MPMRCL

ENVIRONMENTAL IMPACTS ASSESSMENT AND ENVIRONMENTAL MANAGEMENT PLAN OF BHOPAL METRO RAIL PROJECT

Final Report

Madhya Pradesh Metro Rail Company Limited
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Madhya Pradesh - 462023

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Madhya Pradesh Metro Rail Company Limited (MPMRCL), Bhopal, Madhya Pradesh

LIST OF ABBREVIATIONS

ASI	Archaeological Survey of India
MPMRCL	Madhya Pradesh Metro Rail Company Limited
DPR	Detailed Project Report
EIB	European Investment Bank
EIA	Environment Impact Assessment
E&M	Electrical and Mechanical
E&S	Environmental and Social
EMP	Environmental Management Plan
ESMF	Environmental and Social Management Framework
EPBM	Earth Pressure Balance Machine
FIRR	Financial Internal Rate of Return
GC	General Consultant
GOI	Government of India
GOMP	Government of the State of Madhya Pradesh
IA	Implementation Agency
MoEFCC	Ministry of Environment, Forests and Climate Change
NUTP	National Urban Transport Policy
PHPDT	Peak Hour Peak Direction Traffic
RAP	Resettlement Action Plan
RoW	Right of Way
RPF	Resettlement Policy Framework
SIA	Social Impact Assessment
SMF	Social Management Framework
SEU	Social and Environmental Unit
SPV	Special Purpose Vehicle
TBM	Tunnel Boring Machine
TOR	Terms of Reference
TBC	To Be Confirmed

WEIGHTS AND MEASURES

^{0}C	degree Celsius
dB(A)	decibel acoustic
ha	hectare
km	kilometer
km/h	kilometer per hour
kWe	kilowatt-electric
kV	Kilo volt(s)
kVA	kilo Volt-Amps
kW	kilowatt
m	meter
mm	millimeter
MVA	Megavolt Ampere
m^3	cubic meter
m^3/hr	cubic meters per hour
mg/l	milligrams per liter
m/s	meters per second
MTPA	metric tons per annum
MW	megawatt
ppm	parts per million
ppt	parts per thousand
rpm	revolutions per minute
µg/m^3	microgram per cubic meter
sq.m	square meter

Contents

Executive Summary

This Environmental Impact Assessment (EIA) has been prepared for the (a) Karond Square to AIIMS (Purple Line) and (b) Bhadbhada Square to Ratnagiri Tiraha (Red Line) in Bhopal city in the state of Madhya Pradesh (the Project). An outcome of Bhopal's Comprehensive Mobility Plan was Government of Madhya Pradesh (GoMP) commissioned Feasibility Study specifically for Rail based Mass Rapid Transit corridors. Consequently, two metro corridors were identified and have been proposed for implementation under Bhopal Metro Project. The Madhya Pradesh Metro Rail Company Limited (MPMRCL) is the executing agency of the project.

MPMRCL has requested financing from European Investment Bank (EIB) for two metro corridors. These two metro corridors consists both elevated and underground sections. The cumulative length of two metro corridor is 27.87km. The elevated stretch is 25.46 km and underground is 1.79 km which includes a ramp length of 620 m. The alignments have 28 elevated stations and 2 underground stations.

This EIA has been prepared to fulfill policy requirements of EIB and as per EIB's "Statement of Environmental and Social Principles and Standards", the project is categorised as Category-B. This categorization is due to both the environmental and social risks and impacts involved.

The proposed project is located in Bhopal City, Capital of the state of Madhya Pradesh and also the Head quarter of Bhopal district spanning over an area of about 2772 km^2, lies in the central part of the state of Madhya Pradesh. Bhopal is located on hilly terrain within the Malwa Plateau (23 16'N, 77 22'E). The highest elevation of 625m is at Singarcholi near Lalghati and the lowest elevation is recorded about 421 m amsl near village Padariya Jat in Phanda block.

During the earlier planning stages of the project, the feasibility of several metro corridors was considered by MPMRCL based on traffic and engineering studies. The criteria for selecting the final alignment included traffic demand/ridership, accessibility and integration with existing public transport nodes, available right of way within major roads, ground conditions, capital and operating costs, availability of land for the depot and stations as well as minimum disturbance/avoidance of heritage structures. The selected alignments follows the central median of a major road artery of the city whilst in the most densely populated area the alignment is underground. Station locations have been selected to maximize ridership and ease intermodal connections.

The applicable environmental framework and clearances/ permissions required for the project are:

S.No	Permissions/ Clearances	Acts/ Rules/ Notifications/ Guidelines	Concerned Agency
1	Permission for cutting of trees	▪ Forest Conservation Act (1980) in forest areas, and ▪ Madhya Pradesh *Vrikshon ka Parirakshan (Nagariys Shetra) Adhiniyam* 2001 (Annexure 2.1) and Rules 2002 (Annexure 2.2) in Municipal Area.	▪ Divisional Forest Office/ State Forest Department for trees felling in forest areas, and ▪ Bhopal Municipal Corporation in Municipal Area.
2	Consent to operate Hot Mix Plant, Crushers, Batching Plant	Air (Prevention and Control Pollution) Act of 1981 Water (Prevention and Control of Pollution) Act 1974	MP State Pollution Control Board

S.No	Permissions/ Clearances	Acts/ Rules/ Notifications/ Guidelines	Concerned Agency
3	Authorization for disposal of hazardous waste	Hazardous and Other Wastes (Management and Trans-boundary Movement) Rules 2016	MP State Pollution Control Board
4	Consent for Disposal of sewage from labour camps	Water (Prevention and Control of Pollution) Act 1974	MP State Pollution Control Board
5	Pollution Under Control Certificate	Central Motor and Vehicle Act 1988	Central Motor and Vehicle Act 1988
6	Employing Labour/Workers	The Building and Other Construction Workers (Regulation and Employment Conditions of Service) Act, 1996	District Labour Commissioner

The main negative environmental impacts of the project include: (i) cutting down of about 2192 trees[1] (1199 for Purple Line and 993 for Red Line) and 30 poles; (ii) finite use of scarce, sometimes carbon intensive, materials, such as cement; (iii) noise, vibration and visual intrusion for properties adjacent to the alignment; and (iv) generation of about 1.5 million cubic meter of waste material excavated from the tunnelling work; and (v) social impacts such as loss of land, structure, livelihood etc. All other negative impacts are temporary and localized. The project does not impact any nature conservation areas or protected area or sites of historical / archaeological importance.

The main mitigation measures proposed are as follows: (i) compensatory afforestation of 8,828 (8768+60) saplings at ratio of 1:4 for each tree and 1:2 for each pole felled in accordance with local rules; (ii) noise reduction measures (i.e. rubber dampers on the rails and parapet on both sides of viaduct acts as a part noise barrier); (iii) reuse of excavated material where feasible and disposal to construction waste in a regulated manner; and (iv) compensation for social impacts.

The key positive environmental impacts of the project include (i) employment opportunities due to construction, operation and maintenance; (ii) reduction in traffic congestion; (iii) reduction in travel time with high service level; (iv) reduction in accident; (v) reduction in fuel consumption; (vi) modest reduction of GHG emission; and (vii) reduced private vehicle/ reduction in pollutants, noise and vibration due to traffic.

Local communities and stakeholders including women groups were involved in the process of environmental and social assessment through on-site discussions. Informal public consultations in the project areas were conducted during environmental and social studies and it will continue throughout the project cycle. As the project will not have any significant environmental and social impacts, local communities support the project.

The EMP has been prepared in conjunction with MPMRCLs and it will form part of the contract document of the contractor. Environmental Management Plan (EMP) is the key to ensure effective implementation of environmental safeguard measures during different stage of the project. The project specific EMP has been formulated for mitigating and offsetting the anticipated adverse impacts arising out of the project activities. The Environmental Management Plan includes supervision, monitoring and reporting requirements. Quarterly environmental and social monitoring reports will be submitted to EIB.

[1] Tree: girth width > 300mm; Pole: girth width < 300mm measures above ground level

The preliminary estimated cost of the environmental management plan for Purple and Red Lines including implementation and monitoring is INR **9,09,72,000.00.**

The alignment of the proposed Purple and Red Lines and depot area are not located in any environmentally sensitive or protected areas. Careful selection of alignment has avoided sites of historical/archaeological significance. No major impact on wildlife is envisaged as there are no forest and protected areas within project area. The roadside and median plantations are not habitat of any endangered or endemic species of fauna and flora. The project anticipate social impacts including acquisition of land for stations and impacts on structures both residential and commercial affecting livelihood of people. The project will not result in any long-term significant adverse environmental impacts. Minimal environmental impacts are anticipated, mostly during construction. Environmental and social benefits of the project and long-term investment program objectives outweigh the temporary negative impacts.

1. Introduction

1.0. Background

Government of Madhya Pradesh with its vision 2018 has decided to upgrade the quality of the life in its capital city Bhopal by providing a highly efficient and comfortable state of art urban rail system. To materialize the vision, a Comprehensive Mobility Plan (CMP) was prepared for Bhopal city that propose mass mobility corridors for Mass Rapid Transit (MRT) and Bus Rapid Transit (BRT) system based on PHPDT demand. The recommendations of the CMP consequent to Feasibility Study undertaken specifically for Rail based Mass Rapid Transit corridors. Based on this study findings, GoMP commissioned Detailed Project Report (DPR) for two metro corridors with cumulative length of 27.872km for implementation – MRTS Bhopal Metro Rail Project.

This Environmental Impact Assessment has been prepared for (a) Karond Square to AIIMS (Purple Line) and (b) Bhadbhada Square to Ratnagiri Tiraha (Red Line) in Bhopal city in the state of Madhya Pradesh. The Table 1-1 provides salient features of two metro corridors.

Table 1-1: Details of MRTS Bhopal Metro Rail Project in Phase I

Line No.	Description	Stations in Number		Length (km)	
Purple Line	Karond Square to AIIMS	Total Elevated Underground	16 14 2	Total Elevated Ramp Underground	14.99 12.58 0.62 1.79
Red Line	Bhadbada Square to Ratnagiri Tiraha	Total Elevated	14 14	Total Elevated	12.88 12.88
Total			**30**		**27.87**
Source: Detailed Project Report					

MPMRCL has requested financing from European Investment Bank (EIB) for two metro corridors mentioned in Table 1-1. These two metro corridors consists both elevated and underground sections. The elevated stretch is 25.48 km, underground is 1.79 km and a ramp length of 620 m. The alignments have 28 elevated stations and 2 underground stations.

Madhya Pradesh Metro Rail Company Limited (MPMRCL) is a registered company constituted under the companies Act, 1956, a joint venture of Government of Madhya Pradesh (GoMP) and Government of India (GoI). The Madhya Pradesh Metro Rail Co Limited (MPMRCL) is a Special Purpose Vehicle (SPV) entrusted with responsible for implementation of Metro Rail Projects in major cities of Madhya Pradesh.

1.1. EIA Preparation and Objectives of the EIA

This EIA has been prepared in accordance with environmental impact assessment requirements of Government of India. It complies with EIB's Statement of Environmental and Social Principles and Standards

. It aims to ensure good environmental and social practices.

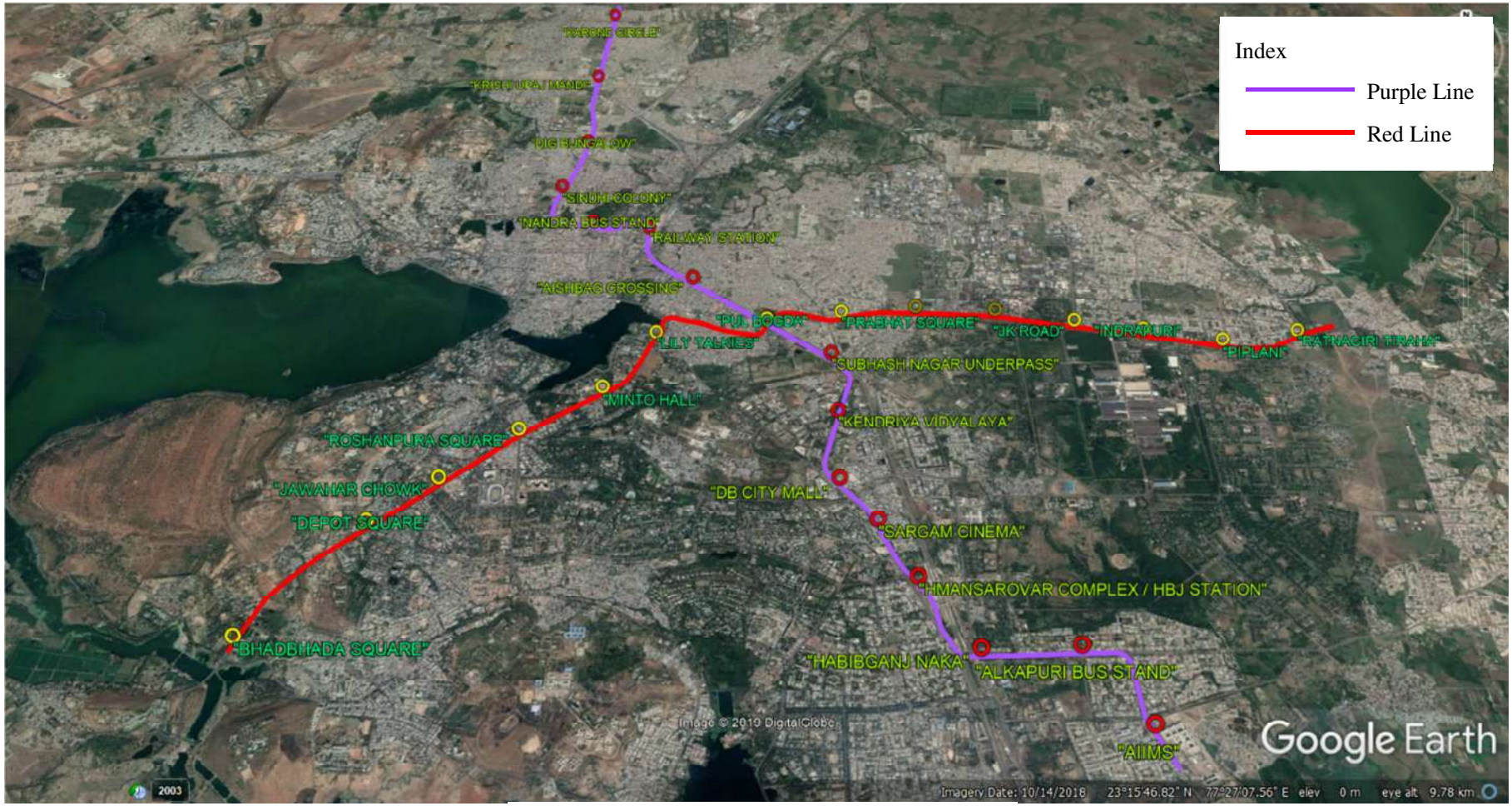

Fig.1: Alignment of Purple Line and Red Line

In order to enable MPMRCL to implement appropriate environmental measures by making clear its procedures and criteria for decision making and for meeting the requirements of funding agency, the main objective of the environmental impact assessment is to ensure transparency, predictability and accountability in the present study. The study shall have following objectives:

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

1.2. Scope and Methodology of the EIA

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

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

1.2.1. Delineation of Project Influence Area

The propose alignment of metro for majority of length follow the axis of existing road. The proposed RoW i.e. 20m is the primary boundary defining the area within which all construction and operation stage activities will be contained. All building structures and trees within this zone will be removed to facilitate construction of the metro lines. The utility lines will be shifted/ relocated to the outer edge of the proposed RoW. Project activity shall have influence on right of way and immediate vicinity. A buffer of 100 m on either side of the project has been considered to define the indirect area of influence. Within such area of indirect influence, environmental features that are important on a regional scale and have perceivable linkages with the project, such as national parks, wild life sanctuaries, reserve forests, archaeological and cultural/religious sites have been considered. The environmental impact and management is design for project implementation and operation periods.

1.2.2. Reconnaissance Surveys

Reconnaissance survey was carried out at inception stage of the project. Sensitive environmental features, cultural & archaeological monuments, land use etc. was noted by walk over survey.

1.2.3. Secondary Data Collection

The consultant collected secondary data relevant to the Project areas to establish the baseline environmental and social condition. Environmental data and their sources are provided in Table 1- below.

Table 1-2: Sources of Environmental Data

Broad Environmental Parameter	Areas of Enquiry	Sources of Information
European Investment Bank's requirements	EIB statement of environmental and social principles and standards	EIB's official web page.
Meteorological Data	Rainfall, humidity, maximum and minimum temperature etc.	Indian Meteorological Department, GoI
Acts, Rules, Standards and Notifications	Environmental Acts, acts related to project activities, EIA notification, EIA guidelines, Environmental standards	Official web page of CPCB, MoEF&CC
Forest Map	Locations of the reserve forests and protected area in the project influence area	Forests Department, GoMP and Forest Survey of India, GoI
Flora and Fauna	Type of flora and Fauna available in the study area. Rare and endangered species recorded in any study by forest department.	Forests Department, GoMP/ Divisional Forest Offices.
Ground water	Ground water potential of the study area	Central Ground Water Board (CGWB)
Air quality and water quality	Ambient air quality, water quality monitoring data	CPCB web page, MPSPCB, Previous study report of the region.
Cultural / heritage and ancient structures	Conservation areas if any, Archeological Building / monuments and heritage structures	From Archeological Survey of India, GoI

1.2.4. Primary Data Collection

The primary data (trees; forest and protected area; biodiversity; water bodies; sensitive receptors like school, hospitals, religious place) for Purple Line were collected through detail survey and information recorded in an agreed survey format. In case of Red Line, a rapid survey of metro corridor was conducted to check consistency and utilizes information of preliminary EIA.

1.2.5. Baseline Environmental Monitoring

On-site environmental monitoring has been carried out for ambient air quality, noise level and water quality (surface and ground). Ambient air quality parameters were selected for particulate matter size less than 10µm or PM_{10} µg/m^3, particulate matter size less than 2.5 µm or $PM_{2.5}$ µg/m^3, Sulphur dioxide (µg/m^3), nitrogen dioxide ((µg/m^3) and carbon monoxide (µg/m^3) first week of June 2018. The tests were carried out as per methodology suggested in

National Ambient Air Quality Standards. Monitoring stations were selected based on the location of receptors.

Ambient noise level data was collected at one minute interval through integrated noise meter for duration of 24 hours consisting day time and night time. Leq (Day) and Leq (Night) are determined from hourly values derived for duration 6 am to 10 pm and from 10 pm to 6 am respectively. Ground water quality samples have been collected from tube wells and tested as per APHA 22nd Edition 2012. Parameters for surface water quality monitoring have been selected as per MoEF&CC guidelines.

1.2.6. Identification of Forest Area and Protected Area

The forest area and protected area (National Parks, Wildlife Sanctuaries) information within project area were collected from various publications of Forest Department and Environment Planning & Coordination Organisation, Government of Madhya Pradesh. This was followed by verification visit to ascertain proximity with respect to project.

1.2.7. Consultation

The EIB guidelines require adoption of participatory approach applied in the engagement with project affected individuals, communities, as well as other relevant stakeholders[2]. In line with EIB's requirement consultation with stakeholders were identified and they were consulted at different levels. The settlements en-route metro alignments was selected in phases for conducting community level consultation. The community was contacted for requesting to arrange for a community level consultation. The people were explained about the project and on the objective of the community consultation in respect to European Investment Bank's guidelines. The date, time and venue for consultation were mutually decided at screening stage. To have consensus of EIA findings, another round of consultation and disclosure meeting would be conducted before finalising of EIA and SIA reports. During which environmental and social issues addressing the probes raised during consultation stage will be discuss and to render advices, which would need to be incorporated in Final EIA report.

1.3. Structure of the EIA

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

i. Executive Summary
ii. Introduction
iii. Policy, Legal, and Administrative Framework
iv. Description of the Project
v. Description of the Environment and Social Baseline
vi. Impact Assessment and Mitigation Measures

[2] As per footnote 4 in EIB Environmental and Social Handbook, 'other relevant stakeholders' are parties that may be impacted by the project or have an interest in it, such as government, other business, NGOs, etc.

vii. Consultations, Participation and Information Disclosure
viii. Environmental and Social Management Plan, and
ix. Conclusion and Recommendation

2. Policy and Legal Frameworks

India has developed a fairly comprehensive regulatory framework to address environmental and social concerns in relation to development projects. Its wide ranging enactments cover almost all component of environment viz. air, water, soil, terrestrial and aquatic flora and fauna, natural resources, and sensitive habitats that need to be addressed in the course of development of infrastructure from a social and environmental perspective. India is signatory to various international conventions and protocols. The chapter is about the applicability of various laws and regulations, conventions, protocols, and safeguards.

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

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

2.1. National Environmental Policies Framework

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

- The Environment (Protection) Act, 1986;
- The Environmental Impact Assessment Notification 2006;
- Forest (Conservation) Act 1980;
- Forest (Conservation) Act, 1980 with Amendment Made in 1988;
- Madhya Pradesh *Vrikshon ka Parirakshan (Nagariys Shetra) Adhiniyam* 2001 and Rules 2002 in Municipal Area;
- Wildlife Protection Act, 1972;
- Traditional Forest Dwellers (Recognition of Forest Rights) Act 2006;
- The Water (Prevention & Control of Pollution) Act, 1974;
- The Air (Prevention and Control of Pollution) Act, 1981;
- Noise Pollution (Regulation and Control) rules 2000;
- The Ancient Monuments and Archaeological sites and Remains (Amendment and Validation Act) 2010;
- Biological Diversity Act, 2002;
- Solid Waste Management Rules 2016;
- Hazardous and Other Wastes (Management and Trans-boundary Movement) Rules 2016;

- The Building and Other Construction Workers (Regulation and Employment Conditions of Service) Act, 1996;
- The Wetlands (Conservation and Management) Rules, 2017;
- Construction and Demolition Waste Management Rules 2016;
- Public Liability Insurance Act, 1991.

2.2. Required Clearances/Permissions

For Implementation of Metro Rail Project in India, required clearances/ permissions related to environment, social and forests have been summarized in Table 2-1.

Table 2-1: Details of Applicable Legal Frameworks

S.No	Permissions/ Clearances	Acts/ Rules/ Notifications/ Guidelines	Concerned Agency
1	Permission for cutting of trees	▪ Forest Conservation Act (1980) in Forest Area ▪ Madhya Pradesh *Vrikshon ka Parirakshan (Nagariys Shetra) Adhiniyam* 2001 (Annexure 2.1) and Rules 2002 (Annexure 2.2) in Municipal Area.	▪ Divisional Forest Office/ State Forest Department for trees felling in forest areas, and ▪ Bhopal Municipal Corporation in Municipal Areas.
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3	Authorization for disposal of hazardous waste	Hazardous and Other Wastes (Management and Trans-boundary Movement) Rules 2016	MP State Pollution Control Board
4	Consent for Disposal of sewage from labour camps	Water (Prevention and Control of Pollution) Act 1974	MP State Pollution Control Board
5	Pollution Under Control Certificate	Central Motor and Vehicle Act 1988	Central Motor and Vehicle Act 1988
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Before the start of civil works for the any section of the sub-project metro, the project proponent (MPMRCL) shall obtain necessary pre-construction stage clearances / permits from statutory authorities. While, clearances / permits applicable during construction stage shall be obtained by the Contractor.

2.3. EIB's Environmental & Social Policy

EIB funds projects that support sustainable development through the protection and improvement of the natural environment, and the promotion of sustainable communities. The objectives of the Treaty of the European Union underpin the EIB standards and its general approach, i.e. regarding "preservation of the environment, protection of human health, rational utilization of natural resources and promotion of measures at international level". In particular climate change, biodiversity and ecosystem considerations are integrated into the lending policies and practices of the Bank. This reflects EIB's contribution to the UN

Framework Convention on Climate Change, the UN Convention Biological Diversity (CBD) and the UN Millennium Development Goals (MDG).

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

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

While all projects should give an overall positive contribution to sustainable development in order to be considered for funding, EIB still requires that projects comply with the environmental and social requirements of the Bank. The Bank pays particular attention to the rights of disadvantaged groups and the impacts that a project might have on people in the workplace and in the local community. The principles and standards are derived from European Union policy and law and in addition to the EU Treaty include:

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

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

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

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

- Emission standards: projects should include measures to prevent, reduce or eliminate pollution that arises directly or indirectly from their activities.
- Ambient standards: projects are required to ensure that they meet the relevant ambient standards, including national standards.
- Procedural standards: e.g. projects for which the EIB requires an EIA, the process and content must be consistent with the requirements of the EU Directive.
- Human rights: financing restricted to projects that respect human rights as defined by Charter of the Fundamental Rights of the European Union and international good practices.

- Involuntary resettlement: people whose livelihoods are negatively affected by a project should have their livelihoods improved or at a minimum restored, and losses should be compensated for. Management of resettlement includes need for an Action Plan and culturally appropriate consultation of affected communities.
- Indigenous people and other vulnerable groups: covers indigenous groups, ethnic minorities, women, migrants, the very young and the very old. The promoter should pay special attention to these groups when affected by the project.
- ILO core labour standards: core labour standards are to be adhered to/reached during the project implementation.
- Occupational and community health and safety: seeks to avoid and minimize risks and impacts to the health and safety of workers and communities.
- Cultural heritage: respecting cultural heritage and not financing projects that threaten the integrity of sites that have a high level of protection for reasons of cultural heritage, e.g. UNESCO World Heritage sites.
- Consultation, participation and public disclosure: based on the Aarhus Regulation promoting transparency of environmental information and the inclusion of stakeholders in projects through consultation in order to identify and manage public concern at an early stage. Includes provisions for the public disclosure of key project information such as the Non-Technical Summary and the ESIA.
- Biological diversity: reducing the biodiversity impacts of projects in line with core international conventions such as HELCOM, OSPAR and Ramsar.
- Climate change: seeks to reduce contributions to climate change through energy efficiency measures, clean technology and promoting projects that lead to reductions in carbon emissions.

2.4. International Treaties and Conventions binding upon GOI

India has been playing an active role in environmental conservation since the first United Nations (UN) conference on Human Environment in Stockholm in 1972 and recognizes that protection of environment is closely linked to combating poverty. Key international agreements that India is signatory to and relevant for the project are provided below:

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

ix. Convention on Biological Diversity (Rio De Janeiro, 1992)
x. Protocol to the United Nations Convention on Climate Change (Kyoto,1997)

The above list of international conventions served as requirements for the project to comply. However, the expected environmental issues that are governed by these international conventions would be insignificant.

2.5. Project Categorisation

The EIA notification, 2006 of MoEF&CC, GoI stipulates conditions for project requiring Environmental Clearance. The Metro Rail project are excluded in schedule –I of EIA notification dated 14th September 2006 and as amended up to December 2016 of Ministry of Environment, Forest and Climate Change, Government of India's. Hence Environmental Clearance is not required for the project.

As per EIB's ESS-1 (Assessment and Management of Environmental and Social Impacts and Risk) and EIA Directive 92/2011/EC (Annex I) in EIB's E&S Handbooks, railway project requires Environmental and Social Impact assessment (ESIA), and Bhoj Wetland a Ramsar Site is located close to Red Line. The proposed project due to potential impacts associated due to construction activities has been categorized as **Category B** and ESIA should be conducted for (a) Purple Line (Karond Square to AIIMS) and (b) Red Line (Bhadbada Square to Ratnagiri Tiraha) metro corridors.

3. Project Description

3.1. Location of Project

The project and its components are located in Bhopal City, the capital of Madhya Pradesh state of India. Bhopal is located on hilly terrain within the Malwa Plateau (23 16'N, 77 22'E). National Highway 12 (Beora – Jabalpur road), which links the city to many large cities in the north – west and the south – east. State Highways connect Indore and Sagar. The city is connected by the broad gauge railway line to Nagpur, Chennai, Delhi and Mumbai. The city is also served by regular air services to Mumbai, Delhi and Indore.

3.2. Details of the Project Components

3.2.1. General System Layout

Bhopal Metro Rail system is of a Metro type based on steel- wheel-technology and use standard gauge tracks of 1435 mm. The system shall be designed for a maximum operational speed of 90 kmph.

3.2.2. Alignment and Stations

The network for the metro in Bhopal consists of 6 lines to be implemented in different phases. Under Phase-I, (a) Karond Square to AIIMS (Purple Line) and (b) Bhadbhada Square to Ratnagiri Tiraha (Red Line) would be taken up.

3.3.2.1. Karond Circle – AIIMS (Purple Line)

The Karond Circle – AIIMS (Purple Line) metro line runs in North – South direction and is 14.99km in length. It starts at Karond Circle and follows Berasiya Road, GPO Road, Railway Station, Pool Patra Road, Jinsi Road, HBJ Station; and Alkapuri Road to the terminal at AIIMS. There are total 16 stations along Purple Line (Table 3-1), of which 14 are elevated and 2 are underground stations.

Table 3-1: List of Stations in Purple Line

S.No	Station name	Station Centre Chainage	C/C Distance Between Stations (Mts.)	Type of Stations
1	AIIMS	20+368		Elevated
2	ALKAPURI	21+541	1173	Elevated
3	HABBIGANJ NAKA	22+326	785	Elevated
4	HABBIGANJ STATION	23+160	834	Elevated
5	MP NAGAR	23+953	793	Elevated
6	DB CITY MALL	24+600	647	Elevated
7	KENDRIYA VIDYALAYA	25+515	915	Elevated
8	SUBHASH NAGAR	26+514	999	Elevated
9	PULBOGDA	27+210	696	Elevated
10	AISHBAGH CROSSING	28+015	805	Elevated
11	BHOPAL STATION	29+484	1469	Underground
12	NANDRA BUS STAND	30+334	850	Underground
13	SINDHI COLONY	32+116	1782	Elevated
14	DIG BUNGALOW	33+116	1000	Elevated

15	KRISHI UPAJ MANDI	34+306	1190	Elevated
16	KAROND CIRCLE	35+758	1452	Elevated

3.3.2.2. Bhadbhada Square - Ratnagiri Tiraha (Red Line)

The Bhadbhada Square - Ratnagiri Tiraha (Red Line) route length is 12.88 km and runs in West – East direction. It starts at Bhadbhada Square and follows Bhadbhada Road, Jahangirabad Road, Chicklod Road, Bogda Pul Road and Raisen Road to the terminal Ratnagiri Tiraha. There are 14 stations along Red Line. The Roshanpura square station is the crossing station to Line 1 and 4 and Pul Bogda station to Purple Line and 3.

Table 3-2: List of Stations in Red Line

S.No.	Station Name	Station Centre Chainage	C/C Distance Between Stations (Mts.)	Type of Stations
1	BHADBHADA SQUARE	50+278		Elevated
2	DEPOT SQUARE	51+679	1401	Elevated
3	JAWAHAR CHOWK	52+355	676	Elevated
4	ROSHANPURA SQUARE	53+062	707	Elevated
5	MINTO HALL	54+137	1075	Elevated
6	LILLY TAKIES	54+900	763	Elevated
7	PULBOGDA	56+364	1464	Elevated
8	PRABHAT SQUARE	57+520	1156	Elevated
9	GOVINDPURA	58+161	641	Elevated
10	GOVINDPURA IND. AREA	58+954	793	Elevated
11	J K ROAD	60+147	1193	Elevated
12	INDRAPURI	60+952	805	Elevated
13	PIPLANI	61+682	730	Elevated
14	RATNAGIRI TIRAHA	62+354	672	Elevated

3.2.3. Ridership

Table 3-3: Traffic Forecast

	Purple Line			Red Line		
Year	**Peak Hour Ridership**	**Number of Passengers**	**Passenger km**	**Peak Hour Ridership**	**Number of Passengers**	**Passenger km**
2021	21,522	2,15,224	9,68,194	13,885	1,38,848	6,46,481
2031	28,370	2,83,703	12,76,250	18,303	1,83,026	8,52,176
2041	37,397	3,73,970	16,82,322	24,126	2,41,260	11,23,318
2054	53,553	5,35,525	24,09,085	34,548	3,45,484	16,08,591

3.2.4. Rolling Stock, Traction and Signalling

- 2.9 meter wide Rolling stock with stainless steel body.
- Axle Load - 16 Ton
- Seating Arrangement - Longitudinal
- Capacity 3 Coach Unit
- Normal - 557 four standing passenger per square meter
- Crush - 766 six standing passenger per square meter
- Class of Accommodation - One

3.2.5. Maintenance Depot

The Purple and Red Lines would have only one central depot near Subhash Nagar Underpass (Fig 2.1). The Depot will have facilities for stabling, inspection and maintenance of vehicles. Typically, mechanised washing plant is provided at the track entry so that at time of entry the trains can be externally washed while on a run through at low speed. The depot also houses the Central control for monitoring the train operations and acting in the case of emergencies. The relief and maintenance vehicles are also housed here.

Fig 2.1: Conceptual layout design of Subhas Nagar Depot

3.2.6. Traction Power Supply

Traction power will be based on 750V DC system using a third rail as contact line.

3.3. Land Requirement

3.3.1. Elevated section

Most of the elevated section is on the road and needs only space for the foundation structure consisting of piles and piles cap, which needs more space from case to case basis for each foundation. An average of 3 meters from the centreline of the alignment in the road towards both the sides of the road is estimated as the required free land for the foundations. Due to curves, some of the sections are required to pass through the existing building so as to

maintain the ride quality and the alignment parameters therefore these buildings must be acquired or rehabilitated or redeveloped or demolished a little for adjustments of free space.

3.4. Project Cost

The total cost of the Bhopal Metro Project amounts to Rs 6941.40 crores.

4. Environmental Baseline

The proposed project is located in Bhopal City, Capital of the state of Madhya Pradesh and also the Head quarter of Bhopal district spanning over an area of about 2772 km^2, lies in the central part of the state of Madhya Pradesh. Prior to independence of India, it was a part of Bhopal state, which was founded by Nawab Dost Mohammad Khan in the year 1722. The district is bounded by Guna district on the north, Vidisha district on the northeast, Raisen district on the east and Sehore and Rajgarh district on the southwest and west respectively. The district lies between North latitude 23°05' and 23°54' and east longitude 77°10' and 77°40', falling in Survey of India Topo Sheet No. 55 E. Bhopal is well connected with all parts of country by Air, Rail and roads. It lies on Delhi-Bhopal-Mumbai and Delhi-Bhopal-Chennai main railway line. Two national highways NH 12 (Jabalpur – Jaipur) and NH 69 (Kanpur-Dewas) passes from the district.

4.1. Physical Environment

4.1.1. Topography

Bhopal city nestles in a hilly terrain, which slopes towards north and southeast. Hillocks of different altitudes are situated along the southwest and northwest portion of the city, these hillocks from a continuous belt from Singarcholi up to Vindhyachal range. The height of Singarcholi near Lalghati is 625m, which is maximum in this area. The lowest elevation in the district is recorded about 421 m amsl near village Padariya Jat in Phanda block. The remarkable topography of the city provides enchanting and panoramic views of the city and of natural scenic beauty.

4.1.2. Geology and Soil

The Bhopal district is part of Malwa plateau with generally an undulating topography. The Vindhyan hill range occupies the eastern part of Phanda block, including a major part of Bhopal city. The geological formations underlying the Bhopal area – at the eastern edge of the Malwa Plateau – are largely red sandstone strata, with the depth of the rock varying according to the slopes. The top portions of the hillocks generally consist of hard red soil, mixed with basaltic boulders.

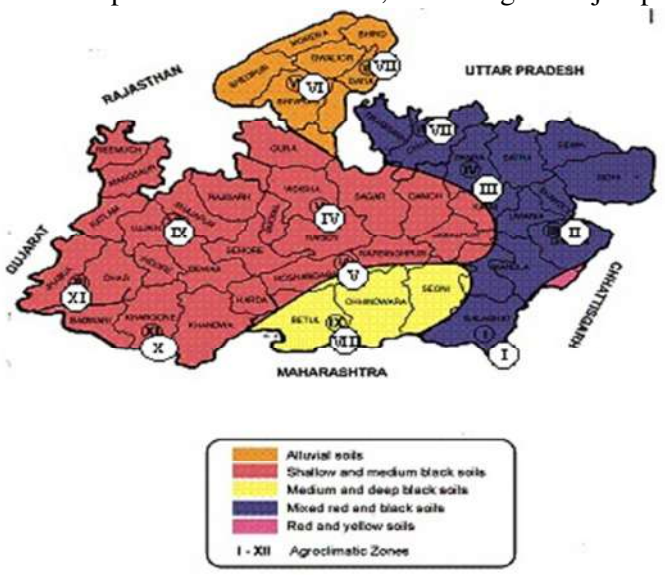


Fig 4-1: Soil Map of Madhya Pradesh

Almost three-fourths area of the Bhopal district is covered with black cotton soils forms by the

weathering of basaltic rocks. The rest part of the district area is covered with yellowish-red, mixed soils derived from sandstone and shale. The alluvial soils are found along the river courses. The higher elevations i.e. the hilly regions have a cover of murum, which is made up of small rounded pieces of weathered basalts. The Vindhyans have a thin cover of sandy loams. The alluvium is derived from hill slopes by numerous streams and watercourses. The black cotton soil is seen at various depths from 1 to 3.0m in Bhopal city.

4.1.3. Soil Analysis

Soil analysis has been carried out for soil samples collected from three locations along the proposed two metro corridors. In order to understand the soil characteristic, soil samples were collected from three locations (2-habitation, 1- near lake) along metro corridors. The physio-chemical characteristics of the soil samples is presented in Table 4-1.

Table 4-1: Physico-chemical Characteristics of Soil

Parameters	Unit	SO1	SO2	SO3
pH		8.03	7.77	7.22
Conductivity	µS/cm	722	812	830
Moisture	% by mass	8.3	9.2	7.4
Available Nitrogen	mg/kg	290	324	272
Available Phosphorous	mg/kg	83	105	119
Calcium	mg/kg	128	185	152
Magnesium	Meq/100gm	74	96	64
Available Nitrate	mg/kg	140	131	128
Sulphate	mg/kg	640	714	520
Organic Matter	% by mass	96	116	83
Chloride	mg/kg	145	165	132
Available Carbon	mg/kg	47	58	38
Copper	mg/kg	26	36	22
Iron	mg/kg	68	80	56
Zinc	mg/kg	50	63	46
Manganese	mg/kg	42	58	33
NaCl	mg/kg	290	315	254
Na_2CO_3	mg/kg	168	186	140
Sodium Absorption Ratio	Meq/100gm	8.26	9.2	8.11
Soil Grain Size Analysis/texture				
Sand	% by mass	46.2	43.4	40.7
Silt	% by mass	29	33.6	39.9
Clay	% by mass	24.8	23	19.4
SO1 – Badhbadha Square; SO2 – Ratnagiri Square; SO3 – Krishi Upaj Mandi				

The soil quality analysis shows that at all the locations soil quality are basic in nature and less moisture retention capacity. The soil texture along the project corridor is sandy loam with good amount of nitrogen content.

4.1.4. Land Use Distribution

The Bhopal Development Plan 2005 had projected a total population of 25 lakhs in the planning area. The details of area allocated for different land uses in the development plan 2005 is in table 4-2. Due to the present gap in rising population and supply of housing, growth of unauthorised settlements can be seen. The urban sprawl has followed major roads such as Chhola, Hoshangabad and Kolar Roads. The city has grown mostly in the south east direction along Hoshangabad Road, due to availability of land and presence of Habibganj Railway Station, an important transport node.

The above growth trend is also influenced by undulating terrain and the Railway line on the northern side that acts as constraints to the spread of urbanization. Further, the vast expanse of the Upper Lake has restricted the growth of the city towards the west.

Table 4-2: Land use composition proposed for Bhopal in BDP 2005

Land use	Area development (ha)	Share (%)
Residential	8190	47
Commercial	650	4
Public-Semi Public	1258	7
Community Facilities	488	3
Industrial	1389	8
Transpiration	2600	15
Recreational	2925	17
Total	17500	100

Along the proposed two metro corridors, there are shops, commercial establishments, open land and residential area. The open land for 3km (approx.) stretch along alignment of Red Line is observed, which are mainly parks, public ground and cultivable land. Otherwise, mixed land use of commercial & residential and followed by residential area is observed along major length of the alignment of Purple Line & Red Line metro corridors.

4.1.5. Seismicity

The majority of Madhya Pradesh geographical area (Fig 4-2) falls under zone least active to moderate zone as per seismic map of India. The study area has no major threat of an earthquake because it is located in seismically stable zone (Zone II).

4.1.6. Air Environment

4.1.6.1. Climate and Meteorology

The climate of Bhopal district is characterized by a hot summer and well-distributed rainfall during the southwest monsoon season. The year can be divided in to four seasons. The winter commences from middle of November and lasts till the end of February. The period from March to about first week of June is the summer season. May is the hottest month of the year. The southwest monsoon starts from middle of June and lasts till end of September. October and middle of November constitute the post monsoon or retreating monsoon season.

Bhopal district receives maximum rainfall during south-west monsoon period (Jun-Sep), which is evident from rainfall data (Table 4-3) of last 5years. About 92 % of the total rainfall takes

place only during the monsoon period. The maximum rainfall (about 41.2%) takes place during the month of July. In winter occasional rainfall of about 4.4 % takes place. During summer only about 2.9 % of the annual rainfall takes place. The highest annual rainfall of 1576.8mm was recorded in 2016, while lowest was recorded in 2017 i.e. 805.1mm. The average annual rainfall for last five year is 1148.02mm.

The temperature starts rising from the beginning of February and reaching maximum in the month of May.

Table 4-3: Monthly Rainfall (mm) - Bhopal District

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Rainfall
2013	0	24.8	21.4	38.9	0	459.5	429.1	332.8	42	26.2	0	0	1374.7
2014	58.5	47.9	3.5	3.3	7.6	23.2	427.1	165.9	109	12.4	0	23.3	881.7
2015	40.1	0	45.5	1.6	13.1	166.7	473.8	315.2	42.6	3.2	0	0	1101.8
2016	21	0.4	5.4	0	9	150.1	660.5	531.3	122.2	76.9	0	0	1576.8
2017	3.4	2	1	0	17.6	102.8	334.5	126.2	217.4	0	0	0.2	805.1

Source: imd.gov.in

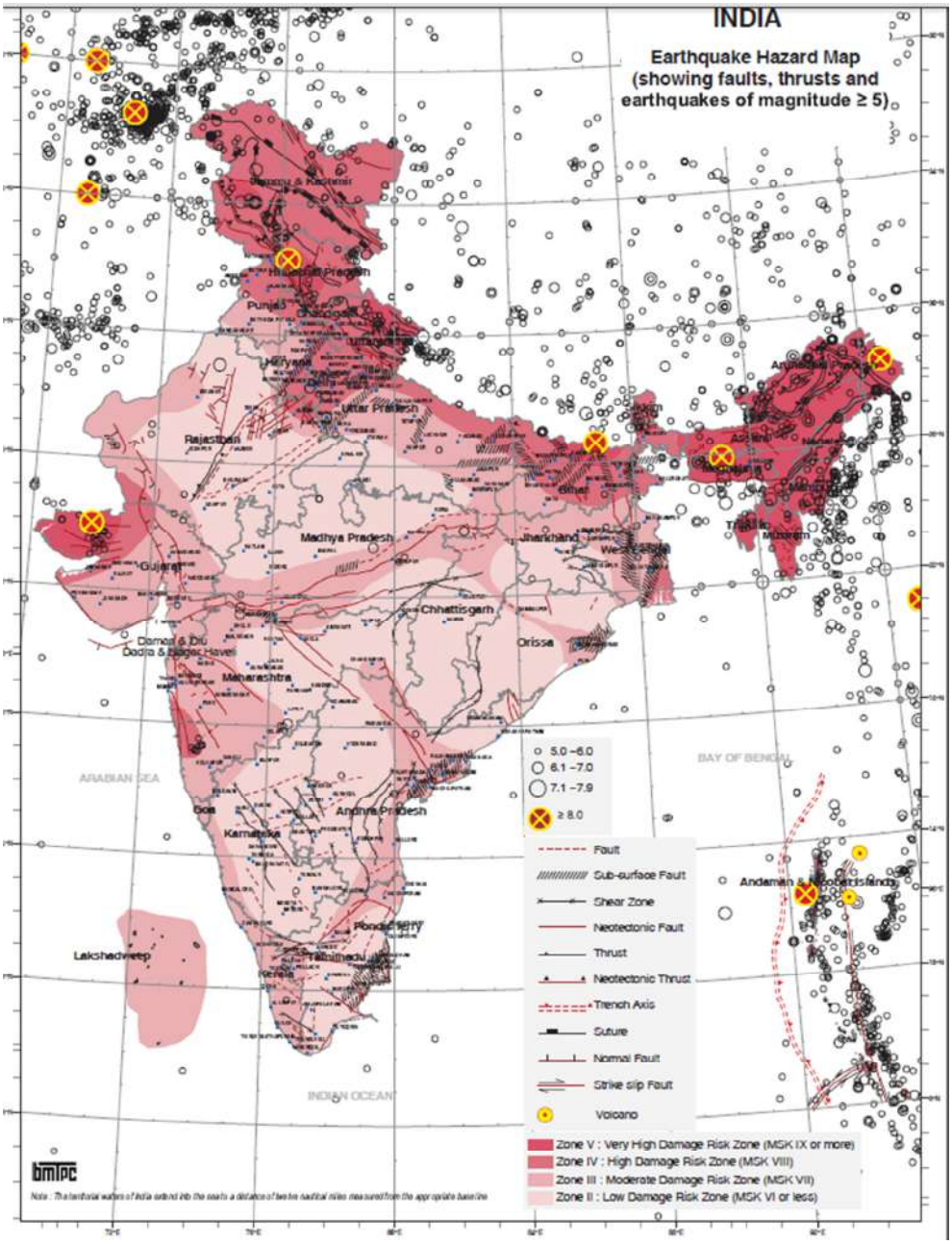


Fig 4-2: Seismic Map of Madhya

The maximum temperature in May goes up to 44°C and minimum temperature recorded is 10.2°C in the month of January. The summer season is the driest period of the year. The humidity comes down lowest in April. It varies between 26 % and 88 % at different time in different seasons. The wind velocity is high during the monsoon period (Table 4-4) as compared to pre and post monsoon. The wind velocity is highest in June around 18.5 km/hr and lowest is 5.9 km/hr in November.

Wind speed (kmph) - Bhopal Airport												
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2014	10	10.1	11	10.9	14.8	18.5	16.2	14	12.7	7.7	6.3	6.3
2015	7.4	6.7	7.3	13.3	16.5	15.5	19	15.3	11.4	8.7	6.7	7.9
2016	7.9	10.6	11.3	13.8	16.9	15	14.7	15.4	12	8.5	5.9	6.9
2017	8.5	9.4	10.9	15.5	14.6	15.3	16.1	13.6	10.2	7.8	6.6	8.3
2018	7.9	8.7	10.4	13	15.2	17.4	15.4	16				

4.1.6.2. Air Quality

The Bhopal is one of cities identified under National Air Quality Monitoring Program (NAQMP), which is coordinated by Central Pollution Control Board. As part of NAQMP, air quality monitoring is done in more than 308 stations spread across the country, and MPPCB carry out monitoring for parameters $PM_{2.5,}$ PM_{10}, SO_2, NO_2, O_3 and NH_3 at identified six stations (Fig 4-3).

As part of EIA study and for understanding ambient air quality of Bhopal city, the monitoring results of six stations (Table 4-5) were collected from MPPCB.

Table 4-5: Ambient Air Quality Results (November, 2017)

Monitoring Location	Zone	NO_2	SO_2	PM_{10}	$PM_{2.5}$	O_3 (8hr)	NH_3	AQI
Standard (24 hr monitoring) - µg/m^3		**80**	**80**	**100**	**60**	**100**	**400**	
Paryawaran Parisar, Bhopal	Residential	7.6	2	74.8	31.3	1.6	10.8	71.1
Civil Hospital, Bairagrah	Commercial	17.9	6.7	112.2	65.0	25.4	23.2	132.2
CETP Govindpura, Bhopal	Industrial	11.1	4.2	119.0	60.2	22.9	19.2	140.1
Kolar Thana, Kolar Road	Residential	15.5	7.0	138.6	45.8	18.2	19.5	126.1
Mrignayani, Hamidia Road	Commercial	18.6	6.9	201.5	74.5	27.8	21.5	190.6
University, Hoshangabad Road	Residential	13.8	3.8	100.6	46.4	15.1	14.4	107.1
Source: http://www.mpenvis.nic.in								

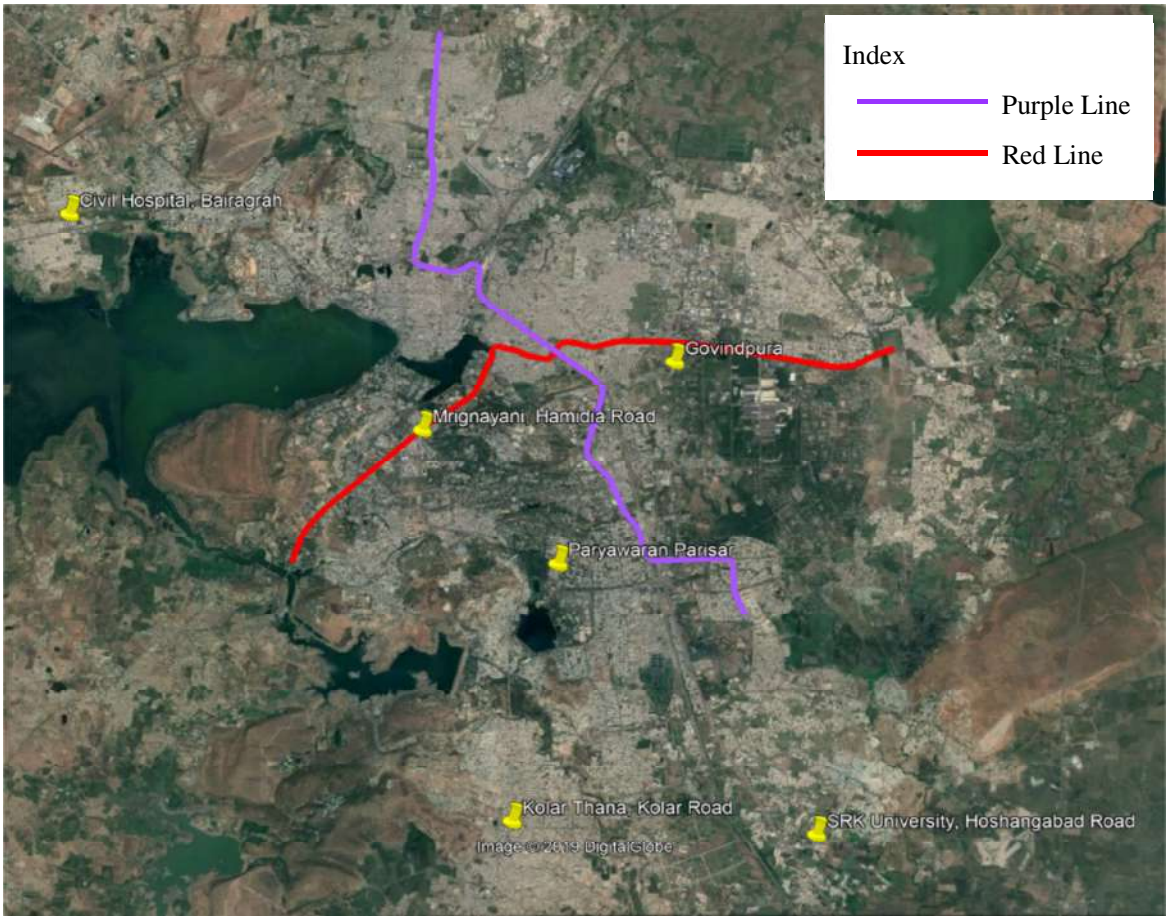
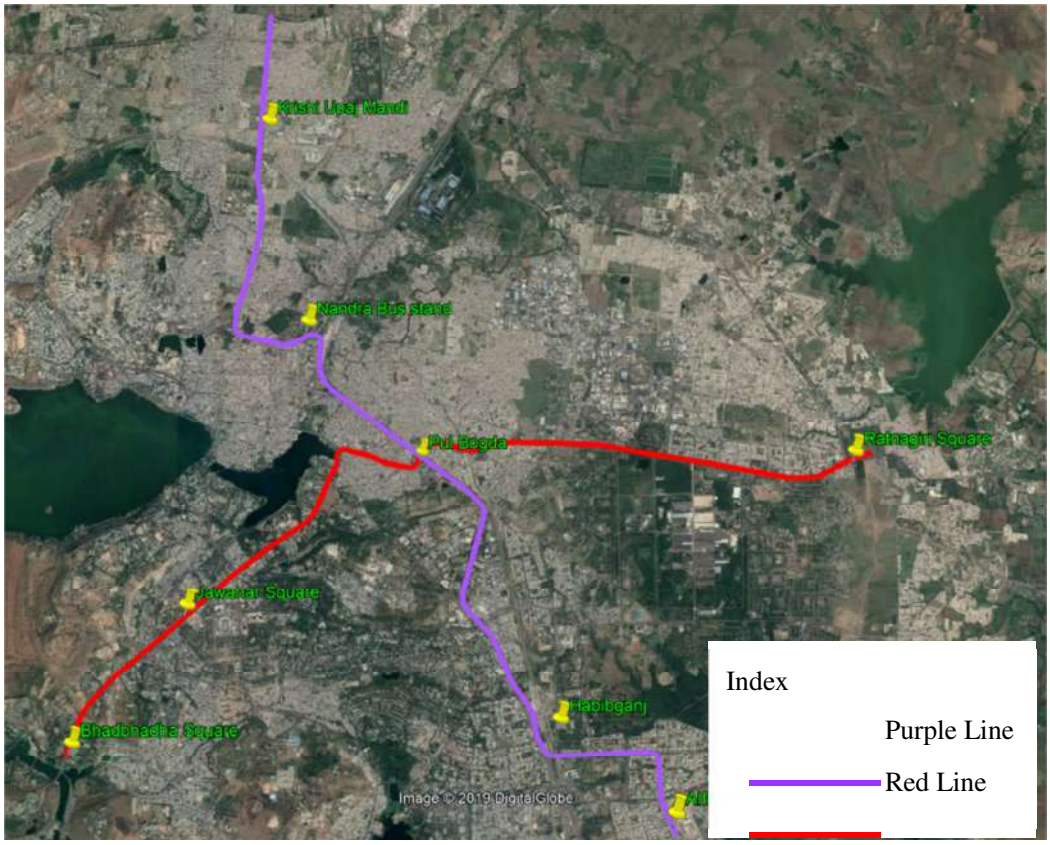


Fig 4-3: Indicative locations of NAQMP monitoring stations in Bhopal

The Paryawaran Parisar, CETP Govindpura, and Mrignayanire monitoring stations of NAQMP are close to proposed two metro lines. The concentration of PM_{10} level at CETP Govindpura, and Mrignayani Hamida road exceeds the permissible limits. Similar observation is also noted for $PM_{2.5}$ level at Mrignayanire at these locations.

To study the baseline ambient air quality scenario within metro corridors with respect to PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO and HC, samples of air were collected in month of July 2018 from eight locations. The monitoring locations selected based on representative of land use and sensitive receptors along the Purple Line and Red Line metro corridors. The air sampling locations with respect to propose metro lines has been represented in Fig 4-4. The air quality analysis report is given Table 4-6.

The results show that the concentration of PM_{10} and $PM_{2.5}$ exceeds the standards (Annexure 4.1) at all locations whereas other parameters are within permissible limits at all the locations. The ambient air results is higher when compared with NAQMP post-monsoon (November, 2017) results.



The test results indicates that 24 hourly mean concentration of PM_{10} in ambient air varied between 159 µg/m^3 and 254 µg/m^3 along Purple Line, while it varies from 172 µg/m^3 and 191 µg/m^3 along Red Line. In case of $PM_{2.5}$ varies from 86 µg/m^3 and 144 µg/m^3 at Purple Line, and 95 µg/m^3 and 111 µg/m^3 along Red Line. The concentrations of PM10 and $PM_{2.5}$ in the ambient air exceeded the National Ambient Air Quality Standards i.e. PM_{10} -100 µg/m^3, $PM_{2.5}$ - 60 µg/m^3) at all monitoring stations along the two metro corridors. The maximum PM_{10} (254 µg/m^3) and $PM_{2.5}$ (144 µg/m^3) concentration is identified at Nadra Bus Stand along Purple Line, that may be due to un-vegetated land in vicinity of sampling location and dust generated during plying of local traffic.

Table 4-6: Ambient Air Quality Results

Monitoring Location	Units	$PM_{2.5}$	PM_{10}	SO_2	NO_2	CO	HC
Limit as per CPCB		60	100	80	80	2	-
Purple Line							
AIIMS	µg/m^3	112	191	10.9	19.1	BDL	BDL
Habibganj	µg/m^3	132	204	9.8	17.3	BDL	BDL

Monitoring Location	Units	$PM_{2.5}$	PM_{10}	SO_2	NO_2	CO	HC
Limit as per CPCB		60	100	80	80	2	-
Nadra Bus Stand	µg/m^3	144	254	10.1	18.4	BDL	BDL
Krishi Upaj Mandi	µg/m^3	86	159	11.2	20.1	BDL	BDL
Red Line							
Bhadbhada Square	µg/m^3	95	172	12.8	21.8	BDL	BDL
Ratnagiri Square	µg/m^3	100	186	10.9	18.2	BDL	BDL
Jawahar Square	µg/m^3	111	191	14.6	22.7	BDL	BDL
Pul Bogda	µg/m^3	104	173	12.4	20.9	BDL	BDL

4.1.7. Noise and vibration

Noise is responsible for adverse impact on physical and mental health of the people. The other impacts are:

- Physiological effects,
- Hearing impairment,
- Communication interference, and
- Sleep disruption

The assessment of impacts of noise sources on surrounding community depends on:

- Characteristics of noise sources (instantaneous, intermittent or continuous in nature).
- Time of day at which noise occurs, for example high noise levels at night in residential areas are not acceptable because of sleep disturbance.
- Location of noise source, with respect to noise sensitive land use, which determines the loudness and period of exposure

Noise level survey was conducted along the alignment of Purple Line and Red Line to establish the baseline noise levels and assess the impacts of total noise expected due to the proposed metro. Noise levels were measured at eight locations where air monitoring was conducted (Table 4-7) consisting residential and commercial landuse. The noise levels along the metro corridors are summarised in Table 4-7.

Table 4-7: Noise Level along Metro Corridors

	Purple Line				Red Line			
Location Code	NO1	NO2	NO3	NO4	NO5	NO6	NO7	NO8
Maximum dB(A)	64.6	60.3	64.2	62.6	61.7	61.9	61.4	62.5
Minimum dB(A)	40.8	38.2	40.1	40.5	38	38.2	38.6	41.8
Ld dB(A)	59.7	57.5	61.2	60.2	59.1	59.1	58.8	57.2
Ln dB(A)	46.6	44	48.1	49.5	46.9	46.4	45.7	43
Ldn dB(A)	58.9	56.6	60.4	60	58.5	58.4	58	56.2
Category of Area	C	B	C	B	C	C	B	B
NO1-AIIMS, NO2-Habibganj, NO3-Nandra Bus Stand, NO4-Krishi Upaj Mandi, NO5-Bhadbhada Square, NO6-Ratnagiri Square, NO7-Jawahar Square, NO8-Bogdapul								

The noise level were compared with standard corresponding land use type in The Noise Pollution (Control and Regulation) Rule 2000 and is provided in (Table 4-8).

Table 4-8: Ambient Air Quality Standard in respect of Noise			
Area Code	Category of Area / Zone	Limit in Leq dB(A)	
		Day Time	Night Time
A	Industrial Area	75	70
B	Commercial Area	65	55
C	Residential Area	55	45
D	Silence Zone	50	40

The daytime noise level was recorded in the range of 57.2 dB(A) to 61.2 dB(A) whereas the same varied from 44 dB(A) to 49.5 dB(A) during night time. The higher level of day time noise level observed at AIIMS could be due to operation of chilling tower across sampling location in premise of AIIMS hospital, while in case of Nandra Bus stand, the noise level is likely to be influenced due to blowing of horn during train movement (100m from monitoring location). In case of Bhadbhada and Ratangiri square the monitoring was done at side of road and may be attributed to noise from vehicular traffic. The noise level in remaining monitoring location are within permissible limit.

4.1.8. Water Resources

Water environment consists of water resources and its quality. Its study is important from the point of view to assess the sufficiency of water resources for the needs of the project in its various stages of the project cycle and also to assess the impact of the project on water environment. Water supply to Bhopal city is from the upper lake, the main source of water, which is also supplemented by Kolar dam and groundwater through 550 motorized tube wells.

4.1.7.1. Surface Water

The natural drainage (Fig 4-5) of the city is provided by three main streams, which are joined by small *nallahs* and rivulets. On the north-eastern side, the drainage is provided by river Halali and on the south-eastern side, it is provided by Kaliyasote River. Both these rivers, drains out in Betwa, Halali near Vidisha and Kaliyasote near Bhoipur. On the south-western side, the drainage is provided by various small *nallahs*, which drain out in Kolar River, which ultimately joins river Narmada.

The drainage water of old city including wastewater is carried away by a *Nallah*, which joins river Halali, which is a perennial river. The water of this river is being used for irrigation purposes and very little discharge meets river Betwa near Vidisha. Moreover, the meeting point is on the down streamside of water works for Vidisha town. River Kaliyasote, which provides drainage on the south-eastern side, joins Betwa near Bhojpur in Raisen District. There is hardly any possibility of utilization of this water on the way for irrigation purposes as passes through a hilly terrain.

4.1.7.2. Ground Water

The pre-monsoon depth to water level in Bhopal district ranges between 5.15 m bgl at Balrampurghati to 18.4 m bgl at Islamnagar in Phanda block. During post-monsoon period, the water level ranges from 1.24 m bgl at Balampurghati to 11.61 m bgl at Islamnagar. The net ground water availability in the district is 32,724 ham and ground water draft for all uses is 26,214 ham, making stage of Ground water development 81% as a whole for Bhopal district.

As per Central Ground Water Board (2013), Berasia block of the district is categorized as safe block, and highest stage of ground water development is computed as 93 % for Phanda Block as Semi critical. Off late, with rapid depletion of groundwater resources, efforts have been initiated to regulate the use of groundwater resources. The Central Ground Water authority, (CGWA) the statutory authority set up by the Central Government has also restricted the drilling of tube wells and bore wells in scarce areas in the country.

In case of project area is in non-notified area list of Central Ground Water Authority. As per CGWA's guideline issued in 2015, abstraction of groundwater for infrastructure project would require obtaining of NOC from Central Ground Water Board.

4.1.7.3. Water Quality

The upper lake and lower lake are two major surface water bodies within project influence area. These lakes are the primary source of drinking water for Bhopal city. In order to understand potential impact on water quality of these major surface water bodies, the water quality results of Madhya Pradesh State Pollution Control Board (MPSPCB) (Annexure 4.3) were analysed for five monitoring locations establish at perimeter of these water bodies. The current monitoring system covers 188 locations across the state. The monsoon (June to September) and post-monsoon (October – December) results were compared for year 2016 and 2017. In case of upper lake, during both seasons and years, the water quality status is observed satisfactory at all four monitoring locations. At Lower Lake, high result of Total Coliform and Faecal Coliform is reported during post monsoon period in test results of 2016 and 2017. As a result the water quality of lower lake has been reported unsatisfactory for drinking purpose.

a. Surface Water quality

Primary data generation on surface water quality was carried out in the month of July, 2018 in order to assess the surface water quality within the project area. The water samples from Bodapul drain and Badhbadha Square (Lake) were collected for assessing the physio-chemical characteristic of water. The analysis result of various quality parameters has been presented in Table 4-9.

Table 4-9: Characteristics of Surface Water in the Project Area

Parameters	Unit	SW1	SW2	Tolerance Limit				
				Class-A	Class-B	Class-C	Class-D	Class-E
pH		7.47	7.54	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.0-8.5
Turbidity	NTU	20.6	4.8					
Temperature	^{o}C	32.5	31.5					
Conductivity	µs/cm	1270	830				1000	2250
Total Dissolve Solids	mg/l	830	542	500		1500		2100
Total Suspended Soilds	mg/l	366	22					
Oil and Grease	mg/l	18	2			0.1	0.1	
Dissolve Oxygen	mg/l	3	5	6.0	5.0	4.0	4.0	
Chloride	mg/l	213	148	250		600		600
Fluoride	mg/l	0.56	0.13	1.5	1.5	1.5		
Sulphate	mg/l	63.2	26.3	400		400		1000

Parameters	Unit	SW1	SW2	Tolerance Limit				
				Class-A	Class-B	Class-C	Class-D	Class-E
Biological Oxygen Demand	mg/l	154	24	2.0	3.0	3.0		
Chemical Oxygen Demand	mg/l	576	166					
Total Alkalinity as $CaCO_3$	mg/l	142	155					
Total Hardness as $CaCO_3$	mg/l	230	190	300				
Total Coliform	MPN/100ml	500	300		500	5000		
Faecal Coliform	MPN/100ml	1600	900					
SW1 - Bogdapul Drain; SW2 - Badhbadha Square Lake								

The analysis result were compared prescribed with IS 2296-1982 (Annexure 4.4) reflects that sample taken from Badhbadha Square lake meet the quality criteria for Class B (Outdoor Bathing) and while Bogdapul water sample meet Class E (Irrigation, industrial cooling or controlled waste disposal) of surface water.

b. Groundwater quality

The generation of baseline data on groundwater quality within the project area was carried in the month of July, 2018. The ground water samples were collected from bore wells at Bogdapul and Badhbadha Square along metro corridors to assess the quality of ground water around project area. The result of physico-chemical analysis of ground water was compared with IS 10500: 2012 (Annexure 4.5) and is given in Table 4-10.

Table 4-10: Characteristics of Ground Water in the Project Area

Parameters	unit	GW1	GW2	Acceptable Limit	Permissible Limit
Colour		<1	<1	5	15
Odour		Agreeable	Agreeable	Agreeable	Agreeable
pH		7.26	7.33	6.5-8.5	No relaxation
Conductivity	µmhos/cm	747	720	-	-
Temperature	^oC	27.2	27.9	-	-
Total Dissolve Solids	mg/l	486	470	500	2000
Calcium	mg/l	41.7	38.5	75	200
Chloride	mg/l	143	127	250	1000
Fluoride	mg/l	0.13	0.1	1	1.5
Magnesium	mg/l	22.4	20.4	30	100
Nitrate	mg/l	13.7	11.9	45	No relaxation
Nitrite	mg/l	5.6	5.1	-	-
Sulphate	mg/l	42	38	200	400
Total Hardness as $CaCO_3$	mg/l	196	180	200	600
Chemical Oxygen Demand	mg/l	<8	<8	-	-
Potassium	mg/l	6	5	-	-
Sodium	mg/l	18	14	-	-
Total Coliform	MPN/100ml	11	13	Shall not be detected in 100ml sample	
Faecal Coliform	MPN/100ml	<2	< 2	Shall not be detected in 100ml sample	
GW1 – Bogdapul; GW2 - Badhbadha Square					

The test results of the ground water samples along the metro corridor at all the locations reflect that the all parameters are within permissible limit. The water sample collected from both locations shows presence of Total Coliform and Faecal Coliform, which indicates contamination of water with faecal waste that may contain other harmful or disease causing organisms, including bacteria, viruses. This may be due to poor maintenance and construction of bore well.

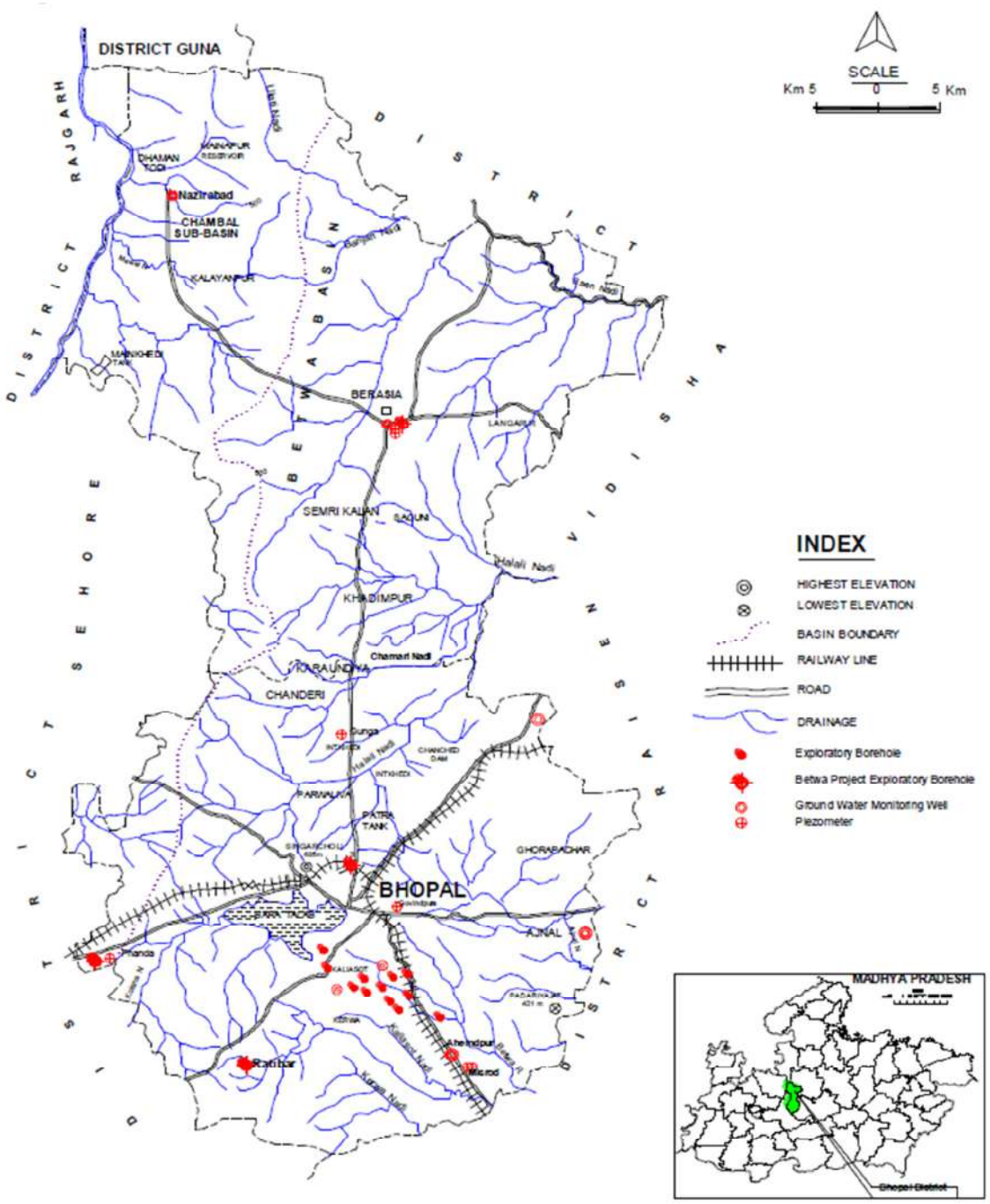


Fig. 4-5: Drainage Map of Bhopal

4.2. Biological Environment

4.2.1. Forest

The forest cover has been classified as dense forest and open forest. The latest estimates of Forest Survey of India (FSI), published in the State of Forest Report (SFR) 2017, suggest that the total forest cover of M.P. is 77414 sq. km., constituting 25.11% of the State's total land area. The total forest cover, very dense forest accounts for 8.48%, moderately dense forest about 44.66% and open forest about 46.86%. Central, eastern, and southern parts of the state are rich in forest cover. Figure 4-6 shows the forest map of the state.

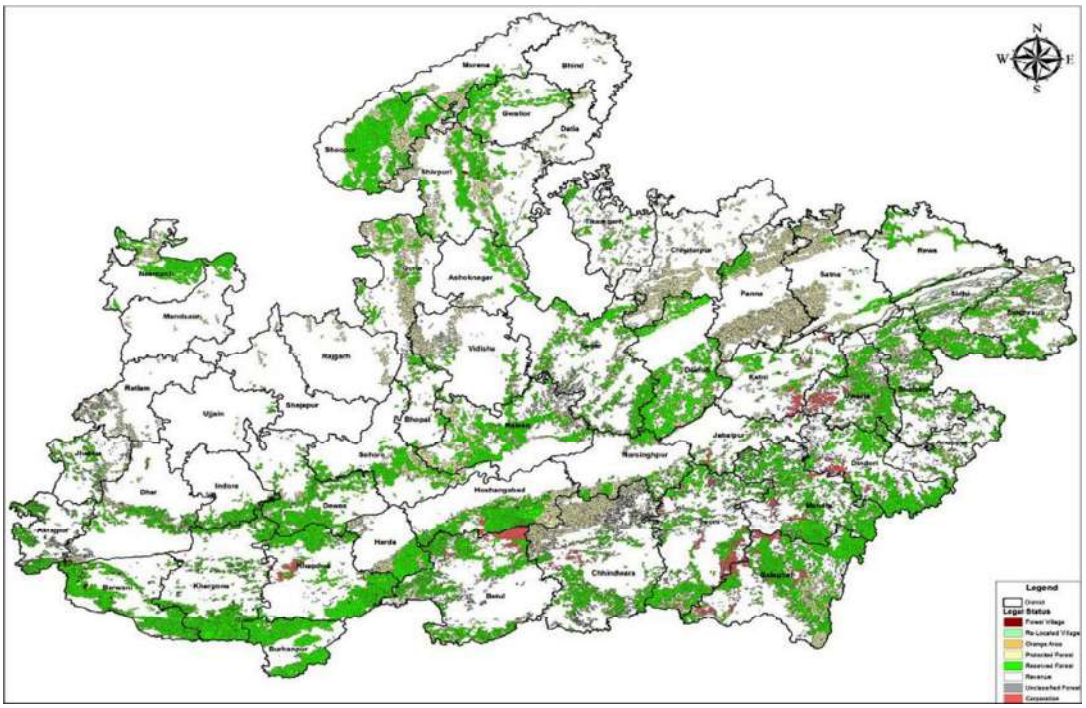


Fig 4-6: Forest Map of Madhya

However, the project district is one of the districts with lowest forest cover in the state with 12.77% share of district's total geographical area. A net decrease of 9 sq.km (Table 4-11) forest area in Bhopal district has been observed that could be attributed to expansion of agriculture, development activities, mining and rotational felling.

Table 4-11: District-wise Forest Cover (area in sq.km)

District	Geo. Area	Very Dense Forest	Mod. Dense Forest	Open Forest	Total	% of GA	Change	Scrub
Bhopal	2772	0	125	229	354	12.77	-9	73
G. Total	308252	6563	34571	36280	77414	25.11	-12	6279

Source: India State of Forest Report (2017), Forest Survey of India, Govt. of India

The propose metro lines follow the alignment of existing road and its viaduct are proposed to be contained within right-of-way of existing road, which has roadside plantation on both sides. Based on observation during reconnaissance survey, to provide encumbrance free construction site, these roadside trees will be impacted. The project will have significant potential impact,

but the impact can be offset by carrying out compensatory plantation in ratio of 1:4 for trees with girth size above 300mm and 1:2 for tree girth size below 300m measured above ground level. The budgetary provision for tree cutting and compensatory plantation shall be included in Environmental Management Plan.

4.2.2. Protected Area

Bhopal has rich biodiversity by the presence of large lakes especially Bhoj Wetland within the city and a National Park Van Vihar within the city. Several lakes and water bodies numbering more than 35 are identified in the vicinity of the city which are used as drinking water sources and are getting contaminated from anthropogenic uses.

National Park: The Van Vihar National Park is located in Bhopal. The boundary of NP is 650m from nearest point of Red Line and 4.05km from Purple Line. To safeguard the National Park, a buffer of 100m distance from boundary of National Park is notified as eco-sensitive zone in all sides. Both Red and Purple lines are located away from eco-sensitive zone. There would not be any direct impact, but indirect impact is likely due to air and noise pollution during construction stage. Though, the impacts will be of lesser significance.

Ramsar Site: The Bhoj wetland includes both upper and lower lakes located in the city of Bhopal. The boundary of upper lake is located 2km (approx.) and those of lower lake is in proximity (Lily Talkies station) to propose alignment of Red Line. The upper lake is the principal source of drinking water for the city of Bhopal, the lower lake meets the requirement of raw water and enhance beauty of the city. In view of biodiversity, the upper lake is habitat for phytoplankton (208 species), zooplankton (105 species), macrophytes (106 species), aquatic insects (98 species), Fish fauna (43 species) and avifauna (both resident – 99 and migratory – 52, local migratory – 28). In view of rich biodiversity, the Bhoj wetland was declared as Ramsar site in 2002.

4.2.3. Flora and Fauna

4.2.3.1. Flora

Plantation of trees along the existing road has been recorded within the RoW of metro corridor. The predominant tree species along the road are Ashok, Babool, Gul Mohar, Kadam, Siris, Sheesham, Neem, and Eucalyptus. Apart from these Mango, Peepal, Banyan, Jamun, Guava, Jack Fruit, etc are also located along the roadside (Annexure 4.7). Mostly single row of linear plantation is located along either side of the existing road along with metro alignment is propose. Altogether for both metro corridors, a total number of 2192 tress and 30 poles (Table 4-12) are located within the corridor of 20 m. The number of trees on right side i.e. 1066 of road is more when compared to left side plantation i.e. 876, while 250 trees are median plantation that would be affected directly in both corridors.

Table 4-12: Details of roadside plantation (Purple and Red Lines)

S.No	Name of Metro Line	LHS	Middle	RHS	Total
1	Karond Circle – AIIMS (Purple Line)	496	236	467	1199

2	Bhadbada Square - Ratnagiri Tiraha (Red Line)[3]	380	14	599	993
Total		**876**	**250**	**1066**	**2192**

4.2.3.2. Fauna

No Wildlife Sanctuary/National Park is located within the 7km radius of project area, except for Van Vihar that is developed and managed as a modern zoological park, following the guidelines of the Central Zoo Authority and maintained by the Forest Department of Madhya Pradesh. It was declared a National Park in the year of 1979. It covers an area of about 4.45 km^2.

The domestic animals in the project area consist of cows, bullock, goat and dogs. The metro corridors being proposed in Bhopal city, no rare or endangered wildlife species have been reported in the project area.

4.3. Cultural Environment

4.3.1. Protected Monument

The Kamalpati Mahal and Taj Mahal Palace are historical and of archaeological importance monuments located along propose metro corridors. The Kamalpati Mahal palace is situated on the bridge, between the larger and the smaller lake. It was built in 1722. This palace has been named after queen Kamlapati the widow of Nizam Shah Gond, Chief of Ginnorgarh. This monument is centrally protected and is locate 2km (approx.) from Red Line. While Taj Mahal Palace is state protected monument located 600m from propose alignment of Purple Line. These identified monuments along the project corridor are located more than 500 m away from propose metro corridors on either side of the project road.

4.3.2. Religious Structures

The religious structure identified along the metro corridor is provided in Table 4-13. The majority of these religious structure within 10m (i.e. from centreline) metro corridor are likely to impacted, which may require to be shifted. The lists of religious structure are presented in Table 4-13.

Table 4-13: List of Physical Cultural Properties

S.No	Chainage	Descriptions	Distance from CL (m)	Location
Purple Line				
1	20.760	Bhawani Shankar Temple	4.7	LHS
2	20.875	Durga Temple	6.2	RHS
3	23.185	Mahaveer Temple	6	RHS
4	25.450	Shiv Maa Durga Temple	17.2	LHS
5	27.065	Madarsa and Masjid	5.5	LHS
6	27.400	Durga Temple	7	RHS
7	27.940	Hardaul Baba	5.2	LHS
8	28.180	Maszid	13	LHS
9	28.230	Bethlehem Church	10.5	LHS

[3] To be revalidated during SIA.

10	31.970	Maszid	6.8	LHS
11	32.745	Shrinath Temple	7	RHS
12	33.230	Maszid	13	RHS
13	34.985	Kali Temple	7.1	LHS
14	35.005	Ramdev Ji Temple	8.1	LHS
15	35.015	Peer Baba Temple	4.5	LHS
16	35.090	Shanker Ji Temple	7.5	RHS
17	35.450	Shanker Ji Temple	14.3	LHS

Durga temple @ km

Madarsa and Masjid @ km

Durga Temple @ km 27.400

4.4. Social Environment

The demographic features of the project city as per 2011 Census is 1,798,218; of which male and female are 936,168 and 862,050 respectively. Although Bhopal city has population of 1,798,218; its urban / metropolitan population is 1,886,100 of which 981,860 are males and 904,240 are females. The population density in Jhansi district is 398 which is far lower than the State's population density of 855 per sq km. The sex ratio reflects the socio-economic and demographic characteristics of the population. It is an important indicator of migration and gender equity (in a developing country context) since it helps to point out the employment opportunity in the districts. The sex ratio in Bhopal city is 919, which is lower than the state's sex ratio of 931 females for every thousand males.

Literacy rate is a significant indicator of any city or district or state's economic as well as social development status. The higher literacy rate indicates higher awareness and vice versa. The Literacy rate of Bhopal city according to the 2011 Census is 83.47%, of which male and female literacy was 87.45 and 79.16 percent.

The economy of Bhopal is essentially divided into modern and traditional industries. The prominent industries in the old city are those of cotton, electrical goods, jewellery and chemical. Some other industries are involved in cloth weaving, making sports equipment, sealing wax and making matches. On the other hand, being the state capital, accommodates many reputed insurance companies, banks and other financial organizations. M P Nagar is Bhopal's most prominent commercial area and accommodates many reputed business houses. Bharat Heavy Electricals Limited (BHEL), which is the largest manufacturing and engineering enterprise in India, has its unit in Bhopal. The industrial suburb of Bhopal is Mandideep, which

accommodates many plants belonging to some of the esteemed companies including Eicher, Crompton Greaves, Procter and Gamble, Larsen and Turbo, Fujitsu and HEG.

5. Anticipated Potential Impacts

In this chapter, potential environmental impacts, both bio-physical and socio-economic, are assessed in terms of the direct and indirect nature of the impact, extent, duration and significance. The level of assessment of each potential impact was based on the important environmental issues identified in baseline environmental studies and activities of the project.

The impacts of major infrastructure projects can be divided into two principal categories. First direct impacts which result from physical presence of the facilities and the way they are designed, built and operated. Second, indirect impacts, which stem from the construction and economic activities surrounding construction and the induced development resulting from improved access.

The potential impacts and risks were analysed in the confines of the metro alignment's direct impact area, which is defined in this study as 10 meters on both sides of the metro's centreline. Influence area where most of the socio-economic and cumulative impacts will occur is defined as the entire confine of the area in Bhopal city.

The construction activities will mainly be restricted to the right-of-way along the entire alignment except for associated facilities such as the temporary camp sites, quarry and borrow areas which are the activities associated with the construction and are usually located beyond the right of way.

The potential environmental impacts are studied as direct, indirect or cumulative effects on various environmental components. Relatively, small potential for negative impacts is generally envisaged for metro rail project. Most of these negative environmental effects can be 'design out' at an early stage through proper engineering designs, which will emphasize the contractors to follow environmentally friendly construction methodology.

Direct environmental impacts are those that are directly caused by metro rail construction or operation. During construction these impacts primarily occur within the right-of-way or immediately adjacent to it, and at ancillary sites such as quarries and workforce camp. Direct construction impacts can include the loss of damage to ecological features such as land resources and water bodies, damage to manmade structures and resettlement.

The metro rail development have positive influence by virtue of higher passenger carrying capacity, faster, smoother, and safer travel, occupy less space, and are non-polluting and energy-efficient. Besides these, negative impacts that are likely to result from the proposed metro line development have been listed under the following headings:

- Impacts due to Project Location;
- Impacts due to Project Design;
- Impacts due to Construction; and
- Impacts due to Project Operation

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

5.1. Project Location - Impacts and Mitigation Measures

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

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

5.1.1. Land Use

The metro alignment are planned on the existing road, acquisition of land is not involved for viaduct. In case of stations, there is likelihood of additional land requirements beyond the right-of-way, which would be establish during Social Impact Assessment and enable in taking decision on extent of acquisition. The required land (permanent & temporary) for the construction of the proposed metro lines from Karond Square to AIIMS (Purple Line) and Bhadbhada Square to Ratnagiri Tiraha and depot at Subhasnagar is mainly owned government land.

The extent of land to be acquired for stations will be determine after the finalization of RFP and SIA. The land acquisition and resettlement & rehabilitation activities of the project will be governed by the following general principles of The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013.

5.1.2. Trees cutting

The proposed two metro lines is in urban/city area and will not pass through any forests. Hence no loss to forest is anticipated due to the project. There are existing roadside plantation along the propose alignment of Purple Line and Red Line metro lines, which requires tree cutting permission from Bhopal Municipal Corporation. A total of 2,192 trees with girth size above 300mm have been identified within right-of-way at both lines, of which, 1199 trees in Purple Line and 993 trees in Red Line. The centreline of propose metro alignment is consistent with those of existing road and the impact on existing median plantation are unavoidable. The application has to be made to Bhopal Municipal Corporation (BMC) for tree cutting/trimming at project site. Compensatory plantation will be made through afforestration drive to compensate loss of trees. As per guidelines for each tree with girth size above 300mm felled four saplings and girth size below 300mm two saplings will be planted. In addition to the compensatory plantation, green belt area can be developed under the elevated corridor using native shrubs, herbs and grasses. Thus the green belt will provide aesthetic view of elevated track and also helps to serve as dust and noise absorbent barrier.

The relative impact of urban forests and their management is much more significant for carbon dioxide than for oxygen (Oxygen Production by Urban Trees in the United States, David J. Nowak, Robert Hoehn, and Daniel E. Crane, Arboriculture & Urban Forestry 2007). From this study amount of oxygen produced per tree per year for urban forests was adopted as 11 kg. Based on model for tropical trees (Tree allometry and improved estimation of

carbon stocks and balance in tropical forests, J.Chave et al, Oecologia 2005) and wood density for Asian species as per Food Agriculture Organization (FAO), CO2 sequestered per year per tree has been estimated for this report as 3 kg for typical tree of 30 cm girth.

There are 2194 trees (girth size above 300mm) and 30 poles (girth size below 300mm) above ground level are likely to be cut during construction. With removal of these trees, the process for CO_2 conversion will get effected and the losses are reported below:

i. Total number of Trees : 2,192
ii. Decrease in CO2 absorption due to loss of trees : 6,576 kg/year
iii. Decrease in Oxygen production due to tree loss : 24,134 kg/year

5.1.3. Issues related to Utility/ Drainage

Proposed metro lines are planned to run through the urban areas of Bhopal city. The alignment will cross many properties, drains/ *nalas*, large number of sub-surface, surface and utility services, viz. sewer, water mains, storm water drains, telephone cables, overhead electrical transmission lines, electric pipes, roads, traffic signals etc. These utilities/ services are essential and have to be maintained in working order during different stages of construction by temporary/permanent diversions or by supporting in position. Since these affect construction and project implementation time schedule/ costs for which necessary planning/ action needs to be initiated in advance.

During construction phase there will be great amount of issues will be encountered for the utility system/infrastructure facilities already existing within the alignment. The most important and hazardous aspect will be pipe lines network running along the alignment. A close coordination with utility department will be require regarding encasing these pipelines, as shifting/relocating will be of great inconvenience to the residential areas.

5.1.4. Socio-Economic Impact

The environmental and social safeguard of the project is to be implemented with reference to EIB's Environmental and Social principles and Standards. The MPMRCL is finalising the RPF to ensure compliance with the requirements of safeguard policies of EIB and all applicable national policies. The affected people will be compensated and assisted as per the provisions of Resettlement Policy Framework (RPF) for the proposed Purple Line and Red Line of Bhopal Metro Rail Project.

The preliminary social screening findings indicates to acquisition of land for stations, impacts on private structures, loss of livelihood including business loss by owners, loss of rental income by residential and commercial owners, business loss by commercial tenants and squatters. However, the details account of Bhopal Metro project's social impacts will be included after SIA is completed and during EIA finalisation.

The Resettlement & Rehabilitation activities of Bhopal Metro Rail Project will be governed by the following general principles of 'The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013'.

5.1.5. Impact on Historical places

The Taj Mahal palace and Kamalapati Mahal are two historical monuments having archaeological value in the vicinity of Purple Line and Red Line, respectively. The Taj Mahal palace is state protected monument located 600m (approx.) distance from Purple Line, while Kamalapati Mahal is centrally protected monument and is 2km (approx.) away from nearest point of Red Line. These monuments are located away at acceptable distance from propose Purple Line and Red Line alignments. Thus on this aspect no impact is anticipated.

Since Purple Line involves tunnelling for underground metro rail section there are possibilities that contractor may encounter artefacts during TBM operation, chance find measures are included in the EMP to minimize the impacts on historical / archaeological artefacts, in case found during tunnelling operation.

5.2. Project Design - Impacts and Mitigation Measures

Considered impacts, due to project designs are:

- Alignment
- Lighting
- Risk Due to Earthquake
- Vibration due to TBM
- Involuntary Resettlement.

5.2.1. Alignment Design

An alignment with less number of curves improves average speed and system capacity resulting in economical operation. In elevated metro sleek structural elements provide for aesthetic appeal. The space planning of stations has significant impact on safely of passengers, time spent in ingress & egress from station and energy consumption in stations.

5.2.2. Lighting

The platforms, concourse, staircase and escalator areas both for elevated and underground stations will have adequate and uniform fluorescent lighting to provide pleasant and cheerful environment. It is proposed to adopt the norms prevailing in Metro for illumination. The height of lighting fixtures will be maintained in a way at minimum height to enable passengers and staff to have a good visual view. A proper lighting concept and blinds where needed shall support good visibility for all users but particularly passengers with limitations.

5.2.3. Earthquake

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

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

5.2.4. Vibration from Tunnel Boring Machine (TBM) operation

The underground construction of metro rail section and stations is limited between chainage km 30.200 to km 31.900 of proposed Purple Line. Amongst other, the key environmental setting include high population density with old structures & buildings, commercial and business establishments, and presence of Taj Mahal Palace at 600m away from propose alignment. These environmental settings along alignment increase potential adverse impacts of the underground construction by triggering of surface settlements and slope instabilities, pollution of groundwater, noise and vibrations, and management of excavated material. The Tunnel Boring Machine reduces occupation of areas at the surface, the relocations of utilities, traffic diversions; potential environmental impacts in terms of noise, dust and visual on sensitive receptors and restricted to those located near the launching and retrieval shaft. Further, the possibility of encountering chance finding or discovering of artefacts and archaeological property during tunnelling between Nandra bus stand to Sindhi colony could not be ruled out due to existing protected monument along alignment. Hence, in the event of the unexpected discovery of archaeological objects this should be treated in accordance with national legislation. The majority of potential environmental impacts attributed to the proposed tunnel construction activities are likely to occur during construction works and mainly will be of temporary nature.

5.2.5. Involuntary Resettlements

The Social Impact Assessment study of propose two metro lines is underway. The findings of the study details of affected PAP's and project's impacts would be reflected in the EIA report during its finalisation.

The affected people will be compensated and assisted as per the provisions of Resettlement Policy Framework (RPF), being finalised by MPMRCL for the proposed Purple Line and Red Line of MRTS Bhopal Metro Rail Project. A Resettlement Action Plan (RAP) is being prepared based on the detailed socio-economic assessment of PAPs.

5.3. Construction Work - Impacts and Mitigation Measures

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

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

- Water Pollution

5.3.1. Soil Erosion and Top Soil

The site clearance includes vegetation clearance and excavation for creating temporary establishments such as temporary camp site, plant and machinery site, casting site, material stockyards, workshops, and other ancillary sites. This is in addition to site development required for construction of depot, station, piling and tunnelling. This will induces vegetation loss as well as loss of top soil and impact on soil fertility.

At the temporary camp site or stockyards, workshops, and other ancillary sites there is chance of loss to soil fertility due to various activities. In order to minimize the impact on soil fertility, the top soil will be preserved separately and the top soil will be reused at site restoration work.

The propose Purple and Red Lines involves construction of pile foundation and tunnelling. These activities will generate spoil materials and if spoils generated are not disposed-off properly, there is a possibility that run off from this unprotected excavated areas can result in excessive soil erosion, especially when the erodibiity of soil is high. Problems could arise from dumping of construction spoils (concrete, bricks) waste materials (from contractor camps) etc. causing surface and ground water pollution. Mitigation measures include careful planning, timing of cut and fill operations and re-vegetation. In general, earthworks should be avoided and stopped during monsoon season.

5.3.2. Traffic Coordination

During construction period, complete/partial traffic diversions on road will be required, as most of the construction activities on elevated sections are on the part of existing arterial road, which is likely to affect flow of traffic and congestion due to reduced carriageway width. During construction stage, the alternative service roads needs to be identified and assess need for providing temporary diversion to manage and allow for operation of traffic together with construction activities. Advance traffic updates/ information on communication systems will be an advantage to users of affected roads.

5.3.3. Excavated Soil Disposal

The proposed two metro corridors is both elevated and underground; there are 28 elevated stations and two underground stations with ramp. The construction activity involves cut and cover, tunnel (bored and rock), foundation, fill and embankment. All these activities will generate spoil soil/muck of 1.5 million cubic meter, of the generated muck quantity, some quantity is likely to be reutilized in backfilling in underground stations and depot. While, the balance unsuitable muck shall be disposed-off at disposal site in an environmental friendly manner. The muck disposal site will be identified considering the quantity of the muck, landscape, cost effectiveness, nearness to source of generation, absence of ground and surface water including displacement of persons is not involved.

The optimisation of muck/soil utilisation for refilling at station site and backfilling, but muck from tunnelling part will be disposed-off at locations/sites approved by pollution control

board and BMC. Responsibility of disposal of this soil will lies with contractor and will be regulated by BMC rules. Some Bentonite muck would also be generated during piling in the project. Disposal of Bentonite would be at designated land fill site.

5.3.4. Air Pollution due to Dust Emission

During construction phase, incremental air quality levels (Suspended Particulate Matter) will be observed during transportation of earth, excavation, loading and unloading of construction materials, vehicular and construction equipment emission and emission from the DG sets. However, this activity will be only short-term. Protective measures shall be undertaken during construction phase. All the measure will be taken to avoid any deviations in the air quality by adopting scientific methods, which includes mandatory certification to construction vehicles, dust entrapment, water sprinkling, etc. (ensure the contractor) Emission from above sources will have temporary but not significant impact on air quality.

The main source of air pollution in the proposed project occurs only during construction. Transportation of construction materials, excavation and filling of land are the major sources of dust. This can be reduced to a greater extent by optimized use of soil material within the vicinity.

5.3.5. Water Demand

The water demand will increase during construction phase for meeting out drinking and domestic water requirement of workers. Water requirement for construction of metro rail will be met through the public supply or through groundwater in compliance with existing environmental framework. Proper care shall be taken while drawing water from public facilities to avoid any negative impact on the residents living in the vicinity of project whose water demand is met by Bhopal Municipal Corporation supplied water.

5.3.6. Construction Material

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

5.3.7. Construction and Demolition Waste Impacts (Debris)

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

The C&D generated during construction is carried over long distances for just dumping and occupies significant space at landfill sites. Improper handling and storing of C&D will utilise land which could be used for other economic activities, and stress the already scarce resource.

The handling and management of C&D waste in project will be following the measures in accordance with Construction and Demolition Waste Management Rules 2016. The potential to utilise construction and demolition waste generated from the project should be explored in the project by recycling or reusing for back filling of low lying areas, leaving no significant impact on environment.

5.3.8. Casting Yard and Batching Plant Impacts

During construction phase there would be establishment and operation of Batching Plant and Casting Yard which would be located in an area designated and away from habitation. There would be requirement to get NOC (Consent to establish) and Consent to operate under water and air Acts from Madhya Pradesh Pollution Control Board. Simultaneously, there would be requirement to get the authorization for storage and handling of hazardous chemicals to store and handle used oils and other such materials.

There would be significant movement of men, material and machinery in batching plant and casting yard. It is expected that both batching and casting yard would be located at same complex. Huge quantity of cement, aggregates and other construction materials would be used in batching plant and casting yard. There would be generation of dust, noise, emission, and other contaminants from the working of heavy machinery for handling and transporting the construction materials. The curing and washing of batching plant activities is another potential source of wastewater generation, which has potential of polluting the soil and water bodies, if in proximity. The mitigation measures have been elaborated in EMP.

5.3.9. Noise Levels

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

5.3.9.1. Noise Due to Operation of Construction Equipment

The major sources of noise during construction phase are due to operation of various construction equipment. The noise levels generated by various construction equipment are given in Table 5-1.

Table 5-1: Average Noise Levels Generated by the Operation of Various Construction Equipment

Equipment	Noise level (dB(A))
Floating pontoon with mixer machine and crane	70
Winch machine	80
Transit mixer	75

Dumpers	75
Generators	85
Batching plant	90
Dredger	85
Booster pumps	85

Significant increases in noise levels is not anticipated as a result of various activities, during the project construction phase due to the following.

a. Noise due to increased vehicular movement

During construction phase, there will be increase in vehicular movement for transportation of construction material. In addition to the noise mentioned above, there will also be background noise of the usual traffic resulting due to traffic congestion and confusion arising due to traffic diversion measures. Efforts should be made for continuous flow of traffic by placing flagmen to manage the traffic, barricading of all work zones, and proper maintenance of vehicle and machinery will help in keeping the noise levels under control and adopting (ear plug) for employee safety measures. Temporary route direction markings will be placed in appropriate locations.

b. Noise Generated due to Drilling

The noise levels monitored at a 10 m distance from the source and operator's cabin is given in the Table 5-2.

Table 5-2: Noise Generated Due To Drilling

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

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

5.3.9.2. Impacts of Noise on Labour

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) may lead to hearing loss 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 5-3).

Table 5-3: Maximum Exposure Periods Specified By OSHA

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

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

5.3.10. Loss of Historical and Cultural Monuments

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

5.3.11. Impacts due to Labour and Construction Camps

Improper disposal of municipal solid waste generated by labour camps (approx. 0.27 tons/day) can pollute surface water bodies and groundwater. Burning of waste can cause air pollution. Construction workers are more prone to infectious diseases due to unsafe sexual activity and lack of sanitation facilities (water supply and human waste disposal) and insect vectors. Problems could arise due to cultural differences between workers from outside and local residents. The discharge of untreated sewage and wastewater from labour and construction camps should be prevent into open land and avoid dumping of solid wastes/earth along stream drain course, which has potential to contaminate surface water.

5.3.12. Water Pollution

The groundwater level is generally estimated to be much below the depth of the proposed structures below ground level but it may be different in some cases due to natural changes. Therefore the construction of substructures may pollute and block the flow of underground water. The impact may not be significant but the monitoring and control procedures to reduce the same shall be enforced.

The contamination of surface water is anticipated due to runoff which contain solid waste and waste water from construction sites. Especially along Red Line, water bodies located in

project influence area are prone to water pollution especially from surface run-off from construction site. The planning and scheduling for construction of column and stations near Lower Lake should be in non-monsoon season. In addition, site specific mitigation and management measures like silt fencing should be consider for worksites located near water bodies. Care also need to be taken to provide adequate sanitation facilities and drainage in the construction camp/office and temporary colonies of construction workers. Provision of adequate washing and toilet facilities with septic tanks and appropriate refuse collection and disposal system should be made obligatory.

Contamination of groundwater can take place, due to leaching and percolation of chemicals and substances used during construction. The bentonite contaminated soil/mud slurry generated from piling has to be mixed with fresh soil to achieve solid state and disposed off at landfill sites. .

5.4. Project Operation - Impacts and Mitigation Measures

Along with many positive impacts, the project may cause the following negative impacts during operation of the project due to the increase in the number of passengers and trains at the stations:

- Noise pollution,
- Water supply and sanitation at Stations,
- Station refuse disposal and sanitation,
- Aesthetic,
- Safety.

5.4.1. Noise Levels

The noise will be generated due to friction of the rolling stocks on the tracks which will generate incremental noise levels. The major noise level generating activities includes (a) Approach and braking of rolling stocks (b) Rolling stock leaving from station, (c) During its travel between two stations and (d) Announcements on the Metro station. These noise generations for all above activities have been recorded from experience of existing Metros in India as well as project authorities. During the operation phase the main source of noise will be from running of metro trains. Noise radiated from train operations and track structures generally constitute the major noise sources. Airborne noise is radiated from elevated structures. The noise level reduces with distance logarithmically.

At stretch of alignment close to residential area, noise attenuation measures like noise barrier could be provided. Noise barriers are normally designed to provide the reduction in noise levels to the tune of 15-dBA at the receptor.

5.4.2. Water and Sanitation Requirements at Stations

Public facilities such as water supply, sanitation and washrooms are very much needed at the stations. The water requirement for stations would be for drinking, toilets, cleaning and also for other purpose like AC. Water Demand as per existing Metro corridors (in India) is calculated and presented in Table 5-4. It is assumed that there would be similar water

requirements in Bhopal Metro as well. Raw water should be treated and brought to national drinking water standards (IS10500:2012), before used for consumption. The water requirement for the stations will be met through the municipal water supply system. To reduce the load on municipal water supply, rainwater harvesting system at stations and depots are also proposed for conserving of water.

Table 5-4: Water Requirement at Stations

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

Thus there would be total water requirement of 690 KLD for 30 stations out of which 587KLD (85% of water demand) of wastewater/sewage will be generate. However, arrangement of water will have to be made at each station separately with proper drainage system for wastewater.

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

5.4.3. Solid Waste Generation at Stations

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

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

The maintenance of adequate sanitary facilities for temporarily storing refuse on the premises is considered a responsibility of the project authorities. The storage containers for this purpose need to be designed. However it is suggested that the capacity of these containers should not exceed 50 litres and these should be equipped with side handles to facilitate handling. The waste generated at stations are recyclable and degradable waste and these wastes must be collection and segregation at source for ease of handling, management and disposal. All degradable and recyclable wastes must be segregated and collected in green and blue coded dust bins. To avoid odour and the accumulation of fly-supporting materials, garbage containers should be washed at frequent intervals.

5.4.4. Aesthetics

The introduction of metro system implies a change in streets through which it will operate. An architecturally well designed elevated section can be pleasing to the eyes of beholders and will minimise the visual impacts due to interference to free sight to the sky and existing

landscape. The project has attempted to design high quality viaduct super structure, substructure and all stations to converse with landscape that would improve visual aesthetic.

5.4.5. Safety

During operation accidents related to train operation like collision, derailment, fire, power outages, or operation stoppage may occur. The safety concerns may arise, in unlikely event of simultaneous tripping of all the input power sources or grid failure, there will be uninterrupted power supply to stations as well as to trains. While a standby silent type DG set of adequate capacity will be provided at underground stations that will sustain essential lighting, signalling, and telecommunications, fire fighting system, lift operation, and tunnel ventilation.

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

5.5. Impacts and Mitigation Measures Due to Depot

One Depot is proposed at Subhasnagar, which will be common for Purple Line and Red Line. The depot will have following facilities:

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

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

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

5.5.1. Oil spills

Oil spillage during change of lubricants, cleaning and repair processes or from oil storage area in the maintenance Depot cum workshop for maintenance of rolling stock, is very common. The spilled oil should be trapped in oil and grease trap. The collected oil would be

disposed-off to authorize collectors, so as to avoid any underground/ surface water contamination.

5.5.2. Noise Pollution

The main source of noise from depot is the operation of workshop. The roughness of the contact surfaces of rail and wheels and train speed are the factors which influence the magnitude of rail - wheel noise. Due to less activity, no impact on the ambient noise is anticipated.

5.5.3. Water Requirement

Water supply will be required for different purposes in the depot. The water requirement for drinking will be 50.kilo litre per day and 1,00,000 litre per day for other requirements. Rainwater harvesting structures are included in the project design as a water balance measures.

5.5.4. Solid and Hazardous Waste

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.

It shall be the responsibility of the contractor to ensure that hazardous wastes are labeled, recorded, stored in impermeable containment and for periods not exceeding mandated periods and in a manner suitable for handling storage and transport. The contractor shall maintain a record of sale, transfer, storage of such waste and make these records available for inspection. Oil and grease generated from the Depot which will be disposed-off through approved re-cyclers.

5.5.5. Surface Drainage

Due to the filling of the low-lying area for the construction of depots, the surface drainage may change specially during monsoon. Similarly, at tunnel and elevated sections as well as stations shall be designed with sufficient drainage, so that temporary flooding during extreme weather conditions are avoided.

6. Analysis of Alternatives

6.1. Introduction

The two metro corridors passes through major congested settlement areas in Bhopal city. The analysis of alternatives has been carried out 'with project' and 'without project' scenarios in terms of potential environmental impacts. The underlying principles for evaluation for each corridor, without affecting the overall usefulness of the corridor, are:

- Minimum land acquisition,
- No Involuntary Resettlement,
- Minimum disturbance to people and
- Minimum disturbance to environment.

Without Project Scenario

The urban sprawl of Bhopal planning area is already 812.26 Sq. km. and the population in the metropolitan area is over 2.3 million which is projected to be over 4.3 million by year 2041. The per capita trip rate is 1.17 for the motorized trips and the accident rates are quite high with about 9 % of them as fatal accidents, 236 persons died in road accidents with severity rate of 6.8 per 100 accidents in the year 2014, the number of vehicles is further increasing rapidly every year and has already reached about one million now. All these above have caused the shortage in the road space for movement & parking of vehicles, space for non-motorized vehicles and Pedestrians. This is also contributing substantially to the increased level of dust, air and noise pollution due to more time spent on the travel time. The increase in road area also needs frequent time to time maintenance for the good ride quality and less wear and tear of the road user vehicles but this maintenance is not always happening due to various factors like fewer funds, climate, traffic, other infrastructure works on the road like laying of cables etc., and other social events.

Therefore a High level of high quality rail based Mass transport system is needed for the city of the Bhopal to attract its people to use clean and sustainable mode of transport to lead a more safe, secure, healthy and high quality of life contributing to maintain the ecosystem of the world by climate change mitigation and sustainable development and by minimize converting further green area into built.

With Project Scenario

With project scenario, the metro network will yield benefits from non-tangible parameters such as socio-economic benefits resulting from the safe and smart mass transport, less travel time, and better accessibility, feeling of reliability and availability at any time leading to peace of mind and freedom with seamless movement – high quality of life. The main benefits of with project scenario are

- Employment opportunities due to construction, operation and maintenance
- City aesthetic and image due to location, design and construction
- Reduction in traffic congestion

- Reduction in travel time with high service level
- Reduction in accident
- Reduction in fuel consumption
- Reduction of GHG emission
- Air pollution reduction
- Economic prosperity
- Optimality in transportations

The above environmental benefits are also economic and social benefits as they contribute to enhance efficiency and competence of the city leading to attract more investments in other business ultimately creating high quality of life.

6.2. Identification of Corridors

The final two corridors of the proposed MRTS Bhopal Metro Rail Project Phase I project have been finalised after taking into account environmental and social concerns, considerations of traffic, integration with the existing system and importantly, the overall economic and financial viability. The analysis of alternatives for metro project at Bhopal is concluded in two aspects.

6.2.1. Horizontal Alignment

This alternative is the result of the alternative analysis of finalized transport demand model and the engineering alignment based on the criteria of cost, availability of land for the right of the way and subsequent widths of structures based on track design for desired designed speed and safety. Therefore it has been considered as preferred alignment for the further studies. However the issue needed to be considered here is whether the lines should overlap the residential or green areas along the preferred routes or should locate in the middle of the roads.

- Alternative 1. Route overlaps the residential building or green areas
- Alternative 2. Route lies right in the middle of the existing roads or its sides wherever the clearance is still available from the shoulders of the road or free sides or service roads.

The comparison between the two alternatives shows that alternative two causes significant traffic congestion but this will be only until a small time during construction for a particular segment as the construction is based on precast segmental technology and will disappear after the construction is done and in fact will be contributing to reduce the vehicular traffic on road and increase the pedestrian and cycle traffic on its sides after the construction and start of operation. In comparison to alternative 1, the impact of alternative 2 involve minimal acquisition of land, impact to structures and green areas and hence requires minimal compensation cost and causes lesser impact on the local residents in terms of lost houses and business. The risk of damages to the building due to vibrations and pile collision during construction is also lower in alternative 2 than alternative 1.

Locating the lines in the middle of the existing roads or its sides wherever the clearance is still available from the shoulders of the road is determined as the preferred alternative and therefore the finalized alternative described with route alignment where approximate 98% of the corridors follows existing right of the way of the road is determined as the preferred alternative.

6.2.2. Vertical Alignment

6.2.2.1. Elevated Section

Segmental construction is common for speedy construction. Elevated construction can be cast in situ segmental or Pre Cast segmental. The Cast in Situ segmental requires more space, material, equipment and labour at site and therefore causes more traffic congestions due to more activities whereas the precast segmental construction most of the part is executed in the casting yard conveniently away from the site with more safety and quality management procedures due to no interference of the outside public and availability of adequate spaces. However, road side plantation within right of way will be affected and the impact is irreversible, but impact could be offset through compensating measures i.e. compensatory afforestation. Therefore this alternative is preferred for 12.58km of Purple Line and entire corridor (12.88km) of Red Line. However for the Construction of columns and pile foundations for the elevated structure cast in situ construction with Ready mix Concrete supplied from off site location is preferred as this is fast, cost effective and takes minimum space at site.

6.2.2.2. Underground Section

The underground Section obviously costs more due to the need of sophisticated technology and equipment. But underground construction is having least impact on the noise environment of the area during the operation of the system and therefore is preferred if one targets this result. The underground section is the preferred alternative for 1.79 km length of Purple Line that is passing through high density settlement area (Nandra Bus Stand and Railway Station) and because there is no other reasonably possible vertical way to make a good connected network for multi-modal integrations. The adopting of this alternative will avoid social impacts and involuntary resettlement.

6.3. Conclusion

With the above comparison it can be concluded that “With” project scenario, positive/beneficial impacts will greatly enhance social & economic development and improve the environment, when compared to the “Without” project scenario, which may further deteriorate the existing environment and quality of life. Hence the “With” project scenario with somereversible impacts is an acceptable option rather than “Without” project scenario. The implementation of the project therefore will definitely be advantageous to improve the environmental quality of the Bhopal city besides to achieve an all-round development of the economy and progress.

There is little increase in the pollution levels during construction. Dust and particulate matter during construction will affect the air quality on a short-term basis but will be temporary in

nature. The safety of road users as well as surrounding population will enhance to great extent due to the project, which are inadequate in the present scenario.

7. Consultations and Information Disclosure

7.1. Consultations

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

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

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7.1.1. Public Consultation

Consultations were held with PAPs during preparation of this EIA process. Public consultation sessions were held from June – July at four locations (Annexure 7.1) to inform the people about project, understand their aspiration regarding environmental issues associated with project and collect environmental settings. Besides this there are several informal consultation session and focus group discussions were organized as part of the project. The table 7.1 provides details of public consultation meetings, number of participants, and photographs.

Table 7.1: Details of Public Consultations

Sl. No.	Date	Place	No. of Participant		Photographs
			M	F	
1	22.06.2018	Slum Area 2A Saket Nagar	09	07	
2	30.06.2018	Slum Area 2A Saket Nagar	02	06	
3	02.07.2018	Azad Nagar, Pullbogda	57	0	
4	03.07.2018	Marble Market Pulbogda	17	0	

7.2. People's Perception

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

- It has been observed that by and large all the stakeholders involving affected persons and other stakeholders are aware of the project.
- Local people showed satisfaction during public consultations as the project will provide hassle free movement in the congested part of the city.
- People suggested to make alternate arrangement for entry of heavy vehicle to marble market during construction period.
- They were concern about closure of existing road and wanted to know how traffic would be managed during construction stage. As they had faced serious problem during construction of Pulbogda railway bridge.
- The people were least concern about noise and air pollution as they are settled along the road. However, suggestions were made to control air pollution (dust) during construction by sprinkling of water.
- Local people requested that suitable mitigation measures should be taken to mitigate the adverse environmental impacts during the construction period due to shifting of utilities, movement of heavy equipment and noise pollution etc.

7.3. Information Disclosure

MPMRCL as integral part of stakeholder engagement will carry out meaningful public consultations, particularly with project affected persons during project cycle. The consultations also aims to ensure access of information on adverse environmental and social impacts assessment process. All environmental documents are subject to public disclosure to comply with ESS-10 of EIB's E&S Handbook. The MPMRCL will disclose environmental and social assessment reports and made accessible to the general public in compliance with EIB's policy. This EIA will be disclosed on EIB websites and at MPMRCL in India as well as at other locations accessible to stakeholders (to be determined by the MPMRCL).

8. Environmental Management Plan

The environmental impacts stemming out of the proposed project can be mitigated with set of measures, dealing with careful planning and designing of the metro alignment and structures. The Environmental Management Plan is based on the Environmental Impact Assessment study carried out for the project.

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

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

8.1. Objectives of the EMP

The main aim of the Environmental Management Plan is to ensure that the various adverse impacts are mitigated and the positive impacts are enhanced. The management practices are developed for all the stages of project, i.e., Pre-construction/Design, Construction and Operational stages. The objectives of the EMP at various stages of the project planning and implementation can be summarized as follows:

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

8.2. Anticipated Environmental Impacts

The key anticipated adverse environmental and social impacts from metro corridors are

- Change in land use due to acquisition of land.
- Involuntary resettlement due to loss of properties / structures.
- Impacts on surrounding area due to tree cutting for the proposed metro lines.
- Noise and vibration impacts due to operation of tunnel boring machine, excavation machines, and materials hauling.
- Increased noise and air pollution resulting from traffic volume during construction
- Temporary impact on land and air environment due to locating construction camp;
- Temporary impact on land, air and water environment due to establishing and operating construction plants (Hot Mix Plant, concrete batching plant and Diesel Generator sets);

- Impact on air quality, water quality, drainage, road users due to construction activities of project road;
- Impact on land and water environment due to disposal of construction waste materials; and
- Impact on occupational health and safety due to all onsite and offsite construction works.

8.3. Environmental Management Plan

This section describes the Environmental Management Plan during different stages of project. The Environmental mitigation measures have been incorporated at all the stages of the project right from Designing phase to Construction and Operational Phase. All care has been taken to provide mitigation measures for all expected environmental degradation at different stages. The Environmental Management plan has been formulated for the present project for mitigation/management/avoidance of potential adverse impacts and the enhancement of the various environmental components along with its location, timeframe of implementation, and overseeing/supervising responsibilities. The safeguard measures identified for different phases are tabulated in **Table 8.1**.

Further, adequate provision of environmental clauses in work contracts and efficient contract management will eliminate or reduce significantly all possible problems. The effectiveness of environmental considerations will, however, depend on appropriate inclusion of these in the work contracts. Finally, the implementation of the mitigation actions requires that the project implementation unit would record an end-of-construction mitigation checklist, before releasing the final payment of any work contract. In addition, MPMRCL should prepare an established Environmental and Health Policy and Procedures and that should become an integral part of contract document.

Table 8.1: Environmental Management Plan

S.No	Activity	Impact	Mitigation Measures	Responsibilities	
				Implementation	Supervision
Planning and Design					
1	Land Acquisition	Acquisition of land affecting private structures and households	Acquisition of private land will be as per The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013. The affected people will be compensated and assisted as per the provisions of Resettlement Policy Framework (RPF). Resettlement & Rehabilitation activities of MPMRP will be governed by the general principles based on The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013.	MPMRCL	GoMP
2	Change in Land Use	Land use will be slightly changed.	The permission will be sought from competent authority before construction.	MPMRCL	GoMP
3	Tree Felling	About 2192 trees with girth size >300mm and 30 trees with girth size <300mm will be affected at alignments, stations and depot area. Additionally in some areas, pruning will be required.	8768 saplings will be planted @1:4 for trees girth size above 300mm; and 60 saplings at ratio of 1:2 ratio for trees girth size below 300mm above ground level under compensatory afforestation plan. Plantation Mangifera indica (Mango), Tamarindus indica (Tentul), Azadirachta indica (Neem, Aegle marmelos (Bel), Delonix regia (Krishnachura), Psidium guajava (Guava), Acacia auriculacformis (Akashmoni), Eucalyptus globus (Eucalyptus), Ficus religiosa (Peepul) tree species with environmental benefit has been proposed in depot area andunder compensatory afforestation in coordination with local forestry officials. Additionally green belt development under the elevated corridor has been proposed using native shrubs, herbs and grasses.	MPMRCL	GoMP

S.No	Activity	Impact	Mitigation Measures	Responsibilities	
				Implementation	Supervision
4	Severance of utilities	The proposed alignments will cross drains and utility services such as sewer, storm water drains, water mains, telephone cables, overhead electrical transmission lines, electric poles, traffic signals etc.	There are many utilities such as water supply and sewer pipe lines, storm water drains, telephone cables, overhead transmission lines, electric poles, traffic signals etc. are essential and have to be maintained in working conditions during different stage of construction. These assets will be maintained without affecting any damages by shifting temporary/ permanently where it is necessary	MPMRCL	GoMP
Construction					
5	Coordinate with the traffic department on Traffic Management Plan	Nuisance congestion	The Contractors will discuss and coordinate the implementation of the traffic re-routing scheme particularly at station area when it starts the cut and cover activities and the hauling and disposal of excavated materials to the project sites. At the minimum, the traffic management plan will have the following components: construction traffic, ensuring access to properties, accommodating pedestrians, parking, access by construction vehicles, faulty traffic lights and problem interchanges, use of public roads, parking provision during construction, use of residential streets and traffic diversion due to temporary road closures, and construction and use of temporary access roads.	Contractor	GC/ MPMRCL
6	Community liaison	Inconvenience and complaints	To ensure that ongoing feedback is provided on the progress of the project together with feedback on the environmental management performance of the project. Contractor through MPMRCL will provide a minimum of two (2) weeks notification to directly affected residents, businesses and other relevant groups of the intended construction commencement date. In providing a mechanism for communication between the contractor and the community and informing the public of construction details (timing, expected impacts), the	Contractor	GC/ MPMRCL

S.No	Activity	Impact	Mitigation Measures	Responsibilities	
				Implementation	Supervision
			concessionaire will undertake consultation and information activities.		
7	Levelling of site	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	Construction vehicles, machinery and equipment will move, or be stationed in the designated area, to avoid compaction of soil. Infiltration losses could be countered by installing Rain Water Harvesting (RWH) pits. Proper drainage will be maintained around sites to allow continue flow of water and avoid water logging or flooding situation.	Contractor	GC/ MPMRCL
9	Tunnel boring	Ground Settlement under the weak structures	The contractor will ensure that no inadvertent damage is incurred to the structures. The contractor will ensure that the design value for settlement under structures is not exceed and the trigger value = 3.5mm and Allowable value = 4.2 meters are implemented. Tilt meters will be installed at key positions to ensure the design value is observed with trigger and allowable values. Crack meters will be installed at key positions to ensure design value of 3.0mm is not exceeded with 2.1mm trigger value and 2.5 mm allowable value. The contractor will immediately cease all operation if any of the trigger values are breached. The GC will advise the contractor mitigation measures and practices to control settlement, tilt, and crack to include but not limited to structural reinforcement and operation parameters of the TBM. The contractor will ensure that no structural damage is incurred and cosmetic damages are repaired under the supervision and control of the local department.	Contractor	GC/ MPMRCL
10	Vibration from tunnel boring	Cosmetic and Structural damages to the structures along the underground metro alignment	Vibration during tunnelling is expected to be lower that internationally accepted 5mm/s. To be on the safe side, the Contractor is to ensure that vibration levels at the key structure	Contractor	GC/ MPMRCL

S.No	Activity	Impact	Mitigation Measures	Responsibilities	
				Implementation	Supervision
		along congested areas.	foundation locations will not exceed 2.0 mm/s.		
11	Excavation	Excavation will result into fugitive dust generation. Noise levels during construction will be from crushing plants, asphalt-mixing plants, movement of heavy vehicles, loading, transportation and unloading of construction materials etc. Dumping of construction spoils like concrete, bricks, waste material from camps etc cause surface water pollution. Dewatering (if done) will adversely affect the groundwater regime. Excavation will adversely affect the land. Loss of aesthetics value due to excavation and related activities.	Water sprinkling to be carried out at regular interval (to be mutually decided by the contractor and MPMRCL). 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. Depending on site conditions and to prevent polluting of surface water, the contractor shall prepare and implement GC's approved drainage measures around active and & large construction sites. The contractor shall prepare and implement GC approved dewatering plan, during excavation of tunnel and underground station or piling. The contractor shall treat contaminated groundwater by collection in sedimentation tank or treating in slurry treatment plant (best practices) or other methods, prior to discharging back into the groundwater table, pumped to the sewer or storm drain system, or used on-site for dust control purposes. Soil erosion by runoff will be controlled by installing proper drainage systems using contour information. It is suggested to avoid bringing soil from outside the project boundary and to use the excavated mounds for filling low laying area where it is necessary The excavation sites will be barricaded on all sides using GI sheets. Hauling will be carried out in non-peak hours. Noisy activities will be discontinued during the night time, esp. in congested areas. The contractor shall install shoring systems to improve soil stability, and providing safe work zone.	Contractor	GC/ MPMRCL

S.No	Activity	Impact	Mitigation Measures	Responsibilities	
				Implementation	Supervision
12	Chance finding of Archaeological/historical Properties	Loss of archaeological evidence and reduction in the potential for archaeological investigation and interpretation.	All fossils, coins, articles of value of antiquity, structures and other remains of archaeological interests discovered on the site shall be the property of the Government and shall be dealt with as per permissions of the relevant legislation. The Contractor shall take reasonable precautions to prevent his workmen or any other persons from removing and damaging such articles or things. The Contractor will immediately stop the work at site upon discovery of such articles or things or archaeological importance during construction. The Contractor shall, immediately upon discovery thereof and before removal, acquaint the General Consultant of such discovery and carry out the GC's instructions for dealing with the same. The MPMRDCL will seek direction from the respective Archaeology Department before instructing the Contractor to recommend the work in the site.	Contractor	GC/ MPMRCL
13	Blasting at underground station	Vibrations and noise will be generated due to blasting activities. This will be of specific importance while using blasting in congested areas and near old & archaeological significance. During explosions flying debris will be generated which can pose serious H&S risk.	To reduce the harmful effects, personnel working at high noise levels would be provided with noise protective gears such as ear mufflers. The blasting shall be carried out during the pre-determined hours of the day preferably during the mid-day lunch hour or at the close of the work as ordered in writing by the GC. The hours shall be made known to the people in the vicinity. The Contractor shall notify each public utility company having structures in proximity to the site of the work of his intention to use explosives. Only contractor's authorised people shall be allow entering this area and all persons including workmen shall be kept away from the flagged area at least 10 minutes before the firing.	Contractor	GC/ MPMRCL

S.No	Activity	Impact	Mitigation Measures	Responsibilities	
				Implementation	Supervision
			A warning siren shall be sounded for the above purpose. All precautions shall be taken such that vibration levels hall not exceed the prescribed limit by the Director General of Mines Safety. The charge holes shall be drilled to required depths and at suitable places. The blasting surface shall be covered with a layers of HD rubber mats and wire mesh to inhibit the physical movement of the fly rock. In addition it is proposed to barricade the entire station area to a height to 10m from the blasting surface. The blasting areas beyond 10m from blast area will be barricaded using 2m tall GI sheet barricades. Thus the visual appeal will be slightly restored. Good housekeeping practice should be adopted.		
14	Haulage of excavation material	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. Dumper trucks carrying excavated material will result into high noise (typically in excess of 85 dB (A) at one m distance, or 57 dB (A) at10 m distance). The adverse impacts of noise will be most intense in the residential / urban areas. Incessant movement of trucks could create social issues. This will have higher occurrences near depots. The movement of trucks will increase the traffic risk of the commuters.	The trucks/dumpers carrying the excavated material will be covered using tarpaulin/similar covering materials. Truck tires will be washed to excess remove soil clinging to it. The routing, timing and logistics of the haul truck movement should be planned to have minimal impacts on noise level. The routing, timing and logistics of the haul truck movement should be planned for safety of inhabitants and minimal impacts on noise level.	Contractor	GC/ MPMRCL
	Dumping of excavated materials	The dumping operation of excavated material will generate fugitive dust in the nearby areas.	The contractor will optimise use of excavated material by	Contractor	GC/ MPMRCL

S.No	Activity	Impact	Mitigation Measures	Responsibilities	
				Implementation	Supervision
		Dumping may increase the height of the land and affect the natural drainage pattern of the area.	reusing in the project and minimise its generation. Site of dumping will be selected in consultation with BMC. The contractor shall not dump excavated material in water body avoid blocking of waterway. To arrest fugitive dust generated during dumping, sprinkling of water should be carried out. The dumping will be done in pre-designated low lying areas identified by BMC & MPMRCL for this specific purpose.		
15	Traffic diversion	The under construction areas will be restricted for human and vehicular movements. This will result in detouring of vehicles and/or pedestrians, esp. This may also result into traffic congestion and air pollution from stagnated vehicles in urban areas. Primary pollutants will be NOx, CO, and SO_2, 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. Traffic diversion (esp. for public transport) will create inconvenience. Detouring will increase the road length to be travelled by a car, thus, increasing the overall fuel consumption.	Permission from BMC and Traffic police will be sought before commencement of work. Detours will be properly planned and enacted during non-peak hours only, if possible. Traffic marshals will be posted near such detours. Proper signage has to be posted informing motorists about detours following IRC norms. Traffic marshals could be posted near busy intersections, to oversee the smooth flow of traffic. Plans will be made to manage traffic during peak hours (morning and evening peaks). Also separate arrangements for bus, auto and taxi parking bays will be made. 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/ MPMRCL
16	Restricted pedestrian movement	Restricted pedestrian movement will cause social uproar, esp. in people living near metro stations. Movement though constricted space may cause potential health & safety issues amongst	The contractor shall provide management measures such as traffic sign post (informatory, caution), traffic barrier, speed reducing measures (rumble strip/flag men) at congested/commercial/residential area for pedestrians' safety	Contractor	GC/ MPMRCL

S.No	Activity	Impact	Mitigation Measures	Responsibilities	
				Implementation	Supervision
		pedestrians.	will be provided wherever possible.		
17	Use of Tunnel Boring Machine	The vibration generated during operation of TBM will affect structures of old houses, archaeological monuments, roots of plants and underground installations. Interfere with groundwater movements. Wastewater generated during tunnelling likely to contaminate groundwater. Occupation health and safety of workers working in confined areas.	All precautions shall be taken such that vibration levels hall not exceed the prescribed limit by the Director General of Mines Safety. The safe depth of construction shall be determine to minimise the effect of vibration on structures. The contractor shall prepare and implement GC approved dewatering plan to pump wastewater. The contractor shall treat contaminated groundwater by collection in sedimentation tank or treating in slurry treatment plant (best practices) or other methods, prior to discharging back into the groundwater table, pumped to the sewer or storm drain system, or used on-site for dust control purposes. Proper H&S evaluation & periodic audit of working condition in tunnels will be done. Toolbox talk with workers will be conducted before start of works on occupational, health and safety risks. Regular training should be provided to all workers engaged in tunnelling on use of personal protective equipment, and work site emergency plan.	Contractor	GC/ MPMRCL
18	Muck generation & disposal (bentonite spent)	The blockage of natural drains, siltation of water bodies, and contamination of surface water. Dust generated from muck dumping site increases PM_{10} and $PM_{2.5}$ content in ambient air and could be a potential health hazard for nearby inhabitant. Dust if settle on plant will affect the growth. Spent bentonite if not handled properly has potential of contaminating groundwater quality. Muck generation will create an aesthetic issue	The contractor shall take following measures to manage muck generated. To reutilized in backfilling in underground stations and depot. Material will be stabilised each day by watering or other accepted dust suppression techniques. The muck shall be filled in the dumping site in layers and compacted mechanically. Stock-piling of earth with suitable slopes. Once the filling is complete, the entire muck disposal area shall be provided with a layer of good earth on the top and covered with vegetation. In case of spent bentonite slurry, the contractor shall mix	Contractor	GC/ MPMRCL

S.No	Activity	Impact	Mitigation Measures	Responsibilities	
				Implementation	Supervision
			excavated earth or fresh soil to achieve solid state and disposed off at landfill sites.		
	Raft foundation	Construction of raft foundation will generate concrete spoils. This will have adverse effects on land.	Concrete spoils will be collected manually and will be disposed-off in proposed disposal grounds.	Contractor	GC/ MPMRCL
	Steel structure preparation	Steel structure preparation will create steel scraps (approx. 5% of total BOQ steel requirement; as per CPWD standard estimate). Bar bending & other activities (including working at heights) might pose Health & safety threat to workers.	Steel scrap will be collected, sorted by size and sold to scrap dealers on alter date. PPE's hand gloves, rigs, harness & safety belts, hard hat, goggles, nose mask, ear plug, safety shoes, safety jacket etc. will be provided to all workers. The contractor's HSE Officer shall make sure workers use PPE at work sites.	Contractor	GC/ MPMRCL
21	Stacking & warehousing of raw material	Washed out raw material could pose serious threat to surface water bodies. Spillage of materials / mix products on the ground could pollute land. Fine products like cement/ silt/sand could cause harm to respiratory system. Stacking of raw material will cause aesthetic issues for residential areas located nearby	Small dikes and garlanding drains along the periphery of the RM yard and ploy boundary could be constructed. This will control runoff and washing out of finer material. Cement and sand will be stacked under tarpaulin and secured by GI sheet barricading (working & wind break). Workers will be provided with respiratory PPEs. The height of walls between the residential area and RM yard / construction area will be raised using GI sheets	Contractor	GC/ MPMRCL
21	RCC pouring (using concrete pump)	RCC pouring using concrete pump will generate low frequency rumbling noise. This will be more perceived and irritating in residential areas. Spillage from concrete pouring may contaminate land Spoils from concrete pouring will create unpleasant looking visuals	Timing of using RCC pumps will be specified. RCC pumps will be covered from all sides. Bends and excessive head will be avoided. The spoils from pouring concrete will be collected and reused as sub-grade material in road construction. After each pouring cycle, the spoils will be manually collected and reused as sub-grade material in road constriction	Contractor	GC/ MPMRCL

S.No	Activity	Impact	Mitigation Measures	Responsibilities	
				Implementation	Supervision
22	Setting of concrete (using needle vibrator)	Needle vibrators generate low frequency noise when dipped in concrete and high frequency noise when raised. Sound levels vary between 82-93 dB (A). During setting, spillage from cast could take place.	If the consistency of concrete could be altered, the need for use of vibrator (esp. in low temperature & low thickness casting) could be reduced. Damping could be used to reduce high frequency noise, and thereby reducing the noise levels. Workers should be provided with suitable PPE. The spoils from pouring concrete will be collected and reused as sub-grade material in road constriction.	Contractor	GC/ MPMRCL
23	Curing of concrete (use of water)	Curing water will drain to the low lying areas and pollute water courses. Hydrating water requirement @0.38: 1 water: cement + Curing will require @ 0.06 kg/m^2/hr. of water, most of it will be supplied from groundwater (through tankers). Curing will create water impounding and may lead to vector propagation	Garland drainage is proposed to be constructed around the construction yard. This will intercept the runoff generated from site. Groundwater from CGWA designated safe areas will be used. Rainwater harvesting (as a compensatory measure) will be practiced.	Contractor	GC/ MPMRCL
24	Use of crane & Launchers	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. Cranes and launchers are a major safety concern. Once case has already been reported taking place in DMRCL. Delhi Metro has faced two such incidents (a) launcher failure in Laxminagar (Oct, 2008) – 2 killed and 30 injured; (b) toppling of Crane in Zamrudpur (July 2009) – 6 killed and 15 injured.	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. Operation of launchers and cranes should be only done under the strict supervision of a qualified engineer and a safety supervisor. Only qualified & trained crane/ launcher operators should be allowed. Proper examination of crane, launchers, labours & operators should take place before commencement of work.	Contractor	GC/ MPMRCL

S.No	Activity	Impact	Mitigation Measures	Responsibilities	
				Implementation	Supervision
25	Construction of labour camp(s) and associated environmental issues	Sewage from labour camps may be discharged into open slopes thus contaminating surface Water In most cases, the labour camps will be supplied water from ground water. In most cases the ground water (drawn from bore well) is not metered or treated. Solid waste generated from the labour camps will cause land pollution Influx of non-local labours will create a social issue. Living in congested condition, make-shift temporary arrangement; the labours are prone to diseases. Labours will consume resources like wood for cooking	Labour camps will be constructed in semi urban / urban set-ups. Thus, sewage and other discharges from the labour camps will be discharged in public sewers. Use of bore well will be restricted for drinking purpose only. Permission of withdrawal from Central Ground Water Authority (CGWA) must be obtained before construction of bore well. Water abstracted must be measured/ recorded periodically. Solid waste will have to be disposed in compliance with Municipal Solid Waste (Management & Handling) Rules, 2000, as amended to date. Mixing of skilled non-local labours with local unskilled people will reduce social frictions. However there are no permanent solutions to this problem. Workers (Regulation of Employment and Conditions of Service) Act, 1996 the employer (contractor) is liable to arrange for health care facilities of labours, free of charge. Labour camps are provided with canteen systems, so most of the labours don't cook by themselves (as per BOCWR. Cooking is done with Commercial LPG gas cylinders (19.4 kg). However in isolated observations it was noted that labours were using kerosene stoves and cooking within their hutments.	Contractor	GC/ MPMRCL
26	Loading and unloading of materials	Loading & unloading of construction material will generate fugitive dust. Loading & unloading of construction material will generate noise Fugitive dust and noise generation will have potential health & Safety implications	Fugitive dust could be controlled using water sprinkling. The RM storage yard will be separately built and enclosed from all sides. This will reduce noise generation at site. Further since concrete preparation will only take place in casting yards (away from habitation) loading & unloading will not be a major problem. Cement and sand will be stacked under tarpaulin and secured by GI sheet barricading (working & wind break). Workers will	Contractor	GC/ MPMRCL

S.No	Activity	Impact	Mitigation Measures	Responsibilities	
				Implementation	Supervision
			be provided with respiratory PPEs. The RM storage yard will be separately built and enclosed from all sides. The worker will be provided with suitable PPEs. Also they will be trained and encouraged in using PPEs		
27	Use of batching plant	Loading & unloading of construction material into batching plant will generate fugitive dust. Operation of batching plant will generate noise Batching plant will use groundwater for mixing. In most cases water will be supplied from groundwater. The batching plant will get its power from DG sets. A 30 m3/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).	All batching plant / casting yard shall be barricaded(screen barrier), which will effectively reduce the fugitive dust generation. Permission from CGWA must be obtained before digging and operating bore wells. Water abstracted must be measured/recorded periodically. Permission shall be obtained by the Contractor for power connection. 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). At all batching plant sites, the Contractor shall provide sedimentation tank for treatment of wastewater generated from washing of batching plant and RMC trucks. For Diesel storage and fuel station, permission from CCOE should be obtained. To prevent soil contamination from leakage from DG set and diesel tanks storage area, the contractor shall store diesel tank and keep DG set in weather proof area and over impervious platform. The contractor shall provide oil interceptor at workshop and potential area of oil spillage and leakage. . The contractor shall secure all such areas by providing fire extinguishers and fire hydrants.	Contractor	GC/ MPMRCL
28	Casting of segments	Casting will require use of groundwater.	Permission from CGWA must be obtained before digging and	Contractor	GC/

S.No	Activity	Impact	Mitigation Measures	Responsibilities	
				Implementation	Supervision
	and I-beams	Casting (incl. operation of gantry and hydraulic pre-stressing units) will consume lot of energy.	operating bore wells. Water abstracted must be measured/ recorded periodically. Pre-stressing and casting are basic requirements. However, most of the power should be drawn from approved lines, not from DG sets.		MPMRCL
29	Curing of segments and I-Beams	Curing will require a significant amount of water, which will mostly supplied from groundwater	Wastages from curing could be collected separately and reused if possible. Stagnation of water (and resultant vector propagation) should be avoided.	Contractor	GC/ MPMRCL
30	Hauling of segments to site	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. 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. Incessant movement of trucks could create social issues. The movement of trucks will increase the traffic risk of the commuters. Movement of trucks will create an aesthetic problem.	Truck tyres will be washed to excess remove soil clinging to it. Near the entry/ exit points of the casting yards, water sprinkling will be undertaken. Trucks will need to have PUC certificate and conform to these norms.	Contractor	GC/ MPMRCL
31	Use of DG sets	Emission from DG sets will create air pollution problems. Noise & vibration will be generated from the use of DG sets. DG sets will consume Diesel (and in effect reduce the levels of a non-renewable resource) Operation of DG sets will cause an aesthetic issue.	DG sets will be used only for power back-ups. Emission norms from DG will follow CPCB specification no. GSR 520(E) dt. 1-7-2003 for DG sets rating < 800 KW, and GSR 489(E) dt. 09-07-2002 for DG sets > 800 KW under E(P) Rules, 1986. Stack height of DG sets will be as per CPCB requirement [stack ht. = 0.2*(rating in kVA) 0.5]. Fuels used for DG will be High Speed Diesel (Sulphur <1% m/m) and DG sets should be enclosed type, with noise levels	Contractor	GC/ MPMRCL

S.No	Activity	Impact	Mitigation Measures	Responsibilities	
				Implementation	Supervision
			approx. 75 dB(A) at a distance of 1m in compliance with GSR 371(E) dt. 17-05-2002. The DG sets will be mounted on damping skids, which will reduce the vibration generated from DG sets. The contractor shall ensure the following: (a) 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. (c) DG sets will be additionally enclosed using GI sheet shuttering to keep them off from public views. For Diesel storage and fuel station, permission from CCOE should be obtained. To prevent soil contamination from leakage, and spillage from DG set and diesel tanks/fuel storage area, the contractor shall store diesel tank and keep DG set in weather proof area and over impervious platform. The contractor shall provide oil interceptor at workshop and potential area of oil spillage and leakage. The contractor shall secure all such areas by providing fire extinguishers and fire hydrants.		
32	Storage of Diesel	Diesel spillage (from underground or above ground storage facility) will affect groundwater quality adversely. 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.	The contractor shall prepare an Event Contingency Plan (ECP) and approved by GC. Spillage will be controlled using methods mentioned in the ECP (should follow Cl. 120, 125, 126 of Chapter V of Petroleum Rules, 2002). Proper onsite emergency plan will be prepared and will be approved through MPMRCL. If the diesel storage crosses the threshold limits permissions from Chief Controller of Explosives (CCoE). Proper fire protection norms have to be undertaken as per National Building Code, 2005 (if building)/ Oil Industry Safety Directorate Standard 117 (if installation).	Contractor	GC/ MPMRCL

S.No	Activity	Impact	Mitigation Measures	Responsibilities	
				Implementation	Supervision
Operational Phase					
	Maintenance of trains in stabling yard	The wastewater discharges from workshops will have high oil & grease, high COD & TSS content.	Effluent water from washing plant shall be recycle and reused. The oil, grease, and detergent containing effluent should be treated in Effluent Treatment Plants (ETPs). The ETP (Annexure 8.1 – ETP schematic Diagram) is propose in Subhasnagar Depot.	MPMRCL	GoMP
34	Use of DG Sets	Emission from DG sets will create air pollution problems. Noise & vibration will be generated from the use of DG sets. DG sets will consume Diesel (and in effect reduce the levels of a non-renewable resource) Operation of DG sets will cause an aesthetic issue	DG sets will be used only for power back-ups. Emission norms from DG will follow CPCB specification no. GSR 520(E) dt. 1-7-2003 for DG sets rating < 800 KW, and GSR 489(E) dt. 09-07-2002 for DG sets > 800 KW under E (P) Rules, 1986. Stack height of DG sets will be as per CPCB requirement [stack ht. = 0.2*(rating in kVA)0.5]. Fuels used for DG will be High Speed Diesel (Sulphur <1% mass/mass). DG sets will be enclosed type, with noise levels approx. 75 dB (A) at a distance of 1m in compliance with GSR 371(E) dt. 17-05- 2002. The DG sets will be mounted on damping skids, which will reduce the vibration generated from DG sets. During operation stage, MPMRCL shall ensure below measures. (a) 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 .	MPMRCL	GoMP
35	Storage of diesel	Diesel spillage (from underground or above ground storage facility) will affect groundwater	Spillage will be controlled using methods mentioned in the environmental contingency plan (should follow Cl. 120, 125,	MPMRCL	GoMP

S.No	Activity	Impact	Mitigation Measures	Responsibilities	
				Implementation	Supervision
		quality adversely. 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.	126 of Chapter V of Petroleum Rules, 2002). Proper onsite emergency plan will be prepared and will be approved through MPMRCL. If the diesel storage crosses the threshold limits permissions from Chief Controller of Explosives (CCoE). Proper fire protection norms have to be undertaken as per National Building Code, 2005 (if building)/ Oil Industry Safety Directorate Standard 117 (if installation).		
38	Ancillary development along metro route	Ancillary developments will take place along with metro corridor.	Ancillary development should be controlled and only specific types of developments should be encouraged. A strict land use policy should be developed & followed by MPMRCL before commencement of operational. It should be balanced and have reasonable mix of commercial, infrastructure and common spaces.	MPMRCL	GoMP

8.4. Environmental Reporting System

The monitoring plan specifies the parameters to be monitored; location of the monitoring sites; frequency and duration of monitoring. The monitoring plan also specifies the applicable standards, implementation and supervising responsibilities. The monitoring plan for environmental attributes of the project in construction and operation stages is presented in Table 8-2.

The reporting system will operate linearly with the contractor who is at the lowest rank of the implementation system reporting to the General Consultant (EC), who in turn shall report to the environmental and social unit (ESU) of MPMRCL. All reporting by the contractor and GC shall be on a quarterly basis. The MPMRCL's ESU will be responsible for preparing targets for each of the identified EMP activities.

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

Photographic records will also be established to provide useful environmental and social monitoring tools. A full record will be kept as part of normal contract monitoring. The reporting system will operate linearly. The contractor will report to the General Consultant (GC), who in turn shall report to the MPMRCL. All reporting by GC to MPMRCL shall be on a quarterly basis. The MPMRCL based on the EMP activity identified shall be responsible for preparing targets. All subsequent reporting by the contractor shall be monitored as per these targets set by the MPMRCL before the contractors move on to the site. The Contractor on monthly bases will report/ submit the progress of work, which will form the basis for monitoring by the MPMRCL, either by its own Environmental Engineer/s or the Environmental Specialist hired by the GC.

8.5. Environmental Budget

The preliminary estimated cost of the environmental management plan for Purple and Red Lines including implementation and monitoring is INR **9,09,72,000.00** as detailed in Table 8.3. This cost estimate is exclusive of land acquisition and resettlement & resettlement cost.

Table 8-3: Cost of EMP Implementation (in INR)

S.No	Description of Item	Cost (INR)
1	Compensatory Afforestation (tree girth size > 300mm) (1450* 4*2192)	1,27,13,600
2	Compensatory Afforestation (tree girth < 300mm) (1450 * 2* 30)	87,000
3	Tree Cutting (girth size > 300mm) (6000*2192)	1,31,52,000
4	Environmental Monitoring	50,19,400
5	Effluent Treatment Plant	1,00,00,000
6	Rainwater Harvesting system in depot, Station and along viaduct (INR 1,60,00,000)	Included in engineering cost.
7	Establishment of Environmental & Social Unit	5,00,00,000
8	**Total**	**9,09,72,000**
Note: This is tentative cost of EMP implementation.		

Table 8-2: Environmental Monitoring Plan

Attribute	Project Stage	Parameter	Frequency	Duration	Location	Rate	Amount	Responsibility
Air	Construction	PM $_{10}$, PM $_{2.5}$, SO_2, NO_x, CO	Monthly	Continuous 24 hours	Project Site	10400	10400 * 5 * 48 = 24,96,000	Contractor
	Operation	PM_{10}, $PM_{2.5}$, SO_2, NO_x, CO	Bi-annually	Continuous 24 hours	Project Site	10400	10400 * 2 * 3 = 62,400	MPMRCL
Water	Construction	pH, BOD, COD, TDS, TSS, Pb, DO Oil & Grease for Surface Water pH, TDS, Total Hardness, Sulphate, Chloride, Fe, Pb, As,	Monthly	Grab Sampling	Source of construction water.	4000	4000* 1 * 48 = 1,92,000	Contractor
		As per IS:10500 for drinking water source	Monthly	Grab sample	Construction camp/Labour camp	4000	4000 * 2 * 48 = 3,84,000	
	Operation	As per IS:10500 for drinking water source	Bi-annually	Grab sample	Source of drinking water source	4000	4000 * 2 * 3 = 24,000	MPMRCL
Noise	Construction	Noise levels on dB (A) scale	Monthly	8 hour during (active operational hours)	Project Sites	3500	3500 * 5 * 48 = 8,40,000	Contractor
	Operation	Noise levels on dB (A) scale	Twice in a year for 3 years	8 hour during (active operational hours)	Alignment and stations	3500	3500 * 2 * 3 = 21,000	MPMRCL
Vibration	Construction	PPV mm/s	Continuous monitoring when the tunnel boring is within 300m of structure.	Tunnel boring period.	At key structure locations	200000/month	200000 * 5 = 10,00,000	Contractor
						Total	**50,19,400**	

Attribute	Project Stage	Parameter	Frequency	Duration	Location	Rate	Amount	Responsibility
Note: GC shall be responsible for supervising implementation of environmental monitoring plan by contractor during construction stage. Assumptions for estimations: (a) construction period of 48 months; (b) noise and air: minimum 5 work sites in a month; (c) drinking water: minimum 2 construction camp; (d) 5 months tunnel boring period								

9. Conclusion and Recommendation

The alignment of the proposed Purple and Red Lines, and depot area are not located in any environmentally sensitive or protected areas. Careful selection of alignment has avoided sites of historical/cultural significance. No major impact on wildlife is envisaged as there are no forest areas within project area. The roadside and median plantations are not habitat of any endangered or endemic species of fauna and flora.

The project anticipate social impacts including acquisition of about land for stations and impacts on structures both residential and commercial affecting livelihood of people. The project will not result in any long-term significant adverse environmental impacts. Minimal environmental impacts are anticipated, mostly during construction. These can be mitigated successfully by implementing the EMP with estimated costs for implementation. Environmental and social benefits of the project and long-term investment program objectives outweigh the temporary negative impacts.

Best available technology and best management practices are built-in to the project design. All project components will be implemented and monitored according with the EIB's Statement of Environmental and Social Principles and Standards. A quarterly environmental monitoring report will be submitted to EIB as required in EIB's E&S handbook.

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

ANNEXURES

Annexure 2.1 - MP Vrikshon ka Parirakshan (Nagariys Shetra) Adhiniyam 2001

The M.P. Vrikshon Ka Parirakshan (Nagariya Kshetra) Adhiniyam, 2001
(M.P. Act No. 20 of 2001)
mp826
[Dated 26th September, 2001]

An Act to make better provision for regulation of felling of trees for the purpose of preservation and replanting of trees in urban areas of Madhya Pradesh.

Be if enacted by the Madhya Pradesh Legislature in the Fifty-Second Year of the Republic of India as follows :-

1. **Short title, extent and commencement.**– (1) This Act may be called the Madhya Pradesh Vrikshon Ka Parirakshan (Nagariya Kshetra) Adhiniyam, 2001.

(2) It extends to the whole of the State of Madhya Pradesh.

(3) Ii shall come into force in all urban areas from the dale of the publication in the *official gazette*.

2. **Definitions.**– In this Act, unless the context otherwise requires,-

(a) *"Appointing Authority"* means an authority appointed by the State Government as appellate authority under this Act;

(b) *"Tree"* means any woody plant, whose branches spring from and are supported upon a trunk or body and whose trunk or body is not less than 30 centimetres in girth at ground level and is not less than 2 metres in height from the ground level;

(c) *"To fell a tree"* with its cognate expression means severing the trunk from the roots, up-rooting the tree and includes bulldozing, cutting, girdling, lopping, polarding, applying poisonous substance, burning or damaging a tree in any other manner;

(d) *"Tree Officer"* means an officer appointed as such by the State Government for the purpose of this Act;

(e) *"Urban area"* means all places within a Municipal Corporation/ Municipality/Cantonment Board or Nagar Panchayat;

(f) Words and expressions used in this Act and defined in the Indian Forest Act, 1927 hut not defined in this Act shall have the meanings respectively assigned to them in that Act.

3. **Restriction on felling of tress.**– Notwithstanding any custom, usage, contract or local-law for the time being in force, no person shall without permission under the provision of this Act fell any tree or cause any tree to be felled in any land, whether of his ownership or otherwise, situated within the urban area.

4. **Appointment of Tree Officer.**– The State Government may appoint one or more forest officers of the rank not below that of a Gazetted Forest Officer, Commissioner, Municipal Corporation or Chief Municipal Officer as "Tree Officer" for the purposes of this Act, for each Urban Area.
5. **Appointment of other officers.**– The State Government may, from time to time, appoint such other officers and employees of Forest Department or Local Authority as may be considered necessary who shall be subordinate to the Tree Officer.
6. **Procedure for obtaining permission to fell, cut, remove or dispose of a tree.**– (1) Any person desiring to fell or remove or otherwise dispose of, by any means, a tree, shall make an application to the concerned Tree Officer for permission in such form and containing such particulars and accompanied by such documents as may be prescribed.

(2) On receipt of the application, the Tree Officer shall acknowledge the application and may by order after inspecting the tree and holding such enquiry, as he may deem necessary, either grant permission in whole or in part or refuse permission for reasons to the recorded in writing, within 30 days from the date of receipt of the application ;

Provided that no permission shall be granted to any person from the same area on more than two occasions during the same year :

Provided further that no permission shall be refused if the tree-

(i) is dead, diseased or wind fallen; or

(ii) constitutes a danger to life and property; or

(iii) is substantially damaged or destroyed by lire, lighting, rain or other natural causes; or

(iv) constitutes an obstruction to traffic or if necessary for maintenance of power/telephone lines etc.

(3) The permission granted under sub-section (2) may by subject to the condition that the applicant shall plant another tree or trees of the same or other suitable species on the same site or premises, and where this is not possible make such contribution as may be prescribed, within thirty days from the date the tree is felled or within such extended period as the Tree Officer may allow.

(4) If the Tree Officer fails to communicate the decision within the period specified under sub-section (2) the permission applied for shall be deemed to have been granted.

7. **Preservation of trees.**– It shall be the duty of the applicant to comply with the order made under sub-section (3) of Section 6 and to ensure that the tree or trees grow well and are well preserved.
8. **Implementation of order made under Section 6.**– (1) Every person who is under an obligation to plant trees under an order made under Section 6 shall start preparatory work within thirty days of the date of receipt of the order or directions, as the case may be and

shall plant trees in accordance with such order or directions in the ensuing or following rainy season or within such extended time as the Tree Officer may allow and shall provide adequate and effective protection to the trees that are planted in the land or the area from any damage.

(2) In case of default by such person, the Tree Officer may cause trees to be planted and may recover the cost of plantation from such person as an arrear of land revenue.

9. **Appeal.**– (1) The State Government may by notification, specify the authorities who shall be the appellate authorities for the purposes of this Act.

(2) When any decision is given or order is made under Sections 6 and 7 by the Tree Officer, any person aggrieved by that order of Tree Officer, may appeal to the appellate authority within a period of thirty days of passing such order or direction by the Tree Officer.

(3) The appellate authority shall decide the appeal within sixty days from the dale of its receipt, alter giving reasonable opportunity to the appellant of being heard.

10. **Seizure of property.**– Where the Tree Officer or any Forest Officer has reasons lo believe that an offense under this Act has been committed in respect of any tree, he may seize the tree or part thereof which has been severed from the ground or the trunk, as the case may be, alongwith the tools and implements used for felling. When the seizure is made by forest officer he will forward the case to the Tree Officer for further action.
11. **Power to release property seized under Section 10.**– The Tree Officer may release the property seized under Section 10, if the owner of the land executes a bond in such form as may be prescribed for its production whenever required.
12. **Timber/Fuelwood, tools etc., when liable to confiscation.**– (1) All timber or fuel-wood which is not the property of the State Government and in respect of which an offense has been committed under this Act, and all animals, tools, boats, vehicles, ropes, chain or any other articles used in committing such offense, shall subject to provisions of Sections 9, 11 and 17, he liable to confiscation upon conviction of the offender for such offense.

Such confiscation may be in addition to any other punishment prescribed for such offense.

(2) Any timber produced from the tree, tools and implements etc. and any boats, animals or other conveyance confiscated under sub-section (1) shall he disposed of by the Court in such manner as may be prescribed.

13. **Offense by organizations.**– (1) If the person committing an offense under this Act is an organization, the organization as well as every person-in-charge of and responsible to the organization for the conduct of its business at the time of the commission of the offense shall be deemed to be guilty of the offense and shall be liable to he proceeded against and punished accordingly :

Provided that nothing contained in this sub-section shall render any such person liable to any punishment if he proves that the offense was committed without his knowledge or that he exercised all due diligence to prevent the commission of such offense.

(2) Notwithstanding anything contained in sub-section (1) where an offense under this Act has been committed by an organization and it is proved that the offense has been committed, with the consent or connivance of, or is attributable to any neglect on the part of its Head of Office/Unit, Secretary, Treasurer, Director, Manager or other officer of the Organization, such Head of Office/Unit, Secretary, Treasurer, Director, Manager or other officer of the organization shall also be deemed to be guilty of that offense and shall he liable to be proceeded against and punished accordingly.

14. **Power to prevent commission of offense.**– Every Tree Officer or his subordinate or any Forest, Revenue or Police Officer shall prevent and may intervene for the purpose of preventing the commission of any offense under this Act.
15. **Power to compound offense.**– (1) The State Government may, by notification, authorize a Tree Officer or any Forest Officer not below the rank of a Divisional Forest Officer, to accept from any person against whom there is reason to believe that he has committed offense under this Act in respect of any tree, such sum of money as may be prescribed by way of composition for the offense which such person is suspected to have committed.

(2) On the payment of such sums or such value or both as the case may be, to such officer the property seized and the offender, if in custody, shall be released and no further proceeding shall be taken against such offender or property.

16. **Contravention of Act to be reported by certain persons.**– It shall be the duty of every Forest Officer, public servant or any person to give immediate information coming to his knowledge, if any contravention of Section 3 and of preparation to commit such contravention to the Tree Officer.
17. **Execution of order for payment of Money.**– Any sum, the payment of which has been directed to be made by any person under this Act shall, without prejudice to any other mode of recovery under any law for the time being in force, be recoverable from him as arrear of land revenue.
18. **Penalty.**– Whoever fells any tree or causes any tree to be felled in contravention of any provision of this Act or Rules or order made thereunder shall, on conviction be punished with imprisonment which may extend to two years or with line which may extend to fifty thousand rupees or with both. The line, if not deposited within the prescribed time limit, will be recoverable as arrears of land revenue.
19. **Persons under this Act to be Public Servants.**– Every person exercising power or discharging any duties or functions under this Act shall be deemed to be public servants within the meaning of Section 21 of Indian Penal Code, 1860 (No. 45 of 1860).
20. **Protection of action taken in good faith.**– No suit, prosecution or other legal proceedings shall lie against the Slate Government or any person empowered to exercise power or to perform duties or discharge functions under this Act for anything done or purporting to be done or omitted to be done in good faith under this Act or the rules and orders made thereunder.

21. **Power of State Government for Preservation of Trees.**– (1) The State Government may, in the interest of general public, declare by notification that any class of trees shall not be felled for such period as is specified in that notification.

(2) The management of such trees shall be regulated in the prescribed manner.

22. **Investing Tree Officer with certain powers.**– The State Government may by notification invest the Tree Officers and other officer with all or any of the following powers, namely :-

(a) Power to enter upon any land to survey, demarcate and make a map of the same;

(b) Power to hold enquiries into offense under the Act and in the course of such enquiry to receive and record evidence.

23. **Transit to felled material.**– The provisions of Sections 41 and 42 of Indian Forest Act, 1927 (No. 16 of 1927) shall *mutatis mutandis*, apply to the transit of the felled trees under this Act.
24. **Power to make rules.**– (1) The State Government may, by notification, make rules to carry out the purposes of this Act.

(2) All rules made under this Act shall be laid on the table of the Legislative Assembly.

Annexure 2.2 - MP Vrikshon ka parirakshan (Nagariys Shetra) Niyam Rule, 2002

[1]Madhya Pradesh Vrikshon Ka Parirakshan (Nagriya Kshetra) Niyam, 2002

Bhopal, the 11th April 2002

No. F-30-4-2001-X-3.— In exercise of the powers conferred by Section 24 of the Madhya Pradesh Vrikshon Ka Parirakshan (Nagariya Kshetra) Adhiniyam, 2001 (No. 20 of 2001), the State Government hereby makes the following rules for the purpose of preservation and replanting of trees in Urban areas of Madhya Pradesh, namely :—

RULES

1. Short title, extent and commencement.— (1) These rules may be called the **Madhya Pradesh Vrikshon Ka Parirakshan (Nagriya Kshetra) Niyam, [2]2002**.

(2) The shall extend to the whole of the State of Madhya Pradesh.

(3) These rules shall apply in all urban areas of the State from the date of their publication in the Madhya Pradesh Gazette.

2. Definitions.— In these rules unless the context otherwise requires :—

(a) **"Adhiniyam"** means the Madhya Pradesh Vrikshon Ka Parirakshan (Nagriya Kshetra) Adhiniyam, 2001 (No. 20 of 2001);

(b) **"Forest Act"** means the Indian Forest Act, 1927 (No. XVI of 1927);

(c) **"Section"** means a section of the Adhiniyam;

(d) **"Transit Rules"** means Madhya Pradesh Transit (Forest Produce) Rules, 2000.

3. Procedure for obtaining permission.— (1) Any person desiring to fell, remove, uproot or sever stem from the root system, or dispose of by any means a tree (s) shall apply to the Tree Officer having jurisdiction on concerning urban area in Form-I, along with a processing Fee of Rs. 100/- per application. The application shall be accompanied by the following documents:—

(a) details of land where the tree is standing (Khasra No., Plot No., Ward No. etc. along with location map);

(b) proof of ownership of land or lease documents or any other document which can substantiate that the applicant has got ownership rights in the land in question;

(c) details of tree(s) species, height, girth at basal area, condition of tree (sound, diseased, dying, dead, damaged, wind fallen, girdled or with any other peculiarity).

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1. Published in M.P. Rajpatra Part 4 (Ga) dated 19-8-2003.
2. Substituted vide Not. No. 38-F-1-52-3/18-3, dated 19-8-2003.

(d) undertaking for compensatory plantation.

(2) The permission granted under sub-section (2) of Section 6 of the Adhiniyam shall be subject to the condition that the applicant shall plant another tree or trees of the same or other suitable species on the same site or the premises and where this is not possible shall make a cash contribution of Rs. 500/tree within 30 days from the date the tree is felled or within such extended period as the Tree Officer may allow.

4. Power to release the property seized under Section 10.— If the owner of the land executes a bond in Form-II the Tree Officer may release the seized property for the production of seized material whenever required.

5. Disposal of confiscated property.— The Tree Officer, shall apply to the Magistrate first class, having jurisdiction for the disposal of the confiscated property. The application shall contain the details of the confiscated property and the order of the confiscation.

6. Power to compound offence.— If the Offender agrees in writing for compounding of the offence and the Tree Officer is also satisfied that the case is not fit for challan in the Court, he may compound the offence by imposing the penalty which may not exceed Rs. 5000/- per tree in respect of offence, which the person is suspected to have committed. In addition to above, the value of the produce will also be realised and seized property and person if in custody shall be released.

[1][**7. Mode of deposit of recovered amount.**— Any amount recovered under these Niyam shall be deposited in the treasury of Municipal Corporation or Municipal Council or Nagar Panchayat, as the case may be, established in the Urban Area.]

FORM – I

[*See* Section 6 (i)]

FORM OF APPLICATION FOR SEEKING PERMISSION TO FELL TREE (S)

(Submit application by hand in 2 copies)

Registered

To,

The Tree Officer,
Urban Area.....
District .....
M.P.

Sub:—Application for seeking permission to fell tree(s) in the urban area of.....

---

1. Inserted vide Not. No. 38/F-1-52-03-18-3, dated 19-8-2003.

Dear Sir,

I, ... (name of applicant), aged ..... years, resident of ..... (Address), do hereby submit application under provisions of the Section 6 (i) of the M.P. Virkshon Ka Parirakshan (Nagriya Kshetra) Adhiniyam, 2001 to fell tree (s) at aforementioned site. The details are as follows :—

1. Name of the applicant .....
2. Father's/Husband's Name .....
3. Address of applicant .....
4. Telephone .....
5. E-mail, if any .....
6. Location of tree(s) which require felling : House/Plot No. .....
   Road .....
   Colony .....
   Khasra No. .....
   Patwari Halka No. .....
   Municipal Ward No. .....
   District. .....
7. Details of trees (s)
   (a) Number of trees with girth : .....
   (b) Species : .....
   (c) State condition of tree(s) : .....
   (Whether dead, dying, diseased, Moribund, broken, lightening affected, wind fallen, uprooted, unsound, half sound, sound etc.)
8. State reasons in detail why applicant wants tc fell tree(s) : .....
9. Details of land proposed for compensatory plantation: : .....
   (a) Location of the site : .....
   (House/Plot No. Street, Colony, R.I. Circle No., Patwari Halka No., Tehsil, District & Ward No.)

(b) Area available for planting : .....

(c) Enclose maps of land : .....

(d) Enclose written consent of the owner of land; if applicant is not the owner of land. : .....

10. Nature of ownership of the land (Bhumiswami patta, lease, tenancy etc.) : .....

11. If the land is not available for compensatory plantation, willingness of the applicant to contribute Rs. 500/ tree. : .....

12. Specify documents enclosed with the application : .....

(a) .....(b) .....

(c) .....(d) .....

(e) .....(f) .....

13. Details of payment of fee (enclosed receipt D.D., Challan etc.)

No. .....

Bank/Treasury .....

Amount Rs. .....

UNDERTAKING

I, ... S/o/W/o. .....

aged ..... years, permanent resident of .....

do hereby swear that the particulars provided in this application are true to the best of my knowledge & belief and nothing material has been suppressed or distorted therein.

I, further confirm that I shall raise and maintain the compensatory plantation as stipulated by the Tree Officer while granting permission to me.

or

I, further confirm that I shall contribute Rs. ..... for compensatory plantation as directed by the Tree Officer.

Signature .....

Name of Applicant .....

Address .....

.....

.....

FOR OFFICE USE ONLY

1.	Case No.	:	.....
2.	Date and Time of receipt	:	.....
3.	Acknowledgement No. issued to applicant	:	.....
4.	Sent to Assistant Tree Officer/ Ward Officer for inquiry	:	.....
5.	Date of receipt of inquiry report	:	.....
6.	Decision of the "Tree Officer"	:	.....
			.....
			.....
7.	Date and despatch No. of order	:	.....

(Incharge of Section)

FORM II

[*See* Rule 4]

SURETY BOND

I, ... (name), S/o. ..... Aged ..... years, permanent resident of ..... do hereby certify that the (details of property) ..... has/have been seized by the competent officer under the provisions of the Section 10 of the M.P. Vrikshon ka Parirakshan (Nagriya Kshetra) Act, 2001. I, ... the owner of land in question, have taken over the possession of said property from the Tree Officer and I hereby furnish ir-revocable bond to produce seized movable property before the investigation officer/court, or elsewhere whenever required.

DEPONENT

VERIFICATION

I, ... (name), S/o. ..... Aged ..... years, permanent resident of ..... do hereby verify that contents of this bond are true to my best belief & knowledge and nothing material has been suppressed in the bond, I again verify that I am bound by the conditions of this bond.

DEPONENT

* To be executed on stamp papers as per provisions of the Stamp Act, and verified by notary public/oath commissioner.

Annexure 4.1 - National Ambient Air Quality Standard, 2009

रजिस्ट्री सं० डी० एल०-33004/99 REGD. NO. D. L.-33004/99

भारत का राजपत्र
The Gazette of India

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राष्ट्रीय परिवेशी वायु गुणवत्ता मानक

केन्द्रीय प्रदूषण नियंत्रण बोर्ड

अधिसूचना

नई दिल्ली, 18 नवम्बर, 2009

सं. बी-29016/20/90/पी.सी.आई.-I.—वायु (प्रदूषण निवारण एवं नियंत्रण) अधिनियम, 1981 (1981 का 14) की धारा 16 की उपधारा (2) (एच) द्वारा प्रदत्त शक्तियों का प्रयोग करते हुए तथा अधिसूचना संख्या का.आ. 384(ई), दिनांक 11 अप्रैल, 1994 और का.आ. 935 (ई) दिनांक 14 अक्टूबर, 1998 के अधिक्रमण में केन्द्रीय प्रदूषण नियंत्रण बोर्ड इसके द्वारा तत्काल प्रभाव से राष्ट्रीय परिवेशी वायु गुणवत्ता मानक अधिसूचित करता है, जो इस प्रकार है:-

राष्ट्रीय परिवेशी वायु गुणवत्ता मानक

क्र. सं.	प्रदूषक	समय आधारित औसत	परिवेशी वायु में सान्द्रण		
			औद्योगिक, रिहायशी, ग्रामीण और अन्य क्षेत्र	पारिस्थितिकीय संवेदनशील क्षेत्र (केन्द्र सरकार द्वारा अधिसूचित)	प्रबोधन की पद्धति
(1)	(2)	(3)	(4)	(5)	(6)
1	सल्फर डाई आक्साइड (SO_2), $\mu g/m^3$	वार्षिक*	50	20	-उन्नत वेस्ट और गाईक
		24 घंटे**	80	80	-पराबैगनी परिदीप्ती
2	नाइट्रोजन डाई आक्साइड (NO_2), $\mu g/m^3$	वार्षिक*	40	30	-उपांतरित जैकब और हॉचाइजर (सोडियम-आर्सेनाईट)
		24 घंटे**	80	80	-रासायनिक संदीप्ति
3	विविक्त पदार्थ (10माइक्रान से कम आकार)या PM_{10}, $\mu g/m^3$	वार्षिक*	60	60	-हरात्मक विश्लेषण
		24 घंटे**	100	100	-टोयम
					-बीटा तनुकरण पद्धति

4	विविक्त पदार्थ (2.5 माइक्रान से कम आकार या $PM_{2.5}$, $\mu g/m^3$	वार्षिक* 24 घंटे**	40 60	40 60	-हरात्मक विश्लेषण -टोयम -बीटा तनुकरण पद्धति
5	ओजोन (O_3) $\mu g/m^3$	8 घंटे** 1 घंटा**	100 180	100 180	-पराबैगनी द्वीप्तिकाल -रासायनिक संदीप्ति -रासायनिक पद्धति
6	सीसा (Pb) $\mu g/m^3$	वार्षिक* 24 घंटे**	0.50 1.0	0.50 1.0	ई.पी.एम 2000 या समरूप फिल्टर पेपर का प्रयोग करके AAS/ICP पद्धति -टेफलॉन फिल्टर पेपर का प्रयोग करते हुए ED-XRF
7	कार्बन मोनोक्साइड (CO) mg/m^3	8 घंटे** 1 घंटा**	02 04	02 04	-अविपेक्षी अवरक्त (NDIR) स्पैक्ट्रम मापन
8	अमोनिया (NH_3) $\mu g/m^3$	वार्षिक* 24 घंटे**	100 400	100 400	-रासायनिक संदीप्ती -इण्डोफिनॉल ब्ल्यू पद्धति
9	बैन्जीन (C_6H_6) $\mu g/m^3$	वार्षिक*	05	05	- गैस क्रोमेटोग्राफी आधारित सतत् विश्लेषक -अधिशोषण तथा निशोषण के बाद गैस क्रोमेटोग्राफी
10	बैन्जो (ए) पाईरीन (BaP) केवल विविक्त कण, ng/m^3	वार्षिक*	01	01	-विलायक निष्कर्षण के बाद HPLC/GC द्वारा विश्लेषण
11	आर्सेनिक (As) ng/m^3	वार्षिक*	06	06	-असंवितरक अवरक्त स्पैक्ट्रामिती ई.पी.एम. 2000 या समरूप फिल्टर पेपर का प्रयोग करके ICP/AAS पद्धति
12	निकिल (Ni) ng/m^3	वार्षिक*	20	20	ई.पी.एम. 2000 या समरूप फिल्टर पेपर का प्रयोग करके ICP/AAS पद्धति

* वर्ष में एक समान अंतरालों पर सप्ताह में दो बार प्रति 24 घंटे तक किसी एक स्थान विशेष पर लिये गये न्यूनतम 104 मापों का वार्षिक अंकगणीतीय औसत ।

** वर्ष में 98 प्रतिशत समय पर 24 घंटे या 8 घंटे या 1 घंटा के मानीटर मापमान, जो लागू हो , अनुपालन कये जाएंगे । दो प्रतिशत समय पर यह मापमान अधिक हो सकता है, किन्तु क्रमिक दो मानीटर करने के दिनों पर नहीं ।

टिप्पणीः

1. जब कभी और जहां भी किसी अपने-अपने प्रवर्ग के लिये दो क्रमिक प्रबोधन दिनों पर मापित मूल्य, ऊपर विनिर्दिष्ट सीमा से अधिक हो तो इसे नियमित या निरंतर प्रबोधन तथा अतिरिक्त अन्वेषण करवाने के लिये पर्याप्त कारण समझा जायेगा ।

संत प्रसाद गौतम, अध्यक्ष

[विज्ञापन-III/4/184/09/असा.]

टिप्पणीः राष्ट्रीय परिवेशी वायु गुणवत्ता मानक संबंधी अधिसूचनाएँ, केन्द्रीय प्रदूषण नियंत्रण बोर्ड द्वारा भारत के राजपत्र आसाधरण में अधिसूचना संख्या का.आ. 384 (ई), दिनांक 11 अप्रैल, 1994 एवं का. आ. 935 (ई), दिनांक 14 अक्टूबर, 1998 द्वारा प्रकाशित की गयी थी ।

NATIONAL AMBIENT AIR QUALITY STANDARDS
CENTRAL POLLUTION CONTROL BOARD
NOTIFICATION

New Delhi, the 18th November, 2009

No. B-29016/20/90/PCI-L—In exercise of the powers conferred by Sub-section (2) (h) of section 16 of the Air (Prevention and Control of Pollution) Act, 1981 (Act No.14 of 1981), and in supersession of the Notification No(s). S.O. 384(E), dated 11th April, 1994 and S.O. 935(E), dated 14th October, 1998, the Central Pollution Control Board hereby notify the National Ambient Air Quality Standards with immediate effect, namely:-

NATIONAL AMBIENT AIR QUALITY STANDARDS

S. No.	Pollutant	Time Weighted Average	Concentration in Ambient Air		
			Industrial, Residential, Rural and Other Area	Ecologically Sensitive Area (notified by Central Government)	Methods of Measurement
(1)	(2)	(3)	(4)	(5)	(6)
1	Sulphur Dioxide (SO_2), $\mu g/m^3$	Annual*	50	20	- Improved West and Gaeke
		24 hours**	80	80	-Ultraviolet fluorescence
2	Nitrogen Dioxide (NO_2), $\mu g/m^3$	Annual*	40	30	- Modified Jacob & Hochheiser (Na-Arsenite)
		24 hours**	80	80	- Chemiluminescence
3	Particulate Matter (size less than 10µm) or PM_{10} $\mu g/m^3$	Annual*	60	60	- Gravimetric - TOEM
		24 hours**	100	100	- Beta attenuation
4	Particulate Matter (size less than 2.5µm) or $PM_{2.5}$ $\mu g/m^3$	Annual*	40	40	- Gravimetric - TOEM
		24 hours**	60	60	- Beta attenuation
5	Ozone (O_3) $\mu g/m^3$	8 hours**	100	100	- UV photometric - Chemilminescence
		1 hour**	180	180	- Chemical Method
6	Lead (Pb) $\mu g/m^3$	Annual*	0.50	0.50	- AAS /ICP method after sampling on EPM 2000 or equivalent filter paper - ED-XRF using Teflon filter
		24 hours**	1.0	1.0	
7	Carbon Monoxide (CO) mg/m^3	8 hours**	02	02	- Non Dispersive Infra Red (NDIR) spectroscopy
		1 hour**	04	04	
8	Ammonia (NH_3) $\mu g/m^3$	Annual*	100	100	-Chemiluminescence
		24 hours**	400	400	-Indophenol blue method

(1)	(2)	(3)	(4)	(5)	(6)
9	Benzene (C_6H_6) $\mu g/m^3$	Annual*	05	05	- Gas chromatography based continuous analyzer - Adsorption and Desorption followed by GC analysis
10	Benzo(a)Pyrene (BaP) - particulate phase only, ng/m^3	Annual*	01	01	- Solvent extraction followed by HPLC/GC analysis
11	Arsenic (As), ng/m^3	Annual*	06	06	- AAS /ICP method after sampling on EPM 2000 or equivalent filter paper
12	Nickel (Ni), ng/m^3	Annual*	20	20	- AAS /ICP method after sampling on EPM 2000 or equivalent filter paper

* Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 08 hourly or 01 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Note. — Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigation.

SANT PRASAD GAUTAM, Chairman
[ADVT-III/4/184/09/Exty.]

Note: The notifications on National Ambient Air Quality Standards were published by the Central Pollution Control Board in the Gazette of India, Extraordinary vide notification No(s). S.O. 384(E), dated 11th April, 1994 and S.O. 935(E), dated 14th October, 1998.

Printed by the Manager, Government of India Press, Ring Road, Mayapuri, New Delhi-110064
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Annexure 4.1a - Air Quality Result

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Testing & Training Institute

Research Institute of Material Sciences Pvt. Ltd.

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Plot No. 22 & 23, Ranaji Enclave, Nangli Sakrawati, New Delhi-110043
Ph.: 011-25324233, (M) 09599983618, Email : info@rimslab.com, Website : www.rimslab.com

JAS-ANZ
Acc. No. M3111204IN

TEST REPORT

AMBIENT AIR QUALITY MONITORING REPORT
Test Report No.: 1807100001-0008
Dispatch Date :20/07/2018

ISSUED TO	**Centre for Management and Social Research,** Plot no. 101, flat no. 103,RR Residency opp. GHMC, Srinagar Colony,Hyderabad-500073
PROJECT NAME	Environmental Monitoring for "Bhopal Metro Rail Project Bhopal M.P"

RESULTS

Locations	Dated	Parameters						
		$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	NO_2 ($\mu g/m^3$)	CO (mg/m^3)	HC ($\mu g/m^3$)	NMHC ($\mu g/m^3$)
AIIMS	03/07/2018 – 04/07/2018	112	191	10.9	19.1	BDL	BDL	BDL
Habibganj	04/07/2018 – 05/07/2018	132	204	9.8	17.3	BDL	BDL	BDL
Nandra Bus Stand	05/07/2018 – 06/07/2018	144	254	10.1	18.4	BDL	BDL	BDL
Krishi Upaj Mandi	06/07/2018 – 07/07/2018	86	159	11.2	20.1	BDL	BDL	BDL
Bhadbhada Square	07/07/2018 – 08/07/2018	95	172	12.8	21.8	BDL	BDL	BDL
Ratnagiri Square	08/07/2018 – 09/07/2018	100	186	10.9	18.2	BDL	BDL	BDL
Jawahar Square	09/07/2018 – 10/07/2018	111	191	14.6	22.7	BDL	BDL	BDL
Bogda Pul	10/07/2018 – 11/07/2018	104	173	12.4	20.9	BDL	BDL	BDL

*BDL=Below Detection Limit

End of Report

Research Institute of Material Sciences Pvt. Ltd. RIMS New Delhi

Authorized Signatory
Sumit Kumar

Annexure 4.2 - Noise Pollution (Regulation and Control) Rule, 2000

THE NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000

(AS AMENDED TO DATE)

THE NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000

MINISTRY OF ENVIRONMENT & FORESTS

NOTIFICATION

[1][S.O.123(E)] – Whereas, the increasing ambient noise level in public places from various sources, inter-alia, industrial activity, construction activity, [2][fire crackers, sound producing instruments], generator sets, loud speakers, public address systems, music systems, vehicular horns and other mechanical devices have deleterious effects on human health and the psychological well being of the people; it is considered necessary to regulate and control of noise producing and generating sources with the objective of maintaining the ambient air quality standards in respect of noise;

Whereas, a draft of Noise Pollution (Regulation and Control) Rule, 1999 was published under the notification of the Government of India in the Ministry of Environment and Forests vide number S.O.528 (E), dated the 28th June, 1999 inviting objections and suggestions from all the persons likely to be affected thereby, before the expiry of the period of sixty days from the date on which the copies of the Gazette containing the said notification are made available to the public;

And, whereas, copies of the said Gazette were made available to the public on the 1st day of July, 1999;

And, whereas the objections and suggestions received from the public in respect of the said draft rules have been duly considered by the Central Government;

Now, therefore, in exercise of the powers conferred by clause (ii) of sub-section (2) of section 3, sub-section (1) and clause (b) of sub-section (2) of section 6 and section 25 of the Environment (Protection) Act, 1986 (29 of 1986) read with Rule 5 of the Environment (Protection) Rules, 1986, the Central Government hereby makes the following rules for the regulation and control of noise producing and generating sources, namely:-

The Noise Pollution (Regulation and Control) Rules, 2000.

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1 As published in the Gazette of India, Extraordinary, Part II- Section 3(ii), vide S.O. 123(E), dated 14.2.2000 and amended by the Noise Pollution (Regulation and Control) (Amendment) Rules, 2000 notified vide S.O. 1046(E), dated 22.11.2000.

2 Inserted by Rule 2 of the Noise Pollution (Regulation and Control) (Amendment) Rules, 2010 notified vide S.O.50 (E), dated 11.01.2010.

1. SHORT-TITLE AND COMMENCEMENT.-

(1) These rules may be called the Noise Pollution (Regulation and Control) Rules, 2000.

(2) They shall come into force on the date of their publication in the Official Gazette.

2. DEFINITIONS.-

In these rules, unless the context otherwise requires,-

(a) "Act" means the Environment (Protection) Act, 1986 (29 of 1986) ;

(b) "area/zone" means all areas which fall in either of the four categories given in the Schedule annexed to these rules;

[1][(c) "authority" means and includes any authority or officer authorized by the Central Government, or as the case may be, the State Government in accordance with the laws in force and includes a District Magistrate, Police Commissioner, or any other officer not below the rank of the Deputy Superintendent of Police designated for the maintenance of the ambient air quality standards in respect of noise under any law for the time being in force];

[2][(d) "court" means a governmental body consisting of one or more judges who sit to adjudicate disputes and administer justice and includes any court of law presided over by judge, judges or a magistrate and acting as a tribunal in civil, taxation and criminal cases;

(e) "educational institution" means a school, seminary, college, university, professional academies, training institutes or other educational establishment, not necessarily a chartered institution and includes not only buildings, but also all grounds necessary for the accomplishment of the full scope of educational instruction, including those things essential to mental, moral and physical development;

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1 Substituted by Rule 2(i) of the Noise Pollution (Regulation and Control) Amendment Rules, 2000 notified vide S.O. 1046(E), dated 22.11.2000, w.e.f. 22.11.2000.

2 Inserted by Rule 2(iii), of the Noise Pollution (Regulation and Control) Amendment Rules, 2000 notified vide S.O. 1046(E), dated 22.11.2000, w.e.f. 22.11.2000).

(f) "hospital" means an institution for the reception and care of sick, wounded, infirm or aged persons, and includes government or private hospitals, nursing homes and clinics;]

[1][(g) "person" shall include any company or association or body of individuals, whether incorporated or not;]

[2][(h) "State Government" in relation to a Union territory means the Administrator thereof appointed under article 239 of the Constitution;]

[3][(i) "public place" means any place to which the public have access, whether as of right or not, and includes auditorium, hotels, public waiting rooms, convention centres, public offices, shopping malls, cinema halls, educational institutions, libraries, open grounds and the like which are visited by general public; and

(j) "night time" means the period between 10.00 p.m. and 6.00 a.m.]

3. AMBIENT AIR QUALITY STANDARDS IN RESPECT OF NOISE FOR DIFFERENT AREAS/ZONES.-

(1) The ambient air quality standards in respect of Noise for different areas/zones shall be such as specified in the Schedule annexed to these rules.

(2) The State Government [4][shall categorize] the areas into industrial, commercial, residential or silence areas/zones for the purpose of implementation of noise standards for different areas.

(3) The State Government shall take measures for abatement of noise including noise emanating from vehicular movements, [5][blowing of horns, bursting of sound emitting fire crackers, use of loud speakers or public address system and sound producing instruments] and ensure that the existing noise levels do not exceed the ambient air quality standards specified under these rules.

(4) All development authorities, local bodies and other concerned authorities while planning developmental activity or carrying out functions relating to town

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1 Re-numbered and substituted by Rule 2(ii) of the Noise Pollution (Regulation and Control) (Amendment) Rules, 2000 notified vide S.O.1046(E), dated 22.11.2000, w.e.f. 22.11.2000.

2 Renumbered by Rule 2(ii), ibid.

3 Inserted by Rule 3 of the Noise Pollution (Regulation and Control) (Amendment) Rules, 2010 notified vide S.O. 50 (E), dated 11.01.2010

4 Substituted by Rule 3 of the Noise Pollution (Regulation and Control) (Amendment) Rules, 2000 notified vide S.O.1046(E), dated 22.11.2000, w.e.f. 22.11.2000

5 Inserted by Rule 4 of the Noise Pollution (Regulation and Control) (Amendment) Rules, 2010 notified vide S.O. 50 (E), dated 11.01.2010

and country planning shall take into consideration all aspects of noise pollution as a parameter of quality of life to avoid noise menace and to achieve the objective of maintaining the ambient air quality standards in respect of noise.

(5) An area comprising not less than 100 meters around hospitals, educational institutions and courts may be declared as silence area/zone for the purpose of these rules.

4. RESPONSIBILITY AS TO ENFORCEMENT OF NOISE POLLUTION CONTROL MEASURES.-

(1) The noise levels in any area/zone shall not exceed the ambient air quality standards in respect of noise as specified in the Schedule.

(2) The authority shall be responsible for the enforcement of noise pollution control measures and the due compliance of the ambient air quality standards in respect of noise.

[1][(3) The respective State Pollution Control Boards or Pollution Control Committees in consultation with the Central Pollution Control Board shall collect, compile and publish technical and statistical data relating to noise pollution and measures devised for its effective prevention, control and abatement.]

5. RESTRICTIONS ON THE USE OF LOUD SPEAKERS/PUBLIC ADDRESS SYSTEM [2][AND SOUND PRODUCING INSTRUMENTS].-

(1) A loud speaker or a public address system shall not be used except after obtaining written permission from the authority.

[3][(2) A loud speaker or a public address system or any sound producing instrument or a musical instrument or a sound amplifier shall not be used at night time except in closed premises for communication within, like auditoria, conference rooms, community halls, banquet halls or during a public emergency.]

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1 Inserted by Rule 2 (i) of the Noise Pollution (Regulation and Control) Amendment Rules, 2006 notified vide S.O.1569(E), dated 19.9.2006.

2 Inserted by Rule 5(i) of the Noise Pollution (Regulation and Control) (Amendment) Rules, 2010 notified vide S.O.50 (E), dated 11.01.2010

3 Substituted by Rule 5(ii) of the Noise Pollution (Regulation and Control) (Amendment) Rules, 2010 notified vide S.O.50 (E), dated 11.01.2010

[1][(3) Notwithstanding anything contained in sub-rule (2), the State Government may subject to such terms and conditions as are necessary to reduce noise pollution, permit use of loud speakers or [2][public address systems and the like during night hours] (between 10.00 p.m. to 12.00 midnight) on or during any cultural or religious festive occasion of a limited duration not exceeding fifteen days in all during a calendar year.] [3][The Concerned State Government shall generally specify in advance, the number and particulars of the days on which such exemption would be operative].

[4][(4) The noise level at the boundary of the public place, where loudspeaker or public address system or any other noise source is being used shall not exceed 10 dB(A) above the ambient noise standards for the area or 75 dB(A) whichever is lower.

(5) The peripheral noise level of a privately owned sound system or a sound producing instrument shall not, at the boundary of the private place, exceed by more than 5 dB(A) the ambient noise standards specified for the area in which it is used].

[5][5A.RESTRICTIONS ON THE USE OF HORNS, SOUND EMITTING CONSTRUCTION EQUIPMENTS AND BURSTING OF FIRE CRACKERS.-

(1) No horn shall be used in silence zones or during night time in residential areas except during a public emergency.

(2) Sound emitting fire crackers shall not be burst in silence zone or during night time.

(3) Sound emitting construction equipments shall not be used or operated during night time in residential areas and silence zones.]

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1 Inserted by Rule 2 of the Noise Pollution (Regulation and Control) Amendment Rules, 2002 notified vide Notification S.O. 1088(E), dated 11.10.2002

2 Substituted by Rule 5(iii)(a) of the Noise Pollution (Regulation and Control) (Amendment) Rules, 2010 notified vide S.O.50 (E), dated 11.01.2010

3 Inserted by Rule 5(iii)(b) of the Noise Pollution (Regulation and Control) (Amendment) Rules, 2010 notified vide S.O.50 (E), dated 11.01.2010

4 Inserted by Rule 5(iv) of the Noise Pollution (Regulation and Control) (Amendment) Rules, 2010 notified vide S.O.50 (E), dated 11.01.2010

5 Inserted by Rule 6 of the Noise Pollution (Regulation and Control) (Amendment) Rules, 2010 notified vide S.O.50 (E), dated 11.01.2010

6. CONSEQUENCES OF ANY VIOLATION IN SILENCE ZONE/AREA.-

Whoever, in any place covered under the silence zone/area commits any of the following offence, he shall be liable for penalty under the provisions of the Act:-

(i) whoever, plays any music or uses any sound amplifiers,

(ii) whoever, beats a drum or tom-tom or blows a horn either musical or pressure, or trumpet or beats or sounds any instrument,

(iii) whoever, exhibits any mimetic, musical or other performances of a nature to attract crowds,

[1][(iv) whoever, bursts sound emitting fire crackers; or

(v) whoever, uses a loud speaker or a public address system.]

7. COMPLAINTS TO BE MADE TO THE AUTHORITY.-

(1) A person may, if the noise level exceeds the ambient noise standards by 10 dB(A) or more given in the corresponding columns against any area/zone [2][or, if there is a violation of any provision of these rules regarding restrictions imposed during night time], make a complaint to the authority.

(2) The authority shall act on the complaint and take action against the violator in accordance with the provisions of these rules and any other law in force.

8. POWER TO PROHIBIT ETC. CONTINUANCE OF MUSIC SOUND OR NOISE.-

(1) If the authority is satisfied from the report of an officer incharge of a police station or other information received by him [3][including from the complainant] that it is necessary to do so in order to prevent annoyance, disturbance, discomfort or injury or risk person who dwell or occupy property on the vicinity, he may, by a written order issue such directions as he may consider necessary to any person for preventing, prohibiting, controlling or regulating :-

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1 Inserted by Rule 7 of the Noise Pollution (Regulation and Control) (Amendment) Rules, 2010 notified vide S.O.50(E), dated 11.01.2010

2 Inserted by Rule 8 of the Noise Pollution (Regulation and Control) (Amendment) Rules, 2010 notified vide S.O.50(E), dated 11.01.2010

3 Inserted by Rule 2(ii)(a) of the Noise Pollution (Regulation and Control) Amendment Rules, 2006 notified vide S.O.1569 (E), dated 19.9.2006.

(a) The incidence or continuance in or upon, any premises of –

(i) Any vocal or instrumental music,

(ii) sounds caused by playing, beating, clashing, blowing or use in any manner whatsoever of any instrument including loudspeakers, [1][public address systems, horn, construction equipment, appliance or apparatus] or contrivance which is capable of producing or re-producing sound,

[2][(iii) sound caused by bursting of sound emitting fire crackers, or]

(b) The carrying on in or upon, any premises of any trade, a vocation or operation or process resulting in or attended with noise.

(2) The authority empowered under sub-rule (1) may, either on its own motion, or on the application of any person aggrieved by an order made under sub-rule (1), either rescind, modify or alter any such order:

provided that before any such application is disposed of, the said authority shall afford to the applicant [3][and to the original complainant, as the case may be] an opportunity of appearing before it either in person or by a person representing him and showing cause against the order and shall, if it rejects any such application either wholly or in part, record its reasons for such rejection.

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1 Substituted by Rule 9(i) of the Noise Pollution (Regulation and Control) (Amendment) Rules, 2010 notified vide S.O.50(E), dated 11.01.2010

2 Inserted by Rule 9(ii) of the Noise Pollution (Regulation and Control) (Amendment) Rules, 2010 notified vide S.O.50(E), dated 11.01.2010.

3 Inserted vide Rule 2(ii)(b) of the Noise Pollution (Regulation and Control) Amendment Rules, 2006 notified vide S.O.1569 (E) dated 19.9.2006.

SCHEDULE

see rule 3(1) and 4(1)

Ambient Air Quality Standards in respect of Noise

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

Note:- 1. Day time shall mean from 6.00 a.m. to 10.00 p.m.

2. Night time shall mean from 10.00 p.m. to 6.00 a.m.

[1][3. Silence zone is an area comprising not less than 100 metres around hospitals, educational institutions, courts, religious places or any other area which is declared as such by the competent authority].

4. 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 which is relatable to human hearing.

A "decibel" is a unit in which noise is measured.

"A", in dB(A) Leq, denotes the frequency weighting in the measurement of noise and corresponds to frequency response characteristics of the human ear.

Leq: It is an energy mean of the noise level over a specific period.

Note: The principal rules were published in the Gazette of India vide number, S.O.123(E), dated 14th February, 2000 and subsequently amended vide S.O.1046(E), dated 22nd November, 2000, S.O. 1088(E), dated 11th October, 2002, S.O. 1569(E), dated the 19th September, 2006 and S.O.50(E), dated 11th January, 2010.

Substituted by Rules 4 of the Noise Pollution (Regulation and Control) (Amendment) Rules. 2000 notified vide S.O. 1046 (E), dated 22.11.2000

Annexure 4.2a - Noise Monitoring 1

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JAS-ANZ
Acc. No. M3111204IN

TEST REPORT

NOISE LEVEL MONITORING REPORT
Test Report No.: 1807100009-0016
Dispatch Date :20/07/2018

ISSUED TO	**Centre for Management and Social Research,** Plot no. 101, flat no. 103,RR Residency opp. GHMC, Srinagar Colony,Hyderabad-500073
PROJECT NAME	Environmental Monitoring for "Bhopal Metro Rail Project Bhopal M.P"

Location Code	N1	N2	N3	N4	N5	N6	N7	N8
Monitoring Date	03/07/2018	04/07/2018	05/07/2018	6/07/2018	07/07/2018	08/07/2018	09/07/2018	10/07/2018
	Noise Level (dBA)	Noise Level (dBA)	Noise Level (dBA)	Noise Level (dBA)	Noise Level (dBA)	Noise Level (dBA)	Noise Level (dBA)	Noise Level (dBA)
Time	Hrly. Leq	Hrly. Leq	Hrly. Leq	Hrly. Leq	Hrly. Leq	Hrly. Leq	Hrly. Leq	Hrly. Leq
Day 6.00	50.1	49.7	51.2	50.2	49.6	49.4	50.1	42.5
7.00	52.1	50.3	55.6	53.2	52.2	52.1	52.7	43.1
8.00	58.6	56.2	60.1	59.5	57.5	56.3	55.1	44.9
9.00	60.4	57.7	62.7	61.6	59.6	58.4	57.9	48.2
10.00	59.7	56.1	61.4	60.8	60.2	60.3	60.1	58.7
11.00	62.2	60.1	63.9	62.2	61.7	61.4	61.2	59
12.00	58.6	58.2	60.2	58.2	58.9	58.2	59.7	59.1
13.00	64.6	60.3	62.5	59.3	58.6	58.9	58	62.5
14.00	60.5	59.9	61.9	60.5	59.5	59.2	58.2	61.5
15.00	57.4	55.1	62	61.6	60.2	60.6	59.6	59.4
16.00	61.2	58.2	64.2	61.9	60.8	61.4	61.1	58.4
17.00	62.4	60.1	63.8	62.6	61.6	61.9	61.4	56.4
18.00	60	60	62.1	61.2	60.2	60.3	60	55.4
19.00	56.1	54.5	59.3	61.7	59.8	60.1	59.1	53.1
20.00	55.1	53.4	56.5	59.2	57.4	57.6	57.3	50.1
21.00	54.2	51.9	52.7	55.5	54.7	54.8	55.5	49.7

Research Institute of Material Sciences Pvt. Ltd. RIMS Testing & Training Institute New Delhi

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JAS-ANZ
Acc. No. M3111204IN

TEST REPORT

NOISE LEVEL MONITORING REPORT
Test Report No.: 1807100009-0016 Dispatch Date :20/07/2018

ISSUED TO	Centre for Management and Social Research, Plot no. 101, flat no. 103,RR Residency opp. GHMC, Srinagar Colony,Hyderabad-500073
PROJECT NAME	Environmental Monitoring for "Bhopal Metro Rail Project Bhopal M.P"

Location Code	N1	N2	N3	N4	N5	N6	N7	N8
Monitoring Date	03/07/2018	04/07/2018	05/07/2018	6/07/2018	07/07/2018	08/07/2018	09/07/2018	10/07/2018
	Noise Level (dBA)	Noise Level (dBA)	Noise Level (dBA)	Noise Level (dBA)	Noise Level (dBA)	Noise Level (dBA)	Noise Level (dBA)	Noise Level (dBA)
Time	Hrly. Leq	Hrly. Leq	Hrly. Leq	Hrly. Leq	Hrly. Leq	Hrly. Leq	Hrly. Leq	Hrly. Leq
Night 22.00	50.6	47.4	49.2	50.8	49.1	49.5	48.2	46.2
23.00	50.2	46.2	47.4	47.7	46.2	46.7	46.9	43.5
24.00	48.2	46.5	46.6	46.2	43.8	43.3	43.1	42.7
1.00	40.8	38.2	40.2	40.5	38	39.2	39.6	41.9
2.00	42.2	40.1	40.1	41	38.6	38.2	38.6	41.8
3.00	43.1	40.8	40.7	41.7	40.4	40.6	40.1	42.4
4.00	41.3	41.2	48.4	48.2	44.9	44.2	43.2	42
5.00	42.8	42.6	53.6	55.8	52.6	51.4	50.4	41.9
Maximum	64.6	60.3	64.2	62.6	61.7	61.9	61.4	62.5
Minimum	40.8	38.2	40.1	40.5	38.0	38.2	38.6	41.8
Ld	59.7	57.5	61.2	60.2	59.1	59.1	58.8	57.2
Ln	46.6	44.0	48.1	49.5	46.9	46.4	45.7	43.0
Ldn	58.9	56.6	60.4	60.0	58.5	58.4	58.0	56.2

Note: N01 - AIIMS, N02 – Habibganj, N03 – Nandra Bus Stand, N04 – Krishi Upaj Mandi, N05 – Bhadbhada Square, N06 – Ratnagiri Square, N07 – Jawahar Square, N08 - Bogdapul

End of Report

Research Institute of Material Sciences ★ New Delhi ★ Testing & Training Institute

Authorized Signatory
Sumit Kumar

Annexure 4.3 - MPPCB Surface Water Quality

Annexure – 4.3

MPPCB Surface Water Quality Results

Surface Water Quality Results (2016)

Monitoring Locations	Sep-16					Oct-16					Dec-16				
	DO >4.0 mg/l	BOD <3.0 mg/l	FC <2500 MPN/100ml	TC <5000 MPN/100ml	Water Quality Status	DO >4.0 mg/l	BOD <3.0 mg/l	FC <2500 MPN/100ml	TC <5000 MPN/100ml	Water Quality Status	DO >4.0 mg/l	BOD <3.0 mg/l	FC <2500 MPN/100ml	TC <5000 MPN/100ml	Water Quality Status
Upper lake at , near Water Supply intake well, Kamla Park	7.5	1.6	2	110	Satisfactory	7.6	1.5	2	130	Satisfactory	7.8	1.5	2	110	Satisfactory
Upper lake at Yatch club, near Water Supply intake well	7.2	1.8	2	90	Satisfactory	7.5	1.6	2	110	Satisfactory	7.5	1.6	2	94	Satisfactory
Upper lake at Karbala, near Water Supply intake well	7.7	1.7	2	120	Satisfactory	7.8	1.6	2	110	Satisfactory	7.6	1.3	2	94	Satisfactory
Upper lake at Bairagarh, near Water Supply intake well	7.6	1.8	2	130	Satisfactory	7.7	1.5	2	130	Satisfactory	7.9	1.6	2	90	Satisfactory
Lower lake near Kalighat, spill out let	5.6	3.3	120	1600	Not Satisfactory	7.6	3.7	110	920	Not Satisfactory	7.3	3.4	230	1600	Not Satisfactory

Surface Water Quality Results (2017)

Monitoring Locations	Jan-17					Jun-17					Sep-17					Dec-16				
	DO >4.0 mg/l	BOD <3.0 mg/l	FC <2500 MPN/100ml	TC <5000 MPN/100ml	Water Quality Status	DO >4.0 mg/l	BOD <3.0 mg/l	FC <2500 MPN/100ml	TC <5000 MPN/100ml	Water Quality Status	DO >4.0 mg/l	BOD <3.0 mg/l	FC <2500 MPN/100ml	TC <5000 MPN/100ml	Water Quality Status	DO >4.0 mg/l	BOD <3.0 mg/l	FC <2500 MPN/100 ml	TC <5000 MPN/100 ml	Water Quality Status
Upper lake at , near Water Supply intake well, Kamla Park	7.7	1.4	2	90	Satisfactory	7.5	1.9	2	130	Satisfactory	7.9	1.8	2	220	Satisfactory	7.8	1.5	2	110	Satisfactory
Upper lake at Yatch club, near Water Supply intake well	7.8	1.6	2	110	Satisfactory	7.5	2	2	130	Satisfactory	7.7	1.8	2	110	Satisfactory	7.5	1.6	2	94	Satisfactory
Upper lake at Karbala, near Water Supply intake well	7.5	1.8	2	90	Satisfactory	7.6	2.6	2	140	Satisfactory	7.8	1.8	2	130	Satisfactory	7.6	1.3	2	94	Satisfactory
Upper lake at Bairagarh, near Water Supply intake well	7.8	1.9	2	130	Satisfactory	7.4	2.7	2	150	Satisfactory	7.8	2.4	2	220	Satisfactory	7.9	1.6	2	90	Satisfactory
Lower lake near Kalighat, spill out let	6.2	3.5	220	1600	Not Satisfactory	6.4	3.5	240	1600	Not Satisfactory	6.5	3.6	210	1600	Not Satisfactory	7.3	3.4	230	1600	Not Satisfactory

Source: http://www.mpenvis.nic.in

Annexure 4.3a - Surface Water Quality

RIMS
Testing & Training Institute

Research Institute of Material Sciences Pvt. Ltd.

A complete testing lab and training institute

Plot No. 22 & 23, Ranaji Enclave, Nangli Sakrawati, New Delhi-110043
Ph.: 011-25324233, (M) 09599983618, Email : info@rimslab.com, Website : www.rimslab.com

JAS-ANZ
Acc. No. M3111204IN

TEST REPORT

SURFACE WATER SAMPLE ANALYSIS REPORT
Test Report No.: 1807100017-0020 Dispatch Date :27/07/2018

ISSUED TO	**Centre for Management and Social Research,** Plot no. 101, flat no. 103,RR Residency opp. GHMC, Srinagar Colony,Hyderabad-500073
PROJECT NAME	Environmental Monitoring for "Bhopal Metro Rail Project Bhopal M.P"

SN	PARAMETERS	UNIT	SW_1	SW_2
			08/07/2018	08/07/2018
1	pH Value at 25°C	-	7.47	7.54
2	Turbidity	NTU	20.6	4.8
3	Temperature	°C	32.5	31.5
4	Conductivity at 25°C	µmhos/cm	1270	830
5	Total Dissolve Solids	mg/L	830	542
6	Total Suspended Solids	mg/L	366	22
7	Oil and Grease	mg/L	18	2
8	Dissolve Oxygen	mg/L	3	5
9	Chloride (as Cl)	mg/L	213	148
10	Fluoride (as F)	mg/L	0.56	0.13
11	Sulphate (as SO_4)	mg/L	63.2	26.3
12	Biochemical Oxygen Demand 5Days	mg/L	154	24
13	Chemical Oxygen Demand	mg/L	576	166
14	Total Alkalinity (as $CaCO_3$)	mg/L	142	155
15	Total Hardness (as $CaCO_3$)	mg/L	230	190
16	Faecal Coliform	MPN/100ml	500	300
17	Total Coliform	MPN/100ml	1600	900

Note:

SW_1 – Bogdapul (Drain) SW_2 – Bhadbhada Square (Lake)

Research Institute of Material Sciences Pvt. Ltd. New Delhi

AUTHORIZED SIGNATORY
Sumit Kumar

Annexure 4.4 - IS 2296-1982 Classified Use of Water

Tolerance and Classification

As per ISI-IS: 2296-1982, the tolerance limits of parameters are specified as per classified use of water (Table 1,2,3,4,5 below) depending on various uses of water. The following classifications have been adopted in India.

Class of Water

Classification	Type of use
Class A	Drinking water source without conventional treatment but after disinfection
Class B	Outdoor bathing
Class C	Drinking water source with conventional treatment followed by disinfection.
Class D	Fish culture and wild life propagation
Class E	Irrigation, industrial cooling or controlled waste disposal

TOLERANCE LIMITS

TABLE-1: TOLERANCE LIMITS FOR INLAND SURFACE WATERS, CLASS – A

S. No.	Characteristic	Tolerance
(1)	(2)	(3)
(i)	pH	6.5 to 8.5
(ii)	Dissolved Oxygen, mg/l,	6.0
(iii)	Bio-chemical Oxygen Demand	2.0
(iv)	Total Coliform Organisms, MPN/100 ml, Max	50
(v)	Colour, Hazen units, Max	10
(vi)	Odour	unobjectionable
(vii)	Taste	Agreeable taste
(viii)	Total Dissolved Solids, mg/l, Max	500
(ix)	Total Hardness (as $CaCO_3$), mg/l ,Max	300
(x)	Calcium Hardness (as $CaCO_3$), mg/l, Max	200
(xi)	Magnesium (as $CaCO_3$), mg/1,Max	100
(xii)	Copper (as Cu), mg/l, Max	1.5
(xiii)	Iron (as Fe), mg/l,Max	0.3
(xiv)	Manganese (as Mn), mg/1,Max	0.5
(xv)	Chlorides (as Cl), mg/l,Max	250
(xvi)	Sulphate (as SO_4), mg/l ,Max	400
(xvii)	Nitrates (as NO_2), mg/1,Max	20
(xviii)	Fluorides (as F,) mg/l,Max	1.5
(xix)	Phenolic compounds(as C_6H_5OH), mg/l,Max	0.002
(xx)	Mercury (as Hg), mg/l ,Max	0.001
(xxi)	Cadmium (as Cd), mg/1,Max	0.01
(xxii)	Selenium (as Se), mg/l ,Max	0.01
(xxiii)	Arsenic (as As), mg/1,Max	0.05
(xxiv)	Cyanides (as CN), mg/l, Max	0.05
(xxv)	Lead (as Pb), mg/l, Max	0.1
(xxvi)	Zinc (as Zn), mg/l, Max	15
(xxvii)	Chromium (asCr^{6+}), mg/l,Max	0.05
(xxviii)	Anionic detergents, (as MBAS), mg/l ,Max .	0.2
(xxix)	Poly-nuclear aromatic hydrocarbons (PAH),	0.2
(xxx)	Mineral oil, mg/l ,Max	0.01
(xxxi)	Barium (as Ba), mg/l ,Max	1.0
(xxxii)	Silver (as Ag), mg/l Max	0.05
(xxxiii)	Pesticides	Absent
(xxxiv)	Alpha emitters, µc/ml, Max	10^{-9}
(xxxv)	Beta emitters, µc/ml, Max	10^{-8}

TABLE- 2: TOLERANCE LIMITS FOR INLAND SURFACE WATERS, CLASS – B

S. No.	Characteristic	Tolerance Limit
(1)	(2)	(3)
(i)	pH Value	6.5 to 8.5
(ii)	Dissolved Oxygen, mg/1,Max	5.0
(iii)	Biochemical Oxygen Demand (5 days at 20 °C), Max	3.0
(iv)	Total Coliform Organisms, MPN/100 ml, Max	500
(v)	Fluorides (as F)<mg/l, Max	1.5
(vi)	Colour, Hazen units, Max	300
(vii)	Cyanides (as CN), mg/l, Max	0.05
(viii)	Arsenic (as As), mg/l, Max	0.2
(ix)	Phenolic Compounds (as C_6H_5OH) mg/l, Max	0.005
(x)	Chromium (as Cr^{6+}), mg/l, Max	1.0
(xi)	Anionic detergents (as MBAS), mg/l, Max	1.0
(xii)	Alpha emitters, µc/ml, Max	10^{-8}

TABLE - 3: TOLERANCE LIMITS FOR INLAND SURFACE WATERS, CLASS – C

S.No.	Characteristic	Tolerance Limit
(1)	(2)	(3)
(i)	pH Value	6.5 to 8.5
(ii)	Dissolved Oxygen, mg/l Minimum	4.0
(iii)	Biochemical Oxygen Demand	3.0
(iv)	Total coliform organisms, MPN/100 ml, Max	5000
(v)	Colour, Hazen units, Max	300
(vi)	Fluorides (as F), mg/l ,Max	1.5
(vii)	Cadmium (as Cd), mg/l, Max	0.01
(viii)	Chlorides (as Cl), mg/l, Max	600
(ix)	Chromium (as Cr^{6+}), mg/l, Max	0.05
(x)	Cyanides (as CN), mg/l, Max	0.05
(xi)	Total Dissolved Solids, mg/l, Max	1500
(xii)	Selenium (as Se), mg/l, Max	0.05
(xiii)	Sulphates (as SO_4), mg/l, Max	400
(xiv)	Lead (as Pb), mg/l, Max	0.1
(xv)	Copper (as Cu),mg/l,Max	1.5
(xvi)	Arsenic (as As), mg/l, Max	0.2
(xvii)	Iron (as Fe), mg/l, Max	50
(xviii)	Phenolic compounds (as C_6H_5OH), mg/l, Max	0.005
(xix)	Zinc (as Zn), mg/l, Max	15
(xx)	Insecticides, mg/l, Max	Absent
(xxi)	Anionic detergents (as MBAS), mg/l, Max	1.0
(xxii)	Oils and grease, mg/l, Max	0.1
(xxiii)	Nitrates (as NO_3), mg/1,Max	50
(xxiv)	Alpha emititers, µc/mg, Max	10^{-9}
(xxv)	Beta emitters, µc/ml, Max	10^{-8}

TABLE- 4: TEOLERANCE LIMITS FOR INLAND SURFACE WATERS, CALSS – D

S.No.	Characteristic	Tolerance Limit
(1)	(2)	(3)
(i)	pH value	6.5 to 8.5
(ii)	Dissolved Oxygen, mg/l, Min.	4.0
(iii)	Free Ammonia (as N), mg/l, Max.	1.2
(iv)	Electrical Conductance at 25 °C, µS, Max	1000
(v)	Free Carbon Dioxide (as $C0_2$),mg/1, Max	6.0
(vi)	Oils and Grease, mg/l, Max	0.1
(vii)	Alpha emitters, µc/ml, Max	10^{-9}
(viii)	Beta emitters, µc/ml, Max	10^{-8}

TABLE- 5: TOLERANCE LIMITS FOR INLAND SURFACE WATERS, CLASS – E

S.No.	Characteristic	Tolerance Limit
(1)	**(2)**	**(3)**
(i)	pH value	6.0 to 8.5
(ii)	Electrical Conductance at 25°C, µS, Max	2250
(iii)	Sodium Adsorption Ratio, Max	26
(iv)	Boron (as B), mg/l, Max	2.0
(v)	Total Dissolved Solids, (inorganic), mg/l, Max	2100
(vi)	Sulphates (as SO_4), mg/l, Max	1000
(vii)	Chlorides (as Cl), Mg/l, Max	600
(viii)	Sodium Percentage, Max	60
(ix)	Alpha emitters, µc/ml, Max	10^{-9}
(x)	Beta emitters, µc/ml, Max	10^{-8}

TEST CHARACTERSTICS FOR DRINKING WATERS

IS — 10500:1991 (Amended)

S. No.	Substance Characteristic	Require-ment*	Undesirable effect outside the desirable limit	Permissible Limit**
A	**Essential Characteristics**			
1.	Colour, Hazen units, Max	5.0	Above 5.0, consumer acceptance decreases	25
2.	Odour	Unobject-ionable	-	-
3.	Taste	Agreeable	-	-
4.	Turbidity, NTU, Max	5.0	Above 5.0, consumer acceptance decreases	10
5.	pH Value	6.5 To 8.5	Beyond this range the water will effect the mucous membrane and/or water supply system	No relaxation
6.	Total Hardness, (as $CaCO_3$) mg/l, Max.	300	Encrustations in water supply structure and adverse effect on domestic use	600
7.	Iron (as Fe), mg/l, Max	0. 3	Beyond this limit taste/appearance are affected, has adverse affect on domestic uses and water supply structures, and promotes iron bacteria	1.0
8.	Chlorides (as Cl), mg/l, Max	250	Beyond this limit taste, corrosion and palatability are affected	1000
9.	Residual free Chlorine, mg/l, Minimum	0.2	-	-
B	**Desirable Characteristics**			
10.	Dissolved Solids, mg/l, Max	500	Beyond this palatability decreases and may cause Gastro intestinal irritation	2000
11	Calcium (as Ca) mg/l, Max.	75	Encrustations in water supply structure and adverse effect on domestic use	200
12.	Magnesium (as Mg) mg/l, Max	30	Encrustations in water supply structure and adverse effect on domestic use	100
13.	Copper (as Cu), mg/l, Max	0.5	Astringent taste, discoloration and corrosion of pipes, fitting and utensils will be caused beyond this	1.5
14.	Manganese (as Mn) mg/l, Max	0.1	Beyond this limit, taste/appearance are affected, has adverse effect on domestic use and water supply structure.	0.3

15.	Sulphates (as SO_4), mg/l, Max	200	Beyond this causes Gastro intestinal irritation when magnesium or sodium are present	400
16.	Nitrate (as NO_3) mg/l, Max.	45	Beyond this methaemoglobinemia takes place.	100
17.	Fluorides (as F), mg/l, Max	1.0	Fluoride may be kept as low as possible. High fluoride may cause fluorosis	1.5
18	Phenolic compounds (as C_6H_5OH), mg/l, Max	0.001	Beyond this, it may cause objectionable taste and odour	0.002
19.	Mercury (as Hg), mg/l, Max	0.001	Beyond this, the water becomes toxic	No relaxation
20.	Cadmium (as Cd), mg/l, Max	0.01	Beyond this, the water becomes toxic	No relaxation
21.	Selenium (as Se), mg/l, Max	0.01	Beyond this, the water becomes toxic	No relaxation
22.	Arsenic (as As), mg/l, Max	0.2	Beyond this, the water becomes toxic	No relaxation
23.	Cyanides (as CN), mg/l, Max	0.05	Beyond this, the water becomes toxic	No relaxation
24.	Lead (as Pb), mg/l, Max	0.1	Beyond this, the water becomes toxic	No relaxation
25.	Zinc (as Zn), mg/l, Max	5.0	Beyond this limit, it can cause astringent taste and an opalescence in water	15
26.	Anionic detergents (as MBAS), mg/l, Max	0.2	Beyond this limit, it can cause a light froth in water	1.0
27.	Chromium (as Cr^{6+}), mg/l, Max	0.05	May be carcinogenic above this limit	No relaxation
28.	Polynuclear aromatic hydrocarbons (as PAH), mg/l, Max	-	May be carcinogenic	-
29.	Mineral Oil, mg/l, Max	0.01	Beyond this limit, undesirable taste and odour after chlorination take place	0.03
30.	Pesticides mg/l, Max	Absent	Toxic	0.001
31.	Alpha emitters, Bq/l, Max	-	-	0.1

32.	Beta emitters, pCi/l, Max	-	-	1.0
33.	Alkalinity mg/l, Max	200	Beyond this limit, taste becomes unpleasant	600
34.	Aluminum (as Al) mg/l, Max	0.03	Cumulative effect is reported to cause dementia	0.2
35.	Boron mg/l, Max	1.0	-	5.0

No sample should contain E. Coli in 100 ml.; No sample should contain more than 10 coliform organisms per 100 ml; and Coliform organisms should not be detectable in 100 ml of any two consecutive samples.

* Desirable limit

** in absence of alternate source

Annexure 4.5 - IS10500 - 2012

भारतीय मानक

पीने का पानी — विशिष्टि

(दूसरा पुनरीक्षण)

Indian Standard

DRINKING WATER — SPECIFICATION

(Second Revision)

ICS 13.060.20

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

May 2012 **Price Group 6**

AMENDMENT NO. 1 JUNE 2015
TO
IS 10500 : 2012 DRINKING WATER — SPECIFICATION

(Second Revision)

[*Page* 2, *Table* 2, *Sl No.* xii), *col* 3] — Substitute '1.0' *for* '0.3'.

[*Page* 3, *Table* 3, *Sl No.* x) , *col* 4] — Substitute 'No relaxation' *for* '0.05'.

(FAD 14)

Publication Unit, BIS, New Delhi, India

FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Drinking Water Sectional Committee had been approved by the Food and Agriculture Division Council.

This standard was originally published in 1983. A report prepared by the World Health Organization in cooperation with the World Bank showed that in 1975, some 1 230 million people were without safe water supplies. These appalling facts were central to the United Nations decision to declare an International Drinking Water Supply and Sanitation decade, beginning in 1981. Further, the VI Five-Year Plan of India had made a special provision for availability of safe drinking water for the masses. Therefore, the standard was formulated with the objective of assessing the quality of water resources, and to check the effectiveness of water treatment and supply by the concerned authorities.

The first revision was undertaken to take into account the up-to-date information available about the nature and effect of various contaminants as also the new techniques for identifying and determining their concentration. Based on experience gained additional requirements for alkalinity; aluminium and boron were incorporated and the permissible limits for dissolved solids, nitrate and pesticides residues modified.

As per the eleventh five year plan document of India (2007-12), there are about 2.17 lakh quality affected habitations in the country with more than half affected with excess iron, followed by fluoride, salinity, nitrate and arsenic in that order. Further, approximately, 10 million cases of diarrhoea, more than 7.2 lakh typhoid cases and 1.5 lakh viral hepatitis cases occur every year a majority of which are contributed by unclean water supply and poor sanitation. The eleventh five year plan document of India (2007-2012) recognizes dealing with the issue of water quality as a major challenge and aims at addressing water quality problems in all quality affected habitations with emphasis on community participation and awareness campaigns as well as on top most priority to water quality surveillance and monitoring by setting up of water quality testing laboratories strengthened with qualified manpower, equipments and chemicals.

The second revision was undertaken to upgrade the requirements of the standard and align with the internationally available specifications on drinking water. In this revision assistance has been derived from the following:

a) EU Directives relating to the quality of water intended for human consumption (80/778/EEC) and Council Directive 98/83/EC.

b) USEPA standard — National Primary Drinking Water Standard. EPA 816-F-02-013 dated July, 2002.

c) WHO Guidelines for Drinking Water Quality. 3rd Edition Vol. 1 Recommendations, 2008.

d) Manual on Water Supply and Treatment, third edition — revised and updated May 1999, Ministry of Urban Development, New Delhi.

This standard specifies the acceptable limits and the permissible limits in the absence of alternate source. It is recommended that the acceptable limit is to be implemented as values in excess of those mentioned under 'Acceptable' render the water not suitable. Such a value may, however, be tolerated in the absence of an alternative source. However, if the value exceeds the limits indicated under 'permissible limit in the absence of alternate source' in col 4 of Tables 1 to 4, the sources will have to be rejected.

Pesticide residues limits and test methods given in Table 5 are based on consumption pattern, persistence and available manufacturing data. The limits have been specified based on WHO guidelines, wherever available. In cases where WHO guidelines are not available, the standards available from other countries have been examined and incorporated, taking in view the Indian conditions.

In this revision, additional requirements for ammonia, chloramines, barium, molybdenum, silver, sulphide, nickel, polychlorinated biphenyls and trihalomethanes have been incorporated while the requirements for colour, turbidity, total hardness, free residual chlorine, iron, magnesium, mineral oil, boron, cadmium, total arsenic, lead, polynuclear aromatic hydrocarbons, pesticides and bacteriological requirements have been modified.

In this revision, requirement and test method for virological examination have been included. Further, requirements and test methods for cryptosporidium and giardia have also been specified.

Routine surveillance of drinking water supplies should be carried out by the relevant authorities to understand the risk of specific pathogens and to define proper control procedures. The WHO Guidelines for Drinking Water Quality, 3rd Edition, Vol. 1 may be referred for specific recommendations on using a water safety approach incorporating risk identification. Precautions/Care should be taken to prevent contamination of drinking water from chlorine resistant parasites such as cryptosporidium species and giardia.

Indian Standard

DRINKING WATER — SPECIFICATION

(Second Revision)

1 SCOPE

This standard prescribes the requirements and the methods of sampling and test for drinking water.

2 REFERENCES

The standards listed in Annex A contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated in Annex A.

3 TERMINOLOGY

For the purpose of this standard the following definition shall apply.

3.1 Drinking Water — Drinking water is water intended for human consumption for drinking and cooking purposes from any source. It includes water (treated or untreated) supplied by any means for human consumption.

4 REQUIREMENTS

Drinking water shall comply with the requirements given in Tables 1 to 4. The analysis of pesticide residues given in Table 3 shall be conducted by a recognized laboratory using internationally established test method meeting the residue limits as given in Table 5.

Drinking water shall also comply with bacteriological requirements (*see* **4.1**), virological requirements (*see* **4.2**) and biological requirements (*see* **4.3**).

4.1 Bacteriological Requirements

4.1.1 *Water in Distribution System*

Ideally, all samples taken from the distribution system including consumers' premises, should be free from coliform organisms and the following bacteriological quality of drinking water collected in the distribution system, as given in Table 6 is, therefore specified when tested in accordance with IS 1622.

4.2 Virological Requirements

4.2.1 Ideally, all samples taken from the distribution

Table 1 Organoleptic and Physical Parameters
(*Foreword* and *Clause* 4)

Sl No.	Characteristic	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source	Method of Test, Ref to Part of IS 3025	Remarks
(1)	(2)	(3)	(4)	(5)	(6)
i)	Colour, Hazen units, *Max*	5	15	Part 4	Extended to 15 only, if toxic substances are not suspected in absence of alternate sources
ii)	Odour	Agreeable	Agreeable	Part 5	a) Test cold and when heated b) Test at several dilutions
iii)	*p*H value	6.5-8.5	No relaxation	Part 11	—
iv)	Taste	Agreeable	Agreeable	Parts 7 and 8	Test to be conducted only after safety has been established
v)	Turbidity, NTU, *Max*	1	5	Part 10	—
vi)	Total dissolved solids, mg/l, *Max*	500	2 000	Part 16	—

NOTE — It is recommended that the acceptable limit is to be implemented. Values in excess of those mentioned under 'acceptable' render the water not suitable, but still may be tolerated in the absence of an alternative source but up to the limits indicated under 'permissible limit in the absence of alternate source' in col 4, above which the sources will have to be rejected.

Table 2 General Parameters Concerning Substances Undesirable in Excessive Amounts
(*Foreword* and *Clause* 4)

Sl No.	Characteristic	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source	Method of Test, Ref to	Remarks
(1)	(2)	(3)	(4)	(5)	(6)
i)	Aluminium (as Al), mg/l, *Max*	0.03	0.2	IS 3025 (Part 55)	—
ii)	Ammonia (as total ammonia-N), mg/l, *Max*	0.5	No relaxation	IS 3025 (Part 34)	—
iii)	Anionic detergents (as MBAS) mg/l, *Max*	0.2	1.0	Annex K of IS 13428	—
iv)	Barium (as Ba), mg/l, *Max*	0.7	No relaxation	Annex F of IS 13428* or IS 15302	—
v)	Boron (as B), mg/l, *Max*	0.5	1.0	IS 3025 (Part 57)	—
vi)	Calcium (as Ca), mg/l, *Max*	75	200	IS 3025 (Part 40)	—
vii)	Chloramines (as Cl_2), mg/l, *Max*	4.0	No relaxation	IS 3025 (Part 26)* or APHA 4500-Cl G	—
viii)	Chloride (as Cl), mg/l, *Max*	250	1 000	IS 3025 (Part 32)	—
ix)	Copper (as Cu), mg/l, *Max*	0.05	1.5	IS 3025 (Part 42)	—
x)	Fluoride (as F) mg/l, *Max*	1.0	1.5	IS 3025 (Part 60)	—
xi)	Free residual chlorine, mg/l, *Min*	0.2	1	IS 3025 (Part 26)	To be applicable only when water is chlorinated. Tested at consumer end. When protection against viral infection is required, it should be minimum 0.5 mg/l
xii)	Iron (as Fe), mg/l, *Max*	0.3	No relaxation	IS 3025 (Part 53)	Total concentration of manganese (as Mn) and iron (as Fe) shall not exceed 0.3 mg/l
xiii)	Magnesium (as Mg), mg/l, *Max*	30	100	IS 3025 (Part 46)	—
xiv)	Manganese (as Mn), mg/l, *Max*	0.1	0.3	IS 3025 (Part 59)	Total concentration of manganese (as Mn) and iron (as Fe) shall not exceed 0.3 mg/l
xv)	Mineral oil, mg/l, *Max*	0.5	No relaxation	Clause **6** of IS 3025 (Part 39) Infrared partition method	—
xvi)	Nitrate (as NO_3), mg/l, *Max*	45	No relaxation	IS 3025 (Part 34)	—
xvii)	Phenolic compounds (as C_6H_5OH), mg/l, *Max*	0.001	0.002	IS 3025 (Part 43)	—
xviii)	Selenium (as Se), mg/l, *Max*	0.01	No relaxation	IS 3025 (Part 56) or IS 15303*	—
xix)	Silver (as Ag), mg/l, *Max*	0.1	No relaxation	Annex J of IS 13428	—
xx)	Sulphate (as SO_4) mg/l, *Max*	200	400	IS 3025 (Part 24)	May be extended to 400 provided that Magnesium does not exceed 30
xxi)	Sulphide (as H_2S), mg/l, *Max*	0.05	No relaxation	IS 3025 (Part 29)	—
xxii)	Total alkalinity as calcium carbonate, mg/l, *Max*	200	600	IS 3025 (Part 23)	—
xxiii)	Total hardness (as $CaCO_3$), mg/l, *Max*	200	600	IS 3025 (Part 21)	—
xxiv)	Zinc (as Zn), mg/l, *Max*	5	15	IS 3025 (Part 49)	—

NOTES

1 In case of dispute, the method indicated by '*' shall be the referee method.

2 It is recommended that the acceptable limit is to be implemented. Values in excess of those mentioned under 'acceptable' render the water not suitable, but still may be tolerated in the absence of an alternative source but up to the limits indicated under 'permissible limit in the absence of alternate source' in col 4, above which the sources will have to be rejected.

Table 3 Parameters Concerning Toxic Substances

(*Foreword* and *Clause* 4)

Sl No.	Characteristic	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source	Method of Test, Ref to	Remarks
(1)	(2)	(3)	(4)	(5)	(6)
i)	Cadmium (as Cd), mg/l, *Max*	0.003	No relaxation	IS 3025 (Part 41)	—
ii)	Cyanide (as CN), mg/l, *Max*	0.05	No relaxation	IS 3025 (Part 27)	—
iii)	Lead (as Pb), mg/l, *Max*	0.01	No relaxation	IS 3025 (Part 47)	—
iv)	Mercury (as Hg), mg/l, *Max*	0.001	No relaxation	IS 3025 (Part 48)/ Mercury analyser	—
v)	Molybdenum (as Mo), mg/l, *Max*	0.07	No relaxation	IS 3025 (Part 2)	—
vi)	Nickel (as Ni), mg/l, *Max*	0.02	No relaxation	IS 3025 (Part 54)	—
vii)	Pesticides, µg/l, *Max*	See Table 5	No relaxation	See Table 5	—
viii)	Polychlorinated biphenyls, mg/l, *Max*	0.000 5	No relaxation	ASTM 5175*	— or APHA 6630
ix)	Polynuclear aromatic hydro-carbons (as PAH), mg/l, *Max*	0.000 1	No relaxation	APHA 6440	—
x)	Total arsenic (as As), mg/l, *Max*	0.01	0.05	IS 3025 (Part 37)	—
xi)	Total chromium (as Cr), mg/l, *Max*	0.05	No relaxation	IS 3025 (Part 52)	—
xii)	Trihalomethanes:				
	a) Bromoform, mg/l, *Max*	0.1	No relaxation	ASTM D 3973-85* or APHA 6232	—
	b) Dibromochloromethane, mg/l, *Max*	0.1	No relaxation	ASTM D 3973-85* or APHA 6232	—
	c) Bromodichloromethane, mg/l, *Max*	0.06	No relaxation	ASTM D 3973-85* or APHA 6232	—
	d) Chloroform, mg/l, *Max*	0.2	No relaxation	ASTM D 3973-85* or APHA 6232	—

NOTES

1 In case of dispute, the method indicated by '*' shall be the referee method.

2 It is recommended that the acceptable limit is to be implemented. Values in excess of those mentioned under ‘acceptable’ render the water not suitable, but still may be tolerated in the absence of an alternative source but up to the limits indicated under 'permissible limit in the absence of alternate source’ in col 4, above which the sources will have to be rejected.

Table 4 Parameters Concerning Radioactive Substances

(*Foreword* and *Clause* 4)

Sl No.	Characteristic	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source	Method of Test, Ref to Part of IS 14194	Remarks
(1)	(2)	(3)	(4)	(5)	(6)
i)	Radioactive materials:				
	a) Alpha emitters Bq/l, *Max*	0.1	No relaxation	Part 2	—
	b) Beta emitters Bq/l, *Max*	1.0	No relaxation	Part 1	—

NOTE — It is recommended that the acceptable limit is to be implemented. Values in excess of those mentioned under ‘acceptable’ render the water not suitable, but still may be tolerated in the absence of an alternative source but up to the limits indicated under ‘permissible limit in the absence of alternate source’ in col 4, above which the sources will have to be rejected.

Table 5 Pesticide Residues Limits and Test Method

(*Foreword* and *Table* 3)

Sl No.	Pesticide	Limit µg/l	Method of Test, Ref to	
			USEPA	AOAC/ ISO
(1)	(2)	(3)	(4)	(5)
i)	Alachlor	20	525.2, 507	—
ii)	Atrazine	2	525.2, 8141 A	—
iii)	Aldrin/ Dieldrin	0.03	508	—
iv)	Alpha HCH	0.01	508	—
v)	Beta HCH	0.04	508	—
vi)	Butachlor	125	525.2, 8141 A	—
vii)	Chlorpyriphos	30	525.2, 8141 A	—
viii)	Delta HCH	0.04	508	—
ix)	2,4- Dichlorophenoxyacetic acid	30	515.1	—
x)	DDT (*o, p* and *p, p* – Isomers of DDT, DDE and DDD)	1	508	AOAC 990.06
xi)	Endosulfan (alpha, beta, and sulphate)	0.4	508	AOAC 990.06
xii)	Ethion	3	1657 A	—
xiii)	Gamma — HCH (Lindane)	2	508	AOAC 990.06
xiv)	Isoproturon	9	532	—
xv)	Malathion	190	8141 A	—
xvi)	Methyl parathion	0.3	8141 A	ISO 10695
xvii)	Monocrotophos	1	8141 A	—
xviii)	Phorate	2	8141 A	—

NOTE — Test methods are for guidance and reference for testing laboratory. In case of two methods, USEPA method shall be the reference method.

Table 6 Bacteriological Quality of Drinking Water[1)]

(*Clause* 4.1.1)

Sl No.	Organisms	Requirements
(1)	(2)	(3)
i)	*All water intended for drinking*:	
	a) *E. coli* or thermotolerant coliform bacteria[2), 3)]	Shall not be detectable in any 100 ml sample
ii)	*Treated water entering the distribution system*:	
	a) *E. coli* or thermotolerant coliform bacteria[2)]	Shall not be detectable in any 100 ml sample
	b) Total coliform bacteria	Shall not be detectable in any 100 ml sample
iii)	*Treated water in the distribution system*:	
	a) *E. coli* or thermotolerant coliform bacteria	Shall not be detectable in any 100 ml sample
	b) Total coliform bacteria	Shall not be detectable in any 100 ml sample

[1)]Immediate investigative action shall be taken if either *E.coli* or total coliform bacteria are detected. The minimum action in the case of total coliform bacteria is repeat sampling; if these bacteria are detected in the repeat sample, the cause shall be determined by immediate further investigation.

[2)]Although, *E. coli* is the more precise indicator of faecal pollution, the count of thermotolerant coliform bacteria is an acceptable alternative. If necessary, proper confirmatory tests shall be carried out. Total coliform bacteria are not acceptable indicators of the sanitary quality of rural water supplies, particularly in tropical areas where many bacteria of no sanitary significance occur in almost all untreated supplies.

[3)]It is recognized that, in the great majority of rural water supplies in developing countries, faecal contamination is widespread. Under these conditions, the national surveillance agency should set medium-term targets for progressive improvement of water supplies.

system including consumers' premises, should be free from virus.

4.2.2 None of the generally accepted sewage treatment methods yield virus-free effluent. Although a number of investigators have found activated sludge treatment to be superior to trickling filters from this point of view, it seems possible that chemical precipitation methods will prove to be the most effective.

4.2.3 Virus can be isolated from raw water and from springs, enterovirus, reovirus, and adenovirus have been found in water, the first named being the most resistant to chlorination. If enterovirus are absent from chlorinated water, it can be assumed that the water is safe to drink. Some uncertainty still remains about the virus of infectious hepatitis, since it has not so far been isolated but in view of the morphology and resistance of enterovirus it is likely that, if they have been inactivated hepatitis virus will have been inactivated also.

4.2.4 An exponential relationship exists between the rate of virus inactivation and the redox potential. A redox potential of 650 mV (measured between platinum and calomel electrodes) will cause almost instantaneous inactivation of even high concentrations of virus. Such a potential can be obtained with even a low concentration of free chlorine, but only with an extremely high concentration of combined chlorine. This oxidative inactivation may be achieved with a number of other oxidants also, for example, iodine, ozone and potassium permanganate, but the effect of the oxidants will always be counteracted, if reducing components, which are mainly organic, are present. As a consequence, the sensitivity of virus towards disinfectants will depend on the *milieu* just as much as on the particular disinfectant used.

4.2.5 Viruses are generally resistant to disinfectants as well as get protected on account of presence of particulate and organic matter in water. Because the difference between the resistance of coliform organisms and of virus to disinfection by oxidants increases with increasing concentration of reducing components, for example, organic matter, it cannot be assumed that the absence of available coliform organisms implies freedom from active virus under circumstances where a free chlorine residual cannot be maintained. Sedimentation and slow sand filtration in themselves may contribute to the removal of virus from water.

4.2.6 In practice, >0.5 mg/l of free chlorine for 1 h is sufficient to inactivate virus, even in water that was originally polluted provided the water is free from particulates and organic matter.

4.2.7 MS2 phage are indicator of viral contamination in drinking water. MS2 phage shall be absent in 1 litre of water when tested in accordance with USEPA method 1602. If MS2 phage are detected in the drinking water, virological examination shall be done by the Polymerase Chain Reaction (PCR) method for virological examination as given in Annex B. USEPA method in Manual of Method for Virology Chapter 16, June 2001 shall be the alternate method. If viruses are detected, the cause shall be determined by immediate further investigation.

4.3 Biological Requirements

4.3.1 Ideally, all samples taken including consumers premises should be free from biological organisms. Biological examination is of value in determining the causes of objectionable tastes and odours in water and controlling remedial treatments, in helping to interpret the results of various chemical analysis, and in explaining the causes of clogging in distribution pipes and filters. In some instances, it may be of use in demonstrating that water from one source has been mixed with that from another.

4.3.2 The biological qualities of water are of greater importance when the supply has not undergone the conventional flocculation and filtration processes, since increased growth of methane-utilizing bacteria on biological slimes in pipes may then be expected, and the development of bryozoal growths such as *Plumatella* may cause operational difficulties.

4.3.3 Some of the animalcules found in water mains may be free-living in the water, but others such as *Dreissena* and *Asellus* are more or less firmly attached to the inside of the mains. Although these animalcules are not themselves pathogenic, they may harbour pathogenic organisms or virus in their intestines, thus protecting these pathogens from destruction by chlorine.

4.3.4 Chlorination, at the dosages normally employed in waterworks, is ineffective against certain parasites, including amoebic cysts; they can be excluded only by effective filtration or by higher chlorine doses than can be tolerated without subsequent dechlorination. *Amoebiasis* can be conveyed by water completely free from enteric bacteria; microscopic examination after concentration is, therefore, the only safe method of identification.

4.3.5 Strict precautions against back-syphonage and cross-connections are required, if amoebic cysts are found in a distribution system containing tested water.

4.3.6 The *cercariae of schistosomiasis* can be detected by similar microscopic examination, but there is, in

any case, no evidence to suggest that this disease is normally spread through piped water supplies.

4.3.7 The cyclops vector of the embryos of *Dracunculus medinensis* which causes dracontiasis or Guinea-worm disease can be found in open wells in a number of tropical areas. They are identifiable by microscopic examination. Such well supplies are frequently used untreated, but the parasite can be relatively easily excluded by simple physical improvements in the form of curbs, drainage, and apron surrounds and other measures which prevent physical contact with the water source.

4.3.8 Cryptosporidium shall be absent in 10 liter of water when tested in accordance with USEPA method 1622 or USEPA method 1623* or ISO 15553 : 2006.

4.3.9 Giardia shall be absent in 10 liter of water when tested in accordance with USEPA method 1623* or ISO 15553 : 2006.

4.3.10 The drinking water shall be free from microscopic organisms such as algae, zooplanktons, flagellates, parasites and toxin producing organisms. An illustrative (and not exhaustive) list is given in Annex C for guidance.

NOTE — In case of dispute, the method indicated by '*' in **4.3.8** and **4.3.9** shall be referee method.

5 SAMPLING

Representative samples of water shall be drawn as prescribed in IS 1622 and IS 3025 (Part 1).

ANNEX A
(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
1622 : 1981	Methods of sampling and microbiological examination of water (*first revision*)
3025	Methods of sampling and test (physical and chemical) for water and waste water:
(Part 1) : 1987	Sampling (*first revision*)
(Part 2) : 2002	Determination of 33 elements by inductively coupled plasma atomic emission spectroscopy
(Part 4) : 1983	Colour (*first revision*)
(Part 5) : 1983	Odour (*first revision*)
(Part 7) : 1984	Taste threshold (*first revision*)
(Part 8) : 1984	Tasting rate (*first revision*)
(Part 10) : 1984	Turbidity (*first revision*)
(Part 11) : 1983	*p*H value (*first revision*)
(Part 16) : 1984	Filterable residue (total dissolved solids) (*first revision*)
(Part 21) : 1983	Total hardness (*first revision*)
(Part 23) : 1983	Alkalinity (*first revision*)
(Part 24) : 1986	Sulphates (*first revision*)
(Part 26) : 1986	Chlorine residual (*first revision*)
(Part 27) : 1986	Cyanide (*first revision*)
(Part 29) : 1986	Sulphide (*first revision*)
(Part 32) : 1988	Chloride (*first revision*)
(Part 34) : 1988	Nitrogen (*first revision*)
(Part 37) : 1988	Arsenic (*first revision*)
(Part 39) : 1989	Oil and grease
(Part 40) : 1991	Calcium
(Part 41) : 1992	Cadmium (*first revision*)
(Part 42) : 1992	Copper (*first revision*)
(Part 43) : 1992	Phenols (*first revision*)
(Part 46) : 1994	Magnesium
(Part 47) : 1994	Lead
(Part 48) : 1994	Mercury
(Part 49) : 1994	Zinc
(Part 52) : 2003	Chromium
(Part 53) : 2003	Iron
(Part 54) : 2003	Nickel
(Part 55) : 2003	Aluminium
(Part 56) : 2003	Selenium
(Part 57) : 2005	Boron
(Part 59) : 2006	Manganese
(Part 60) : 2008	Fluoride
13428 : 2003	Packaged natural mineral water — Specification (*first revision*)
14194	Radionuclides in environmental samples — Method of estimation:
(Part 1) : 1994	Gross beta activity measurement
(Part 2) : 1994	Gross alpha activity measurement
15302 : 2002	Determination of aluminium and barium in water by direct nitrous oxide-acetylene flame atomic absorption spectrometry
15303 : 2002	Determination of antimony, iron and selenium in water by electrothermal atomic absorption spectrometry

ANNEX B

(*Clause* 4.2.7)

POLYMERASE CHAIN REACTION (PCR) METHOD

B-1 GENERAL

The method involves the concentration of viruses from 100 litre of drinking water to 1 ml by membrane filter technique. The concentrate is subjected to amplification using polymerase chain reaction (PCR) and primers based on highly conserved regions of viral genomes. This method can detect as low as 10 genome copies. Stringent precautions are needed to avoid contamination with amplified DNA products leading to false positive reactions. Detection of hepatitis A virus (HAV) RNA and enterovirus (EV) RNA is considered as an indication of presence of viruses in water. Steps involved include concentration of water, RNA extraction, complementary DNA (cDNA) synthesis and PCR.

B-2 CONCENTRATION OF DRINKING WATER

B-2.1 Apparatus

B-2.1.1 *Pressure Pump*

B-2.1.2 *Membrane Filter Assembly with 144 mm Diameter with Tripod Stand*

B-2.1.3 *Pressure Vessel (50 litre capacity) with Pressure Gauge*

B-2.1.4 *Inter-connecting Pressure Tubes*

B-2.2 Reagents

Autoclaved double distilled water shall be used for the preparation of reagents/buffers in this study.

B-2.2.1 *Aluminium Chloride*

B-2.2.2 *HCl/NaOH Urea (Extra Pure)*

B-2.2.3 *Disodium Hydrogen Phosphate* ($Na_2HPO_4.2H_2O$) — 0.2 M, filter sterilized.

B-2.2.4 *Sodium Dihydrogen Phosphate* ($NaH_2PO_4.2H_2O$) — 0.2 M, filter sterilized.

B-2.2.5 *Citric Acid* — 0.1 M, filter sterilized.

B-2.2.6 *L-Arginine* — 0.5 M, filter sterilized.

B-2.2.7 *Urea-Arginine Phosphate Buffer* (*U-APB*) — Mix 4.5 g of urea with 2 ml of 0.2 M NaH_2PO_4 and 2 ml of 0.5 M L - Arginine and make up the volume to 50 ml with sterile distilled water. The *p*H of the eluent shall be 9.0.

B-2.2.8 *Magnesium Chloride* ($MgCl_2$) — 1 M.

B-2.2.9 *McII Vaines Buffer* (*p*H *5.0*) — Mix 9.7 ml of 0.1 M citric acid with 10.3 ml of 0.2 M $Na_2HPO_4.2H_2O$ under sterile conditions.

B-2.3 Procedure

Filter 100 litre of drinking water sample through membrane filter assembly using either positively charged membrane of 144 mm diameter or 0.22 micron diameter pore size nitrocellulose membrane. For positively charged membrane the test water *p*H need not be adjusted. But for the 0.22 micron nitrocellulose membrane adjust the *p*H to 3.5 after adding the aluminium chloride as a coagulant to a final concentration of 0.000 5 M.

At lower *p*H pass the water through the membrane. The flow rate shall be 40 litre/h approximately. After the completion of the filtration, elute the adsorbed particles using 100 ml of urea-arginine phosphate buffer (U-APB). Precipitate the suspended particles using 1 ml of magnesium chloride (1 M). Dissolve the resultant precipitate centrifuged out of the sample in 800-1.0 ml of McII vaines buffer. The processed sample can be stored at refrigerator until required.

B-3 RNA EXTRACTION

B-3.1 Apparatus

B-3.1.1 *Cooling Centrifuge*

B-3.1.2 *Deep Freezer (–20°C)*

B-3.1.3 *Vortex Mixer*

B-3.1.4 *Pipette Man*

B-3.2 Reagents

B-3.2.1 *Cetyl Trimethyl Ammonium Bromide (CTAB) Buffer*

CTAB	:	1 percent
Sodium Dodecyl Sulphate (SDS)	:	1 percent
EDTA	:	20 mM
Sodium Chloride	:	1 M

B-3.2.2 *Phenol, Chloroform and Isoamylalcohol in the ratio of 25:24:1 (PCI)*

B-3.2.3 *Ethanol*

B-3.2.4 *TE Buffer (p*H *8.0)*

Tris base	:	1 M
EDTA	:	0.5 M

B-3.2.5 *Sodium Acetate* — 3 M.

B-3.3 Procedure

Treat 300 µl of concentrated water sample with equal volume of CTAB and 1/10th volume of PCI. Vortex and centrifuge at 5 000 × g for 30 min at 4°C. Add 1/10th volume of 3 M sodium acetate and double the volume of cold ethanol to the aqueous layer. Keep the mixture at either at –20°C for overnight or in liquid nitrogen for 2-5 min. Centrifuge at 10 000 × g, for 30 min at 4°C. Discard the supernatant and air dry the pellet and dissolve it in 20 µl TE buffer.

B-4 COMPLEMENTARY DNA (c DNA) SYNTHESIS

B-4.1 Apparatus

B-4.1.1 *PCR Machine*

B-4.1.2 *Deep Freezer (–20°C)*

B-4.2 Reagents

B-4.2.1 *cDNA Synthesis Kit*

B-4.3 Procedure

Suspend the extracted RNA in 20 µl of cDNA reaction mixture, which consists of 4 µl of 5X reverse transcriptase reaction buffer [250 mM TRIS–HCl (*p*H 8.5), 40 mM KCl, 150 mM $MgCl_2$, 5 mM dithiothreitol (DTT)], 0.5 µl of 10 mM deoxynucleotide phosphate (dNTP), 2 µl of hexa nucleotide mixture, 1 µl of 25 U of Maloney Murine Leukaemia Virus (M-MuLV) reverse transcriptase, 0.5 µl of 20 U of human placental RNase inhibitor. Heat the reaction mixture to 95°C for 5 min and rapidly chill on ice, this is followed by the addition of 1 µl (25 U/µl) of M-MuLV reverse transcriptase. Incubate the reaction mixture as given by the manufacturer of the kit and quickly chill the reaction tube on ice.

B-5 PCR AMPLIFICATION

B-5.1 Apparatus

B-5.1.1 *PCR Machine*

B-5.1.2 *Deep Freezer (–20°C)*

B-5.1.3 *Micropippette*

B-5.2 Reagents

B-5.2.1 *Primers for EV and HAV*

EV sense primer, 5' — TCC TCC GGC CCC TGA ATG CG — 3'

antisense primer, 5' — ATT GTC ACC ATA AGC AGC CA — 3'

HAV sense primer, 5' — GTTTT GCTCC TCTTT ATCAT GCTAT G-3'

antisense primer, 5' — GGAAA TGTCT CAGGT ACTTT CTTTG-3'

B-5.2.2 *PCR Master Mix*

B-5.2.3 *Mineral Oil*

B-5.3 Procedure

B-5.3.1 *PCR Amplification for Hepatitis A Virus (HAV)*

In 5 µl of cDNA, add 95 µl of a PCR Master Mix (10 mM TRIS–HCl (*p*H 8.3), 50 mM KCl, 2.5 mM $MgCl_2$, 0.01 percent gelatin (1× PCR buffer), 200 µM of each dNTP, 1.5 U of *Thermus aquaticus* polymerase). Add 25 pico moles of sense and antisense oligonucleotide primers of HAV and overlay with mineral oil. Appropriate positive and negative controls shall be included with each run. Set the following reaction at thermo cycler:

Denaturation at 94°C for 2 min

Denaturation for	1.0 min	at 94°C	} 35 cycles
Annealing for	1.0 min	at 57°C	
Extension for	1.3 min	at 72°C	

Final extension at 72°C for 7 min.

B-5.3.2 *PCR Amplification for Enterovirus (EV)*

In 5 µl of cDNA, add 95 µl of a PCR Master Mix (10 mM TRIS–HCl (*p*H 8.3), 50 mM KCl, 2.5 mM $MgCl_2$, 0.01 percent gelatin (1X PCR buffer), 200 µM of each dNTP, 1.5 U of *Thermus aquaticus* polymerase). Add 25 pico moles of sense and antisense oligonucleotide primers of EV and overlay with mineral oil. Appropriate positive and negative controls shall be included with each run. Set the following reaction at thermo cycler:

Denaturation at 94°C for 2 min

Denaturation for	1.0 min	at 94°C	} 35 cycles
Annealing for	1.0 min	at 42°C	
Extension for	2.0 min	at 72°C	

Final extension at 72°C for 7 min.

B-6 AGAROSE GEL ELECTROPHORESIS

B-6.1 Apparatus

B-6.1.1 *Micropippette*

B-6.1.2 *Electrophoresis Apparatus*

B-6.1.3 *Gel Documentation System*

B-6.2 Reagents

B-6.2.1 *Running Buffer* — 50X TAE buffer

Tris base/Tris buffer : 121.00 g

Glacial acetic acid	:	28.55 ml
0.5 M EDTA	:	50 .00 ml
Distilled water (autoclaved)	:	300.45 ml

Make the final volume upto 1 000 ml with deionised distilled water, sterilize and store at 4°C. The final concentration for the preparation of agarose gel and to run the gel shall be 1X.

B-6.2.2 *Tracking Dye* — 6X bromophenol blue.

B-6.2.3 *Ethidium Bromide* — 0.5 µg/ml.

B-6.3 Procedure

Run the PCR amplified product of EV and HAV on 1.5 percent agarose gel using 1X TAE buffer. Load 10 µl of amplified product after mixing it with 1 µl 10X loading dye. Run the molecular weight marker along with the samples. Run the electrophoresis at 100 V for 30 min. Stain the gel with ethidium bromide (0.5 µl/ml) for 20 min. Wash it with distilled water and view under UV transilluminator and photograph the gel to analyse the band pattern. EV gives the band as 155 base pair and the HAV gives band as 225 base pair.

ANNEX C

(*Clause* 4.3.10)

ILLUSTRATIVE LIST OF MICROSCOPIC ORGANISMS PRESENT IN WATER

Sl No. (1)	*Classification of Microscopic Organism* (2)	*Group and Name of the Organism* (3)	*Habitat* (4)	*Effect of the Organisms and Significance* (5)
i)	Algae	a) Chlorophyceae:		
		1) *Species of* Coelastrum, Gomphospherium, Micractinium, Mougeotia, Oocystis, Euastrum, Scenedesmus, Actinastrum, Gonium, Eudorina Pandorina, Pediastrum, Zygnema, Chlamydomonas, Careteria, Chlorella, Chroococcus, Spirogyra, Tetraedron, Chlorogonium, Stigeoclonium	Polluted water, impounded sources	Impart colouration
		2) *Species of* Pandorina, Volvox, Gomphospherium, Staurastrum, Hydrodictyon, Nitella	Polluted waters	Produce taste and odour
		3) *Species of* Rhizoclonium, Cladothrix, Ankistrodesmus, Ulothrix, Micrasterias, Chromulina	Clean water	Indicate clean condition
		4) *Species of* Chlorella, Tribonema, Clostrium, Spirogyra, Palmella	Polluted waters, impounded sources	Clog filters and create impounded difficulties
		b) Cyanophyceae:		
		1) *Species of* Anacystis and Cylindrospermum	Polluted waters	Cause water bloom and impart colour
		2) *Species of* Anabena, Phormidium, Lyngbya, Arthrospira, Oscillatona	Polluted waters	Impart colour
		3) *Species of* Anabena, Anacystis, Aphanizomenon	Polluted waters, impounded sources	Produce taste and odour
		4) *Species of* Anacystis, Anabena, Coelospherium, Cleotrichina, Aphanizomenon	Polluted waters	Toxin producing
		5) *Species of* Anacystis, Rivularia, Oscillatoria, Anabena	Polluted waters	Clog filters

Sl No. (1)	*Classification of Microscopic Organism* (2)	*Group and Name of the Organism* (3)	*Habitat* (4)	*Effect of the Organisms and Significance* (5)
		6) *Species of* Rivularia	Calcareous waters and also rocks	Bores rocks and calcareous strata and causes matted growth
		7) *Species of* Agmenellum, Microcoleus, Lemanea	Clean waters	Indicators of purification
		c) Diatoms (Bacillareophyceae):		
		1) *Species of* Fragillaria, Stephanodiscus, Stauroneis	—	Cause discoloration
		2) *Species of* Asterionella, Tabellaria	Hill streams high altitude, torrential and temperate waters	Taste and odour producing clog filters
		3) *Species of* Synedra and Fragillavia	Polluted waters	Taste and odour producing
		4) *Species of* Nitzchia, Gomphonema	Moderately polluted waters	Cause discoloration
		5) *Species of* Cymbela, Synedra, Melosira, Navicula, Cyclotella, Fragillaria, Diatoma, Pleurogsigma	Rivers and streams impounded sources	Clog filters and cause operational difficulties
		6) *Species of* Pinmularia, Surinella, Cyclotella, Meridion, Cocconeis	Clean waters	Indicators of purification
		d) Xanthophyceae:		
		Species of Botryococcus	Hill streams, high altitude and temperate waters	Produces coloration
ii)	Zooplankton	a) Protozoa:		
		1) Amoeba, Giardia Lamblia Arcella, Difflugia, Actinophrys	Polluted waters	Pollution indicators
		2) Endamoeba, Histolytica	Sewage and activated sludge	Parasitic and pathogenic
		b) Ciliates:		
		Paramoecium, Vorticella, Carchesium, Stentor, Colpidium, Coleps, Euplotes, Colopoda, Bodo	Highly polluted waters, sewage and activated sludge	Bacteria eaters
		c) Crustacea:		
		1) Bosmina, Daphnia	Stagnant polluted waters	Indicators of pollution
		2) Cyclops	Step wells in tropical climate	Carrier host of guinea worm
iii)	Rotifers	a) Rotifers:		
		Anurea, Rotaria, Philodina	Polluted and Algae laden waters	Feed on algae
		b) Flagellates:		
		1) Ceratium, Glenodinium, Peridinium Dinobryon	Rocky strata, iron bearing and acidic waters	Impart colour and fishy taste
		2) Euglena, Phacus	Polluted waters	Impart colour

Sl No.	*Classification of Microscopic Organism*	*Group and Name of the Organism*	*Habitat*	*Effect of the Organisms and Significance*
(1)	(2)	(3)	(4)	(5)
iv)	Miscellaneous Organisms	a) Sponges, Hydra	Fresh water	Clog filters and affect purification systems
		b) Tubifex, Eristalls, Chironomids	Highly polluted waters, sewage and activated sludge and bottom deposits	Clog filters and render water unaesthetic
		c) Plumatella	Polluted waters	Produces biological slimes and causes filter operational difficulties
		c) Dreissena, Asellus	Polluted waters	Harbour pathogenic organisms

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This Indian Standard has been developed from Doc No.: FAD 25 (2047).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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Annexure 4.6 - Soil Quality Analysis

RIMS
Testing & Training Institute

Research Institute of Material Sciences Pvt. Ltd.

A complete testing lab and training institute

Plot No. 22 & 23, Ranaji Enclave, Nangli Sakrawati, New Delhi-110043
Ph.: 011-25324233, (M) 09599983618, Email : info@rimslab.com, Website : www.rimslab.com

JAS-ANZ
Acc. No. M3111204IN

TEST REPORT

SOIL SAMPLE ANALYSIS REPORT
Test Report No.: 1807100021-0023
Dispatch Date :27/07/2018

ISSUED TO	**Centre for Management and Social Research,** Plot no. 101, flat no. 103,RR Residency opp. GHMC, Srinagar Colony,Hyderabad-500073
PROJECT NAME	Environmental Monitoring for "Bhopal Metro Rail Project Bhopal M.P"

SN	Parameters	Unit	RESULTS		
			SO_1	SO_2	SO_3
			03/07/2018	05/07/2018	07/07/2018
1.	pH Value at 25°C	-	8.03	7.77	7.22
2.	Conductivity at 25°C	µS/cm	722	812	830
3.	Moisture	% by mass	8.3	9.2	7.4
4.	Available Nitrogen	mg/Kg	290	324	272
5.	Available Phosphorous	mg/Kg	83	105	119
6.	Calcium	mg/Kg	128	185	152
7.	Magnesium	Meq/100gm	74	96	64
8.	Potassium	mg/Kg	140	131	128
9.	Available Nitrate	mg/Kg	640	714	520
10.	Sulphate	mg/Kg	96	116	83
11.	Organic Matter	% by mass	1.29	1.26	1.11
12.	Chloride (as Cl)	mg/Kg	145	165	132
13.	Available Carbon	mg/Kg	47	58	38
14.	Copper	mg/Kg	26	36	22
15.	Iron	mg/Kg	69	80	56
16.	Zinc	mg/Kg	50	63	46
17.	Manganese	mg/Kg	42	58	33
18.	Nacl	mg/Kg	290	315	254
19.	Na_2CO_3	mg/Kg	168	186	140
20.	Sodium Absorption Ratio (SAR)	Meq/100gm	8.26	9.20	8.11
Soil Gran Size Analysis/ Texture					
a	Sand	% by mass	46.2	43.4	40.7
b	Silt	% by mass	29.0	33.6	39.9
c	Clay	% by mass	24.8	23	19.4

S_1 – Bhadbhada, S_2 – Ratnagiri Square S_3 – Krishi Upaj Mandi

AUTHORIZED SIGNATORY
Sumit Kumar

Annexure 4.7- Detail of Trees species and girth size

Annexure: 4.7

Detail of Tree within Right-of-Way of metro corridor

Purple Line (AIIMS to Karond Circle)					
S.No	Chainage as per metro alignment (km)	Local Name of Tree Species	Distance from Alignment Centreline (in Mtr.)	Location (Left Hand Side 'OR' Right Hand Side of Alignment Centreline)	Tree Girth Size at 1 meter above ground (in Mtr.)
1	20.005	Siris	10	LHS	0.35
2	20.035	Aam	10	LHS	1.32
3	20.05	Ashok	10	LHS	0.45
4	20.052	Ashok	10	LHS	0.45
5	20.054	Ashok	10	LHS	0.45
6	20.056	Ashok	10	LHS	0.45
7	20.058	Ashok	10	LHS	0.45
8	20.07	Aam	9	LHS	0.3
9	20.071	Aam	9	LHS	0.35
10	20.072	Nariyal	1	LHS	0.3
11	20.075	Nariyal	1	LHS	0.35
12	20.078	Nariyal	1	LHS	0.35
13	20.08	Nariyal	1	LHS	0.6
14	20.1	Siris	1	RHS	0.55
15	20.11	Siris	1	RHS	0.9
16	20.12	Siris	1	RHS	0.45
17	20.142	Siris	1	RHS	1.1
18	20.152	Pipal	1	LHS	4
19	20.167	Jamun	1	RHS	1.6
20	20.175	Babul	1.5	RHS	1.4
21	20.19	Neem	1	LHS	0.58
22	20.2	Aam	9.5	LHS	1
23	20.21	Aam	10	LHS	0.75
24	20.25	Gul Mohar	1.5	LHS	1
25	20.26	Gul Mohar	0.5	RHS	1
26	20.268	Gul Mohar	1	LHS	1.25
27	20.3	Gul Mohar	19.4	LHS	1.8
28	20.303	Gul Mohar	23.6	LHS	1.4
29	20.315	Gul Mohar	1	RHS	0.8
30	20.317	Siris	1	RHS	0.6
31	20.322	Siris	1	RHS	0.8
32	20.324	Gul Mohar	1	RHS	0.7
33	20.326	Babul	1	LHS	0.75
34	20.329	Neem	16.3	RHS	0.6
35	20.33	Babul	16.1	RHS	0.6
36	20.333	Aam	12.2	LHS	1.4
37	20.333	Aam	13.1	LHS	1.6
38	20.333	Nibu	10.4	LHS	0.35
39	20.334	Gul Mohar	1	LHS	0.35
40	20.335	Siris	14.9	RHS	0.6
41	20.338	Babul	15.8	RHS	0.5
42	20.339	Gul Mohar	1	RHS	0.75
43	20.342	Gul Mohar	1	RHS	1.2
44	20.345	Siris	11.2	RHS	1.1
45	20.345	Siris	16.4	RHS	0.55
46	20.346	Gul Mohar	1.2	RHS	0.55
47	20.348	Gul Mohar	1	LHS	1.15
48	20.35	Neem	15.2	RHS	1
49	20.355	Neem	15.2	RHS	1.05
50	20.36	Siris	1.2	RHS	0.55
51	20.36	Siris	15.1	RHS	0.4
52	20.362	Neem	1	LHS	0.7
53	20.362	Neem	1	LHS	0.65
54	20.365	Sisam	1.2	LHS	0.5
55	20.365	Sisam	1.2	LHS	0.6

56	20.365	Amrud	10.2	LHS	0.45
57	20.367	Nibu	10.5	LHS	0.4
58	20.369	Sahijan	1.1	LHS	1.4
59	20.37	Aam	10.4	LHS	1
60	20.373	Gul Mohar	1	RHS	0.7
61	20.374	Gul Mohar	1	LHS	1.2
62	20.376	Neem	1	LHS	0.8
63	20.377	Sahijan	1	LHS	0.35
64	20.38	Neem	1.1	LHS	1.75
65	20.388	Siris	1	LHS	0.65
66	20.389	Siris	1	LHS	0.6
67	20.389	Siris	1	RHS	0.65
68	20.39	Gul Mohar	15.4	RHS	0.7
69	20.39	Neem	10.4	LHS	0.5
70	20.39	Neem	10.1	LHS	1.25
71	20.39	Neem	10.4	LHS	1
72	20.391	Gul Mohar	1.3	LHS	1
73	20.392	Gul Mohar	15.4	RHS	0.6
74	20.393	Gul Mohar	15.3	RHS	0.6
75	20.393	Siris	1	LHS	0.8
76	20.393	Siris	1	LHS	0.65
77	20.394	Siris	1	RHS	0.45
78	20.395	Siris	10.1	LHS	0.5
79	20.395	Siris	15.3	RHS	0.5
80	20.396	Siris	1	RHS	0.55
81	20.396	Siris	1	RHS	0.55
82	20.397	Gul Mohar	1	LHS	0.9
83	20.4	Siris	1	RHS	1.5
84	20.407	Neem	1	LHS	1
85	20.408	Siris	1	LHS	1
86	20.41	Siris	1	RHS	0.6
87	20.413	Aanwala	1	LHS	0.8
88	20.415	Aanwala	1	LHS	0.5
89	20.417	Neem	1	LHS	0.6
90	20.417	Pipal	1	LHS	1.9
91	20.419	Sisam	1	RHS	0.35
92	20.42	Neem	2	RHS	0.85
93	20.432	Neem	0.5	LHS	0.6
94	20.437	Siris	1	RHS	0.55
95	20.439	Siris	0	-	0.5
96	20.439	Siris	0	-	0.5
97	20.44	Siris	1	LHS	0.5
98	20.44	Siris	16.2	RHS	0.5
99	20.441	Babul	16.1	RHS	0.5
100	20.445	Neem	1	LHS	1.7
101	20.452	Gul Mohar	1	RHS	0.9
102	20.452	Gul Mohar	1.05	RHS	0.35
103	20.455	Siris	1.2	RHS	0.9
104	20.46	Neem	1.1	RHS	0.8
105	20.461	Jamun	1	RHS	0.4
106	20.481	Neem	1.25	LHS	1.2
107	20.482	Siris	1	RHS	1
108	20.487	Neem	1.1	LHS	0.6
109	20.488	Siris	1.5	RHS	0.6
110	20.488	Siris	1	RHS	0.75
111	20.49	Siris	1.2	RHS	0.45
112	20.491	Neem	1	LHS	0.5
113	20.491	Neem	1.1	LHS	0.65
114	20.495	Siris	1.05	LHS	0.5
115	20.495	Siris	0.6	LHS	0.3
116	20.498	Aam	1	LHS	0.55
117	20.498	Siris	1.2	LHS	0.5
118	20.5	Neem	1.1	LHS	1
119	20.502	Neem	1	LHS	0.75
120	20.503	Sahijan	4	LHS	0.6

121	20.503	Sahijan	4.3	LHS	0.8
122	20.504	Aanwala	1.5	LHS	0.5
123	20.504	Aanwala	1	LHS	0.35
124	20.509	Neem	1.1	LHS	0.65
125	20.509	Neem	1.05	LHS	0.65
126	20.511	Neem	1.15	RHS	0.5
127	20.514	Babul	1.3	RHS	1.45
128	20.743	Pipal	1	LHS	2.05
129	20.75	Pipal	9	LHS	1.6
130	20.755	Pipal	9.4	LHS	1.5
131	20.795	Neem	8.4	RHS	0.65
132	20.795	Neem	7.9	RHS	0.5
133	20.798	Neem	8.1	RHS	0.45
134	20.8	Sahijan	5	LHS	0.7
135	20.86	Neem	9.3	LHS	1.2
136	20.875	Sahijan	8	LHS	1.1
137	20.885	Sahijan	7.1	LHS	1.2
138	21	Imili	3	RHS	0.6
139	21.002	Kadam	3.2	RHS	0.5
140	21.004	Kadam	3.1	RHS	0.7
141	21.006	Imili	4	RHS	0.65
142	21.06	Pipal	4.2	RHS	2.1
143	21.1	Neem	7.2	RHS	1.3
144	21.1	Neem	1.1	LHS	1.35
145	21.105	Pipal	4.3	RHS	1.7
146	21.108	Pipal	4	RHS	1.1
147	21.108	Pipal	8.2	LHS	1.35
148	21.109	Pipal	8.9	LHS	1.3
149	21.11	Jamun	5.3	LHS	1.7
150	21.15	Siris	9.7	RHS	0.85
151	21.15	Imili	4.1	LHS	1.6
152	21.15	Siris	5.2	LHS	1.4
153	21.16	Babul	9.8	RHS	0.8
154	21.167	Ber	8.3	RHS	0.6
155	21.173	Neem	9.1	RHS	1.4
156	21.175	Babul	8.3	RHS	1.25
157	21.179	Ber	8.1	RHS	0.65
158	21.195	Ber	3.2	LHS	0.9
159	21.198	Ber	2.4	LHS	0.7
160	21.215	Babul	1.2	LHS	1.35
161	21.225	Babul	1.1	LHS	1.2
162	21.229	Babul	1.5	LHS	1.8
163	21.233	Babul	2.5	RHS	1.1
164	21.241	Babul	1.5	RHS	0.8
165	21.25	Babul	1.2	RHS	1.35
166	21.252	Ber	1.1	RHS	0.6
167	21.264	Babul	3.3	LHS	1.05
168	21.272	Sahijan	0	-	0
169	21.28	Ber	1.2	RHS	0.75
170	21.284	Ber	0	-	0.5
171	21.29	Neem	0	-	0.35
172	21.3	Babul	9.5	RHS	1.8
173	21.3	Neem	1.3	LHS	1.6
174	21.312	ber	2.4	LHS	0.65
175	21.315	Sisam	1.45	LHS	0.7
176	21.32	Babul	1	RHS	0.85
177	21.323	Neem	0	-	0.8
178	21.362	Ber	1.2	RHS	1.1
179	21.372	Ber	1.3	LHS	1.25
180	21.44	Babul	1.2	LHS	1.55
181	21.45	Jangli Jalebi	1.5	RHS	0.6
182	21.46	Siris	1.3	RHS	1.8
183	21.46	Ashok	11.6	RHS	0.6
184	21.461	Ashok	11.6	RHS	0.6
185	21.462	Ashok	11.6	RHS	0.6

186	21.463	Ashok	11.6	RHS	0.6
187	21.464	Ashok	11.6	RHS	0.6
188	21.465	Ashok	11.6	RHS	0.6
189	21.468	Siris	1.1	RHS	1.5
190	21.468	Jangli Jalebi	1	RHS	0.35
191	21.475	Ashok	11.5	RHS	0.5
192	21.477	Nariyal	11.5	RHS	0.6
193	21.495	Nariyal	12	RHS	1.4
194	21.495	Aam	18	RHS	1.6
195	21.497	Ashok	12	RHS	0.6
196	21.497	Ashok	10.1	RHS	0.5
197	21.498	Ashok	10.1	RHS	0.4
198	21.498	Ashok	18.2	RHS	0.5
199	21.498	Ashok	18.2	RHS	0.45
200	21.5	Nariyal	18.2	RHS	1.6
201	21.501	Nariyal	18.2	RHS	1.3
202	21.502	Nariyal	18.2	RHS	1.4
203	21.519	Nariyal	15.1	RHS	1.3
204	21.522	Nariyal	19.2	RHS	1.4
205	21.523	Ashok	10.2	RHS	1.3
206	21.525	Aam	15.1	RHS	1.4
207	21.527	Katahal	15.1	RHS	1.4
208	21.54	Neem	9.2	RHS	1.2
209	21.545	Neem	9	RHS	0.6
210	21.56	Neem	9.1	RHS	1.7
211	21.614	Neem	9.4	RHS	1.7
212	21.63	Ashok	9	RHS	0.45
213	21.63	Ashok	8.85	RHS	0.45
214	21.63	Ashok	9.2	RHS	0.45
215	21.63	Ashok	9.1	RHS	0.4
216	21.63	Ashok	9.3	RHS	0.45
217	21.64	Ashok	1.3	RHS	1.85
218	21.655	Semar	1.2	LHS	0.7
219	21.75	Babul	0	-	0.6
220	21.751	Babul	0	-	0.8
221	21.755	Neem	9.6	RHS	0.8
222	21.775	Babul	1	LHS	1.2
223	21.79	Babul	1.2	RHS	0.9
224	21.8	Gul Mohar	1.35	RHS	0.35
225	21.84	Babul	1.2	RHS	1.15
226	21.843	Babul	2.1	RHS	0.4
227	21.845	Babul	1.1	LHS	0.7
228	21.848	Babul	1.1	RHS	0.7
229	21.848	Babul	1.15	LHS	0.7
230	21.865	Sisam	1.25	LHS	0.45
231	21.865	Sisam	3.55	RHS	0.9
232	21.87	Sisam	1.55	LHS	0.85
233	21.874	Babul	1.2	RHS	0.65
234	21.88	Sahijan	5.4	LHS	1.2
235	21.886	Jangli Jalebi	1.5	RHS	0.9
236	21.887	Jangli Jalebi	1.55	RHS	0.65
237	21.892	Siris	1.15	RHS	0.65
238	21.895	Sisam	1.25	LHS	0.9
239	21.9	Siris	1.5	RHS	0.7
240	21.903	Siris	1	LHS	1.05
241	21.911	Siris	1.1	RHS	0.55
242	21.913	Siris	1.2	RHS	0.8
243	21.913	Siris	1.15	RHS	0.3
244	21.915	Siris	0	-	0.6
245	21.917	Siris	1	RHS	0.7
246	21.917	Jangli Jalebi	2	RHS	0.8
247	21.92	Jangli Jalebi	1.1	RHS	1.2
248	21.921	Sisam	1.05	LHS	0.3
249	21.925	Siris	1.11	LHS	0.85
250	21.925	Gul Mohar	2.15	RHS	0.9

251	21.935	Gul Mohar	2.5	RHS	1.3
252	21.94	Siris	1.3	RHS	0.45
253	21.94	Siris	1.2	RHS	0.4
254	21.945	Gul Mohar	3.5	RHS	1.5
255	21.949	Siris	2	RHS	0.5
256	21.951	Ashok	2.2	RHS	0.35
257	21.951	Siris	2.05	RHS	0.35
258	21.951	Siris	2.13	RHS	0.3
259	21.951	Siris	2.15	RHS	0.35
260	21.951	Siris	2.05	RHS	0.4
261	21.953	Siris	1.25	RHS	0.8
262	21.953	Siris	3.1	RHS	0.3
263	21.955	Siris	1.84	RHS	0.5
264	21.955	Siris	1.02	RHS	0.9
265	21.957	Gul Mohar	3	RHS	0.7
266	21.96	Siris	1.4	RHS	1
267	21.96	Siris	0.5	LHS	0.3
268	21.963	Pipal	3.25	RHS	1.2
269	21.964	Siris	1.3	RHS	0.95
270	21.966	Siris	3.15	RHS	0.9
271	21.97	Siris	3.18	RHS	0.6
272	21.97	Gul Mohar	5.1	RHS	0.63
273	21.973	Siris	1.2	RHS	0.6
274	21.973	Siris	1.2	RHS	0.75
275	21.976	Siris	1.08	RHS	0.51
276	22.01	Jangli Jalebi	2.14	RHS	1.1
277	22.016	Siris	2	RHS	1
278	22.017	Siris	2.15	RHS	0.3
279	22.02	Siris	3.28	RHS	0.7
280	22.02	Sisam	2.08	RHS	0.35
281	22.022	Siris	2.15	RHS	0.45
282	22.022	Siris	3	RHS	0.7
283	22.022	Siris	2.06	RHS	55
284	22.022	Eucalyptus	2.1	RHS	0.65
285	22.022	Eucalyptus	2	RHS	0.5
286	22.024	Sisam	2.23	RHS	0.3
287	22.025	Siris	2.5	RHS	0.36
288	22.03	Babul	4.18	RHS	0.5
289	22.03	Sisam	3.2	RHS	0.65
290	22.035	Siris	3.15	RHS	1.25
291	22.035	Eucalyptus	4.15	RHS	0.75
292	22.037	Eucalyptus	4.2	RHS	1.8
293	22.037	Eucalyptus	7.4	LHS	1
294	22.042	Eucalyptus	8.1	LHS	1.3
295	22.087	Siris	10	RHS	0.35
296	22.087	Siris	9.6	LHS	1.1
297	22.097	Siris	10	LHS	1.15
298	22.1	Siris	9.5	RHS	0.45
299	22.1	Siris	1.15	RHS	0.47
300	22.105	Siris	0.5	LHS	0.5
301	22.21	Siris	0.6	LHS	0.5
302	22.117	Siris	1	LHS	1
303	22.127	Jangli Jalebi	1.1	RHS	0.7
304	22.13	Siris	2.5	RHS	0.45
305	22.132	Babul	1	LHS	0.7
306	22.132	Siris	1.2	RHS	0.6
307	22.132	Babul	0.7	LHS	0.7
308	22.142	Siris	1.15	RHS	0.55
309	22.143	Babul	1.07	RHS	0.85
310	22.154	Jangli Jalebi	0.75	RHS	2
311	22.175	Siris	1.2	RHS	0.7
312	22.182	Siris	1.5	RHS	0.45
313	22.195	Babul	2.3	RHS	1.7
314	22.205	Sisam	2.3	RHS	0.35
315	22.215	babul	1.25	RHS	1

316	22.215	Sisam	9.7	LHS	0.3
317	22.22	Sisam	9.5	LHS	0.5
318	22.224	Sisam	10	LHS	0.3
319	22.24	Gul Mohar	11.1	LHS	0.6
320	22.24	Gul Mohar	11	LHS	0.4
321	22.24	Rain Tree	23.1	RHS	1.45
322	22.24	Siris	18	LHS	0.2
323	22.24	Gul Mohar	23	LHS	0.4
324	22.24	Siris	11	LHS	0.3
325	22.24	Siris	11	LHS	0.45
326	22.24	Gul Mohar	11	LHS	0.3
327	22.24	Shirol	12	LHS	0.3
328	22.24	Gul Mohar	12	LHS	0.3
329	22.24	Siris	15	LHS	0.3
330	22.242	Rain Tree	23.1	RHS	1.45
331	22.242	Sisam	9.2	LHS	0.45
332	22.242	Rain Tree	23.3	RHS	1.5
333	22.244	Sisam	9.8	LHS	0.55
334	22.245	Gul Mohar	18	LHS	0.3
335	22.245	Siris	18	LHS	0.3
336	22.245	Siris	15	LHS	0.5
337	22.245	Gul Mohar	18	LHS	0.5
338	22.245	Gul Mohar	18	LHS	0.5
339	22.248	Neem	23.4	RHS	1.6
340	22.25	Siris	18	LHS	0.5
341	22.25	Gul Mohar	18	LHS	0.8
342	22.25	Siris	18	LHS	0.4
343	22.25	Siris	15	LHS	0.4
344	22.25	Gul Mohar	15	LHS	0.45
345	22.25	Gul Mohar	22	LHS	0.7
346	22.25	Sisam	9.35	LHS	0.7
347	22.255	Rain Tree	23.8	RHS	1.45
348	22.255	Sisam	9.5	LHS	0.6
349	22.258	Babul	22	LHS	0.55
350	22.258	Sisam	22	LHS	0.4
351	22.258	siras	15	LHS	0.8
352	22.258	Nariyal	23.9	RHS	1.8
353	22.258	Rain Tree	23.8	RHS	0.6
354	22.258	siras	22	LHS	0.35
355	22.258	Babul	11	LHS	1.2
356	22.258	Shirol	15	LHS	0.5
357	22.258	Shirol	22	LHS	0.5
358	22.262	Rain Tree	24.1	RHS	1.5
359	22.265	Shirol	15	LHS	0.5
360	22.265	siras	15	LHS	0.5
361	22.265	siras	15	LHS	0.5
362	22.265	Khajur	23.9	LHS	0.8
363	22.265	Khajur	23.9	LHS	0.8
364	22.265	Gul Mohar	15	LHS	0.5
365	22.265	Gul Mohar	11	LHS	0.5
366	22.265	Gul Mohar	15	LHS	0.6
367	22.27	Ber	1.5	RHS	0.5
368	22.27	Ber	1.5	RHS	0.55
369	22.272	Gul Mohar	15	LHS	0.6
370	22.272	Gul Mohar	15	LHS	0.55
371	22.272	Siris	15	LHS	0.6
372	22.272	Gul Mohar	22	LHS	0.65
373	22.272	Siris	11	LHS	0.55
374	22.272	Siris	11	LHS	0.6
375	22.272	Gul Mohar	15	LHS	0.5
376	22.272	Gul Mohar	18	LHS	0.5
377	22.28	Siris	18	LHS	0.5
378	22.28	Gul Mohar	18	LHS	0.7
379	22.28	Neem	23.1	RHS	1.5
380	22.28	Siris	22	LHS	0.75

381	22.28	Siris	22	LHS	0.8
382	22.28	Gul Mohar	11	LHS	0.75
383	22.285	Kadam	23.1	RHS	1.7
384	22.285	Gul Mohar	19	LHS	0.6
385	22.285	Babul	19	LHS	0.65
386	22.285	Sisam	22	LHS	0.7
387	22.285	siras	22	LHS	0.55
388	22.29	Sisam	15.6	LHS	1
389	22.295	siras	22	LHS	0.45
390	22.295	Gul Mohar	22	LHS	0.8
391	22.295	Gul Mohar	22	LHS	0.5
392	22.295	Gul Mohar	11	LHS	0.8
393	22.295	Siris	11	LHS	0.8
394	22.295	Paltaform	22.5	RHS	1.25
395	22.297	Paltaform	23.1	RHS	1.35
396	22.298	Paltaform	24	RHS	1.4
397	22.299	Paltaform	23.4	RHS	2.2
398	22.299	Paltaform	22.1	RHS	1.3
399	22.3	Paltaform	24.1	RHS	1.9
400	22.3	Siris	11	LHS	0.7
401	22.3	Gul Mohar	11	LHS	0.6
402	22.3	Gul Mohar	15	LHS	0.7
403	22.3	Siris	15	LHS	0.65
404	22.3	Gul Mohar	15	LHS	0.7
405	22.3	Siris	11	LHS	0.7
406	22.3	Ashok	23.5	RHS	0.4
407	22.302	Ashok	23.5	RHS	0.45
408	22.304	Ashok	23.5	RHS	0.35
409	22.306	Ashok	23.5	RHS	0.3
410	22.308	Ashok	23.5	RHS	0.35
411	22.31	Ashok	23.5	RHS	0.25
412	22.31	Siris	11	LHS	0.65
413	22.31	Gul Mohar	11	LHS	0.6
414	22.31	Gul Mohar	11	LHS	0.95
415	22.31	Babul	15	LHS	0.75
416	22.31	Sisam	15	LHS	0.8
417	22.312	Paltaform	22.5	RHS	1.35
418	22.313	Paltaform	22.5	RHS	2.2
419	22.315	Paltaform	22.5	RHS	1.8
420	22.315	Paltaform	22.5	RHS	1.7
421	22.316	Paltaform	22.5	RHS	1.7
422	22.317	siras	22	LHS	0.65
423	22.317	Gul Mohar	22.1	RHS	0.6
424	22.317	siras	14	LHS	0.7
425	22.317	Gul Mohar	14	LHS	0.85
426	22.317	Siris	18	LHS	0.8
427	22.317	Gul Mohar	18	LHS	0.9
428	22.325	babul	2.14	RHS	0.9
429	22.325	babul	2.25	RHS	0.8
430	22.325	Gul Mohar	11	LHS	0.8
431	22.325	Babul	15	LHS	0.5
432	22.325	Sisam	18	LHS	0.5
433	22.325	siras	18	LHS	0.35
434	22.325	siras	22	LHS	0.45
435	22.335	Siris	22	LHS	0.4
436	22.335	Gul Mohar	22	LHS	0.45
437	22.335	Gul Mohar	22	LHS	0.38
438	22.345	Babul	22	LHS	0.45
439	22.345	Gul Mohar	15	LHS	0.43
440	22.345	Babul	11	LHS	0.5
441	22.355	Sisam	15	LHS	0.4
442	22.355	siras	14	LHS	0.5
443	22.355	siras	15	LHS	0.45
444	22.355	Gul Mohar	22	LHS	0.45
445	22.355	Siris	22	LHS	0.45

446	22.355	Gul Mohar	15	LHS	0.5
447	22.355	Gul Mohar	18	LHS	0.8
448	22.355	Babul	17	LHS	0.8
449	22.362	Sisam	11	LHS	0.65
450	22.362	siras	11	LHS	0.75
451	22.362	siras	11	LHS	0.7
452	22.362	Siris	11	LHS	0.4
453	22.362	Gul Mohar	11	LHS	0.4
454	22.362	Gul Mohar	11	LHS	0.4
455	22.37	Babul	18	LHS	0.4
456	22.37	Gul Mohar	18	LHS	0.8
457	22.37	Babul	16	LHS	0.75
458	22.37	Sisam	15	LHS	0.4
459	22.37	Rain Tree	15	LHS	0.8
460	22.37	Rain Tree	15	LHS	0.75
461	22.372	Gul Mohar	15.2	RHS	1.4
462	22.372	Gul Mohar	22.2	RHS	1.4
463	22.375	Gul Mohar	22.2	RHS	1.8
464	22.378	Gul Mohar	22.2	RHS	1.7
465	22.378	Gul Mohar	22.2	RHS	1.1
466	22.379	Gul Mohar	22.2	RHS	1.45
467	22.38	Rain Tree	13	LHS	0.5
468	22.38	Sisam	23.9	RHS	0.65
469	22.38	Neem	23.9	RHS	1.35
470	22.38	Neem	23.9	RHS	0.8
471	22.38	Paltaform	23.9	RHS	1
472	22.38	Paltaform	23.9	RHS	1.7
473	22.38	Gul Mohar	13	LHS	0.4
474	22.38	siris	12	LHS	0.4
475	22.38	Gul Mohar	12	LHS	0.3
476	22.38	Rain Tree	14	LHS	0.5
477	22.38	siris	15	LHS	0.5
478	22.38	Rain Tree	14	LHS	0.4
479	22.39	Gul Mohar	18	LHS	0.45
480	22.39	siris	18	LHS	0.45
481	22.39	Gul Mohar	19	LHS	0.45
482	22.39	Rain Tree	15	LHS	0.45
483	22.39	siris	22	LHS	0.3
484	22.39	Rain Tree	23	LHS	0.5
485	22.39	Paltaform	24	RHS	2.2
486	22.39	Paltaform	15	RHS	1.8
487	22.395	Gul Mohar	23	LHS	0.45
488	22.395	siris	22	LHS	0.3
489	22.395	Gul Mohar	11	LHS	0.35
490	22.395	Rain Tree	13	LHS	30
491	22.395	siris	14	LHS	46
492	22.395	Rain Tree	22	LHS	0.5
493	22.395	Rain Tree	23	LHS	0.6
494	22.395	Rain Tree	21	LHS	0.65
495	22.395	Rain Tree	20	LHS	0.7
496	22.48	Eucalyptus	7.15	LHS	1.65
497	22.484	Eucalyptus	3.1	LHS	2.2
498	22.505	Siris	3.15	LHS	1.45
499	22.505	Jamun	2.15	RHS	1.2
500	22.505	Sisam	5.1	RHS	1.3
501	22.58	Sisam	3.2	RHS	1.1
502	22.585	Sisam	3.1	RHS	1
503	22.593	Sisam	5	RHS	0.6
504	22.615	Sisam	9.4	RHS	0.9
505	22.62	Sisam	9	RHS	1
506	22.628	Sisam	9.7	RHS	1.05
507	22.7	Siris	3.1	LHS	1.2
508	22.73	Siris	2.2	LHS	1.15
509	23.002	Jangli Jalebi	8.05	RHS	0.5
510	23.05	Eucalyptus	2.3	RHS	1.9

511	23.15	Sisam	9.25	RHS	0.7
512	23.158	Pipal	9.5	RHS	1.8
513	23.165	Gul Mohar	8.2	RHS	0.45
514	23.21	Eucalyptus	3.05	RHS	1.5
515	23.22	Eucalyptus	2.12	RHS	0.5
516	23.23	Gul Mohar	9.1	RHS	1.6
517	23.23	Gul Mohar	9.1	RHS	0.5
518	23.24	babul	4.2	RHS	1
519	23.35	Eucalyptus	4.3	RHS	1
520	23.354	Eucalyptus	4.1	RHS	1.15
521	23.354	Eucalyptus	8.9	RHS	1.25
522	23.36	Sisam	4	RHS	0.5
523	23.362	Siris	8.2	RHS	0.5
524	23.41	Eucalyptus	8	RHS	1.7
525	23.416	Siris	8.9	RHS	1
526	23.42	Eucalyptus	4	RHS	1.8
527	23.425	Siris	6.85	RHS	0.8
528	23.427	Eucalyptus	4.2	RHS	1.15
529	23.435	Eucalyptus	3.9	RHS	1.8
530	23.435	Eucalyptus	4.1	RHS	0.7
531	23.47	Eucalyptus	2.95	RHS	1.7
532	23.478	Eucalyptus	8.3	RHS	0.7
533	23.485	Eucalyptus	8.1	RHS	1.9
534	23.49	Eucalyptus	4	RHS	1.6
535	23.492	Eucalyptus	5	RHS	1.2
536	23.492	Aam	7.8	RHS	0.4
537	23.495	Jamun	8	RHS	0.5
538	23.5	Siris	7.2	RHS	0.55
539	23.5	Siris	7.2	RHS	0.5
540	23.5	Siris	7.2	RHS	0.45
541	23.5	Siris	7.2	RHS	0.65
542	23.505	Siris	8.1	RHS	0.6
543	23.505	Neem	8	RHS	0.9
544	23.508	Eucalyptus	3.4	RHS	1.6
545	23.508	Neem	8.3	RHS	0.4
546	23.512	Eucalyptus	6.8	RHS	0.6
547	23.513	Eucalyptus	8	RHS	0.55
548	23.515	Eucalyptus	3.7	RHS	1.65
549	23.518	Eucalyptus	3.8	RHS	2.1
550	23.521	Eucalyptus	3.2	RHS	1.9
551	23.524	Eucalyptus	4	RHS	1.4
552	23.529	Eucalyptus	3.5	RHS	1.25
553	23.529	Sisam	8.2	RHS	0.4
554	23.529	Sisam	8.2	RHS	0.55
555	23.529	Sisam	7.1	RHS	0.45
556	23.529	Sisam	8.4	RHS	0.4
557	23.614	Eucalyptus	4.3	RHS	2.1
558	23.616	Babul	5.1	RHS	1.1
559	23.618	Babul	4.2	RHS	1.3
560	23.622	Eucalyptus	4	RHS	2.5
561	23.624	Eucalyptus	5.1	RHS	2.4
562	23.625	Eucalyptus	1.1	RHS	2.2
563	23.633	Sisam	8.2	RHS	0.4
564	23.633	Sisam	7.3	RHS	0.45
565	23.638	Sisam	8.5	RHS	0.45
566	23.64	Sisam	8.1	RHS	0.6
567	23.64	Sisam	7.5	RHS	0.45
568	23.64	Eucalyptus	4.3	RHS	2.4
569	23.642	Sisam	8.1	RHS	0.4
570	23.644	Eucalyptus	3	RHS	2.1
571	23.645	Babul	4.1	RHS	0.8
572	23.645	Eucalyptus	4	RHS	2.4
573	23.647	Eucalyptus	4.1	RHS	2.4
574	23.654	Eucalyptus	4.3	RHS	1.5
575	23.666	Eucalyptus	4.1	RHS	1.7

576	23.668	babul	4.2	RHS	1.8
577	23.67	Eucalyptus	4.5	RHS	2.4
578	23.675	Eucalyptus	4	RHS	2.4
579	23.682	Eucalyptus	4.2	RHS	1.8
580	23.694	Eucalyptus	4.1	RHS	2.1
581	23.74	Babul	1.3	RHS	1.45
582	23.74	Babul	4	RHS	0.5
583	23.745	Sahijan	1.5	RHS	0.55
584	23.747	Neem	1.1	RHS	0.55
585	23.755	Shirol	1.2	LHS	2
586	23.755	Shirol	1.3	LHS	1.1
587	23.755	Shirol	1	LHS	0.7
588	23.757	Shirol	4.3	RHS	1.4
589	23.757	Shirol	4.2	RHS	1.45
590	23.765	Shirol	4	RHS	0.55
591	23.765	Shirol	4	RHS	0.55
592	23.765	Neem	4.2	RHS	0.45
593	23.77	Siris	5.4	RHS	0.5
594	23.77	Siris	4	RHS	0.5
595	23.77	Siris	4	RHS	0.55
596	23.785	Neem	7.1	RHS	1.6
597	23.798	Neem	3.3	RHS	1.2
598	23.798	Neem	6.3	RHS	1.6
599	23.8	Sisam	1	RHS	1.2
600	23.8	Sisam	1.1	RHS	0.5
601	23.9	Palas	2.1	LHS	1.05
602	23.91	Neem	4.1	RHS	0.6
603	23.93	Balam Khira	7.3	RHS	1.6
604	23.93	Balam Khira	7.2	RHS	0.75
605	23.935	Balam Khira	7.3	RHS	1.5
606	23.937	Siris	6.2	LHS	1.1
607	23.937	Palas	9.7	RHS	1.2
608	23.941	Siris	7.1	LHS	1.1
609	23.945	Balam Khira	7	RHS	0.9
610	23.95	Balam Khira	7.1	RHS	1.8
611	23.952	Balam Khira	7.15	RHS	1.8
612	23.952	Balam Khira	7.24	RHS	1
613	23.962	Balam Khira	7.2	RHS	2.3
614	23.964	Balam Khira	7.18	RHS	2.3
615	23.972	Balam Khira	7.05	RHS	9
616	23.976	Balam Khira	7.35	RHS	1
617	23.976	Balam Khira	7.35	RHS	2.3
618	23.978	Palas	7.13	RHS	1.3
619	23.986	Balam Khira	6.9	RHS	2.1
620	23.991	Balam Khira	6.95	RHS	1.1
621	23.993	Balam Khira	6.8	RHS	1.6
622	23.994	Balam Khira	6.7	RHS	1.7
623	24	Balam Khira	7	RHS	1.7
624	24.116	Neem	7.2	RHS	1.3
625	24.12	Balam Khira	7.1	RHS	1.4
626	24.12	Balam Khira	1.1	RHS	1.3
627	24.13	Babul	1.05	LHS	0.5
628	24.133	Siris	1	LHS	1.1
629	24.147	Karol	2.1	RHS	1.3
630	24.151	Neem	1	LHS	1
631	24.153	Neem	1.3	LHS	1
632	24.27	Neem	1.4	LHS	1
633	24.43	Neem	9.05	RHS	1.3
634	24.5	Karol	9.7	RHS	0.8
635	24.5	Karol	9.7	RHS	0.5
636	24.505	Karol	9.7	RHS	1.4
637	24.515	Nariyal	9.7	RHS	1.3
638	24.525	Nariyal	7.2	LHS	1.4
639	24.525	Nariyal	7.2	RHS	1.25
640	24.529	Nariyal	9.1	LHS	1.3

641	24.534	Nariyal	9.1	RHS	1.2
642	24.534	Pipal	9.1	RHS	0.6
643	24.54	Nariyal	8.7	LHS	1.8
644	24.54	Nariyal	8.9	RHS	1.7
645	24.545	Nariyal	8.8	LHS	1.7
646	24.545	Neem	8.8	LHS	0.55
647	24.55	Nariyal	8	LHS	1.75
648	24.55	Neem	9	LHS	1
649	24.555	Nariyal	9.1	LHS	1.6
650	24.555	Siris	8.4	RHS	1.1
651	24.56	Pipal	9.1	LHS	1.3
652	24.56	Nariyal	9.1	RHS	1.2
653	24.561	Nariyal	9.3	LHS	1.3
654	24.564	Nariyal	9.7	LHS	1.4
655	24.57	Nariyal	9.4	LHS	1.45
656	24.575	Nariyal	8.9	LHS	1.5
657	24.58	Nariyal	8.7	LHS	1.6
658	24.582	Nariyal	8.6	LHS	1.7
659	24.6	Nariyal	9	RHS	1.6
660	24.605	Nariyal	9	RHS	1.4
661	24.605	Pipal	9.1	RHS	0.85
662	24.622	Nariyal	9	RHS	1
663	24.635	Semar	7.9	RHS	1.2
664	24.638	Nariyal	6.7	RHS	1.3
665	24.638	Nariyal	6.7	LHS	1.3
666	24.642	Nariyal	8	RHS	1.3
667	24.642	Semar	8.2	LHS	0.6
668	24.646	Nariyal	7	RHS	1.1
669	24.65	Nariyal	7.1	RHS	1.2
670	24.65	Neem	6.9	RHS	0.7
671	24.655	Nariyal	8.1	RHS	1.3
672	24.66	Nariyal	7.9	RHS	1.4
673	24.664	Nariyal	7.8	RHS	1.3
674	24.67	Nariyal	7.6	RHS	1.3
675	24.67	Nariyal	7.6	LHS	1.1
676	24.672	Sisam	8	LHS	0.55
677	24.675	Nariyal	8	LHS	1.3
678	24.675	Nariyal	9.1	RHS	1.4
679	24.68	Sisam	8.3	LHS	1
680	24.68	Nariyal	8.3	RHS	1.2
681	24.684	Nariyal	8.2	RHS	1.35
682	24.69	Nariyal	8.2	LHS	1.4
683	24.69	Nariyal	8.2	RHS	1.3
684	24.69	Nariyal	8.2	LHS	1.2
685	24.692	Nariyal	8.1	LHS	1.1
686	24.692	Nariyal	8	LHS	1.2
687	24.694	Nariyal	8.3	LHS	1.25
688	24.697	Nariyal	7.9	LHS	1.3
689	24.697	Nariyal	7.9	LHS	1.2
690	24.7	Nariyal	8	LHS	1.1
691	24.7	Nariyal	8.1	RHS	1.6
692	24.7	Nariyal	8.2	RHS	1.7
693	24.705	Neem	8.2	RHS	1.3
694	24.71	Nariyal	8.9	LHS	1.2
695	24.714	Nariyal	8.7	LHS	1.25
696	24.718	Nariyal	8.8	LHS	1.4
697	24.721	Nariyal	9	LHS	1.4
698	24.724	Nariyal	9	LHS	1.45
699	24.728	Nariyal	9.1	LHS	1.6
700	24.73	Nariyal	9.2	LHS	1.65
701	24.732	Nariyal	9.1	LHS	0.9
702	24.732	Sisam	9	LHS	0.9
703	24.75	Sisam	3	RHS	0.6
704	24.75	Sisam	3.9	RHS	0.7
705	24.75	Pipal	6.8	RHS	1

706	24.755	Pipal	8	RHS	1.1
707	24.755	Kadam	7.9	RHS	0.4
708	24.755	Siris	7	RHS	1.2
709	24.755	Ber	8.1	RHS	1.1
710	24.755	Sisam	9.7	RHS	1.1
711	24.755	Ber	3	RHS	0.55
712	24.755	Semar	2.9	RHS	0.9
713	24.755	Siris	3.1	RHS	0.5
714	24.76	Siris	3	RHS	1.35
715	24.76	Siris	3	RHS	0.5
716	24.76	Siris	3.3	RHS	0.55
717	24.76	Siris	2.9	RHS	0.6
718	24.76	Siris	2.9	RHS	0.4
719	24.762	Siris	3.1	RHS	0.5
720	24.762	Siris	3.2	RHS	1.1
721	24.765	Sisam	3	RHS	0.9
722	24.767	Siris	3	RHS	1.3
723	24.769	Siris	3.1	RHS	1
724	24.771	Siris	2.9	RHS	0.4
725	24.773	Siris	2.8	RHS	0.7
726	24.774	Siris	3	RHS	1.4
727	24.784	Siris	3	RHS	1.05
728	24.786	Siris	4.9	RHS	1
729	24.788	Siris	6.1	RHS	0.9
730	24.79	Siris	1	RHS	1.6
731	24.792	Siris	7.1	RHS	1.63
732	24.794	Siris	8.1	RHS	1.3
733	24.796	Siris	9.1	RHS	0.5
734	24.798	Siris	9.7	RHS	0.5
735	24.798	Siris	9.8	RHS	1.4
736	24.8	Sisam	9.7	RHS	1
737	24.801	Siris	9.7	RHS	1
738	24.802	Kadam	9.75	RHS	0.7
739	24.802	Siris	9.7	RHS	1.15
740	24.804	Semar	9.6	RHS	1.9
741	24.806	Siris	9.9	RHS	1.3
742	24.808	Kadam	9.7	RHS	0.8
743	24.81	Siris	9.7	RHS	1.35
744	24.813	Kadam	9.7	RHS	0.45
745	24.815	Siris	9.7	RHS	1.35
746	24.817	Babul	9.7	RHS	1.1
747	24.82	Neem	8.9	LHS	0.5
748	24.827	Semar	8.9	RHS	1.5
749	24.827	Neem	8	LHS	1.4
750	25.1	Karol	9.2	LHS	0.7
751	25.108	Neem	7.9	LHS	1.1
752	25.113	Neem	8.8	LHS	0.9
753	25.114	Neem	9.8	LHS	1.3
754	25.117	Kadam	9.9	LHS	1.5
755	25.127	Siras	8.85	LHS	0.7
756	25.13	Siras	8.9	LHS	0.85
757	25.133	Siras	8	LHS	0.65
758	25.133	Siras	8.2	LHS	0.6
759	25.14	Siras	8.1	LHS	0.8
760	25.145	Siras	9.7	LHS	1.4
761	25.145	Neem	8.9	LHS	1.6
762	25.148	Siris	9.1	LHS	1.1
763	25.152	Siris	9	LHS	1
764	25.156	Karol	9.8	LHS	1.45
765	25.163	Babul	9.7	LHS	0.8
766	25.163	Semar	9.9	RHS	0.4
767	25.163	Semar	9	RHS	0.4
768	25.163	Jangli Jalebi	8.9	RHS	1.6
769	25.163	Neem	9.7	RHS	1.6
770	25.17	Babul	9.8	RHS	1.4

771	25.187	Neem	9.7	LHS	1.3
772	25.25	Sisam	8	LHS	1.2
773	25.25	Babul	9	RHS	1.3
774	25.295	Babul	9.8	LHS	1.4
775	25.295	Siris	9	RHS	0.5
776	25.3	Babul	9.9	RHS	1.4
777	25.3	Babul	9.7	RHS	1.35
778	25.31	Semar	9.1	RHS	1
779	25.31	Semar	9.1	RHS	1.2
780	25.37	Neem	9.8	RHS	1.4
781	25.38	Sisam	9.8	LHS	1.2
782	25.425	Neem	16.1	RHS	1.1
783	25.425	Aam	21.5	LHS	0.8
784	25.425	Bargad	20.25	LHS	0.8
785	25.425	Neem	22.7	LHS	0.55
786	25.43	Jamun	17.2	RHS	2.4
787	25.43	Siris	22.6	RHS	0.9
788	25.43	Siris	22.6	RHS	0.9
789	25.432	Siris	21.8	RHS	0.6
790	25.435	Kadam	21.1	LHS	1
791	25.438	Bargad	19.8	LHS	2.45
792	25.441	Katahal	17.35	LHS	1.25
793	25.45	Siris	15.4	RHS	2.1
794	25.45	Jangli Jalebi	22.7	RHS	1.1
795	25.45	Jangli Jalebi	23	RHS	0.9
796	25.451	Pipal	21.65	LHS	6.95
797	25.467	Gul Mohar	24.35	LHS	1.4
798	25.468	Jangli Jalebi	15.4	RHS	0.4
799	25.468	Neem	16.3	RHS	0.55
800	25.47	Gul Mohar	20.2	LHS	1.35
801	25.48	Gul Mohar	23.8	LHS	2.25
802	25.48	Gul Mohar	23.9	LHS	2
803	25.48	Semar	9	LHS	0.5
804	25.48	Neem	8	LHS	0.5
805	25.48	Neem	7.9	LHS	0.4
806	25.48	Neem	7.8	LHS	0.45
807	25.482	Jamun	23.9	RHS	1.3
808	25.482	Pipal	24.1	RHS	0.9
809	25.485	Jamun	14.2	RHS	1.3
810	25.485	Neem	17.2	RHS	1.1
811	25.485	Katahal	13.1	RHS	1.1
812	25.485	Neem	14.2	RHS	1.6
813	25.495	Neem	13	RHS	1.4
814	25.495	Siris	18	RHS	0.7
815	25.495	Siris	22	RHS	1.3
816	25.495	Jamun	22	RHS	1.3
817	25.495	Jamun	13	RHS	0.9
818	25.5	Neem	8	LHS	0.5
819	25.503	Neem	9	LHS	0.4
820	25.504	Siris	9	LHS	0.4
821	25.504	Siris	9	LHS	0.55
822	25.508	Neem	15	RHS	1.3
823	25.508	Neem	17	RHS	1
824	25.51	Palas	9.9	RHS	1.5
825	25.518	Neem	15	RHS	1.3
826	25.518	Siris	20	RHS	1.15
827	25.518	Siris	22	RHS	1.3
828	25.518	Jamun	13	RHS	1
829	25.518	Babul	12	RHS	0.9
830	25.52	Gul Mohar	17	LHS	0.8
831	25.52	Gul Mohar	17.8	LHS	0.5
832	25.52	Gul Mohar	22.1	LHS	0.7
833	25.522	Gul Mohar	15.2	LHS	1.1
834	25.522	Gul Mohar	24.2	LHS	0.5
835	25.523	Gul Mohar	24.2	LHS	0.4

836	25.525	Neem	15	RHS	1.2
837	25.525	Neem	20	RHS	1
838	25.53	Babul	14	RHS	1.1
839	25.535	Siris	18	RHS	1.1
840	25.535	Siris	18	RHS	1.2
841	25.535	Siris	18	RHS	1.15
842	25.537	Gul Mohar	17.1	LHS	1
843	25.537	Gul Mohar	13	LHS	0.9
844	25.539	Gul Mohar	15	LHS	0.75
845	25.539	Gul Mohar	15	LHS	1.3
846	25.54	Gul Mohar	13.9	LHS	1.4
847	25.54	Gul Mohar	14.7	LHS	0.5
848	25.545	Gul Mohar	14.9	LHS	1.4
849	25.548	Gul Mohar	14.8	LHS	1.2
850	25.548	Gul Mohar	13.2	LHS	0.9
851	25.549	Eucalyptus	13.1	LHS	1.4
852	25.549	Eucalyptus	14	LHS	1.35
853	25.55	Siris	15	RHS	0.9
854	25.55	Siris	16	RHS	1.1
855	25.55	Siris	21	RHS	0.95
856	25.66	Jangli Jalebi	9.7	LHS	1.7
857	25.675	Neem	9.9	LHS	1.4
858	25.81	Sisam	9.8	RHS	0.9
859	25.9	Siris	9.9	RHS	1
860	25.905	Neem	9.7	RHS	1
861	25.91	Neem	8.9	RHS	1.2
862	25.915	Neem	9.1	RHS	1
863	25.918	Neem	8.9	RHS	1
864	25.92	Neem	7.9	RHS	0.8
865	25.923	Neem	8	RHS	0.7
866	25.937	Neem	9	LHS	1.15
867	25.95	Neem	7	LHS	1
868	25.99	Neem	8	RHS	1.2
869	26.005	Karol	9.5	LHS	1.1
870	26.3	Sisam	6.7	RHS	1.8
871	26.31	Sisam	7	RHS	0.5
872	26.32	Sisam	7	RHS	1.4
873	26.32	Sisam	6.7	RHS	0.5
874	26.325	Sisam	6.9	RHS	1.1
875	26.33	Sisam	2	RHS	0.7
876	26.332	Sisam	2.9	RHS	0.8
877	26.34	Sisam	1.3	LHS	0.8
878	26.35	Neem	1.4	RHS	1.3
879	26.358	Neem	2	RHS	1.2
880	26.405	Neem	4.9	LHS	1.8
881	26.62	Amrud	1	LHS	0.45
882	26.625	Aam	5	LHS	1.3
883	26.625	Aam	5	LHS	1.4
884	26.63	Sahijan	3	RHS	1
885	26.64	Amrud	3	LHS	0.4
886	26.645	Amrud	3	LHS	0.4
887	26.647	Amrud	1.1	RHS	0.5
888	26.65	Neem	1.5	RHS	0.6
889	26.65	Neem	1.5	RHS	0.7
890	26.65	Neem	1.5	RHS	1.2
891	26.65	Neem	1.5	RHS	1.2
892	26.79	Katahal	1.5	LHS	0.7
893	26.79	Aanwala	1.5	LHS	0.45
894	26.79	Nibu	1.5	LHS	0.25
895	26.79	Chiku	1.5	LHS	0.45
896	26.89	Katahal	3	RHS	1.15
897	26.895	Neem	3	RHS	1.15
898	26.9	Siras	5	LHS	0.6
899	26.905	Siras	5	LHS	0.7
900	27.17	Neem	3	RHS	1.3

901	27.175	Gul Mohar	3	RHS	1.2
902	27.177	Siras	5	LHS	1.1
903	27.21	Jamun	5	LHS	1.2
904	27.2	Bargad	5	LHS	1.3
905	27.21	Pipal	15	LHS	1.4
906	27.41	Bargad	8.1	RHS	3
907	27.41	Neem	8.1	RHS	1
908	27.415	Pipal	8.1	RHS	1
909	27.417	Sisam	7	LHS	1.1
910	27.417	Jamun	3	LHS	1.1
911	27.42	Nariyal	3	LHS	1.4
912	27.73	Neem	7	RHS	0.8
913	27.73	Kadam	7	RHS	1.2
914	27.732	Neem	8.5	LHS	0.8
915	27.733	Neem	8.5	LHS	1.6
916	27.733	Neem	9.8	LHS	1.2
917	27.735	Sahijan	9.8	LHS	0.5
918	28.24	Pipal	10.5	LHS	7.1
919	28.241	Ashok	10.5	LHS	0.3
920	28.242	Ashok	10.5	LHS	0.3
921	28.243	Ashok	10.5	LHS	0.3
922	28.243	Jangli Jalebi	10.5	LHS	2.3
923	28.244	Ashok	10.5	LHS	0.3
924	28.245	Ashok	10.5	LHS	0.3
925	28.246	Ashok	10.5	LHS	0.3
926	28.246	Neem	18.5	LHS	1.25
927	28.247	Ashok	10.5	LHS	0.3
928	28.248	Ashok	10.5	LHS	0.3
929	28.248	Ashok	17.4	LHS	1.7
930	28.248	Ashok	12.1	LHS	1.35
931	28.249	Ashok	10.5	LHS	0.3
932	28.25	Ashok	10.5	LHS	0.3
933	28.251	Ashok	10.5	LHS	0.3
934	28.252	Ashok	10.5	LHS	0.3
935	28.253	Ashok	10.5	LHS	0.3
936	28.254	Ashok	10.5	LHS	0.3
937	28.255	Ashok	10.5	LHS	0.3
938	28.256	Ashok	10.5	LHS	0.3
939	28.257	Ashok	10.5	LHS	0.3
940	28.258	Ashok	10.5	LHS	0.3
941	28.259	Ashok	10.5	LHS	0.3
942	28.26	Ashok	10.5	LHS	0.3
943	28.261	Ashok	10.5	LHS	0.3
944	28.262	Ashok	10.5	LHS	0.3
945	28.263	Ashok	10.5	LHS	0.3
946	28.264	Ashok	10.5	LHS	0.3
947	28.265	Ashok	10.5	LHS	0.3
948	28.266	Ashok	10.5	LHS	0.3
949	28.267	Ashok	10.5	LHS	0.3
950	28.268	Ashok	10.5	LHS	0.3
951	28.269	Ashok	10.5	LHS	0.3
952	28.27	Ashok	10.5	LHS	0.3
953	28.271	Ashok	10.5	LHS	0.3
954	28.272	Ashok	10.5	LHS	0.3
955	28.273	Ashok	10.5	LHS	0.3
956	28.274	Ashok	10.5	LHS	0.3
957	28.275	Ashok	10.5	LHS	0.3
958	28.276	Ashok	10.5	LHS	0.3
959	28.277	Ashok	10.5	LHS	0.3
960	28.278	Ashok	10.5	LHS	0.3
961	28.278	Khajur	13.4	LHS	1.1
962	28.279	Ashok	10.5	LHS	0.3
963	28.28	Ashok	10.5	LHS	0.3
964	28.281	Ashok	10.5	LHS	0.3
965	28.282	Ashok	10.5	LHS	0.3

966	28.283	Ashok	10.5	LHS	0.3
967	28.284	Ashok	10.5	LHS	0.3
968	28.285	Ashok	10.5	LHS	0.3
969	28.286	Ashok	10.5	LHS	0.3
970	28.287	Ashok	10.5	LHS	0.3
971	28.288	Ashok	10.5	LHS	0.3
972	28.289	Ashok	10.5	LHS	0.3
973	28.289	Ashok	10.5	LHS	0.3
974	28.41	Kadam	8.9	LHS	1.5
975	28.412	Kadam	8.95	LHS	1.25
976	28.415	Kadam	8.7	LHS	1.25
977	28.425	Kadam	8.8	LHS	1.2
978	28.425	Kadam	8.9	LHS	1.35
979	28.435	Kadam	8.2	LHS	0.8
980	28.455	Siris	7	LHS	0.85
981	28.46	Siris	3	LHS	0.9
982	28.465	Siris	5	LHS	0.9
983	28.467	Siris	5	LHS	0.9
984	28.469	Siris	5	LHS	1.5
985	28.469	Siris	5	LHS	1.4
986	28.474	Siris	5	LHS	1.2
987	28.476	Siris	5	LHS	0.9
988	28.478	Siris	5	LHS	1.4
989	28.48	Eucalyptus	3	LHS	1.35
990	31.737	Babul	6.9	LHS	0.8
991	31.737	Sikanji	7.8	RHS	1.1
992	31.737	Sikanji	7.9	RHS	0.9
993	31.738	Sikanji	7.9	RHS	0.45
994	31.738	Sisam	6.8	RHS	0.9
995	31.739	Neem	6	LHS	0.9
996	31.74	Neem	8.9	LHS	0.35
997	31.74	Jamun	7.9	LHS	0.35
998	31.74	Ber	7.8	LHS	0.4
999	31.744	Ashok	7.8	LHS	0.3
1000	31.745	Ashok	7.8	LHS	0.4
1001	31.76	Siris	7.8	LHS	0.55
1002	31.762	Jamun	7.8	LHS	1
1003	31.765	Amrud	7.8	LHS	0.3
1004	31.775	Ber	7.9	LHS	0.45
1005	31.78	Ashok	8	LHS	0.55
1006	31.782	Neem	7.8	LHS	0.35
1007	31.795	Ber	8	LHS	0.25
1008	31.8	Gul Mohar	8	LHS	1.1
1009	31.84	Siris	7.7	LHS	1.1
1010	31.845	Siris	7.8	LHS	1
1011	31.85	Jamun	7.9	RHS	1.05
1012	32.5	Ashok	7.9	RHS	1.25
1013	32.6	Sikanji	6.5	LHS	2.5
1014	32.605	Imili	8.6	RHS	3.5
1015	32.635	Sikanji	6.6	LHS	1.5
1016	32.64	Sikanji	7	RHS	1.6
1017	32.71	Imili	4.3	LHS	3
1018	32.71	Gul Mohar	7.9	LHS	4.5
1019	32.725	Pipal	7.8	LHS	1.7
1020	32.73	Sisam	9.2	LHS	1.1
1021	32.74	Sisam	7	LHS	1.7
1022	32.745	Sisam	6.7	LHS	1.1
1023	32.755	Sisam	6.9	LHS	1
1024	32.828	Ashok	7.8	RHS	1
1025	32.828	Ashok	6.8	RHS	1.2
1026	32.83	Ashok	6.8	RHS	0.9
1027	32.835	Sisam	6	LHS	1.25
1028	32.835	Sisam	6.9	LHS	1.35
1029	32.837	Sisam	6.8	LHS	1.2
1030	32.839	Sisam	6.85	LHS	1.3

1031	32.85	Imili	5.7	LHS	5.5
1032	32.85	Ashok	6.9	RHS	0.6
1033	32.85	Ashok	6.8	RHS	1.2
1034	32.85	Ashok	6.9	RHS	0.9
1035	32.85	Ber	6.7	LHS	0.45
1036	32.89	Neem	6.9	LHS	1.7
1037	32.9	Sisam	9.5	LHS	1.4
1038	32.91	Sisam	5.9	LHS	1
1039	32.92	Sisam	7	LHS	0.9
1040	32.925	Sisam	8.8	LHS	2.3
1041	32.927	Sisam	7.2	LHS	1.2
1042	32.94	Sisam	8.3	LHS	1.3
1043	32.945	Sisam	7.1	LHS	1.2
1044	32.95	Nariyal	6.5	RHS	1.3
1045	32.955	Sisam	9.5	LHS	1.4
1046	32.955	Jangli Jalebi	7	RHS	1.2
1047	32.98	Sisam	4.9	LHS	1.2
1048	32.98	Sisam	4.9	LHS	1.45
1049	32.985	Sisam	6.1	LHS	1
1050	32.99	Khajur	7.1	RHS	0.9
1051	32.99	Sisam	9.5	LHS	0.9
1052	33.02	Sisam	6.5	RHS	1.4
1053	33.025	Sisam	6.9	LHS	1.2
1054	33.027	Sisam	5.8	LHS	1.3
1055	33.03	Sisam	7	LHS	1.5
1056	33.05	Sisam	9.5	LHS	1.8
1057	33.065	Sisam	6.8	LHS	1.2
1058	33.065	Sisam	6.9	LHS	1.35
1059	33.065	Sisam	7.2	RHS	1
1060	33.08	Sisam	9	RHS	1.3
1061	33.085	Siris	7.1	RHS	1.1
1062	33.085	Sisam	9.3	RHS	1.4
1063	33.085	Sisam	6	RHS	1.1
1064	33.085	Sisam	9.1	RHS	1.5
1065	33.085	Sisam	6.2	LHS	1.4
1066	33.085	Sisam	7.1	LHS	1.2
1067	33.085	Sisam	6.9	LHS	1.4
1068	33.09	Siris	7	RHS	0.55
1069	33.092	Siris	7	RHS	0.35
1070	33.092	Sisam	7	LHS	2.5
1071	33.093	Sisam	8.5	LHS	2.35
1072	33.095	Ber	7	RHS	0.7
1073	33.095	Siris	7	RHS	1.3
1074	33.095	Sisam	7	LHS	1.2
1075	33.095	Sisam	7	LHS	1.1
1076	33.095	Neem	7	RHS	1.1
1077	33.1	Neem	7	RHS	0.9
1078	33.105	Sisam	7	LHS	0.9
1079	33.105	Sisam	6.9	LHS	0.85
1080	33.105	Sisam	8	LHS	0.9
1081	33.11	Sisam	9	LHS	0.95
1082	33.115	Sisam	8	LHS	1.1
1083	33.135	Sisam	9	LHS	1.2
1084	33.14	Sisam	7	LHS	1.6
1085	33.15	Sisam	8	LHS	1.8
1086	33.165	Aam	7	RHS	0.3
1087	33.2	Sisam	9	LHS	2.3
1088	33.205	Sisam	9	LHS	2.2
1089	33.21	Sisam	9	LHS	1.8
1090	33.215	Sisam	9	LHS	2.4
1091	33.23	Sisam	7	LHS	1.6
1092	33.23	Sisam	7.1	LHS	1.2
1093	33.245	Sisam	6.9	RHS	0.2
1094	33.29	Neem	8	RHS	1
1095	33.305	Khajur	7	LHS	1.25

1096	33.305	Khajur	9.5	LHS	0.9
1097	33.325	Sisam	9.2	LHS	1.7
1098	33.39	Eucalyptus	9.2	RHS	1.4
1099	33.395	Eucalyptus	9.5	RHS	2
1100	33.4	Eucalyptus	9.5	RHS	1
1101	33.41	Chiku	9.5	RHS	1.6
1102	33.44	Eucalyptus	4.1	RHS	1.7
1103	33.445	Eucalyptus	6.9	RHS	1.8
1104	33.445	Eucalyptus	7	RHS	1.6
1105	33.46	Siris	7	RHS	1.2
1106	33.49	Aam	9.5	LHS	1
1107	33.495	Sahijan	7	RHS	1.1
1108	33.5	Amrud	7	RHS	0.35
1109	33.525	Imili	6	RHS	1.7
1110	33.53	Aam	9	LHS	0.5
1111	33.54	Siris	9.5	LHS	1.2
1112	33.545	Siris	11.1	RHS	0.6
1113	33.6	Pipal	7	LHS	2.5
1114	33.61	Khajur	8	RHS	1
1115	33.7	Pipal	9	RHS	1.8
1116	33.725	Pipal	8	LHS	1
1117	33.8	Pipal	5	RHS	6
1118	33.873	Siris	7	LHS	1
1119	33.873	Siris	7.5	LHS	1
1120	33.875	Siris	8	RHS	1.45
1121	33.88	Siris	8	RHS	1.1
1122	33.88	Siris	8	RHS	1
1123	33.9	Babul	8	RHS	1.1
1124	33.905	Sisam	4	LHS	0.45
1125	33.925	Eucalyptus	12.2	RHS	1.3
1126	33.925	Eucalyptus	13.1	LHS	1.3
1127	33.93	Eucalyptus	13.1	RHS	1
1128	33.93	Eucalyptus	14.2	LHS	1.3
1129	33.935	Eucalyptus	12.9	RHS	1.2
1130	33.935	Eucalyptus	12.9	LHS	1.1
1131	33.939	Eucalyptus	12.3	RHS	1.2
1132	33.939	Eucalyptus	12.3	LHS	1.4
1133	33.945	Eucalyptus	12.4	RHS	1.4
1134	33.945	Eucalyptus	12	LHS	1.4
1135	33.95	Eucalyptus	13.4	LHS	1.5
1136	33.98	Siris	9	RHS	0.8
1137	34.01	Babul	9	RHS	1
1138	34.015	Babul	7	RHS	1.6
1139	34.021	Gul Mohar	7	RHS	1
1140	34.025	Gul Mohar	9	RHS	1.3
1141	34.03	Gul Mohar	9	RHS	0.2
1142	34.07	Babul	9	RHS	1.1
1143	34.085	Siris	8.1	LHS	0.7
1144	34.087	Eucalyptus	12.1	RHS	1.8
1145	34.089	Eucalyptus	13.3	RHS	1.3
1146	34.09	Eucalyptus	11.9	RHS	1.4
1147	34.09	Siris	8	LHS	0.8
1148	34.1	Siris	8	LHS	2.1
1149	34.18	Gul Mohar	8	RHS	0.85
1150	34.28	Babul	8	LHS	1.3
1151	34.285	Siris	6	RHS	1
1152	34.288	Siris	6	RHS	0.8
1153	34.29	Siris	8	RHS	0.75
1154	34.295	Siris	8	RHS	0.75
1155	34.295	Siris	8	RHS	0.75
1156	34.298	Siris	7	RHS	0.75
1157	34.3	Gul Mohar	8	LHS	1.4
1158	34.31	Gul Mohar	8	LHS	0.8
1159	34.315	Neem	9	RHS	1.1
1160	34.42	Siris	7	RHS	1.3

1161	34.43	Siris	7	RHS	1
1162	34.435	Siris	8	LHS	0.85
1163	34.44	Siris	8	LHS	0.85
1164	34.45	Siris	8	LHS	1
1165	34.465	Siris	7	LHS	1.4
1166	34.47	Siris	7	LHS	1.8
1167	34.485	Khajur	9	RHS	1.3
1168	34.485	Sisam	9	LHS	0.95
1169	34.485	Siris	7	LHS	1.2
1170	34.5	Babul	7	RHS	1.4
1171	34.515	Gul Mohar	8	LHS	2
1172	34.52	Sisam	7	LHS	1
1173	34.55	Sisam	7	LHS	1.2
1174	34.565	Gul Mohar	7	LHS	1.25
1175	34.567	Sisam	8	LHS	1.5
1176	34.57	Sisam	9	LHS	1.1
1177	34.625	Siris	9	LHS	1
1178	34.63	Siris	7	LHS	0.9
1179	34.64	Siris	7	RHS	2
1180	34.75	Babul	6	RHS	2
1181	34.756	Sisam	8	LHS	1
1182	34.76	Neem	8	RHS	1.05
1183	34.8	Sisam	8	RHS	1.4
1184	34.805	Babul	8	LHS	0.6
1185	34.81	Neem	8	LHS	1.2
1186	34.815	Bargad	5	RHS	1.8
1187	34.82	Sahijan	5	LHS	1
1188	34.825	Khajur	8	LHS	1
1189	34.875	Gul Mohar	9	RHS	1.4
1190	34.88	Neem	8	LHS	1.4
1191	34.91	Siris	8	LHS	0.5
1192	34.915	Neem	7	LHS	1.4
1193	34.917	Eucalyptus	8	RHS	1.6
1194	34.98	Sikanji	8	RHS	1.4
1195	34.98	Sikanji	8	RHS	1.3
1196	34.985	Neem	7	LHS	0.9
1197	35.01	Pipal	4	LHS	2
1198	35.025	Pipal	5	RHS	1.8
1199	35.4	Pipal	20	LHS	2

Red Line (Bhadbhada square to RATNAGIRI TIRAHA)									
LOCATION	LEFT			MIDDLE			RIGHT		
	NAME OF TREES	GIRTH	QNTY	NAME OF TREES	GIRTH	QNTY	NAME OF TREES	GIRTH	QNTY
BHADBHADA S QUARE	BADH	3	1	-	-	-	KHAJUR	1.4	2
	FALI	1.5,1.8	4	-	-	-	FALI	1.5,1.8	4
	TREE	1.3	1	-	-	-	CHILBIL	1	2
	FALI	1.2	2	-	-	-	FALI	1.3	1
	LYPTUS	1.2	1	-	-	-	FALI	1.4	2
	FALI	1.3	3	-	-	-	LYPTUS	1	1
	SISAM	1.3	1	-	-	-	SERES	1.6	4
	FALI	1.4	1	-	-	-	SISAM	1.4	1
	CHILBIL	1.4	1	-	-	-	SERES	1.6	4
	-	-	-	-	-	-	SISAM	1.7	2
	-	-	-	-	-	-	FALI	1.6	2

	-	-	-	-	-	-	LYPTUS	1.8	2
	-	-	-	-	-	-	SISAM	1.5	2
	-	-	-	-	-	-	SISAM	1.4	2
	-	-	-	-	-	-	MAHUA	3	1
	-	-	-	-	-	-	TREE	1.5	1
	-	-	-	-	-	-	SISAM	1.3	1
	-	-	-	-	-	-	MAHUA	2.8	1
SF QUARTER U/ C BUILDING	-	-	-	-	-	-	AAM	1.6	1
	SISAM	1.3	1	-	-	-	IMLI	1.2	1
	CHILBIL	1.8	1	-	-	-	SISAM	1.4	2
	CHILBIL	1.5	5	-	-	-	SISAM	1.2	2
	CHILBIL	1.4	2	-	-	-	CHILBIL	1.2	1
	CHILBIL	1.6	2	-	-	-	CHILBIL	1	1
	-	-	-	-	-	-	NEEM	1.5	3
	-	-	-	-	-	-	MAHA NE EM	1.4	1
	LYPTUS	1.8	5	-	-	-	CHILBIL	1.2	1
	CHILBIL	1.8	1	-	-	-	SISAM	1.4	1
	CHILBIL	1.4	3	-	-	-	LYPTUS	1.3	2
	-	-	-	-	-	-	LYPTUS	1.3	1
	-	-	-	-	-	-	CHILBIL	1.5	1
	-	-	-	-	-	-	SISAM	1.6	2
	-	-	-	-	-	-	TREE	1.3	1
	-	-	-	-	-	-	CHILBIL	1.5	2
	-	-	-	-	-	-	LYPTUS	1.4	1
	-	-	-	-	-	-	FALI	1.6	1
	-	-	-	-	-	-	CHILBIL	1.4	1
	NEEM	1.2	1	-	-	-	NEEM	1.3	5
	CHILBIL	1.3	1	-	-	-	SISAM	1.4	2
	TREE	1.3	2	-	-	-	FALI	1.2	2
	BADH	1.2	1	-	-	-	BADH	1.9	1
DEPOT SQUARE		1.5,2	6	-	-	-	BADH	1.4	1
	LYPTUS	1.4	1	-	-	-	FALI	0.8,1	4
	NEEM	1.5	1	-	-	-	SISAM	1.2	1
	SISAM	1.4	1	-	-	-	FALI	1.4	6
	FALI	1.3	1	-	-	-	TREE	1.3	7
	ASHOK	1.5,2	6	-	-	-	LYPTUS	1.6	1
	FALI	1.6	1	-	-	-	FALI	1.8,2	6
	BABUL	1.5,2	4	-	-	-	TREES	1.2	6
	NARYAL	1.5	2	-	-	-	-	-	-
	FALI	1.9	1	-	-	-	-	-	-
	PIPAL	1.4	1	-	-	-	-	-	-
	CHILBIL	1.3	1	-	-	-	KARONJ	1.5	4

	NEEM	1.9	1	-	-	-	MAHA NEEM	1.7	6
	CHILBIL	1.4	2	-	-	-	FALI	1.6	3
	MAHA NEEM	-	-	-	-	-	BADH	1.3	1
	-	-	-	-	-	-	PIPAL	1.8,2.2	2
	-	-	-	-	-	-	MAHA NEEM	1.6,2.3	5
	-	-	-	-	-	-	NEEM	1.6	4
	-	-	-	-	-	-	TREE	1.7	5
	-	-	-	-	-	-	MAHA NEEM	1.2,2.2	10
	-	-	-	-	-	-	FALI	1.4,1.9	5
	-	-	-	-	-	-	NEEM	1.5,2	5
JAWAHAR CHOWK	LYPTUS	-	-	-	-	-	KARONJ	1.4,1.9	5
		1	25	-	-	-	SISAM	1.3	2
	MAHA NEEM	1.2,2	3	-	-	-	PIPAL	1.5,2	3
	PIPAL	1.9	1	-	-	-	BADH	2.5	1
	MAHA NEEM	1	1	-	-	-	ASHOK	1.6	9
	PIPAL	2	2	-	-	-	-	-	-
RANGMAHAL SQUARE	MAHA NEEM	1.5	2	-	-	-	-	-	-
	BADH	1.5,1.9	2	-	-	-	-	-	-
	BABUL	1.5	2	-	-	-	-	-	-
ROSHANPURA SQUARE	PIPAL	2.5	2	-	-	-	-	-	-
	-	-	-	-	-	-	NEEM	1.9	1
	-	-	-	-	-	-	SISAM	1.8	1
	-	-	-	-	-	-	TREE	1.4	1
	-	-	-	-	-	-	NEEM	2.8	1
	-	-	-	-	-	-	BADH	1.6	1
	-	-	-	-	-	-	GUL MOHAR	1.5	1
	-	-	-	-	-	-	SERES	1.5,2.5	14
	-	-	-	-	-	-	NEEM	1.6	1
	-	-	-	-	-	-	NEEM	2.5,3	7
	-	-	-	-	-	-	KARONJ	1.5,2	5
	-	-	-	-	-	-	PIPAL	2.3	1
	-	-	-	-	-	-	NEEM	2.3	1
PANJIYAN BHAWAN	NEEM	2.5,3	11	-	-	-	-	-	-
	NEEM	1.9,2.2	2	-	-	-	-	-	-
	CHILBIL	1.6,1.9	2	-	-	-	-	-	-
	NEEM	1.8	1	-	-	-	-	-	-
	NEEM	3	1	-	-	-	-	-	-
	CHILBIL	1.5	1	-	-	-	-	-	-
	NEEM	2.5	1	-	-	-	-	-	-
	CHILBIL	3	1	-	-	-	-	-	-

	SISAM	1.2	1	-	-	-	-	-	-
	NEEM	1.6	1	-	-	-	-	-	-
	LYPTUS	1.7	1	-	-	-	-	-	-
	ASHOK	1.6	1	-	-	-	-	-	-
	MAHA NEEM	1.6	2	-	-	-	-	-	-
	LYPTUS	3	1	-	-	-	-	-	-
	NEEM	1.4	1	KATHAL	2	1	-	-	-
	FALI	1.3	1	SISAM	1.4	5	-	-	-
	-	-	-	ASHOK	1.3	4	NEEM	2.8	1
				MAHA Neem	2.5	1	Ashok	1	22
				ASHOK	1	9	LYPTUS	2.5	1
				SISAM	1.2	3	SISAM	1.6	3
JAHANGIRABAD	-	-	-	NEEM	1.3	1	-	-	-
	ASHOK	1.3	2	-	-	-	NEEM	1.3	1
	CHIBIL	1.5, 2.5	4	-	-	-	LYPTUS	1.6, 2	5
	-	-	-	-	-	-	BADH	1.2	1
JINSI TIRAHA	Imli	1.6	1	-	-	-	MAHA NEEM	1.7	1
	PIPAL	2.3	1	-	-	-	-	-	-
	tree	2.5	1	-	-	-	-	-	-
	fali	1	1	-	-	-	-	-	-
	MAHA NEEM	1.2	1	-	-	-	-	-	-
	LYPTUS	1.2	1	-	-	-	PIPAL	2.3	6
	-	-	-	-	-	-	GUL MOHAR	1.2	2
	-	-	-	-	-	-	Badam	1.3	1
	-	-	-	-	-	-	NEEM	1.3	1
	-	-	-	-	-	-	NEEM	1.3	3
	-	-	-	-	-	-	PIPAL	2	1
	-	-	-	-	-	-	PIPAL	1.2	1
	NEEM	1.9	1	-	-	-	-	-	-
	SEMAL	2	4	-	-	-	-	-	-
BHEL GATE NO 3	MAHA NEEM	1.5	1	TREE	1	1	-	-	-
	SISAM	2	23	LYPTUS	2	1	-	-	-
	MAHA NEEM	2.5	1	-	-	-	-	-	-
	SERES	1.6	1	-	-	-	KARANJ	1	10
	SERES	1.9	6	MAHA NEEM	1.5 2		MAHA NEEM	1.5,2	3
	ASHOK	1	3	-	-		MAHA NEEM	2	6
	ASHOK	1	3	-	-	-	BAIR	1.5	1
	BABUL	1.3	1	-	-	-	MAHA NEEM	1.8	2
	SISAM	1.4	1	-	-	-	SISAM	1.3	2
	FALI	1.5	5	-	-	-	-	-	-
	BAIR	1	1	-	-	-	-	-	-

	SERES	1.2	2	-	-	-	-	-	-
	SERES	1.5,2	7	-	-	-	-	-	-
	BAIR	1.5	2	-	-	-	-	-	-
	MAHA NEEM	1.8	2	-	-	-	-	-	-
	NEEM	1	1	-	-	-	-	-	-
PIPLANI PETROLPUMP	SISAM	1	1	-	-	-	-	-	-
	MAHA NEEM	1.5	4	MAHA NEEM	1.2	1	TREES	1	16
	NEEM	0.5	1	-	-	-	SISAM	1	2
	NEEM	1,1.5	4	-	-	-	SERES	1.3	2
	MAHA NEEM	1.5	2	-	-	-	MAHA NEEM	1.5	2
	SISAM	1	1	-	-	-	SATPEDWA	1.5,2	7
	JAMUN	1.4	1	-	-	-	SATPEDWA	1.5	10
	NEEM	1.5	1				SERES	1.2	1
	MAHA NEEM	1	1	MAHA NEEM	1	1			
	PIPAL	1	1	-	-	-	-	-	-
	NEEM	1	1	-	-	-	-	-	-
	PIPAL	1.5	1	-	-	-	-	-	-
	MAHA NEEM	1	2	-	-	-	-	-	-
	NEEM	1.4	1	-	-	-	-	-	-
	SISAM	1.5	1	-	-	-	-	-	-
RATNAGIRI TIRAHA	MAHA NEEM	1	1	-	-	-	-	-	-

Annexure 7.1 - Details for Public Consultation and attendance sheet

Annexure 7.1

Details of Public Consultation and Attendance Sheet

Sl. No.	Date	Place	No. of Participant		Issues	Photographs
			M	F		
1	22.06.2018	Slum Area 2A Saket Nagar	09	07	1. Discussed about the Bhopal Metro Project and explained to them about the proposed alignment and relocation option. 2. Project Affected Persons (PAPs) expressed that families who already relocated are facing lots of issues like drinking water scarcity, have to travel long distances for employment as the houses were provided on the outskirts. 3. Lack of education facilities in resettlement colonies and connectivity with city are also major issues. 4. This slum area has more than 200 families who depend on wage labour. If they are relocated to outskirts of the city there will be employment problems due to long distance travels. 5. Project Affected Persons suggested to provide land instead of houses under Indira Awas Yojana as basic facilities will be lacking in the government housing schemes	

2	30.06.2018	Slum Area 2A Saket Nagar	02	06	1. Discussed about the Bhopal Metro Project and explained to them about the proposed alignment and relocation option 2. According to PAPs BMC has already completed the family survey for relocation purpose and explained about the relocation of the current Slum area. 3. Unemployment is major issues in the slum area 4. They demanded only land from government instead of relocation. 5. Government is allotting flat to each family in the outskirts of the city	
3	02.07.2018	Azad Nagar, Pullbogda	57	0	1. Discussed about the Bhopal Metro Project and explained to them about the proposed alignment. 2. They want land near jail Bag Ground or back side of this area in Survey no 920 and 921 for relocation of all affected families as they have been staying in this location more than 100 years. 3. They requested to Govt not to disturb their livelihoods and life unless proper arrangements have been made. 4. According to the affected families they expressed that they do not have any concern about dust and sound pollution due to construction of the project during construction period.	
Sl. No.	**Date**	**Place**	**No. of Participant**		**Issues**	**Photographs**
			M	**F**		

4	03.07.2018	Marble Market Pulbogda	17	0	1. Discussed about the Bhopal Metro Project and explained to them about the proposed alignment 2. About 5-7 marble shops are going to be affected and this will impact on their income and livelihood. 3. According to land owners they are getting Rs. 35000 to 40000 per month as rent. If these shops are demolished there will be huge loss to their income and employment. 4. All shopkeepers are legal title holders and near about 120-130 workers are depending on thes affected shops. Their livelihood will be affected. 5. They expressed that government lands near Gala Mandi may be provided or Government should provide alternative shops for carrying out their marble business. 6. Due to existing bridge there will be traffic jams during the construction period. Therefore suggested that necessary arrangements have to be made entry of heavy vehicles which carry marbles for transportation to different locations.	

Attendance Sheet

भोपाल मेट्रो परियोजना
मध्यप्रदेश सरकार
(मार्ग–2, एम्स से करोंद चौराहा)

स्थान– बांगड़ा पुल | दिनांक– 03/07/2018

क्रमांक	नाम	पद/व्यवसाय	मोबाईल नं0	हस्ताक्षर/अंगूठे का निशान
1	Chote Khan	Owner	9303122586	[illegible]
2	[illegible] (शफीक भाई)	Plot Oner.	7241176409	[illegible]
3	Nishat Ulla Khan		9893104292	[illegible]
4	Vikas Sahu Paras Stone	Buisness	7241176409 9753412114	[illegible]
5	UMAIR AZIZ	LandLot	7241176409 9203303030	[illegible]
6	JAMEEL AHMAD	Busnis	9424412844	[illegible]
7	KHALEEL AHMAD	Busnis		[illegible]
8	Mehmood Khan	Busnis	9303133601	M.M KHAN
9	Mehfooz Khan			Mehfooz
10	Naseem Ahmed		9826084808	M. Ahmed

भोपाल मेट्रो परियोजना
मध्यप्रदेश सरकार
(मार्ग-2, एम्स से करोंद चौराहा)

आजाद नगर मदरसा | दिनांक- 07/07/2018

क्र.	नाम	पद/व्यवसाय	मोबाईल नं०	हस्ताक्षर/अंगूठे का निशान
1	मो० जुबेर		7772028832	[signature]
2	मो. साजिद		9893349338	M. [signature]
3	समी उल्ला		7987105968	[signature]
4	अ० वदूद		9893472778	عبدالودود
5	राशिद भाई		8930396636	[signature]
6	खालिद भाई		9826575278	[signature]
7	ऐजाज		9977577948	एजाज
8	आरिफ		9827015880	आरिफ
9	वसीम		9303156291	वसीम
10	मतीन भाई			मतीन
11	बुरहान		8305119056	[signature]
12	अरमान भाई		9685991372	अरमान
13	रामलाल		8518954147	राम
14	सन्नूलाल			सन्नू लाल
15	छबीली			छबीला
16	मतीन भुरा		7224969878	मतीन
17	रफीक		9795991559	रफीक
18	हामीद		8349006686	हामिद

2A. सांईनगर बस्ती

आज दिनांक 30/06/2018 को 2A सांईनगर बस्ती मे भोपाल मेट्रो परियोजना लाईन-2 के अंतर्गत सी.एम.एस.आर. संस्था के कार्यकर्ताओं के द्वारा बैठक किया गया। निम्नलिखित बिन्दुओ पर चर्चा की गई।

→ नगरपालिका द्वारा इस बस्ती के लोगों का सर्वे किया जा चुका है स्थानीय लोगों के मकानों की कीमत के मालिकों का निर्धारण किया जा रहा है जहाँ हमारे लोगों को ~~विस्थ~~ स्थापित किया जायेगा।

⇒ नगरपालिका द्वारा जारी की गई विस्थापन प्रमाण पत्र कुछ लोगों को नहीं मिला है लगभग 70 लोगों को नहीं मिला है

⇒ यहाँ के लोगों का ~~स्थानीय~~ सामान्य मूल्य व्यवसाय मजदूरी है

⇒ स्थानीय लोगों की मूल्य समस्या है की रोजगार की कमी है पर्याप्त रोजगार नहीं मिलता

⇒ इनके अनुसार दूसरे स्थान पर स्थापित किये जाने के कारण रोजगार में कमी आयेगी। दूसरे स्थान पर जाने से रोजगार खोजने में दिक्कत आयेगी यहाँ की औरतें कार्य आदि का करती है

⇒ स्थानीय लोगों के अनुसार सबके राशन कार्ड है जिससे राशन पानी आदि मिलता है

⇒ इस परियोजना से लोगों के अनुसार इन लोगों को काफी दूर काम पर आने में कम पैसे में समय पर पहुँच पायेंगे

⇒ इनका कहना है की मांग है की इन लोगों को जो घर दिया जा रहा है उसके लिए जो पैसे देना है वो इन देने मे असमर्थ है

⇒ इनके अनुसार सरकार द्वारा मकान बनाया जा रहा है वह बहुत ऊँचा है उसमें चढ़ने में पानी-सामान ऊपर ले जाने मे परेशानी होती।

⇒ यहाँ के लोग लगभग 30-45 वर्ष से यहाँ रह रहे है।

⇒ स्थानीय लोगों के अनुसार इन्हे ~~फ्लैट~~ फ्लैट न देकर जमीन दिया जाय। हमलोग खुद से घर बना लेंगे।

उपस्थित लोगों के हस्ताक्षर

(1) अंजनी

(2) जमुना

(3) Neetu

(4) सोनू साहू

(5)

(6)

(7)

(8) शकुन्तला

(9) श. मोर्चा

(10)

(11)

(12) पिंकू

(13) मधुमालती

(14)

आज दिनांक 22-06-18 को 2A साकेत नगर मे प्रभावित परिवार को साथ सर्वेक्षण किया गया जिसमे सभी परिवार को इस परियोजना से लाभ एवं हानि के बारे मे चर्चा किया गया एवं सभी सामाजिक आर्थिक सर्वेक्षण किया गया

आश्रित परिवार का हस्ताक्षर

1. प्रभा साहू
2. जानकी साहू
3. आशाराम
4. अंजनी
5. Kanchan pawar
6. Neetu
7. [illegible]
8.
9. शकुन्तला
10.
11. सुनीता
12. काजल नगर
13. लीला शर्मा (आंगनबाड़ी)
14. [illegible]
15. [illegible]
17. [illegible]
18. Durgesh Sahu
19.

Annexure 8.1 - Schematic Diagram of Effluent Treatment Plant

Annexure 8.1

Schematic Diagram of Effluent Treatment Plant