Temporary	Non-Significant	Nuclear	Hindu	General		Secondary	360000
32	Hingna	Hingna Kasba, Ward No. 4, Nagpur	Hingna Bus Station	LHS	22.7	Manish Nathu Choudhary	Small Business	Kiosk	NTH	Temporary	Non-Significant	Joint	Hindu	OBC		Secondary	360000
33	Hingna	Bhole Baba Nagar, Dhankadpur, Hingna, Ward No. 15, Nagpur	Hingna Bus Station	LHS	15.7	Nitesh Dharmopal Ghatode	Small Business	Kiosk	NTH	Temporary	Non-Significant	Joint	Hindu	SC		Secondary	144000
34	Hingna	Hingna Kasba, Ward No. 7, Nagpur	Hingna Bus Station	LHS	16.8	Sheshrao Sadashiv Bansore	Small Business	Kiosk	NTH	Temporary	Non-Significant	Joint	Hindu	OBC		Primary	180000
35	Hingna	Hingna Kasba, Ward No. 7, Nagpur	Hingna Bus Station	LHS	15.8	Prabhakar Sakharam Dorke	Small Business	Kiosk	NTH	Temporary	Non-Significant	Nuclear	Hindu	ST		Primary	144000
36	Hingna	Hingna Kasba, Ward No. 4, Nagpur	Hingna Bus Station	LHS	16.8	Sudhir Motiram Bhakare	Small Business	Kiosk	NTH	Temporary	Non-Significant	Nuclear	Hindu	OBC		Secondary	180000
37	Hingna	Shivaji Nagar, Ward No. 9, Nagpur	Hingna Bus Station	LHS	15	Vinod Devrao Vaidya	Small Business	Kiosk	NTH	Temporary	Non-Significant	Nuclear	Hindu	OBC		Primary	84000
38	Hingna	Hingna Dhankadpur, Ward No. 2, Nagpur	Hingna Bus Station	LHS	16.8	Dilip Bithalrao Khedkar	Small Business	Kiosk	NTH	Temporary	Non-Significant	Nuclear	Hindu	OBC		Secondary	96000

39	Hingna	Hingna (Bhosle Badi) Ward No. 8, Nagpur	Hingna Bus Station	LHS	18.75	Narendra Hiramani Rakhunde	Small Business	Kiosk	NTH	Temporary	Non-Significant	Joint	Hindu	OBC		Primary	216000
40	Hingna	Hingna Kasba, Ward No. 5, Nagpur	Hingna Bus Station	LHS	16.5	Ranjana Nilkanth Nalnawar e	Small Business	Kiosk	NTH	Temporary	Non-Significant	Nuclear	Hindu	ST		Secondary	120000
41	Hingna	Bhosle Wade Ward No. 9, Nagpur	Hingna Bus Station	LHS	18.5	Baban Laxmanrao Chavhan	Small Business	Kiosk	NTH	Temporary	Non-Significant	Joint	Hindu	General		Primary	240000
42	Hingna	Hingna Kasba, Ward No. 5, Near Ganesh Mandir, Nagpur	Hingna Bus Station	LHS	16.9	Niranjan Udav Jadhav	Small Business	Kiosk	NTH	Temporary	Non-Significant	Nuclear	Hindu	General		Secondary	600000
43	Hingna	Ward No. 1, Hingna, Nagpur	Hingna	LHS	15	Suresh Pundikram Lonara	Small Business	Kiosk	NTH	Temporary	Non-Significant	Nuclear	Hindu	OBC	MPCE	Graduate	24000
44	Bhandewadi	Pardi, Nagpur	Pardi	RHS	16.5	Ganga Bai Chauhan	Small Business	Kiosk	NTH	Temporary	Non-Significant	Joint	Hindu	SC		Primary	192000
45	Bhandewadi	Pardi, Nagpur	Pardi	RHS	15.5	Alka Vilash Dhande	Small Business	Kiosk	NTH	Temporary	Non-Significant	Joint	Hindu	OBC	WHH	Graduate	156000
46	Bhandewadi	Pardi, Nagpur	Pardi	RHS	18	Dileswar Fulbande	Small Business	Kiosk	NTH	Temporary	Non-Significant	Nuclear	Hindu	OBC		Secondary	180000
47	Bhandewadi	Pardi, Nagpur	Pardi	RHS	18.5	Tanmay Panchabude	Small Business	Kiosk	NTH	Temporary	Non-Significant	Nuclear	Hindu	OBC		Secondary	96000

ANNEXURE 8: LIST OF NON-RESPONSIVE PAHs

Sr.	Reach	Proposed station	Names	Reason for non-responses
1	Reach 1	Metro city to Ashokvan	Shri Anil Jambhulkar. (Mahalaxmi plot)	No contact number
2			Shri Atul Pazare. (Mahalaxmi Plot)	At USA
3			Shri Shyam Sambhal	No Contact number
4			Shri Pradeep Jadhav	Not responding / not willingness
5			Shri Dilip Motirao Hinge	Not responding / not willingness
6		Mohagaon	Smt Sandhya Asthankar	No Contact number
7	Reach 2	Kasara Fata	Shri Udaysingh Seriya	Not responding / not willingness
8	Reach 3	Rajiv Nagar	Shri Abhijeet Jaisawal – (Abhijeet Power)	Not responding / not willingness
9		Wanadongari	Shri Arun Patil	No contact number
10		APMC	Shri Yavarao Yerpude	No contact number

ANNEXURE 9: PUBLIC CONSULTATION FINDINGS

<table>
<tr><td>1</td><td>Public Consultation Date</td><td>28.04.2023</td></tr>
<tr><td></td><td>Location</td><td>Dongargaon traders and Grampanchayat (REACH-1A)</td></tr>
<tr><td></td><td>Findings</td><td>The consultation is conducted with Dongargaon Grampanchayat and weekly market traders (CPR).
The team has initiated the discussion with lady sarpanch Smt. Kalpana Koram. This public consultation was interactive and conversation with exchange of ideas and suggestion on relocation of CPR.
People were in favour of Phase II project, and they wanted to complete the project as early as possible. Sarpanch and other committee members have demanded the alternative land for relocation of market and necessary basic amenities like water and power connection, road connectivity etc to the new location.
Peoples also concerned about arrangement of safety precaution during civil activity as they are located near station.
The participation of women was very good. The decision-making power remains with many of women in the gram panchayat committee. Many of traders are women and they shared their view on relocation. They demanded that the resettlement site should have all the basic facilities like water and electricity connection. The proposed market should be spacious with proper shed.
It was informed to the participants that their concerns and valuable suggestions will be intimated to the concern officer of NMRP for consideration for planning and implementation of the project.</td></tr>
<tr><td></td><td>Attendance List</td><td>
<table>
<tr><th>Sr.N</th><th>Name of Participants</th><th>Occupation</th><th>Age</th><th>Sex</th></tr>
<tr><td>1</td><td>Mrs. Kalpana S. Koram -</td><td>Sarpanch</td><td>32</td><td>Female</td></tr>
<tr><td>2</td><td>Mrs. Ranjana M. Bondre</td><td>Dy. Sarpanch</td><td>45</td><td>Female</td></tr>
<tr><td>3</td><td>Shri Devendra Singh Gour</td><td>Member</td><td>30</td><td>Male</td></tr>
<tr><td>4</td><td>Smt Chaaya Pradip Sharnagat</td><td>Member</td><td>45</td><td>Female</td></tr>
<tr><td>5</td><td>Shri Raju Amte</td><td>Member</td><td>36</td><td>Female</td></tr>
<tr><td>6</td><td>Smt Rajiyabegam Saiyad</td><td>Member</td><td>47</td><td>Female</td></tr>
<tr><td>7</td><td>Shri Pramod Pulkar</td><td>Member</td><td>48</td><td>Male</td></tr>
<tr><td>8</td><td>Shri Narendra Maske</td><td>Member</td><td>38</td><td>Male</td></tr>
<tr><td>9</td><td>Smt Vijaya Amle</td><td>Member</td><td>48</td><td>Female</td></tr>
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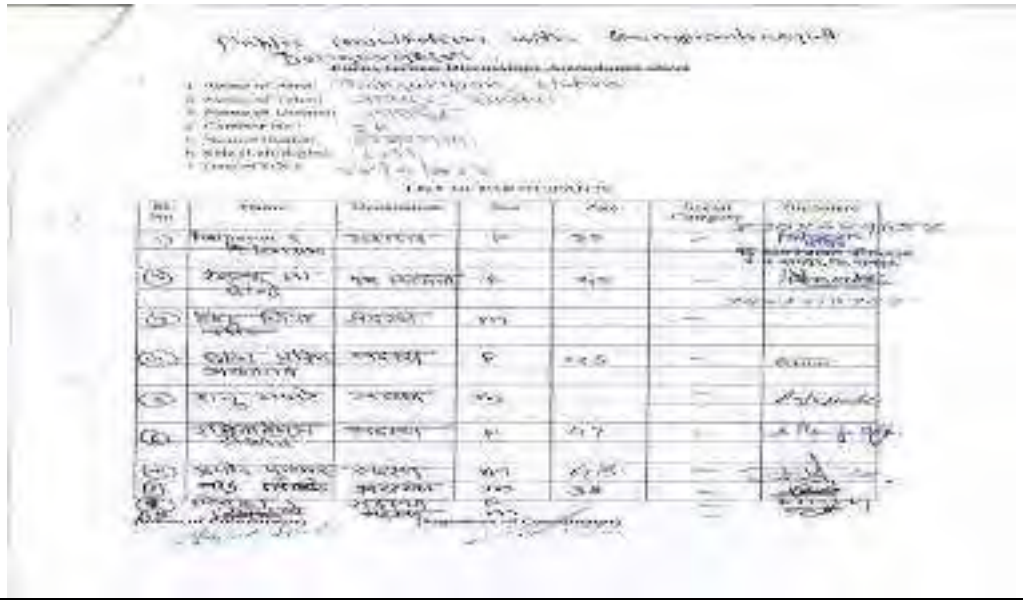
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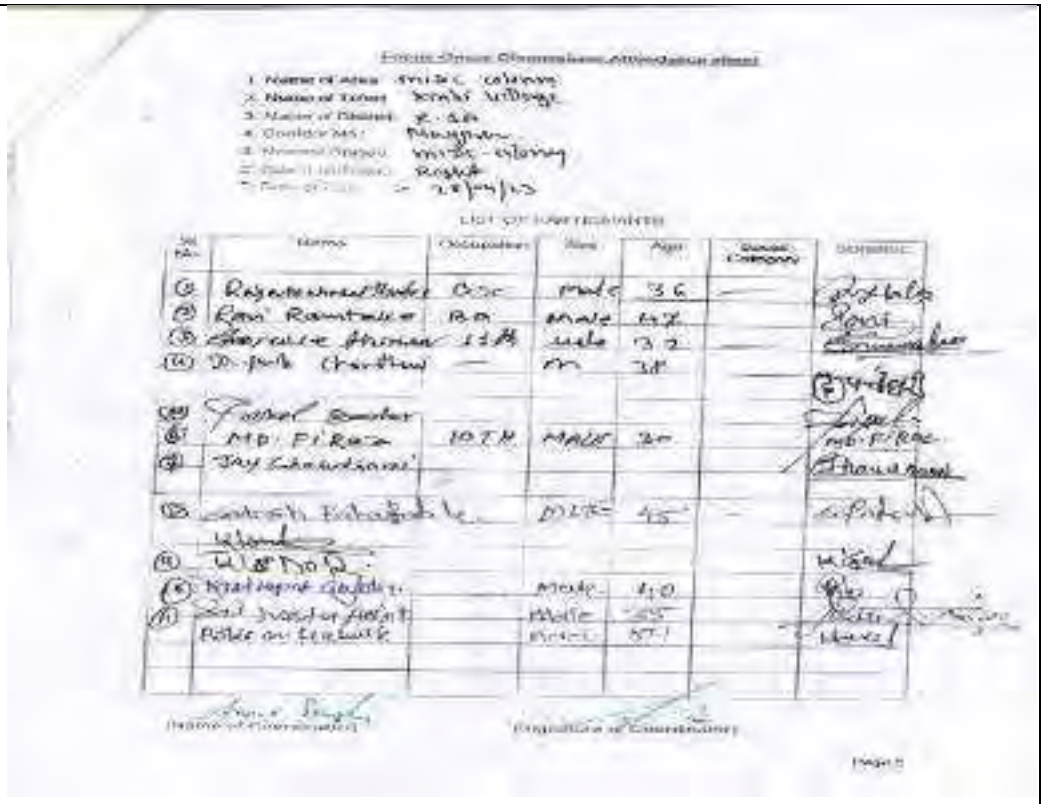
2	Public Consultation Date	28.04.2023 (REACH-1A)
	Location	MIDC Colony
	Findings	This consultation is conducted with some kiosk owners. All the people were happy for Phase-II project, as the transportation will increase the footfalls near them thereby there are chances to increase in their business. All the kiosk holders expressed concern about the location where NMRP is going to relocate them. Most of the people demanded feasible alternate space for relocation. People also insisted to start work early and complete within the time so that there will be no traffic congestion during civil work. Majority of people asked about the transportation assistance for relocation. It was informed to the participants that their concerns and valuable suggestions will be intimated to the concern officer of NMRP for consideration for planning and implementation of the project.

Attendance

Sr.No	Name of Participants	Occupation	Age	Sex
1	Shri Rajan Thombar	Business	36	Male
2	Shri Ravi Ramteke	Business	47	Male
3	Smti Grarcake Ahirwar	Business	32	Female
4	Shri Deepak Choudhari	Working	38	Male
5	Shri Tripal Bhaskar	Business	50	Male
6	Md. Firoz	Business	34	Male
7	Smt Jaya Choudhari	Business	35	Female
8	Shri Santosh Rahafable	Working	45	Male
9	Shri Kishor	Business	32	Male
10	Shri Rastrapat Gajbhiye	Working	40	Male
11	Shri Sai Pant	Business	35	Male
12	Shri Ashish Malvire	Business	50	Male

		
		 
3	Public Consultation Date	11.04.2023
	Location	Pili Nadi, (REACH-2A)
	Findings	The consultation conduced with local public. They were happy for the Phase-II project. The people have demanded the project should start and finished in time so that there will be no traffic congestion. Some of the people were concerned about the dust formation during the civil work start. People were also concerned about the safety management plan and precaution of local travellers during the commencement of civil work. It was informed to the people that proper care and safety will be taken during the construction period. It was informed to the participants that their concerns and valuable suggestions will be intimated to the concern officer of NMRP for consideration for planning and implementation of the project.

Attendance

Sr.No	Name of Participants	Occupation	Age	Sex
1	Shri Bablu Ladse	Business	43	Male
2	Smt Varsha Naruli	Business	34	Male
3	Shri Rahul Kumar	Business	22	Male
4	Smt Jaya Sharma	Business	30	Female
5	Smt Vinaya Kumar	Private Job	35	Female
6	Shri Sandip Singh	Business	42	Male
7	Shri Sanjay Varma	Business	35	Male
8	Shri Vinayak Choudhari	Business	40	Male
9	Shri Aakash Dip	Working	38	Male
10	Shri Narendra Gupta	Business	35	Male
11	Shri Vishwanath Sharma	Private Job	38	Male
12	Shri Pravin Kumar	Private Job	35	Male
13	Shri Ajay Gupta	Private Job	38	Male

<table>
<tr><td>4</td><td>Public Consultation Date</td><td>11.04. 2023</td></tr>
<tr><td></td><td>Location</td><td>Khasara Fata, (REACH-2A)</td></tr>
<tr><td></td><td>Findings</td><td>The consultation was held with general public and TH.
The people were asking about the compensation of loss of land and assets.
People were asking about commencement of civil work and concerned about the traffic congestion and dust pollution.
Some of the people suggested to take proper care of safety of people during execution of civil work.
It was informed to the people that the land will be purchased as per government rule of direct purchase method. Proper care and safety will be taken during the construction period.
The consultation was very fruitful as people were informed about the project progress and status.
All the people were in favour of the project and support for it.
It was informed to the participants that their concerns and valuable suggestions will be intimated to the concern officer of NMRP for consideration for planning and implementation of the project.</td></tr>
<tr><td></td><td>Attendance</td><td>
<table>
<tr><th>Sr.No</th><th>Name of Participants</th><th>Occupation</th><th>Age</th><th>Sex</th></tr>
<tr><td>1</td><td>Shri Rafiqe Khan</td><td>Student</td><td>20</td><td>Male</td></tr>
<tr><td>2</td><td>Shri Nathakat Ahir</td><td>Private Job</td><td>23</td><td>Male</td></tr>
<tr><td>3</td><td>Shri Ankush Rana</td><td>Private Job</td><td>27</td><td>Male</td></tr>
<tr><td>4</td><td>Shri Rangadhar</td><td>Business</td><td>21</td><td>Male</td></tr>
<tr><td>5</td><td>Shri Piyush Techchand Karate</td><td>Business</td><td>24</td><td>Male</td></tr>
<tr><td>6</td><td>Shri Sumit Rahagade</td><td>Wage Labor</td><td>29</td><td>Male</td></tr>
<tr><td>7</td><td>Shri Liladhar Patel</td><td>Wage Labor</td><td>35</td><td>Male</td></tr>
<tr><td>8</td><td>Shri Gopal Singh</td><td>Wage Labor</td><td>30</td><td>Male</td></tr>
<tr><td>9</td><td>Shri Ajay Kumar</td><td>Wage Labor</td><td>30</td><td>Male</td></tr>
<tr><td>10</td><td>Shri Vinita Jha</td><td>Wage Labor</td><td>32</td><td>Female</td></tr>
<tr><td>11</td><td>Shri Pralhad Singh</td><td>Wage Labor</td><td>30</td><td>Male</td></tr>
<tr><td>12</td><td>Shri Sunil Kumar</td><td>Wage Labor</td><td>32</td><td>Male</td></tr>
<tr><td>13</td><td>Shri Krishna Ingle</td><td>Wage Labor</td><td>33</td><td>Male</td></tr>
<tr><td>14</td><td>Smt Vinaya Gupta</td><td>Wage Labor</td><td>32</td><td>Female</td></tr>
<tr><td>15</td><td>Shri Deepak Kumar</td><td>Wage Labor</td><td>35</td><td>Male</td></tr>
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</td></tr>
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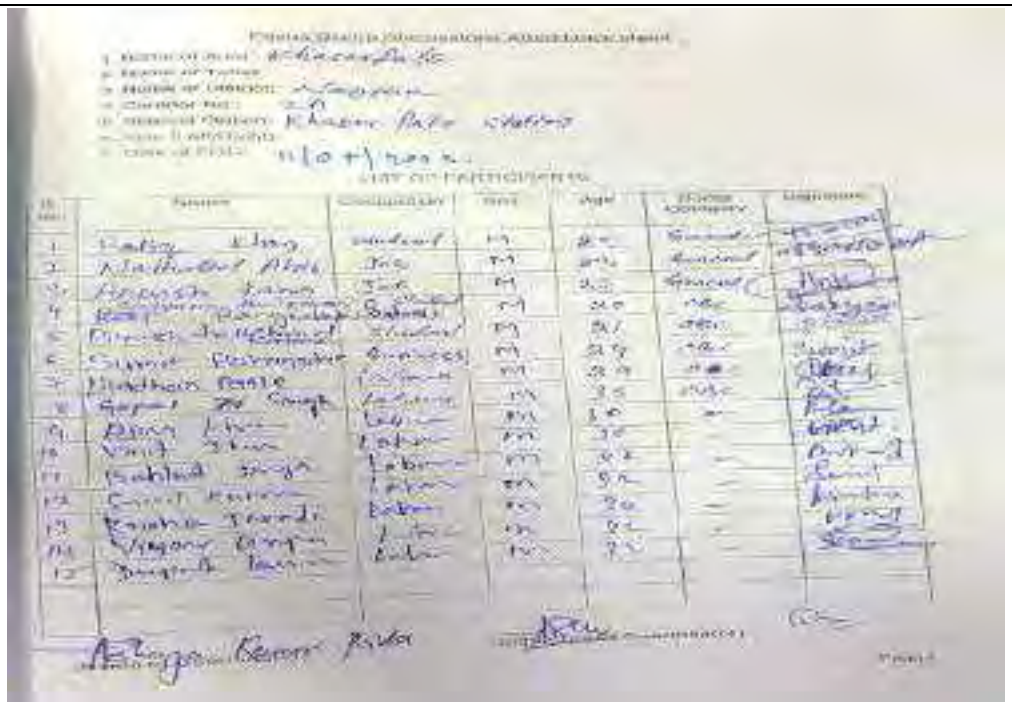
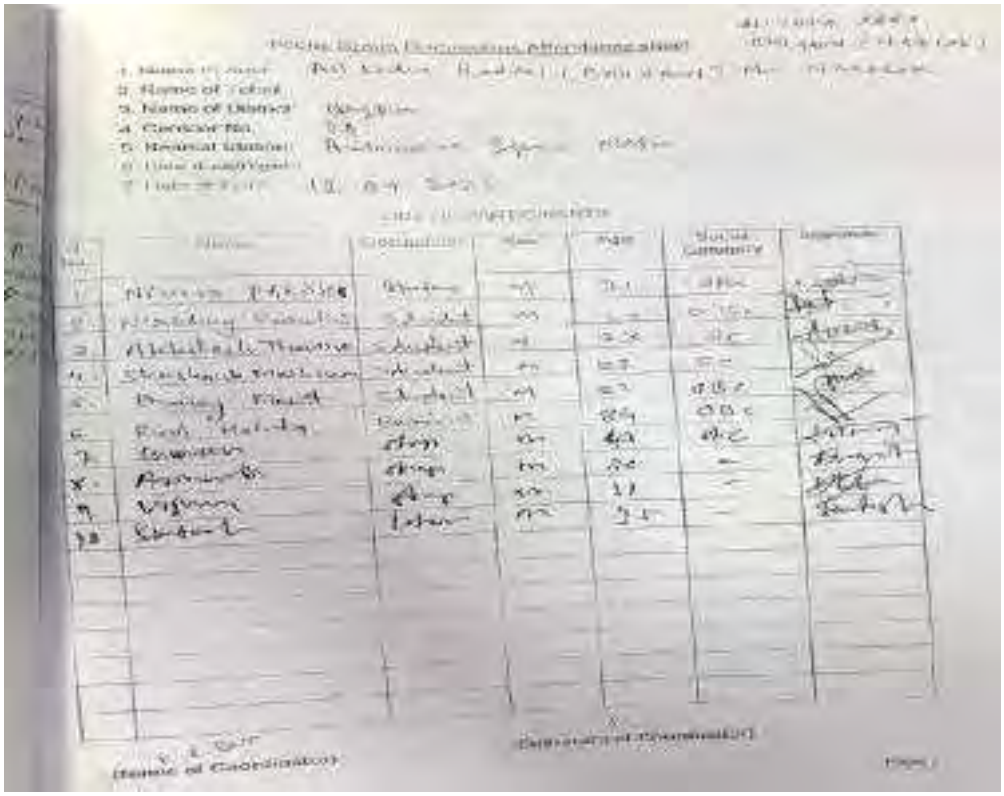
		
		
5	Public Consultation Date	12.04. 2023
	Location	All India Radio, (REACH-2A)
	Findings	This Consultation was held with general public and NTH. The participants were asking about the actual rate of compensation against acquisition of land and assets. The people were demanding widening of road and smooth traffic during the construction period. People were happy for the project and keen to know the date of commencement and completion. The kiosk owners were concerned about the relocation. It was informed to the participants that the land will be purchased under direct purchase method under government rule. NMRP will take responsibility to relocate the NTH to nearby location. During execution of work, it will be ensured that no traffic will be affected. Also, for this purpose coordination shall be done on day-to-day basis with traffic police. The civil work will start in the year 2024.

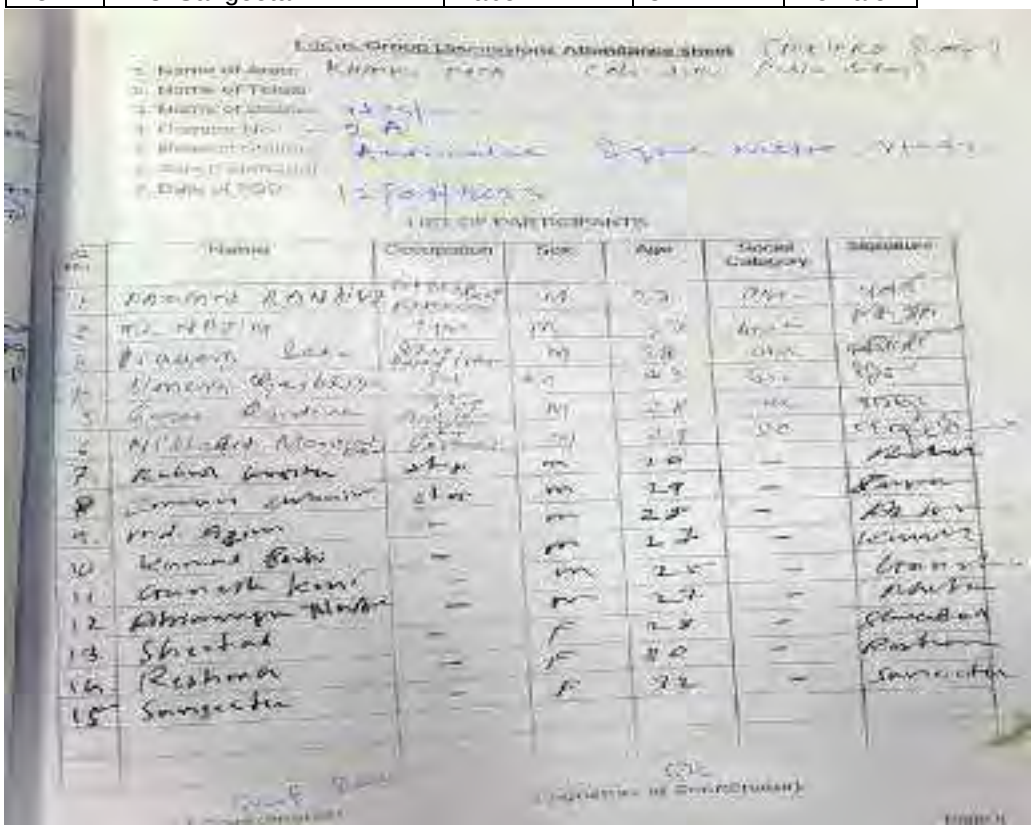
Attendance

Sr.No	Name of Participants	Occupation	Age	Sex
1	Shri Nivesh Parshi	Private job	21	Male
2	Shri Nirbhay Pardhi	Student	23	Male
3	Shri Akhilesh Thawre	Student	23	Male
4	Shri Shashank Meshram	Student	23	Male
5	Smt Pranaya Raut	Student	22	Female
6	Shri Ravi Mehta	Business	84	Male
7	Shri Sawan	Shop	43	Male
8	Shri Ananda	Shop	30	Male
9	Smt Vijaya	Shop	31	Female
10	Smt Santoshi	Shop	35	Female



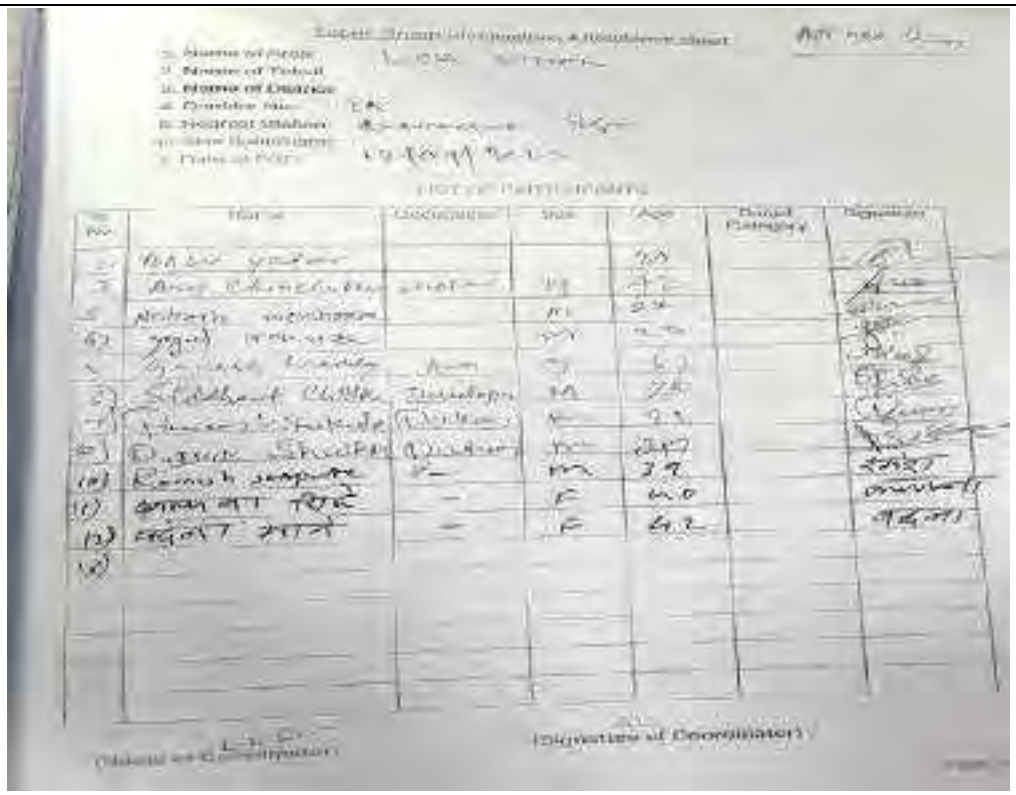
6	Public Consultation Date	12.04. 2023
	Location	Khairi Fata, (REACH-2A)
	Findings	The consultation was held with TH, NTH and general public. Peoples were happy for the Phase- II project; and they show their support to the infrastructure development project in Nagpur. Some of them are concerned about the traffic congestion during the civil work. They are keen to know the starting and completion date of the work. Also, they have demanded safety precaution should be considered during the execution of civil work. It was informed to the participants that all safety measures will be adopted during the execution of the civil work. Overall, the consultation was fruitful to the people
	Attendance	

Sr.No	Name of Participants	Occupation	Age	Sex
1	Shri Pawan Randive	Business	27	Male
2	Md Nijiam	Business	37	Male
3	Shri Pravesh Sahu	Business	38	Male
4	Shri Umesh Gajbhiye	Business	43	Male
5	Shri Gagan Randive	Business	28	Male
6	Shri Nishant Mantarkar	Business	29	Male
7	Shri Rahul Gupta	Business	20	Male
8	Shri Imran Zubair	Business	29	Male
9	Md. Azim	Business	28	Male
10	Shri Kamat Bali	Labor	27	Male
11	Shri Ganesh Keni	Labor	25	Male
12	Shri Abhimanyu Nete	Labor	27	Male
13	Mrs Sheetal	Labor	28	Female
14	Mrs Reshma	Labor	30	Female
15	Mrs Sangeeta	Labor	32	Female




7	Public Consultation Date	12.04. 2023
	Location	Lok Vihar, (REACH-2A)
	Findings	The consultation is held with general public and TH. The people were asking about information on compensation of loss of land and assets. Some of them have also demanded job in Metro. Some other suggested that for civil work road should be widened during the implementation of project. It was informed to the people that the land will be purchased under direct purchase method under government rule. It was informed to the participants that their concerns and valuable suggestions will be intimated to the concern officer of NMRP for consideration for planning and implementation of the project. People were happy for the project and keen to know the date of commencement and completion. All the people were in favour of the project and support for it.
	Attendance	

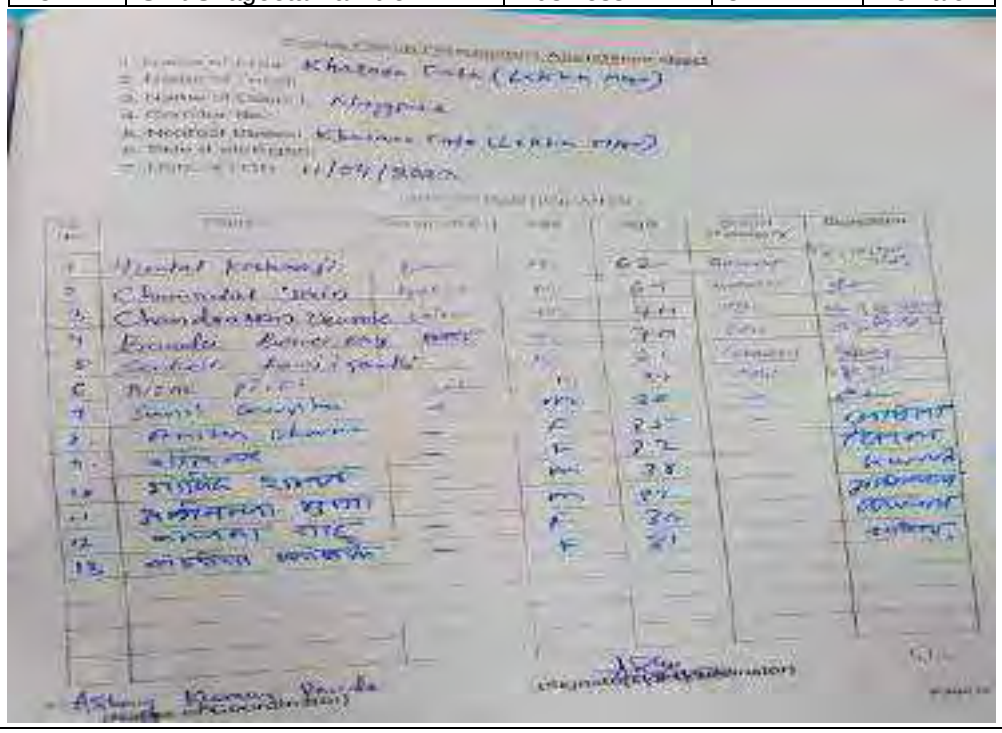
Sr.No	Name of Participants	Occupation	Age	Sex
1	Shri Ballu Yadav	Business	25	Male
2	Shri Anil Chinchulkar	Business	42	Male
3	Mrs Aswini Meshram	Business	27	Female
4	Shri Yugal Tekade	Business	28	Male
5	Shri Ganesh Frandy	Business	52	Male
6	Shri Siddharth Chikhale	Business	23	Male
7	Shri Puram Kitakale	Business	21	Male
8	Shri Raju Shaikh	Business	42	Male
9	Shri Ramesh Satpute	Business	39	Male
10	Smt Kalpana Shinde	Business	40	Female
11	Smt Vandana Mane	Business	42	Female

		
		 
8	Public Consultation Date	12.04.2023
	Location	Lekha Nagar, (REACH-2A)
	Findings	The consultation was held with general public and NTH. During the consultation, the people were asking about provisions for safety during the execution of civil work. Some of them was concern about traffic congestion during the implementation of project. The people also asked about the availability of grievance mechanism for Phase-II project. It was informed to them that all types of safety measures and traffic management will be ensured during the implementation of project. Also, for this purpose coordination shall be done on day-to-day basis with traffic police.

For catering to all kinds of grievances, the Grievance Redress Committee will be established at field and HQ level. NMRP will ensure that all the grievances received shall be redressed and documented.

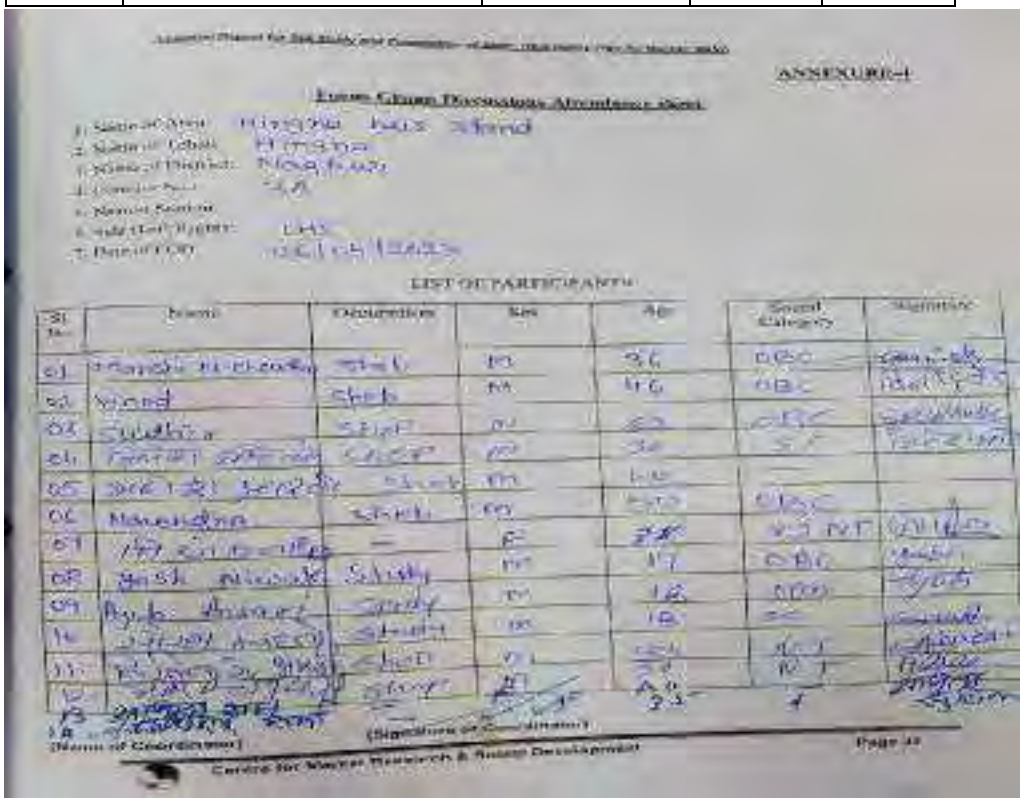
Attendance

Sr.No	Name of Participants	Occupation	Age	Sex
1	Shri Hiral Kishorji	Business	62	Male
2	Shir Champalal Jain	Business	65	Male
3	Shri Chandrakant Daware	Business	70	Male
4	Shri Bandu Bawankar	Business	70	Male
5	Shri Saheb Ravaji Pardhi	Business	65	Male
6	Shri Bisal Pile	Business	50	Male
7	Shri Sunil Gurtha	Private job	38	Male
8	Mrs Anita Chavan	Private Job	35	Female
9	Mrs Sheetal	Business	32	Female
10	Shri Govind Sharma	Business	38	Male
11	Smt Abhinya Gupta	Business	32	Female
12	Smt Kalpana Shanu	Business	30	Female
13	Smt Snageeta Kamble	Business	31	Female



9	Public Consultation Date	06.04. 2023
	Location	Hingna bus stop (REACH-3A)
	Findings	The consultation was held with NTH and general public. Peoples were happy for the Phase- II project; they showed their support to the infrastructure development project in Nagpur. The people were demanding wider road and smooth traffic during the construction period. The kiosk owners were concerned about the relocation site and transportation assistance. It was informed to them that all type of safety measures and traffic management will be adopted during the execution of the project. The relocation of kiosk owners will be done by NMRP in proper coordination with local self-government. The relocation will be done after consultation and to nearby location ensuring that their livelihood will not be impacted.
	Attendance	

Sr.No	Name of Participants	Occupation	Age	Sex
1	Shri Manshi N. Choudhari	Business	36	Male
2	Shri Vinod	Business	46	Male
3	Shri Sudhir	Business	63	Male
4	Shri Nilesh Ghotale	Business	36	Male
5	Shri Ganesh Bharati	Business	60	Male
6	Shri Nerandra	Business	50	Male
7	Shri Niranjan Jadhav	Business	38	Male
8	Shri Yesh Niwale	Study	17	Male
9	Md. Ayub Ansari	Study	18	Male
10	Shri Saurabh Mehta	Study	18	Male
11	Shri Nitin Bharti	Business	33	Male
12	Shri Abhay Choudhari	Business	30	Male
13	Shri Anil Shah	Business	40	Male
14	Smt Sushila Sharma	Business	35	Female


ANNEXURE-I

LIST OF PARTICIPANTS

10	Public Consultation Date	06.04.2023
	Location	Raipur, (REACH-3A)
	Findings	The consultation was held with NTH and general public. The people are in favour of Phase-II project, and they wanted to complete the project within timeline. They also suggested during the construction period the road should be wider for smooth vehicular traffic movement. The shop owners were concerned about their relocation. It was clarified to them that the NMRP will relocate the entire shops to nearby location in consultation with them. The NMRP will provide transportation facilities. The safety measures and traffic management will be ensured during the implementation of project. It was informed to the participants that their concerns and valuable suggestions will be intimated to the concern officer of NMRP for consideration for planning and implementation of the project.
	Attendance	

Sr.No	Name of Participants	Occupation	Age	Sex
1	Shri Ghanshyam	Business	40	Male
2	Shri Krishna Bodal Khande	Business	62	Male
3	Shri Sachin Kurikar	Business	34	Male
4	Shri Chaitanya lorokar	Business	19	Male
5	Smt Rashmi lorikar	Business	33	Female
6	Smt Nitu Jaiswal	Business	40	Female
7	Shri Harshal More	Business	22	Male
8	Smt Prachi Dalal	Business	18	Female
9	Shri Mayur Rujorkar	Business	26	Male
10	Shri Akash Ringayate	Business	23	Male
11	Shri Manik Kalamkar	Business	63	Male
12	Shri Narayan	Business	67	Male

		
	 	
11	Public Consultation Date	10.04.2023
	Location	Pardi, (REACH-4A)
	Findings	The consultation was held with Rickshaw driver, NTH and general public. The peoples were in favour of the Phase-II project, and they wanted to complete the project as early as possible. The kiosk owners were concerned about the relocation site and transportation assistance. It was informed to them that the relocation of NTH will be done by NMRP in proper coordination with local self-government. The place of relocation will be chosen after consultation with NTH ensuring that their livelihood will not be impacted. The landowners were asking for the compensation on loss of land and assets. It was clarified to them that the Compensation of loss of land will be given as per Direct Purchase Method of Government of Maharashtra Rule and the compensation will be decided by the competent authority at District level. Some of them suggested to ensure the safety of women, labour and commuters. It was informed to the participants that their concerns and valuable suggestions will be intimated to the concern officer of NMRP for consideration for planning and implementation of the project.

Attendance

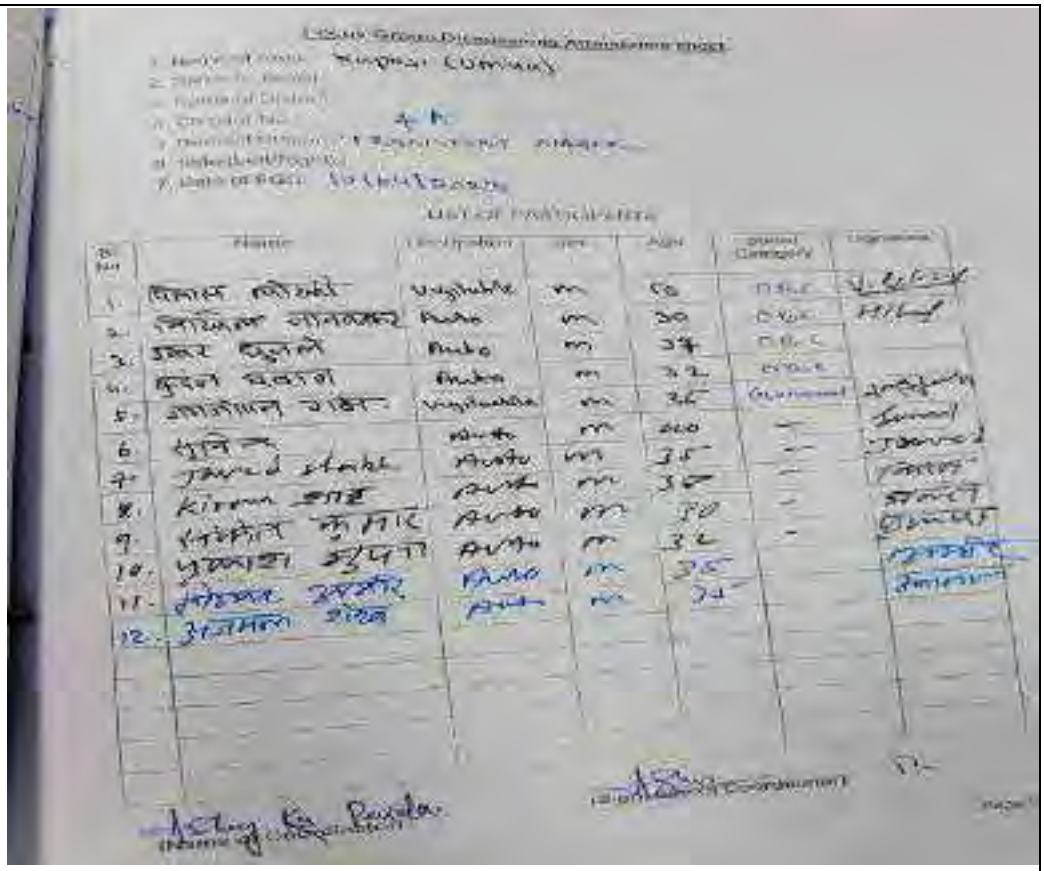
Sr.No	Name of Participants	Occupation	Age	Sex
1	Shri Ajay Jawane	Business	23	Male
2	Shri Suresh Panchabhude	Labor	42	Male
3	Shri Devansh Nimbhakar	Business	28	Male
4	Shri Dileshra Phyubande	Business	50	Male
5	Shri Shahpur Fubande	Working	21	Male
6	Smt Chaitanya Dande	Student	22	Female
7	Shri Gajendra Dande	Working	50	Male
8	Shri Shaikh Javed	Business	35	Male
9	Shri Bablu Meshram	Labor	38	Male
10	Shri Arbaz Khan	Labor	30	Male
11	Shri Krishna Yadav	Labor	32	Male
12	Shri Kishan Kumar	Labor	30	Male
13	Shri Ajay Gupta	Labor	30	Male
14	Shri Deepak Kumar	Labor	35	Male
15	Shri Sanjay Ghate	Labor	32	Male

Photos

12	Public Consultation Date	10.04.2023
	Location	Transport Nagar, (REACH-4A)

	Findings	Majority participants of the public consultation are Rickshaw drivers. They were concerned about their earning may be hampered due to Phase-II metro. It was clarified to them that due to extension of metro network, there will be increase in the number of commuters. This area has many small and medium enterprises and majority of people will use auto rickshaw to Reach metro station and it will help in increasing in the income of Rickshaw drivers. Most of the participants demanded job in metro during the construction. The demand regarding job opportunity during the metro construction has been noted and every effort will be made to recruit local people during the construction phase through contractors. The people were also asking about the availability of grievance mechanism for Phase-II project. It was informed to them that for catering all kinds of grievances, the Grievance Redress Committee will be established at field and HQ level. NMRP will ensures that all the grievances received shall be redressed and documented. It was informed to the participants that their concerns and valuable suggestions will be intimated to the concern officer of NMRP for consideration for planning and implementation of the project.
	Attendance	

Sr.No	**Name of Participants**	**Occupation**	**Age**	**Sex**
1	Shri Vikas Lokhande	Business	50	Male
2	Shri Nikhil Nanavkar	Rickshaw Driver	30	Male
3	Shri Iswar Dhunale	Rickshaw Driver	37	Male
4	Shri Kundan Chavan	Rickshaw Driver	32	Male
5	Shri Jagjivan Raksh	Business	35	Male
6	Shri Sunil	Rickshaw Driver	40	Male
7	Shri Javad Shaikh	Rickshaw Driver	35	Male
8	Shri Kiran Shah	Rickshaw Driver	38	Male
9	Shri Sanket Kumar	Rickshaw Driver	30	Male
10	Shri Prakash Gupta	Rickshaw Driver	32	Male
11	Md Amir	Rickshaw Driver	35	Male
12	Shri Ajmal Shaikh	Rickshaw Driver	35	Male

		
	Photos	 
13	Public Consultation Date	08.05.2023 (Consultation with Students)
	Location	Zero mile
	Findings	The consultation was held with students. The students were happy for the Phase-II project. since many of students were coming from outskirts of Nagpur city for college, they mentioned that the metro will not only save their time but also provide safe mode of transport. Some of them are already travelling in Phase-I line and they said it is the safest mode of transportation. The students informed that the ticket rates are quite high and there should be minimum rate for students for daily transportation. The consultation was fruitful.

It was informed to the students that their concerns and valuable suggestions will be intimated to the concern officer of NMRP for consideration for planning and implementation of the project.

Attendance

Sr.N	Name of Participants	Occupation	Age	Sex
1	Mangesh Tungare	Student	21	Female
2	Janaki Kalbande	Student	21	Female
3	Trupti Lavghare	Student	21	Female
4	Dipali Dalal	Student	23	Female
5	Mayuri Dangdge	Student	21	Female
6	Lalita Bhute	Student	22	Female
7	Vidhi Bothra	Student	20	Female
8	Shahnawaz Ahmad	Student	25	Male
9	Adesh Chimurkar	Student	19	Male
10	Rahul Kumar	Student	24	Male
11	Sanjana	Student	18	Female
12	Piyush D.	Student	18	Male

Photos

MAHARASHTRA METRO RAIL CORPORATION LIMITED
Nagpur Metro Rail Project

Regd Off: *"Metro House", 28/2,*
CK Naidu Marg, Anand Nagar,
Civil Lines, Nagpur-440001

Corp. Off: *"Metro Bhavan", East High court*
Road (VIP Road), Near Dikshbhoomi, Nagpur-440010
CIN: U60100MH2015SGC262054, www.metrorailnagpur.com

Annexure - 19

F. No. 19-130/2015-IA III
Government of India
Ministry of Environment, Forest and Climate Change
(I.A. Division)

Indira Paryavaran Bhawan
Aliganj, Jorbagh Road,
New Delhi - 110003

E-mail : aditya.narayan@nic.in
Telefax : 011: 24695398
Dated: 1st March, 2016

The Managing Director
Nagpur Metro Rail Corporation Ltd.,
Metro House, 26/2, CK Naidu Marg, Anand Nagar,
Civil Lines
Nagpur-440001.

Sub Detailed Project Reports (DPRs) of Nagpur Metro Rail Project - comments of MoEF&CC regarding

Ref : Your letter no. NMRCL/PLN/223 dated 6th February, 2016.

Sir,

In the context of your letter dated 6th February, 2016 seeking comments of this Ministry on the Detailed Project Reports (DPRs) of Nagpur Metro Rail Project, I am directed to state that construction of Metro Rail is not covered under EIA Notification, 2006. However, project proponent may note as following for strict compliance

i Proposed construction projects shall incorporate green building features, rain water harvesting system, energy efficiency, water conservation sewage/effluent treatment/disposal, solid waste management vehicle parking etc

ii Statutory clearances under Forest (Conservation) Act, 1980, the Wildlife (Protection) Act, 1972, Air and Water Act as may be required in the case shall be obtained.

iii If any construction is proposed within CRZ area, clearance shall be obtained under the CRZ Notification, 2011. Any construction within CRZ-I shall be on stilts Maintenance and repair activities (Industrial Activities) are not permissible within CRZ

iv Construction of building within Metro rail project for commercial purposes such as mall, offices or residential buildings etc having built up area equal or more than 20,000 m^2 shall require prior environmental clearance from respective State Level Environmental Impact Assessment Authority.

This issues with the approval of the Competent Authority

(A N Singh)
Joint Director (S)

Director (Projects)

Annexure-20: Details of Batching Plant / Casting Yards / Labour Camps

Batching Plant / Casting Yard

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-9A of this EIA-EMP report and Maha Metro's SHE Manual (Annexure-12). Location for RSS and Batching Plant for Reach 2A has been finalised as shown in **Figure 1**.

Figure 1: LOCATION OF RSS LAND, BATCHING PLANT (REACH-2A)

Layout Plan of the Khairi RSS is shown in **Figure 2** below:

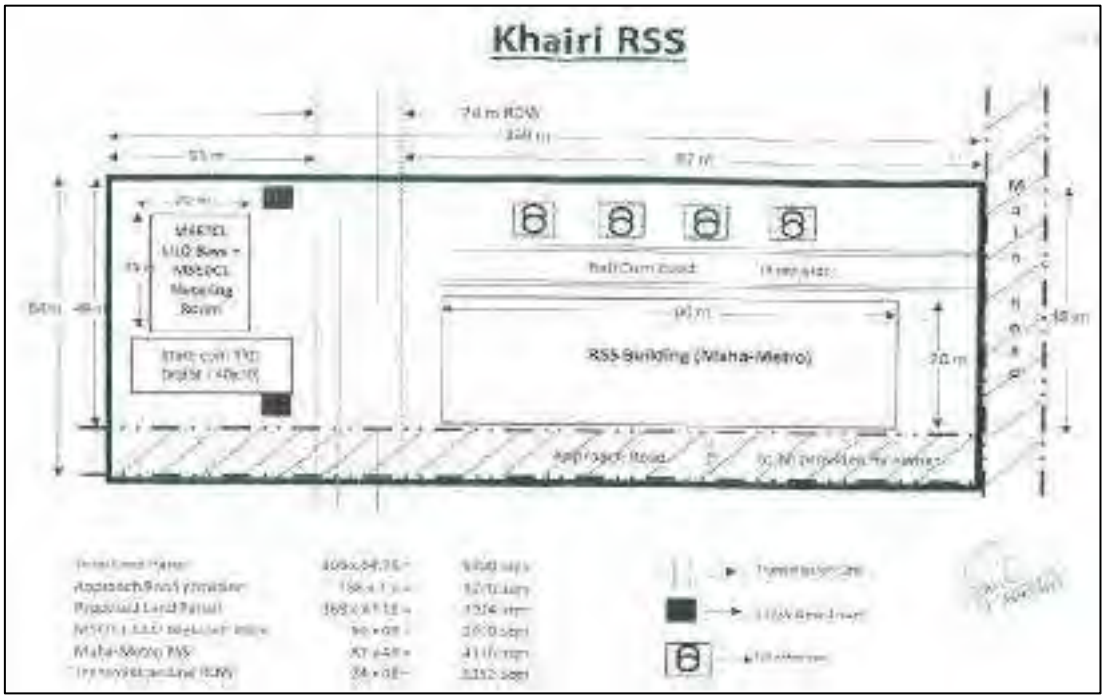


Figure 2: LAYOUT PLAN OF KHAIRI RSS

The Contractor finalised for Reach 2A has obtained Consent to Establish (CtE) from Maharashtra State Pollution Control Board (MPCB) as prescribed, and applied for Consent to Operate (CtO). Copy of the CtE is attached below.

MAHARASHTRA POLLUTION CONTROL BOARD

Tel: 0712-2560152
Fax: 0712-2560851
Website: http://mpcb.gov.in
Email: sronagpur1@mpcb.gov.in

Udyog Bhavan , 6th floor , Near Sales Tax Office, Civil Line , Nagpur - 440 001

GREEN/S.S.I (G37)
No:- Format1.0/SRO/UAN
No.0000196394/CE/2403001813

Date: 18/03/2024

To,
M/s. D. P. Jain and Co. Infrastructure Pvt. Ltd
S. No. 14/1,S. No. 14/1, Vill. Khairi,
Tal. Kamptee, Dist. Nagpur

Your Service is Our Duty

Sub: Application for Grant of Consent to Establish under Green Category.

Your application No.MPCB-CONSENT-0000196394 Dated 29.01.2024

For: Grant of Consent to Establish under Section 25 of the Water (Prevention & Control of Pollution) Act, 1974 & under Section 21 of the Air (Prevention & Control of Pollution) Act, 1981 and Authorization under Rule 6 and Rule 18(7) of the Hazardous & Other Wastes (Management & Transboundary Movement) Rules 2016 is considered and the consent is hereby granted subject to the following terms and conditions and as detailed in the schedule I, II, III & IV annexed to this order:

1. **The consent is granted for a period up to :- Commissioning of the unit or up to 5 year whichever is earlier.**
2. **The capital investment of the project is Rs.0.6825 Crs. (As per undertaking submitted by pp Existing CI is-Rs. Crs + Expansion/Increase in C.I. – Rs. Crs)**
3. **Consent is valid for the manufacture of:**

Sr No	Product	Maximum Quantity	UOM
Products			
1	Ready Mix Concrete	3000	m3/month

4. **Conditions under Water (P&CP), 1974 Act for discharge of effluent:**

Sr No	Description	Permitted (in CMD)	Standards to	Disposal Path
1.	Trade effluent	0	As per Schedule-I	Not Applicable
2.	Domestic effluent	0.70	As per Schedule-I	Soaked in soak pit

5. **Conditions under Air (P& CP) Act, 1981 for air emissions:**

Sr No.	Stack No.	Description of stack / source	Number of Stack	Standards to be achieved
1	0	0	0	As per Schedule -II

6. **Non-Hazardous Wastes:**

Sr No	Type of Waste	Quantity	UoM	Treatment	Disposal
NA					

Solid waste from transit mixture washing, muck (debris/sludge) generated from RMC shall either be reused through recovery unit/ Reclaiming system OR disposed off at a designated approved site by local body, for debris / construction waste.

7. **Conditions under Hazardous & Other Wastes (M & T M) Rules 2016 for Collection, Segregation, Storage, Transportation, Treatment and Disposal of hazardous waste:**

Sr No	Category No./ Type	Quantity	UoM	Treatment	Disposal
NA					

8. The consent is issued subject to direction issued by CPCB under section 18(1) (b) of Water (Prevention and Control of Pollution) Act, 1974, regarding classification of Industries dated 07th March 2016.
9. Operation of RMC plant shall be in daytime only. The Day time is reckoned in between 6 a.m. and 6 p.m. i.e. from sun rise to sunset.
10. The Board may make the standards stringent for the RMC/batching plants located within Corporation areas.
11. Commercial plants shall install continuous ambient air quality monitoring station (CAAQMS) within the premises.
12. Captive plants shall carryout ambient air quality monitoring twice in a week for 24 hours.
13. The industry shall comply with the siting criteria as per RMC Notification dtd 16.10.2016.
14. The entire RMC Plant should be enclosed.
15. Industry shall provide covering at all the emission generating points.
16. Industry shall carry out monitoring of ambient air quality twice in a week for 24 hours at windward & lean ward direction and submit the data to Board office on monthly basis.
17. The Board reserves the right to review, amend, suspend, revoke etc. this consent and the same shall be binding on the industry.
18. This consent should not be construed as exemption from obtaining necessary NOC/permission from any other Government authorities.
19. The applicant shall make an application for renewal of consent to operate 60 days prior to the date of expiry of the consent.
20. This consent is issued with the approval of competent authority of the Board.
21. The Board reserves the right to review, amend, suspend, revoke this consent and the same shall be binding on the industry.
22. This consent should not be construed as exemption from obtaining necessary NOC/ permission from any other Government authorities.
23. The applicant shall make an application for renewal of consent 60 days prior to date of expiry of the consent. (Operate/Renewal)
24. This consent is issued as per deligation of powers issued vide office order no. 12/2020 dtd 23/12/2020

25. The RMC plants where the norms are not followed and the technology is old (Star type) shall be discarded within 1 year. Existing RMC plant shall implement the suggested guidelines within a year. The renewal of Maharashtra Pollution Control Board's consent shall be considered only after implementation of new guidelines. The RMC's having valid consent of Maharashtra Pollution Control Board shall amend their consent in compliance with guideline within a year
26. Operation of RMC plant shall be in day time only. However in notified MIDC area, notified industrial parks, outside corporation area timing are not applicable. The Day time shall mean from 6 a.m. to 10 p.m.
27. The industry strictly follows the Guidelines for Ready Mix Concrete Plant (RMC) for sitting criteria of RMC Plant in the State of Maharashtra as per notification dated 7/11/2016.
28. This consent should not be construed as any exemption from obtaining necessary NOC from other Govt. agencies / local bodies as may deemed fit necessary.
29. The applicant shall obtain Consent to Operate from Maharashtra Pollution Control Board before actual commencement of the Unit/Activity. (Establish)
30. The applicant shall make an application for renewal of consent to operate 60 days prior to the date of expiry of the consent.
31. The industry shall submit strictly online all required annual report, manifest, Environment Statement through portal dashboard to this office as Rules time to time.
32. Industry shall also comply with the industry specific standards notified under environment protection act.
33. The applicant shall not used ground water until and unless obtained CGWA NOC till that only out sourced water through tanker shall be used (if applicable).
34. Industry shall obtained Authorization / Registration and submit modalities for waste collection system based EPR approved by UDD, action plan for setting of Plastic Waste Management System under Plastic Waste Management Rules, 2016 as per Rules no. 9 & Plastic Notification 23/03/2018 and amendment thereof.. within 01 Months after approval from UDD submit quarterly report to this office. (If Applicable)
35. The industry shall obtain necessary permission from the Directorate of Industrial Safety and Health (DISH) as per Circular dtd 24/03/2021.
36. Industry shall strictly comply with Board Circular vide No. MPCB/JD(APC)/NCAP/DG Set/B-0090 dtd. 02/06/2023 regarding Retro-Fitting of Emission Control Device (RECD) for in-use Diesel Operated Internal Combustion Engines/D.G. Sets.

Received Consent fee of -

Sr.No	Amount(Rs.)	Transaction/DR.No.	Date	Transaction Type
1	5000.00	TXN2402000518	03/02/2024	Online Payment

Copy to:

1. Regional Officer, MPCB, Nagpur
2. Chief Accounts Officer, MPCB,Sion, Mumbai

SCHEDULE-I

Terms & conditions for compliance of Water Pollution Control:

1. A] Generation - As per your application the treated effluent generation is Nil.

   B] Treatment - NA

   C] Disposal - NA

2. A] As per your application, you have provided Septic Tank followed by Soak pit for the treatment of 0.70 CMD of sewage.

   B] The Applicant shall operate the sewage treatment system to treat the sewage so as to achieve the following standards.

Sr.No	Parameters	Standards (mg/l)	
1	Suspended Solids	Not to exceed	50
2	BOD 3 days 27°C	Not to exceed	30
3	COD	Not to exceed	100

   C] The treated sewage shall be recycled for secondary purposes to the maximum extent and remaining shall be discharged on land for gardening within premise after confirming above standards. In no case, sewage shall find its way for gardening / outside factory premises.

3. The Board reserves its rights to review plans, specifications or other data relating to plant setup for the treatment of waterworks for the purification there of & the system for the disposal of sewage or trade effluent or in connection with the grant of any consent conditions. The Applicant shall obtain prior consent of the Board to take steps to establish the unit or establish any treatment and disposal system or an extension or addition thereto.

4. The industry shall ensure replacement of pollution control system or its parts after expiry of its expected life as defined by manufacturer so as to ensure the compliance of standards and safety of the operation thereof.

5. The Applicant shall comply with the provisions of the Water (Prevention & Control of Pollution) Act, 1974 and as amended, by installing water meters and other provisions as contained in the said act:

Sr. No.	Purpose for water consumed	Water consumption quantity (CMD)
1.	Industrial Cooling, spraying in mine pits or boiler feed	5.00
2.	Domestic purpose	1.00
3.	Processing whereby water gets polluted & pollutants are easily biodegradable	0.00
4.	Processing whereby water gets polluted & pollutants are not easily biodegradable and are toxic	0.00
5.	Gardening	0

6. The Applicant shall provide Specific Water Pollution control system as per the conditions of EP Act, 1986 and rule made there under from time to time/ Environmental Clearance/ CREP guidelines.

SCHEDULE-II

Terms & conditions for compliance of Air Pollution Control:

1. As per your application, you have proposed to provide the Air pollution control (APC) system and also to erect following stack (s) to observe the following fuel pattern:

Stack No.	Source	APC System provided/proposed	Stack Height(in mtr)	Type of Fuel	Sulphur Content(in %)	Pollutant	Standard
0	0	na	0.00	0 0 -- NA--	-	0	-

2. The Applicant shall provide Specific Air Pollution control equipments as per the conditions of EP Act, 1986 and rule made there under from time to time/ Environmental Clearance / CREP guidelines.
3. The Applicant shall obtain necessary prior permission for providing additional control equipment with necessary specifications and operation thereof or alteration or replacement/alteration well before its life come to an end or erection of new pollution control equipment.
4. The Board reserves its rights to vary all or any of the condition in the consent, if due to any technological improvement or otherwise such variation (including the change of any control equipment, other in whole or in part is necessary).
5. The applicant shall install a comprehensive control system consisting of control equipments as is warranted with reference to generation of emission and operate and maintain the same continuously so as to achieve the level of pollutants to the following standards:

6. Control Equipment:

a. In-house measures :-

1. All material transfer points should be covered.
2. The dust containment system shall be provided incorporating either of the following:

   i) Barricading all around the periphery of the plot boundary of height minimum 20 feet or 5 feet above free fall air emission area. Whichever is height with tin sheets same may extend above with netlon clothing whenever required.

   ii) Water sprinkling/Chemical dust stabilizing agent spraying system along the periphery inside the premises of RMC.

   iii) Tree plantation along the periphery inside boundary of the RMC premises having minimum width of 5 meters, on all sides. The foliage of the trees shall adequately cover area upto about 20m height.
3. Internal work area shall be, cement concreted/Asphalted
4. Daily cleaning / Removal of dust accumulation inside the plant (dry/wet) shall be carry out with industrial vacuum cleaner.
5. Two level type washing facility shall be provided at entry and exit points, for transit mixture vehicle.

b. Raw material storage & handling:-

1. Storage silos of cement & fly-ash shall be adequate capacity of dust Collection system such as multi – cyclone followed by bag house assembly.
2. Handling of Cement, sand, fly ash and aggregates shall be carried out with mechanical closed system only.
3. Manual operations shall be permitted only in a closed shed, equipped with dust control system at the loading point as well as roof top secondary dust control system.
4. All Conveyor belts of Sand, aggregate shall be covered with tin sheets and at points dust collection system to be installed to avoid secondary fugitive emissions.
5. Mixing section of cement, aggregate & sand shall be equipped with adequate capacity dust collection system, such as multi-cyclone followed by bag houses, so as to limit dust emissions.
6. Storage area of sand & aggregates shall be equipped with roof top water sprinkler system.
7. The production plant shall be interlocked with air pollution control system.
8. Alternative power supply system should cover both the production and Air Pollution control system.
9. Industry shall provide treatment facility industrial effluent.
10. Industry shall provide disposal facility for treated effluent.
11. Industry shall provide disposal facility for solid waste.
12. Industry shall provide proper exhaust system in the premises.

c. Ambient air quality as a distance of 10 mtr form source or the plant boundary whichever is nearer, shall meet the following standards

Particulate Matter PM 10	Not to Exceed	100 ug/m3
Particulate Matter PM 2.5	Not to Exceed	60 ug/m3

d. Solid waste treatment and disposal:

Solid waste from transit mixture washing, muck (debris/sludge) generated from RMC shall either be reused through recovery unit/ Reclaiming system OR disposed off at a designated approved site by local body, for debris / construction waste. Industry shall comply with following additional conditions:

1. The RMC plants where the norms are not followed and the technology is old (Star type) shall be discarded within 1 year. Existing RMC plant shall implement the suggested guidelines within a year. The renewal of Maharashtra Pollution Control Board's consent shall be considered only after implementation of new guidelines. The RMC's having valid consent of Maharashtra Pollution Control Board shall amend their consent in compliance with guideline within a year.
2. Operation of RMC plant shall be in day time only. However in notified MIDC area, notified industrial parks, outside corporation area timing are not applicable. The Day time shall mean from 6 a.m. to 10 p.m.
3. The industry strictly follows the Guidelines for Ready Mix Concrete Plant (RMC) for sitting criteria of RMC Plant in the State of Maharashtra as per notification dated 7/11/2016.

SCHEDULE-III

Details of Bank Guarantees:

Sr. No.	Consent (C2E/ C2O /C2R)	Amt of BG Imposed	Submission Period	Purpose of BG	Compliance Period	Validity Date
NA						

BG Forfeiture History

Srno.	Consent (C2E/C2O/C2R)	Amount of BG imposed	Submission Period	Purpose of BG	Amount of BG Forfeiture	Reason of BG Forfeiture
NA						

BG Return details

Srno.	Consent (C2E/C2O/C2R)	BG imposed	Purpose of BG	Amount of BG Returned
NA				

SCHEDULE-IV

General Conditions:

1. The Energy source for lighting purpose shall preferably be LED based
2. The PP shall harvest rainwater from roof tops of the buildings and storm water drains to recharge the ground water and utilize the same for different industrial applications within the plant
3. Conditions for D.G. Set
   a) Noise from the D.G. Set should be controlled by providing an acoustic enclosure or by treating the room acoustically.
   b) Industry should provide acoustic enclosure for control of noise. The acoustic enclosure/ acoustic treatment of the room should be designed for minimum 25 dB (A) insertion loss or for meeting the ambient noise standards, whichever is on higher side. A suitable exhaust muffler with insertion loss of 25 dB (A) shall also be provided. The measurement of insertion loss will be done at different points at 0.5 meters from acoustic enclosure/room and then average.
   c) Industry should make efforts to bring down noise level due to DG set, outside industrial premises, within ambient noise requirements by proper sitting and control measures.
   d) Installation of DG Set must be strictly in compliance with recommendations of DG Set manufacturer.
   e) A proper routine and preventive maintenance procedure for DG set should be set and followed in consultation with the DG manufacturer which would help to prevent noise levels of DG set from deteriorating with use.
   f) D.G. Set shall be operated only in case of power failure.
   g) The applicant should not cause any nuisance in the surrounding area due to operation of D.G. Set.
   h) The applicant shall comply with the notification of MoEFCC, India on Environment (Protection) second Amendment Rules vide GSR 371(E) dated 17.05.2002 and its amendments regarding noise limit for generator sets run with diesel.
4. The applicant shall maintain good housekeeping.
5. The non-hazardous solid waste arising in the factory premises, sweepings, etc. be disposed of scientifically so as not to cause any nuisance / pollution. The applicant shall take necessary permissions from civic authorities for disposal of solid waste.
6. The applicant shall not change or alter the quantity, quality, the rate of discharge, temperature or the mode of the effluent/emissions or hazardous wastes or control equipments provided for without previous written permission of the Board. The industry will not carry out any activity, for which this consent has not been granted/without prior consent of the Board.
7. The industry shall ensure that fugitive emissions from the activity are controlled so as to maintain clean and safe environment in and around the factory premises.
8. The industry shall submit quarterly statement in respect of industries obligation towards consent and pollution control compliance's duly supported with documentary evidences (format can downloaded from MPCB official site).
9. The industry shall submit official e-mail address and any change will be duly informed to the MPCB.
10. The industry shall achieve the National Ambient Air Quality standards prescribed vide Government of India, Notification No. B-29016/20/90/PCI-L dated. 18.11.2009 as amended.
11. The Board reserves its rights to review plans, specifications or other data relating to plant setup for the treatment of waterworks for the purification thereof & the system for the disposal of sewage or trade effluent or in connection with the grant of any consent conditions. The Applicant shall obtain prior consent of the Board to take steps to establish the unit or establish any treatment and disposal system or an extension or addition thereto.

12. The industry shall ensure replacement of pollution control system or its parts after expiry of its expected life as defined by manufacturer so as to ensure the compliance of standards and safety of the operation thereof.
13. The PP shall provide personal protection equipment as per norms of Factory Act
14. Industry should monitor effluent quality, stack emissions and ambient air quality monthly/quarterly.
15. Whenever due to any accident or other unforeseen act or even, such emissions occur or is apprehended to occur in excess of standards laid down, such information shall be forthwith Reported to Board, concerned Police Station, office of Directorate of Health Services, Department of Explosives, Inspectorate of Factories and Local Body. In case of failure of pollution control equipments, the production process connected to it shall be stopped.
16. The applicant shall provide an alternate electric power source sufficient to operate all pollution control facilities installed to maintain compliance with the terms and conditions of the consent. In the absence, the applicant shall stop, reduce or otherwise, control production to abide by terms and conditions of this consent.
17. The industry shall recycle/reprocess/reuse/recover Hazardous Waste as per the provision contain in the Hazardous and Other Wastes (M & TM) Rules 2016, which can be recycled /processed /reused /recovered and only waste which has to be incinerated shall go to incineration and waste which can be used for land filling and cannot be recycled/reprocessed etc. should go for that purpose, in order to reduce load on incineration and landfill site/environment.
18. An inspection book shall be opened and made available to the Board's officers during their visit to the applicant.
19. Industry shall strictly comply with the Water (P&CP) Act, 1974, Air (P&CP) Act, 1981 and Environmental Protection Act, 1986 and industry specific standard under EP Rules 1986 which are available on MPCB website (www.mpcb.gov.in).
20. Separate drainage system shall be provided for collection of trade and sewage effluents. Terminal manholes shall be provided at the end of the collection system with arrangement for measuring the flow. No effluent shall be admitted in the pipes/sewers downstream of the terminal manholes. No effluent shall find its way other than in designed and provided collection system.
21. Neither storm water nor discharge from other premises shall be allowed to mix with the effluents from the factory.
22. The industry should not cause any nuisance in surrounding area.
23. The industry shall take adequate measures for control of noise levels from its own sources within the premises so as to maintain ambient air quality standard in respect of noise to less than 75 dB (A) during day time and 70 dB (A) during night time. Day time is reckoned in between 6 a.m. and 10 p.m. and night time is reckoned between 10 p.m. and 6 a.m.
24. The industry shall create the Environmental Cell by appointing an Environmental Engineer, Chemist and Agriculture expert for looking after day to day activities related to Environment and irrigation field where treated effluent is used for irrigation.
25. The applicant shall provide ports in the chimney/(s) and facilities such as ladder, platform etc. for monitoring the air emissions and the same shall be open for inspection to/and for use of the Board's Staff. The chimney(s) vents attached to various sources of emission shall be designated by numbers such as S-1, S-2, etc. and these shall be painted/ displayed to facilitate identification.
26. The industry should comply with the Hazardous and Other Wastes (M & TM) Rules, 2016 and submit the Annual Returns as per Rule 6(5) & 20(2) of Hazardous and Other Wastes (M & TM) Rules, 2016 for the preceding year April to March in Form-IV by 30th June of every year.
27. The applicant shall install a separate meter showing the consumption of energy for operation of domestic and industrial effluent treatment plants and air pollution control system. A register showing consumption of chemicals used for treatment shall be maintained.

28. The applicant shall bring minimum 33% of the available open land under green coverage/ plantation. The applicant shall submit a yearly statement by 30th September every year on available open plot area, number of trees surviving as on 31st March of the year and number of trees planted by September end.
29. The Board reserves its rights to review plans, specifications or other data relating to plant setup for the treatment of waterworks for the purification thereof & the system for the disposal of sewage or trade effluent or in connection with the grant of any consent conditions.
30. The firm shall submit to this office, the 30th day of September every year, the Environment Statement Report for the financial year ending 31st March in the prescribed FORM-V as per the provisions of Rule 14 of the Environment (Protection) (second Amendment) Rules, 1992.
31. The Applicant shall obtain necessary prior permission for providing additional control equipment with necessary specifications and operation thereof or alteration or replacement/alteration well before its life come to an end or erection of new pollution control equipment.
32. The Board reserves its rights to vary all or any of the condition in the consent, if due to any technological improvement or otherwise such variation (including the change of any control equipment, other in whole or in part is necessary).
33. The applicant shall provide facility for collection of environmental samples and samples of trade and sewage effluents, air emissions and hazardous waste to the Board staff at the terminal or designated points and shall pay to the Board for the services rendered in this behalf.

This certificate is digitally & electronically signed.

Labour Camp:

The Contractor during the progress of work will provide, erect and maintain the necessary (temporary) living accommodation and ancillary facilities for labour to standards and scales approved by the NMRCL. All temporary accommodation must be constructed and maintained in such a fashion that uncontaminated water is available for drinking, cooking and washing. Safe drinking water shall be provided to the dwellers of the construction camps. Adequate washing and bathing places shall be provided, and kept in clean and drained condition. Construction camps are the responsibility of the concerned contractors and these shall not be allowed in the construction areas but sited away. Adequate health care is to be provided for the work force. NMRP through the GC shall time to time be monitoring whether the contractor is providing proper facilities at Labour camps and if found not being done properly would be penalised.

Influx of non-local labours will create a social issue, to avoid or minimize the impact following measures shall be adopted.

- Mixing of skilled non-local labours with local unskilled people will reduce social frictions.
- To avoid labour influx risk, sensitizing of local community and the non-local workers separately as well as jointly shall be done regularly.

Sanitation Facilities:

Construction sites and camps shall be provided sanitary latrines and urinals. Sewerage drains shall be provided for the flow of used water outside the camp. Drains and ditches should be treated with bleaching powder on a regular basis. The sewage system for the camp must be properly designed, built and operated so that no health hazard occurs and no pollution to the air, ground or adjacent watercourses takes place. Garbage bins must be provided in the camp and regularly emptied and the garbage disposed-off in a hygienic manner. NMRP through the GC shall time to time be monitoring whether the contractor is providing proper sanitation facilities and if found not being done properly would be penalised.

Shelter at Workplace:

At every workplace, shelter shall be provided free of cost, separately for use of men and women labourers. Sheds shall be maintained in proper hygienic conditions. NMRCL through the GC shall time to time be monitoring whether the contractor is providing proper shelter facilities and if found not being done properly would be penalised.

First aid facilities:

At every workplace, a readily available first-aid unit including an adequate supply of sterilized dressing materials and appliances shall be provided. Suitable transport shall be provided to facilitate taking injured and ill persons to the nearest hospital. NMRP through the GC shall time to time be monitoring whether the contractor is providing proper first aid facilities and if found not being done properly would be penalised.

Housekeeping

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. Contractor shall understand and accept that improper housekeeping is the primary hazard in any construction site and ensure that a high degree of environmental sanitation is always maintained. Environmental sanitation is the responsibility of all site personnel, and line management commitment shall be demonstrated by the continued efforts of supervising staff towards this activity. NMRP through the GC shall time to time be monitoring whether the contractor is providing house-keeping and if found not being done properly would be penalised. General housekeeping shall be carried out by the contractor and at all times at Work Site, Construction Depot, Batching Plant, Labour Camp, Stores, Offices and toilets/urinals. The contractor shall employ a special group of housekeeping personnel to carry out following activities:

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.

The structure dimension of the barricade, material and composition, its colour scheme, NMRP logo and other details.

- 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.
- All surplus earth and debris are removed/disposed-off from the working areas to designated dumpsites. Trucks carrying sand, earth and any pulverized materials etc. in order to avoid dust or odour impact shall be covered while moving.
- No parking of trucks/trolleys, cranes and trailers etc. shall be allowed on roads, which may obstruct the traffic movement.
- Roads shall be kept clear and 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.
- Water logging or spillage on roads shall not be allowed.
- 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.
- Flammable chemicals / compressed gas cylinders shall be safely stored.
- Unused/surplus cables, steel items and steel scrap lying scattered at different places within the working areas shall be removed to identified locations.
- All wooden scrap, empty wooden cable drums and other combustible packing materials, shall be removed from work place to identified location(s).
- Empty cement bags and other packaging material shall be properly stacked and removed.