Environmental Impact Assessment

EXTERNAL
Revision No. 3

November 2023

India: Nagpur Metro Urban Mobility Project

Prepared by MITCON Consultancy and Engineering Services Ltd. for the Maharashtra Metro Rail Corporation Limited (Maha Metro) and the Asian Development Bank (ADB).

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
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
WB	-	World Bank
WBG-EHS	-	World Bank Group – Environment, Health and Safety
WHO	-	World Health Organization

WEIGHTS AND MEASURES

amsl / AMSL	-	above mean sea level
^oC	-	degree Celsius
cu.m	-	cubic meters
dB(A)	-	decibel acoustic
ha.	-	hectare
km	-	kilometer
km/h, kmph	-	kilometer per hour
KLD	-	Kilo litre per day
kWe	-	kilowatt-electric
kV	-	Kilo volt(s)
kVA	-	kilo Volt-Amps
kW	-	kilowatt
m	-	meter
mm	-	millimetre
MLD	-	Million litre per day
msl / MSL	-	mean sea level
MVA	-	Megavolt Ampere
MW	-	Megawatt
m^3	-	cubic meter
m^3/hr	-	cubic meters per hour
mg/l	-	milligrams per liter
m/s	-	meters per second
MTPA	-	metric tons per annum
MW	-	megawatt
ppm	-	parts per million
ppt	-	parts per thousand
rpm	-	revolutions per minute
µg/m^3	-	microgram per cubic meter

NOTES

(i) The fiscal year (FY) of the Government of India ends on 31 March. “FY” before a calendar year denotes the year in which the fiscal year ends, e.g., FY2023 ends on 31 March 2023.

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

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EXECUTIVE SUMMARY

(NMRP Phase II EIA-EMP Report)

1. Nagpur—the Orange City of India, is the third largest city of Maharashtra and second capital of state. As per 2011 Census data, the city has 24 Lakh 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 rail system. 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 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 Tahsil office and Reach 4A- Prajapati Nagar (Pardi) - Transport Nagar). The total cost including taxes and duties of the project is estimated of Rs. 6707.88 Crores as per the 2022 price levels. 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 from October, 2023 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 analyses potential impact of all the activities from construction phase to the operational phase and proposes mitigation measures for the same. Social impact assessment (SIA) with a resettlement action plan (RAP) for implementation is presented as a separate report.

7. The EIA and environmental management plan (EMP) are prepared in line with Environmental Framework/ Environmental Assessment Policy of International Funding Agency i.e., Asian Development Bank's (ADB) Safeguard Policy Statement (2009). (OP/BP-4.01, OP/BP-4.02, OP/BP-4.04 etc.) & European Investment Bank (EIB) Environmental & Social Standards (2nd Feb 2022).

8. From the field visits conducted and secondary information collected, it can be inferred that NMRP Phase-II shall slightly compromise aesthetics and a minor impact on noise and vibration may be expected. No other major potential impacts are anticipated due to the project. 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 mostly 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. Wainganga 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 measurements were carried out at 9 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 to 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; (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;

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 & Affordability, Financial and Economic Effects and Approvals & 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. In this regard 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. The consultation will continue throughout the project implementation phase. Information disclosure will follow the procedure and requirements of MDB's policy for category A projects.

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 MDBs' guidelines, NMRP will constitute two-tier Grievance Redressal Committee (GRC) with representative from implementing agency, community, NGOs etc. for NMRP Phase-II project. If the affected party is not satisfied by the response of two-tier committee, then option to escalate the grievances to the judiciary system is available.

19. Environmental management plan (EMP) is prepared in accordance with MDBs' applicable policies, and regulatory requirements of GoM and GoI. 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. EMP will be committed by Maha-Metro as part of its agreement with Multilateral Development Banks (MDBs). External Monitor will be engaged for entire NMRP Phase-II Project corridors if required. The external monitor will conduct independent monitoring and inspections to inform Maha-Metro of any remediation actions to ensure the safeguard compliances. Implementation of the EMP will be monitored half yearly by MDBs through their experts. The total estimated cost for EMP of all 4 corridors of Nagpur Metro Project- Phase-II Corridors is ₹14.68 Cr.

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 / 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, Environmental Impact Assessment; (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) Grievance Redressal Mechanism; (ix) Environmental Management Plan; 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 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.

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-1 is already in operation.

4. 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 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 ADB and the 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[1]

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) (ADB+EIB) [III=I+II]**	**-**	**3585.60**	**2301.70**	**1245.32**	**3547.02**	**-38.58**
IV	GST Component of Funded Package	-	-	414.31	224.16	638.46	-

[1] As approved by Competent Authority of MahaMetro 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)

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**	**-**

1. Existing Nagpur Metro Rail Network

6. 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 on August 2023, the NMRP Phase I 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 1-2**.

Table 1-2: Description of NMRP Phase I Project Corridors[2]

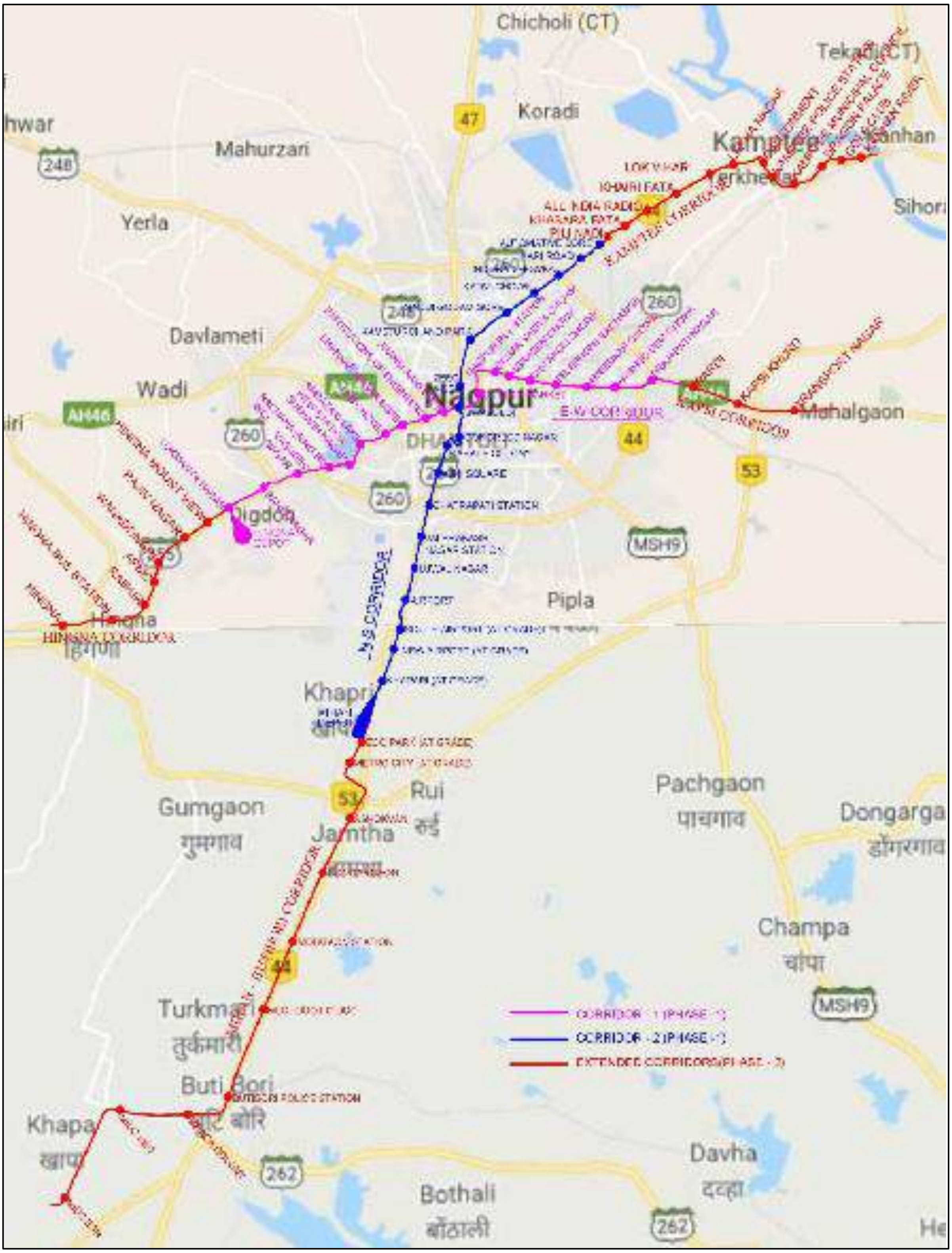
Corridor	Stations			Length (in Km) As per DPR			Length (in Km) As per Execution		
	Elevated	At Grade	Total	Elevated	At Grade	Total	Elevated	At Grade	Total
NS Corridor	15	**3**	**18**	15.06	4.6	19.66	15.39	5.15	20.54*
EW Corridor	20	**0**	**20**	18.56	-	18.56	19.41[#]	0	19.41
Total	**35**	**3**	**38**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

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

Figure 1-1: Routes of the Existing NMRP Phase I and Proposed NMRP Phase II[3]



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

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

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

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.

9. Maharashtra Metro Rail Corporation Ltd. (MahaMetro) 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. MahaMetro as the implementing agency, will be responsible for implementing, operating, and maintaining the city's metro system.

10. 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.

B. OBJECTIVE OF THE STUDY

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

12. 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-EMP studies also intend to raise awareness of development approaches that are ecologically sustainable.

C. SCOPE OF EIA-EMP STUDY

13. The scope of work for the Environmental Impact Assessment (EIA) Study for entire stretch is given below, along with status of compliance of the same:

(i) EIA and EMP shall be undertaken in accordance with Environmental Framework/ Environmental Assessment Policy of International Funding Agency like World Bank (WB), European Investment Bank (EIB) Environmental & Social Standards (2^{nd} Feb., 2022) & ADB Safeguard Policy Statement (SPS), 2009. (OP/BP-4.01, OP/BP-4.02, OP/BP-4.04 etc.);

(ii) Review of National, state, and local environmental regulatory requirements on environmental aspects and available standards besides requirement of Funding Agencies like WB Bank Guidelines and ADB / EIB. Also, external factors review and assessment of Depots and their building plan areas to check with applicability of Environmental clearance;

(iii) Description on all applicable laws and regulations for the project. Description of necessary approvals/consent requirement from the regulatory authorities;

(iv) An environmental screening and categorization framework as per world bank criteria & Preparation of the REA Checklist as per ADB SPS,2009 for Project Categorization for the proposed project to identify the environmental analysis and planning aspects of the project;

(v) Identification of hot spots like involvement of forests, roads, rail crossing, bridges, rivers, nallahs, bore-wells, surface drainage, and archaeological / historical / religious structures. Also, Habitat analysis in the ecological baseline assessment - defining natural, modified and critical habitat, any presence of avifauna parks or biodiversity zones;

(vi) Study and summarize the existing condition of surface and subsurface water flow condition within the project area (From the secondary authenticated published data);

(vii) Earmarking the project Location throughout the city and assessment with respect to environmentally sensitive areas, and community concerns;

(viii) Inventory survey of Sensitive Receptors such as schools, hospitals, religious places within 100 m from central line of the proposed metro rail corridor will be identified using latest satellite images, field survey and interviews with residents;

(ix) Assessment of existing land use pattern and study the possible impacts of the project on land use pattern;

(x) Description of alternatives considered from the relevant point of views (e.g. route, land use, technical aspects, environmental & social aspects);

(xi) Establish the baseline status of the study area with reference to the air, noise & vibration, water quality, soil quality, solid waste, protected areas, physical environment (e.g. hydrology), biological and social aspects along the section. Also, Habitat analysis in the ecological baseline assessment - defining natural, modified and critical habitat, any presence of avifauna parks or biodiversity zones;

(xii) Air & Noise quality monitoring shall be conducted at all proposed metro stations, casting yard and depots location to generate the data for baseline scenario;

(xiii) Justification must be given for selection of locations for assessment of baseline,

(xiv) Impacts to be identified for pre-construction (Location / design stage), construction phase and operation phase for the proposed Metro Rail project;

(xv) Detailed Ecological and Biodiversity Impact Assessment and suggesting mitigation plan. Ecological study (details inventory chainage-/ station-wise of number of trees to be cut with diameter, height & species). Also, Habitat analysis in the ecological baseline assessment - defining natural, modified and critical habitat, any presence of avifauna parks or biodiversity zones;

(xvi) Consultant shall propose the soil disposal plan for construction phase of project. Also, the consultant shall propose the areas in or outside the cities where soil could be re-used or disposed;

(xvii) Consultant shall assess in principle impact of project construction and operation specifically w.r.t. air, noise and vibration and shall identify the sensitive receptors for these impacts;

(xviii) **Noise Study:** Mapping and modelling of noise resulting from ambient noise and noise due to operation of Metro rail system shall be carried out using the international standard software for rail noise mapping;

(xix) The Noise mapping shall be carried on the GIS platform showing the noise contours. Prediction of noise at these locations due to train operation shall be made for 30 years with an interval of 3 years;

(xx) The outputs of measurement and prediction shall be submitted in the form of noise contours for about 250 meters along the proposed metro rail route;

(xxi) Consultant shall propose the mitigation measures for attenuating noise levels below the statutory standards / baseline (whichever is higher) during operation phase of metro rail;

(xxii) **Vibration Measurement:** Existing vibration measurement (24 hr. monitoring) at sensitive receptors, structures close to the alignment & Archaeological importance structures and vibration prediction at same sites during construction and operation of metro rail. The vibration mapping shall be carried on the GIS platform showing the vibration contours;

(xxiii) The consultant shall justify the selection of location and methodology for conducting the vibration monitoring;

(xxiv) Consultation and review with affected sensitive receptors (Major Hospitals) along the corridor due to Noise & Vibration;

(xxv) Identification of water body directly or indirectly affected, impact on water quality in the identified rivers/canals/creeks and supplementing the collection of existing and published data on water quality;

(xxvi) Identification of major impacts due to Air, Noise & Vibration on Archaeological/ historical/ cultural/ religious structures, sensitive receptors. Assessment of likely impact on, water quality (Surface & Ground), ecological, muck/ soil, seepage water, land subsidence and waste. Assessment of impact due to labour camps and depots;

(xxvii) Suggest suitable measures separately for mitigating the impact of noise and vibration in surrounding environment and habituated area that is likely to be generated during construction and from operation of metro train;

(xxviii) Consultant shall report socio-economic data on demography, social status, local economy, local culture & custom and land details in the report for the project location. (Such data may be collated from secondary authentic sources);

(xxix) Project specific Risk and Hazardous management studies & suggesting construction Workers management plan (Occupational health and safety);

(xxx) Analysis of natural hazards and climate disasters in the region, vulnerability profile and also various adaptation measures considered in the project design;

(xxxi) Preparing and suggesting project specific Environmental Management Plan (EMP) and Environmental Management Action Plan (EMAP) duly following MoEF&CC / WB / ADB / EIB guidelines for environmental sustainability, including budget for implementation;

(xxxii) EMP shall be prepared reach-wise in such a manner that these are amenable to incorporation in the bidding / contract documents;

(xxxiii) EMP shall list all mandatory Government Clearance conditions and procedure for procuring clearances;

(xxxiv) EMP shall suggest mitigation measures, management & monitoring plan for all the significant impacts assessed for the project during design, construction & operation phases of the project;

(xxxv) EMP shall include the organization structure for implementation of EMP with specific responsibilities for contractors, general consultants and project proponents during design, construction and operation phases of the project;

(xxxvi) Preparation of sub-EMP plans Like Air Quality, Water and Waste-water quality Management Plan, Traffic Management plan during construction phase, Labour camp management pan, Solid waste and Hazardous waste management Plan;

(xxxvii) Preparation of Environment Assessment Review Framework (EARF) as per ADB SPS, 2009;

(xxxviii) Preparation of Environmental Monitoring Plan (EMoP) based on analysis of collected data, impacts, mitigation strategy, EMoP will be finalised incorporating feedback from local residents participated in Public Consultation Meetings;

(xxxix) Preparation of Environmental Monitoring Forms based on EMP and EMoP;

(xl) Identification of Institutional needs to implement environmental assessment recommendations, (review the authority and capability of institutions and recommend steps to strengthen or expand them so that the management and monitoring plans in the environmental assessment can be implemented.);

(xli) Organizing/ Conducting project level Public Consultation in obtaining the views of affected groups as part of EIA report;

(xlii) Carbon Credit study with explore opportunities for claiming Carbon Credits against this project including methodologies and documentation;

(xliii) Content of EIA report should be as per the WB/ ADB/ EIB funding agency policy;

(xliv) The Consultant will prepare a plan for in-country disclosure, specifying the timing and locations; translate the key documents, such as the Environmental Assessment Summary in local language for disclosure; and

(xlv) The Consultant shall prepare a non-technical EA Summary Report for public disclosure.

D. EIA CONSULTANT

14. 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.

15. 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/2124/RA 0229) is attached as **Annexure-1** of this report.

E. ENVIRONMENTAL IMPACT ASSESSMENT

1. Categorization

16. 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.

17. 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.

18. Rail-based systems have been excluded from the scheduled list under the Environmental Impact Assessment (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.

2. Purpose of the EIA Report

19. 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 Redresses; and
(ix) Formulate environmental management and monitoring plan with institutional measures for effective implementation of mitigation measures proposed.

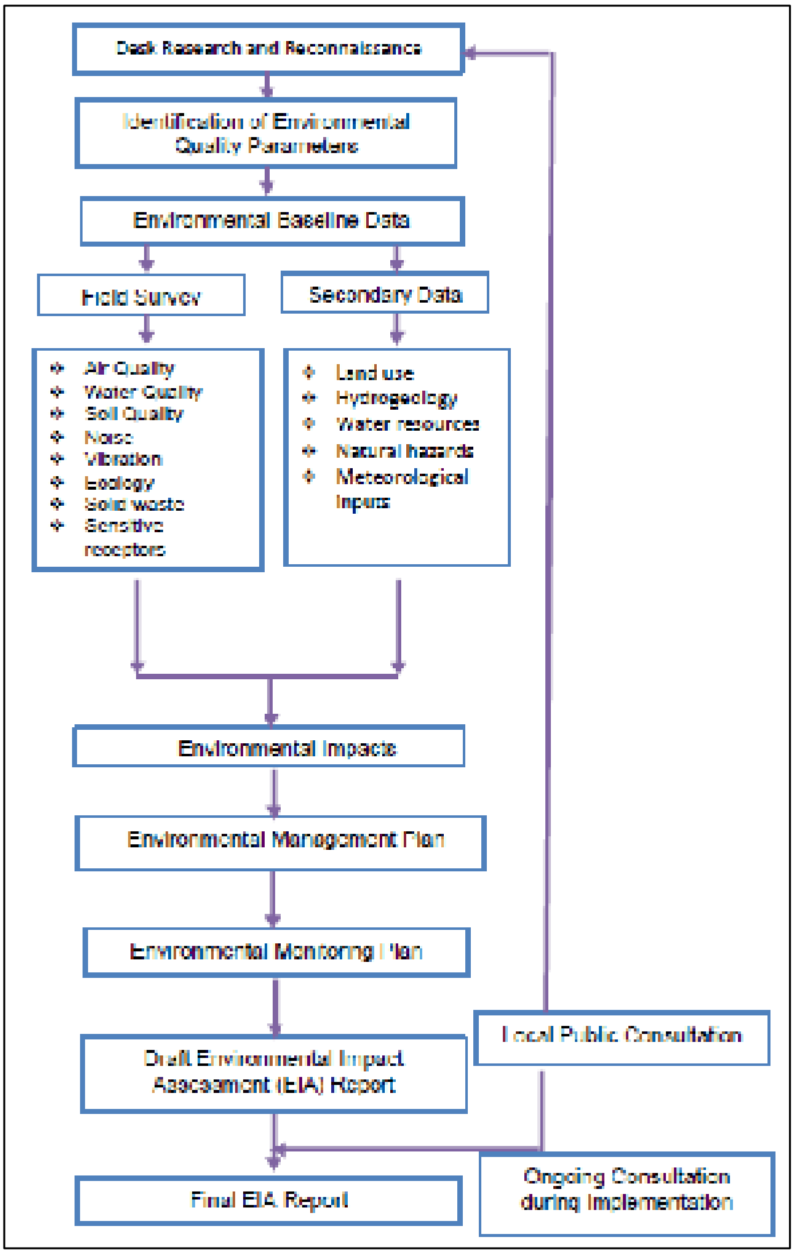
20. Social Impact Assessment (SIA) with a Resettlement Action Plan (RAP) for implementation is presented as a separate Report.

3. Approach and Methodology

21. 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 Environment Management Plan (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 Environmental Monitoring Plan (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 MahaMetro 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



22. The baseline data for air, water and soil quality was collected in width 100m on either side of proposed center line of all the four alignments of NMRP-P2, and data for noise and vibration in width 50m on either side of alignment. Sensitive receptors located in width 100m 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 Environmental Impact Assessment Report is as per **Table 1-3**.

Table 1-3: Structure of the EIA Report

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	Environmental strategy to offset / mitigate the probable adverse impacts, including the Environmental Monitoring Plan (EMoP), has been outlined in this chapter.
Chapter 10	Conclusions & Recommendations	This chapter summarizes the conclusions of this EIA-EMP Report and outlines specific recommendations, if any.

II. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

23. 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.
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

24. 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

25. 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

26. 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;	To protect and improve the overall environment	Ministry of Environment, Forests, and Climate Change (MoEF&CC)

Legislation	Objective	Responsible Institution
- National Environment Policy of 2006		
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	MPCB

Legislation	Objective	Responsible Institution
	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.	
The Mines and Minerals (Development and Regulation) Act, 1957	To protect the environment from quarry operation	State Department of Mines and Geology
Central Motor Vehicle Act (1988) and Rules (1988)	To control vehicular air and noise pollution. To regulate development of the transport sector, check and control vehicular air and noise pollution	State Transport Department
- Indian Treasure Trove Act, 1878 (as modified up to September 1949); - Ancient Monuments and Archaeological Sites and Remains Act (1958)	Conservation of Cultural and historical remains found in India (Chance finds, if any, during construction)	Archaeological Survey of India (ASI), GoI
- National Policy on HIV/AIDS and the World of Work - 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

Legislation	Objective	Responsible Institution
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 / Permissions

27. Railway is not listed among activities requiring prior Environmental Clearance (EC) in GoI's EIA Notification 2006 and therefore NMRP Phase II does not require EC 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 EC. EC 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 EC from SEIAA and that the project has to incorporate green building features, rain water harvesting system, energy efficiency, water conservation, sewage / effluent treatment / 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 EC for railway and Metro rail projects.

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

28. 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, MahaMetro through the Contractor, must obtain necessary clearances/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 Required for NMRP Phase II project

SI	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 MahaMetro
B.	**Implementation 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 MahaMetro
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 MahaMetro
4.	Permission for withdrawal / dewatering of groundwater[4]	Environment (Protection) Act, 1986; Groundwater Survey and Development Authority (GSDA), GoM; Guidelines / Criteria for evaluation of proposals / requests for groundwater abstraction (With effect from 16.11.2015)	CGWA, 3 months (to be obtained before start of construction)	Contractor engaged by MahaMetro
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 MahaMetro
6.	Permission for sand mining from riverbed, if any	Environment (Protection) Act, 1986	State Mining Dept. / MoEF&CC	Contractor engaged by MahaMetro
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 MahaMetro

[4] 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
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 MahaMetro
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 MahaMetro
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 MahaMetro
11.	Roof Top Rainwater Harvesting (RWH)	Central Groundwater Authority (CGWA) Guidelines	CGWA, 3 months, to be obtained before installation	Contractor engaged by MahaMetro
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 MahaMetro
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 MahaMetro
14.	Authorization for Disposal of Construction and Demolition (C&D) Waste	Construction and Demolition Waste Management Rules, 2016	NMC, 2 months, to be obtained before installation	Contractor engaged by MahaMetro
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 MahaMetro
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 MahaMetro
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	MahaMetro

4. Institutional Framework

29. 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 (MoEF&CC)

30. 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 Government of India set up a Department in November 1980 under the portfolio of the Prime Minister. The department, later renamed as the MoEF&CC plays a vital role in environmental management for sustained development and for all environmental matters in the country. 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 / Assessments to establish that preventive measures are planned by installing adequate pollution control and monitoring equipment, and that effluent discharged into the environment will not exceed permissible levels. The MoEF&CC appraises these statements / assessments and approves the project from the environmental angle.

(b) Central Pollution Control Board (CPCB)

31. The Central Pollution Control Board 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.

32. The SPCB in consultation with the Central Pollution Control Board (CPCB) may establish norms for air quality, gaseous emissions, noise levels, etc.

(c) Maharashtra Pollution Control Board (MPCB)

33. The Maharashtra Pollution Control Board was established on 7th 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 Maharashtra Pollution Control Board 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 (CGWB)

34. The CGWB is responsible for the development, dissemination of technologies, and monitoring of India's groundwater resources, including their exploration, assessment, conservation, augmentation, protection from pollution and distribution. The CGWB, under the Ministry of Water Resources, was established in 1970. Various activities related to regulation and control of ground water development in the country is the responsibility of the Central Ground Water Authority (CGWA) specifically constituted under the Environmental (Protection) Act, 1986. The CGWA has identified over exploited-areas across India where groundwater withdrawal is regulated. To date, 43 critical / 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 (NGT)

35. The 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.

36. 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

37. 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)

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

1. ADB's Safeguards Policy Statement (SPS) 2009[5]

39. ADB is committed to ensuring the social and environmental sustainability of the projects it supports. In this context, the goal of the SPS 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.

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

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

41. Policy Principles of ADB's Environment Safeguards (ADB SPS 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

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

planning and management. Prepare an environmental management plan (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 taken into account. 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 implementation.

42. The SPS requires assessment, mitigation and commitment towards environmental protection, and the extent of assessment depends on the category of the project. ADB's SPS 2009 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 initial environmental examination 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.

43. 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 / 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.

44. 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 (2009). 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)[6]

45. This section discusses the processes and contents of the Environmental Impact Assessment 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

46. 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 taken into account in the decision-making processes. It recognises the

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

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.

47. 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.

48. 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 taken into account 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.

49. In order to enhance the efficiency of the ESIA at project level, promoters are encouraged to use the SEA-type approach to ensure that environmental, climate and social considerations and alternatives are addressed as early as possible in plans or programmes that establish the framework for the development of specific projects, whenever relevant. The SEA should address direct and indirect effects, as well as the cumulative impacts. The ESIA process may involve some or all of the following steps: (i) the determination of the need for an ESIA; (ii) the scope and level of details of the assessment; 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 Environmental and Social Impact Assessment:
   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 taking into account the criteria specified in Annex 1a of this Standard.
   c. In determining the need for an environmental and social impact assessment, 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 environmental and social impact assessment is required, the promoter shall prepare a report that takes into account 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

50. This Standard recognises the importance of stakeholder engagement, as a means to ensure respect for the rights to[7]: (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.

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

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

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

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

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

52. 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, taking into account the type and complexity of the project, sector and country context.

53. 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.

[7] 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.

54. 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/EC 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/EC establishing a framework for Community action in the field of water policy, as amended; Directive 2008/56/EC establishing a framework for community action in the field of marine environmental policy, as amended.

55. 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

56. 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.

57. 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.

58. 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

59. 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.

60. 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.

61. 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.

62. Specific Requirements of this Standard involves 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/associated works/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 exists 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 reasonable foreseeable needs of future generations.

(e) Standard 5: Climate Change

63. 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.

64. This Standard promotes the alignment of projects supported by the EIB with the goals and principles of: (i) the Paris Agreement[8] 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).

65. 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.

66. 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),

[8] 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.

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.

67. When applying Standard 5, the promoter shall take into account 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.

68. 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

69. 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.

70. 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

71. 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.

72. 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.

73. 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.

74. 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

75. 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.

76. 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.

77. 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[9], are determined during the EIA/ESIA process (as outlined in Standard 1).

78. 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).

79. 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 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.

[9] 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]

(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. Taking into account security considerations 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.

80. 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 taking action 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

81. 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.

82. 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).

83. 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.

84. 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[10].

[10] 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

(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.

85. 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 take into account 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, taking into account 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 take into account 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 take into account and 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 all project workers and all persons accessing the project

Enforcement Officials, (iii) the Voluntary Principles on Security and Human Rights and (iv) the International Code of Conduct on Private Security Providers.

site (including suppliers, supervisors, visitors), to abide and comply with the applicable health and safety plans.

(iii) Personal Protective Equipment (PPE): Based on the assessment referred to in point a. above, and considering the hierarchy of controls, project workers shall be provided with appropriate 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 environmental and social impact assessment 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 take into account 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 take into account 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 take into account 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 implementation 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

86. 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.

87. 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.

88. 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.

89. For the purpose of this Standard, Cultural Heritage includes both tangible and intangible heritage:
- (i) Tangible cultural heritage[11] 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[12] 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.

90. This Standard applies also to Natural Heritage[13] recognised by the local communities and peoples as part of their history, values, beliefs, knowledge and/or traditions and which the

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

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

[13] 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

communities and peoples consider valuable, and desires to sustain and transmit to future generations.

91. 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.

92. 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.

93. The promoter shall ensure that the impact on cultural heritage is duly considered in the ESIA process by taking into account 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.

94. 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.

95. 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.

96. Following processes/considerations are part of the specific requirements of this Standard:

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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).

(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 implementation) 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.

97. 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.

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

3. IFC Performance Standards on Environmental & Social Sustainability

99. 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

100. The project will follow national as well as international best practices and standards related to environment, health and safety. 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
(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
(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) EC Regulations 1881/2006, 629/2008 and 835/2011 cover toxic metals, nitrates, Persistent Organic Pollutants (POPs) and Polycyclic Aromatic Hydrocarbons (PAHs)

(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
(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
(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) Take into account 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.
(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;
(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

101. 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[14]. By 2030, Indian cities are projected to be home to another 250 million people[15]. The metropolitan areas are facing extremely high population densities and traffic congestion.

102. 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.

103. 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 (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.

104. 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, MahaMetro (Maharashtra Metro Rail Corporation Ltd.) intends to develop the proposed Nagpur Metro Rail Project – Phase 2 (NMRP-P2).

105. NMRCL, MahaMetro 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 18th February 2015.

B. DESCRIPTION OF NMRP PHASE II PROJECT[16]

106. 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**.

[14] Source: https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS?locations=IN
[15] Source: Urbanization beyond Municipal Boundaries : Nurturing Metropolitan Economies and Connecting Peri-Urban Areas in India (worldbank.org)
[16] 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**

107. Geotechnical investigations were carried out along the proposed Phase II alignments, to determine the required strength characteristics of the underlying soil / 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.

108. 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)

109. 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.

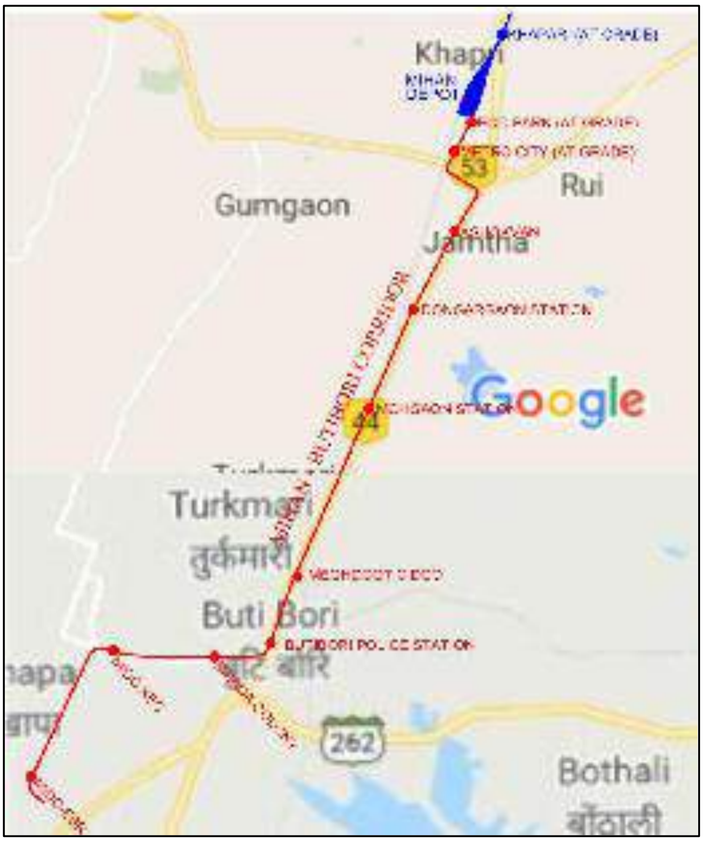
110. Total 10 stations (2 At-grade & 8 elevated) are proposed in this corridor, starting from ECO Park Station (Ch.: 20462m) and terminating at MIDC ESR Station (Ch: 38352m). Details of Line 1A are summarized as under in **Table 3-2**, while Line 1A map if presented as **Figure 3-1**.

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-1 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)

111. 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.

112. 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
	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 & MahaMetro) 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)

113. 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.

114. 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 hear 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)

115. 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

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 Station (132/33/25 kV)	E-W Corridor (including Phase 2 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

116. 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.

117. 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 is in compliance 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
(vi) Typically designed Elevated stations dimensions: 79.00m x 20.85m

118. 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.

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

120. 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.

121. 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**

122. 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 & Telecommunication

123. **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 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

124. **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

125. **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%

126. **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**

127. **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.

128. The Receiving Substations (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)

129. 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.

130. **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.

131. **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

132. 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.
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.

133. 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:

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

134. 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.

135. Community based specific facilities for workers are as follows:
(i) HIV AIDS Policy,
(ii) Grievance Redressal procedure, and
(iii) Equality in wages

136. 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 MahaMetro 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 (EA) on the matter.

137. The monitoring & reporting will comprise of three-layer system which includes the Contractor, General Consultant and MahaMetro. 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 MahaMetro will review the works executed by Contractors & GC.

138. 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

139. 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.

140. 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 are 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.

141. **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.

142. **Pre-Engineering Building (PEB):** The stations are provided with roofing supported by 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.

143. **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 & 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.
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 MahaMetro before establishment.

144. **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:

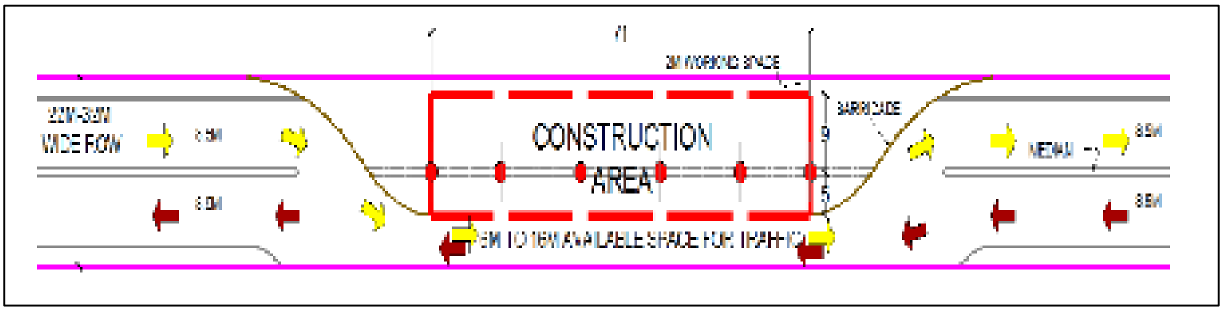
Scenario 1: Two way at stations

Scenario 2: One way at stations

145. 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



146. 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

147. **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	35,70,387
Aggregates	MT	71,40,774
Sand	MT	53,55,580
Fly Ash	MT	40,312
Reinforcement	MT	20,28,628

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

148. The sand from Kanhan River is considered to be of high quality as far as the construction of buildings is concerned. Sand will be procured from Authorised Sand vendors with valid certification, as required[17]. 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.

149. 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.

150. **Location of Casting Yards:** As per the contract conditions land for Casting Yard for casting of girders 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 cannot be ruled out.

151. The location of Casting Yards used by the NMRP Phase-I in all the Reaches is shown in **Figure 3-7**. Contractors can use the same Casting Yards or may establish an alternate casting yard of their choice, on approval by MahaMetro.

152. As per the contract conditions, land for Casting Yard is to be arranged by the contractors. NMRP Phase-II is basically an extension of Phase-I in all the directions, and its terminals are located in the NMRDA region having several pockets of non-agriculture land. In addition of above option, the land parcels utilized by the agencies in Phase-I can also be extended for Phase II as per convenience of the Contractors.

153. 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.

[17] 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 MahaMetro / GC.

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

D. IMPLEMENTATION PLAN & CONSTRUCTION SCHEDULE[18]

1. Project Implementation Plan

154. 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
1	First Detailed Project Report (DPR) Final Approved DPR	July, 2018 November, 2019
2	State Government Approval of DPR	January, 2019
3	Final Approval by GoI	December, 2022
4	Appointment of DDC for Civil Works	August, 2023
5	Packaging and Invitation of Bids	February, 2023
6	Appointment of General Consultants	-
7	Commencement of Civil Works	October, 2023
8	Commencement of Operation	October, 2027

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

2. Implementation Structure

155. 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 MahaMetro, 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

156. **Capital Cost Estimate:** Cost estimate for Nagpur Metro corridors has been prepared covering civil, electrical, signalling and telecommunications works, rolling stock, environmental protection, rehabilitation, 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, Environmental protection and traffic management	110.71	78.00	39.94	33.73	**262.38**

Sr. No.	Item	February 2019 Price Level (₹ in Crore) Corridor 1A	Corridor 2A	Corridor 3A	Corridor 4A	Total
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

157. **Double Decker section Near Pardi station in Reach 4A:** 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. Howvere, 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

158. Associated facilities are those that are not included or funded by the Project but are:
   (i) directly and materially related to the Project;
   (ii) carried out or planned to be carried out, contemporaneously with the Project;
   (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.

159. The NMRP Phase I, 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.

160. **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)
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	

161. As per EIA notification (2006) Section 8(a), any project with with built-up area more than 20000 sq.m but less than 150000 sq.m. needs prior Environmental Clearance from Competent Authority. Since the construction built-up areas of both MIHAN & Hingna Depots of NMRP have area less than 20000 sq.m. hence no EC 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.

162. 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.

163. 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.

164. 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

166. 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.

167. 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.

168. 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

169. 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.

170. 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.

171. 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

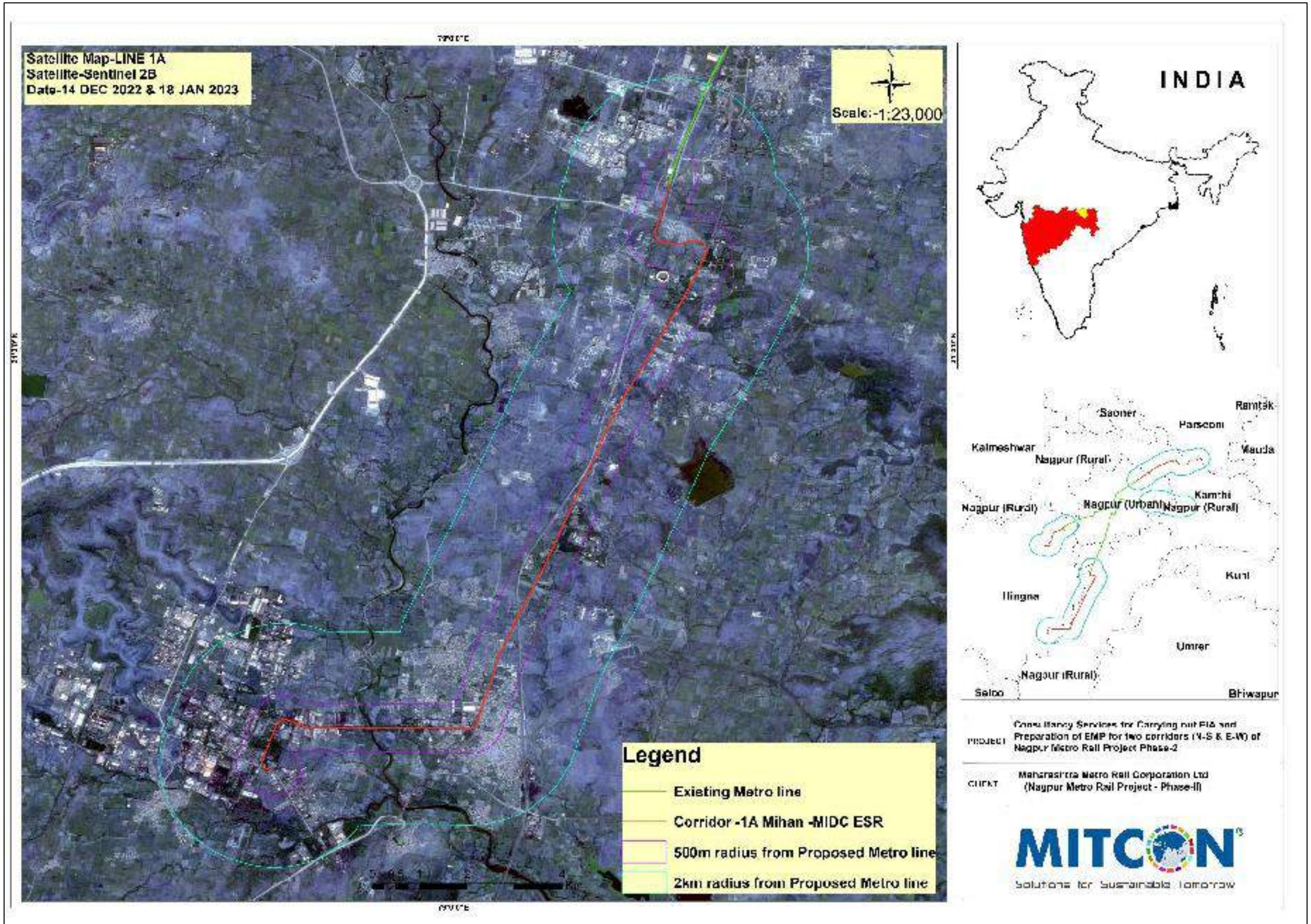


Figure 4-2: Satellite map of the NMRP-Phase II Line 2A showing Project Study area

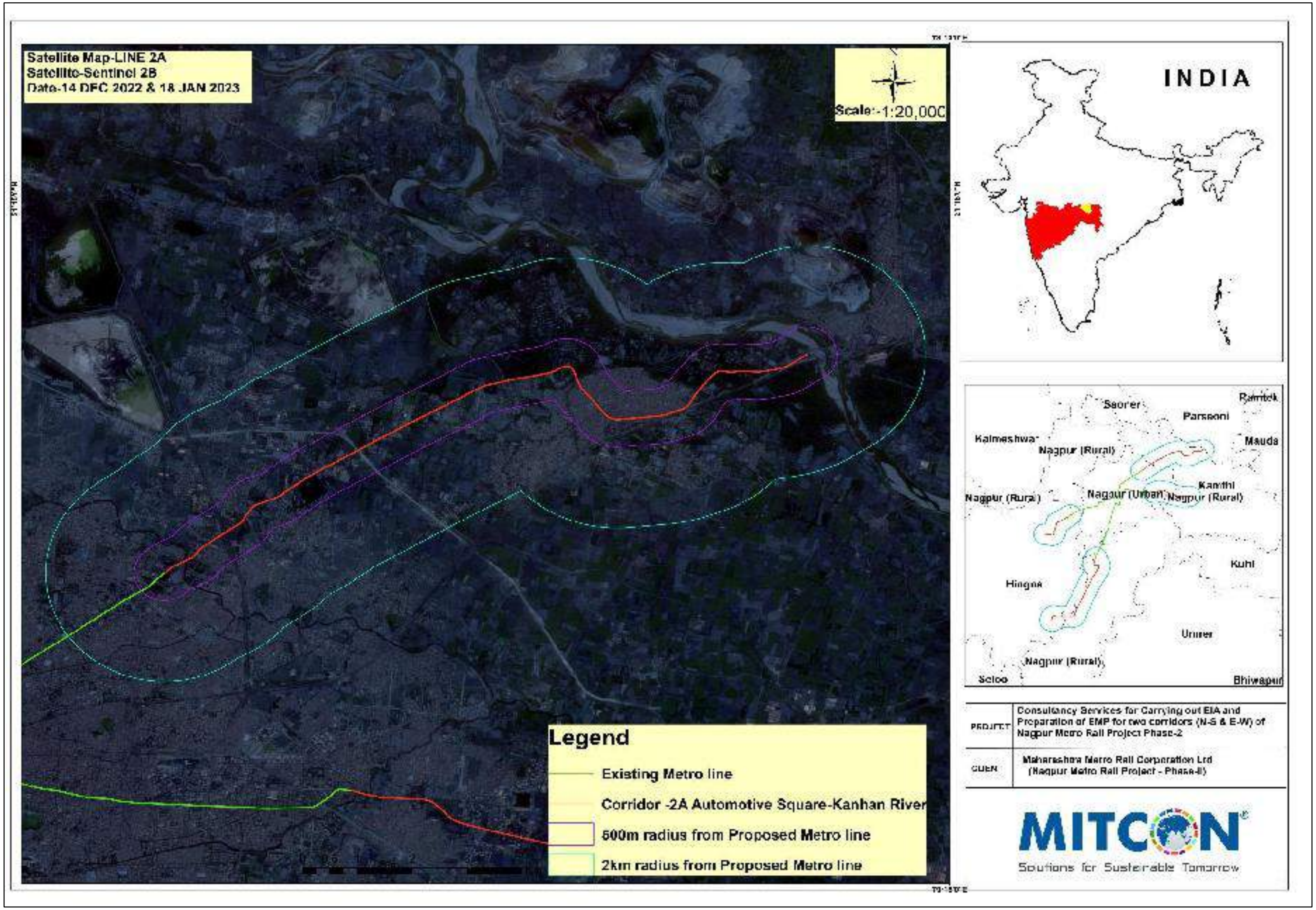


Figure 4-3: Satellite map of the NMRP-Phase II Line 3A showing Project Study area

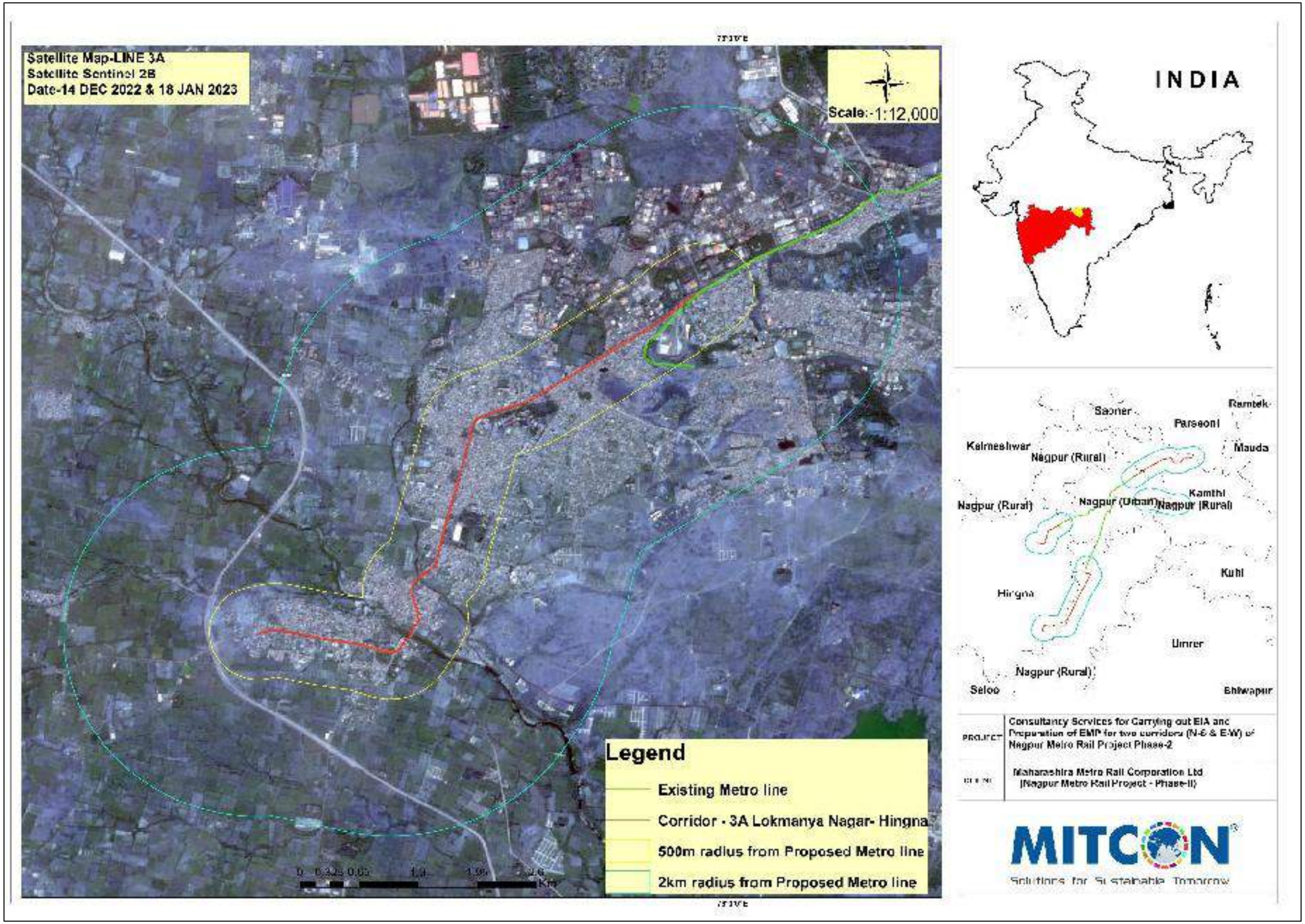
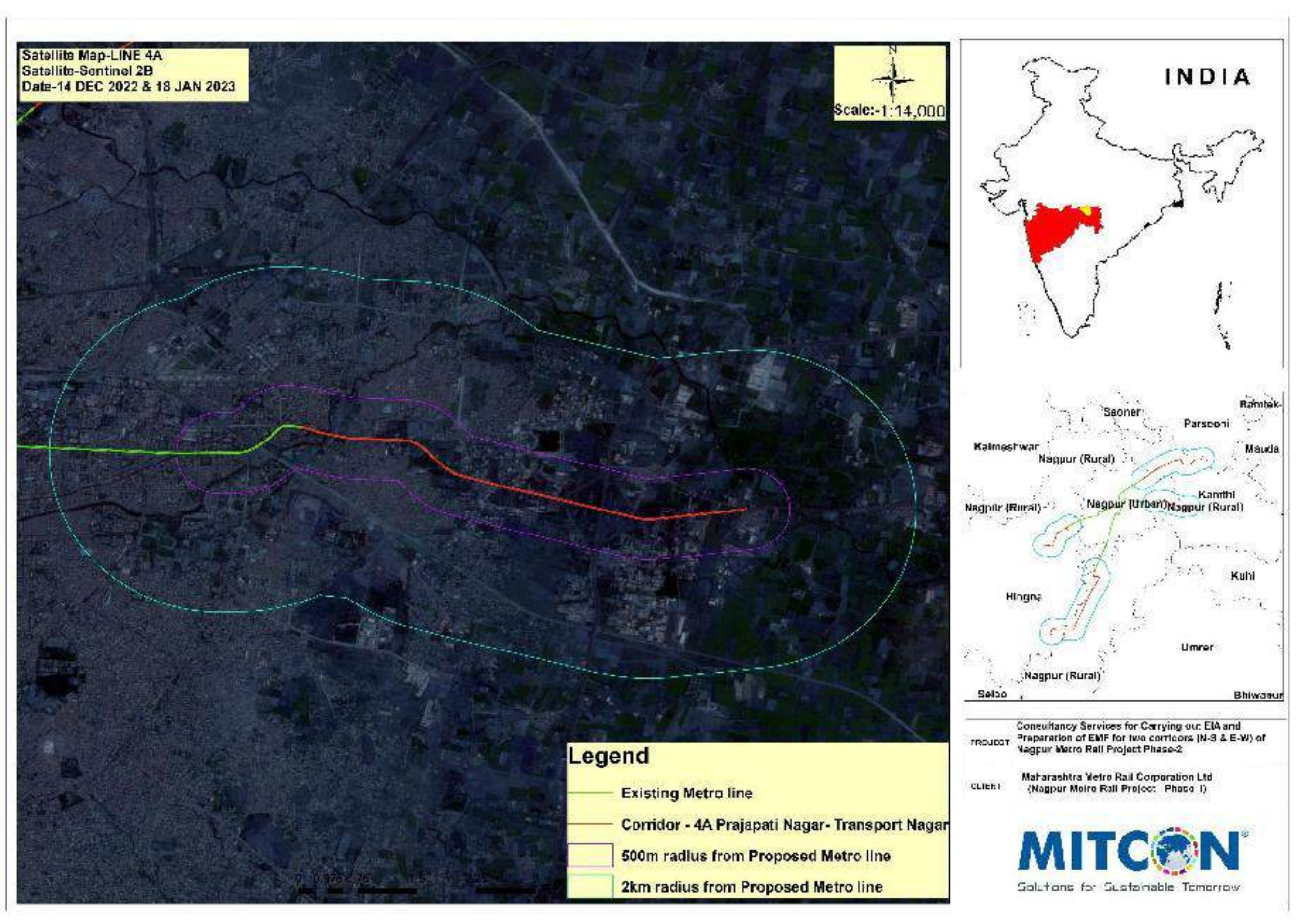


Figure 4-4: Satellite map of the NMRP-Phase II Line 4A showing Project Study area



C. ENVIRONMENTAL PARAMETERS

172. 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) NO_x: 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 9 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

173. 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.

174. 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)

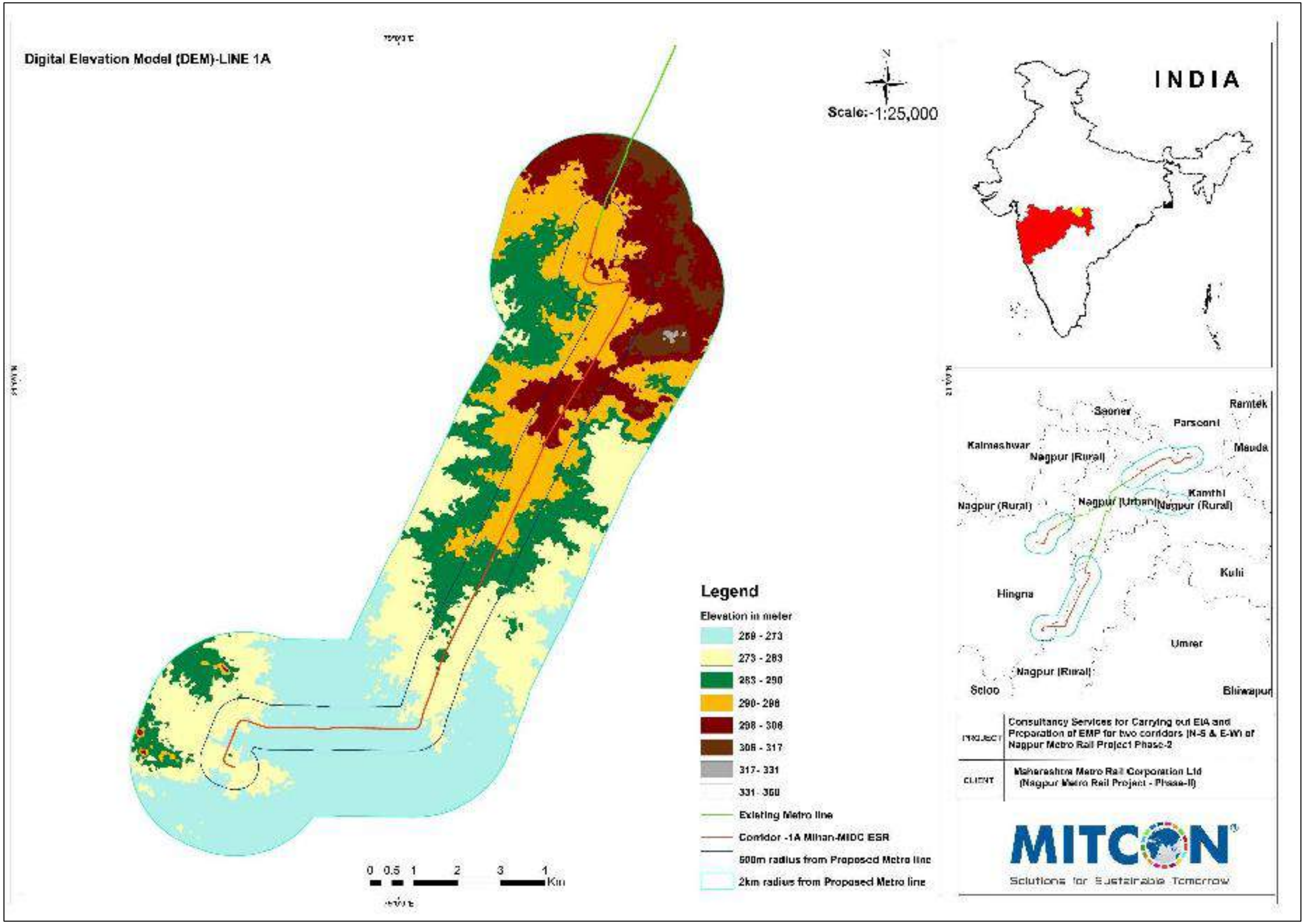


Figure 4-6: DEM of the Core and Buffer study areas of Reach 2A (NMRP Phase II)

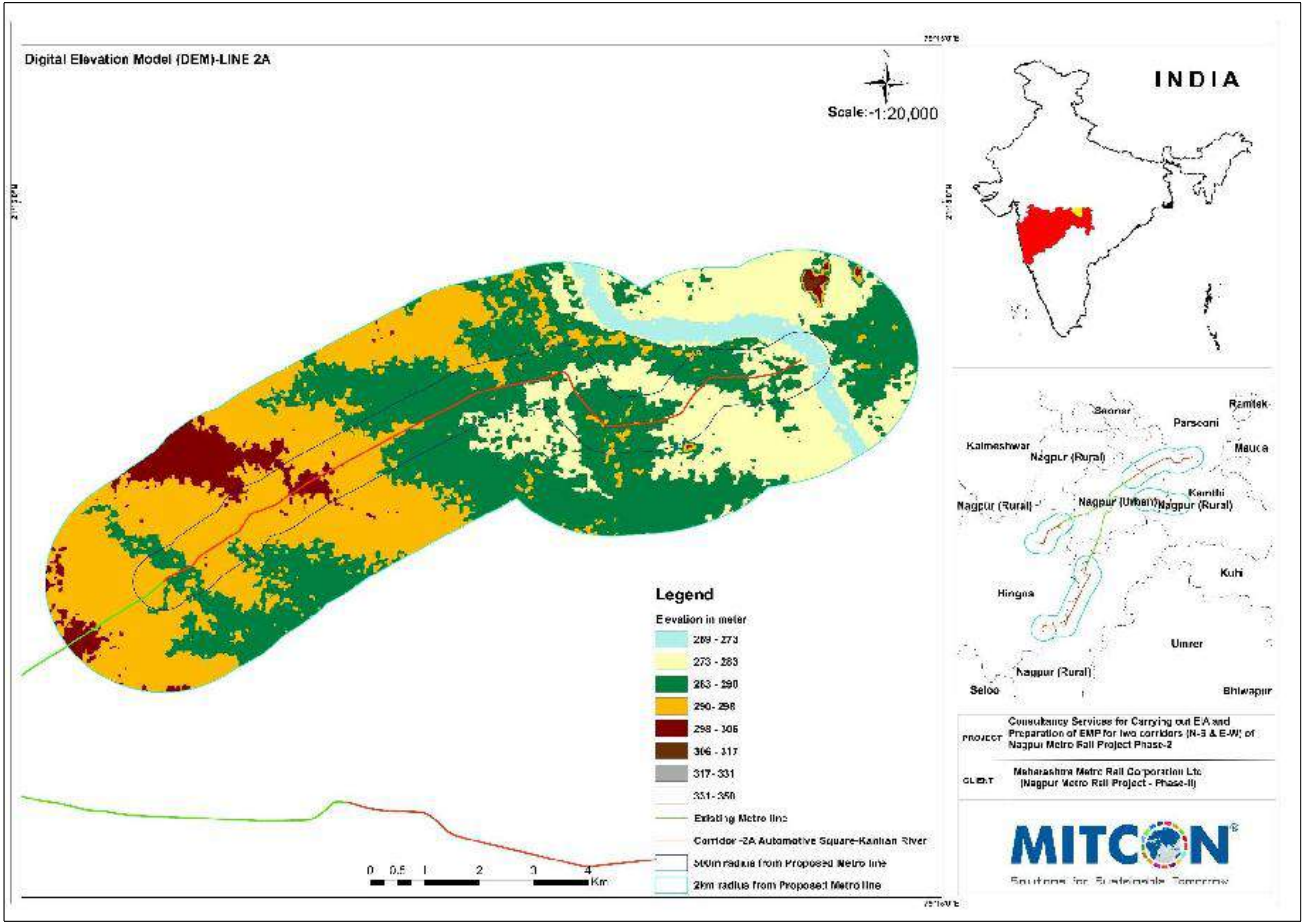


Figure 4-7: DEM of the Core and Buffer study areas of Reach 3A (NMRP Phase II)

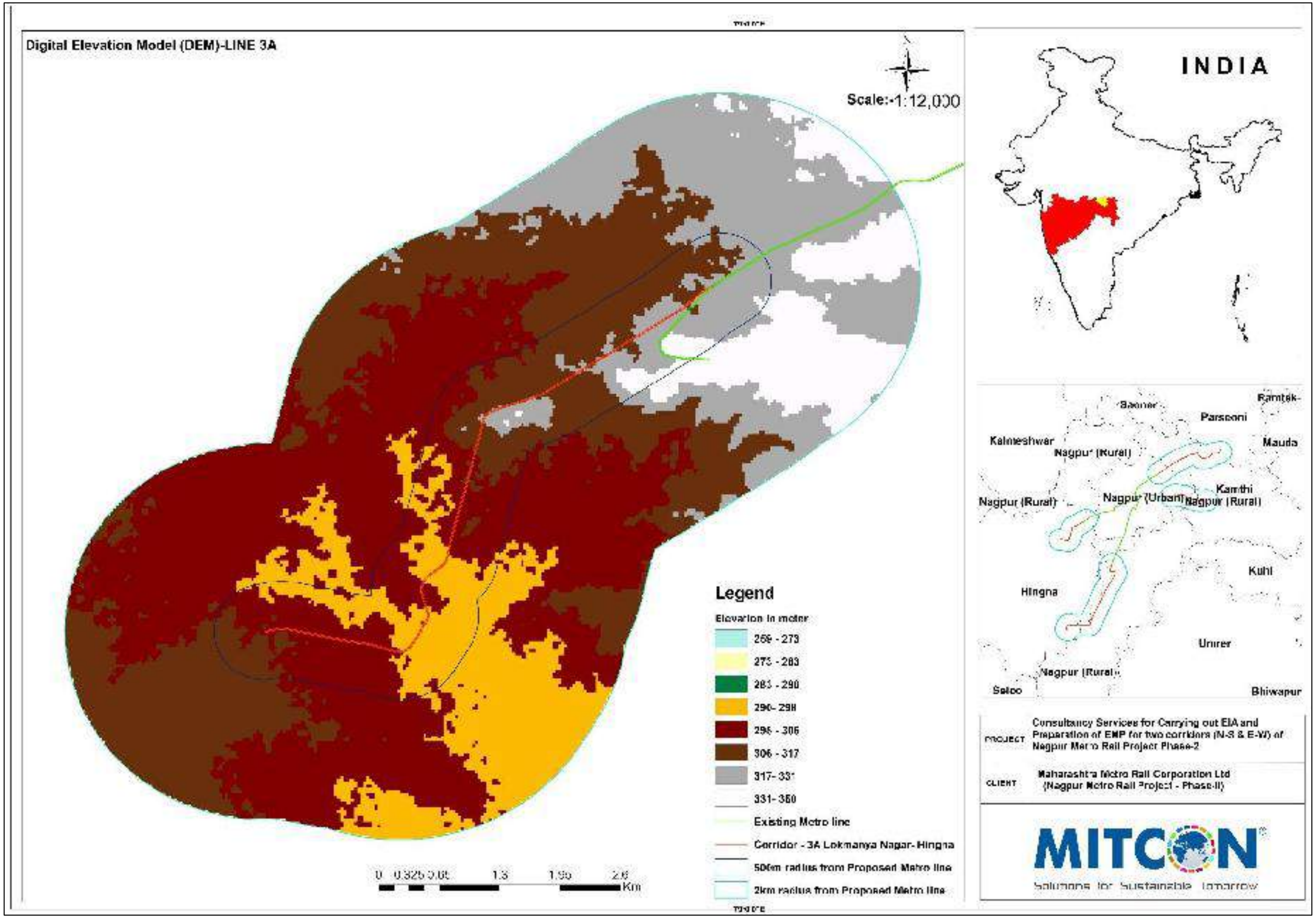
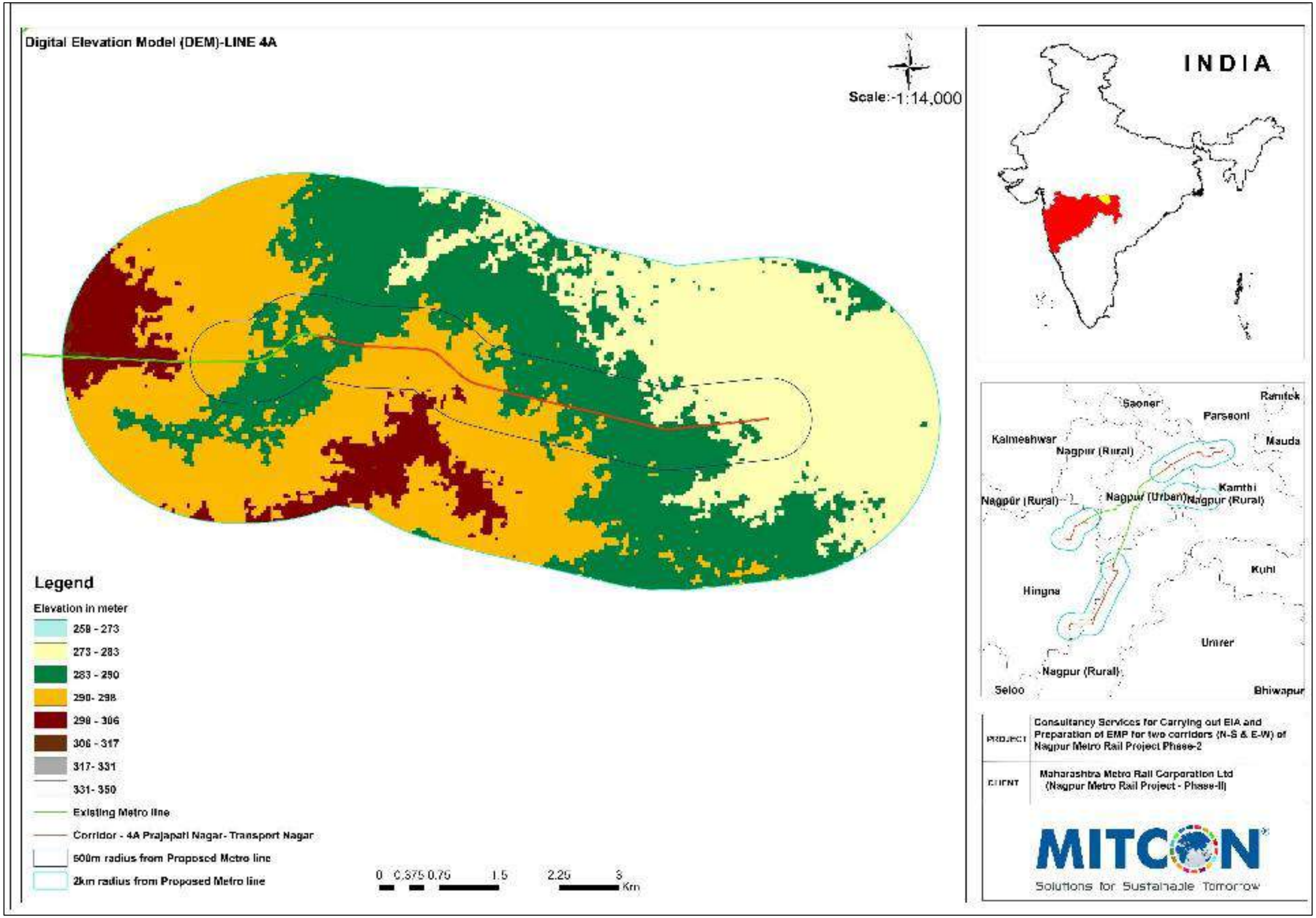


Figure 4-8: DEM of the Core and Buffer study areas of Reach 4A (NMRP Phase II)



2. Geology

175. 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

176. **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.

177. **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.

178. **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.
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.

179. **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.

180. 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

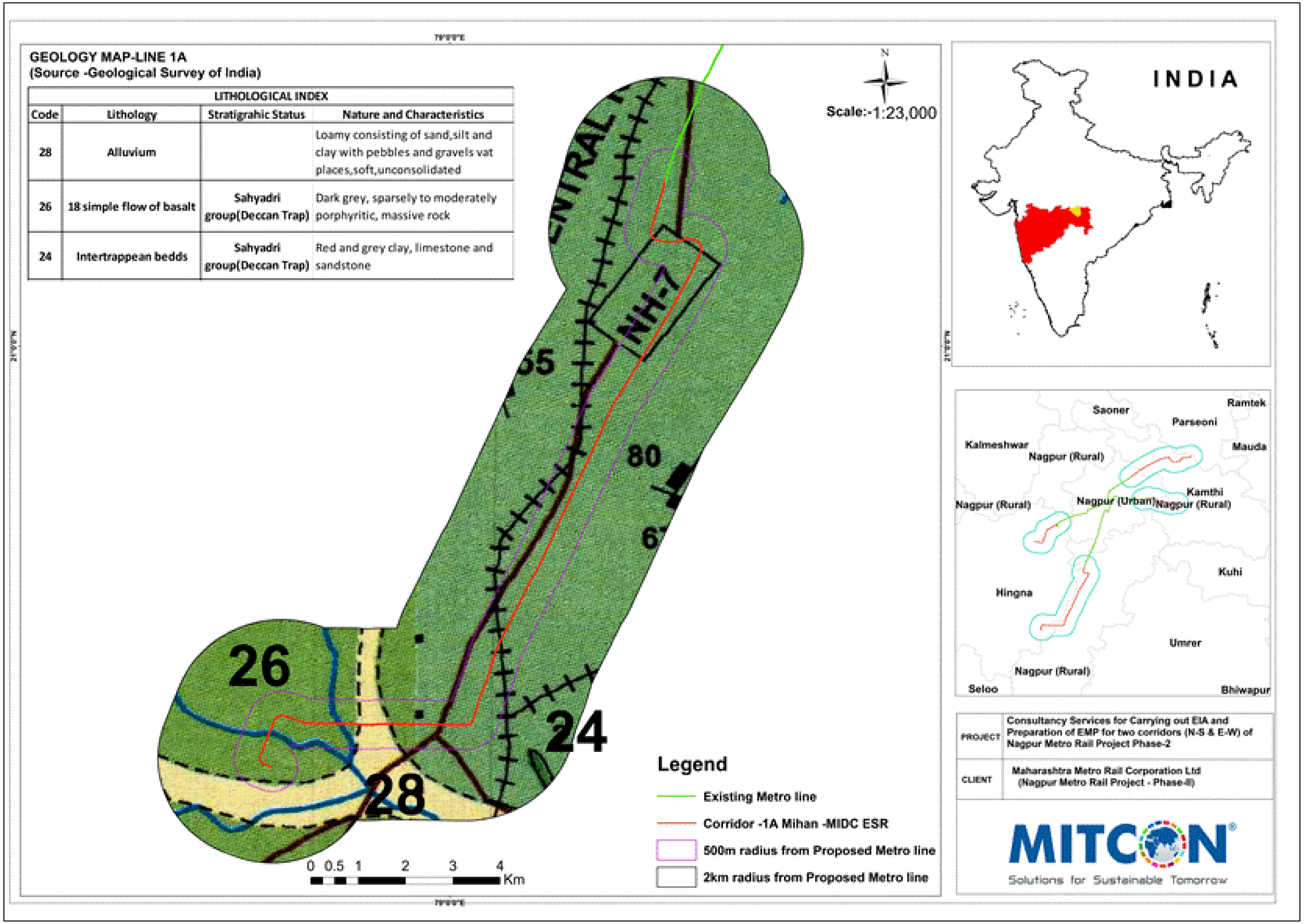


Figure 4-10: Geology of Project Study Area of Reach 2A as per GSI – Nagpur DRM

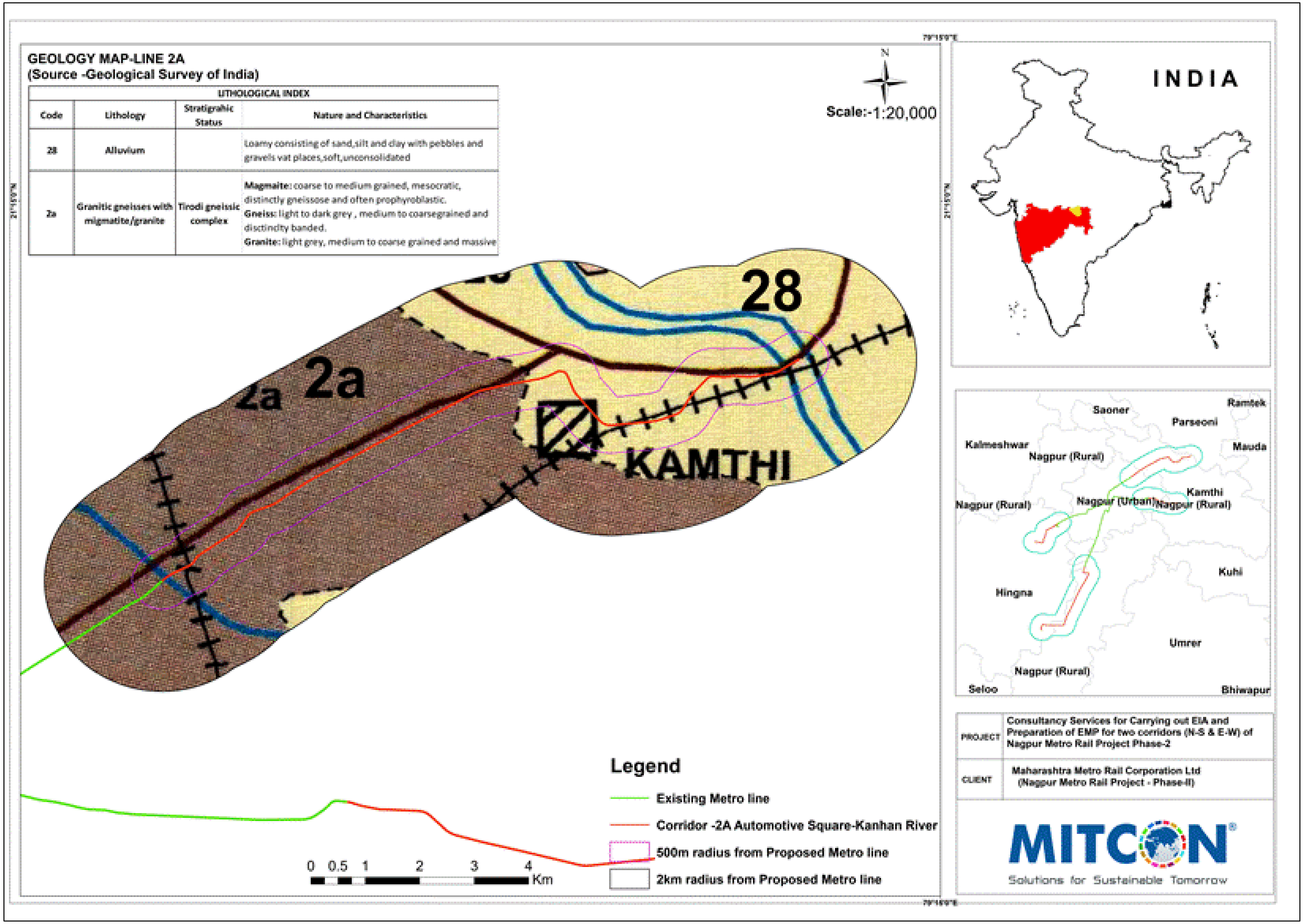


Figure 4-11: Geology of Project Study Area of Reach 3A as per GSI – Nagpur DRM

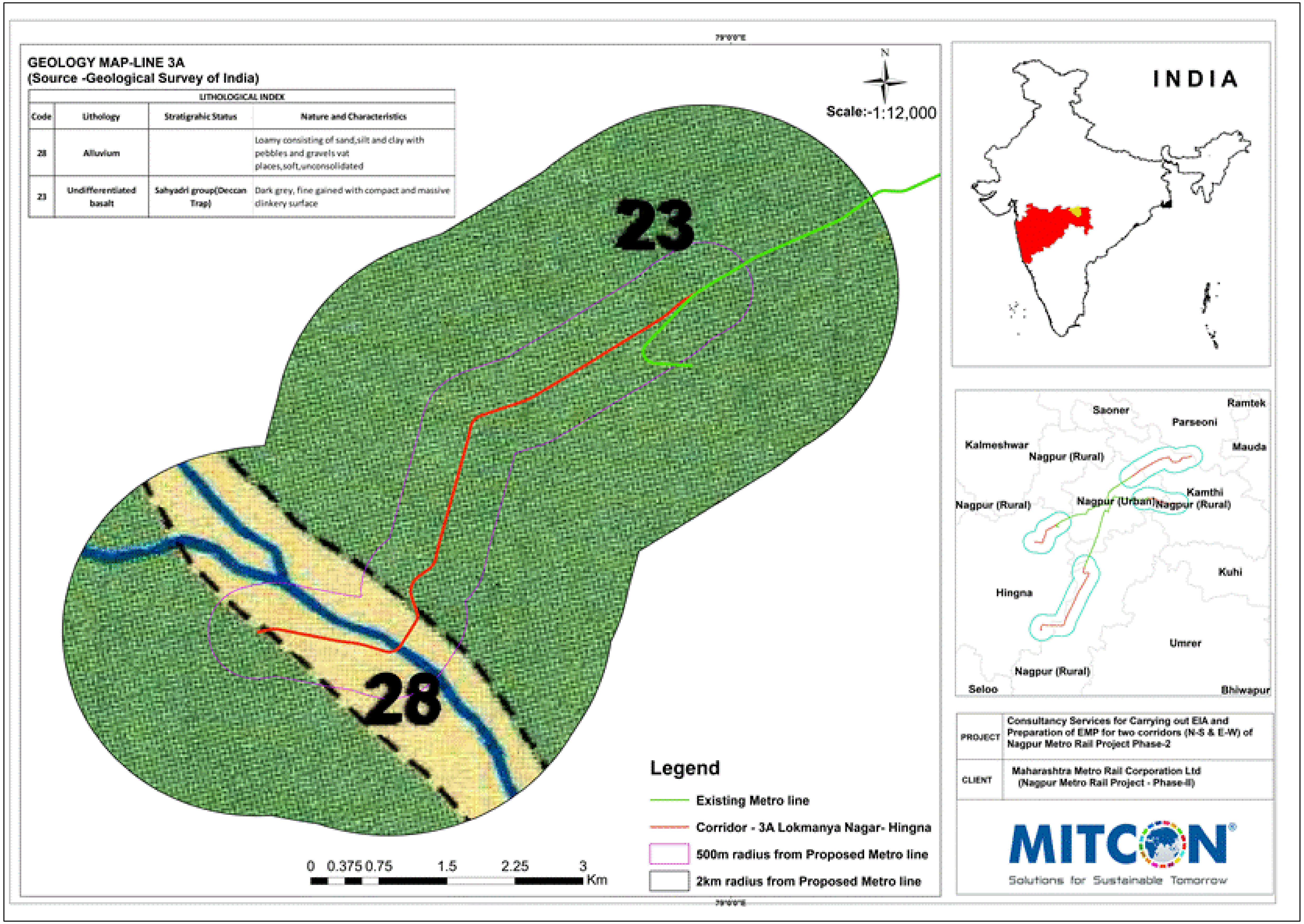
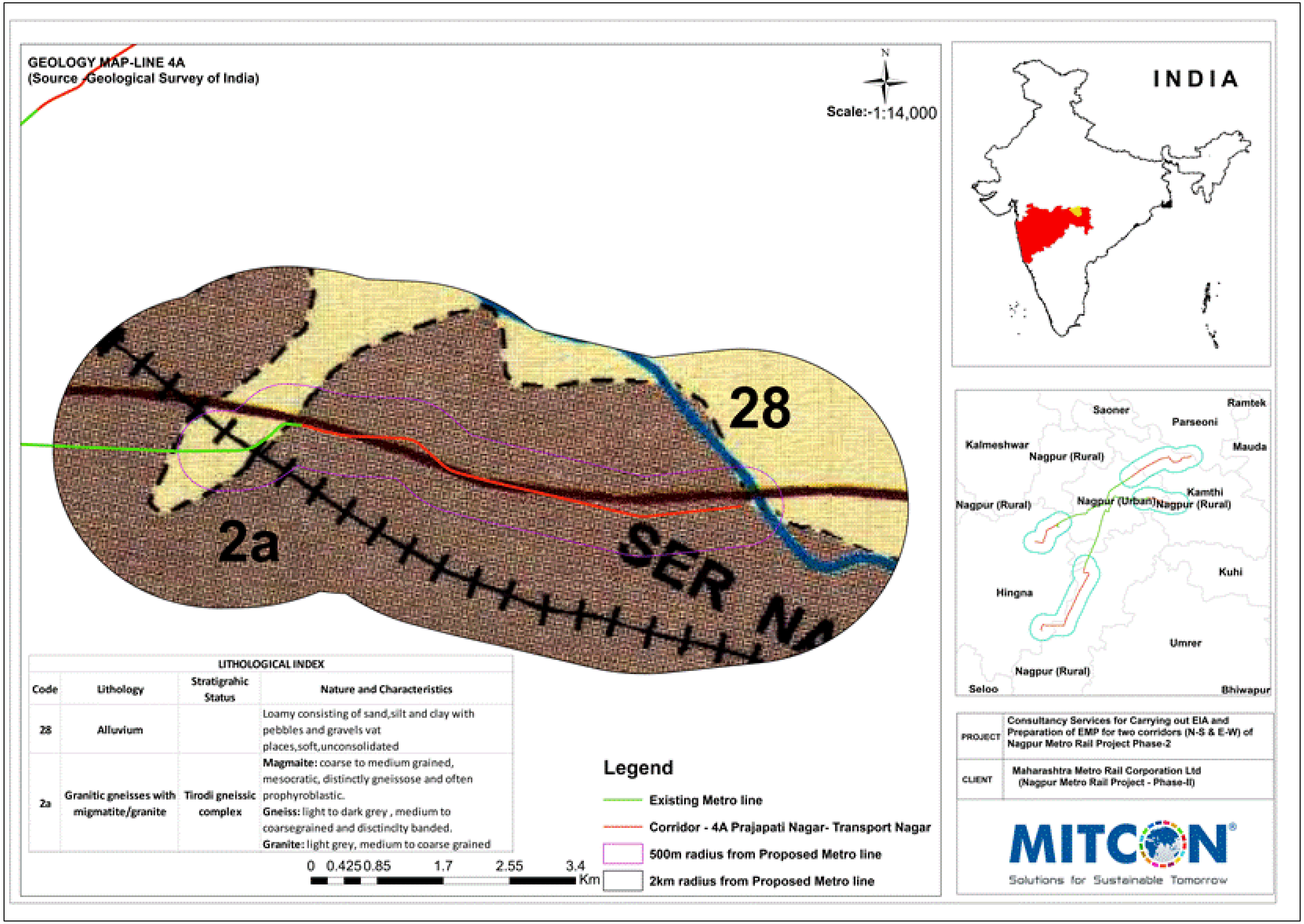


Figure 4-12: Geology of Project Study Area of Reach 4A as per GSI – Nagpur DRM



181. **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.

182. 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.

183. 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

184. '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

185. 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

186. Soil samples were collected once from 20 different locations within the study area, as shown in **Table 4-4**. **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** & **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

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

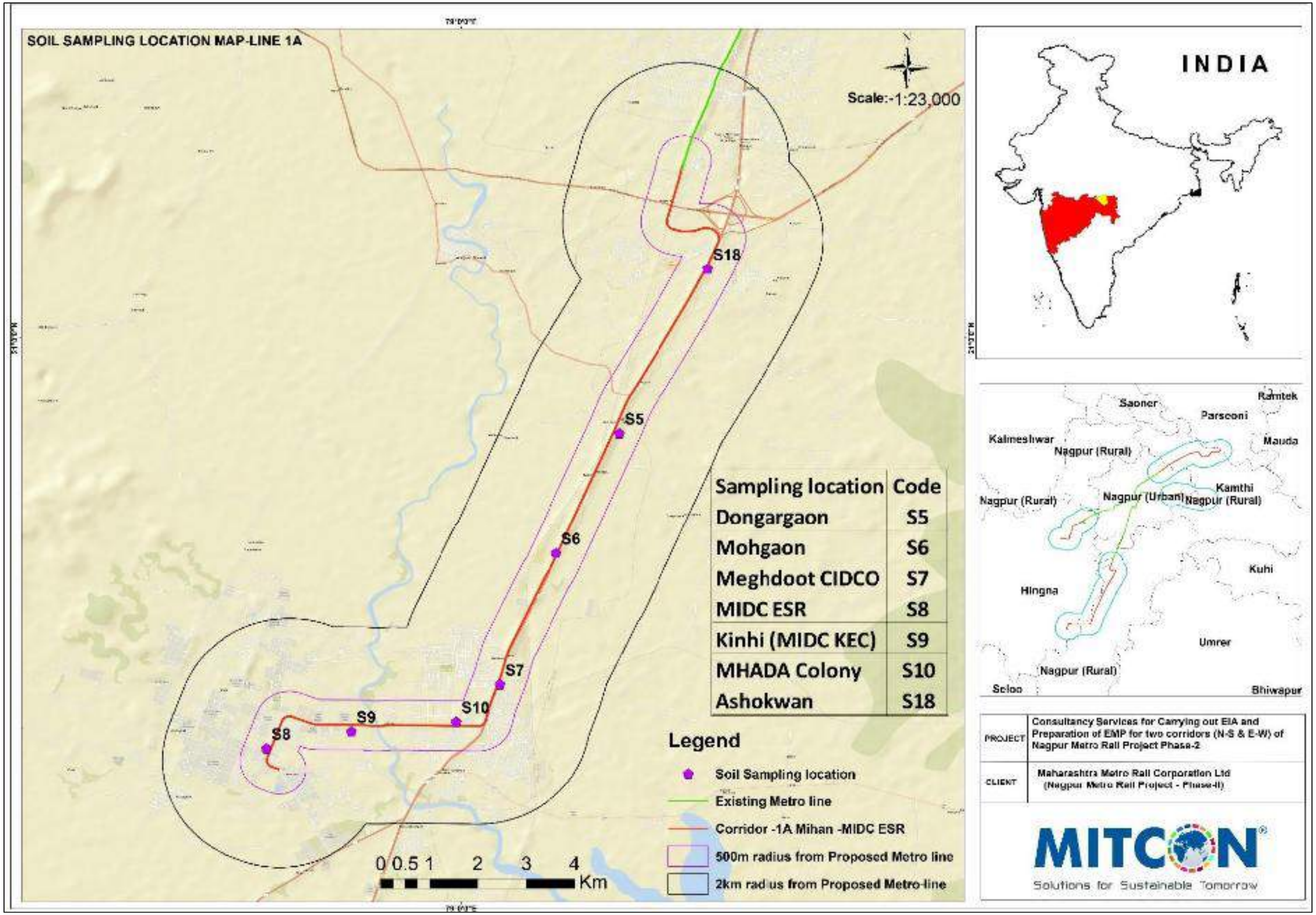


Figure 4-15: Soil sampling locations for NMRP Phase II project - Reach 2A

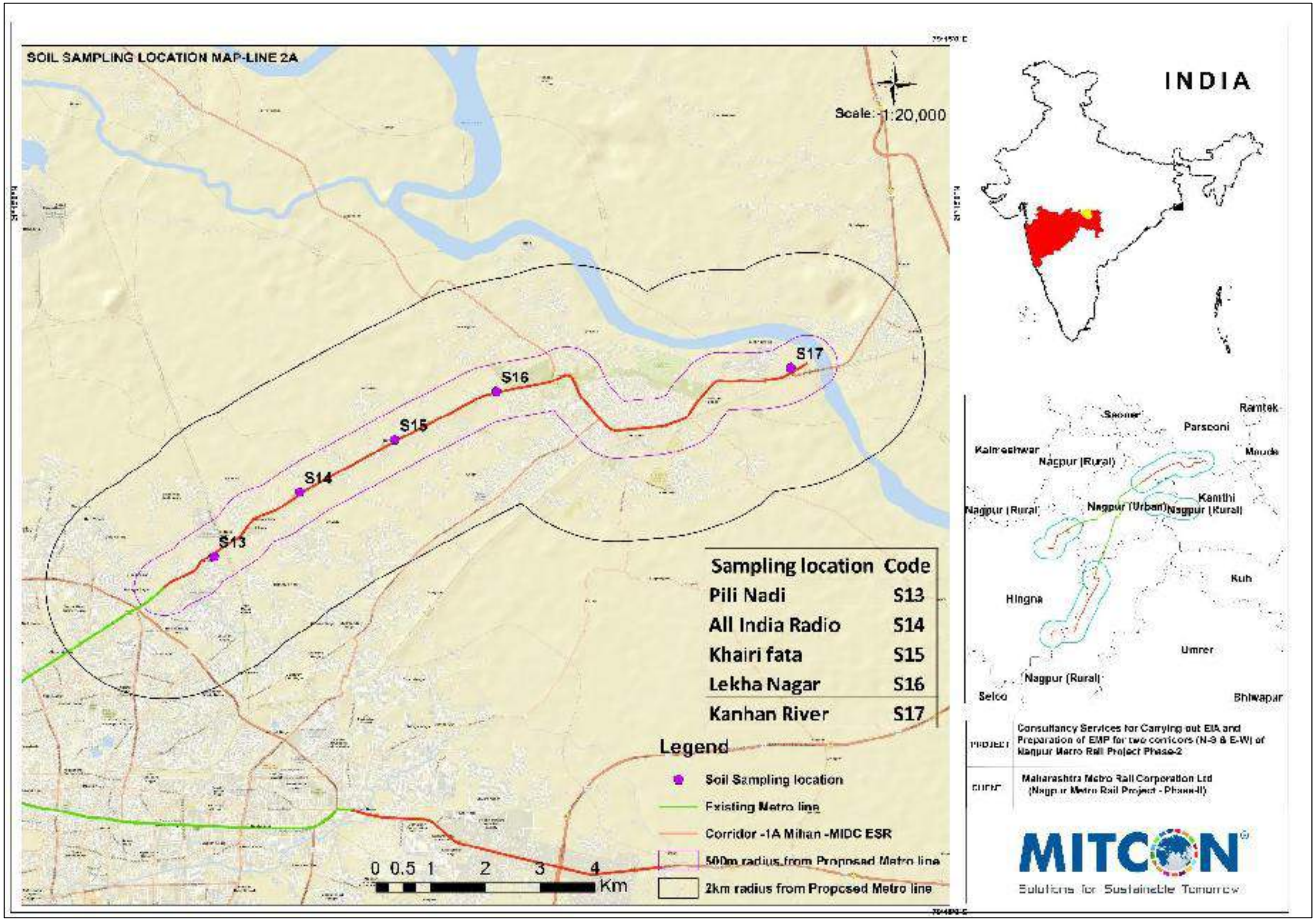


Figure 4-16: Soil sampling locations for NMRP Phase II project - Reach 3A

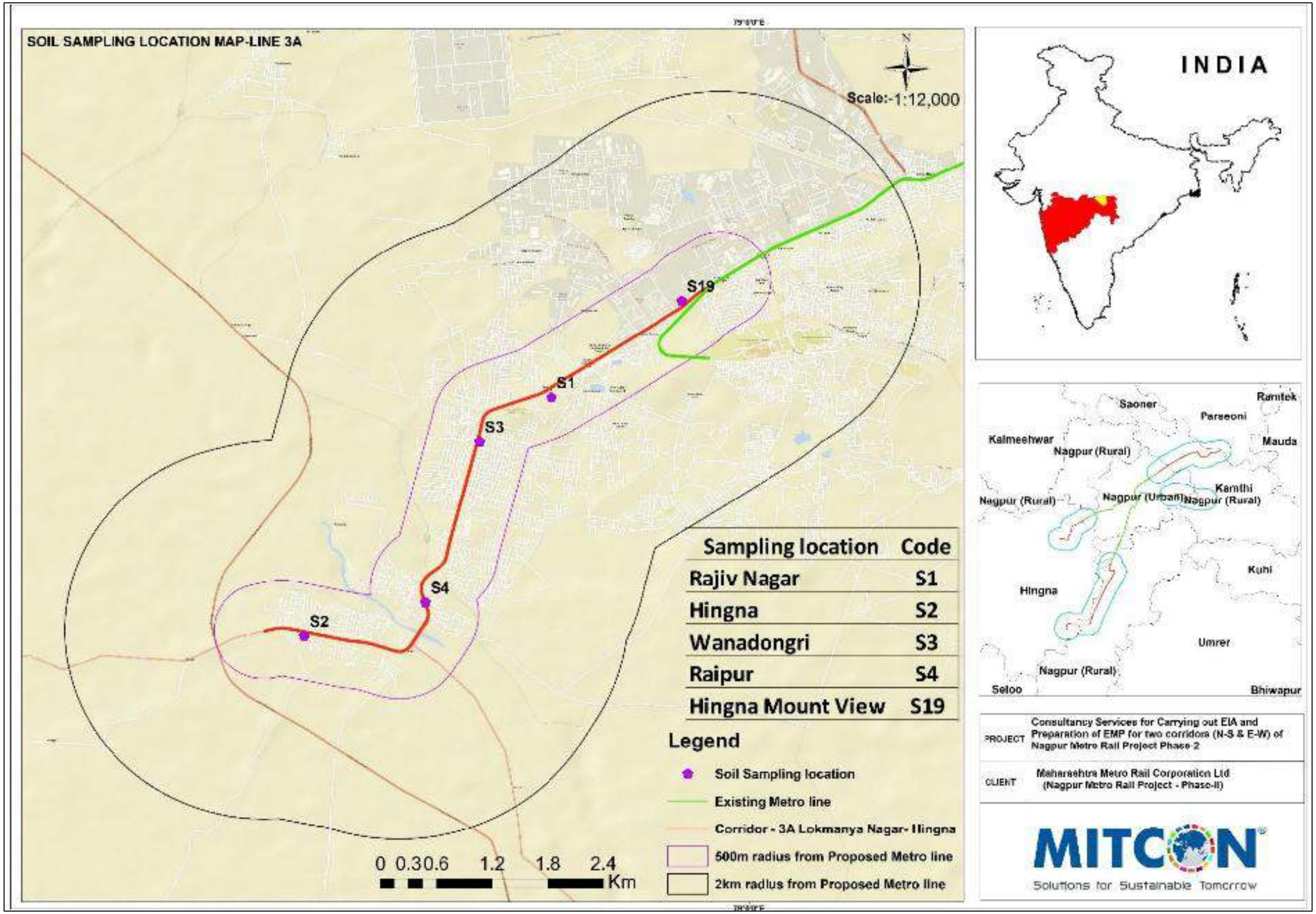
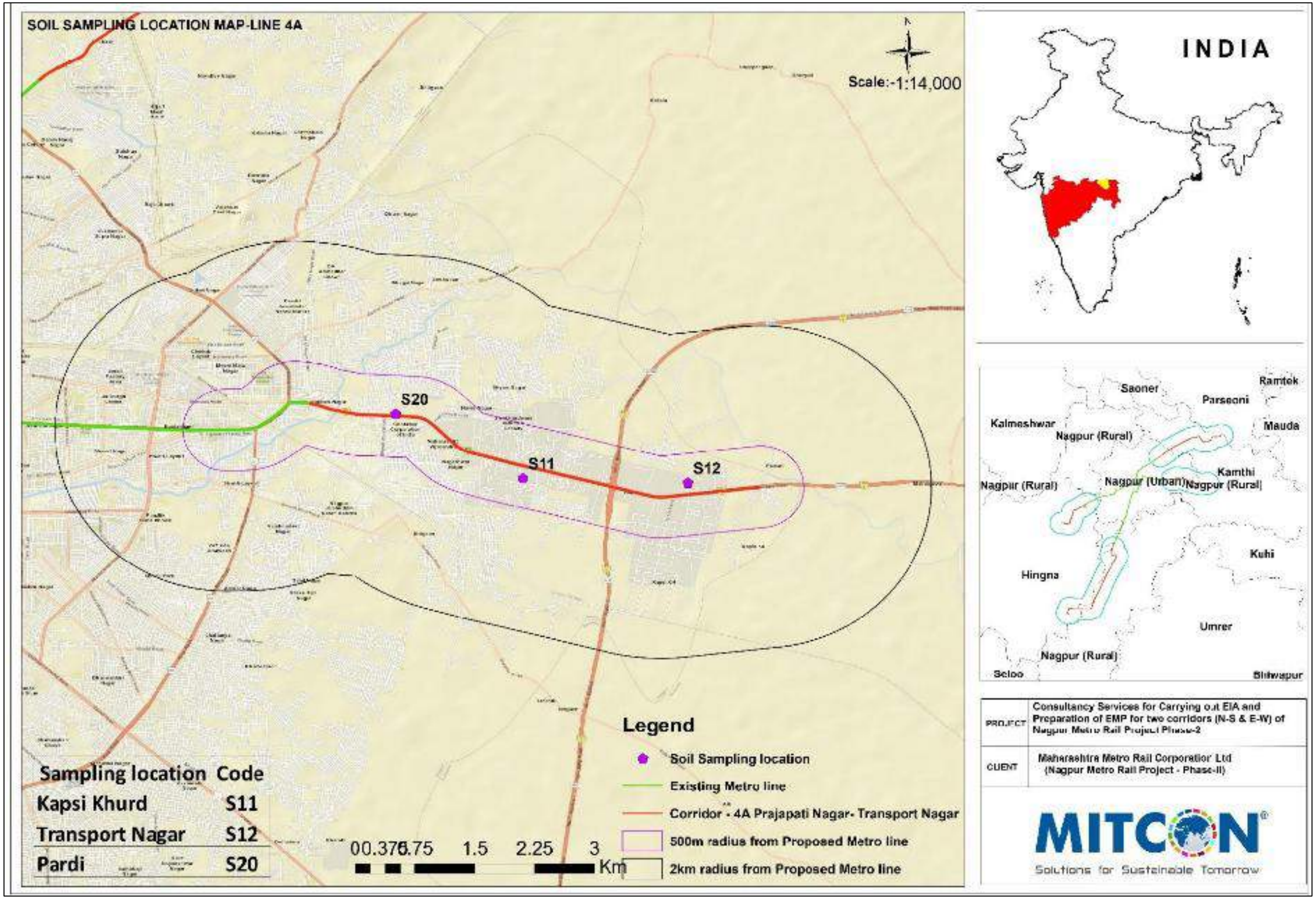


Figure 4-17: Soil sampling locations for NMRP Phase II project - Reach 4A



(c) Soil Sampling Results

187. 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/cm2	%	%	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

188. 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[19]. 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%
- (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 / Land Cover

189. 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.

190. 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**

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

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

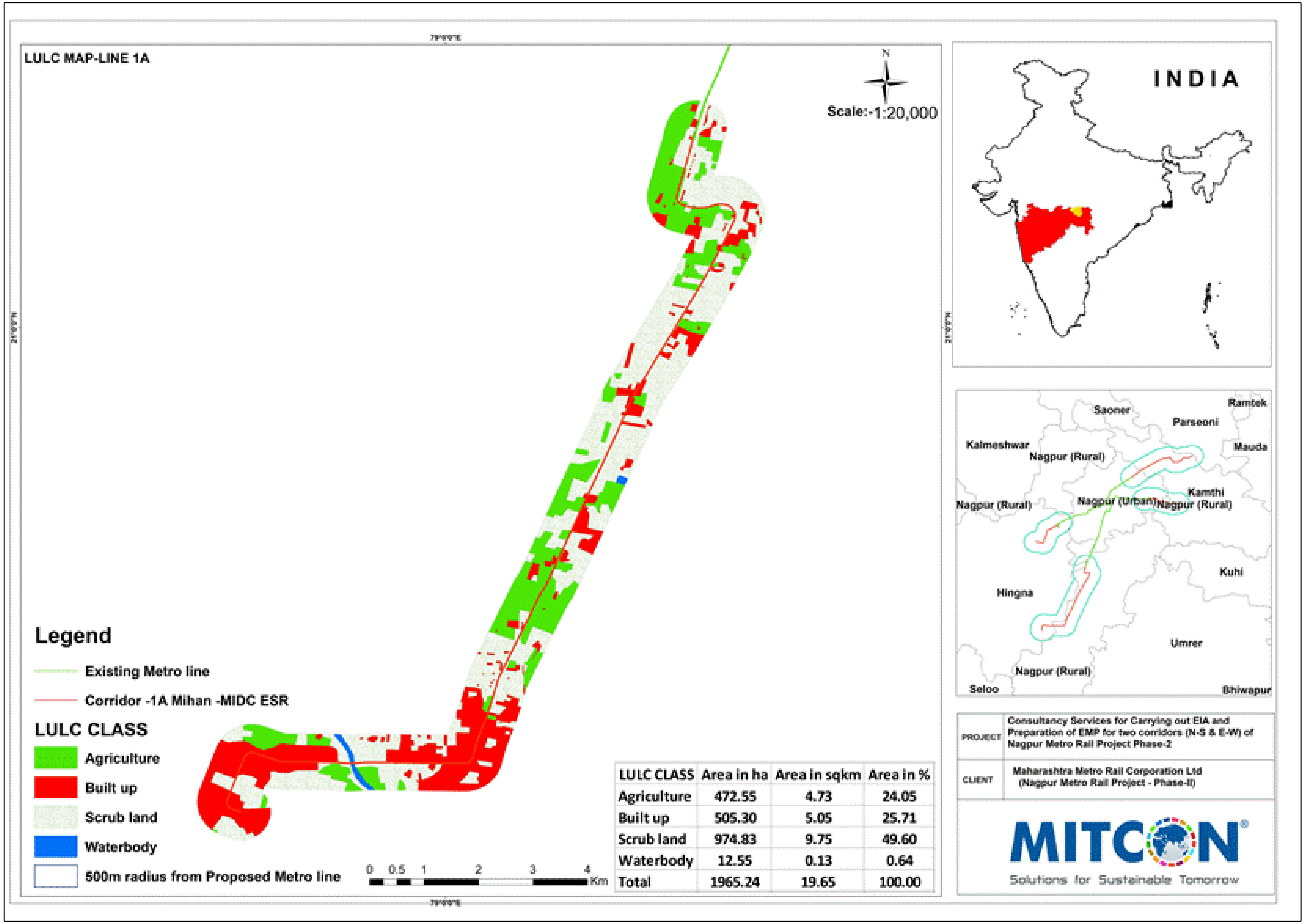


Figure 4-19: Land use / Land Cover in 500 m Core Study Area of Line 2A

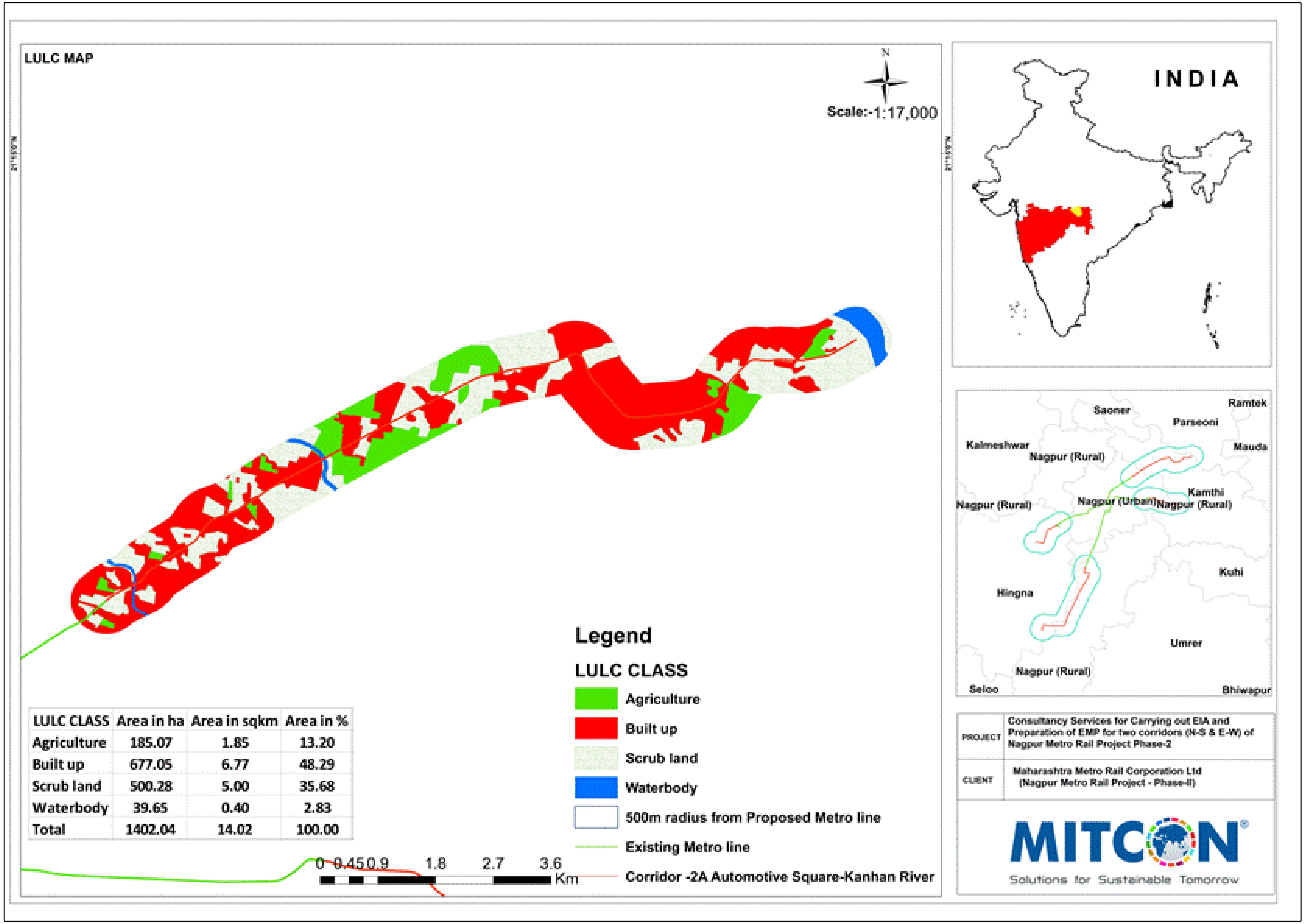
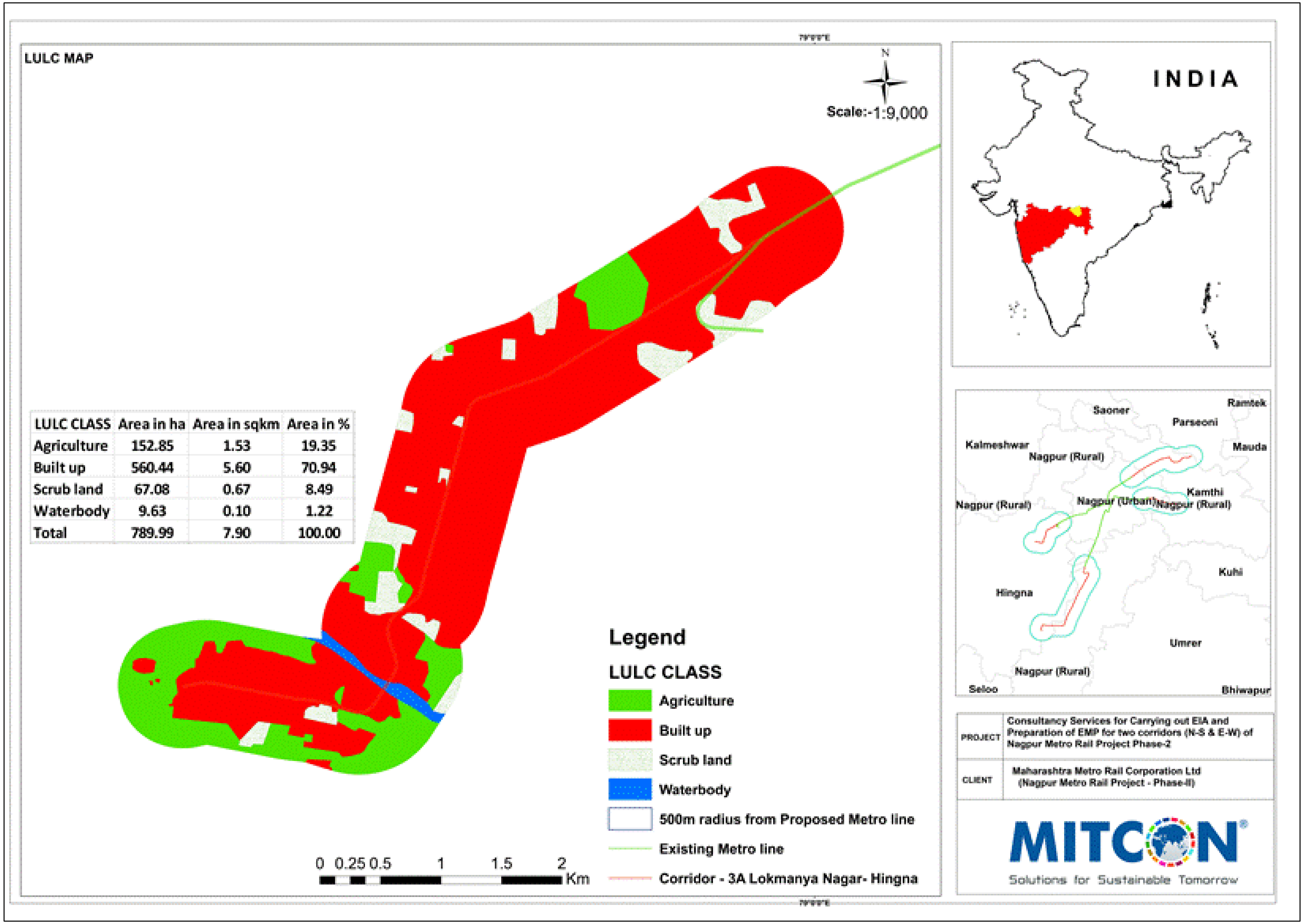
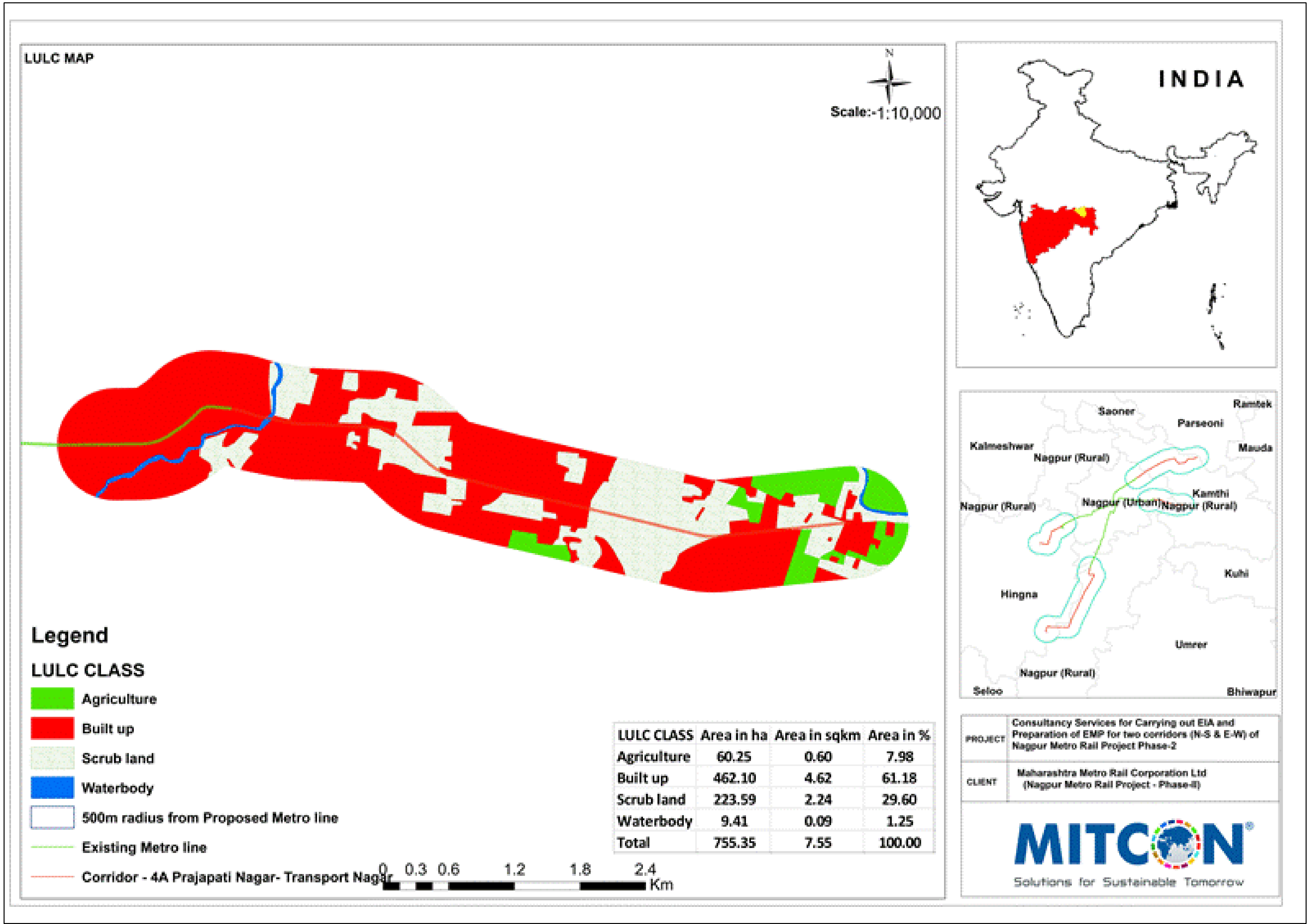


Figure 4-20: Land use / Land Cover in 500 m Core Study Area of Line 3A



LULC CLASS	Area in ha	Area in sqkm	Area in %
Agriculture	152.85	1.53	19.35
Built up	560.44	5.60	70.94
Scrub land	67.08	0.67	8.49
Waterbody	9.63	0.10	1.22
Total	789.99	7.90	100.00

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



LULC CLASS	Area in ha	Area in sqkm	Area in %
Agriculture	60.25	0.60	7.98
Built up	462.10	4.62	61.18
Scrub land	223.59	2.24	29.60
Waterbody	9.41	0.09	1.25
Total	755.35	7.55	100.00

5. Natural Hazards

191. 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.

192. 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

193. 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[20]

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)

194. 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

[20] 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]

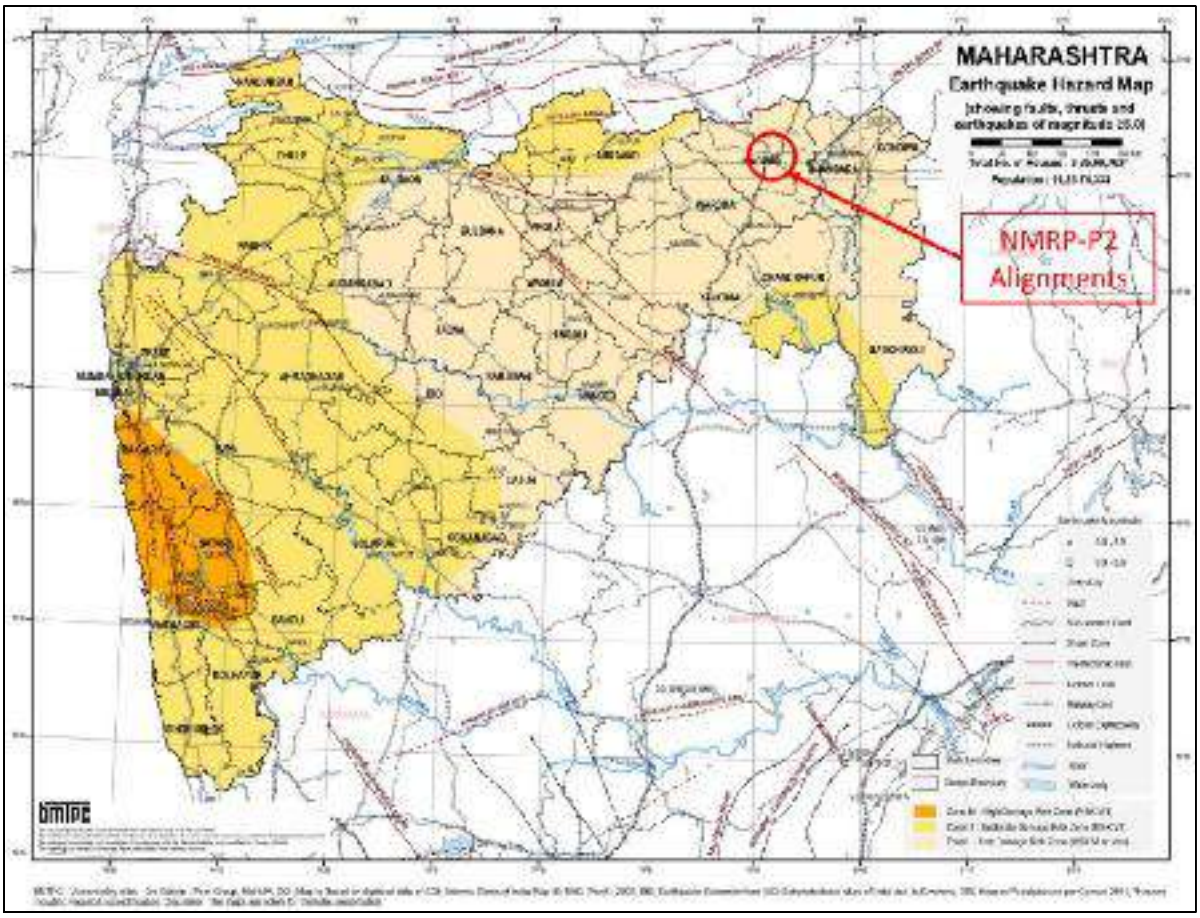
and water pollution, shrinking green spaces, increased flash floods due to increased build-up areas and emergence of urban heat islands etc.[21]

195. 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 [22]. 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

196. Bureau of Indian Standards (BIS) has prepared a seismic zoning map of India based on tectonic features and records of past earthquakes. **Figure 4-IV-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-IV-22: BMTPC Earthquake Hazard Map of Maharashtra[23]



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

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

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

E. AMBIENT ENVIRONMENT

1. Meteorology

197. 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

198. 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)

199. 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)[24]

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: 21°06'N, Longitude: 79°03'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

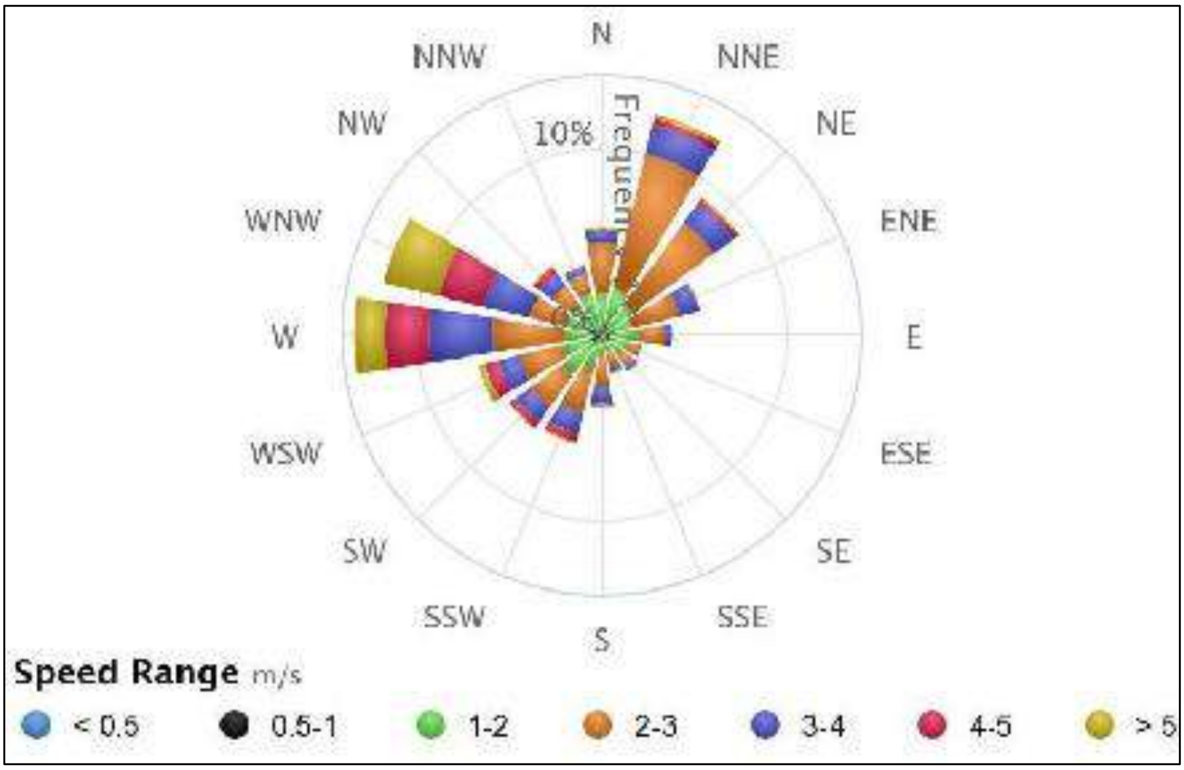
Month	Temperature ° C				Humidity %		Rainfall		Mean Wind Speed m/s	Predominant direction
	Daily Max	Daily Min	Highest in Month	Lowest in Month	Max	Min	Monthly Total in mm	No. of Rainy Days		
January	29.0	13.4	32.5	8.8	67	42	21.6	1.2	4.7	N, NNE
February	31.8	15.6	35.7	11.1	54	31	15.6	1.2	5.6	N, NNE
March	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

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

Month	Temperature ° 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**

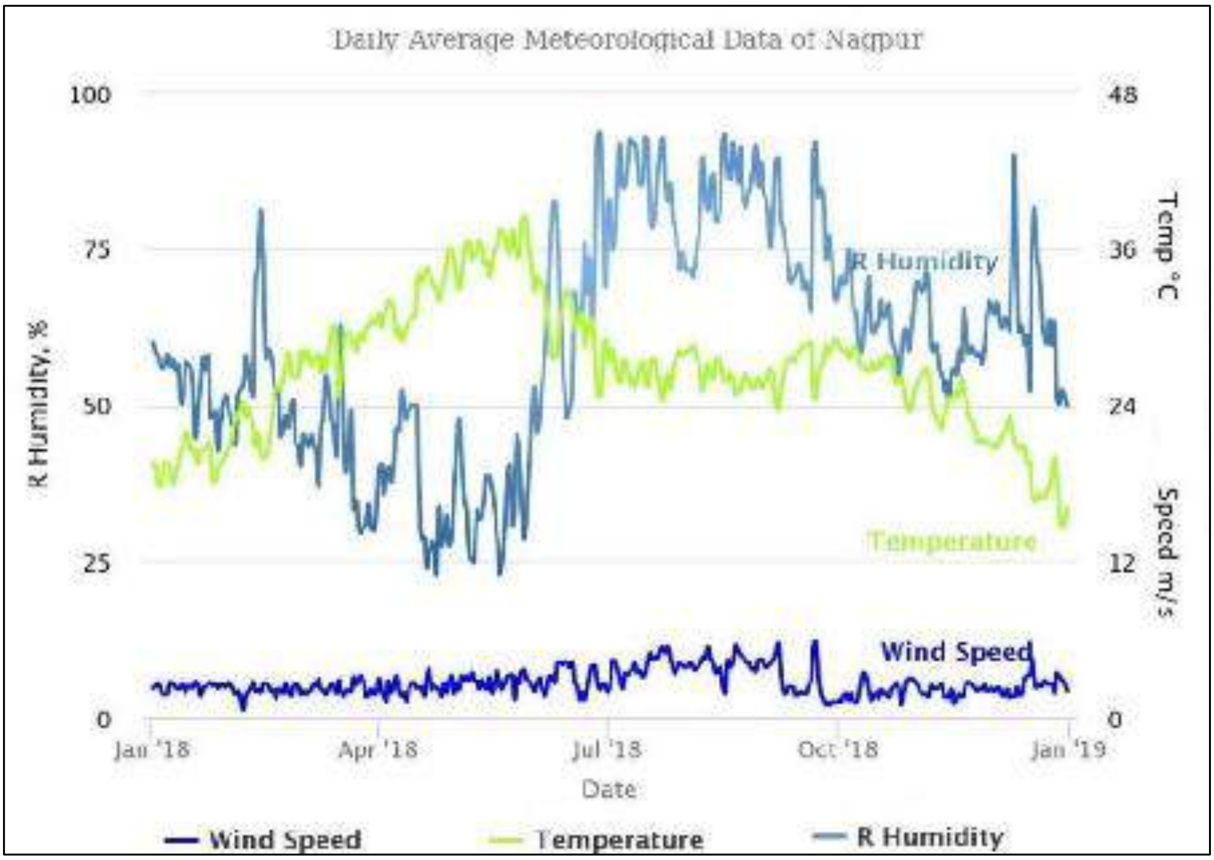
200. The Annual Wind-rose has been obtained from IMD Nagpur (Sonegaon) and shown as **Figure 4-23** and Daily Average Meteorological data (Climatological Norm) for Nagpur i.e. Temperature, Rainfall and Relative Humidity are shown as **Figure 4-24**.

Figure 4-23: Annual Wind-rose – Nagpur[25]



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

Figure 4-24: Climatological Norm at Nagpur[26]



2. Ambient Air Environment

201. 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)

202. 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).

203. 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

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

from action of nitrogen oxides and VOCs; nitrogen oxides are measured as dioxide and therefore ozone was not measured.

204. The sampling and analysis of ambient air quality parameters was carried out as per the procedures detailed in relevant Parts of IS-5182 (Indian Standards for Ambient Air Quality Parameters).
The following air pollution parameters were monitored and measured by sampling:

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

(b) Techniques for Measurement

205. 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

206. 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-IV11**.

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-IV11: 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 Asha Hospital and Asharam College & School of Nursing	Residential and Sensitive Receptor (School & Hospital)	21°13'8.90"N	79°10'36.83"E	CW
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

Line	Sampling Date	Machine Details	Sampling Code	Sampling Location	Type of Sample	Latitude	Longitude	Wind type[#]
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	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 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.*

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

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

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

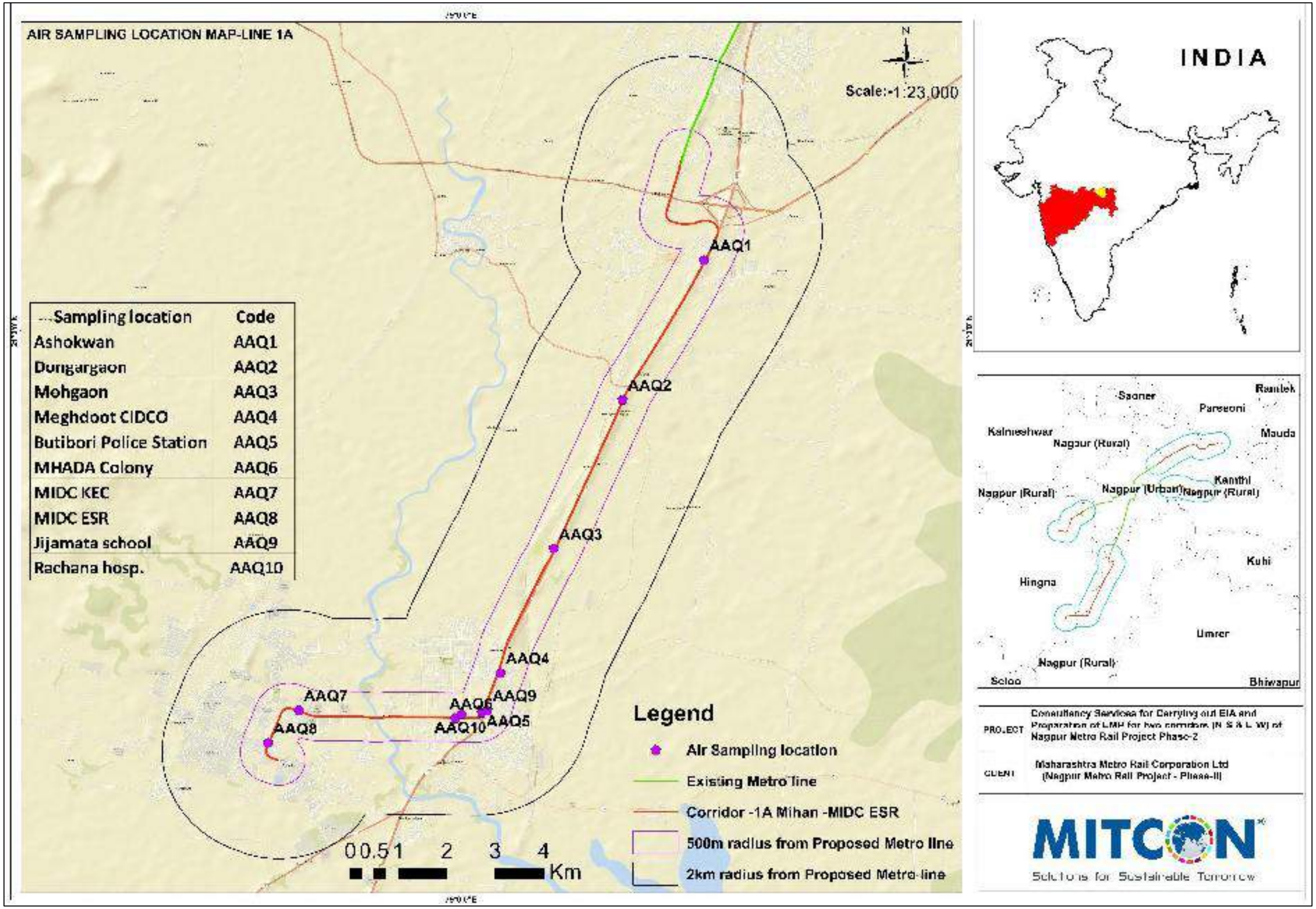


Figure 4-27: Air Monitoring Locations for Reach 2A of NMRP-Phase II Project

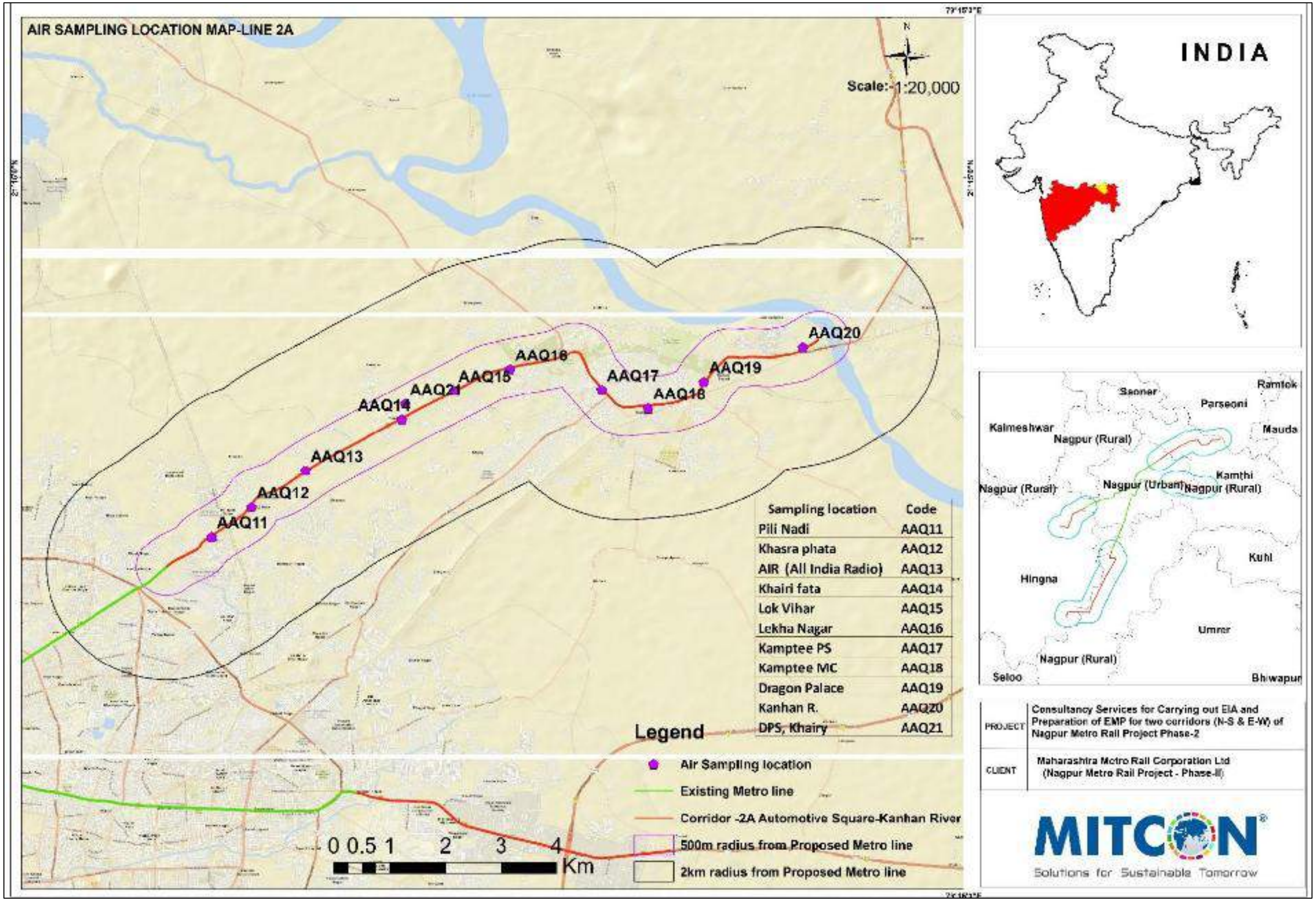
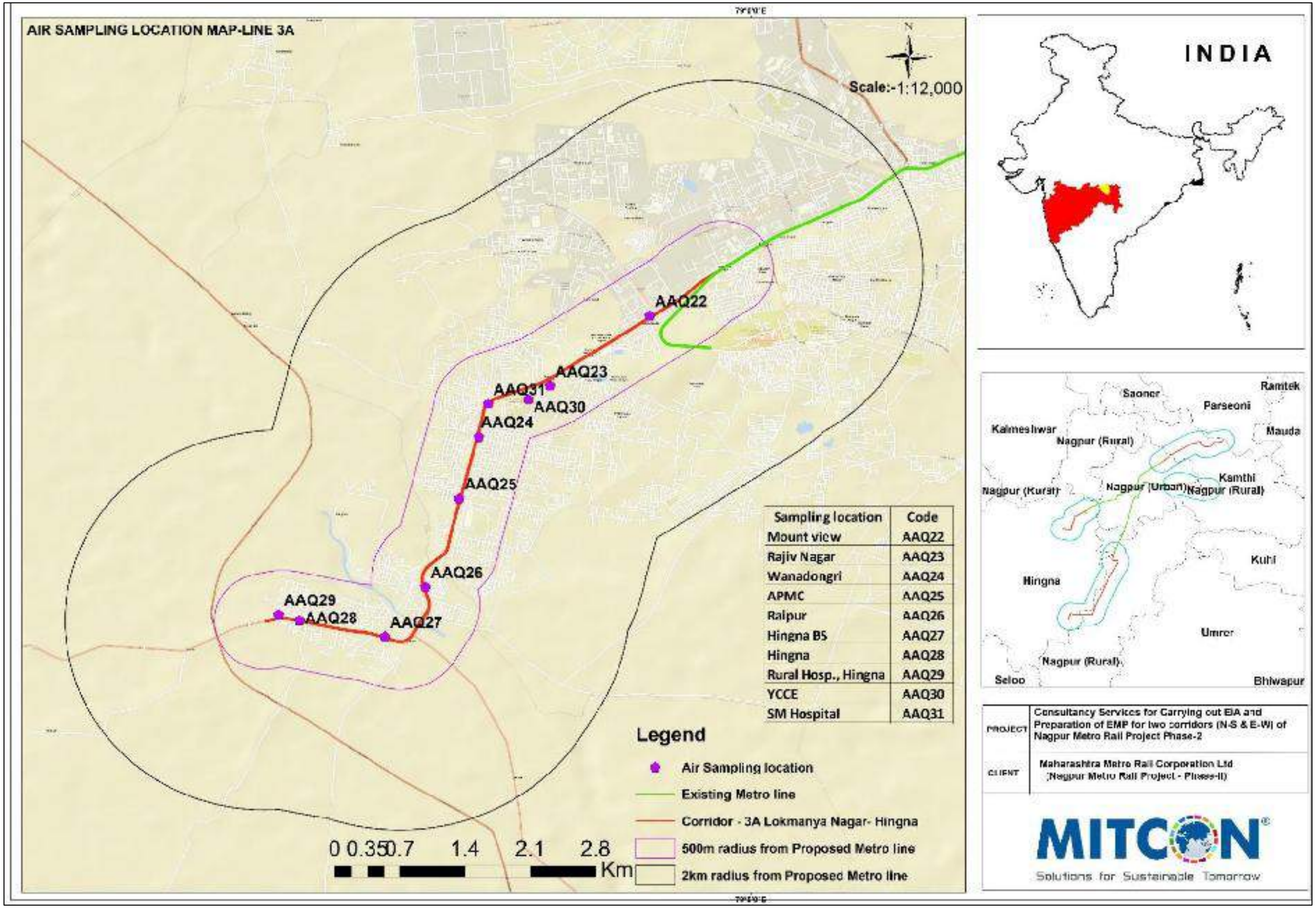
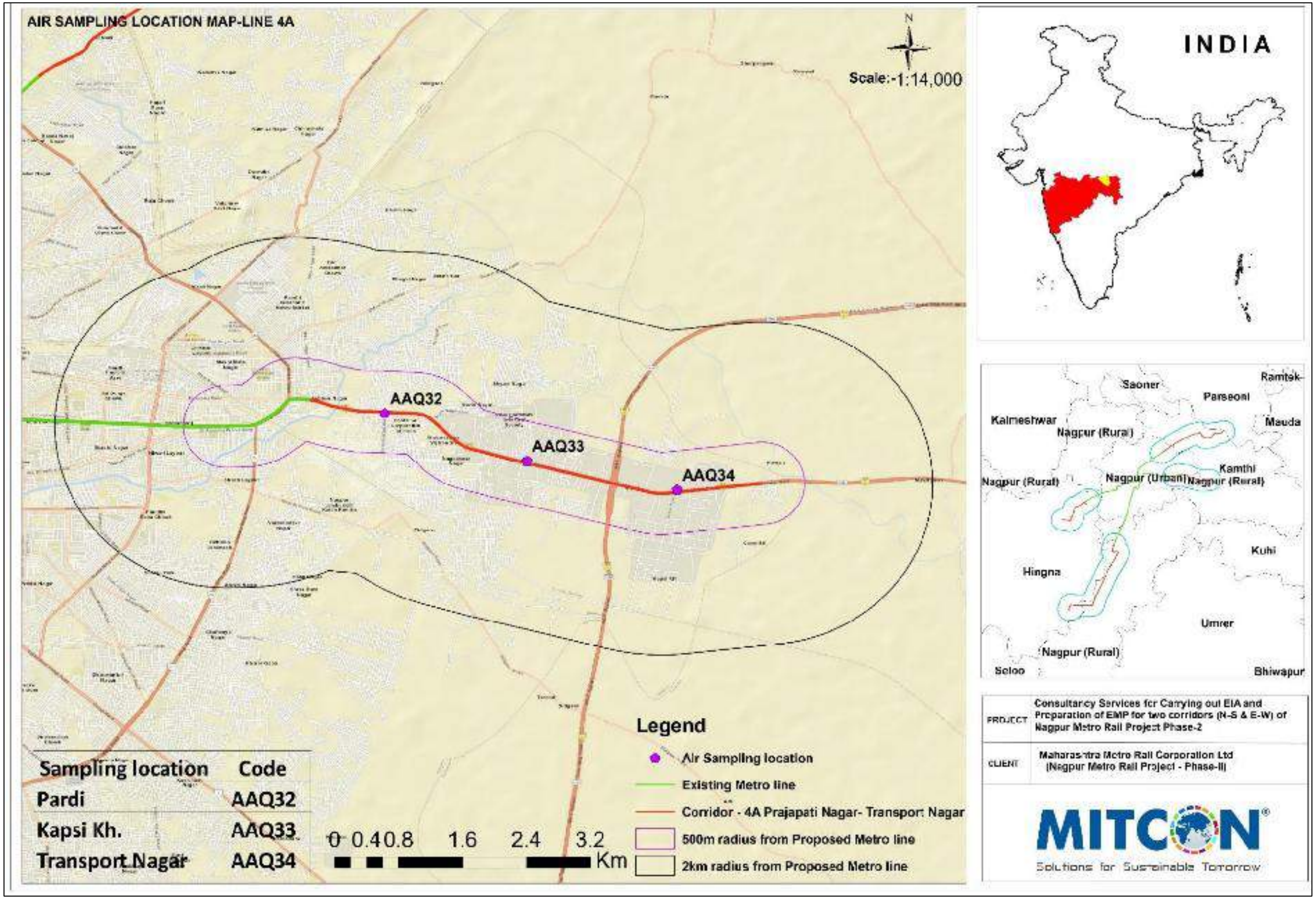


Figure 4-28: Air Monitoring Locations for Reach 3A of NMRP-Phase II Project



Sampling location	Code
Mount view	AAQ22
Rajiv Nagar	AAQ23
Wanadongri	AAQ24
APMC	AAQ25
Raipur	AAQ26
Hingna BS	AAQ27
Hingna	AAQ28
Rural Hosp., Hingna	AAQ29
YCCE	AAQ30
SM Hospital	AAQ31

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



(d) Ambient Air Quality Results

207. 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

208. 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. 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 (2005) 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[27]		WHO Guidelines (2021 AQGs)[28]	WBG-EHS Guidelines (2005)[29]
		Industrial, Residential, Rural, and Other Areas	Ecologically Sensitive Area (notified by Central Government)		
Sulphur dioxide (SO_2), µg/m³	Annual	50	20	-	
	24 hours	**80**	80	**40**	**20**
Nitrogen dioxide (NO_2), µg/m³	Annual	40	30	10	
	24 hours	**80**	80	**25**	
	1 hour				200
Particulate matter (<10 µm) or PM_{10}, µg/m³	Annual	60	60	15	
	24 hours	**100**	100	**45**	**50**
Particulate matter (< 2.5 µm) or $PM_{2.5}$, µg/m³	Annual	40	40	5	
	24 hours	**60**	60	**15**	**25**
Carbon monoxide or CO, mg/m³	24 hours	-	-	4	
	8 hours	**2**	2	**-**	
	1 hour	4	4	-	

(e) Air Modelling Studies

209. 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.

210. 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

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

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27 Source: CPCB guidelines for AAQM (National Ambient Air Quality Standards or NAAQS, 2009)

28 Source: WHO Global Air Quality Guidelines (AQGs) 2021 [https://iris.who.int/bitstream/handle/10665/345329/9789240034228-eng.pdf?sequence=1]

29 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]

212. 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 affects 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

213. 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

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

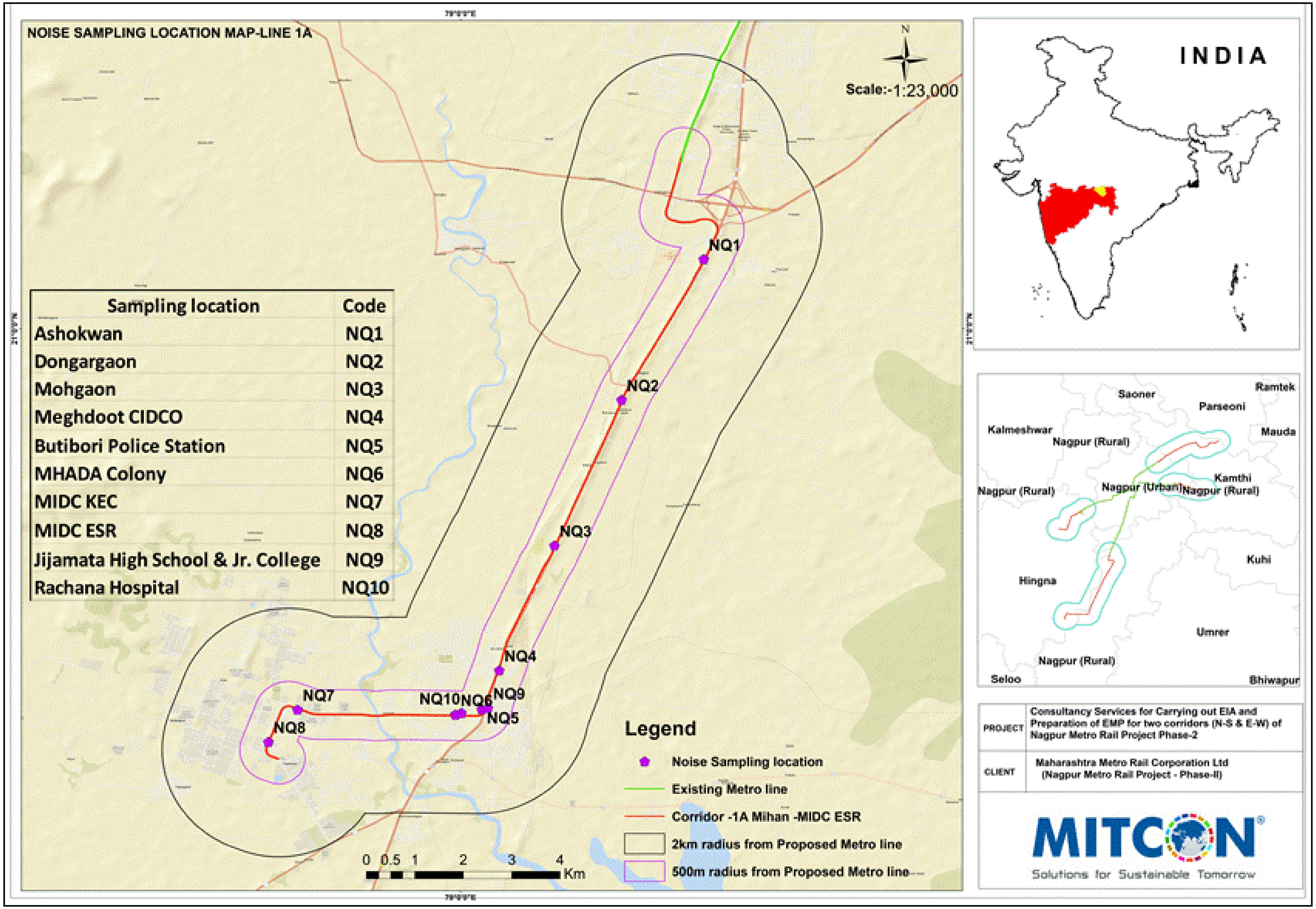


Figure 4-32: Noise Monitoring Sampling Locations for Reach 2A

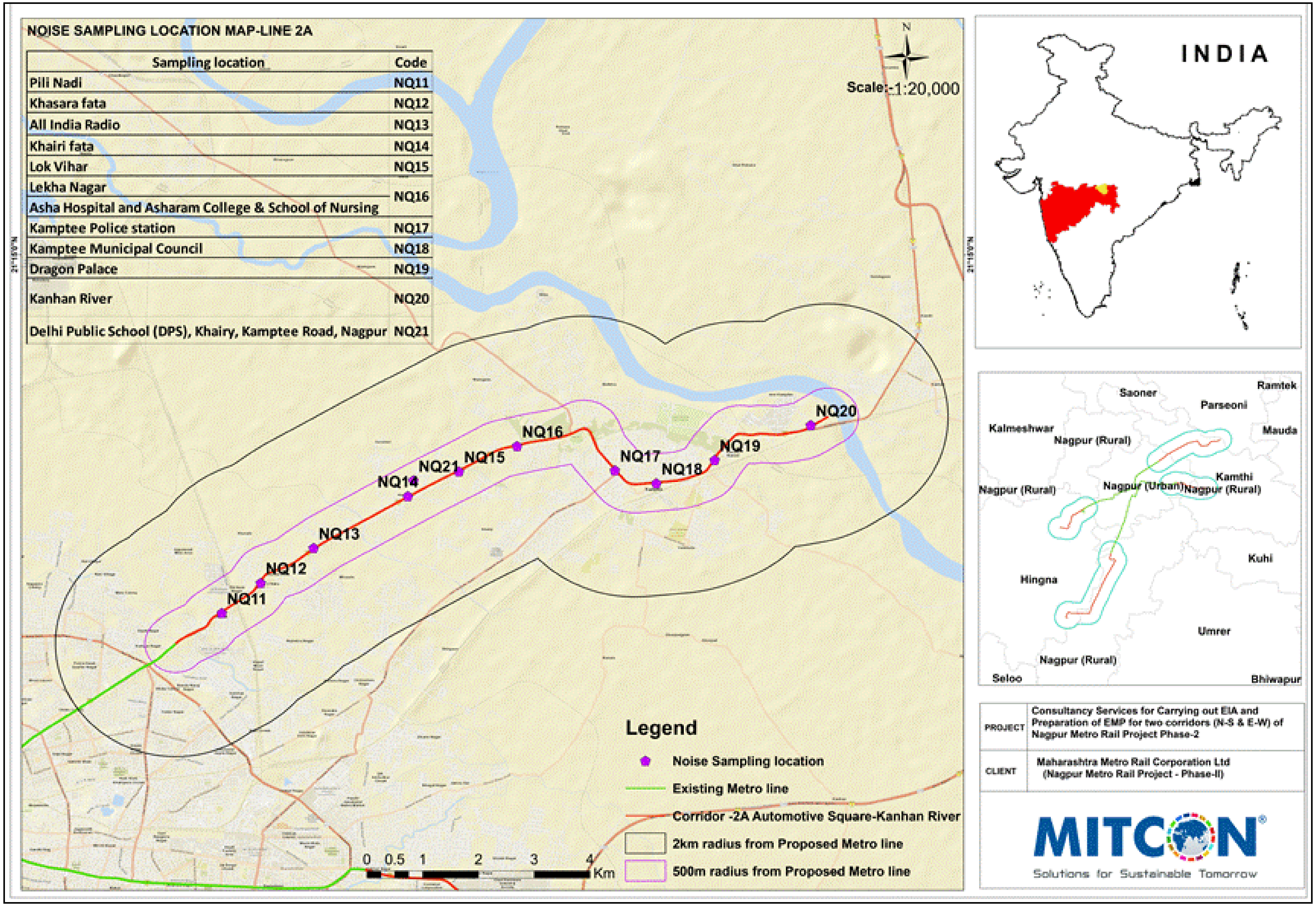


Figure 4-33: Noise Monitoring Sampling Locations for Reach 3A

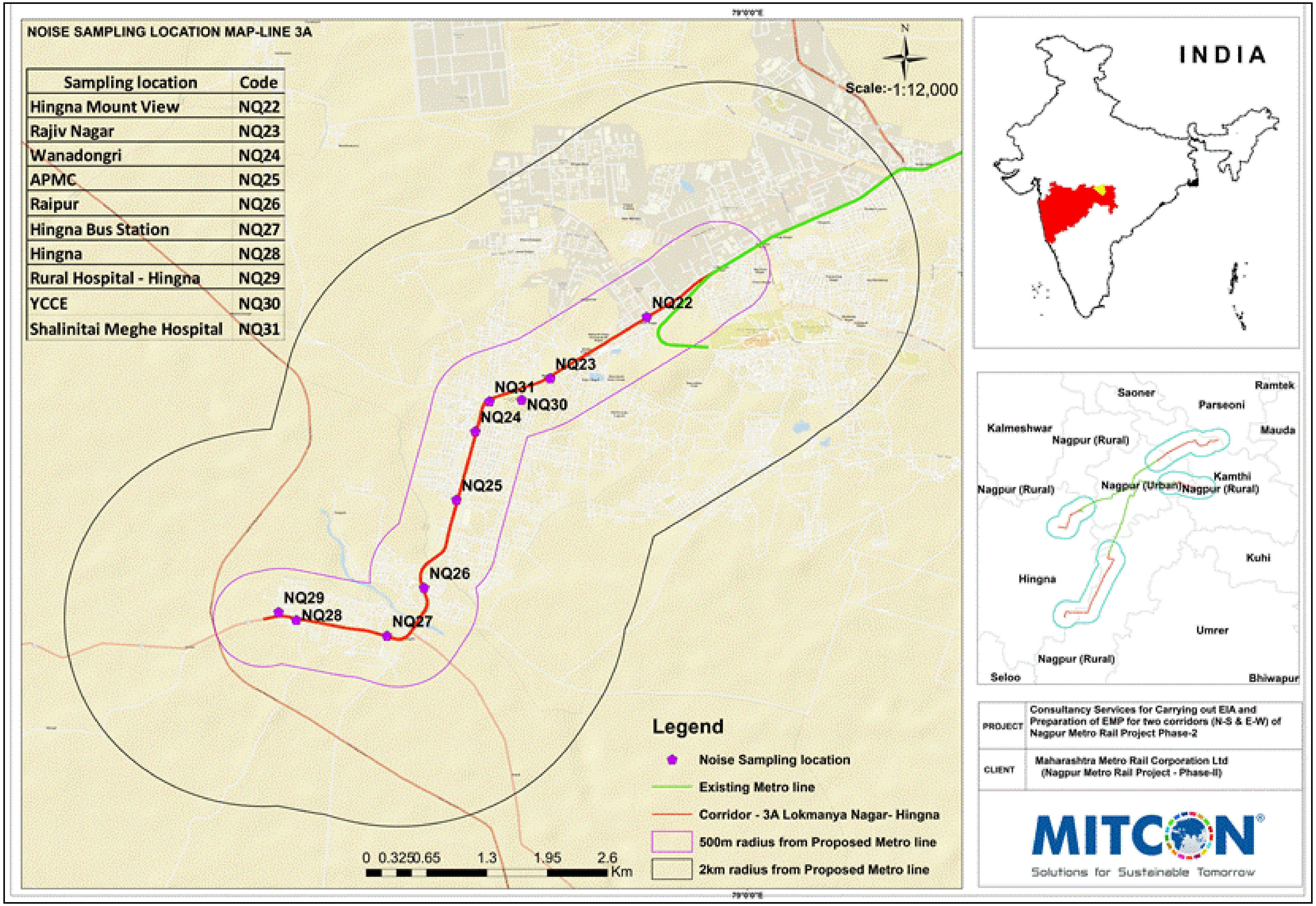
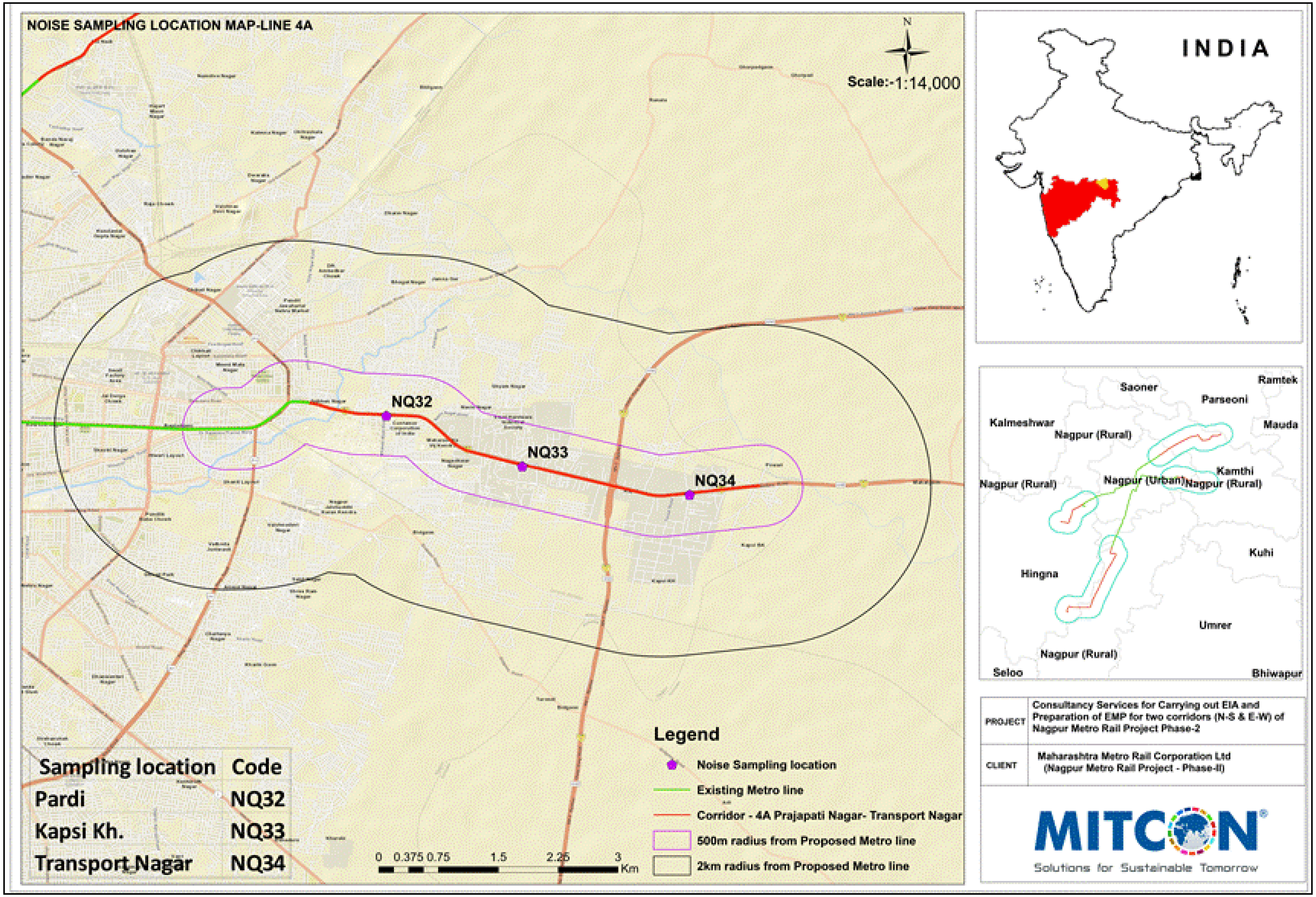


Figure 4-34: Noise Monitoring Sampling Locations for Reach 4A



(c) Noise Quality Sampling Results

214. 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

215. The Noise monitoring results most of the sampling locations are found to be within the prescribed standards (shown in **Table 4-IV-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-IV-16: Guidelines/Standards with respect to Noise

Area Code	Category	CPCB Limits[30] in dB(A) Leq		WBG-EHS Limits[31] 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) Leq 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

216. Noise modelling for the NMRP Phase II alignments was carried out using Dhwani Pro 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.

4. Vibration Analysis

(a) Methodology

217. 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.

218. 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

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30 Source: CPCB guidelines for AAQM (National Ambient Air Quality Standards or NAAQS, 2009)
31 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]

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

219. 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

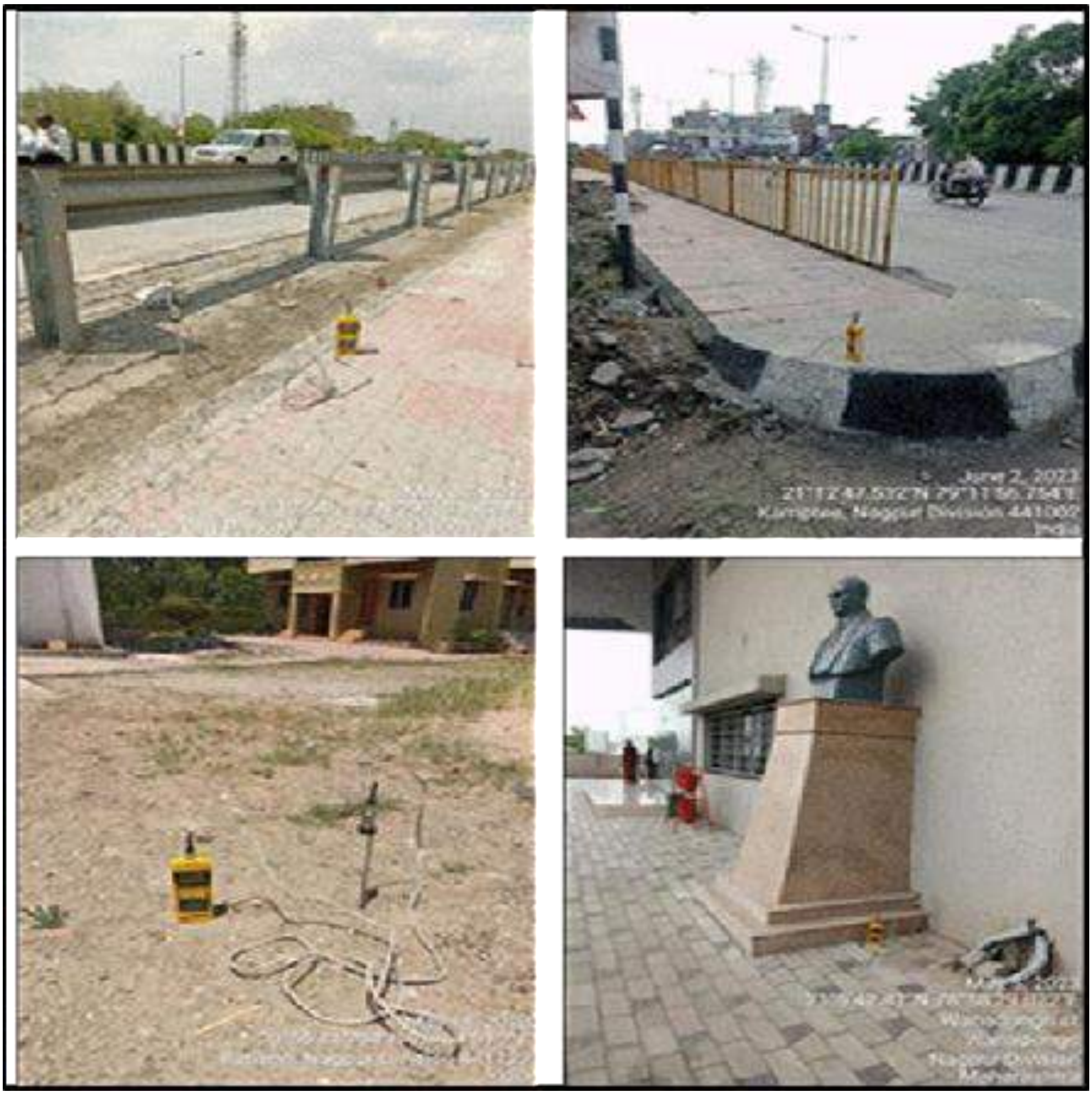


Figure 4-36: Vibration Sampling Locations for Reach 1A

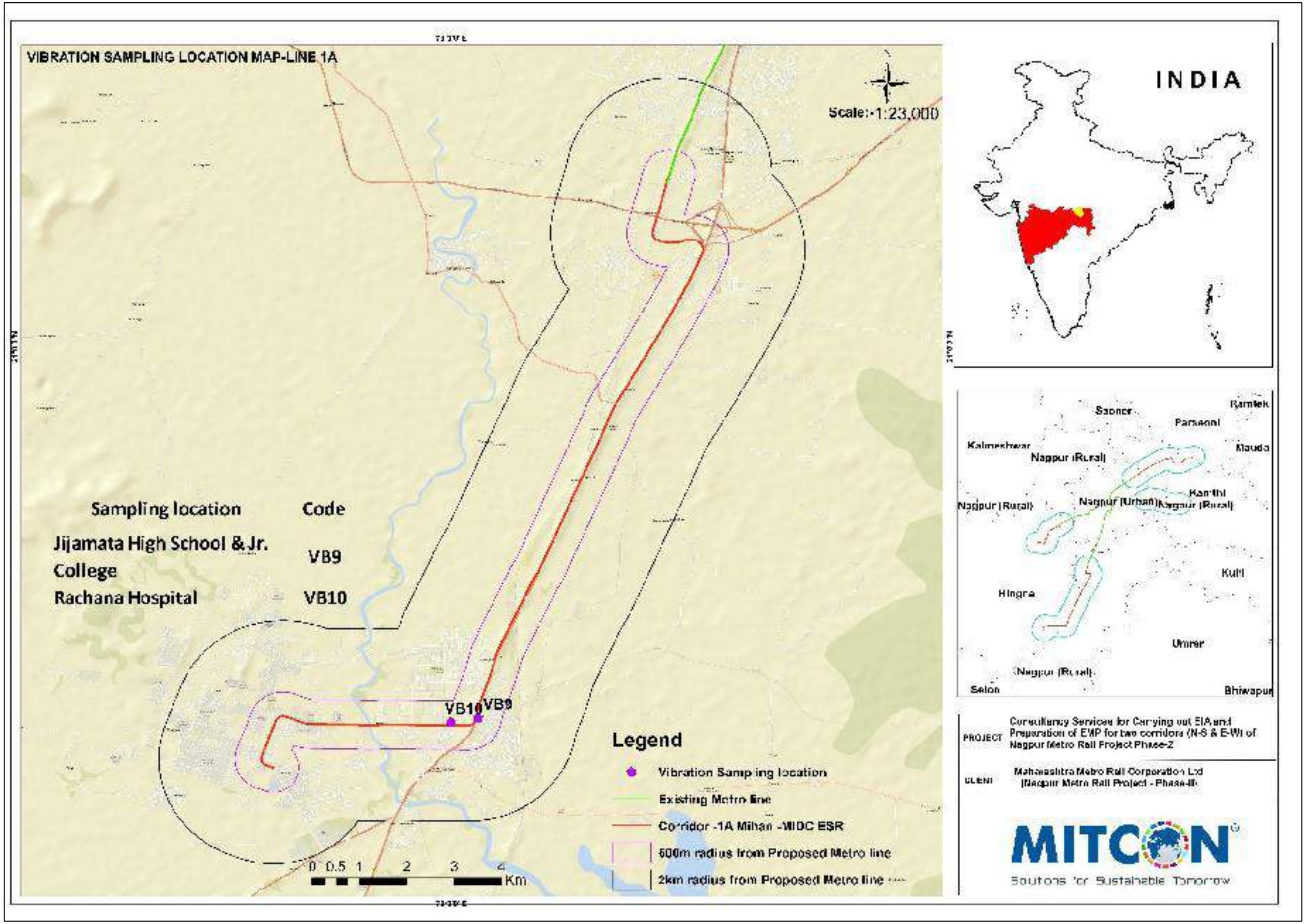


Figure 4-37: Vibration Sampling Locations for Reach 2A

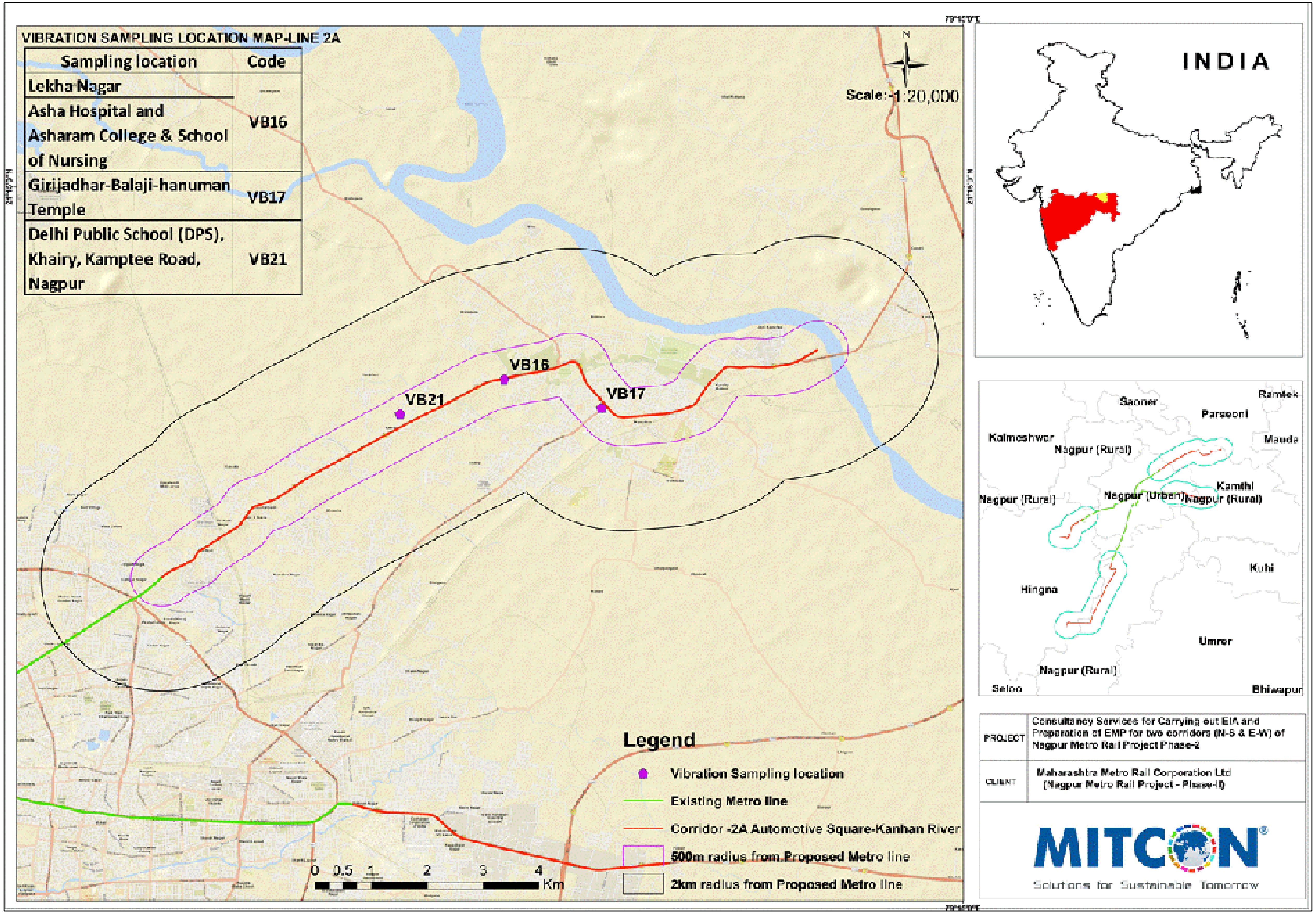


Figure 4-38: Vibration Sampling Locations for Reach 3A

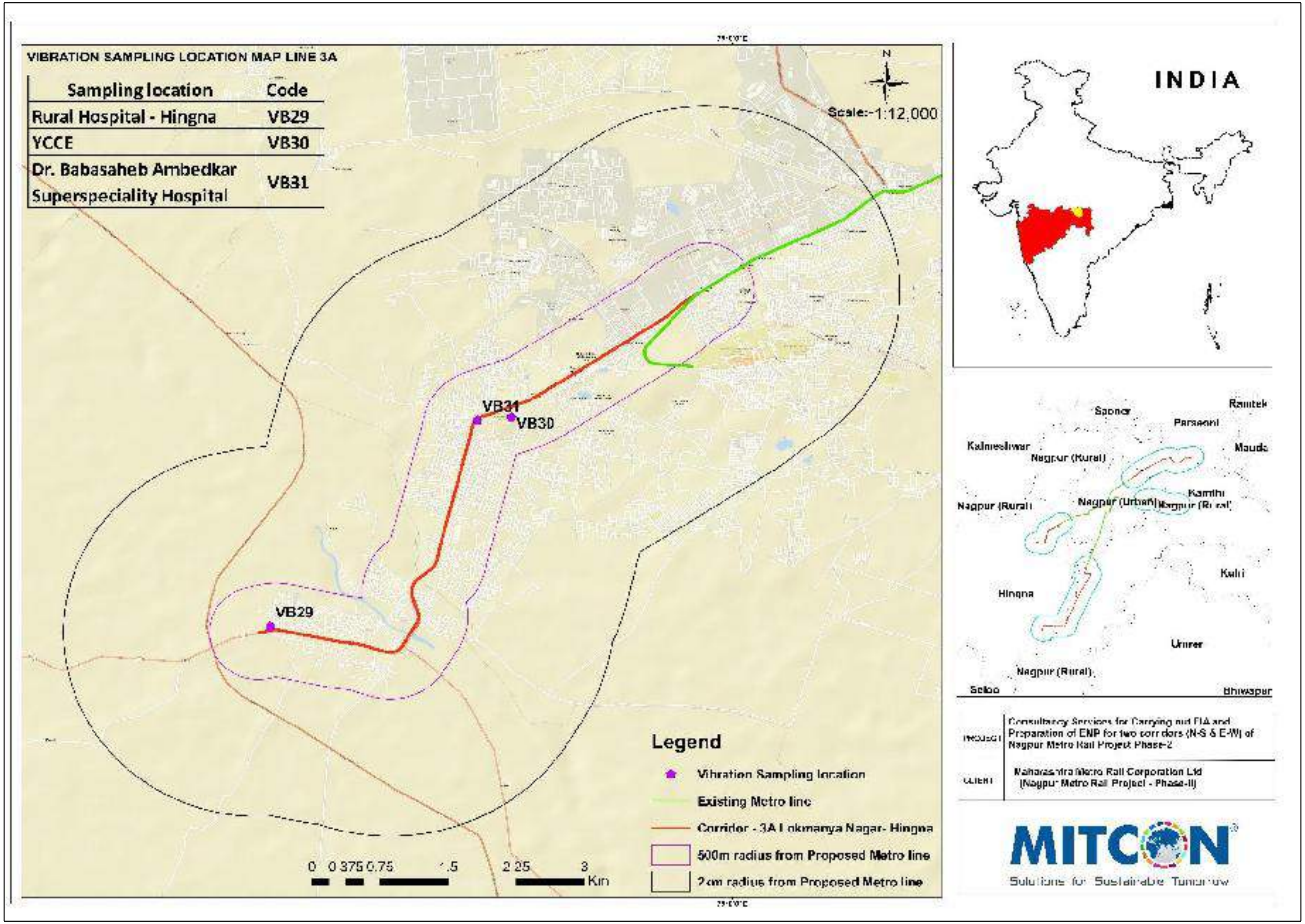
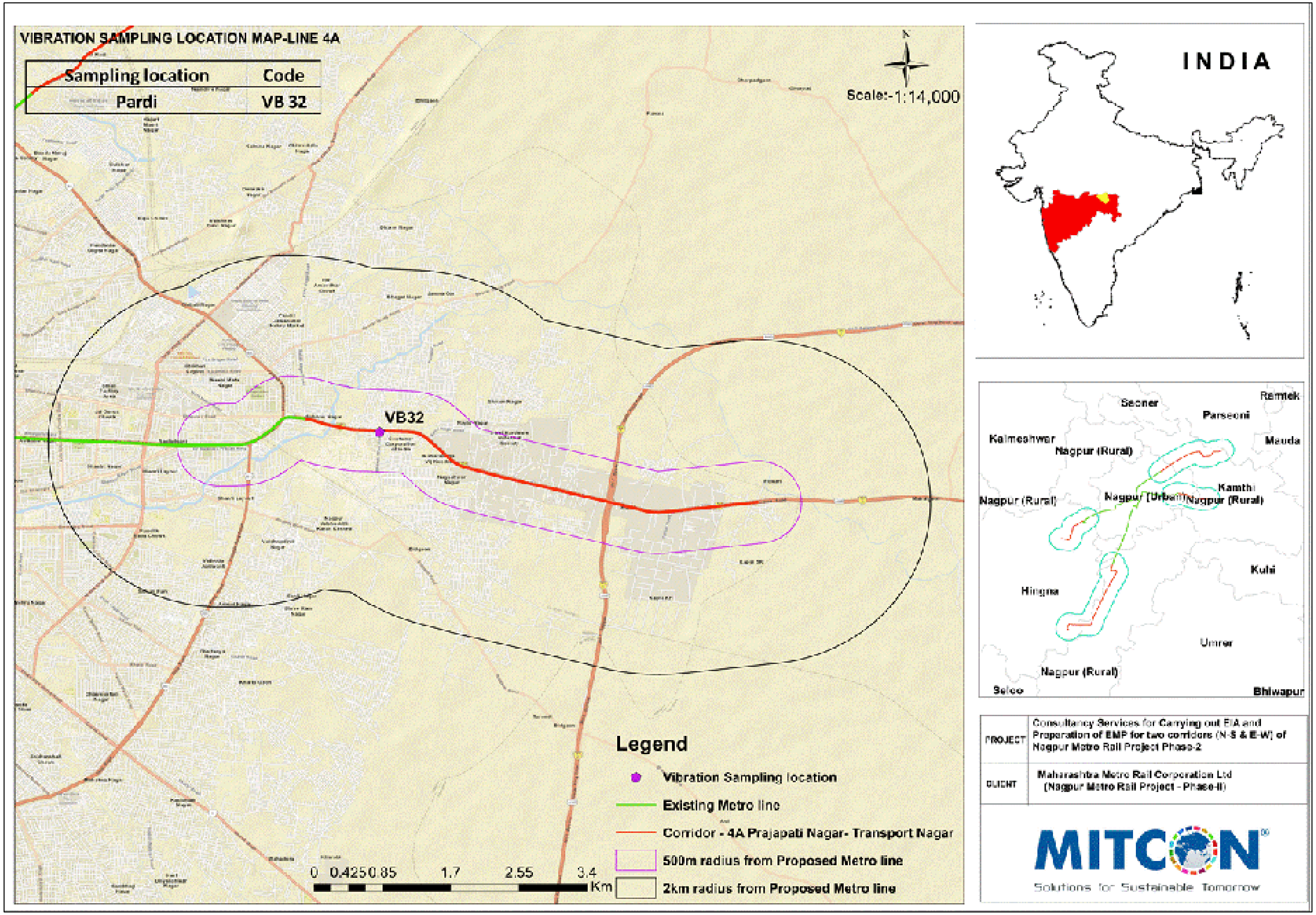


Figure 4-39: Vibration Sampling Location for Reach 4A



(c) Vibration Sampling Results

220. 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

221. 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[32]

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

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

Table 4-20: Directorate General of Mines Safety (DGMS) guidelines w.r.t. Vibration[33]

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[34]

Land use category	Ground-borne Vibration Impact Levels (VdB ref=25.4μ mm/s)	Ground-borne Noise Impact Levels (dB ref 20 μ Pa)
Category 1: Buildings where vibration would interfere with interior operations	65 VdB	N/A*
Category 2: Residences and buildings where people normally sleep	72 VdB	35 dBA
Category 3: Institutional land uses with primarily day time use	75 VdB	40 dBA

ibration sensitive equipment is not sensitive to ground-borne noise

Figure 4-41: Caltrans Guidelines for Vibration Damage Potential Threshold Criteria[35]

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.

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

Figure 4-42: Human Response to typical levels of Ground-Borne Vibration (GBV)[36]

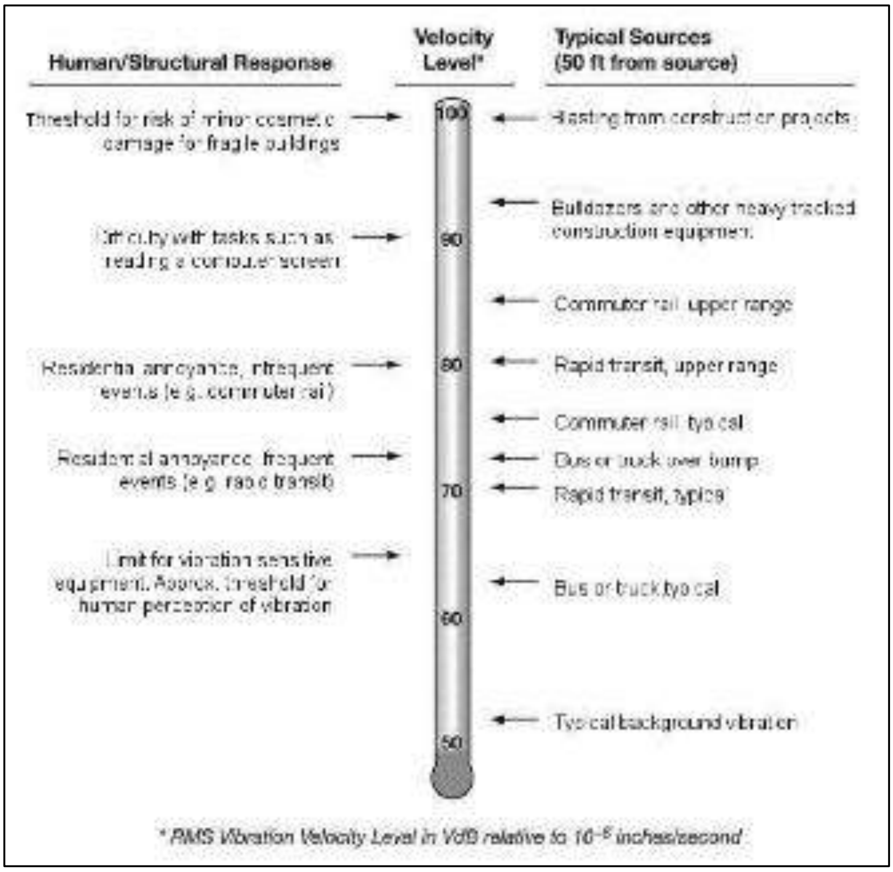


Figure 4-43: Ground-Borne Vibration (GBV) and Ground-Borne Noise (GBN) Impact Criteria for General Assessment[37]

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

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

(d) Vibration Modelling Studies

222. Noise 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.

F. WATER ENVIRONMENT

1. Hydrology / Drainage

223. 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.

224. 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. where 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:

iii. Alignment crosses “Kumhar Nallah” (a small water course having a clear width of 30m) on the northeastern outskirts of Kamptee. at which 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.

iv. 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:

v. 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

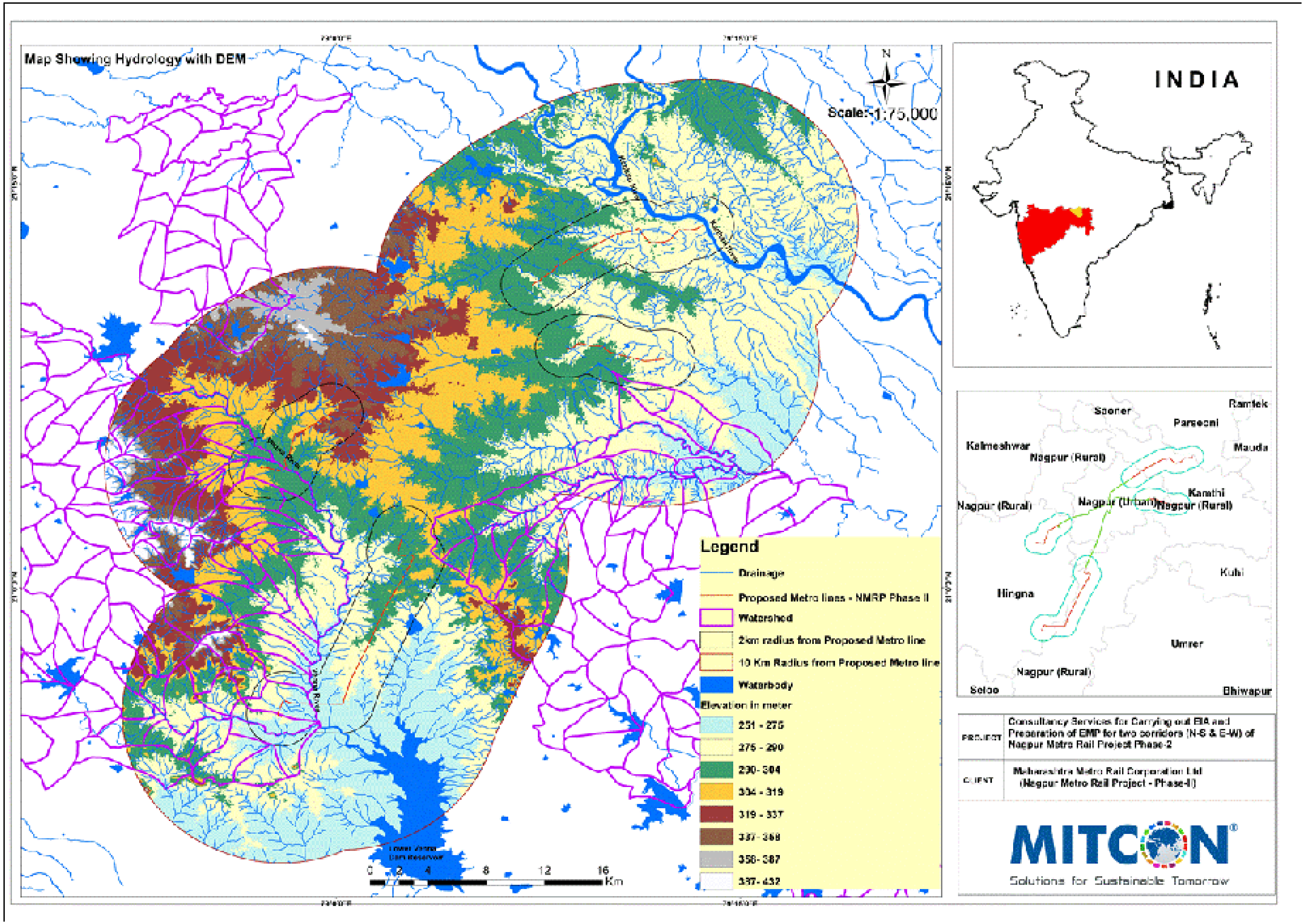


Figure 4-45: Drainage Pattern in 2km study area of Reach 1A - NMRP Phase II

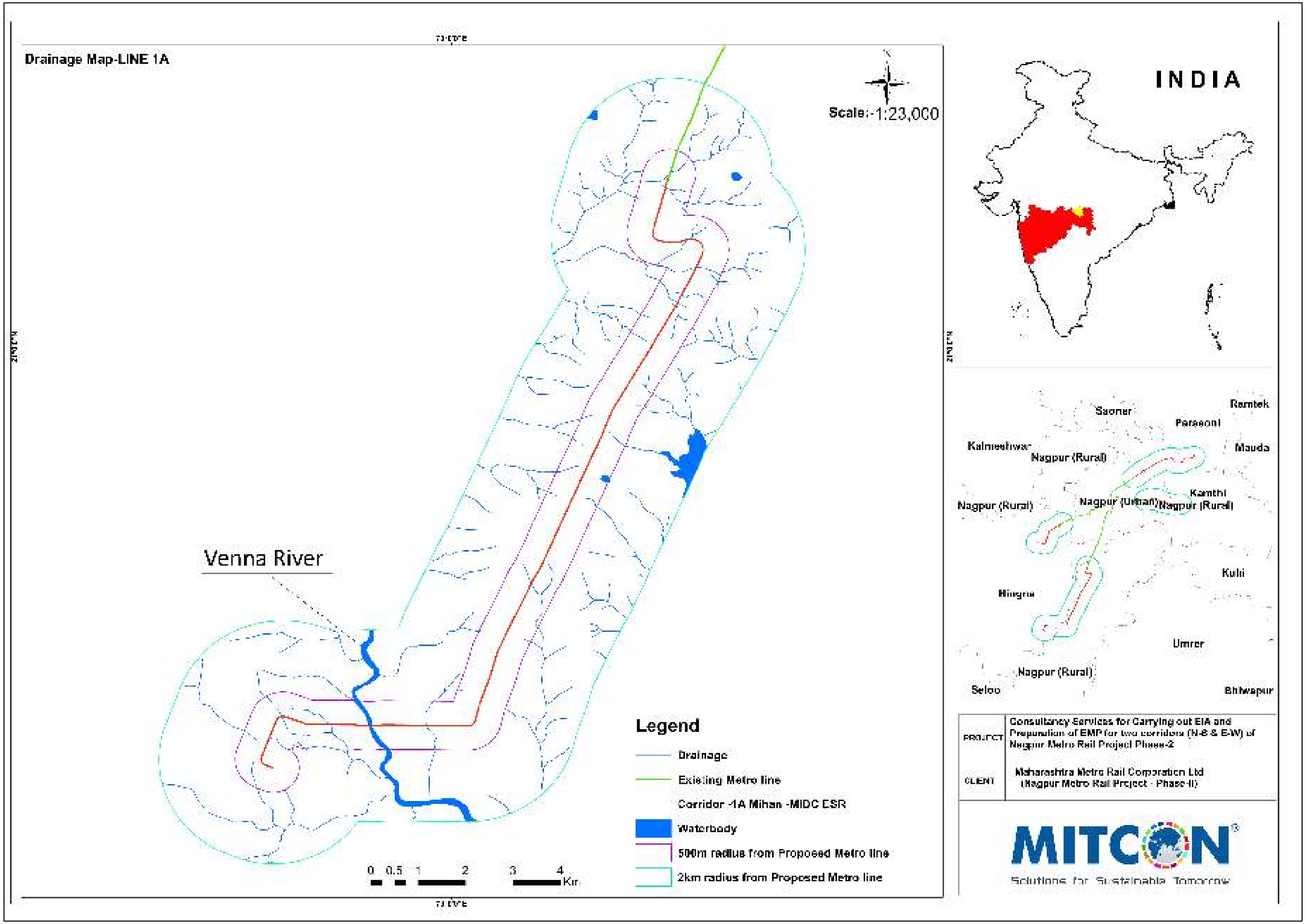


Figure 4-46: Drainage Pattern in 2km study area of Reach 2A - NMRP Phase II

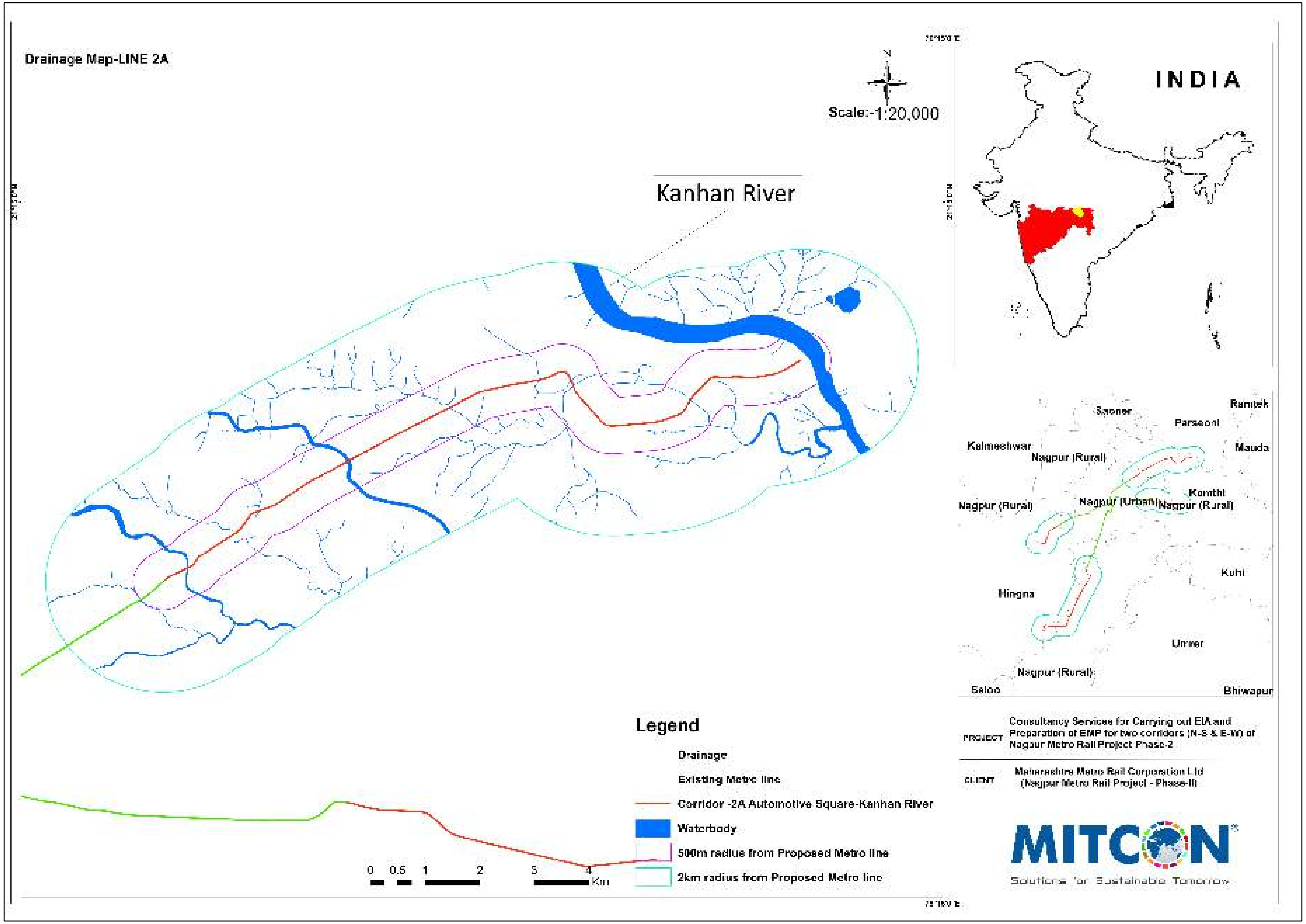


Figure 4-47: Drainage Pattern in 2km study area of Reach 3A - NMRP Phase II

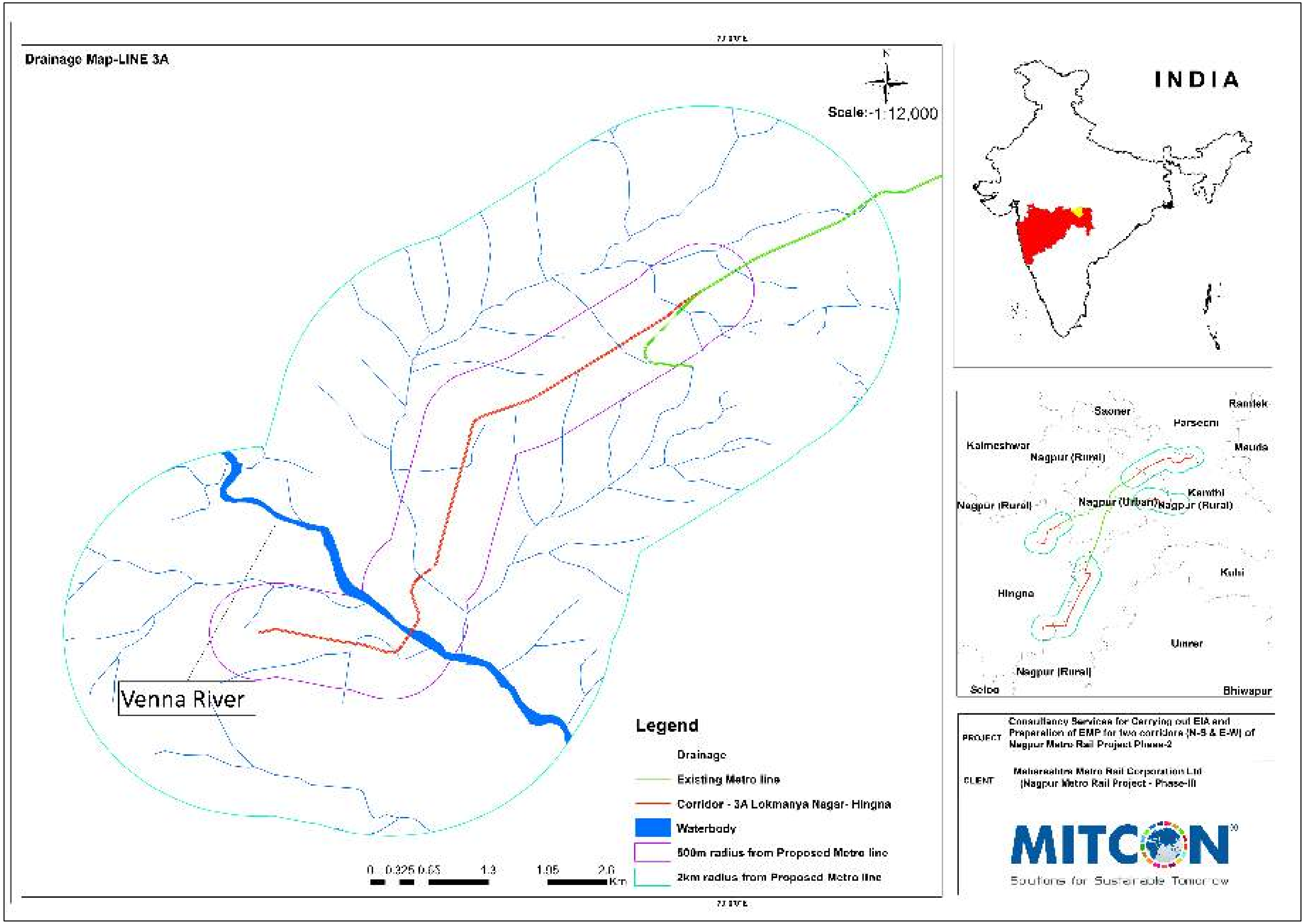
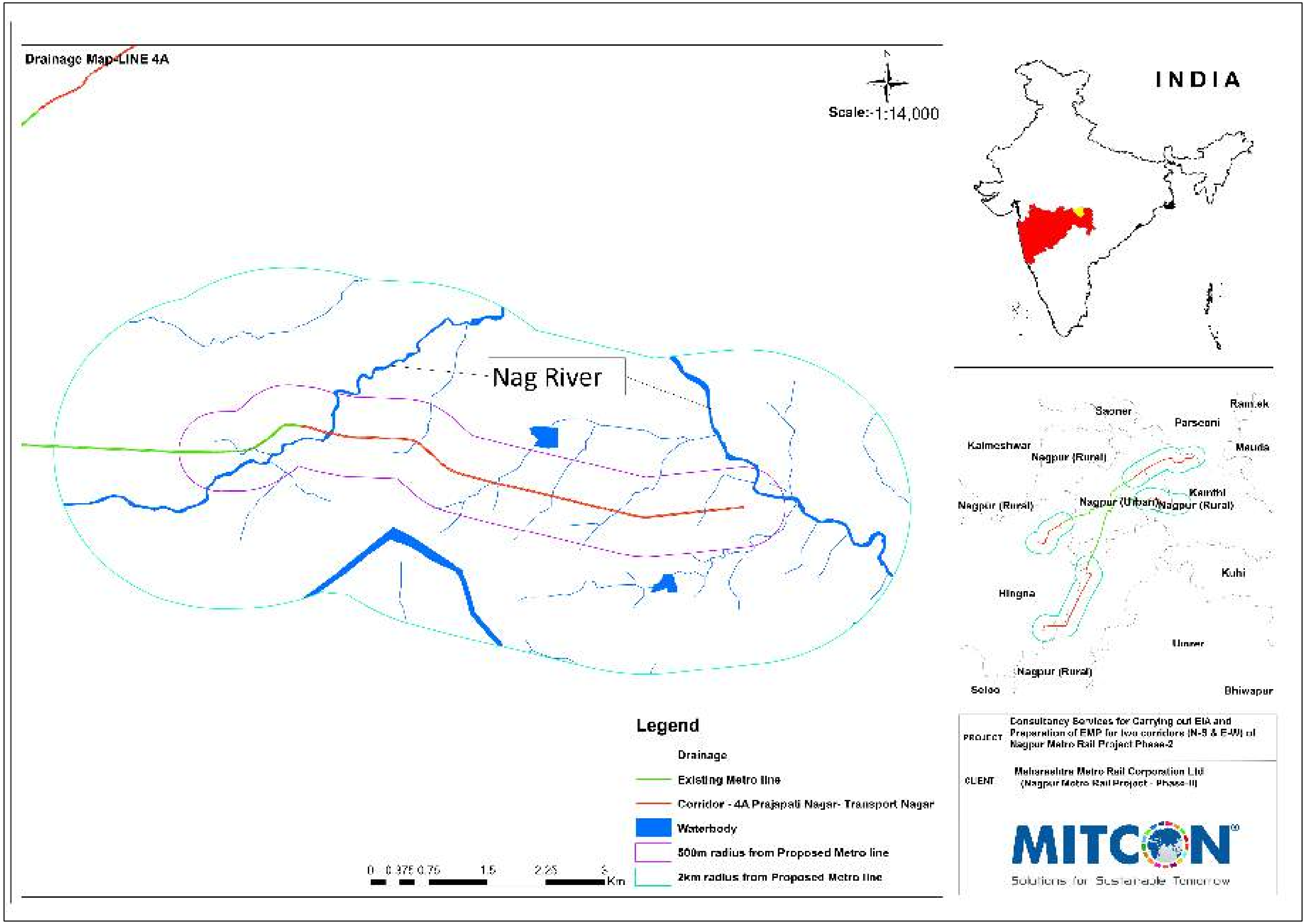


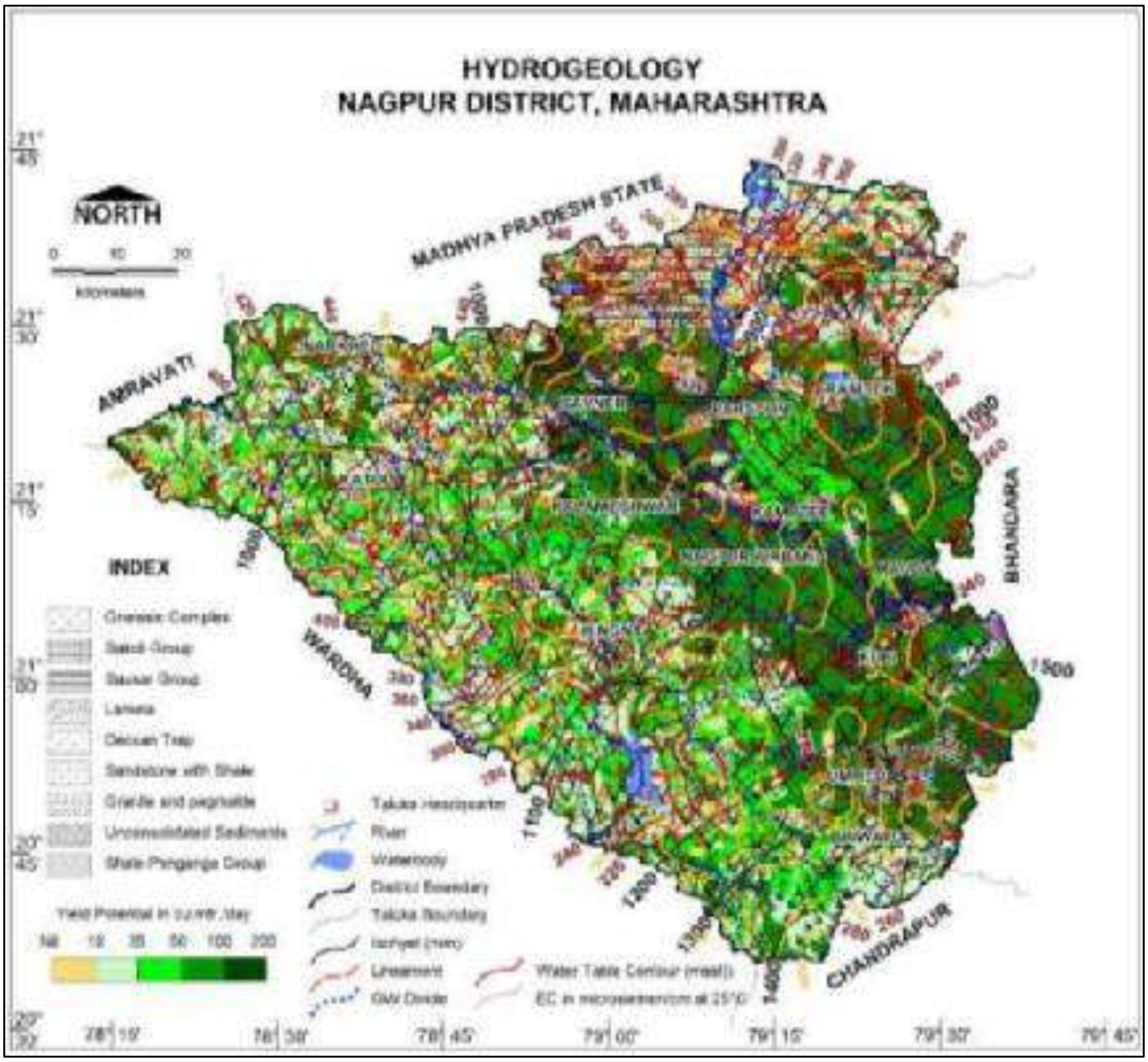
Figure 4-48: Drainage Pattern in 2km study area of Reach 4A - NMRP Phase II.



2. Hydrogeology and Groundwater[38]

225. 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

226. **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

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

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 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.

227. **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.

228. **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

229. 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 EC, Fluoride and Nitrate affected villages) drinking & agriculture.					

3. Water Quality Analyses

230. 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.

231. 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.

232. 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

233. 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.

234. 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

Line	Sampling Code	Sampling Location / Type	Latitude	Longitude
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
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

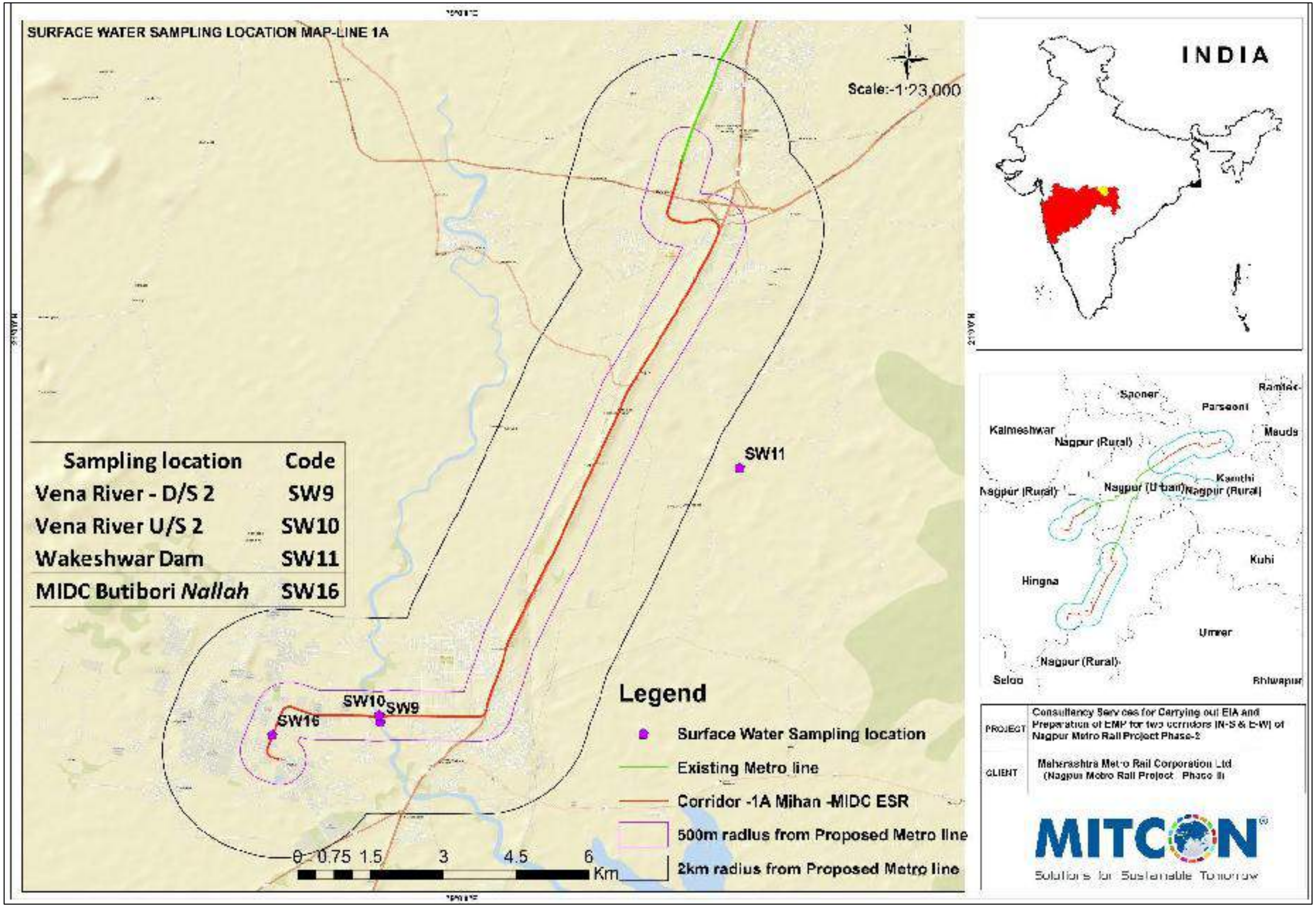


Figure 4-51: Surface Water monitoring locations for Reach 2A

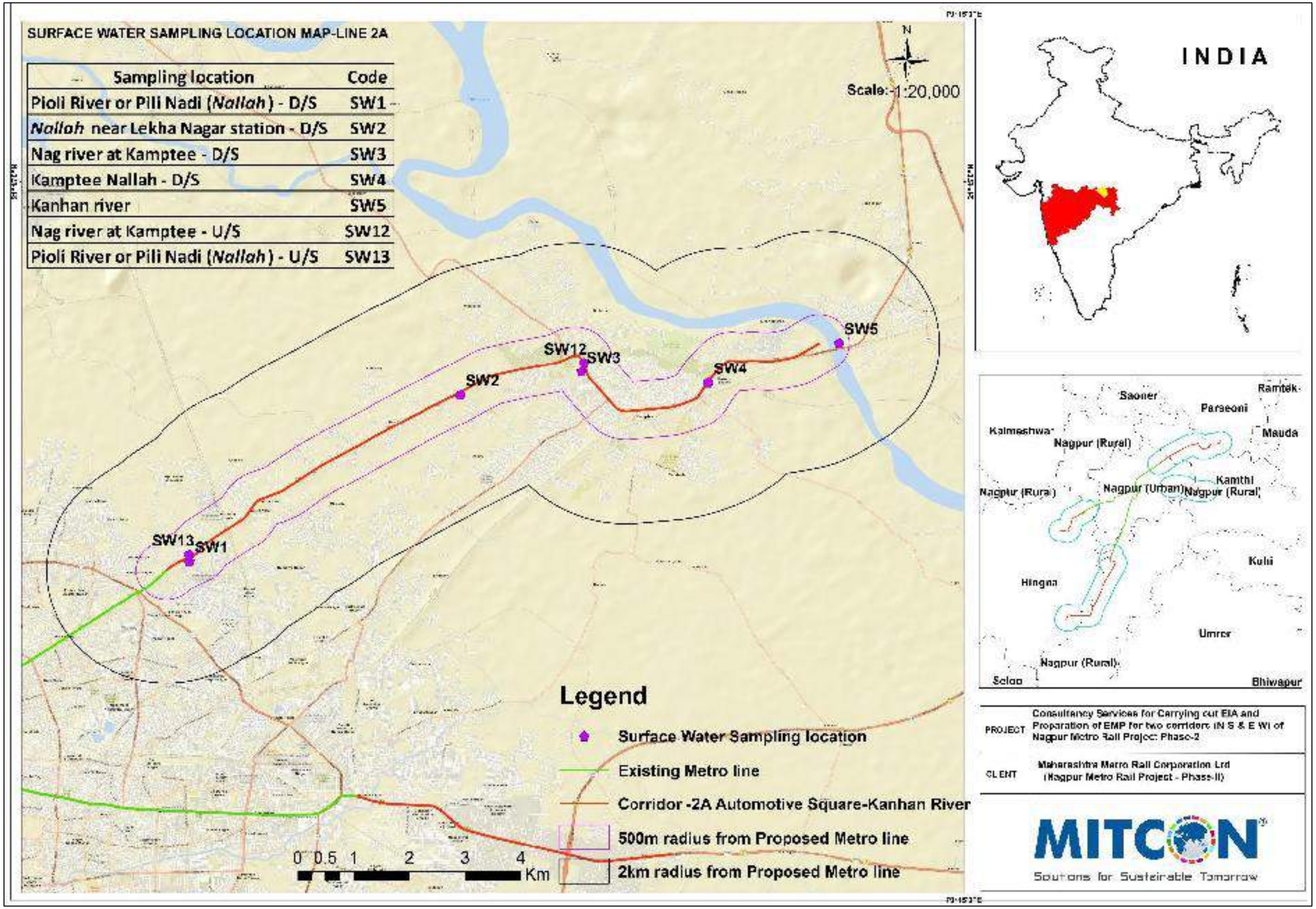


Figure 4-52: Surface Water monitoring locations for Reach 3A

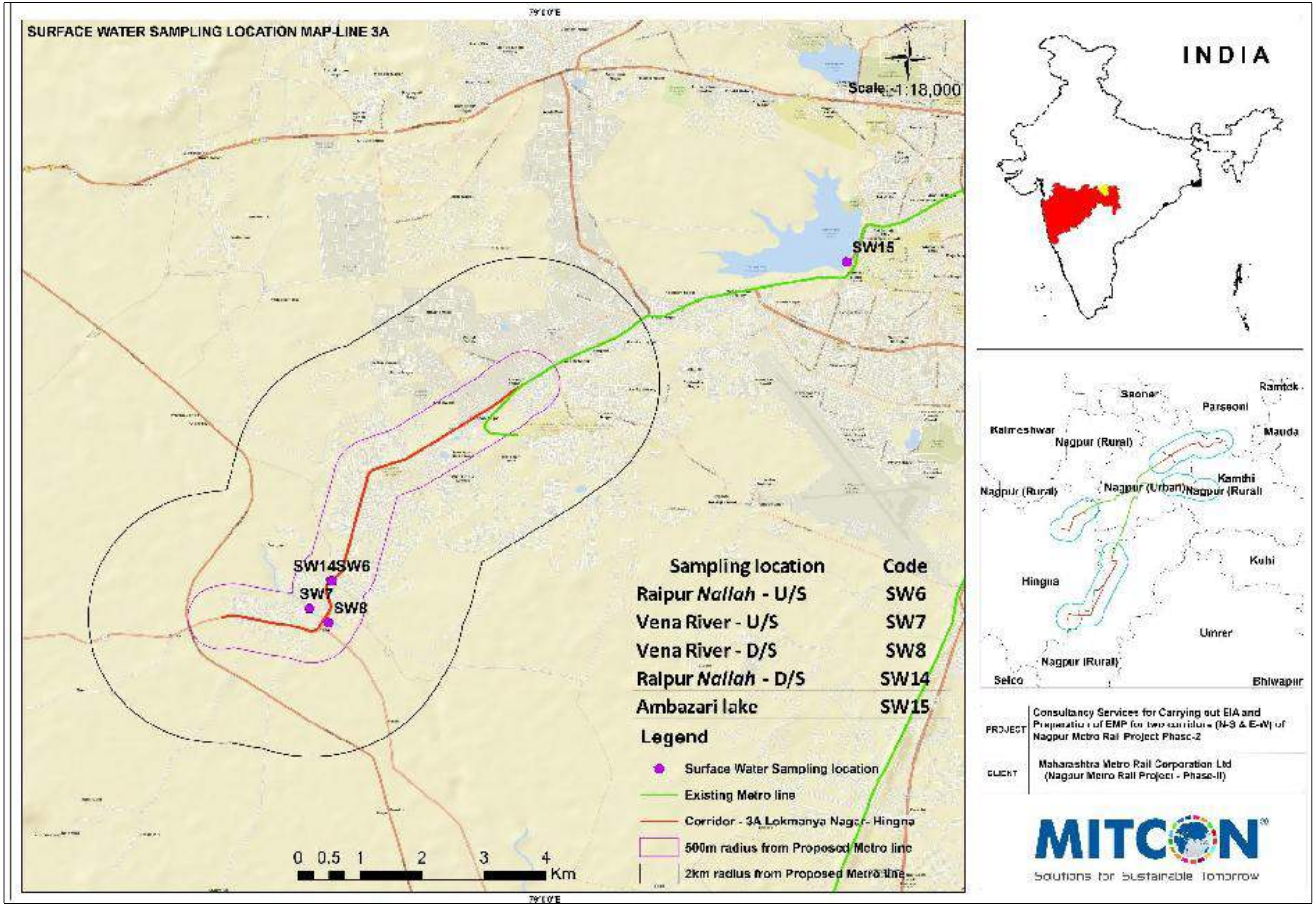


Figure 4-53:Surface Water monitoring locations for Reach 4A

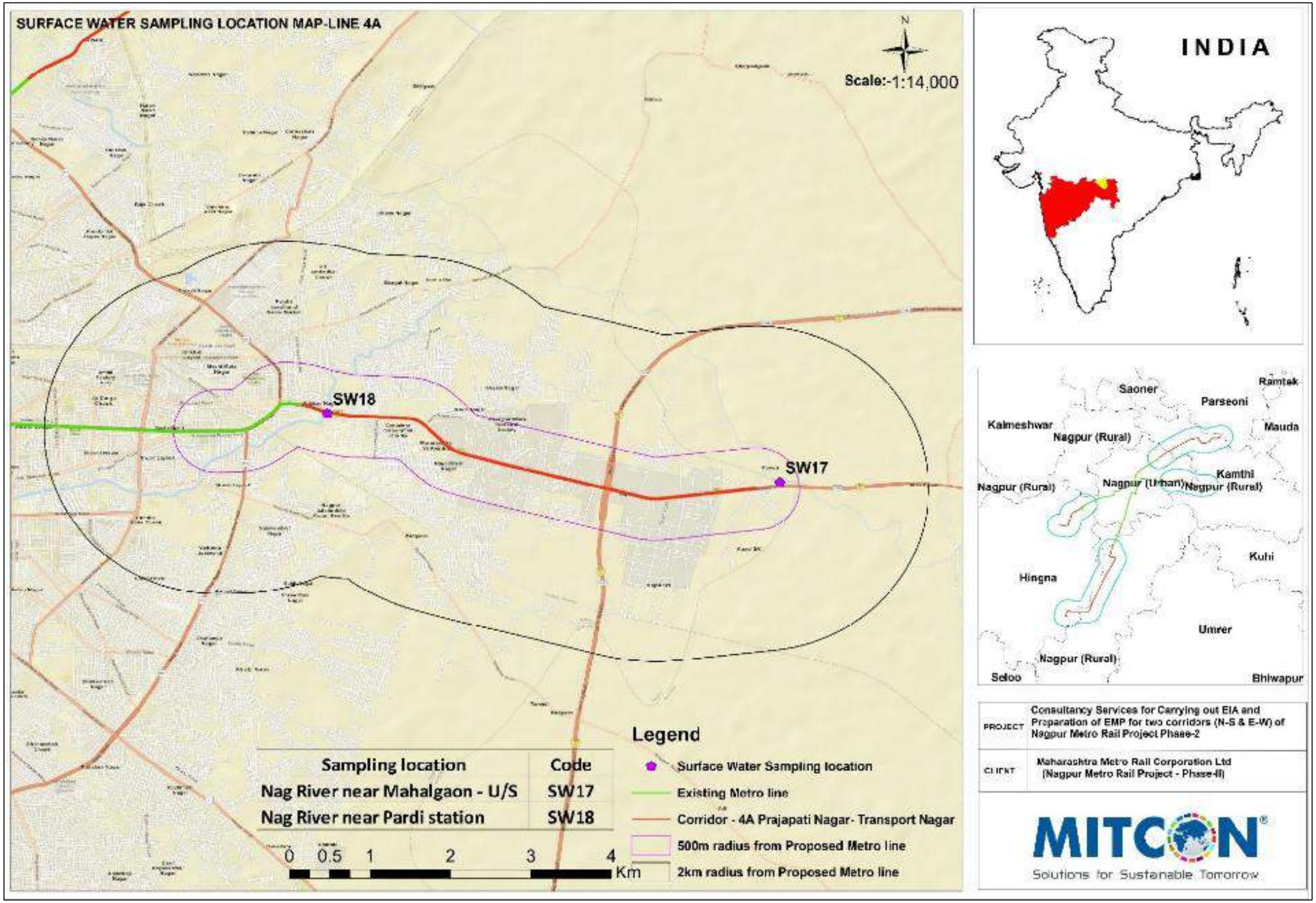


Figure 4-54: Groundwater monitoring locations for Reach 1A

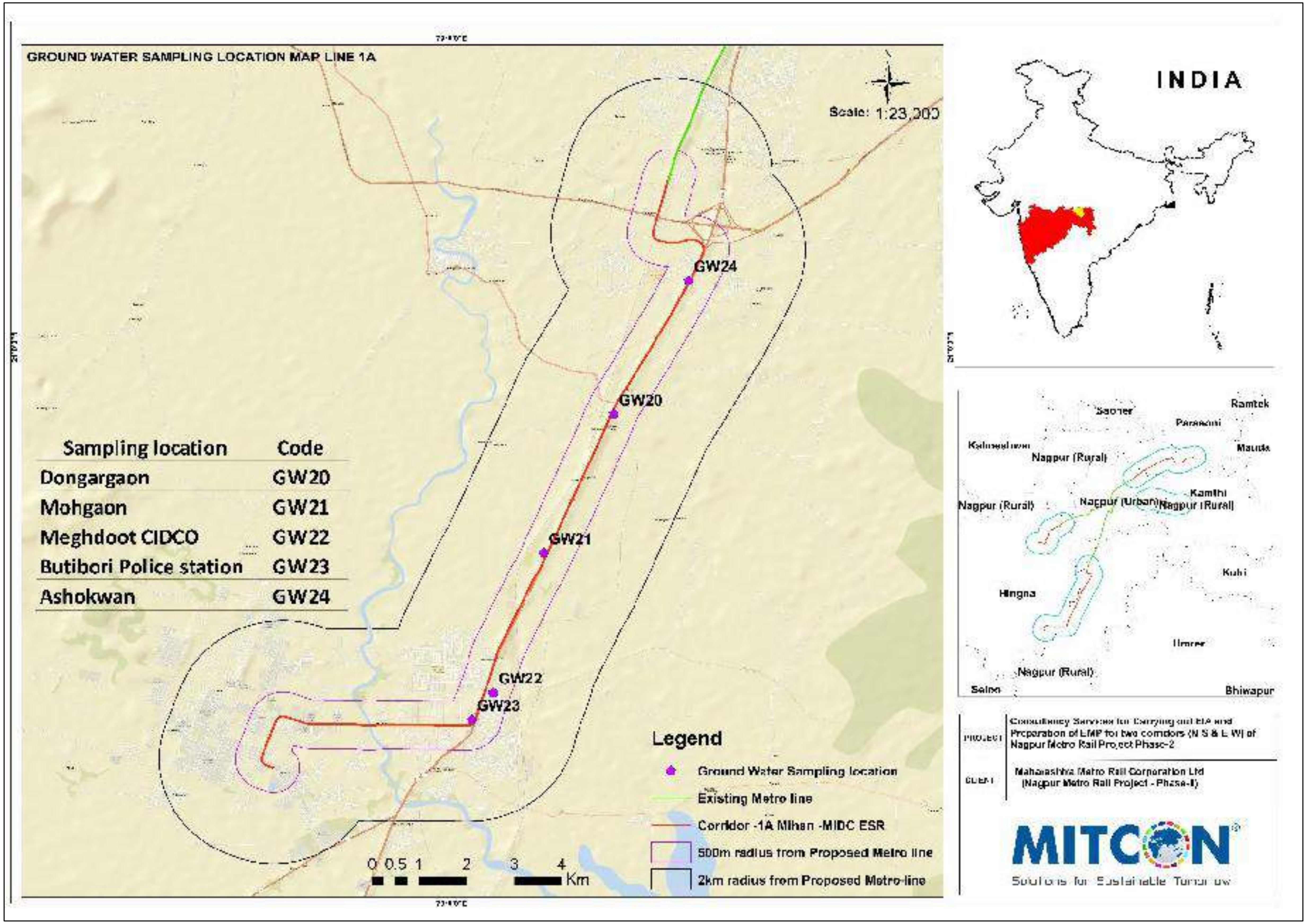


Figure 4-55: Groundwater monitoring locations for Reach 2A

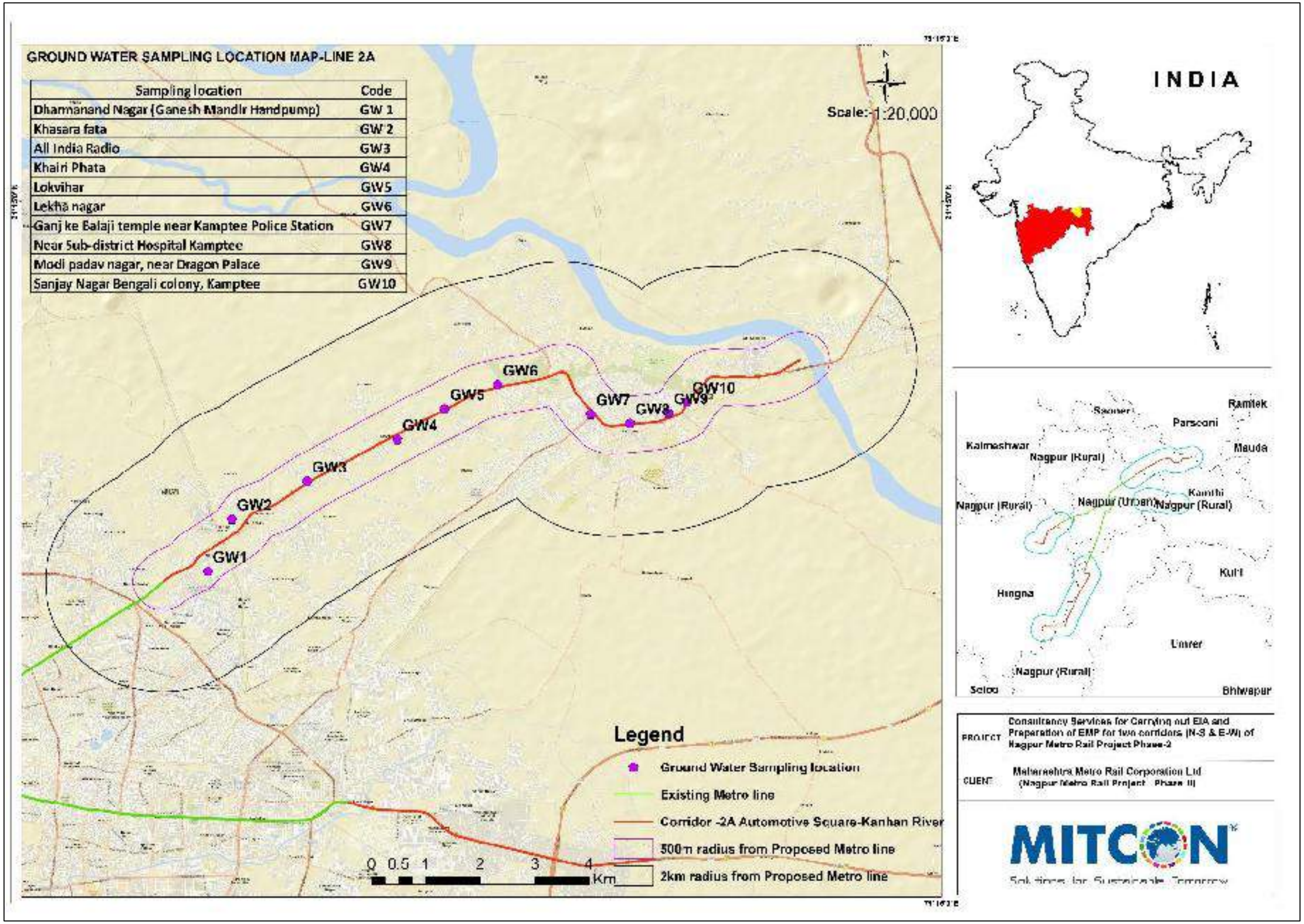


Figure 4-56: Groundwater monitoring locations for Reach 3A

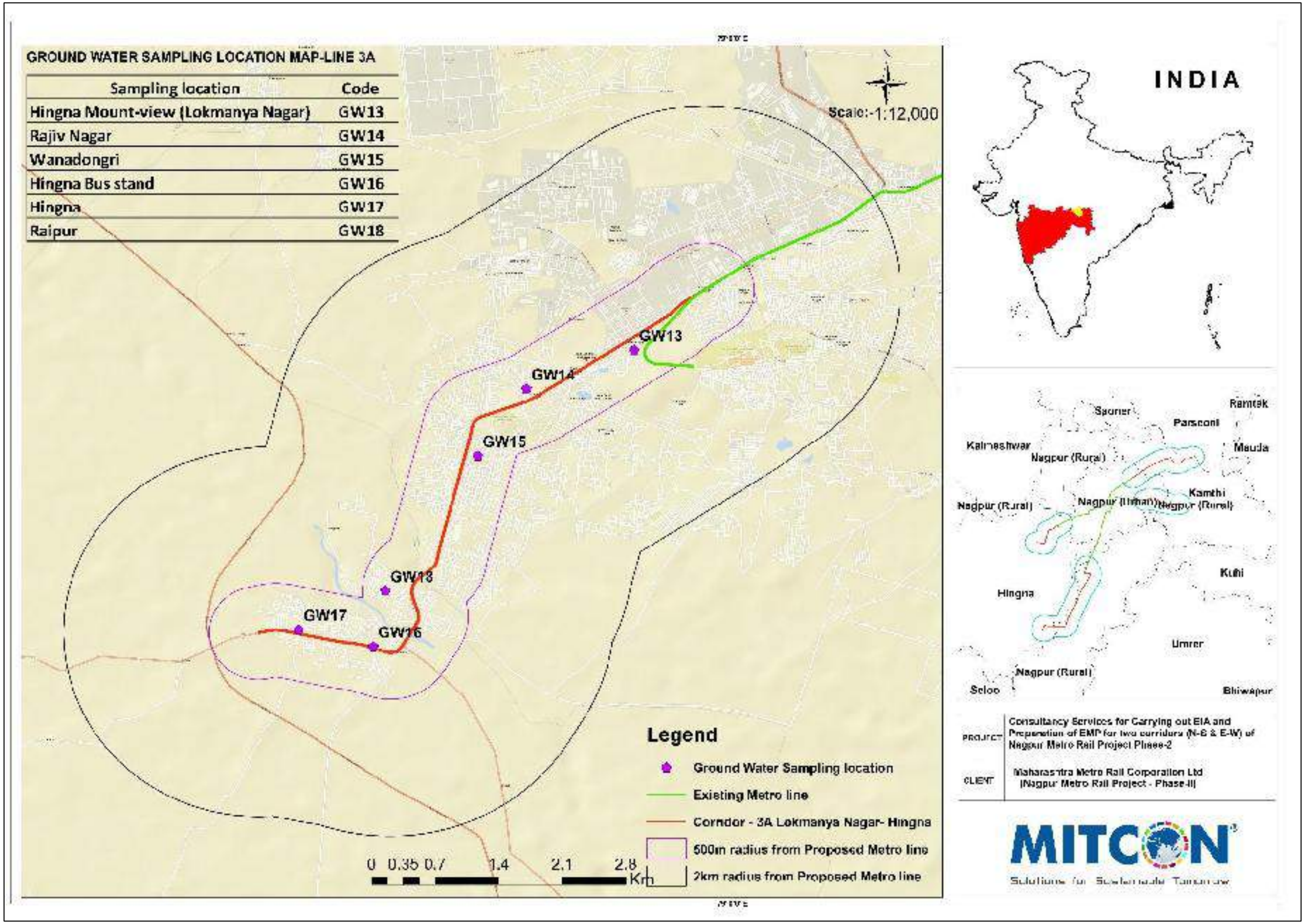
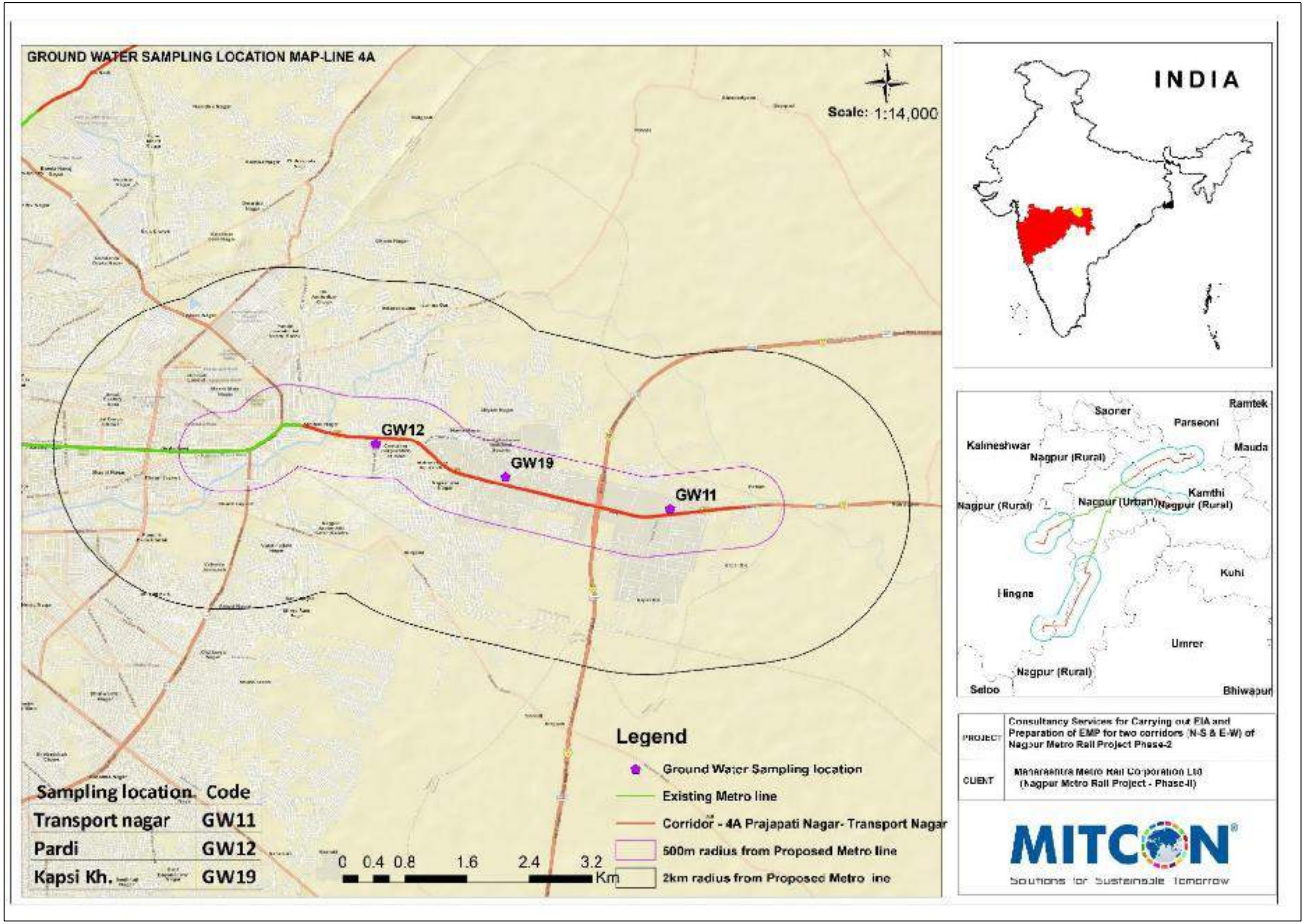


Figure 4-57: Groundwater monitoring locations for Reach 4A



235. 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

Figure 4-59: Some Photographs Showing Groundwater Quality Monitoring

(d) Water Quality Analyses Results

236. 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
		IS:10500:2012 Required Standards	6.50 to 8.50	Agreeable	N.S.	≤ 1	N.S.	≤ 75	N.S.	≤ 0.003	≤ 0.001	N.S.	Absent	Absent
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

Alignment (Line)	Sample Code	Potability	Chemical										Bacteriological	
		Parameter	pH at 25 ^{o}C	Electrical Conductivity at 25 ^{o}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
		IS:10500:2012 Required Standards	6.50 to 8.50	Agreeable	N.S.	≤ 1	N.S.	≤ 75	N.S.	≤ 0.003	≤ 0.001	N.S.	Absent	Absent
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
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

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	GW1 0	Sanjay Nagar Bengali colony, Kamptee	7.24	1890	1204	<5	375.8	227.43	<0.1	Absent	Absent
4A	GW1 1	Transport nagar	7.56	1484	810	<5	301.83	145.54	<0.1	Absent	Absent
4A	GW1 2	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 ºC	Electrical Conductivity at 25 ºC	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

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

238. The measured values were not compared with CPCB 1978 criteria for irrigation & industrial cooling nor with EPR guide for effluent discharge into irrigation land as the sites are not meant for use in irrigation.

(i) **Surface Water Quality:** All the parameters were compared with IS 10500:2012, and most of them 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 samples collected.

(ii) **Ground Water Quality:** Most of the analysed physico-chemical parameters are within permissible limits as per IS 10500:2012 except in pH, chlorides and coliforms.

G. ECOLOGY AND BIODIVERSITY

1. Introduction and Study Area

239. 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 as Tiger capital. Since there are 3 – 4 National parks/ Wildlife Sancturies around the nagpur city. However, Metro Rail project is quite away from these parks. 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

240. 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 • 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

241. 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

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

243. **Aquatic Fauna:**

A. Fish Survey

244. **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

245. **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

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

247. 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

248. 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

249. 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

<u>Floral Studies</u>

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.

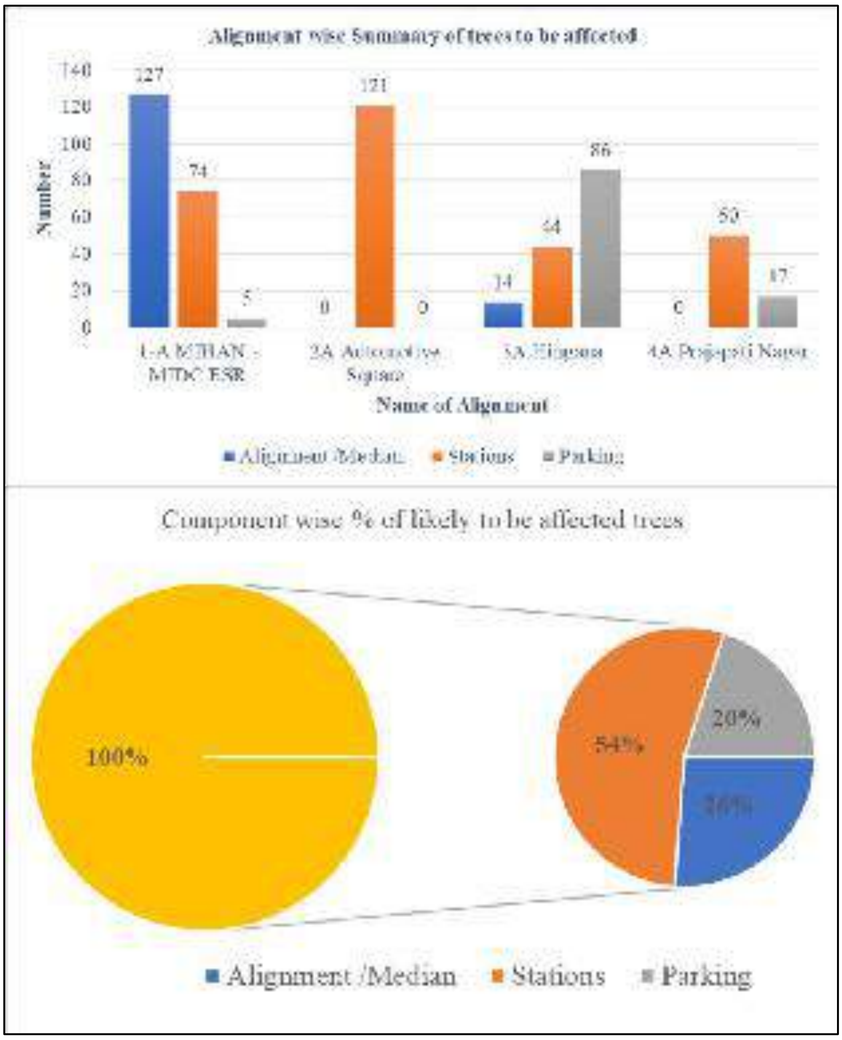
(b) Trees likely to be affected

250. 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



251. 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

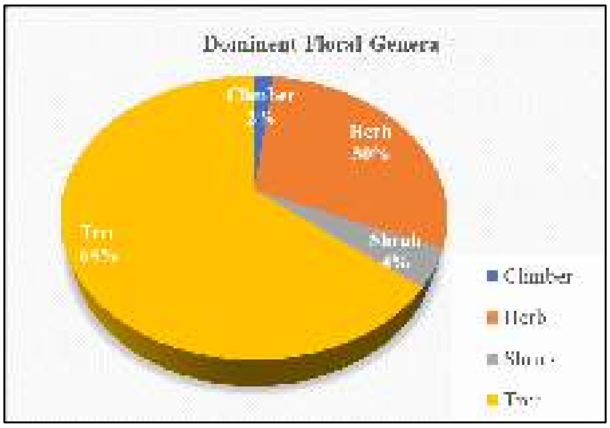
Side of Alignment	Girth size (in cm)						Total
	0 – 30	31 – 60	61 – 90	91 – 120	121 – 150	> 150	
LHS	86	89	34	27	11	20	**267**
RHS	33	35	20	20	8	14	**130**
Median	5	44	29	29	21	13	**141**
Total	**124**	**168**	**83**	**76**	**40**	**47**	**538**

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

(c) Floral Diversity

252. 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



253. 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

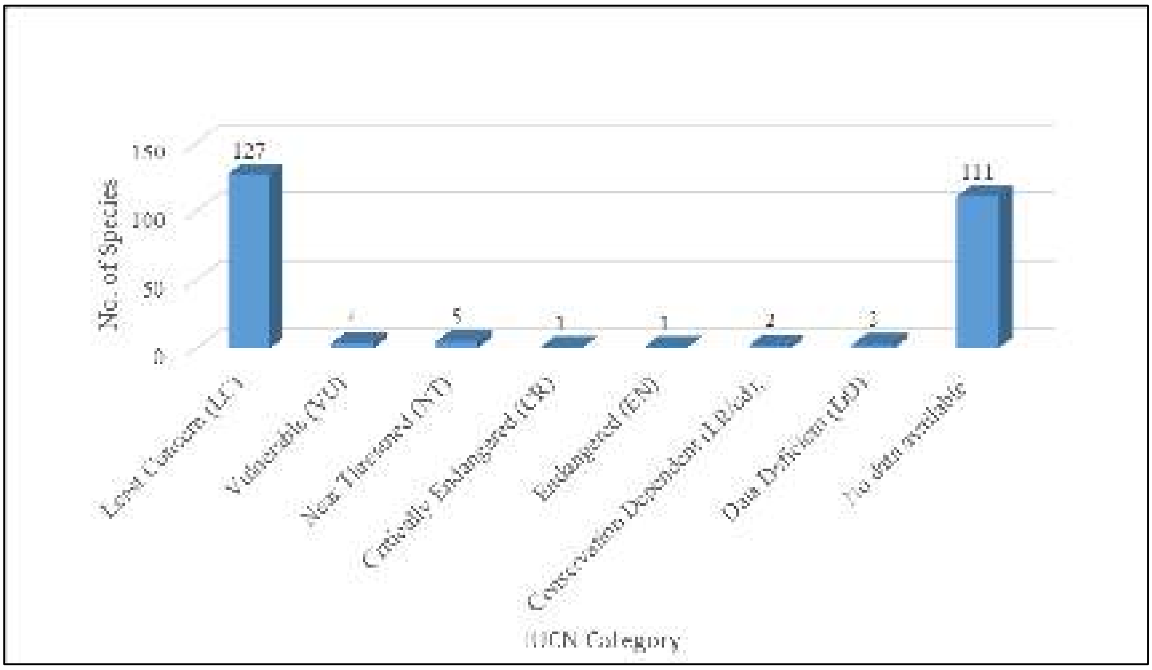


Figure 4-64: Family-wise number of Species observed in the Project Study Area

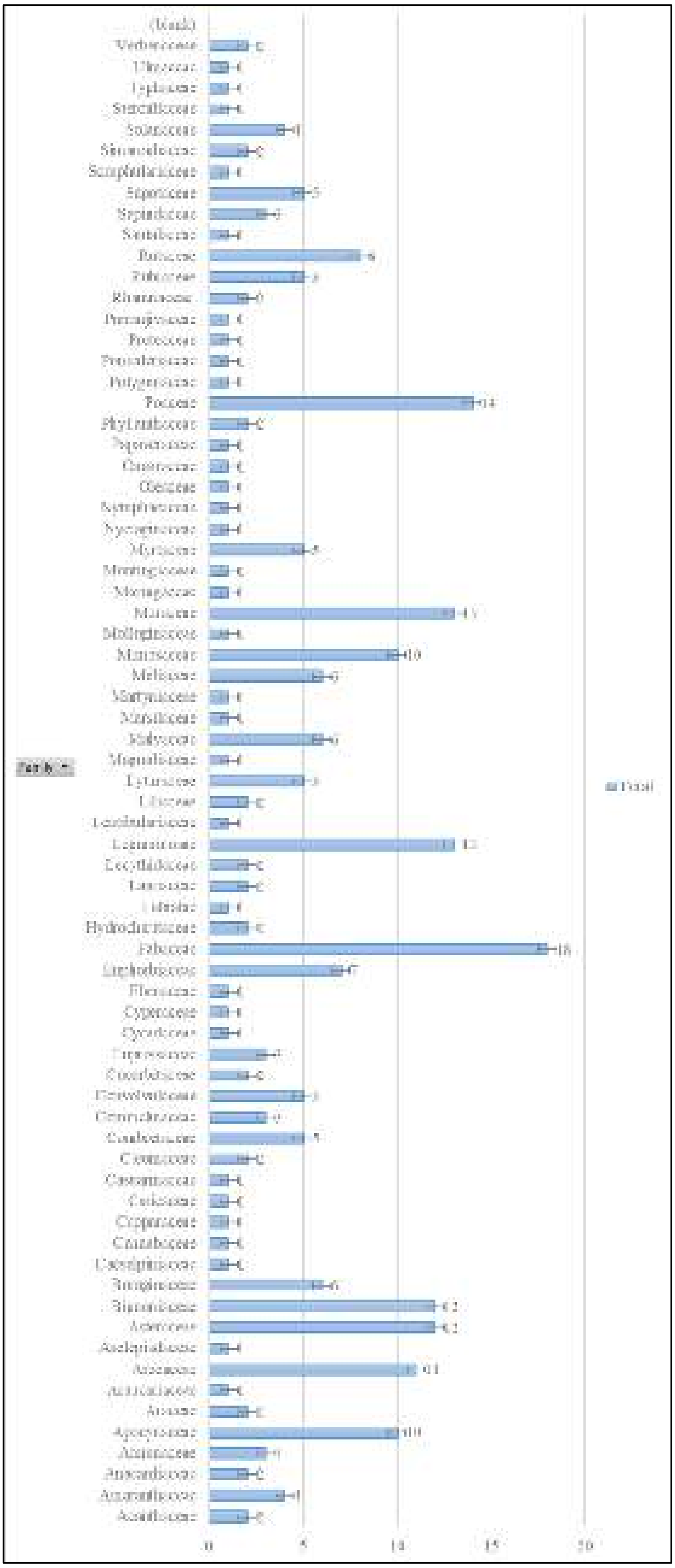


Figure 4-65: Some Photographs of Floral Diversity observed in the Project Study Area

	
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.

	
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	

Sr.No.	Botanical Name	Family	Common Name	Class	IUCN Status
191	*Paspalidium flavidum* (Retz.) A. Camus	Poaceae	Yellow Water-crown Grass	Herb	LC
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

Sr.No.	Botanical Name	Family	Common Name	Class	IUCN Status
227	*Solanum surattense* Burm.f.	Solanaceae	Kateringani	Herb	
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

254. 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[39]

SI	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

255. Total 283 bird species found in and around Nagpur City[40], 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

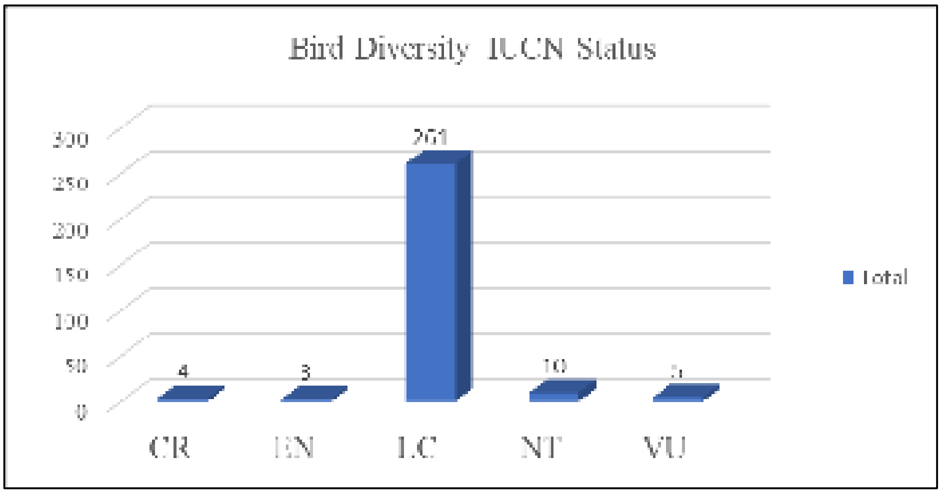


Table 4-31: Avian Diversity of Nagpur

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

[39] Source: Primary Survey by MITCON and secondary data acquired from authenticated sources (research papers)
[40] 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
7	Blyth's Reed Warbler	*Acrocephalus dumetorum*	W	U	LC
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

Sr. No.	Name of Bird	Zoological Name	Status	Abundance	IUCN Status
57	Greater Coucal	*Centropus sinensis*	R	C	LC
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

Sr. No.	Name of Bird	Zoological Name	Status	Abundance	IUCN Status
103	Black Bittern	*Dupetor flavicollis*	R	Rr	LC
104	Little Egret	*Egretta garzetta*	R	U	LC
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

Sr. No.	Name of Bird	Zoological Name	Status	Abundance	IUCN Status
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
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

Sr. No.	Name of Bird	Zoological Name	Status	Abundance	IUCN Status
199	Sirkeer Malkoha	*Phaenicophaeus leschenaultii*	R	O	LC
200	Great Cormorant	*Phalacrocorax carbo*	LM	O	LC
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

Sr. No.	Name of Bird	Zoological Name	Status	Abundance	IUCN Status
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
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

256. 14 species of Herpetofauna have been recorded in Nagpur city and surrounding areas by various authors[41], which are all LC species as per IUCN, as summarised in **Table 4-32**.

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

Table 4-32: Herpatofaunal Diversity of Nagpur

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

257. Ashis D. Tiple has recoded 65 butterflies in Nagpur City[42], 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

SI	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	-

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

SI	Zoological Name	Common Name	Family	IUCN Status
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	-
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

258. 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[43], all of which are LC as per IUCN, as presented in **Table 4-34**.

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

SI	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

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

SI	Zoological Name	Common Name	Family	Status	IUCN Status
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, 1839)	Crimson Marsh Skimmer	Libellulidae	C	LC
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

259. 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)[44].

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

[44] *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*

(e) Integrated Biodiversity Assessment Tool (IBAT) Analysis

260. 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 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 Softshe	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*		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	✓	✓	✓	✓

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*		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*		ACTINOPTERYGII	VU	Decreasing	Freshwater	✓	✓	✓	✓

(f) Aquatic Ecology Studies

1. Benthic Diversity

261. 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[45].

262. 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[46].

Table 4-36: Benthic diversity of Ambazari, Sakkardara, Gandhi, Sagar and 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	-

[45] 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.

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

2. Fish Diversity

263. 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[47]

SI	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[48]


Catla sps & Cat Fish at Hinga River

Spotted snakehead fish

[47] Source: Primary Survey by MITCON.
[48] *Source: Primary Survey by MITCON*

Tilapi

Maral sps at Gorewadi Lake

Tilapi

Rohu Sps.

(g) Riparian studies

1. Sampling Locations:

264. 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[49]

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
9	Kamptee Nallah	21°13'10.922"N	79°11'19.454"E

[49] Source: Primary Survey by MITCON.

SN	Name of Nallah or River/Waterbody	Latitude	longitude
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

2. Riparian Flora

265. 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: List of Herbaceous flora recorded along the 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.

(h) Habitat analysis

266. 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:

267. 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[50]

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

[50] *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

268. 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)

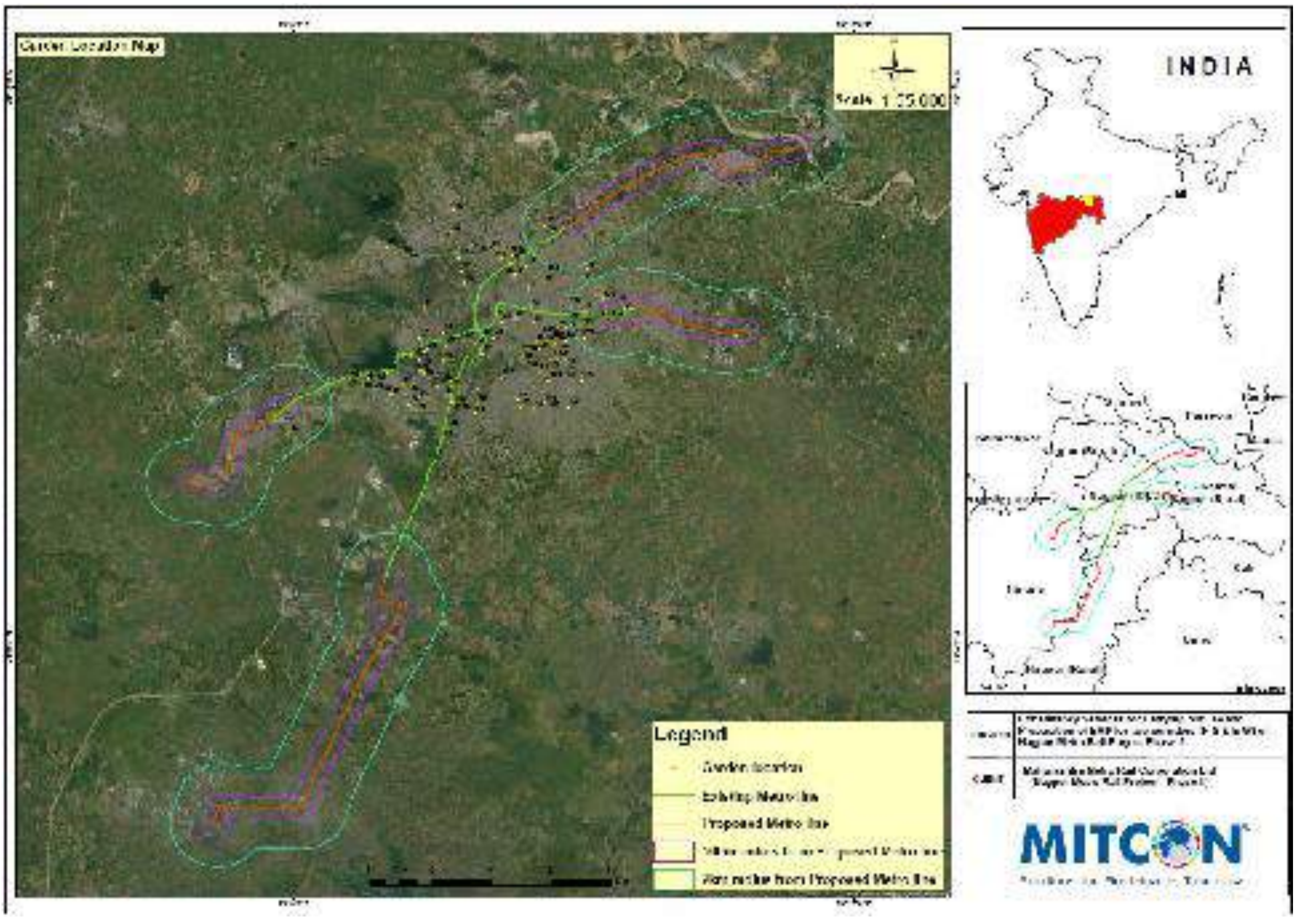


Table 4-40: Gardens in Nagpur with distances from nearest NMRP Phase II Alignment

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 Nagr 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:

269. 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) **A Hingana:** Ambazari Lake, Hingana *Nallah*, Hingana River
(iv) **A Prajapati Nagar:** Nag River near Pardi, Umiya Lake, Nag River Near Transport Nagar

5. Protected Areas

270. 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

271. 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

272. 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.

273. 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.

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

1. Demographic Features of Nagpur District

275. 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.

276. 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.

277. 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[51]

Indicators	Values
Area Sq. Km	9,892.00
Population (2011 Census)	46,53,171
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%

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

279. 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%

280. **Religion-wise population:** 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

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

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

281. **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

282. **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:

283. **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.

284. 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:

285. **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

286. 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.

287. 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.

288. NMRP Phase II alignments pass number of educational and medical institutions located within 100 meter 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.

289. Based on the Resettlement plan (RP) 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 which is part of the RP. No residential households are impacted.

3. Physical Cultural Resources

290. 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.[52]

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[52] 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]

291. 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.

292. 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.[53] Other examples of PCR include sites used for religious or social functions such as weddings, funerals or other traditional community activities, etc.

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

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

Sr. No.	Physical Cultural Resource(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
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

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

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
40	Vaibhavi Laxmi Mata Mandir/Jai Maa Ghanteshwari Mandir	Temple	LHS	

V. ANTICIPATED IMPACTS AND MITIGATION MEASURES

A. METHODOLOGY

295. 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

296. 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.

297. **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.

298. **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;

299. **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.

300. **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.

301. 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 / infrastructure / utility structures	Medium	The alignment will cross sub-surface, surface and utility services, viz. sewer, water mains, storm water drains, telephone cables, overhead electrical transmission lines, electric

			pipes, traffic signals, roadside lights, footbridges etc.
3.3	Noise	High	The ambient noise levels in general meet the CPCB and WHO limits, except at a few locations. However some residential buildings and sensitive receptors are close to the proposed alignments.
3.4	Vibration	Medium	There are several structures located near the proposed alignments. Regular traffic such as buses and trucks on the existing roads add to vibration levels. However, vibration analyses show that all levels are within National and International Limits
3.5	Occupational Health & Safety	Medium	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)

302. **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.

303. **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.

304. **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.

305. 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

306. 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.

307. 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

SI	Parameter	Adverse Impacts												Significance before mitigation	Residual impacts after mitigation
		Duration			Extent			Intensity / Risk			Likelihood				
		S	T	P	O	L	R	L	M	H	U	L	D		
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

SI	Parameter	Adverse Impacts												Significance before mitigation	Residual impacts after mitigation
		Duration			Extent			Intensity / Risk			Likelihood				
		S	T	P	O	L	R	L	M	H	U	L	D		
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 meter 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

SI	Parameter	Adverse Impacts												Significance before mitigation	Residual impacts after mitigation
		Duration			Extent			Intensity / Risk			Likelihood				
		S	T	P	O	L	R	L	M	H	U	L	D		
	construction 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

SI	Parameter	Adverse Impacts												Significance before mitigation	Residual impacts after mitigation
		Duration			Extent			Intensity / Risk			Likelihood				
		S	T	P	O	L	R	L	M	H	U	L	D		
12	Noise and Vibration due to operation of construction equipment and vehicular movement		*		*				*				*	Major	Minimal –ve
13	Impacts due to possible poor conditions in Labour camp, working at height and with heavy machinery, risk of transmission of communicable diseases including Covid-19		*		*			*			*			Moderate	Moderate –ve
14	Public exposure to traffic, noise, vibrations, dust and communicable diseases including Covid-19		*		*				*			*		Moderate	Minimal –ve
15	Chance finds of objects of physical or cultural value		*		*			*			*			Minor	Neutral
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		*			*			*			*		Moderate	Minimal –ve

SI	Parameter	Adverse Impacts												Significance before mitigation	Residual impacts after mitigation
		Duration			Extent			Intensity / Risk			Likelihood				
		S	T	P	O	L	R	L	M	H	U	L	D		
	electromagnetic radiation and communicable diseases														
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

308. **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)

309. 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) Impoact 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).

310. 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. Other impacts of Moderate nature are:

311. 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

312. In the following Sections, the identified impacts on each of the VECs will be 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

313. 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 are presented in **Table 5-4**.

Table 5-4: Reduction in Pollution (Ton/Year)54

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 Rs (Lakh)	839.86	982.01	468.54

314. **Impacts:** Air pollution can be caused on 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.

315. 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[55]

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

316. **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.

[54] Detailed Project Report (DPR) for Extension of Nagpur Metro Rail Phase 2, November 2019
[55] Detailed Project Report for Extension of Nagpur Metro Rail Phase 2, November 2019.

317. 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.

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

319. 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

320. 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.

321. 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.

322. 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.

323. 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.

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

325. **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 less 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.

326. **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

327. Baseline noise without metro is within permissible limits, except at 11 of the 34 monitored locations, but the NMRP Phase II prject will add to it. Noise during operation of the metro could cause annoyance and disturbance to daily living and impact health of residents and workers along the alignment. A total of 9 sensitive receptors were identified along the proposed NMRP Phase II alignments, as listed in **Annexure-13** to this EIA-EMP Report. 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.

328. **Impact:** Noise will be generated from equipment during construction and wheel-rail interactions 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.
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.
Noise generation from metro operation has been recorded from past experience from existing metros in India as presented in **Table 5-6** and **Table 5-7**. The noise level at 2 m distance from the rail alignment is about 73 dB(A) which is higher than the CPCB permissible limit of 65 dB(A), and is much higher than the 50 dB (A) daytime limit for silence zones. The noise level reduces with distance logarithmically.

Table 5-6: Exterior Noise Levels at Metro Stations in India[56]

Sr. No.	Description	Average Noise Levels dB(A) for Elevated Tracks
1	Background Noise Level	64.0 ± 1.5
2	Train entering the Platform (Max)	84.0 ± 1.5
3	Train leaving the Platform (Max)	84.0 ± 1.5
4	Train stopping in Platform	79.0 ± 0.0
5	Train stationary in Platform	76.0 ± 0.5
6	Train starting from Platform	78.5 ± 1.0
7	Train braking	86.0 ± 0.0
8	Announcement	74.0 ± 0.5
Overall		**76.0 ± 7.0**

[56] *Source: Studies carried out by Central Road Research Institute (CRRI) for metro projects in India*

Table 5-7: Interior Noise Levels in Metro Trains[57]

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

329. The **major** sources of noise during construction phase are due to 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[58] 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 5-8**, while actual noise generated by various construction equipment is summarised in **Table 5-9**.

Table 5-8: Average Noise Levels Generated by Various Construction Equipment[59]

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

[57] Source: Studies carried out by Central Road Research Institute (CRRI) for metro projects in India
[58] Construction Noise Handbook August 2006, FHWA, USA
[59] Source: FTA Transit Noise and Vibration Guidance Handbook, May 2006

Equipment	Typical Noise Level (dBA) at 50 ft from source
Scraper	89
Shovel	82
Truck	88

Table 5-9: Actual Noise Levels Generated by Various Construction Equipment[60]

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

330. 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. The effect of high noise levels on the operating personnel has to be considered as this may be particularly harmful. It is known that continuous exposures to high noise levels above 90 dB(A) affects the hearing acuity of the workers/operators and hence, should be avoided. To prevent these effects, it has been recommended by Occupational Safety and Health Administration (OSHA) that the exposure period of affected persons is limited (**Table 5-10**).

Table 5-10: Maximum Exposure Periods Specified By OSHA

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

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. In order to establish feasibility of noise mitigation for the NMRP Phase II corridors, initial noise modelling has been carried out at station locations and sensitive receptors including educational and medical buildings located within distance of 100m for noise during operation phase, on either side of alignment. For the NMRP Phase II corridors, the initial noise modelling focused on identified sensitive receptors as well as all station locations along the four alignments. If an impact is expected during construction, then noise barriers can mitigate construction noise to an extent that baseline noise is not increased more than 3-5dB(A).

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

Furthermore, the high levels of construction noise can be related to piling operations in those instances where in-situ casting is not possible. These piling operations will be restricted during day time hours only, the piling operation would be short term, few hours in a day and therefore the significance of the noise disturbance is not continuous and can be reduced by carefully planning the piling operations.

331. Although the NMRP Phase II project will operate at an average scheduked speeds of 32-34 kmph, initial noise modelling assumes the maximum desihn train speed of 80 kmph and the absence of any barriers (i.e. worst case scenario). Modelling was carried out over the lifetime of the project (construction and operation phases), including increase in estimated number of trains over time as per the DPR. Furthermore, the reduction in vehicular traffic is projected to lead to a decrease in road traffic noise.

332. During the operation phase, there will be no metro operating between 10pm to 6am. However, both Day time as well as Night time scenarios are considered in the Noise modelling carried out for the project The predicted noise levels during operation phase for Day time are summarized in **Table 5-11**, while those for Night time are summarised in **Table 5-12**. In the operational phase of NMRP Phase II project, almost all of the 34 selected noise monitoring locations would be impacted without additional mitigation measures. The initial noise modeling shows that a 3-meter-high polycarbonate noise barrier would reduce operational noise to acceptable levels at these locations. The noise modeling report also suggests noise barriers to be put in place near the identified sensitive receptors along the alignments and at some of the station locations.

Table 5-11: Day Time Predicted Noise levels during NMRP Phase II Operation

Sampling Code	Sampling Location	Latitude	Longitude	Baseline Noise level dB(A)	Predicted Cumulative Noise Levels dB(A)	
					Without Barriers	With Barrier
NQ1	Ashokwan	21° 0'46.64" N	79° 2'42.53" E	50.1	73.7	62.8
NQ2	Dongargaon	20°59'12.64" N	79° 1'47.68" E	47.2	69.2	63.7
NQ3	Mohgaon	20°57'35.33" N	79° 1'2.72" E	51.6	73.0	68.2
NQ4	Meghdoot CIDCO	20°56'11.89" N	79° 0'25.86" E	62.7	77.3	66.9
NQ5	Butibori Police Station	20°55'45.83" N	79° 0'14.09" E	59.8	70.4	62.0
NQ6	MHADA Colony	20°55'42.27" N	78°59'56.53" E	61.6	71.7	63.2
NQ7	MIDC KEC	20°55'45.70" N	78°58'11.06" E	73.6	76.2	65.8
NQ8	MIDC ESR	20°55'24.14" N	78°57'51.55" E	68.0	74.9	64.7
NQ9	Jijamata High School & Jr. College	20°55'46.75" N	79° 0'18.26" E	51.6	74.9	60.8
NQ10	Rachana Hospital	20°55'43.41"N	79° 0'0.56"E	54.2	73.6	63.2
NQ11	Pili Nadi	21°11'32.28"N	79° 7'44.11"E	60.3	76.1	64.3
NQ12	Khasara fata	21°11'49.79" N	79° 8'6.70" E	61.4	73.0	64.2
NQ13	All India Radio	21°12'9.97"N	79° 8'37.43"E	64.2	72.2	65.4
NQ14	Khairi fata	21°12'40.05" N	79° 9'32.12" E	60.9	73.5	62.7
NQ15	Lok Vihar	21°12'54.36" N	79°10'1.8" E	54.9	76.0	60.9
NQ16	Lekha Nagar Asha Hospital and Asharam College & School of Nursing	21°13'9.11" N	79°10'35.50" E	56.8	76.4	61.9
NQ17	Kamptee Police station**	21°12'55.03" N	79°11'32.30" E	59.8	69.3	61.4

Sampling Code	Sampling Location	Latitude	Longitude	Baseline Noise level dB(A)	Predicted Cumulative Noise Levels dB(A)	
					Without Barriers	With Barrier
NQ18	Kamptee Municipal Council	21°12'47.51" N	79°11'56.43" E	55.1	70.3	59.4
NQ19	Dragon Palace	21°13'1.00"N	79°12'30.16"E	54.9	76.2	65.8
NQ20	Kanhan River	21°13'21.24" N	79°13'26.03" E	52.1	72.2	58.9
NQ21	Delhi Public School (DPS), Khairy, Kamptee Road, Nagpur	21°12'49.14" N	79° 9'35.39" E	50.1	63.0	52.5
NQ22	Hingna Mount View	21° 6'12.21" N	78°59'24.77" E	56.9	73.6	63.0
NQ23	Rajiv Nagar	21° 5'50.78" N	78°58'51.05" E	60.3	72.9	63.4
NQ24	Wanadongri	21° 5'32.24" N	78°58'24.93" E	59.8	75.4	66.3
NQ25	APMC	21° 5'8.39" N	78°58'18.37" E	61.2	76.2	65.9
NQ26	Raipur	21° 4'37.69" N	78°58'7.10" E	64.1	75.8	67.1
NQ27	Hingna Bus Station	21° 4'20.91" N	78°57'54.13" E	62.7	76.4	66.1
NQ28	Hingna	21° 4'26.42" N	78°57'22.52" E	67.4	74.4	64.4
NQ29	Rural Hospital - Hingna	21° 4'29.18" N	78°57'16.31" E	53.2	68.6	66.4
NQ30	YCCE	21° 5'43.27" N	78°58'41.14" E	55.4	69.8	59.0
NQ31	Shalinitai Meghe Hospital	21° 5'42.77" N	78°58'29.87" E	56.6	75.2	63.1
NQ32	Pardi	21° 8'58.10" N	79° 9'38.54" E	59.8	74.0	63.9
NQ33	Kapsi Kh.	21° 8'37.52" N	79°10'33.68" E	62.3	72.7	64.3
NQ34	Transport Nagar	21° 8'25.97" N	79°11'41.65" E	64.9	72.4	65.8

Table 5-12: Night Time Predicted Noise levels during NMRP Phase II Operation

Sampling Code	Sampling Location	Latitude	Longitude	Baseline Noise level dB(A)	Predicted Cumulative Noise Levels dB(A)	
					Without Barriers	With Barrier
NQ1	Ashokwan	21° 0'46.64" N	79° 2'42.53" E	36.1	73.7	62.8
NQ2	Dongargaon	20°59'12.64" N	79° 1'47.68" E	30.6	69.2	57.7
NQ3	Mohgaon	20°57'35.33" N	79° 1'2.72" E	40.5	73.0	62.2
NQ4	Meghdoot CIDCO	20°56'11.89" N	79° 0'25.86" E	49.4	77.1	66.8
NQ5	Butibori Police Station	20°55'45.83" N	79° 0'14.09" E	48.3	70.0	58.4
NQ6	MHADA Colony	20°55'42.27" N	78°59'56.53" E	49.8	71.3	58.6
NQ7	MIDC KEC	20°55'45.70" N	78°58'11.06" E	52.5	72.8	61.8
NQ8	MIDC ESR	20°55'24.14" N	78°57'51.55" E	54.9	74.0	63.8
NQ9	Jijamata High School & Jr. College	20°55'46.75" N	79° 0'18.26" E	44.7	74.9	60.4
NQ10	Rachana Hospital	20°55'43.41"N	79° 0'0.56"E	45.6	73.6	63.1
NQ11	Pili Nadi	21°11'32.28"N	79° 7'44.11"E	51.3	76.0	62.5
NQ12	Khasara fata	21°11'49.79" N	79° 8'6.70" E	52.1	72.7	61.4
NQ13	All India Radio	21°12'9.97"N	79° 8'37.43"E	50.4	71.5	59.8
NQ14	Khairi fata	21°12'40.05" N	79° 9'32.12" E	51.9	73.3	58.9
NQ15	Lok Vihar	21°12'54.36" N	79°10'1.8" E	45.7	76.0	59.8

Sampling Code	Sampling Location	Latitude	Longitude	Baseline Noise level dB(A)	Predicted Cumulative Noise Levels dB(A)	
					Without Barriers	With Barrier
NQ16	Lekha Nagar Asha Hospital and Asharam College & School of Nursing	21°13'9.11" N	79°10'35.50" E	44.9	76.3	60.4
NQ17	Kamptee Police station**	21°12'55.03" N	79°11'32.30" E	50.1	68.8	57.2
NQ18	Kamptee Municipal Council	21°12'47.51" N	79°11'56.43" E	45.6	70.2	57.7
NQ19	Dragon Palace	21°13'1.00"N	79°12'30.16"E	44.2	76.1	55.8
NQ20	Kanhan River	21°13'21.24" N	79°13'26.03" E	40.6	72.0	58.0
NQ21	Delhi Public School (DPS), Khairy, Kamptee Road, Nagpur	21°12'49.14" N	79° 9'35.39" E	43.6	62.8	49.9
NQ22	Hingna Mount View	21° 6'12.21" N	78°59'24.77" E	42.3	73.5	62.9
NQ23	Rajiv Nagar	21° 5'50.78" N	78°58'51.05" E	46.9	72.7	60.6
NQ24	Wanadongri	21° 5'32.24" N	78°58'24.93" E	44.8	75.3	65.3
NQ25	APMC	21° 5'8.39" N	78°58'18.37" E	55.1	75.9	65.5
NQ26	Raipur	21° 4'37.69" N	78°58'7.10" E	53.7	75.5	64.4
NQ27	Hingna Bus Station	21° 4'20.91" N	78°57'54.13" E	55.9	76.2	65.9
NQ28	Hingna	21° 4'26.42" N	78°57'22.52" E	52.1	73.5	63.4
NQ29	Rural Hospital - Hingna	21° 4'29.18" N	78°57'16.31" E	46.8	68.5	66.2
NQ30	YCCE	21° 5'43.27" N	78°58'41.14" E	43.9	69.6	56.8
NQ31	Shalinitai Meghe Hospital	21° 5'42.77" N	78°58'29.87" E	47.8	75.1	62.2
NQ32	Pardi	21° 8'58.10" N	79° 9'38.54" E	49.1	73.8	61.9
NQ33	Kapsi Kh.	21° 8'37.52" N	79°10'33.68" E	50.2	72.3	60.4
NQ34	Transport Nagar	21° 8'25.97" N	79°11'41.65" E	51.3	71.6	59.5

333. **Embedded Measures:** Noise barriers shall be placed along the identified sections of the corridors mainly including the identified sensitive receptors and a few residential areas, as summarised in **Table 5-13**.

Table 5-13: Locations and Details of proposed Noise Barriers

Line	Location	Significance	Length (m)	Height (m)	Area (sq.m)	Estimated cost (@₹5000/sq.m)
1A	MHADA Colony station towards Butibori Police Station on either side of the track (Ch. 33933 to 34233)	Jijamata High School & Jr. College (Sensitive Receptor)	300	3	900	45,00,000.00
	Butibori Police Station towards MHADA Colony station on either side of the track (Ch. 33540 to 33640)	Rachana Hospital (Sensitive Receptor)	100	3	300	15,00,000.00

2A	Lekhanagar Station towards Cantonment on either side (Ch. -7199 to -7349)	Asha Hospital and Asharam College & School of Nursing (Sensitive Receptor)	150	3	450	22,50,000.00
	Khairi Fata Station towards LokVihar Station on either side of the track (Ch. -5250 to -5400)	Delhi Public School (DPS), Khairi (Sensitive Receptor)	150	3	450	22,50,000.00
3A	From Ch. 19907 to 20107	YCCE and Shalinitai Meghe Hospital (both Sensitive Receptors are adjacent to each other)	500	3	1500	75,00,000.00
4A	From Ch. - 1215 to - 1365	Pardi (Residential area)	150	3	450	22,50,000.00
	From Cg. - 1365 to - 1515	Kapsi (Residential area)	150	3	450	22,50,000.00
				Total	**4500**	**2,25,00,000.00**

334. The ballast-less track supported on two layers of rubber pads can 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.

335. **Proposed Measures:** 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. Common path treatments are described below.

(i) 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;

(i) Noise barriers close to vehicles – Barriers located very close to a rapid transit train, for example, may only need to be approximately 1 to 3m above the top of rail to be effective. Standard barriers close to vehicles can provide noise reductions of 6 to 10 dB; and

(i) Noise barriers at ROW line – Barriers on the ROW (Right of Way) 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.

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

337. During construction various measures such as noise mufflers, enclosures, low-noise equipment and temporary noise barriers will reduce noise. 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 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 could 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 may be confined to certain routes (based on infrastructure capacity) or restricted to certain off -peak hours (that is, to reduce noise pollution at night or to avoid commuting and school hours during the day);

(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.

338. 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.

339. **Residual impact:** Even with the proposed design features metro operation will add to the baseline noise and vibration levels that are already high enough to cause annoyance. Without additional mitigation the residual impact could be moderate negative. Initial noise modelling shows it is feasible to mitigate the operational noise by means of noise barriers, the final layout, height and length of noise barriers required has to be established during detailed design. It is expected the increase in noise can be mitigated to an extent that the increase is less than 3dB(A), thus a minimal negative residual impact will remain.

340. **Impact Significance:**

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

3. Vibration

341. 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.
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.

342. **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.

343. 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.

344. 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.

345. Vibration from pile driving can be calculated with the following equation (FTA, 2018):

$PPV_{\text{Impact Pile Driver}} = PPV_{\text{Ref}}\ (25/D)^{1.5}$

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.)

346. 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.

347. 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) [61]

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

348. **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 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 carrying out construction at such locations. Also, vibration mitigation measures will be implemented. Vibratory Rollers shall be avoided near sensitive structures.

349. 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:

(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.

350. Damping treatments, localized stiffening or mass addition at the receptors to reduce post -construction vibration. Wave-impleding blocks (WIP), subgrade stiffening and wave barriers can be 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 shall 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.

351. In the case of vibrations from road traffic and pile driving, very deep barriers (in excess of 10 m) shall 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

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

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[62]. 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.

352. 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.

353. **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.

354. **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.

355. **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

356. **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 implementation of the project, as well as the local environmental conditions.

357. 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.

358. 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.

[62] *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.*

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.

359. 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.

360. **Mitigation:** Anticipated impacts of pier construction shall 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 can be executed by providing suitable cofferdams for foundations / sub-structures.

361. 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 shall 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 shall be finished strictly adhering to the time schedules decided;
(iii) Restoration of the work sites shall 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 shall be maintained by minimal disturbance to the surroundings;
(vi) It will be mandatory for the Contractor to adhere to the mitigation measures provided in the EMP section of Contract documents.

362. **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.

363. **Impact Significance:**

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

5. Surface water and Groundwater Quality

364. **Impact:** The waste water 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.

365. 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.

366. **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.

367. In order to detect any leaks in the sewer system as soon as possible during the operational phase, it is important to carry out regular visual inspections of the terrain surrounding the stations. If subsidence of the ground is observed the sewer must be excavated for inspection and repairs when necessary.

368. **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.

369. **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

370. **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.

371. **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.

372. 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.

373. Water for dust suppression (sprinkling) and tire washing will be sourced from surface runoff, wastewater from construction sites, construction yards and seawater. 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.

374. 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.

375. **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.

376. **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

377. **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.

378. Quarry operations are independently regulated activities and outside the purview of the project proponent. It is, nonetheless, appropriate to give consideration to the environmental implications in selection of quarry sources since poorly run operations create dust problems, contribute noise pollution, ignore safety of their employees, or cause the loss of natural resources. So, the construction material 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.

379. 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).

380. 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.

381. **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 has to follow the criteria for site selection, as laid down in **Annexure-9A** of this EIA-EMP report and MahaMetro’s SHE Manual (**Annexure-12**), with the final location and layout of the sites. Locations will be approved by MahaMetro 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 MahaMetro and the funding agencies before establishment.
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 MahaMetro 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.

382. 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.

383. 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 MahaMetro.

384. 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.

385. Sites for disposal of surplus excavated soil and C&D waste will be decided by MahaMetro 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.

386. 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.

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

388. 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.

389. **Impact Significance:**
- **Design and pre-construction stage – minor negative**
- **Construction stage – moderate negative**
- **Operation stage – neutral**
- **Residual Impact after Mitigation – minimal negative**

8. Flora

390. **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. None of trees to be cut are rare or endangered species. 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

391. 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. Therefore, there will be no net loss of biodiversty because of the project.

392. 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.

393. **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 MahaMetro 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. These 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.

394. 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, MahaMetro will plant saplings in the road median: this re-planting is not in scope of works of the construction contractor.

395. Tree cutting and felling shall be done only if the tree is in the way of construction and only after receiving clearance from MahaMetro and competent Authorities. No damage shall be caused to trees during construction activities other than the trees marked for felling. Vegetative cover shall 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 shall be taken to prevent exposed soil from drying out and causing damage to the tree and its roots.

396. To avoid negative impact on herbaceous vegetation along the waterways encountered along the alignments, vehicle & construction machinery movement should be restricted to designated roads. Similarly, it is suggested to avoid dumping of muck, excessive site clearance, levelling etc. in the river/nallah basin. No Excavated material should be stored near river/nallah basins. Vegetation clearing by chemicals / herbicides will not be permitted and workers shall 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 shall be provided at construction site.

397. **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.

398. **Impact Significance:**

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

9. Fauna

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

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

401. **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.

402. **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.

403. **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

404. **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.

405. **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 / Resettlement Plan (RP).

406. **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.

407. **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

408. **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 5-14**.

Table 5-14: 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

409. In case any gas pipelines have to be crossed, a proper HAZOP study (& Risk Analysis) will be conducted as mentioned in the EMP by contractor and MahaMetro during pre-construction period for any kind of handling of this issue in concurrence with gas supply agency.

410. 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.

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

412. **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 shall be made by MahaMetro 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.

413. 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.

414. 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.

415. In order to retain satisfactory levels of traffic flow during the construction period, traffic management and engineering measures need to be taken. They can be road widening, traffic segregation, one-way movements, traffic diversions, acquisition of service lanes, etc. 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.

416. 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.
(x) If necessary, bus service and other public and private transport services in the area should be improved to meet residents' transportation needs.

417. **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.

418. **Impact Significance:**

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

12. Aesthetics

419. **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.

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

421. **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.

422. **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

423. **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.

424. 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.

425. 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.

426. Harmful electromagnetic radiation is emitted by electrical traction and rolling stock: exposure of personnel needs to be minimized; electronic equipment needs to be immunized. MahaMetro personnel could be impacted by the effects of electromagnetic interference, electromagnetic radiation, musculoskeletal disorders (MSDs), stress and other communicable diseases.

427. 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.

428. **Mitigation.** MahaMetro has a SHE Manual in place outlining the minimum Health and Safety standards that shall be required by MahaMetro 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 MahaMetro; 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.

429. SHE Manual, comprising the above mentioned sections, as mandated by MahaMetro 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 MahaMetro. Hazards and requisite safety measures related to working at height are of primary focus on this corridor.

430. 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 MahaMetro, 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.

431. 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 MahaMetro for construction and operation phases.

432. 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.

433. 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.

434. 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.

435. 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.

436. In order to safeguard MahaMetro 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.

437. 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.

438. 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.

439. Stress can be managed at three levels of intervention:

(i) Primary level intervention: The main priority for MahaMetro 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.

440. **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.

441. **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)

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

443. **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.

444. **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.

445. 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.

446. Before start of civil work the contractor and MahaMetro 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.

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

448. 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 MahaMetro.

449. 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.

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

451. **Impact Significance:**

- **Design and pre-construction stage – neutral**
- **Construction stage – minor negative**

- **Operation stage** **– neutral**
- **Residual Impact after Mitigation** **– none**

15. Energy consumption

452. **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.

453. **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.

454. **Impact Significance:**
- **Design and pre-construction stage** **– neutral**
- **Construction stage** **– moderate negative**
- **Operation stage** **– neutral / positive**
- **Residual Impact after Mitigation** **– minimal negative**

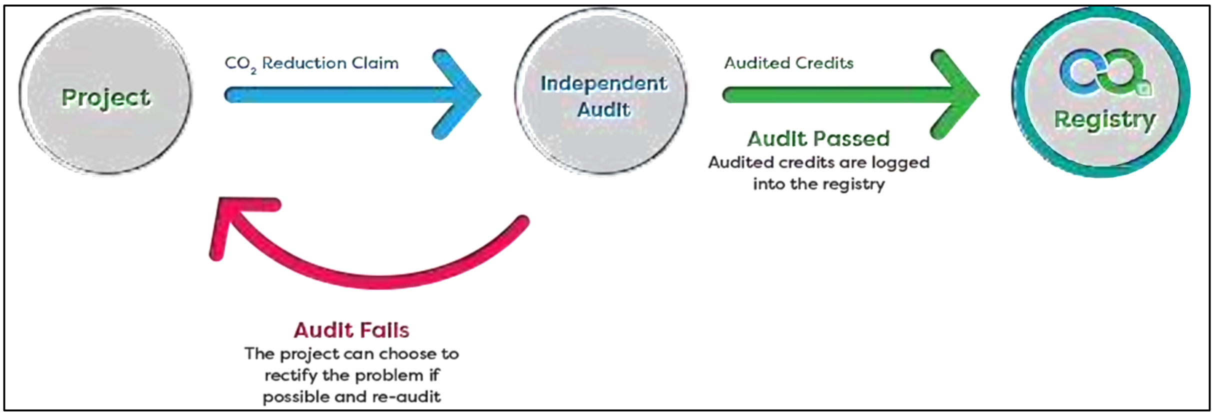
455. •Construction of metro project in a city like Nagpur will yield many tangible benefits such as better accessibility; reduction in atmospheric air pollution; less travel time; more comfort and improved quality of life. Some of the benefits expected from the project include:
(i) **Employment Opportunities –** 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?

456. 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?

457. 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.

458. 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.

459. 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

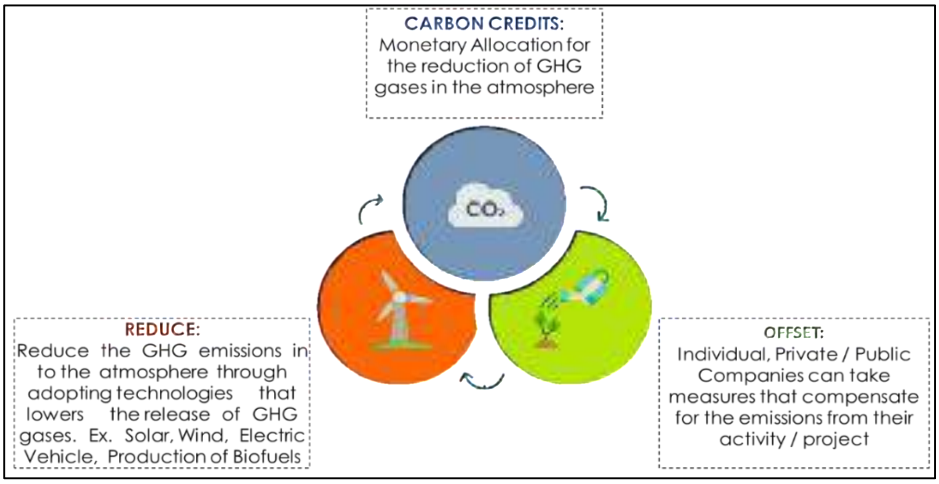
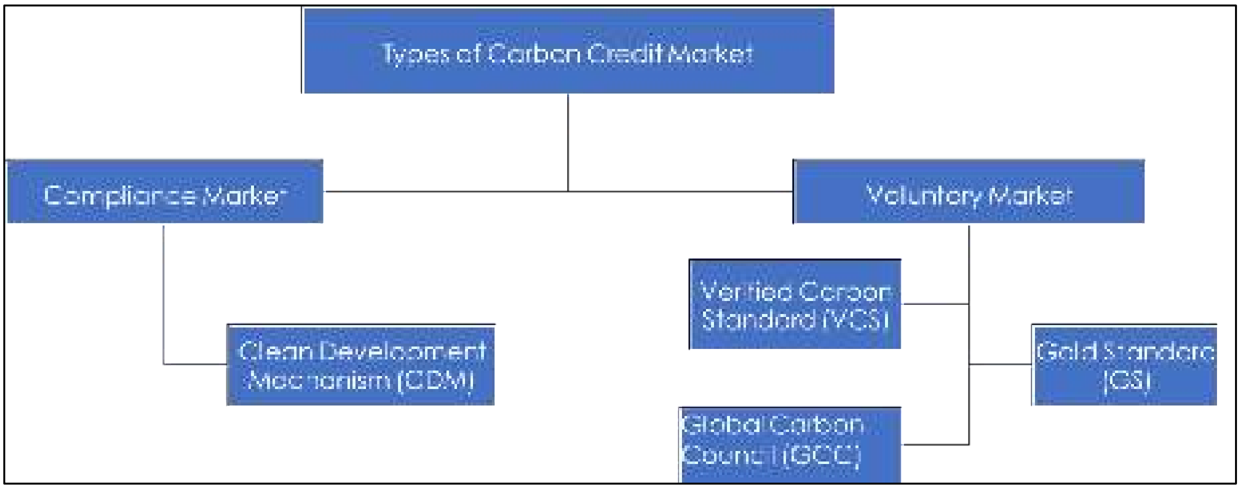


Figure 5-4: Types of Carbon Credit Markets



460. 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 5-15** below.

Table 5-15: 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

461. 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 5-16**.

Table 5-16: Daily Ridership for NMRP project (Phase I + Phase II)

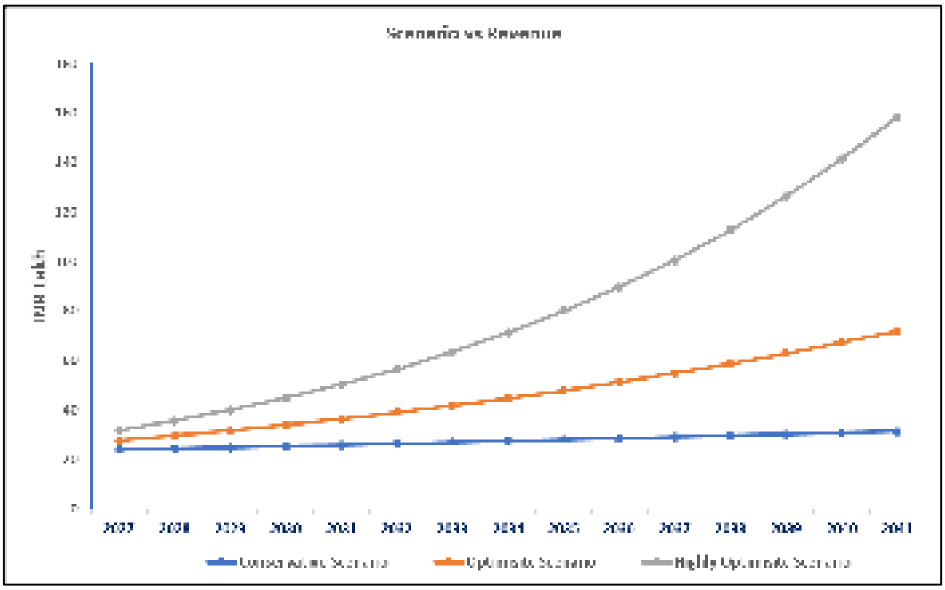
Corridor	Daily Ridership (Lakh Passengers)	
	2031	**2041**
Kanhan-MIHAN (NS corridor)	2.98	3.69
Transport Ngr –Hingna (EW Corridor)	2.96	3.58
Total Ridership	**5.94**	**7.27**

462. 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 5-17** 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 5-17: Details for calculation of Carbon Credits

Year	**2031**	**2041**
Ridership (Lakh/year)	5.94	7.27
tCO2eq (Carbon Credits generated) [63]	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



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

VI. ANALYSIS OF ALTERNATIVES

A. PROJECT PURPOSE

463. 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.

464. 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

465. 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

466. 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

467. 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:

468. 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

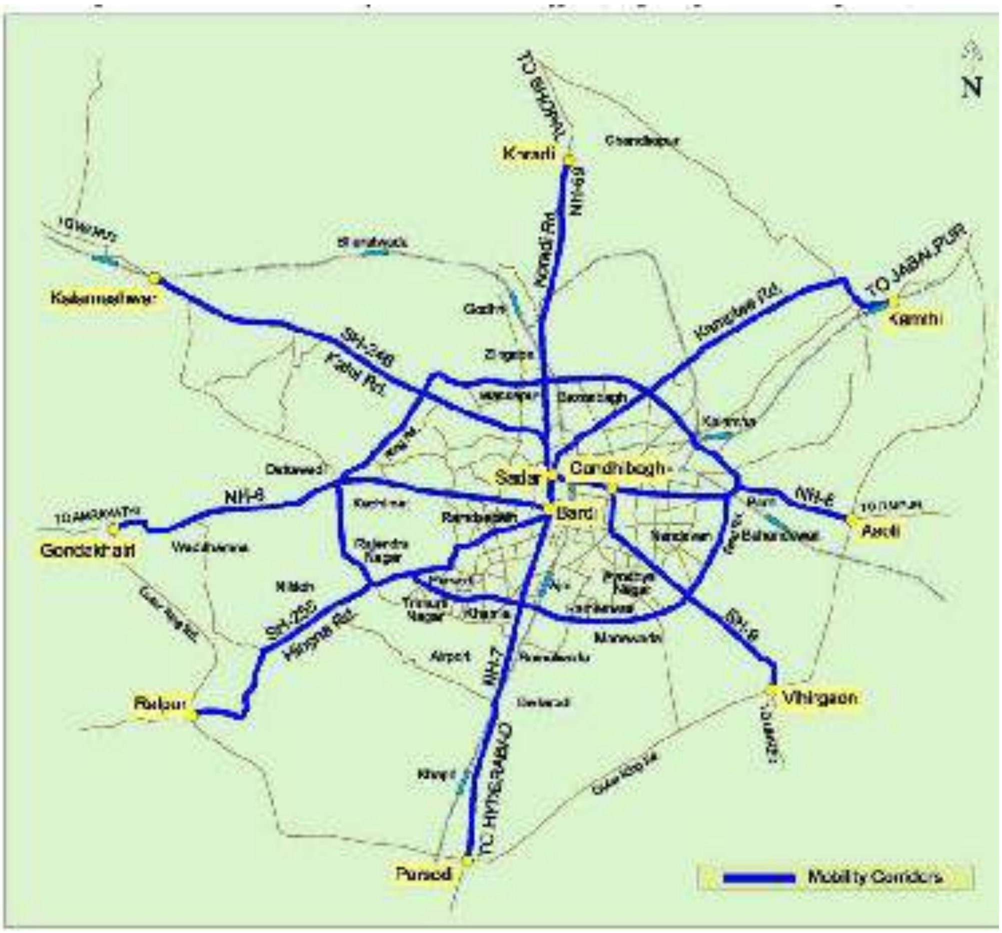
Goal 4: Develop a Parking System that reduces the demand for parking and need for private mode of transport and also facilitate organized parking for various types of vehicles.

469. 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.

470. 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



471. 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:

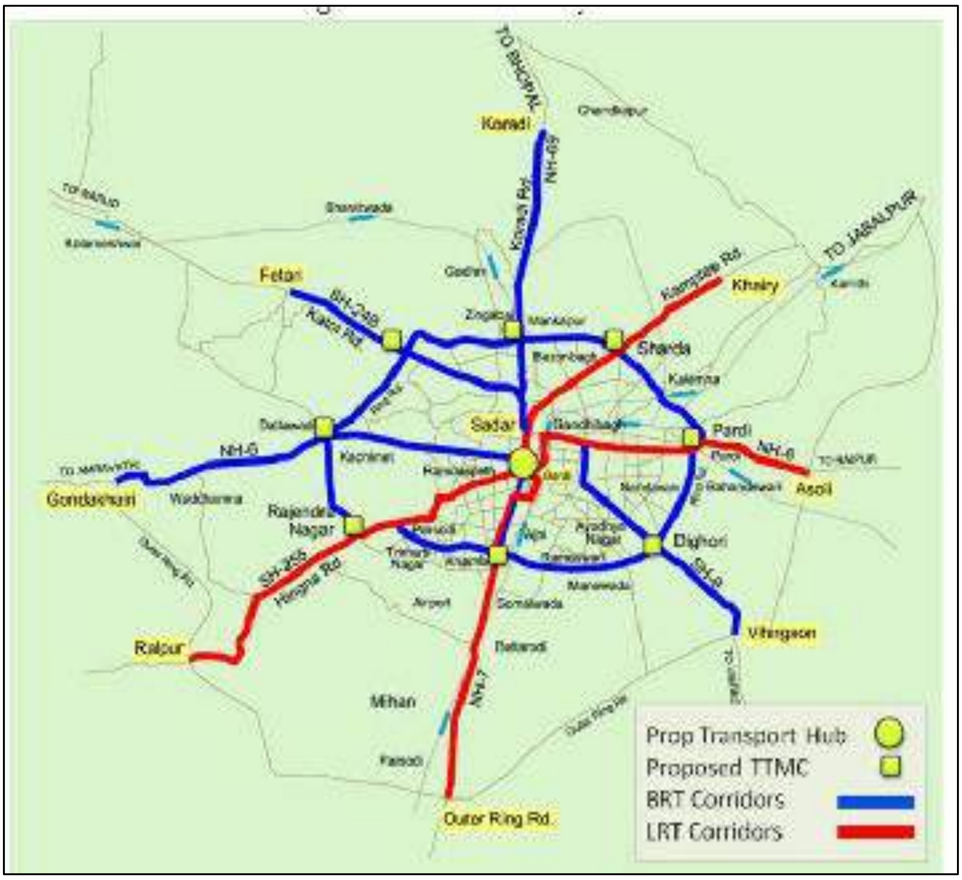
(i) Do Nothing – Without Any Development
(ii) Do Something – Considering Sanctioned Projects
(iii) Do Everything – Sustainable Urban Transport

472. 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.

473. 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.

474. 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



475. 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.

476. 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.

477. 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

478. 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)

479. 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.

480. 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.

481. 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**

482. 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%)

483. 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	15

Sl	Criterion	Objectives	Weightage
		• Protect and enhance cultural heritage, landmarks and archaeological monuments	
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
		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:

484. 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

Screening Parameter	Description	Total Score	Metro Rail	LRT	Elevated BRT	Normal Bus System
	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**
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**

485. 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

486. 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:

487. **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

488. 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**	**-**	**-**	**-**	**-**

489. 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.

490. 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)

Pollutant	Metro of LRT or Elevated BRT				Metro of LRT	Metro
	2024	2031	2041	2044	2047	2051
Carbon Monoxide (CO)	490.07	579.50	724.11	774.71	829.13	908.15
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

491. 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.

492. 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.

493. 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.

494. **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.

495. **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.

496. **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.

497. **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

Screening Parameter	Description	Total Score	Metro Rail	LRT	Elevated BRT
	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 Effects	Economic Returns	10	7.5	5	10
	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**

498. 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.

499. 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 for 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.

Impacts	Metro	LRT	BRTS
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

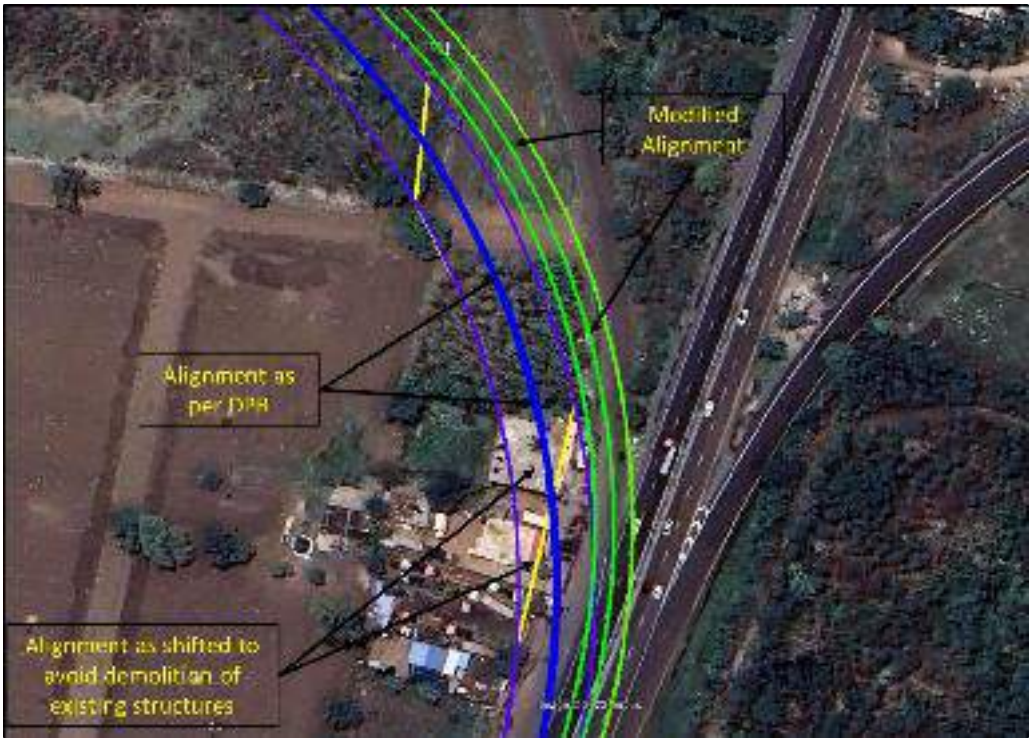
4. Alignment Alternatives

500. 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.

501. 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:
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

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:

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

502. 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.

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.

503. 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.

504. 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 and other stakeholders were consulted through focus group discussions and individual interviews.

B. IDENTIFICATION OF STAKEHOLDERS

505. 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),
- (ii) Project beneficiaries, and
- (iii) Implementing agency.

506. The secondary stakeholders include the revenue officials, village heads, gram panchayat offices, NGOs and business communities in the affected areas.

507. 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

508. 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 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 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

509. Public consultations and discussions with the displaced persons (DPs) 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) and Resettlement Plan (RP) 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)	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.

510. 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 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**

511. 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

512. The DPs 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 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 **Figure 7-1**.

Table 7-3: Summary of Public Consultations carried out for NMRP Phase II Project

Sr. No	Location (Reach) & Date	Participants	Issue raised by Participants	Reply from MahaMetro
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. b) Peoples also concerned about arrangement of safety precaution during civil activity as they are located near station.	a) The suggestion has been incorporated and this will circulate to the concerned office for further approval. b) The necessary safety precaution will take during the civil work.
2	MIDC Colony (R-1A) 28.04.2023	11	a) All the kiosk holders were concerned about alternative locations.	a) Provision will be kept in the RP for NTH (Kiosk). They will relocate in very nearby feasible location

			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.	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 implementation 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. 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) 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, (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 implementation 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)	13	a) Proper care of safety of people should be considered	a) All types of safety measures will be adopted

	12.04.2023		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.	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 implementation 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 implementation 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) 10.04.2023	12	a) The compensation against loss of land or property will 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.	a) The compensation against loss property 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, 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

513. 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.

F. PLAN FOR FUTURE PUBLIC CONSULTATIONS

514. 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 will form part of further stages of project preparation and implementation. The Implementing Agency – MahaMetro – 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 and other stakeholders will be consulted in selection of alignment for minimization of resettlement impacts, development of mitigation measures, etc.
ii) MahaMetro 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 in Plan implementation.
iii) During the implementation of RP, MahaMetro 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 implementation & operation phases, they will be specifically involved in the consultation process.

515. As part of the future public consultations to be held for continual development four PC were held, 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 (MahaMetro) 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.

The exact proceedings of these PC with their minutes, photographs and other details are attached as **Annexure-15** of this Report.

G. INFORMATION DISCLOSURE

516. To keep more transparency in planning and for further active participation for DPs 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.

517. 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 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 MahaMetro office as well as at other locations, easily accessible to all stakeholders. MahaMetro 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 (GRM)

A. INTRODUCTION

518. 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) 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.

519. 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 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)

520. To receive and facilitate resolution of the DPs 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.

521. 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.

522. 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:

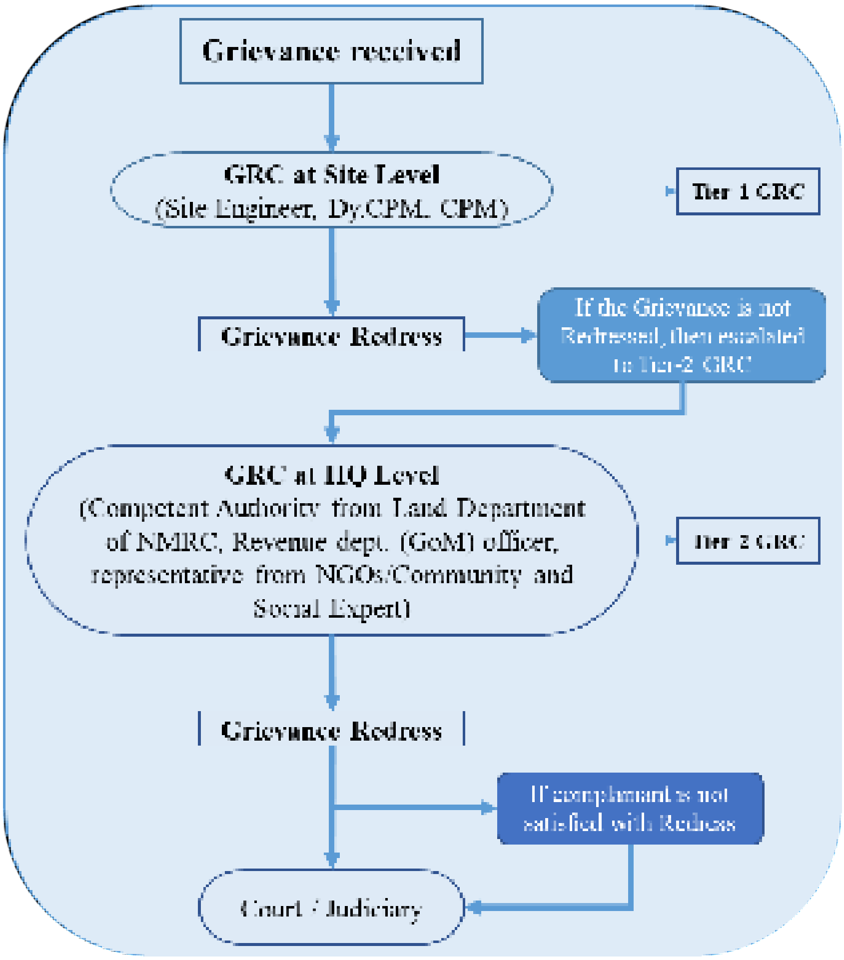
(i) Grievances of DPs will be first brought to the attention at field level staff (Site Engineer).

(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.

523. 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.

524. 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

525. 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.

526. 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

527. 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 (EA)

528. Maharashtra Metro Rail Corporation Limited (MahaMetro) 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.

529. MahaMetro shall be responsible for implementation of the proposed four corridors of metro rail project. The Managing Director (MD), MahaMetro will be the in charge of the overall project activities. MahaMetro shall be accountable to GoM (i.e. the EA).

530. Project Implementation Unit (PIU), MahaMetro 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 MahaMetro

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 MahaMetro.

2. Implementation of EMP

(a) MahaMetro:

531. EMP will be committed by MahaMetro as part of its agreement with Multilateral Development Banks (MDBs). The responsibility to implement the EMP including Grievance Redressal rests with MahaMetro. 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 MahaMetro.

(b) Contractor:

532. 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).

533. 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) MahaMetro and GC:

534. Supervision and review of implementation will be the responsibility of GC. With assistance from GC, MahaMetro 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 MahaMetro. Separate MahaMetro 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.

535. 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 MahaMetro will report directly to Director (Works) and Managing Director, MahaMetro.

536. 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 MahaMetro and jointly with contractor;
    (b) Weekly review meetings by MahaMetro and contractor.
    (c) Periodic quarterly reports will be submitted on implementation of EMP and its internal monitoring by MahaMetro to MDBs.
    (d) Orientation and training of MahaMetro team in implementation of EMP and environmental monitoring will be undertaken at the beginning of the project.

(d) MDBs:

537. Implementation of the EMP will be monitored half yearly by MDBs through their experts.

(e) External Monitor:

538. An external agency will be engaged by MahaMetro, if required, in consultation with MDBs to evaluate the environmental performance of afore-mentioned parties. The agency will report to GC & MahaMetro 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 MahaMetro to implement;
(iv) Involving users and stakeholders in the monitoring process; and
(v) Strengthening the capacity of the MahaMetro to manage and replicate third-party monitoring with metro users and other stakeholders.

539. The reporting line of all relevant parties is: **Contractor → PIU → MahaMetro 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 MahaMetro. MahaMetro may disseminate the information to all interested parties.
(ii) Non- compliance of the monitoring will be seen by the MahaMetro.
(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.

540. The external monitor will conduct independent monitoring and inspections to inform MahaMetro 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)	Monthly till completion of construction	Contractor to GC	Maha-Metro
Submission of EMP & EMoP Progress report to MDBs	Half Yearly	GC to MDBs	Maha-Metro
Submission of External E&S progress report by third party (If required)	• Semi-annually for the four years of construction phase • Yearly during first 2 years of Operation & Maintenance.	GC to MDBs	Maha-Metro

D. EMP FOR NMRP PHASE II CORRIDORS

541. Environmental Management Plan (EMP) Matrix including mitigation measures proposed for NMRP Phase II corridors is presented in **Table 9-2**.

Table 9-2: Environmental Management Plan (EMP) Matrix

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility: Implementation	Responsibility: 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).	MahaMetro	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.	MahaMetro	MahaMetro (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 prepare subcontract agreements accordingly. • Contractor management incorporates “adaptive management” to monitor and adapt over time; integration with sustainable procurement approach or concepts.	Contractor / GC	MahaMetro

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
				• 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 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	Contractor / GC	MahaMetro

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
				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.		
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,	Contractor	GC / MahaMetro

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
				responsibilities, and requirements in contractor or subcontractor agreements related to worker rights. • Grievance Redress Mechanism (GRM) 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.		
		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 • MahaMetro 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 vehicles.	Contractor	GC / MahaMetro

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
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. • Conditions set in permission and consents to be incorporated into the site-specific EMPs, with dedicated officers to maintain the regulatory compliance tracker.	MahaMetro / 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	• MahaMetro 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 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	MahaMetro / Contractor	Tree Authority (NMC), Maharashtra Forest Dept., GoM and NMRDA

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
				done in sites to be identified in consultation with Nagpur Municipal Corporation (NMC) and Maharashtra Forest Dept. MahaMetro to allocate sufficient tree replantation budget. • Stakeholder communication to avoid or minimize public concerns or protests. • Definition of adequate budget and contingencies as well as financial resources to cover all related costs. This will be finalized before work on relevant section is commenced between MahaMetro 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 store 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		

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility: Implementation	Responsibility: 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 MahaMetro. • The existing structures should be demolished one after another cautiously.	Contractor	GC / MahaMetro
		Physical Cultural Resources	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. • 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 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/MahaMetro before submitting to all lenders.	Contractor	GC / MahaMetro / NMRDA
8.	Severance of utilities	Social EHS	The proposed alignments will cross drains and utility	• Assets and utilities will be maintained without affecting and damages by shifting temporary/ permanently where it is necessary.	MahaMetro / Contractor	MahaMetro / NMC, NMRDA,

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
			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.	• Based on utility maps and network information, MahaMetro and Contractor in collaboration with utility owners oversees an investigation of existing utility MahaMetro 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. • For gas pipeline, Contractor will conduct the hazardous operation study to ensure the smooth and safe shifting. • Utility shifting plan will be developed by MahaMetro 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 MahaMetro to the property owner on the same principles as temporary		MSEB, MNGL, Telecon companies, etc.

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
				land acquisition. Following completion of construction of metro, such utilities shall be rehabilitated on public land.		
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, 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.	Contractor	GC / MahaMetro
10.	Coordinate with the Traffic	Land, Occupational 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	Contractor	GC / MahaMetro /

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
	Department on Traffic Management Plan	Community safety		(IRC:SP:55-2014), prior to mobilization for respective sections with site- or station-specific plans and measures to minimize the overall impact on traffic throughout the construction and operation periods. • At congested sections, the temporary traffic coordinators will be engaged by MahaMetro 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 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		Traffic Police Dept.

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
				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. • MahaMetro and local authorities continue to play an oversight role in approving these plans during construction, evaluating their cumulative impact with other infrastructure projects in the region, and ensuring their dissemination to all relevant stakeholders.		
11.	Construction method, construction material and sites selection	Environment	Pollution and nuisance	• 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	Contractor	GC / MahaMetro

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
				construction activities. In those instances, where extraction of groundwater becomes unavoidable, contractor shall, with consent of MahaMetro 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 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 MahaMetro 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 MahaMetro before start of		

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
				construction in consultation with 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 MahaMetro. 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 to reduce the extensive use of grid-generated electricity supplied to the station for operation and maintenance.	Contractor	GC / MahaMetro
13.	Site-specific Environmental Baseline	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.	Contractor	GC / MahaMetro

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
	Collection and Assessment			• 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). • Contractor to prepare site-specific EMPs for MahaMetro 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. • MahaMetro and GC to provide EMP orientation to contractor.		
14.	Documents Review and Information Disclosure	Environment	Unanticipated impacts management	• With the assistance of GC, MahaMetro will review the above said data collections, surveys and pre-construction plans prepared by Contractor.	MahaMetro	GoM

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
				• MahaMetro will submit to all lenders to review the documents and disclose in a timely and meaningful manner prior to construction.		
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 MahaMetro website or other media as approved by MahaMetro	MahaMetro	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 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).	Contractor	GC / MahaMetro
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 / MahaMetro on monthly basis.	Contractor / GC	MahaMetro

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
				• GC / MahaMetro 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 MahaMetro. • 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 MahaMetro of the occurrence of such risks or impacts, with detailed description of the event and proposed corrective action plan. MahaMetro will report to all lenders accordingly. • MahaMetro to engage qualified and experienced third party monitor, if required, to verify information produced through the Project monitoring process, and facilitate the carrying out of any verification activities by such third party monitor. • MahaMetro to submit the semi-annual monitoring reports (GC's and third party's) using the agreed the template to all lenders. • MahaMetro 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	Contractor	GC / MahaMetro

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
				mechanism for communication between the contractor and the community and informing the public of construction details (timing, expected impacts), MahaMetro 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 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.	Contractor	GC / MahaMetro

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	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.		
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	Contractor	GC / MahaMetro
21.	Mechanical piling	Noise	During mechanical piling operations, noise will be generated which may go up to 88-90 dB (A) at a distance of 5m	• At sensitive locations, auger piling will be carried out in place of mechanical (by driven) piling which will generate less noise than mechanical piling (around 70-75 dB(A)). Also 2m high barricade of GI sheet will be installed on all sides of piling operations. This could effectively cut down noise levels by 10-15 dB (A). Piling operations will be restricted during day time hours only. • Efforts should be made to keep the noise levels under control by appropriate noise attenuation and adopting employee safety measures. • Use of low-noise equipment and ensuring good maintenance, and trying to avoid using high-noise equipment simultaneously at the same section. • Wherever baseline noise already exceeds the standards, only 3dB of noise increase is allowed.	Contractor	GC / MahaMetro

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
				• 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	Pile driving for viaduct piers and buildings driving generate 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 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.	Contractor	GC / MahaMetro

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
		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 MahaMetro. • 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 the requirements of this ESS and national law; and to train project personnel and project workers on chance find procedures.	Contractor	GC / MahaMetro
		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.	Contractor	GC / MahaMetro

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
				• Procedure to receive, evaluate, and compensate (if applicable) damages due to construction and establishment of financial resources to cover this expense.		
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 MahaMetro). 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 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.	Contractor	GC / MahaMetro
		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. • Wherever baseline noise already exceeds the standards, only 3dB of noise increase is allowed.	Contractor	GC / MahaMetro

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
				• 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. • 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.		

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
				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 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.	Contractor	GC / MahaMetro
		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. • To avoid water pollution and soil erosion due to flooding, earthwork will be limited during monsoon season.	Contractor	GC / MahaMetro

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
		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.	Contractor	GC / MahaMetro
		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 MahaMetro. • 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 the requirements of this ESS and national law; and to train project personnel and project workers on chance find procedures	Contractor	GC / MahaMetro
		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	Contractor	GC / MahaMetro

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
				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.		
		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.	Contractor	GC / MahaMetro
23.	Hauling of excavated material	Air	During transportation of excavated material, fugitive dust will be generated from two sources, (1) from re-suspension of dust from road surface, (2) from the movement of air, against the excavated material being hauled	• The traffic management plan will be stringently implemented with regular monitoring and inspections. • 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	Contractor	GC / MahaMetro / Traffic Police Dept.

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
				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.		
		Noise	Dumper trucks carrying excavated material will result into high noise (typically in excess of 85 dB (A) at one m distance, or 57 dB (A) at 10 m distance). The adverse impacts of noise will be most intense in the residential / urban areas.	• 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 noise levels under control by appropriate noise attenuation and adopting employee safety measures. • Wherever baseline noise already exceeds the standards, only 3dB of noise increase is allowed. • Information dissemination to local residents and shop owners about the nature and duration of intended activities including the construction method, probable effects, quality control measures and precautions prior to commencement and kept updated as to changes in the management and mitigation plan. • 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.	Contractor	GC / MahaMetro
		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.	Contractor	GC / MahaMetro

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	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 should be planned to have minimal impact on occupational and community health and safety.	Contractor	GC / MahaMetro
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.	Contractor	MahaMetro / 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 MahaMetro 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.	Contractor	GC / MahaMetro
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 may also result into	• 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 implementation and adjustments, as needed, to reflect actual traffic congestion or related issues	Contractor	GC / MahaMetro / Traffic Police Dept.

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
			traffic congestion and air pollution from stagnated vehicles in urban areas. Primary pollutants will be NOx, CO, NMHC, and VOCs.	• 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.	Contractor	GC / MahaMetro
		Social	Traffic diversion (esp. for public transport) will create inconvenience	• Implement the traffic management plan. Plans will be made to spare traffic diversion during peak hours (morning and evening peaks). Also separate arrangements for bus, auto and taxi parking bays will be made. Street furniture for pedestrians will be provided wherever possible. • 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	Contractor	GC / MahaMetro

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
				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 / MahaMetro
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 MahaMetro, 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.	Contractor	GC / MahaMetro
		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 / MahaMetro
27.	C&D waste (muck) generation & disposal (incl. spent drill fluid	Surface water	Muck generated including spent polymer slurry from auger drilling operations will drain	• 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.	Contractor	GC / MahaMetro

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
	and polymer slurry)		with surface runoff and pollute nearby water bodies	• 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.		
		Groundwater	Muck, spent polymer slurry & drill fluids may settle down from pond / tanks and will affect groundwater	• The tanks / ponds holding muck will be lined to prevent infiltration into groundwater. It will be passed through settling chambers and discharged into public sewers; it will be treated by municipal agencies to Environment Protection Rules (EPR) 1986 Schedule VI standards of discharge of general effluents into surface water. Upon discharge of general wastewater into municipal sewers by MahaMetro, the municipal agencies are required by law to treat it appropriately before disposal. MahaMetro shall duly consult with the agencies before start of construction. • Groundwater quality monitoring before, during and after the use of muck tanks/ponds.	Contractor	GC / MahaMetro
		Aesthetics	Muck generation will create an aesthetic issue	• The construction site will be covered from all sides to reduce visual impacts.	Contractor	GC / MahaMetro
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.	Contractor	GC / MahaMetro
		Health & safety	Bar bending & other activities (inc. working at heights)	• Workers will be provided appropriate hand gloves and other personal protective equipment (PPE) such as fall protection when working at height.	Contractor	GC / MahaMetro

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
			might pose a H&S threat to workers	• Skilled workers working at height or doing hot work will be required to seek permission from site		
29.	Stacking & warehousing of raw material	Surface water	Washed out raw material could pose serious threat to surface water bodies	• Small dykes and garlanding drains along the periphery of the yard and ploy boundary could be constructed. This will control runoff and washing out of finer material.	Contractor	GC / MahaMetro
		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.	Contractor	GC / MahaMetro
		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	Contractor	GC / MahaMetro
		Aesthetics	Stacking of raw material will cause aesthetic issues for residential areas located nearby	• The height of walls between the residential area and RM yard / construction area will be raised using GI sheets.	Contractor	GC / MahaMetro
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. • Wherever baseline noise already exceeds the standards, only 3dB of noise increase is allowed.	Contractor	GC / MahaMetro

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
		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.	Contractor	GC / MahaMetro
		Aesthetics	Spoils from concrete pouring will create unpleasant looking visuals	• After each pouring cycle, the spoils will be manually collected and reused as sub-grade material in road constriction.	Contractor	GC / MahaMetro
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. • Wherever baseline noise already exceeds the standards, only 3dB of noise increase is allowed.	Contractor	GC / MahaMetro
		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.	Contractor	GC / MahaMetro
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.	Contractor	GC / MahaMetro

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	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.	Contractor	GC / MahaMetro
		Aesthetics	Curing will create water impounding and may lead to vector propagation	• Garlanding drain will be constructed around the construction area. The curing water impounded will be reused for curing.	Contractor	GC / MahaMetro
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. • Wherever baseline noise already exceeds the standards, only 3dB of noise increase is allowed. • Information dissemination to local residents and shop owners about the nature and duration of intended activities including the construction method, probable effects, quality control measures and precautions prior to commencement and kept updated as to changes in the management and mitigation plan. • Enclose especially noisy activities if above the noise limits and employ transportable noise screens between noise sources and identified noise sensitive areas for the duration of noisy construction activities.	Contractor	GC / MahaMetro
		Health & Safety	Cranes and launchers are a major safety concern.	• As per MahaMetro's SHE Manual, operation of launchers and cranes should be only done under the strict supervision of a qualified engineer and a safety	Contractor	GC / MahaMetro

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
				supervisor. Only qualified & trained crane/ launcher operators should be allowed. Proper examination of crane, launchers, labours & operators must take place before commencement of work.		
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. Sewage 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. • 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.	Contractor	GC / MahaMetro
		Groundwater	Surface water on flat terrain could percolate and contaminate groundwater.	• Contractor to collect the groundwater baseline data prior to construction. • Disposal in compliance with applicable regulatory requirements. • 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.	Contractor	GC / MahaMetro
		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.	Contractor	GC / MahaMetro

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
				• 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.		
		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.	Contractor	GC / MahaMetro
		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) (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.	Contractor	GC / MahaMetro

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
		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.	Contractor	GC / MahaMetro
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. • 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.	Contractor	GC / MahaMetro
		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). • Wherever baseline noise already exceeds the standards, only 3dB of noise increase is allowed.	Contractor	GC / MahaMetro

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
				• 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.		
		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.	Contractor	GC / MahaMetro
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.	Contractor	GC / MahaMetro
		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. • Wherever baseline noise already exceeds the standards, only 3dB of noise increase is allowed.	Contractor	GC / MahaMetro

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
		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. • 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.	Contractor	GC / MahaMetro
		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 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.	Contractor	GC / MahaMetro

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
				• 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. • Refer to Activity 42 “Use of DG sets” and Activity 44 “Storage of Diesel” for further measures.	Contractor	GC / MahaMetro
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.	Contractor	GC / MahaMetro

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
				• Groundwater quality monitoring.		
		Resources	Casting (incl. operation of gantry and hydraulic pre-stressing units) will consume lot of energy	• Pre-stressing and casting are basic requirements. However, whenever possible of the power should be drawn from approved lines, not from DG sets.	Contractor	GC / MahaMetro
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. • Groundwater will not be used. Water will be sourced from municipal supply, surface runoff or water from dewatering.	Contractor	GC / MahaMetro
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.	Contractor	GC / MahaMetro

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
				• 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.		
		Noise	Trucks carrying segments will result 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	• 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 noise levels under control by appropriate noise attenuation and adopting employee safety measures. • Wherever baseline noise already exceeds the standards, only 3dB of noise increase is allowed. • Information dissemination to local residents and shop owners about the nature and duration of intended activities including the construction method, probable effects, quality control measures and precautions prior to commencement and kept updated as to changes in the management and mitigation plan. • 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.	Contractor	GC / MahaMetro
		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.	Contractor	GC / MahaMetro

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	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.	Contractor	GC / MahaMetro
		Aesthetics	Movement of trucks will create an aesthetic problem	• Proper housekeeping activities have to be undertaken near the casting yard and nearby areas.	Contractor	GC / MahaMetro
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.	Contractor	GC / MahaMetro
		Noise & Vibration	Noise & vibration will be generated from the use of DG sets	• DG sets compliant with CPCB norms will be used. • Wherever baseline noise already exceeds the standards, only 3dB of noise increase is allowed.	Contractor	GC / MahaMetro

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
				• 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.		
		Resources	DG sets will consume Diesel (and in effect reduce the levels of a non-renewable resource)	• DG sets should always be use as a power back up, and not the primary sources of power. This should be made mandatory for all Contractors. • Refer to Activity 42 "Storage of Diesel" for further measures.	Contractor	GC / MahaMetro
		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.	Contractor	GC / MahaMetro
41.	All Construction Activities	Environment	Construction and Demolition (C&D) waste results from land clearing, excavation, construction, demolition, remodelling and repair of structures, roads and utilities	• Records of movement and loading/unloading of C&D waste and records of waste loaded by vendors. • C&D waste will be reused/recycled as it has the potential to save natural resources (stone, river sand, soil etc.) and energy. C&D waste generated from metro construction has potential use after processing and grading. • 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	GC / MahaMetro

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
				• Contractor will adhere with the C&D Waste Management Rules.		
		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. • The use of hearing protection should be enforced actively when the equivalent sound level over 8 hours reaches 85 dB(A), the peak sound levels reach 140 dB(C), or the average maximum sound level reaches 110dB(A). Hearing protective devices provided should be capable of reducing sound levels at the ear to at least 85 dB(A)	Contractor	GC / MahaMetro
42.	Storage of Diesel	Groundwater Health & safety	Diesel spillage (from underground or above ground storage facility) will affect groundwater quality adversely	• Before it percolates into the groundwater, contaminated runoff water can be run through adsorbents such as polymer slurry to remove the diesel. The diesel will be quickly collected into steel trays and disposed to authorized recyclers. • 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.	Contractor	GC / MahaMetro
			Storage of Diesel will attract the provisions of Hazardous Chemicals (Management & Handling) Rules and	• Proper onsite emergency plan will be prepared and will be approved through MahaMetro. • If the diesel storage crosses the threshold limits permissions, proper fire protection norms have to be undertaken as per National Building Code, 2005 (if	Contractor	GC / MahaMetro

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
			Petroleum Rules; as amended to date. It could cause serious damage to health & safety of workers / property if ignited	building) / Oil Industry Safety Directorate Standard 117 (if installation).		
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.	Contractor	GC / MahaMetro
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 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	Maha-Metro through Third Party Agency for Noise & Vibration Monitoring	MahaMetro

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
				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 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.		

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
		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 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.	O & M - MahaMetro	MahaMetro
			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.	O & M - MahaMetro	MahaMetro

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
				• Emotional resilience training, counselling for recovery and rehabilitation.		
		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.	O & M - MahaMetro	MahaMetro
		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 - MahaMetro	MahaMetro
45.	Track repair	Environment	Spill accidents	• MahaMetro to ensure no illegal disposal of solid waste or wastewater.	O & M - MahaMetro	
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	O & M - MahaMetro	MahaMetro
		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 be in compliance with GSR 371(E) dt. 17-05-2002. • Wherever baseline noise already exceeds the standards, only 3dB of noise increase is allowed. If baseline noise is below the CPCB and IFC-EHS standards, the operation noise has to meet these standards that is, noise level has to be less than level prescribed in these standards.	O & M - MahaMetro	MahaMetro

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
				• 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	O & M - MahaMetro	MahaMetro
		Health & safety	Storage of Diesel will attract the provisions of Hazardous Chemicals (Management & Handling) Rules and Petroleum Rules; as amended to date. It could cause serious damage to health & safety of workers / property if ignited	• Diesel should be stored in designated sites prior to final disposal. • 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 MahaMetro.	O & M - MahaMetro	MahaMetro
		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.	O & M - MahaMetro	

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
		Aesthetics	Operation of DG sets will cause an aesthetic issue	• Enclosures for DG Sets will be used.	O & M - MahaMetro	MahaMetro
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	• MahaMetro 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.	O & M - MahaMetro	MahaMetro
		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. • The appointed personnel should assist passengers to reach their destinations. An easily accessible grievance Redressal system should be established by MahaMetro	O & M - MahaMetro	MahaMetro
		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.	O & M - MahaMetro	MahaMetro

SR. No	Activity	Aspect / Parameter affected	Impact	Mitigation Measures	Responsibility	
					Implementation	Supervision
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.	O & M - MahaMetro	MahaMetro
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.	O & M - MahaMetro	
		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	O & M - MahaMetro	MahaMetro

Note: This EMP Matrix will form part of the contract document together with MahaMetro's SHE Manual for all contractors. This EMP has been aligned with the SHE Manual wherever possible.

E. EMP BUDGET

542. 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 (INR / ₹)
1.	Compensatory Plantation of 5380 trees in lieu of 538 affected trees (in 1:10 ratio)	53,80,000
2.	Noise Barriers	3,00,00,000
3.	Rainwater Harvesting[64]	8,35,21,000
4.	Environmental Monitoring	2,60,40,000
5.	Training and Capacity building[65]	18,50,000
	Total EMP Cost for NMRP Phase II corridors	**14,67,91,000**

543. Thus, total cost of EMP for all 4 Nagpur Metro Project- Phase 2 Corridors works out to be around **₹ 14.68 Cr**.

F. DEVELOPMENT AND IMPLEMENTATION OF SUB-PLANS

544. 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 MahaMetro'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
1.	Work plan for securing all permits and approvals	The plan will list all necessary permits, approvals and/ or consent including the responsible authorities and the timeframe of obtaining them.	Yes	Yes	No
2.	Construction and Labour Camp Management Plan	The plan will provide a layout map of the construction sites and campsite and clearly show the access road, entry and exit and different facilities inside the camp. Facilities inside the camp may include contractor's office, residential quarters, toilets, health center, construction plants, storage areas etc. The plan will include information on waste management, supply of	Yes	Yes	No

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

Sr. No.	Plan	Description	Approvals / NoC		
			PIU	GC	MDBs
		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., excavations, piling, etc.), use of heavy equipment, transport of materials and other hazards associated	Yes	Yes	Yes

Sr. No.	Plan	Description	Approvals / NoC PIU	GC	MDBs
		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	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 be in compliance 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 vibration; description of the instrumentation and equipment to be used; copies of the instruction manuals and the laboratory calibration and test	Yes	Yes	Yes

Sr. No.	Plan	Description	Approvals / NoC		
			PIU	GC	MDBs
		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)

545. 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

546. 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 (INR / ₹)
Pre-Construction stage					
Air	Emission of dust and particulate matter as PM2.5 and PM10, NOx and SOx, CO	GoI and WHO / IFC (whichever stringent)	Once, 24 hours continuously	Each station, batching plant and casting yard, Muck disposal site	13,60,000

Environmental Features	Aspect to be Monitored	Standard to be complied with	Time and Frequency of Monitoring	Location	Estimated Total Cost (INR / ₹)
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 (whichever 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	16,80,000
Soil	pH, Sulphate (SO3), Chloride, ORP, water Soluble salts EC, Organic Matter (Mineral Oil (GC)), Heavy metals, Poly-Aromatic Hydrocarbons (PAH), Moisture Content	GoI and WHO / IFC (whichever stringent)	Once, 1 sample each location	At batching plant and casting yard, Muck disposal site, construction camps	6,40,000
a) Noise & vibration b) Building condition survey	Noise levels in dB(A) Vibration PPV mm/s Building condition survey	GoI and WHO/IFC whichever 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.	13,60,000
				Sub-Total (A)	**50,40,000**
Construction stage					
Air	Emission of dust and particulate matter as PM2.5 and PM10, NOx and SOx, CO	GoI and WHO / IFC (whichever stringent)	24 hours continuously every month	For each station until civil works completed batching plant and casting yard, Muck disposal site, throughout construction	27,20,000

Environmental Features	Aspect to be Monitored	Standard to be complied with	Time and Frequency of Monitoring	Location	Estimated Total Cost (INR / ₹)
				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 (whichever 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	33,60,000
Soil	PH, Sulphate (SO3), Chloride, ORP, water Soluble salts EC, Organic Matter (Oil), Heavy metals, PAH, Moisture Content	GoI and WHO / IFC (whichever stringent)	Quarterly, 1 sample each location	At batching plant and casting yard, Muck disposal site, construction camps throughout construction phase	12,80,000
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 (whichever 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 vibration survey has been done during pre-	27,20,000

Environmental Features	Aspect to be Monitored	Standard to be complied with	Time and Frequency of Monitoring	Location	Estimated Total Cost (INR / ₹)
				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	40,00,000
				Sub-Total (B)	**1,40,80,000**
Operation Stage					
Air	Emission from DG sets (SPM, NOx and SOx), Odor	GoI and WHO / IFC (whichever stringent)	At least 2 times in a year for the first year, annually for next 3 years	DG sets of all stations	13,60,000
Groundwater	DO, Turbidity, Conductivity, pH, Heavy metals, TP, TN, E.Coli, TSS, Oil and Grease, VOCs and TDS	GoI and WHO / IFC (whichever 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.	8,40,000
Noise	Noise levels in dB(A)	GoI and WHO / IFC (whichever stringent)	At least 2 times in a year for the first year, annually for next 3 years	Alignment, Stations	13,60,000
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 (for cat. 2) on either side of alignment	13,60,000

Environmental Features	Aspect to be Monitored	Standard to be complied with	Time and Frequency of Monitoring	Location	Estimated Total Cost (INR / ₹)
Health and Safety	As specified in project EMP and MahaMetro's SHE Manual	IFC General and Sector EHS Guidelines or any other international recognized guidelines	Monthly for 4 years	Station locations	20,00,000
				Sub-Total (C)	**69,20,000**
				Grand Total (A + B + C)	**2,60,40,000**

H. GENERAL CONDITIONS FOR E&S WELFARE

547. 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
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

Sr. No.	General Condition	Reference from SHE manual of NMRCL	Responsibility
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
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

Sr. No.	General Condition	Reference from SHE manual of NMRCL	Responsibility
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

548. MahaMetro's current capacity in monitoring of metro projects in adequate. However, it is proposed to conduct a training program for MahaMetro 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 MahaMetro and the MDBs. A budget for the same has been allocated in the EMP.

549. An Environmental Safeguards Specialist has been added to the PIU, who will supervise work on all MDB corridors. The MahaMetro core Environment Safeguards team will be responsible for all corridors: it will be supported during construction by MahaMetro 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.

X. CONCLUSIONS AND RECOMMENDATIONS

550. 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.

551. 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.

552. Measures to mitigate adverse impacts have been recommended.

553. After mitigation some residual impacts are expected, predominantly due to noise, vibration, visual intrusion and health and safety risks.

554. 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.

555. 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.

556. 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.

557. 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.

558. 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.

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

QUALITY COUNCIL OF INDIA
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National Accreditation Board for Education and Training

Certificate of Accreditation

MITCON Consultancy and Engineering Services Ltd., Pune

Agriculture College Campus, Next to DIC Office, Shivajinagar, Pune – 411005

*The organization is accredited as **Category-A** under the QCI-NABET Scheme for Accreditation of EIA Consultant Organization, Version 3: for preparing EIA-EMP reports in the following Sectors –*

S. No	Sector Description	Sector (as per) NABET	Sector (as per) MoEFCC	Cat.
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

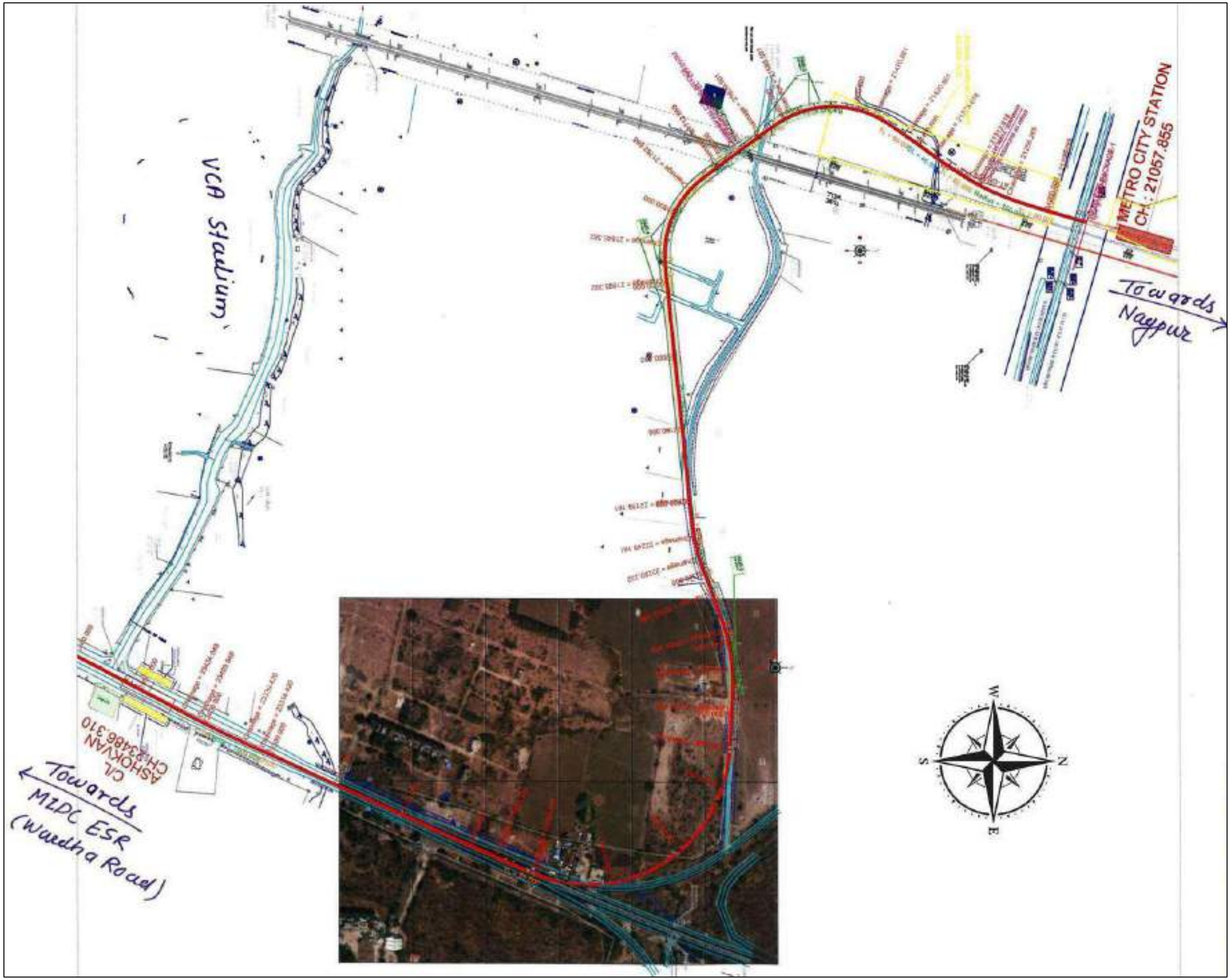
Certificate No.
NABET/EIA/2124/RA 0229_Rev 02

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
METRO CITY STATION
CH : 21057.855
Towards
Nagpur
C/L
ASHOKVAN
CH:23486.310
Towards
MIDC ESR
(Wardha Road)

Figure B

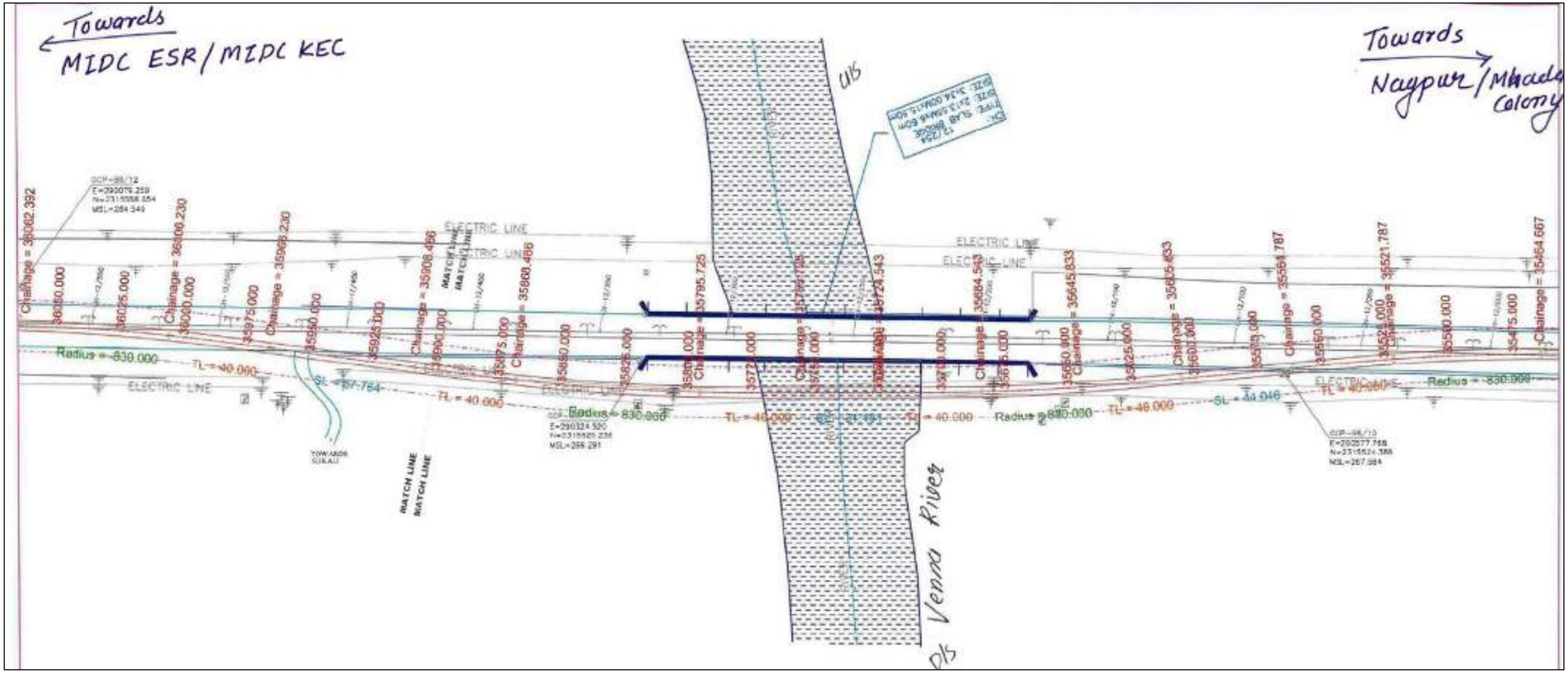

Towards
MIDC ESR/MIDC KEC
Towards
Nagpur/Mhada Colony
U/S
D/S
Venna River
ELECTRIC LINE
MATCH LINE
TOWARDS SUKALI

Figure C

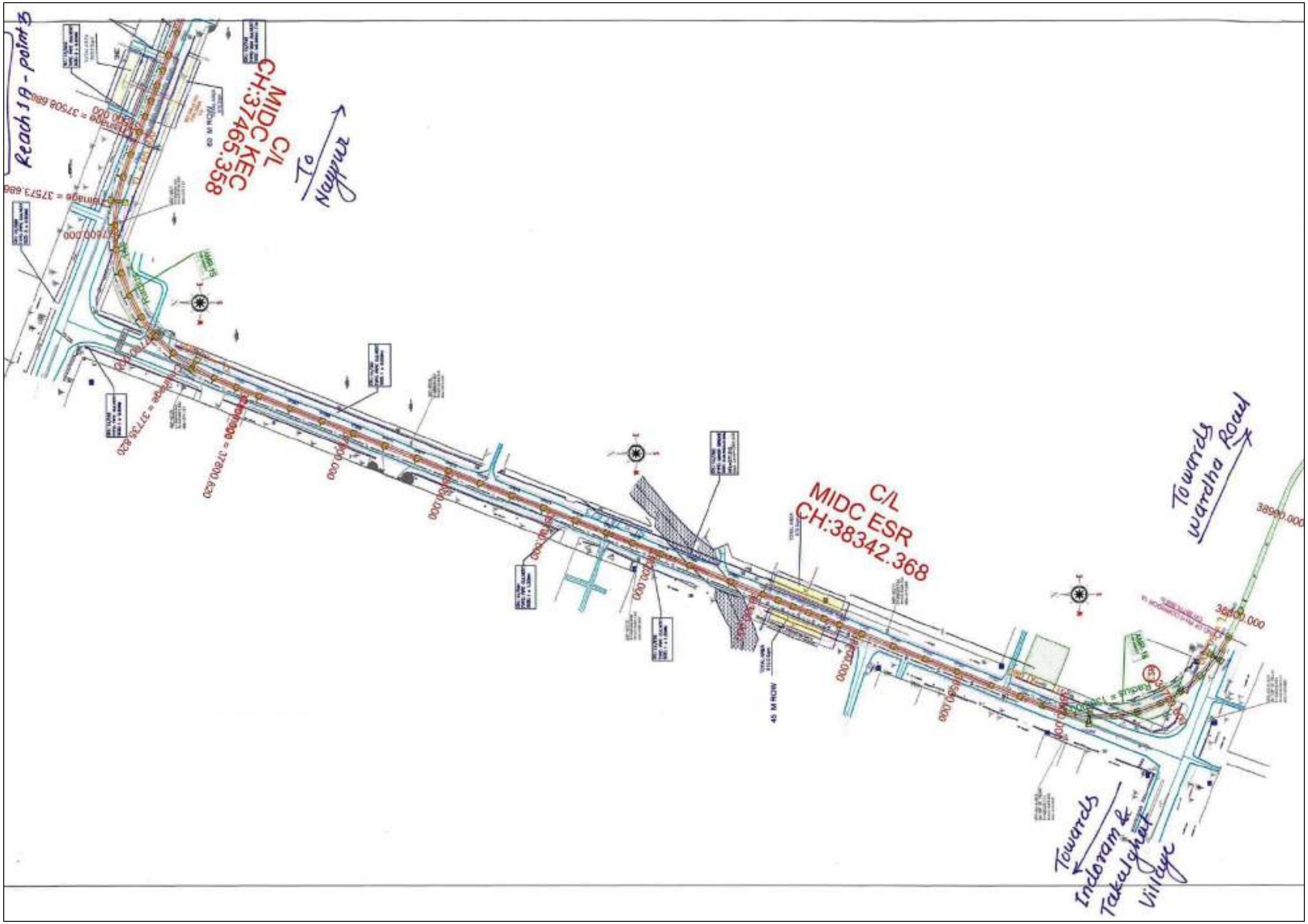

Reach 1A - point 3
C/L
MIDC KEC
CH:37465.358
To Nagpur
C/L
MIDC ESR
CH:38342.368
Towards wardha Road
Towards Indoram & Takalghat Village
45 M ROW
38900.000
38800.000

Figure D

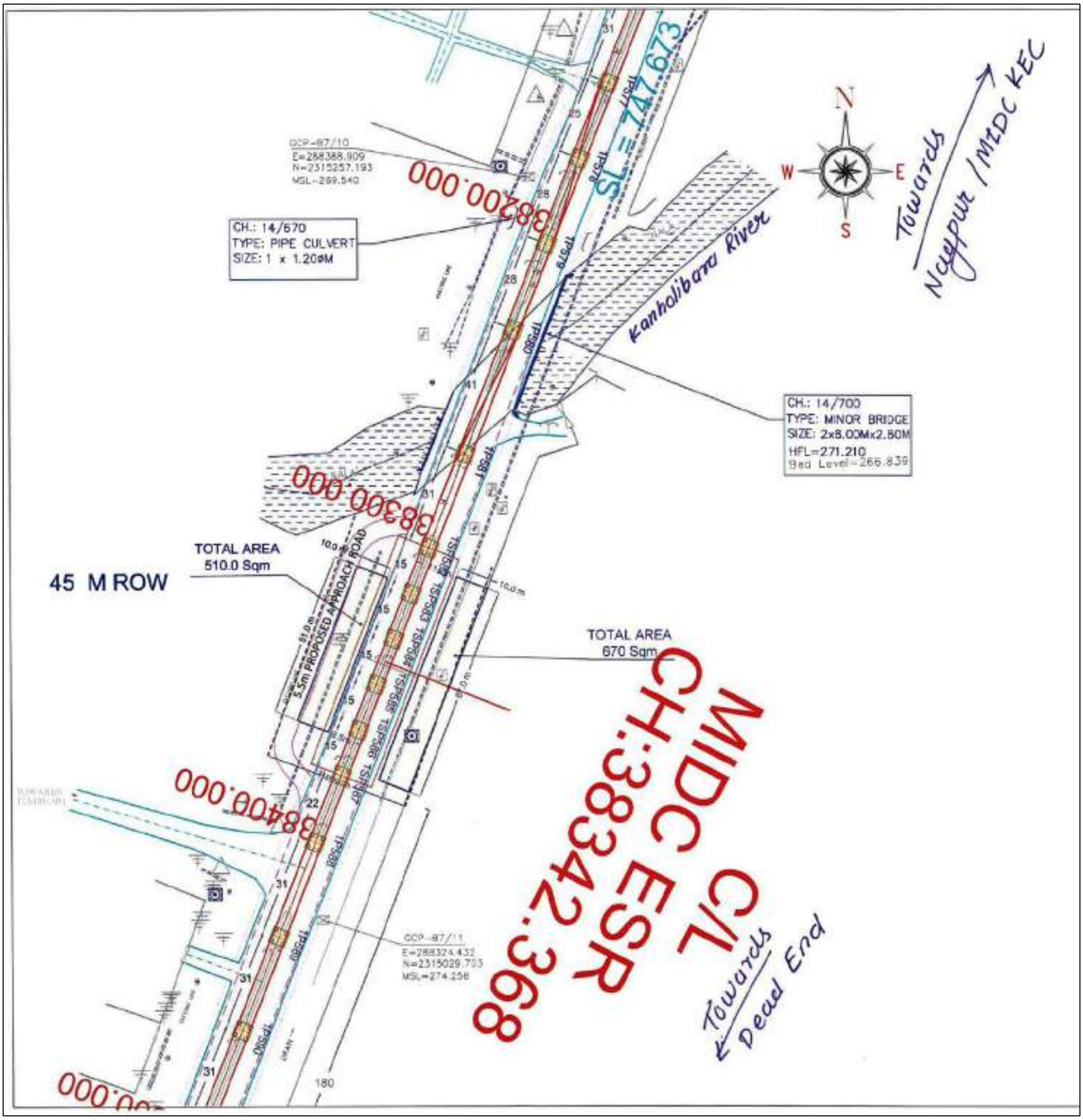

GCP-87/10
E=288388.909
N=2315257.193
MSL=269.540
882000.000
CH.: 14/670
TYPE: PIPE CULVERT
SIZE: 1 x 1.20ØM
SL = 747.673
Towards
Nagpur /MIDC KEC
Kanholibara River
CH.: 14/700
TYPE: MINOR BRIDGE
SIZE: 2x8.00Mx2.80M
HFL=271.210
Bed Level=266.839
883000.000
TOTAL AREA
510.0 Sqm
45 M ROW
5.5m PROPOSED APPROACH ROAD
TOTAL AREA
670 Sqm
MIDC ESR C/L
CH:38342.368
884000.000
GCP-87/11
E=288324.432
N=2315029.703
MSL=274.256
Towards
Dead End

Figure E

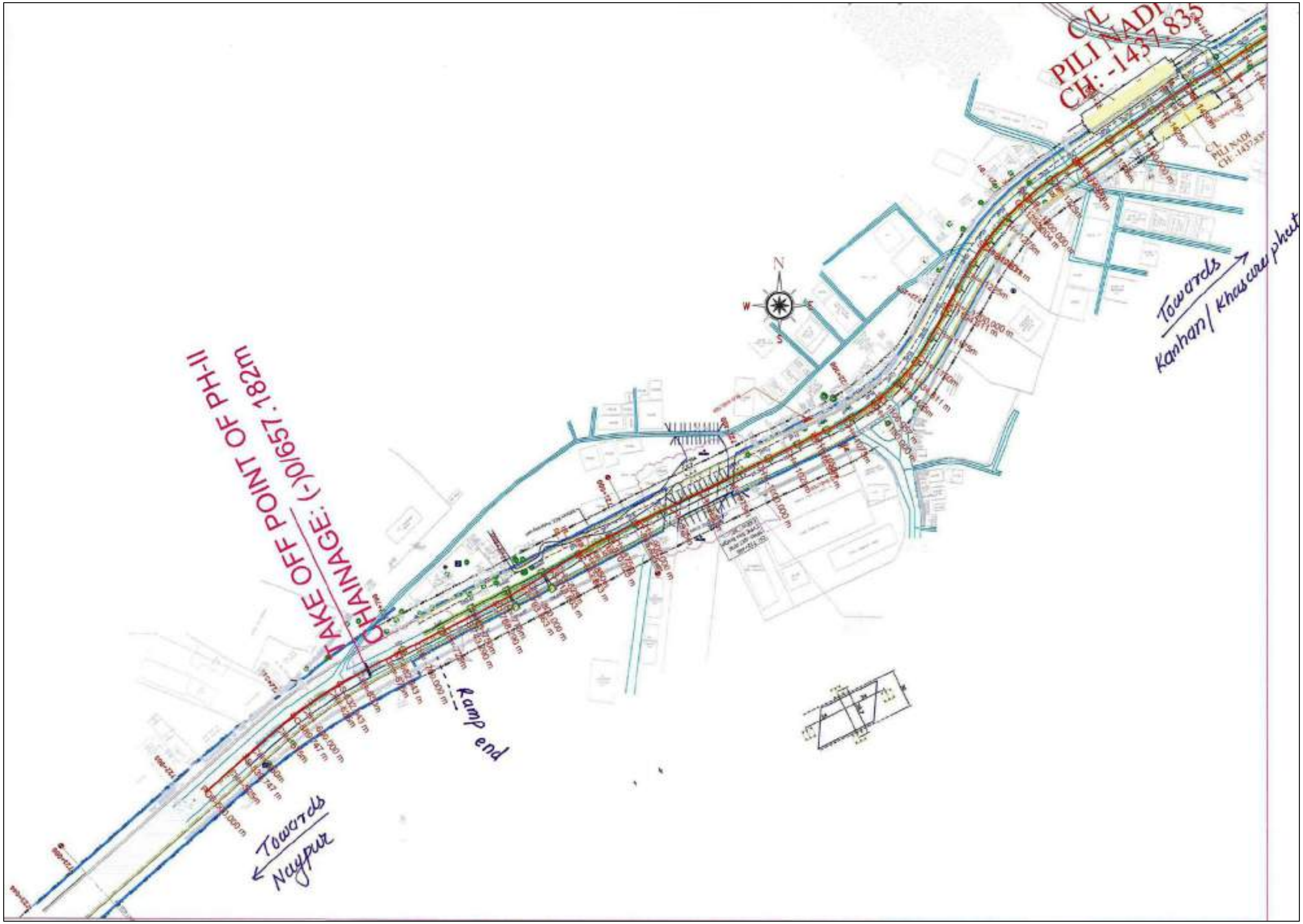

C/L
PILI NADI
CH: -1437.835
TAKE OFF POINT OF PH-II
CHAINAGE: (-)0/657.182m
Towards
Kanhan / Khasarra phata
Ramp end
Towards
Nagpur

Figure F

Towards Nagpur
Kanhan
Kumhari Nallah
Towards Nagpur
BUS SHELTER
<<< Kamthee
Ajni Neri Gadha >>>
CH.:711+985
SPAN:RHS 1x8
LHS 2X7.2+1X8
TYPE:Arch Bridge
711+900
712+000
712+100
712+200
N
E
S
W

Figure G

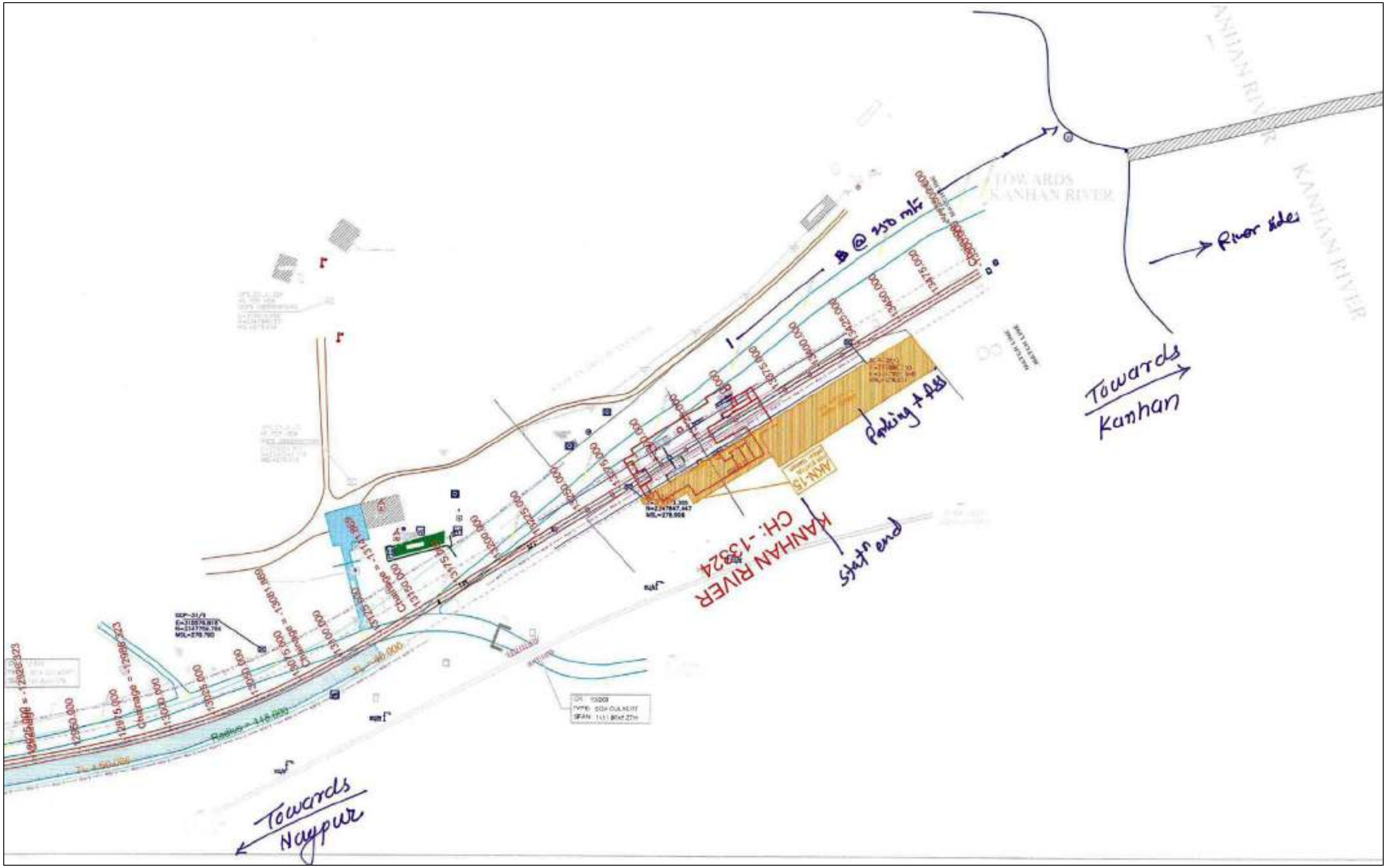
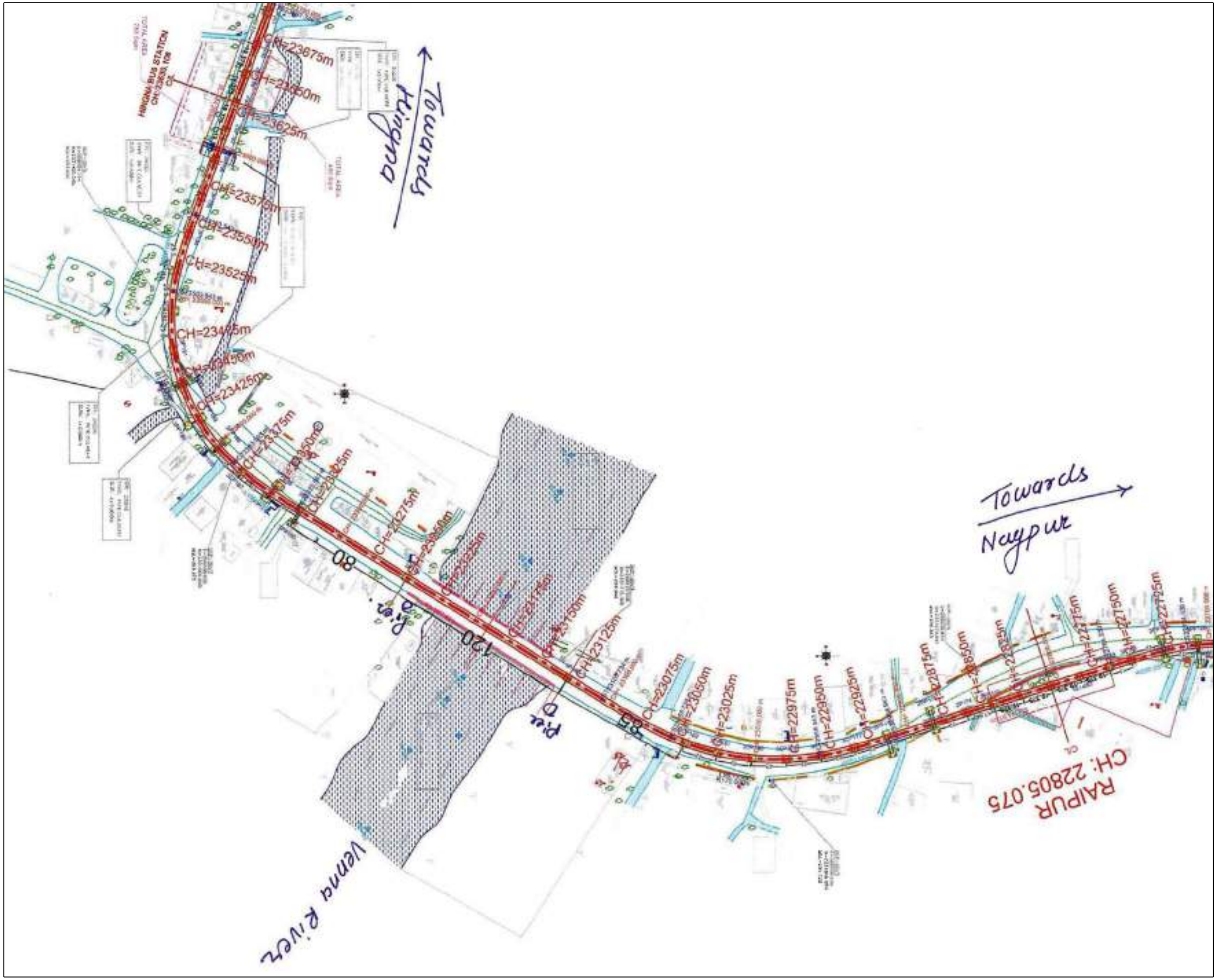

Towards Nagpur
KANHAN RIVER CH.:-13524
AKN-15
Parking + ASS
Start end
Towards Kanhan
River side
TOWARDS KANHAN RIVER
KANHAN RIVER
@ 250 mts

Figure H

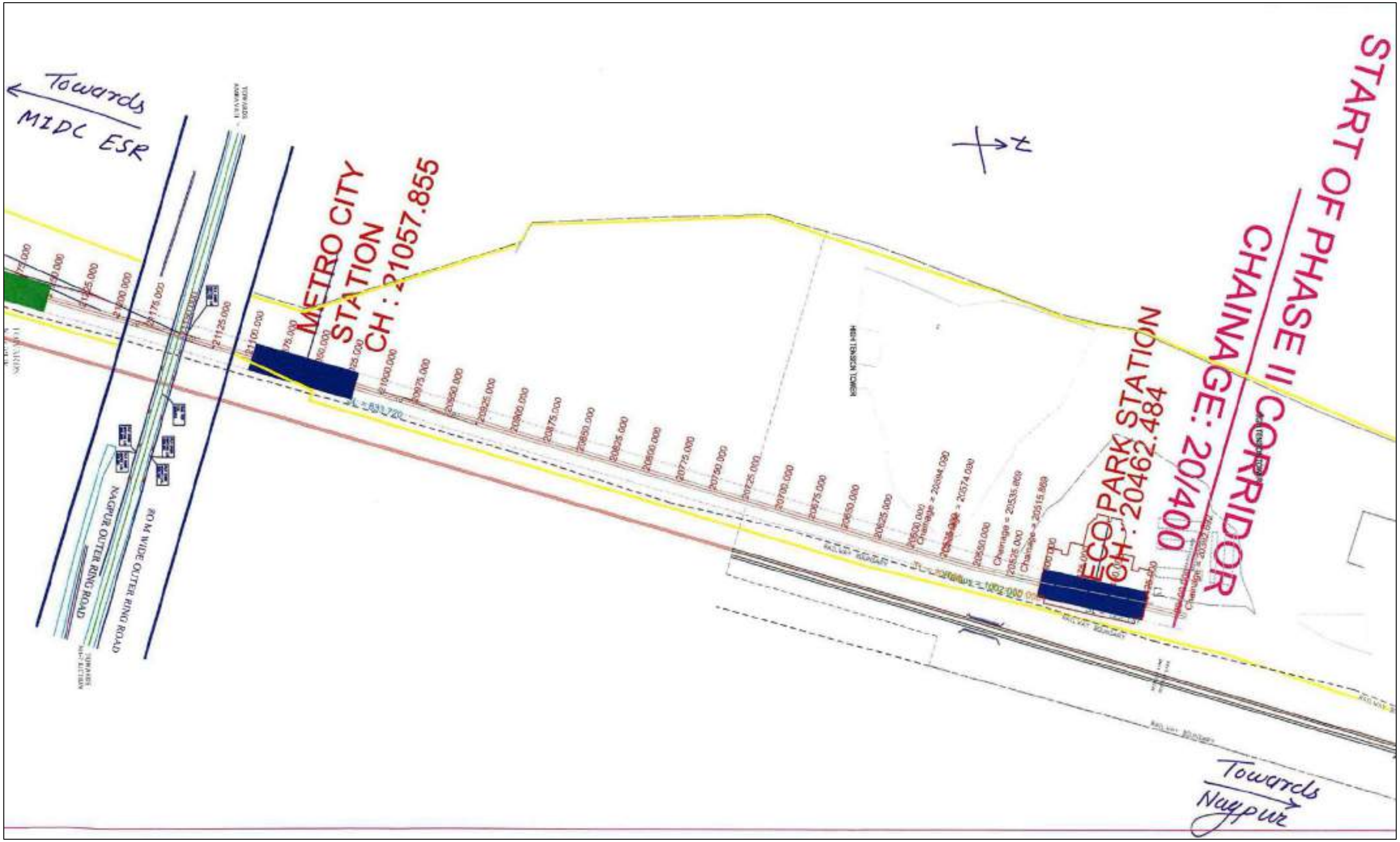
Towards Nagpur
Lekha nagar
Kanhan nalla.
Towards Kanhan
Kamthi Police Station

Figure I



Towards Hingna
Towards Nagpur
Venna River
RAIPUR CH: 22805.075
HINGNA BUS STATION
CH=23875m
CH=23850m
CH=23625m
CH=23575m
CH=23550m
CH=23525m
CH=23475m
CH=23450m
CH=23425m
CH=23375m
CH=23275m
CH=23075m
CH=23050m
CH=23025m
CH=22975m
CH=22950m
CH=22925m
CH=22750m
CH=22725m
80
120
85

Figure J



Towards MIDC ESR
METRO CITY STATION CH : 21057.855
ECO PARK STATION CH : 20462.484
START OF PHASE II CORRIDOR CHAINAGE: 20/400
80 M WIDE OUTER RING ROAD
NAGPUR OUTER RING ROAD
Towards Nagpur

Figure K

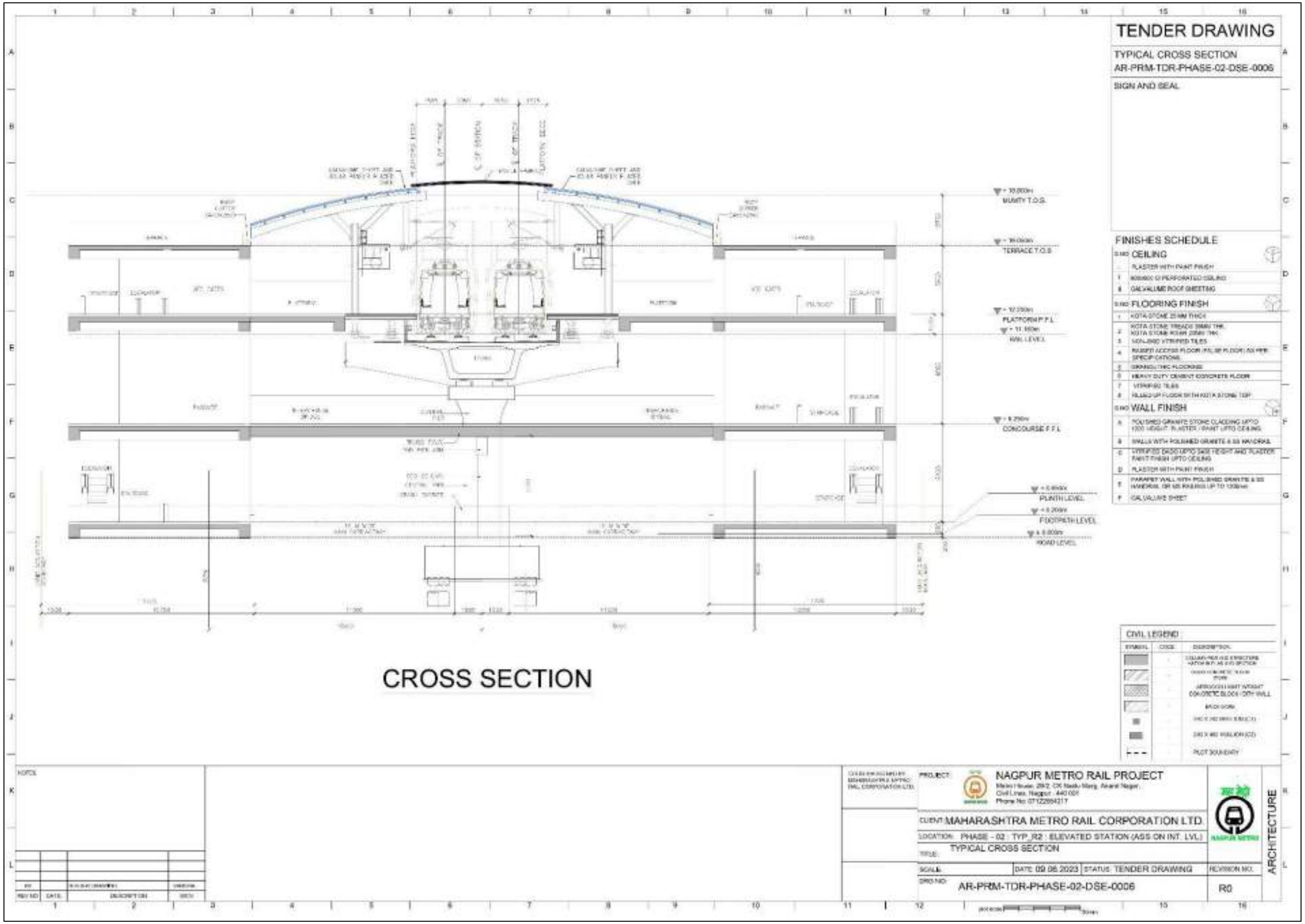
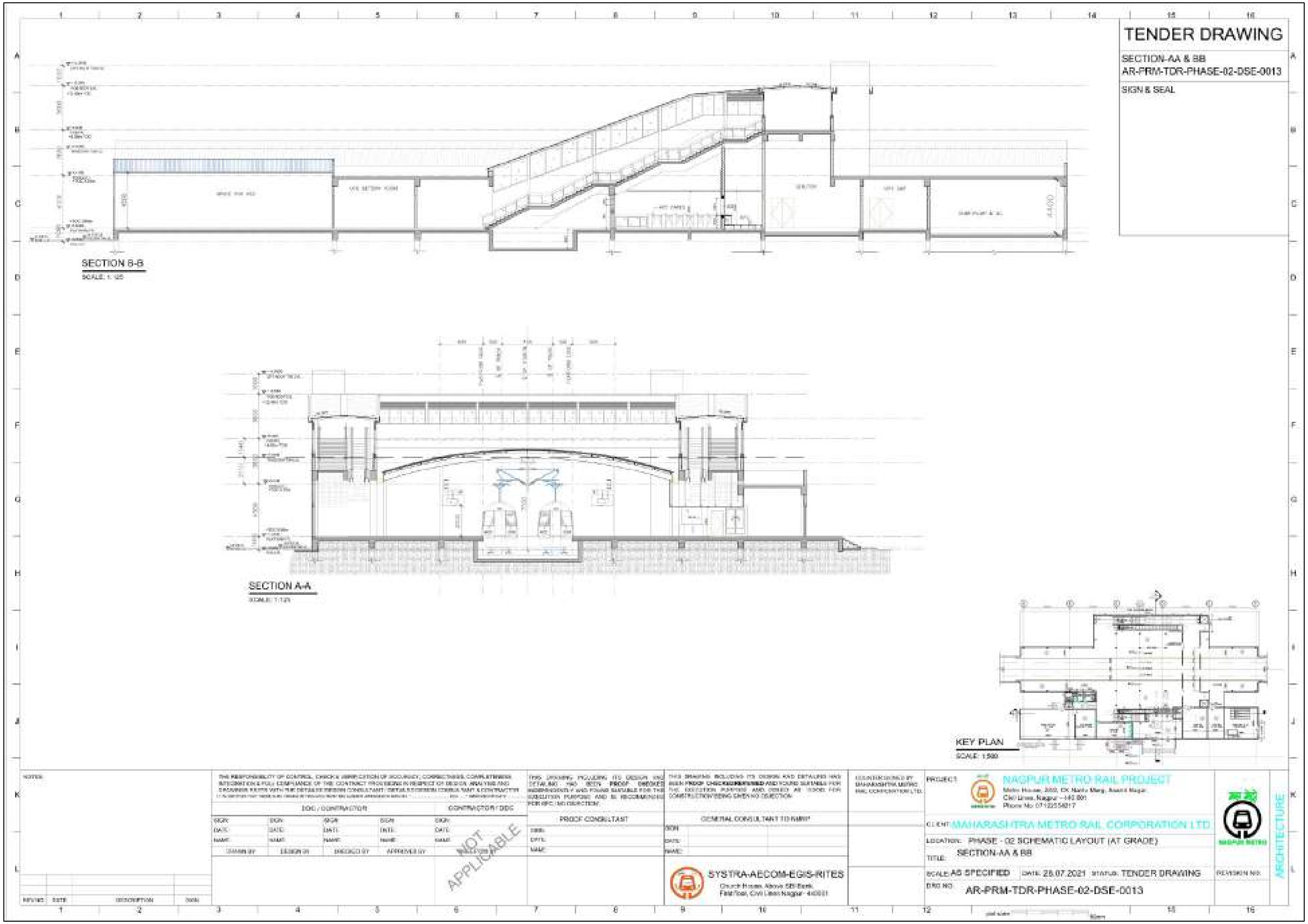
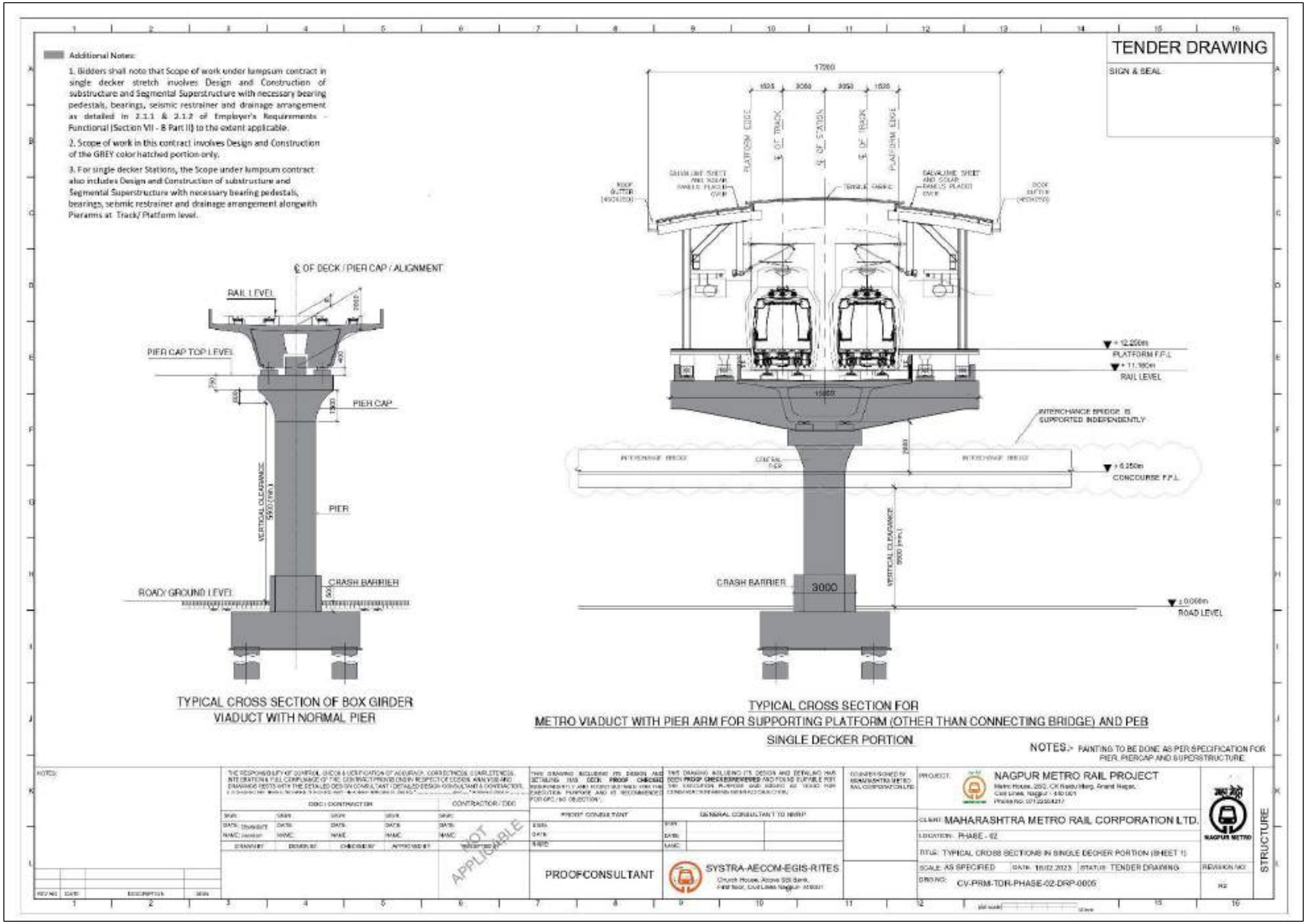

TENDER DRAWING
TYPICAL CROSS SECTION
AR-PRM-TDR-PHASE-02-DSE-0006
SIGN AND SEAL
MUMTY T.O.S.
TERRACE T.O.S
PLATFORM F.F.L
RAIL LEVEL
CONCOURSE F.F.L
PLINTH LEVEL
FOOTPATH LEVEL
ROAD LEVEL
FINISHES SCHEDULE
CEILING
FLOORING FINISH
WALL FINISH
CIVIL LEGEND
CROSS SECTION
PROJECT:
NAGPUR METRO RAIL PROJECT
CLIENT: MAHARASHTRA METRO RAIL CORPORATION LTD.
LOCATION: PHASE - 02 : TYP_R2 : ELEVATED STATION (ASS ON INT. LVL)
TITLE: TYPICAL CROSS SECTION
SCALE
DATE 09.06.2023
STATUS TENDER DRAWING
REVISION NO.
DRG NO. AR-PRM-TDR-PHASE-02-DSE-0006
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:
DDC / CONTRACTOR
CONTRACTOR / DDC
PROOF CONSULTANT
GENERAL CONSULTANT TO NMRP
NOT APPLICABLE
SYSTRA-AECOM-EGIS-RITES
PROJECT:
NAGPUR METRO RAIL PROJECT
CLIENT: MAHARASHTRA METRO RAIL CORPORATION LTD
LOCATION: PHASE - 02 SCHEMATIC LAYOUT (AT GRADE)
TITLE: SECTION-AA & BB
SCALE: AS SPECIFIED
DATE: 28.07.2021
STATUS: TENDER DRAWING
REVISION NO:
DRG NO: AR-PRM-TDR-PHASE-02-DSE-0013
ARCHITECTURE

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 Pierarms at Track/ Platform level.
℄ OF DECK / PIER CAP / ALIGNMENT
RAIL LEVEL
PIER CAP TOP LEVEL
PIER CAP
PIER
VERTICAL CLEARANCE
CRASH BARRIER
ROAD/ GROUND LEVEL
TYPICAL CROSS SECTION OF BOX GIRDER VIADUCT WITH NORMAL PIER
17000
PLATFORM EDGE
℄ OF TRACK
℄ OF STATION
PLATFORM EDGE
TENSILE FABRIC
+ 12.250m
PLATFORM F.F.L
+ 11.180m
RAIL LEVEL
INTERCHANGE BRIDGE IS SUPPORTED INDEPENDENTLY
+ 6.250m
CONCOURSE F.F.L
CRASH BARRIER
3000
± 0.000m
ROAD LEVEL
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: 16.02.2023
STATUS: TENDER DRAWING
DRG NO: CV-PRM-TDR-PHASE-02-DRP-0005
STRUCTURE
NAGPUR METRO

MITCON Consultancy & Engineering Services Ltd.
Agriculture College Campus, Next to DIC office, Shivaji Nagar, Pune. 411 005,
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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	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
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 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_3-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)

MITCON CONSULTANCY & ENGINEERING SERVICES LTD. PUNE

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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	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.

Kdeshmukh
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	**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
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 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	7.89	-	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_3-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	1.312	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_3-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_2	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	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
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 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_3-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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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	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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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	Sample Code	MITCON/2023-24/April/144/S
	Name of Sample	Surface water
	Sample Details	Kanhan River
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
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 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	7.58	-	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_3-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_2	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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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.

Kadambari
Checked By
(Mrs. Kadambari Deshmukh)

Authorised 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	Sample Code	MITCON/2023-24/April/144/6
	Name of Sample	Surface water
	Sample Details	Rapur Nala upstream
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
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 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 2-39 23rd 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_3-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_2	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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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	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)

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/144/7
	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 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	7.12	-	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_3-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.

Kdeshmukh
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	**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
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 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 2-59 ,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_3-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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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	12	mg/l	IS: 3025 Part-44-1993 (Rev.1, RA 2014)
34	Chemical Oxygen Demand	48	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
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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 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 2-39 23rd 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_3-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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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:11/05/2023**

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	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.

Kdeshmukh
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 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/144/10
	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 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	7.26	-	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_3-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)
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)

Authorised 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	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
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 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 NH_3-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_2	6.12	mg/l	N.S.	APHA 4500 SIO2, C 4-175 to 4-177 ,23rd Ed.2017.

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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)	<0.06	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	<0.06	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)

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	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
Consultancy Services for carrying out EIA and Preparation of Environmental mitigation plan(EMP) for both the corridors(north south and east west)of Nagpur metro rail project	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 2-39 23rd 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.

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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	Sample Code	MITCON/2023-24/April/144/13
	Name of Sample	Surface water
Consultancy Services for carrying out EIA and Preparation of Environmental mitigation plan(EMP) for both the corridors(north south and east west)of Nagpur metro rail project	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 2-39 23rd 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_2	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	Per 100 ml	Absent	IS: 15185:2016
02	E-coli	>1600	Per 100 ml	Absent	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Kdeshmukh
Checked By
(Mrs. Kadambari Deshmukh)

MITCON CONSULTANCY & ENGINEERING SERVICES LTD. ★ PUNE ★

Authorised 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	**Sample Code**	MITCON/2023-24/April/144/14
	Name of Sample	Surface water
	Sample Details	Raipur Nallah D/S
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
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 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	435.4	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 1R.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_3-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	5.99	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 Cr5+)	<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	Per 100 ml	Absent	IS: 15185:2016
02	E-coli	300	Per 100 ml	Absent	IS: 15185:2016

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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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	**Sample Code**	MITCON/2023-24/April/144/15
	Name of Sample	Surface water
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 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:2017)
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.
12	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_3-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_2	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 ★

Authorised 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	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
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 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	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 2-39 23rd 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_2	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)

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	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
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 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 2-39 23rd 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_3-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_2	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.

Kdeshmukh
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	**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
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 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_3-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_2	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	Per 100 ml	Absent	IS: 15185:2016
02	E-coli	90	Per 100 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, 23[rd] Ed.2017.
2	Temperature	28.3	°C	N.S.	APHA 2550 B,2-69 to 2-70 ,23[rd] Ed.2017.
3	Electrical Conductivity at 25 °C	1190	µS/cm	N.S.	APHA 2510 B,2-56 to 2-58 ,23[rd] 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, 23[rd] Ed.2017.
6	Total Solids	712.0	mg/l	N.S.	APHA 2540 C, 2-68 to 2-69, 23[rd] Ed.2017.
7	Total suspended Solids	<5	mg/l	N.S	APHA 2540 D ,2-70 to 2-71 23[rd] 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 2-3923[rd] Ed.2017..
10	Total Hardness as $CaCO_3$	300.14	mg/l	≤ 200	APHA 2340 C ,2-48 to 2-50,23[rd] Ed.2017.
11	Calcium as Ca	72.14	mg/l	≤ 75	APHA 3500 Ca B, 3.-69 to 3-70,23[rd] Ed.2017.
12	Magnesium as Mg	35.12	mg/l	≤ 30	APHA 3500 Mg B, 3.-86 ,23[rd] Ed.2017.
13	Chloride as Cl^-	38.46	mg/l	≤ 250	APHA 4500 Cl B,4-75 to 4-76,23[rd] Ed.2017.
14	Sulphates as SO_4	20.14	mg/l	≤ 200	APHA 4500 SO4-E,4-199 to 4-200 23[rd] Ed.2017.
15	Nitrate as NO3	6.23	mg/l	≤ 45	APHA 4500 NO3 - B 4-127 23[rd] 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 23[rd] 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-NH_3 C
18	salinity	0.069	ppt	N.S.	By Calculation
19	Fluoride as F	<0.1	mg/l	≤ 1.0	APHA 4500 F-D 4-90 to 4-91 ,23rd Ed.2017.
20	Total Phosphorous	<1	mg/l	N.S.	APHA 4500 P-C4-162, 23rd Ed.2017.
21	Silica as SiO_2	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:RA: 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. Kadamban 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 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/144/20
	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 2-39 23rd 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_2	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.

Kdeshmukh
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, 23[rd] Ed.2017.
2	Temperature	28.3	°C	N.S.	APHA 2550 B,2-69 to 2-70 ,23[rd] Ed.2017.
3	Electrical Conductivity at 25 °C	1320	µS/cm	N.S.	APHA 2510 B,2-56 to 2-58 ,23[rd] 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, 23[rd] Ed.2017.
6	Total Solids	835.0	mg/l	N.S.	APHA 2540 C, 2-68 to 2-69, 23[rd] Ed.2017.
7	Total suspended Solids	<5	mg/l	N.S	APHA 2540 D ,2-70 to 2-71 23[rd] 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 2-39 23[rd] Ed.2017..
10	Total Hardness as $CaCO_3$	375.83	mg/l	≤ 200	APHA 2340 C ,2-48 to 2-50,23[rd] Ed.2017.
11	Calcium as Ca	89.92	mg/l	≤ 75	APHA 3500 Ca B, 3.-69 to 3-70,23[rd] Ed.2017.
12	Magnesium as Mg	48.37	mg/l	≤ 30	APHA 3500 Mg B, 3.-86 ,23[rd] Ed.2017.
13	Chloride as Cl^-	119.52	mg/l	≤ 250	APHA 4500 Cl B,4-75 to 4-76,23[rd] Ed.2017.
14	Sulphates as SO_4	94.35	mg/l	≤ 200	APHA 4500 SO4-E 4-199 to 4-200 23[rd] Ed.2017.
15	Nitrate as NO3	8.52	mg/l	≤ 45	APHA 4500 NO3 - B 4-127 23[rd] 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 23[rd] 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_2	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.

Kdeshmukh
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:11/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010	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
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 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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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	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 ✱

Authorised 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	**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
Consultancy Services for carrying out EIA and Preparation of Environmental mitigation plan(EMP) for both the corridors(north south and east west)of Nagpur metro rail project	**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 2-3923rdEd.2017..
10	Total Hardness as $CaCO_3$	585.12	mg/l	≤ 200	APHA 2340 C ,2-48 to 2-50,23rdEd.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	Aromonical 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	0.385	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-C4-162, 23rd Ed.2017.
21	Silica as SiO_2	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.

Kadambari
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:11/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur-440010	Sample Code	MITCON/2023-24/April/144/24
	Name of Sample	Ground Water
	Sample Details	Lekha nagar borewell
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	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_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	0.17	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 3-21 23rd 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 ★

Authorised 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	Sample Code	MITCON/2023-24/April/144/25
	Name of Sample	Ground Water
	Sample Details	Ganjke balaji temple near kamptee police station
Consultancy Services for carrying out EIA and Preparation of Environmental mitigation plan(EMP) for both the corridors(north south and east west)of Nagpur metro rail project	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.

KDeshmukh
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	Sample Code	MITCON/2023-24/April/144/26
	Name of Sample	Ground Water
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 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 2-39 23rd 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_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	0.303	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	10.12	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	**Sample Code**	MITCON/2023-24/April/144/27
	Name of Sample	Ground Water
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 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_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	0.094	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	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.

KDeshmukh
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	**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
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 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 2-39 23rd 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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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-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)

MITCON CONSULTANCY & ENGINEERING SERVICES LTD. • PUNE •

Authorised 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 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/144/25
	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_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	0.262	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.

Kdeshmukh
Checked By
(Mrs. Kadambari Deshmukh)

MITCON CONSULTANCY & ENGINEERING SERVICES LTD. * PUNE *

Authorised 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	Sample Code	MITCON/2023-24/April/144/30
	Name of Sample	Ground Water
	Sample Details	Pardi Borewell
	Container Details	2 ltr Plastic Can + 100 ml Sterile bottle
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 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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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-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.

Kdeshmukh
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 Dikshabhoomi,Ramdaspeth,Nagpur-440010	**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
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 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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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:11/05/2023**

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 *

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/144/31**
	Name of Sample	Ground Water
	Sample Details	Hingna Mount view 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	7.18	-	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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Report Number : MITCON/2023-24/April/144 **Report Date:11/05/2023**

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	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.

Kdeshmukh
Checked By
(Mrs. Kadambari Deshmukh)

MITCON CONSULTANCY & ENGINEERING SERVICES LTD.

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	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
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 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_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	0.112	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	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)

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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	**Sample Code**	MITCON/2023-24/April/144/33
	Name of Sample	Ground Water
	Sample Details	Wakegni Handpump
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
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 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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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-C4-162, 23rd Ed.2017.
21	Silica as SiO_2	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.

Kdeshmukh
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(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	**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
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 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	111.9	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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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	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 3-21 23rd 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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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,Ramdespeth,Nagpur-440010	Sample Code	MITCON/2023-24/April/144/25
	Name of Sample	Ground Water
	Sample Details	Hingna Hand pump
	Container Details	2 lit Plastic Can + 100 ml Sterile bottle
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 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_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	0.151	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)

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	**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
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 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 1R.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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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	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 3-21 23rd 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	Per 100 ml	Absent	IS: 15185:2016
02	E-coli	Absent	Per 100 ml	Absent	IS: 15185:2016

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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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	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
Consultancy Services for carrying out EIA and Preperation of Environmental mitigation plan(EMP) for both the corridors(north south and east west)of Nagpur metro rail project	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 2-3923rdEd.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.-66 ,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 ★

Authorised 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 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/144/38
	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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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-C4-162, 23rd Ed.2017.
21	Silica as SiO_2	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	Per 100 ml	Absent	IS: 15185:2016
02	(E-coli	Absent	Per 100 ml	Absent	IS: 15185:2016

For MITCON Consultancy & Engineering Services Ltd.

Kdeshmukh
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 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/144/39
	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 2-39 23rd 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.

Kudeshmukh
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	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
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 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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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	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	<0.06	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 3-21 23rd 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	Per 100 ml	Absent	IS: 15185:2016
02	E-coli	Absent	Per 100 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	**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
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 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_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	0.055	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-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.

Kadeshmukh
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	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
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 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	0.067	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.

Kadeshmukh
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 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/144/43
	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	20	%	IS 2720 (Part 4)
	Silt	30	%	
	Clay	50	%	
03	Soil Moisture	2.32	%	IS 2720Part II1973
04	Bulk Density	1.12	gm/cm³	IS 2720 (part XXIX)
05	Water Holding Capacity	53.2	%	IS 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	24.2	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.

KDeshmukh
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	Sample Code	MITCON/2023-24/April/144/44
	Name of Sample	Soil
	Sample Details	Hingna
	Container Details	1 kg plastic bag
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 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	23	%	IS 2720 (Part 4)
	Silt	55	%	
	Clay	22	%	
03	Soil Moisture	3.13	%	IS 2720 Part II 1973
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)	132.7	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.

Kadambari
Checked By
(Mrs. Kadambari Deshmukh)

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Authorised 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	**Sample Code**	**MITCON/2023-24/April/144/45**
Metro Bhavan,East high court road(VIP Road)	**Name of Sample**	Soil
Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010	**Sample Details**	Waradongri
	Container Details	1 kg plastic bag
Consultancy Services for carrying out EIA and	**Sample Collected By**	MITCON
Preparation of Environmental mitigation	**Sample Collected On**	24/04/2023
plan(EMP) for both the corridors(noth south and	**Date of Sample Receipt**	25/04/2023
east west)of Nagpur metro rail project	**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	30	%	IS 2720 (Part 4)
	Silt	20	%	
	Clay	50	%	
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.

Kdeshmukh
Checked By
(Mrs. Kadambari Deshmukh)

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Test Report

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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	Sample Code	MITCON/2023-24/April/144/46
	Name of Sample	Soil
	Sample Details	Raipur
	Container Details	1 kg plastic bag
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 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	06/05/2023

ANALYSIS RESULTS

Sr. No.	Parameters	Results	Unit	Test Method
01	Texture	clay	-	IS 2720 (Part 4)
02	Percentage Of Different Components			
	sand	25	%	IS 2720 (Part 4)
	Silt	25	%	
	Clay	50	%	
03	Soil Moisture	3.02	%	IS 2720 Part II1973
04	Bulk Density	1.08	gm/cm²	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	0.48	%	IS 2720 (Part 22)
09	Calcium (as Ca)	83.3	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)	0.62	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.

Kdeshmukh
Checked By
(Mrs. Kadambari Deshmukh)

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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:11/05/2023**

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/144/47
	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/cm³	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)	14.2	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)	<0.06	mg/kg	USEPA 3050 B
20	Nickel (as Ni)	<0.02	mg/kg	USEPA 3050 B
21	Cadmium (as Cd)	<0.06	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)

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/144/48
	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	35	%	IS 2720 (Part 4)
	Silt	35	%	
	Clay	30	%	
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.

Kdeshmukh
Checked By
(Mrs. Kadambari Deshmukh)

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 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/144/49
	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	20	%	IS 2720 (Part 4)
	Silt	35	%	
	Clay	45	%	
03	Soil Moisture	1.01	%	IS 2720 Part II 1973
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.

Kdeshmukh
Checked By
(Mrs. Kadambari Deshmukh)

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/144/50**
	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/cm^3	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

Kdeshmukh
Checked By
(Mrs. Kadambari Deshmukh)

MITCON CONSULTANCY & ENGINEERING SERVICES LTD. PUNE

Authorized Signatory
Dr. Sandeep Jadhav
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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	Sample Code	MITCON/2023-24/April/144/S1
	Name of Sample	Soil
	Sample Details	Kinhi MIDC(KEC)
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	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	30	%	
	Clay	50	%	
03	Soil Moisture	0.83	%	IS 2720 Part (I)1973
04	Bulk Density	1.09	gm/cm^3	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.

Kdeshmukh
Checked By
(Mrs. Kadambari Deshmukh)

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Authorised 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 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/144/52
	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	20	%	IS 2720 (Part 4)
	Silt	30	%	
	Clay	50	%	
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,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. SHIVAJI NAGAR PUNE

Authorised Signatory
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Test Report

Report Number : MITCON/2023-24/April/144 **Report Date:11/05/2023**

Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010	Sample Code	MITCON/2023-24/April/144/52
	Name of Sample	Soil
	Sample Details	Kapsi Khurd
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	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	40	%	IS 2720 (Part 4)
	Silt	20	%	
	Clay	40	%	
03	Soil Moisture	0.72	%	IS 2720 Part II 1973
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
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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 Dikshabhoomi,Ramdaspeth,Nagpur- 440010	**Sample Code**	MITCON/2023-24/April/144/53
	Name of Sample	Soil
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 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	45	%	IS 2720 (Part 4)
	Silt	20	%	
	Clay	35	%	
03	Soil Moisture	0.52	%	IS 2720 Part II 1973
04	Bulk Density	1.11	gm/cm²	IS 2720 (part XXIX)
05	Water holding Capacity	47.2	%	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	115.26	kg/ha	IS 14684
12	Phosphorous (as P)	10.21	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	0.09	-	EME/LAB/SOP/SAR

For MITCON Consultancy & Engineering Services Ltd.

KDeshmukh
Checked By
(Mrs. Kadambari Deshmukh)

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/144/54**
	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	30	%	IS 2720 (Part 4)
	Silt	20	%	
	Clay	50	%	
03	Soil Moisture	1.23	%	IS 2720 Part II 1973
04	Bulk Density	1.08	gm/cm^3	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	121.4	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.

Kdeshmukh
Checked By
(Mrs. Kadambari Deshmukh)

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 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/144/55
	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/cm³	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 2012 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.

Kdeshmukh
Checked By
(Mrs. Kadambari Deshmukh)

MITCON CONSULTANCY & ENGINEERING SERVICES LTD. * PUNE *

Authorized Signatory
Dr. Sandeep Jadhav
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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 Preparation of Environmental mitigation plan(EMP) for both the corridors(north south and east west)of Nagpur metro rail project	Sample Code	MITCON/2023-24/April/144/56
	Name of Sample	Soil
	Sample Details	Lakha 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	23	%	IS 2720 (Part 4)
	Silt	30	%	
	Clay	47	%	
03	Soil Moisture	1.07	%	IS 2720 Part II1973
04	Bulk Density	1.17	gm/cm^3	IS 2720 (part XXIX)
05	Water Holding Capacity	56.2	%	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.

Kadambari
Checked By
(Mrs. Kadambari Deshmukh)

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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	Sample Code	MITCON/2023-24/April/144/57
	Name of Sample	Soil
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 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	27	%	IS 2720 (Part 4)
	Silt	30	%	
	Clay	43	%	
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	52.4	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.

Kadambari
Checked By
(Mrs. Kadambari Deshmukh)

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Dr. Sandeep Jadhav
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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	**Sample Code**	MITCON/2023-24/April/144/S8
	Name of Sample	Soil
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 Details**	Ashokvan
	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/cm²	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 soils 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.

Kdeshmukh
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	**Sample Code**	MITCON/2023-24/April/144/59
	Name of Sample	Soil
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 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	45	%	IS 2720 (Part 4)
	Silt	10	%	
	Clay	45	%	
03	Soil Moisture	0.90	%	IS 2720 Part II 1973
04	Bulk Density	1.13	gm/cm²	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	801.6	µs/cm	IS 14767,2000,Reaff 2016
08	Organic Carbon	0.49	%	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.

Kdeshmukh
Checked By
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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	Sample Code	MITCON/2023-24/April/144/60
	Name of Sample	Soil
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 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	35	%	IS 2720 (Part 4)
	Silt	30	%	
	Clay	35	%	
03	Soil Moisture	0.52	%	IS 2720 Part II:1973
04	Bulk Density	1.09	gm/cm²	IS 2720 (part XXIX)
05	Water Holding Capacity	58.8	%	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 N	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)	<0.06	mg/kg	USEPA 3050 B
19	Total Chromium (as Cr)	<0.06	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	0.97	-	EME/LAB/SOP/SAR

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

MITCON CONSULTANCY & ENGINEERING SERVICES 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 Preparation of Environmental mitigation plan(EMP) for both the corridors(north 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	30	%	IS 2720 (Part 4)
	Silt	30	%	
	Clay	40	%	
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	20.4	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.

Kadambari
Checked By
(Mrs. Kadambari Deshmukh)

MITCON CONSULTANCY & ENGINEERING SERVICES * 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	Sample Code	MITCON/2023-24/April/144/02
	Name of Sample	Soil
	Sample Details	Pardi
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	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	40	%	IS 2720 (Part 4)
	Silt	20	%	
	Clay	40	%	
03	Soil Moisture	1.11	%	IS 2720 Part II:1973
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)	83.15	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 irrigation 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)

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: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 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/144/63
	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.

KDeshmukh
Checked By
(Mrs. Kadambari Deshmukh)

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Authorized Signatory
Dr. Sandeep Jadhav
Quality Manager/HOD

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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	Sample Code	MITCON/2023-24/April/144/64
	Name of Sample	Ambient Air
Consultancy Services for carrying out EIA and Preparation of Environmental mitigation plan(EMP) for both the corridors(north south and east west)of Nagpur metro rail project	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
(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 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/144/65
	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

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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	**Sample Code**	MITCON/2023-24/April/144/66
	Name of Sample	Ambient Air
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	**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.

Kdeshmukh
Checked By
(Mrs. Kadambari Deshmukh)

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Quality Manager/HOD

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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	Sample Code	MITCON/2023-24/April/144/67
	Name of Sample	Ambient Air
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	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.

Kdeshmukh
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	**Sample Code**	**MITCON/2023-24/April/144/08**
	Name of Sample	Ambient Air
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	**Location Name**	AAQ 5
	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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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 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/144/69
	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 Preparation of Environmental mitigation plan(EMP) for both the corridors(north 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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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	**Sample Code**	MITCON/2023-24/April/144/71
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	**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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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 Preparation of Environmental mitigation plan(EMP) for both the corridors(north 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	06/05/2023

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
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/144/73
	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
Limits as per NAAQ	≤60	≤100.0	≤80.0	≤80.0	≤4.0

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

CONSULTANCY & ENGINEERING SERVICES LTD. * PUNE *

Authorized Signatory
Dr. Sandeep Jadhav
Quality Manager/HOD

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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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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
Limits as per NAAQ	≤60	≤100.0	≤80.0	≤80.0	≤4.0

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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 Date	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
Limits as per NAAQ	≤60	≤100.0	≤80.0	≤80.0	≤4.0

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Kdeshmukh
Checked By
(Mrs. Kadambari Deshmukh)

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Authorised Signatory
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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	Sample Code	MITCON/2023-24/April/144/78
	Name of Sample	Ambient Air
	Location Name	AAQ 16
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	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
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 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/144/79
	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	21/04/2023
	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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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 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/144/80
	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

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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 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/144/81
	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

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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 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/144/82**
	Name of Sample	Ambient Air
	Location Name	AAQ 20
	Sampling Method	IS5182
	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
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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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	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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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
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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	Sample Code	MITCON/2023-24/April/144/85
	Name of Sample	Ambient Air
	Location Name	AAQ 23
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	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	06/05/2023

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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Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010	Sample Code	MITCON/2023-24/April/144/86
	Name of Sample	Ambient Air
	Location Name	AAQ 24
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	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

For MITCON Consultancy & Engineering Services Ltd.

Kdeshmukh
Checked By
(Mrs. Kadambari Deshmukh)

CONSULTANCY & ENGINEERING SERVICES LTD. PUNE

Authorized Signatory
Dr. Sandeep Jadhav
Quality Manager/HOD

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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	Sample Code	MITCON/2023-24/April/144/87
	Name of Sample	Ambient Air
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	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

For MITCON Consultancy & Engineering Services Ltd.

Checked By
(Mrs. Kadambari Deshmukh)

MITCON CONSULTANCY & ENGINEERING SERVICES LTD. PUNE 411005

Authorized Signatory
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Quality Manager/HOD

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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	**Sample Code**	MITCON/2023-24/April/144/88
	Name of Sample	Ambient Air
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	**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	
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 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/144/89
	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	Sample Code	MITCON/2023-24/April/144/90
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	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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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	**Sample Code**	MITCON/2023-24/April/144/92
	Name of Sample	Ambient Air
	Location Name	AAQ 30
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	**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	05/06/2023

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
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 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/144/99
	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

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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/144/94
	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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Client's Name & Address	Sample Details	
Maharashtra Metro Rail Corporation Limited Metro Bhavan,East high court road(VIP Road) Near Dikshabhoomi,Ramdaspeth,Nagpur- 440010	**Sample Code**	**MITCON/2023-24/April/144/98**
	Name of Sample	Ambient Air
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	**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
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 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/144/97
	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	≤50dB(A)	≤40 dB(A)
4	Industrial	≤75 dB(A)	≤70 dB(A)

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(Report)

Oct. -2023

Vibration Modelling for Extension of Nagpur Metro Rail Project Phase-II, Corridors

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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

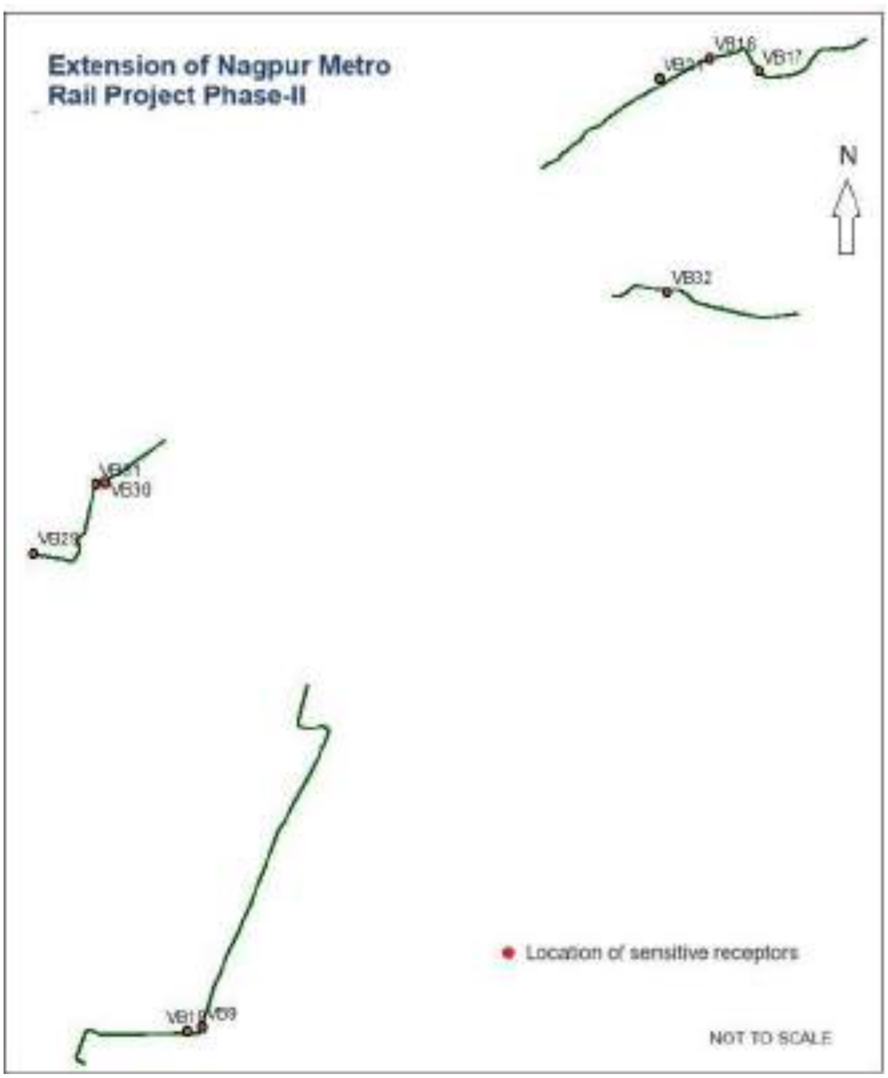

Figure 2. 1: Showing the location of Vibration monitoring on proposed phase-II extension of NMRP.

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.

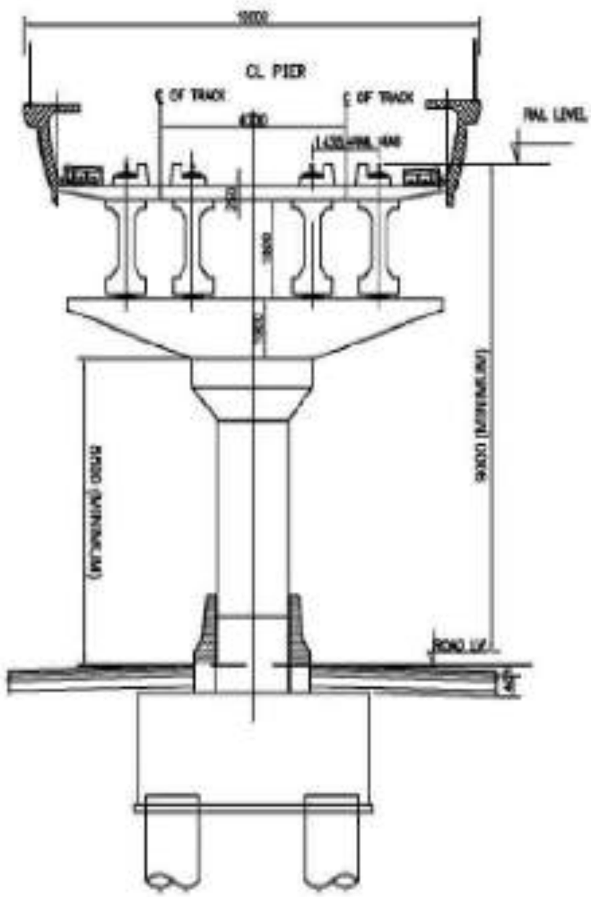

Figure 2.2: showing the cross-section of Box Girder Viaduct Section

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:

$$A(f) = F\left[S(f), P(f), R(f)\right]$$

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

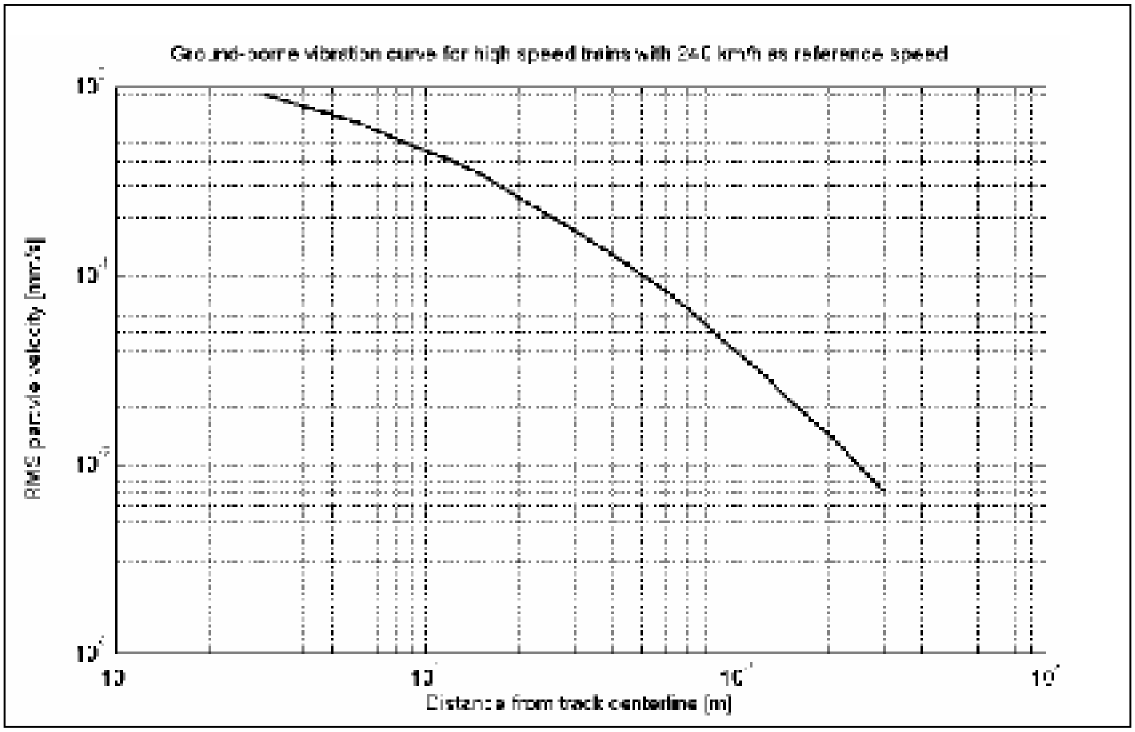

Figure 3.1: Generalized ground-borne vibration curve (DOT-293630-1, 1989).

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.

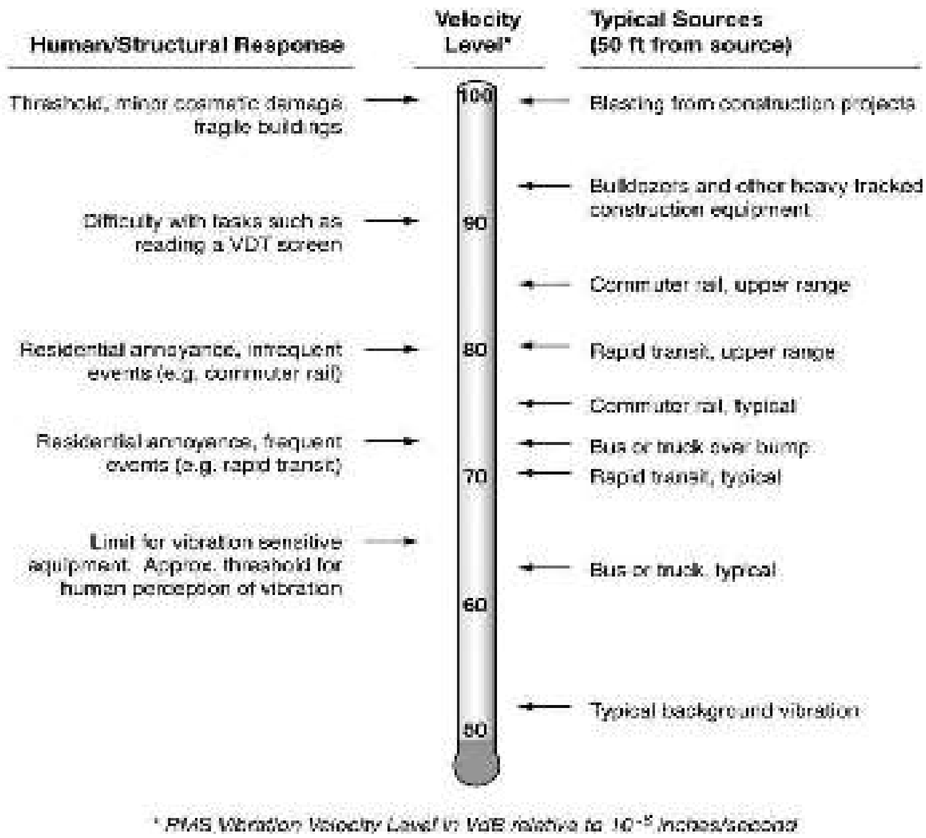

Figure 3.2 Typical levels of Ground-Borne Vibration

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.

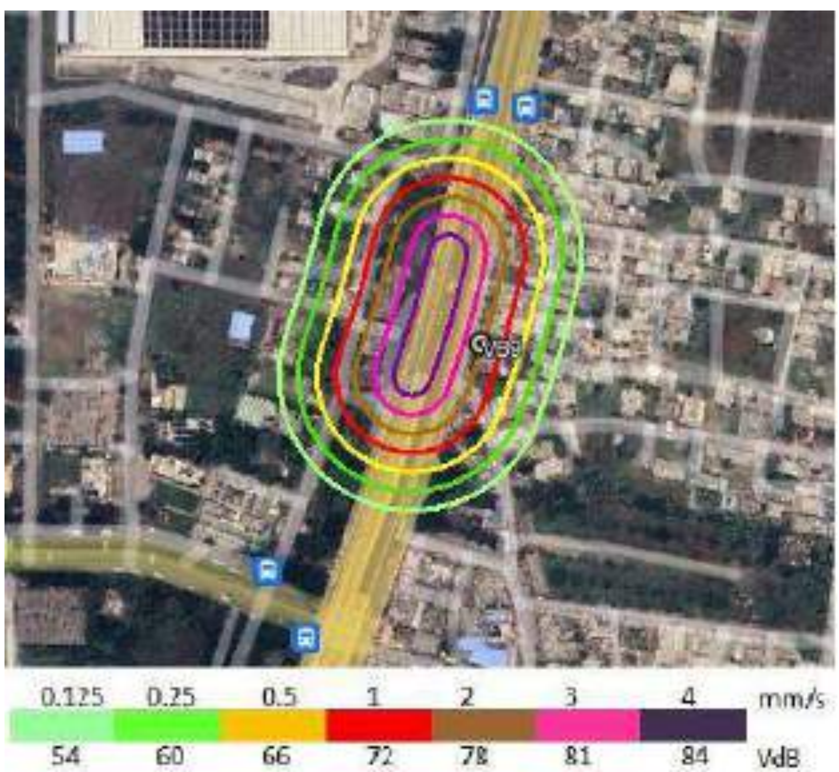

Figure 4.1: showing the predicted vibration contours due to train operation at Jijamatha High school location.

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.

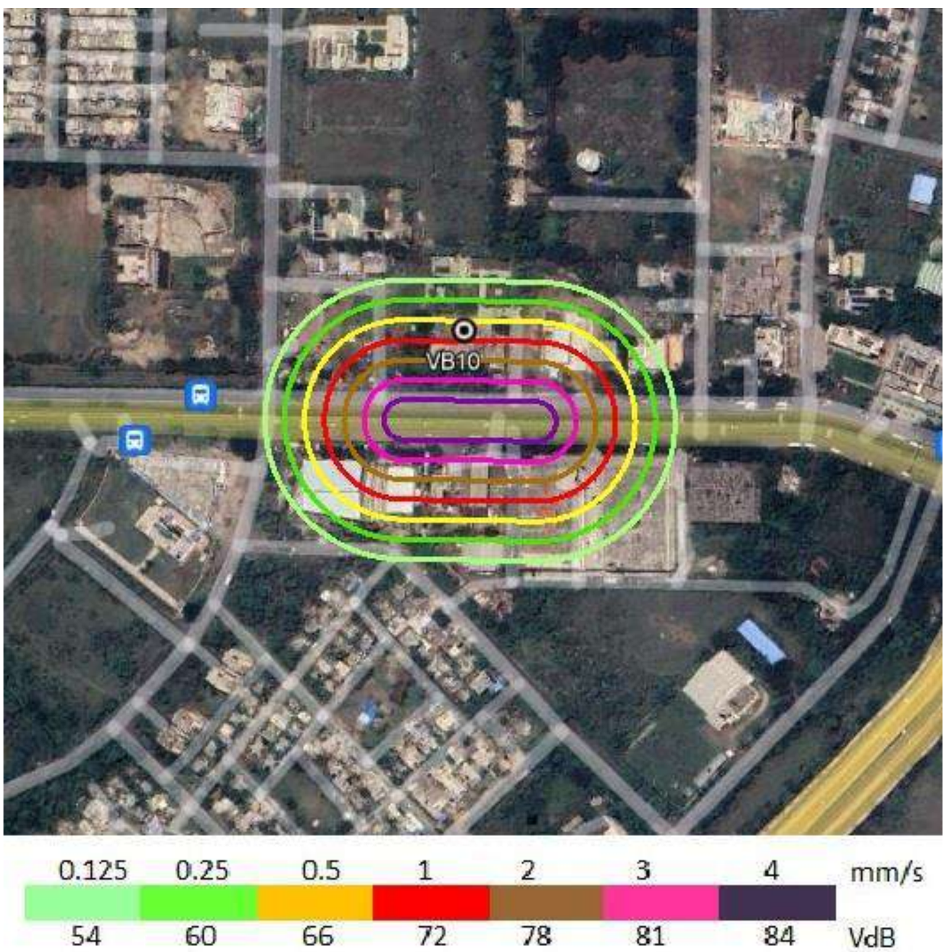

Figure 4.2: showing the predicted vibration contours due to train operation at Rachana Hospital location

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.

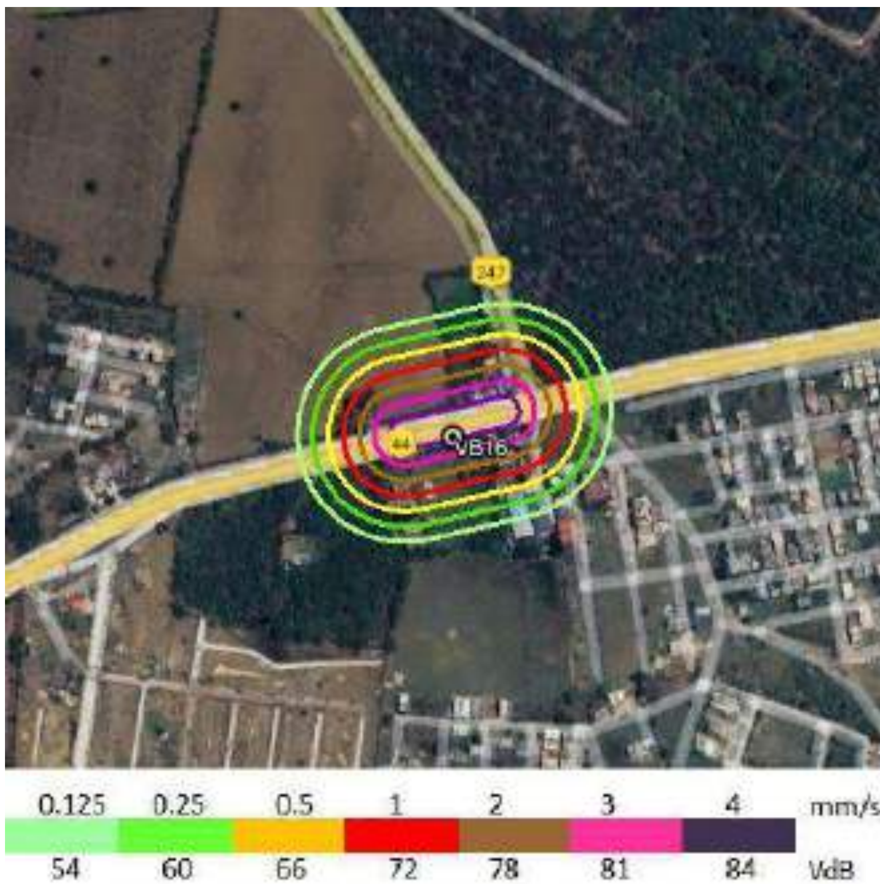

Figure 4.3: showing the predicted vibration contours due to train operation at Asha Hospital and Asharam College & School of Nursing

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.

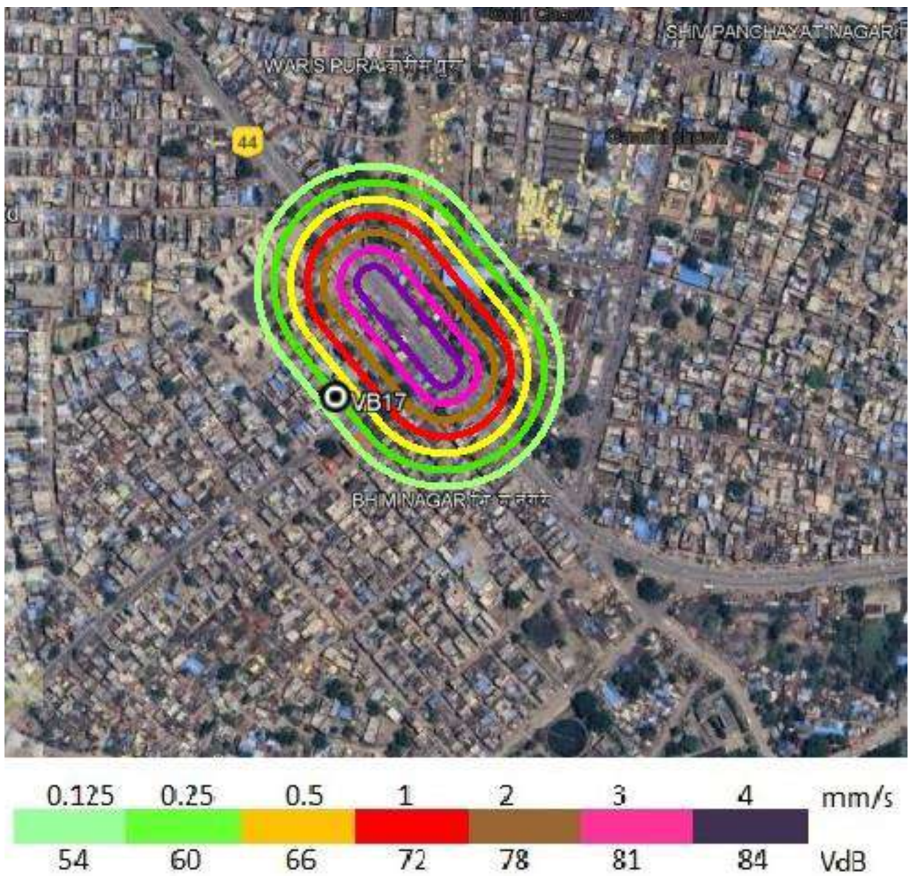

Figure 4.4: showing the predicted vibration contours due to train operation at Shree Girijadhar Balaji Hanuman Temple

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.

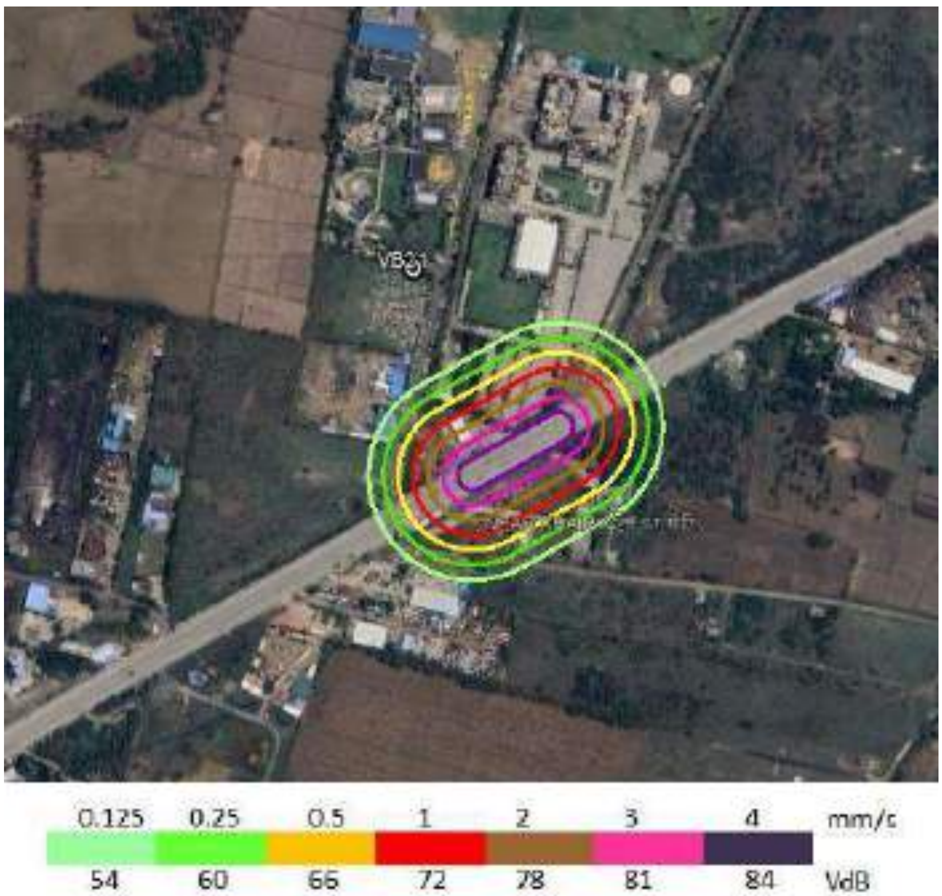

Figure 4.5: showing the predicted vibration contours due to train operation at DPS Khairy

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.

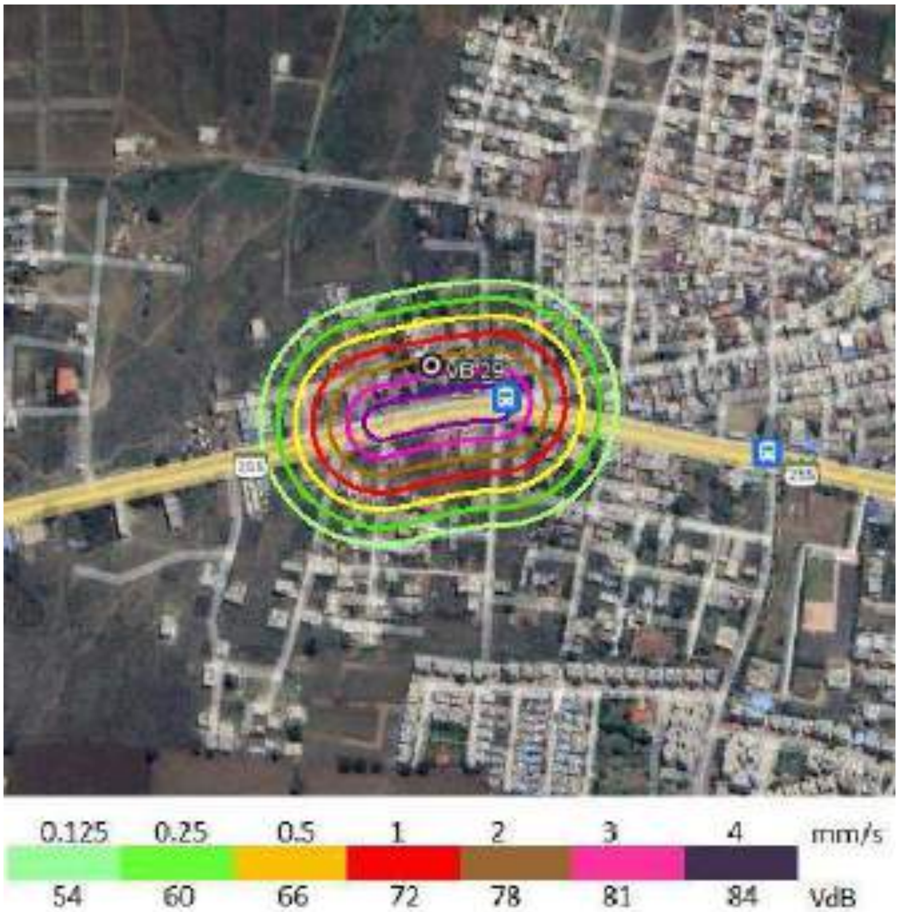

Figure 4.6: showing the predicted vibration contours due to train operation at Rural Hospital Hingna

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.

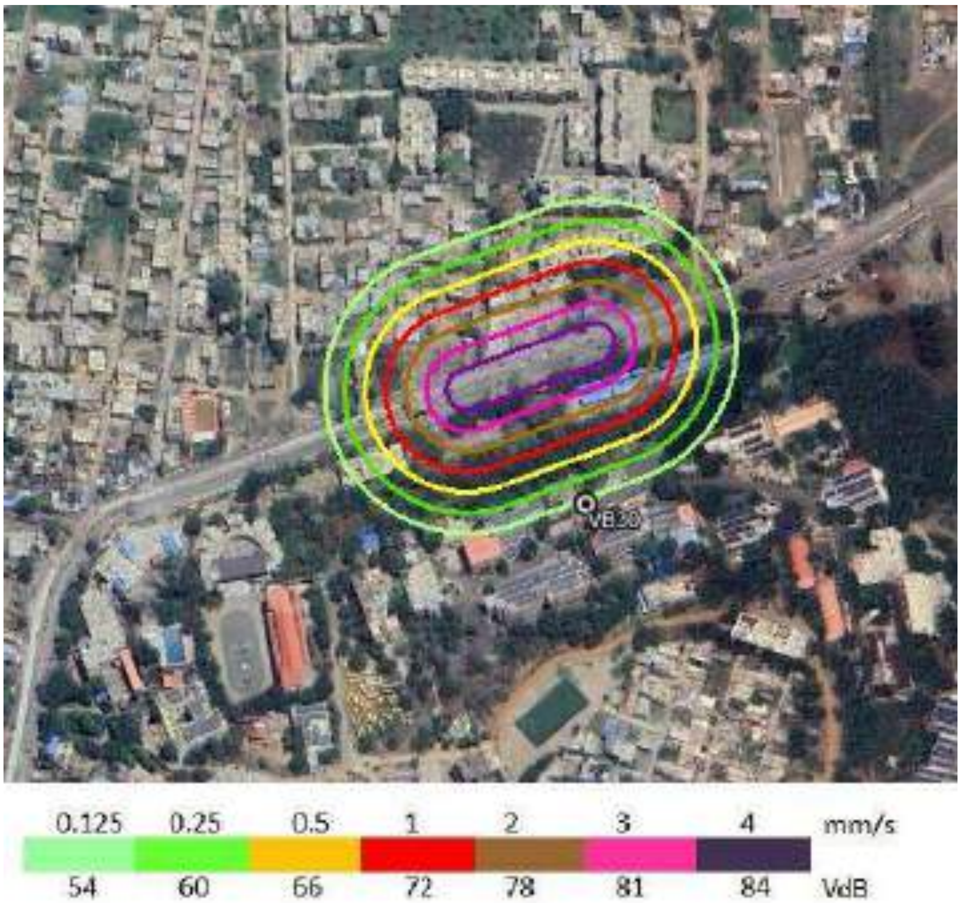

Figure 4.7: showing the predicted vibration contours due to train operation at YCCE

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.

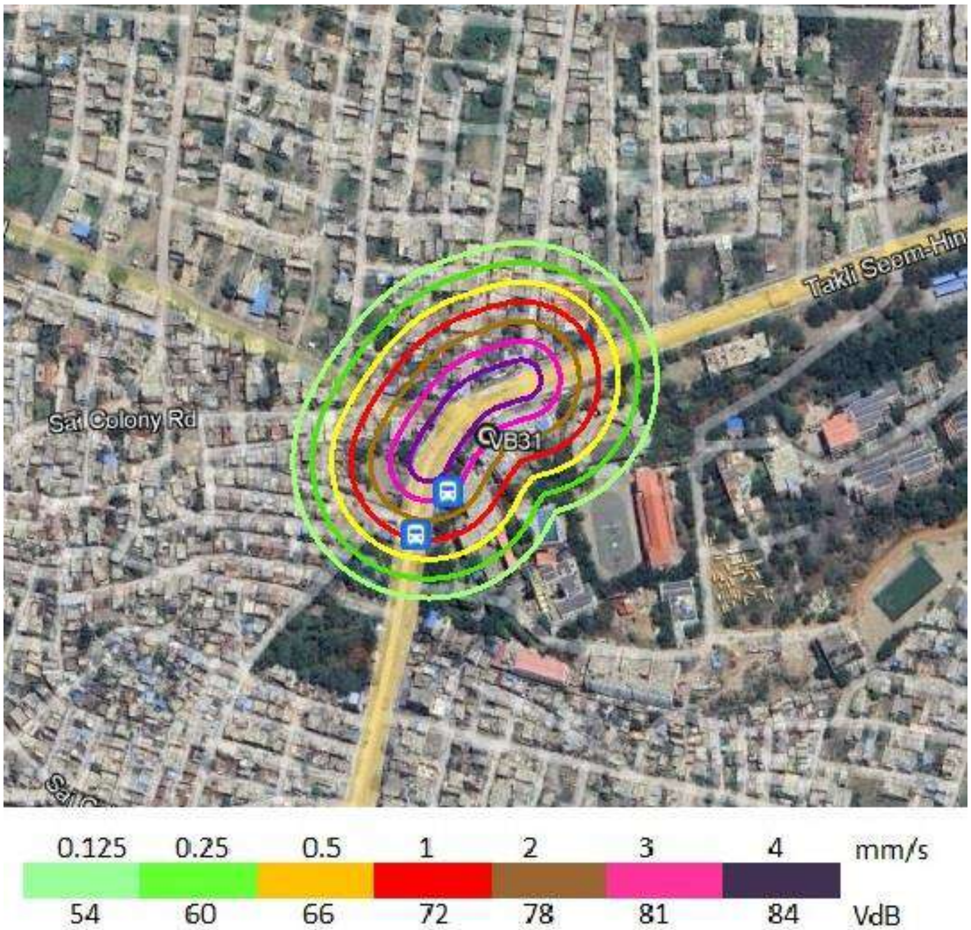

Figure 4.8: showing the predicted vibration contours due to train operation at DBASH

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.

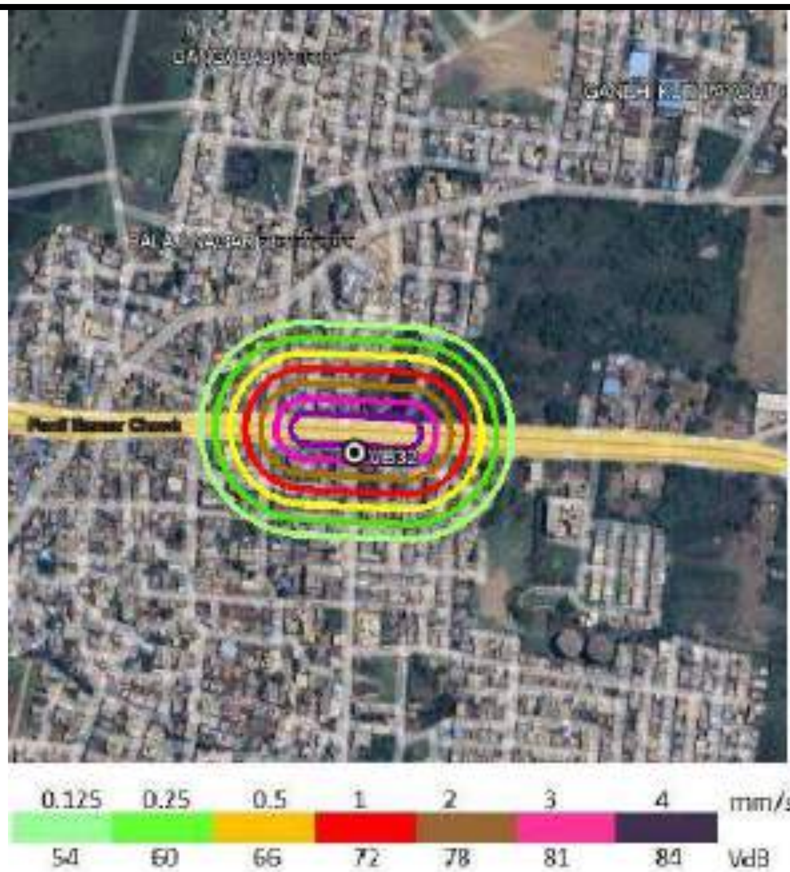

Figure 4.9: showing the predicted vibration contours due to train operation at Pardi residential area.

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.

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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

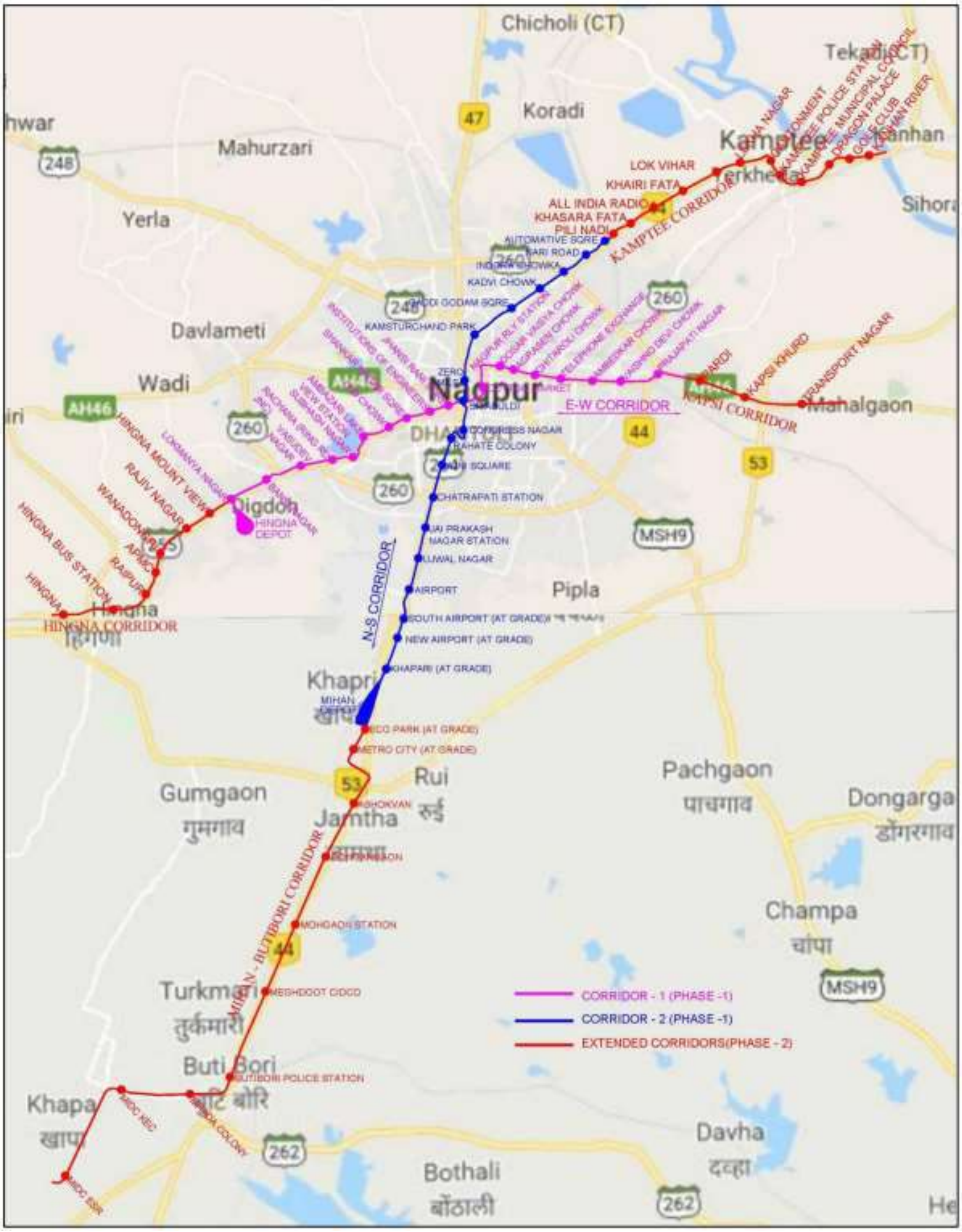

Figure 1: Routes of NMRP Phase II

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**

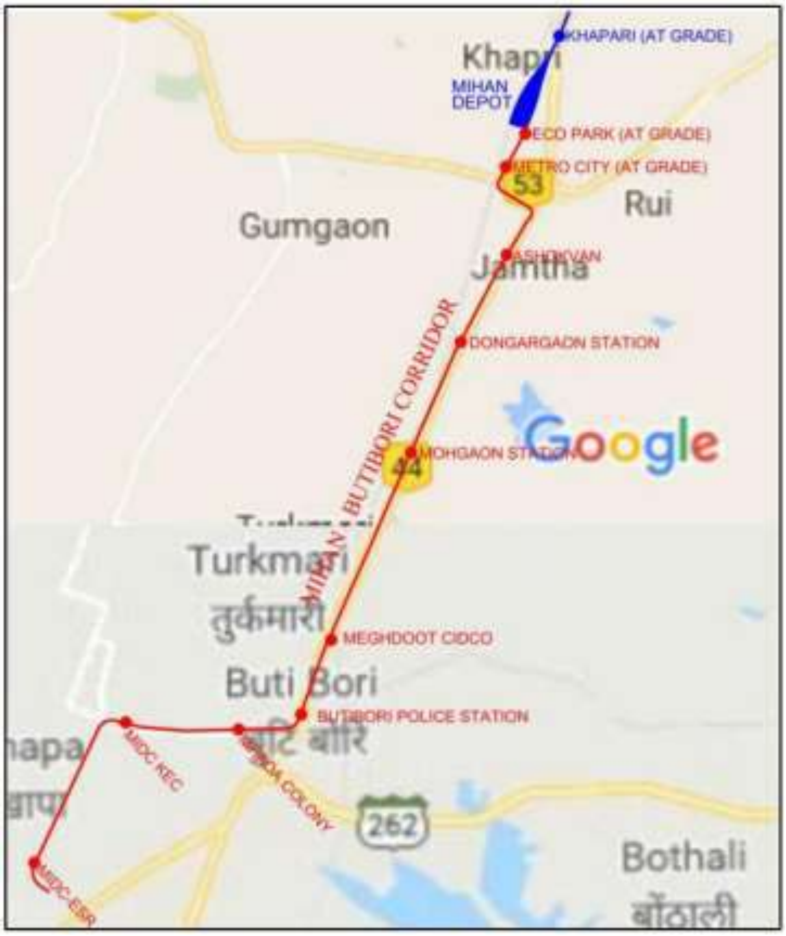

Figure 2: Alignment Map of Corridor-1A

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 Asha Hospital and Asharam College & School of Nursing	NMRP-P2 station Sensitive Receptor (School & Hospital)	21°13'8.90"N	79°10'36.83"E	CW
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

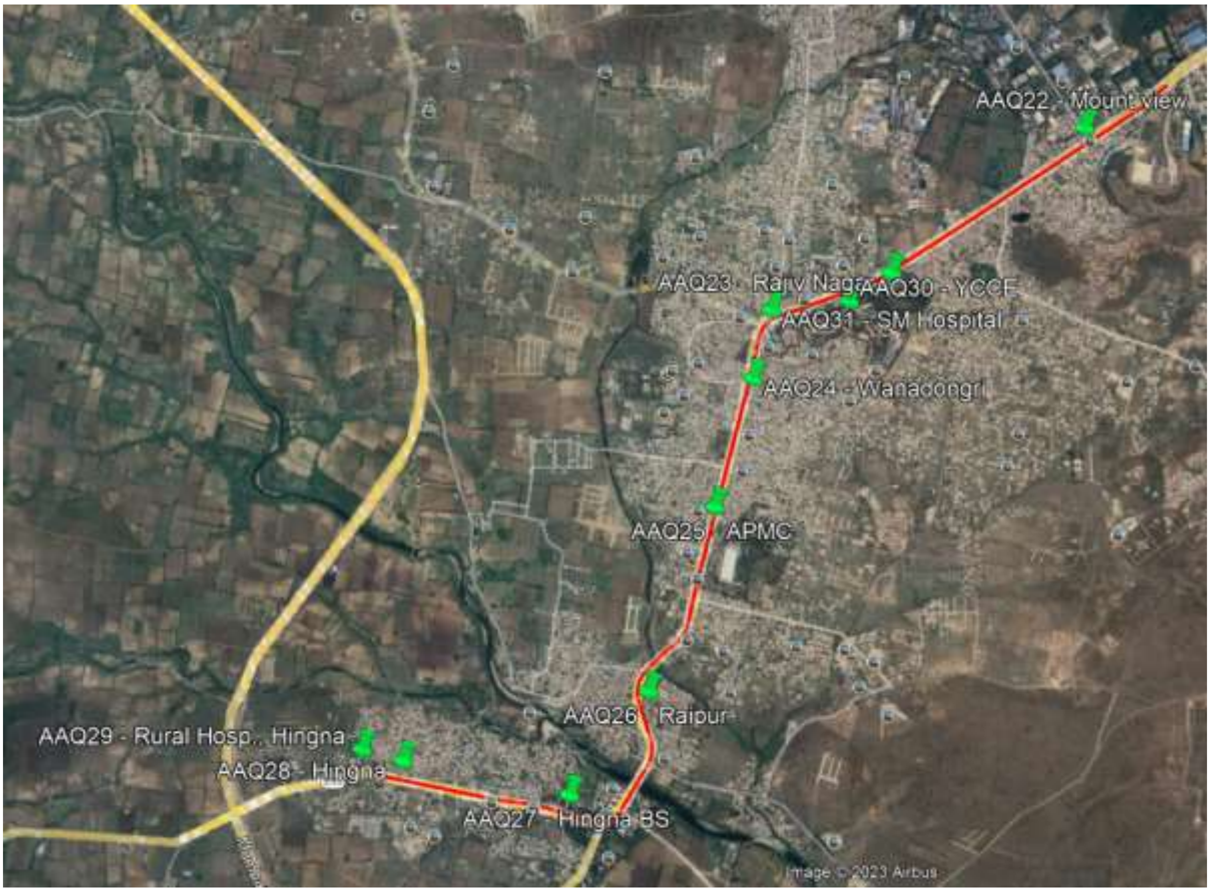

Figure 8: Air Monitoring Locations for Line 3A

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/m^3)	PM_{10} (100 µg/m^3)	SO_2 (80 µg/m^3)	Nox (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

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.

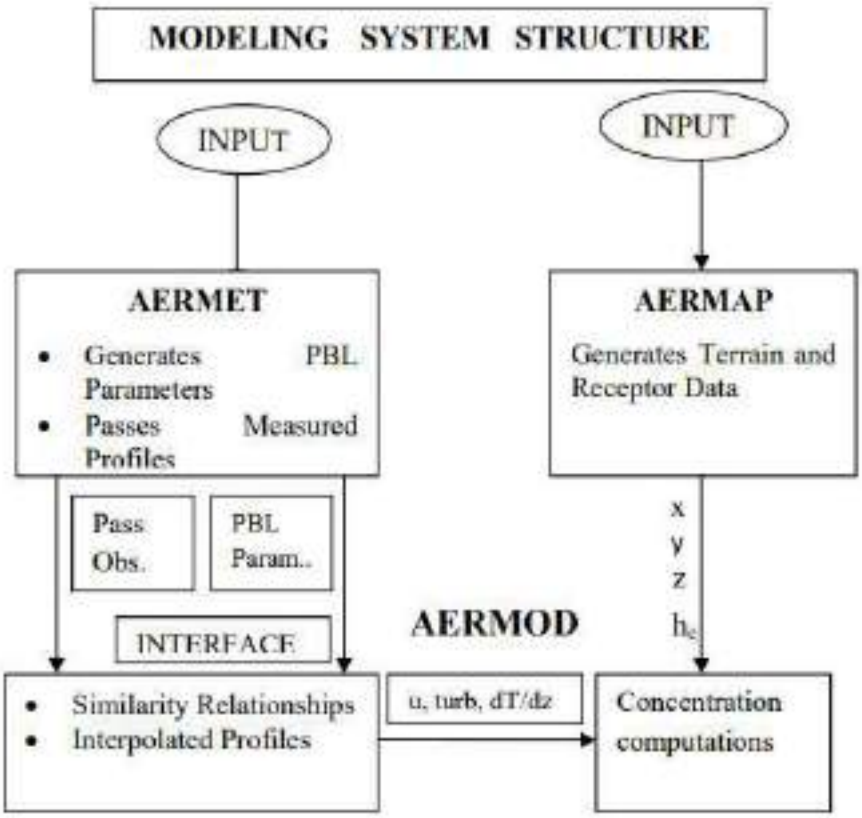

Figure 10: Dataflow in AERMOD modelling system

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.**

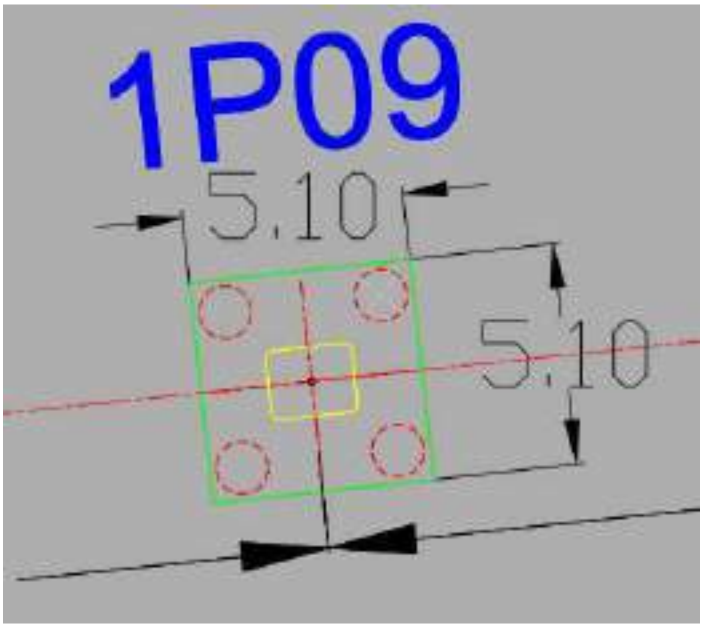

Figure 11: Typical plan of Pier considered for modelling

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 –

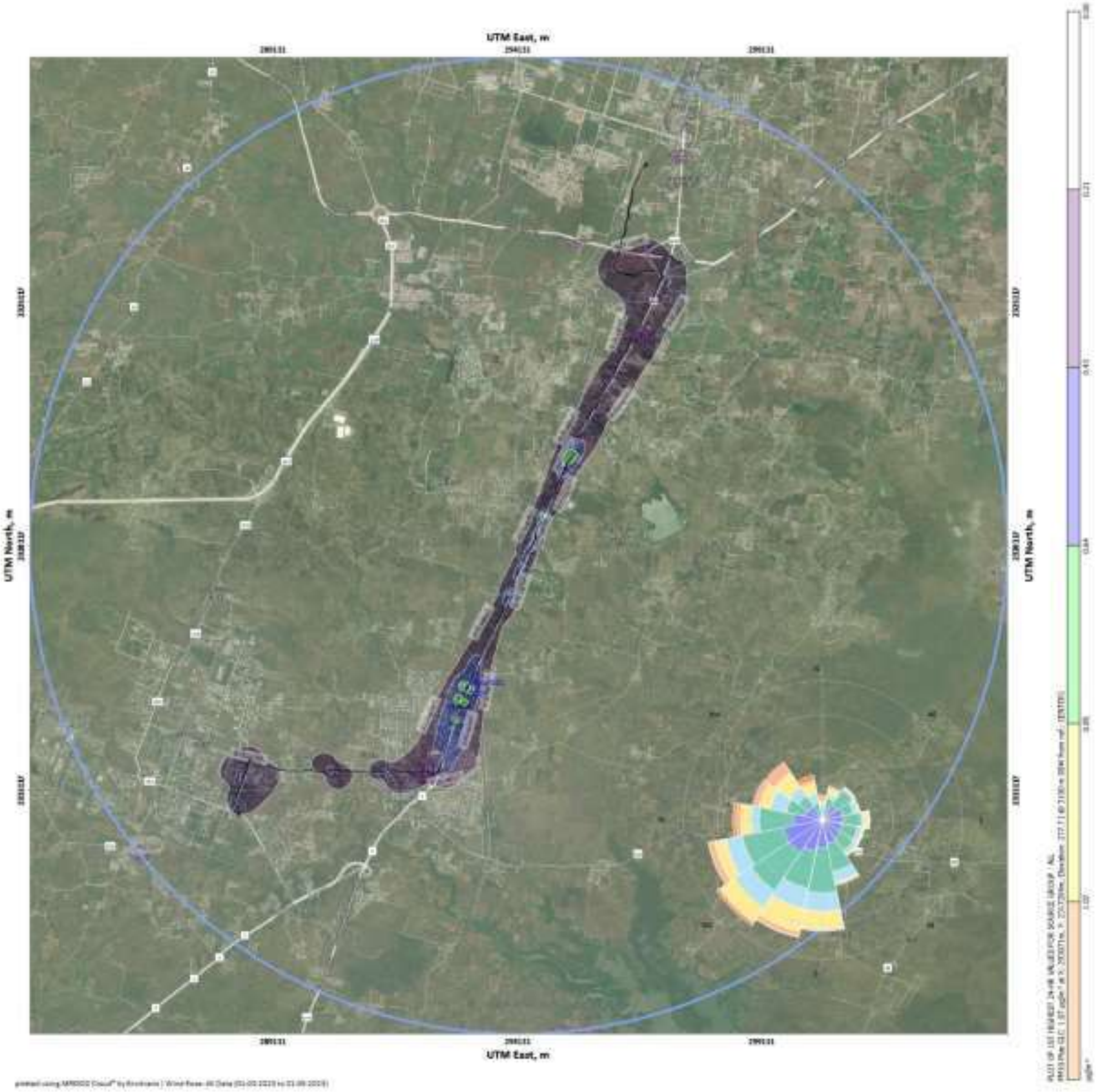

Figure 12: Isopleth of Incremental concentration of PM_{10} (Line 1A)

Table 11: Cumulative concentration of PM_{10} (Line 1A)

Sampling Code	Sampling Location	Baseline Concentration (µg/m³)	Incremental Concentration (µg/m³)	Total Concentration (µg/m³)
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 –

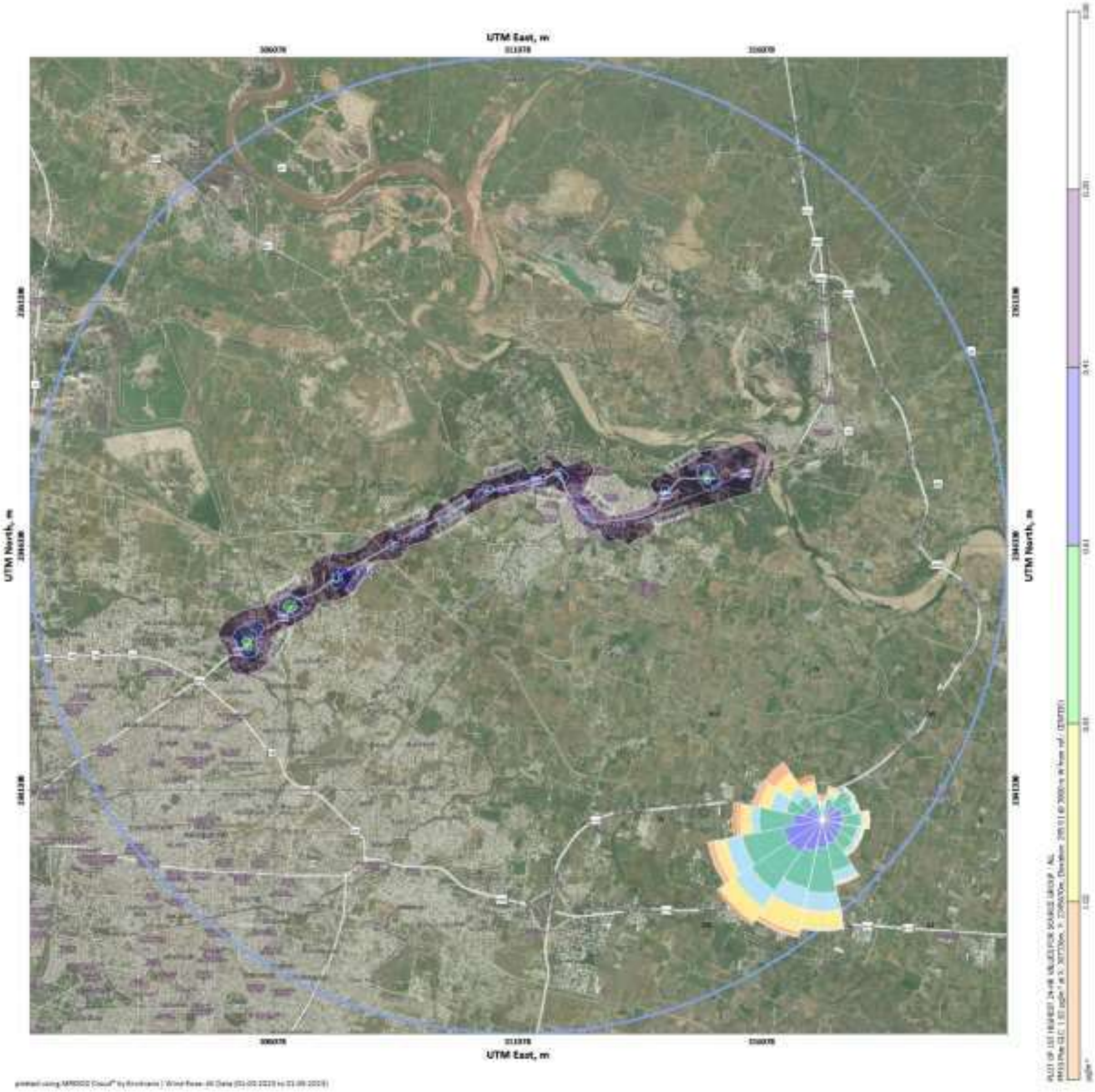

Figure 13: Isopleth of Incremental concentration of PM_{10} (Line 2A)

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 –

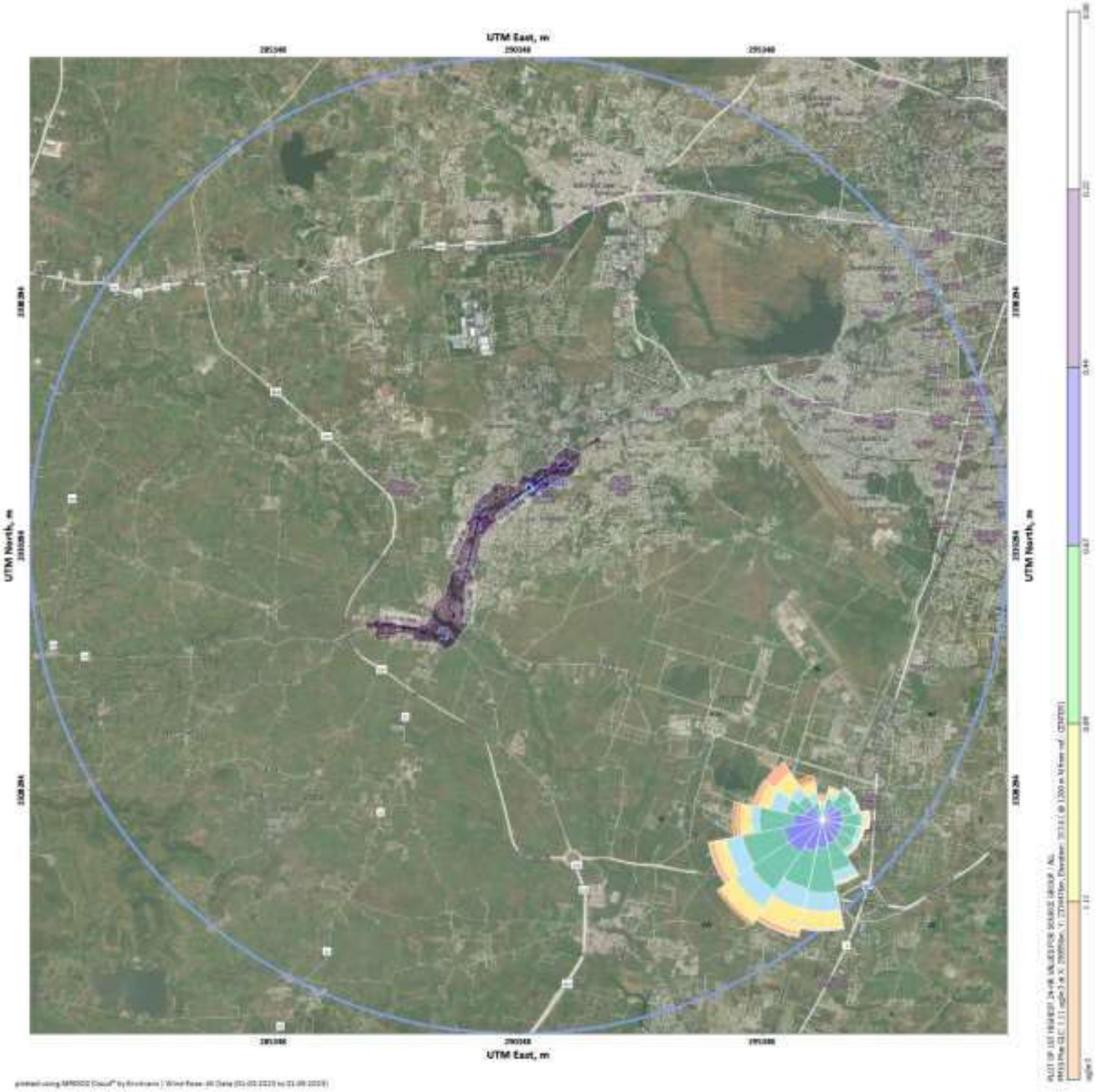

Figure 14: Isopleth of Incremental concentration of PM_{10} (Line 3A)

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 –

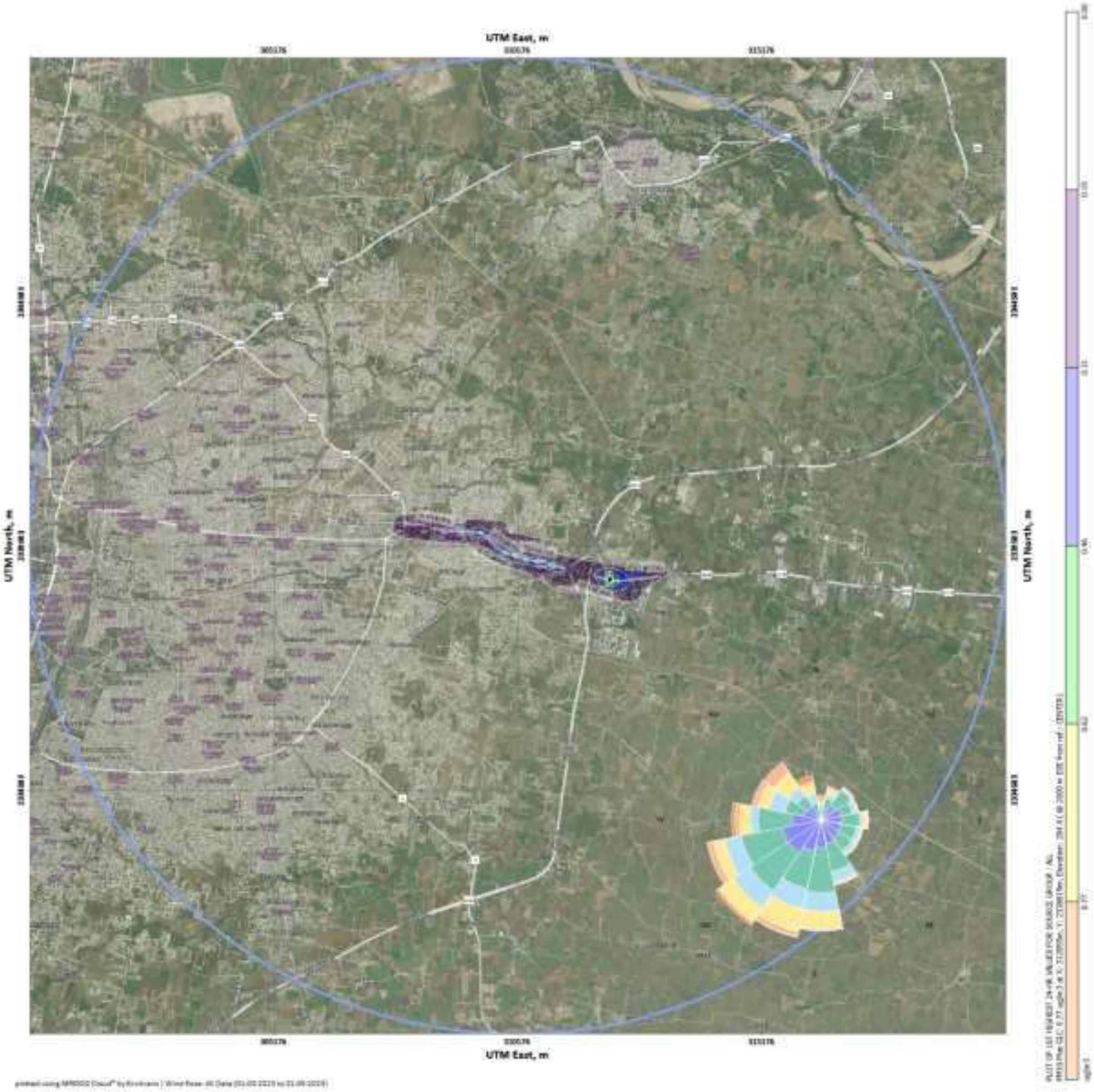

Figure 15: Isopleth of Incremental concentration of PM_{10} (Line 4A)

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 -

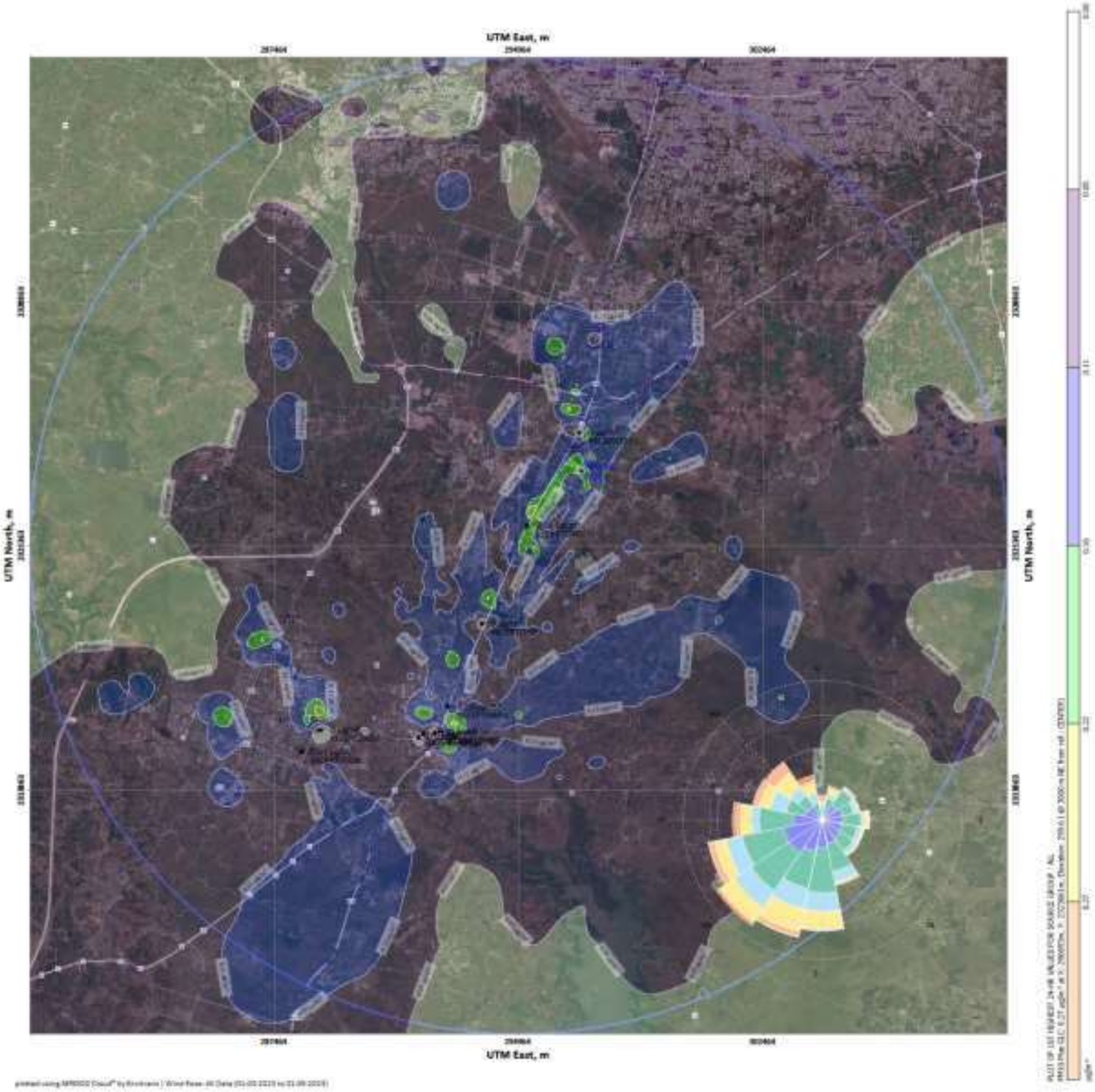

Figure 16: Isopleth of Incremental concentration of PM_{10}

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

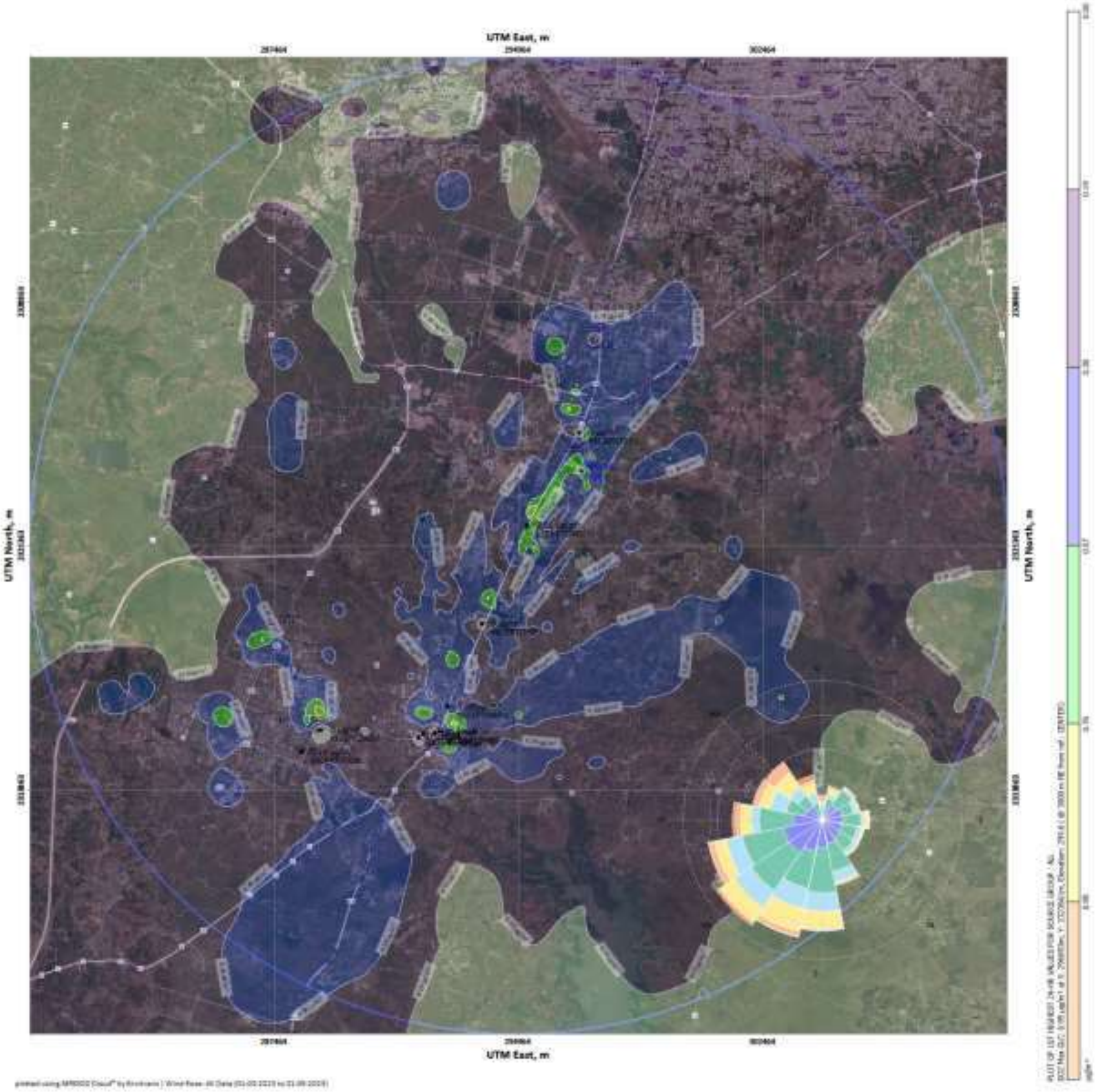

Figure 17: Isopleth of Incremental concentration of SO_2

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

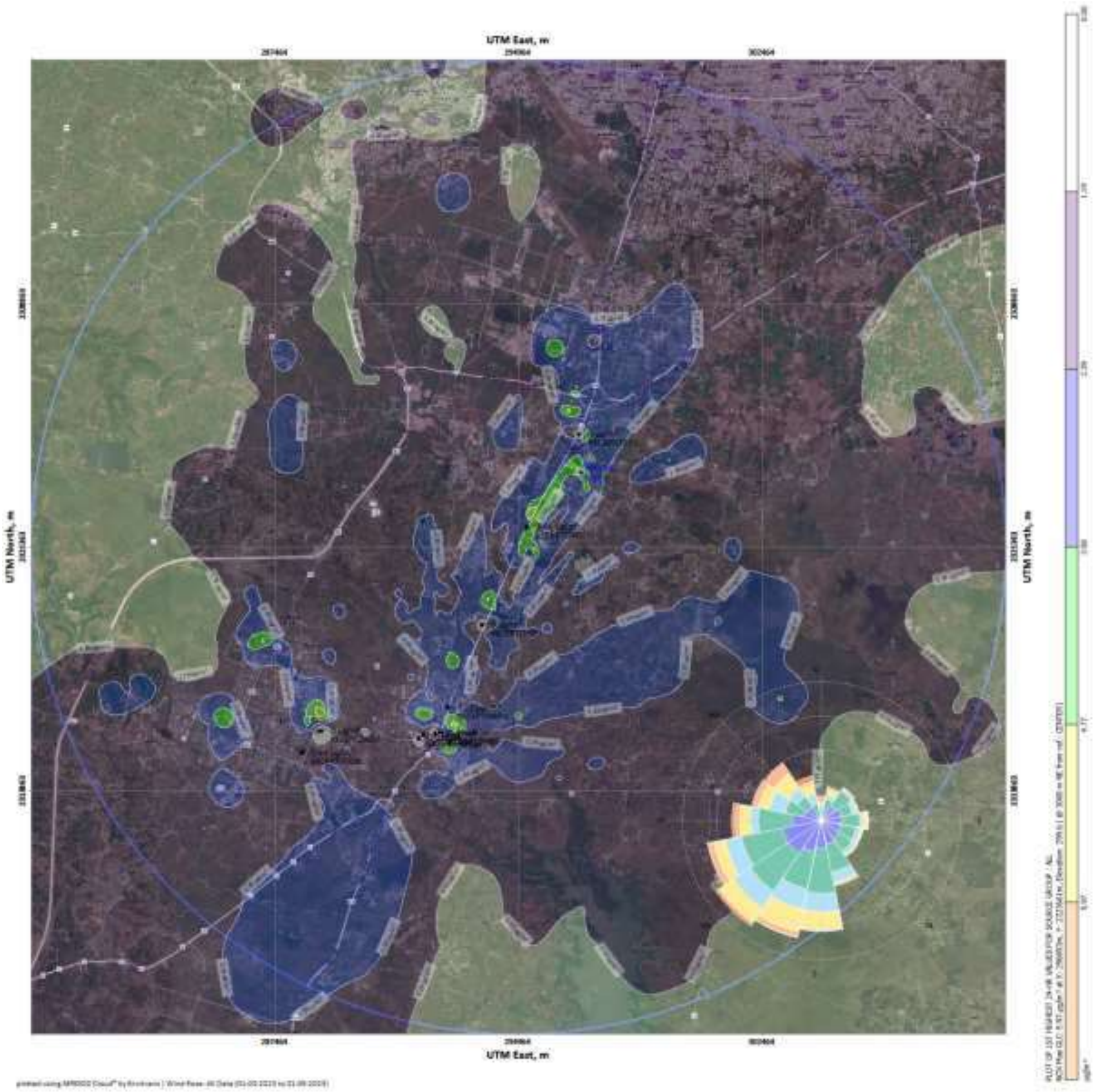

Figure 18: Isopleth of Incremental concentration of NO_x

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 -

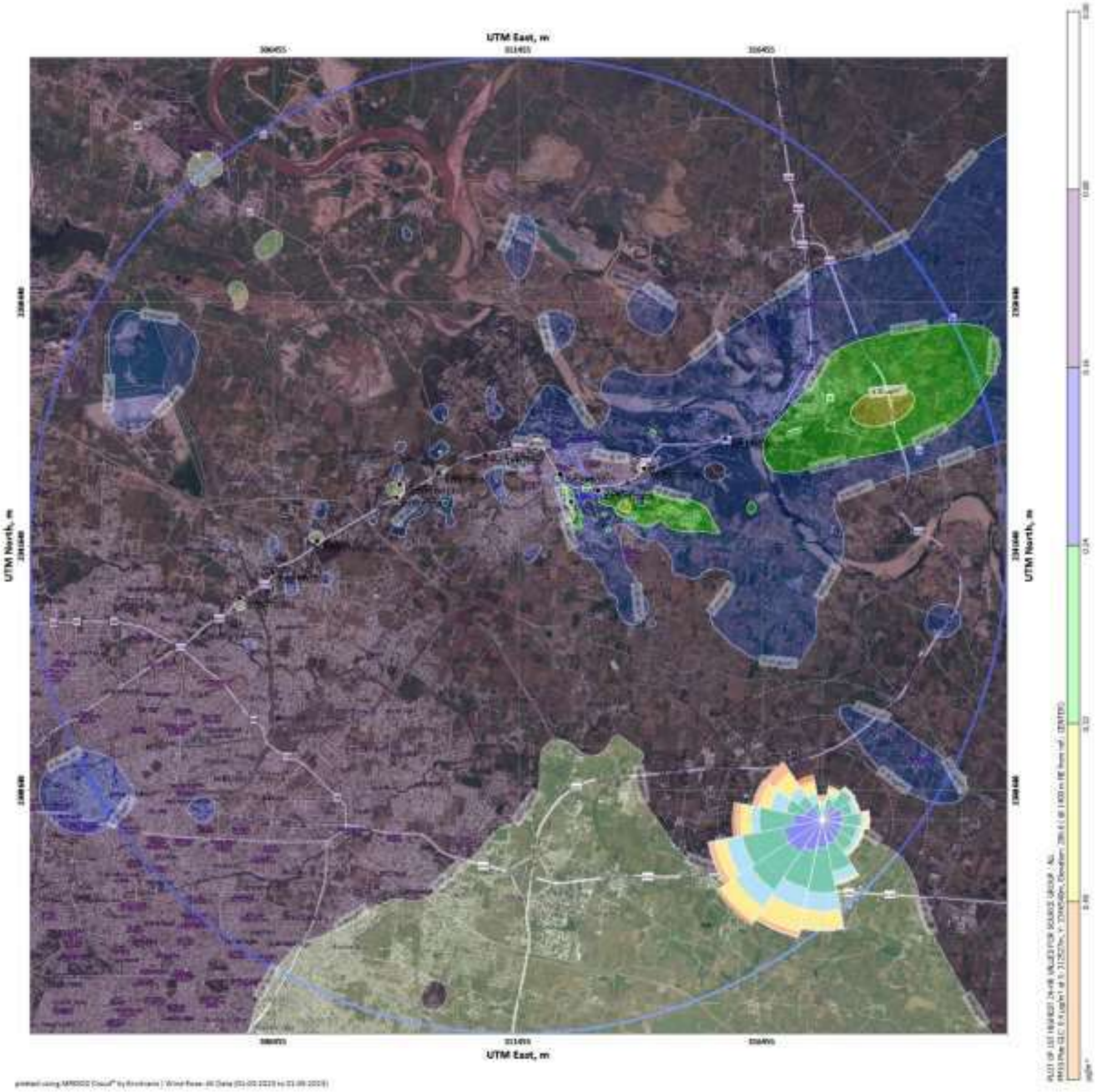

Figure 19: Isopleth of Incremental concentration of PM_{10}

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

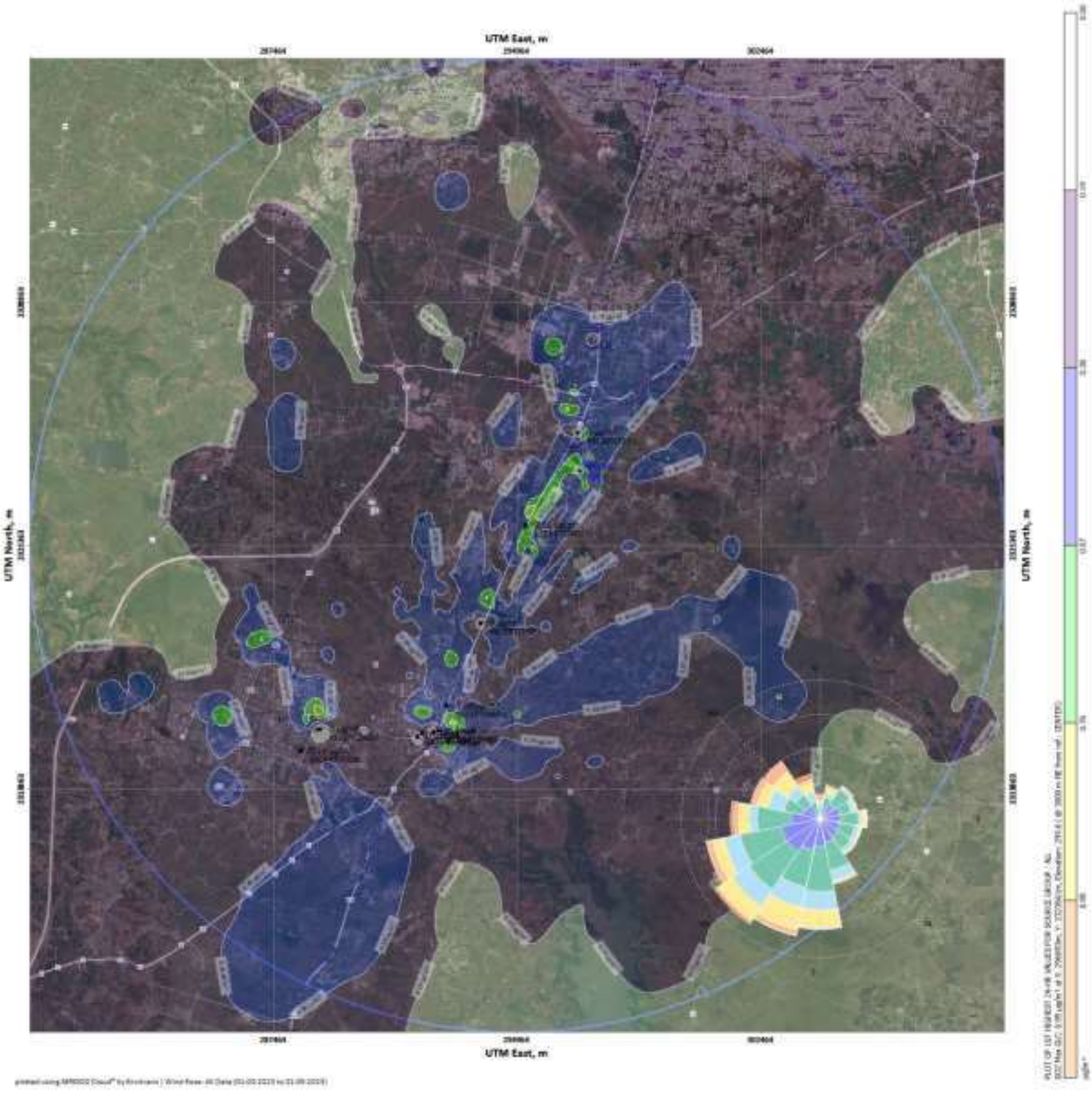

Figure 20: Isopleth of Incremental concentration of SO_2

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	24.1	0.50	24.6
	Asha Hospital and Asharam College & School of Nursing			
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

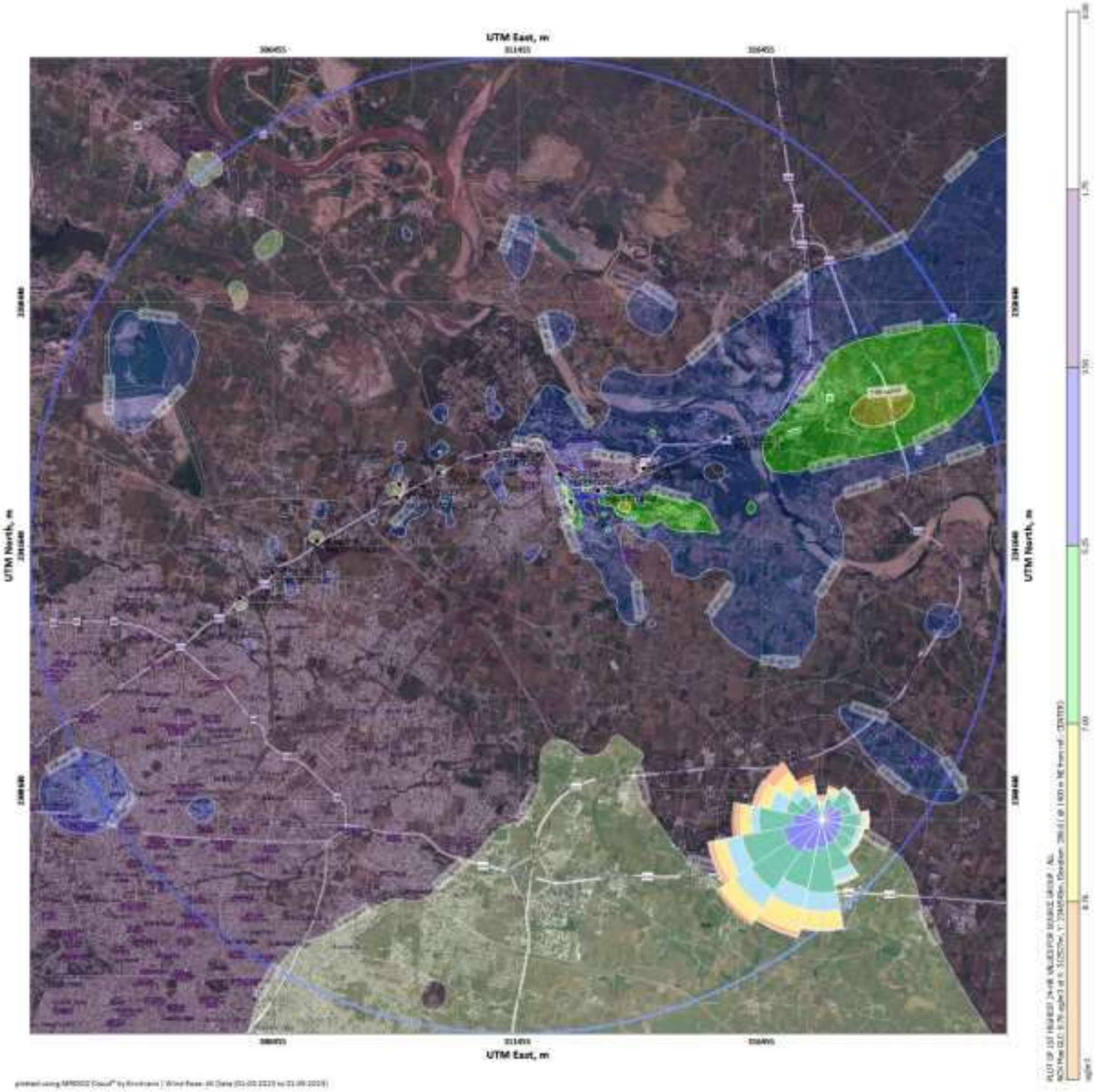

Figure 21: Isopleth of Incremental concentration of NO_x

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 -

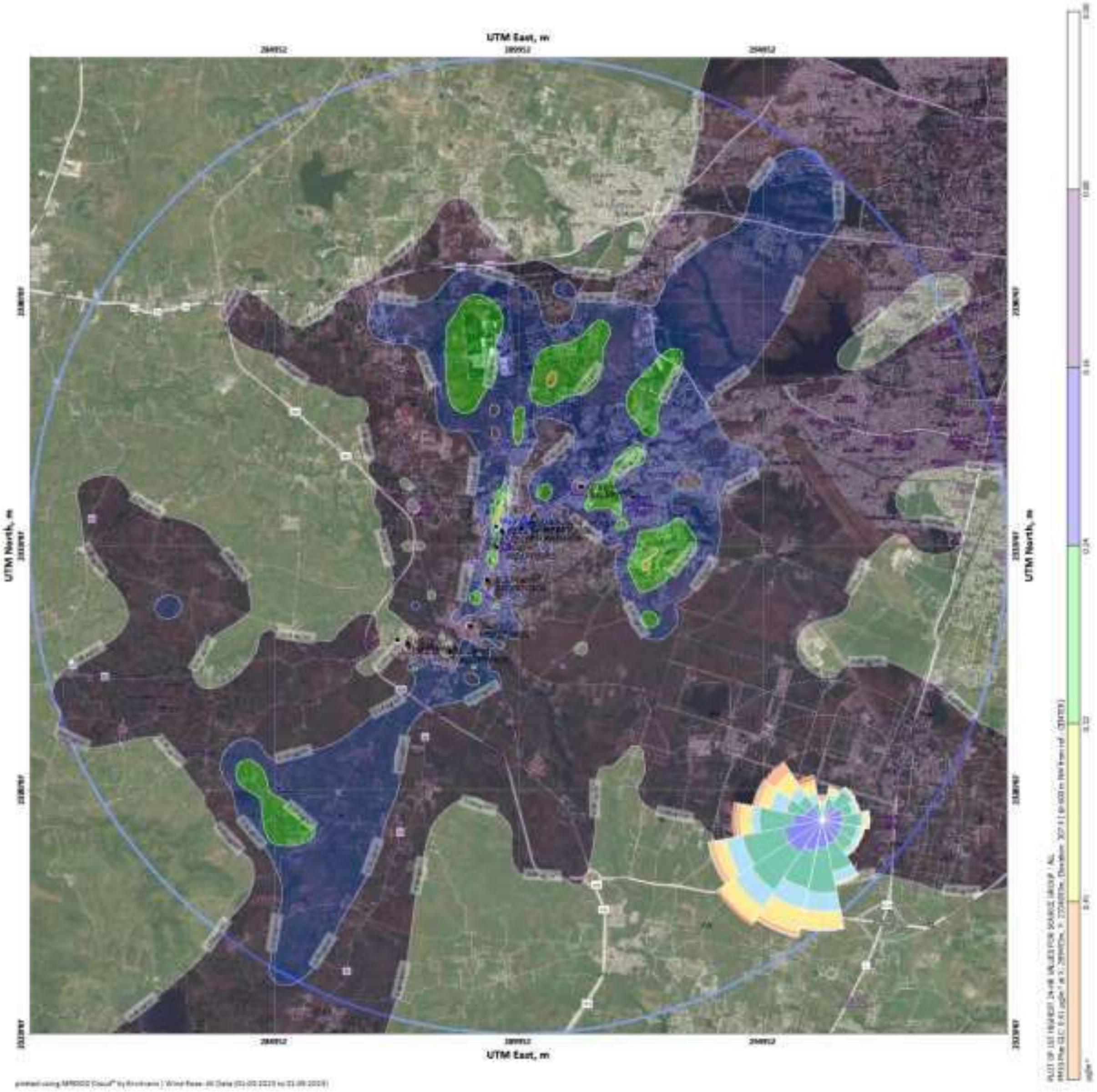

Figure 22: Isopleth of Incremental concentration of PM_{10}

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

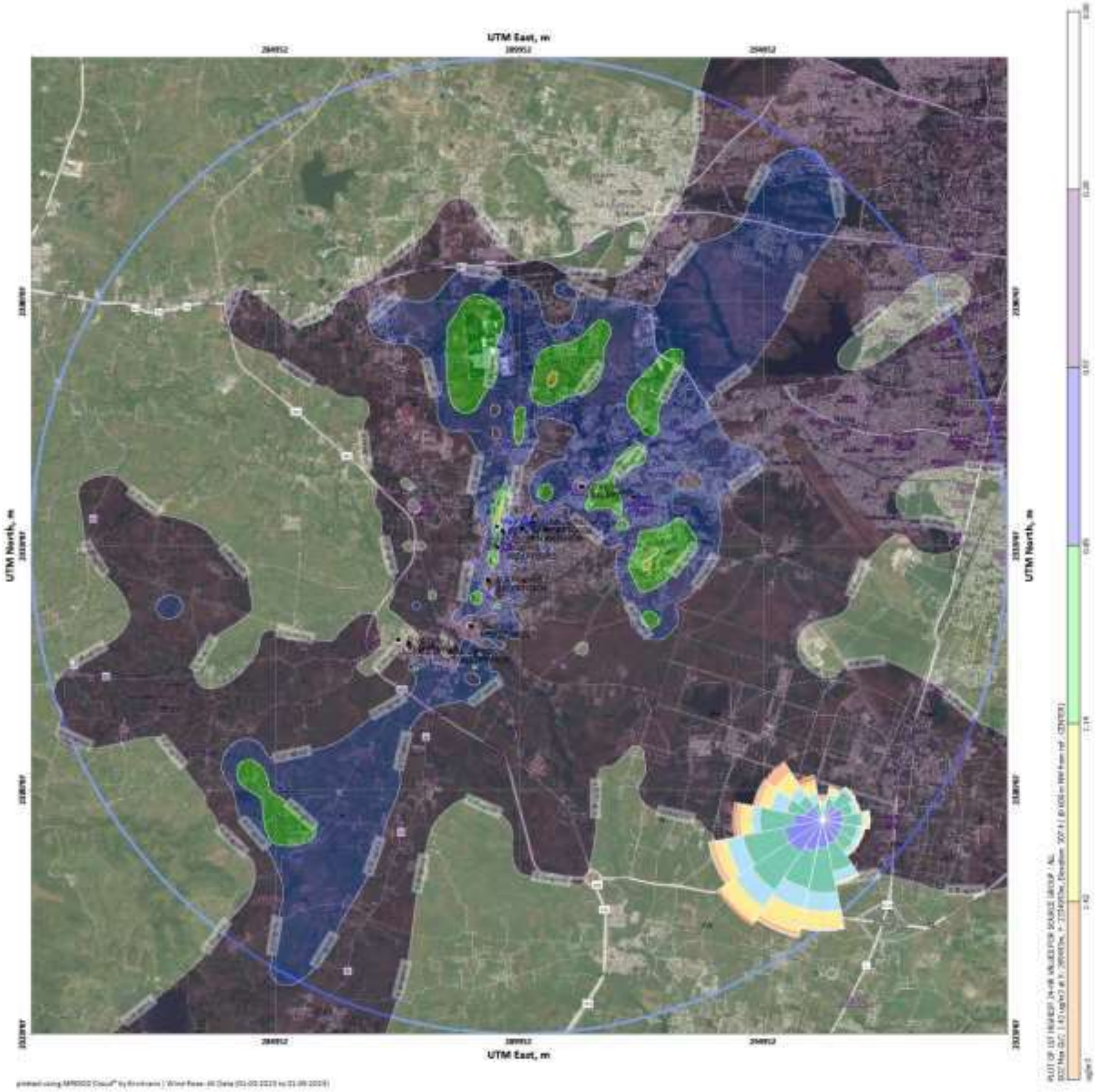

Figure 23: Isopleth of Incremental concentration of SO_2

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

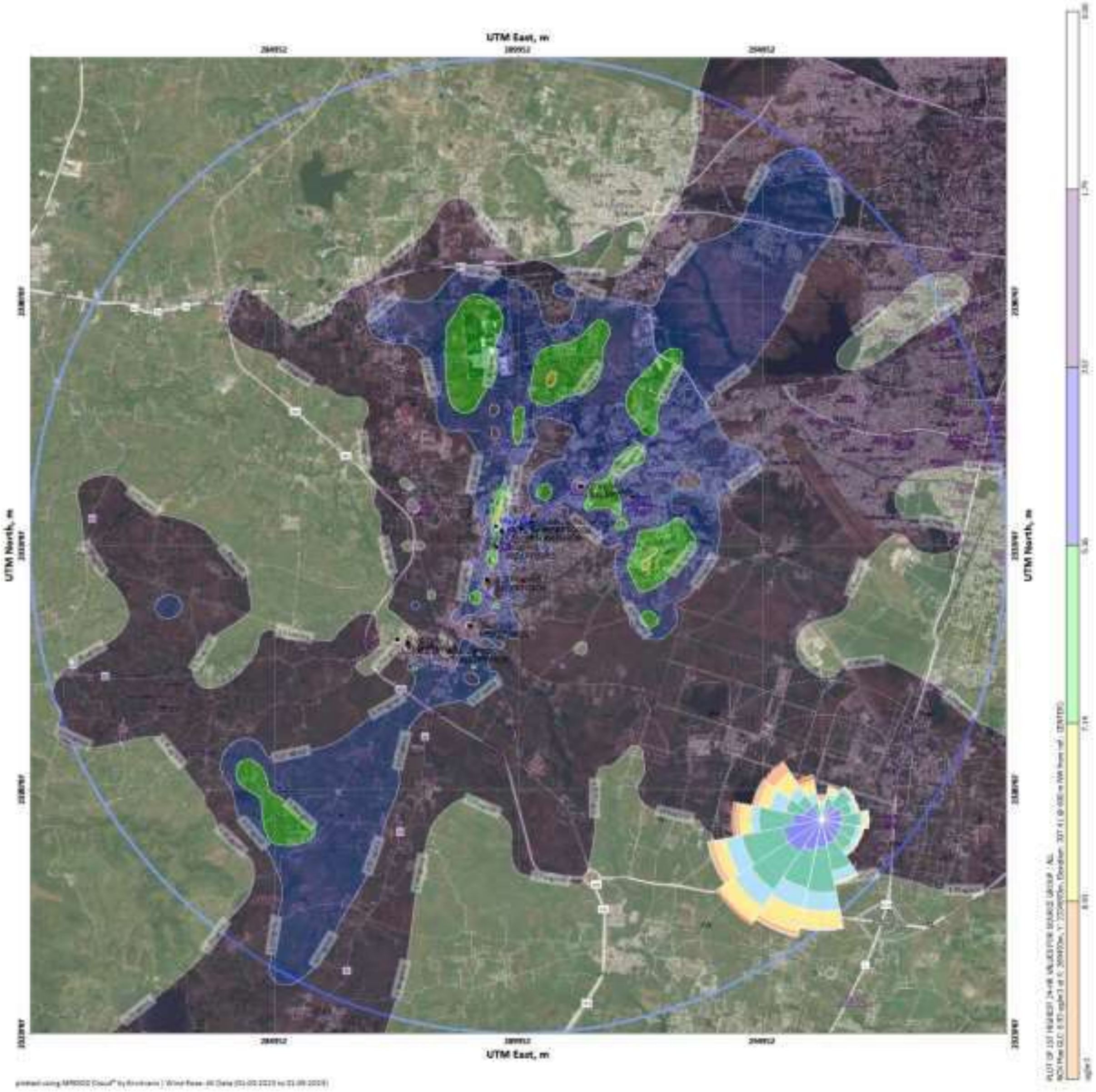

Figure 24: Isopleth of Incremental concentration of NO_x

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 -

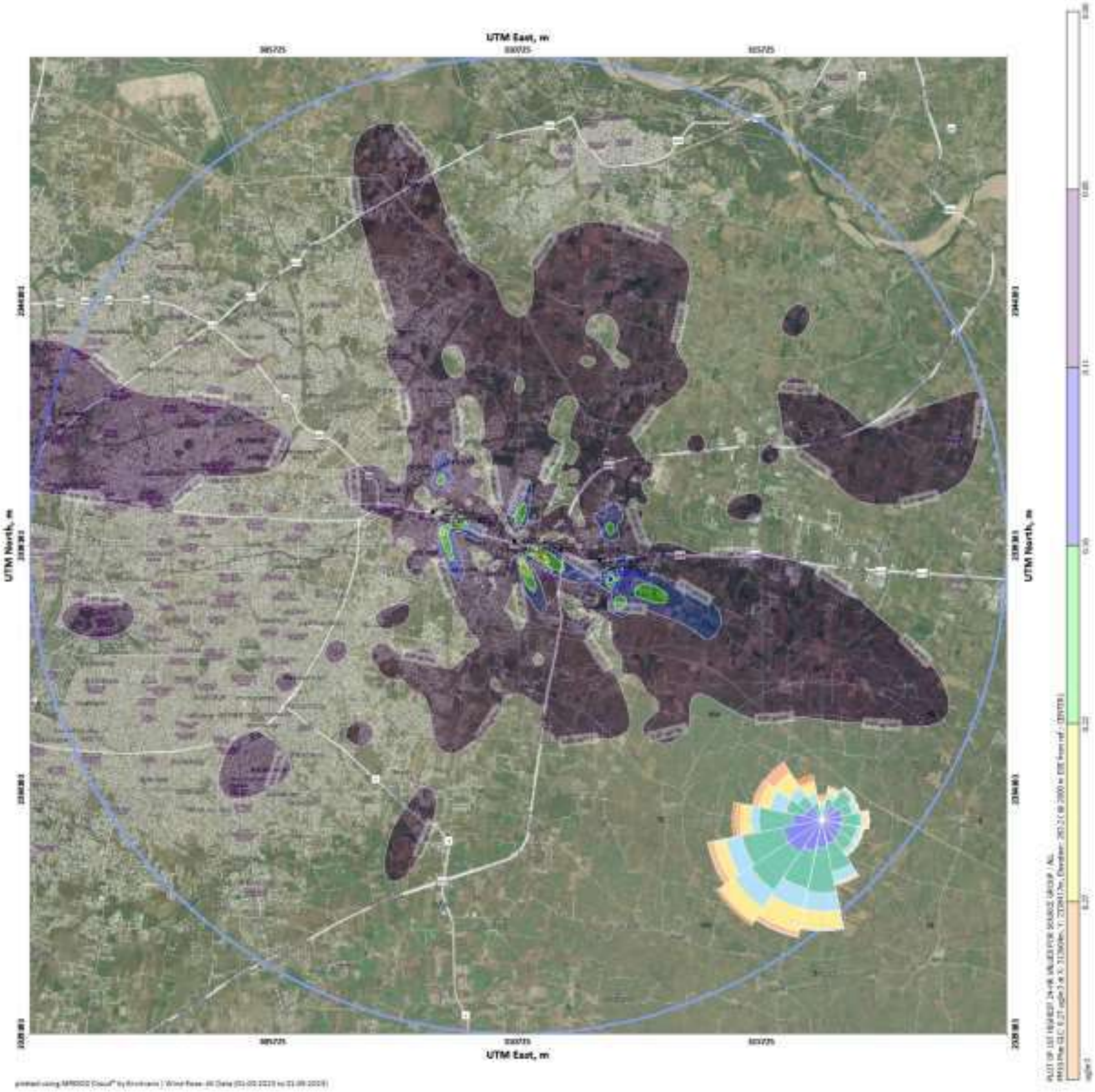

Figure 25: Isopleth of Incremental concentration of PM_{10}

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

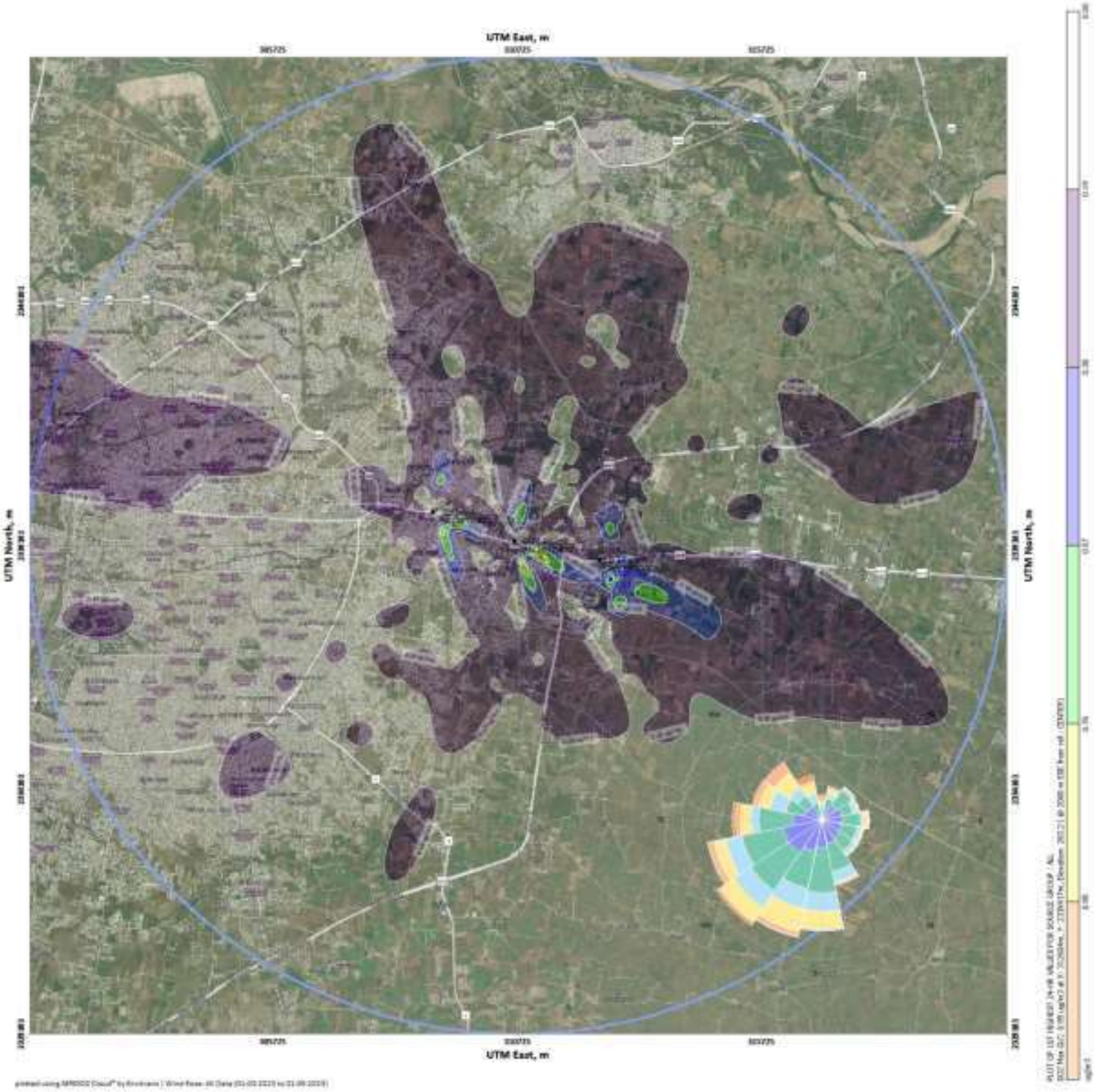

Figure 26: Isopleth of Incremental concentration of SO_2

Table 25: Cumulative concentration of SO_2

Sampling Code	Sampling Location	Baseline Concentration ($\mu g/m^3$)	Incremental Concentration ($\mu g/m^3$)	Total Concentration ($\mu g/m^3$)
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

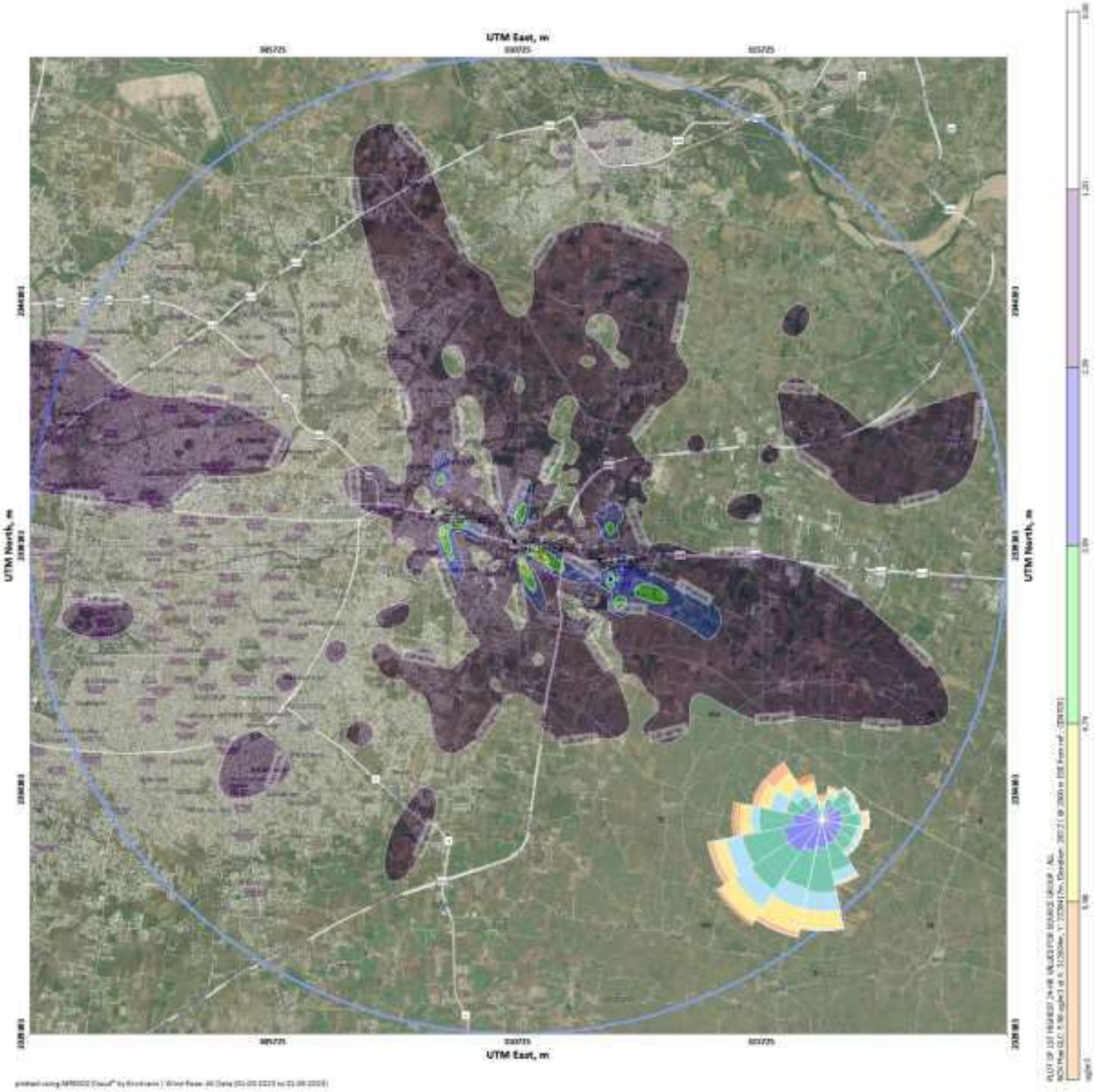

Figure 27: Isopleth of Incremental concentration of NO_x

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.

NOISE MODELLING REPORT

FOR

EXTENSION OF NAGPUR METRO RAIL PHASE 2

BY

MAHARASHTRA METRO RAIL CORPORATION LIMITED

Submitted to

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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

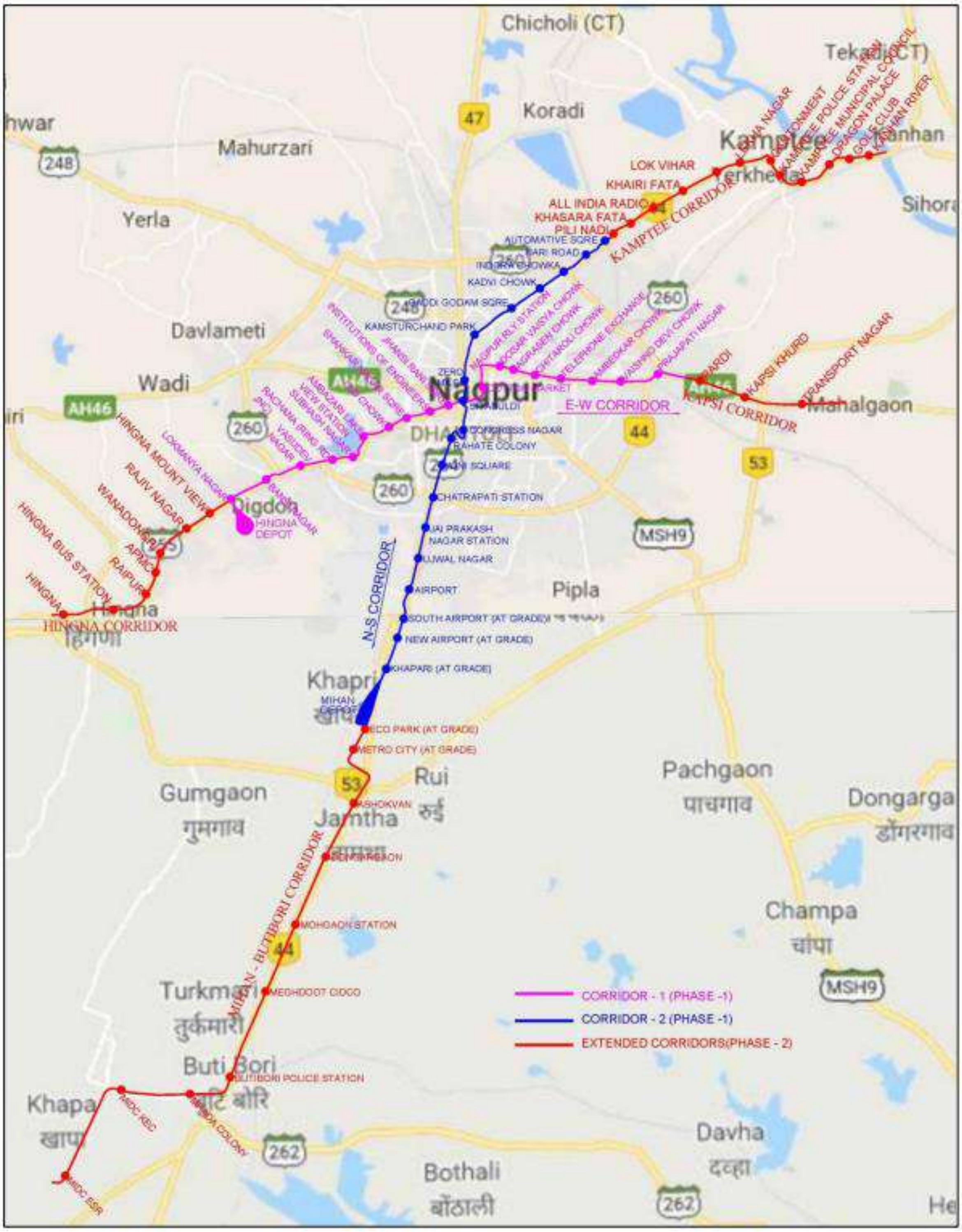

Figure 1: Routes of NMRP Phase II

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**

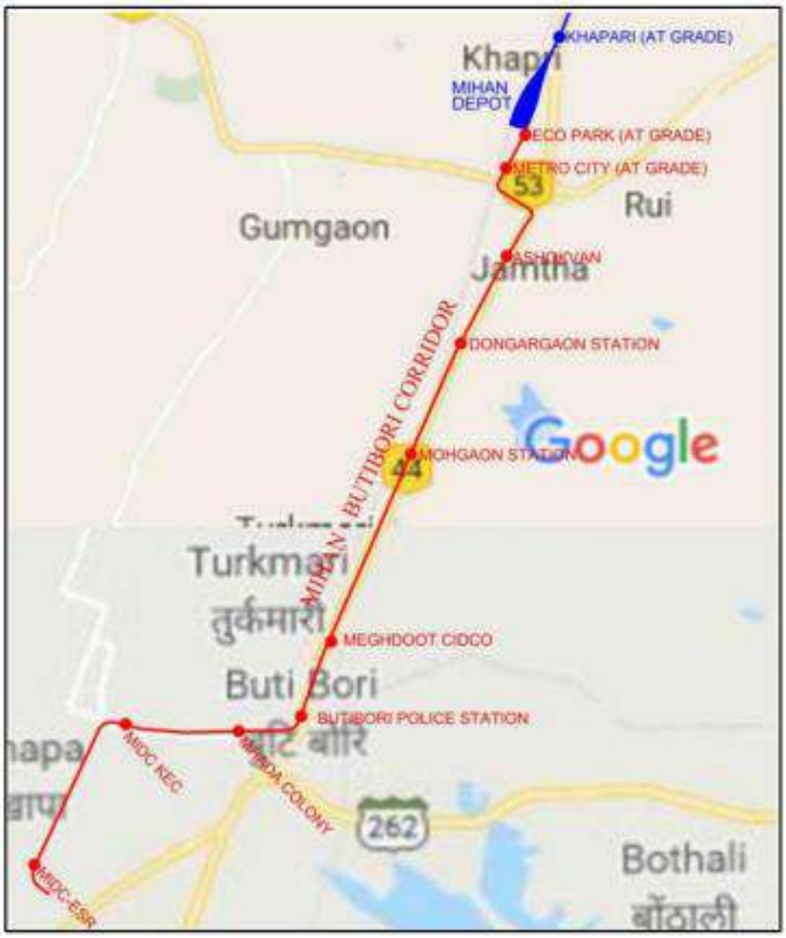

Figure 2: Alignment Map of Corridor-1A

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**

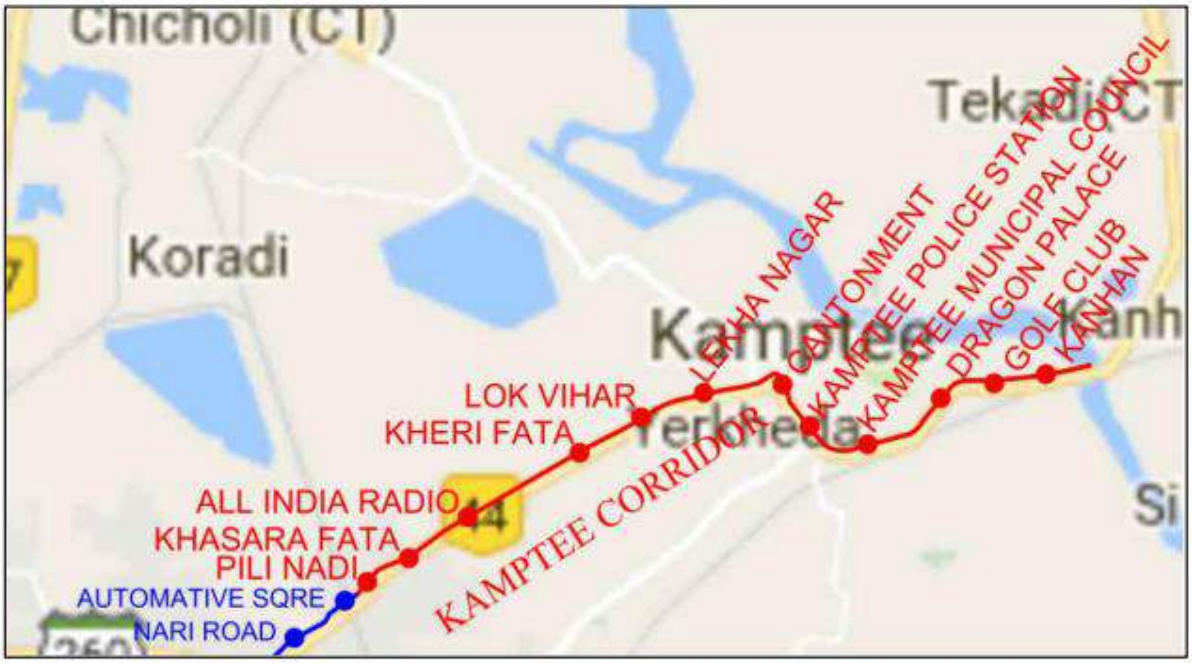

Figure 3: Alignment Map of Corridor-2A

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 Noise Environment

As part of the process, primary baseline data was collected for Ambient Noise during April to June 2023.

3.1 Methodology

The methodology adopted for Noise Monitoring is outlined below:

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

- The noise measurement instrument is continuously supervised during the monitoring period (24 hours at each location).
- In case of extraneous noise conditions like honking from passing vehicles, adverse meteorological conditions, if any, etc., the "Pause" function on the instrument can be used to exclude any such extra noise.

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

- **Source:** The proximity of the villages to the Project site. The closer the villages are the severe would be the impact.
- **Path:** The meteorology and the wind flow affects the impact on the receiver. The impact is higher during night time and low in 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.
- **Receiver:** The impact is higher if the receiver is considered to be sensitive w.r.t the NAAQ Standards for noise. Such sensitive receptors could be hospital, school, hospitals, etc.

3.2 Sampling Period, Frequency and Parameters

Ambient noise levels were monitored at 34 locations, identified during preliminary baseline survey within the study area, as shown in Table 4-12. Details of Sampling locations for each line are shown in **Table 6**, whereas the same marked on google earth are shown in **Figure 6** to **Figure 10.**

Table 6: Noise Monitoring Sampling Locations of NMRP-P2 corridors

Line	Sampling Code	Sampling Location	Significance	Latitude	Longitude	Type of Location
1A	NQ1	Ashokwan	NMRP2 station	21° 0'46.64" N	79° 2'42.53" E	Residential
1A	NQ2	Dongargaon	NMRP2 station	20°59'12.64" N	79° 1'47.68" E	Residential
1A	NQ3	Mohgaon	NMRP2 station	20°57'35.33" N	79° 1'2.72" E	Residential
1A	NQ4	Meghdoot CIDCO	NMRP2 station	20°56'11.89" N	79° 0'25.86" E	Commercial
1A	NQ5	Butibori Police Station	NMRP2 station	20°55'45.83" N	79° 0'14.09" E	Commercial
1A	NQ6	MHADA Colony	NMRP2 station	20°55'42.27" N	78°59'56.53" E	Commercial
1A	NQ7	MIDC KEC	NMRP2 station	20°55'45.70" N	78°58'11.06" E	Industrial
1A	NQ8	MIDC ESR	NMRP2 station	20°55'24.14" N	78°57'51.55" E	Industrial
1A	NQ9	Jijamata High School & Jr. College	Sensitive Receptor (School)	20°55'46.75" N	79° 0'18.26" E	Silence
1A	NQ10	Rachana Hospital	Sensitive Receptor (Hospital)	20°55'43.41"N	79° 0'0.56"E	Silence
2A	NQ11	Pili Nadi	NMRP2 station	21°11'32.28"N	79° 7'44.11"E	Commercial

2A	NQ12	Khasara fata	NMRP2 station	21°11'49.79" N	79° 8'6.70" E	Commercial
2A	NQ13	All India Radio	NMRP2 station	21°12'9.97"N	79° 8'37.43"E	Commercial
2A	NQ14	Khairi fata	NMRP2 station	21°12'40.05" N	79° 9'32.12" E	Commercial
2A	NQ15	Lok Vihar	NMRP2 station	21°12'54.36" N	79°10'1.8" E	Residential
2A	NQ16	Lekha Nagar	NMRP2 station	21°13'9.11" N	79°10'35.50" E	Residential / Silence
		Asha Hospital and Asharam College & School of Nursing	Sensitive Receptor (School & Hospital)			
2A	NQ17	Kamptee Police station**	NMRP2 station	21°12'55.03" N	79°11'32.30" E	Commercial
2A	NQ18	Kamptee Municipal Council	NMRP2 station	21°12'47.51" N	79°11'56.43" E	Residential
2A	NQ19	Dragon Palace	NMRP2 station	21°13'1.00"N	79°12'30.16"E	Residential
2A	NQ20	Kanhan River	NMRP2 station	21°13'21.24" N	79°13'26.03" E	Residential
2A	NQ21	Delhi Public School (DPS), Khairy, Kamptee Road, Nagpur	Sensitive Receptor (School)	21°12'49.14" N	79° 9'35.39" E	Silence
3A	NQ22	Hingna Mount View	NMRP2 station	21° 6'12.21" N	78°59'24.77" E	Residential
3A	NQ23	Rajiv Nagar	NMRP2 station	21° 5'50.78" N	78°58'51.05" E	Commercial
3A	NQ24	Wanadongri	NMRP2 station	21° 5'32.24" N	78°58'24.93" E	Commercial
3A	NQ25	APMC	NMRP2 station	21° 5'8.39" N	78°58'18.37" E	Commercial
3A	NQ26	Raipur	NMRP2 station	21° 4'37.69" N	78°58'7.10" E	Commercial
3A	NQ27	Hingna Bus Station	NMRP2 station	21° 4'20.91" N	78°57'54.13" E	Commercial
3A	NQ28	Hingna	NMRP2 station	21° 4'26.42" N	78°57'22.52" E	Commercial
3A	NQ29	Rural Hospital - Hingna	Sensitive Receptor (Hospital)	21° 4'29.18" N	78°57'16.31" E	Silence
3A	NQ30	YCCE	Sensitive Receptor (Engg. College)	21° 5'43.27" N	78°58'41.14" E	Silence
3A	NQ31	Shalinitai Meghe Hospital	Sensitive Receptor (Hospital)	21° 5'42.77" N	78°58'29.87" E	Silence
4A	NQ32	Pardi	NMRP2 station	21° 8'58.10" N	79° 9'38.54" E	Commercial
4A	NQ33	Kapsi Kh.	NMRP2 station	21° 8'37.52" N	79°10'33.68" E	Commercial
4A	NQ34	Transport Nagar	NMRP2 station	21° 8'25.97" N	79°11'41.65" E	Commercial

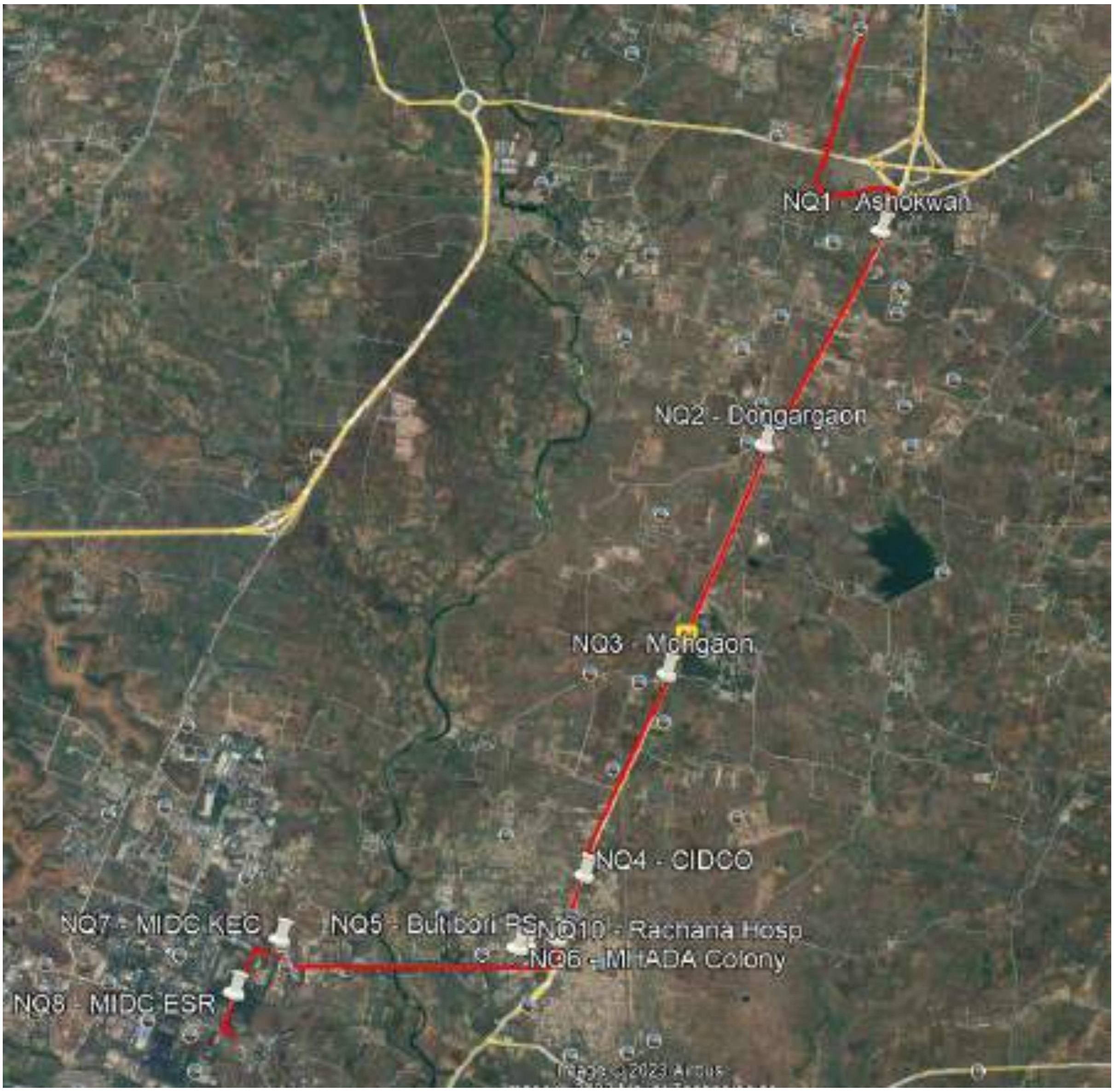

Figure 6: Noise Monitoring Locations for Line 1A

Figure 7: Noise Monitoring Locations for Line 2A

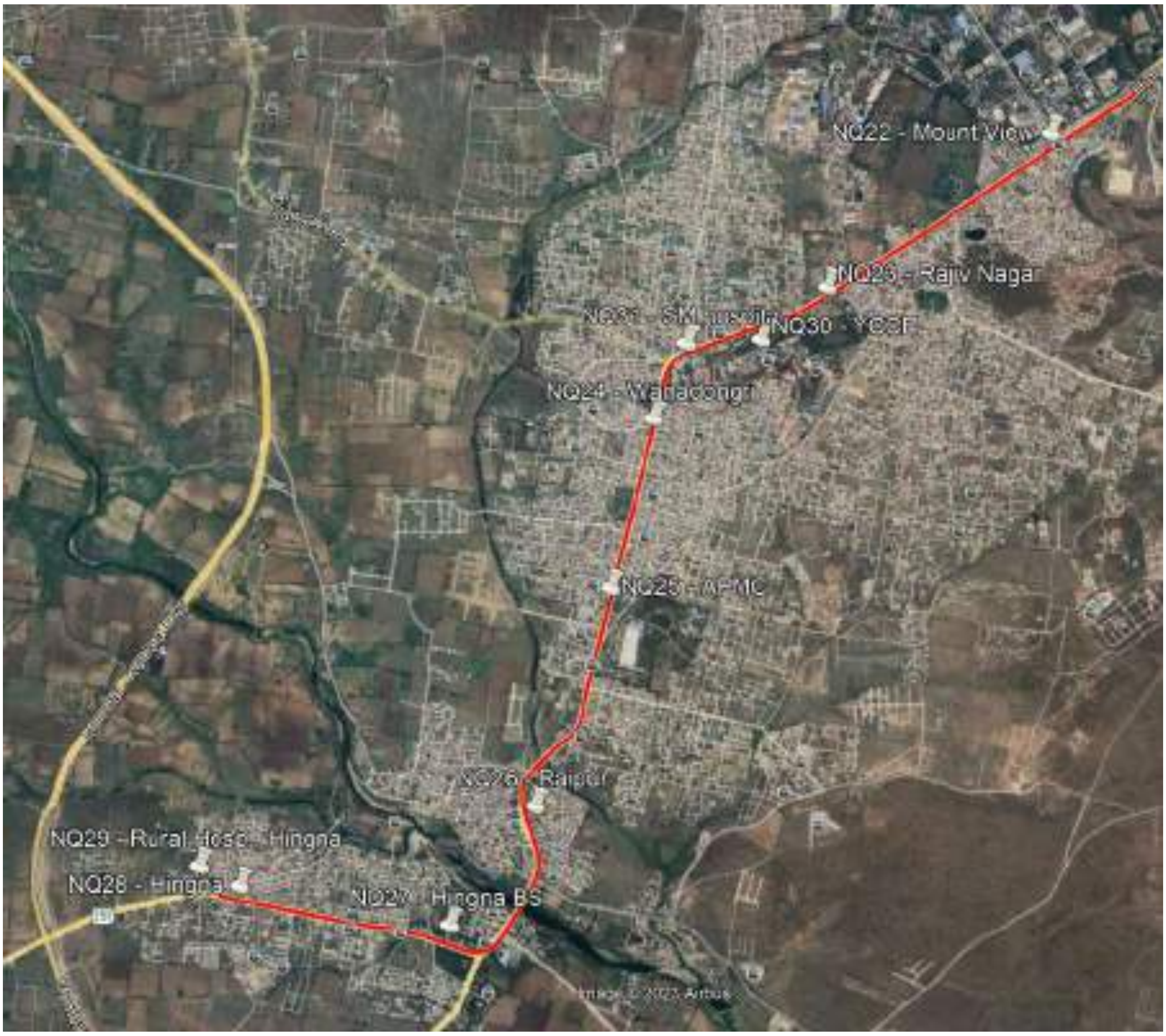

Figure 8: Noise Monitoring Locations for Line 3A

Figure 9: Noise Monitoring Locations for Line 4A

3.3 Noise Quality Sampling Results

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 7**.

Table 7: 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	Residential / Silence	56.8	44.9
NQ17	Kamptee Police station	Commercial	59.8	50.1
NQ18	Kamptee Municipal Council	Residential	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	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

4. Anticipated Impacts

During the operation phase the main source of noise will be from running of metro trains. Noise radiated from train operations and track structures generally constitute the major noise sources. Airborne noise is radiated from at-grade and elevated structures, while ground-borne noise and vibration are of primary concern in underground operations.

In the context of rapid rail transit, noise levels exhibit distinct variations: when trains traverse viaducts at a speed of 80 kmph, the noise level at a distance of 15 m from the tracks registers at 82 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). Throughout the operation phase, 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. Although the trains will run 32 to 34 kmph, the analysis assumes maximum train speed of 80 kmph and the absence of any barriers (Worst-Case scenario). Furthermore, the reduction in vehicular traffic is projected to lead to a decrease in road traffic noise. Source Reference Noise levels at 50 feet (15m) for different sources are given in Table 8 below -

Table 8: Source Reference Noise Levels at 50 Feet: Fixed-Guideway Sources @ 50 mph [2]

Source	Reference SEL (dBA)	Approximate L_{max} (dBA)	Prefer Measurements?
Rail Cars	82	80	NO
Locomotives – Diesel	92	88	NO
Locomotives – Electric	90	86	NO
Diesel Multiple Unit (DMU)	85	81	YES
AGT - Steel Wheel	80	78	YES
AGT - Rubber Tire	78	75	YES
Monorail	82	80	YES
Maglev	72	70	YES
Transit Car Horns (Emergency)	93	90	NO
Transit Car Whistles	81	78	NO
Locomotive Horns			
At Grade Crossing	113	110	NO
From Crossing to 1/8 mile	113-3*(D_x/660)	110	
From 1/8 mile to ¼ mile	110	110	
D_x = distance from grade crossing parallel to tracks			

[2] Source - Transit Noise and Vibration Impact Assessment by Office of Planning and Environment Federal Transit Administration, Department of Transportation, United States of America.

5. Noise Modelling

Noise pollution poses a major health risk to surrounding people. When noise in the form of waves impinges the eardrum, it begins to vibrate, stimulating other delicate tissues and organs in the ear. If the magnitude of noise exceeds the tolerance limits, it is manifested in the form of discomfort leading to annoyance and in extreme cases to loss of hearing. Detrimental effects of noise pollution are not only related to sound pressure level and frequency, but also on the total duration of exposure and the age of the person. Frequency levels and associated mental and physical response of humans are given in **Table 9**.

Table 9: Noise Exposure Levels & Its Effects[3]

Noise Levels dB(A)	Exposure Time	Effects
85	Continuous	Safe
85-90	Continuous	Annoyance and irritation
90-100	Short term	Temporary shift in hearing threshold, generally, with complete recovery
Above 100	Continuous	Permanent loss of hearing
	Short term	Permanent hearing loss can be avoided
100-110	Several years	Permanent deafness
110-120	Few months	Permanent deafness
120	Short term	Extreme discomfort
140	Short term	Discomfort with actual pain
150 and above	Single exposure	Mechanical damage to the ear

It is a well-accepted fact that noise pollution causes fatigue to operating personnel. Provision will be made to keep down the noise level to the extent it is feasible.

5.1 Sources of Noise Pollution

Airborne noise emanates from both at-grade and elevated structures, whereas ground-borne noise and vibration are primarily significant in underground operations. Throughout the operational phase, the predominant noise source will be the movement of metro trains. Fundamental origins of wayside airborne noise encompass:

- Wheel / Rail Noise: Due to wheel /rail roughness
- Propulsion Equipment: Traction motors, cooling fans for TM, reduction gears etc.
- Auxiliary Equipment: Compressors, motor generators, brakes, ventilation systems, other car mounted equipment
- Elevated Structure Noise
  - At low speed (<15 km/h) auxiliary equipment may predominate.
  - At speeds up to approx. 50 km/h, W/R noise predominates.

[3] Source: Hand Book of EIA, Rao & Wooten

- At speeds greater than 50 km/h, the propulsion equipment noise predominates.
- For light weight steel elevated structures, the structure noise can predominate at all speeds above 15 km/h.

5.2 Methodology

The study's methodology is depicted in **Figure 10**. Initial data collection encompassed comprehensive photography along the entire corridor, supplemented by the collection of noise data from various points along the same route. Secondary data regarding micrometeorology was sourced from the IMD. Utilizing the derived estimates, appropriate remedial actions, such as the implementation of Noise Barriers, are recommended.

Figure 10: Methodology

5.3 Noise Model Software: Dhwani Pro

A computer program developed to undertake construction, industrial and traffic noise propagation modelling for which an environmental noise assessment may be required. A variety of scenarios can be created quickly in Dhwani PRO, allowing the user to determine the impact of changing the source, layout and adding/removing the effects of shielding due to noise mitigation devices such as barriers. The ISO 9613-2 General noise calculation model was used which considers frequency dependent attenuation due to geometric divergence, atmospheric absorption, and ground effect.

The equivalent continuous downwind octave-band sound pressure level at a receiver location, Lft (DW) will be calculated for each point source, and its image sources, and for the eight octave bands with nominal mid band frequencies from 63 Hz to 8 kHz, from equation (1):

$L_{fT}(DW) = L_W + D_C – A$ ----- (1)

Lw - Octave-band sound power level

Dc – Directivity Correction

A – Octave-band attenuation

The attenuation term A in equation can be given by

$A = A_{div} + A_{atm} + A_{gr} + A_{bar} + A_{misc}$. --------(2)

Where

A_{div} – Attenuation due to geometrical divergence

A_{atm} – Attenuation due to atmospheric absorption

A_{gr} – Attenuation due to the ground effect

A_{bar} – Attenuation due to a barrier

A_{misc} – Attenuation due to miscellaneous other effects

The equivalent continuous A-weighted downwind sound pressure level will be obtained by summing the contributing time-mean-square sound pressures calculated according to equations (1) and (2) for each point sound source, for each of their image sources, and for each octave band, as specified by equation (3):

$$L_{AT}(DW) = 10 \lg \left\{ \sum_{i=1}^{n} \left[\sum_{j=1}^{8} 10^{0,1\left[L_{fT}(ij) + A_f(j)\right]} \right] \right\} \text{ dB}$$ --------------- (3)

n is the number of contributions i (sources and paths);

j is an index indicating the eight-standard octave-band mid-band frequencies from 63 Hz to 8 kHz

A_f denotes the standard A-weighting

The long-term average A-weighted sound pressure level $L_{AT}(LT)$ shall be calculated according to

$L_{AT}(LT) = L_{AT}(DW) - C_{met}$ (C_{met} – Meteorological Correction) --------- (4)

5.4 Input to the Model

Major noise sources as cumulative noise source has been identified are given above. For convenience of the contours, 500 m grid scale is chosen. The centre of the entire alignment is taken as centre (0.0) for calculating the co-ordinates of noise generating sources within the study area. An attempt has been made to predict the noise levels at different receptors. Coordinates X and Y are taken as input to the model is correlated with grid size and scale (1:100 m). The input to the model has been taken as the cumulative noise of four noise-generating sources as mentioned in section 5.1. The data considered for the modelling are as follows:

- SELref: 85 dB (A) for fixed guide-way Rail cars @ 80 kmph at 15 m distance,
- Ground Factor G for ground attenuation is considered as zero,
- Attenuation due to Shielding between source and receptor is considered as zero,
- Adjustment Factor of +4 is considered for Aerial Structure with Slab Track.
- Day Time has been considered as 6:00 am to 10:00 pm and Night time noise has been considered from 10:00 pm to 6:00 am.

For determining the reference noise level for each noise source, following equation is used –

$$L_{eq} = \left[10^{\left(L_{eq} / 10 \right)} + 10^{\left(L_{eq} / 10 \right)} \right]$$

Where,

$$L_{eqL}\,(h) = SEL_{ref} + 10 \log (N_{locos}) + K \log\left(\frac{S}{50}\right) + 10 \log (V) - 35.6$$

Where K = -10 for passenger diesel; = 0 for DMU; = +10 for electric

Where,

N_{locos}	= average number of locomotives per train
N_{cars}	= average number of cars per train
S	= train speed, in miles per hour
V	= average hourly volume of train traffic, in trains per hour

So, as per the formula mentioned above, the reference noise level due to operation of metro train at the speed of 80 kmph is calculated to be 80 dB(A) at 5 m distance.

5.5 Results and Conclusion

The noise modelling has been carried out considering two scenarios viz. Without Noise Barrier and with noise barrier. Cumulative impacts on the receptors with and without noise barrier for Lines 1A, 2A, 3A and 4A are presented in **Table 10** to **Table 13** whereas the Noise Modelling contours are presented in **Figure 11** to **Figure 18**.

5.5.1 Line 1A

5.5.1.1 Day Time

Table 10: Results of Noise Modelling for Line 1A (Day Time)

Sampling Code	Sampling Location	Latitude	Longitude	Baseline Noise level dB(A)	Predicted Cumulative Noise Leve without barrier dB(A)	Predicted Cumulative Noise Leve with barrier dB(A)
NQ1	Ashokwan	21° 0'46.64" N	79° 2'42.53" E	50.1	73.7	62.8
NQ2	Dongargaon	20°59'12.64" N	79° 1'47.68" E	47.2	69.2	63.7
NQ3	Mohgaon	20°57'35.33" N	79° 1'2.72" E	51.6	73.0	68.2
NQ4	Meghdoot CIDCO	20°56'11.89" N	79° 0'25.86" E	62.7	77.3	66.9
NQ5	Butibori Police Station	20°55'45.83" N	79° 0'14.09" E	59.8	70.4	62.0
NQ6	MHADA Colony	20°55'42.27" N	78°59'56.53" E	61.6	71.7	63.2
NQ7	MIDC KEC	20°55'45.70" N	78°58'11.06" E	73.6	76.2	65.8
NQ8	MIDC ESR	20°55'24.14" N	78°57'51.55" E	68.0	74.9	64.7
NQ9	Jijamata High School & Jr. College	20°55'46.75" N	79° 0'18.26" E	51.6	74.9	60.8
NQ10	Rachana Hospital	20°55'43.41"N	79° 0'0.56"E	54.2	73.6	63.2

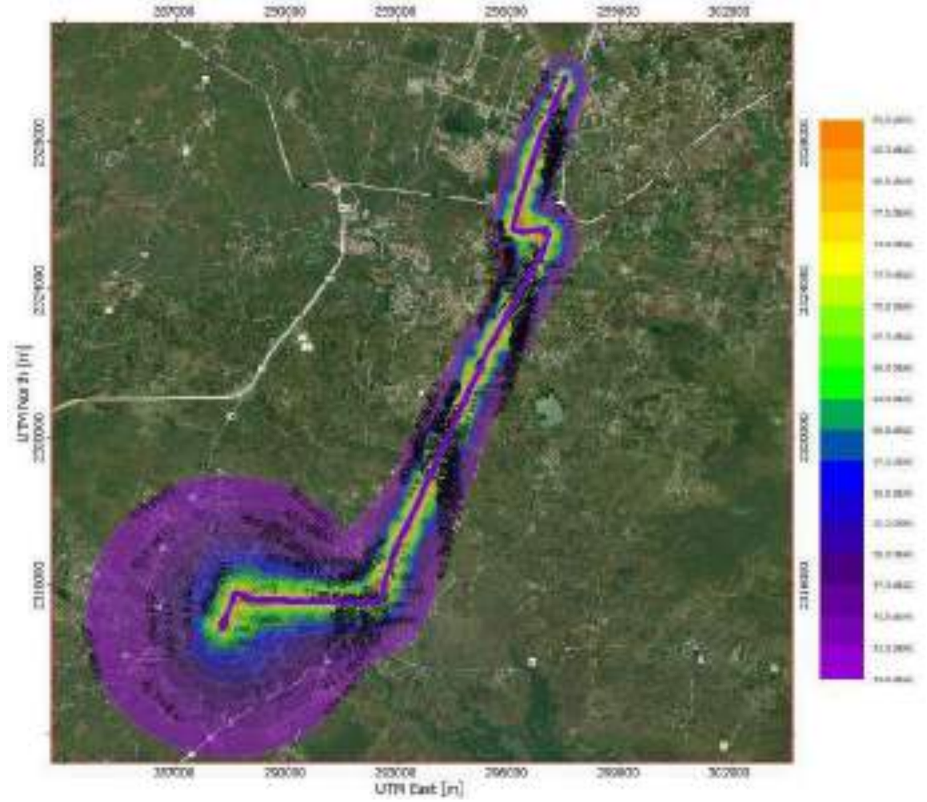

Figure 11: Cumulative Noise Level Contours without Noise Barrier for line 1A (Day Time)

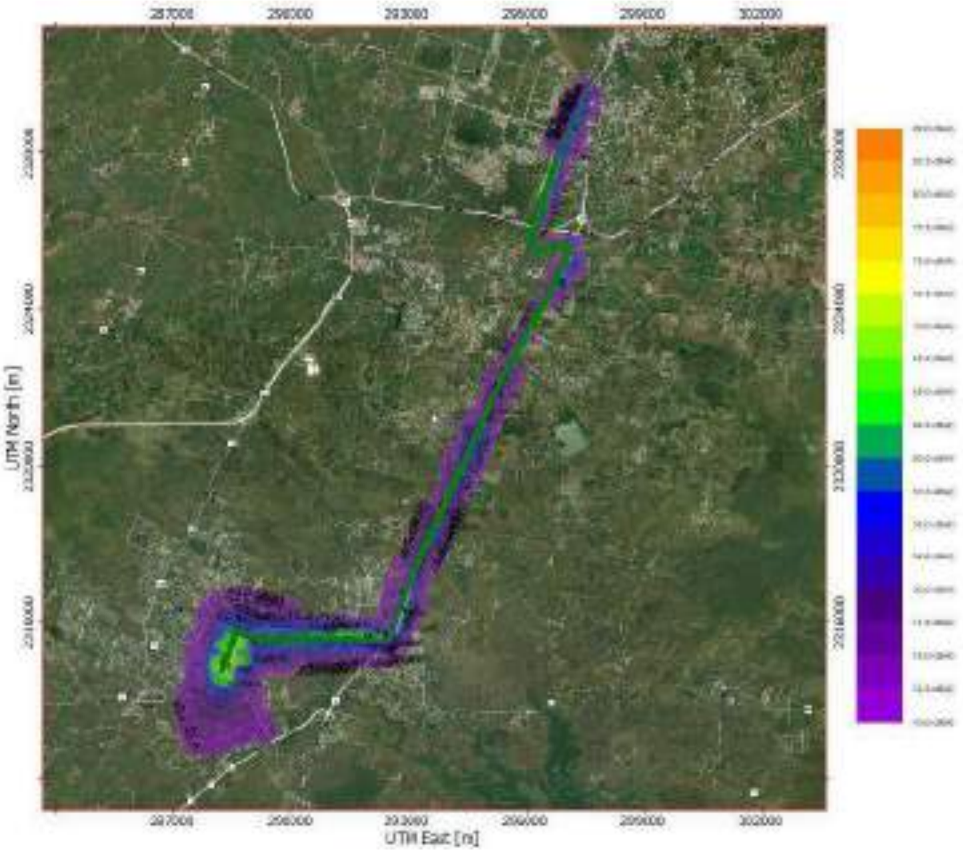

Figure 12: Cumulative Noise Level Contours with Noise Barrier for line 1A (Day time)

5.5.1.2 Night Time

Table 11: Results of Noise Modelling for Line 1A (Night Time)

Sampling Code	Sampling Location	Latitude	Longitude	Baseline Noise level dB(A)	Predicted Cumulative Noise Leve without barrier dB(A)	Predicted Cumulative Noise Leve with barrier dB(A)
NQ1	Ashokwan	21° 0'46.64" N	79° 2'42.53" E	36.1	73.7	62.8
NQ2	Dongargaon	20°59'12.64" N	79° 1'47.68" E	30.6	69.2	57.7
NQ3	Mohgaon	20°57'35.33" N	79° 1'2.72" E	40.5	73.0	62.2
NQ4	Meghdoot CIDCO	20°56'11.89" N	79° 0'25.86" E	49.4	77.1	66.8
NQ5	Butibori Police Station	20°55'45.83" N	79° 0'14.09" E	48.3	70.0	58.4
NQ6	MHADA Colony	20°55'42.27" N	78°59'56.53" E	49.8	71.3	58.6
NQ7	MIDC KEC	20°55'45.70" N	78°58'11.06" E	52.5	72.8	61.8
NQ8	MIDC ESR	20°55'24.14" N	78°57'51.55" E	54.9	74.0	63.8
NQ9	Jijamata High School & Jr. College	20°55'46.75" N	79° 0'18.26" E	44.7	74.9	60.4
NQ10	Rachana Hospital	20°55'43.41"N	79° 0'0.56"E	45.6	73.6	63.1

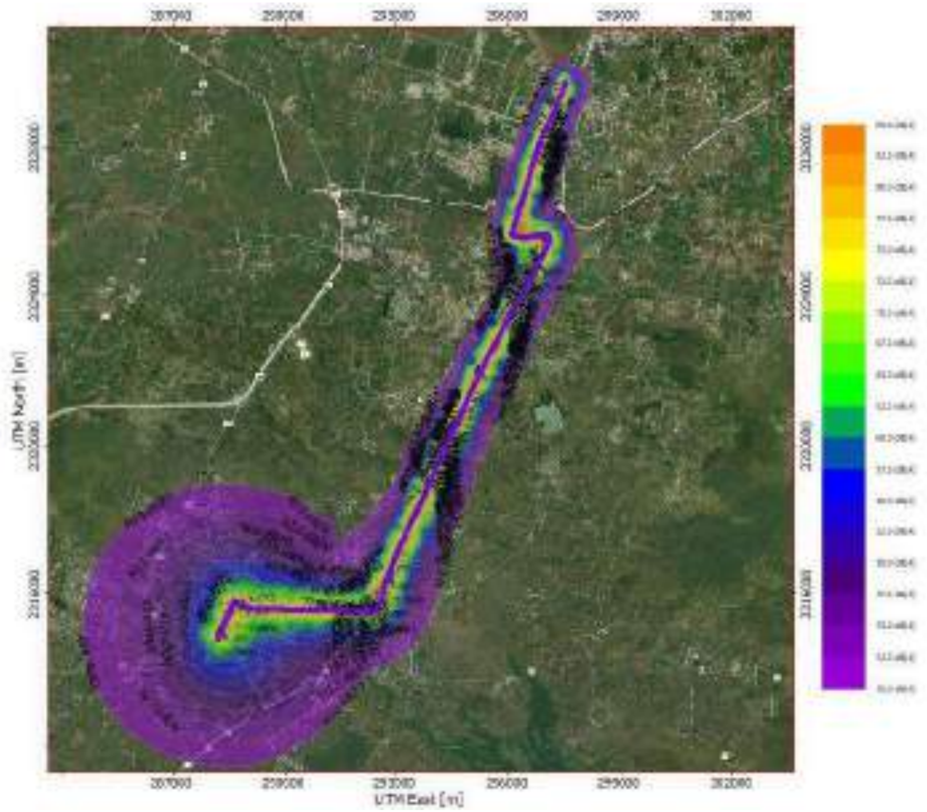

Figure 13: Cumulative Noise Level Contours without Noise Barrier for line 1A Night Time)

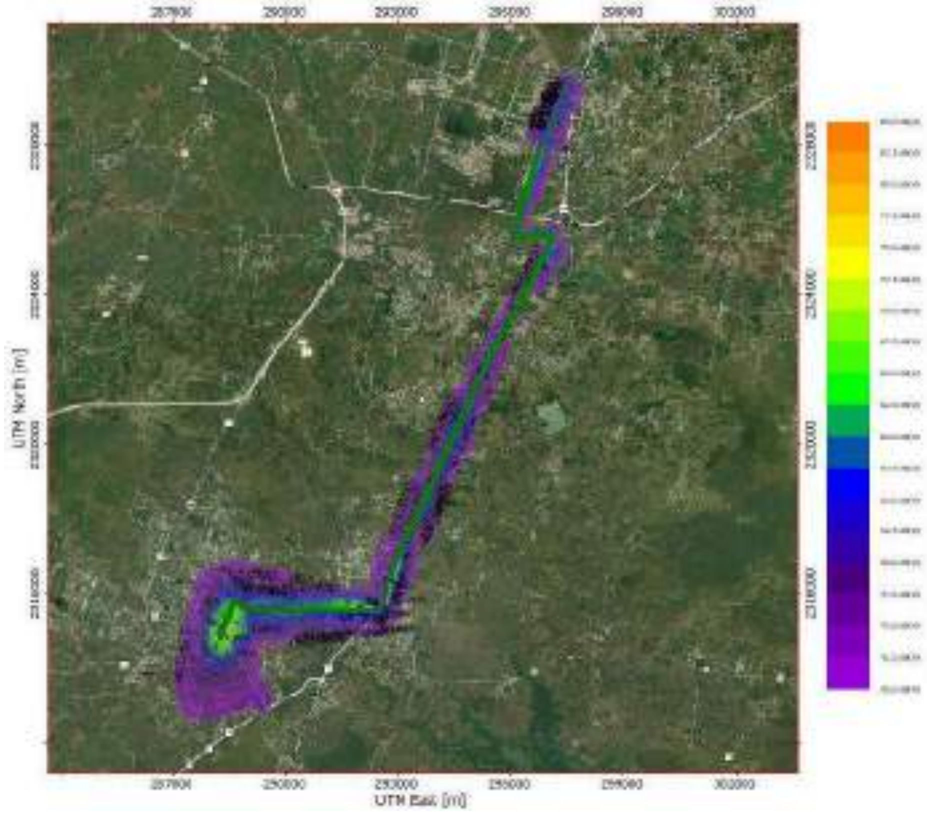

Figure 14: Cumulative Noise Level Contours with Noise Barrier for line 1A (Night Time)

5.5.2 Line 2A

5.5.2.1 During Day Time

Table 12: Results of Noise Modelling for Line 2A (Day Time)

Sampling Code	Sampling Location	Latitude	Longitude	Baseline Noise level dB(A)	Predicted Cumulative Noise Leve without barrier dB(A)	Predicted Cumulative Noise Level with barrier dB(A)
NQ11	Pili Nadi	21°11'32.28"N	79° 7'44.11"E	60.3	76.1	64.3
NQ12	Khasara fata	21°11'49.79" N	79° 8'6.70" E	61.4	73.0	64.2
NQ13	All India Radio	21°12'9.97"N	79° 8'37.43"E	64.2	72.2	65.4
NQ14	Khairi fata	21°12'40.05" N	79° 9'32.12" E	60.9	73.5	62.7
NQ15	Lok Vihar	21°12'54.36" N	79°10'1.8" E	54.9	76.0	60.9
NQ16	Lekha Nagar Asha Hospital and Asharam College & School of Nursing	21°13'9.11" N	79°10'35.50" E	56.8	76.4	61.9
NQ17	Kamptee Police station**	21°12'55.03" N	79°11'32.30" E	59.8	69.3	61.4
NQ18	Kamptee Municipal Council	21°12'47.51" N	79°11'56.43" E	55.1	70.3	59.4
NQ19	Dragon Palace	21°13'1.00"N	79°12'30.16"E	54.9	76.2	65.8
NQ20	Kanhan River	21°13'21.24" N	79°13'26.03" E	52.1	72.2	58.9
NQ21	Delhi Public School (DPS), Khairy, Kamptee Road, Nagpur	21°12'49.14" N	79° 9'35.39" E	50.1	63.0	52.5

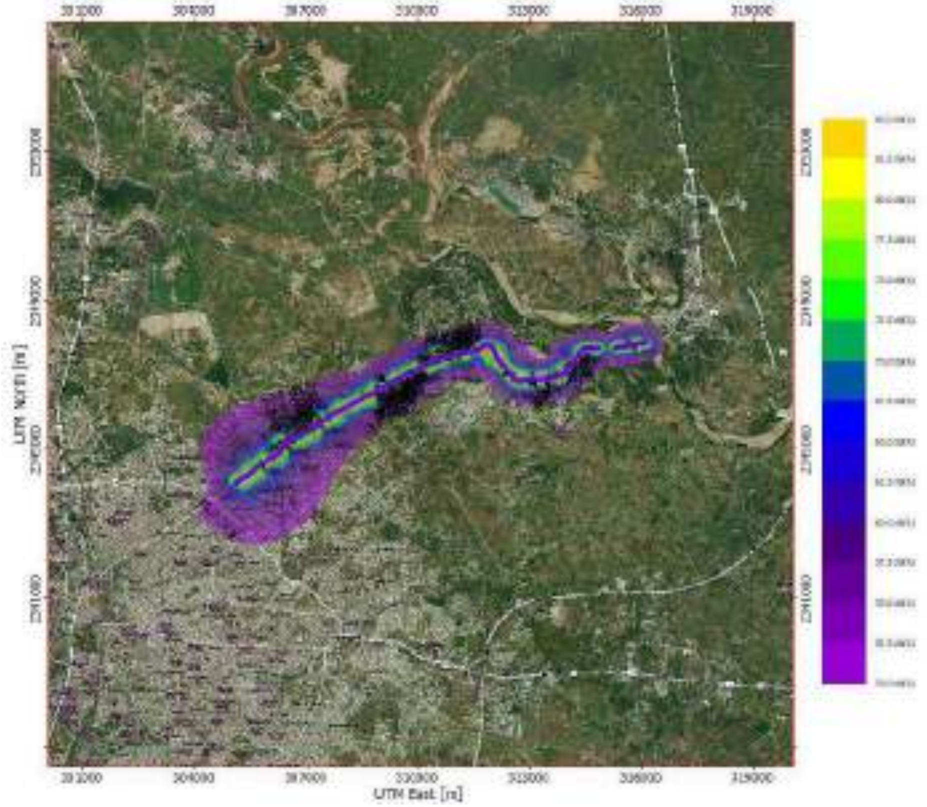

Figure 15: Cumulative Noise Level Contours without Noise Barrier for line 2A (Day Time)

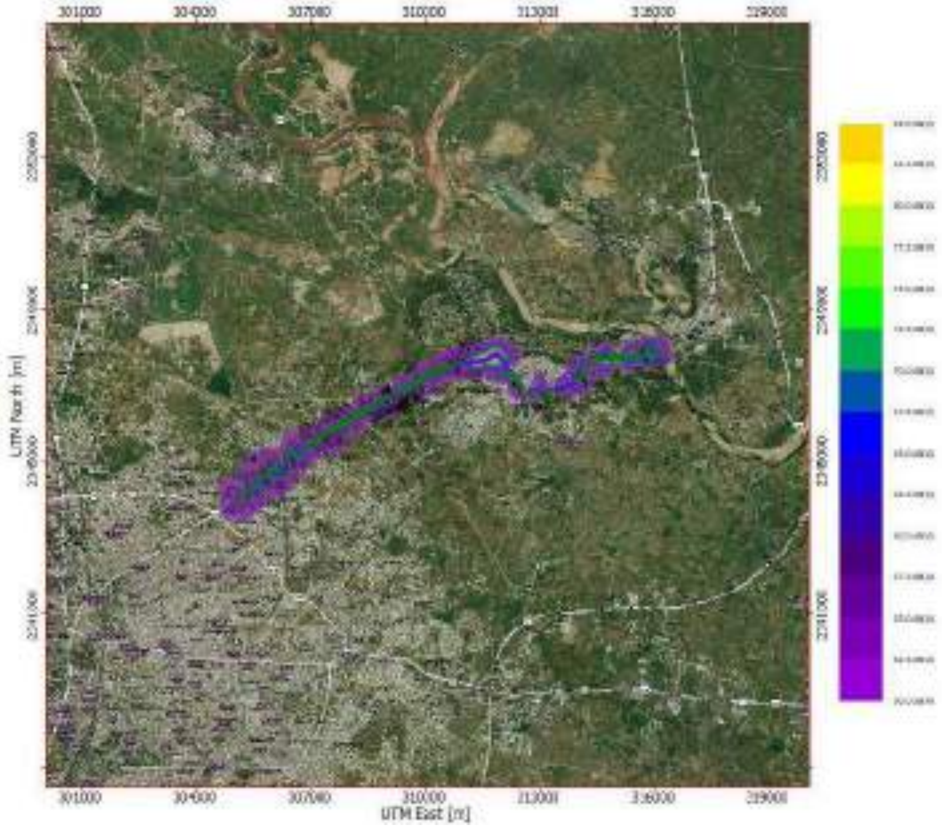

Figure 16: Cumulative Noise Level Contours with Noise Barrier for line 2A (Day Time)

5.5.2.2 Night Time

Table 13: Results of Noise Modelling for Line 2A (Night Time)

Sampling Code	Sampling Location	Latitude	Longitude	Baseline Noise level dB(A)	Predicted Cumulative Noise Leve without barrier dB(A)	Predicted Cumulative Noise Level with barrier dB(A)
NQ11	Pili Nadi	21°11'32.28"N	79° 7'44.11"E	51.3	76.0	62.5
NQ12	Khasara fata	21°11'49.79" N	79° 8'6.70" E	52.1	72.7	61.4
NQ13	All India Radio	21°12'9.97"N	79° 8'37.43"E	50.4	71.5	59.8
NQ14	Khairi fata	21°12'40.05" N	79° 9'32.12" E	51.9	73.3	58.9
NQ15	Lok Vihar	21°12'54.36" N	79°10'1.8" E	45.7	76.0	59.8
NQ16	Lekha Nagar	21°13'9.11" N	79°10'35.50" E	44.9	76.3	60.4
	Asha Hospital and Asharam College & School of Nursing					
NQ17	Kamptee Police station**	21°12'55.03" N	79°11'32.30" E	50.1	68.8	57.2
NQ18	Kamptee Municipal Council	21°12'47.51" N	79°11'56.43" E	45.6	70.2	57.7
NQ19	Dragon Palace	21°13'1.00"N	79°12'30.16"E	44.2	76.1	55.8
NQ20	Kanhan River	21°13'21.24" N	79°13'26.03" E	40.6	72.0	58.0
NQ21	Delhi Public School (DPS), Khairy, Kamptee Road, Nagpur	21°12'49.14" N	79° 9'35.39" E	43.6	62.8	49.9

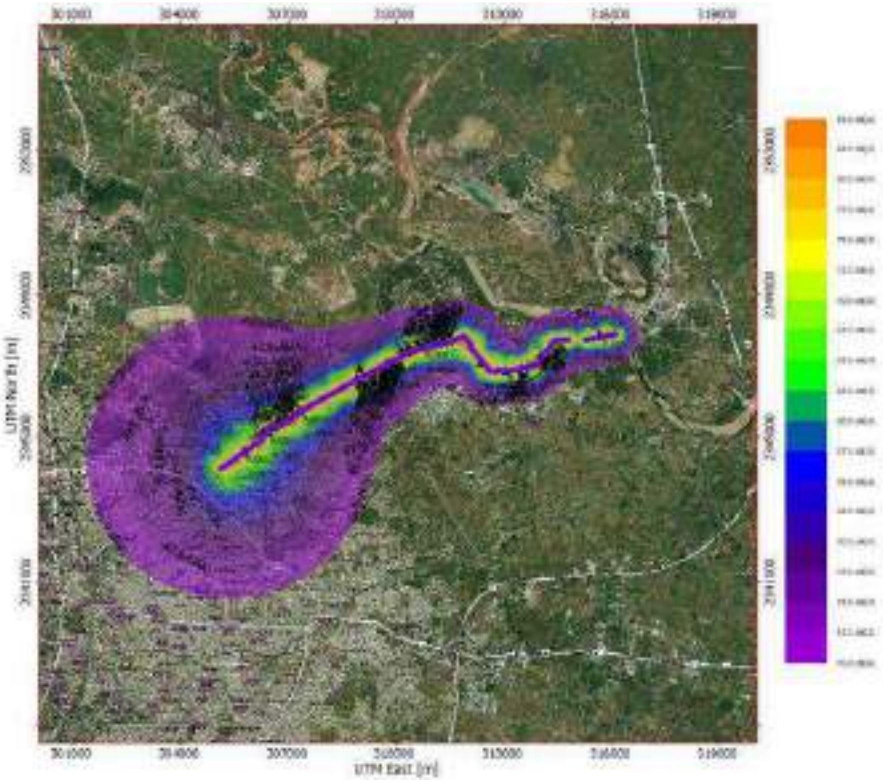

Figure 17: Cumulative Noise Level Contours without Noise Barrier for line 2A (Night Time)

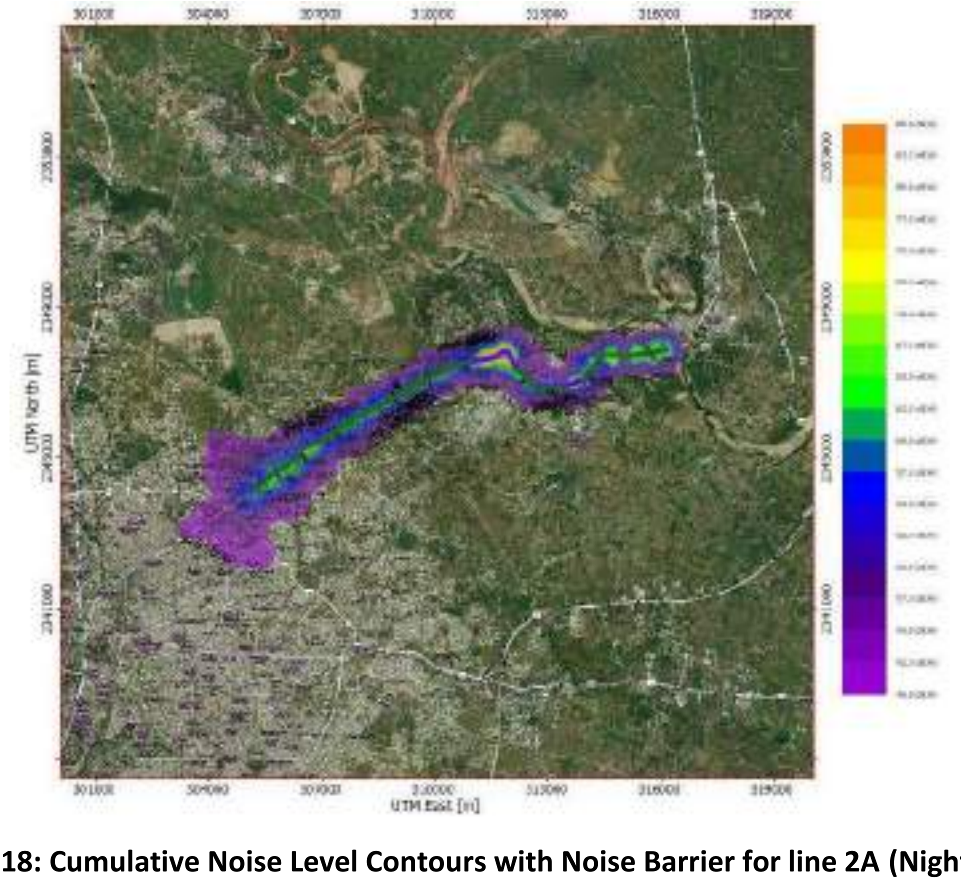

Figure 18: Cumulative Noise Level Contours with Noise Barrier for line 2A (Night Time)

5.5.3 Line 3A

5.5.3.1 Day Time

Table 14: Results of Noise Modelling for Line 3A (Day Time)

Sampling Code	Sampling Location	Latitude	Longitude	Baseline Noise level dB(A)	Predicted Cumulative Noise Leve without barrier dB(A)	Predicted Cumulative Noise Leve with barrier dB(A)
NQ22	Hingna Mount View	21° 6'12.21" N	78°59'24.77" E	56.9	73.6	63.0
NQ23	Rajiv Nagar	21° 5'50.78" N	78°58'51.05" E	60.3	72.9	63.4
NQ24	Wanadongri	21° 5'32.24" N	78°58'24.93" E	59.8	75.4	66.3
NQ25	APMC	21° 5'8.39" N	78°58'18.37" E	61.2	76.2	65.9
NQ26	Raipur	21° 4'37.69" N	78°58'7.10" E	64.1	75.8	67.1
NQ27	Hingna Bus Station	21° 4'20.91" N	78°57'54.13" E	62.7	76.4	66.1
NQ28	Hingna	21° 4'26.42" N	78°57'22.52" E	67.4	74.4	64.4
NQ29	Rural Hospital - Hingna	21° 4'29.18" N	78°57'16.31" E	53.2	68.6	66.4
NQ30	YCCE	21° 5'43.27" N	78°58'41.14" E	55.4	69.8	59.0
NQ31	Shalinitai Meghe Hospital	21° 5'42.77" N	78°58'29.87" E	56.6	75.2	63.1

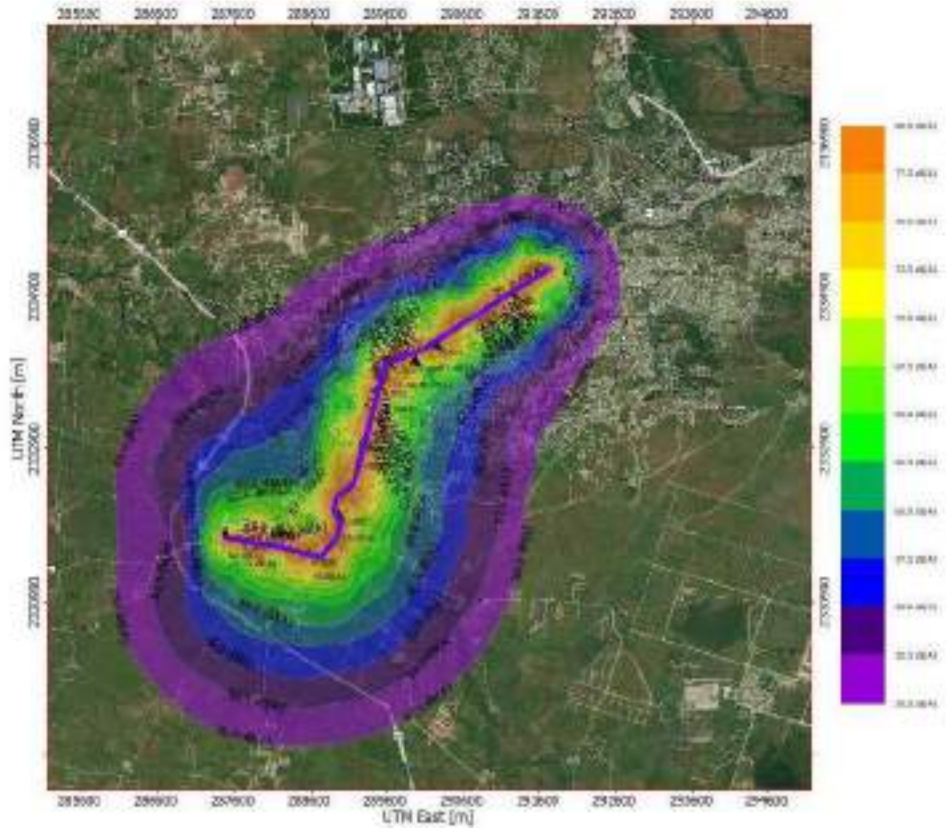

Figure 19: Cumulative Noise Level Contours without Noise Barrier for line 3A (Day Time)

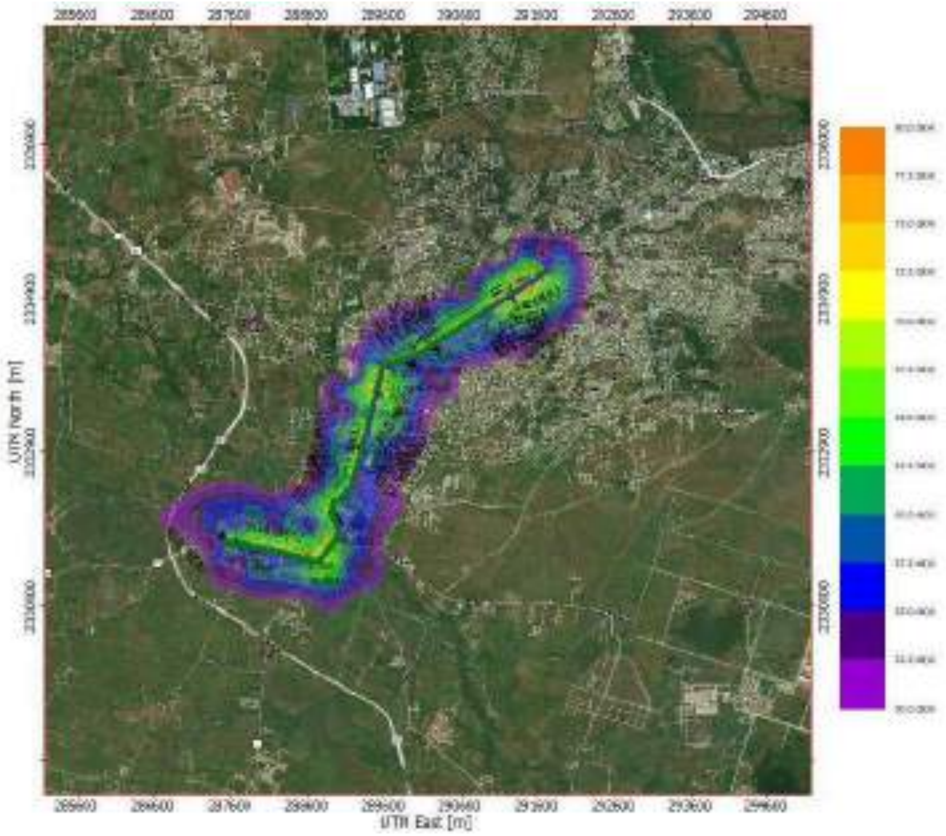

Figure 20: Cumulative Noise Level Contours with Noise Barrier for line 3A (Day Time)

5.5.3.2 Night Time

Table 15: Results of Noise Modelling for Line 3A (Night Time)

Sampling Code	Sampling Location	Latitude	Longitude	Baseline Noise level dB(A)	Predicted Cumulative Noise Leve without barrier dB(A)	Predicted Cumulative Noise Leve with barrier dB(A)
NQ22	Hingna Mount View	21° 6'12.21" N	78°59'24.77" E	42.3	73.5	62.9
NQ23	Rajiv Nagar	21° 5'50.78" N	78°58'51.05" E	46.9	72.7	60.6
NQ24	Wanadongri	21° 5'32.24" N	78°58'24.93" E	44.8	75.3	65.3
NQ25	APMC	21° 5'8.39" N	78°58'18.37" E	55.1	75.9	65.5
NQ26	Raipur	21° 4'37.69" N	78°58'7.10" E	53.7	75.5	64.4
NQ27	Hingna Bus Station	21° 4'20.91" N	78°57'54.13" E	55.9	76.2	65.9
NQ28	Hingna	21° 4'26.42" N	78°57'22.52" E	52.1	73.5	63.4
NQ29	Rural Hospital - Hingna	21° 4'29.18" N	78°57'16.31" E	46.8	68.5	66.2
NQ30	YCCE	21° 5'43.27" N	78°58'41.14" E	43.9	69.6	56.8
NQ31	Shalinitai Meghe Hospital	21° 5'42.77" N	78°58'29.87" E	47.8	75.1	62.2

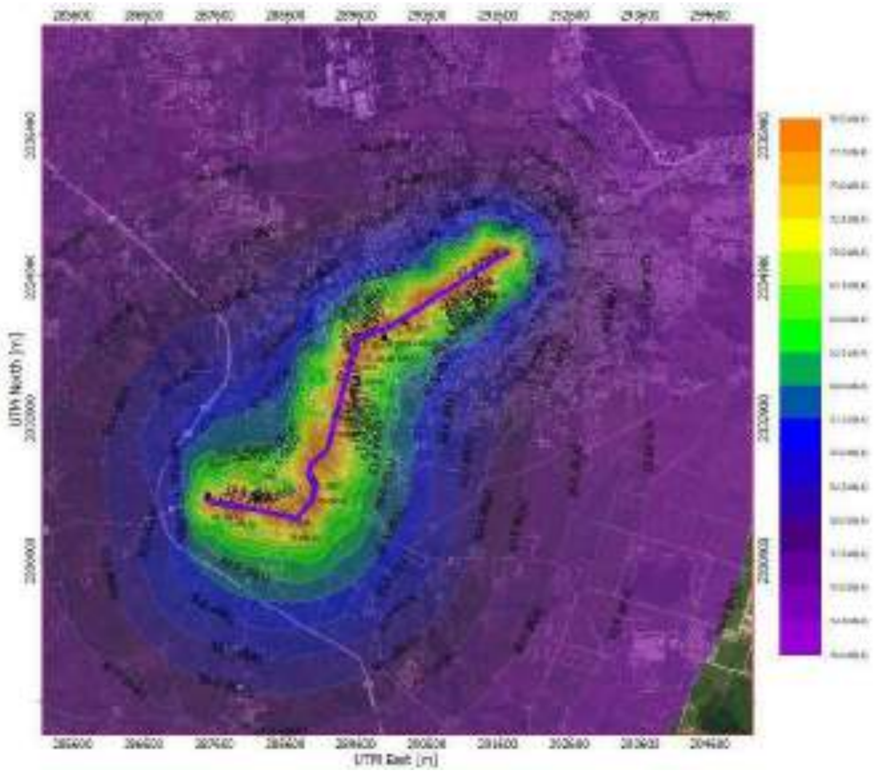

Figure 21: Cumulative Noise Level Contours without Noise Barrier for line 3A (Night Time)

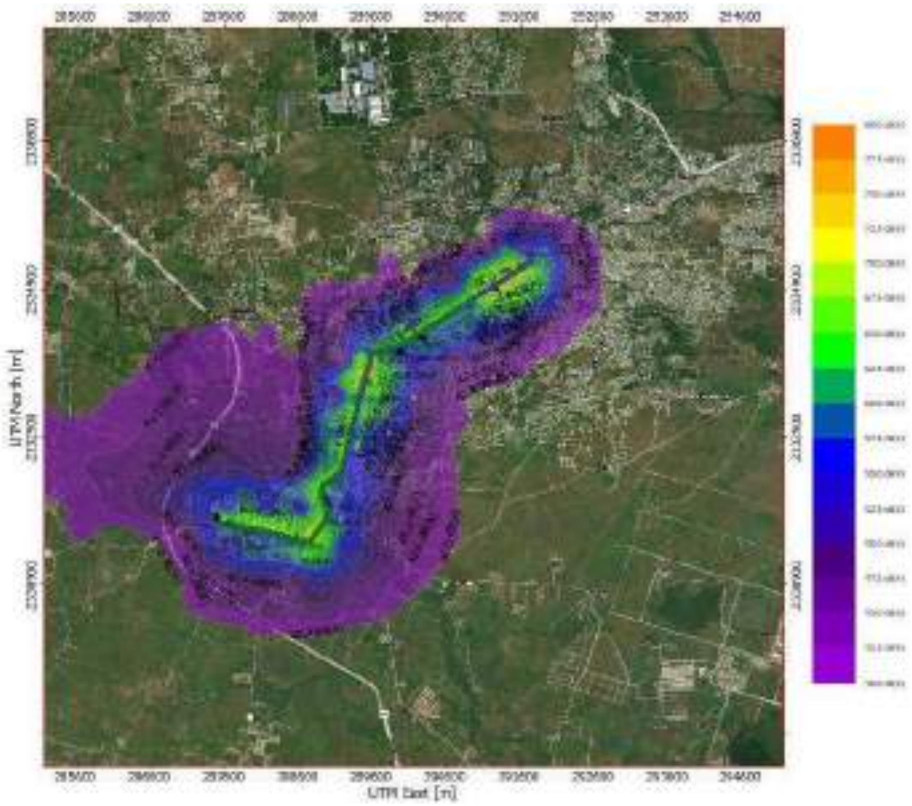

Figure 22: Cumulative Noise Level Contours with Noise Barrier for line 3A (Night Time)

5.5.4 Line 4A

5.5.4.1 Day Time

Table 16: Results of Noise Modelling for Line 4A (Day Time)

Sampling Code	Sampling Location	Latitude	Longitude	Baseline Noise level dB(A)	Predicted Cumulative Noise Leve without barrier dB(A)	Predicted Cumulative Noise Leve with barrier dB(A)
NQ32	Pardi	21° 8'58.10" N	79° 9'38.54" E	59.8	74.0	63.9
NQ33	Kapsi Kh.	21° 8'37.52" N	79°10'33.68" E	62.3	72.7	64.3
NQ34	Transport Nagar	21° 8'25.97" N	79°11'41.65" E	64.9	72.4	65.8

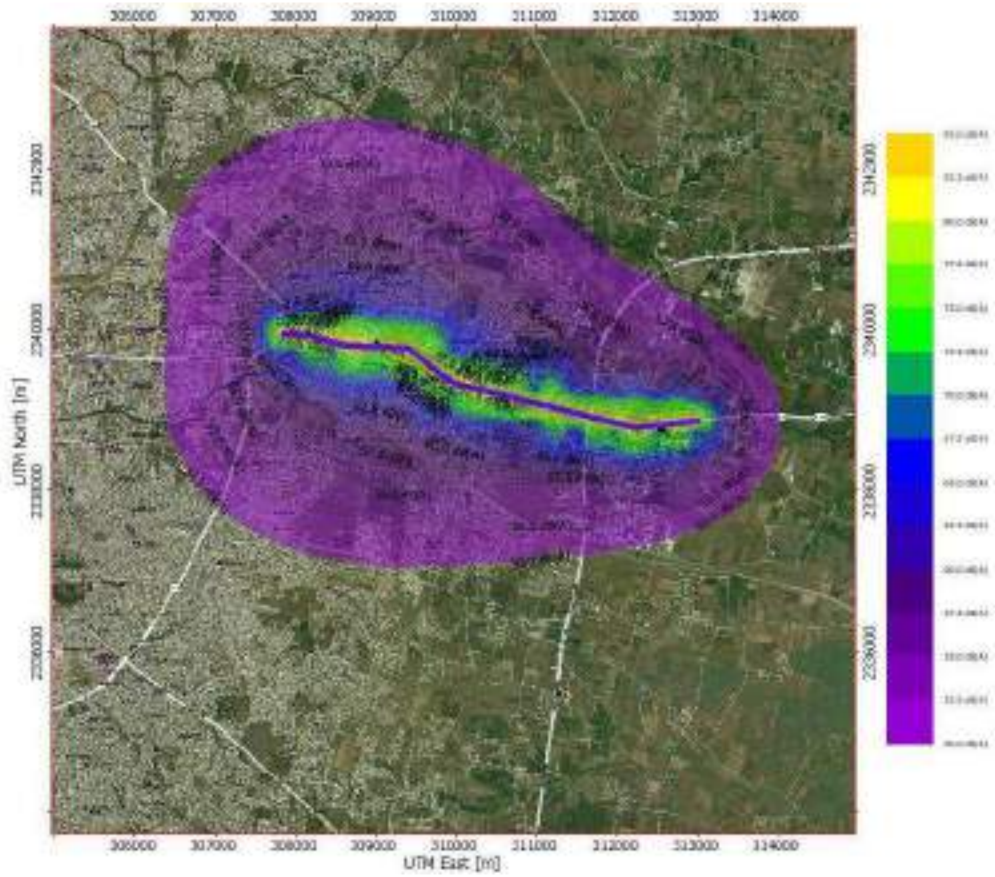

Figure 23: Cumulative Noise Level Contours without Noise Barrier for line 4A (Day Time)

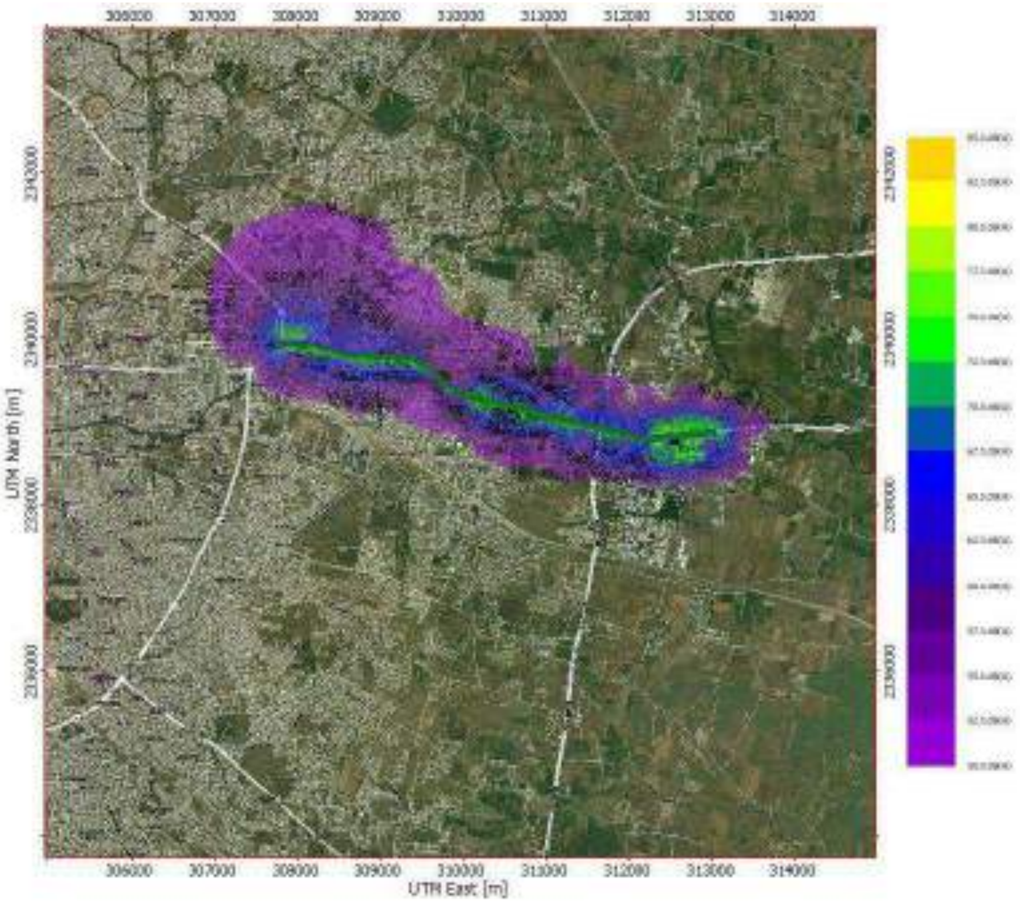

Figure 24: Cumulative Noise Level Contours with Noise Barrier for line 4A (Day Time)

5.5.3.2 Night Time

Table 17: Results of Noise Modelling for Line 4A (Night Time)

Sampling Code	Sampling Location	Latitude	Longitude	Baseline Noise level dB(A)	Predicted Cumulative Noise Leve without barrier dB(A)	Predicted Cumulative Noise Leve with barrier dB(A)
NQ32	Pardi	21° 8'58.10" N	79° 9'38.54" E	49.1	73.8	61.9
NQ33	Kapsi Kh.	21° 8'37.52" N	79°10'33.68" E	50.2	72.3	60.4
NQ34	Transport Nagar	21° 8'25.97" N	79°11'41.65" E	51.3	71.6	59.5

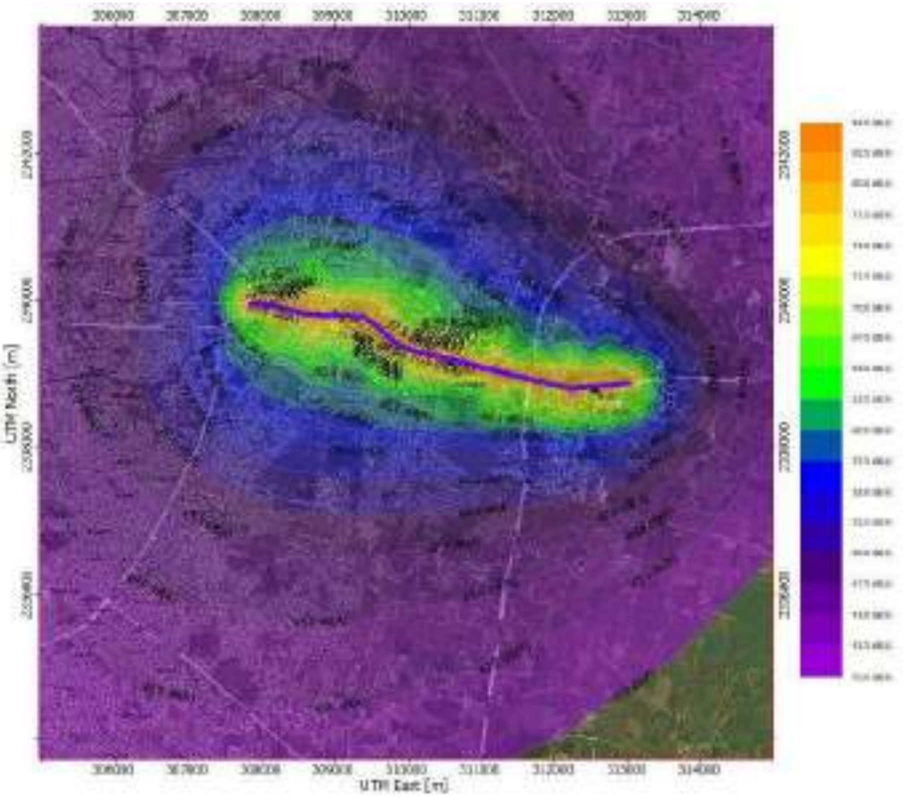

Figure 25: Cumulative Noise Level Contours without Noise Barrier for line 4A (Night Time)

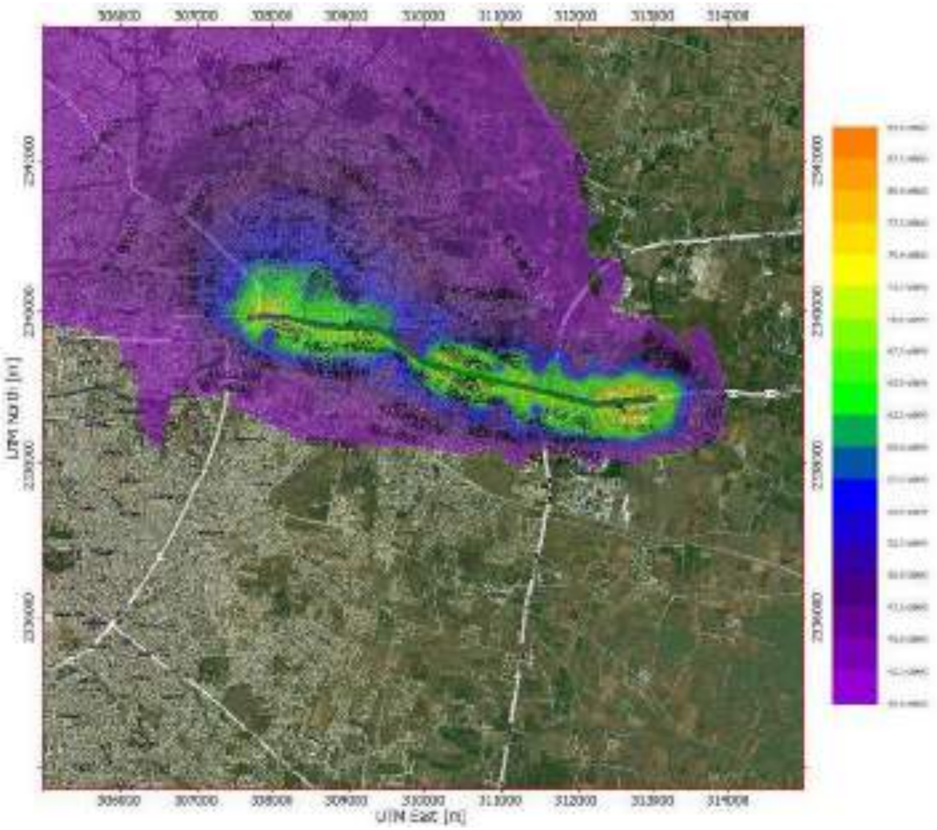

Figure 26: Cumulative Noise Level Contours with Noise Barrier for line 4A (Night Time)

Cumulative future noise levels in the project area are modelled based on existing measured sound levels and predicted noise levels due to future daily metro rail operations.

5.6 Mitigation measures

Mitigating noise pollution during the operation phase of metro construction is essential to ensure the well-being of nearby residents and the overall environment. Here are some effective mitigation measures:

- **Noise Barriers and Enclosures:** Install noise barriers or enclosures around construction sites, particularly in high-noise areas. These structures can help contain and reduce noise propagation to the surrounding environment.
- **Source Control:** Apply noise-reducing modifications to DG Set and other noise generating machinery, such as mufflers and silencers.
- **Regular Monitoring:** Set up a noise monitoring system to assess noise levels in real-time.
- **Vegetation and Greenery:** Plant trees, shrubs, and vegetation around the construction site as natural sound barriers. Greenery can absorb and attenuate noise, creating a more pleasant environment for residents.
- **Continuous Improvement:** Regularly review and assess the effectiveness of noise mitigation measures. Implement feedback from stakeholders and make adjustments as needed to improve noise control.

By implementing a combination of these measures, metro projects can significantly reduce noise pollution during the operation phase, ensuring a more harmonious coexistence with the surrounding community.

5.7 Noise Barriers

A noise barrier is an exterior structure designed to protect sensitive land uses from noise pollution. Noise barriers are the most effective method of mitigating roadway, railway, and industrial noise sources - other than cessation of the source activity or use of source controls. Noise barriers, often referred to as ‘Sound abatement walls’ are commonly constructed using steel, concrete, masonry, wood, plastics, poly carbonate, acrylic, insulating wool, or composites. Some noise barriers may consist of a masonry wall or earthwork, or a combination thereof (such as a wall atop an earth berm). Noise barriers fall in one of the two categories: absorptive and reflective. Absorptive barriers, as the name suggests, absorb sound energy emanating from the source of sound.

A porous surface material and sound-dampening content material is said to be absorptive. This means little noise is reflected back towards the source or elsewhere. Barriers without any added absorptive treatment or design, such as block, concrete, polycarbonate sheet, glass, acrylic sheet, wood or metal, are considered reflective. This means, in the case of metro rail applications for example, that sound energy actually bounces from one side of the metro track to the other. Reflective barriers may either be on one side or on both sides of the track. Noise barriers can be extremely effective tools for noise pollution abatement. These can be given various shapes like parabolic, partial curve, inclined or even straight to meet desired aesthetic appeal or different land-use pattern.

5.7.1 Noise Barriers for Elevated Corridors

The noise generated by elevated rail can undergo multiple reflections between the parapet side walls and the train surfaces and finally escape into the surrounding. To reduce this effect the side walls of the viaduct can be treated with Micro-perforated aluminium noise barrier with combination of polycarbonate sheet. Typical drawing of a Noise Barrier is shown in the **Figure 27,** elevation in **Figure 28** and cross section is shown in **Figure 29.** below –

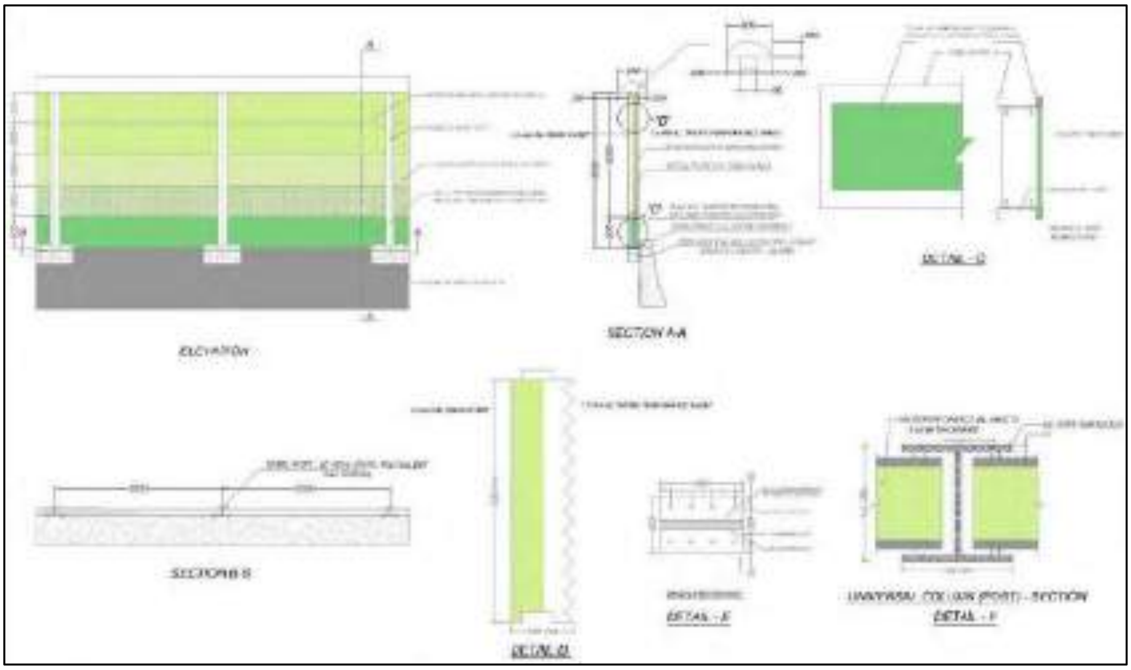

Figure 27: Typical Section of Noise Barrier

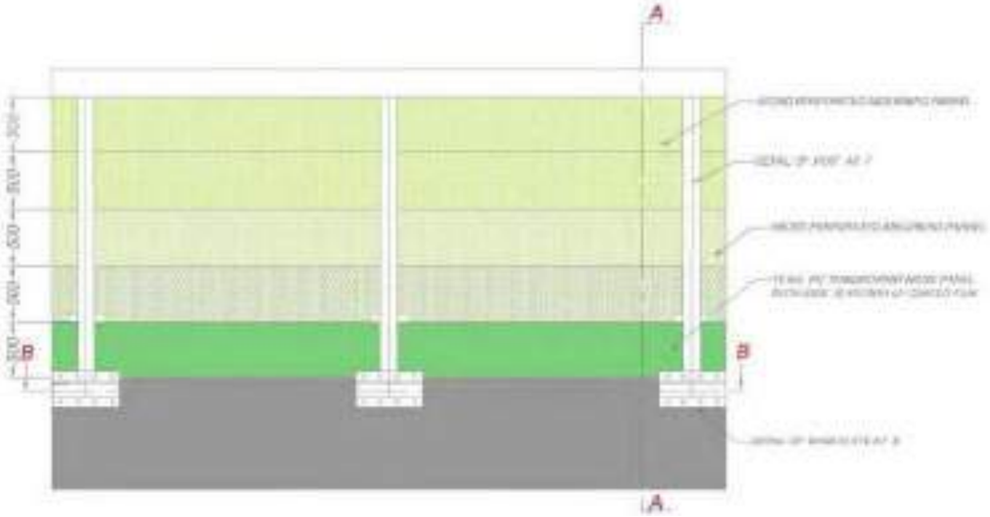

Figure 28: Typical Elevation of the Noise Barrier

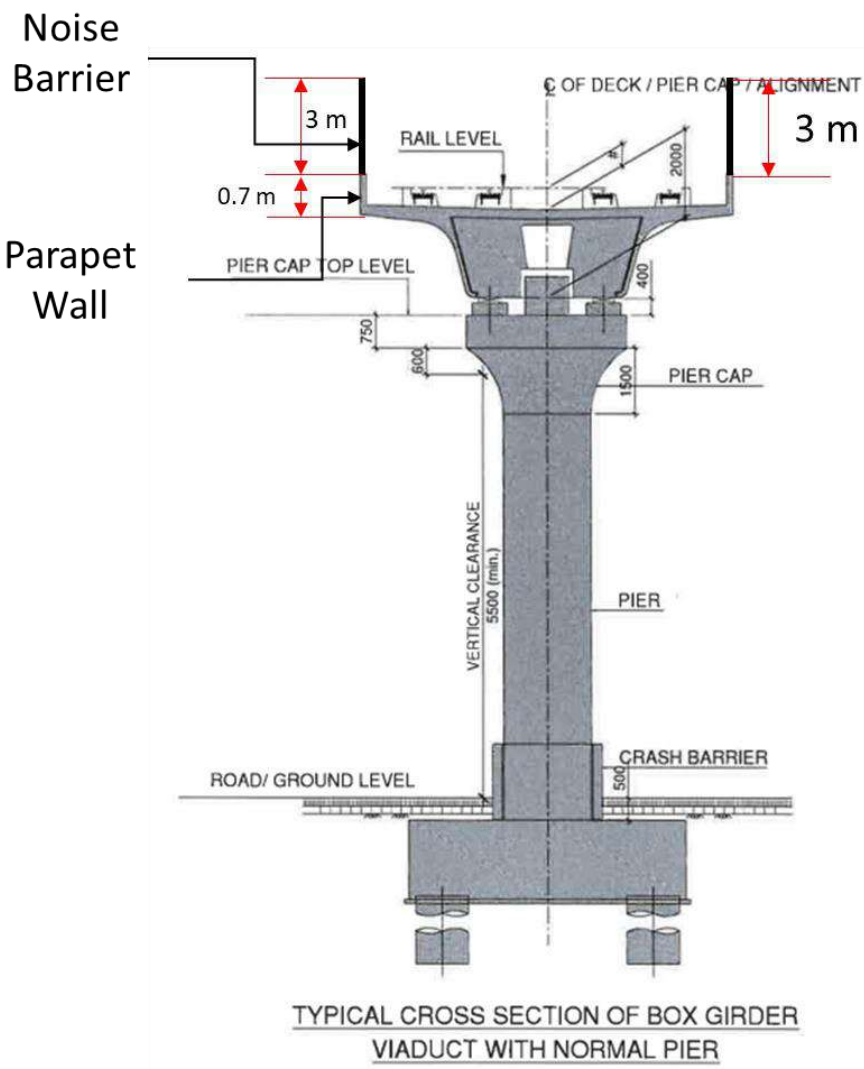

Figure 29: Cross section of the Box girder showing location of Noise Barrier

5.7.2 Location of Noise Barriers

The placement of noise barriers in a metro project is a multifaceted process that involves a thorough understanding of noise sources, affected areas, local geography, urban planning, aesthetics, safety, materials, and budget constraints. By carefully considering these factors, Noise barriers have been considered at sensitive locations such as Schools, Colleges, Hospitals and residential areas. For Line 1 A, two locations i.e., Near Jijamata High School & Jr. College and Near Rachana Hospital are considered. For Line 2A, two locations i.e., Near Asha Hospital and Asharam College & School of Nursing and Near Delhi Public School (DPS), Khairy, Kamptee Road, Nagpur are considered. For Line 3A, at the start, many hotels and residential area is observed. Hence 500 m of barriers on either side are proposed. Also, noise barriers have been proposed near Near YCCE & Shalinitai Meghe Hospital for Line 3A. For Line 4A, two locations viz. Pardi (Residential area) and Kapsi (Residential area) have been considered.

Details of location and costing of Noise Barriers proposed are given in **Table 18** as follows –

Table 18: Details of Noise Barriers considered

Line	Location	Significance	Length (m)	Height (m)	Area (sq.m)	Estimated cost (@₹5000/sq.m)
1A	MHADA Colony station towards Butibori Police Station on either side of the track (Ch. 33933 to 34233)	Jijamata High School & Jr. College (Sensitive Receptor)	300	3	900	45,00,000.00
	Butibori Police Station towards MHADA Colony station on either side of the track (Ch. 33540 to 33640)	Rachana Hospital (Sensitive Receptor)	100	3	300	15,00,000.00
2A	Lekhanagar Station towards Cantonment on either side (Ch. -7199 to -7349)	Asha Hospital and Asharam College & School of Nursing (Sensitive Receptor)	150	3	450	22,50,000.00
	Khairi Fata Station towards LokVihar Station on either side of the track (Ch. -5250 to -5400)	Delhi Public School (DPS), Khairi (Sensitive Receptor)	150	3	450	22,50,000.00
3A	Start of the line upto 500 m on either side (Ch. 18218 to 18718)	Hotels and residential area	500	3	1500	75,00,000.00
	From Ch. 19907 to 20107	YCCE and Shalinitai Meghe Hospital (both	500	3	1500	75,00,000.00

		Sensitive Receptors are adjacent to each other)				
4A	From Ch. - 1215 to - 1365	Pardi (Residential area)	150	3	450	22,50,000.00
	From Cg. - 1365 to - 1515	Kapsi (Residential area)	150	3	450	22,50,000.00
				Total	**4500**	**3,00,00,000.00**

--------o----- End of report -----o--------

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

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.

Annexure - 12

MAHA-METRO

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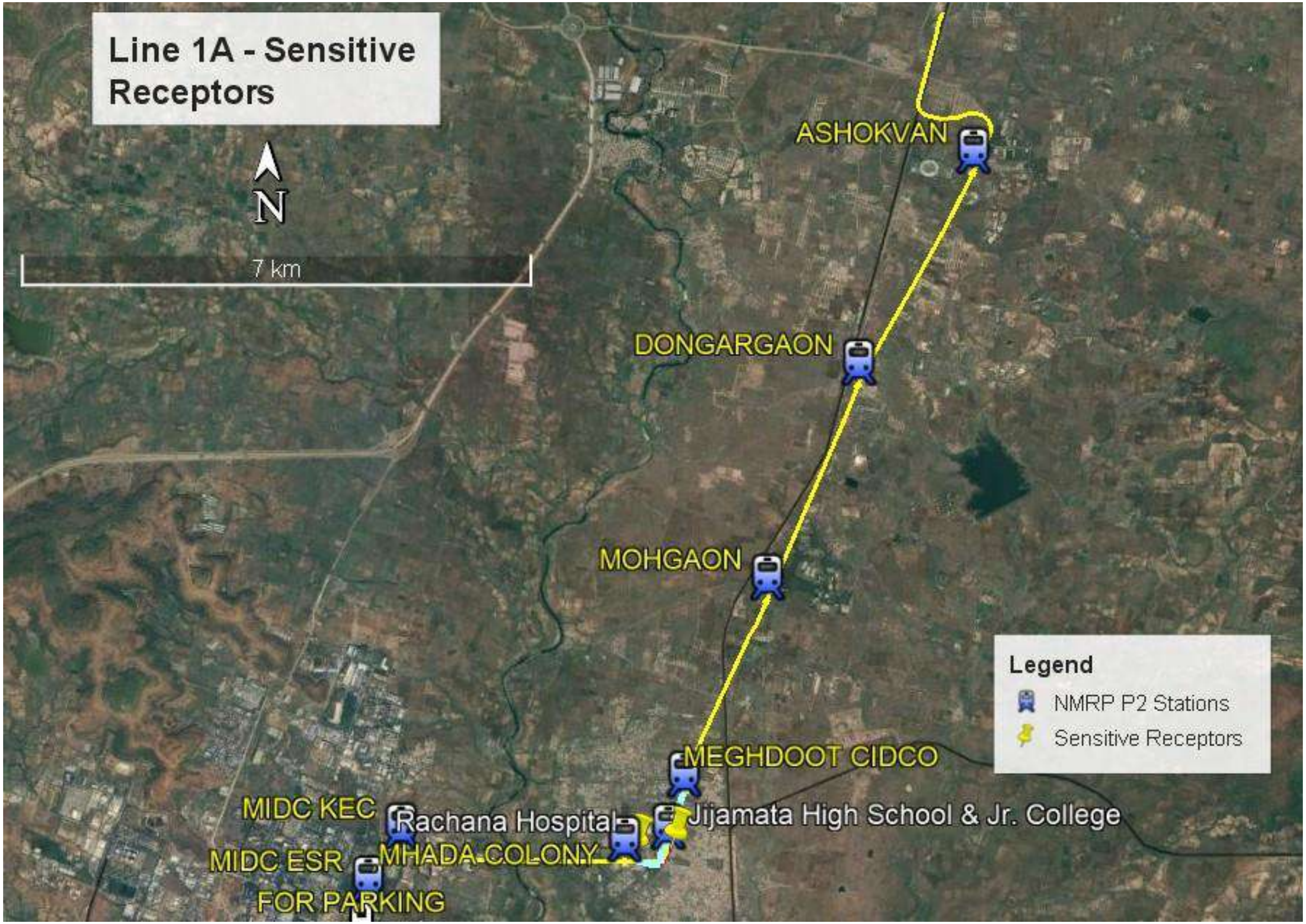
NAGPUR METRO

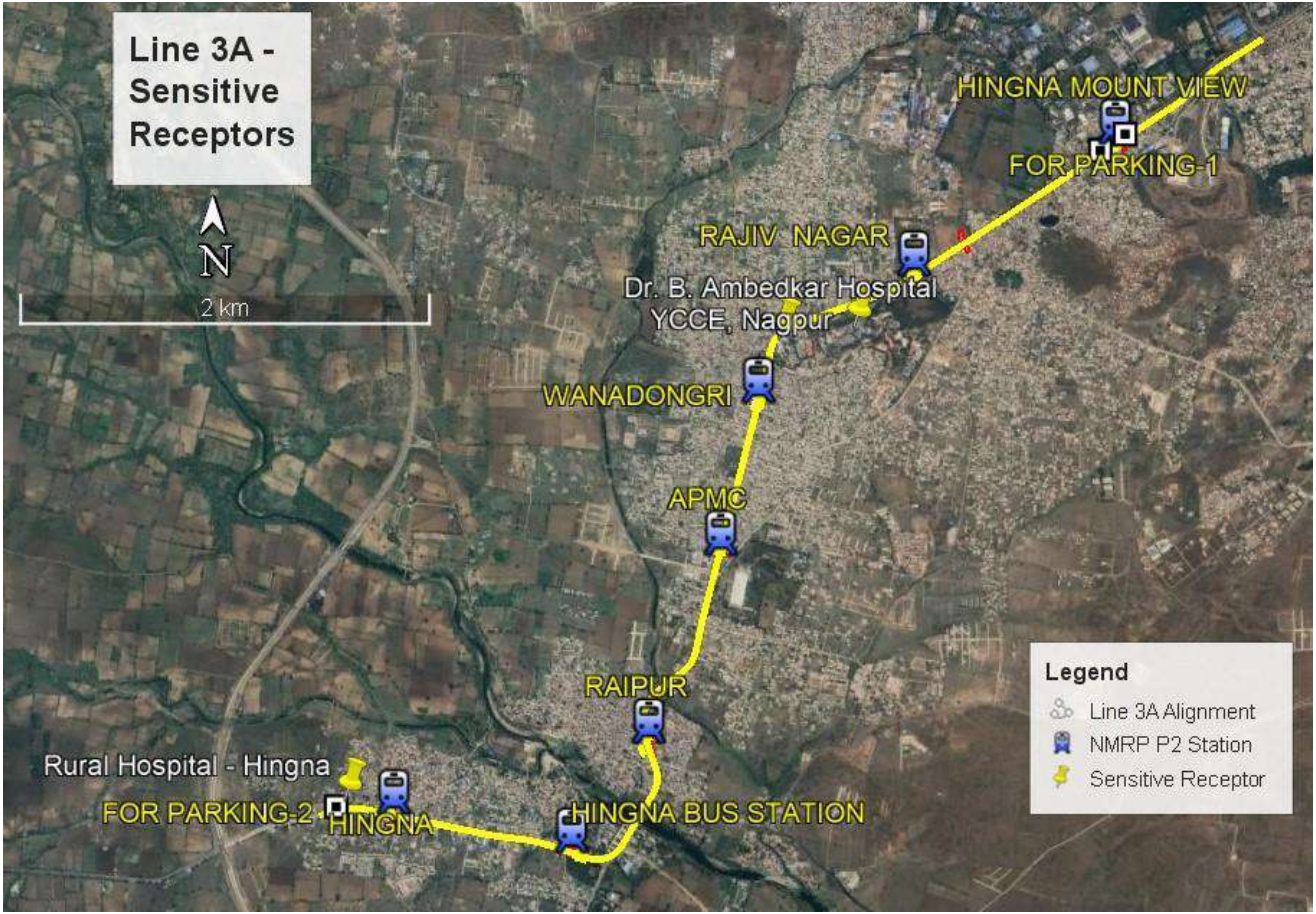
SHE Manual

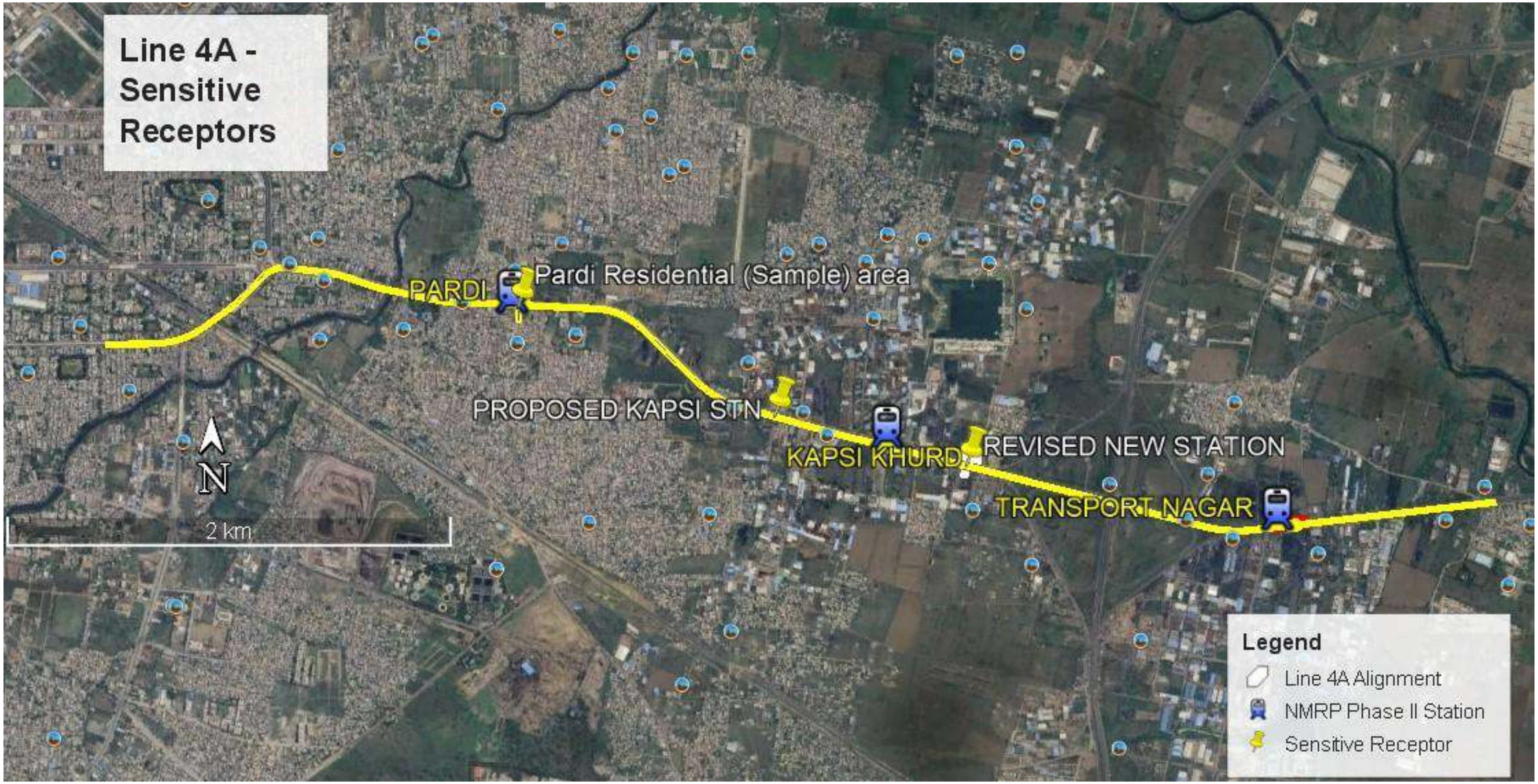
Annexure 13 – List of Sensitive Receptors

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
MIDC ESR
MHADA COLONY
FOR PARKING
Legend
NMRP P2 Stations
Sensitive Receptors


Line 2A - Sensitive Receptors
N
4 km
PILI NADI
KHASARA FATA
ALL INDIA RADIO
KHAIRI FATA
DPS Khairi
LOK VIHAR
Asha Hospital
LEKHA NAGAR
FOR PARKING -1
KAMPTEE POLICE STATION
CANTONMENT
KAMPTEE MUNICIPAL COUNCIL
DRAGON PALACE
GOLF CLUB
KANHAN RIVER
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 Residential (Sample) area
PARDI
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

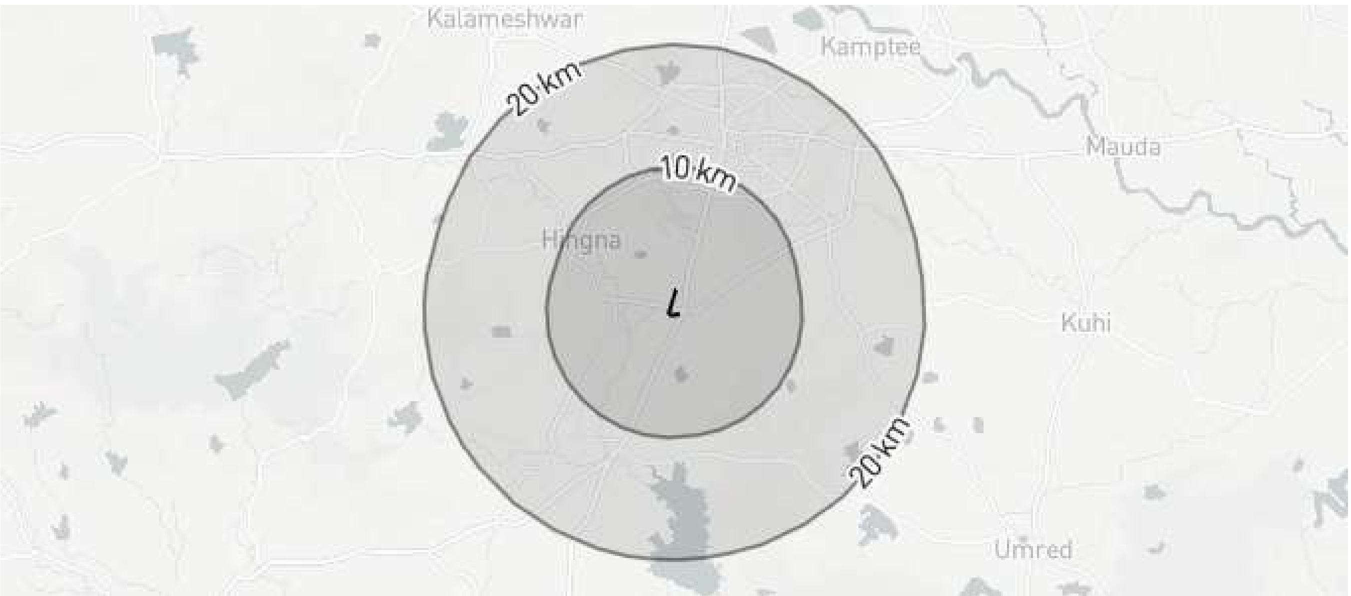
IUCN Red List Biomes: Marine, Terrestrial, Freshwater

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.

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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

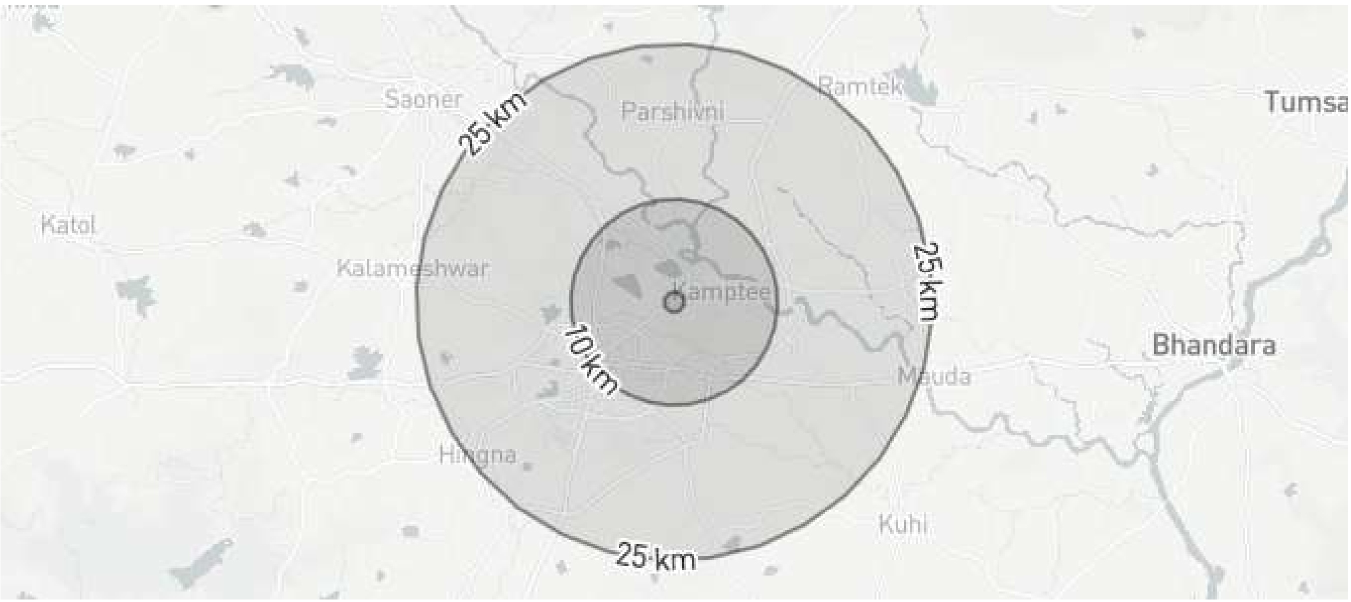
IUCN Red List Biomes: Marine, Freshwater, Terrestrial

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

- 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.
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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

IBAT Proximity Report. Generated under licence 6775-50036 from the Integrated Biodiversity Assessment Tool on 17 October 2023 (GMT). www.ibat-alliance.org

How to use this report

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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

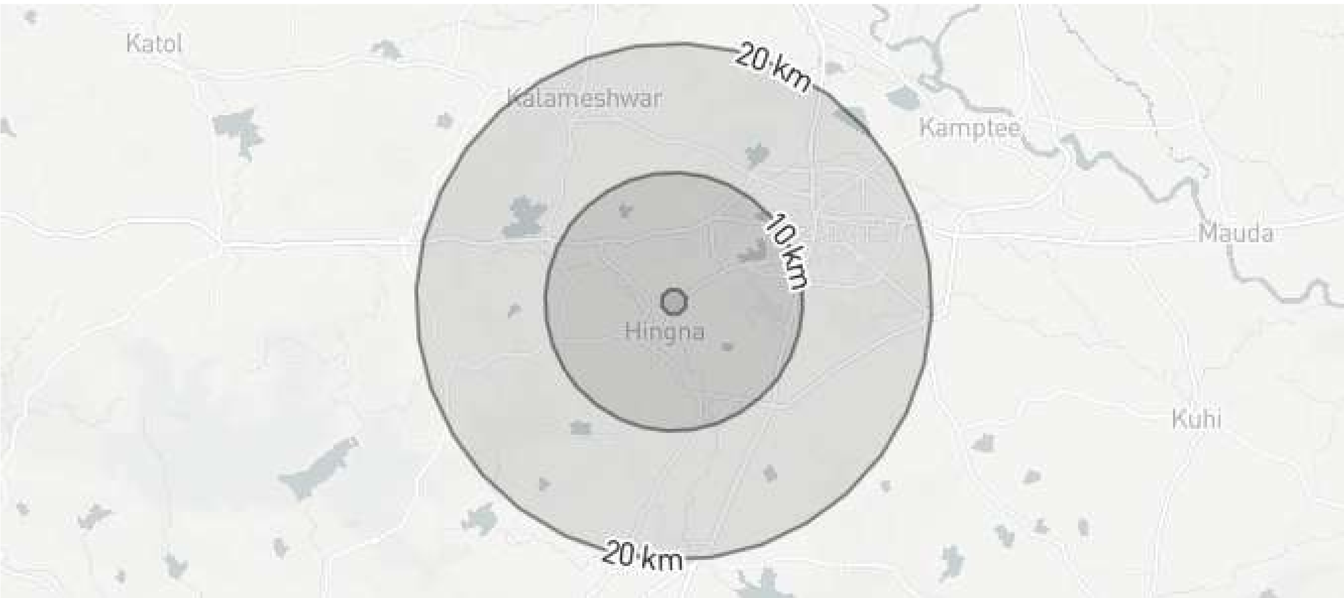
IUCN Red List Biomes: Terrestrial, Freshwater, Marine

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

IBAT Proximity Report. Generated under licence 6775-50037 from the Integrated Biodiversity Assessment Tool on 17 October 2023 (GMT). www.ibat-alliance.org

How to use this report

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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

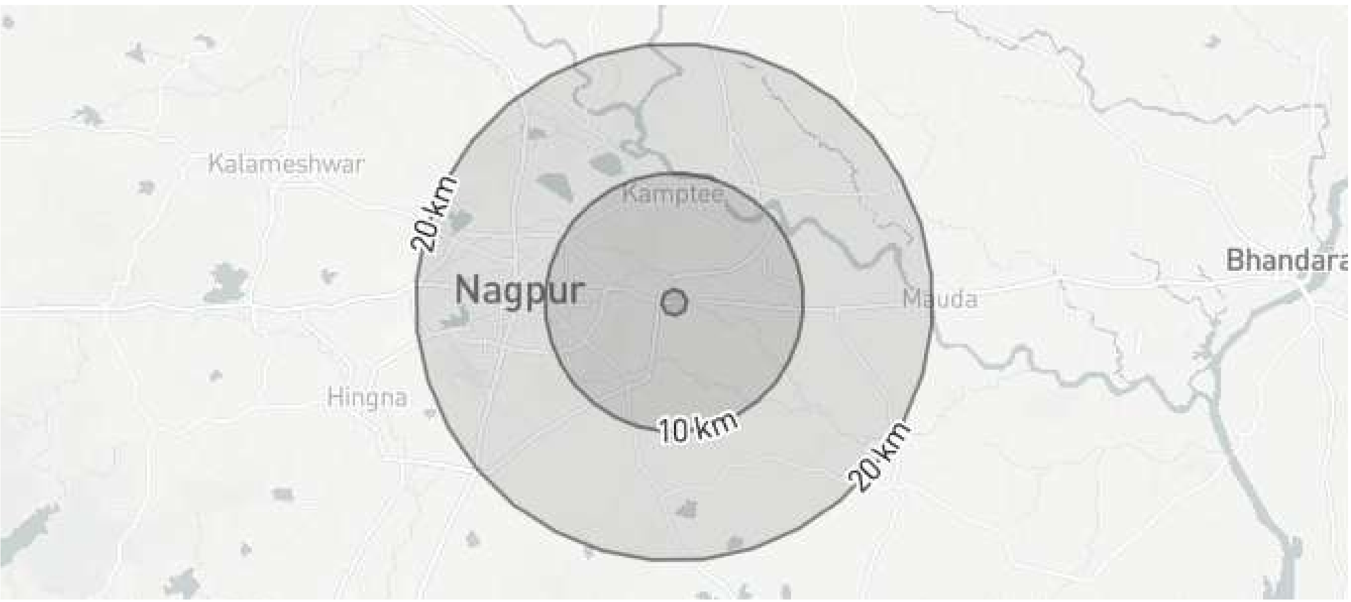
IUCN Red List Biomes: Terrestrial, Freshwater, Marine

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

This report presents the results of [6775-50039] 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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Data used to generate this report

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- 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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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.

The report does not provide details of potential indirect, downstream or cumulative impacts. Furthermore, the report should be regarded as a "first-step", providing a set of conservation values sourced from global data sets, and is not a substitute for further investigation and due diligence, especially concerning national and/or local conservation priorities.

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
8312066158		Chaya Pradip Sharnagat	Member of Gram Panchayat	Chayay
8308229795		Vijaya Mukunda Amle	Member of Gram Panchayat	V.M. Amle
		Jitan Makaram (Bolughat)		
		Gaurishankar Lanjewar	Hair Salon	गौ. शं. Lanjewar
9823557009		Dharmaji Ghanode	Business	Dhanode
9372218656		Sanjay Pawar	Lohar	संजय पवार
9158813817		Vayankatrao Nanwate	Retired Central Railway	व्यं. नानवटे
7745857845		Bandu S Chivande	Business	Chivande
9822565583		Johwar Bhojankar	Business	Bhojankar
9960127561		Raju Kulmate	Labour	राजू कुलमेते
9371726026		Yasin Pathan	Business	
9860531873		Shaikh Miya	Business (Chicken Shop)	शेख मिया
9860217513		Firoz Khan	Business	फिरोज खान
		Rajendra moon	Taylor	R. moon
		Dashrathji Kumbhare	Taylor	
		Nilkhantraj Marashkohle	Farmer	N.P. Marashkole
9022604060		Mubin Shaikh	chicken shop	मुबिन शेख
9146350419		Rahul S Gisho	Gramsevak	
7263012737		Vitthal Uikey	Labour	
9922064842		Pramod Futane	Member	
		Laureen Lamit	Social Devt. Specialist	
		Suvalaxmi Sen	Environmental Specialist	
		Mario Sprong	Environment Specialist	
		Ranjana Bondre	ग्रा सदस्य	Bondre
		Kalpana Karam	Sarpanch	Kakaram
		Sushila Bhanuse	Gram Sevak	Bhanuse
		Rajinder Singh	DY. CPM/Civil Maha Metro	Rajinder S
		Pratish Nitey	AGM/Env Maha-Metro	
		Nathu Shivram		नथु शिवराम
		Shailendra Kamble (8325723353)	Labour	
		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 Mo. no	Signature
1	Purushottam P. Sable	Chandrani Nagar	
2	[illegible]	8208495643 9960493658	
3	[illegible]	9370183817	
4	सौ. अनीता [illegible]	7304055693	सौ. [illegible]
5	[illegible]	दुकान	
6	[illegible]	8551883920	
7	[illegible]	9923597025	
8	मकबुल [illegible]	9763250552	
9	[illegible]	8928587774	
10	[illegible]	9370530069	
11	राम [illegible]	9881751904	
12	संजय मेश्राम	9890236893	
13	[illegible]	8858488890	
14	शोभा [illegible]	9850697870	
15	Manish Dhande	8805652790	
16	Madhuri Uikey	9765965212	
17	V.P. Manwatkar	9850248597	
18	Aditya Athawale (MITCON)	9096780015	
19	[illegible] (ADB)		
20	Marco Sperano (ADB)		
21	Laurien Lauritz		
22	Arvind Singh	SIA Consultant	
23	ज्योति [illegible]	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:


ADB

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		Shridap Dhandekar	Pan Thela	Dhandekar
8806991106		Manish Chaudhari	Chinese Centre	Manish
—		Narendra Rakhunde	Pan Thela	
7038082410		Baban Laxman Chauhan		
9361960368		Ranjana Narnaware	General Store	[illegible]
9208651883		Ganesh Gajanan Bharti	Business	[illegible]
7754936383		Prabhakar Dhodke	Panthela	[illegible]
9765185560		Mangesh Khose	water purifier	[illegible]
9011642827		Sudhir Bhakne	Salone	[illegible]
7038619767		Vinod Vaidya	Cycle shop	[illegible]
9158913661		Nitesh Dhatode	Garage	[illegible]
9623912182		Dilip Khedkar	Garage	[illegible]
9765751566		Pankaj Deshmukh	Business	[illegible]
9373788311		Sanket Kanankar	—	[illegible]
8830100385		Nikhil Ambule	—	[illegible]
80[illegible] 81570		Rajendra Kapre	— service	[illegible]
		Laureen	Social Devl. Specialist	[illegible]
		Suvalaxmi Sen	Environment Specialist	Suvalaxmi
		Malko Sprong	Environment Specialist	[illegible]
9860971451		Shubhash Suhanpure	Consultant metro	[illegible]
9494339835		Arvind Singh	SSA Consultant	[illegible]
(90967800 m)		Aditya Atkande	MITCON (Consultant)	[illegible]
		[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 नारायणजी ढोरे	9604727370	सुनील ढोरे
2	किशोर देवरावजी [illegible]	9923594407	[illegible]
3	सुरेश पंचबुद्धे	8055049813	सुरेश
4	शंकर फुलबांधे	7080358321	[illegible]
5	मन्मथ पंचबुद्धे	9359736213	[illegible]
6	अनंत ना. बोकडे	9422578927	[illegible]
7	नितीन अण्णाजी राऊत	8888441300	[illegible]
8	अण्णाजी हेमराजजी [illegible]	9372232539	[illegible]
9	गंगाबाई चव्हाण		
10	वंदना महादेवराव शृंगारे	9421776451	[illegible]
11	सौ. मिना दिवाकर कोठे	9763173053	[illegible]
12	[illegible]	9588434125	[illegible]
13	Sau. P. G. Chaudhari	9765964255	Chaudhari
14	Sau. Hemlata G. Gondane	7875425139	[illegible]
	Aditya Athawale	9096780015	[illegible]