

Environmental Impact Assessment (EIA) Report

for

Kochi Metro Phase II From JLN Station to Info Park, Kochi, Kerala

Proposed By



Kochi Metro Rail Limited

January, 2020

Environmental Consultant:



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LIST OF ABBREVIATIONS

Acronym	Description
AAQ	Ambient Air Quality
AMSL	Above Mean Sea Level
APP./APPROX.	Approximately
ASI	Archaeological Survey of India
BIS	Bureau of Indian Standards
CCE	Chief Controller of Explosives
CFO	Chief Forest Officer
CGWA	Central ground Water Authority
CGWB	Central ground Water Board
CPCB	Central pollution Control Board
dB	Decibels
DEM	Digital Elevation Model
DG	Diesel Generator
DM	District Magistrate
DPR	Detailed Project Report
EHS	Environment Health & Safety
EIA	Environment Impact Assessment
EMP	Environment Management Plan
ENE	East North East
EPC	Engineering, Procurement, and Construction
ESE	East South East
GHG	Green House Gas
GoI	Government of India
GRM	Grievance Redressal Mechanism
GW	Groundwater
Ha	Hectares
HDPE	High Density Poly Ethylene
HFL	Highest Flood Level
HH	House Hold
HT	High Tension
IMD	Indian Meteorological department
INR	Indian Rupees
INTACH	Indian National Trust for Art and Cultural Heritage
KLD	Kiloliters Per day
Km	Kilometers
Kmph	Kilometer Per Hour
kV	Kilo Volts
LHS	Left Hand Side
LOTO	Lock Out Tag Out

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LPM	Liters Per Minute
LT	Low Tension
LULC	Land Use Land Cover
Max	Maximum
Mbgl	Meter Below Ground Level
MDR	Major district roads
Mg/l	Miligrams/liters
Min	Minimum
Mm	Millimeter
MoEF&CC	Ministry of Environment, Forest & Climate Change
MSW	Municipal Solid Waste
MT	Metric Tonnes
MW	Mega Watt
NAAQ S	National Ambient Air Quality Standards
NABL	National Accreditation Board for Testing and Calibration Laboratories
NE	North East
NGT	National Green Tribunal
NH	National Highway
NMV	Non-Motorized Vehicles
NNW	North North West
NOC	No Objection Certificate
NW	North West
O&M	Operation and Maintenance
OSHAS	Occupation Health and Safety Assessment Series
PA	Public Addressal
PCU	Passenger Car Unit
PET	Ploy Ethylene
pH	Pouvoir Hydrogène
PHPDT	Peak Hour Per Direction Traffic
PIC	Prior Informed Consent
PM	Particulate Matter
PPE	Personal protective Equipment
PPHA	Person per Hectare
PPIO	Passenger protect Inquiry Office
PS	Performance Standard
PUC	Pollution Control Certificate
QA/QC	Quality Assurance/quality control
RET	Rare Endangered & Threatened
RH	Relative Humidity
RHS	Right hand Side
RoW	Right of Way

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RWH	Rain Water Harvesting
SE	South East
SEAC	State Expert Appraisal Committee
SEIAA	State Environment Impact Assessment Authority
SH	State Highway
SHE	Safety Health & Environment
SPCB	State Pollution Control Board
SPV	Special purpose Vehicle
SSE	South South East
SSW	South South West
STP	Sewage Treatment Plant
SW	South West & Surface Water
TDS	Total Dissolved Solids
ToR	Terms of Reference
TSS/RSS	Traction/Receiving Sub-station
UG	Underground
UTM	Universal Testing Machine
W/sq m	Watt/ square meter
WNW	West North West
WSW	West South West
ZSI	Zoological Survey of India

CHAPTER 1. INTRODUCTION

This chapter provides background information of the project, project proponent, need of the project, purpose & need of EIA study, approach & methodology adopted for EIA study, limitation of EIA study and structure of the EIA report.

1.1 PROJECT BACKGROUND

In effort to improve the transportation system of the Kochi city and to move towards the cleaner and sustainable mode of transportation, Government of Kerala intends to develop metro rail network (elevated) system for the entire city with the financial aid from French Development Agency-Agence Française de Développement (AFD). Metro systems are one of the Mass Rapid Transit System known for its speed, reliability, comfort, sustainability, cost effective (for passenger) and are successful for congested cities which are already facing or in near future are expected face huge traffic congestion. A Special Purpose Vehicle (SPV), i.e. Kochi Metro Rail Limited (KMRL), has been formed by the Government of Kerala for implementation, operation and maintenance of the Metro projects. KMRL has already constructed Phase I of the Kochi Metro Rail from Aluva to Petta and has planned to expand it from Petta to Tripunithura. Now KMRL has planned to develop Phase II from JLN to Info Park. This phase-II corridor will be connected with the Phase-I at JLN Stadium Metro station to ensure integration of Phase I. Phase II will have total length of 11.7 km (~say 11.2 km) and Phase II & Phase I will be connected at JLN. Phase II will have 11 stations excluding JLN stadium station.

It is expected that due to development of phase II, there will be significant increase in the ridership in metro with shift of passenger from road to metro system. There are further plans of the Kochi Metro Rail Limited to extend the metro line network in other parts of the city and also to connect the Kochi metro rail with the other modes of transportation like railways, buses and water metro to make the metro and the other public transportation system as integrated transportation system. This will overall enhance efficiency of the metro system and the other existing public transportation system and will reduce the dependency on the private vehicles thereby reducing the air pollution and traffic congestion on roads.

1.2 BRIEF ABOUT PROJECT & PROJECT PROPONENT

Kochi metro is first metro rail project of Kerala State and the project will be implemented by Kochi metro Rail Ltd (KMRL). KMRL has proposed to develop Phase II of the Kochi Rail Metro after construction of Phase I. Phase II will be connected with Phase I at JLN Station. The length of phase-II measure 11.2 km and comprise of 11 no of stations, i.e Palarivottom JN, Palarivottom Bypass , Chembumukku, Vazhakkala , Padamughal, Kakkanad Jn, Kochin SEZ, Chittethukara, Kinfra, Infopark 1 and Infopark 2. Map showing the phase II of the Kochi metro rail is given in **Figure 1.1**.

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Figure 1.1: Proposed Metro Link Route Between JLN Station and Info Park-II.

Proposed metro route will traverse through the central verge of the road along the stretch and it is proposed to widen the roads to accommodate the metro construction and the existing traffic on the roads. Road widening will not only ease the traffic movement and metro construction works but also will reduce the accidents on the road as the stretch is prone to accidents. Detailed project report for the project was prepared by RITES and is updated by Kochi Metro Rail Limited. Construction works for Phase II are expected to start from April, 2020 and end by May, 2024.

Kochi Metro Rail Limited (KMRL) is special purpose vehicle formed by Government of Kerala for Implementation, Operation and Maintenance of Metro Project in Kerala. Office of KMRL is located at 8th Floor, Revenue Tower, Park Avenue, Kochi-682011. Contact details of the client is given below

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1.3 NEED OF THE PROJECT

Kochi is major port city and falls in District Ernakulum of Kerala. Kochi is the most densely populated city of Kerala and has area of 94.88 sq km. Kochi city is part of the Greater Kochi region and is classified as Tier II city by Government of India. It is also known as financial, commercial and industrial capital of Kerala. Kochi has well developed transportation infrastructure including international airport at Nedumbassery and good rail & road network. Additionally NW-3, i.e. Kollam Kottapuram Waterway exists in the city which provided an excellent transportation system for men and material.

Population of the Kochi city region is 1255733 with average annual population growth rate of +8.51%. Increasing population of the Kochi city has made it congested and stressed significantly the available public transportation system of the city. Development of the transportation infrastructure and public transportation system in Kochi is not in pace with the demand of the increasing population. Public transportation system is not enough to cater the increasing traffic and also the road infrastructure is limited. People prefer to use their private vehicle over the existing public transportation system which has led to substantial increase in traffic on the road. Due to insufficient road infrastructure, traffic jams are common in the city. All these have contributed significantly in increase in air pollution of the city.

Metro project is planned for overall development of the city. Metro system is expected to bring a major shift of private transport user and public transport users to the metro system thereby reducing the traffic congestion on road. Metro systems are faster, reliable and automated as compared to road transport. Due to these features of metro system, it is expected ridership in metro system will increase with the increasing metro network in the city. Development of the metro system will encourage people to use the public transportation system and may reduce the traffic congestion on roads and thus the vehicular emissions. Shifting to metro system will also save significant time of the people and will improve the overall quality of life. The metro system is planned such that the metro system will be connected to all the public transportation systems such as city bus, Indian railway and water metro. This will help in integrating all the available public transportation system and will enhance the ridership of the metro system and other public transportation systems as well.

1.4 DEVELOPMENT STRATEGY OF THE PROJECT

Kochi metro Rail Ltd intends to develop metro rail network for the entire city. Under Phase II, it was proposed to develop elevated metro rail corridor from JLN Station to Info Park (11.2 km). The station locations were strategically selected to be near main road intersections and Inter-modal interchange points such as Railway stations/ bus terminals so as to improve passenger interchange and accessibility, for ensuring higher passenger convenience and ridership on the proposed metro corridor and this will overall increase the efficiency & utilization of public transportation system of the city. Stations are

designed while incorporating the green building norms. Safety for passenger is kept as prime concern in the project design and KMRL will implement the project in accordance to the safety policy of the KMRL. Environment safeguard measures and green initiatives are also incorporated in the project design and some of them are listed below

1. Cleaner transportation mode as compared to road transportation
2. Installation of solar panels at stations (to meet 15% of the power requirement)
3. Adoption of green building norms for construction phase of metro corridor and station building
4. Usage of low energy intensive building material like fly-ash
5. Preservation of excavated top soil and using it for landscaping
6. Usage of LED lights for internal lighting
7. Compensatory plantation in ratio of 1:12
8. Rain water harvesting provision at stations and along viaduct
9. Preparation and implementation of environment management plan during construction and operation stage of the project

Proposed metro system will provide an alternate transportation system and is likely to improve the mobility in the city while reducing the traffic congestion and vehicular emission thereby improving the air quality of the area.

1.5 OBJECTIVE AND SCOPE OF EIA STUDY

Environment impact assessment is carried out for the Phase II of Kochi metro Rail, i.e. from JLN Station to Info Park. The EIA study is carried out with the objective of identification of the potential environmental impacts, designing the measures to mitigate the impacts in time bound manner with the minimum possible resources, to prepare the environment management plan and develop the institutional mechanism for implementation of environment management plan. Scope of the EIA study is given below

- Review of DPR for Metro Rail Corridor from JLN Stadium to Info Park via Kakkanad;
- EIA shall include a concise description of the proposed project and its geographic, environmental, social, and temporal context, including any offsite investments that may be required (e.g., dedicated pipelines, access roads, power supply, water supply, housing, and raw material and product storage facilities), as well as the project's primary suppliers;
- Secondary Data Collection and Literature Review: Secondary Data Collection and Literature Review Secondary data and literature review shall be done through previous studies, available literature, field visits and collection of information through various Government Offices. These data and information shall be verified and supplemented through field reconnaissance. In addition, the environmental standards and regulations, related policies and guidelines, legal requirements relating to the implementation of EIA study shall be collected and summarized.

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- Conducting Baseline Survey and Census as per **Table 1.1** below: To collect all possible secondary data and primary data on environmental baseline information, this may affect environmental components of the aligned area. The EIA Study shall include the identification of potential heritage/cultural sites located in the project area (and the associated mitigation measures).
- The EIA Report shall include the maps of sufficient detail, showing the project site and the area that may be affected by the projects direct, indirect, and cumulative impacts and other related data.
- Environmental Field Survey;
- Environmental Impact identification, Environmental Impact Unit (EIU) Quantification in pre and post Metro Scenario and Formulation of mitigation measure to avoid and minimize the impacts:
 - To assess and calculate potential impacts on natural environment and pollution caused by the proposed alignment, including the project associated facilities.
- The EIA Study shall include an analysis of alternatives (incl. the No project alternative)
- To prepare Environmental Management and Monitoring Plan (EMMP) for the necessary actions to minimize potential environmental and social impacts as well as to propose proper mitigation measures. Environment management plan shall include pollution prevention plan for air pollution, water pollution, soil contamination, noise & vibration, waste, offensive odour, bottom sediments and disasters
- Organizing Public Consultation Meetings for EIA
- Preparation of EIA Report
- The report shall also include:
 - the list of the individuals or organizations that prepared or contributed to the environmental and social assessment,
 - References (written materials both published and unpublished that have been used).
 - Record of meetings, consultations and surveys with stakeholders, including those with affected people and other interested parties.
 - Tables presenting the relevant data referred to or summarized in the main text
 - list of associated reports or plants
- Information disclosure of the EIA Report
- The EIA Study shall cover all the requirements under the environmental legislations in India, especially The Environment (Protection) Act-1986, The Wetland and Paddy Fields Act-2008 and World Bank Environmental and Social Framework Standards 2017.

Table 1.1: Scope of Baseline Study and EIA Study

Item	Tentative Scope of EIA Study
Natural Environment	<ul style="list-style-type: none"> • Protected Forest, Mangroves. Wetlands, Paddy Fields & Wildlife Conservation Area

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	<ul style="list-style-type: none"> • Identification of the boundary of recorded forests/mangroves/Wetlands/Paddy Fields • Collection of information from/and interview with • Forest Department, CRZ authority, academicians, local NGOs • Estimation of the number of trees to be cut (e.g. Height and diameter in each species) • Field reconnaissance: Vegetation distribution, important fauna, endangered fauna
Noise & Vibration	<ul style="list-style-type: none"> • Inventory Survey on the Sensitive Receptors: Sensitive receptors such as schools, hospitals, religious places within 60-100 m from the central line of the proposed metro rail corridor will be identified using satellite images, field reconnaissance and interviews with local residents • Land-use Survey: <ul style="list-style-type: none"> • The land use within 60-100 m from the central line of the proposed metro rail corridor will be identified using satellite images and field reconnaissance. • Noise & Vibration Measurement: <ul style="list-style-type: none"> • Existing metro noise and vibration measurement at sensitive receptors along the major metro stations • Background noise and vibration measurement along the major metro stations • Metro noise and vibration predictions at the same sites.
Water quality	<ul style="list-style-type: none"> • Identification of major rivers/creeks likely to be affected by Metro. • Measurement of water quality (e.g. Temperature, pH, electrical conductivity, DO, SS, BOD, COD etc.) in the identified rivers/creeks • Collection of existing and published data on water quality
Literature and Interview Survey	<ul style="list-style-type: none"> • In addition to above mentioned environmental information, existing data on air quality, water quality, soil, status on solid waste, etc. will be collected • Interviews with the experts on the relevant field will be conducted, if necessary.
Preparation of Environment Management Plan (EMP) and Environment Monitoring Plan (EMoP)	<ul style="list-style-type: none"> • Based on analysis of collected data, EMP and EMoP along with mitigation strategy will be prepared. • Through PCMs on EIA, Mitigation Strategy, EMP and EMoP will be finalized incorporating feedback from local residents participated in PCMs

1.6 NEED AND PURPOSE OF THE EIA STUDY

EIA study involves identification of the impacts associated with the project activities during the construction and operation phase of the project. Impact associated are assessed quantitatively and qualitatively to know their magnitude and significance. On the basis of the severity of impacts, experts propose the mitigation and management plan so as to ensure environmentally and socially sound implementation of the project. Thus, the EIA study helps to identify the negative impacts associated with the project and suggest measures to be taken for mitigating the impacts.

In order to ensure that development is sustainable it is essential to integrate environmental concerns into development activities. EIA is currently the only explicit legal instrument available to comprehensively assess resource impacts of large buildings and townships. The purpose of EIA Report is to assist in the decision- making process and to ensure that the project options under consideration are environmentally sound and sustainable. The approach adopted in the EIA study is to ensure that positive environmental impacts are maximized and the negative are minimized /reduced to the extent possible. The steps taken generally consist of incorporation of appropriate mitigation measures in engineering designs, construction schedules and techniques, as well as in operational and management practices outlined as a part of Environmental Management Plan (EMP).

Metro rail projects are not considered under the purview of EIA Notification, 2006 but the project is being funded by French Development Agency-Agence Française de Développement (AFD). As per the environment and social management policy of the AFD, environment impact assessment study is mandatory for the projects having potential to cause environment and social impacts.

1.7 Methodology for Environment Impact Assessment Study

Large scale infrastructure projects are expected to cause adverse environmental impacts at and in surroundings of the project site during construction and operation phases. Intensity and significance of impacts depends on the nature, size and spread of the project. Environment impact assessment is only tool in India which can be used to assess the impacts associated with any project prior project implementation and identify the suitable measures to mitigate the identified impacts. These impacts if integrated with the project design, helps in designing the project which environmentally feasible and has minimum environmental impacts.

EIA was introduced in India with EIA Notification, 1994 and thereafter by EIA Notification, 2006. EIA Notification, 2006 makes EIA study mandatory for the projects as listed under Schedule I of the said notification. Methodology and structure of EIA report has been defined under the said notification for carrying out the EIA studies under Annexure III which has been followed for preparing this EIA report. The project is being funded by French Development Agency-Agence Française de Développement (AFD)

and the environment and social management policy of the AFD and World Bank Environment Policies are also considered while preparing the EIA report.

EIA study is divided into three phases: first phase is identification of significant environmental parameters and assessing the existing (pre-project) status within the impact zone with respect to Air, Noise, Water, Land and socio - economic environment. Second phase is prediction of impacts from proposed project on identified environmental parameters using various mathematical models. Third phase includes the evaluation of total impacts after superimposing the predicted impacts over baseline data and preparation of Environmental Impact Statement (EIS) which helps in incorporating proper mitigation measures wherever necessary for preventing deterioration in environmental quality. Detailed methodology for the EIA study is given below

- **Signing of Contract Agreement and Initial Meeting with Client for Understanding of Project:** After the selection process, agreement with the client will be signed and work award letter will be issued by the client. A brief meeting for getting basic understanding of the project, sharing the information on details required for environmental clearance for the project and discussion on mobilization of team for project purpose will be conducted.
- **Review of available documentations, planning for the study and pre-study discussion with the project proponent:** Information like DPR, proposed project alignment, previously undertaken environmental/social impact assessment study, alternate alignments, shift of passenger on this corridor, traffic data, tree cutting/displacement etc will be collected from the client. Information about the project site & surroundings will be collected through secondary sources like toposheets, IMD and Google Earth. Data collected from client and through secondary sources will be studied and based on the study pre-assessment of project impacts will be carried out.
- **Reconnaissance site visit to firm up the planning:** After carrying out pre-assessment studies, reconnaissance site visit will be planned by team leader to collect information on sensitive receptors at the project site and its vicinity and ground truthing of the data collected through the desktop study. Inception report will be submitted based on the data collected during the desktop study and site visit.
- **Environmental Baseline Data Generation through Primary and Secondary Sources as per RFP:** Site visit will be conducted by the experts and monitoring team for collection of baseline data through primary & secondary sources. Detailed baseline monitoring of various environmental attributes such as ambient air quality, noise levels, water quality (surface & ground water), soil quality, ecology and other parameters will be carried out as per the findings of reconnaissance study and schedule given above in Table 1.1 in Chapter 1. As per RFP air quality study is required to be undertaken on basis of secondary data only but as per the requirement of KMRL, limited air quality monitoring study has been undertaken for the project additionally.

- Environmental strip mapping will also be carried out at this stage which will also include environmental sensitive receptor, noise sensitive receptors, archaeological features and other sensitive environmental attributes. Major issue with the metro rail projects will involve noise, vibration, stability of the structures and social issues thus the monitoring will be undertaken considering these factors. Maps showing the environmental baseline monitoring stations will also be prepared for the project.
- Stakeholder consultation: Informal stakeholder consultation shall be carried out for the project to assess the public views, perception and suggestions on the project so as these can be incorporated in the EMP for improving the social acceptability of the project.
- Data Analysis and Interpretation and relating it to the Environmental Factors: Baseline data collected will be tabulated, analyzed and inference will be drawn in graphical form. The baseline status of the environmental parameters will be assessed and will be related to anticipate impacts during pre-assessment. Primary data collected will also be validated through the available secondary data as published by the authentic organizations.
- Analysis of the Alternatives: This exercise will be performed for all the alternative alignments, alternative station locations and technologies considered for the project. Analysis for the alternatives will be carried out with environmental and social perspective.
- Environmental Impacts Identification, preparation of Impact Mitigation & Enhancement Plan: Impact assessment of the project will be carried out using qualitative and quantitative technique for all project components and each stage of project development, considering design, construction and operation stage. These impacts will be classified in order of its magnitude and significance for each of affected physical, social and biological environmental component. Impact assessment and evaluation will be carried out using the various tools like checklists and matrixes. Three stage impact assessment and evaluation will be carried out which will involve the business as usual (without project), with project and no mitigation and with project & mitigation measures. This will help to assess the residual impacts of the project. Further air modeling and noise modeling study will be carried out for the project alignment as required for quantification of the impact assessed. After Assessment of impacts, impact mitigation plan will be prepared, and budget allocation will be made for the proposed mitigation measures and implementation. Suggestions for environmental design consideration shall be given if feasible and required.
- Preparation and submission of Environment Impact Assessment report, EMP &EMoP: EMP will comprise set of mitigation and enhancement measures proposed to reduce/mitigate the anticipated environmental impact and enhance the project benefits. Environment Management Budget & Environment monitoring & supervision plan, pollution prevention plan, mitigation measures implementation plan, occupational health and safety plan and grievance redress mechanism will be

included in the Environment Management Plan. This will also include the suggested institutional aspects which will also cover environmental monitoring plan and reporting requirement.

- Preparation and Submission of EIA Report for Phase I Extension and Phase II: EIA Report prepare will include outcome of all the above activities. EIA report will be submitted to client for review and the EIA report will be finalized after incorporation of the client’s comment in the report. Final EIA report will be submitted after incorporation of clients’ comment
- Assisting Client for Disclosure of EIA Report

1.8 LIMITATIONS OF THE EIA STUDY

The EIA study is undertaken on the basis of the DPR and the alignment provided. If there is any change in the alignment in future then a separate EIA study shall be undertaken for that section of the alignment to address the environmental issues.

1.9 STRUCTURE OF THE EIA REPORT

The EIA Report is presented as defined below:

Chapter 1: Introduction

This chapter provides background information of the project, project proponent, need of the project, purpose & need of EIA study, approach & methodology adopted for EIA study, policy, legal & administrative framework, environmental standards, limitation of EIA study and structure of the EIA report.

Chapter 2: Policy Legal and Administrative Framework:

This chapter deals with the identification & listing of applicable legislations and applicable administrative framework. It also provides screening of applicable operational policies of World Bank and IFC EHS Guidelines on the project

Chapter 3: Project Description

This chapter deals with the details of the Proposed Project, project components, site settings, surroundings & connectivity, land & utility requirement, project cost and implementation schedule

Chapter 4: Description of Environment

This chapter describes the baseline environmental conditions around the surrounding area of the proposed project for various environmental attributes, viz. physical, biological and socio-economic. Topography, soil, water, meteorology, air, noise, and land constitute the physical environment, whereas flora and fauna constitute the biological environment. Demographic details and occupational pattern in the study area constitute socio-economic environment. Baseline environmental conditions are based on the field studies carried out at and around the proposed site and through secondary data collected from published sources.

Chapter 5: Analysis of Alternatives

This chapter details the analysis of the alternatives considered for the project. Scenarios for with and without project are considered and assessed.

Chapter 6: Environmental Impact Assessment

This chapter details the inferences drawn from the environmental impact assessment of the proposed project. It describes the overall impacts of the project activities and underscores the areas of concern, which need mitigation measures.

Chapter 7: Environmental Management Plan

This chapter details the pollution prevention & management plan, disaster management plan, Institutional Framework for Implementation of EMP, Environment Monitoring Plan, SHE Policy, Grievance Redressal System, Trainings, Monitoring & Audits, Environment management Budget, Documentation, Updating and Record Keeping.

1.10 Reference Used For the EIA Study

List of the secondary data which was referred for preparing the EIA report are listed below

Table 1.2: References Used for EIA Study

S. No.	References
1	Indian Metrological Department Website
2	Census of India
3	Kerala Forest Department
4	Bureau of Indian Standard for seismicity map of India
5	Bird Life International for Important Bird Area
6	Diversity of fishes, Crustaceans and Molluscs of Puthuvypeen of Ernakulam District, Kerala, South India by Sahadevan P
7	Detailed Project Reports for Kochi Metro Rail
8	National Ambient Air Quality Monitoring Programme
9	Kerala State Disaster Management Authority
10	City Sanitation Plan for Kochi, June 2010
11	Metro Rail Transit System “Guidelines for Noise & Vibrations”
12	Socialist Republic of Viet Nam: Ha Noi Pilot Metro Light Metro Line, section Nhon - Ha Noi Railway Station (MRT3) by People’s Committee of Ha Noi for the Asian Development Bank
13	EIA Report for Kochi Water Metro Project
14	Kochi City Mobility Plan
15	Ernakulum District Ground Water Brochure

CHAPTER 2. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

This chapter provides details on the legislative regulatory framework of India w.r.t environmental angle and its applicability on the project. Also the chapter details applicability of the World Banks' policies on the project

2.1 INTRODUCTION

India is developing economy and has experience significant growth in past 50 years. With the growth and introduction of developmental project, need of conserving environment and interest of society was felt and accordingly Government of India has framed adequate legislation and policies to safeguard the environment and interest of people along which may get affected due to developmental projects. India has introduced the right to clean environment as fundamental right of its citizen and obligatory duty of every citizen to conserve environment through 42nd amendment by introducing article 48 A and 51 A in 1976. As a result, numbers of laws have been framed to safeguard the environment and interest of people. Environmental legislations are framed to achieve the following targets

1. Environmental Protection
2. Forest Conservation
3. Wildlife Protection
4. Protecting the interest of society

Key umbrella legislations framed to achieve the above targets are given below

The Environment (Protection) Act 1986 was enacted with the objective of providing for the protection and improvement of the environment. It empowers the Central Government to establish authorities charged with the mandate of preventing environmental pollution in all its forms and to tackle specific environmental problems that are peculiar to different parts of the country. Various rules are framed under this Act for grant of environmental clearance for any developmental project, resources conservation and waste management.

The Forest Conservation Act 1980 was enacted to help conserve the country's forests. It strictly restricts and regulates the de-reservation of forests or use of forest land for non-forest purposes without the prior approval of Central Government. To this end the Act lays down the pre-requisites for the diversion of forest land for non-forest purposes.

Wild Life (Protection) Act 1972 amended 2003 was enacted with the objective of effectively protecting the wild life of this country and to control poaching, smuggling and illegal trade in wildlife and its derivatives. It defines rules for the protection of wild life and ecologically important protected areas.

Resettlement and Rehabilitation Act, 2013 was enacted with the objective of laying down the procedure for acquisition of land, resettlement & rehabilitation of people so as the interest of society does not get affected during acquisition.

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The MoEF&CC, the pollution control boards (CPCB - Central Pollution Control Board and SPCBs - State Pollution Control Boards) and revenue department together form the regulatory and administrative core of the part. Other Ministries/Statutory Bodies/Departments responsible for ensuring environmental compliance and granting various clearances includes state ministry /dept. of environment, regional offices of MoEF&CC and state forests/wildlife departments.

2.1.1 Applicable Environmental Legislation

As per the nature of the project, screening has been done to identify the legislations of Government of India which are applicable to the project. List of the legislations is given in **Table 2.1**

Table 2.1 : Environment legislations Applicable to Metro projects

Legislation	Key Requirements	Applicability	Permits & Stage of Obtaining Permit	Concerned Authority	Responsibility of Obtaining & implementation	Monitoring & Supervision
Environment (Protection) Act, 1986 with Rules amended 1991	<ul style="list-style-type: none"> Overall Environment Protection Compliance to environmental (Air, Water, Noise) Standards issued under EPR 	Applicable	No permit but rules shall be followed	MoEF&CC	Contractor	CSC ¹ & KMRL
Air (Prevention and Control of Pollution) (Union Territories) Rules, 1982, 1983 Air (Prevention and Control of Pollution) Act,	<ul style="list-style-type: none"> An act to prevent and control Air pollution 	Applicable: Consent to Establish prior start of construction and Consent to operate prior start of operation	Consent to Establish shall be obtain prior start of construction for operating DG sets, batching plant and hot	KSPCB	Contractor	CSC & KMRL

¹Construction Supervision Consultant

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Legislation	Key Requirements	Applicability	Permits & Stage of Obtaining Permit	Concerned Authority	Responsibility of Obtaining & implementation	Monitoring & Supervision
1981 with Rules, amended 1987			mix plant (road widening works) Consent to Operate shall be obtain prior start of operation for DG sets			
Water (Prevention and Control of Pollution) Act, 1974 with Rules.	<ul style="list-style-type: none"> An act to prevent and control water pollution. 	<p>Applicable:</p> <p>Consent to Establish prior start of construction and Consent to operate prior start of operation</p>	<p>Consent to Establish shall be obtain prior start of construction for managing the wastewater from construction works</p> <p>Consent to Operate shall</p>	KSPCB	Contractor	CSC & KMRL

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Legislation	Key Requirements	Applicability	Permits & Stage of Obtaining Permit	Concerned Authority	Responsibility of Obtaining & implementation	Monitoring & Supervision
			be obtain prior start of operation for STP			
Noise Pollution (Regulation and Control) (Amendment) Rules, 2010	<ul style="list-style-type: none"> Compliance with Ambient Noise and emission Standards in accordance to use classification for the area 	Applicable, involves generation of noise due to operation of DG sets, pumps and vehicular movement ad day to day operations	No permit but rules shall be followed – Construction and Operation stage	KSPCB	Contractor – Construction Phase KMRL-Operation Phase	CSC & KMRL
Wildlife Protection Act, MoEF&CC 1972, amended 2010	<ul style="list-style-type: none"> Lays down rules and regulations pertaining to Wildlife Sanctuaries, National Parks. Obtain NBWL Clearance if site is within 10 km radius of WLS/NP/ Protected Areas 	Applicable as Manglavanam Bird Sanctuary exists at 3 km from JLN Stadium. However there is a draft notification on ESZ of aid bird sanctuary which states that ESZ varies from 0-1.5 km around the boundary of the bird	Wildlife Clearance	Wildlife Department of Kerala State	KMRL to obtain and Contractor to follow the conditions	KMRL

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Legislation	Key Requirements	Applicability	Permits & Stage of Obtaining Permit	Concerned Authority	Responsibility of Obtaining & implementation	Monitoring & Supervision
		sanctuary				
Kerala Forest Act, 1961 as amended	<ul style="list-style-type: none"> This act was enacted in Kerala in 1961 to unify and amend the law relating to the protection and management of forests in the state of Kerala 	Applicable as the project involves cutting of road side trees	Tree Cutting Permission	Kerala Forest Department	KMRL to obtain and Contractor to follow the conditions	KMRL
The Kerala Preservation of Trees Act, 1986 The Kerala Restriction of Cutting and Destruction of Valuable Trees Rules, 1974	<ul style="list-style-type: none"> This act is applicable for preservation of listed species of trees in the act 	Applicable as there is Teak trees within/along the alignment. If these trees will be cut then this law will be applicable	Tree Cutting Permission	Forest Officer	KMRL to obtain and Contractor to follow the conditions	KMRL
Hazardous & Other Waste (Management & Handling) Rules, 2016	<ul style="list-style-type: none"> Protection to general public against improper handling storage and disposal of 	Applicable, involves generation of used oil from machineries and DG sets	Authorization- Prior Start of Generation of Waste/Used Oil	KSPCB	Contractor	CSC & KMRL

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Legislation	Key Requirements	Applicability	Permits & Stage of Obtaining Permit	Concerned Authority	Responsibility of Obtaining & implementation	Monitoring & Supervision
	hazardous waste. The rules prescribe the management requirement of hazardous wastes from its generation to final disposal.					
Solid Waste Management Rules, 2016	<ul style="list-style-type: none"> Management of solid waste to be generated from labour camp/accommodations and the construction site 	Applicable. Waste will be generated from labour camps/accommodations and construction site	No permit but rules shall be followed – Construction and Operation stage	Local Bodies like Kochi Municipal Corporation	Contractor – Construction Phase KMRL-Operation Phase	CSC & KMRL
Construction and Demolition Waste Management Rules, 2016	<ul style="list-style-type: none"> Management of construction and demolition waste to be generated from project site 	Applicable as project will involve demolition of existing road, associated structure and private/government structures within RoW	No permit but rules shall be followed – Construction and Operation stage	Local Bodies like Kochi Municipal Corporation	Contractor – Construction Phase KMRL-Operation Phase	CSC & KMRL

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Legislation	Key Requirements	Applicability	Permits & Stage of Obtaining Permit	Concerned Authority	Responsibility of Obtaining & implementation	Monitoring & Supervision
Plastic Waste Management Rules, 2016	<ul style="list-style-type: none"> Management of plastic waste to be generated from project site during construction and operation phase 	Applicable as there may be generation of plastic waste at site like pipes, broken plastic buckets, dustbins, storage containers and packaging waste	No permit but rules shall be followed – Construction and Operation stage	Local Bodies like Kochi Municipal Corporation	Contractor – Construction Phase KMRL-Operation Phase	CSC & KMRL
Bio-medical Waste Management Rules, 2016	<ul style="list-style-type: none"> To control storage, transportation and disposal of Bio Medical Waste. 	Applicable for the disposal of bio-medical waste from first aid centre	Authorization and Rules shall be followed	KSPCB	Contractor	CSC & KMRL
Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989 (as amended)	<ul style="list-style-type: none"> Notifying regulatory authority (in this case, the State Factories Inspectorate) of storage of hazardous substances like HSD Follow guidelines on such storage, maintain updated 	Applicable, only if there is storage of hazardous chemical above threshold limit as defined under schedule 2 & 3.	License	Chief Controller of Explosives, MoEF&CC and DC	Contractor	CSC & KMRL

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Legislation	Key Requirements	Applicability	Permits & Stage of Obtaining Permit	Concerned Authority	Responsibility of Obtaining & implementation	Monitoring & Supervision
	<p>MSDS, submit annual Safety Report to authority</p> <ul style="list-style-type: none"> Prepare Onsite Emergency Plan 					
Motor Vehicles Act with Rules, 1988 and amendments	<ul style="list-style-type: none"> Lay down restriction for vehicles not having Pollution Under Control Certificate (PUC) or proper labeling to enter premises 	Applicable as the motor vehicle movement is involved both during construction and operation phase	No permit but rules shall be followed – Construction and Operation stage	Motor Vehicle Department (Licensing authority, registration authority & State Transport Authorities)	<p>Contractor – Construction Phase</p> <p>KMRL-Operation Phase</p>	CSC & KMRL
Irrigation Department	<ul style="list-style-type: none"> Withdrawal of water from Surface water Bodies 	Applicable if withdrawal of water from river/canal	Permission for withdrawal of water	Irrigation Department	<p>Contractor – Construction Phase</p> <p>KMRL-Operation Phase</p>	CSC & KMRL
State Groundwater Regulation	<ul style="list-style-type: none"> Conform to restriction for drawing of groundwater Arrange for 	Applicable, if ground water is utilized/withdrawn	Permission for withdrawal of ground water	Central ground Water Development Authority	<p>Contractor – Construction Phase</p> <p>KMRL-Operation</p>	CSC & KMRL

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Legislation	Key Requirements	Applicability	Permits & Stage of Obtaining Permit	Concerned Authority	Responsibility of Obtaining & implementation	Monitoring & Supervision
	recharge through Rainwater Harvesting Schemes (as applicable)				Phase	
The Batteries (Management and Handling) Rules 2001	<ul style="list-style-type: none"> To regulate the disposal and recycling of lead acid batteries 	Applicable for disposal of used lead acid battery if likely to be used in any equipment during construction and operation stage.	No specific registration required. Compulsion to buy and sale through registered vendor only.	MoEF&CC	Contractor – Construction Phase KMRL-Operation Phase	CSC & KMRL
Petroleum Rules, 2002	Use and Storage of Petroleum products	Applicable if storage of HSD/LPG or any other petroleum product may be required for the project purpose more than the defined threshold limits	License to store petroleum beyond prescribed quantity.	Chief Controller of Explosives/DC	Contractor	CSC/KMRL
The Gas Cylinder Rules	To regulate the storage of gas / possession of	Applicable if contractor store	License to store gas	Chief Controller of	Contractor	CSC/KMRL

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2004	gas cylinder more than the exempted quantity	more than the exempted quantity of gas cylinder.	cylinder more than the regulated quantity	explosives		
Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996	To regulate the employment and conditions of service of buildings and other construction workers and to provide for their safety, health and welfare measures and for other matters connected therewith or incidental thereto.	Yes as the project involve construction activities and handling of heavy machinery	No permit is required- Construction Phase, Mandatory for contractors to provide Safety Health and Welfare measures for workers	Labour Commissioner	Contractor	CSC/KMRL
<p>Contractor to Comply with the provisions of these laws/guidelines as applicable.</p> <ul style="list-style-type: none"> • The Metro Railways (Operation & Maintenance) Act 2002 as amended vide The Metro Railways (Amendment) Act 2009 (disaster management) • Metro Rail Transit System, Guidelines for Noise and Vibrations, RDSO, Ministry of Railways, September 2015 • ISO/ TC 108 (vibration) • CPCB guidelines for ambient air quality monitoring, ambient noise monitoring and water quality monitoring • NBC, 2016 						

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Legislation	Key Requirements	Applicability	Permits & Stage of Obtaining Permit	Concerned Authority	Responsibility of Obtaining & implementation	Monitoring & Supervision
<ul style="list-style-type: none"> • Energy Conservation Building Code 2017 & IGBC Green MRTS Abridged reference guide • The Child Labour (Prohibition and Regulation) Act, 1986 • The Bonded Labour System (Abolition) Act 1976 • Minimum Wages Act, 1948 • The Payment of Wages Act, 1936, amended in 2005 • Equal Remuneration Act, 1976 • Workmen's Compensation Act, 1923 • Maternity Benefit Act, 1961 • Inter-State Migrant Workmen's (Regulation of Employment & Condition of Service) Act, 1979 • Petroleum Rules, 2002 • The Employees Provident Fund and Miscellaneous Provisions Act, 1952 • Payment of Bonus Act, 1965 and Amendment Act No.43 of 1977 and No.48 of 1978 and amendments • Payment of Gratuity Act, 1972 • Public Provident Fund Act, 1968 • Employee State Insurance Act, 1948 • The Contract Labour (Regulation & Abolition) Act, 1970 and Rules • Employer's Liability Act, 1938 (as amended) • Labour (Regulation and Abolition) Act 1970 • Sexual Harassment of Women at the Workplace 9 Prevention, Prohibition and Redressal) Act 2013 • The Personal Injuries (Compensation Insurance) Act, 1963 (as amended) 						
Not Applicable						

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EIA Notification, 2006 and amendments	<ul style="list-style-type: none"> Prepare EIA / EMP report Obtain Environmental Clearance from MoEF&CC/SEIAA 	Not Applicable as Metro/Railway projects does not fall under Schedule 1 of the Notification	Environment Clearance	MoEF&CC and SEIAA	Contractor	CSC ² & KMRL
E-waste (Management) Rules, 2016	<ul style="list-style-type: none"> Management of e-waste during construction and operation phase 	Not Applicable as no E-waste will be generated as per the Category defined in the Rules	NOC	SPCB	Contractor	CSC ³ & KMRL
The Forest (Conservation) Act, 1980 and amendments The Forest (Conservation) Rules 2003	<ul style="list-style-type: none"> To protect forest by restricting conversion of forested areas into non-forested areas and deforestation and prevent tree cutting 	Not Applicable as no forest area is being diverted and also State forest Law will prevail over this	Forest Clearance	Forest Department	Contractor	CSC ⁴ & KMRL
Kerala	<ul style="list-style-type: none"> The Government of 	Not Applicable as	Change of	District	KMRL to obtain	CSC/KMRL

²Construction Supervision Consultant

³Construction Supervision Consultant

⁴Construction Supervision Consultant

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Legislation	Key Requirements	Applicability	Permits & Stage of Obtaining Permit	Concerned Authority	Responsibility of Obtaining & implementation	Monitoring & Supervision
Conservation of Paddy Land & Wetland Act, 2008. Paddy Fields And Wetlands Conservation Policy Of The State Government	Kerala discourages all conversion of paddy cultivating areas to any other purpose. This activity is governed by the Land Utilization Order of 1961 and the Kerala conservation of paddy land and wetland act, 2008. Due to the environmental impacts, the paddy ion	proposed RoW does not fall under any paddy field	land use	Collector	and Contractor to follow the conditions	
Ecologically Fragile Zone Act 2007 as amended	<ul style="list-style-type: none"> This law is aimed at conserving ecologically fragile habitats in Kerala. Mangrove forests are also offered protection under this act. The Forest 	Not Applicable as there are no mangroves within the RoW and 50 m buffer area	No Objection certificate	Forest Department of Kerala	KMRL to obtain and Contractor to follow the conditions	CSC/KMRL

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Legislation	Key Requirements	Applicability	Permits & Stage of Obtaining Permit	Concerned Authority	Responsibility of Obtaining & implementation	Monitoring & Supervision
	Department of Kerala is in the process of documenting most of the remnant natural mangrove patches and is attempting to bring a large portion of these patches under a Reserved Forest network.					
Biological Diversity Act, 2002	Conservation of biological diversity, sustainable use of its components and fair and equitable sharing of the benefits arising out of the use of biological resources, knowledge and for matters connected there with or incidental there to	Not Applicable	No permit issued under this Act.	National Biodiversity Authority and State Biodiversity Board	Contractor	CSC/KMRL
The Wetland	<ul style="list-style-type: none"> to ensure better 	Not Applicable as	NOC	MoEF&CC	Contractor	CSC/KMRL

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Legislation	Key Requirements	Applicability	Permits & Stage of Obtaining Permit	Concerned Authority	Responsibility of Obtaining & implementation	Monitoring & Supervision
(Conservation and Management) Rules, 2010 as amended	conservation and management and to prevent degradation of existing wetlands in India (115 nos as identified)	none of the 115 identified wetland falls within the RoW				
Fly ash Notification, 2007	<ul style="list-style-type: none"> Use of fly ash (wholly or partly) in building construction wherever it costs same or less than the clay, limestone, sand etc. and is available and technically feasible, compliance of which shall be the duty of the person/ agencies undertaking construction 	Not Applicable as no coal/lignite based thermal power plant exists within 100 km radius of the proposed alignment, however options should be explored for usage of fly ash in station building and viaduct construction	No permits but rules should be followed	MoEF&CC	Contractor	CSC/KMRL

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Legislation	Key Requirements	Applicability	Permits & Stage of Obtaining Permit	Concerned Authority	Responsibility of Obtaining & implementation	Monitoring & Supervision
Coastal Zone Management Act 2011	To regulate development activities within the 500m of high tide line in coastal zone and 100 m of tidal influence rivers.	Not Applicable as the project does not falls in the CRZ area	CRZ Clearance	SCZMA, NCZMA	KMRL	KMRL
Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996	Requirement of preparation of on-site and off-site Disaster Management Plans for accident-prone areas.	Not Applicable. The project does not involve handling of any hazardous chemical during both construction and operation phase which may lead to continuous, intermittent or repeated exposure to death, or injury.	No permits issued under this act	Central, State & District Crisis Group	Contractor	CSC/KMRL
Public Liability and Insurance Act 1991	Protection from liability arising due to accidents from handling of hazardous chemicals.	Not Applicable. The project does not involve storage of any chemicals (HSD) beyond the threshold limit during	No permits issued under this act. Owner of project shall take out	Collector of the Area	Contractor	CSC/KMRL

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Legislation	Key Requirements	Applicability	Permits & Stage of Obtaining Permit	Concerned Authority	Responsibility of Obtaining & implementation	Monitoring & Supervision
		construction and	insurance policies providing for contracts of insurance so as he is insured against liability to give relief, before handling any such hazardous material			
Explosive Act 1884 & Explosive Rules, 2008	Safe transportation, storage and use of explosive material	Not Applicable a no explosive (as described in act & rules) shall be used in the construction and operation stage of the project.	Permission for storage and usage of explosive	Chief Controller of Explosives	Contractor	CSC/KMRL
Ancient Monuments and Archaeological	Conservation of cultural and historical remains found in India.	Not Applicable as it is applicable only if any intervention is	No objection certificate	Archaeological Dept. Gol, Indian	Contractor * Contractor shall	CSC/KMRL

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Legislation	Key Requirements	Applicability	Permits & Stage of Obtaining Permit	Concerned Authority	Responsibility of Obtaining & implementation	Monitoring & Supervision
Sites and Remains Act, 1958	According to this Act, area within the radii of 100m and 300m from the “protected Property” is designated as “protected area” and “controlled area” respectively. No development activity (including building, mining, excavating, blasting) is permitted in the “protected area” and development activities likely to damage the protected property is not permitted in the “controlled area” without prior permission of the Archaeological Survey of India (ASI).	planned within 300 m of archaeological protected sites		Heritage Society and Indian National Trust for Art and Culture Heritage (INTACH).	report to ASI in case of chance finding of any artifact or archaeological property while excavation for project development and the work shall be stopped immediately	
Kerala Minor	Control of extraction,	No as the earth will	NOC	Mines	Contractor	CSC/KMRL

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Legislation	Key Requirements	Applicability	Permits & Stage of Obtaining Permit	Concerned Authority	Responsibility of Obtaining & implementation	Monitoring & Supervision
Mineral Concession Rules, 2015	collection and removal of minor minerals	be removed only for purpose of foundation which will be refilled to the maximum extent back in the excavated area and any earth required for construction will be purchased from authorized vendors		Department		

2.2 International Best Practices & Guidelines

Operational Policies of World Bank

The project is being developed with the financial aid from French Development Agency- Agence Française de Développement (AFD) and thus the environment and social risk management policy will be applicable on the project. AFD has adopted the World Banks’ prevailing environment and social operational standards for assessment of project with high and substantial risk and other projects are assessed on the basis of compliance to the prevailing national and social regulations in the country where the operation takes place. World Banks’ environment safeguard operational policies are listed in **Table 2.2** below.

Table 2.2 World Banks Operational Policies - Environmental & Social Safeguard

Name	Key Requirement	Applicability	Remarks
OP 4.01 Environmental Assessment	Ensures sustainability and environmental feasibility of the project. Projects are classified into A, B & C category depending on the nature and extent of the impact.	Triggers	Project classified as Category A considering nature of activities and impacts on flora of area and the community
OP 4.04 Natural habitats	Ensures conservation of natural habitats and discourages disturbance of nay natural habitat due to project development by recommending adoption of alternative method/route/approach or adopting management measures	Not Triggered	No natural habitat is getting disturbed due to the project, however cutting of road side trees and trees within the private properties will be cut
OP 4.36 Forests	Ensures that project activities do not disturbs/interfere with the forest, forest dwellers activities, fauna and flora of the forest. Prevents and discourages deforestation and impacts on rights of forest dependent people.	Triggers	Road side trees are considered as social forest and project involves cutting of road side trees
OP 4.12 Involuntary Resettlement	Ensures minimal involuntary resettlement by considering feasible alternatives project design, assisting displaced people	Triggers	Private land will be acquired/purchased for road widening as well for construction of viaduct and stations

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	to improve their former living standard.		
OP 4.10 Indigenous people	Ensures protection of the dignity, right and cultural uniqueness of indigenous people and ensures they receive social and economic benefits	Not Triggers	Project area does not habituates any indigenous population
OP 4.11 Physical Cultural Resources	Ensures preservation of property of cultural and religious importance, heritage and property of natural importance and enhancement of cultural properties	Triggered	Applicable as some of cultural resources like Church, mosque, school are getting affected due to project development
IFC EHS GUIDELINES			
IFC General EHS Guidelines	Technical reference document for guidance of general health & safety measures to be taken for general industries, construction and other such activities	Applicable	To be followed
IFC EHS Guidelines for Railways	Technical reference document for guidance of general health & safety measures to be taken for railways	Applicable	To be followed

World Bank’s operational policy 4.01 (OP 4.01) categorize the project into Category A, B & C on the basis of nature and extent of the impacts anticipated from the project. Scope of Environmental assessment studies depends on the category in which the project falls and is defined below.

Category A - Projects with significant environmental impacts and requiring a full Environmental Assessment (EA),

Category B - Projects with moderate environmental impacts and requiring a lesser level of environmental assessment,

Category C - Projects which require no environmental analysis.

Proposed Project involves development of the metro rail from JLN Station to Info Park having length of 11.2 km. Project activities are majorly land acquisition for road widening and construction of metro rail, tree cutting, vegetation removal, construction & demolition

works, material sourcing, traffic diversion/route diversions and handling of the heavy machineries. These impacts are considered as significant and can affect both environment and community if not managed properly. Thus considering the significance of the impacts, project is classified as Category A.

2.3 ENVIRONMENTAL STANDARDS

Environmental standards are being framed under above mentioned legislations, acts and rules. Environmental standards present the maximum value of concentration of pollutants that can be discharged into the environment and thus help in maintaining the environmental quality. Standards to be maintained during the development and operation phase of the project are listed below.

1. National Ambient Air Quality Standards, 2009 (**Annexure 2.1**)
2. Noise Standards, CPCB (**Annexure 2.2**)
3. OSHAS Noise Exposure Limits for the Work Zone (**Annexure 2.3**)
4. Drinking water Quality Standards-IS:10500:2012(**Annexure 2.4**)
5. Effluent Discharge Standards for Inland Surface Water (**Annexure 2.5**)
6. Tolerance Limit for Inland Surface Water Quality (**Annexure 2.6**)

CHAPTER 3. PROJECT DESCRIPTION

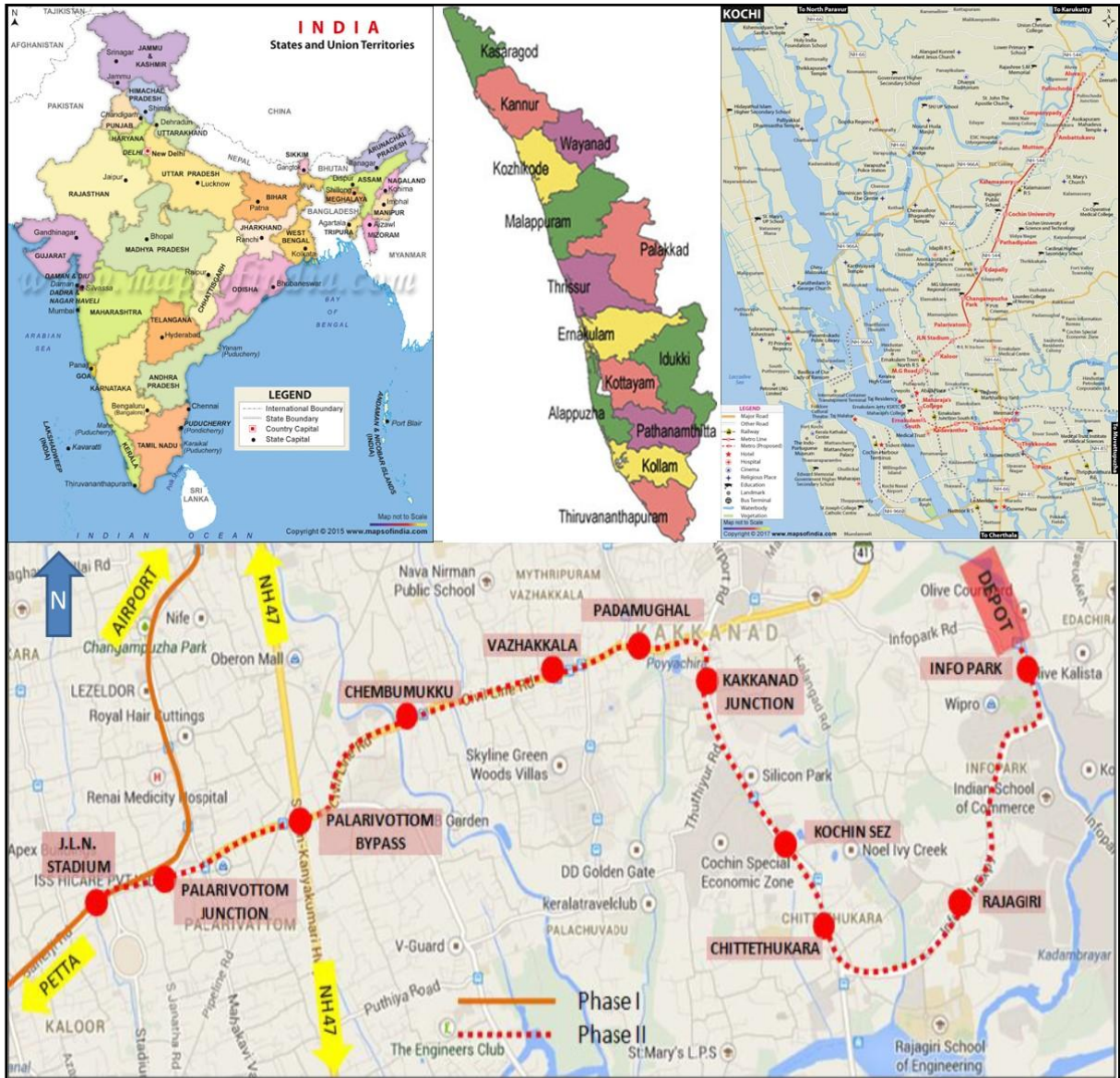
This chapter deals with the details of the Proposed Project, project components, site settings, surroundings & connectivity, land & utility requirement, project cost and implementation schedule

3.1 Introduction

Proposed project involves development of the Phase II of Kochi Metro rail, i.e. from JLN Station to Info Park via Kakkanad. Length of the Phase II is approx. 11.2 km. There are in total 11 stations planned to be developed in Phase II excluding JLN stadium station. Phase II will connect the existing Phase I line with the busy areas of the city like Palarivattom, Chembukku, Vazhakkala, Padamughal, metro city etc. Planned metro rail line is elevated section and will traverse through the road median and road edges. Roads are narrow from JLN to Kakkanad area where the road will be widened, however after Kakkanad road width is more than 30 m.

3.2 Project Location

Project is located in Kochi City. Project Start from JLN stadium metro station of Phase I and ends at Info Park. The start and end point geographical co ordinate of alignment are 10° 0'0.30"N & 76°17'55.82"E and 10° 1'8.39"N & 76°21'41.24"E. Land use of the proposed RoW includes commercial and mixed use areas. Location map of the proposed project (Phase II) is given below in **Figure 3.1**.



Source: DPR and Google Maps

Figure 3.1: Location map Showing Kochi Metro Rail Phase II Alignment

3.3 Description of Route

Kochi metro phase-II alignment starts from JLN metro station and will end at Info park. The alignment after take-off at JLN station traverses towards eastern side along MKK Nair Padamughal, metro city and Kakkannad to reach Kakkannad/ Info Park following the course of the road (MKK Nair road/ civil lines road). Then runs along Seaport – Airport road up to Chittethukara and enters in Info Park area along Info Park Expressway. Detailed route description is given below.

The Route Start from JLN station and after the station, alignment takes right turn on the MKK Nair Road/civil lines road having very narrow RoW. JLN station is common station for both Phase I and II. Palarivottam junction station is planned at 890 m from JLN station after junction of MKK Nair road and Mahakavi Vailloppalli Road. After Palarivottam junction station, the alignment traverses on the Civil lines road and follows the road alignment on the mid of the road up to the NH 47 where Palarivottam Bypass station is proposed on the

junction of Civil lines road and NH 47 at chainage 1/622, at a distance of 732m from previous station and kept on the straight and level section. After this the alignment takes left turn and due to site conditions, alignment deviates from the road and some private properties are required to be acquired in this section. The Chembumukku station has been proposed at Chainage 2/790 near Roman Catholic Church. Due to site constraints the station has been kept partially on canal to minimize property acquisition. After Chembumukku station alignment continues to run along the civil lines road and reaches near Jama Masjid area where Vazhakkala station has been proposed at Chainage 3/580, at a distance of 790 m from the previous station. After Vazhakkala station the alignment continues to run on the middle of the civil lines road except from Chainage 4/552 to 4/635 where it deviates from C/L of ROW. The alignment takes right turn just after NGO junction. The next station “Padamughal station” has been proposed near Hidhayatullsmal Madarsa at chainage 4/218. Due to site constraints, this location is selected at a short distance of 638m from the previous station. This is the nearest location to serve Metro city locality. After the Padamughal station alignment follows the civil lines road upto Kakkanad junction. Kakkanad Junction station is proposed at Chainage 5/312 at a distance of 1094m from previous station. After Kakkanad station, alignment traverses along the Seaport – Airport road up to Chittethukara which is propose to be widened. The alignment on this road has been planned on the median of the ROW of the proposed widened road. Kochi SEZ station is planned at Chainage 6/366 at a distance of 1054m from previous station. Alignment after Kochin SEZ station continues to run along the Seaport – Airport road and reaches near to info Park Junction where Chittethukara station is proposed at Chainage 7/457 just before the Info Park junction at a distance of 1091m from previous station. After the Chittethukara station, alignment to reach to info park area, leaves the sea port - airport road and turns left towards Info park area to traverse along Info park expressway. After this the road is in curve and accordingly to keep the alignment on the middle of existing road, has to turn left again. Then after a small Cross junction of the road, KINFRA Station is planned at chainage 8/735 near Vastugram at a distance of 1278m from previous station. After KINFRA station alignment runs along the Info Park Express way. This station has been added at Chainage 10/048 as the gap between KINFRA station and Info Park-2 station is substantially more. After Info Park-1 station the alignment continues to run on Info Park expressway and takes sharp left turn. Then it runs parallel on the road along existing nalah on right hand side. It runs on the right side of the road along the nalah. The Info Park-2 Station on this corridor has been planned as a terminal station at Chainage 10/715 at a distance of 667m from previous station just before the T-Junction of the main road in front of main buildings of Info park area. As this station is terminal station therefore, provision of stabling line with reversal facility has been planned with 300m length after station. Map showing alignment from JLN station to Info park II is given in **Figure 3.2**.

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Proposed JLN Junction station



Proposed Palarivottom Junction station



Proposed Palarivottom Bypass station



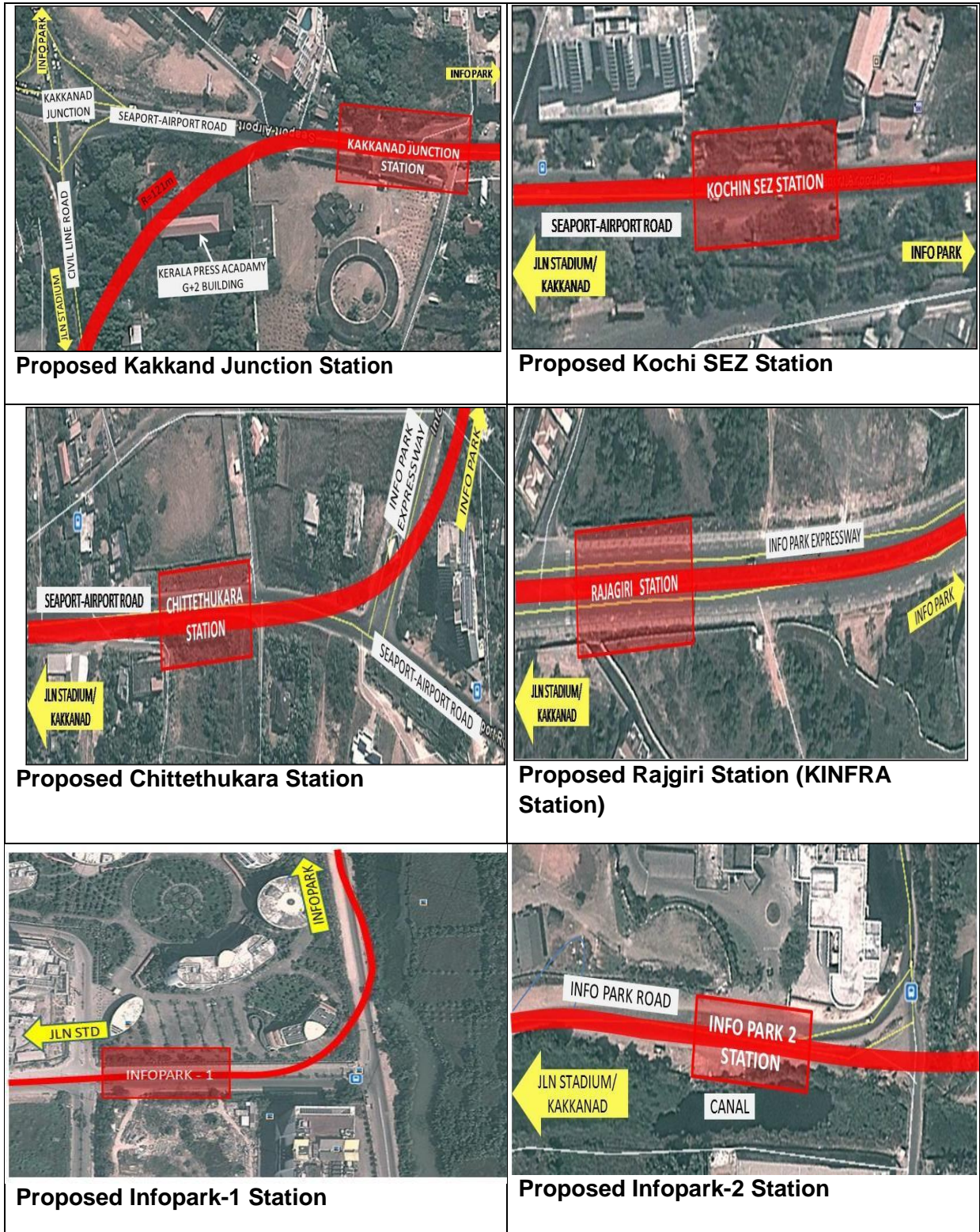
Proposed Chembumukku Station



Proposed Vazhakkala Station



Proposed Padamughal Station



Source: DPR



Figure 3.2: Maps Showing Alignment from JLN Station to Info Park-2 Station

3.4 Project Site Description, Surroundings and Connectivity

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Proposed metro route is proposed within the Kochi city of Kerala. Land use of the RoW and the surroundings is mix of residential and commercial. Proposed project traverses through Kaloor, Pallarivottam, Chembumukku, Vazhakkala, Padamughal, Kakkanad, SEZ area, Chittethukara and Info Park. Proposed project is being developed as Phase II but will be connected to Phase I at JLN stadium. Phase II will connect JLN stadium to Info park via Kakkanad there by providing metro rail connectivity in the busiest corridor of city. Entire corridor is elevated and is along the road. However roads are narrow thus it is proposed to widen the road prior undertaking metro construction work to minimize the issues due to traffic congestion. Proposed route is approx. 11.2 km in length having 11 stations excluding JLN station. Location and features of the proposed station sites are given in **Table 3.1**. Land is also required temporarily for establishment of the casting yards/storage yards. Two locations are identified at Kalamassery which belong to HMT and FACT respectively. Distance of these casting yards/storage yards from the alignment is 4.5 km and 5.8 km respectively in North direction.

Table 3.1 :Location and Features of the Proposed Station Sites

S. No.	Station	Photograph	Land Use of Station Site	Elevation Level-amsl	Connectivity/Accessibility
1.	JLN Stadium		Commercial	0-13	Well connected with MKK Nair Road
2.	Palarivottom Jn		Commercial	10	Well connected with Civil Line Road





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3.	Palarivottom		Commercial	11	Well connected with Civil Line Road
4.	Chembumukku		Commercial	11-12	Well connected with Civil Line Road
5.	Vazhakkala		Mixed use	11-12	Well connected with Civil Line Road

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6.	Padamughal		Mixed use	12	Well connected with Civil Line Road
7.	Kakkanad Jn		Mixed use	21	Well connected with Civil Line Road
8.	Kochin SEZ		Commercial	16-17	Well connected with Seaport-Airport road

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9.	Chittethukara		Commercial	21-22	Well connected with Seaport-Airport road
10.	KINFRA		Mixed use	4-5	Well connected with Info Park Expressway
11.	INFOPARK 1			3	Well connected with Info Park Expressway
12.	INFOPARK 2			3	Well connected with Info Park Road

Source: DPR and Site Visit

3.5 Existing Facilities/Utilities at Site

Proposed metro route traverses majorly along the road barring some diversions while negotiating existing/proposed Bridges/flyovers, curves and other obligatory points etc. The sewer/drainage lines generally exist away from main carriageway. However, in certain stretches; these might have come near the central verge or under main carriageway, as a result of subsequent road widening. The sewer / drainage lines and water main running across the alignment and getting affected by the normal location of column foundations are proposed to be taken care of by relocating column supports of viaduct by change in span length or by suitably adjusting the layout of pile foundation. Where, this is not feasible, these utilities lines will be suitably diverted. Provision has been made in the project cost estimate towards diversion of utility service lines. Details of the utilities getting affected is given in **Table 3.2.**

Table 3.2 : Details of Utilities to be Impacted

JLN TO INFOPARK CORRIDOR						
ELECTRICAL LINE						
S. NO.	CHAINAGE		DESCRIPTION	AFFECTED LENGTH	POSITION W.R.T ALIGNMENT	OWNERSHIP
	FROM	TO				
KSEB /KALOOR SUB-DIVISION						
1	-100	10	11 KV U/G CABLES - 6NOS. (HIGHWAY,GIRINAG AR,KATHRIKADVU, AZAD, KALOOR BUS STYAND & SPARE FEEDERS)	110	LEFT SIDE	KSEB/KALOOR
2	-100	10	11 KV U/G CABLES - 6NOS. (HIGHWAY,GIRINAG AR,KATHRIKADVU, AZAD, KALOOR BUS STYAND& SPARE FEEDERS)	110	RIGHT SIDE	KSEB/KALOOR
3	9		11 KV UG CABLES - 6NOS. FROM KALOOR S/S		PERPENDICULAR TO ALIGNMENT	KSEB
4	27		11KV UG CABLES - 4NOS. FROM KALOOR S/S		PERPENDICULAR TO ALIGNMENT	KSEB
5	30		11KV UG CABLE KATHRIKADVU FEEDER TO STADIUM		PERPENDICULAR TO ALIGNMENT	KSEB
6	144		11KV UG CABLE JANATHA FEEDER TO MRF TYRE		PERPENDICULAR TO ALIGNMENT	KSEB

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7	30	380	11 KV U/G CABLES-3NOS. (TAMANAM,JANATHA & EDAPALLY FEEDERS)	350	RIGHT SIDE	KSEB/KALOOR
8	380	500	11 KV U/G CABLES - 2NOS. (JANATHA & EDAPALLY FEEDERS)	120	RIGHT SIDE	KSEB/KALOOR
9	130		11 KV U/G CABLE - 1NO. JANATHA FEEDER		PERPENDICULAR TO ALIGNMENT	KSEB/KALOOR
KSEB /PALARIVATTOM SUBDIVISION						
1	700		2NOS. U/G CABLES 300 SQMM (11 KV) TAMANAM & JANATHA FEEDER		RIGHT SIDE	AE/PALARIVATTOM
2	800		11 KV U/G CABLES TAMANAM FEEDER		RIGHT SIDE	AE/PALARIVATTOM
3	900		11 KV UG CABLES(JANATHA &MAMANGALAMFEEDER)		DIAGONAL	AE/PALARIVATTOM
4	900	1300	11 KV UG CABLES(3 NOS. SURABHI LINE & CITY TEXTILE - 1NO.)	400	RIGHT SIDE	AE/PALARIVATTOM
5	900		11 KV UG CABLES		LEFT SIDE	AE/PALARIVATTOM
6	1200	1500	11 KV UG CABLES-2NOS. (1 U/G & 1 OH)	300	LEFT SIDE	AE/PALARIVATTOM
7	1300		11 KV UG CABLES		PERPENDICULAR TO ALIGNMENT	AE/PALARIVATTOM
KSEB /VENNALA SUB-DIVISION						
1	2200		11 KV UG CABLES-3NOS. (300SQMM)		PERPENDICULAR TO ALIGNMENT	AE/ VENNALA
2	2100	2200		100	RIGHT SIDE	AE/ VENNALA

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3		2571	11 KV UG CABLES- 3NOS. (300SQMM)	2571	PERPENDICUL AR TO ALIGNMENT	AE/ VENNALA
4	2500	2600		100	LEFT SIDE	AE/ VENNALA
5	1600	1730	11 KV UG CABLES (300SQMM)- ASIANET	130	RIGHT SIDE	AE/ VENNALA
6	2040	2200	11 KV UG CABLES (300SQMM)	160	RIGHT SIDE	AE/ VENNALA
KSEB /TRIKAKARA EAST SUB-DIVISION						
1	5480		PROPOSED 3X300SQMM XLPE (11 KV) UG CABLES HOYASALA		PERPENDIC ULAR TO ALIGNMENT	AEE/VYTILA
2	5490	5600	PROPOSED 3X300SQMM XLPE (11 KV) UG CABLES SATELITE FEEDER	110	RIGHT SIDE	AEE/VYTILA
3	5700		PROPOSED 3X300SQMM XLPE (11 KV) UG CABLES		DIAGONAL	AEE/VYTILA
4		5800	DLF FEEDER	100	RIGHT SIDE	AEE/VYTILA
5	10200	1070 0	PROPOSED 3X300SQMM XLPE (11 KV) UG CABLES - SKYLINE	500	ON ALIGNMENT	AEE/VYTILA
6	10200	1070 0	PROPOSED 3X300 SQ MM XLPE (11 KV) UG CABLES -GREEN VISTHA	500	ON ALIGNMENT	AEE/VYTILA
7	10200	1070 0	11 KV DOUBLE CIRCUIT EDACHIRA&KUSUMA GIRI FEEDER	500	ON ALIGNMENT	AEE/VYTILA
8	10700				PERPENDICU LAR TO ALIGNMENT	AEE/VYTILA
KSEB /TRIKAKARA WEST SUBDIVISION						
1	2860	5580	PROPOSED 2X300SQMM (11 KV) UG CABLES -UNDER RAPDRP SCHEME - CHEMBUMUKKU&VAZ HAKALAFEEDER	2720	RIGHT SIDE	AEE/VYTILA
FUEL SUPPLY LINE						

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S.NO.	CHAINAGE		DESCRIPTION	AFFECTED LENGTH	POSITION W.R.T ALIGNMENT	OWNERSHIP
	FROM	TO				
1	5216	5287	COCHIN-COIMTORE KANNUR PIPELINE FROM 0 TO 9 KM 18" DIA. HDD/MS/SKO PRESSURE - 100KG/SQCM AT 1 TO 1.5M DEPTH	73	DIAGONAL	PETRONET -CCK
2	5552	5735		183	RIGHT SIDE	PETRONET -CCK
3	6950	7200		250	RIGHT SIDE	PETRONET -CCK
4	7350	7500		150	RIGHT SIDE	PETRONET -CCK
5	7500	7500		16.45	PERPENDICULAR TO ALIGNMENT	PETRONET -CCK
6	7704	7704		16.45	PERPENDICULAR TO ALIGNMENT	PETRONET -CCK
BPCL-NAPHTHA PIPE LINE -10" DIA. AT 3 TO 5M. DEPTH						
S. NO.	CHAINAGE		DESCRIPTION	AFFECTED LENGTH	POSITION W.R.T ALIGNMENT	OWNERSHIP
	FROM	TO				
1	5216	5287	BPCL-10" NAPHTHA PIPE	73	LEFT SIDE	BPCL- KOCHIN REFINERY
2	5552	5735	BPCL-10" NAPHTHA PIPE	183	LEFT SIDE	BPCL- KOCHIN REFINERY
3	6950	7200	BPCL-10" NAPHTHA PIPE	250	LEFT SIDE	BPCL- KOCHIN REFINERY
4	7350	7600	BPCL-10" NAPHTHA PIPE	250	LEFT SIDE	BPCL- KOCHIN REFINERY
5	7704	7704	BPCL-10" NAPHTHA PIPE	16.45	PERPENDICULAR TO ALIGNMENT	BPCL- KOCHIN REFINERY
BPCL-ATF PIPE LINE -8" DIA. AT 1.2 TO 1.5M. DEPTH						
1	5216	5287	BPCL-ATF PIPE LINE - 8" DIA.	73	LEFT SIDE	BPCL- KOCHIN REFINERY
2	5552	5735	BPCL-ATF PIPE LINE - 8" DIA.	183	LEFT SIDE	BPCL- KOCHIN REFINERY
3	6950	7200	BPCL-ATF PIPE LINE - 8" DIA.	250	LEFT SIDE	BPCL- KOCHIN REFINERY
4	7350	7600	BPCL-ATF PIPE LINE - 8" DIA.	250	LEFT SIDE	BPCL- KOCHIN REFINERY
5	7704	7704	BPCL-ATF PIPE LINE -	16.45	PERPENDI	BPCL- KOCHIN

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			8" DIA.		CULAR TO ALIGNMENT	REFINERY
BPCL-WATER PIPE LINE -18" DIA.						
1	5216	5287	BPCL-ATF PIPE LINE - 8" DIA.	73	LEFT SIDE	BPCL- KOCHIN REFINERY
2	5552	5735	BPCL-ATF PIPE LINE - 8" DIA.	183	LEFT SIDE	BPCL- KOCHIN REFINERY
3	6950	7200	BPCL-ATF PIPE LINE - 8" DIA.	250	LEFT SIDE	BPCL- KOCHIN REFINERY
4	7350	7600	BPCL-ATF PIPE LINE - 8" DIA.	250	LEFT SIDE	BPCL- KOCHIN REFINERY
5	7704	7704	BPCL-ATF PIPE LINE -8" DIA.	16.45	PERPENDICULAR TO ALIGNMENT	BPCL- KOCHIN REFINERY
WATER SUPPLY LINE						
S.NO	CHAINAGE		DESCRIPTION	AFFECTED LENGTH	POSITION W.R.T ALIGNMENT	OWNERS HIP
	FROM	TO				
CI PIPE						
1	51	145	300 MM DIA PIPE	94	LEFT SIDE	KWA
2	290	410	300 MM DIA PIPE	120	LEFT SIDE	KWA
3	478	820	300 MM DIA PIPE	342	LEFT SIDE	KWA
4	820	820	300 MM DIA PIPE	17	PERPENDICULAR TO ALIGNMENT	KWA
5	820	1440	300 MM DIA PIPE	620	LEFT SIDE	KWA
6	870	1520	300 MM DIA PIPE	650	RIGHT SIDE	KWA
7	1453	1473	300 MM DIA PIPE	22	DIAGONAL	KWA
8	1494	1808	300 MM DIA PIPE	314	LEFT SIDE	KWA
9	1873	1930	300 MM DIA PIPE	57	LEFT SIDE	KWA
10	2080	2380	300 MM DIA PIPE	300	LEFT SIDE	KWA
11	2445	2540	300 MM DIA PIPE	95	LEFT SIDE	KWA
12	5572	5700	300 MM DIA PIPE	128	RIGHT SIDE	KWA
13	5817	6000	300 MM DIA PIPE	183	RIGHT TO LEFT SIDE	KWA
14	6145	6222	300 MM DIA PIPE	80		KWA

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AC PIPE						
1	51	151	100 MM DIA PIPE	100	LEFT SIDE	KWA
2	315	400	100 MM DIA PIPE	85	LEFT SIDE	KWA
3	51	790	100 MM DIA PIPE	739	RIGHT SIDE	KWA
4	1740	1880	100 MM DIA PIPE	140	RIGHT SIDE	KWA
5	1910	2660	100 MM DIA PIPE	750	RIGHT SIDE	KWA
6	4090	4430	100 MM DIA PIPE	340	RIGHT SIDE	KWA
7	4096	4300	200 MM DIA PIPE	204	RIGHT SIDE	KWA
8	4500	4530	250 MM DIA CROSSING	32	DIAGONAL	KWA
9	10710		300 MM DIA CROSSING		PERPENDICULAR TO ALIGNMENT	KWA
PVC PIPE						
1	2743	2940	90 MM DIA PIPE	197	LEFT SIDE	KWA
2	2777	2777	90 MM DIA PIPE	11	PERPENDICULAR TO ALIGNMENT	KWA
3	2777	2990	90 MM DIA PIPE	213	RIGHT SIDE	KWA
4	2840	2840	90 MM DIA PIPE	10	PERPENDICULAR TO ALIGNMENT	KWA
5	2962	2962	90 MM DIA PIPE	12	PERPENDICULAR TO ALIGNMENT	KWA
6	2940	3820	160 MM DIA PIPE	880	LEFT TO RIGHT SIDE	KWA
7	4545	4605	75 MM DIA PIPE	60	LEFT SIDE	KWA
8	4545	4555	75 MM DIA PIPE	17	DIAGONAL	KWA
9	4615	4977	75 MM DIA PIPE	36	RIGHT TO	KWA

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				2	LEFT SIDE	
10	5214	5300	110 MM DIA PIPE	86	RIGHT SIDE	KWA
11	5280	5445	200 MM DIA PIPE	16 5	LEFT SIDE	KWA
12	6322	6600	160 MM DIA PIPE	27 8	RIGHT SIDE	KWA
13	6355	6733	200 MM DIA PIPE	37 8	LEFT SIDE	KWA
14	6733	7326	160 MM DIA PIPE	593	LEFT SIDE	KWA
15	7166	7210	75 MM DIA PIPE	44	LEFT TO RIGHT SIDE	KWA
16	7492	7508	75 MM DIA PIPE	33	LEFT TO RIGHT SIDE	KWA
17	7708	7708	90 MM DIA PIPE (2 NOS.)	16.45	PERPENDICU LAR TO ALIGNMENT	KWA
18	8680	8700	100 MM DIA CROSSING	26.7	DIAGONAL	KWA
GI PIPE						
1	3050	3600	80 MM DIA PIPE	550	LEFT SIDE	KWA
2	3815	3855	80 MM DIA PIPE	40	LEFT SIDE	KWA
3	4235	4500	80 MM DIA PIPE	265	LEFT SIDE	KWA
DI PIPE						
1	820	820	250 MM DIA PIPE	17	PERPENDIC ULAR TO ALIGNMENT	KWA
2	1453	1473	1050 MM DIA PIPE	22	DIAGONAL	KWA
BSNL CABLE						
S.NO	CHAINAGE		CHAINAGE	AFFEC TED LENGT H	POSITION W.R.T ALIGNMENT	OWNERSHIP
	FROM	TO				
BSNL PALLORIVOTTAM OFFICE						

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1	0	1600	1X96F OFC	160 0	RIGHT SIDE	BSNL
2	0	1600	1X800 PAIR MAIN LINE	160 0	RIGHT SIDE	BSNL
3	1500	1600	1X200PAIR	100	LEFT SIDE	BSNL
4	1650	4500	1X96F OFC	285 0	RIGHT SIDE	BSNL
5	1650	4500	3X12F OFC	285 0	LEFT SIDE	BSNL
6	1650	2200	1X400 PAIR MAIN LINE	550	LEFT SIDE	BSNL
7	1650	2680	1X800 PAIR MAIN LINE	103 0	RIGHT SIDE	BSNL
8	4500	6100	1X96F OFC	160 0	RIGHT SIDE	BSNL
9	10600	10700	3X12F OFC	100	LEFT SIDE	BSNL
10	9900	10700	1X96F OFC	800	RIGHT SIDE	BSNL
11	10200		1X96F OFC		PERPENDICULAR TO ALIGNMENT	BSNL
BSNL : KALAMASERY/TRIKAKARA OFFICE						
1	2808		1X400 PAIR DISTRIBUTION LINE		RIGHT SIDE	BSNL
2	3000		1X800 PAIR MAIN LINE		DIAGONAL	BSNL
3	3000	3365	1X1200 PAIR MAIN LINE	365	RIGHT SIDE	BSNL
4	3365		1X400 PAIR X-ING ALIGNMENT			BSNL
5	3365	4200	P-46 TO CH -3570 (1X800 & 1X1200 PAIR)	835	RIGHT SIDE	BSNL
6	4200		1X400PAIR FROM P-46(2000PAIR) TO P--45(1000PAIR)		PERPENDICULAR TO ALIGNMENT	BSNL
7	4500		1X400PAIR FROM VAZHAKKALA CABLE TO NGO QTRS.		PERPENDICULAR TO ALIGNMENT	BSNL
8	4500	5000	1X1600, 2X1200 & 1X800PAIR FROM KAKKANAD EXCHANGE TO	500	RHS TO LHS X-ING	BSNL

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			VAZHAKKALA			
9	5000		1X100,1X200, 2X400 &1X800PAIR FROM KAKKANAD EXCHANGE TO P-32		RHS TO LHS X-ING	BSNL
10	5000	6600	P-32 TO P-34(1X400, 1X800 & 1X100 PAIR)		RIGHT SIDE	BSNL
11	6130	6600	P-36 TO P- 34(1X400PAIR)	470	RIGHT SIDE	BSNL
12	6130	7600	1X200 PAIR WITH 1X100PAIR (SPAIR) ALONG ALIGNMENT FROM P-36	147 0	LEFT SIDE	BSNL
13	7650		1X200 PAIR X-ING ALIGNMENT			BSNL
14	7578		1X200 PAIR X-ING ALIGNMENT			BSNL
15	7750		1X100 PAIR X-ING ALIGNMENT			BSNL
16	10700		1X400PAIR (P-26) WITH X-ING ALIGNMENT		DIAGONAL	BSNL
BSNL-STR : PALARIVATTOM OFFICE						
1	0	1200	3NOS.BSNL-STR OFC CABLE DUCT (ERNAKULAM- CHERTHALA-	1200	RIGHT SIDE	BSNL- STR
2	1200		6F,ERNAKULAM- MUVATTUPUZHA-		DIAGONAL	BSNL- STR
3	1210	1650	12F&ERNAKULAM- PALARIVATTOM-6F)	440	LEFT SIDE	BSNL- STR
4	1650	1850	2 NOS. BSNL-STR OFC CABLE DUCT (ERNAKULAM-	200	RIGHT SIDE	BSNL- STR
5	1880		CH ERTHALA- 6F,&ERNAKULAM- MUVATTUPUZHA-12F)	-1880	DIAGONAL	BSNL- STR
6	1870	4550	1NO.BSNL-STR OFC CABLE DUCT(ERNAKULAM-	2680	LEFT SIDE	BSNL- STR
7	4550	4633	MUVATTUPUZHA-24F) FROMVYTI	83	RIGHT SIDE	BSNL- STR
8	4633	5100		467	LEFT SIDE	BSNL- STR

3.6 Project Components

Project components can be divided into the design and the construction Phase. Project components under the design phase are given below

3.6.1 Detailed design/Pre-Construction Stage:

Detailed design stage/Preconstruction stage includes various components which are listed below

- a. **Alignment finalization and the route survey:** Survey has been carried out by KMRL and route alignments are finalized. Various alternatives are considered and thereafter routes were finalized. Alternatives considered are provided in Chapter 6.
- b. **Land acquisition and Resettlement and rehabilitation study:** Total Land require for the project is 29424.69 m² out of which 11153.136 m² is private land and 18295.83 m² is Government land. Details of the land required for the different components are given below in **Table 3.3**. Resettlement & Rehabilitation study has also been undertaken for the project and details for the compensation criteria is given below in **Table 3.4**.
- c. **Preparation of Detailed Project Reports** while considering the Noise and vibration protection requirements both during construction & operation phase, Requirement for drainage and wastewater treatment systems, waste management system, energy conservation systems, landscaping & compensatory afforestation requirements etc. All the surveys like topographical survey, geotechnical investigations etc were undertaken at DPR preparation stage including cost estimation.
- d. **Road Widening for preparing roads for undertaking the metro construction works:** The existing ROW of the roads of the corridors where metro alignment is envisaged is generally narrow. To ascertain the feasibility of the metro corridor along such roads, acquisition of land and property has been considered. Minimum distance desired between viaducts and properties is 3 m and width of the viaducts with track centre at 4.87 m c/c is 10.45 m. Thus, minimum RoW available for metro construction required is 16.45 m and for road widening to two lane traffic is 22m. Typical cross section for the proposed RoW is given in **Figure 3.3**. Road widening is proposed to be undertaken from Palarivottam to Info Park to ensure smooth movement of traffic while undertaking construction of proposed metro. A road bridge may also require to be constructed at chainage 2650-2700 on nalla “Edapallytodu”. A separate SIA study has been undertaken to understand the impact of land acquisition due to the project. Approx 2.8306 ha of land is required to be acquired for road widening along the RoW. Proposed RoW falls within the three villages, i.e. Edapally South, Vazhakkala and Kakkanadu. Details of available RoW of existing road is given in **Table 3.5**.
- e. **Traffic management requirements and measures to be taken during construction and operation phase:** Any reduction of road space during Metro construction will result in constrained traffic flow. In order to retain satisfactory levels of traffic flow during the construction period; traffic management and engineering measures need to be taken. They can be road widening exercises, traffic segregation, one-way movements, traffic diversions on influence area roads, acquisition of service lanes, etc. For elevated section wherever it is passing along the road, the requirement would be mainly along the central verge. As regards to the alignment cutting across a major traffic corridor, ‘Continuous Cantilevered Construction Technology’ would be applied to prevent traffic hold-ups or diversions of any kind. Wherever the stations are isolated, areas available around it should be utilized for road diversion purposes such as lay-byes and service roads.

- a. **Tree survey and obtaining permissions for tree cutting:** Trees which are falling within the RoW are required to be cut. Survey has been carried out by RITES/KMRL for the entire corridor.

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Table 3.3 :Details of Land Requirement

S. No.	Viaduct/Station Name	Extent of Land in Cents			Type of Land
		LHS	RHS	Total	
	Viaduct				
1.	Info Park Gate to End			165	Government
	Stations				
1.	Palarivattom Jn.	19.27	2.22	21.49	Private
2.	Palarivattom Bypass	22	15.94	37.94	Private
3.	Chempumukku	20.26	23.84	44.1	Private
4.	Vazhakkala	26.68	27.18	53.86	Private
5.	Padamugal	20.01	17.91	37.92	Private
6.	Kakkanad Jn.	38.91	20.63	59.54	Government
7.	Cochin SEZ	35.58	26.18	61.76	LHS (P), RHS(G)
8.	Chittethukara	29.65	15.06	44.71	Private
9.	Rajagiri	28.91	22.48	51.39	Government
10.	Info Park I	25	25	50	Government
11.	Infor Park II	25	25	50	Government
	Others				
1.	Sub Station			50	
	Total Private Land			275.6	
	Total Government Land			452.11	
	Total Land in Cents			727.71	
	Total Land in Ha.			2.92	

Source: DPR

Table 3.4 : Criteria for Resettlement and Rehabilitation

S. No.	Provisions	Details	Cost Per Family
1.	Provision of housing units in case of displacement	a) A constructed house not less than 50 sq.mts. b) If one does not take the house as offered in option (a), he shall get a minimum of Rs.150,000 as one-time financial assistance for constructing a house.	150,000
2.	Choice of annuity or employment	a) Provision for employment to at least one member per affected family at a rate not lower than the minimum wages or b) one-time payment of Rs.5,00,000 per affected family or c) annuity of Rs. 2,000 per month per family for 20 years with indexation	500,000
3.	One-time Resettlement allowance	One-time resettlement allowance of Rs 50,000	50,000
4.	Transportation cost for displaced families	One-time financial assistance of Rs. 50,000	50,000
5.	Subsistence grant	For each displaced family at Rs. 3,000 per month for one year from the date of award.	36,000
6.	Cattle shed/petty Shop	One-time financial assistance of Rs. 25,000(minimum) for construction of cattle shed/petty shop.	25,000
7.	Artisan/small traders	One-time financial assistance of Rs.25,000 (minimum)	25,000
8.	Land for land in case of irrigation project	At least one acre of land in common area of the project in lieu of compensation to	1 acre land

		be paid for acquired land.	
9.	Offer for developed land	If land is acquired for urbanization purpose then 20% of the developed land will be reserved and offered to land owning project affected families in proportion to the area of their land acquired and at a price equal to the cost of acquisition and cost of development.	20% of developed land

Source: DPR

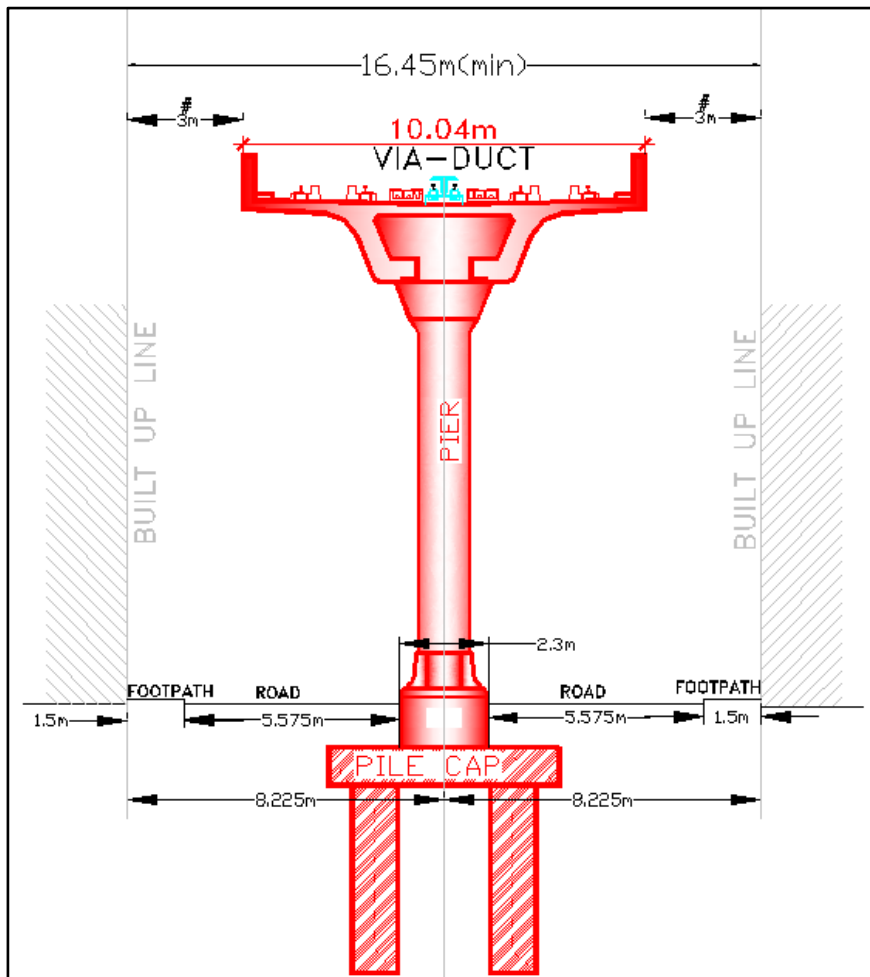


Figure 3.3: Typical Cross-Section of Metro RoW

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Table 3.5 :Details of RoW along the corridor

S. No	Chainage	Existing ROW (m)	Location
1	150	21	In front of GCDA Shopping complex, Kaloor
2	250	22	Near Hotel Abhirami, M.G.Road.
3	360	20	Janatha junction
4	540	14	In front of Church
5	635	22	In front of Kalyan complex
6	792	21	
7	920	25	Near Palarivattom junction
8	1015	24	
9	1120	25	Near Palarivattom junction
10	1225	17	BSNL Telephone Exchange, Palarivattom
11	1340	20	
12	1685	32	In front of South Indian Bank NH-47 By Pass
13	1858	19	
14	1940	20	In front of Shopping Complex Padivattom
15	2282	25	More Shopping Mall
16	2750	22	In front of Roman Catholic Church
17	3050	23	In front of KVM Tower
18	3450	21	
19	3850	23	
20	4250	20	
21	4490	19	
22	4760	17	
23	4867	22	In front of Happy Industries
24	5050	24	In front of Legal Mythology Bhawan
25	5405	30	In front of Medical Center Kakkanad
26	5640	43	In front of Prasar Bharti Maintenance Center, Kakkanad Kochi

27	5850	30	In front of LIC Branch Kakkanad
28	6315	36	BGC Residency Town, Cochin Special Economic Zone Area
29	6650	34	Sabi Hotel, Kannankeri Nagar
30	7138	36	Node focus Building
31	7538	0	In front of Karukatharayil Plaza
32	7628	30	Start of Expressway Road on Info park
33	8000	30	On Expressway Info Park
34	8460	37	
35	8795	33	
36	9145	32	
37	350	33	
8	10050	40	In front of Tejomaya Building
39	10450	30	Near WIPRO Building, Info park
40	10650	29	Near Leela Info park

Source: DPR

3.6.2 Civil Construction Works

Proposed metro project involves development of metro structure (track, via duct, piers, pier cap and platforms), station building, parking facility, RSS & TSS (Receiving & Traction Sub-station) and Radio towers. All the components of the project are discussed in sections below.

3.6.2.1 Gauge

Standard gauge is proposed to be adopted for proposed metro rail system. Standard gauge has width of 1435 mm.

3.6.2.2 Viaduct

The proposed viaduct structure for the Kochi Metro is a 'U'-shaped pre-stressed concrete deck, carrying two tracks supported on single pier located on the median of the road. Width of the deck is 9.0 m and the piers will be elliptical of 1.2 m x 1.85 m size. Road clearance of 5.5 m is ensured below the viaduct structure. The foundation shall be pile foundation at most of the locations. Open foundations are possible at certain isolated locations. The superstructure shall be pre-cast segmental construction which will cause minimal inconvenience to the road users during the execution stage.

3.6.2.3 Tracks

From considerations of maintainability, riding comfort and to contain vibrations and noise levels, the complete track is proposed to be joint-less including the turnouts. The track will be laid with 1 in 20 canted rails and the wheel profile of Rolling Stock should be compatible with the rail cant and rail profile. Track structure has been proposed with the few details given below

- 60 Kg Head Hardened (HH) 1080 grade rails for main line.
- Ballastless track for elevated viaduct and underground section of tunnel.
- Fastening system conforming to "Performance criteria of fastening system for Ballastless track on Metro Railways/MRTS System".
- Turnouts 1 in 9 with lead radius of 190m and speed potential of 30kmph on divergent track.
- Scissor Cross over (1 in 9) is provided for this corridor.
- Flash Butt welds (to minimize the noise and vibrations during welding operations)

3.6.2.4 Spans

The max spans c/c of piers of standard simply supported spans constructed by pre-cast segmental construction technique has been proposed as 28.0m. The usual segments shall be 3.0m in length except the Diaphragm segments, which shall be 2.0m each. The other standard spans (c/c of pier) comprises of 25.0m, 31.0m, 22.0m, 19.0m & 16.0m, which shall be made by removing/adding usual segments of 3.0m each from the center of the span.

3.6.2.5 Rails

Due to sharp curves, gradients coupled with high frequency of trains and frequent acceleration and deceleration at stations (typically located at about 1 km interstation distances), on main lines 60 kg/m, grade 1080 Head Hardened rails as per IRS-T- 12-96 are proposed.

3.6.2.6 Buffer Stops

On mainlines, friction buffer stops with mechanical impact absorption (non-hydraulic type). On elevated section the spans on which friction buffer stops are to be installed are to be designed for an additional longitudinal force of 85 T, which is likely to be transmitted in case of Rolling Stock impacting the friction Buffer Stops.

3.6.2.7 Rail Expansion Joints

Rail expansion joints will be provided in railways to allow for expansion & contraction of rails due to weather changes. For the project, it is proposed that REJ in ballasted track will be for a minimum gap of 120 mm and for ballast less track it will be of 180 mm.

3.6.2.8 Traction System

The 750V dc third rail system is being provided on the Phase-I corridor of Kochi Metro. Thus, to ensure consistency with the existing system, 750V dc third rail traction system is proposed for the JLN Stadium – Info park corridor. Since the route is entirely grade separated there is no danger of safety hazard to passengers from third rail.

3.6.2.9 Signalling and Train Control System

Signaling & Train Control system on the Kochi Metro Phase II corridor viz JLN Station to Info-park-II is proposed for design headway of 90 seconds so as to meet sustained train operation at up to 2 minutes interval during peak hours. Therefore, these requirements of the metro are planned to be achieved by adopting a State of art Communication based Train Control System (CBTC). CBTC shall include applicable CATC sub-systems, which consists of following:

- Automatic Train Protection (ATP)
- Automatic Train Supervision (ATS)
- Automatic Train Operation (ATO)

3.6.2.10 Telecommunication System and Transmission Media

The telecommunication system acts as the communication backbone for Signaling and other systems and provides telecommunication services to meet operational and administrative requirements of metro network. The proposed system shall be compatible with the existing Kochi Metro Phase-I system for seamless operation & maintenance. The proposed telecom system and transmission media will have following systems:

- Optical Fiber Cable
- Telephone Exchange
- Mobile Radio Communication
- Public Address System
- Centralized Clock System
- Passenger Information System
- Close Circuit Television
- Central Voice Recording System (CVRS) and
- Supervisory Control and Data Acquisition (SCADA) System

3.6.2.11 Automatic Fare Collection System

Computer based automatic fare collection system with Contactless smart token/card type ticketing will be provided for the proposed project. The equipments for the same may be provided at each station viz. Automatic Fare Gates, Ticket Office Machines, Ticket Readers, Portable Ticket Decoders, Central and Station Computers, POMs and UPS.

3.6.2.12 Depot

Current Depot of Phase I at Muttom can cater the requirement for Phase II also.

3.6.2.13 Design Specifications of the Metro System

Design specifications considered for metro system are given in **Table 3.6**

Table 3.6 : Design Specification of the Proposed Project (JLN Stadium to info-park-2)

S. No.	Feature	Description
1.	Chainage	0 m to 10715m
2.	Location	JLN Stadium to Info Park
3.	Start Coordinates	10° 0'0.30"N, 76°17'55.82"E

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4.	End Coordinates	10° 1'8.39"N, 76°21'41.24"E			
5.	Stations Nos and Type	11 nos and elevated (Excluding JLN station)			
6.	Station Name	Geographical Coordinates	Chainage	Land Use	Average Inter-station spacing
a	Palarivattom Jn.	10° 0'10.09"N, 76°18'24.48"E	890	Private	890
b	Palarivattom Bypass	10° 0'18.27"N, 76°18'46.81"E	1622	Private	732
c	Chempumukku	10° 0'39.08"N, 76°19'15.28"E	2790	Private	1168
d	Vazhakkala	10° 0'45.46"N, 76°19'39.99"E	3580	Private	790
e	Padamugal	10° 0'51.03"N, 76°20'0.03"E	4218	Private	638
f	Kakkanad Jn.	10° 0'50.51"N, 76°20'30.06"E	5312	Government	1094
g	Cochin SEZ	10° 0'20.12"N, 76°20'44.00"E	6366	LHS (P), RHS(G)	1054
h	Chittethukara	9°59'51.09"N, 76°21'3.26"E	7457	Private	1091
i	Rajagiri	10° 0'0.96"N, 76°21'36.20"E	8735	Government	1278
j	Info Park I	10° 0'36.75"N, 76°21'51.47"E	10048	Government	1313
k	Info Park	10° 0'54.58"N, 76°21'50.76"E	10715	Government	667
7.	Nos of Railway Crossings & ROB crossings	0			
8.	No of Road Crossings	49-Annexure 3.1			
9.	No of nalah/drain crossing	19-Annexure 3.2			
10.	No of power line crossing	71-Annexure 3.3			
11.	PHPDT	Year	Peak Hour Peak Direction Traffic (PHPDT)		
		2023	7340		
		2028	8464		
		2033	9745		
		2038	11597		
		2043	14029		
		2048	16263		
12.	Daily Passengers	Years	Total Daily Ridership	PHPDT	
		2023	104,357	7340	
		2024	108,704	7556	
		2025	113,572	7778	
		2026	118,480	8000	

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		2027	123,810	8229
		2028	129,675	8464
		2029	136,134	8706
		2030	143,304	8955
		2031	151,258	9211
		2032	160,115	9474
		2033	170,059	9745
		2034	181,231	10024
		2035	193,870	10310
		2036	209,591	10722
		2037	227,534	11151
		2038	248,180	11597
		2039	272,010	12061
		2040	299,751	12544
		2041	332,172	13045
		2042	356,410	13541
		2043	382,763	14029
		2044	411,434	14506
		2045	442,757	14970
		2046	477,059	15419
		2047	514,615	15851
		2048	556,010	16263
13.	Traction Power Supply	33kV/750V dc		
14.	Rolling Stock	2.9 m wide, stainless steel body, longitudinal seating arrangement, 16 T axle load,		
15.	Capacity/train	1000 passengers in 3 coach units		
		Description	3 Train Car	
			Normal	Crush
				Dense Crush
		Seated	136	136
		Standing	316	630
		Total	452	766
				975
16.	No of Cars/Train	3 nos (L = 23 m, W= 2.9 m and H = 3.9 m)		
17.	Length of Platform	81 m		
18.	Hours of Operation	19 hours/yr		
19.	System	Metro System		
20.	Fare Collection System	Automatic Fare Collection System with contactless smart card/QR code type ticketing		
21.	Construction methodology	“Elevated sections and viaduct is carried over pre-stressed concrete U/I Girders with pile/Open foundations”		
22.	Type of signaling	CBTC		
23.	Telecommunication	Integrated system with Fiber Optic cable, Supervisory Control And Data Acquisition (SCADA), Train Radio, CBTC etc.		
24.	Storage/Casting Yards	Kalamassery (belongs to HMT and FACT)		
25.	Horizontal curves			
	Min curve radius	200 m		
	Min curve length	120 m		

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26.	Transition Curve Min. Length Desirable length Min straight b/w two transition curves Min curve length b/w two transition curves Overlap between transition curves and vertical curves not allowed	0.44 times actual cant/cant deficiency whichever is higher 0.72 times actual cant/cant deficiency whichever is higher 25 m or nil 25 m
27.	Vertical Clearance (above road level)	Min 5.5 m
28.	Radius of Vertical curves (where gradient is > 0.4%) Main line Other locations Min. length	2500m 1500m 20m
29.	Max. speed	80 kmph
30.	Min distance between adjacent track (Centre to centre)	4.2 m
31.	Length of span	28 m. Longer spans may be required at location where alignment crosses road
32.	Nos. of curve	32 horizontal curves 29 vertical curves
Source: DPR		

3.7 Estimated Ridership

Traffic survey, current metro traffic and interview of people were used to estimate the nos. of riders for proposed metro project. Data estimated for ridership is given in **Table 3.7**.

Table 3.7 : Ridership Forecast on Metro Corridor

S. No.	Parameter	Horizon Years		
		2023	2035	2047
JLN Stadium To Info Park				
1.	Total daily passengers from JLN Stadium to Info Park	1.04 Lakh	1.93 Lakh	5.56 Lakh

S. No.	Parameter	Horizon Years				
		2028	2033	2038	2043	2048
JLN Stadium To Info Park						
1.	Peak Hour Peak Direction Traffic (PHPDT)	8464	9745	11597	14029	16263

Source: DPR

3.8 Utility Requirements

Utility for the project includes land, water requirement, power requirement and construction material requirement. Details are given in sections below.

3.8.1 Water Requirement

Water requirement during construction phase will be to meet domestic water requirement of construction labour and water requirement for the construction activity and batching plants. It is estimated that app. 1500 employee/labour will be employed for construction of Phase II thus domestic water requirement for the labour is anticipated to be 120 KLD (@80 kl/capita/day assuming all labour are resident labour). Water requirement for construction purpose & at casting yards is approx 200-250 KLD. As per DPR, proposed source of water is ground water after taking permission from CGWA. However, it is recommended to purchase STP treated water from municipality for non consumption purpose. There is 4.5 MLD CSTP existing at Elamkulam which is approx 5 km from proposed alignment and 14 km from casting yards. Treated water from CSTP can be considered for construction purpose of metro after providing suitable treatment as feasible.

Water requirement during operation phase will met through Ground water as per DPR. Permission shall be obtained from CGWA prior extraction of ground water. Details of water requirement during the operation phase are given below in **Table 3.8**.

Table 3.8 : Water requirement During Operation Phase

S. No	Particular	Water Demand (KLD)
1.	At Station For Drinking Purpose	72
2.	In Elevated Station	360
Total		432

Source: DPR

3.8.2 Power Requirement & Back-up

Power requirement during the construction phase will be supplied through the State Grid. Additionally, DG sets of requisite capacity will be provided at sites as power back-up during power failure.

Power requirement during operation phase is required for traction and for auxiliary purpose. Energy consumption of the rolling stock is 65 KWh/ 1000 GTKM and for provision of the same 750 V DC traction with 3rd rail current collection system is adopted. Power will be supplied for corridor through substation at Brahamanpura (220 KV). RSS⁵ (220/33 KV) of the KMRL will be established at Info park

Auxiliary substations will be provided at each of the station to cater auxiliary load. The ASS will be located at mezzanine or plat form level inside a room. Wherever TSS is required, ASS & TSS will be housed together inside a room. The auxiliary load requirements assessed to be about 200kW for elevated / at-grade stations in inception year which is likely to

⁵Receiving Sub-station

increase up to 300 KW in the year 2031 and accordingly two dry type cast resin transformers (33/0.415kV) of 500 kVA capacity are proposed to be installed at elevated station (one transformer as standby). For property Development within the footprints of the station, a provision to add third transformer at a later date may be kept at elevated station. DG sets of capacity 160 kVA each is proposed to be provided at each of the station for power backup in case of power failure for essential services like lift operations, essential lighting, Signaling and telecommunication, fire-fighting and fare collection system. Also, DG sets will be equipped with the acoustic enclosure to control the noise level. Entire power supply system will be monitored and controlled from a centralized Operation Control Centre (OCC) through SCADA system.

Part of the auxiliary power requirement, mainly of stations, is proposed to be met through solar power for which solar power plants shall be installed at the stations. Initially approx. 11% of the total traction & auxiliary power demand will be met through solar power and will gradually reach 15%.

Depot at Muttom will be used for maintenance and repair works of Phase II also thus initially there will not be significant increase in load at depot but it may increase with time and it can be considered as 1000 KW by 2043.

Power requirement during operation phase of Phase II is estimated to be 5 MVA in 2023, 7 MVA by 2033 and 11.5 MVA by 2043/2048.

To minimize the electrical load requirement of the project, entire electrical system is designed as per ECBC and international recommendation. Following measures are considered for energy conservation

- Modern rolling stock with 3 phase VVVF drive and light weight stainless steel coaches, which has the benefits of low specific energy consumption and almost unity power factor.
- Rolling stock has regeneration features and it is expected that 30% of total traction energy will be regenerated and fed back to 750V dc third rail to be consumed by nearby trains
- Effective utilization of natural light is proposed. In addition, the lighting system of the stations will be provided with different circuits (33%, 66% & 100%) and the relevant circuits can be switched on based on the requirements (day or night, operation or maintenance hours etc).
- Machine-room less type lifts with gearless drive has been proposed with 3 phase VVVF drive. These lifts are highly energy efficient.
- The proposed heavy-duty public service escalators will be provided with 3 phase VVVF drive which gives energy efficiency & improved power factor.
- Further, the escalators will be provided with infra-red sensors to automatically reduce the speed (to idling speed) when not being used by passengers.
- The latest state of art and energy efficient electrical equipment (e.g. transformers, motors, light fittings etc) has been incorporated in the system design.
- Efficient energy management is possible with proposed modern SCADA system by way of maximum demand (MD) and power factor control.
- Solar power plant may be installed at station to produce electricity which may meet the energy requirement of the station. KMRL has already a Power Purchase

Agreement with a private company for installing the Solar Power Plants. The price for solar power is being paid @ Rs. 4.59 per unit.

3.8.3 Ventilation and Lighting

With heavy passenger loading of 6 persons/ m² for standee area and doors being closed from consideration of safety and with windows being sealed type to avoid transmission of noise, air conditioning of coaches has been considered essential. Each coach shall be provided with two air conditioning units capable of automatically controlling interior temperature throughout the passenger area all the times under varying ambient condition up to full load. For emergency situations such as power failure or both AC failures etc, ventilation provision supplied from battery will be made. Provision shall be made to shut off the fresh air intake and re-circulate the internal air of the coach, during an emergency condition, such as fire outside the train causing excessive heat and smoke to be drawn in to the coach.

All the stations are elevated and are thus naturally ventilated in platform areas. Air conditioners are provided in security rooms. Illumination levels required for different facilities are different and are given in **Table 3.9** which will be maintained. Retrofitting standard luminaries with high-efficiency spectacular reflectors or replacing standard luminaries with high-efficiency luminaries.

Table 3.9 : Illumination at Different Locations

Location/Premises	Illumination (LUX)
Entrance to stations from the road	250
Booking/Concourse	200
Platforms	30-40
Passenger staircase and escalator areas	100-150
Toilets	100
Offices	100
Emergency lighting of stations, platforms, passages, escalators & public utilities	50

3.9 Sewage Management System

Sewage at station will be disposed through the septic tank and soak pits.

3.10 Storm Water Management System

Storm water drainage system is proposed to be provided at the stations to channelize the storm water. Storm water from the station areas will be collected. This collected storm water shall be recharged into the ground through rain water harvesting pits. Rain water harvesting system shall also be provided for via duct. Storm water collection & harvesting system shall also be provided at viaduct. One Rain water collection and recharge pits shall be provided per 500 m of viaduct. Thus total 22 nos of RWH pits shall be provided for viaduct and 11 for stations. RWH pits of 60 cum shall be provided for viaducts whereas RWH pits of 50 cum shall be provided for station buildings.

3.11 Solid Waste Management System

In order to achieve better waste management and proper disposal of waste, scheme will be formulated for retention and disposal of waste from stations. The aim of KMRL is to assess and minimize the waste generation, to reutilize/recycle waste and to operate in full compliance with applicable environmental laws. Waste to be generated during construction phase includes the left over concrete, timber, broken bricks, tiles, glass, paint and paint boxes, metal rods and bars, used cement bags, rags, redundant machinery & tools, storage containers, plastic bags and containers, metal containers, diesel storage barrels etc. The waste generated during construction phase is majorly recyclable. Entire waste will be segregated on time to time and will be sold to authorized vendors. Used oil from DG sets will be collected and stored in HDPE containers. This waste will be sold periodically to authorized dealers (M/s Excel Petrochemicals Koonamthai, Kochi is authorized dealer for hazardous waste management & handling in Kochi). Project development also involves demolition of various structures which are to be acquired. Demolition debris shall be collected and segregated in the reusable and reject fraction. Reusable fraction shall be stored in covered condition and reject fraction shall be disposed through the authorized vendors.

Also, there will be generation of muck during excavation of soil for construction of foundation for the pillars and construction of entry-exit of stations. Total muck to be generated due to excavation (assuming 400 piers, excavation depth 8.5 m; width 2 m; and length 2 m and 25 nos of entry exits for 11 stations having width 5 m, length 10 m and depth 3 m) will be approx. 17350 cum out of which 427.5 cum is top soil (15 cm depth). Top soil will be kept aside for undertaking compensatory plantation works. Considering swell factor of 40%, excavated muck other than top soil will be 23691.5 cum. Most of the soil will be filled back (~70%) after construction of piers and entry/exit and remaining (7108 cum) can be used for road widening and construction purpose if feasible. Surplus can be disposed at designated C&D sites of Kochi Municipal Corporation. One such site is located at Bhramanpura.

No construction labour hutments shall be located at the project site. Contractor shall arrange rented accommodation for the labour with all the basic facilities at different location but near to the site. App. 1500 labour will be required for construction of project. Thus, MSW of app. 375 kg/day is expected to be generated at the rate of 0.25 kg/day per person. The waste to be generated from labour accommodation will required to be collected, segregated, recycled and disposed off in accordance to the Solid Waste Management Rules, 2016. Wet waste and other recyclable waste will be collected in two color bins. Wet waste will be disposed off through local agencies in the area and recyclable waste will be sold to authorized vendors.

During operation phase, major solid waste to be generated at stations will comprise of the paper, packaging waste, floor sweeping, small quantity of used oil from DG sets and small quantity of other waste which includes plastic, food waste etc. The recyclable waste like paper will be sold to the recyclers. Remaining waste like floor sweepings and other waste will be disposed off through local agencies in the area on daily basis. Used oil from DG sets will be sold periodically to authorized dealers (M/s Excel Petrochemicals Koonamthai, Kochi is authorized dealer for hazardous waste management & handling in Kochi).

Expected nos. of staff (skilled and unskilled) at all the three metro stations is approx. 550 and amount of the waste generated is estimated at the rate of 0.25 kg/day is 137.5 kg/day. The stations where the commercial areas are planned or where small shops are provided, waste generated will include plastic, packaging waste, food waste etc. Store owners should

ensure that the waste is disposed off through the local agencies in the area on daily basis and no waste will be dumped on road or other area.

3.12 Parking Facility

Sufficient Parking facility is provided at Chittetukara and Info Park 2 station while minimum parking is ensured at other stations due to space constraint.

Table 3.10 : Parking Details

S No.	Metro Station	Approximate Parking Area (m²)
1	Chittethukara	1200
2	Info Park 2	10000
	Total	11200

Source: DPR

3.13 Fire-Fighting System

Provision of fire-fighting is made in all the stations. Setbacks are provided in accordance to requirement of NBC and local bye laws & requirement of CFO. Fire fighting facilities provided for project are detailed below.

Rolling Stock

The rolling stock is provided with fire retarding materials having low fire load, low heat release rate, low smoke and toxicity inside the cars. The electric cables used are also normally low smoking zero halogen type which ensures passenger safety in case of fire.

The rolling stock is provided with emergency doors at both ends of the train saloon to ensure well directed evacuation of passengers in case of any emergency including fire in the train.

At Station

Fire detection and suppression system will be provided at all the stations. Fire-fighting facilities like hose reel; fire water tank, pumps, down-comer, wet-risers, Hydrants, Automatic smoke detection, automatic sprinkler system, electrical fire alarm system, Fire extinguishers, exit signage, fire staircase and PA system etc shall be provided at all the stations. NOC from local fire office shall be obtained for all the stations.

3.14 Green Belt Area

All the stations are elevated so no green cover will be developed at stations. However green areas will be provided on the medians and edges of the road proposed to be widened and through which metro is proposed to be traversed. Compensatory plantation shall also be carried out for each tree cut in ratio of 1:12

3.15 Construction Material Requirement

Details of construction material requirement for the project are given below in **Table 3.11**

Table 3.11 : Construction Material Requirement & Source

S. No.	Building Material	Unit	Quantity	Source & Lead (km)
Elevated Station				
1.	Concrete	Cum	96394 (or 232310 MT)	Source are not exactly identified yet, however it will source from an environmentally approved mines/facilities and will be transported meeting the regulatory requirement like covering of the trucks.
2.		MT	13082	
Viaduct				
3.	Concrete	Cum	183596 (or 442466 MT)	Source are not exactly identified yet, however it will source from an environmentally approved mines/facilities and will be transported meeting the regulatory requirement like covering of the trucks.
4.			Steel	
5.	HT stand	MT	1322	

Source: DPR

Material for Phase I was sourced from Perumbavoor, Angamaly & Kalady (all sites located in Ernakulum district) so these sites may be considered. Concrete will be manufactured in the automated batching plants proposed to be established in the casting yards. Concrete of grade M-35 will be used for piles, pile cap, open foundation & other misc. Structures. Concrete of M-40 grade will be used for piers. Concrete of M-45 grade will be used for all pre-cast elements for viaduct & stations. Concrete of M-60 grade will be used for portals and cantilever piers. HYSD 500 or TMT steel will be used as reinforcement bars. For pre-stressing works low relaxation high tensile steel strands with configuration of 12 T13 and or 19 K 15 is recommended.

3.16 Construction Machinery

Machinery to be used for construction purpose will include hydraulic rig, JCB, cranes of various capacity up to 400-ton capacity, Gantry, Man Lifter, Poclain, hoppers, dumpers, batching plants, launching girders and transit mixer

3.17 Construction Methodology

Construction of elevated, underground alignment involves following type of constructions: -

- Sub-structure - Columns on Open/Pile foundations with pier cap at top of columns. Alternatively, Portal arrangement is provided at certain locations.
- Superstructure by segmental construction of whole unit construction. Box segments are most common type of segmental construction. I-Girder and U-girder are most common type of non-segmental construction methods where the structural element for whole span length is pre-casted and launched in position.

Generally, for the construction of viaduct (superstructures) & stations, precast segments are used to minimize construction time. Area of 2.5-3 ha is required for setting up of casting yards. Casting yards have facilities like casting beds, curing and stacking areas, batching plants with storage facilities for aggregates and cement, site testing laboratories, reinforcement steel yard and fabrication yard etc. For casting of spans, both long line and short line methods are used. Long line methods are used for casting the spans curved in a plan whereas short line is good for straight spans. The cast segments are cured on the bed as well as in stacking yards. Ends of the segments are to be made rough through sand blasting so that gluing of segments can be effective.

The cast segments will be transported on trailers and launched in position through launching girders. Launching girders is erected on pier head at one end of the work. The segments are lifted in sequence and when lifting is over, they are drying matched while hanging from the launching girder. Casted segments are transferred from casting yards to point of erection will be through low bedded trailers. Segments are lifted using the erection portal gantry moving on launching girder.

After dry matching, the segments are glued with epoxy and pre-stressed from one end and then the girders are lower down on temporary/permanent bearings. Launching girders then moves over the launched span to the next span and sequence continues. At the crossings or over/along the existing bridges, special steel or continuous units are provided. These segments are constructed by cast in situ balanced cantilever construction technique.

These segments are supported on single cast in place RC piers. For standard spans, piers will gradually widen at the top to support the bearing under the box webs. The piers are 1.5-1.7 m in diameter and are circular for most of its height so as they occupy minimum space at ground level. To prevent the direct collision of vehicle to pier, a Jersey shaped crash barriers of 1.0 m height above existing road level will be provided all around the piers.

3.18 Maintenance Works

For maintenance purpose depot at Muttom will be used. Maintenance schedule is established for maintenance of the rolling stock and rakes. Checks will be at various levels and intervals. Daily night check and 72 hours check of the rolling stock will be carried out to check train condition & functioning. Train will be cleaned & mopped on daily basis. Detailed inspection of train will be carried out to check the functioning of the sub-system, under frames, replacement & topping up of oils & lubricant after every 15 days or coverage of 6000 km. Further detailed inspection of above tasks is carried out on completion of 18000 km or 45 days, 36,000 km or 90 days, 72,000 km or 180 days, 150,000 km or 360 days and 300,000 km or two years. All the sub-assemblies (electrical & mechanical) are checked thoroughly after covering 520000 km or 3.5 years, During this maintenance, pneumatic valves & compressor are over hauled. All the system & sub-systems are brought to original conditions and replacement & rectification of the parts during the inspection. After every 7 years (1,040,000 km) all the sub-assemblies, bogies suspension system, traction motor, gear control equipment, air conditioning units will be dismantled or are overhauled to bring them to normal condition. Similar inspections/maintenance will be carried out after completion of 1,560,000 km or 10.5 years and 2,250,000 km or 15 years. Changing of heavy item such as bogies, traction motor, axles, gear cases and axle boxes etc. will be under heavy repair work and will be carried out as required.

All the trains will be washed after every 3 days through automatic washing plant provided at depot. It takes 10 minutes to clean the train. Heavy washing is carried out at depot after every 30 days and it takes 2-3 hours.

3.19 Multi-Modal Transportation System

In order to have an efficient public transportation system and reduce the dependency on private vehicle, KMRL has planned to integrate metro system with other modes of transport. People living within 500m can walk up to the metro station. Various modes of transportation like feeder buses and bicycles can provide first mile as well as last mile connectivity other than walking to the metro station. The facilities of footpaths / walkways, feeder buses and bicycles (bike sharing) have been planned for peak hours of various horizon years. Thus for having an adequate Meta transportation system for the walk modal share, KMRL has proposed the following measures.

Improvement of Footpaths/ walkways in influence zone of the stations

For smooth and safe movement of pedestrians, adequate footpaths shall; be available at least within 500 m radius of the metro stations. Pedestrianization work for Phase II is covered under road widening scheme of the State Government.

Feeder Bus System and Public Bike Sharing Service

Considering that the passengers from nearby areas not on the metro network will have to use various modes to reach the station, there is a need to integrate proposed metro stations with feeder buses and shared public bicycle services. The feeder buses shall be of high quality, ultra-modern and customer oriented that can deliver fast, comfortable and cost-effective urban mobility. Easy-to-board (low floor), attractive and environmentally friendly buses with air conditioning having capacity of 35 (25 seating + 10 standing) are proposed for feeder system. The feeder bus routes for identified metro stations of proposed corridor of Kochi Metro Phase II have been planned to cater to peak hour metro passengers and details of the feeder buses routes is given in **Table 3.12**.

Table 3.12 Detail of City Bus and Feeder Bus Requirement in Phase II

Metro Stations	Fleet size	
	2023	2045
JLN	-	-
Palarivattom Jn	3	31
Palarivattom by pass	18	12
Chembumukku	3	9
Vazhakala	3	9
Padamughal	5	12
Kakkanadu	4	27
K SEZ	3	19
Chittetukara	3	4
Kinfra	4	5
Infopark 1	8	5
Infopark 2	23	9
	76	142

Source: DPR

Bicycle Sharing System

A bicycle sharing system is the service in which bicycles are made available for free and shared use to metro passengers on a short-term basis. The main purpose is to allow passengers to depart or arrive at metro stations. Details of the system for Phase II stations is given in **Table 3.13**

Table 3.13 : Bicycle and Docking Station Details For Phase II

Metro Stations	Bicycles Per station	Docking points per station	Corresponding number of Spoke Stations	Bicycles at corresponding spoke station	Docking points per spoke station
JLN	35	38	1	7	10
Palarivattom Junction	43	46	4	11	14
Palarivattom by-pass	12	15	2	6	9
Chembumukku	6	9	2	3	6
Vazhakala	7	10	2	4	7
Padamughal	15	18	2	8	11
Kakkanadu	41	44	4	10	13
Cochin SEZ	29	32	5	6	9
Chittetukara	5	8	5	1	4
Kinfra	7	10	3	2	5
Info park 1	6	9	2	3	6
Info park 2	14	17	4	3	6

Source: DPR

In addition to all these facilities there should be halt and go facility available for the auto rickshaw/cabs/battery rickshaws near the station entry point.

3.20 Project Cost

Cost of the project is estimated to be INR 1957.05 Crores

Table 3.14: Project Cost

S. No.	Item	Amount (Rs. In Crores)
1	Alignment and Formation	474.40
2	Station Buildings incl. Civil works, EM works, ECS, TVS, Lift, escalators & Architectural Finishes etc	312.18
3	Depot including civil, EM, Machinery & plants, general works & OCC Building	0.00
4	P-Way for main line, depot and depot connectivity	73.92
5	Traction & power supply for main line and depot incl. Third Rail, ASS, GIS etc.	157.98
6	Signalling and Telecom etc.	100.73
6a	Automatic fare collection Elevated Stations	38.50
7	Environmental costs	10.82

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8	Misc. Utilities, road works, Topographic Surveys, Geotechnical Investigation, Barricading, Tree Cutting and replanting, other civil works such as signage's, Environmental protection and traffic management	67.20
9	Capital Expenditure on Security including civil and EM works	4.07
10	Staff Quarters including civil, electrical works	51.00
11	Capital Expenditure on Inter modal integration including Footpath for pedestrians	33.00
12	Rolling Stock (RS)	48.00
13	Total Cost at Jan 2019 price levels (Excluding Land, R&R, IDC, General Charges, Contingencies, Central & State Taxes and)	1371.80
14	General Charges @ 5%	68.59
15	Deleted	
16	Contingencies @ 3 %	41.15
17	Total Cost at Jan 2019 price levels incl. General Charges and Contingencies (Excluding Land, R&R, IDC, Central & State Taxes)	1481.54
18	Total Cost at Jan 2019 price level include General Charges, (Excluding Land, R&R, IDC, Contingencies, Central & State Taxes)	1440.38
19	Escalation at 5 % p.a on all items except contingencies	131.39
20	Total Cost include General Charges, Contingencies, Escalation, (excluding Land, R&R, PPP, IDC, Central & State Taxes)	1612.92
21	Central Taxes including basic customs duty	117.02
22	Escalation at 5 % p.a on Central Taxes including basic customs duty	10.67
23	Total of Central Taxes including escalation	127.69
24	Total Cost include General Charges, Contingencies, Escalation, Central Taxes (excluding Land, R&R, PPP, IDC, State Taxes)	1740.62
25	State Taxes	86.32
26	Escalation at 5 % p.a on State Taxes	7.87
27	Total of State Taxes including escalation	94.19
28	Land Cost and R & R cost	82.68
29	Deleted	
30	Total of Land and R&R Costs	82.68
31	Deleted	
32	Interest during Construction (IDC) including Front End Fee	39.56
33	Total Completion Cost	1957.05

Source: DPR

3.21 Implementation Schedule

Construction for the proposed project “JLN Stadium station to Info Park-2 via Kakkanad Phase II” will start by April, 2020 and the project is expected to be completed by May, 2024.

CHAPTER 4. DESCRIPTION OF ENVIRONMENT

This chapter will describe the study area, period of study, components and methodology, establishment of baseline data for valued environmental components and base maps of all environmental component like Meteorology, Ambient air quality, Ambient noise quality, Hydrology and water quality, Land use, Agriculture, Soil quality, Ecology, Demography, Occupational pattern and Socio-economics.

4.1 Background (Study Area, Methodology, References, Etc.)

Generation of environmental baseline of a project area is an important part of any Environmental Assessment process. Baseline data provide vital information on the existing environmental quality in which a development is planned. It is also useful for delineating environmental sensitive areas and for preparing an Environmental Sensitivity Map for contingency planning. In this study, the environmental characteristics of the project area were established through extensive literature search, field sampling/measurements, laboratory analysis, stakeholder consultation and data interpretation.

Secondary data from literature search were also taken from the Govt. sources i.e. Indian Meteorological Department, CPCB publications and other Govt. Sources. The baseline environmental data generation has been done for the limited period, i. e 31st May to 6th June, 2019. To have a sound impact assessment study, establishment of baseline environmental status both primary and secondary data in and around proposed project is necessary that depicts the existing environmental conditions of air, noise, water, soil, biological and socio-economic environment. The secondary and primary data has been collected within the “Project Influence Area”.

4.2 Project Influence Area

Project influence area is area which is likely to get affected due to project development. For the linear projects impact area considered is RoW of proposed metro alignment, station areas and construction sites and casting/storage yards. However spillover impacts of the activities to be carried out in the project influence area will be there in the surrounding area. Considering the nature of the activities involves, this impact zone is considered to be 500 m radius area from the proposed RoW/station areas/construction sites and casting/storage yards. However to comply with the legislative requirements of Government of India, presence of notified eco-sensitive zones is assessed within the 10 km radius from proposed RoW/station areas. Maps showing the study area are given in **Figure 4.1-4.4**.

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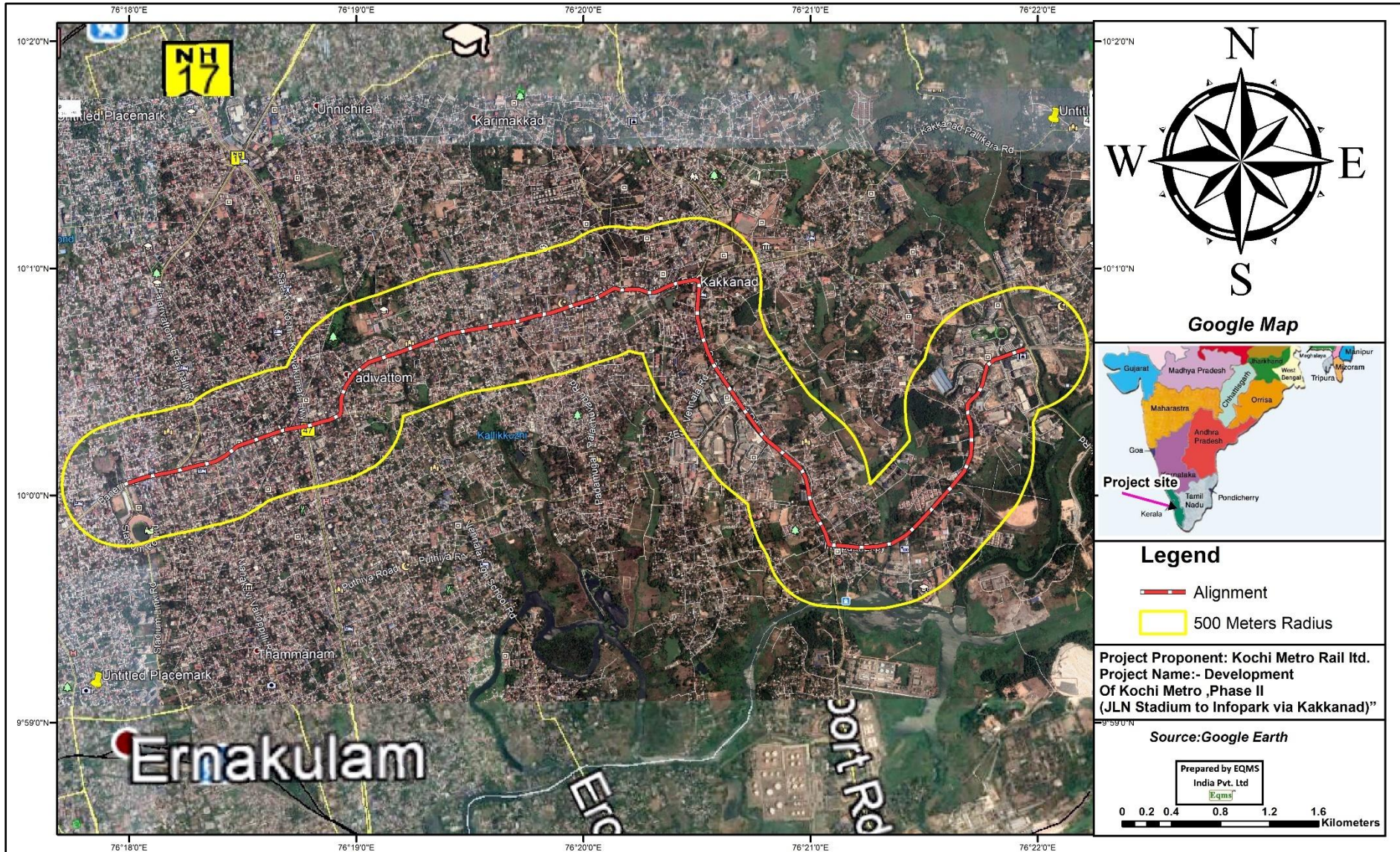


Figure 4.1: Project Influence Area for Proposed RoW/Stations (500 m Radius Area)

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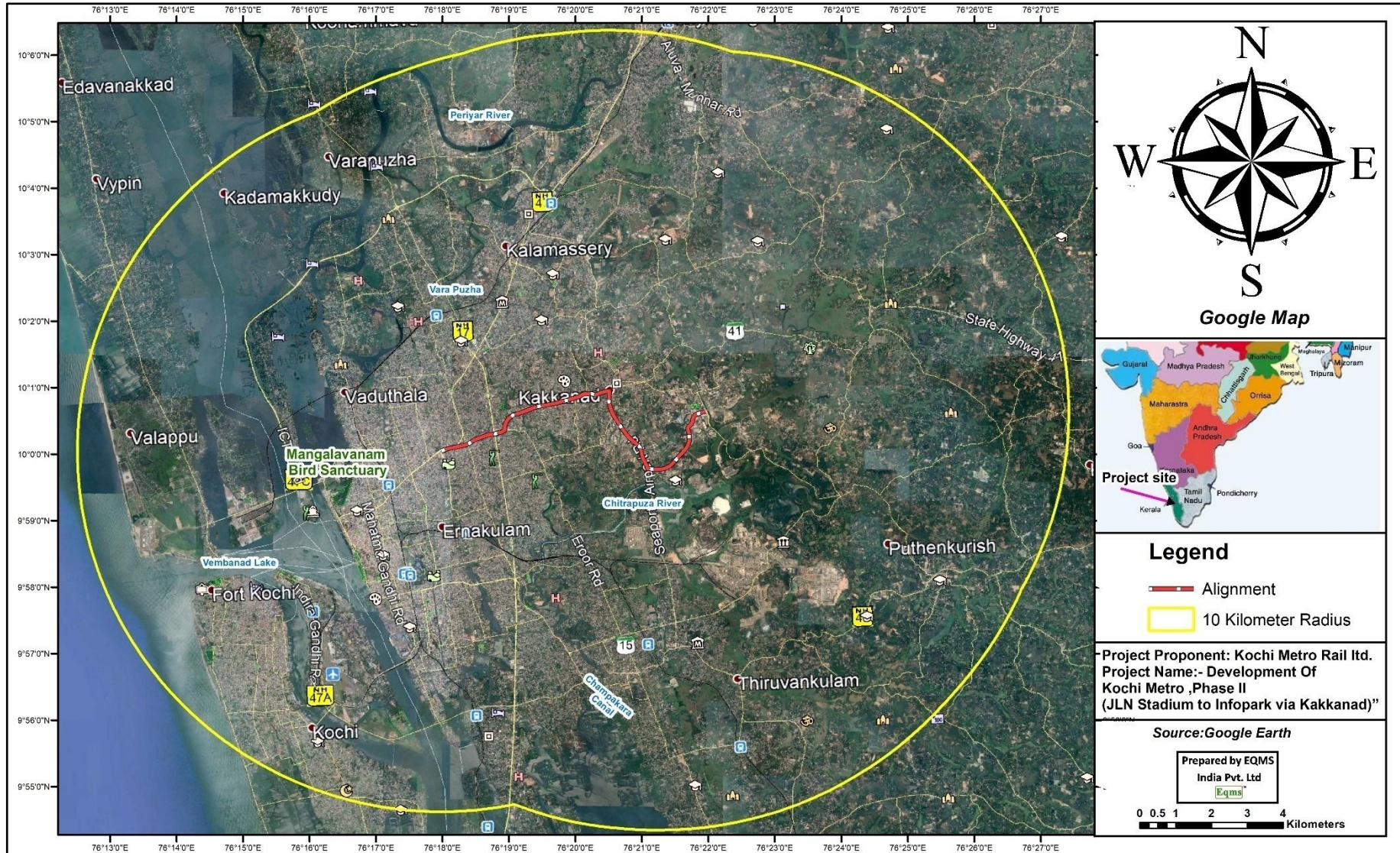


Figure 4.2: Surroundings of Project Site within 10 km Radius Area

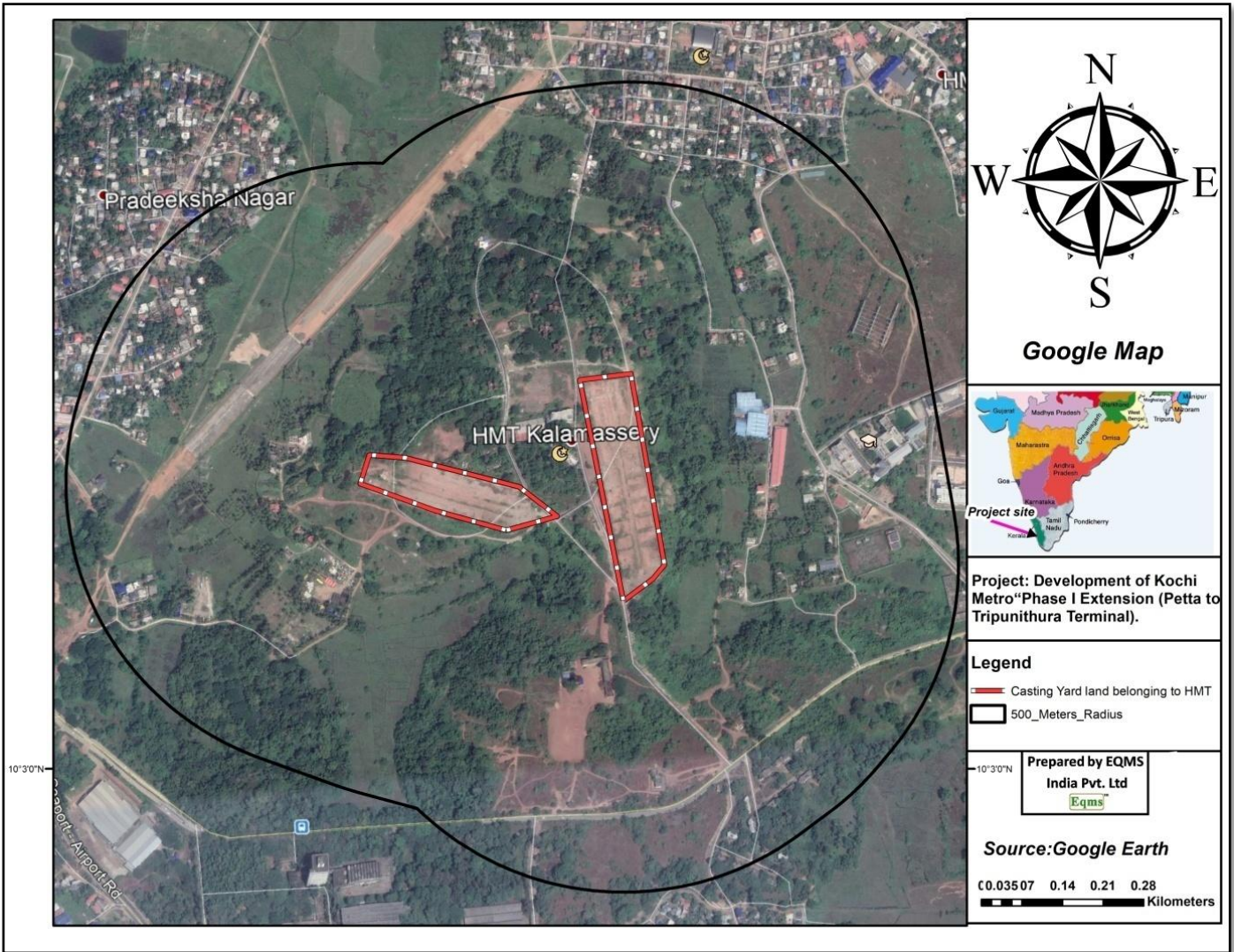


Figure 4.3: Project Influence Area for Casting Yard Belonging to HMT

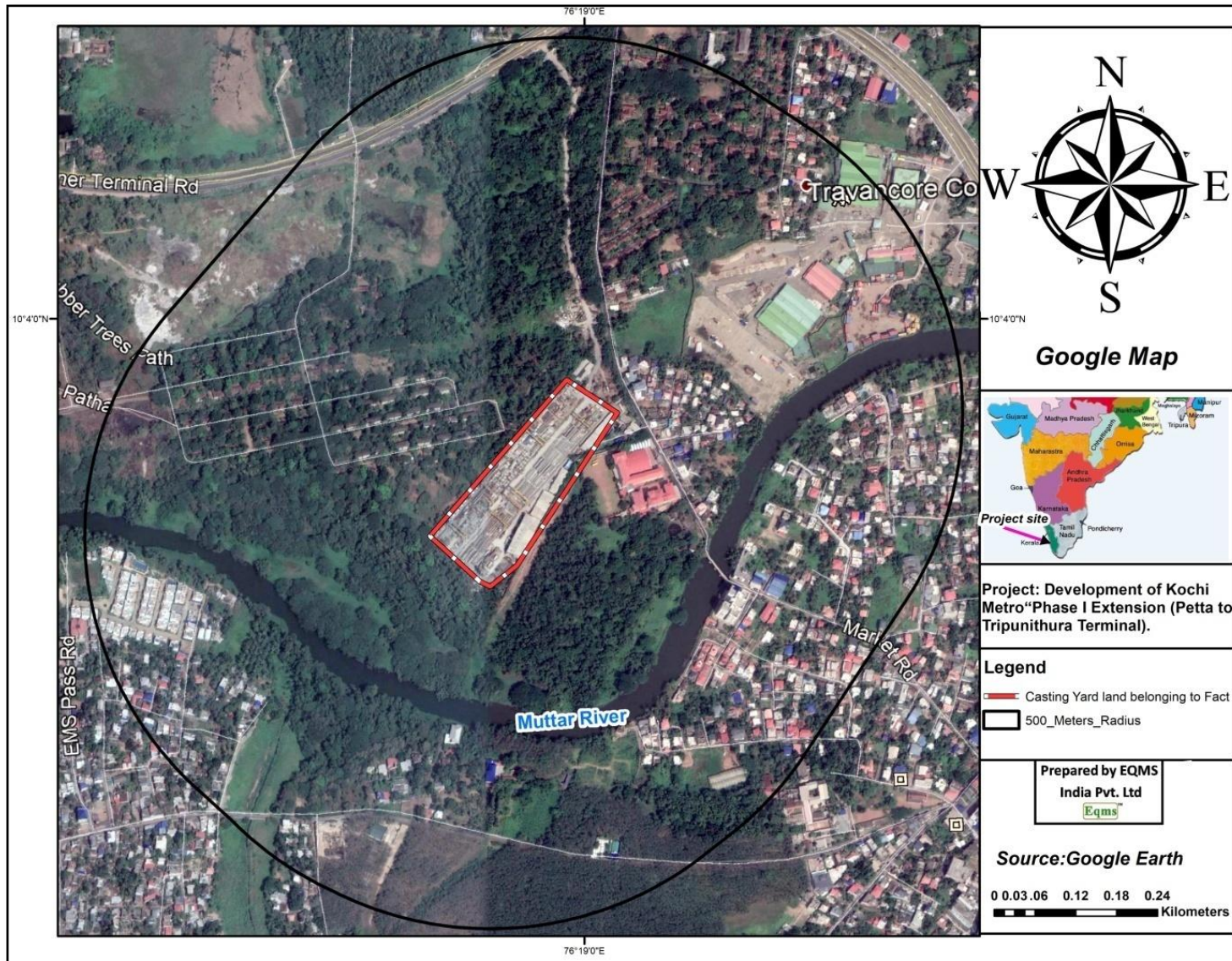


Figure 4.4: Map Showing Location of Casting Yard Belonging to FACT

4.3 Site Description and Its Environmental Salient Features

Project alignment is located within the Kochi city. Project alignment takes off from proposed JLN metro station and will terminate at Info Park. Length of proposed alignment is 11.2 km. Start and end point geographical coordinates of alignment are 9°59'50.85"N, 76°18'8.22"E and 10° 0'38.57"N, 76°21'56.74"E. The alignment will traverse through JLN stadium, Palarivottom, Chembumukku, Vazhakkala, Padamughal, Kakkanad Jn, Kochin SEZ, Chittethukara, Kinfra, and Info park. There is no eco-sensitive zone along the alignment or within 10 km of the alignment except Manglavanam Bird Sanctuary which is located at 3 km from JLN station. However, there is a draft notification on ESZ of the bird sanctuary which states that ESZ varies from 0-1.5 km around the boundary of the bird sanctuary and project area falls outside this ESZ. Land use of the proposed RoW includes residential, commercial and mixed use areas. Setting of the project area is urban and the terrain is flat with no or minor undulations. Majority of the alignment run along the road in median or edges. But the roads are narrow and thus additional land is planned to be acquired for widening of these roads. Salient Environmental Features of project area is summarized at **Table 4.1**. Toposheet map showing the 10 km radius area is given in **Figure 4.5**.

Table 4.1: Salient Environmental Features of Proposed Metro Alignment

Sensitivity	Within RoW/Station Site	Study Area- 10 km Radius	Remarks
Wildlife Sanctuary	None	None	--
National park	None	None	
Biosphere reserves	None	None	--
Bird Sanctuary	None	Yes	Manglavanam Bird Sanctuary is at 3.0 km (from JLN stadium). However there is a draft notification on ESZ of aid bird sanctuary which states that ESZ varies from 0-1.5 km around the boundary of the bird sanctuary and project area falls outside this ESZ
Important bird areas	None		-
Important migration routes of birds	None	None	--
Ramsar sites (Wetlands of International Importance)	None	None	--
Unique or threatened ecosystems	None	None	--
Important topographical features, including ridges, river valleys, shorelines, and riparian	None	None	-

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areas			
Reserve & protected Forests	None	Some forest patches	
Water Bodies	Yes	Yes	
Seismicity	Falls in Zone-III	Falls in Zone-III	--
State Boundary	None	None	--
Road connectivity	Well connected	Well connected	Within 10 km radius study area: Eeroor road, HMT Road, Baner ji Road, Stadium Link road, Mahakavi Vallopalli road, Puthiya Road, vennalalalachuvadyu Road, Infopark express, Edappally palarivattom road, salem Kochi Kanyakumari Road, vennala high school road, Seaport-Airport Road, NH47, NH17.
Rail connectivity	None	Yes	Ernakulum Town Railway Station-1.7 km, NE
Air Connectivity	None	None	No airport exist within 10 km radius area
Physical Sensitive Receptors	None	Few man made social sensitive receptors like temple, maszid, kabristan, shamshan are present along the alignment but no such structure is present within 200 m of alignment	--
Archaeological Monuments	None	--	None within 300 m of alignment
Defence Installation	None	None	--
Notified Ground Water Zone by CGWA	None	None	Area falls under safe category
Critically Environmental polluted Area	None	None	--
Habitated Areas	Yes	Yes	JLN stadium, Palarivottom, Chembumukku, Vazhakkala, Padamughal, Kakkanad Jn, Kochin SEZ, Chittethukara, Kinfra, Infopark Phase I and Info Park Phase II
Pollution Sources	Entire area is urban area and developed. Land uses along the alignment are residential, industrial, commercial and agriculture. Although no heavy polluting industry is present along the alignment. Various roads run through the alignment and study area.		

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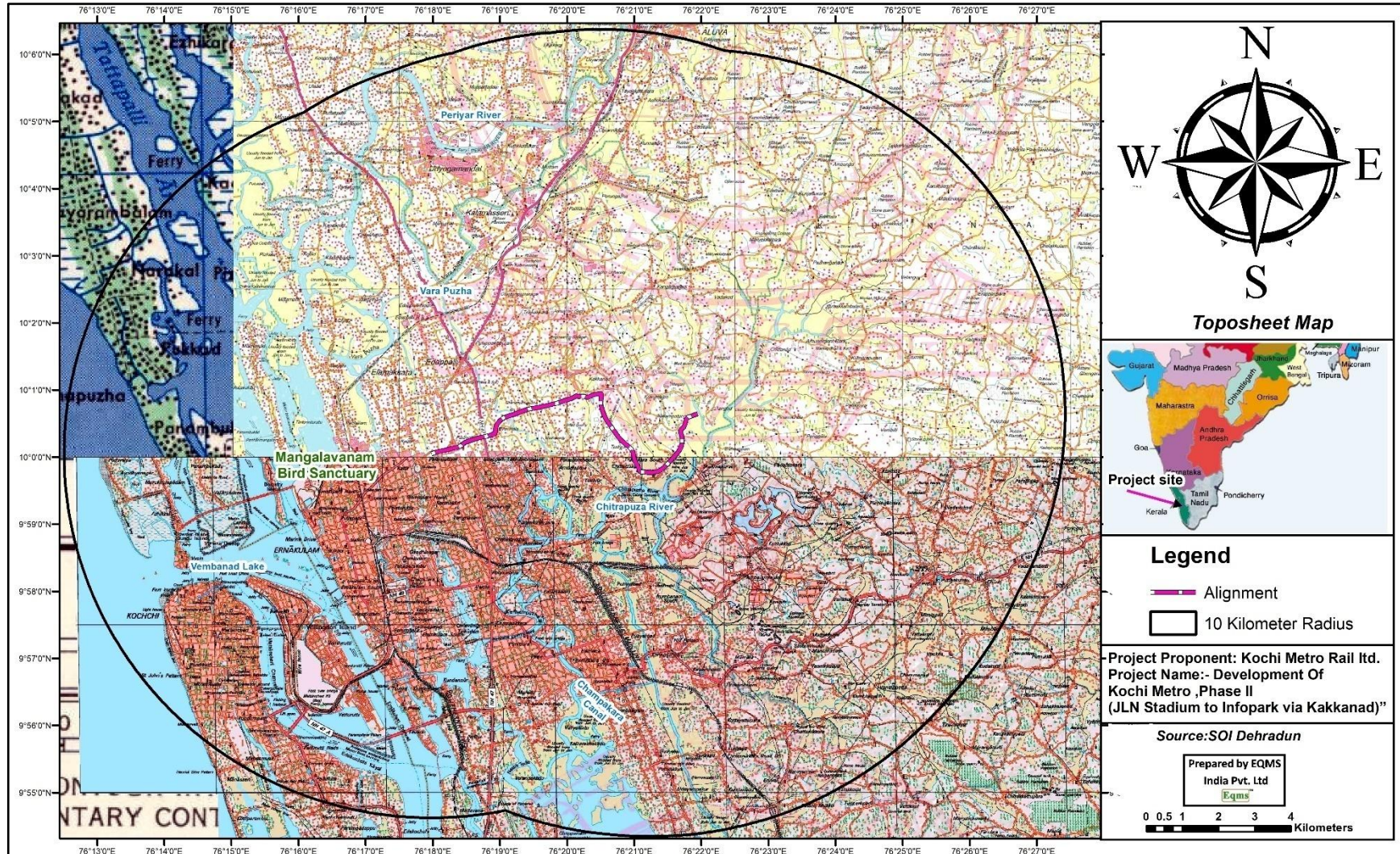


Figure 4.5 Toposheet Map of Alignment and area within 10 km radius

4.4 Primary Data Collection: Monitoring Plan and Quality Assurance Procedures

The primary baseline environmental data generation of the proposed project area has been collected for the period of 30th May to 6th June, 2019. Standard methods and procedures have been strictly adhered to in the course of this study. QA/QC procedures were strictly followed which covers all aspects of the study, and includes sample collection, handling, laboratory analyses, data coding, statistical analyses, presentation and communication of results. All analysis was carried out in NABL/MoEF&CC accredited/recognized laboratory. Summary of monitoring plan with sampling testing methodology followed is summarized in **Table 4.2**. Map depicting location of the monitoring stations is given in **Figure 4.6**.

Table 4.2: Summary of Methodology for Primary/Secondary Baseline Data Collection

Parameters	No. of sampling stations (location of sampling stations)	Frequency	Remark
Ambient Air Quality			
PM ₁₀ , PM _{2.5} , SO ₂ , NO ₂ , CO	3 locations: JLN Stadium (Pump House) Chembumukku, Chittetukara (Hyundai Showroom)	Twice a Week	AAQ monitoring was carried out at one location for 24 hourly twice in a week As per CPCB guide lines (CPCB Gazette notification dated 18.11.2009 on AAQ).
Meteorology			
Temperature, Humidity, Wind speed, Direction, storm, barometric pressure, Strom, Rainfall etc.	-	--	Meteorological status of the impact zone is analyzed based on secondary data collected from nearby IMD station for past 30 years.
Ground Water Quality			
pH, Temperature, Conductivity, Turbidity, TDS, Aluminum, Calcium, Chlorides, Copper, Fluoride, Free residual chlorine, Iron, Magnesium, Manganese, Nitrate, Phenolic compounds, Sulphate, Sulphide, Total Alkalinity, Total Hardness, Zinc, Cadmium, Cyanide, Lead, Mercury, Nickel, Total Arsenic, Total Chromium	3 location: Pallorivattam Junction, Chembumuk ku, Hyundai Showroom	Once	Ground water sample is collected from one location within project area. Samples was preserved, transported and analyzed for different parameters based on APHA methods. Temp, conductivity and pH were measured at site itself
Surface Water Quality			

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IS:10500, BOD, COD, E coli, DO, SS and others	1 location: Kadambryar River	Once	Alignment crosses various water bodies, however it is unlikely a pier will be installed in water bodies
Soil			
Texture, bulk density, pH, conductivity, cation exchange capacity, organic matter, Total N,P,K, and Heavy metals	3 location: Chembumukku, Info Park Phase II, Pallorivattam Junction	Once	One soil samples was collected and analyzed as per IARI method.
Noise			
Noise profiling for 24 hrs	At 11 locations	Once	Noise monitoring was conducted at 3 locations within the project area for 24 hrs using integrated sound level meter, as per CPCB guidelines.
Terrestrial & Aquatic Ecology			
Flora & Fauna	Project Area	Once	Primary survey/ Secondary sources, carried out in study area
Vibrations			
Vibrations from Existing Metro Operation	2 Locations: Kaloor and JLN Stadium	Once	Vibration were monitored close to piers of the existing metro stations through vibration meters
Socio-Economic			
Demography & Socioeconomic	-	Once	Secondary sources

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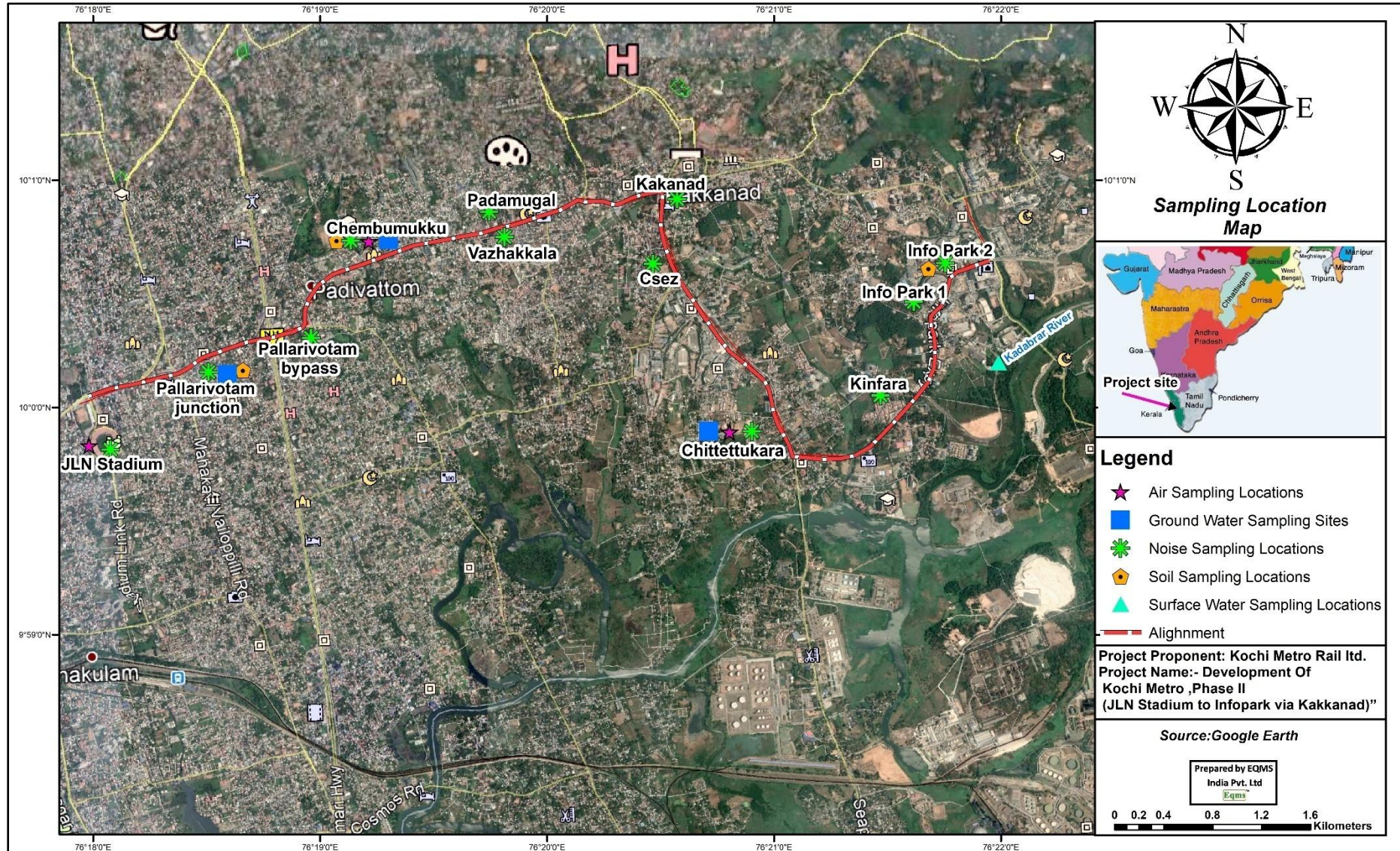
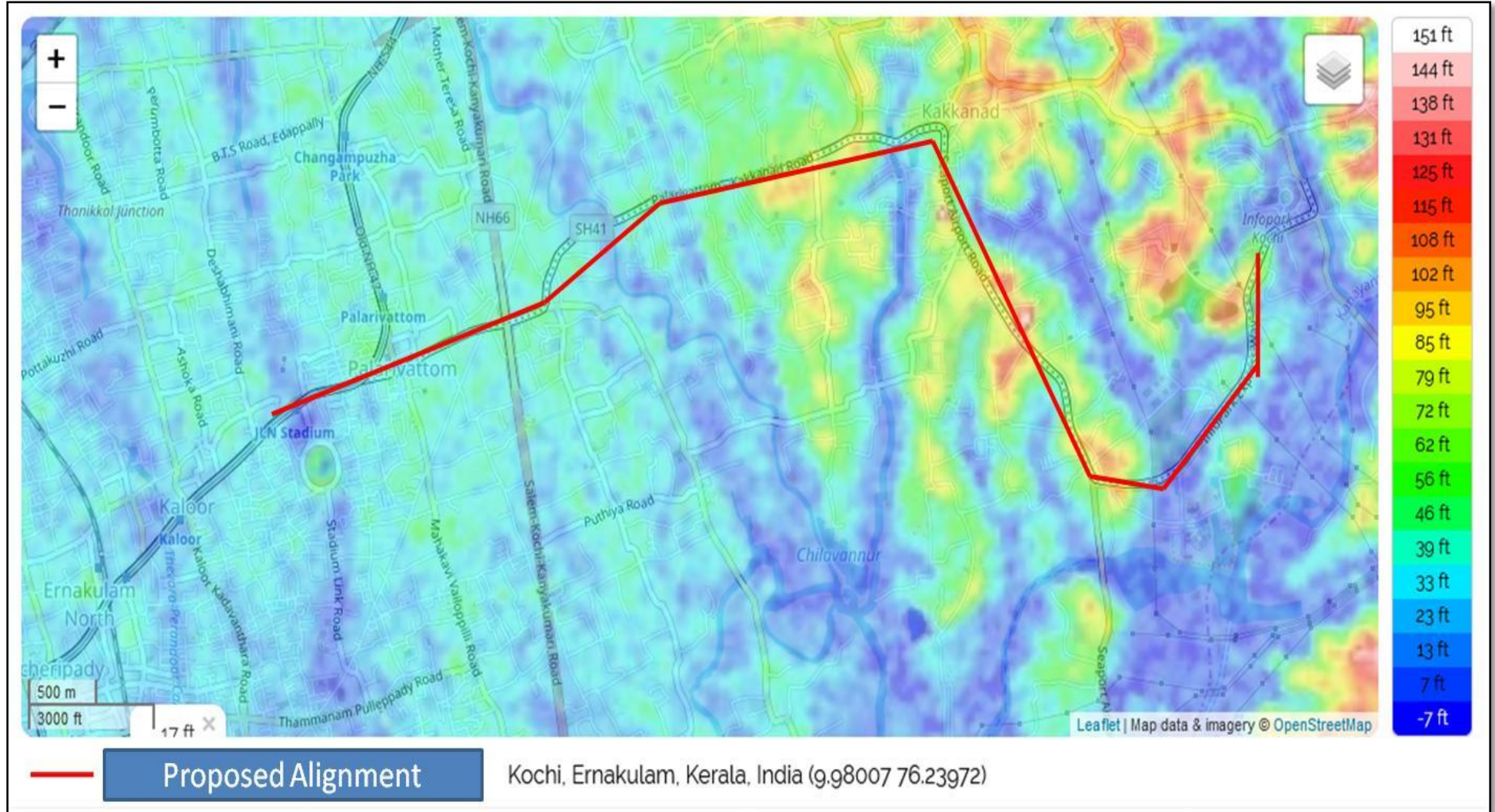


Figure 4.6 Map Depicting Location of Baseline Monitoring Stations

4.5 PHYSICAL ENVIRONMENT

4.5.1 Topography

The Ernakulum district is divided into three well-defined parts – lowland, midland and the highland consisting of seaboard, plains and the hills and forests respectively. 20 percent of the total area is low land region. The midland consists mainly of plain land and group of islands having natural facilities of drainage via backwaters and canals. The hilly or eastern portion is formed by a section of Western Ghats. Muvattupuzha and Kothamangalam taluks which were initially parts of Kottayam district can be called the highlands. Kochi is located at latitude 9° 42' 38" North and longitude 76° 12' East with an average elevation of 1.2 m above mean sea level. Western part of Kochi forms the part of coastal plain of the district. The proposed project route is level terrain with little undulation. Elevation of the project alignment varies from 2-29 m amsl. Elevation map for the project area is given in **Figure 4.7**. Contour map and digital elevation map for project alignment and surrounding area within 500 m radius area are given in **Figure 4.8 and 4.9**.



Source: Topographic maps.com

Figure 4.7 Topographic/Elevation Map

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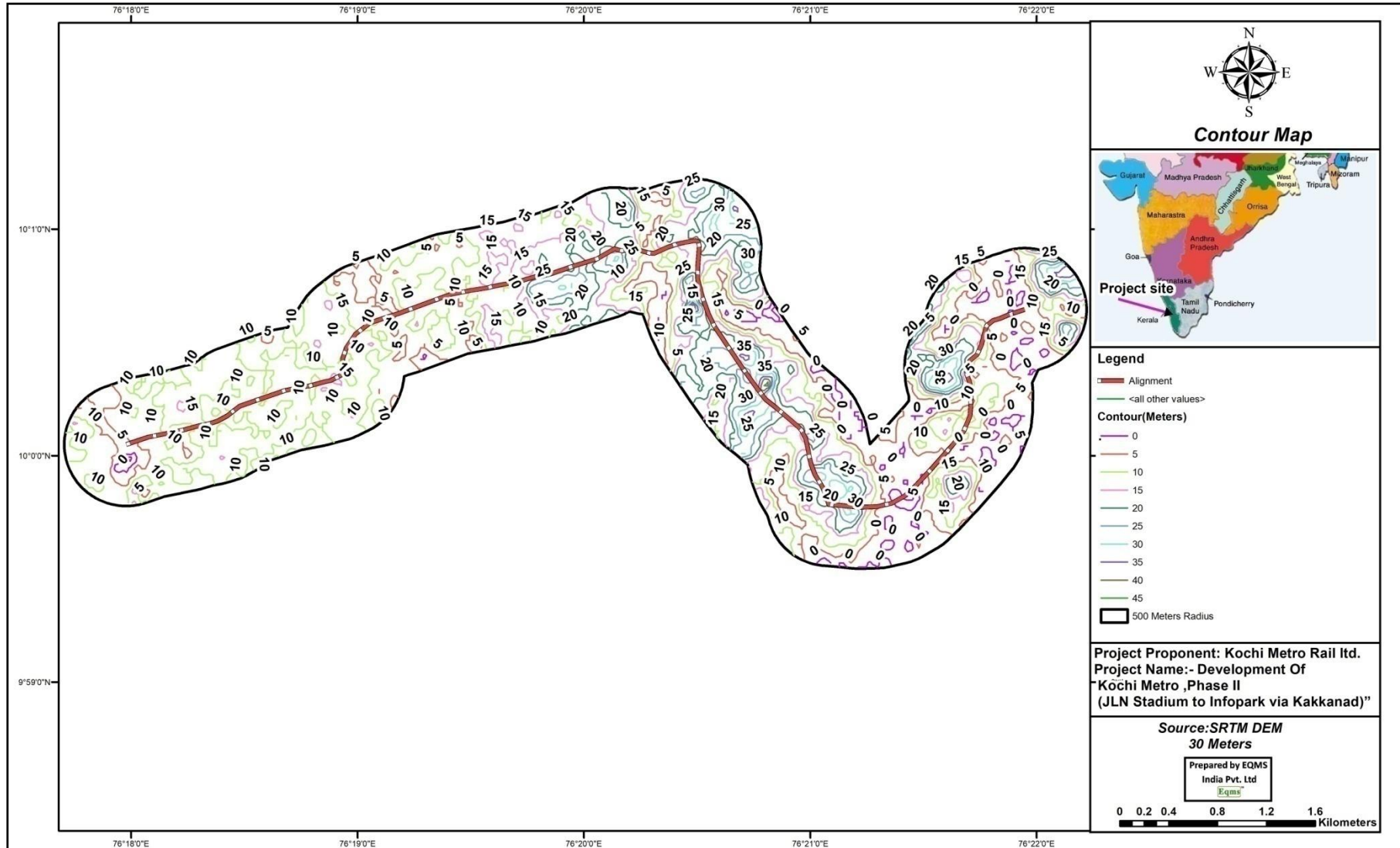


Figure 4.8 Contour Map-500 m Radius Area

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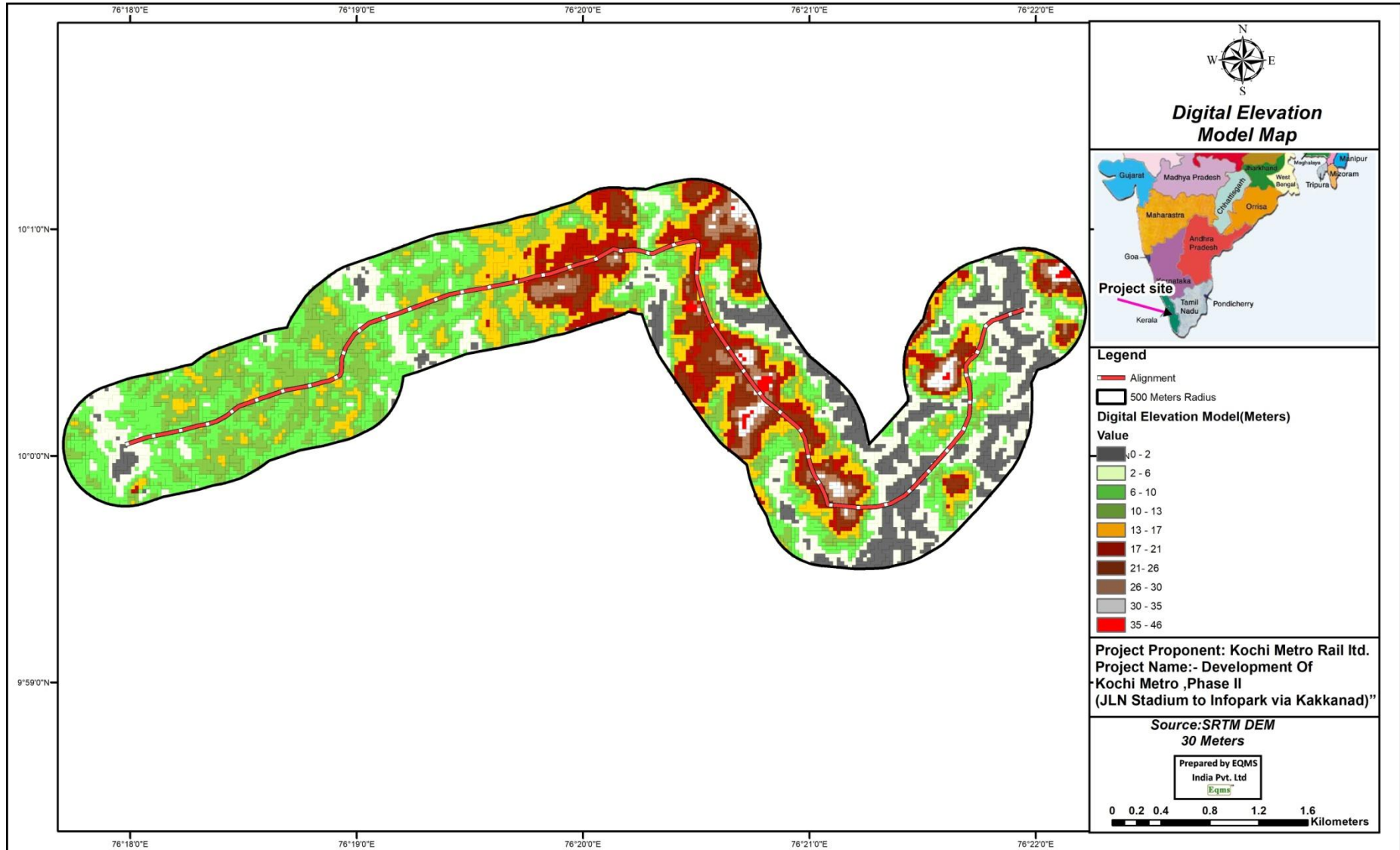


Figure 4.9 Digital Elevation Map-500 m Radius Area

4.5.2 .Drainage Pattern

The district is drained by the Periyar and its tributaries in the north and Muvattupuzha River in the south. Periyar, the longest river in the state with a total length of 244 km originates from the Cardamom hills of the Western Ghats flows in a Northerly direction initially and then in North-west direction as it flows through Idukki district before entering Ernakulam district at Neriamangalam. Muvattupuzhayar River flows through Muvattupuzha, Aluva, Kunnathunad and Parur taluks. During rainy season these rivers are full and heavy floods affect the low-lying areas on the banks, but in the summer season they generally go dry and narrow.

Cochin is dissected by numerous canals and backwaters. Cochin is a coastal settlement interspersed with backwater system and fringed on the eastern side by laterite capped low hills from which a number of streams originate and drain into the backwater system. Cochin is inseparably linked with the wetlands of Vembanad estuary. The Vembanad Lake and the surrounding geological formation are the fruit of all the major rivers of central Kerala, namely Chalakkudypuzha, Periyar, Muvattupuzha River, Meenachilar, Manimalayar, Pampa River and Achancoil River and lesser rivers like Keecheri, Karuvannur and Puzhackal. Vembanad wetland system is the largest of its kind on the west coast.

Proposed alignment crosses Edappally todou, stream from Chitrappuzha River, Kadambryar River, drains and nallas. Study area of 500 m surrounding proposed alignment is drained by the mentioned water bodies. Drainage map of the project influence area (500 m) is given in **Figure 4.10**. Drainage map of the alignment and surrounding area is given in **Figure 4.11**.

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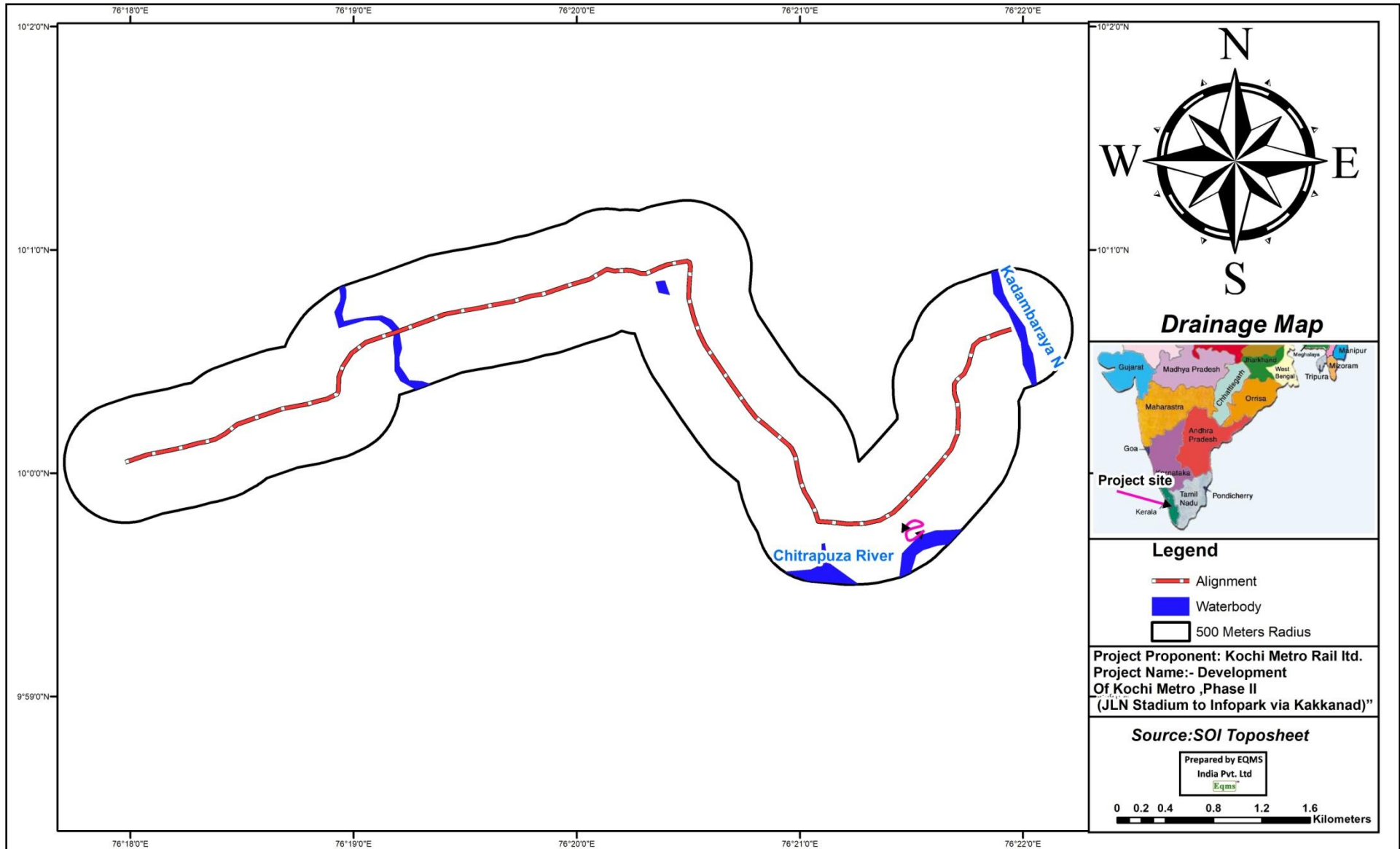
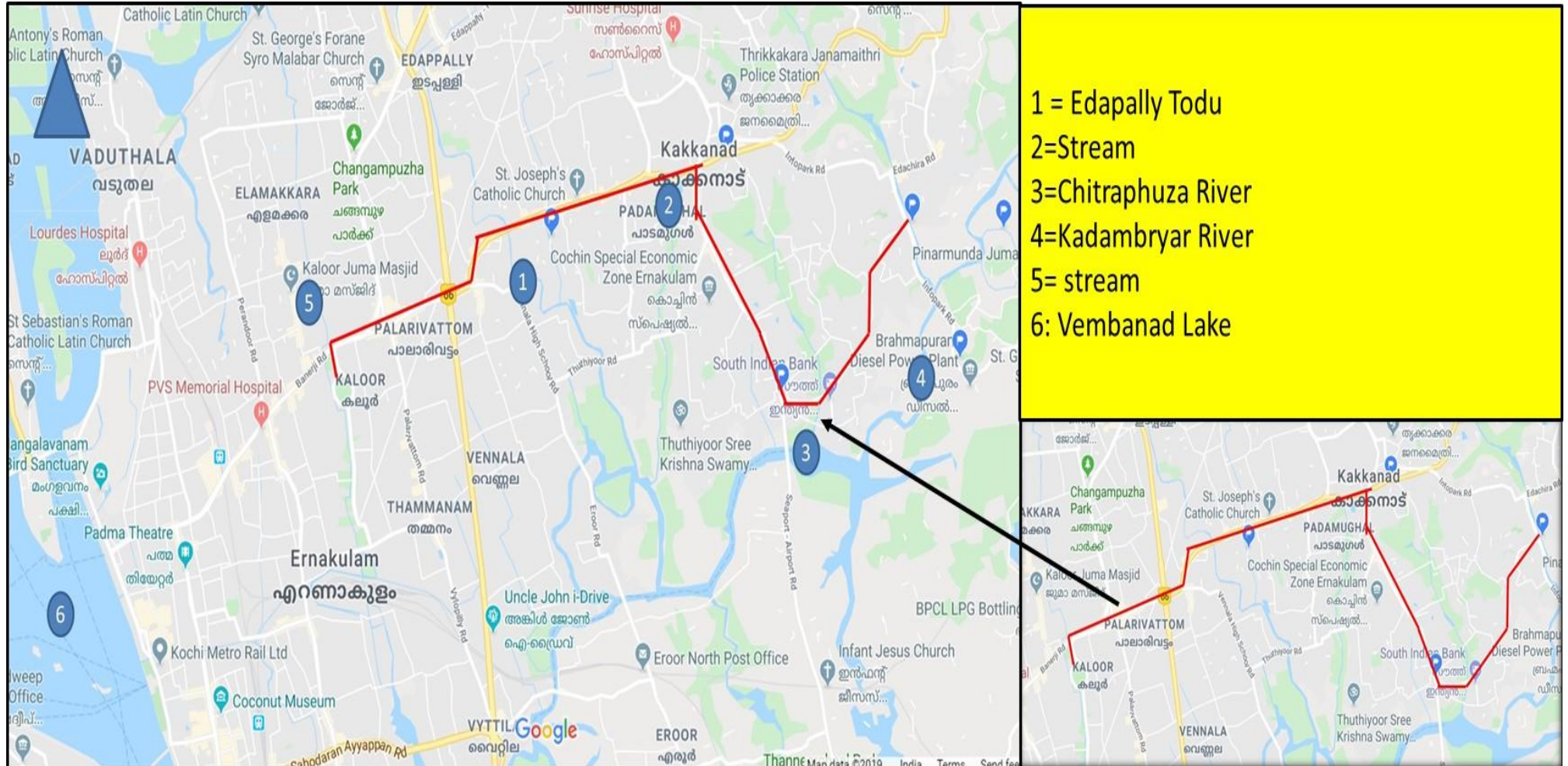


Figure 4.10 Drainage Map of Proposed RoW and 500 m Radius Area

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Source: Google Map imagery

Figure 4.11 Drainage Maps of Proposed RoW and Surroundings

4.5.3 Geology

Geologically two distinct litho units are discernible in the Ernakulum District. The eastern part is occupied by hard rocks representing Precambrian metamorphosed rocks while the coastal tract in the west is covered by soft rock or the unconsolidated coastal alluvium. Major part of the district is occupied by charnockite and moigmatite groups of rocks of Precambrian age. Patchy outcrops of Warkalli beds, consisting of pebble bed, grit, friable sandstone and variegated clay is seen in the western part around Edappalli, kalamasseri areas.

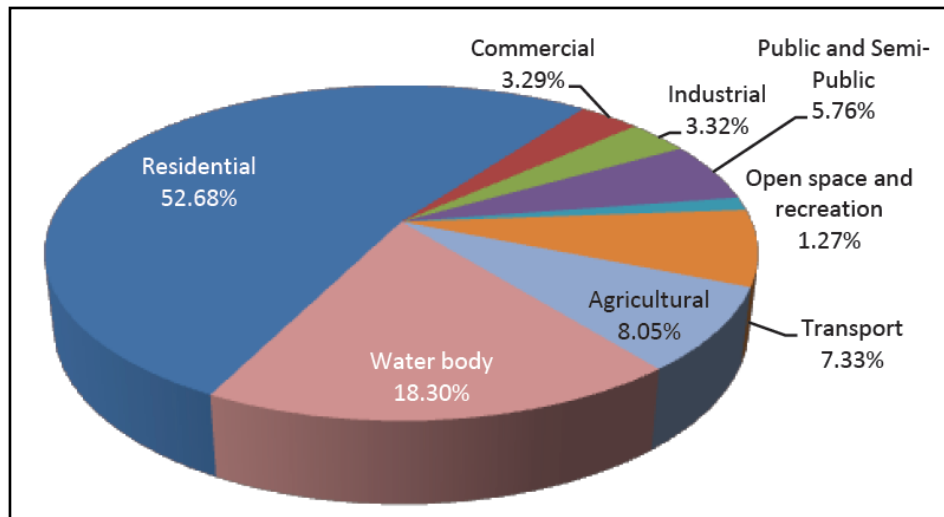
The coastal tract is covered by Quaternary sediments like beach sand, palaeo-beach ridge deposits (sand), flood plain deposits (sand, silt, clay) and tidal deposits (clay, mud). Proposed project area falls under Kochi city of Ernakulum District. Project area is majorly covered with the Laterite of quaternary group and minor Dolerite of upper cretaceous group. The geology of the project area and surroundings is presented below in **Table 4.3**.

Table 4.3 Geology of Project Area and Surroundings

Age	Group	Lithology
Cenozoic	Quaternary and Tertiary	Laterite, Warkalli beds, Paleo beach deposit
Mesozoic	Upper Cretaceous	Dolerite
Archaean	Migmatites Complex	Hornblende-biotite gneiss
	Charnockite Group	Charnockite/Charnockite Gneiss, Pyroxene granulite
	Khondalite group	Quartzite

4.5.4 Land-use Pattern

In the past two decades, the land utilization pattern in Kochi has witnessed a significant change. Broadly, while the land used for agriculture and occupied by water bodies has decreased significantly, the amount of land that has been developed has increased. Land use pattern of Kochi is given in **Figure 4.12**.



Source: City Sanitation Plan for Kochi
Figure 4.12 Land Use Map of Kochi City

Land used for transportation includes roads, airports, railway stations, bus stops, dockyards, port areas, garages, and jetties. In 1981, the percentage of land used for transport infrastructure was under 6%. This increased to approximately 7.33% in 2001. As the city continues to grow as an economic centre, so too will the floating population in and out of the city. This will require a more well-developed transport system, with better facilities, such as rest areas, changing rooms and toilets, etc.

Proposed project is planned keeping in consideration this need of city and its population. Proposed alignment is traversing through the city and will areas having residential, commercial and mixed land use. Areas through which alignment will traverse are Kaloor, Palarivottom, Chembumukku, Vazhakkala, Padamughal, Kakkanad, SEZ area, Chittethukara, Kinfra, and Info park. Land use analysis was carried out for proposed RoW and 500 m radius area using remote Sensing Data. Interpretation approach based on systematic digital imaging was used for delineating the land use classes. The demarcation of boundaries falling under different land use/land cover units is done using different colors assigned to different land use/land cover units of satellite imagery. Land use of the project influence area (500 m radius area) and graphical representation of land use of the study area is shown in **Table 4.4** and **Figure 4.13**. Land use map of the project influence area is given in **Figure 4.14**. As per the land use analysis for project influence area it is understood that most of the area is under settlement, i.e. 73.2% followed by vegetation and open scrub land.

Table 4.4 Land use of the Study Area

Class	Area(Sq. Km)	Percentage (%)
Agricultural Land/Plantation	0.23	2.1
Settlement	8.18	73.2
Vegetation	2.38	21.3
Water body	0.05	0.4
Open Scrub Land	0.33	3.0
Total	11.17	100%

Source: Satellite Image Analysis by EQMS

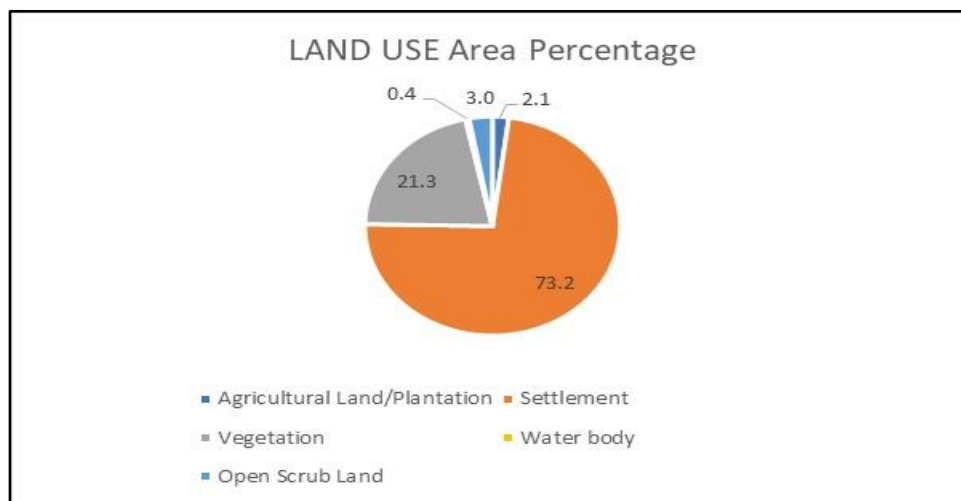


Figure 4.13: Graphical Representation of Land Use of the Study Area

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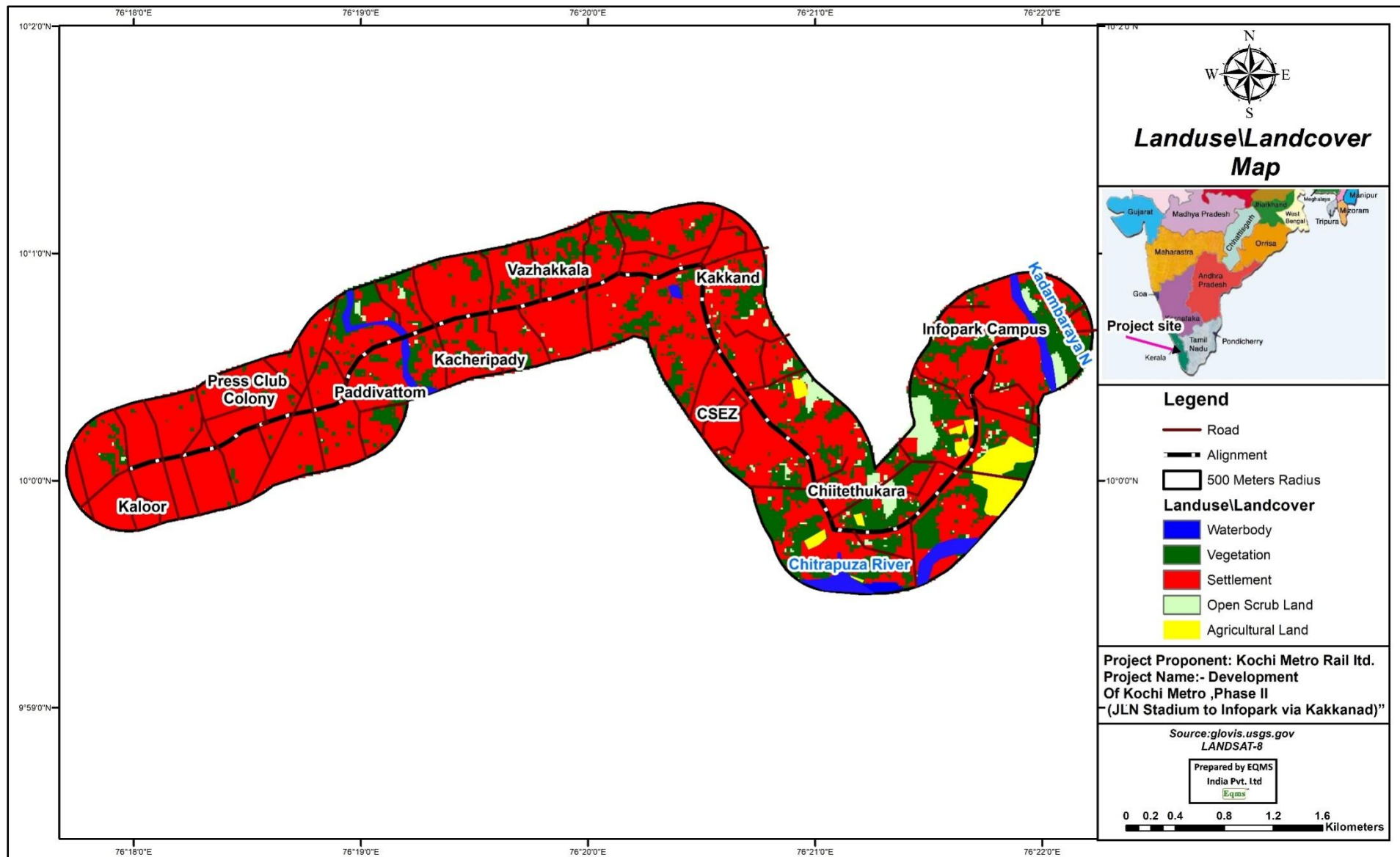


Figure 4.14 Land Use Map of the Study Area

4.5.5 Soil Quality

On the basis of morphological features and physico-chemical properties, the soils of the district are classified as Lateritic, Hydromorphic saline, Brown hydromorphic, Riverine alluvium and Coastal alluvium. Lateritic soil is the most predominant soil type of the district followed by Brown hydromorphic soil. Small patches of hydromorphic saline soil are encountered in the coastal tracts of the district in Kanayannur and Cochin taluk. In Cochin taluk coastal alluvium is encountered and is composed of sand and clay. Coconut is the major crop in these soils. Other crops grown in this soil are tapioca, rubber, area canut, pepper, cashew and spices.

Soil quality is studied in the project influence area of the proposed alignment. For general characterization of soil random samples from the study area to the depth of about 15-cm may be sufficient. The soil sample was collected from three selected location from Phase-II (Chembumukku, Info Park Phase II and Pallorivattam Junction) during the field study. The samples collected from three locations were homogeneous representative of sampling location. Soil samples was collected from 15-cm below the surface. It was uniformly mixed before homogenizing the soil samples. The sample about 500-gms was packed in polythene bag labelled in the field with location & number and sent to the laboratory for the analysis of physicochemical parameters. Detail of the sampling location is given in **Table 4.5**. Photographs of soil sampling are given in **Figure 4.12**.

Table 4.5 Soil Sampling Locations

S. No.	Location	Land Use	Coordinates
S-1	Pallorivattam Junction	Residential Area	10° 0'7.39"N, 76°18'24.24"E
S-2	Chembumukku	Field Area near Residential complex	10°00'34.0"N 76°19'29.5"E
S-3	Info Park Phase II	Open land along Road	10° 0'0.30"N, 76°22'16.89"E



Figure 4.15 Photographs of Soil Quality Monitoring

Analysis of Soil Samples

The soil samples were examined for various physicochemical parameters, to determine the existing soil characteristics of the study area. Soil samples were collected from the vicinity of proposed project site. Physicochemical characteristics of soil are presented in **Table 4.5**

Table 4.6: Physicochemical Characteristics of Soil

S. No.	Parameters	Unit	Pallorivattam Junction	Chembumukku	Info Park Phase-2
Physical Characteristics					
1.	Color	-	Reddish Brown	Reddish Brown	Reddish Brown
2.	Texture	USDA	Clay Loam	Clay Loam	Clay Loam
3.	Particle Size Distribution				
i).	Sand (0.02 to 0.20-mm)	%	28	24	26
ii).	Silt (0.002 to 0.02-mm)	%	42	41	40
iii).	Clay (< 0.002-mm)	%	30	35	34
4.	Porosity	%	47.8	51.3	49.2
5.	Bulk Density (BD)	gm/cc	1.38	1.29	1.35
6.	Water Holding Capacity	%	31.2	30.2	29.5
7.	Permeability	cm/hr	0.42	0.32	0.33
Chemical Characteristics					
8.	pH (at 25°C)	1:2 Suspension	6.82	6.84	7.05
9.	Conductivity (EC)	µmhos/cm	398	385	412
10.	CEC	meq/100-gm	19.5	18.5	17.6
11.	Organic Matter	%	0.88	1.14	1.17
12.	Organic Carbon	%	0.51	0.66	0.68
13.	Copper as Cu	mg/Kg	0.54	0.72	0.65
14.	Zinc as Zn	mg/Kg	0.85	0.81	0.77
15.	Iron as Fe	mg/Kg	12.8	11.6	14.2
16.	Boron as B	mg/Kg	0.60	0.58	0.61
17.	Manganese as Mn	mg/Kg	8.12	6.16	5.24
18.	Available Nutrients				
i).	Nitrogen as N	kg/ha	391.5	384.5	410.5
ii).	Phosphorus as P	kg/ha	18.2	22.6	21.4
iii).	Potassium as K	kg/ha	179.2	182.8	196.8

Observation on Soil Quality

- **Physical Properties**

Reddish Brown colour soils are observed in the study area. Texturally the soils of study area are observed as Clay Loam Soils. The Bulk Density (BD) of the soils was found in the range 1.29-1.35 gm/cc. Water Holding Capacity (WHC) of study area soils was observed as range of 29.5%-31.2%. Permeability values were found to range varies from 0.32-0.42 cm/hr under Clay Loam textured soil in the study area.

- **Chemical Properties**

The soil pH was found as range of 6.82-7.05, thereby indicating the soil is neutral in nature. The organic carbon content in sampled soil was observed as range of 0.51%-0.68%) thereby implying that soils are sufficient in organic content.

- **Macronutrients**

Available nitrogen content was observed in the surface soil as 384.5 -410.5 kg/ha, thereby indicating that soil is medium in available nitrogen content. Available phosphorus content was observed as range of 18.2-22.6 kg/ha, thereby indicating that soil is medium in available phosphorus. Available potassium content in the sampled soil was also observed as 179.2-196.8 kg/ha, thereby is indicating that the soil is medium in potassium content.

- **Micronutrients**

The available manganese content in sampled surface soil was recorded as 5.24-8.12 mg/kg, as the critical limit of available manganese is 2.0-mg/kg. The available Boron content in the sampled soil was found as 0.58-0.61mg/kg. The critical limit for deficiency of the available Boron is 0.5-mg/kg.

4.5.6 Seismicity of the Study Area

Based on tectonic features and records of past earthquakes, a seismic zoning map of India has been prepared by a committee of experts under the auspices of Bureau of Indian Standard (BIS Code: IS: 1893: Part I 2002. According to the seismic-zoning map of India, the project area falls in Zone III of seismicity where the maximum expected intensity is 5.6 M. Thus, lies among the moderate-risk earthquake areas. The seismicity map of study area is shown in **Figure 4.13**

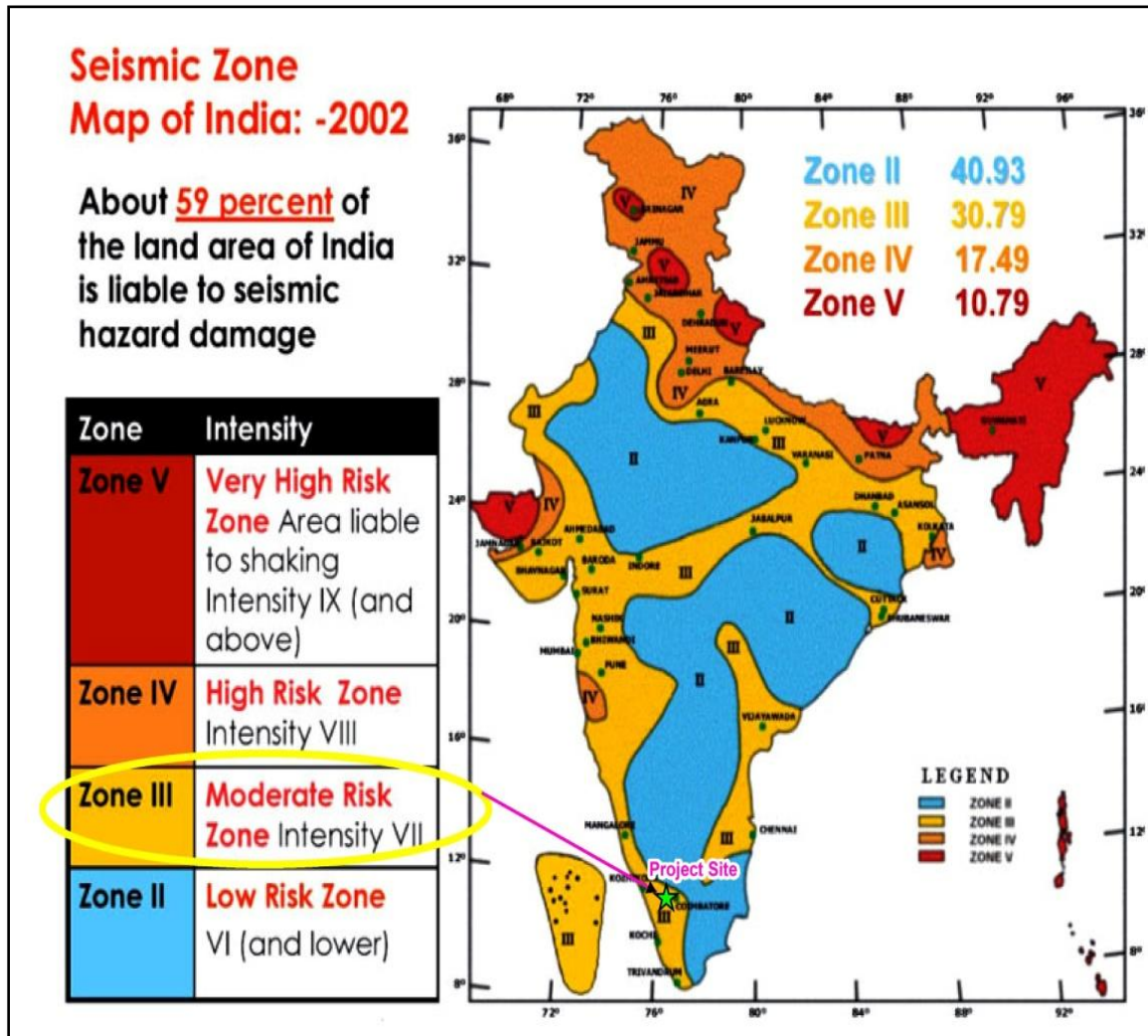


Figure 4.16 Seismic Zone Map of India

4.5.7 Meteorology

The meteorological parameters play a vital role in transport and dispersion of pollutants in the atmosphere. Nearest IMD observatory to the project site is Kochi and thus data for Kochi is considered to define the meteorology of the study area.

Climate

Under the Koppen climate classification, Kochi features a tropical monsoon climate (Am). Kochi's proximity to the equator along with its coastal location results in little seasonal temperature variation, with moderate to high levels of humidity. Details of the various climatological parameters on the basis of long term data (1981-2010) are given in **Table 4.7**.

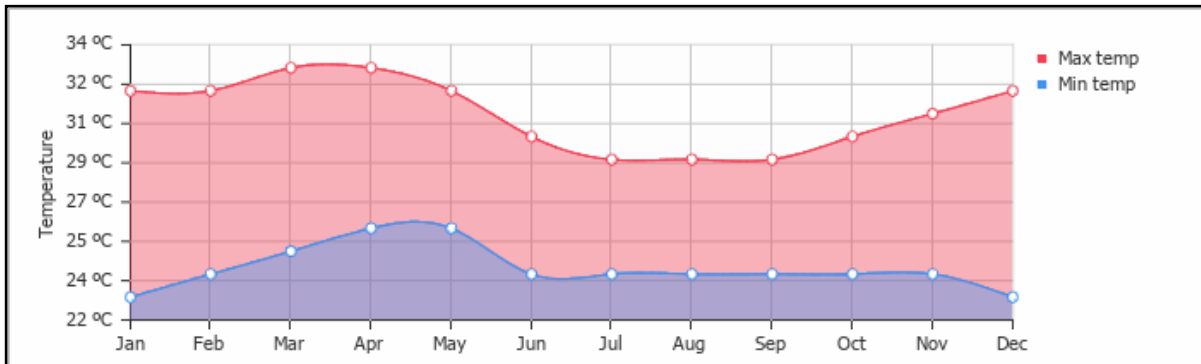
Table 4.7 Long Term Meteorological Data of Kochi (Cochin) (30 years average)

Month	Temperature (°C) Daily		Relative Humidity (%)		Rainfall (mm)	Rainy Days	Predominant Wind Direction (From)	Calm Period		Cloud Amounts (all cloud)		Wind Speed Km/hr
	Max	Min	08:30	17:30				08:30	17:30	08:30	17:30	
January	31.9	23.0	75	61	24.3	1.1	W, NW	31	0	2.8	2.5	2.4
February	32.0	24.2	79	65	27.1	1.2	W, NW	41	0	2.8	2.3	2.9
March	32.6	25.5	79	68	45.0	2.6	W, NW	54	1	3.0	3.2	3.3
April	33.0	25.9	79	70	113.1	6.9	W, NW	59	1	4.4	4.9	3.7
May	32.4	25.7	82	73	284.5	11.0	W, NW	52	2	5.3	5.4	3.5
June	30.3	24.2	90	82	700.3	23.0	W, NW	38	7	6.5	6.5	3.0
July	29.6	23.8	91	83	575.5	22.8	NW, W	42	5	6.6	6.6	2.7
August	29.5	24.0	90	82	378.8	19.0	NW, W	48	3	6.2	6.3	2.8
September	30.2	24.2	87	79	310.3	13.4	NW, W	47	2	5.6	5.8	2.8
October	30.7	24.1	86	77	366.6	14.2	W, NW	58	3	5.3	5.7	2.4
November	31.3	24.1	82	72	150.4	7.2	W, SW	59	3	4.6	5.1	2.1
December	31.9	23.2	76	64	39.0	1.8	W, NW	35	1	3.3	3.5	2.1

Source: Climatological Normals, Kochi IMD-1981-2010

Temperature

The temperature remains similar in all the months with daily mean minimum temperature around 24.3°C and daily mean maximum temperature around 31.3°C. March-April is the hottest month with daily mean maximum temperature at 33°C and daily mean minimum temperature at 25.5°C. Graphical presentation of the average minimum and maximum temperature in year is given in **Figure 4.17**



Source: Kochi IMD

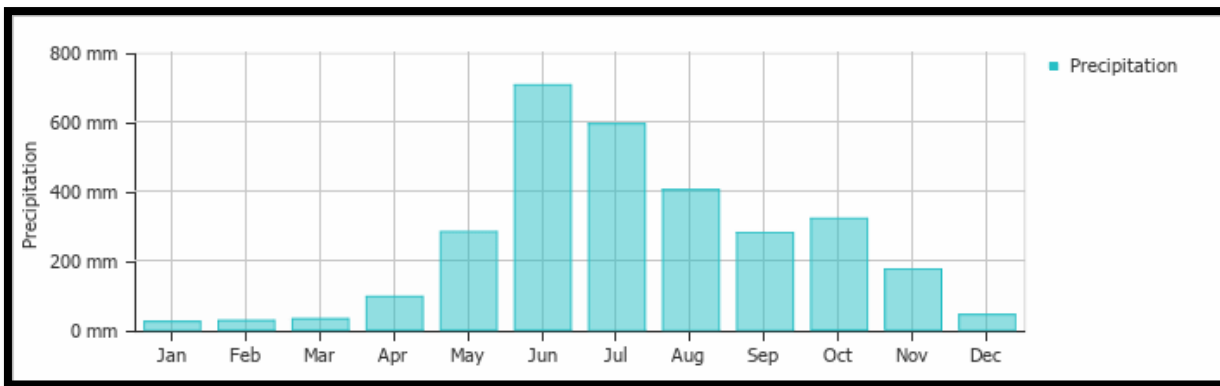
Figure 4.17 Average Annual Minimum and Maximum Temperature for Kochi

Relative Humidity

The air is generally moist in the region and relative humidity is high throughout the year. With the retreat of south-west monsoons, there is a marginal decrease in humidity. The lowest humidity is observed for the period from December to March. The humidity level ranges between 61 & 91%. The maximum humidity during rainy season is 91%. Details are given in **Table 4.7**.

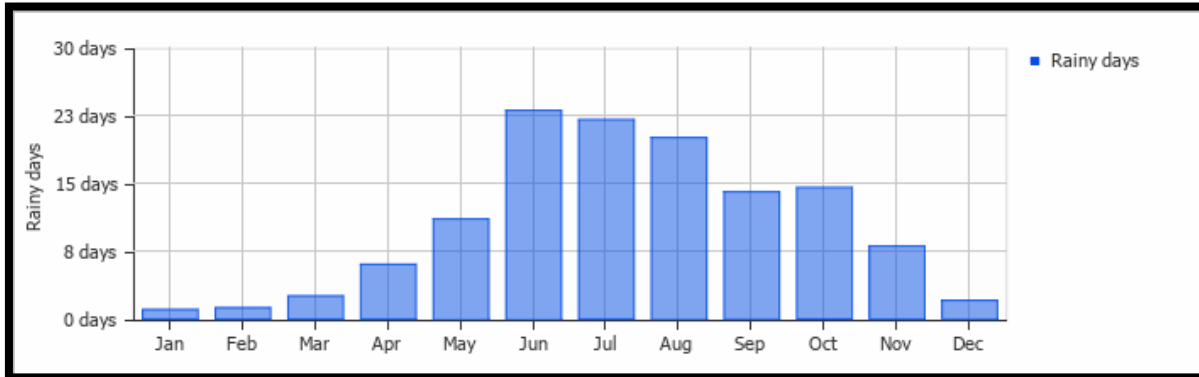
Rainfall

The study area receives high rains. Annual total rainfall is 3014.8 mm. Over 86% of the total annual rainfall is received between the months of May to October. Graphical presentation of the monthly precipitation in year is given in **Figure 4.18**. Average monthly rainy days over the year is presented in **Figure 4.19**.



Source: Kochi IMD

Figure 4.18 Average Annual Minimum and Maximum Temperature for Kochi

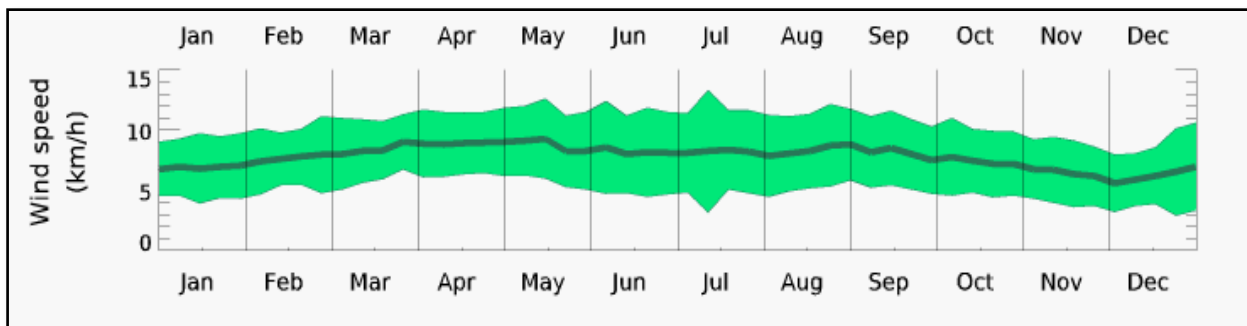


Source: Kochi IMD

Figure 4.19 Average Monthly Rainy Days in Year for Kochi

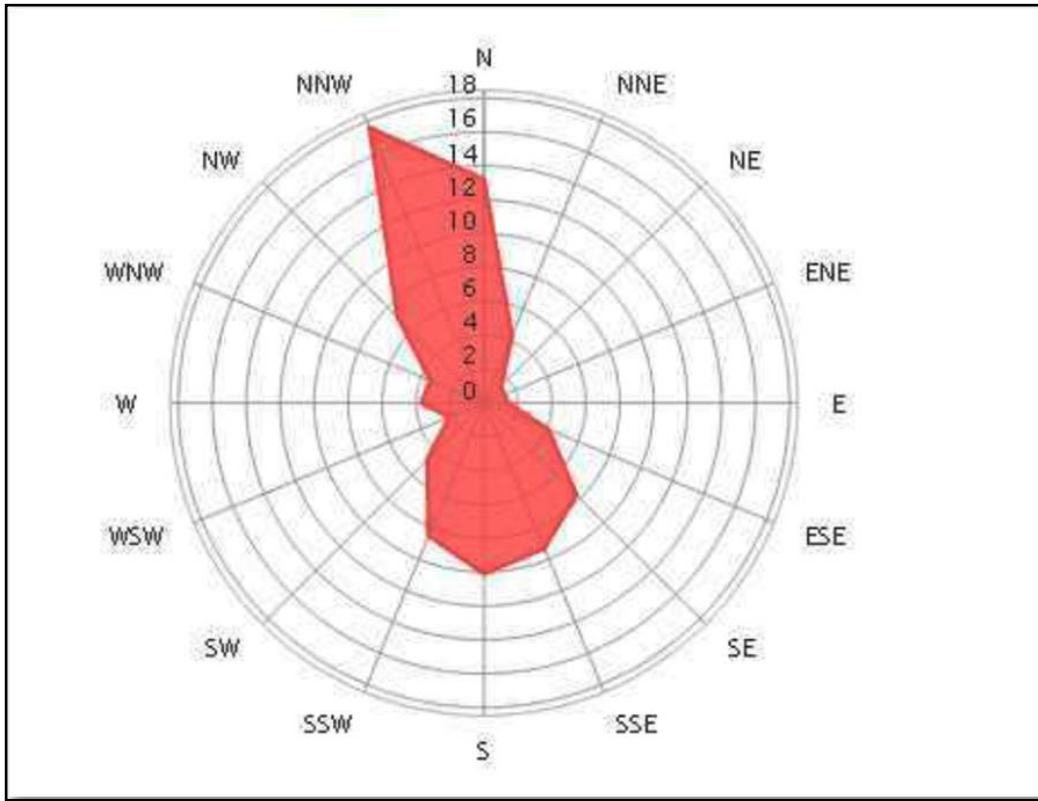
Wind Speed and Direction

Generally, light to moderate winds prevail throughout the year. Winds were light and moderate particularly during the morning hours. While during the afternoon hours the winds were stronger. The annual mean wind speed is 2.9 km/hr in Kochi district. Graphical presentation of wind speed is given in **Figure 4.20**. High wind speeds were observed during pre-monsoon season. Pre-dominant wind direction in the area is W, NW and SW. Annual windrose for Kochi city is given below in **Figure 4.21**.



Source: Kochi IMD

Figure 4.20 Graphical Presentation of Wind Speed



Source: Kochi IMD

Figure 4.21 Annual Windrose of Kochi

Cloud Cover

The details of cloud cover of Kochi are given in **Table 4.8** respectively.

Table 4.8 Cloud Cover of Kochi

MONTH	Time (hrs)	All Cloud	Low Cloud
Jan	08.30	2.8	0.7
	17.30	2.5	0.7
Feb	08.30	2.8	1
	17.30	2.3	0.9
Mar	08.30	3	1.4
	17.30	3.2	1.8
Apr	08.30	4.4	2.3
	17.30	4.9	3.1
May	08.30	5.3	3.0
	17.30	5.4	3.3
June	08.30	6.5	4.0
	17.30	6.5	4.0
July	08.30	6.6	3.9
	17.30	6.6	3.9

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Aug	08.30	6.2	3.6
	17.30	6.2	3.6
Sep	08.30	5.6	3.3
	17.30	5.8	3.3
Oct	08.30	5.3	2.8
	17.30	5.7	3.4
Nov	08.30	4.6	2.0
	17.30	5.1	2.7
Dec	08.30	3.3	1.0
	17.30	3.5	1.4

Source: Kochi IMD

Special Weather Phenomenon

Some of the special weather phenomenon of Kochi includes precipitation of more than 0.3 mm or more in a day and thunderstorms. Ernakulam is considered as one of the thunder and lightning prone district of the state. Fog and squall occurs but is very less.

4.5.8 Marine Phenomenon

Kochi city is situated on the coast of Arabian Sea. Distance of project alignment from the sea is approx 8.70 km and the sea is in West direction of the alignment. Various phenomenon of the sea are described below.

Waves

The wave climate in district is governed by the south-west monsoons when wave action can be strong with prevailing wave direction from north-west to south-west. Deep water (15m) wave observation in the past indicate the significant wave heights of 4m, 2m and 1m at the water depths of 10m, 5m and 2m respectively, the predominant wave direction being west.

Wave action inside the Ernakulum Channel is insignificant because of narrow entrance between Cochin Gut and Fort Cochin and the configuration of the land. Generally calm conditions prevail throughout the year except during the times of extreme wind action.

Inland waterways (NW-3) also exist within the city and these are protected by land masses. The wave action in most of the jetties is insignificant. The following maximum wave heights under normal conditions are considered:

- Fort Kochi and Vypeen – 1.0 m
- Other locations – 0.5 m

Tides

Cochin experiences semi diurnal tides with marked daily inequality. The tidal levels as per

- Naval Hydro graphic Chart for the Port of Kochi are as follows:
- Highest Astronomical Tide (HAT) + 1.20 m CD
- Mean Higher High Water Level (MHHWL) + 0.90 m CD
- Mean Lowest High Water Level (MLHWL) + 0.80 m CD
- Mean Sea Level (MSL) + 0.60 m CD
- Mean Highest Low Water Level (MHLWL) + 0.60 m CD

- Mean Lower Low Water Level (MLLWL) + 0.30 m CD

Currents

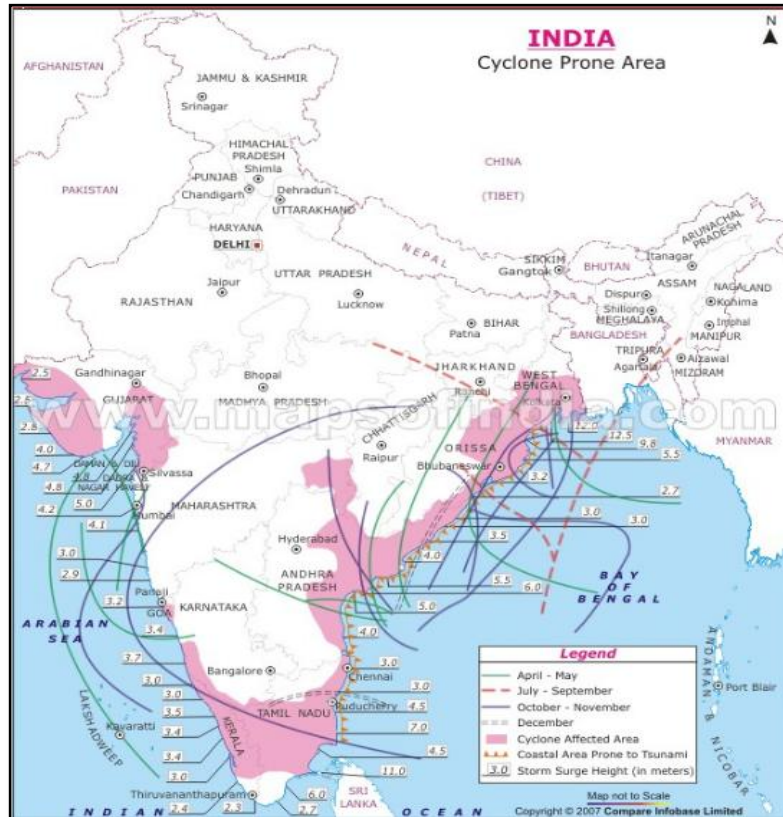
The currents along the coast of Cochin consists of tide, wave and wind induced components. As per observations the maximum current velocities at the Cochin Gut during the non-monsoon periods is of the order of 3 knots, which could increase to as high as 5.5 knots during the monsoon periods. Inside the Ernakulam Channel the current velocities are low, of the order of 0.5 knots only, with directions varying at different locations.

Littoral Drift

The littoral drift influenced by the monsoon is southwards during south–west monsoon period and northwards during non–monsoon period. Though this contributes to the siltation in the approach channel, it has no direct impact in the Ernakulam Channel.

Cyclones

Cyclones are not seen to affect the district in recent past but the impact due to gustna does and high velocity winds due to localized cyclonic or convective systems have caused damage to life and property in the district. Ernakulum district was affected due to the cyclone in Nov 1978 and damage was restricted to Paravoor of Ernakulum district. No major cyclonic event causing damage is observed in Ernakulum district in past 20 years. Recent cyclone which affected Kerala state is Ockhi but not direct damage was caused in Ernakulum district due to it. As preparatory measures, approx 2648 people/220 families were evacuated from Kochi and were shifted to seven safe shelters. However, fishermen of Kerala in high seas were affected. Map of the cyclone prone area of India is given in **Figure 4.22** which indicates that storm surge in Kochi can be approx 3.4-3.5 m during cyclone. The entire infrastructure for the proposed project is elevated and is designed considering the maximum wind speed in the area.



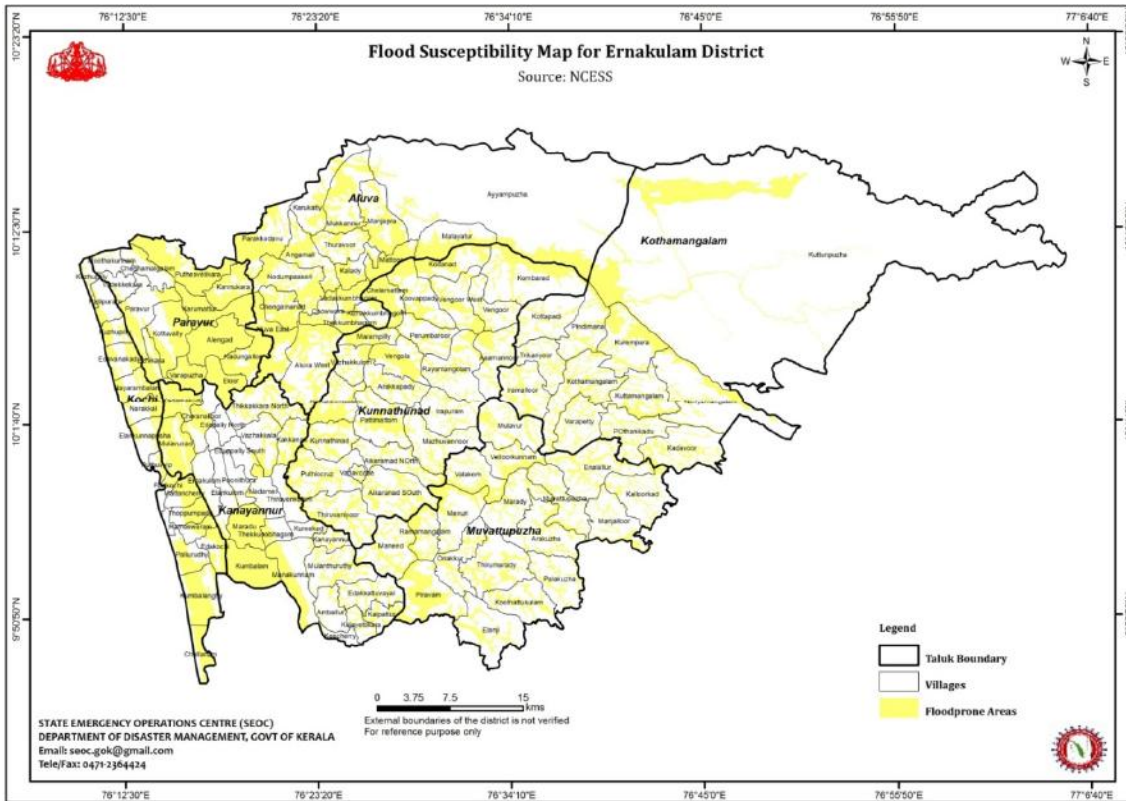
Source: National cyclone Risk Mitigation Project (NCRMP)

Figure 4.22 Cyclones Prone Area Map of India

4.5.9 Flood Hazards

Many parts of the district get affected due to the flood. Flood prone taluka of the district are Kothamangalam, Kunnathunadu, Muvattupuzha, Aluva and Cochin. Floods are caused due to unusual high rainfall. Flood crisis management plan is prepared for the district which involves formation of crisis groups, flood warning system, safety shelters for people, fire and rescue service etc. Flood susceptibility map for the district is given in **Figure 4.23** which shows that various areas in and around Kochi are prone to flood. Kochi has experienced devastating floods in 2018 due to unusual high rainfall and release of water from various small dams in Kerala during high rainfall. The rainfall was 116% more than the usual rainfall in Kerala as the State received 310 mm of rainfall in 48 hours. All the operation in the area was ceased including Kochi airport. This led to disturbance in the entire city and caused lot of damage to life and property both. Approx 483 people died and 140 are missing due to flood. This was declared as level 3 emergency/calamity of severe nature by the Government of India. This is worst flood in entire state after the floods of 1924.

However, the entire proposed infrastructure is elevated and thus is not likely to be directly affected by floods. But indirect impact due to inundation of streets, inaccessibility to metro stations etc may affect the proposed metro system during floods.



Source: District Disaster Management Authority, Ernakulam

Figure 4.23 Flood Susceptibility Map of Ernakulam District

4.5.10 Other Hazards

Other hazards in the district include coastal erosion and drought. The Ernakulam district possesses a coastal belt of 46 Km and 12 coastal villages. About 69% coastal lines in Cochin Taluk have been eroded (CESS, 2010). Hence, the whole coastal area can be considered as coastal erosion prone area.

The district experiences severe water shortage crisis for drinking and agricultural purposes when there is a decline in the rainfall intensity during March to June. The situation is becoming severe in the recent years.

4.5.11 Air Environment

Air quality is an important component of environment. Air quality is likely to be affected due to the project development especially during construction phase. Thus, baseline data on air quality has been collected through primary and secondary sources so as in future effectiveness of the proposed mitigation measures can be assessed against the baseline air quality data. At present major source of air pollution in the project influence area is vehicular traffic. Primary baseline data was collected for 1 week from 31st May to 6th June. Ambient air quality monitoring was carried out at JLN Stadium, Chembumukku, Top of Guard Room of Hyundai Showroom. Details of location of monitoring station are given in **Table 4.9**.

Table 4.9 Detail of Air Quality Monitoring Station

S. No.	Location	Coordinates	Land Use	Date of Monitoring
1.	JLN Stadium (Pump House)	10° 0'0.29"N, 76°17'54.01"E	Metro Station	1st June & 2nd June
2.	Chembumukku	10° 0'37.29"N & 76°19'27.72"E	Residential Area	3rd June & 4th June
3.	Top of Guard Room of Hyundai Showroom (Between Chittetukara and KINFRA Metro Stations)	9°59'47.5"N 76°21'04.7"E	Commercial Area	5th June & 6th June

Selection of Monitoring Stations

One monitoring station is selected along the alignment (3.2, i.e. 3 stations at every 3 kms) to assess the existing ambient air quality within the project area. The CPCB guide lines were adhered to for monitoring net work design. However, certain adjustments were incorporated because of local infrastructure. Logistic considerations as ready accessibility, security, availability of reliable power supply etc. were examined while finalizing the monitoring locations. The AAQ stations were established on the roof of the buildings located along the proposed RoW. Analysis of ambient air quality is given in **Table 4.10** below. Photographs of the ambient air quality are given in **Figure 4.24**.

Table 4.10: Analysis of Ambient Air Quality

Location	Date	PM ₁₀ (µg/m ³)	PM _{2.5} (µg/m ³)	SO ₂ (µg/m ³)	NO ₂ (µg/m ³)	CO (mg/m ³)
JLN Stadium (Pump House)	01/06/2019	68	33.2	7.4	13.7	0.42
	02/06/2019	76	37.4	6.7	16.8	0.51
Chembumukku	03/06/2019	66	29.6	6.1	15.2	0.39
	04/06/2019	59	26.3	5.7	13.6	0.27
Chittetukara (Hyundai Showroom)	05/06/2019	72	32.8	7.2	18.4	0.45
	06/06/2019	65	30.3	5.7	13.9	0.39

Source: NAAQS, 2009



Figure 4.24 Photographs of Ambient Air Quality

Observation on Ambient Air Quality

Particulate Matter (PM₁₀): The highest PM₁₀ level was found at JLN Station (68µg/m³) and lowest PM₁₀ level was found in Chembumukku (59µg/m³) while the concentration ranges between 59-76 µg/m³. The monitored PM₁₀ level are found well within the permissible limit i.e. NAAQMS level 100µg/m³.

Particulate Matter (PM_{2.5}): The highest PM_{2.5} level was found at JLN Station (37.4 µg/m³) and lowest PM_{2.5} level was observed at Chembumukku 26.3µg/m³ while the conc. ranges between 37.4-26.3 µg/m³. The monitored PM_{2.5} level is found well within the permissible limit i.e. NAAQMS level 60µg/m³.

Sulphur Dioxide (SO₂): The highest SO₂ level was found at JLN Station location as 7.4µg/m³ and lowest SO₂ level at Chembumukku 5.7µg/m³ while the conc. ranges between 5.7& 7.4 µg/m³. The monitored SO₂ level are found well within the permissible limit i.e. NAAQMS level 80µg/m³.

Oxides of Nitrogen (NO_x): The highest NO_x level was found at Chittetukara Station 18.4 µg/m³) and lowest NO_x level were observed at Chembumukku 13.6 µg/m³ while the conc. ranges between 13.6 & 18.4 µg/m³. The monitored NO_x levels are found well below the permissible limit i.e. NAAQMS level 80µg/m³.

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CO :The highest CO level was found at JLN Stadium (Pump House)Station as 0.51 mg/m³ and lowest CO level was observed at Chembumukku as 0.27 mg/m³ while the conc. ranges between 0.27 & 0.51 mg/m³. The monitored CO levels are found well below the permissible limit i.e. NAAQMS level 04µg/m³.

Analysis of the air quality of the city is also analysed using the secondary data (National Ambient Air Quality Programme, 2017). Data is available for Irupanam which is approx 1.5 km from site in NE direction. As per analysis, values obtained during baseline monitoring are found to be within the range as given in the NAAQP data. Secondary data is presented in **Table 4.11**.

Table 4.11 Secondary Data Ambient Air Quality

Location	Date	PM ₁₀ (µg/m ³)	PM _{2.5} (µg/m ³)	SO ₂ (µg/m ³)	NO ₂ (µg/m ³)	CO (mg/m ³)
Irupanam (2017)	31/05/2019	28-92	--	2-6	5-34	--

Source: NAAQP, 2017

4.5.9 Ambient Noise Quality

Noise level monitoring was carried out at eleven locations along the alignment. Noise level meters has been used to measure noise levels as instant values which are integrated over a given period to give LEQ values as 'A' weighted average. Detail of noise quality monitoring stations is given in **Table 4.12**. Primary baseline data was collected for 1 week from 31st May to 6th June.

Table 4.12: Location of Noise Level Monitoring

Stations	Location	Land use/Zone	Geographical Coordinates	Date of Monitoring
NQ 1	Pallorivattam Junction	Commercial Area	10° 0'8.86"N, 76°18'23.46"E	1st June
NQ 2	Chembumukku	Field Area near Residential complex	10°00'34.0"N 76°19'29.5"E	3rd June
NQ 3	Hyundai Showroom (Between Chittetukara and KINFRA Metro Stations)	Commercial Area	9°59'47.5"N 76°21'04.7"E	4th June
NQ4	Info Park Gate	Commercial Area	10° 0'38.53"N, 76°21'57.86"E	5th June

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NQ5	Info Pak Phase I-Sanskar School	Sensitive Receptor	10°00'36.5"N 76°22'37.2"E	5th June
NQ6	Kakkanad	Commercial Area	10°00'59.1"N 76°20'41.9"E	4th June
NQ7	Vazhakala	Sensitive Receptor -St Joseph Church	10° 0'45.89"N, 76°19'40.29"E	2nd June
NQ8	CSEZ	Commercial Area	10° 0'21.93"N, 76°20'42.75"E	2nd June
NQ9	JLN Stadium	Metro Station	10° 0'0.29"N, 76°17'54.01"E	3rd June
NQ10	Pallorivattam By pass	Commercial Area	10° 0'18.80"N, 76°18'47.91"E	6th June
NQ11	Padamughal	Residential Area	10° 0'52.01"N, 76°20'3.88"E	6th June

Selection of Monitoring Stations

Site is located in urban area and major source of the noise in the area is movement of vehicles. Noise level monitoring is carried out at eleven locations along proposed alignment at interval of approx 1 km having different land use to get the representative results for the entire project area and available land use in the area. Analysis of the noise data collected from the site is given in **Table 4.13**.

Table 4.13: Analysis of Noise Level Monitoring

Location	Land Use	Standards		Day Time			Night Time		
		Day	Night	Max	Min	Leq	Max	Min	Leq
Pallorivattam Junction	Commercial Area	65	55	65.7	57.1	62.0	56.1	44.5	51.2
Chembumukku	Field Area near Residential complex	55	45	56.6	45.5	50.7	43.5	39.5	41.8
Hyundai Showroom (Between	Commercial Area	65	55	67.3	58.3	62.8	56.7	48.7	53.6

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Chittetukara and KINFRA Metro Stations)									
Info Park Gate	Commercial Area	65	55	65.1	48.3	59.3	55.4	43.8	51.3
Info Pak Phase I- Sanskar School	Sensitive Receptor	50	40	53.2	41.4	47.9	43.1	38.4	41.4
Kakkanad	Commercial Area	65	55	67.8	56.3	62.9	56.8	48.2	52.8
Vazhakala	Sensitive Receptor - St Joseph Church	50	40	65.4	52.2	60.3	54.2	43.0	51.2
CSEZ	Commercial Area	65	55	58.3	47.0	54.3	47.6	40.9	43.9
JLN Stadium	Metro Station/Commercial	65	55	68.7	56.8	63.9	57.3	47.6	53.4
Pallorivattam By pass	Commercial Area	65	55	65.6	54.2	61.3	55.3	48.3	51.7
Padamughal	Residential Area	55	45	57.8	45.5	52.9	46.2	41.0	43.5



Chembumukku



Pallarivottam Junction

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Hyundai Showroom	Infopark Gate
	
Info Pak Phase I-Sanskar School	Kakkanad
	
Vazhakala	CSEZ Area
	
JLN Station	Pallarivottam Bypass



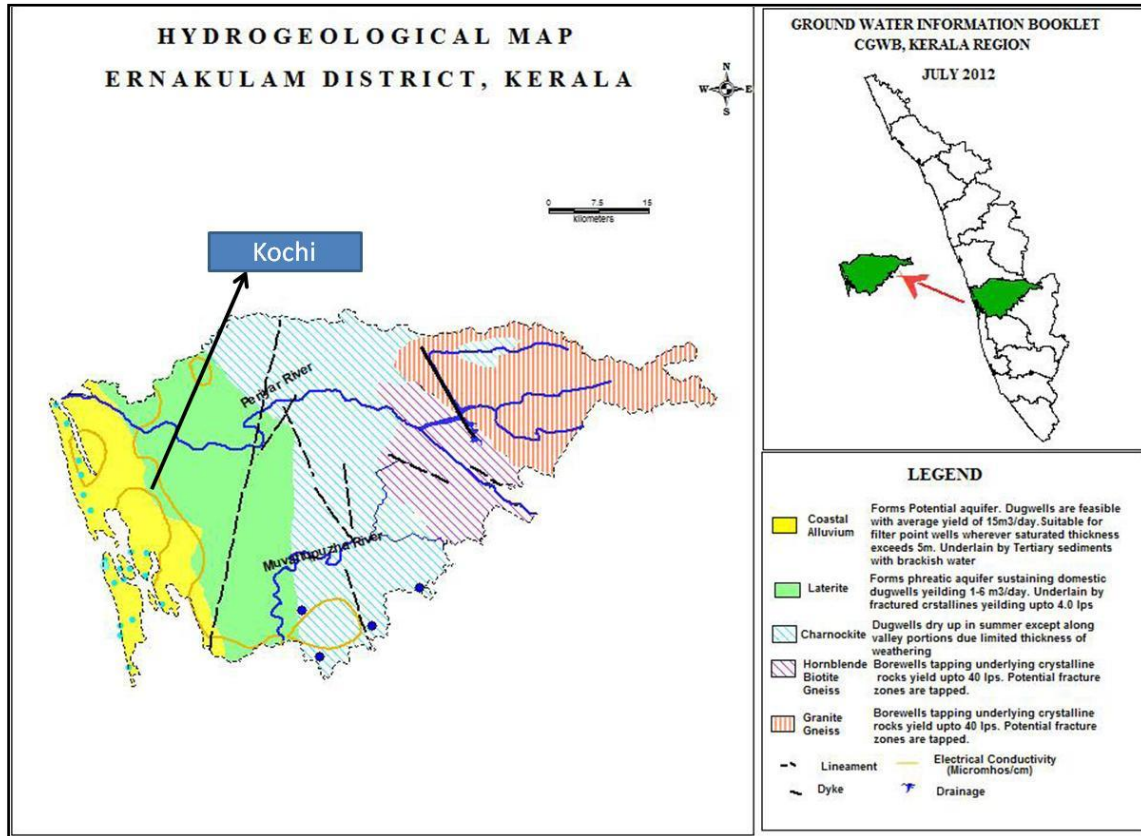
Figure 4.25 Photographs of Noise Level Monitoring

Observation on Noise Levels of Area

Maximum noise level during day time exceeds the prescribed standards at all locations except CSEZ area, however Leq day is within the limits as prescribed under Noise Rules, 2000. Maximum noise level during night exceeds the prescribed standards at all locations except CSEZ area and Chembumukku, however Leq night is within the limits as prescribed under Noise Rules, 2000.

4.5.12 Hydrogeology

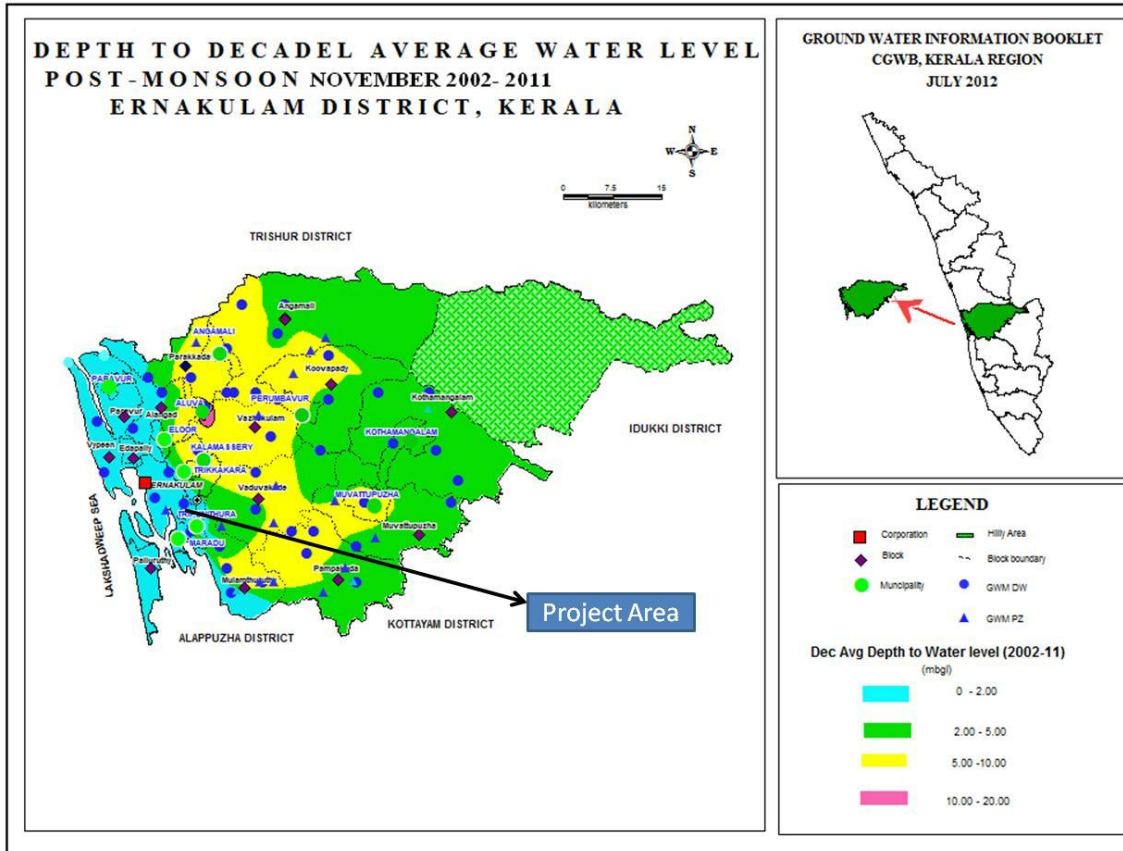
Groundwater generally occurs under phreatic conditions in weathered and fractured crystalline rocks, laterites and unconsolidated coastal sediments. It occurs under semi-confined to confined conditions in the deep seated fractured aquifer of the crystallines rocks and Tertiary sediments. The weathered zone in the crystallines below acts as good storage for groundwater. Project area is majorly covered with the Laterite of quaternary group and minor Dolerite of upper cretaceous group. Hydrogeological map of the district is given in **Figure 4.26**. The laterites are highly porous and permeable. It is extensively developed by dug wells in the mid land area for domestic and to a limited extent for irrigation. The depth of wells in laterite ranges from 3.4 to 14.8 mbgl and depth to water level ranges from 1.55 to 11.06 mbgl. Water level in project area during pre monsoon season it varies from 2-5 mbgl and during post monsoon season, it varies from 0-2 mbgl. Maps showing the pre-monsoon and post-monsoon water level are given in **Figure 4.27 & 4.28**. Wells located on slopes and elevated areas go dry or have very small water column during summer season. The yield of well ranges from 0.5 to 6 m³/day and sustain pumping for 3 to 4 hrs a day. All the blocks of the district are either falling in safe zone or semi-critical. Project area falls in safe category and map showing categorization of the district is given in **Figure 4.29**.



Source: Ground Water Information Booklet of Ernakulam District, Kerala State

Figure 4.26: Hydrogeological map of Ernakulam District

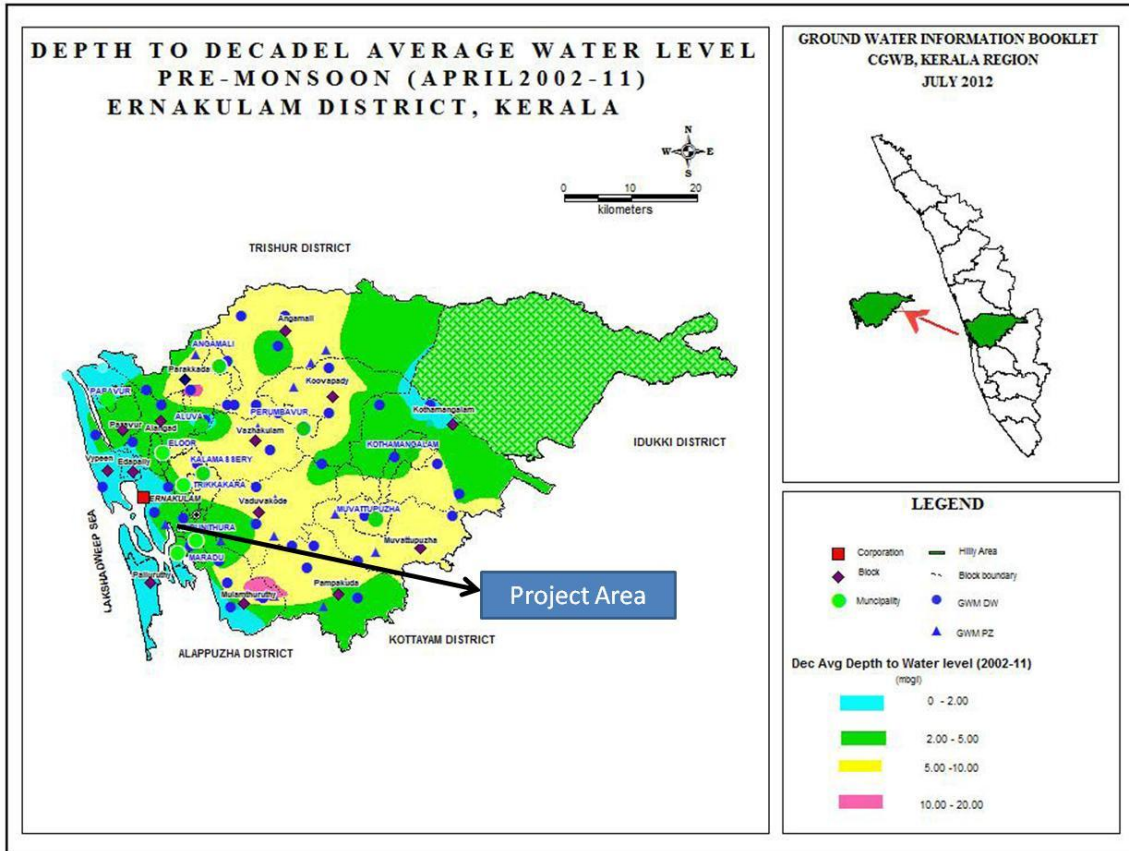
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Source: Ground Water Information Booklet of Ernakulam District, Kerala State

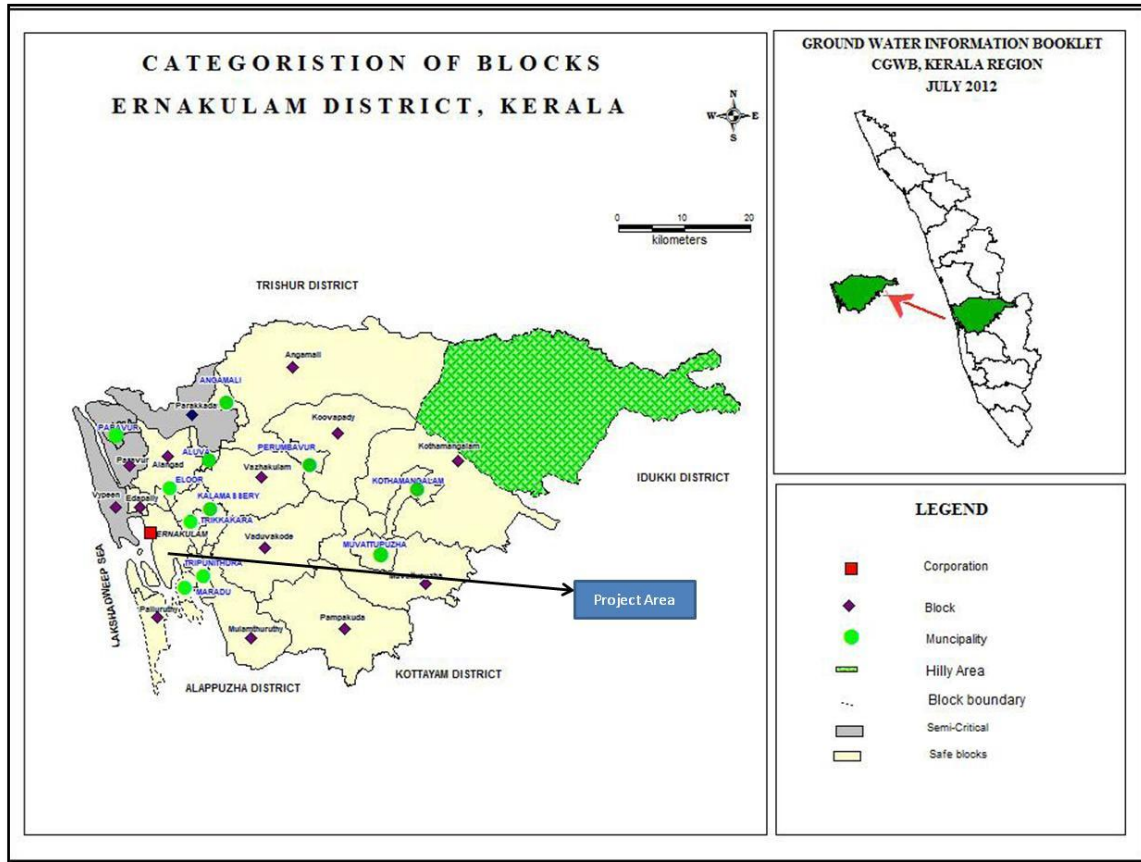
Figure 4.27: Depth of Ground Water Level During Post-Monsoon in District

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Source: Ground Water Information Booklet of Ernakulam District, Kerala State

Figure 4.28: Depth of Ground Water Level During Pre-Monsoon in District



Source: Ground Water Information Booklet of Ernakulam District, Kerala State

Figure 4.29: Categorization of District

4.6 Ground Water Quality

Source of water in the area was supply water and ground water both. A sample was collected from Pallorivattam Junction, Chembumukku and Hyundai Showroom (Between Chittetukara and KINFRA Metro Stations) to assess the ground water quality in the area during study period, 31st May to 6th June, 2019. Detail of the location of ground water collection is given in **Table 4.14**.

Table 4.14 Location for Ground Water Quality Monitoring

S. No.	Stations	Land Use	Lat	Long	Date
GW1	Pallorivattam Junction	Residential Area	10° 0'7.39"N	76°18'24.24"E	2nd June
GW2	Chembumukku	Field Area near Residential complex	10°00'34.0"N	76°19'29.5"E	3rd June
GW3	Hyundai Showroom	Commercial Area	9°59'47.5"N	76°21'04.7"E	5th June

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	(Between Chittetukara and KINFRA Metro Stations)				
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Analysis of Ground Water Quality

The water sample was examined for physico-chemical parameters and bacteriological parameters. The samples were collected and analyzed as per the procedures specified in Standard Methods. Samples for chemical analyses were collected in polyethylene carboys. Samples for a bacteriological analysis were collected in sterilized bottles. Temperature, pH, conductivity was measured at site itself. Analysis result of ground water quality is provided in **Tables 4.15**. Photographs of ground water quality monitoring are given in **Figure 4.30**. Lab reports for ground water quality are given in **Annexure 4.3**.

Table 4.15 Results of Analysis of Ground Water Quality

S.N.	Parameters	Pallorivattam Junction	Chembumukku	Hundai Showroom, Chittetukara Near Info Park Gate way
1	pH Value	7.24	7.90	7.58
2	Temperature °C	25.2	25.0	25.2
3	Conductivity, µmhos/cm	608	767	1314
4	Turbidity (NTU)	<1	<1	<1
5	Total Dissolved Solids mg/l	384	487	841
6	Total Suspended Solids mg/l	<2	<2	<2
7	Total Hardness as	198	214	222
8	Chloride as Cl mg/l	47	72	259
9	Total Alkalinity mg/l	184	252	240
10	Sulphates as SO ₄ mg/l	42	45	39
11	Nitrates as NO ₃ mg/l	7.6	18.3	19
12	Fluoride as F mg/l	0.42	0.52	0.40
13	Iron as Fe mg/l	0.24	0.28	0.22
14	Zinc as Zn mg/l	0.58	0.88	0.95
15	Calcium as Ca mg/l	72	78	73.4
16	Magnesium as Mg mg/l	4.5	4.7	9.4
17	Sodium as Na mg/l	48	81	194
18	Potassium as K mg/l	3.5	7	18
19	Cadmium as Cd mg/l	<0.01	<0.01	<0.01
20	Copper as Cu mg/l	<0.01	<0.01	<0.01
21	Nickel as Ni mg/l	<0.01	<0.01	<0.01
22	Lead as Pb mg/l	<0.01	<0.01	<0.01
23	Mercury as Hg mg/l	<0.001	<0.001	<0.001
24	Chromium (Total as Cr) mg/l	<0.05	<0.05	<0.05
25	Arsenic as As mg/l	<0.01	<0.01	<0.01
26	Phenolic compound mg/l	<0.001	<0.001	<0.001
27	Total coliform MPN/100ml	ND <2	ND <2	ND <2

Observations

- Total dissolve solids value was found range of 384-841mg/l which is within the desired range and also within permissible range (2000 mg/l) of is 10500:2012.
- Chloride found in range of 47-259 mg/l which found well within desired range (250 mg/l) and also within permissible range (1000 mg/l) of is 10500:2012
- Total hardness values found in range of 198-222 mg/l which found well within desired range (200 mg/l) and also within permissible range (600 mg/l) of is 10500:2012
- Total alkalinity values 184-252 mg/l which found well within desired range (200 mg/l) and also within permissible range (600 mg/l) of is 10500:2012.
- Mg values 4.5-9.4 mg/l which found well within desired range (30 mg/l) and also within permissible range (100 mg/l) of is 10500:2012.
- Overall the ground water quality of the study area is found well within the permissible limit of Indian standard is: 10500:2012. No metallic and bacterial contaminations were observed in ground water samples. Secondary data for pallorivattam junction, chembumukku hyundai showroom (between chittetukara and kinfra metro stations) area is not available for making comparison however nearest available data on ground water quality is available for eroor area from the eia report of kochi water metro project. As per the results of ground water quality for eroor area presented in the eia report, all the parameters are also within the permissible limits of prescribed standards is: 10500: 2012.



Figure 4.30: Photographs of Ground Water Quality Monitoring

4.7 Surface Water Quality

Proposed alignment crosses Edappally tod, stream from Chitraphuza River, Kadambryar River, drains and nallas. To study the surface water quality of the study area, a sample is withdrawn from Kadambryar River at Info Park. Detail of the sampling location is given in **Table 4.16**.

Table 4.16: Location of Surface Water Quality Monitoring Stations

S. No.	Stations	Lat	Long	Date of Sampling
SW1	Kadambryar River	10°00'38.4"N	76°21'59.3"E	4th June

Analysis of Surface Water Quality

The water samples were examined for physico-chemical parameters and bacteriological parameters. The samples were collected and analyzed as per the procedures specified in Standard Methods. Samples for chemical analyses were collected in polyethylene carboys. Samples for bacteriological analyses were collected in sterilized bottles. Temperature, pH, conductivity were measured at site itself. Analysis results of surface water quality are provided in **Tables 4.17**. Photograph of surface water sampling is given in **Figure 4.31**. Lab reports for surface water quality are given in **Annexure 4.4**.

Table 4.17: Analysis of Surface Water Quality

S.N.	Parameters	Kadambryar River
1.	pH Value	7.11
2.	Temperature °C	25.0
3.	Conductivity, µmhos/cm	3088
4.	Turbidity (NTU)	14
5.	Total Dissolved solids mg/l	1976
6.	Total Suspended solids mg/l	4
7.	Total Hardness as CaCO ₃ mg/l	454
8.	Chloride as Cl mg/l	756
9.	Total Alkalinity mg/l	318
10.	Sulphates as SO ₄ mg/l	132
11.	Fluoride as F mg/l	0.68
12.	Iron as Fe mg/l	0.42
13.	Zinc as Zn mg/l	1.02
14.	Calcium as Ca mg/l	132
15.	Magnesium as Mg mg/l	30.8
16.	Cadmium as Cd mg/l	<0.01
17.	Copper as Cu mg/l	<0.01
18.	Nickel as Ni mg/l	<0.01
19.	Lead as Pb mg/l	<0.01
20.	Mercury as Hg mg/l	<0.001

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21.	Chromium (Total as Cr) mg/l	<0.05
22.	Arsenic as As mg/l	<0.025
23.	Oil & Grease mg/l	<2
24.	Chemical Oxygen Demand as COD mg/l	18
25.	Bio- Chemical Oxygen Demand as BOD (for 3 Days 27 °C) mg/l	3.4
26.	Dissolved Oxygen mg/l	5.2
27.	Total Coliform MPN/100ml	2.1x10 ³

Observations

Surface water quality was analysed against the Designate Best Use Criteria by CPCB. The quality of water matches with the category D and thus the water body is fit for propagation of wildlife and fisheries. Comparison is also made with the available secondary source for the water bodies in Info Park area as provided in the Environment Impact Assessment Study of Kochi water metro. Analysis of water quality as per the source is given in **Table 4.18**. It was found that concentration of BOD and CI are more in the collected samples whereas value of Temperature BOD and TSS is found less in sample collected when compared to this data.

Table 4.18: Analysis of Surface Water Quality (Secondary Source)

S.N.	Parameters	Surface Water Body-Info Park
1	pH Value	7.7-7.8
2	Temperature °C	29.1-29.3
3	Total Suspended solids mg/l	37.54-58.32
4	Chloride as Cl mg/l	2.33-3.18
5	Oil & Grease mg/l	0.3
6	Bio- Chemical Oxygen Demand as BOD (for 3 Days 27 °C) mg/l	2.8-2.9
7	Dissolved Oxygen mg/l	5.2-5.3

Source: EIA Report Kochi Water Metro (Feb-March, 2018)



Kadambryar River

Figure 4.31: Photographs of Surface Water Quality Monitoring

4.8 Traffic Survey

Kochi is one of the few cities of India blessed with connection to other parts by all major modes of transport like road, rail, air and water. NH 17, NH 47 and NH 49; 3 National Waterways, an International Airport, Cochin Port located on strategic International Route and broad gauge lines linking Kochi to other States are the major intercity linkages.

Increasing urbanization over the years has resulted in the development of vast areas as urban extensions. Many roads were laid in an incremental manner to cater to the increased traffic demand. The City has developed in a disintegrated urban form spreading along major traffic corridors.

As per the detailed project report of Kochi Metro, the registered vehicles in Ernakulam have increased significantly over the years. The number has climbed from 8.9 to 17.6 Lakh in six years (2009-10 to 2016-17). This high density and rapid growth of vehicles have worsened the transport situation to a significant extent. The growth has been phenomenal registering a growth of 10% p.a. in 3 years (2006-07 to 2009-10). It is significant to note that 10% of the vehicles now in Ernakulam are cars. Total registered vehicles in Ernakulam district by 2016-2017 are 1768869. The analysis of mode wise growth of registered vehicles as given DPR shows that the personalized mode of transport i.e. two wheelers and cars, have been growing tremendously with the annual increase of 9% and 14% respectively. The buses registered annual growth of 4% and auto rickshaws showed annual growth of 8%. Traffic survey study has been carried out for various locations in Kochi and the data is provided in City mobility plan⁶. Traffic data of the roads around the project alignment is presented in **Table 4.19 below.**

Table 4.19: Daily Vehicular Traffic in Project Area (2005)

S. N.	Location Name	Road	As per Survey in 2005 by NATPAC						Projected - 2019	
			Inbound		Outbound		Total		Total	
			No	PCU	No	PCU	No	PCU	No	PCU
1	Edappally bridge	NH-47 & bypass	25,4 15	31,8 29	23,5 71	28,3 31	48,9 86	60,1 59	56,5 16	69,4 05
2	Near thodu	Kakkanad road	16,4 27	15,2 14	15,2 35	14,7 65	31,6 62	29,9 79	36,5 28	34,5 87
3	Arkkakadavu bridge	Alinchuvadu to Thrippunithura road	3,15 9	2,44 8	2,56 0	1,96 9	5,72 0	4,41 7	6,59 9	5,09 6
4	Thykooodam bridge	NH-47 bypass	12,9 99	16,6 74	16,2 38	21,2 42	29,2 37	37,9 15	33,7 31	43,7 43

Source: City Mobility Plan-Kochi

Traffic study study has been carried out for NH-47 at Alapuzha and Thrissur. Data is presented in **Table 4.20**

⁶Sourced in Kochi City Mobility Plan from NATPAC Study Report, 2006

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Table 4.20: Daily Vehicular Traffic on NH-47 (2005)

S. No.	Location	Inflow	Outflow	Total
1	N.H.47 towards Alapuzha	14108	13434	27542
2	N.H.47 towards Thrissur	14851	13708	28559

Source: City Mobility Plan-Kochi

Composition of the vehicle at Edapally bridge at NH-47 and NH-47 bypass is given in **Table 4.21**

Table 4.21: Daily Vehicular Traffic on NH-47 (2005)

S.No.	Type of Vehicle	NH 47 bypass and NH-47 at Edappally bridge		
		In bound	Out bound	Total
1.	Private Bus	811	862	1,673
2.	Other Buses	262	317	579
3.	Mini-bus/Tempo	181	619	800
4.	Car/Van/Jeep	7,763	7,330	15,093
5.	Passenger auto rickshaw	1,743	1,550	3,293
6.	Two-Wheeler	8,008	8,068	16,076
7.	Mat	458	405	863
8.	Truck	2,568	1,774	4,342
9.	Mini-truck /tempo	1,950	1,304	3,254
10.	Goods autorickshaw	1,195	964	2,159
11.	Bi-cycle	194	99	293
12.	Total (No.)	25,415	23,571	48,986
13.	Total (PCU)	31,829	28,331	60,159

Traffic study has been taken by RITES also as part of the Kochi metro project study in 2018 for Kochi city. Data collected for Kochi city for the roads around the project alignment are given below in **Table 4.22**

Table 4.22: Traffic on Roads around Project Alignment

Location	Total Vehicle	PCUs	Morning Peak				Evening Peak			
			(Veh.)	% of Total Traffic	(PCU's)	% of Total Traffic	(Veh.)	% of Total Traffic	(PCU's)	% of Total Traffic
Venduruthy Bridge-NH-47	25937	25923	2674	10.3	2530	9.8	2178	8.4	2210	8.5
Thevara Bridge, NH-47A	16310	15480	1793	11.0	1474	9.5	1795	11.0	1565	10.1
Eloor	18452	21137	1209	6.6	1384	6.6	1505	8.2	1630	7.7

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Road, near Pathalam Bridge										
Varapuzha Bridge, NH-47	15596	16242	1181	7.6	1086	6.7	1626	10.4	1547	9.5
Near Calasanz Bhawan, NH-47	24193	41904	1643	6.8	2931	7.0	2205	9.1	3551	8.5

Source: Traffic Report, Feasibility Study and DPR for Kochi Metro Phase II

4.9 Biological Environment

Flora and fauna are important components of the environment. They are organized into natural communities with mutual dependencies among their members and show various responses and sensitivities to anthropogenic activities. The objective this floral and faunal inventory of the project area, is to provide necessary information on floristic structure in the study area for formulating effective management and conservation measures. The climatic, edaphic and biotic variations with their complex interrelationship and composition of species, which are adapted to these variations, have resulted in different vegetation cover, characteristic of each region. The survey was carried out during study period to know the ecological status of the project area w.r.t. flora and fauna; the details of which is described below:

4.9.1 Terrestrial Flora of Study Area

Proposed alignment traverses through the urban area and the flora in the study area (RoW& 500 m buffer zone) is in form of road side plantation, agriculture fields/plantations and homestead plantation. List of the tree species which are found in the study area (RoW and 500 m buffer zone) are given in the **Table 4.23**. Major tree species found are *Azadirachta indica*, *Bombax malabaricum*, *Syzygiumcumini*, *Pletophorumpterocarpum*, *Ipomoea carnea*, *Terminalia catappa*, *Azadirachta indica*, *Thespesia populnea*, *Mangifera indica*, *Mimusopselengi*, *Macaranga pelata*, *cocus nucifera*, *Delonix regia*, *Areca catechu*, *Alstoniascholaris*, *Neolamarckiacadamba* etc. There are also various medicinal trees found in the project area which are given in **Table 4.24**. Some of the important medicinal trees found in study area are *Cassia fistula*, *Azadirachta Indica*, *Aegle marmelos*, *Areca catechu* etc.

Table 4.23: Tree Species Found in Project Area (RoW& 500 m Radius Area)

Name of Species	Family
<i>Acacia auriculiformis</i>	Mimosaceae
<i>Achras sapota</i>	Sapotaceae
<i>Adina cordifolia</i>	Rubiaceae
<i>Aegle marmelos</i>	Rutaceae

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<i>Ailanthus excelsa</i>	Simaroubaceae
<i>Albizialebbeck</i>	Mimosaceae
<i>Alstoniascholaris</i>	Apocynaceae
<i>Anacardiumoccidentale</i>	Anacardiaceae
<i>Anthocephaluscadamba</i>	Rubiaceae
<i>Areca catechu</i>	Arecaceae
<i>Artocarpushirsutus</i>	Moraceae
<i>Artocarpusintegrifolius</i>	Moraceae
<i>Avicennia alba</i>	Avicenniaceae
<i>Avicennia officinalis</i>	Avicenniaceae
<i>Azadirachtaindica</i>	Meliaceae
<i>Barringtoniaacutangula</i>	Lecythidaceae
<i>Bauhinia racemosa</i>	Caesalpiniaceae
<i>Bombax malabaricum</i>	Bombacaceae
<i>Borassusflabellifer</i>	Arecaceae
<i>Butea monosperma</i>	Fabaceae
<i>Caesalpnia coriaria</i>	Caesalpiniaceae
<i>Callistemon lanceolatus</i>	Myrtaceae
<i>Caryotaurens</i>	Arecaceae
<i>Cassia fistula</i>	Fabaceae
<i>Cassia siamea</i>	Caesalpiniaceae
<i>Casuarina equisetifolia</i>	Casuarinaceae
<i>Cocus nucifera</i>	Arecaceae
<i>Dalbergia sissoo</i>	Fabaceae
<i>Delonix regia</i>	Caesalpiniaceae
<i>Erythrina indica</i>	Fabaceae
<i>Eucalyptus tereticornis</i>	Myrtaceae
<i>Euphorbia tirucalli</i>	Euphorbiaceae
<i>Ficusauriculata</i>	Moraceae
<i>Ficusbenghalensis</i>	Moraceae
<i>Ficusbenjamina</i>	Moraceae
<i>Ficuselastica</i>	Moraceae
<i>Ficushispida</i>	Moraceae
<i>Ficus religiosa</i>	Moraceae
<i>Garcinia gummi-gutta</i>	Clusiaceae
<i>Gmelina arborea</i>	Verbenaceae
<i>Holoptelea integrifolia</i>	Ulmaceae
<i>Kandeliacandel</i>	Rhizophoraceae

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<i>Lagerstroemia indica</i>	Lythraceae
<i>Lanneacoromandelic</i>	Anacardiaceae
<i>Leucanealeucocephala</i>	Mimosaceae
<i>Madhuca longifolia</i>	Sapotaceae
<i>Mangifera indica</i>	Anacardiaceae
<i>Manihot esculenta</i>	Euphorbiaceae
<i>Manilkara hexandra</i>	Sapotaceae
<i>Melia azedarach</i>	Meliaceae
<i>Mimusops elengi</i>	Sapotaceae
<i>Morinda tinctoria</i>	Rubiaceae
<i>Myristica fragrans</i>	Myristicaceae
<i>Nyctanthes arbor-tristis</i>	Oleaceae
<i>Phoenix laurieri</i>	Arecaceae
<i>Phoenix sylvestris</i>	Arecaceae
<i>Phyllanthus emblica</i>	Euphorbiaceae
<i>Piper longum</i>	Piperaceae
<i>Plectrophorum pterocarpum</i>	Caesalpiniaceae
<i>Plumeria alba</i>	Apocynaceae
<i>Plumeria rubra</i>	Apocynaceae
<i>Polyalthia longifolia</i>	Annonaceae
<i>Pongamia pinnata</i>	Fabaceae
<i>Prosopis juliflora</i>	Mimosaceae
<i>Psidium quajava</i>	Myrtaceae
<i>Pterocarpus marsupium</i>	Fabaceae
<i>Samanea saman</i>	Mimosaceae
<i>Santalum album</i>	Santalaceae
<i>Saraca asoka</i>	Fabaceae
<i>Sonneratia alba</i>	Sonneratiaceae
<i>Sonneratiacaseolaris</i>	Sonneratiaceae
<i>Swietenia macrophylla</i>	Meliaceae
<i>Syzygium cumini</i>	Myrtaceae
<i>Syzygium samarangense</i>	Myrtaceae
<i>Tamarindus indicus</i>	Caesalpiniaceae
<i>Tectonagrandis</i>	Verbenaceae
<i>Terminalia catappa</i>	Combretaceae
<i>Thespesia populnea</i>	Malvaceae
<i>Trema orientalis</i>	Ulmaceae
<i>Wrightia tinctoria</i>	Apocynaceae

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<i>Zanthoxylumrhetsa</i>	Rutaceae
<i>Ziziphusjuzuba</i>	Rhamnaceae
Shrubs	
<i>Abutilon indicum</i>	Malvaceae
<i>Acanthus ilicifolius</i>	Acanthaceae
<i>Annona squamosa</i>	Annonaceae
<i>Asparagus racemosus</i>	Asparagaceae
<i>Bixaorellana</i>	Bixaceae
<i>Caesalpinjabonduc</i>	Caesalpinaceae
<i>Caesalpiniasappan</i>	Caesalpinaceae
<i>Carissa carandas</i>	Apocynaceae
<i>Cassia alata</i>	Caesalpinaceae
<i>Cassia auriculata</i>	Caesalpinaceae
<i>Cassia occidentalis</i>	Caesalpinaceae
<i>Chromolaenaodorata</i>	Asteraceae
<i>Clerodendruminermis</i>	Verbenaceae
<i>Clerodendrumviscosum</i>	Verbenaceae
<i>Cressacretica</i>	Convolvulaceae
<i>Hibiscus rosa-sinensis</i>	Malvaceae
<i>Holarrhenaantidysenterica</i>	Apocynaceae
<i>Ipomoea carnea</i>	Convolvulaceae
<i>Jatropha curcas</i>	Euphorbiaceae
<i>Lantana camara</i>	Verbenaceae
<i>Lawsoniainermis</i>	Lythraceae
<i>Murrayapaniculata</i>	Rutaceae
<i>Nerium oleander</i>	Apocynaceae
<i>Pandanus odoratissimus</i>	Pandanaceae
<i>Psychotria sp.</i>	Rubiaceae
<i>Solanum torvum</i>	Solanaceae
<i>Tabernaemontanadivaricata</i>	Apocynaceae
<i>Tephrosiapurpurea</i>	Fabaceae
<i>Vitex negundo</i>	Verbenaceae
Herbs	
<i>Acalyphaindica</i>	Euphorbiaceae
<i>Alternanthera sessilis</i>	Amaranthaceae
<i>Alysicarpusrugosus</i>	Fabaceae
<i>Amaranthus spinosus</i>	Amaranthaceae
<i>Amaranthus viridis</i>	Amaranthaceae

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<i>Bacobamonni</i>	Scrophulariaceae
<i>Blumealacera</i>	Asteraceae
<i>Boerhaviadiffusa</i>	Nyctaginaceae
<i>Borreriahispid</i>	Rubiaceae
<i>Borreriaocymoides</i>	Rubiaceae
<i>Cassia tora</i>	Caesalpiniaceae
<i>Centelaasiatica</i>	Apiaceae
<i>Colocasia esculenta</i>	Araceae
<i>Corchorus aestuans</i>	Tiliaceae
<i>Costospeciosus</i>	Costaceae
<i>Croton hirtum</i>	Euphorbiaceae
<i>Curculigoorchioides</i>	Hypoxidaceae
<i>Cynotiscristata</i>	Commelinaceae
<i>Cyperusdifformis</i>	Cyperaceae
<i>Cyperusiria</i>	Cyperaceae
<i>Cyperusrotundus</i>	Cyperaceae
<i>Desmodiumtriflorum</i>	Fabaceae
<i>Eclipta alba</i>	Asteraceae
<i>Eichorniacrassipes</i>	Pontederiaceae
<i>Emelia sonchifolia</i>	Asteraceae
<i>Euphorbia hirta</i>	Euphorbiaceae
<i>Fimbristylisdichotoma</i>	Cyperaceae
<i>Fimbristylistetragona</i>	Cyperaceae
<i>Hygrophilaauriculata</i>	Acanthaceae
<i>Justicia procumbens</i>	Acanthaceae
<i>Leanotisnepetiifolia</i>	Lamiaceae
<i>Leucas aspera</i>	Lamiaceae
<i>Ludwigia parviflora</i>	Onagraceae
<i>Mimosa pudica</i>	Mimosaceae
<i>Musa paradisiaca</i>	Musaceae
<i>Oldenlandiacorymbosa</i>	Rubiaceae
<i>Parthenium hysterophorus</i>	Asteraceae
<i>Pavoniaprocumbens</i>	Malvaceae
<i>Phyla nodiflora</i>	Verbenaceae
<i>Phyllanthus urinaria</i>	Euphorbiaceae
<i>Physalis minima</i>	Solanaceae
<i>Polygala sp.</i>	Polygalaceae
<i>Scopariadulcis</i>	Scrophulariaceae

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<i>Sidaacuta</i>	Malvaceae
<i>Sidarhomboides</i>	Malvaceae
<i>Sphearanthus indicus</i>	Asteraceae
<i>Synedrellanodiflora</i>	Asteraceae
<i>Tridaxprocumbens</i>	Asteraceae
<i>Triumfetta pentandra</i>	Tiliaceae
<i>Urenalobata</i>	Malvaceae
<i>Vanda tesellata</i>	Orchidaceae
<i>Vernonia cinerea</i>	Asteraceae
Grass	
<i>Bambusa arundinacea</i>	Poaceae
<i>Bothriochloa pertusa</i>	Poaceae
<i>Cenchrus ciliaris</i>	Poaceae
<i>Chloris barbata</i>	Poaceae
<i>Cymbopogon citratus</i>	Poaceae
<i>Cynodon dactylon</i>	Poaceae
<i>Dactyloctenium aegyptium</i>	Poaceae
<i>Elesine indica</i>	Poaceae
<i>Eragrostis</i> sp.	Poaceae
<i>Imperata cylindrica</i>	Poaceae
<i>Oplismenus compositus</i>	Poaceae
<i>Phragmites karka</i>	Poaceae
<i>Rottboellia exaltata</i>	Poaceae
<i>Saccharum spontaneum</i>	Poaceae
<i>Setaria verticillata</i>	Poaceae
<i>Typha angustifolia</i>	Poaceae
Climbers	
<i>Abrus precatorius</i>	Fabaceae
<i>Aristolochia indica</i>	Aristolochiaceae
<i>Cadaba indica</i>	Capparidaceae
<i>Cayratia pedata</i>	Vitaceae
<i>Coccinia grandis</i>	Cucurbitaceae
<i>Cuscuta reflexa</i>	Convolvulaceae
<i>Ipomoea aquatica</i>	Convolvulaceae
<i>Ipomoea pes-caprae</i>	Convolvulaceae
<i>Mukiamaderaspatana</i>	Cucurbitaceae
<i>Passiflora edulis</i>	Passifloraceae
<i>Quisqualis indica</i>	Combretaceae

Table4.24: Medicinal Tree Species Found in Project Area (RoW& 500 m Radius Area

Tree	
Scientific Name of Species	Family
<i>Aegle marmelos</i>	Rutaceae
<i>Madhucalongifolia</i>	Sapotaceae
<i>Phyllanthus emblica</i>	Euphorbiaceae
<i>Cassia fistula</i>	Fabaceae
<i>Azadirachta indica</i>	Meliaceae
<i>Santalum album</i>	Santalaceae
<i>Wrightia tinctoria</i>	Apocynaceae
<i>Nyctanthes arbor-tristis</i>	Oleaceae
<i>Bauhinia racemosa</i>	Caesalpinaceae
<i>Erythrina indica</i>	Fabaceae
<i>Areca catechu</i>	Arecaceae
<i>Zanthoxylum sp</i>	Rutaceae
<i>Morinda tinctoria</i>	Rubiaceae
<i>Mimusops elengi</i>	Sapotaceae
<i>Holoptelea integrifolia</i>	Ulmaceae
<i>Garcinia gummi-gutta</i>	Clusiaceae
<i>Ficus hispida</i>	Moraceae
<i>Butea monosperma</i>	Fabaceae
Shrubs	
<i>Asparagus racemosus</i>	Asparagaceae
<i>Solanum torvum</i>	Solanaceae
<i>Clerodendrum inermis</i>	Verbenaceae
<i>Datura metel</i>	Solanaceae
<i>Murraya paniculata</i>	Rutaceae
<i>Abutilon indicum</i>	Malvaceae
<i>Lawsonia inermis</i>	Lythraceae
Herbs	
<i>Acalypha indica</i>	Euphorbiaceae
<i>Leucas aspera</i>	Lamiaceae
<i>Boerhavia diffusa</i>	Nyctaginaceae
<i>Curculigo orchioides</i>	Hypoxidaceae
<i>Blumea lacera</i>	Asteraceae
<i>Sida acuta</i>	Malvaceae

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<i>Centelaasiatica</i>	Apiaceae
<i>Justicia procumbens</i>	Acanthaceae
<i>Tridaxprocumbens</i>	Asteraceae
<i>Cassia tora</i>	Caesalpiniaceae
<i>Eclipta alba</i>	Asteraceae
<i>Leantisnepetiifolia</i>	Lamiaceae
<i>Urenalobata</i>	Malvaceae
<i>Phyla nodiflora</i>	Verbenaceae
<i>Costospeciosus</i>	Costaceae
<i>Alysicarpusrugosus</i>	Fabaceae
<i>Bacobamonnier</i>	Scrophulariaceae
Cimbers	
<i>Cuscutareflexa</i>	Convolvulaceae
<i>Abruspreicatorius</i>	Fabaceae
<i>Mukiamaderaspatana</i>	Cucurbitaceae
<i>Piper longum</i>	Piperaceae
<i>Passiflora edulis</i>	Passifloraceae

4.9.2 Terrestrial Fauna in Project Area

Due to urbanization and presence of human activities, no significant wildlife was observed/ reported in the area. There are no forest areas or notified eco-sensitive zone or jungle within 500 m of the proposed RoW. No wildlife habitat or notified eco-sensitive zone under Wildlife Act. 1972 is present within the 10 km radius area of proposed RoW except Managlavanam bird sanctuary which is present at 3 km from JLN station. Thus, fauna in study area is confined to the cattle/stray animals. Major faunal species found/observed/reported in the project area during the visit and through secondary sources are given in **Table 4.25**.

Table 4.25: Fauna Species in Study Area (RoW& 500 m Radius Area)

Name	Botanical Name
Mammals	
Squirrel	<i>Funumbuls palmarum</i>
Rat	<i>Mus rattus</i>
Porcupine	<i>Hystrixindica</i>
Mouse	<i>Mus musculus</i>
Indian Hare	<i>Lapusnigricollis</i>
Reptiles	
Lizard	<i>Hemidactylus sp</i>
Garden Lizard	<i>Calotesvescicolor</i>
Chameleon	<i>Chameleon zeylanicus</i>

Krait	<i>Bangarusp</i>
Indian Cobra	<i>Najanaja</i>
Russel viper	<i>Viperasp</i>
Amphibians	
Common frog	<i>Rana tigrina</i>
Toad	<i>Bufo melanostictus</i>

4.9.2.1 Butterflies

A few common Butterflies seen/reported in the study area are Common Crow, Common Emigrant, Grey pansy, Grey pansy, Common Rose, Common Wanderer, Blue Tiger, Common Leopard, Common Wanderer, Common sailer, Common Mormon, Common Jezebel, Common Jezebel.

4.9.2.1 Notified Eco-sensitive Areas within 10 km Radius

Mangalavanam bird sanctuary exists at 3 km from the proposed alignment. The sanctuary was notified as bird sanctuary in 2004. Mangalavanam Bird Sanctuary is located at a close proximity to Kochi city and it is the only green patch which serves as green lung to twin cities of Ernakulam and Kochi and situated in the central part of Kerala. The Mangalavanam Bird Sanctuary lies between latitudes 9°59'13.4" N and longitudes 76°16'26.1" E in the east of Central Marine Fisheries Research Institute (CMFRI) and National Institute of Oceanography (NIO) close to the new building complex of the High court of Kerala. Map showing location of the project alignment and Mangalavanam sanctuary is given in **Figure 4.32**.

A Draft notification, SO 2810 (E) is also issued by MoEF&CC for declaring ESZ for Mangalavanam bird sanctuary according to which the buffer zone around the sanctuary varies from 0-1.5 km from the boundary of sanctuary. Total ESZ comprise of 0.45 sq km of area.

Mangalavanam Bird Sanctuary is the only one coastal protected area in the State of Kerala with an extent of 2.74 hectare of tidal wetland supporting fragile mangrove vegetation which comprises of five species of mangroves and 25 of other floral species and the Mangalavanam Bird Sanctuary also supports 3 species of mammals, 9 species of reptiles, 51 species of spiders, 2 species of amphibian, 72 species of birds and 7 species of fishes. Common birds present in the study area and Mangalavanam Bird Sanctuary are Asian Koel (*Eudynamis scolopacea*), Common Myna (*Acridotheres tristis*), House Sparrow (*Passer domesticus*), Little Cormorant (*Phalacrocorax niger*), Grey Heron (*Ardeacinerea*), Red-wattled Lapwing (*Vanellus indicus*), Indian Robin (*Saxicoloides fulicata*), Intermediate Egret (*Mesophoyx intermedia*), House Crow (*Corvus splendens*), Darter (*Anhinga melanogaster*), Black Kite (*Milvus migrans*), Brahminy Kite (*Haliastur indus*), Indian Pond-heron (*Ardeolagrayii*), Indian Cormorant (*Phalacrocorax fuscicollis*), and Little Egret (*Egretta garzetta*).

Some of the seasonal birds found in winter in the sanctuary and nearby area includes Ashy Drongo (*Dicrurus leucophaeus*), Chestnut-tailed Starling (*Sturnus malabaricus*), Common Sandpiper (*Actitis hypoleucos*), Common Redshank (*Tringatotanus*), Grey Heron (*Ardeacinerea*), Marsh Sandpiper (*Tringastagnatilis*) are seasonal visitors to the area.

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According to Azeez and Bhupathy, 2006.;Nameer 2010, Greenish Warbler (*Phylloscopustrochiloides*), Blyth’s Reed-Warbler (*Acrocephalusdumetorum*), Wood Sandpiper (*Tringaglareola*), Common Greenshank (*Tringanebularia*) and Marsh Sandpiper (*Tringastagnatilis*). Mangalavanam also houses a shallow water body which is connected to the backwater and attract the waders and support mangrooves. The Marsh sandpiper is the most commonly observed bird species followed by Spotted Sandpiper. Apart from the sandpipers, good population of other waders such as common redshank, common greenshank, brahminy kite, white breasted waterhen etc. are also reported. List of the bird species found in Mangalavanam bird sanctuary is given in **Table 4.26**.

Mammals found within the sanctuary include Indian flying-fox, painted bat, three-striped palm squirrel/dusky palm squirrel, house rat/black rat, bandicota, and Eurasian otter. Two species of amphibians, *Limnonecteslimnocharis* and *Duttaphrynusmelanostictus*, and seven species of fishes: *Anabas testudineus*, Striped panchax, Malabar swamp eel, Orange chromide, Blackline rasbora, *Etroplussuratensis* and *Sarotherodonmossambica* are found here. Other than these 17 species of butterflies are also reported within the sanctuary area. The true mangrove and mangrove associate species that exist in the sanctuary are *Avicenniaofficinalis*, *Rhizophora mucronata*, *Acanthus ilicifolius* and *Acrostichumaureum*

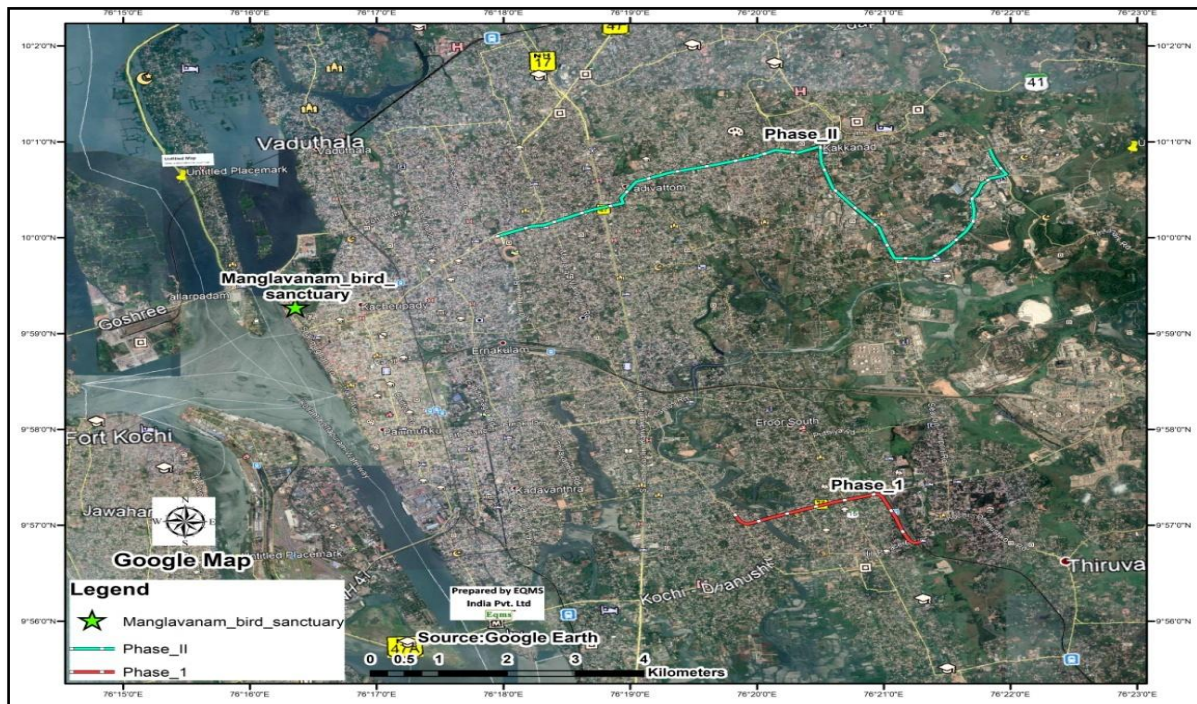


Figure 4.32: Map of Project Alignment and Mangalavanam Sanctuary

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Table 4.26 Avifauna Found in Manglavanam Sanctuary

Scientific Name	Common Name
<i>Acridotheres fuscus</i>	Jungle Myna
<i>Acridotheres tristis</i>	Common Myna
<i>Actitis hypoleucos</i>	Common Sandpiper
<i>Aethopygia siparaja</i>	Crimson Sunbird
<i>Alcedo atthis</i>	Common Kingfisher
<i>Alcedomeninting</i>	Blue-eared Kingfisher
<i>Amaurornis phoenicurus</i>	White-breasted Waterhen
<i>Anhinga melanogaster</i>	Darter
<i>Ardeacinerea</i>	Grey Heron
<i>Ardea purpurea</i>	Purple Heron
<i>Ardeola grayii</i>	Indian Pond-heron
<i>Bubulcus ibis</i>	Cattle Egret
<i>Butorides striatus</i>	Little Heron
<i>Centropus sinensis</i>	Greater Coucal
<i>Ceryle rudis</i>	Pied Kingfisher
<i>Columba livia</i>	Rock Pigeon
<i>Copsychus saularis</i>	Oriental Magpie -Robin
<i>Corvus macrorhynchos</i>	Large-billed Crow
<i>Corvus splendens</i>	House Crow
<i>Cypsiurus balasienis</i>	Asian Palm Swift
<i>Dendrocygna bicolor</i>	Fulvous Whistling-duck
<i>Dicaeum erythrorhynchos</i>	Pale-billed Flowerpecker
<i>Dicrurus leucophaeus</i>	Ashy Drongo
<i>Dicrurus macrocercus</i>	Black Drongo
<i>Dicrurus paradiseus</i>	Greater racket-tailed Drongo
<i>Dinopium benghalense</i>	Black-rumped Flameback
<i>Dinopium shorii</i>	Common Flameback
<i>Dryocopus hodgei</i>	Rufous Woodpecker
<i>Dupetor flavicollis</i>	Black Bittern
<i>Egretta garzetta</i>	Little Egret
<i>Scientific Name</i>	<i>Common Name</i>
<i>Eudynamis scolopacea</i>	Asian Koel
<i>Gallinula chloropus</i>	Common Moorhen
<i>Halcyon capensis</i>	Stork-billed Kingfisher
<i>Halcyon smyrnensis</i>	White-throated Kingfisher
<i>Haliaeetus leucoryphus</i>	Pallas's fish- Eagle

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<i>Haliasturindus</i>	Brahminy Kite
<i>Himantopus himantopus</i>	Black-winged Stilt
<i>Ixobrychus cinnamomeus</i>	Cinnamon Bittern
<i>Lonchura malacca</i>	Black-headed Munia
<i>Megalaima viridis</i>	White-cheeked Barbet
<i>Mesophoyx intermedia</i>	Intermediate Egret
<i>Milvus migrans</i>	Black Kite
<i>Nectarinia asiatica</i>	Purple Sunbird
<i>Nettion coromandelianus</i>	Cotton Pygmy-goose
<i>Nycticorax nycticorax</i>	Black-crowned night Heron
<i>Orthotomus sutorius</i>	Common Tailorbird
<i>Passer domesticus</i>	House Sparrow
<i>Phalacrocorax fuscicollis</i>	Indian Cormorant
<i>Phalacrocorax niger</i>	Little Cormorant
<i>Prinia inornata</i>	Plain Prinia
<i>Prinia socialis</i>	Ashy Prinia
<i>Psittacula krameri</i>	Rose-ringed Parakeet
<i>Saxicola leucurus</i>	Indian Robin
<i>Sturnus malabaricus</i>	Chestnut-tailed Starling
<i>Tachybaptus ruficollis</i>	Little Grebe
<i>Threskiornis melanoleuca</i>	Black-headed Ibis
<i>Tringa erythrorhynchos</i>	Common Redshank
<i>Vanellus indicus</i>	Red-wattled Lapwing

4.9.3 Tree Species within the RoW

Proposed project will move along the road median from JLN Station to Infopark-II. In this section, the alignment moves within the private property comprising of houses, open plots, water logged areas and fields. Details of Trees which are present within the RoW of alignment are given in **Table 4.27**. Trees with girth 15 cm and 1 m height are considered as trees. Total 3645nos of trees fall within RoW. Compensatory plantation will be undertaken in ratio of 1:12 as per policy of KMRL which is more than the requirement of State Forest Department.

Table 4.27 Trees within Proposed RoW

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S. No	Common Name	Scientific Name	Total Nos	Girth (m)	App. Height (m)
1.	Acacia	<i>Acacia sp</i>	247	0.25-3.1	4-15.0
2.	Akashbani	<i>Acacia sp.</i>	79	0.25-3.8	3-11.0
3.	Akashmoni	<i>Acacia auriculiformis</i>	28	0.3 - 1.2	3.0 - 8.0
4.	Amla (Amloki)	<i>Phyllanthus emblica</i>	3	0.3 - 0.7	3.0 - 5.0
5.	Amra	<i>Spondiasmombin</i>	3	0.9-1.10	5.0-7.0
6.	Amrut	<i>Psidium guajava</i>	3	0.3-0.4	2.0-6.0
7.	Guava	<i>Psidium guajava</i>	14	0.40-0.85	3.0-5.0
8.	Arjun	<i>Terminalia arjuna</i>	8	0.5-1.3	4.0-11.0
9.	Atta	<i>Ficusglomerata</i>	5	0.5-0.6	3.0-6.0
10.	Badam	<i>Terminalia cattapa</i>	5	0.48-0.8	5.0-11.0
11.	Bokul	<i>Mimosopselengi</i>	6	0.5-2.7	4.0-10.0
12.	Banyan	<i>FigusBengalensis</i>	3	0.7-2.7	4.0-10.0
13.	Bel	<i>Aegelmarmelos</i>	1	0.5	4.0
14.	Bottle Palm	<i>Hyophorbelagenicaulis</i>	75	0.5-1.4	2.0-10.0
15.	Cashew	<i>Anacardiumoccidentale</i>	9	0.4-1.0	5.0-10.0
16.	Kajubadam	<i>Anacardiumoccidentale</i>	10	0.65-1.3	3.0-9.0
17.	Chatim	<i>Alstoniascholaris</i>	31	0.5-3.2	2.0-10.0
18.	Pala	<i>Alstoniascholaris</i>	15	0.7-1.10	4.0-8.0
19.	Chemeakam	<i>Magnolia champaca</i>	32	0.25-1.6	2.0-10.0
20.	Coconut	<i>Cocus nucifera</i>	959	0.45-1.40	2.0-16.0
21.	Darchine	<i>Cinnamomumverum</i>	5	0.55-0.9	4.0-9.0

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22.	Devdaru	<i>Cedrusdeodara</i>	93	0.35-1.8	3.0-11.0
23.	Gular	<i>Ficusracemosa</i>	1	0.5	6.0
24.	Gasagase	<i>Muntingiacalabura</i>	141	0.28-1.5	2.0-12.0
25.	Gulmohor	<i>Delonix regia</i>	174	0.30-2.6	2.0-14.0
26.	Pungiliam	<i>Delonix regia</i>	2	0.95-1.2	9.0 & 10.0
27.	Imly	<i>Tamarindusindica</i>	1	0.6	10.0
28.	Tamarind	<i>Tamaranidusindica</i>	9	0.5-1.8	2.0-10.0
29.	Jackfruit	<i>Artocarpusheterophyllus</i>	88	0.3-2.85	3.0-14.0
30.	Jagogular	<i>Gmelina arborea</i>	1	1.2	6.0
31.	Jaifal	<i>Myristicafragrans</i>	18	0.4-1.10	5.0-8.0
32.	Jamrul	<i>Syzygiumsamarangense</i>	2	0.9-1.1	9.0
33.	Jamun	<i>Syzygiumcumini</i>	31	0.3-1.6	3.0-10.0
34.	Jari	<i>Ficus religiosa</i>	1	0.4	3.0
35.	Jhau	<i>Tamarixdioica</i>	5	0.3-1.1	5.0-10.0
36.	Jungali	<i>Broussonetiapapyrifera</i>	1	0.5	3.0
37.	Kaari	<i>Eucalyptus diversicolor</i>	4	0.35-0.95	3.0-6.0
38.	Kadam	<i>Neolamarckiacadamba</i>	79	0.4-1.5	3.0-19.0
39.	Kadachaka (M)	<i>Artocarpusaltilis</i>	2	1.2-1.3	3.0-5.0
40.	Kanakonna	<i>Cassia fistula</i>	34	0.2-1.3	2.0-10.0
41.	Pulanisnake	<i>Cassia fistula,</i>	2	0.65 & 1.4	5.0 & 9.0
42.	Kanjanan	<i>Gmelina arborea</i>	4	0.7-1.4	4.0-7.0
	Kanna	<i>Sceletiumtortuosum</i>	1	0.5	5.0

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43.					
44.	Karanja	<i>Millettiapinnata</i>	5	0.45-0.80	3.0-4.0
45.	Khaskhas	<i>Vetiveriazizanioides</i>	1	0.6	7.0
46.	Khrismas	<i>Araucaria heterophylla</i>	6	0.6-1.2	4.0-11.0
47.	Lemon	<i>Citrus limon</i>	1	0.5	4.0
48.	Mahogany	<i>Swietenia macrophylla</i>	30	0.2-2.3	3.0-10.0
49.	Mango	<i>Mangifera indica</i>	185	0.2-2.8	2.0-14.0
50.	Neem	<i>Azadirachta indica</i>	24	0.45-2.9	3.0-12.0
51.	Owaga (M)	<i>Millettiapinnata</i>	3	0.5-1.2	4.0-9.0
52.	Pang	<i>Madhucabetis</i>	3	1.1-1.3	11.0-13.0
53.	Paper Flower	<i>Bougainvillea glabra</i>	2	0.5 & 0.6	3.0 & 4.0
54.	Papri	<i>Holoptelea integrifolia</i>	7	0.35-1.10	3.0-6.0
55.	Peepal	<i>Ficus religiosa</i>	3	1.10-2.40	5.0 -7.0
56.	Pieae(M)	<i>Melia Dubia</i>	4	1.3-1.5	9.0-11.0
57.	Vatta (Pituli)	<i>Macaranga peltata</i>	262	0.3-2.5	2.0-12.0
58.	Plum	<i>Prunus subg.</i>	3	0.7-1.1	6.0-8.0
59.	Rubber	<i>Hevea brasiliensis</i>	381	0.3-3.6	4.0-13.0
60.	Sabada	<i>Ziziphus mauritiana</i>	3	0.35 - 0.85	3.0 - 6.0
61.	Teak (Shegun)	<i>Tectona grandis</i>	184	0.35-1.3	3.0-15.0
62.	Shirish	<i>Albizia lebbek</i>	185	0.2- 5.2	2.0-15.0
63.	Silver	<i>Leucadendron argenteum</i>	2	0.3 & 0.48	5.0 & 7.5
64.	Simul	<i>Bombax ceiba</i>	5	0.7-2.0	4.0-11.0
65.	Supari	<i>Areca catechu</i>	20	0.4-0.6	3.0-10.0
66.	Tagar	<i>Tabernaemontana Divaricata</i>	1	0.6	2.0

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67.	Talitanga	<i>Gmelina arborea</i>	1	0.8	5.0
68.	Telli	<i>Parinaricuratellifolia</i>	34	0.2-1.3	2.0-10.0
69.	Tulla	<i>Thujaoccidentalis</i>	5	0.45-1.05	7.0-11.0
70.	Other Tree	--	50	0.2-1.7	2.0-12.0
Total			3645		

4.10 Aquatic Flora/Fauna in Study Area

Kochi has fair network of rivers, streams and backwaters. Kochi backwaters form a significant habitat for aquatic and amphibian species. These backwaters support life of mangroves and variety of aquatic animals. Large scale shrimp farming is carried out in these back waters. Proposed alignment is at distance of approx 3.4 km from Vembanad lake and National waterways. Proposed alignment crosses Edappally tod, stream from Chitraphuza River, Kadambryar River, drains and nallas. Plankton and benthos species found in the backwaters of Kochi is given in **Table 4.28 and Table 4.29.**

Table 4.28 Planktons in Kochi back Waters

S No	Species name	S No	Species name
Phytoplanktons			
1	<i>Skeletonemacostatum</i>	18	<i>C.wailesii</i>
2	<i>Stephanopyxisturris</i>	19	<i>Protopteridiniumconicoides</i>
3	<i>Leptocylindrusdanicus</i>	20	<i>P.diabolum</i>
4	<i>Chaetocerosconstrictus</i>	21	<i>P.pentagonum</i>
5	<i>C. capense</i>	22	<i>Triceritium favus</i>
6	<i>C. didymus</i>	23	<i>Bacteriastrumhyalinum</i>
7	<i>C.compressus</i>	24	<i>Bacillariapaxillifera</i>
8	<i>C.decipiens</i>	25	<i>Pleurosigma directum</i>
9	<i>C.diversus</i>	26	<i>P.formosum</i>
10	<i>C. fusus</i>	27	<i>P. diverse-striatum</i>
11	<i>C. lineatum</i>	28	<i>Pseudo-nitzschiaseriata</i>
12	<i>Coscinodiscus centralis</i>	29	<i>P.nitzschiapungens</i>
13	<i>C.asteromphalus</i>	30	<i>Plagiotropis lepidoptera</i>
14	<i>C. marginatus</i>	31	<i>Actinocyclusoctonarius</i>
15	<i>C.granii</i>	32	<i>Pyrophacussteinii</i>
16	<i>C.radiatus</i>	33	<i>Thalassionemanitzschioides</i>
17	<i>Gyrosigmadiminutum</i>		
Zooplanktons			
1	<i>Acartiagravelyi</i>	9	<i>O. brevicornis</i>
2	<i>Acartiaplumosa</i>	10	<i>T. tocantinensis</i>
3	<i>Acrocalanussimilis</i>	11	<i>Doliolum sp.</i>

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4	<i>B. quadridentatus</i>	12	<i>Microsetellanorvegica</i>
5	<i>B. rotundiformis</i>	13	<i>M. rosa</i>
6	<i>Oithonabrevicornis</i>	14	<i>Macrosetellagracilis</i>
7	<i>O. similis</i>	15	Bivalve spot
8	<i>O. simplex</i>	16	Gastropod larvae

Table:4.29 Benthos in Kochi back Waters

SNo	Species	SNo	Species
Polychaeta worms		Bivalves	
1	<i>Cossuracoasta</i>	1	<i>Corbicula fluminea</i>
2	<i>Prionospiocirrifera</i>	2	<i>Corbicula cyreniformis</i>
3	<i>P. pinnata</i>	Insect larvae	
4	<i>P. polybranchiata</i>	1	<i>Cirolanafluviatilis</i>
5	<i>Paraprionospiopinnata</i>	2	<i>Gammarus lacustris</i>
6	<i>Capitella capitata</i>	3	<i>Americorophiumtriaeaonyx</i>
7	<i>Capitella</i> sp.	4	<i>Chironomus</i>
8	<i>Heteromastusfiliformis</i>	5	<i>Ctenapseudes</i>
9	<i>Heteromastussillilis</i>		

4.10.1 Fish and Fisheries in Study Area

Due to presence of backwaters and network of rivers/streams and other water bodies, fishing is one of the major occupations of people in study area. Fishermen in the area use principally Chinese nets, cast nets, shore seine, stake nets and gill nets for catching fish. Kochi is also famous for its Chinese fishing nets and has formed tourist attraction. The kochi metro phase II route crosses Edappally tod, stream from Chitraphuza river, Kadambryar river, drains and nallas. These water bodies are ultimately connected to NW-3 and forms part of NW-3. As per secondary literature available there are approx 150 species of fishes found in NW-3 and back water system of Kochi. As per study carried out by Sahadevan P (Diversity of fishes, Crustaceans and Molluscs of Puthuvypeen of Ernakulam District, Kerala, South India) for identifying the fisheries in Kochi backwaters and connected water bodies, 57 species of fin fishes belonging to 27 families, 19 species of crustaceans belonging to 7 families and 11 species of molluscs belonging to 7 families were found in Kochi backwaters and connected water bodies. As per the per study, among the fin fishes one species (*Anguilla bicolor*) belonged to Near Threatened (NT) category and another species (*Hyporhamphusxanthopterus*) to Vulnerable (V) category as defined in IUCN list. 17 species belonged to the category of Least Concern (LC), 2 species belonged to Data Deficient (DD) category and 36 species were not evaluated (NE). Of the crustaceans 3 species belonged to LC and 16 species to NE category. Among the molluscs 4 species belonged to LC and 7 to NE categories. One species (*Oreochromis mossambicus*) was an alien species. Shrimps and prawns are also found in the back waters and common prawns and shrimp species found in the area are *Metapenaeusdobsoni*, *M. affinis*, *M. Monoceros*, *Peneaussemisulcatus*, *P.monodon* etc. Fisheries found to present in the area as per the study is given in **Table 4.30**.

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Table 4.30 Fishes of Backwaters of Kochi

Sl. No.	Scientific name	Common name in English	Family	IUCN status
A.	Fishes			
1.	<i>Anchoviellaindica</i> (Van Hasselt)	Indian anchovy	Engraulidae	NE
2.	<i>Thryssamalabarica</i> (Bloch)	Malabar thryssa	Engraulidae	NE
3.	<i>Anchoviellaindica</i> (Van Hasselt)	Commerson's anchovy	Engraulidae	NE
4.	<i>Chanoschanos</i> (Forsk.)	Milk fish	Chanidae	NE
5.	<i>Tylosurusstrongylurus</i> (Van Hasselt)	Round tail alligator gar	Belonidae	NE
6.	<i>Xenentodoncancila</i> (Hamilton-Buchanan)	Freshwater gar fish	Belonidae	LC
7.	<i>Hyporhamphusxanthopterus</i> (Valenciennes)	Red tipped half beak	Hemirhamphidae	VU
8.	<i>Mugil cephalus</i> Linnaeus	Grey mullet	Mugilidae	LC
9.	<i>Liza parsia</i> (Hamilton-Buchanan)	Gold spot mullet	Mugilidae	NE
10.	<i>L. macrolepis</i> (Smith)	Borneo mullet	Mugilidae	NE
11.	<i>L. dussumieri</i> (Valenciennes)	Dussumier's mullet	Mugilidae	NE
12.	<i>Polynemus indicus</i> Shaw	Indian tassel fish	Polynemidae	NE
13.	<i>Latescalcarifer</i> (Bloch)	Giant perch	Latidae	NE
14.	<i>Theraponjarbua</i> (Forsk.)	Crescent perch	Theraponidae	NE
15.	<i>Sillagosihama</i> (Forsk.)	Silver whiting	Sillaginidae	NE
16.	<i>Carangoidesmalabaricus</i> (Bloch)	Malabar trevally	Carangidae	NE
17.	<i>Caranxsexfasciatus</i> Quoy and Gaimard	Six banded trevally	Carangidae	LC
18.	<i>Megalaspiscordyla</i> (Linnaeus)	Torpedo trevally	Carangidae	NE
19.	<i>Menemaculata</i> (Bloch)	Moon fish	Menidae	NE
20.	<i>Lutjanusfulviflamma</i> (Forsk.)	One spot golden snapper	Lutianidae	NE
21.	<i>L. johni</i> (Bloch)	Moses perch	Lutianidae	NE
22.	<i>L. argentimaculatus</i> (Forsk.)	Red snapper	Lutianidae	NE
23.	<i>L. russelli</i> (Bleeker)	Russel's one spot snapper	Lutianidae	NE
24.	<i>Johniusdussumieri</i> (Cuvier)	Dussumier's silver jewfish	Sciaenidae	NE
25.	<i>Scatophagusargus</i> (Linnaeus)	Spotted butterflyfish	Scatophagidae	LC
26.	<i>Oreochromis mossambicus</i> (Peters)	Tilapia	Cichlidae	NE
27.	<i>Etroplussuratensis</i> (Bloch)	Pearl spot	Cichlidae	NE

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28.	<i>E. maculatus</i> (Bloch)	Orange chromide	Cichlidae	NE
29.	<i>Megalops cyprinoides</i> (Broussonet)	Tarpon	Megalopidae	DD
30.	<i>Anodontostomachacunda</i> (Hamilton- Buchanan)	Short nose gizzard shad	Clupeidae	NE
31.	<i>Sardinella longiceps</i> (Valenciennes)	Indian oil sardine	Clupeidae	LC
32.	<i>Kowalacoval</i> (Cuvier)	White sardine	Clupeidae	NE
33.	<i>Nematalosa nasus</i> (Bloch)	Bloch's gizzard shad	Clupeidae	NE
34.	<i>Anguilla bicolor</i> McClelland	Level- finned eel	Anguillidae	NT
35.	<i>Macronesgulio</i> (Hamilton- Buchanan)	Long whiskered cat fish	Bagridae	NE
36.	<i>Pseudariusjella</i> (Day)	Small eye cat fish	Tachysuridae	NE
37.	<i>Tachysuruscoelatus</i> (Valenciennes)	Engraved cat fish	Tachysuridae	NE
38.	<i>Tachysurussubrostratus</i> (Valenciennes)	Short nosed cat fish	Tachysuridae	NE
39.	<i>Tachysurus maculatus</i> (Thunberg)	Spotted cat fish	Tachysuridae	NE
40.	<i>Panchax lineatus</i> (Steindachner)	Striped top minnow	Cyprinodontidae	NE
41.	<i>P. panchax</i> (Arnold)	Lesser top minnow	Cyprinodontidae	NE
42.	<i>Ambassisdayi</i> Bleeker	Day's glassy perchlet	Ambassidae	LC
43.	<i>A. commersoni</i> Cuvier	Commerson's glassy perchlet	Ambassidae	NE
44.	<i>A. gymnocephalus</i> (Lacepede)	Naked head lassyperchlet	Ambassidae	LC
45.	<i>Parambassisthomassi</i> (Day)	Western Ghat glassy perchlet	Ambassidae	LC
46.	<i>Elopsmachnata</i> (Forsk.)	Giant herring	Elopidae	LC
47.	<i>Leignognathusequulus</i> (Forsk.)	Greater pony fish	Leignognathidae	LC
48.	<i>L. dussumieri</i> (Valenciennes)	Dussumier's pony fish	Leignognathidae	NE
49.	<i>Gerresfilamentosus</i> Cuvier	Long rayed silver biddy	Gerridae	LC
50.	<i>Glossogobiusgiuris</i> (Hamilton- Buchanan)	Bar-eyed goby	Gobiidae	LC
51.	<i>Puntius sarana</i> ((Hamilton- Buchanan)	Olive barb	Cyprinidae	LC
52.	<i>P. filamentosus</i>	Filamented barb	Cyprinidae	LC

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	(Valenciennes)			
53.	<i>P. vittatus</i> Day	Striped barb	Cyprinidae	LC
54.	<i>P. ticto</i> (Hamilton- Buchanan)	Fire fin barb	Cyprinidae	NE
55.	<i>P. amphibius</i> (Valenciennes)	Scarlet-banded barb	Cyprinidae	DD
56.	<i>Rasbora daniconius</i> (Hamilton- Buchanan)	Slender rasbora	Cyprinidae	LC
57.	<i>Amblypharyngodonmola</i> (Hamilton)	Molacarplet	Cyprinidae	LC
B.	Crustaceans			
1.	<i>Fenneropenaeus indicus</i> (H. Milne Edwards)	Indian white prawn	Penaeidae	NE
2.	<i>Penaeus monodon</i> (Fabricius)	Black tiger prawn	Penaeidae	NE
3.	<i>P. semisulcatus</i> (De Haan)	Green tiger prawn	Penaeidae	NE
4.	<i>Metapenaeusdobsoni</i> (Miers)	Flower tail prawn	Penaeidae	NE
5.	<i>M. affinis</i> (H. Milne Edwards)	Brown shrimp	Penaeidae	NE
6.	<i>M. monoceros</i> (Fabricius)	Speckled shrimp	Penaeidae	NE
7.	<i>Macrobrachiumrosenbergii</i> (De Man)	Giant freshwater prawn	Palaemonidae	LC
8.	<i>M. equidens</i> (Dana)	Rough river prawn	Palaemonidae	LC
9.	<i>M. idella</i> (Hilgendorf)	Slender river prawn	Palaemonidae	LC
10.	<i>Portunuspelagicus</i> (Linnaeus)	Reticulate crab	Portunidae	NE
11.	<i>Scylla serrata</i> (Forsskål)	Mangrove crab	Portunidae	NE
12.	<i>S. tranquibarica</i> (Fabricius)	Green mud crab	Portunidae	NE
13.	<i>Parasesarmaaplicatum</i> (Latreille)	Mud flat crab	Grapsidae	NE
14.	<i>Varunalitterata</i> (Fabricius)	Paddler crab	Grapsidae	NE
15.	<i>Ucainversainversa</i> (Hoffmann)	Fiddler crab	Ocypodidae	NE
16.	<i>Ucavirens Salmon and Atsides</i>	Green banded fiddler crab	Ocypodidae	
17.	<i>Neosarmatiumsmithi</i> (H. Milne Edwards)	Large mangrove crab	Pilumnidae	NE
18.	<i>N. malabaricum</i> (Henderson)	Sesarmid crab	Pilumnidae	NE
19.	<i>Balanus amphitrite</i> Darwin	Striped barnacle	Balanidae	NE
B.	Molluscs			
1.	<i>Meretrix meretrix</i> (Linnaeus)	Asiatic hard clam	Veneridae	NE
2.	<i>M. casta</i> (Gmelin)	Backwater clam	Veneridae	NE
3.	<i>Paphiamalabarica</i> (Chemnitz)	Short neck clam	Veneridae	NE
4.	<i>Villoritacyprinooides</i> Gray	Black clam	Cyrenidae	LC
5.	<i>Crassostrea madrasensis</i>	Backwater oyster	Ostreidae	NE

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	(Preston)			
6.	<i>Saccostrea cucullata</i> (Born)	Rock oyster	Ostreidae	NE
7.	<i>Bulla ampulla</i> Linnaeus	Bubble snail	Bullidae	NE
8.	<i>Telescopium telescopium</i> (Linnaeus)	Horn snail	Potamididae	LC
9.	<i>Pernaviridis</i> (Linnaeus)	Green mussel	Mytilidae	NE
10.	<i>Pila globosa</i> (Swainson)	Fresh water snail	Ampullariidae	LC
11	<i>Lamellidens marginalis</i> (Lamarck)	Indian freshwater mussel	Unionidae	LC

4.11. Socio-Economic Environment

4.11.1 Population of Kochi Region

Kochi metro Phase II is planning to connect JLN Stadium station to InfoPark II via Kakkanad. The area falls under Kochi city region which comprise of Kochi city, two municipalities and fourteen panchayat. The Kochi City Region has a population of 12, 55,733 as per Census 2011 figures. The growth rate for last decade in Corporation of Kochi area is 6.38% where as the nearby areas registered decadal growth of an average of 9.20%. The entire region has witnessed the average decadal growth of 8.51% over the last decade. Detail of the population of the Kochi region is given in **Table 4.31**.

Table 4.31: Population of Kochi Region

S. No.	Area	Study Area Population 2013
Municipal Corporation		
1	Kochi Municipal Corporation	646287
Municipalities		
2	Maradu	45603
3	Thrippunithura	70785
4	Kalamassery	72466
5	Eloor	38221
6	Aluva	22879
7	Angamaly	34138
8	Thrikkakara	78873
9	Perumbavoor	28675
10	Paravur	32136
Village Panchayat		
11	Pallipuram	32971
12	Kuzhuppilly	24338
13	Edavanakkad	22225
14	Nayarambalam	24612
15	Njarackal	24238
16	Elamkunnappuzha	63885
17	Mulavukad	24312

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18	Cheranallur	31209
19	Kadamakkudy	16623
20	Ezhikkara	11030
21	Kottuvally	43785
22	Varappuzha	27288
23	Alangad	48280
24	Kadungalloor	40463
25	Chengamanad	30170
26	Nedumbassery	30303
27	SreeMoolan Gram	37829
28	Kanjoor	42240
29	Keezmad	36739
30	Vazhakulam	42467
31	Edathala	79375
32	Choorikkara	44075
33	Vadavukode	48878
34	Chottanikkara	13616
35	Mulamthuruthy	47453
36	Udayamperoor	36058
37	Kumbalam	29780
38	Kumbalangy	43219
39	Chellanam	15228
Grand Total		2082751

4.11.2 Population Projection

Development Plan for Kochi City Region 2031 gives the likely growth to take place in various areas in the region. The total population projection for the year 2021 and 2031 is estimated on the basis of density pattern proposed to be achieved in the Development Plan for Kochi City Region 2031. The KCR Development Plan 2031 proposes the population for the region as 22.7 Lakh including migration population in the year 2031. Projected population of the study area for year 2031 is given in **Table 4.32** below.

Table 4.32: Projected Population of Kochi Region

Area	Population		Growth Rate (p.a.)
	2013	2031	2013-31
Kochi City Region	1276893	2273787	3.2%
Other Municipalities / Panchayats	805858	1038692	1.4%
Total	2082751	3312479	2.5%

4.11.3 Work Force Population

As per Development Plan for Kochi City Region 2031 the workforce participation rate (WFPR) of Kochi City Region is 37% in 2011. The WFPR for horizon years 2021 and 2031 has been assumed as 40% and 41% respectively as envisaged for Kochi city region. The employment in the study area, which is 7.7 Lakh in 2013, is expected to grow to 10.3 Lakh in 2021 and 13.6 Lakh in 2031.

Table 4.33: Work Force Population of Kochi Region

Year	Population	Employment	Percentage
2013	2082751	772252	37.1
2021	2580991	1032396	39.99
2031	3312479	1358047	40.99

4.11.4 Population of ROW

As per the census records 2011, the total population of the study area was recorded as 678819 persons living in urban part of the study area under Kochi Municipal Corporation (Ward no. 1 to 71) and two census towns namely Kakkanad (CT) and Vazhakkala (CT) under two Sub-District / Tehsil namely Kochi and Kanayannur of Ernakulum District of Kerala. Study zone mainly falls in urban part of Ernakulum district in Kerala. Total number of ‘Households’ was observed as 169942 in the study zone. Male-female wise total population was recorded as 334732 males and 344087 females respectively. Male-Female and Caste wise population distribution of the entire study area is shown in **Table 4.34 & Figure 4.33** given as follows

Table 4.34: Male-Female wise Population Distribution in the Study Zone (Phase-II)

Study Zone	Total Households	Total Population		
		Total Population	Males	Females
Total Kochi (MC) + 2 CT's	169942	678819	334732	344087

Source-Census Records 2011

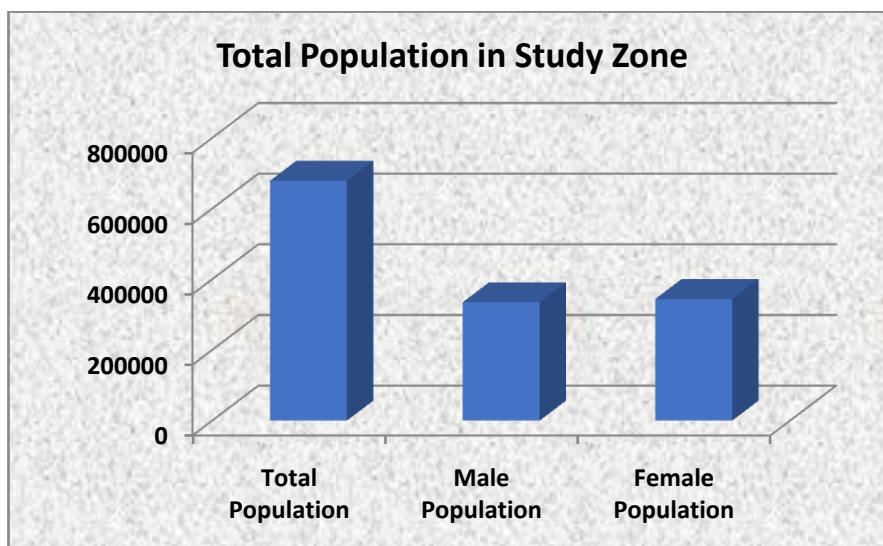


Figure 4.33: Male-Female wise Population Distribution in the Study Area

4.11.5 Caste Wise Distribution of Population of Project Area (RoW and 500 m radius Buffer Area)

On the basis of the village/town wise SC & ST population distribution of the study area during 2011, the ‘Scheduled Castes’ population was observed as 27145 persons consisting of 13296 males and 13849 females respectively in the study area which accounts as 4.0% to the total population (678819 persons) of the study area. ‘Scheduled Tribes’ population was observed as 2593 persons, accounting as 0.4% to the total population of the study area consisting of 1337 males and 1256 females. It implies that the rest 95.6% of the total population belongs to the General category. Male-female wise distribution of ‘SC’ & ‘ST’ population in the study area is graphically shown in **Figure 4.34 &4.35** as follows.

Table 4.35: Caste-wise Population Distribution in the Study Area

Name / No of the Ward & Towns	No of Households	Total Population			Scheduled Castes		Scheduled Tribes	
		Persons	Male	Female	Male	Female	Male	Female
Kochi (M Corp.) WARD NO.-0001	2578	10279	4880	5399	89	109	8	11
Kochi (M Corp.) WARD NO.-0002	1652	7814	3708	4106	1	1	10	10
Kochi (M Corp.) WARD NO.-0003	1282	6425	3038	3387	0	0	7	3
Kochi (M Corp.) WARD NO.-0004	2003	8882	4360	4522	158	141	3	3
Kochi (M Corp.) WARD NO.-0005	2227	10144	5035	5109	46	56	15	8
Kochi (M Corp.) WARD NO.-0006	1517	7108	3453	3655	5	4	9	10

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Kochi (M Corp.) WARD NO.-0007	2012	7741	3883	3858	25	21	10	18
Kochi (M Corp.) WARD NO.-0008	2810	11429	5499	5930	60	70	5	8
Kochi (M Corp.) WARD NO.-0009	1107	5046	2392	2654	61	71	6	3
Kochi (M Corp.) WARD NO.-0010	1815	7673	3713	3960	44	51	7	9
Kochi (M Corp.) WARD NO.-0011	2342	9266	4512	4754	78	85	7	7
Kochi (M Corp.) WARD NO.-0012	2201	8925	4517	4408	166	169	18	8
Kochi (M Corp.) WARD NO.-0013	2417	10203	5005	5198	113	121	17	12
Kochi (M Corp.) WARD NO.-0014	2448	10699	5116	5583	41	47	19	17
Kochi (M Corp.) WARD NO.-0015	2302	9574	4782	4792	441	466	52	57
Kochi (M Corp.) WARD NO.-0016	1897	7808	3835	3973	229	262	5	7
Kochi (M Corp.) WARD NO.-0017	2299	9442	4668	4774	93	89	2	6
Kochi (M Corp.) WARD NO.-0018	2387	9863	4772	5091	100	130	13	16
Kochi (M Corp.) WARD NO.-0019	2569	11100	5452	5648	60	62	11	15
Kochi (M Corp.) WARD NO.-0020	2010	8747	4279	4468	124	106	4	3
Kochi (M Corp.) WARD NO.-0021	2749	11046	5390	5656	126	128	34	31
Kochi (M Corp.) WARD NO.-0022	3899	14723	7290	7433	236	256	20	18
Kochi (M Corp.) WARD NO.-0023	2002	8403	4121	4282	5	4	4	3
Kochi (M Corp.) WARD NO.-0024	2041	8121	3919	4202	53	48	3	1
Kochi (M Corp.) WARD NO.-0025	1653	6623	3154	3469	44	46	6	8
Kochi (M Corp.) WARD NO.-0026	1775	7277	3601	3676	192	203	10	8
Kochi (M Corp.) WARD NO.-0027	1754	7456	3854	3602	97	98	28	11
Kochi (M Corp.) WARD NO.-	2364	9439	4545	4894	308	321	3	4

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0028								
Kochi (M Corp.) WARD NO.-0029	1557	4666	2391	2275	59	47	4	2
Kochi (M Corp.) WARD NO.-0030	1837	10076	6990	3086	291	301	59	60
Kochi (M Corp.) WARD NO.-0031	2296	9025	4427	4598	75	65	6	6
Kochi (M Corp.) WARD NO.-0032	1970	7795	3758	4037	63	79	19	24
Kochi (M Corp.) WARD NO.-0033	2195	8547	4194	4353	158	138	8	9
Kochi (M Corp.) WARD NO.-0034	2307	9034	4497	4537	200	176	14	8
Kochi (M Corp.) WARD NO.-0035	2326	8757	4304	4453	143	146	10	12
Kochi (M Corp.) WARD NO.-0036	1840	7589	3721	3868	188	173	34	23
Kochi (M Corp.) WARD NO.-0037	2408	9183	4574	4609	68	65	8	7
Kochi (M Corp.) WARD NO.-0038	2320	8634	4202	4432	66	79	5	5
Kochi (M Corp.) WARD NO.-0039	1953	7638	3766	3872	101	114	8	4
Kochi (M Corp.) WARD NO.-0040	1566	5770	2785	2985	49	55	14	7
Kochi (M Corp.) WARD NO.-0041	3043	11745	5746	5999	315	332	9	8
Kochi (M Corp.) WARD NO.-0042	2504	9708	4768	4940	113	125	40	35
Kochi (M Corp.) WARD NO.-0043	2433	9354	4622	4732	120	129	12	13
Kochi (M Corp.) WARD NO.-0044	2123	8582	4232	4350	276	277	22	22
Kochi (M Corp.) WARD NO.-0045	2414	9938	4984	4954	141	134	31	16
Kochi (M Corp.) WARD NO.-0046	1599	6557	3257	3300	111	134	6	7
Kochi (M Corp.) WARD NO.-0047	1248	4952	2473	2479	134	154	24	17
Kochi (M Corp.) WARD NO.-0048	2415	9126	4498	4628	304	316	42	40
Kochi (M Corp.) WARD NO.-0049	1968	7524	3674	3850	106	118	30	27

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Kochi (M Corp.) WARD NO.-0050	2143	8024	3986	4038	85	86	20	22
Kochi (M Corp.) WARD NO.-0051	2333	8935	4380	4555	236	268	35	32
Kochi (M Corp.) WARD NO.-0052	2900	10726	5264	5462	221	220	31	24
Kochi (M Corp.) WARD NO.-0053	1467	5119	2445	2674	112	107	14	6
Kochi (M Corp.) WARD NO.-0054	1752	6279	3075	3204	234	230	17	15
Kochi (M Corp.) WARD NO.-0055	3037	11267	5479	5788	485	523	26	24
Kochi (M Corp.) WARD NO.-0056	2048	7933	3862	4071	241	220	33	38
Kochi (M Corp.) WARD NO.-0057	1474	5522	2672	2850	125	158	17	21
Kochi (M Corp.) WARD NO.-0058	2738	9973	4895	5078	542	551	56	54
Kochi (M Corp.) WARD NO.-0059	1175	4569	2274	2295	76	68	6	5
Kochi (M Corp.) WARD NO.-0060	1741	5941	2854	3087	101	105	45	36
Kochi (M Corp.) WARD NO.-0061	2364	8721	4271	4450	351	385	19	19
Kochi (M Corp.) WARD NO.-0062	2597	10047	4967	5080	145	167	9	10
Kochi (M Corp.) WARD NO.-0063	2100	7887	3855	4032	141	141	9	11
Kochi (M Corp.) WARD NO.-0064	2131	8734	4317	4417	80	89	6	10
Kochi (M Corp.) WARD NO.-0065	1140	4414	2111	2303	58	49	4	2
Kochi (M Corp.) WARD NO.-0066	1480	5970	2794	3176	25	33	11	8
Kochi (M Corp.) WARD NO.-0067	2264	9018	4455	4563	107	111	9	9
Kochi (M Corp.) WARD NO.-0068	2581	10174	4993	5181	79	82	20	25
Kochi (M Corp.) WARD NO.-0069	2552	10488	5201	5287	94	100	10	13
Kochi (M Corp.) WARD NO.-0070	2311	8968	4320	4648	111	104	8	9
Kochi (M Corp.) WARD NO.-	1996	7881	3843	4038	88	98	3	4

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0071								
Kakkanad (CT)	6422	25531	12750	12781	1966	2044	56	56
Vazhakkala (CT)	12762	51242	25033	26209	1517	1588	132	136
Total	16994	678819	33473	34408	1329	13849	133	1256
	2		2	7	6		7	1256
Source-Census Records 2011								

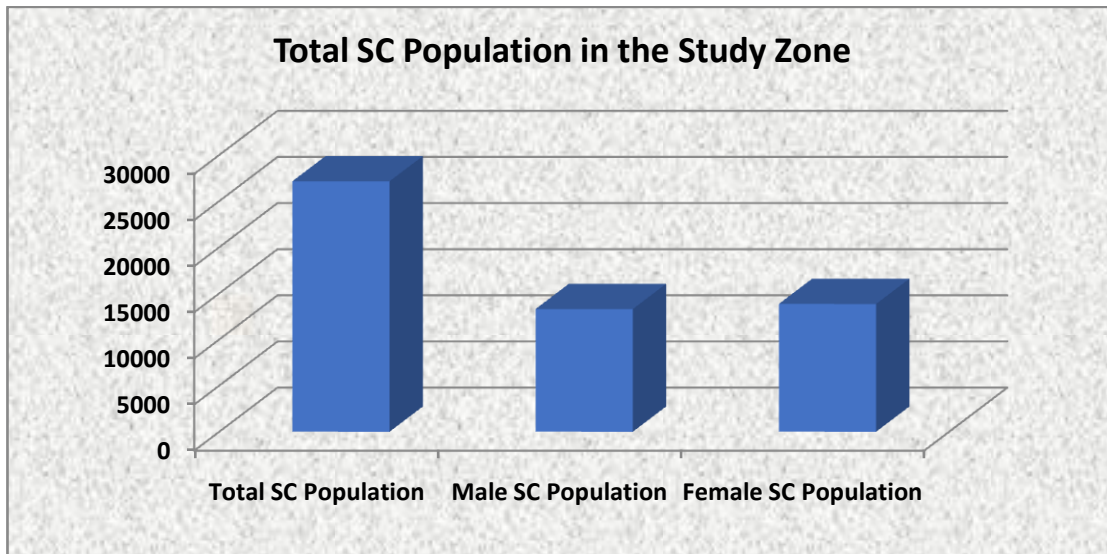


Figure4.34: Scheduled Caste Population in the Study Area

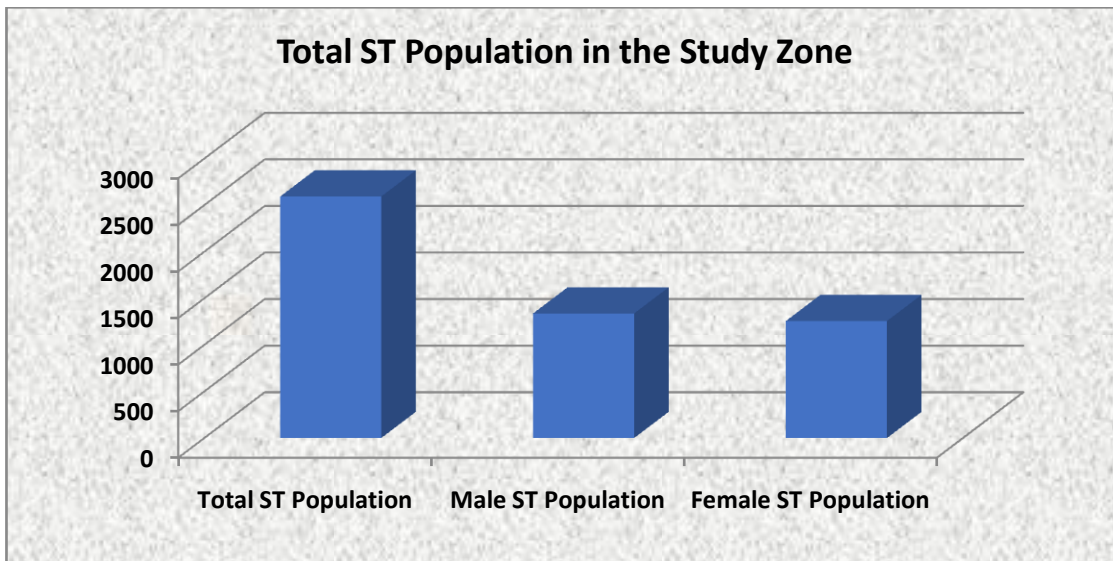


Figure4.35: Scheduled Tribes Population in the Study Area

4.11.6 Literacy Rate

Literacy level is quantifiable indicator to assess the development status of an area or region. Male-Female wise literates and illiterate's population is represented in **Table 4.33**.

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Total literates' population was recorded as 362143 persons (89.3%) in the study area. **Table 4.33** reveals that Male-Female wise literates are observed as 178104 & 184039 persons respectively, implies that the 'Literacy Rate' is recorded as 89.3% with male-female wise percentages being 43.9% & 45.4% respectively. The total illiterate's population was recorded as 43295 persons (10.7%) in the study area. Male-Female wise illiterates were 20609 (5.1%) and 22686 (5.6%) respectively. The Male-Female wise graphical representation of literates & illiterates' population in study area villages/town is shown in **Figure 4.35**

Literacy level is quantifiable indicator to assess the development status of an area or region. Male-Female wise literates and illiterate's population is represented in **Table 4.33** Total literates' population was recorded as 598707 persons (88.2%) in the study area. **Table 4.36** reveals that Male-Female wise literates are observed as 297188 & 301519 persons respectively, implies that the 'Literacy Rate' is recorded as 88.2% with male-female wise percentages being 43.8% & 44.4% respectively. The total illiterate's population was recorded as 80112 persons (11.8%) in the study area. Male-Female wise illiterates were 37544 (5.5%) and 42568 (6.3%) respectively. The Male-Female wise graphical representation of literates & illiterates' population in study area villages/town is shown in **Figure 4.36**

Table 4.36 Male-Female Wise Literates & Illiterates

Name / No of the Ward & Towns	Total Population	Literates			Illiterates		
		Persons	Males	Females	Persons	Males	Females
Kochi (M Corp.) WARD NO.-0001	10279	9283	4406	4877	996	474	522
Kochi (M Corp.) WARD NO.-0002	7814	6557	3146	3411	1257	562	695
Kochi (M Corp.) WARD NO.-0003	6425	5324	2568	2756	1101	470	631
Kochi (M Corp.) WARD NO.-0004	8882	7690	3792	3898	1192	568	624
Kochi (M Corp.) WARD NO.-0005	10144	8693	4370	4323	1451	665	786
Kochi (M Corp.) WARD NO.-0006	7108	5825	2896	2929	1283	557	726
Kochi (M Corp.) WARD NO.-0007	7741	6979	3508	3471	762	375	387
Kochi (M Corp.) WARD NO.-0008	11429	10149	4921	5228	1280	578	702
Kochi (M Corp.) WARD NO.-0009	5046	4247	2035	2212	799	357	442
Kochi (M Corp.) WARD NO.-0010	7673	6692	3275	3417	981	438	543
Kochi (M Corp.) WARD NO.-	9266	8252	3996	4256	1014	516	498

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0011							
Kochi (M Corp.) WARD NO.-0012	8925	7890	4029	3861	1035	488	547
Kochi (M Corp.) WARD NO.-0013	10203	9077	4495	4582	1126	510	616
Kochi (M Corp.) WARD NO.-0014	10699	9184	4422	4762	1515	694	821
Kochi (M Corp.) WARD NO.-0015	9574	8414	4205	4209	1160	577	583
Kochi (M Corp.) WARD NO.-0016	7808	6908	3408	3500	900	427	473
Kochi (M Corp.) WARD NO.-0017	9442	8350	4156	4194	1092	512	580
Kochi (M Corp.) WARD NO.-0018	9863	8680	4234	4446	1183	538	645
Kochi (M Corp.) WARD NO.-0019	11100	9705	4809	4896	1395	643	752
Kochi (M Corp.) WARD NO.-0020	8747	7551	3713	3838	1196	566	630
Kochi (M Corp.) WARD NO.-0021	11046	9882	4842	5040	1164	548	616
Kochi (M Corp.) WARD NO.-0022	14723	12500	6151	6349	2223	1139	1084
Kochi (M Corp.) WARD NO.-0023	8403	7336	3596	3740	1067	525	542
Kochi (M Corp.) WARD NO.-0024	8121	7231	3483	3748	890	436	454
Kochi (M Corp.) WARD NO.-0025	6623	5881	2816	3065	742	338	404
Kochi (M Corp.) WARD NO.-0026	7277	6408	3204	3204	869	397	472
Kochi (M Corp.) WARD NO.-0027	7456	6630	3458	3172	826	396	430
Kochi (M Corp.) WARD NO.-0028	9439	8356	4060	4296	1083	485	598
Kochi (M Corp.) WARD NO.-0029	4666	3701	1954	1747	965	437	528
Kochi (M Corp.) WARD NO.-0030	10076	9229	6563	2666	847	427	420
Kochi (M Corp.) WARD NO.-0031	9025	8037	3961	4076	988	466	522
Kochi (M Corp.) WARD NO.-0032	7795	6939	3375	3564	856	383	473

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Kochi (M Corp.) WARD NO.-0033	8547	7605	3741	3864	942	453	489
Kochi (M Corp.) WARD NO.-0034	9034	7931	3937	3994	1103	560	543
Kochi (M Corp.) WARD NO.-0035	8757	7841	3859	3982	916	445	471
Kochi (M Corp.) WARD NO.-0036	7589	6594	3237	3357	995	484	511
Kochi (M Corp.) WARD NO.-0037	9183	8269	4131	4138	914	443	471
Kochi (M Corp.) WARD NO.-0038	8634	7832	3809	4023	802	393	409
Kochi (M Corp.) WARD NO.-0039	7638	6833	3391	3442	805	375	430
Kochi (M Corp.) WARD NO.-0040	5770	5198	2522	2676	572	263	309
Kochi (M Corp.) WARD NO.-0041	11745	10417	5108	5309	1328	638	690
Kochi (M Corp.) WARD NO.-0042	9708	8666	4251	4415	1042	517	525
Kochi (M Corp.) WARD NO.-0043	9354	8342	4120	4222	1012	502	510
Kochi (M Corp.) WARD NO.-0044	8582	7507	3724	3783	1075	508	567
Kochi (M Corp.) WARD NO.-0045	9938	8774	4423	4351	1164	561	603
Kochi (M Corp.) WARD NO.-0046	6557	5726	2885	2841	831	372	459
Kochi (M Corp.) WARD NO.-0047	4952	4445	2216	2229	507	257	250
Kochi (M Corp.) WARD NO.-0048	9126	8173	4054	4119	953	444	509
Kochi (M Corp.) WARD NO.-0049	7524	6786	3322	3464	738	352	386
Kochi (M Corp.) WARD NO.-0050	8024	7131	3578	3553	893	408	485
Kochi (M Corp.) WARD NO.-0051	8935	8035	3945	4090	900	435	465
Kochi (M Corp.) WARD NO.-0052	10726	9577	4723	4854	1149	541	608
Kochi (M Corp.) WARD NO.-0053	5119	4700	2254	2446	419	191	228
Kochi (M Corp.) WARD NO.-	6279	5700	2807	2893	579	268	311

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0054							
Kochi (M Corp.) WARD NO.-0055	11267	10042	4883	5159	1225	596	629
Kochi (M Corp.) WARD NO.-0056	7933	7041	3460	3581	892	402	490
Kochi (M Corp.) WARD NO.-0057	5522	4936	2397	2539	586	275	311
Kochi (M Corp.) WARD NO.-0058	9973	8826	4350	4476	1147	545	602
Kochi (M Corp.) WARD NO.-0059	4569	4229	2128	2101	340	146	194
Kochi (M Corp.) WARD NO.-0060	5941	5525	2655	2870	416	199	217
Kochi (M Corp.) WARD NO.-0061	8721	7660	3796	3864	1061	475	586
Kochi (M Corp.) WARD NO.-0062	10047	8973	4411	4562	1074	556	518
Kochi (M Corp.) WARD NO.-0063	7887	6972	3424	3548	915	431	484
Kochi (M Corp.) WARD NO.-0064	8734	7918	3942	3976	816	375	441
Kochi (M Corp.) WARD NO.-0065	4414	4005	1901	2104	409	210	199
Kochi (M Corp.) WARD NO.-0066	5970	5392	2525	2867	578	269	309
Kochi (M Corp.) WARD NO.-0067	9018	7967	3964	4003	1051	491	560
Kochi (M Corp.) WARD NO.-0068	10174	9054	4443	4611	1120	550	570
Kochi (M Corp.) WARD NO.-0069	10488	9238	4596	4642	1250	605	645
Kochi (M Corp.) WARD NO.-0070	8968	7982	3875	4107	986	445	541
Kochi (M Corp.) WARD NO.-0071	7881	7070	3433	3637	811	410	401
Kakkanad (CT)	25531	21543	10952	10591	3988	1798	2190
Vazhakkala (CT)	51242	44672	22169	22503	6570	2864	3706
Total	678819	598707	297188	301519	80112	37544	42568
<i>Source-Census Records 2011</i>							

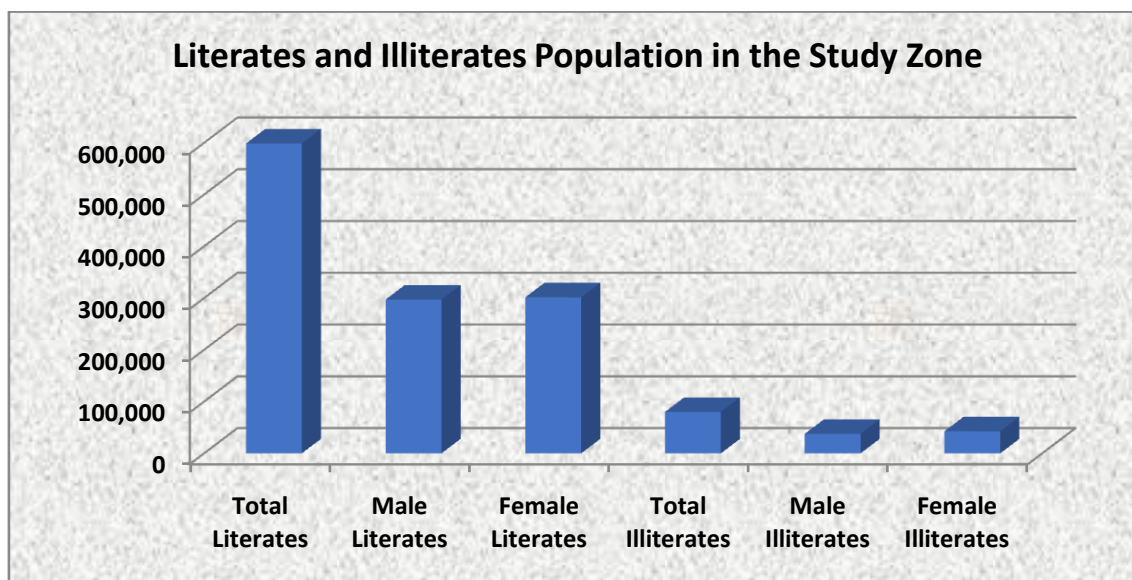


Figure 4.36: Male-Female wise Distribution of Literates & Illiterates

4.11.7 Economic Structure

Study area is mainly urban study area under Kanayannur tehsil of Ernakulum district in Kerala. In urban parts of the study area, the existing scenario is completely reversed as most of the people there are engaged in non-agricultural activity especially in local hotels/restaurants and as drivers some people also operate their vans/jeeps/cars as tourist vehicle.

Annual income helps in identifying families below poverty line. During the field survey, income of a household through all possible sources was recorded. Agriculture and allied activities were reported to be the major source of income followed by non-farm wage labor, business, Government and Private Service etc. The other important sources of income include government pension and income from selling of fodder.

Economy of the District

Agriculture constitutes the most important component of the district's economy and it is the biggest source of employment. About 70% of the geographical area is under cultivation. Rice, coconut, lemongrass, rubber, pepper, ginger, mango, cashew nut etc. are the most important agricultural products of the district. Coconut is the mainstay of Kerala's rural economy in view of its multifarious contribution to income and employment. In the district 42894 hectares are under coconut cultivation in 2010-11.

Industrial development is a major factor in accelerating the growth of the economy. Ernakulum district may well be called the hub of industrialization in Kerala State. With the availability of easy and cheap means of transport by road, rail and backwater, sea and air, superior advantages in regard to raw material, fuel and skilled labour, plentiful supply of water for industrial purposes, easy access to the electric power stations etc., this district especially the Alwaye-Ernakulum area, has been the seat of major industrial units for several decades. Any industry with an eye on the export market would prefer a location in

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this district because of its proximity to Cochin harbor. So also is the case with industries whose raw materials have to be imported. Cheap backwater transport facility and a network of motorable roads add to the facilities of communication and brighten the industrial prospects of the region. The possibility of Inter-firm utilization of products and by-products is also another factor that has contributed to the concentration of factories in the region.

4.11.7.1 Workers Scenario (Occupation Pattern)

Occupational pattern was studied to assess the skills of people in the study area. Occupational pattern helps in identifying major economic activities of the area. The main and marginal workers population with further classification as casual, agricultural, households and other workers is shown in **Table 4.37** In the study area the Main and Marginal Workers population was observed as 235482 (34.7%) and 22268 (3.3%) respectively of the total population (678819) while the remaining 421069 (62.0%) persons were recorded as non-workers. Thus, it implies that the semi-skilled and non-skilled work-force required in study area for the project is available in aplenty.

Table 4.37: Village wise Occupational Pattern in the Study Area

Name / No of the Ward & Towns	MAIN WORK_P	MAI N_C L_P	MAI N_A L_P	MAIN _HH_ P	MAIN _OT_ P	MARG WORK_P	MAR G_C L_P	MAR G_AL _P	MAR G_H H_P	MAR G_OT _P
Kochi (M Corp.) WARD NO.-0001	3198	9	6	34	3149	279	2	3	5	269
Kochi (M Corp.) WARD NO.-0002	2062	5	6	11	2040	230	0	0	3	227
Kochi (M Corp.) WARD NO.-0003	1755	2	3	10	1740	78	1	0	1	76
Kochi (M Corp.) WARD NO.-0004	2818	0	4	101	2713	218	1	1	7	209
Kochi (M Corp.) WARD NO.-0005	3100	19	10	45	3026	426	6	3	5	412
Kochi (M Corp.) WARD NO.-0006	1949	1	4	12	1932	155	2	0	2	151
Kochi (M Corp.) WARD NO.-0007	2820	0	8	110	2702	320	2	2	10	306
Kochi (M Corp.) WARD NO.-0008	4118	2	27	87	4002	228	2	3	7	216

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Kochi (M Corp.) WARD NO.-0009	1567	2	4	11	1550	91	7	0	0	84
Kochi (M Corp.) WARD NO.-0010	2400	0	7	78	2315	300	3	0	5	292
Kochi (M Corp.) WARD NO.-0011	3246	4	5	78	3159	189	1	2	3	183
Kochi (M Corp.) WARD NO.-0012	3434	2	15	22	3395	291	3	2	4	282
Kochi (M Corp.) WARD NO.-0013	3713	3	10	20	3680	425	5	3	5	412
Kochi (M Corp.) WARD NO.-0014	3378	3	2	46	3327	397	2	2	9	384
Kochi (M Corp.) WARD NO.-0015	3642	33	13	31	3565	259	7	4	7	241
Kochi (M Corp.) WARD NO.-0016	2807	2	13	14	2778	464	0	3	2	459
Kochi (M Corp.) WARD NO.-0017	2924	0	7	62	2855	703	0	6	16	681
Kochi (M Corp.) WARD NO.-0018	3288	0	3	45	3240	505	3	8	9	485
Kochi (M Corp.) WARD NO.-0019	3632	12	19	22	3579	314	1	2	5	306
Kochi (M Corp.) WARD NO.-0020	2875	0	11	38	2826	241	5	1	4	231
Kochi (M Corp.) WARD NO.-0021	3913	5	6	48	3854	313	5	1	8	299
Kochi (M Corp.) WARD NO.-0022	4607	4	26	83	4494	384	4	1	7	372
Kochi (M	2982	1	12	39	2930	194	2	1	3	188

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Corp.) WARD NO.-0023										
Kochi (M Corp.) WARD NO.-0024	2551	0	6	20	2525	270	3	1	4	262
Kochi (M Corp.) WARD NO.-0025	1935	1	6	25	1903	417	1	0	3	413
Kochi (M Corp.) WARD NO.-0026	2222	3	10	17	2192	582	8	5	2	567
Kochi (M Corp.) WARD NO.-0027	2568	2	12	28	2526	432	2	1	3	426
Kochi (M Corp.) WARD NO.-0028	3124	2	2	82	3038	435	4	1	12	418
Kochi (M Corp.) WARD NO.-0029	2649	1	3	12	2633	49	0	0	1	48
Kochi (M Corp.) WARD NO.-0030	5831	5	11	0	5815	107	1	4	0	102
Kochi (M Corp.) WARD NO.-0031	3163	3	15	40	3105	269	3	1	5	260
Kochi (M Corp.) WARD NO.-0032	2694	2	5	44	2643	243	0	1	1	241
Kochi (M Corp.) WARD NO.-0033	3235	1	13	35	3186	191	0	0	2	189
Kochi (M Corp.) WARD NO.-0034	3217	1	154	52	3010	231	1	3	6	221
Kochi (M Corp.) WARD NO.-0035	3183	0	10	106	3067	156	0	3	6	147
Kochi (M Corp.) WARD NO.-0036	2350	0	12	9	2329	508	3	4	2	499
Kochi (M Corp.) WARD	3289	3	11	41	3234	130	3	2	4	121

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NO.-0037										
Kochi (M Corp.) WARD NO.-0038	3134	5	3	107	3019	151	0	0	2	149
Kochi (M Corp.) WARD NO.-0039	2678	4	9	91	2574	147	0	0	2	145
Kochi (M Corp.) WARD NO.-0040	1996	5	4	27	1960	118	0	0	4	114
Kochi (M Corp.) WARD NO.-0041	4180	5	14	72	4089	222	0	3	2	217
Kochi (M Corp.) WARD NO.-0042	3273	8	6	94	3165	272	2	0	12	258
Kochi (M Corp.) WARD NO.-0043	3462	7	1	97	3357	83	3	1	5	74
Kochi (M Corp.) WARD NO.-0044	2886	0	4	97	2785	311	0	1	1	309
Kochi (M Corp.) WARD NO.-0045	3523	7	4	38	3474	261	19	0	4	238
Kochi (M Corp.) WARD NO.-0046	2069	1	1	65	2002	427	3	2	19	403
Kochi (M Corp.) WARD NO.-0047	1822	4	2	24	1792	113	3	4	6	100
Kochi (M Corp.) WARD NO.-0048	3523	3	14	64	3442	323	4	1	16	302
Kochi (M Corp.) WARD NO.-0049	2759	1	7	48	2703	250	3	2	7	238
Kochi (M Corp.) WARD NO.-0050	2898	10	14	45	2829	405	2	7	32	364
Kochi (M Corp.) WARD NO.-0051	3163	6	28	35	3094	253	1	1	4	247

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Kochi (M Corp.) WARD NO.-0052	3779	12	14	57	3696	539	5	1	6	527
Kochi (M Corp.) WARD NO.-0053	1762	3	4	44	1711	159	0	1	3	155
Kochi (M Corp.) WARD NO.-0054	2217	4	16	52	2145	208	0	0	9	199
Kochi (M Corp.) WARD NO.-0055	4164	12	13	33	4106	252	5	0	5	242
Kochi (M Corp.) WARD NO.-0056	2755	5	18	76	2656	294	3	3	7	281
Kochi (M Corp.) WARD NO.-0057	1899	3	2	28	1866	151	0	1	4	146
Kochi (M Corp.) WARD NO.-0058	3608	1	13	33	3561	352	1	1	13	337
Kochi (M Corp.) WARD NO.-0059	1678	5	7	35	1631	101	0	2	8	91
Kochi (M Corp.) WARD NO.-0060	2041	6	12	60	1963	151	5	1	6	139
Kochi (M Corp.) WARD NO.-0061	3567	3	16	66	3482	145	4	0	9	132
Kochi (M Corp.) WARD NO.-0062	3598	7	8	90	3493	339	13	1	17	308
Kochi (M Corp.) WARD NO.-0063	2744	2	1	60	2681	230	2	0	6	222
Kochi (M Corp.) WARD NO.-0064	3213	1	7	107	3098	188	3	0	10	175
Kochi (M Corp.) WARD NO.-0065	1655	1	6	22	1626	33	0	1	0	32
Kochi (M	1996	2	8	81	1905	108	1	0	4	103

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Corp.) WARD NO.-0066										
Kochi (M Corp.) WARD NO.-0067	3048	2	19	89	2938	241	1	2	4	234
Kochi (M Corp.) WARD NO.-0068	3470	5	1	90	3374	210	3	2	4	201
Kochi (M Corp.) WARD NO.-0069	3669	5	6	42	3616	199	4	1	5	189
Kochi (M Corp.) WARD NO.-0070	2930	2	3	55	2870	290	1	2	1	286
Kochi (M Corp.) WARD NO.-0071	2793	5	7	100	2681	227	3	1	10	213
Kakkanad (CT)	8637	54	107	84	8392	1098	21	41	21	1015
Vazhakkala (CT)	16654	50	75	292	16237	2393	33	26	60	2274
G. Total	235482	389	965	4058	23007 0	22268	241	183	506	21338

Source-Census Records 2011

List of Abbreviations used in Table.....:

MAIN WORKERS POPULATION:

MAIN_WORK_P : Main workers total population

MAIN_CL_P : Main cultivated labour population

MAIN_AL_P : Main agricultural labour population

MAIN_HH_P : Main workers population involved in household industries

MAIN_OT_P : Main other workers population

MARGINAL WORKERS POPULATION:

MARG_WORK_P : Marginal workers total population

MARG_CL_P : Marginal cultivated labors total population

MARG_AL_P : Marginal agricultural labors population

MARG_HH_P : Marginal workers involved in household industries

MARG_OT_P : Marginal other workers Population

Occupation Pattern wise distribution of Population and Graphical representation of 'Workers Scenario' of the study area are shown as **Table 4.38 &Figure 4.37** respectively as follows;

Table 4.38 Distribution of Work Participation Rate

Occupational Class	2011
Main Workers	235482 (34.7 %)
Male	178095 (75.6 %)
Female	57387 (24.4 %)
Marginal Workers	22268 (3.3 %)
Male	12136 (54.5 %)
Female	10132 (45.5 %)
Non-Workers	421069 (62.0 %)
Male	144501 (34.3 %)
Female	276568 (65.7 %)
Total Population	678819 (100 %)

Source: Census of India Records, 2011

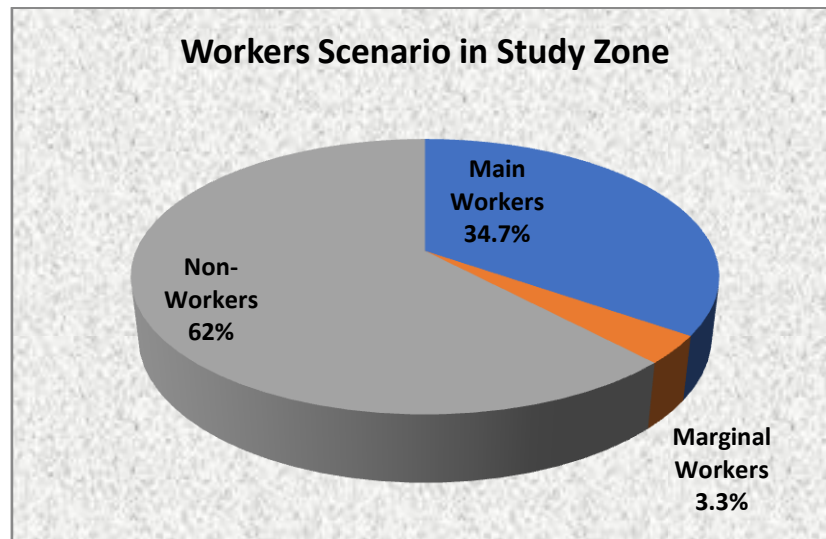


Figure 4.37: Male-Female wise Distribution of Literates & Illiterates

Composition of Main Workers

The ‘Main Workers’ were observed as 235482 persons (34.7%) to the total population of the study area and its composition is made-up of casual laborers as 389 (0.17%), agricultural laborers as 965 (0.41%), household workers 4058 (1.72%) and other workers as 230070 (97.7%) respectively. Composition of main workers is shown below as **Figure 4.38**

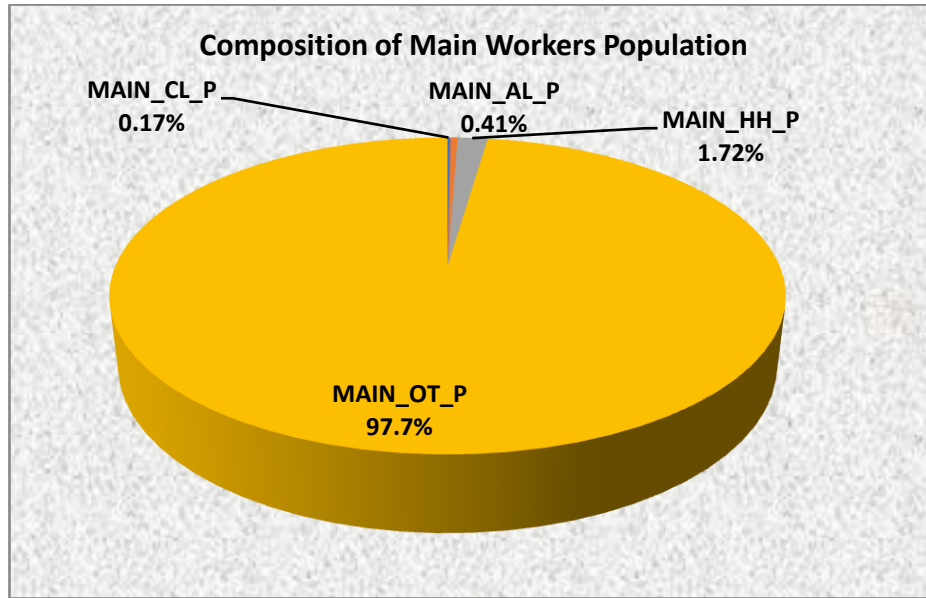


Figure 4.38: Composition of Main Workers Population

Composition of Marginal Workers

The total marginal workers are observed as 22268 which constitute 3.3% of the total population (678819) comprising of marginal casual laborers as 241 (1.1%), marginal agricultural laborers as 183 (0.8%), marginal household laborers as 506 (2.3%) and marginal other workers were also observed as 21338 (95.8%) of the total marginal workers respectively. Details about marginal workers in the study area are tabulated in **Table 4.39**. Composition of marginal workers is shown in **Figure 4.39** as follows.

Table 4.39 Distribution of Work Participation Rate

Occupational Class	2011
Main Workers	235482 (34.7 %)
Male	178095 (75.6 %)
Female	57387 (24.4 %)
Marginal Workers	22268 (3.3 %)
Male	12136 (54.5 %)
Female	10132 (45.5 %)
Non-Workers	421069 (62.0 %)
Male	144501 (34.3 %)
Female	276568 (65.7 %)
Total Population	678819 (100 %)

Source: Census of India Records, 2011

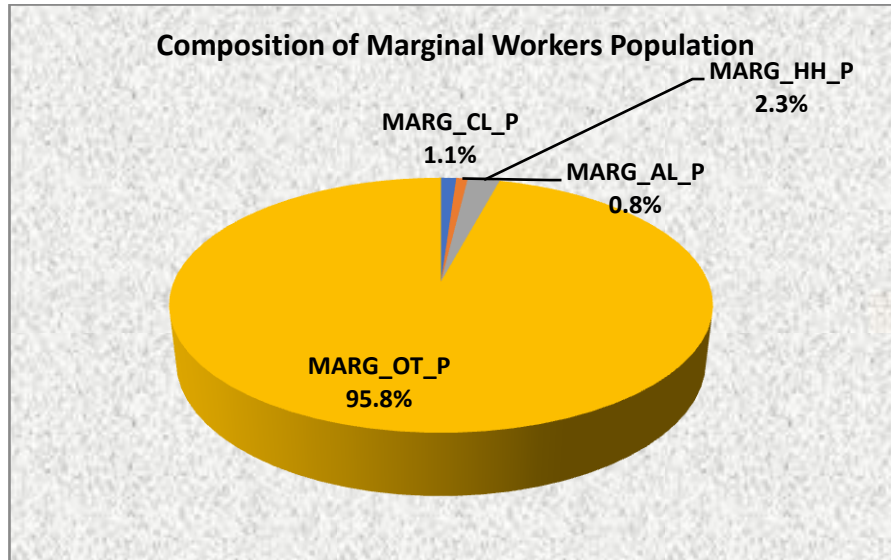


Figure 4.39: Composition of Marginal Workers

Composition of Non-Workers

The total Non-workers population was observed as 421069 which constitute 62.0% to the total population (678819) of the study area. Male-female wise Non-workers population was recorded as 144501 Males (34.3%) and 276568 Females (65.7%) respectively. Details about total Non-workers of the study area and graphical representation are provided in **Table 4.40** and **Figure 4.40**

Table 4.40: Composition of Non-Workers

Non-Workers Population		
Persons	Males	Females
421069	144501 (34.3%)	276568 (65.7%)

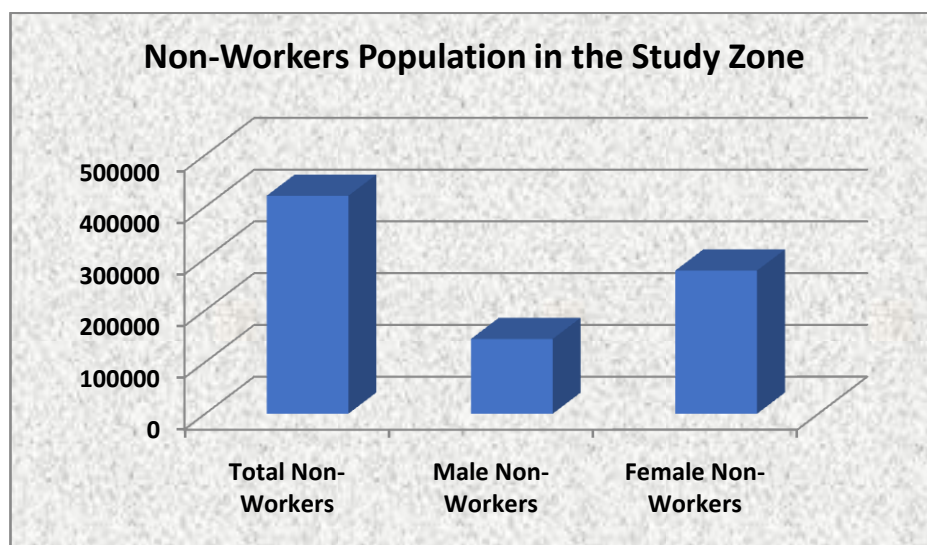


Figure 4.40: Composition of Non-Workers

4.11.8 Infrastructure Facilities in Project Area

A review of Basic infrastructure facilities available in the study area villages has been done on the basis of the Field survey & Census records, 2011. As per the Census Records of India 2011, Entire study area is mainly urban part of the study area under two Sub-District / Tehsil namely Kochi and Kanayannur of Ernakulum District of Kerala. The study area has good level of basic infrastructure facilities like educational, medical, potable water, power supply, and transport & communication network.

4.11.9 Land Requirement for the Project and Affected Structures

Project involves acquisition of the private as well as the Government land. Land is being acquired for road widening so as construction works of metro can be undertaken easily without impacting the existing road traffic and for establishment of entry/exit of metro stations and associated facilities. Total land to be acquired is 29424.69 m² out of which 11153.136 m² is private land and 18295.83 m² is Government land. The land will be acquired by KMRL. Details of land acquisition are given in **Table 3.3 of Chapter 3**. Detailed SIA study is being undertaken for the project as per LARA Act, 2013.

As per SIA study, it is likely that approx. 56 structures belonging to 45-50 families will be affected due to the proposed project. Out of the total affected structures, 16 structures are residential, 21 are commercial and 17 are residential cum commercial.

4.11.10 Archaeological and Historical Monuments

There are no Archaeological and historical monuments within 300 m radius of the alignment. Archaeological and historical monuments within 10 km radius area are Mattan cherry Palace Museum, Hill Palace Museum, Museum of Kerala History and St. Francis Church, Kochi.

4.11.12 Cultural and Religious Properties

Religious structures along proposed RoW are a St Martins church (Chainage 540- 10° 0'6.37"N, 76°18'13.52"E), temple (open land of temple: chainage 1987- 10° 0'23.65"N, 76°18'55.79"E) and St Michals Roman Catholic Church (Chainage 2790- 10° 0'40.13"N, 76°19'15.09"E). There are various religious structures along the RoW but they are not getting affected directly. However measures would be required during construction to minimize disturbance to these structures.

4.11.13 Sensitive Features along RoW

There is no school or colleges or forest area along the RoW, however there is one hospital, i.e. verma hospital along the RoW. Measures shall be taken near this hospital to minimize the noise level.

4.11.14 Utility Diversion in RoW

Utilities to be affected include electricity line, Fuel supply pipeline, BPCL oil pipeline, telecom cables, sewerage line, drainage lines and water supply line. Details are provided in **Table 3.2 of Chapter 3**.

4.11.15 Community Consultation

Discussions were carried out with the people to understand their perspective about the project and the issues associated with the project. Consultations were carried out with local people residing or having business along the proposed RoW and the existing RoW of Phase I and Phase II. People are aware about the project and are in favor of project with some suggestions. Some of the discussions with the people are given below in **Table 4.41**.

Table 4.41: Community Consultations (Along phase I and Phase II)

S. No.	Name of Person	Details of Person	Discussions	Inclusion in EMP
1	Mr Saji Stanely	Business man- 93807064840	<ul style="list-style-type: none"> • Project is good, but this has affected our business badly as shops got masked during the construction. Visibility is impacted during operation phase also due to station building • Fares of metro are higher than the buses also it is for very short distance, so we generally do not prefer travelling in metro • It is comfortable and reliable system and also safe, so I think, it can be properly put under use only if it is developed for larger area and fare should be reduced to make it comparative with other available modes • Due to higher fares, no impact is seen on traffic on this road atleast and traffic is increasing day by day. 	Provision of alternate route to access these shops and provision of the boards to maintain the visibility of these shops
2	Mr Paulose	Manager- Indian Oil Pump: 9249936777	<ul style="list-style-type: none"> • Business got suffered significantly during construction phase • Business has got to normal after completion of construction • Government shall either remove all the property which can be masked during 	Most of the alignment is in middle of the road and measures like provision of access and the boards to maintain the

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			construction and shift it to other location or shall carry out construction in median of road	visibility of the shops will be provided
3	Ms. Chikku	Manager of Shop Pearl Craft: 9496188558	<ul style="list-style-type: none"> • Project is good, but this has affected our business badly as shops got masked during the construction. • Business has been shifted during the other stores during construction phase so it is not resumed during operation phase also 	Provision of alternate route to access these shops and provision of the boards to maintain the visibility of these shops
4	Mr. Darish Mr. Deepu Mr. Suddish	Workers and owners of shop in Chembumukku	<ul style="list-style-type: none"> • Business of people will get affected badly due to construction works if undertaken in side of the road • Roads are really narrow, and they should be widened prior undertaking construction works else the condition will become further worst • Metro is good, but development should be quicker, the project in Phase I got substantially delayed and it took long time for completion and it is taking longer for further expansion also • Proper connectivity/modes of transportation shall be provided with metro station. There is no connectivity at Pallarivotam metro station and at night people get stuck in middle of the road if they use metro. These things shall be considered in the proposed design. Else people may not like to use metro • Metro is currently being used 	<p>Most of the alignment is in middle of the road and measures like provision of access and the boards to maintain the visibility of the shops will be provided</p> <p>Proposal for provision of feeder buses is already considered</p> <p>It is proposed to provide the halt & go facility for taxi & auto rickshaws at metro stations</p> <p>Road widening is proposed to be undertaking prior start of</p>

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			<p>for leisure due to less coverage and also high fares</p> <ul style="list-style-type: none"> • Traffic issues are become severe in area, so metro should come and we believe situation will become better with metro only if they take proper measures for managing traffic during construction, undertake and complete construction works timely and provide proper connectivity through other modes of transport 	construction works
5	Mr. Joseph	Church member of St Joseph Church at Vazhakkala: 8606020000	<ul style="list-style-type: none"> • We welcome the project as it is for development of the city • Some part of the church like wall and a idol may also get affected due to Phase II metro development but Church administration and KMRL has already discussed over it and Church has promised for all cooperation • But for long there are no discussions on land acquisition so now we are unaware about what will happen and when. Thus, these work shall be expedited, planned and communicated to us in time prior taking any action • Business of people will get affected badly due to construction works if undertaken in side of the road • Roads are really narrow, and they should be widened prior undertaking construction works else the condition will become further worst 	Land acquisition and compensation shall be provided as per LARA, 2013, WB OP 4.11 and KMRL R & R policy
6	Mr.	Joined owners	<ul style="list-style-type: none"> • We are owner of this property 	Land

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	K.S.Mohanan and Mr. Venugopalan	of residential property Aaranya near Padamughal: 9446524358 (Retired people)	<p>and families resides in this building jointly</p> <ul style="list-style-type: none"> • We will cooperate with KMRL to the extent possible, but we will not allow KMRL to take all the land • Some of the part like compound wall or further some part we can give-off in lieu of compensation but not more than this • KMRL has visited only once for marking the property but that was long back and now those marks are also gone due to rains, paints etc • KMRL has never communicated officially if we are getting impacted or not but we want KMRL to properly and timely communicate with us if at all land is required from our property 	acquisition and compensation shall be provided as per LARA, 2013, WB OP 4.11 and KMRL R & R policy
7	Mr. Jibu VC	Service Manager: 8086071676, VTJ Hyundai Between Chittetukara and KINFRA	<ul style="list-style-type: none"> • Project is good for project development • Project development shall be expedited • In long term everybody will appreciate the project • Metro is need of the city and it should come 	--

CHAPTER 5. ANALYSIS OF ALTERNATIVES

This chapter details the analysis of the alternatives considered for the project. Scenarios for with and without project are considered and assessed.

5.1 Approach

KMRL has planned to construct phase-II of metro rail in Kochi from JLN station to Infopark-II. Feasibility study for the routes has been undertaken by RITES considering various aspects including design, cost, environment and social. Analysis of alternatives is discussed for the alternative alignments considered for project development and for With & Without project Scenario.

5.2 Alternative Alignments

Alignments are selected considering the various factors like available RoW and land acquisition requirement, presence of forest/wildlife/plantations, planned Government projects, existing/ under construction road infrastructure/ flyovers / ROBs, water channels, abutting structures including high rise building and Railway infrastructure, land availability for stations, terminals/ depots and train operation planning.

Two alternative alignments were considered for this section. All the alternatives are discussed below:

Alternative 1: JLN STADIUM STATION (PHASE-I) TO INFO PARK VIA KAKKANAD

This alternative route is shorter than other alternative route (Kalamassery station to Infopark via Kakkanad) by 1 km. Total length of this route 11.2 km and this route traverses through very congested areas like Palarivattom, Chembmukku, Vazhakaal, Padamughal, metro city etc. It connects to Phase I at JLN Stadium which is midpoint of Phase I, i.e. from Aluva to Petta.

Alternative 2: KALAMASSERY STATION (PHASE-I) TO INFO PARK VIA KAKKANAD

This alternative route takes off from kalamassery station of phase I in kalamassery area. This route is longer than first alternative and does not serve heavily populated area thus land acquisition will be minimal. Further this corridor does not connect with the existing Phase I of metro.

Conclusion

Considering the pros and cons of the proposed two alignments, alignment 1 is considered as preferred alignment. Map showing the two alternative, i.e.1 & 2 is given below in **Figure 5.1**.

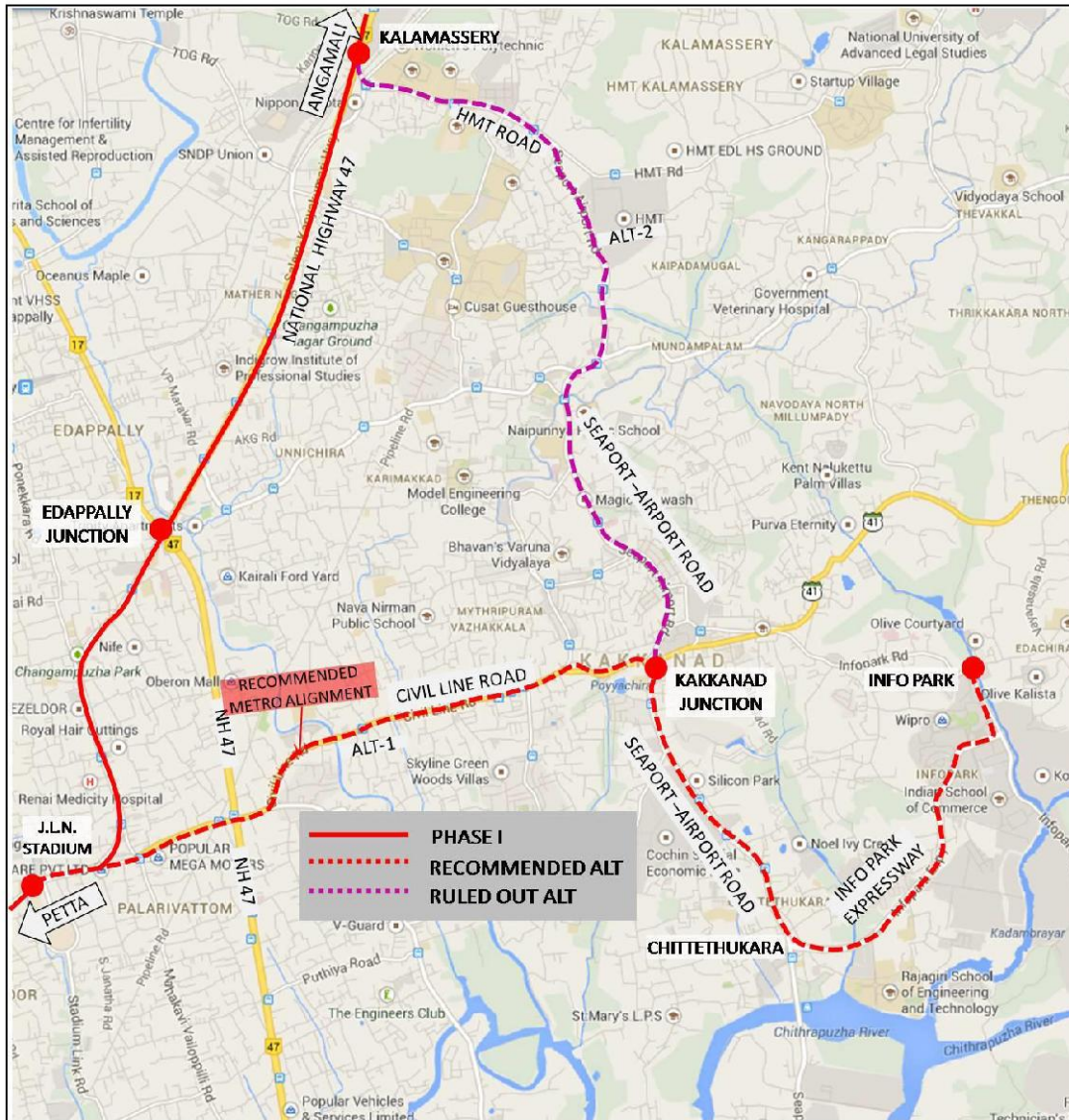


Figure 5.1: Alternative Alignments Considered for Proposed Project

5.3 “With” & “Without” Project Scenario

Kochi is the most densely populated city in the state and is part of an extended metropolitan region, which is the largest urban agglomeration in Kerala. Rapid urbanization and intense commercial developments in the recent past have resulted in steep rise in travel demand putting Kochi’s transport infrastructure to stress. However increase in capacity of the transport system has not been compatible with transport demand. With ever increasing demand for road space – both for vehicular movement and parking, it is difficult to depend only on road based transport solutions. Only public transport systems are more efficient users of space. Government of Kerala has thus planned to develop metro rail system for the city. Analysis is carried out to assess the impacts of project in both With & Without project considering physical and social environment component, and is given in **Table 5.1**.

Table 5.1 Demographic Profile of Study Area

S. No.	Environment	Without project Scenario	With Project scenario
1.	Physical Environment	<p>Climate of the area may get affected due to increased GHG emissions due to increased nos. of vehicle & increased congestion in the area. Increased GHG emissions may affect the temperature profile and rainfall pattern of the area</p> <p>Air environment will continue to affect and air quality will continue to degrade due to addition of nos. of private vehicle & their exhaust emissions. Congestion will increase due to addition of the vehicle on roads that will add the additional exhaust on the roads.</p> <p>Further for expansion of roads, tree will required to be cut which have impact on the air quality. During construction of roads, emission of pollutants will result which may affect the air quality of the area.</p> <p>Water environment does not get significantly affected except the one time water requirement for construction of roads. During operation phase surface water quality may get affected due to inflow of contaminated run-off from the roads into drains.</p> <p>Noise environment will continue</p>	<p>Development of the project will reduce the share of private vehicle on the roads thereby reducing GHG generation from vehicles. It is estimated that due to project development, approx. 657,192 vehicle km will be reduced by 2021 and 1,042,098 vehicle km will be reduced by 2031. Vehicle movement reduction will reduce the fuel requirement and it is estimated that diesel requirement will be reduced by 59.857 million liters by 2021 and 93.055 million liters by 2031. It is estimated that petrol requirement will reduce by 0.678million liters by 2021 and 1.333million liters by 2031.</p> <p>This will reduce the vehicular emissions including HC, NO_x, Particulate Matter, CO & CO₂.</p> <p>An emission on HC, NO_x, Particulate Matter and CO to be reducing by 2021 (in Tons/yr) is 87, 2070, 144 and 2211 and to be reducing by 2031 (in Tons/yr) is 137, 3216, 224 and 3439.</p> <p>It is estimated that app. 1,22,855 tonne of carbon di-oxide reduction will be achieved by 2021 and 1,91,668 tonne will be achieved by 2031. Carbon credits (certified emission reductions) of the tune of Rs. 62 million in 2021 and Rs. 96 million in 2031 can be earned due to</p>

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		<p>to get affected due to increased vehicular noise during movement and due to jams.</p> <p>Land use will not be affected as the road development is as per the master plan designed for the area. But due to increased requirement of the roads, more area may be required to be diverted for construction of roads</p> <p>Soil environment will continue to affect due to the project. Soil quality may get affected due to inflow of the contaminated run-off from roads into the nearby agricultural fields. Also large quantity of soil is required for construction of roads & highways. Construction of roads & highway or the expansion of existing roads & highways will be required to accommodate the increasing vehicles in the area</p>	<p>reduction of vehicles.</p> <p>Due to this overall quality of the life in city will be improved. Air will be cleaner, traffic jams will be lesser, time of travelling will be reduced</p> <p>Also along with the metro, KMRL has proposed to provide the feeder buses and shared bicycle along the routes which will enhance the public transportation system/non pollution modes of transportation in the area which further reduces the vehicular emission.</p> <p>Emission reductions due to metro and feeder buses will improve the air quality in the area in long term.</p> <p>However air quality may get impacted during construction of the metro line and stations and also during operation phase, air quality near the stations may get impacted due to increased vehicular movement near the stations. But overall, air quality of the cities will be improved.</p> <p>Water environment may get affected as water will be required for curing, construction and to meet the domestic water requirement of staff and construction workers (app. 120 KLD). But since there is minimal chance of leakage of fuel/lubricant in metro project when compared to road vehicles, chances of contamination of run-off is minimal. Further to manage storm water, it is proposed to</p>
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			<p>have dedicated storm water management system in via duct and metro stations and RWH recharge pits is proposed along viaduct and at stations to recharge the collected storm water. This will improve the ground water aquifers of the cities. To prevent contamination, desalting chambers and oil traps will be provided with RWH pit.</p> <p>Noise environment will be improved in the area due to reduction of traffic overall in the area. Noise will be generated both during construction and operation phase of the project. Construction noise is one time and will be localized. However, during operation, source of noise will be rail noise, operation of traction equipment, motors, compressors and noise due to elevated structures. But when compared to noise levels due to road traffic, the noise levels will be lower.</p> <p>Entire corridor is elevated thus requirement of land is minimal and very less when compared to road/highway projects. Cautiously land involving minimum R & R and other social impacts are considered. Impact on land use due to metro projects is anticipated to be comparatively lesser than that of road projects</p> <p>Soil environment will not be significantly affected due to project. There could be impact on</p>
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			soil quality during construction phase due to erosion and contamination of soil but during operation phase impact on soil quality is nil. During construction phase soil is required to be excavated for construction of piers and foundation of station building (if any). But the excavated soil is generally spread back on medians to be utilized for green belt development. Majorly metro are proposed along the existing roads and utilizing its RoW or median.
2.	Biological environment	Biological environment may get affected due to increased dust generation and other pollutants generated due to vehicular movement. Further tree cutting will required to be carried out for expansion of existing or construction of new road/highways. Forest land may also be required to be diverted for purpose of expansion of old alignment and construction of green field projects.	For metro construction project tree cutting is required to be undertaken to have clear RoW and for road widening but tree cutting is comparatively lesser for metro projects as compared to new road projects. 3645 nos of trees exist within and along RoW. These trees may required to be cut for construction of metro project
3.	Social Environment	Social environment will continue to get affected due to development of proposed project due to various reasons 1. Increased traffic and increased vehicular emissions 2. Increased noise level due to increased traffic 3. Increased land acquisition and R & R for expansion of old and construction of new highway/roads 4. Increased traffic jams and	Social environment will be highly benefited due to the project due to following reasons 1. Low cost, reliable, fast and safe public transportation system 2. Low transportation cost & less exposure to pollutants thus cost saving due to reduction in expenditure on health 3. Reduced fuel consumption & associated GHG & exhaust emissions 4. No private land acquisition

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		<p>increased time loss in traffic jams due to travelling</p> <p>5. Reduced right of pedestrian on the roads</p> <p>6. Increased road accidents</p> <p>7. High cost of travelling using private vehicles</p> <p>8. High fuel consumption</p> <p>9. Increased road infrastructure development and infrastructure development along the new constructed roads</p>	<p>5. Reduced traffic congestion and associated exhaust emissions &GHGs due to congestion</p> <p>6. Reduction in travelling time</p> <p>7. Improved quality of life</p> <p>8. Well developed transportation infrastructure</p> <p>9. Generation of employment during construction & operation phase</p> <p>10. Development of commercial activities at and near stations thus development of area, facility for public and generation of indirect employment</p> <p>11. Minimal tree cutting</p> <p>12. Development of greenery under viaducts and in depot area</p>
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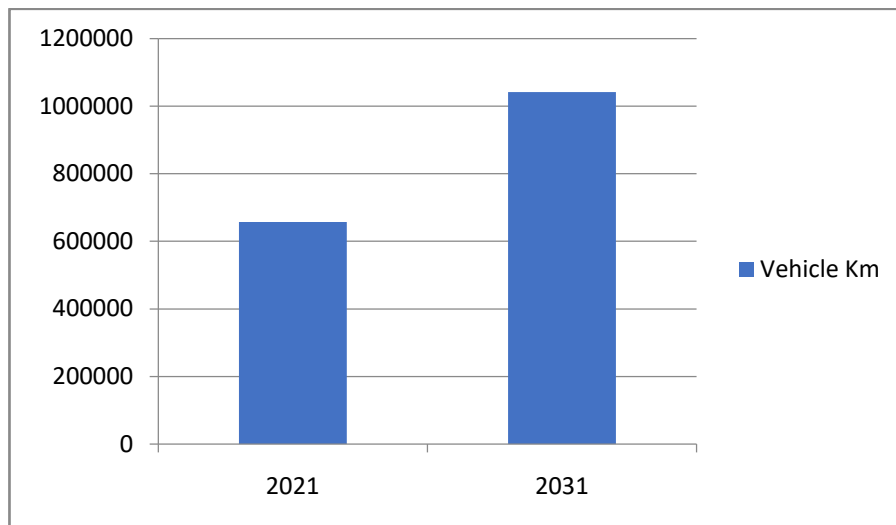


Figure 5.2: Reduction in Vehicle Km due to development of project

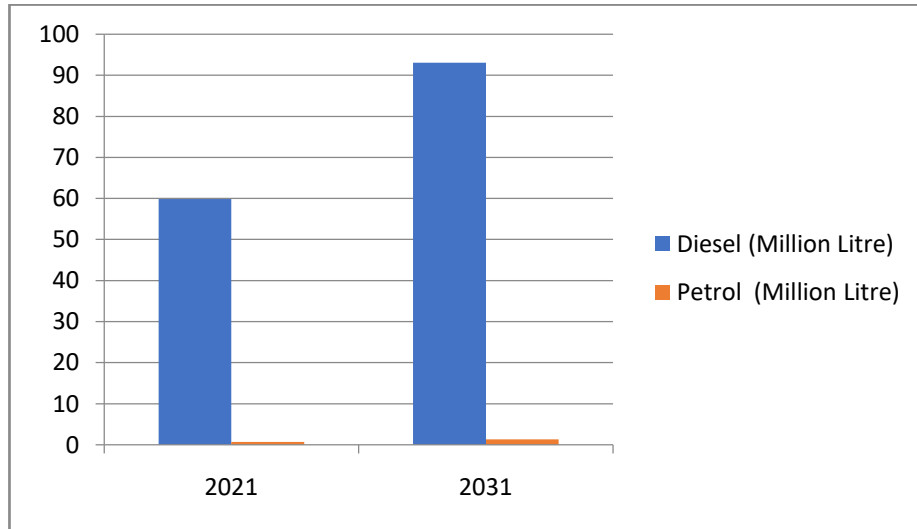


Figure 5.3: Reduction in Fuel Consumption

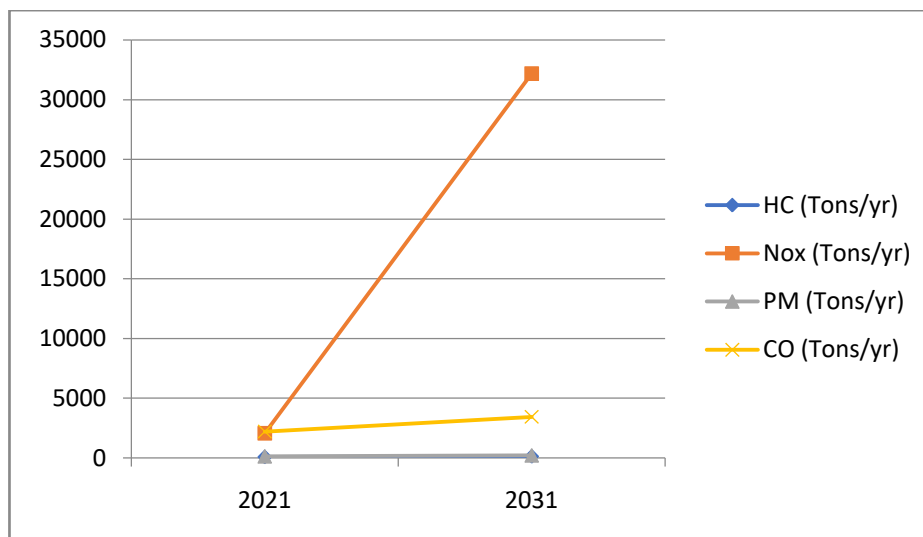


Figure 5.4: Pollution Reduction (Tons/year)

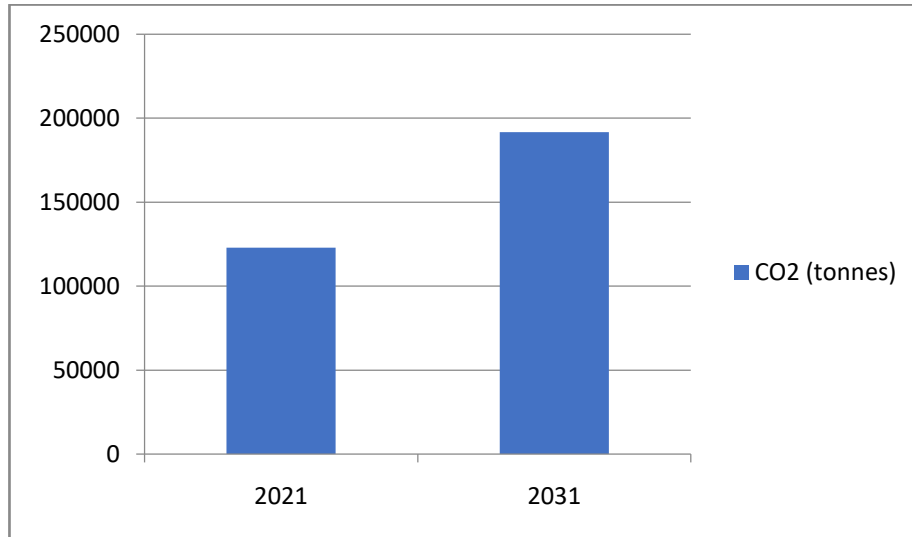


Figure 5.5: Reduction in CO2 level

5.4 Conclusion

From the above, it can be concluded that overall in the “Without” project scenario environment will continue to get affected whereas in “With” project scenario there is expected reduction in traffic, congestion on roads, development of safe, reliable, fast & cost effective public transportation system, reduced air & noise pollution and increased employment generation in long term. Overall the project will result into development of public transportation system which will be integrated with the other modes like NMVs, feeder buses, city buses, cycle rickshaws and auto rickshaws, overall improving the connectivity and accessibility of the site.

CHAPTER 6. ENVIRONMENTAL IMPACT ASSESSMENT

This chapter details the inferences drawn from the environmental impact assessment of the proposed project. It describes the overall impacts of the project activities and underscores the areas of concern, which need mitigation measures.

6.1 Approach

Environment Impact Assessment is the most important activity of any EIA study. It helps in identifying the likely change in environment quality of surrounding area post implementation of a project. Impact analysis is carried out for all stages of project viz, design construction and operation stage. Impact analysis is carried out for all three broad aspects of environment namely physical, biological and socio-economic aspects. Many scientific techniques and methodologies are available to predict qualitative and quantitative environmental impacts due to the project.

6.2 Impact Assessment Criteria

The impact has been identified by the following methods

1. **Matrix method:** Interaction between the various project activities (during pre-construction, construction and operation phase) and environmental components using the grid like table. “✓” Tick sign is being used wherever; activity is interfering with the environmental component. This matrix method also helps in preparing checklist.
2. **Checklist:** Checklists are comprehensive lists of environmental effects and impact indicators designed to stimulate the analyst to think broadly about possible consequences of contemplated actions. This method is being used to identify the direct and indirect impact due to the project.
3. **Scaling Checklist:** It is similar to the descriptive checklist with additional information on subjective scaling of the parameters. Impacts will be assessed on basis of their duration, nature, scale and severity. Impact assessment criteria is given in **Table 6.1**

Table 6.1: Impact Assessment Criteria

Criteria	Description
Duration of Impact	Long term, Short term
Nature of Impact	Reversible, Irreversible
Scale	Core zone, Buffer Zone
Severity	Low, Moderate, High

After assessment of the impacts, significance of the impact will be judge. An impact can be of low significance, moderate significance or high significance depending on its effect on the environment and social parameters to be affected due to project development.

Significance criteria have been designed for various permutation and combinations of above given impact assessment criteria. Impact significance matrix is given in **Table 6.2**.

Table 6.2: Impact Assessment Criteria

Significance	Scenarios
High Significance	Long term, Irreversible, buffer/core zone & high; Short term, irreversible, buffer/core zone & high
Moderate Significance	Long term, Irreversible/reversible, core zone & moderate; Short term, irreversible, buffer/core zone & moderate; Long term, reversible, core/buffer zone & high/moderate; Short term, reversible, buffer/core zone & high; Long term, Irreversible/reversible, buffer zone & low;
Low Significance	Long term, Irreversible/reversible, core zone & low; Short term, reversible, buffer/core zone & moderate/low
Nil	No Impacts

6.2 Project Impact Area

Project impact area is the area which get influenced or impacted due to project development during different stages of lifecycle. Depending on the intensity of the impacts, project impact areas are classified into direct impact zone and buffer zone.

Direct impact zone area: RoW of the metro rail

Buffer zone area: It is area within 500 m radius of the proposed alignment. For the study of presence of notified eco-sensitive zones, area within 10 km radius from the proposed alignment is considered.

6.3 Baseline Scenario of the Study Area

Baseline monitoring study has been carried out for the project site and summary of baseline scenario of the study area is given in **Table 6.3**.

Table 6.3: Baseline Scenario within Project Alignment and Surrounding Area

S. No.	Environment	Description	Sensitivity Level as per baseline scenario	Probability of Getting impacted Due to Project
1.	Topography	Flat land	--	Nil
2.	Drainage	Proposed alignment crosses Edappally todou, stream from Chitraphuza river, Kadambryar river, drains and nallas	Protected by embankments	Moderate

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3.	Geology	Laterite of quaternary group and minor Dolerite of upper cretaceous group	--	Low
4.	Soil Quality	Reddish Brown colour soils are observed in the study area. Texturally the soils of study area are observed as Clay Loam Soils.	Not polluted	Moderate
5.	Land Use	Agriculture (2.1%, Settlement 73.2%, Vegetation 21.3%, Water Body 0.4% and Open Scrub Land 3.0%	--	Low
6.	Seismicity	IV	--	High
7.	Flood Hazard	Nil	--	Nil
8.	Climate	Tropical monsoon climate	--	Nil
9.	Temperature	Highest mean-31.3 ⁰ C, Lowest Mean-25.5 ⁰ C	--	Nil
10.	Dominant wind direction	W, NW and SW	--	Nil
11.	Annual Mean Wind Speed	2.9 Kmph	--	Nil
12.	Humidity	Max-91% & Min-61%	--	Nil
13.	Cloud cover	Cloudy during monsoon	--	Nil
14.	Air quality	PM ₁₀ -59-76 µg/m ³ , PM _{2.5} -26.3 – 37.4 µg/m ³ , SO ₂ -5.7-7.4 µg/m ³ , NO _x -13.6 – 18.4 µg/m ³ , CO-0.27-0.51(mg/m ³)	Concentration is within the prescribed NAAQS, 2009	High
15.	Noise Level	Day Time=53.2 to 68.7 dB(A) and Night Time = 43.1 dB(A) to 56.8 dB(A)	Maximum noise level during day time exceeds the prescribed standards at all locations except CSEZ area, however Leq day is within the limits as prescribed	High

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			under Noise Rules, 2000. Maximum noise level during night exceeds the prescribed standards at all locations except CSEZ area and Chembumukku, however Leq night is within the limits as prescribed under Noise Rules, 2000	
16.	GW Levels	Pre-monsoon-2-5 mbgl & post monsoon-0-2 mbgl	--	Low
17.	GW Quality	Concentration of all parameters of IS:10500	Not potable	Low
18.	SW quality	Surface water quality was analyzed against the Designate Best Use Criteria by CPCB. The quality of water matches with the category D and thus the water body is fit for drinking water source after conventional treatment and disinfection	Highly polluted waters	Low
19.	Road Connectivity	Good road connectivity	Good	High
20.	Flora & Fauna	No major flora and fauna except road side plantation and green belts along rivers	No significant bio-diversity	Moderate
21.	Eco-sensitive zone	Manglavanam Bird Sanctuary is at 3 km from JLN Stadium.	--	Nil
22.	Tree to be cut & shifted	3645	Native/local species	High
23.	Demography	Areas experiencing high population, economic &	--	High

		infrastructure growth.		
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6.4 Identification of Project Activities and Associated Impact

Impacts anticipated due to project development are majorly associated during construction phase. Major impacts anticipated during construction phase are on air quality, noise levels, soil quality, land use, socio-economy, micro-climate, water resources and surface water quality. Impacts anticipated during operation phase are on safety of passenger & staff, noise levels, surface water quality, water resources, soil quality and aesthetics. Impacts are identified for each of the project activity for both construction & operation phase of the project. Impact identification matrix is given in **Table 6.4**.

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Table 6.4: Impact Identification Matrix for the Project

S. No.	Project Activities	Land Use	Ecology & Micro Climate	Water Resources	Air Quality	Soil Quality	Noise Levels & Vibration	Water Quality	Traffic	SE & Livelihood	OHS & Community Health, Safety & Security	Aesthetics	Quality of Life	Topography & Drainage
Design/Pre-Construction Phase														
1	Land Acquisition	√								√				
3	Removal of vegetation and tree cutting		√			√						√		
4	Setting up casting yards, site offices, batching plants, labour accommodation and workshops	√*	√							√		√		
5	Shifting of utilities				√	√	√		√		√	√		
Construction Phase														
1	Excavation				√	√	√	√			√			√
2	Transportation of materials				√	√	√		√		√			
3	Storage of material													
4	Loading & Unloading of Materials				√		√				√			
5	Construction of			√	√	√	√	√		√	√	√	√	√

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	piers, viaduct (spans) etc in casting yards													
6	Installation of Piers and construction of viaducts and stations				√	√	√		√	√	√	√	√	
7	Movement of construction vehicles/machinery/equipment				√	√	√		√		√			
8	Construction & domestic waste storage and handling		√		√	√		√						
9	Construction labour Accommodation			√				√		√	√		√	
10	Sewage and wastewater handling					√		√						
11	Spillage of oil and construction materials or chemicals or paints					√		√						
12	Washing & Cleaning of construction					√		√						

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	equipment/machinery													
13	Dismantling of temporary infrastructure like casting yards, stores & workshop set up during construction phase	√			√	√	√					√		
14	Demolition of buildings and management of demolition waste				√	√	√					√		
Operation Phase														
1	Operation of Stations & metro rail		√	√	√	√	√	√	√	√	√	√	√	
2	Maintenance works			√	√	√	√	√	√	√	√			
*:Temporary impacts														

6.5 Impact Assessment

Impact assessment for each of the identified impacts during each of the project stage will be assessed and evaluated and the detailed assessment is given in sections below.

6.6 Impact Due To Pre-Construction Activities (Location Impacts)

6.6.1 Impact Due to Land Acquisition

Most of the alignment is proposed to be located on road median and road edges. But road width is not sufficient to support construction of metro corridor as well as traffic, thus it is proposed to widen the road prior undertaking metro construction works. Thus, land along the roads is required to be acquired for road widening purpose.

Other than this land is required for construction of entry/exit of the elevated metro stations and associated services. Total land required for the project is 29424.69 m² out of which 11153.136 m² is private land and 18295.83 m² is Government land. The land will be acquired by KMRL. Land will be acquired by KMRL.

Land will also be required temporarily for establishment of the labour camps, casting yards batching plants, workshops and storage yards. Two land parcels are identified for setting up the casting yards which are located at Kalamassery and belongs to FACT and HMT. Measures to minimize the impact due to land acquisition are defined below

Mitigation Measures

- Land owners/tenants shall be consulted prior initiating the process of land acquisition
- Land acquisition shall be undertaken as per the LARA Act, 2013, Land Acquisition Policy of KMRL and WB OP 4.11
- Social impact assessment study and resettlement action plan prepared as per the LARA Act, 2013, Land Acquisition Policy of KMRL and WB OP 4.11 and shall be updated if there is any change in alignment and shall be followed strictly for land acquisition
- Criteria for resettlement and rehabilitation as given in **Table 3.4** of Chapter 3 shall be considered for resettlement and rehabilitation works
- Land acquisition shall be undertaken only after provision of the compensation to the land owners and the tenants
- No additional land other than identified land shall be used for any purpose of project development
- If any additional land is required for establishment of any facility including labour camp, storage yards, casting yards, work shop or any project related facility then prior approval shall be undertaken by KMRL followed by approval from the land owner. Supplementary SIA and RAP shall be prepared for the additional land.

- Labour camps shall be avoided to be established and rented accommodation with all basic facilities shall be provided for the construction labour by contractor to minimize the temporary land requirement

6.6.2 Impact on Structures

As per DPR, approx. 56 structures occupied by 45-50 families would be affected between JLN Station and Infopark II. Details are provided in **Section 4.11.9** of Chapter 4 of the report. However, there could be impact on other neighboring structures as well due to construction and demolition works to be undertaken for project development. Following measures shall be taken to reduce the impacts on the structures

Mitigation Measures

- Owners shall be pre-informed about the detail of the extent to which the structure will be impacted, and consent shall be obtained from owner prior demolishing or dismantling the structure
- Compensation as per RAP shall be provided to the owners
- No structure or property shall be affected during metro construction works other than pre-identified structures
- Contractor shall bear all the expense of renovation/repair of the damage to any other property. Structure other than pre-identified structures

6.6.3 Impact on Livelihood

Both direct and indirect impacts are anticipated on livelihood due to the proposed project. Direct impacts are anticipated on the livelihood is due to impact on commercial structures which will be demolished for development of proposed project. 21 commercial structures and 17 residential cum commercial structures will be affected due to the project development. Thus, livelihood of the people owning these structures and people working in these structures will be affected. Thus, the compensation shall be provided to the people whose livelihood will be affected as per RAP to be prepared for the project. Assistance shall be provided to people to identify alternative livelihood location and source.

Indirect impact on livelihood is anticipated on the stores/shops/commercial structures which will be masked temporarily during construction phase due to barricading of the proposed RoW& route diversion and on the structures, which will be masked permanently behind the elevated station buildings during operation phase. The income from these structures get affected significantly both during construction and operation phases. Some of the measures are proposed below to minimize the impacts on livelihood of people.

However, the project will also generate employment for people both during construction and operation phase. Employment opportunities will be generated for all skilled, semi-skilled and unskilled labour. Approx. 1500 labour will be employed during construction

phase and approx. 550 people will be employed during operation phase. This will have positive impact on the livelihood.

Mitigation Measures

- Compensation for livelihood for the directly affected people shall be given as per approved RAP
- Provision for visibility shall be kept for the stores which get masked behind the barricaded and the station building during construction and operation phase so as the income does not get affected due to visibility reasons
- Local people should be preferred for provision of jobs (unskilled, semi-skilled and skilled) both during construction and operation phase
- Minimum wage act should be followed for the labour
- Labour and staff engaged should be provided with the safe and clean working environment

6.6.4 Impact on Land Use

Project alignment lies in urban area and land use along the alignment is mixed type comprising of both residential and commercial developments. Land use of RoW after the development will be changed for metro development works. Land use will also be changed temporarily for land parcels to be used for setting up casting yards batching plants, workshops and storage yards. Two land parcels are identified for setting up the casting yards. Storage yards which are located at Kalamassery and belongs to FACT and HMT. Measures are suggested below to minimize the impact on the land-use.

Mitigation Measures

- Temporary acquired areas like areas for casting yards & workshops etc. should be properly rehabilitated after completion of the construction phase and handed back to the owner
- Labour Camp establishment shall be avoided, and rented accommodations shall be arranged for the labour by contractor
- Measures shall be undertaken to prevent the encroachment of the land in the nearby development work areas

6.6.5 Impact due to Traffic Diversion

Traffic movement may get disturbed due to additional traffic load of transportation vehicle carrying construction material and debris required/generated from the proposed project. Approx. 30 trucks are anticipated to bring material at site on daily basis. This additional traffic load will have impact on existing traffic.

Construction of metro will be undertaken on the road for entire stretch. Metro construction works may require partial or complete closure of the road which may significantly impact the existing traffic and pedestrian movement on the road. Minimum

RoW required for metro construction works is 13 m. Available RoW of existing roads is also not sufficient and varies from 14-43 m. Thus, it is proposed to undertake the road widening work prior undertaking the metro construction works wherever available RoW is less than 16.45 m. Road widening works shall ease the traffic condition on road and will minimize the impact of metro construction on traffic and pedestrian movement. As a part of project development, it is also proposed to improve the footpaths within 1 km area of the proposed stations to encourage the pedestrian mode. Pedestrian footpath work will be undertaken by the State Government. Various other measures are proposed to be undertaken to minimize the impact on traffic which are discussed below

Mitigation Measures

- Provision of access pathway & adequate parking areas at construction site, storage yards & casting yards
- Construction material vehicle and debris carrying vehicle should not be parked on road especially during peak traffic hours
- Regulating the time of vehicle carrying construction material & debris to avoid peak traffic hours
- Drivers should be given instruction for not over speeding the vehicle, not overtaking other vehicle, not to drink and drive and to do lane driving to minimize the chances of accidents. Drivers should be penalized in case any such activity is reported. Accidents may disturb the traffic badly. Drivers shall be trained for defensive driving practices
- Routes and time should be designated for movement of the transportation vehicle and same shall be strictly followed
- Contact no of EHS cell officials, movement path and timing should be displayed on the vehicles carrying construction material and debris so as complaints can be reported against the vehicle if any unfair activity is seen to be carried out by drive
- Village roads/narrow routes should be avoided for transportation of construction materials
- At locations where alignment is cutting across a major traffic corridor, 'Continuous Cantilevered Construction Technology' would be applied to prevent traffic hold-ups or diversions of any kind.
- Obtaining all required permits, land acquisition works, provision of compensation and implementation of RAP shall be undertaken prior start of the construction works so as the construction works can be undertaken rapidly without any undue delay
- Permission from RTO shall be taken prior partial/full closure of any road
- A detailed plan shall be prepared for traffic management including details on closure of roads, requirement of sign ages and details of diversion of traffic and

same shall be shared with the public through appropriate media including newspaper (local & English language), National television and through radio at least 1-week prior diversion

- Proper MS barricaded with LED lights on top shall be provided along the construction area and traffic marshals shall be deputed in major traffic areas like junctions, roundabout, circles etc. to manage and guide the traffic
- Proper signage shall be provided to inform people about the diversion/blockage
- All the diverted routes/roads shall be restored back to original condition after completion of construction works

6.6.6 Impact Due to Tree Cutting and Vegetation Removal

There are approx. 3645 nos of trees within and along ROW however as per DPR, it is estimated approx. 345 nos of tree are required to be cut. Trees have various roles to play in environment including provision of clean breathable air, provision of shade, binding of soil, facilitate percolation of water down to ground and maintaining good aesthetics. Thus, cutting of trees will overall impact the environment. Impacts can be significant if proper mitigation measures are not taken. Estimations are made to evaluate the cost of loss of trees on basis of the capacity of trees to remove CO₂ from environment and capacity of O₂ production and calculations are given below

- Tree to be cut: 345
- Decrease in CO₂ absorption @21.8 kg/yr tree for 8 years⁷= 60,168 kg
- Decrease in Oxygen production @49 kg/year tree for 8 years = 1,35,240 kg

The average consumption of oxygen for a person is 182 kg/yr. It means these trees will meet the O₂ requirement of about 93 people in one year. The total value of tree lost is calculated to be INR 5,17,500 @ rate of INR 1500 per tree.

To minimize the impact of the tree cutting, it is proposed to carry out compensatory plantation for tree to be cut in ratio of 1:12. For plantation of 4140 trees, app. 8.27 ha of the land will be required (500 tree/ha). As per the standards, cost of afforestation is app. INR 70,000/ha thus cost of compensatory afforestation is approx. INR 5, 78,688.7. Measures proposed for minimizing the impact of tree cutting are given below

Mitigation Measures

- A joint survey shall be undertaken by engineer of KMRL, engineer of contractor and environment expert of contractor to assess the requirement of tree cutting and how the same can be minimized
- Permission shall be taken from District Tree Authority as per GO (P) No.85/86/F&WLD dated. 2nd September 1986 and GO (P) No.68/2010/F&WLD dated 10.02.2010 prior undertaking tree cutting

⁷Time period of 8 years is considered for obtaining full grown tree

- Budget for the compensatory plantation shall be considered in DPR
- All conditions mentioned in permission letter shall be followed
- Compensatory afforestation shall be undertaken as per 1:12 ratio as directed by Forest Department
- Only native species with less water & maintenance requirement shall be considered for Compensatory afforestation
- Survival rate of minimum 70% shall be maintained for Compensatory afforestation. Compensatory afforestation shall be monitored, and survival rate report shall be prepared annually

6.6.7 Impact Due to Establishment of Labour Camps/Construction Camps

There could be various impacts which may happen due to the labour camp establishment. These impacts will vary as per the location of establishment and will include temporary change in land use due to establishment of the labour camp; Vegetation removal and tree cutting; Generation of municipal waste and disposal on land and water; generation of sewage; Increase in crime in the area; and Generation of unhygienic condition due to open defecation and improper disposal of sewage and pollution of river and ground water. These impacts will vary as per the location of the labour camp site. Thus, recommendations are given for siting the labour and provision of the basic facilities in labour camp for maintaining hygiene and prevent pollution.

Mitigation Measures

- Labour camp should not be established instead rented accommodation with proper toilets, sewerage system and waste management facility should be provided for labour by contractor
- If established, camps should not be established in residential areas, agriculture land, forest area and vegetated or planted area. Waste land or open area shall be preferred for establishment of such campus
- Campus shall be established at minimum distance of 500 m from residential areas, sensitive zones (educational, religious and health centres), forest areas, wildlife areas and water bodies
- Basic facility like bedding, toilets with running water facility, cooking area and LPG fuel, bathing area, washing area, proper ventilation and proper illumination should be provided in the campus
- Dustbins should be provided for waste collection and the waste should be disposed off through the local bodies
- LPG should be used as cooking fuel. No open burning of bio-mass should be allowed
- Labour should be trained about not practicing any unfair practices and get involved in any crime like theft/drinking alcohol etc.

6.6.8 Impact Due to Shifting of Existing Utilities

Proposed metro alignment is proposed within the urban area and there are various above ground and underground utilities existing within the proposed RoW. These utilities will be affected due to the project development. The utilities to be affected include electricity line, Fuel supply pipeline, BPCL oil pipeline, telecom cables, sewerage line, drainage lines and water supply line. These utilities are essential for the community and disturbance to any of this facility may affect the community significantly. Details of the utilities to be impacted due to the project are given in **Table 3.2** of Chapter 3. Measures are proposed to minimize the impact on the community due to utility shifting and are given below

Mitigation Measures

- Concerned authorities, i.e. KWA (Kochi Water Authority), BPCL, KSEB (Kerala State Electricity Board) and BSNL and others shall be consulted prior dismantling any of these services and prior permission shall be obtained from these authorities for shifting of these utilities
- All conditions of the permission shall be followed and complied
- Alternate arrangement for the resource shall be arranged for community prior dismantling/disturbing these utilities
- Public shall be pre-informed through appropriate media for preparedness in case of disturbance of service which cannot be shifted prior dismantling and some alternate arrangement shall be made for public
- Budget shall be kept in DPR for shifting of utilities

6.6.9 Impacts Due to Natural Hazards

The project involves construction of elevated track and stations, buildings, substations etc. Project area lie in moderate seismic risk zone (Zone III) as per BIS classification and prone to moderate intensity earthquakes. Any damage to any structure during earthquake may affect life of millions staying in the nearby areas. Thus, the design should include adequate provisions as per NBC, 2005 for design of structures. Measures taken up while designing the structures are given below.

Project corridor lies in the flood prone zone, but all the proposed facilities are elevated and thus will not be directly affected due to flood. However, it is required that plinth of the entry/exit of station building should be planned above the HFL to prevent entry of water in the station building. There will be significant indirect impact of flood on metro system due to inundation of the roads/streets. Metro construction and operation works will be halted during high floods. Thus, floods can significantly impact the both construction and operation phase

Mitigation Measures

- Construction activities shall be stopped during monsoon and on red alert days by IMD
- Construction sites shall be made clear off loose construction material and debris prior onset of monsoon
- Safe sites shall be identified for shelter in case of massive flood
- Run-off from stations & viaducts shall be collected through the drainage system and shall be recharge into the ground through pits
- Structure shall be designed considering the seismic risk for (higher level) Zone IV to ensure that structure does not get impacted due to earthquake of moderate intensity as expected in Zone III
- Suitable seismic coefficient shall be adapted in the design of structure commensurate to the Indian Standard seismic zoning of the country
- Provision of Bureau of Indian Standards codes like IS: 1893:1984, IS :1893(Part 1):2002, IS: 1893(Part 4):2005, IS: 4326:1993 etc. shall be incorporated suitably while designing the structures

6.7 Impacts Due To Construction Activities

6.7.1 Impact Due to Excavation and Muck Disposal

Excavation will be undertaken only for construction of piers and foundation of the entry/exit structures. Total muck to be generated due to excavation (assuming 400 piers, excavation depth 8.5 m; width 2 m; and length 2 m and 25nos of entry exits for 11 stations having width 5 m, length 10 m and depth 3 m) will be approx. 17350 cum out of which 427.5 cum is top soil (15 cm depth). Top soil will be kept aside for undertaking compensatory plantation works. Considering swell factor of 40%, excavated muck other than top soil will be 23691.5 cum. Most of the soil will be filled back (~70%) after construction of piers and entry/exit and remaining (7108 cum) can be used for road widening and construction purpose if feasible. Surplus can be disposed at designated C&D sites of Kochi Municipal Corporation. One such site is located at Bhramanpura. This muck if disposed in improper or unscientific manner may impact the soil quality, air quality and water quality of the area significantly. Following measures are proposed to minimize the impact due to disposal of muck

Mitigation Measures

- Options shall be used for exploring usage of excavated muck for the road widening and construction purpose or for construction purpose of metro works
- In case this excess muck is not used then it should be disposed off with the permission of Kochi Municipal Corporation. There is an existing solid waste management site at Bhramapuram.

- If permission is not obtained, then contractor shall identify the location for establishment of the debris disposal site. This debris disposal site shall preferably be established on the waste land.
- Debris disposal site shall not be constructed in the forest area, agriculture field and settlement area and minimum distance of approx. 500 m shall be maintained from water body, settlement area, forest/wildlife area
- Debris disposal site shall be covered through wall on all the sides and proper drainage channels shall be provided at the site to channelize the run-off
- This site shall be used for disposal of excess excavated muck and the remaining construction waste which is non-hazardous in nature
- Site shall be properly compacted after disposal of muck and top soil cover of 15 cm shall be provided after compaction. This site shall be stabilized by carrying out the turfing and tree plantation on the site

6.7.2 Impact on Micro Climate

Kochi metro project development will contribute in improving the micro climate of area by reducing the total CO₂ emissions due to transportation in long term. It is anticipated that the vehicle on road will be reduced due to development of the metro rail which will reduce the fuel consumption thereby reducing the emissions due to vehicular fuel burning. It is estimated that app. 1, 22,855 tonne of carbon di-oxide reduction will be achieved by 2021 and 1, 91,668 tonne will be achieved by 2031. Carbon credits of the tune of Rs. 62 million in 2021 and Rs. 96 million in 2031 can be earned. Detailed calculations for the reduced emission are given in **Table 6.5-6.7**

Table 6.5 Vehicle Km Reduction

Mode	2021	2031
Bus	4,87,132	7,56,580
Car	27,822	75,720
2W	1,01,560	1,64,688
Auto	40,678	45,110

Source: DPR

Table 6.6 Reduction in Fuel Consumption

Year	Diesel (Million liters)	Petrol (Million liters)
2021	59.857	0.678
2031	93.055	1.333

Source: DPR

Table 6.7 CO₂ Emission Reduction (tons/year)

Pollutant	JLN Station To Infopark II km
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	2021	2031
Carbon Dioxide (CO₂)	1,22,855	1,91,668

Source: DPR

Other than the metro system, it is proposed to enhance the overall public transportation system by integrating the metro system with the existing public transportation mode. Phase II will be connected to the Phase I at JLN Stadium. Phase I is connected with the Railways at Tripunithura station. Further halt points for auto rickshaws and taxi will also be provided close to the metro station. KMRL has proposed to introduce the feeder buses on the routes near to the proposed metro stations so as people use these feeder buses to reach metro station in place of using private vehicles. Details of feeder buses to provided is given in **Table 3.11**. Bicycle sharing system is also planned to be introduced by KMRL in which bicycles are made available for free and shared use to metro passengers on a short-term basis. This is proposed to promote non-motorized vehicular modes and reduce overall CO₂ and other emissions. All these will enhance usage of public transportation and will reduce the number of private vehicles on road and thus the pollution due to vehicular exhaust in long term.

However due to tree cutting, CO₂ absorption will reduce by 60,168kg in period of 8 years. However, this will be compensated by planting the trees under compensatory plantation. It is proposed to plant 4140 trees against 345 trees to be cut. CO₂ removal due to the compensatory plantation (@70% rate) after 8 years time is estimated to be 90252 kg/year. Overall the project will have positive impact on micro-climate. Some of the measures proposed to enhance the impacts are given below

Mitigation Measures

- Only identified trees should be cut/shifted
- All the conditions as mentioned in the tree cutting NOC shall be followed
- Compensatory plantation should be taken in ratio of 1:12 and survival rate of minimum 70% should be maintained.
- Proper maintenance and after care shall be undertaken for the compensatory plantation. Tree guards shall be provided for all the trees to be planted
- Tree requiring less water and care shall be selected for plantation and Euclayptus shall strictly be avoided
- Feeder bus system and bicycle sharing system as proposed shall be implemented and enhanced
- Adequate parking space shall also be identified in nearby areas so as people can park their vehicle in that area and use metro for travel

6.7.3 Impact on Soil Quality

Tree cutting may loosen the soil and may make soil in the affected areas prone to erosion. Top soil in the area is most nutritive layer and may get eroded after loosening. Run off from unprotected excavated areas, can result in excessive soil erosion, especially when the erodibility of soil is high. Further there could be leakage of oil from the construction machinery & the vehicles which may contaminate the soil.

However, the vegetation removal will be taken up only in RoW thus impacts of the project on soil quality during pre-construction stage are short term, irreversible, restricted to RoW and are anticipated to be of low severity, i.e. low significance if adequate mitigation measures are adopted. Mitigation measures are proposed to be taken to minimize the impacts further and are listed below.

Mitigation Measures

- No excavation works or tree cutting, or vegetation removal works shall be undertaken during rainy season
- Only the identified tree for cutting as per Forest NOC should be cut
- Construction activity should be initiated immediately after the vegetation is removed from work area
- All the excavated material shall be properly stacked in the pile with the slope not more than 1:2 and shall be kept covered. Excess excavated soil shall be removed from the site on regular basis
- Disposal of the excavated muck and construction debris shall be done as per the debris disposal plan only
- Waste to be generated from the labour campus shall be collected and stored in covered area and shall be sent for disposed off through local agency on daily basis
- No construction waste or redundant machinery shall be left behind at site or on road etc. after construction works are completed
- Fuel, used oil, paints and loose construction material shall be stored on paved surface in covered condition only to prevent its spillage. Entry to this area shall be restricted and only authorized and trained person shall be allowed. Proper drainage shall be provided around the fuel/used oil/paint storage area so as any spillage can be collected. These drains shall be provided with oil & grease trap also to prevent mixing of oil with the site run-off
- Machinery to be used should be regularly serviced and maintained to prevent the leakages of fuel
- Workers should be trained to handle the material and machinery so as there is minimal spillage, leakage due to breakage during handling

- Any hazardous waste like used oil from DG sets/machinery shall be disposed off through authorized hazardous waste vendors
- Areas to be used temporarily shall for establishing casting yards, workshops, storage, labour campus shall be restored back to the original conditions
- Measures shall be taken to prevent the erosion of banks in area where construction is proposed to be undertaken near the water body. Silt arresters shall be provided along the water bodies in the activity area to prevent flow of silt in water bodies

6.7.4 Topography & Drainage

Topography of the entire alignment is flat. No major impact on topography is anticipated due to project development. Proposed alignment crosses Edappally tod, stream from Chitrappuzha River, Kadambryar River, drains and nallas. No metro pier shall be constructed in these water bodies. However, A road bridge may also required to be constructed at chainage 2650-2700 on nalla “Edappally tod”. Construction of Road Bridge may have impact on flow of this water body. Also, due to construction of metro system, run-off generation may increase slightly, and this increased run-off will find its way in the nearest water body. The increased run-off also may have impact on the drainage of area. Measures to be taken to prevent impact on drainage are given below.

Mitigation Measures

- No pier construction should be carried out in water bodies falling along the RoWs
- No disturbance to the flow or hydrology of the water bodies should be made due to project construction. If any pier construction is undertaken in any water body then, proper hydro geological modeling study shall be undertaken by contractor to study impact on flow & drainage of construction on these water bodies
- Temporary Drainage should be provided at the construction site, casting/storage yards, labour campus sites as per the natural drainage pattern of the area. These drains shall be provided with the silt trap and oil & grease traps.
- No drain/water body/stream should be closed during project construction
- Storm water from viaduct and station buildings shall be collected and recharged to ground through RWH pits

6.7.5 Impact on Air Quality

It is anticipated that air quality will improve during long term due to the metro operation. The project overall will help in reducing the vehicular movement on the road thereby reducing the vehicular emissions. It is estimated that due to project development, approx. 657192 vehicle km will be reduced by 2021 and 1042098 vehicle km will be reduced by 2031. Vehicle reduction will reduce the fuel requirement and it is estimated that diesel requirement will be reduced by 59.857 million liters by 2021 and 93.055 million liters by 2031. It is estimated that petrol requirement will reduce by 0.678 million liters by 2021 and 1.333 million liters by 2031. This will reduce the vehicular emissions

including HC, NOx, Particulate Matter and CO. Emissions on HC, NOx, Particulate Matter and CO to be reduce by 2021 (in Tons/yr) is 87, 2070, 144 and 2211 and to be reduce by 2031 (in Tons/yr) is 137, 3216, 224 and 3439. Total vehicle km reduction and fuel consumption reduction is given in **Table 6.5& 6.6** above and total vehicular emission reduction is given in **Table 6.8** below.

Table 6.8: Estimation of Vehicular Emission Reduction

Pollutant	Year	
	2021	2031
Carbon Monoxide (CO)	2,211	3,439
Hydro-Carbons (HC)	87	137
Nitrogen Oxide (Nox)	2,070	3,216
Particulate Matter (PM)	144	224
Carbon Dioxide (CO ₂)	1,22,855	1,91,668

Source: DPR

However, air quality will get impacted in the area during construction phase due to various project activities including vegetation removal, site preparation, demolition of structures, excavation and filling, Transportation and storage of raw materials & debris, movement of construction vehicle, Operation of construction machinery & equipment and Operation of DG sets. All these activities have potential to generate fugitive dust emissions. Operation of DG sets, construction equipment/machinery and vehicles may also generate the exhaust which affects the air quality of the area. Quantifications are made to calculate the emissions due to transportation of construction material. Quantity of construction material to be used is given in **Table 6.9**.

Table 6.9: Construction Material Requirement

Material	Unit	Total Qty
Elevated Station		
Concrete	cum	96394
Steel	MT	13082
Viaduct		
Concrete	cum	183596
Steel	MT	26018
HT stand	MT	1322

Source: DPR

It is anticipated that material will be purchased from the vendors with an average distance of approx. 200 km then the distance to be travelled by per truck in each trip is 400 km. Emission load estimations are made for construction phase of the project per day and are given below in **Table 6.10**

**Table 6.10: Quantification of Pollution Load Due to Movement of Trucks
(Per Day)**

Parameter	Nos. of trucks	Emission Factor (g/Km)*	Pollution Load (g/Km) per day	Average Distance to be Travelled (km) in round trip	Emissions generated per day (kg/day)	Emissions generated During Construction Phase (Tonnes)
CO	30	6.0	180	400	72	84.2
NO_x		9.30	279		111.6	130.6
PM		1.24	37.2		14.88	17.4
SO₂		0.15	4.5		1.8	2.1
HC		0.37	11.1		4.44	5.2

***Source of emission factors: ARAI, Pune and Study by TERI**

As per the baseline data assessment, it is found that all the parameters monitored, i.e. PM₁₀, PM_{2.5}, SO₂, NO₂ and CO are well within the permissible limit. Concentration of PM₁₀ and PM_{2.5} though within the permissible limit but are on higher side. Thus, the impact of increased emission will impact most the particulate matter concentration in the area. Thus, measures shall be taken to overall reduce the emissions due to the project to minimize impact on air quality. Suggestive mitigation measures are given below.

Mitigation Measures

- Site should be barricaded from all the sides and shall remain barricaded till all the construction works are over and the construction machinery and material are removed from the site
- Construction Vehicles/machinery should be regularly serviced and maintained. Vehicle and all wheel/chain mounted machinery should carry the PUC certificate. All the vehicle should be covered
- Vehicle inspection camp shall be established to ensure that vehicle are properly serviced and maintain and comply with the emission norms
- All the transportation vehicle carrying construction material, debris, muck etc. should be properly cleaned and covered
- Old machinery and equipment (older than 3 years) should not be used for construction purpose and they should meet the prescribed emission norms
- Raw material and debris should not be piled up at site and should be ordered as per the need at site.

- Raw materials/debris/excavated muck should be properly stacked and stored under covered conditions at designated areas/storage yards. Debris/muck should be regularly removed from the site for regular storage/disposal
- Muck shall be compacted after disposal in debris disposal site
- Minimal storage of construction material at the site shall be ensured. Construction material should be brought to the site from storage yards as per need and piling of material should be avoided at site.
- Locally available raw material should be preferably used, and raw material should be purchased from licensed vendors only
- Temporary connection of electricity should be taken for operation of machinery/equipment and lighting at site and usage of DG sets should be minimal
- Low Sulphur diesel only should be used as fuel in DG sets. DG sets should be provided with the stack height of minimum 6 feet. DG sets should be used only in case of power failure
- For construction workers at accommodations, only LPG should be provided as fuel. Burning of the wood or any other fuel or open burning of the waste should be prohibited at the site and the labour accommodation site
- Water sprinkling should be carried out at casting & storage yards, construction site, loading & unloading area, approach road, haulage road, raw material storage area and muck disposal sites. Flow rate of water sprinklers should be maintained to minimize the run-off and for effective results
- Adequate parking area should be provided for vehicle for loading & unloading so as to prevent parking on the road and causing traffic jams and congestion
- Compensatory plantation shall be undertaken in the ratio of 1:12 and minimum survival rate of 70% shall be maintained
- Precautions w.r.t air pollution control as stipulated in IS: 5121 ‘Safety code for Piling and other Deep Foundation’ should be adopted.
- Casting yards, batching plants etc. should be located away from residential and sensitive areas. Pre-identified casting yards at Kalamassery shall be used with prior permission of the concerned agency

6.7.6 Impact on Noise Levels

Source of noise during the construction phase of project are operation of construction machinery such as vegetation removal machinery, hot mix plants, bull dozer, dumpers, back hoes, loaders, JCBs, concrete mixers etc. However, magnitude of the impact will depend upon the type and nature of the machinery, time schedule of operations, construction method and management practices followed during activities. Though the effect of noise would be insignificant during day time, the residential areas located in the

near vicinity may get disturbed during the night time. Noise levels generated during various stages of construction and due to construction machinery is given in **Table 6.11**.

Table 6.11: Noise Levels during Various Construction Phase and from Construction Machinery

Construction Phase and Equipment for Different Activities	Noise Level in dB(A)
Construction Stage	
Ground clearance	85
Excavation	90
Foundation	80
Pile driving	100
Erection	90
Finishing	90
Construction Machinery	
Bulldozer	80
Front end loader	72-84
Dump Truck	83-94
Crane with ball	75-87
Scraper	80-93
Grader	80-93
Roller	73-75
Crane	75-77
Welding generator	71-82
Concrete mixer	74-88
Concrete pump	81-84
Concrete vibrator	76
Air compressor	74-87
Pneumatic rods	81-98
Paver	86-88
Truck	83-94
Tamper	74-77
Backhoe	72-93

It is evident from the above table that operation of construction machinery & equipment will generate high noise levels due to which it may affect the health of construction labour and nearby residents if the adequate mitigation measures are not taken. Highest noise level during construction phase may reach up to 100 dB (A). Estimations are also made to calculate the distance at which the sound levels will attenuate to the acceptable noise levels as defined by CPCB in Noise Rules, 2000. Standard sound wave propagation equation is used to calculate the noise levels at receptor and the equation is given below.

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$$\text{Noise}_{(\text{receptors})} = \text{Noise}_{(\text{source})} - 20 \text{ Log}[\text{distance}_{(\text{receptor})}/\text{distance}_{(\text{Source})}]$$

For purpose of calculating noise level using above equation, flat terrain is considered, and environmental attenuation factors are not considered so as to formulate the worst-case scenario. Noise levels predicted by logarithmic equation up to a receptor location of 1 km is presented in Figure 6.1. Referring to the graph given in Figure 6.1, it can be said that noise levels of 50 dB (A) can be achieved at distance of app. 1107 m from noise source. This distance is required when no noise shield, buffer or absorbent is used. When these are used the distance required may reduce significantly. Also, minimum distance which is required for each type of land use identifying within the project area has defined CPCB under Noise Rules, 2000 as amended in 2010 is calculated and is given in Table 6.12.

Table 6.12: Minimum Distance Required from Different Land Use (Pre-construction phase) to Achieve Prescribed Noise Levels as Per Noise Rules, 2000⁸

Zone	Receptor Noise level dB(A) as per CPCB	Minimum Safe Receptor Distance (m)
Residential	55	622
Commercial	65	197
Industrial	75	63
Silence	50	1107

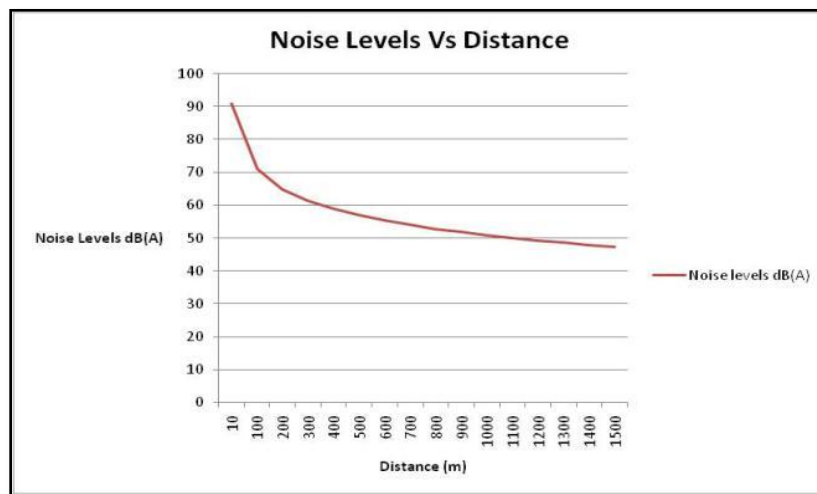


Figure 6.1: Noise Levels at Various Distances from Construction Equipment

As per baseline study, maximum noise levels of day & night time are more than the specified CPCB standards thus the impact on noise environment with the slight increase in noise level may be of significant and impact nearby residents especially during night time. Also, high noise level may impact the workers' health. Thus, measures should be taken to minimize the noise level. Proposed mitigation measures for minimizing noise levels from the site are given below.

⁸ Amended in 2010

Mitigation Measures

- All the construction machinery and equipment used should be provided with adequate noise mufflers and noise suppression equipment. Proper lubrication and maintenance of the machinery & equipment and vehicle to be carried out to minimize the noise generation due to abrasion
- Any diversion/closure of route shall be done with the prior permission of RTO and as per traffic Management Plan only
- Honking should be prohibited at the site. For management of traffic, a traffic supervisor and marshals should be available 24 X 7.
- All noisy activities should be carried out during day time only (9:00 AM to 10:00 PM). No noisy works shall be undertaken during night time
- Activity area should be barricaded. Barricading helps to lower the noise levels. Effective noise barriers can reduce the noise levels even by 20 decibels. Steel barricades can be used for reducing the noise as well as for controlling dust spread.
- Casting yards, batching plants etc. should be located away from residential and sensitive areas.
- Temporary noise shields should be provided all around the heavy noise making activity especially pile driving. Noise blankets, combined sound absorbent etc. may be used to reduce the noise level in high noise generating activities like pile driving. Precautions w.r.t noise control as stipulated in IS: 5121 'Safety code for Piling and other Deep Foundation' should be adopted.
- Noise level from loading & unloading of material can be reduced by usage of various types of cranes & placing material on sand or sandy bag beds.
- Noise monitoring should be carried out to ensure the effectiveness of mitigation measures and develop a mechanism to record and respond to complaints on noise.
- Adequate parking space to be provided at the project site to minimize the honking requirement due to congestion and jams and restricting the speed limits.
- Job rotations should be practiced for workers, working in noisy environment.
- Protection devices (earplugs or earmuffs) shall be provided to the workers operating near high noise generating machines.
- Workers in those sections where periodic adjustment of equipment/machinery is necessary, should be provided with sound proof control rooms, so that exposure to higher noise level is reduced
- Hearing test for the workers prior to deployment at site and high noise areas followed by periodic testing every six months.

- Automation of equipment and machineries, wherever possible should be done to avoid continuous exposure of workers to noise
- OSHAS guidelines should be followed for maintaining noise exposure levels of the construction workers. As per standards, workers’ exposure to 90 dB(A) noise level should not be more than 8 hours. OSHAS guidelines should be followed for exposure to specific noise levels for workers and are listed in **Table 6.13**

Table 6.13: OSHAS Noise Exposure Limits for The Work Environment

Noise Levels in dB(A)	Permissible Exposure (hours & minutes)
85	16 hrs
90	8 hrs
96	3 hrs 30 minutes
102	1 hr 30 minutes
108	40 min
115	15 min
121	6 min
127	3 min
130	1 min

Source: Marsh, 1991, p.322

6.7.7 Impact on Water Resources

Water will be required for domestic purpose of construction workers and staff and for carrying out construction activities, in batching plant for manufacturing of RMC, curing of structures, material mixing etc. 1500 employee/labour will be employed for construction of project, thus domestic water requirement for the labour is anticipated to be 120 KLD (@80 kl/capita/day) assuming all labour are resident labour. Water requirement for construction purpose & at casting yards is approx 200-250 KLD. As per DPR, proposed source of water is ground water after taking permission from CGWA. However, it is recommended to purchase STP treated water from municipality. There is 4.5 MLD CSTP existing at Elamkulum which is approx 5 km from proposed alignment and 14 km from casting yards. Treated water from CSTP can be considered for construction purpose of metro after providing suitable treatment as feasible.

Construction will be continued only for 39 months; thus the impact is anticipated to be confined to construction phase only. Measures are proposed to minimize the water requirement so as to minimize the impact on water resources.

Mitigation Measures

- Ground water should be used only after obtaining NOC from CGWB and all conditions as mentioned in NOC shall be followed and complied by contractor
- Low flow taps shall be provided in toilets and kitchen and all water storage tanks should be covered to minimize loss due to evaporation

- Regular inspection of the water storage structures and pipelines to detect leakages. Detected leakages should be immediately repaired to minimize water loss
- Using curing agents for carrying out curing. If water is used for curing then low flow sprinklers should be used for curing purpose, curing should be carried out during early morning & evening to minimize evaporation, concrete structures should be covered with gunny bags after curing is done to conserve the moisture
- Run-off from curing should be collected through drains into sedimentation tank and should be re-used for curing or washing of vehicle/machinery or for wheel washing
- Workers should be educated to use water wisely and do not leave the taps open without use. Written notice should be displayed near the water taps for saving water & closing the taps.
- Provision of storm water drains and rain water harvesting pits and to collect storm water from station area and viaducts and to recharge the water in the ground

6.7.8 Impact on Water Quality

Removal of vegetation/tree cutting/shifting may loosen the soil and the loose soil may get mixed with rainfall run-off and make way into the nearby water bodies like Kadambyar River, drains and nallas. App. 345 trees will be cut for the project. However, construction works will be started immediately after the tree removal thus anticipated impact on water quality due to vegetation removal is not significant.

Construction material, debris, oil, fuel, lubricants, paints etc are stored at construction site, casting yards and storage yards. Any of these materials may get mixed with the run-off and may enter the nearby water bodies polluting the water quality of the surface water body. Run-off from labour may get polluted due to provision of improper sanitation facilities at site which may also impact the quality of the run-off impacting the surface water quality. Thus, measures are required to be taken to manage the contamination of the run-off to prevent pollution of these water bodies due to project.

Also, if these materials get spilled on the ground may enter the underground water aquifer system through soil polluting the ground water in the area. Thus, proper management of construction material, debris, oil, fuel, lubricant etc. is required to prevent the spillage. Also, the management system should be developed for managing the spillage of fuel or oil. A road bridge will be constructed at chainage 2650-2700 on Edapally Todu, thus water quality may also get impacted during bridge construction due to spillage of construction material or debris in the water body. The impact anticipated on water quality during construction phase are for short term but significant thus measures shall be taken to prevent these impacts. Mitigation measures are listed below

Mitigation Measures

- No excavation, vegetation removal and tree cutting/shifting work should be carried out during monsoon season or during rains or during storm.
- After tree cutting or shifting of trees & shrubs, soil in that location should be compacted
- No waste/material/debris/excavated muck should be thrown in any water body
- Machinery and vehicle should be serviced and maintained regularly to prevent fuel leakages. Leakages from tanks should be regularly inspected
- Training to be given to workers for handling of materials, chemical and machinery to minimize spillage of any contaminant at site
- Proper toilets shall be provided at site and labour camps to prevent open defecation. Sewage shall be disposed from toilets, kitchen and washing area through septic tanks. Septic tank shall be cleaned on regular basis through the authorized agencies of local bodies
- Fuel storage should be minimized at the site. Fuel if stored should be stored in isolated locations in HDPE container on paved surface provided with the drains & oil interceptors. Design of the oil & grease trap is given in **Figure 6.2**.
- Drip pans shall be provided with vehicles with leaks to prevent soil contamination
- Waste to be generated at construction site should be handled, managed and disposed properly and should not be allowed to contaminate the run-off from the site. No waste should be thrown in any water body during construction phase.
- Water tanks should be covered always and should be cleaned on regular basis
- Sedimentation tanks should be provided all around the excavation sites especially near the water bodies. Silt curtains should be provided in the water body when construction is taking place close to the water body
- Minimal construction material should be stored at the site. Construction material should be stored at the storage yards only in the covered sheds and on paved surfaces to minimize their interface with the air, water & soil.
- Curing run-off should be minimized by using low flow sprinklers for curing or using curing agents. Curing run-off should be collected in the sedimentation tank and should be used for curing purpose or dust suppression. Further wastewater from batching plant can be collected in sedimentation tank for arresting the sediments and the run-off can be used for curing & dust suppression. Sediments can be collected and can be disposed
- No machinery washing or cleaning should be undertaken near any water body. Vehicle washing water should be collected and channelized into septic tank. Fuel storage should also be away from water body (minimum 100 m). No maintenance workshop shall be established within 100 m of any water body
- Area along the water bodies shall be barricaded and silt fencing shall be provided near the river to prevent flow of silt/debris in river.

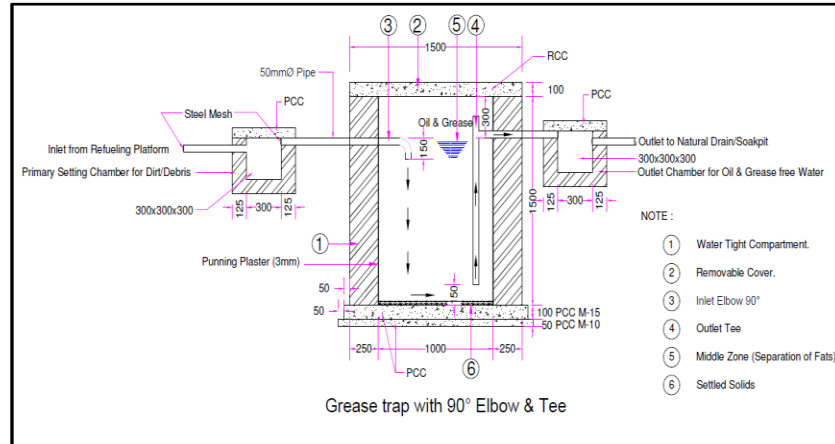


Figure 6.2: Indicative Design for Grease Trap

6.7.9 Impact on Ecology

Impacts are anticipated on ecology as the project involves removal of vegetation and cutting of 345 trees. However, these impacts are discussed in section of tree cutting above. Construction activities generate dust and this dust when get settled on leaves surface may impact the photosynthesis capacity of the plants. Some of the tree species may also get impacted due to increased emission during construction phase. Thus, measures shall be taken to minimize the impact on the ecology

Mitigation Measures

- No tree/shrubs/vegetation should be removed except which are approved in the forest NOC
- If any additional tree cutting is required, prior approval from Tree Authority/Forest department should be taken
- Construction sites, casting yards, storage yards etc. shall be regularly sprinkled with water for dust suppression
- Machinery staging & movement, machinery & vehicle parking, material storage, debris storage should be carried out at designated locations only and no such activity should be carried out at green belts along the road/drains, parks, playgrounds, agriculture fields etc.
- No eco-sensitive area or forest area or thickly vegetated areas should be procured for any project related activity
- No debris/construction waste should be disposed-off in any water body in the area or any other vegetated land
- Silt fencing shall be provided along water bodies to prevent inflow of silt/sediment/materials in the River.

- Workers and staff at the site should be clearly instructed about not harming any animal or bird or removing vegetation or cutting any tree for any purpose from the site and nearby area
- Entire activity area should be barricaded so as to prevent trespassing of any animal
- No toxic or poisonous substance should be stored in open which can be consumed/spilled by any fauna

6.7.10 Impact on Aesthetics

Staging of construction machinery, stacking of construction material & debris, storage yards, excavated areas, piling of construction debris etc. may disturb the aesthetics of the area. But these impacts are limited to the construction phase only thus are short term and temporary. Mitigation measures are proposed to be undertaken to minimize the impact on aesthetics of the area and are listed below

Mitigation Measures

- Machinery/vehicle should be parked only at the designated location. No parking should be done on the road or in front of any private or Government building or public utility
- Entire activity area, casting yards, storage yards etc. should be barricaded
- Temporary structures at storage yards and casting yards etc. should be dismantled immediately after the construction works are completed and these areas should be restored back to the original condition
- Construction debris & excavated soil should be removed on regular basis from the site & should be re-used & disposed off at the designated sites in accordance to the waste management rules
- Construction machinery, scraps (if any), debris, damaged equipment etc. should be removed from the site after construction is completed. No redundant machinery, scrap or material shall be left on the construction site after construction is completed

6.7.11 Impact on Community

Community will be benefited with the project in long term. Metro project will provide a reliable public transportation system which will have multi-modal linkage and Para transit system of feeder buses in the city. This will help the community to travel at lower cost and in less time with comfort and avoiding the traffic jams. Estimations are made for the money which metro users can save on fuel expenditure with the metro Phase II project and it is given in **Table 6.14 below**. The project will overall improve the quality of life of people.

However, community will be impacted during the construction phase of the metro. Impacts due to construction will include route diversions, traffic congestion, longer traveling time, exposure to dust and high noise levels, loss of property loss of livelihood

and safety issues. These impacts can significantly impact community if the proper mitigation measures are not undertaken. Measures proposed are given below

Table 6.14 Net Saving on Fuel Expenditure (Rs Million)

Fuel	2021	2031
Diesel	3,754	5,836
Petrol	50	99
Total	3,804	5,935

Source: DPR

Mitigation Measures

- Suggested environment management plan should be implemented to minimize the pollution from the project and associated social issues
- Traffic diversion and management plan shall be prepared prior undertaking diversion in consultation with RTO and same shall be shared with the public through appropriate media including newspaper (local & English language), National television and through radio at least 1-week prior diversion
- Alternate arrangement for the resource shall be arranged for community prior dismantling/disturbing the utilities (water supply pipeline, sewerage line, drainage line, electricity lines, telecom line and BPCL pipeline) which will be affected due to project development
- Public shall be pre-informed through appropriate media for preparedness in case of disturbance of service which cannot be shifted prior dismantling and some alternate arrangement shall be made for public
- No batching plant, construction labour camps, casting yard, fuel storage site etc. should be installed within 500 m of any of the residential area, sensitive zone, forest/wildlife area and water body
- Land acquisition shall be undertaken as per the SIA study and RAP prepared for the project prepared in line with LARA, 2013, WB policies and KMRL R & R policies and affected families/people should be provided compensation accordingly. A separate SIA/RAP shall be prepared if there is any change in land requirement
- A grievance redressal system be in place and communicate to the public to register their grievances, if any. Grievance redressal mechanism should be such that all the complaints should be registered irrespective of colour, caste, creed & position. All the registered complaints should be enacted within 15 days of registration. Consultation with the affected/grieved should be carried out by in charge of the grievance redressal cell. Registered grievance should be resolved completely within 1 month of registering the grievance.

6.7.12 Impact on Occupational Health & Safety and Community Health Safety & Security

Construction activities involve risks to health & safety of construction workers as it involves handling of heavy construction machinery/vehicle/components & lifting equipment, work at height etc. Occupational risks involved during construction phase are fall, slip, accidents, failure of crane, fire, electric shock etc. Safety measures are required to be taken to prevent any injury or accident during the construction phase. Further due to setting up of plants and pollution emission from the construction activities, there could be impacts on community health safety and security. Impacts anticipated during construction phase on occupational health and safety and community health, safety & security are short termed are restricted to the construction stage only.

Measures are proposed to ensure occupational, health & safety of the workers and staff and community health safety and security during construction phase and are listed below.

Mitigation Measures

- All construction site, activity area, casting yards, fuel storage area, workshop area etc. should be barricaded and the entry should be restricted to authorized personnel only. ID cards should be issued to all the authorized personnel including the workers, labour, employee, staff, inspectors & visitors
- No excavated area should be left open without barricading. LED lights should be provided on the barricading to guide the traffic in night. Traffic marshals should be deputed in the area requiring minor & major traffic diversion to guide the traffic about the diversions. Notices should be displayed on LED lit boards to caution public about the work in progress, speed limits to be kept, sharp curves, diversions etc.
- No public place like parks, footpaths etc. should be used for any purpose for project without any prior permission from concerned department and information to the affected public
- No utility shifting should be done without providing the alternative before dismantling. New utility should be developed at the new location prior dismantling the old facility. Information about any inconvenience which may occur to local public should be given to the public in advance (min 24 hours).
- KMRL has framed the SHE policy and it is essential for all contractors to follow the SHE Policy of the KMRL. The SHE policy is made in line with the requirement of BOCWA and BOCWR. SHE policy addresses safety of the construction workers as well as the safety of the nearby community
- Transportation vehicle should be in good conditions and should comply with all safety conditions. Transportation vehicle should carry the load according to its capacity

- All the lifting equipment should be properly examined and tested prior usage. All relevant information should be known about the load, method of slinging and attachment points
- Person involved for lifting and installation works and those working in heights should be properly trained for the work assigned
- Safety officers & supervisors should be present all the time at site during execution of the work, laying of foundations, piers, piers cap, slabs etc.
- Where possible, exclusion zones should be established and maintained in order to prevent any unauthorized access to lifting areas
- When lifting large loads, ensure weather conditions are favorable for the task. Heavy lifting equipment typically has safe operating parameters included in its operating manual and these parameters should not be exceeded at any time
- All the workers should provide personal protective equipment (PPE) like safety jacket, helmet, gloves, goggles, ear muffs, safety belts/harness etc. It should be mandatory for all the workers to wear the PPEs
- Gas cylinders should be kept up right on a custom build stand or trolley. Metal cap should be kept in place to protect the valve when the cylinder is not connected for use. All gas cylinders should be fixed with pressure regulator and dial gauges. Non-return valve and flashback arresters shall be fixed at both end of cylinder and torch.
- Fire fighting facility should be available at the site. CO₂ based fire extinguishers should be provided at the gas cutting/welding area and foam based should be provided at fuel storage area. Fire extinguishers should be provided at all areas as per suitability defined in IS: 2190. Fire evacuation plan should be provided at each work area. Fire evacuation plan should be explained to all the workers, staff & visitors. Fire exit signs should be provided at all the areas and these signs should be LED lit.
- First aid trained personnel should be available at the site and tie ups with the nearby hospital should be made so as emergency situation can be handled. Ambulance or safety motorized vehicle should be available at the site 24 X 7.
- Labour should be trained for on social behavior and community interaction and should be cautioned for not indulging in any unfair means, crime or similar activity at site
- No child labour should be engaged at plant site or for any work
- Load carrying vehicle should move at slow speed only to prevent accidents like toppling over, collisions etc. Speeds should be designated for these vehicle as per the load and vehicle violating the rules shall be penalized

- Labour accommodation should be provided with all the basic facilities like proper bedding, proper sanitation facility (toilets, bathroom & washing area), clean kitchen area, potable drinking water, waste & sewage management facility, LPG fuel for cooking
- Rest area should be provided for the workers at site and workers should not be allowed to rest or lay down on the floor/machine or any other area at the construction site
- Open burning of fuel should be prohibited at the site and at labour accommodation.
- Workers should be instructed for not harming any flora & fauna for any reason
- Labour should be given PEP talks on daily basis, training for handling heavy machinery & equipment, for working on heights, handling the construction material, training on general safety etc. on monthly basis. Further mock drills should be arranged for workers for firefighting, earthquake, rescue a person for a person stuck at height etc.
- Emergency assembly area should be provided at the site and the location should be communicated to all. All worker should collect at that location during the emergency
- Emergency contact nos. (SHE head, SHE officers, Traffic managers, First Aid Personnel, Ambulance, Fire Brigade, Hospital) should be displayed at the site
- Safety guidelines, safety policy, safety slogans should be displayed at the site in English and local language of the area

6.7.13 Impact Due to Dismantling of Temporary Structures Built During Construction Phase

Some of the areas are procured for temporary uses like casting yards, workshops, storage yards, labour camps etc. during construction phase. Generally, the areas under temporary use are not cleaned and restored back. The materials at these areas get eroded away, leaches polluting the natural environment and aesthetics of the area. Measures are proposed to be taken to minimize the pollution due to the temporary installments & structures

Mitigation Measures

- All the debris, rejects, remaining materials etc. at the site should be disposed off safely to the designated location after the construction is completed
- All the redundant machinery, equipment, drums etc. should be sold to authorized vendor and should not be allowed to stay there

- Ground level & drainage pattern of the site should be restored back to original condition
- The soil should be stabilized after restoring back the normal level
- Area should be planted preferably with the shrubs and grass to minimize the soil erosion

6.8 IMPACT during Operation Phase

6.8.1 Ecology

No adverse impact is anticipated on ecology due to project operation. However, KMRL shall ensure that compensatory plantation carried out is being maintained properly. Minimum 70% of survival rate of the tree planted shall be maintained. Proper aftercare and maintenance shall be undertaken. All grown plants shall be provided the critical care like watering, manuring, weeding, protection from stray & grazing animals etc for minimum 5 years. Proper and routine inspection shall be carried out fortnightly on status of the survival of plantation and consolidated reports of fortnightly plantation shall be prepared every six monthly.

6.8.2 Water Resources

Water will be required during operation stage majorly for meeting drinking water requirement of staff, toilets at stations and cleaning & washing of stations. Total water requirement at stations is estimated to be 120 KLD. It is proposed that water will be withdrawn from ground after obtaining permission from CGWA. To minimize the impact on water resources, demand side management should be undertaken so as to minimize the water requirement. Measures are already discussed in design/pre-construction stages which are considered in project design for minimizing the water requirement. Other than this, staff shall be made aware on importance of conservation of water through campaigns and awareness drive.

6.8.3 Micro Climate

Metro project will not have any negative impact on climate during operation phase. Long term benefits of metro rail projects on climate are discussed in sections above

6.8.4 Air Quality

Metro systems will not have any negative impact on air quality. Metro systems are planned to reduce the share of private vehicle on road and enhance the usage of public transport so as to decongest the road. Reduction of vehicles will lead to reduction of vehicular exhaust which is released due to plying of vehicles and due to idling of vehicles in traffic jams. Estimations are made on approximate emission reductions which are discussed in sections above. Some measures shall be incorporated in design are proposed which shall be taken to prevent any impact on air quality.

Mitigation Measures

- Sufficient parking space should be available at all the stations so as people can leave their private vehicle and travel in metro. Further parking of private vehicle should not lead to congestion on roads. Details of available parking area are given in Table 3.10 of chapter 3 of the report.
- Wide access pathways and sufficient nos. of exit & entry should be provided at each station to minimize the congestion
- Rumble strips should be provided on the roads in front of stations so as the speed of vehicle is regulated near station area and chances of accident is minimized
- Adequate feeder services should be provided so as to maximize the catchment area of proposed metro system and minimize the usage of private vehicle to reach the station. These feeder buses should be integrated and linked to city bus services and other Para-transit systems like auto rickshaws and NMVs
- Roads in the station area should be properly maintained and sprinkled with water

6.8.5 Soil Quality

Soil quality at the stations may get impacted if the sewage generated and the waste generated at the stations is not managed properly and is disposed off in open on land. It is estimated approx. 19.8 KLD of sewage will be generated from stations. However, there is provision of the septic tanks for disposal of sewage at the stations.

Waste to be generated during operation phase will be municipal waste comprising of small quantity of food waste, wrappers of packed food and paper waste from offices. Small quantity of used oil may be generated from DG sets. Approx. 137.5 kg of municipal waste is expected to be generated from stations. Twin color dustbins will be provided at the station for collection and at source segregation of waste into recyclable and rejected fraction. Recyclable fraction will be sold to authorized vendors on regular basis and rejected fraction will be disposed off through local agencies in the area responsible for waste management. Used oil will be disposed off through the authorized vendors. Measures proposed to be taken for minimizing impact on soil quality are listed below

Mitigation Measures

- Disposal of sewage through septic tank at stations and timely evacuation of the septic tanks.
- No area should be left excavated or open after any repair & maintenance works
- Fuel, waste oil & used oil should be stored in HDPE containers in isolated areas on paved surface. These paved surfaces should be provided with the drains and oil interceptors should be installed in the drains.

- Hazardous waste, if any should be stored, managed, transported and disposed as per Hazardous & Other Waste Rules, 2016
- Authorization shall be obtained from SPCB for generation of hazardous waste
- Waste generated should be properly collected and segregated at each station in twin bin system. Recyclable fraction of waste should be sold to authorized vendor periodically and non-recyclable/rejected version should be disposed on daily basis through local agencies in the area responsible for waste management
- Used oil shall be disposed through authorized vendor only

6.8.6 Water Quality

Water quality will not be significantly impacted directly due to the project. Water quality will be affected during operation phase only if the waste/sewage generated is improperly stored and disposed. Sewage or untreated or semi treated effluent and waste should not be stored in unlined pond or area else it may lead to pollution of ground water. Any spillage if occurs should be cleaned immediately so as it does not get mixed with the run-off and pollute the surface water quality. Chances of accidents are less in metro as compared to road transportation system thus chances of spillage and leakage of oil also reduces thereby reducing chances of surface water pollution. Measures are proposed to minimize the water quality pollution and the measures are given below

Mitigation Measures

- Disposal of sewage through septic tank at stations and timely evacuation of the septic tanks.
- No area should be left excavated or open after any repair & maintenance works so as there will not be chance of sediments getting mixed with the rainfall run-off
- Proper storm water drainage system and rain water harvesting pits should be provided to harvest the storm water and recharge the same into ground water aquifer system to augment the ground water level and reduce the run-off into the surface water bodies. Along with the stations, it is also proposed to provide the pits at the viaducts to harvest the storm water from viaducts also
- Storm water drains and pits shall be cleared every year prior start of monsoon

6.8.7 Noise Levels

The main sources of noise are traction motors, cooling fans, wheel-rail interaction, electric generator and miscellaneous noise from rolling stock. An attempt is made to predict the rise in ambient noise at different distances. In the present study, following assumptions are adopted:

Track is standard, and

Maximum speed 80 km per hour

The noise produced by the train has been split into:

Noise due to rolling stock, and

Traction motor noise at full powers: 90-dB (A)

The continuous point source model has been used. The ambient noise in railways increases with train speed. The roughness of the contact surfaces of rail, wheel and train speeds are the factors which influences the magnitude of rail wheel noise. The contact surface of rail-wheel noise proposition two ways side is approximately by the continuous point should model, using the following relations at 2 m distance from the source.

$$LAWr = 30 \log_{10} (V/V_0) + 60 \text{ dB (1)} = 63.74 \text{ dB(A)}$$

Where; LAWr - sound pressure level, V - rail car speed, 32 km/hr & Vo - reference sound, 24 km/hr.

The vibration, of concrete structures also radiates noise. This noise has lower frequencies than rail wheel noise. Contribution of this noise at way side is generally insignificant in tracks. When a train is running, definite gear noise is generated at a frequency equal to the number of gear in unit time. The dependence of gear noise level on train velocity is rather intense, so it overcomes the rail wheel noise at the speed higher than 270 km/hr. However, in the case of MRTS train velocity will be far below this speed, i.e. app. 80 kmph.

Traction motor (LAtm) and gear noise (Lag) have been estimated using the following relationship at 2 m distance from the source:

$$LAtm = 60 \log_{10} (V) + C1 \text{ (2)} = 85.7 \text{ dB(A)}$$

$$Lag = 10 \log_{10} (V) + C2 \text{ (3)} = 81.7 \text{ dB(A)}$$

Where C1 and C2 are the constants and have values of -4.6 and 66.7 respectively, V is average rail car speed, i.e. 32 kmph and

Each aerodynamic noise mentioned above is generated from the local structure of the car surface. Magnitudes, numbers and distribution of noise sources are different from each other. These noise sources can be approximated as point sources, when we estimate the influence of these on wayside. Each aerodynamic noise from the solid surface is radiated strongly in the direction normal to the surface.

Presently, a hemispherical sound wave propagation model through a homogeneous loss free medium is used. The mathematical representation of the model is given below:

$$L(P) = LPS - 20 \log (d) - 8$$

Where, LP - sound pressure level, at a distance d, D - distance in meters of the receptors & LPS - point noise source

The cumulative impact of all these different sources in a particular place is calculated by the logarithmic addition model as:

$$LP \text{ (Total)} = 10 \log (10^{LPQ1/10} + 10^{LPQ2/10} + 10^{LPQ3/10})$$

Using the above formula maximum noise level is calculated as follows at a distance of 5.5m form source.

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At a distance of 5.5m sound pressure due to motor noise is given by

$$L(P) = L_{ps} - 20\log(d) - 8$$

$$L(P) = 85.7 - 20\log(5.5) - 8$$

$$L(P) = 62.9 \text{ dB(A)}$$

At a distance of 5.5m sound pressure due to gear noise is given by

$$L(P) = L_{ps} - 20\log(d) - 8$$

$$L(P) = 81.7 - 20\log(5.5) - 8$$

$$L(P) = 58.9 \text{ dB(A)}$$

At a distance of 5.5m sound pressure due to wheel – rail contact noise is given by

$$L(P) = L_{ps} - 20\log(d) - 8$$

$$L(P) = 63.7 - 20\log(5.5) - 8$$

$$L(P) = 40.9 \text{ dB(A)}$$

The cumulative impact of these sources is given by logarithmic addition model

$$LP \text{ (Total)} = 10 \log (10^{LPQ1/10} + 10^{LPQ2/10} + 10^{LPQ3/10})$$

$$LP \text{ (Total)} = 10 \log (10^{62.9} + 10^{58.9} + 10^{40.9})$$

$$LP \text{ (Total)} = 64.3 \text{ dB(A)}$$

The maximum noise level at particular time at 5.5 m is thus estimated as 64 dB(A) including background noise level as 20 dB(A) inside the Metro corridor (Metro corridor is defined as the viaduct structure of 10m plus 5 meter on either side of viaduct. Thus, the width of the corridor is normally taken as 20m)

Noise level at a distance of 12.5m, 25m, and 50m from the alignment have been calculated similarly and these comes out to be 57.23, 51.21 and 45.2 dB(A) respectively. With the years nos. of the metro will increase per hour for peak hour. Thus, the increase in noise level with the distance in year 2017, 2021 & 2031 are given below in **Table 6.15**.

Table 6.15 Noise Estimation Levels for Operation Phase

Distance (m)	Year					
	2023	2028	2033	2038	2043	2048
	Nos. of trains per hour					
	7	9	10	13	18	18
	Max speed = 80 kmph Av Rail car Speed = 32 kmph					
	Noise Level (Leq) during peak hours dB(A)					
5.5	72.5	73.5	74.0	75.1	76.6	76.6
12.5	65.7	66.8	67.2	68.4	69.8	69.8
25	59.7	60.8	61.2	62.3	63.8	63.8
50	53.7	54.7	55.2	56.3	57.8	57.8

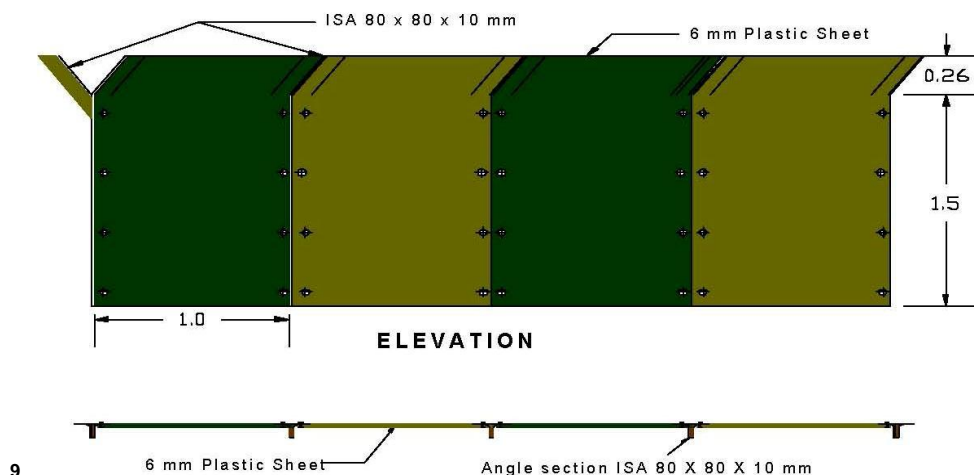
Maximum noise levels observed are 76.6 dB (A) due to operation of project in year 2031 at distance of 5.5 m. This noise level will not cause significant problem during day time

but may be an issue during night time. It is recommended to take the measures during the design stage of the project to minimize the noise level and the suggested measures are given below.

Mitigation Measures

- Provision of anti dumping floor and noise absorption material
- Low speed compressor, blower and air conditioner
- Mounting of under frame equipment and anti-vibration pad
- Smooth and gradual control of door
- Provision of GRP baffle on the via duct for elimination of noise transmission
- Provision of sound absorbing material in the supply duct and return grill of air conditioner
- Sealing design to reduce the aspiration of noise through the gap in the sliding doors and piping holes
- Provision of bolsters less type bogies having secondary air spring
- Ballast less track supported on two layers of rubber pads can be used to reduce track noise and ground vibrations
- In sensitive areas, track on floating slab can be used to reduce track noise and ground vibrations
- Trackside lubrication can be effective in avoiding wheel squeal, which often occurs as Metro rail vehicles traverses tight-radius curves. This installation automatically deposits a small amount of biodegradable lubricant on the top of the rail, and has effectively eliminated wheel squeal and associated complaints from nearby residents
- To prevent development of surface irregularities on the rail, a fairly heavy rail section is to be used. Further, rail grinding at regular intervals by Rail grinding machine and also lubrication of rail by vehicle mounted lubricator have been contemplated
- Rail shall be continuously welded and also shall be laid to fine tolerances so that any noise/vibration on account of irregular track geometry could be reduced. Rails should be grinded in regular basis to minimize the vibrations
- The vibration generated from rail-wheel interaction will be greatly absorbed by the elastic fastening system proposed to be used. Resilient fasteners are used to fasten the rail to concrete track slabs or ballastless bed.
- A ballast mat consists of a rubber or other type of elastomeric pad that is placed under the ballast can be used for reducing vibrations. The mat generally must be placed on a concrete base to be effective

- Other measures which can be taken to reduce vibrations are usage of resiliently supported ties in which concrete ties are supported by rubber pads
- Wheel turning or wheel truing to re-contour the wheel, provides a smooth-running surface and remove wheel flats. The most dramatic vibration reduction results from removing wheel flats. However, significant improvements also can be observed simply from smoothing the running surface. Install wheel flat detector system to identify vehicles which are most in need of wheel truing.
- Implement vehicle reconditioning programs, particularly when components such as suspension system, brakes, wheels, and slip-slide detectors will be involved. The regular regime of reconditioning helps not only mitigation of vibration but also in lower resultant defect generation.
- In addition, it is proposed to provide skirting on coach shells covering the wheel, which will screen any noise coming from rail-wheel interaction from propagating beyond the viaduct
- Noise barrier⁹ helps in reduction of the noise level. Noise level reduction with the help of the barriers is depicted in **Figure 6.3**. Noise barriers can reduce the noise level from 6-15 dB (A). Noise barriers should be provided to minimize the noise levels along the LBS Computer College (Ch-945-965), NLP School (Ch225-275), Holy Kings College (Ch-275-325), Londin College of Business and Finance (Ch 3900-3925), St Martin De Porres Church (Ch-500-550), St Joseph Catholic Church (Ch 3575-3625), SyroMalbar Church (3825-3850), St Kuriakose Knanya Church (Ch-3825-3850), Juma Masjid (Ch275-325), Ahamadia Masjid (Ch 3300-3325), Hanuman Mandir (Ch750-825) and residential areas along the corridor. Noise barrier comprising of absorptive type metal panel and reflective type polycarbonate sheets can be located on edge of the viaducts to reduce the noise intensity to be generated due to metro movement. Height of these barriers can be kept 1.5-2.0 m above the top of rail. The barrier must be long enough to



screen out a moving train along most of its visible path. Thus, length of the barrier shall be considered additional 1 m on both ends at proposed locations.

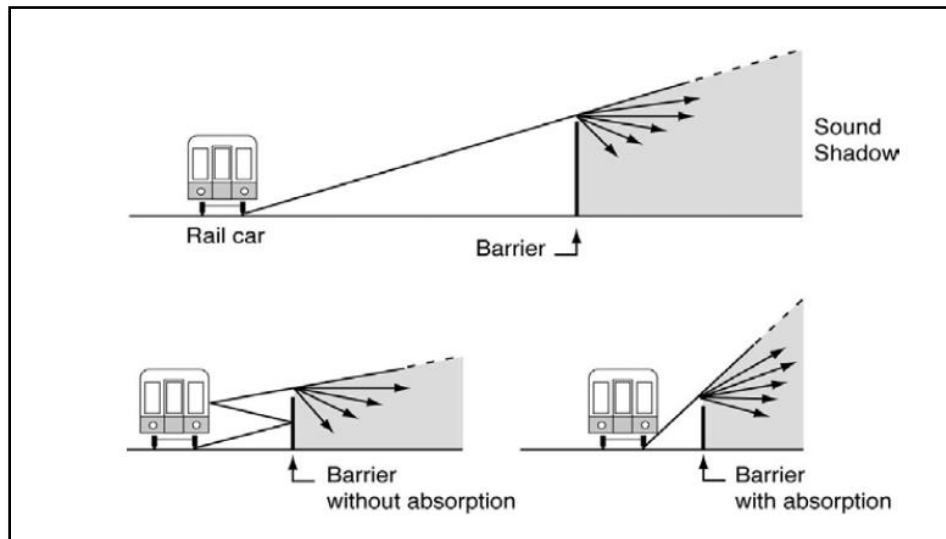


Figure 6.3 Noise Barrier Mechanisms

6.8.8 Traffic Pattern

It is expected that the proposed metro project will shift the load from road to metro thereby reducing the nos. of private vehicle on road. It is estimated that due to project development, approx. 657192 vehicle km will be reduced by 2021 and 1042098 vehicle km will be reduced by 2031. Thus, the project will decongest the road network and the traffic congestion. Further apart from this it is planned by KMRL to overall improve the transportation network of the Kochi region. In Endeavour to this additionally feeder bus service and shared bicycle are planned to be provided by KMRL. These buses will increase the catchment of the proposed metro route. Also, the feeder buses and city buses are planned on such routes that they get integrated with other modes of transportation like city buses, auto-rickshaws & NMVs. This will improve overall traffic pattern in the area and reduce the congestion.

6.8.9 Livelihood

Livelihood of the people whose store will be masked due to station building will get impacted during operation phase

Proposed Phase II metro project involves direct employment of app. 550 people during operation phase. Apart from this indirect employment will be generated due to the project in form of food joints & small shops within metro stations. Also, sale of the stores close to the metro station can be enhanced due to increased foot fall in the area. Overall the proposed metro project has good employment generation potential.

However, since the proposed metro will shift the traffic load from road to the metro corridor thus there may be effect on the earning of the drivers of taxi, auto rickshaws and

NMVs. Thus, a proper planning of the transportation system is required to be undertaken so as these people do not lose the livelihood and also a proper transportation system can be achieved in the area. These transportation modes shall continue to ply but shall act as feeder to bus service or directly to metro routes and thereby will reduce the congestion on road, increase the catchment of the public transportation system and livelihood of all will be protected.

6.8.10 Occupational Health & Safety and Community Health Safety & Security

Operation & maintenance involves various risks for the staff, passengers and people residing near the metro corridor & allied facilities. The risks associated are accidents of metro, accident of people, collapse of structures, fall/slip while working, electrical shocks, electrical fire, fire in DG sets & fuel tanks etc. Various safety measures are proposed to be followed which should be taken to prevent the accidents and near miss.

Mitigation Measures-General

- All the staff should be given training for carrying out the work assigned keeping the safety as priority.
- All staff should be provided with personal protective equipment like HT gloves, safety helmets, safety jackets, ear muffs, safety belts, welding masks, safety shoes, Goggles, safety shoes, full body harness) as required
- Periodic inspection of PPE should be done to ensure that they are in proper condition by keeping the records
- Tests should be undertaken for workers working at heights prior joining. Work at height should be undertaken during day time only.
- Fall arrest system should be provided at the areas which involves working at height
- Induction training should be given to all the workers at the time of joining which should include awareness of the activities to be carried out by worker, tools involved, risks involved and personal protective equipment to be used
- Health check-ups should be undertaken for workers every year
- Proper signage about the stations, entry, exit, fire exit, directions, safety messages, conservation of energy & water, non-spitting, non-littering, restricted entry etc. should be provided at all the stations and inside the metro to make the passenger and staff about the risks involved and required safety measures to be taken
- Adequate emergency exit should be provided in the metro and at station and the location of the same should be displayed at all the suitable locations. Along with the visual display, audio messages should also be communicated at the stations and in metro about the safety measures to be taken

- Proper guards/safety provision should be made along the railings of elevated metro stations. Entry beyond the certain points should be restricted for the passengers
- Entry to the control rooms, firefighting rooms, DG area and other similar areas should be restricted for passengers and entry of such areas should be guarded
- Elevators provided should be regularly maintained and checked for proper functioning
- Maintenance of the metro and other equipment should be carried out regularly as per the approved maintenance schedule
- Functioning of metro, stations, electrical equipment & network, DG sets etc. should be audited and inspected by eligible third part on regular basis
- All the platforms should be properly guarded to ensure people board & de board in queue and do not stand beyond the demarcated area
- Certified First aid trainer should be present at all the stations all the time
- System of work permits should be issued in case any maintenance work is being undertaken at track, electrical wires, OHE, control room and any such area. LOTO system should be implemented to minimize the accidents
- Every day PEP Talks should be taken up with the security & maintenance staff to communicate the major safety principle to be followed and kept in mind.
- Safety meetings should be held monthly to discuss the existing safety practices and measures for improvising the procedures
- Mock drills should be conducted to train staff for handling emergency situations
- Emergency preparedness & response plan prepared for the project should be followed
- Dos and Don'ts during the natural calamity and accidents should be displayed at stations and in metro for passengers and staff so as they know what is to be done during and after emergency.
- Trainings should be conducted for drivers on regular basis to train them about the safety procedures and strictly following the rules
- Regular monitoring, servicing & maintenance of all the signaling, transmission and communication system to minimize the chances of accidents
- Emergency contact numbers should be displayed at the stations & in metro
- Photography should be restricted in the metro premises
- Floors of stations and metros should be cleaned on daily basis
- Lifting equipment engaged should be thoroughly and regularly examined before use

- Fire-fighting equipment should be provided at all the locations, i.e. inside metro, stations at depot as per the granted NOC from local Fire Department. Fire evacuation plan should be displayed at all the desired locations
- Accident records should be maintained. Accident reporting should be done within 1 day after accident and detailed root cause analysis should be carried out for each accident so as preventive measures can be taken to prevent any similar accidents in future
- Regular maintenance of the viaduct, piers, pier caps, OHE system should be done. Regular inspections should be carried out to detect any breakage, cracks or deformity

6.8.11 Aesthetics

Since the metro corridor is elevated section, it may obstruct the views from the nearby building which. Also, the existence of the metro corridor along the road or along the median in the busy stretch of the roads may also affect the aesthetic value of the area. Further the areas under the viaducts if not maintained may be used by people for dumping waste or may be encroached upon by slum dwellers. Sometime outer areas of the stations are also encroached by the slum dwellers. Thus, following measures should be taken to prevent the impact on aesthetics in the area.

Mitigation Measures

- Area under the viaduct and near the stations should be regularly monitored and no commercial establishments or slums should be allowed to come up
- Color of the viaducts and piers should be kept white
- Bills should not be allowed to be stick on the piers and other structures
- Regular cleaning of the stations, nearby areas and the areas under via duct should be carried out
- Area under viaducts and additional land if available near stations and depots should be used for development of green area

6.8.12 Quality of Life

Project is proposed with the ambit of improving the public transportation system in the Kochi region. Planned metro system is light weight rail system and is safe, reliable, comfortable and cost-effective. Proposed project will help in shifting the road traffic to the proposed metro and thus will help in reducing the congestion on roads, reducing emissions/pollution emitting due to traffic congestion, improved environment, reduction in time of travelling, reducing the cost involved in travelling and improved transportation system. This will overall improve the quality of life of the people of the area. Further metro project will generate substantial employment opportunity, i.e. for app 550 people. This will increase the earning of people and will improve their purchasing power and will improve their quality of life. Overall impact of the project on quality of life of people is positive.

6.9 Conclusion

From above analysis, it is found that the impacts anticipated vary from high to low significance and magnitude. Major anticipated impact of the project are due to increased noise levels, polluted air quality, tree cutting and disrupted traffic during the pre-construction & construction phase however major impact during operation phase is increased noise levels. The project also has various positive impacts like reduction in carbon emissions, improved overall air quality of the city, better transportation system and improved quality of the life. It is believed that the anticipated negative impacts can be normalized by taking the proposed mitigation measures.

CHAPTER 7. ENVIRONMENTAL MANAGEMENT PLAN

This chapter details the pollution prevention & management plan, disaster management plan, Institutional Framework for Implementation of EMP, Environment Monitoring Plan, SHE Policy, Grievance Readressal System, Trainings, Monitoring & Audits, Environment management Budget, Documentation, Updating and Record Keeping

7.1 Introduction

The Environmental Management Plan (EMP) is the synthesis of all proposed mitigating and monitoring actions, set to a time frame with specific responsibility assigned and follow-up actions defined. The EMP is a plan of action for avoidance, mitigation and management of the envisaged negative impacts of the projection environment and enhancing the project benefits.

7.2 Objectives of EMP

The EMP consists of a set of mitigation, monitoring and institutional measures to be taken during the design/pre-construction, construction and operation stages of the project. The EMP has been designed keeping in view the regulatory and other requirements to ensure the following:

- Minimum disturbance to the environment and social components
- Compliance with the environmental acts, rules and guidelines of GoI & maintaining the quality of air, water, soil and noise as per the prescribed norms by regulatory bodies.
- Conservation of natural resources to the extent possible
- No/minimal disturbance the social environment
- Enhancement of Project benefits for Society & Environment
- Sustainable development and operation of project

7.3 Environment Management Plan

As assessed in above chapter the project will have impact of low to high significance on both environmental and social components. To manage the impacts, mitigation measures are proposed but management plan, implementation and supervision agencies, and period of implementation should be defined for implementation of the listed mitigation measures. Environment management plan for the project is given in **Table 7.1** below.

Table 7.1: Environment Management Plan

Environmental Component/Issue/Activities	Remedial measures	Reference to Laws and Other Documents	Institutional Responsibility	
			Implementation	Monitoring
DESIGN AND PRE-CONSTRUCTION PHASE				
Land Acquisition	<ul style="list-style-type: none"> • Land owners/tenants shall be consulted prior initiating the process of land acquisition • Land acquisition shall be undertaken as per the LARA Act, 2013, Land Acquisition Policy of KMRL and WB OP 4.11 • Social impact assessment study and resettlement action plan prepared as per the LARA Act, 2013, Land Acquisition Policy of KMRL and WB OP 4.11 and shall be updated if there is any change in alignment and shall be followed strictly for land acquisition • Criteria for resettlement and rehabilitation as given in Table 3.4 of Chapter 3 shall be considered for resettlement and rehabilitation works • Land acquisition shall be undertaken only after provision of the compensation to the land owners and the tenants • No additional land other than identified land shall be used for any purpose of project development • If any additional land is required for establishment of any facility including labour camp, storage yards, casting yards, work shop or any project related facility then prior approval shall be undertaken by KMRL followed by approval from the land owner. Supplementary SIA and RAP shall be prepared for the additional land. 	<ul style="list-style-type: none"> • LARA Act, 2013 • Land Acquisition Policy of KMRL • WB OP 4.11 	KMRL	KMRL

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	<ul style="list-style-type: none"> • Labour camps shall be avoided to be established and rented accommodation with all basic facilities shall be provided for the construction labour by contractor to minimize the temporary land requirement 			
Impact on Structures	<ul style="list-style-type: none"> • Owners shall be pre-informed about the detail of the extent to which the structure will be impacted, and consent shall be obtained from owner prior demolishing or dismantling the structure • Compensation as per RAP shall be provided to the owners • No structure or property shall be affected during metro construction works other than pre-identified structures • Contractor shall bear all the expense of renovation/repair of the damage to any other property. Structure other than pre-identified structures 	<ul style="list-style-type: none"> • LARA Act, 2013 • Land Acquisition Policy of KMRL • WB OP 4.11 	KMRL	KMRL
Livelihood	<ul style="list-style-type: none"> • Compensation for livelihood for the directly affected people shall be given as per approved RAP • Provision for visibility shall be kept for the stores which get masked behind the barricaded and the station building during construction and operation phase so as the income does not get affected due to visibility reasons • Local people should be preferred for provision of jobs (unskilled, semi-skilled and skilled) both during construction and operation phase • Minimum wage act should be followed for the labour • Labour and staff engaged should be provided with the safe and clean working environment 	<ul style="list-style-type: none"> • LARA Act, 2013 • Land Acquisition Policy of KMRL • WB OP 4.11 	KMRL	KMRL
Land Use	<ul style="list-style-type: none"> • Temporary acquired areas like areas for casting yards & workshops etc. should be properly rehabilitated after completion of the construction phase and handed back to the owner 	Rules and Regulations of Local bodies/village panchayat	Concessionaire	KMRL

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	<ul style="list-style-type: none"> • Labour Camp establishment shall be avoided, and rented accommodations shall be arranged for the labour by contractor • Measures shall be undertaken to prevent the encroachment of the land in the nearby development work areas 			
<p>Traffic Diversion</p>	<ul style="list-style-type: none"> • Provision of access pathway & adequate parking areas at construction site, storage yards & casting yards • Construction material vehicle and debris carrying vehicle should not be parked on road especially during peak traffic hours • Regulating the time of vehicle carrying construction material & debris to avoid peak traffic hours • Drivers should be given instruction for not over speeding the vehicle, not overtaking other vehicle, not to drink and drive and to do lane driving to minimize the chances of accidents. Drivers should be penalized in case any such activity is reported. Accidents may disturb the traffic badly. Drivers shall be trained for defensive driving practices • Routes and time should be designated for movement of the transportation vehicle and same shall be strictly followed • Contact no of EHS cell officials, movement path and timing should be displayed on the vehicles carrying construction material and debris so as complaints can be reported against the vehicle if any unfair activity is seen to be carried out by drive • Village roads/narrow routes should be avoided for transportation of construction materials • At locations where alignment is cutting across a major traffic corridor, ‘Continuous Cantilevered Construction Technology’ would be applied to prevent traffic hold-ups or diversions of any kind. 	<p style="text-align: center;">Rules of RTO</p>	<p style="text-align: center;">Concessionaire</p>	<p style="text-align: center;">KMRL</p>

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	<ul style="list-style-type: none"> • Obtaining all required permits, land acquisition works, provision of compensation and implementation of RAP shall be undertaken prior start of the construction works so as the construction works can be undertaken rapidly without any undue delay • Permission from RTO shall be taken prior partial/full closure of any road • A detailed plan shall be prepared for traffic management including details on closure of roads, requirement of sign ages and details of diversion of traffic and same shall be shared with the public through appropriate media including newspaper (local & English language), National television and through radio at least 1-week prior diversion • Proper MS barricaded with LED lights on top shall be provided along the construction area and traffic marshals shall be deputed in major traffic areas like junctions, roundabout, circles etc. to manage and guide the traffic • Proper signage shall be provided to inform people about the diversion/blockage • All the diverted routes/roads shall be restored back to original condition after completion of construction works 			
<p>Tree Cutting and Vegetation Removal</p>	<ul style="list-style-type: none"> • A joint survey shall be undertaken by engineer of KMRL, engineer of contractor and environment expert of contractor to assess the requirement of tree cutting and how the same can be minimized • Permission shall be taken from District Tree Authority as per GO (P) No.85/86/F&WLD dated. 2nd September 1986 and GO (P) No.68/2010/F&WLD dated 10.02.2010 prior undertaking tree cutting • Budget for the compensatory plantation shall be considered in 	<ul style="list-style-type: none"> • State Forest Act • GO (P) No.85/86/F&WLD dated. 2nd September 1986 regarding felling of trees and GO (P) No.68/2010/F&WLD dated 10.02.2010 	<p>Concessionaire</p>	<p>KMRL</p>

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	<p>DPR</p> <ul style="list-style-type: none"> • All conditions mentioned in permission letter shall be followed • Compensatory afforestation shall be undertaken as per 1:12 ratio as directed by Forest Department • Only native species with less water & maintenance requirement shall be considered for Compensatory afforestation • Survival rate of minimum 70% shall be maintained for Compensatory afforestation. Compensatory afforestation shall be monitored, and survival rate report shall be prepared annually 	<ul style="list-style-type: none"> • The Kerala Preservation of Trees Act, 1986 • The Kerala Restriction of Cutting and Destruction of Valuable Trees Rules, 1974 		
<p>Impact Due to Establishment of Labour Camps/Construction on Camps</p>	<ul style="list-style-type: none"> • Labour camp should not be established instead rented accommodation with proper toilets, sewerage system and waste management facility should be provided for labour by contractor • If established, camps should not be established in residential areas, agriculture land, forest area and vegetated or planted area. Waste land or open area shall be preferred for establishment of such campus • Campus shall be established at minimum distance of 500 m from residential areas, sensitive zones (educational, religious and health centers), forest areas, wildlife areas and water bodies • Basic facility like bedding, toilets with running water facility, cooking area and LPG fuel, bathing area, washing area, proper ventilation and proper illumination should be provided in the campus • Dustbins should be provided for waste collection and the waste should be disposed off through the local bodies • LPG should be used as cooking fuel. No open burning of biomass should be allowed 	<p align="center">--</p>	<p align="center">Concessionaire</p>	<p align="center">KMRL</p>

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	<ul style="list-style-type: none"> • Labour should be trained about not practicing any unfair practices and get involved in any crime like theft/drinking alcohol etc. 			
Impact due to shifting of existing utilities	<ul style="list-style-type: none"> • Concerned authorities, i.e. KWA (Kochi Water Authority), BPCL, KSEB (Kerala State Electricity Board) and BSNL and others shall be consulted prior dismantling any of these services and prior permission shall be obtained from these authorities for shifting of these utilities • All conditions of the permission shall be followed and complied • Alternate arrangement for the resource shall be arranged for community prior dismantling/disturbing these utilities • Public shall be pre-informed through appropriate media for preparedness in case of disturbance of service which cannot be shifted prior dismantling and some alternate arrangement shall be made for public • Budget shall be kept in DPR for shifting of utilities 	--	Concessionaire	KMRL
Impacts Due to Natural Hazard	<ul style="list-style-type: none"> • Construction activities shall be stopped during monsoon and on red alert days by IMD • Construction sites shall be made clear off loose construction material and debris prior onset of monsoon • Safe sites shall be identified for shelter in case of massive flood • Run-off from stations & viaducts shall be collected through the drainage system and shall be recharge into the ground through pits • Structure shall be designed considering the seismic risk for (higher level) Zone IV to ensure that structure does not get impacted due to earthquake of moderate intensity as expected in Zone III • Suitable seismic coefficient shall be adapted in the design of structure commensurate to the Indian Standard seismic zoning 	--	Concessionaire	KMRL

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	<p>of the country</p> <ul style="list-style-type: none"> • Provision of Bureau of Indian Standards codes like IS: 1893:1984, IS :1893(Part 1):2002, IS: 1893(Part 4):2005, IS: 4326:1993 etc. shall be incorporated suitably while designing the structures 			
CONSTRUCTION PHASE				
<p>Impact Due to Excavation and Muck Disposal</p>	<ul style="list-style-type: none"> • Options shall be used for exploring usage of excavated muck for the road widening and construction purpose or for construction purpose of metro works • In case this excess muck is not used then it should be disposed off with the permission of Kochi Municipal Corporation. There is an existing solid waste management site at Bhramapuram. • If permission is not obtained, then contractor shall identify the location for establishment of the debris disposal site. This debris disposal site shall preferably be established on the waste land. • Debris disposal site shall not be constructed in the forest area, agriculture field and settlement area and minimum distance of approx. 500 m shall be maintained from water body, settlement area, forest/wildlife area • Debris disposal site shall be covered through wall on all the sides and proper drainage channels shall be provided at the site to channelize the run-off • This site shall be used for disposal of excess excavated muck and the remaining construction waste which is non-hazardous in nature • Site shall be properly compacted after disposal of muck and top soil cover of 15 cm shall be provided after compaction. This site shall be stabilized by carrying out the turfing and tree 	<p>Construction and Demolition Waste (Management & Handling) Rules, 2016</p>	<p>Concessionaire</p>	<p>KMRL</p>

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	plantation on the site			
Impact on Micro Climate	<ul style="list-style-type: none"> • Only identified trees should be cut/shifted • All the conditions as mentioned in the tree cutting NOC shall be followed • Compensatory plantation should be taken in ratio of 1:12 and survival rate of minimum 70% should be maintained. • Proper maintenance and after care shall be undertaken for the compensatory plantation. Tree guards shall be provided for all the trees to be planted • Tree requiring less water and care shall be selected for plantation and Eucalyptus shall strictly be avoided • Feeder bus system and bicycle sharing system as proposed shall be implemented and enhanced • Adequate parking space shall also be identified in nearby areas so as people can park their vehicle in that area and use metro for travel 	--	Concessionaire	KMRL
Impact on Soil Quality	<ul style="list-style-type: none"> • No excavation works or tree cutting, or vegetation removal works shall be undertaken during rainy season • Only the identified tree for cutting as per Forest NOC should be cut • Construction activity should be initiated immediately after the vegetation is removed from work area • All the excavated material shall be properly stacked in the pile with the slope not more than 1:2 and shall be kept covered. Excess excavated soil shall be removed from the site on regular basis • Disposal of the excavated muck and construction debris shall be done as per the debris disposal plan only • Waste to be generated from the labour campus shall be collected and stored in covered area and shall be sent for 	<ul style="list-style-type: none"> • Municipal Waste (Management & handling) Rules, 2016 • Hazardous & Other Waste (Management & Handling) Rules, 2016 	Concessionaire	KMRL

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	<p>disposed off through local agency on daily basis</p> <ul style="list-style-type: none"> • No construction waste or redundant machinery shall be left behind at site or on road etc. after construction works are completed • Fuel, used oil, paints and loose construction material shall be stored on paved surface in covered condition only to prevent its spillage. Entry to this area shall be restricted and only authorized and trained person shall be allowed. Proper drainage shall be provided around the fuel/used oil/paint storage area so as any spillage can be collected. These drains shall be provided with oil & grease trap also to prevent mixing of oil with the site run-off • Machinery to be used should be regularly serviced and maintained to prevent the leakages of fuel • Workers should be trained to handle the material and machinery so as there is minimal spillage, leakage due to breakage during handling • Any hazardous waste like used oil from DG sets/machinery shall be disposed off through authorized hazardous waste vendors • Areas to be used temporarily shall for establishing casting yards, workshops, storage, labour campus shall be restored back to the original conditions • Measures shall be taken to prevent the erosion of banks in area where construction is proposed to be undertaken near the water body. Silt arresters shall be provided along the water bodies in the activity area to prevent flow of silt in water bodies 			
Impact on Topography and	<ul style="list-style-type: none"> • No pier construction should be carried out in water bodies falling along the RoWs • No disturbance to the flow or hydrology of the water bodies 	--	Concessionaire	KMRL

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Drainage	<p>should be made due to project construction. If any pier construction is undertaken in any water body then, proper hydro geological modeling study shall be undertaken by contractor to study impact on flow & drainage of construction on these water bodies</p> <ul style="list-style-type: none"> • Temporary Drainage should be provided at the construction site, casting/storage yards, labour campus sites as per the natural drainage pattern of the area. These drains shall be provided with the silt trap and oil & grease traps. • No drain/water body/stream should be closed during project construction • Storm water from viaduct and station buildings shall be collected and recharged to ground through RWH pits 			
Impact on Air Quality	<ul style="list-style-type: none"> • Site should be barricaded from all the sides and shall remain barricaded till all the construction works are over and the construction machinery and material are removed from the site • Construction Vehicles/machinery should be regularly serviced and maintained. Vehicle and all wheel/chain mounted machinery should carry the PUC certificate. All the vehicle should be covered • Vehicle inspection camp shall be established to ensure that vehicle are properly serviced and maintain and comply with the emission norms • All the transportation vehicle carrying construction material, debris, muck etc. should be properly cleaned and covered • Old machinery and equipment (older than 3 years) should not be used for construction purpose and they should meet the prescribed emission norms • Raw material and debris should not be piled up at site and should be ordered as per the need at site. 	Air Act (Pollution Prevention & Control), 1981	Concessionaire	KMRL

	<ul style="list-style-type: none"> • Raw materials/debris/excavated muck should be properly stacked and stored under covered conditions at designated areas/storage yards. Debris/muck should be regularly removed from the site for regular storage/disposal • Muck shall be compacted after disposal in debris disposal site • Minimal storage of construction material at the site shall be ensured. Construction material should be brought to the site from storage yards as per need and piling of material should be avoided at site. • Locally available raw material should be preferably used, and raw material should be purchased from licensed vendors only • Temporary connection of electricity should be taken for operation of machinery/equipment and lighting at site and usage of DG sets should be minimal • Low Sulphur diesel only should be used as fuel in DG sets. DG sets should be provided with the stack height of minimum 6 feet. DG sets should be used only in case of power failure • For construction workers at accommodations, only LPG should be provided as fuel. Burning of the wood or any other fuel or open burning of the waste should be prohibited at the site and the labour accommodation site • Water sprinkling should be carried out at casting & storage yards, construction site, loading & unloading area, approach road, haulage road, raw material storage area and muck disposal sites. Flow rate of water sprinklers should be maintained to minimize the run-off and for effective results • Adequate parking area should be provided for vehicle for loading & unloading so as to prevent parking on the road and causing traffic jams and congestion • Compensatory plantation shall be undertaken in the ratio of 			
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	<p>1:12 and minimum survival rate of 70% shall be maintained</p> <ul style="list-style-type: none"> • Precautions w.r.t air pollution control as stipulated in IS: 5121 ‘Safety code for Piling and other Deep Foundation’ should be adopted. • Casting yards, batching plants etc. should be located away from residential and sensitive areas. Pre-identified casting yards at Kalamassery shall be used with prior permission of the concerned agency 			
<p>Impact on Noise Level</p>	<ul style="list-style-type: none"> • All the construction machinery and equipment used should be provided with adequate noise mufflers and noise suppression equipment. Proper lubrication and maintenance of the machinery & equipment and vehicle to be carried out to minimize the noise generation due to abrasion • Any diversion/closure of route shall be done with the prior permission of RTO and as per traffic Management Plan only • Honking should be prohibited at the site. For management of traffic, a traffic supervisor and marshals should be available 24 X 7. • All noisy activities should be carried out during day time only (9:00 AM to 10:00 PM). No noisy works shall be undertaken during night time • Activity area should be barricaded. Barricading helps to lower the noise levels. Effective noise barriers can reduce the noise levels even by 20 decibels. Steel barricades can be used for reducing the noise as well as for controlling dust spread. • Casting yards, batching plants etc. should be located away from residential and sensitive areas. • Temporary noise shields should be provided all around the heavy noise making activity especially pile driving. Noise blankets, combined sound absorbent etc. may be used to 	<p>Noise Rules, 2000 as amended in 2010</p>	<p>Concessionaire</p>	<p>KMRL</p>

	<p>reduce the noise level in high noise generating activities like pile driving. Precautions w.r.t noise control as stipulated in IS: 5121 ‘Safety code for Piling and other Deep Foundation’ should be adopted.</p> <ul style="list-style-type: none"> • Noise level from loading & unloading of material can be reduced by usage of various types of cranes & placing material on sand or sandy bag beds. • Noise monitoring should be carried out to ensure the effectiveness of mitigation measures and develop a mechanism to record and respond to complaints on noise. • Adequate parking space to be provided at the project site to minimize the honking requirement due to congestion and jams and restricting the speed limits. • Job rotations should be practiced for workers, working in noisy environment. • Protection devices (earplugs or earmuffs) shall be provided to the workers operating near high noise generating machines. • Workers in those sections where periodic adjustment of equipment/machinery is necessary, should be provided with sound proof control rooms, so that exposure to higher noise level is reduced • Hearing test for the workers prior to deployment at site and high noise areas followed by periodic testing every six months. • Automation of equipment and machineries, wherever possible should be done to avoid continuous exposure of workers to noise • OSHAS guidelines should be followed for maintaining noise exposure levels of the construction workers. As per standards, workers’ exposure to 90 dB(A) noise level should not be more than 8 hours. OSHAS guidelines should be followed for 			
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	exposure to specific noise levels for workers			
Impact on Water Resources	<ul style="list-style-type: none"> • Ground water should be used only after obtaining NOC from CGWB and all conditions as mentioned in NOC shall be followed and complied by contractor • Low flow taps shall be provided in toilets and kitchen and all water storage tanks should be covered to minimize loss due to evaporation • Regular inspection of the water storage structures and pipelines to detect leakages. Detected leakages should be immediately repaired to minimize water loss • Using curing agents for carrying out curing. If water is used for curing then low flow sprinklers should be used for curing purpose, curing should be carried out during early morning & evening to minimize evaporation, concrete structures should be covered with gunny bags after curing is done to conserve the moisture • Run-off from curing should be collected through drains into sedimentation tank and should be re-used for curing or washing of vehicle/machinery or for wheel washing • Workers should be educated to use water wisely and do not leave the taps open without use. Written notice should be displayed near the water taps for saving water & closing the taps. • Provision of storm water drains and rain water harvesting pits and to collect storm water from station area and viaducts and to recharge the water in the ground 	Ground Water Guidelines for Withdrawal and Policies of Irrigation Department	Concessionaire	KMRL
Impact on Water Quality	<ul style="list-style-type: none"> • No excavation, vegetation removal and tree cutting/shifting work should be carried out during monsoon season or during rains or during storm. • After tree cutting or shifting of trees & shrubs, soil in that 	Water Act (Pollution Prevention & Control), 1974	Concessionaire	KMRL

	<p>location should be compacted</p> <ul style="list-style-type: none"> • No waste/material/debris/excavated muck should be thrown in any water body • Machinery and vehicle should be serviced and maintained regularly to prevent fuel leakages. Leakages from tanks should be regularly inspected • Training to be given to workers for handling of materials, chemical and machinery to minimize spillage of any contaminant at site • Proper toilets shall be provided at site and labour camps to prevent open defecation. Sewage shall be disposed from toilets, kitchen and washing area through septic tanks. Septic tank shall be cleaned on regular basis through the authorized agencies of local bodies • Fuel storage should be minimized at the site. Fuel if stored should be stored in isolated locations in HDPE container on paved surface provided with the drains & oil interceptors. • Drip pans shall be provided with vehicles with leaks to prevent soil contamination • Waste to be generated at construction site should be handled, managed and disposed properly and should not be allowed to contaminate the run-off from the site. No waste should be thrown in any water body during construction phase. • Water tanks should be covered always and should be cleaned on regular basis • Sedimentation tanks should be provided all around the excavation sites especially near the water bodies. Silt curtains should be provided in the water body when construction is taking place close to the water body • Minimal construction material should be stored at the site. 			
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	<p>Construction material should be stored at the storage yards only in the covered sheds and on paved surfaces to minimize their interface with the air, water & soil.</p> <ul style="list-style-type: none"> • Curing run-off should be minimized by using low flow sprinklers for curing or using curing agents. Curing run-off should be collected in the sedimentation tank and should be used for curing purpose or dust suppression. Further wastewater from batching plant can be collected in sedimentation tank for arresting the sediments and the run-off can be used for curing & dust suppression. Sediments can be collected and can be disposed • No machinery washing or cleaning should be undertaken near any water body. Vehicle washing water should be collected and channelized into septic tank. Fuel storage should also be away from water body (minimum 100 m). No maintenance workshop shall be established within 100 m of any water body • Area along the water bodies shall be barricaded and silt fencing shall be provided near the river to prevent flow of silt/debris in river. 			
Impact on Ecology	<ul style="list-style-type: none"> • No tree/shrubs/vegetation should be removed except which are approved in the forest NOC • If any additional tree cutting is required, prior approval from Tree Authority/Forest department should be taken • Construction sites, casting yards, storage yards etc. shall be regularly sprinkled with water for dust suppression • Machinery staging & movement, machinery & vehicle parking, material storage, debris storage should be carried out at designated locations only and no such activity should be carried out at green belts along the road/drains, parks, playgrounds, agriculture fields etc. 	<ul style="list-style-type: none"> • State Forest Act • GO (P) No.85/86/F&WLD dated. 2nd September 1986 regarding felling of trees and GO (P) No.68/2010/F&WLD dated 10.02.2010 • The Kerala Preservation of Trees 	Concessionaire	KMRL

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	<ul style="list-style-type: none"> • No eco-sensitive area or forest area or thickly vegetated areas should be procured for any project related activity • No debris/construction waste should be disposed-off in any water body in the area or any other vegetated land • Silt fencing shall be provided along water bodies to prevent inflow of silt/sediment/materials in the River. • Workers and staff at the site should be clearly instructed about not harming any animal or bird or removing vegetation or cutting any tree for any purpose from the site and nearby area • Entire activity area should be barricaded so as to prevent trespassing of any animal • No toxic or poisonous substance should be stored in open which can be consumed/spilled by any fauna 	<p>Act, 1986</p> <ul style="list-style-type: none"> • The Kerala Restriction of Cutting and Destruction of Valuable Trees Rules, 1974 		
<p>Impact on Aesthetics</p>	<ul style="list-style-type: none"> • Machinery/vehicle should be parked only at the designated location. No parking should be done on the road or in front of any private or Government building or public utility • Entire activity area, casting yards, storage yards etc. should be barricaded • Temporary structures at storage yards and casting yards etc. should be dismantled immediately after the construction works are completed and these areas should be restored back to the original condition • Construction debris & excavated soil should be removed on regular basis from the site & should be re-used & disposed off at the designated sites in accordance to the waste management rules • Construction machinery, scraps (if any), debris, damaged equipment etc. should be removed from the site after construction is completed. No redundant machinery, scrap or material shall be left on the construction site after construction 	<p align="center">--</p>	<p align="center">Concessionaire</p>	<p align="center">KMRL</p>

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	is completed			
Impact on Community	<ul style="list-style-type: none"> • Suggested environment management plan should be implemented to minimize the pollution from the project and associated social issues • Traffic diversion and management plan shall be prepared prior undertaking diversion in consultation with RTO and same shall be shared with the public through appropriate media including newspaper (local & English language), National television and through radio at least 1-week prior diversion • Alternate arrangement for the resource shall be arranged for community prior dismantling/disturbing the utilities (water supply pipeline, sewerage line, drainage line, electricity lines, telecom line and BPCL pipeline) which will be affected due to project development • Public shall be pre-informed through appropriate media for preparedness in case of disturbance of service which cannot be shifted prior dismantling and some alternate arrangement shall be made for public • No batching plant, construction labour camps, casting yard, fuel storage site etc. should be installed within 500 m of any of the residential area, sensitive zone, forest/wildlife area and water body • Land acquisition shall be undertaken as per the SIA study and RAP prepared for the project prepared in line with LARA, 2013, WB policies and KMRL R & R policies and affected families/people should be provided compensation accordingly. A separate SIA/RAP shall be prepared if there is any change in land requirement • A grievance readressal system be in place and communicate to the public to register their grievances, if any. Grievance 	--	Concessio naire	KMRL

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	<p>readressal mechanism should be such that all the complaints should be registered irrespective of colour, caste, creed & position. All the registered complaints should be enacted within 15 days of registration. Consultation with the affected/grieved should be carried out by in charge of the grievance readressal cell. Registered grievance should be resolved completely within 1 month of registering the grievance.</p>			
<p>Impact on Occupational Health & Safety and Community Health Safety and Security</p>	<ul style="list-style-type: none"> • All construction site, activity area, casting yards, fuel storage area, workshop area etc. should be barricaded and the entry should be restricted to authorized personnel only. ID cards should be issued to all the authorized personnel including the workers, labour, employee, staff, inspectors & visitors • No excavated area should be left open without barricading. LED lights should be provided on the barricading to guide the traffic in night. Traffic marshals should be deputed in the area requiring minor & major traffic diversion to guide the traffic about the diversions. Notices should be displayed on LED lit boards to caution public about the work in progress, speed limits to be kept, sharp curves, diversions etc. • No public place like parks, footpaths etc. should be used for any purpose for project without any prior permission from concerned department and information to the affected public • No utility shifting should be done without providing the alternative before dismantling. New utility should be developed at the new location prior dismantling the old facility. Information about any inconvenience which may occur to local public should be given to the public in advance (min 24 hours). • KMRL has framed the SHE policy and it is essential for all contractors to follow the SHE Policy of the KMRL. The SHE policy is made in line with the requirement of BOCWA and 	<p align="center">--</p>	<p align="center">Concessionaire</p>	<p align="center">KMRL</p>

	<p>BOCWR. SHE policy addresses safety of the construction workers as well as the safety of the nearby community</p> <ul style="list-style-type: none"> • Transportation vehicle should be in good conditions and should comply with all safety conditions. Transportation vehicle should carry the load according to its capacity • All the lifting equipment should be properly examined and tested prior usage. All relevant information should be known about the load, method of slinging and attachment points • Person involved for lifting and installation works and those working in heights should be properly trained for the work assigned • Safety officers & supervisors should be present all the time at site during execution of the work, laying of foundations, piers, piers cap, slabs etc. • Where possible, exclusion zones should be established and maintained in order to prevent any unauthorized access to lifting areas • When lifting large loads, ensure weather conditions are favorable for the task. Heavy lifting equipment typically has safe operating parameters included in its operating manual and these parameters should not be exceeded at any time • All the workers should provide personal protective equipment (PPE) like safety jacket, helmet, gloves, goggles, ear muffs, safety belts/harness etc. It should be mandatory for all the workers to wear the PPEs • Gas cylinders should be kept up right on a custom build stand or trolley. Metal cap should be kept in place to protect the valve when the cylinder is not connected for use. All gas cylinders should be fixed with pressure regulator and dial gauges. Non-return valve and flashback arresters shall be fixed at both end 			
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	<p>of cylinder and torch.</p> <ul style="list-style-type: none"> • Fire fighting facility should be available at the site. CO₂ based fire extinguishers should be provided at the gas cutting/welding area and foam based should be provided at fuel storage area. Fire extinguishers should be provided at all areas as per suitability defined in IS: 2190. Fire evacuation plan should be provided at each work area. Fire evacuation plan should be explained to all the workers, staff & visitors. Fire exit signs should be provided at all the areas and these signs should be LED lit. • First aid trained personnel should be available at the site and tie ups with the nearby hospital should be made so as emergency situation can be handled. Ambulance or safety motorized vehicle should be available at the site 24 X 7. • Labour should be trained for on social behaviour and community interaction and should be cautioned for not indulging in any unfair means, crime or similar activity at site • No child labour should be engaged at plant site or for any work • Load carrying vehicle should move at slow speed only to prevent accidents like toppling over, collisions etc. Speeds should be designated for these vehicle as per the load and vehicle violating the rules shall be penalized • Labour accommodation should be provided with all the basic facilities like proper bedding, proper sanitation facility (toilets, bathroom & washing area), clean kitchen area, potable drinking water, waste & sewage management facility, LPG fuel for cooking • Rest area should be provided for the workers at site and workers should not be allowed to rest or lay down on the floor/machine or any other area at the construction site 			
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	<ul style="list-style-type: none"> • Open burning of fuel should be prohibited at the site and at labour accommodation. • Workers should be instructed for not harming any flora & fauna for any reason • Labour should be given PEP talks on daily basis, training for handling heavy machinery & equipment, for working on heights, handling the construction material, training on general safety etc. on monthly basis. Further mock drills should be arranged for workers for firefighting, earthquake, rescue a person for a person stuck at height etc. • Emergency assembly area should be provided at the site and the location should be communicated to all. All worker should collect at that location during the emergency • Emergency contact nos. (SHE head, SHE officers, Traffic managers, First Aid Personnel, Ambulance, Fire Brigade, Hospital) should be displayed at the site • Safety guidelines, safety policy, safety slogans should be displayed at the site in English and local language of the area 			
<p>Impact Due to Dismantling of Temporary Structures Built During Construction Phase</p>	<ul style="list-style-type: none"> • All the debris, rejects, remaining materials etc at the site should be disposed off safely to the designated location after the construction is completed • All the redundant machinery, equipment, drums etc should be sold to authorized vendor and should not be allowed to stay there • Ground level & drainage pattern of the site should be restored back to original condition • The soil should be stabilized after restoring back the normal level • Area should be planted preferably with the shrubs and grass to minimize the soil erosion 	<p align="center">--</p>	<p align="center">Concessionaire</p>	<p align="center">KMRL</p>

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OPERATION PHASE				
Air Quality	<ul style="list-style-type: none"> • Sufficient parking space should be available at all the stations so as people can leave their private vehicle and travel in metro. Further parking of private vehicle should not lead to congestion on roads. • Wide access pathways and sufficient nos. of exit & entry should be provided at each station to minimize the congestion • Rumble strips should be provided on the roads in front of stations so as the speed of vehicle is regulated near station area and chances of accident is minimized • Adequate feeder services should be provided so as to maximize the catchment area of proposed metro system and minimize the usage of private vehicle to reach the station. These feeder buses should be integrated and linked to city bus services and other Para-transit systems like auto rickshaws and NMVs • Roads in the station area should be properly maintained and sprinkled with water 	Air Act (Pollution Prevention & Control), 1981	Concessionaire	KMRL
Soil Quality	<ul style="list-style-type: none"> • Disposal of sewage through septic tank at stations and timely evacuation of the septic tanks. • No area should be left excavated or open after any repair & maintenance works • Fuel, waste oil & used oil should be stored in HDPE containers in isolated areas on paved surface. These paved surfaces should be provided with the drains and oil interceptors should be installed in the drains. • Hazardous waste, if any should be stored, managed, transported and disposed as per Hazardous & Other Waste Rules, 2016 • Authorization will be obtained from SPCB for generation of hazardous waste • Waste generated should be properly collected and segregated at each station in twin bin system. Recyclable fraction of waste should 	<ul style="list-style-type: none"> • Municipal Waste (Management & handling) Rules, 2016 • Hazardous & Other Waste (Management & Handling) Rules, 2016 	Concessionaire	KMRL

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	<p>be sold to authorized vendor periodically and non-recyclable/rejected version should be disposed on daily basis through local agencies in the area responsible for waste management</p> <ul style="list-style-type: none"> • Used oil shall be disposed through authorized vendor only 			
Water Quality	<ul style="list-style-type: none"> • Disposal of sewage through septic tank at stations and timely evacuation of the septic tanks. • No area should be left excavated or open after any repair & maintenance works so as there will not be chance of sediments getting mixed with the rainfall run-off • Proper storm water drainage system and rain water harvesting pits should be provided to harvest the storm water and recharge the same into ground water aquifer system to augment the ground water level and reduce the run-off into the surface water bodies. Along with the stations, it is also proposed to provide the pits at the viaducts to harvest the storm water from viaducts also • Storm water drains and pits shall be cleared every year prior start of monsoon 	Water Act (Pollution Prevention & Control), 1974	Concessionaire	KMRL
Noise Level	<ul style="list-style-type: none"> • Provision of anti-dumping floor and noise absorption material • Low speed compressor, blower and air conditioner • Mounting of under frame equipment and anti-vibration pad • Smooth and gradual control of door • Provision of GRP baffle on the via duct for elimination of noise transmission • Provision of sound absorbing material in the supply duct and return grill of air conditioner • Sealing design to reduce the aspiration of noise through the gap in the sliding doors and piping holes • Provision of bolsters less type bogies having secondary air spring 	Noise Rules, 2000 as amended in 2010	Concessionaire	KMRL

	<ul style="list-style-type: none"> • Ballast less track supported on two layers of rubber pads can be used to reduce track noise and ground vibrations • In sensitive areas, track on floating slab can be used to reduce track noise and ground vibrations • Trackside lubrication can be effective in avoiding wheel squeal, which often occurs as Metro rail vehicles traverses tight-radius curves. This installation automatically deposits a small amount of biodegradable lubricant on the top of the rail, and has effectively eliminated wheel squeal and associated complaints from nearby residents • To prevent development of surface irregularities on the rail, a fairly heavy rail section is to be used. Further, rail grinding at regular intervals by Rail grinding machine and also lubrication of rail by vehicle mounted lubricator have been contemplated • Rail shall be continuously welded and also shall be laid to fine tolerances so that any noise/vibration on account of irregular track geometry could be reduced. Rails should be grinded in regular basis to minimize the vibrations • The vibration generated from rail-wheel interaction will be greatly absorbed by the elastic fastening system proposed to be used. Resilient fasteners are used to fasten the rail to concrete track slabs or ballastless bed. • A ballast mat consists of a rubber or other type of elastomeric pad that is placed under the ballast can be used for reducing vibrations. The mat generally must be placed on a concrete base to be effective • Other measures which can be taken to reduce vibrations are usage of resiliently supported ties in which concrete ties are supported by rubber pads • Wheel turning or wheel truing to re-contour the wheel, provides a smooth-running surface and remove wheel flats. The most dramatic 			
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	<p>vibration reduction results from removing wheel flats. However, significant improvements also can be observed simply from smoothing the running surface. Install wheel flat detector system to identify vehicles which are most in need of wheel truing.</p> <ul style="list-style-type: none"> • Implement vehicle reconditioning programs, particularly when components such as suspension system, brakes, wheels, and slip-slide detectors will be involved. The regular regime of reconditioning helps not only mitigation of vibration but also in lower resultant defect generation. • In addition, it is proposed to provide skirting on coach shells covering the wheel, which will screen any noise coming from rail-wheel interaction from propagating beyond the viaduct • Noise barrier¹⁰ helps in reduction of the noise level. Noise barriers can reduce the noise level from 6-15 dB (A). Noise barriers should be provided to minimize the noise levels along the LBS Computer College (Ch-950), NLP School (Ch225-275), Holy Kings College (Ch-275-325), Londin College of Business and Finance (Ch 3900-3925), St Martin De Porres Church (Ch-500-550), St Joseph Catholic Church (Ch 3575-3625), SyroMalbar Church (3825-3850), St Kuriakose Knanya Church (Ch-3825-3850), Juma Masjid (Ch275-325), Ahamadia Masjid (Ch 3300-3325), Hanuman Mandir (Ch750-825) and residential areas along the corridor. Noise barrier comprising of absorptive type metal panel and reflective type polycarbonate sheets can be located on edge of the viaducts to reduce the noise intensity to be generated due to metro movement. Height of these barriers can be kept 1.5-2.0 m above the top of rail. The barrier must be long enough to screen out a moving train along most of its visible path. Thus, length of the barrier shall be considered additional 1 m on both ends at proposed locations. 			
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<p>Occupational Health & Safety</p>	<ul style="list-style-type: none"> • All the staff should be given training for carrying out the work assigned keeping the safety as priority. • All staff should be provided with personal protective equipment like HT gloves, safety helmets, safety jackets, ear muffs, safety belts, welding masks, safety shoes, Goggles, safety shoes, full body harness) as required • Periodic inspection of PPE should be done to ensure that they are in proper condition by keeping the records • Tests should be undertaken for workers working at heights prior joining. Work at height should be undertaken during day time only. • Fall arrest system should be provided at the areas which involves working at height • Induction training should be given to all the workers at the time of joining which should include awareness of the activities to be carried out by worker, tools involved, risks involved and personal protective equipment to be used • Health check-ups should be undertaken for workers every year • Proper signage about the stations, entry, exit, fire exit, directions, safety messages, conservation of energy & water, non-spitting, non-littering, restricted entry etc. should be provided at all the stations and inside the metro to make the passenger and staff about the risks involved and required safety measures to be taken • Adequate emergency exit should be provided in the metro and at station and the location of the same should be displayed at all the suitable locations. Along with the visual display, audio messages should also be communicated at the stations and in metro about the safety measures to be taken • Proper guards/safety provision should be made along the railings of elevated metro stations. Entry beyond the certain points should be 	<ul style="list-style-type: none"> • BOCWA • The Child Labour (Prohibition and Regulation) Act, 1986 • The Child Labour (Prohibition and Regulation) Act, 1986 • The Trade Union Act, 1926 • Minimum Wages Act, 1948 • Other labour related acts & rules 	<p>Concessionaire</p>	<p>KMRL</p>
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	<p>restricted for the passengers</p> <ul style="list-style-type: none"> • Entry to the control rooms, firefighting rooms, DG area and other similar areas should be restricted for passengers and entry of such areas should be guarded • Elevators provided should be regularly maintained and checked for proper functioning • Maintenance of the metro and other equipment should be carried out regularly as per the approved maintenance schedule • Functioning of metro, stations, electrical equipment & network, DG sets etc. should be audited and inspected by eligible third part on regular basis • All the platforms should be properly guarded to ensure people board & de board in queue and do not stand beyond the demarcated area • Certified First aid trainer should be present at all the stations all the time • System of work permits should be issued in case any maintenance work is being undertaken at track, electrical wires, OHE, control room and any such area. LOTO system should be implemented to minimize the accidents • Every day PEP Talks should be taken up with the security & maintenance staff to communicate the major safety principle to be followed and kept in mind. • Safety meetings should be held monthly to discuss the existing safety practices and measures for improvising the procedures • Mock drills should be conducted to train staff for handling emergency situations • Emergency preparedness & response plan prepared for the project should be followed • Dos and Don'ts during the natural calamity and accidents should be displayed at stations and in metro for passengers and staff so as 			
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	<p>they know what is to be done during and after emergency.</p> <ul style="list-style-type: none"> • Trainings should be conducted for drivers on regular basis to train them about the safety procedures and strictly following the rules • Regular monitoring, servicing & maintenance of all the signaling, transmission and communication system to minimize the chances of accidents • Emergency contact numbers should be displayed at the stations & in metro • Photography should be restricted in the metro premises • Floors of stations and metros should be cleaned on daily basis • Lifting equipment engaged should be thoroughly and regularly examined before use • Fire-fighting equipment should be provided at all the locations, i.e. inside metro, stations at depot as per the granted NOC from local Fire Department. Fire evacuation plan should be displayed at all the desired locations • Accident records should be maintained. Accident reporting should be done within 1 day after accident and detailed root cause analysis should be carried out for each accident so as preventive measures can be taken to prevent any similar accidents in future • Regular maintenance of the viaduct, piers, pier caps, OHE system should be done. Regular inspections should be carried out to detect any breakage, cracks or deformity 			
Aesthetics	<ul style="list-style-type: none"> • Area under the viaduct and near the stations should be regularly monitored and no commercial establishments or slums should be allowed to come up • Color of the viaducts and piers should be kept white • Bills should not be allowed to be stick on the piers and other structures • Regular cleaning of the stations, nearby areas and the areas under 	--	Concessionaire	KMRL

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	via duct should be carried out • Area under viaducts and additional land if available near stations and depots should be used for development of green area			
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7.4 Emergency Preparedness and Response Plan

Disaster is an unexpected event due to sudden failure of the system, external threats, internal disturbances, earthquakes, fire and accidents. Infrastructure project of this scale may have various risks associated to it which may results into hazards/disasters. Nature and type of hazards/disasters will vary during construction and operation phases of the project. Emergency preparedness and response plan for both phases is given in **Annexure 7.1**.

7.5 Institutional Framework for Implementation of EMP

For effective implementation of the proposed environmental management plan, it is necessary to have permanent organizational set up charged with the task of ensuring effective implementation of EMP and to monitor the implementation efficiency. KMRL is agency for planning, implementation and operating the project.

Thus, the implementation agency KMRL shall have SHE cell to monitor the implementation of the EMP during the construction stage and to implement the proposed EMP during operation phase. SHE cell should be chaired by the person having experience in field of Rails project & SHE for minimum 25 years. Other suggested members of SHE cell are Environmental Engineer/Officer, Safety Officer, Technical Assistant (environment background) and two other assistants (miscellaneous works).

During construction stage SHE cell of KMRL will work in coordination with the contractor/concessionaire SHE cells to ensure implementation of the EMP and safety procedure as per KMRL SHE Policy. In operation stage KMRL solely should ensure that each station should have SHE personnel.

Progress of the SHE cell shall be reviewed by an Environmental Adviser every year. The Environmental Adviser would be an experienced Environmentalist familiar with environmental management in similar projects. Third party safety audits can be conducted to ensure the compliance of proposed SHE system. Costs for the functioning of SHE unit and external third party SHE audit. Increase of 10% annual price can be considered to calculate cost of upcoming years. Costing is given in **Table7.2**

Table 7.2: Cost of SHE Cell Operation and SHE Audits (Phase II)

S. No.	Item	Cost Per Year
1.	SHE Head	20,00,000
2.	Environmental Expert-1 no	12,00,000
3.	Safety Officer-1 no	12,00,000
4.	Technical Assistant-1 no	5,00,000
5.	Other Assistants-2 Nos.	8,00,000
6.	Third party Safety Audits per year	5,00,000
7.	Miscellaneous	3,00,000
	Total	65,00,000

7.5.1 Roles & Responsibilities of the SHE Cell KMRL

Roles and responsibilities of SHE Cell of KMRL includes the following

- To ensure that the suggested EMP is being implemented by concessionaire adequately during construction phase and to implement the EMP during operation phase
- To ensure suggested safety practices are being followed at the site during construction & operation phase
- To ensure all regulatory approvals required for the projects are taken and being renewed time to time
- To ensure compliance is being done to the conditions specified in consents/approvals issued
- To ensure all the prescribed environmental standards and labour laws are being followed
- To ensure effective grievance redressal system is implemented by concessionaire at the site during construction & operation stage and response all the grievances raised are addressed adequately
- To attend and conduct the SHE meetings and audits
- To ensure that third party SHE audits are being conducted regularly
- To review the SHE reports submitted by the concessionaire
- To review the accidents records and to the accidental reports submitted by concessionaire during construction phase and to maintain the similar records during operation phase
- To maintains safe working environment at the site and gives safety the priority
- To train the staff to handle emergency conditions, giving first aid treatments and handling the firefighting equipment

7.5.2 Roles & Responsibilities of the Concessionaire

- Roles and responsibilities of SHE Cell of concessionaire includes the following
- Implementation of suggested EMP and Environment monitoring plan
- Obtaining mandatory approvals as per requirement of Gol and complying with all the conditions specified in consent orders
- Provision of training to staff to handle emergency conditions, giving first aid treatments and handling the firefighting equipment
- To conduct mock drills and to maintain the records in form of attendance & photographs
- To arrange safety meetings monthly and to maintain the records in form of attendance & photographs
- To submit the monthly safety report to the KMRL
- To ensure the all adequate safety a measure are being taken at the site as per KMRL SHE policy and maintains the safety and clean working environment
- To provide the accommodations to the labour equipped with all the basic facilities including neat & clean bedding, proper sanitation facility, clean fuel, proper waste management system, first aid facilities, and crèche facility for kids of labour etc.
- To maintain safe working environment at the site

- To minimize the chances of occurrence of accidents by implementation of suggested EMP. To maintain records of accidents and to carry out route cause analysis for each accident. Learning should be drawn from each accident so as similar mistake does not happens again in future leading to accident
- To obtain certifications from third party for all lifting equipment
- To establish & maintains the grievance readressal cell

7.6 Effective Implementation of Environmental Management Plan during Construction Phase

KMRL is responsible for construction and implementation of the project. Concessionaire will be contracted for construction of the project. Thus, during construction phase concessionaire will have to implement the suggested environment management plan for construction phase under supervision of KMRL

For implementation of Environmental Management Plan, it is necessary that EMP for construction & operation phase should be included in the agreement document of concessionaire so as he is aware of the environmental provision to be kept during project construction phase. This will ensure effective implementation of the EMP. EMP implementation by concessionaire / PSP can be achieved by following ways:

- Incorporation of EMP in RFP for Concessionaire and Concessionaire agreement
- Concessionaire should have full-fledged SHE cell to ensure the implementation of the EMP and the DMP. SHE cell should be headed by an experienced person in the field of both environment and safety. SHE cell should also have environment and safety officers who will ensure implementation of the EMP & DMP during construction stage. A monthly progress report on implementation of EMP, safety at site and accidents at site should be prepared by the environment and safety officers and should be submitted to monitoring committee on monthly basis.
- Site specific EMP should be prepared by the concessionaire in line with the EMP provided in this report and should be submitted to the KMRL prior starting the development along with the implementation plan and CV of personnel of EHS cell for approval. Construction should be started only after approval of the EMPs, and CVs of personnel of EHS cell by KMRL

7.7 Environmental Monitoring Plan

Environmental monitoring should be conducted for the key indicators which are likely to be affected during construction & operation stage of the project. Key monitoring indicators and the frequency of the monitoring is given in **Table 7.3** below.

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Table 7.3: Environment Monitoring Plan

S. No.	Key Indicators	Location of Monitoring	Frequency of Monitoring	Parameters to be monitored
Pre-Construction & Construction Phase				
1.	Drinking water Quality	Construction sites, labour accommodation, casting yards, workshop & site office	Monthly	Parameters as per IS:10500
2.	Surface Water Quality	Edapally Todu, Kadambryar River	Monthly (if construction is being undertaken close to the water bodies)	BOD, COD, TSS, pH, DO, Heavy metals
3.	Air Quality	Construction site, casting yards & batching plant and workshop	Monthly	24 hourly monitoring of PM ₁₀ , PM _{2.5} , SO _x , NO _x & CO
4.	DG Set Stack	DG sets at stations and station	Six Monthly	Parameters: PM _{2.5} , SO _x , NO _x
5.	Noise levels	Construction site, casting yards & batching plant and workshop	Monthly	24 hourly Day time & Night time levels
6.	Occupational health & Safety	Construction site, casting yards & batching plant, workshop and labour accommodation	Daily & Monthly	Workers are wearing PPE, conditions of PPE, Availability of firefighting equipment, Availability of safety officers at site, frequency of safety meeting & PEP talks, Records of SHE meetings & Mock drills, Frequency of mock drills, accidents records, records at entry gate etc.
7.	Community Issues	Study area	Monthly	Grievance readressal box and interaction with community to identify their issues, if any being faced due to project development
8.	Solid Waste (Municipal, hazardous & Other)	Construction site, casting yards & batching plant, workshop and	Daily	Storage, management, transportation & disposal, obtaining consents & authorization

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		labour accommodation		
9.	Construction vehicles	Construction sites	Monthly	Safety kit, first aid kit, maintenance & service records, DL (driving license), PUC, drivers training records, driver awareness
10.	Ambulance & First aid kits	Construction site, casting yards & batching plant, workshop and labour accommodation	Monthly	Inspection of condition of ambulance, first aid kits, certification of first aid practitioner
11.	Heavy Lifting equipment	Construction site, casting yards & batching plant and workshop	Monthly	Third party certification, servicing & maintenance records, PUC, RC (as applicable), Load charts legibility, DL
12.	Fuel storage area	Construction sites	Monthly	Availability of fire-fighting equipment, drainage, oil interceptors, absence of electrical supply and OHE/UG cable
Operation Stage				
1.	Noise levels	Stations & depot	Monthly	24 hourly Day time & Night time levels
2.	Air Quality	Depot site	Six Monthly	24 hourly monitoring of PM ₁₀ , PM _{2.5} , SO _x , NO _x , CO & VOC
3.	DG Set Stack	DG sets at stations and station	Six Monthly	Parameters: PM _{2.5} , SO _x , NO _x
4.	Drinking water Quality/Ground Water Quality	Stations & depot	Monthly	Parameters as per IS:10500
5.	Occupational health & Safety	Station & Depot	Daily	Workers/staff are wearing PPE, conditions of PPE, Availability of firefighting equipment, Availability of safety officers at site, frequency of safety meeting & PEP talks, Records of SHE meetings & Mock drills, Frequency of mock drills, accidents at site, Records at entry gate, work permits, LOTO system
6.	Community Issues	Study area	Monthly	Grievance redressal box and interaction with community to identify their issues, if any being faced due to project

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				development, CSR activities
7.	Waste	Station & Depot	Daily & Monthly	Storage, management, transportation & disposal and authorization for hazardous waste and bio-medical ware
8.	Fuel storage area	Construction sites	Monthly	Availability of fire-fighting equipment, drainage, oil interceptors

7.8 SHE Policy

KMRL has well developed SHE Policy for both the construction and operation phase. Contractor shall develop his SHE policy based on SHE Policy of KMRL and shall get it approved by KMRL. KMRL SHE Policy will be followed during the operation phase.

7.9 Grievance Redress Mechanism

A grievance mechanism should be established to receive the concerns and issues being faced by community in the project area both during construction and operation phase. Information of such system should also be made available to the public through consultations, notices, advertisements, displaying on website etc. Grievance redressal cell should be established by concessionaire, implementation agency and project proponent during the construction phase and by the proponent during the operation phase.

Through the grievance redressal mechanism, community is free to lodge their concerns and submit their suggestions. The grievance mechanism should be scaled to the risks and adverse impacts of the project. It should address concerns promptly, using an understandable and transparent process that is culturally appropriate and readily accessible to all segments of the affected communities, and at no cost and without retribution. The mechanism should not impede access to judicial or administrative remedies. The client will inform the affected communities about the mechanism. Grievance redressal system will include provision of a box at construction site, casting yard & workshop site, storage yard site & site office site, labeled as grievance redressal box. Grievances can be dropped by aggrieved into this box. Also, a registered for grievance redressal should be maintained at entry gate of all above mentioned areas where aggrieved can register its complaint along with his details like name, contact number and can take the reference complaint number. Grievance redressal box or register will be reviewed every week and first response to the grievance to the aggrieved should be given within 7 days of grievance submitted by the receiver. Grievance redressal cell should consider the following points for functioning

- The decision on the grievance would be communicated to the aggrieved person within a timeframe (1 week).
- There should be a nodal officer designated by concessionaire, implementing agency & proponent for each site/work area
- All grievances should be documented and indexed for future reference. The proceeding and actions against each of the grievance should be documented and should also carry this index number for easy traceability. The grievance received should be communicated to all the concerned SHE personnel of concessionaire, implementing agency & proponent

- If required, the aggrieved community member can also be made a part of the Redressal process, so he is able to place his point of view.
- The Grievance Redressal committee (incharge & nodal officers) of concessionaire, implementing agency & proponent should meet at regular interval and discuss on the grievance and take necessary action.

7.10 Trainings

The staff employed for SHE cell should be well experienced & qualified. Further to keep them updated with upcoming legislation, technologies etc., it is required to provide the training so as to ensure the SHE management system works well and is in line with the latest legislations and technologies. Training to be given are listed below

1. Training for usage of personal protective equipment
2. Behavioral based safety
3. Training for usage of firefighting equipment
4. Training for rescue of person in case of fall from height (fall arrest system)
5. Training for working on heights
6. First aid training
7. Training for quality and environment management systems
8. Training on understanding the environmental and social impacts of metro projects
9. Training for handling heavy lifting machinery & equipment and other construction machinery and safety measures to be adopted

7.11 Monitoring and Audit

Regular monitoring and audit should be undertaken at the site to check the status and effectiveness of implementation of suggested EMP

1. Internal SHE audit by concessionaire, KMRL
2. Third party SHE audit for all project components
3. Third party audits for heavy lifting equipment and machinery
4. Audits for proper servicing, maintenance & operation of the project components

7.12 Reporting

Contractor shall submit the following reports to KMRL

- Site specific EMP
- Layout for casting yards/labour camps/workshops/other areas for temporary usage with permission of land owners
- SOPs for undertaking all the project activities
- Environment Social Management System Manual with SHE Policy prior start of project
- Emergency Preparedness and Response Plan
- Waste Management Plan (Municipal, Recyclable, Hazardous and Bio-medical Waste)

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- Copy of permits to be obtained and compliance to the conditions on monthly basis
- Monthly Progress Report (detailing monthly progress on works, working hours, number of labour, details of the payments made of labour, details on accident and details on near miss)
- Monthly report containing details on compensatory plantation and their survival rate

7.13 Environmental Management Budget

Budget for environmental management both during construction and operation phase is given below in **Table 7.4** below.

Table 7.4: Environment Management Budget

S. No.	Item No.	Capital Cost (INR)	Recurring Cost/Yr (INR)	Total Recurring Cost (2 years)
Pre Construction & Construction phase				
1.	Compensatory A forestation	5,78,688.7	--	--
2.	Maintenance of compensatory afforestation, monitoring and reporting for 5 years (@INR1,00,000/month)	12,00,000	12,00,000	24,00,000
3.	Toilets and Septic tanks (8 nos of toilets, 4 nos of septic tank) for construction labour and employee- 2 years	8,00,000	1,20,000	1,20,000
4.	Site barricading with LED lights on top (MS barricades)	40,00,000	0	0
5.	Noise barriers (500 m and 2 m height @ INR 550/sq ft)	59,20,150.5	0	0
6.	Muck Disposal and Demolition Waste Management (7108 MT of muck)-2 years	6,66,200	2,00,000	4,00,000
7.	Waste Collection, Segregation, Disposal & Management (provision of covered areas for waste storage, provision of dustbins, collection of	5,00,000	2,00,000	4,00,000

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	waste through local body, and labour for waste management)-3years			
8.	Temporary sheds and containers for material storage, paved areas and rest areas for workers-2 years	8,00,000	2,00,000	4,00,000
9.	Labour accommodation and the basic facilities-3 years	50,00,000	50,00,000	1,00,00,000
10.	Temporary storm water drainage (construction site, construction yards, labour camp sites), oil interceptors, silt fencing near water bodies for 3 years	15,00,000	2,00,000	4,00,000
11.	PPE Cost, maintenance and repair for 1500labour for 3 years	25,00,000	10,00,000	20,00,000
12.	Environmental Monitoring	5,12,000	5,12,000	10,24,000
	• Drinking water quality (monthly for 3 years)	1,20,000	1,20,000	2,40,000
	• Air quality (monthly for 3 years)	14,40,000	14,40,000	28,80,000
	• DG set stack (six-monthly for 3 years)	50,000	50,000	1,00,000
	• Noise quality (monthly for 3 years)	72,000	72,000	1,44,000
	• Surface water quality (monthly for 1 year to be undertaken if construction takes place close to water body)	1,20,000	1,20,000	2,40,000
13.	Trainings	20,00,000	10,00,000	10,00,000

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14.	Audits and Monitoring	15,00,000	15,00,000	30,00,000
15.	Construction of Septic tanks for operation phase-11 nos	33,00,000	0	0
16.	RWH pits construction - 33nos	66,00,000	0	0
17.	Provision of stacks with DG sets	Part of project cost		
18.	Provision of safety signage's	8,00,000	1,00,000	2,00,000
	S. Total	3,81,77,039.2	2,24,64,000	
Operation Stage (Calculated Annually)				
19.	Septic Tank Maintenance-11 stations	1,50,000		
20.	Maintenance of storm water drains and pits	3,00,000		
21.	Waste Collection, Segregation, Disposal & Management	22,00,000		
22.	Environmental Monitoring/Yr	13,00,000		
	• Drinking water quality (monthly)	6,60,000		
	• Air quality (Once in year for 1 month at 3 locations)	2,00,000		
	• DG set stack (six-monthly-11 DG sets)	2,20,000		
	• Noise quality (monthly at 11 stations -2 location at each station)	2,64,000		
23.	PPE Provision maintenance and repair	10,00,000		
24.	Trainings	10,00,000		
25.	Audits and Monitoring	10,00,000		
26.	Total-Operation Phase	69,50,000		

7.14 Documentation, Updating and Record Keeping

Documents for environmental health & safety management should be regularly updated and maintained for betterment of implementation and management systems. Documents to be updated are given below

1. EMP
2. SHE Policy
3. Formats for record keeping

Records to be maintained at the site will include the following

1. Records of monthly safety meetings
2. Records on health check-ups of workers and employee
3. Records of accidents& near-miss
4. Records of entry/exit of the vehicle at the site
5. Records of training & mock drills
6. Records of vehicle inspection and maintenance
7. Record of induction training of new staff joined
8. Records of nos. of PPE and health/rejection of PPE
9. Records of grievances (received & closed)
10. Audit reports (internal & external)
11. Monitoring Reports

CHAPTER 8. SUMMARY OF THE PROJECT

8.1 Project Background

In effort to improve the transportation system of the Kochi city and to move towards the cleaner and sustainable mode of transportation, Government of Kerala intends to develop metro rail network (elevated) system for the entire city with the financial aid French Development Agency- Agence Française de Développement (AFD). A Special Purpose Vehicle (SPV) has been formed by the Government of Kerala for implementation, operation and maintenance of the Metro projects. Construction of Phase I of the Kochi Metro Rail started in June 2013 and is expected to be completed by 2019. Kochi Metro Rail Ltd has planned to introduce the phase II from JLN Station to Infopark II which is 11.2 km in length. This EIA report is prepared to study the environmental impacts of the metro Phase II from JLN Station to Infopark II.

8.2 Project Location

Project is located in Kochi City. Project Start from JLN stadium metro station of Phase I and ends at InfoPark. The start and end point geographical co ordinate of alignment are 10° 0'0.30"N & 76°17'55.82"E and 10° 1'8.39"N & 76°21'41.24"E. Phase II will connect the existing Phase I line with the busy areas of the city like Palarivattom, Chembukku, Vazhakkala, Padamughal, metro city etc.

8.3 Project Site, Surroundings & Connectivity

Proposed metro route is proposed within the Kochi city of Kerala. Land use of the RoW and the surroundings is mix of mix use and commercial. Proposed project run along the road (NH-47) and Info Park road. It is connected with Phase I at JLN Stadium. Entire corridor is elevated but RoW of the roads along which it is planned is not sufficient to undertake the construction. Thus it is proposed to widen the roads prior undertaking construction of metro. Land is also required temporarily for establishment of the casting yards/storage yards. Two locations are identified at Kalamassery for establishing casting yards, which belong to HMT and FACT. Distance of these casting yards/storage yards from the alignment is 4.5 km and 5.8 km respectively in North direction.

8.4 Utility Shifting and Tree Cutting

There is several above ground and underground facilities exist along the RoW which includes roads, sewers, water mains, storm water drains, telephone cables, electrical transmission lines, electric poles, street lights, traffic signals etc. These utilities may get impacted due to road widening works and construction works for metro. These utilities are essentially to be maintained to prevent any impact on the population being catered.

8.5 PROJECT COMPONENTS

Project components can be divided into the design and the construction Phase. Project components under the design phase are given below

Detailed design/Pre-Construction Stage:

Detailed design stage/Preconstruction stage includes various components which are listed below

- a. **Alignment finalization and the route survey:** Survey has been carried out by KMRL and route alignments are finalized. Various alternatives are considered and thereafter routes were finalized.
- b. **Land acquisition and Resettlement and rehabilitation study:** Total Land required for the project is 29424.69 sq m out of which 11153.136 sq m is private land and 18295.83 sq m is Government land.
- c. **Preparation of Detailed Project Reports** while considering the Noise and vibration protection requirements both during construction & operation phase, Requirement for drainage and wastewater treatment systems, waste management system, energy conservation systems, landscaping & compensatory afforestation requirements etc. All the surveys like topographical survey, geotechnical investigations etc shall be undertaken at DPR preparation stage including cost estimation
- d. **Road Widening for preparing roads for undertaking the metro construction works:**
The existing ROW of the roads along which metro alignment is planned is generally narrow. To ascertain the feasibility of the metro corridor along such roads, acquisition of land and property has been considered. Minimum distance desired between via ducts and properties is 3 m and width of the viaducts with track centre at 4.87 m c/c is 10.45 m. Thus, minimum RoW available for metro construction required is 16.45 m and for road widening to two lane traffic is 22 m. Road widening is proposed to be undertaken from Palarivottam to Info Park to ensure smooth movement of traffic while undertaking construction of proposed metro. A separate SIA study has been undertaken to understand the impact of land acquisition due to the project. Approx 2.8306 ha of land is required to be acquired for road widening along the RoW. Proposed RoW falls within the three villages, i.e. Edapally South, Vazhakkala and Kakkanadu.
- e. **Traffic management requirements and measures to be taken during construction and operation phase:** Any reduction of road space during Metro construction will result in constrained traffic flow. In order to retain satisfactory levels of traffic flow during the construction period; traffic management and engineering measures need to be taken. They can be road widening exercises, traffic segregation, one-way movements, traffic diversions on influence area roads, acquisition of service lanes, etc. For elevated section wherever it is passing along the road, the requirement would be mainly along the central verge. As regards to the alignment cutting across a major traffic corridor, ‘Continuous Cantilevered Construction Technology’ would be applied to prevent traffic hold-ups or diversions of any kind. Wherever the stations are isolated, areas available around it should be utilized for road diversion purposes such as lay-byes and service roads.
- f. **Tree survey and obtaining permissions for tree cutting:** Trees which are falling within the RoW are required to be cut. Survey has been carried out by RITES/KMRL for the entire corridor.

Civil Construction Works

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Proposed metro project involves development of metro structure (track, via duct, piers, pier cap, platforms) station building, parking facility, RSS & TSS (Receiving & Traction Sub-station) and Radio towers. Detailed specification of project components is given in **Table 8.1**.

Table 8.1: Design Specification of Proposed Metro System

S. No.	Feature	Description			
1.	Chainage	0 m to 10715m			
2.	Location	JLN Stadium to Info Park			
3.	Start Coordinates	10° 0'0.30"N, 76°17'55.82"E			
4.	End Coordinates	10° 1'8.39"N, 76°21'41.24"E			
5.	Stations Nos and Type	11 nos and elevated (Excluding JLN station)			
6.	Station Name	Geographical Coordinates	Chainage	Land Use	Average Inter-station spacing
a	Palarivattom Jn.	10° 0'10.09"N, 76°18'24.48"E	890	Private	890
b	Palarivattom Bypass	10° 0'18.27"N, 76°18'46.81"E	1622	Private	732
c	Chempumukku	10° 0'39.08"N, 76°19'15.28"E	2790	Private	1168
d	Vazhakkala	10° 0'45.46"N, 76°19'39.99"E	3580	Private	790
e	Padamugal	10° 0'51.03"N, 76°20'0.03"E	4218	Private	638
f	Kakkanad Jn.	10° 0'50.51"N, 76°20'30.06"E	5312	Government	1094
g	Cochin SEZ	10° 0'20.12"N, 76°20'44.00"E	6366	LHS (P), RHS(G)	1054
h	Chittethukara	9°59'51.09"N, 76°21'3.26"E	7457	Private	1091
i	Rajagiri	10° 0'0.96"N, 76°21'36.20"E	8735	Government	1278
j	Info Park I	10° 0'36.75"N, 76°21'51.47"E	10048	Government	1313
k	Info Park	10° 0'54.58"N, 76°21'50.76"E	10715	Government	667
7.	Nos of Railway Crossings & ROB crossings	0			
8.	No of Road Crossings	49-Annexure 3.1			

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9.	No of nalah/drain crossing	19-Annexure 3.2		
10.	No of power line crossing	71-Annexure 3.3		
11.	PHPDT	Year	Peak Hour Peak Direction Traffic (PHPDT)	
		2023	7340	
		2028	8464	
		2033	9745	
		2038	11597	
		2043	14029	
		2048	16263	
12.	Daily Passengers	Years	Total Daily Ridership	PHPDT
		2023	104,357	7340
		2024	108,704	7556
		2025	113,572	7778
		2026	118,480	8000
		2027	123,810	8229
		2028	129,675	8464
		2029	136,134	8706
		2030	143,304	8955
		2031	151,258	9211
		2032	160,115	9474
		2033	170,059	9745
		2034	181,231	10024
		2035	193,870	10310
		2036	209,591	10722
		2037	227,534	11151
		2038	248,180	11597
		2039	272,010	12061
		2040	299,751	12544
		2041	332,172	13045
2042	356,410	13541		
2043	382,763	14029		
2044	411,434	14506		
2045	442,757	14970		
2046	477,059	15419		
2047	514,615	15851		
2048	556,010	16263		
13.	Traction Power Supply	33kV/750V dc		

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14.	Rolling Stock	2.9 m wide, stainless steel body, longitudinal seating arrangement, 16 T axle load,																			
15.	Capacity/train	1000 passengers in 3 coach units <table border="1"> <thead> <tr> <th rowspan="2">Description</th> <th colspan="3">3 Train Car</th> </tr> <tr> <th>Normal</th> <th>Crush</th> <th>Dense Crush</th> </tr> </thead> <tbody> <tr> <td>Seated</td> <td>136</td> <td>136</td> <td>136</td> </tr> <tr> <td>Standing</td> <td>316</td> <td>630</td> <td>839</td> </tr> <tr> <td>Total</td> <td>452</td> <td>766</td> <td>975</td> </tr> </tbody> </table>	Description	3 Train Car			Normal	Crush	Dense Crush	Seated	136	136	136	Standing	316	630	839	Total	452	766	975
Description	3 Train Car																				
	Normal	Crush	Dense Crush																		
Seated	136	136	136																		
Standing	316	630	839																		
Total	452	766	975																		
16.	No of Cars/Train	3 nos (L = 23 m, W= 2.9 m and H = 3.9 m)																			
17.	Length of Platform	81 m																			
18.	Hours of Operation	19 hours/yr																			
19.	System	Metro System																			
20.	Fare Collection System	Automatic Fare Collection System with contactless smart card/QR code type ticketing																			
21.	Construction methodology	“Elevated sections and viaduct is carried over pre-stressed concrete U/I Girders with pile/Open foundations”																			
22.	Type of signaling	CBTC																			
23.	Telecommunication	Integrated system with Fiber Optic cable, Supervisory Control And Data Acquisition (SCADA), Train Radio, CBTC etc.																			
24.	Storage/Casting Yards	Kalamassery (belongs to HMT and FACT)																			
25.	Horizontal curves Min curve radius Min curve length	200 m 120 m																			
26.	Transition Curve Min. Length Desirable length Min straight b/w two transition curves Min curve length b/w two transition curves Overlap between transition curves and vertical curves not allowed	0.44 times actual cant/cant deficiency whichever is higher 0.72 times actual cant/cant deficiency whichever is higher 25 m or nil 25 m																			
27.	Vertical Clearance (above road level)	Min 5.5 m																			
28.	Radius of Vertical curves (where gradient is > 0.4%) Main line	2500m																			

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	Other locations Min. length	1500m 20m
29.	Max. speed	80 kmph
30.	Min distance between adjacent track (Centre to centre)	4.2 m
31.	Length of span	28 m. Longer spans may be required at location where alignment crosses road
32.	Nos. of curve	32 horizontal curves 29 vertical curves
Source: DPR		

8.6 Utility Requirement

8.6.1 Water Requirement

Water requirement during construction phase will be to meet domestic water requirement of construction labour and water requirement for the construction activity and batching plants. It is estimated that app. 1500 employee/labour will be employed for construction of Phase II thus domestic water requirement for the labour is anticipated to be 120 KLD (@80 kl/capita/day assuming all labour are resident labour). Water requirement for construction purpose & at casting yards is approx 200-250 KLD. As per DPR, proposed source of water is ground water after taking permission from CGWA. However, it is recommended to purchase STP treated water from municipality for non consumption purpose. There is 4.5 MLD CSTP existing at Elamkulam which is approx 5 km from proposed alignment and 14 km from casting yards. Treated water from CSTP can be considered for construction purpose of metro after providing suitable treatment as feasible.

Water requirement during operation phase will met through Ground water as per DPR. Permission shall be obtained from CGWA prior extraction of ground water. It is estimated total water requirement during operation phase is 432 KLD out of which 72 KLD is drinking water requirement and 360 KLD is required for toilets and cleaning of stations.

8.6.2 Power Requirement

Power requirement during the construction phase will be supplied through the State Grid. Additionally, DG sets of requisite capacity will be provided at sites as power back-up during power failure.

Power requirement during operation phase is required for traction and for auxiliary purpose. Energy consumption of the rolling stock is 65 KWh/ 1000 GTKM and for provision of the same 750 V DC traction with 3rd rail current collection system is adopted. Power will be supplied for corridor through substation at Brahamanpura (220 KV). RSS (220/33 KV) of the KMRL will be established at Info park

8.7 Ventilation and Lighting

All the stations are elevated and are thus naturally ventilated in platform areas. Air conditioners are provided in security rooms of stations. In stations or depot where basements are provided, mechanical ventilation through exhaust fans will be provided. Retrofitting standard luminaries with high-efficiency spectacular reflectors or high efficiency luminaries shall be provided at stations

8.8 Construction Materials & Machinery

Major construction materials required are cement, sand, aggregates, water, admixture and material. Machinery to be used for construction purpose will include hydraulic rig, JCB, cranes of various capacity upto 400 ton capacity, Gantry, Man Lifter, Poclain, hoppers, dumpers, batching plants, launching girders and transit mixer

8.9 ENVIRONMENTAL MANAGEMENT & SAFETY SYSTEMS

8.9.1 Sewage Management System

Sewage at station will be disposed through the septic tank and soak pits.

8.9.2 Storm Water Management System

Storm water drainage system is proposed to be provided at the stations to channelize the storm water. Storm water from the station areas will be collected. This collected storm water shall be recharged into the ground through rain water harvesting pits. Rain water harvesting system shall also be provided for via duct. Storm water collection & harvesting system shall also be provided at viaduct. One Rain water collection and recharge pits shall be provided per 500 m of viaduct. Thus total 22 nos of RWH pits shall be provided for viaduct and 11 for stations. RWH pits of 60 cum shall be provided for viaducts whereas RWH pits of 50 cum shall be provided for station buildings

8.9.3 Solid Waste Management System

Waste to be generated during construction phase includes the left over concrete, timber, broken bricks, tiles, glass, paint and paint boxes, metal rods and bars, used cement bags, rags, redundant machinery & tools, storage containers, plastic bags and containers, metal containers, diesel storage barrels etc. The waste generated during construction phase is majorly recyclable and reusable. Entire waste will be segregated on time to time and will be sold to authorized vendors. Used oil from DG sets will be collected and stored in HDPE containers. This waste will be sold periodically to authorized dealers (M/s Excel Petrochemicals Koonamthai, Kochi is authorized dealer for hazardous waste management & handling in Kochi). Project development also involves demolition of various structures which are to be acquired. Demolition debris shall be collected and segregated in the reusable and reject fraction. Reusable fraction shall be stored in covered condition and reject fraction shall be disposed through the authorized vendors

Also, there will be generation of muck during excavation of soil for construction of foundation for the pillars and construction of entry-exit of stations. Total muck to be generated due to excavation (assuming 400 piers, excavation depth 8.5 m; width 2 m; and length 2 m and 25 nos of entry exits for 11 stations having width 5 m, length 10 m and depth 3 m) will be approx. 17350 cum out of which 427.5 cum is top soil (15 cm depth). Top soil will be kept aside for undertaking

compensatory plantation works. Considering swell factor of 40%, excavated muck other than top soil will be 23691.5 cum. Most of the soil will be filled back (~70%) after construction of piers and entry/exit and remaining (7108 cum) can be used for road widening and construction purpose if feasible. Surplus can be disposed at designated C&D sites of Kochi Municipal Corporation. One such site is located at Bhramanpura.

No construction labour hutments shall be located at the project site. Contractor shall arrange rented accommodation for the labour with all the basic facilities at different location but near to the site. App. 1500 labour will be required for construction of project. Thus, MSW of app. 375 kg/day is expected to be generated at the rate of 0.25 kg/day per person. The waste to be generated from labour accommodation will required to be collected, segregated, recycled and disposed off in accordance to the Solid Waste Management Rules, 2016. Wet waste and other recyclable waste will be collected in two color bins. Wet waste will be disposed off through local agencies in the area and recyclable waste will be sold to authorized vendors.

During operation phase, major solid waste to be generated at stations will comprise of the paper, packaging waste, floor sweeping, small quantity of used oil from DG sets and small quantity of other waste which includes plastic, food waste etc. The recyclable waste like paper will be sold to the recyclers. Remaining waste like floor sweepings and other waste will be disposed off through local agencies in the area on daily basis. Used oil from DG sets will be sold periodically to authorize dealers (M/s Excel Petrochemicals Koonamthai, Kochi is authorized dealer for hazardous waste management & handling in Kochi).

Expected nos. of staff (skilled and unskilled) at all the three metro stations is approx. 550 and amount of the waste generated is estimated at the rate of 0.25 kg/day is 137.5 kg/day. The stations where the commercial areas are planned or where small shops are provided, waste generated will include plastic, packaging waste, food waste etc. Store owners should ensure that the waste is disposed off through the local agencies in the area on daily basis and no waste will be dumped on road or other area.

8.9.4 Parking Facility

Sufficient Parking facility is provided at Chittetukara and Info Park II station while minimum parking is ensured at other stations due to space constraint.

Table 8.2 Parking Detail

S No.	Metro Station	Approximate Parking Area (Sqm.)
1	Chittethukara	1200
2	Info Park 2	10000
	Total	11200

8.9.5 Fire fighting System

Provision of fire-fighting is made in all the stations. Fire-fighting equipments are provided in accordance to requirement of NBC and local bye laws & requirement of CFO.

8.9.6 Green Belt Area

All the stations are elevated so no green cover will be developed at stations. However green areas will be provided on the medians and edges of the road proposed to be widened and through which metro is proposed to be traversed. Compensatory plantation shall also be carried out for each tree cut in ratio of 1:12.

8.10 Maintenance Works

Maintenance works shall be carried out at the existing depot at Muttom.

8.11 Multimodal Transportation System

In order to have an efficient public transportation system and reduce the dependency on private vehicle, KMRL has planned to integrate metro system with other modes of transport. People living within 500m can walk up to the metro station. Various modes of transportation like feeder buses and bicycles can provide first mile as well as last mile connectivity other than walking to the metro station. The facilities of pedestrian infrastructure, feeder buses and bicycles (bike sharing) have been planned to be provided under the project.

8.12 Project Cost

Cost of the project is estimated to be INR 2310 Crores

8.13 Implementation Schedule

Construction for the proposed project “JLN Stadium station to Info Park-2 via Kakkanad Phase II” will start by April, 2020 and the project is expected to be completed by May, 2024.

8.14 Baseline Environment

The baseline environmental data generation has been done for the period of 31st May to 6th June, 2019. The secondary and primary data has been collected within the “Project Influence Area”. Project influence area is area which is likely to get affected due to project development. For the linear projects impact area considered is RoW of proposed metro alignment, station areas and construction sites and casting/storage yards. However, spillover impacts of the activities to be carried out in the project influence area will be there in the surrounding area. Considering the nature of the activities involves, this impact zone is considered to be 500 m radius area from the proposed RoW/station areas/construction sites and casting/storage yards. However, to comply with the legislative requirements of Government of India, presence of notified eco-sensitive zones is assessed within the 10 km radius from proposed RoW/station areas.

8.14.1 Topography

The proposed project route is level terrain with little undulation. Elevation of the project alignment varies from 2-29 m amsl.

8.14.2 Drainage Pattern

Proposed alignment crosses Edappally tod, stream from Chitrappuzha River, Kadambryar River, drains and nallas. Study area of 500 m surrounding proposed alignment is drained by the mentioned water bodies.

8.14.3 Geology

Project area is majorly covered with the Laterite of quaternary group and minor Dolerite of upper cretaceous group.

8.14.4 Soil Quality

Reddish Brown colour soils are observed in the study area. Texturally the soils of study area are observed as Clay Loam Soils. The Bulk Density (BD) of the soils was found in the 1.29-1.38 gm/cc. Water Holding Capacity (WHC) of study area soils was observed as 29.5% 31.2%. Permeability values were found to vary from 0.42 cm/hr under Clay Loam textured soil in the study area.

The soil pH was found as 6.82-7.05, thereby indicating the soil is neutral in nature. The organic carbon content in sampled soil was observed as 0.51%-0.68% thereby implying that soils are sufficient in organic content.

Available nitrogen content was observed in the surface soil as 384.5-410.5 kg/ha, thereby indicating that soil is medium in available nitrogen content. Available phosphorus content was observed as 18.2-22.6 kg/ha, thereby indicating that soil is medium in available phosphorus. Available potassium content in the sampled soil was also observed as 179.2-196.8 kg/ha, thereby is indicating that the soil is medium in potassium content

The available manganese content in sampled surface soil was recorded as 5.24-8.12 mg/kg, as the critical limit of available manganese is 2.0-mg/kg. The available Boron content in the sampled soil was found as 0.58-0.61 mg/kg. The critical limit for deficiency of the available Boron is 0.5-mg/kg.

8.14.5 Land Use

As per the land use analysis for project influence area it is understood that most of the area is under settlement, i.e. 73.2% followed by vegetation and open scrub land.

8.14.6 Seismicity and Associated Hazards in Project Area

Based on tectonic features and records of past earthquakes, a seismic zoning map of India has been prepared by a committee of experts under the auspices of Bureau of Indian Standard (BIS Code: IS: 1893: Part I 2002. According to the seismic-zoning map of India, the project area falls in Zone III of seismicity where the maximum expected intensity is 5.6 M. Thus project area lies among the moderate-risk earthquake areas.

8.14.7 Meteorology

Under the Köppen climate classification, Kochi features a tropical monsoon climate (Am). Kochi's proximity to the equator along with its coastal location results in little seasonal temperature variation, with moderate to high levels of humidity.

The temperature remains similar in all the months with daily mean minimum temperature around 24.3 °C and daily mean maximum temperature around 31.3°C. March-April is the hottest month with daily mean maximum temperature at 33°C and daily mean minimum temperature at 25.5°C.

The air is generally moist in the region and relative humidity is high throughout the year. With the retreat of south-west monsoons, there is a marginal decrease in humidity. The lowest humidity is observed for the period from December to March. The humidity level ranges between 61 & 91%.

The study area receives high rains. Annual total rainfall is 3014.8 mm. Over 86% of the total annual rainfall is received between the months of May to October.

Generally, light to moderate winds prevail throughout the year. Winds were light and moderate particularly during the morning hours. While during the afternoon hours the winds were stronger. The annual mean wind speed is 2.9 km/hr in Kochi district.

Some of the special weather phenomenon of Kochi includes precipitation of more than 0.3 mm or more in a day and thunderstorms. Ernakulam is considered as one of the thunder and lightning prone district of the state. Fog and squall occurs but is very less.

Kochi city is situated on the coast of Arabian Sea. Distance of project alignment from the sea is approx. 8.70 km and the sea is in West direction of the alignment.

The wave climate in district is governed by the south-west monsoons when wave action can be strong with prevailing wave direction from north-west to south-west. Deep water (15m) wave observation in the past indicate the significant wave heights of 4m, 2m and 1m at the water depths of 10m, 5m and 2m respectively, the predominant wave direction being west. Inland waterways (NW-3) also exist within the city and these are protected by land masses. The wave action in most of the jetties is insignificant. Cochin experiences semi diurnal tides with marked daily inequality.

The currents along the coast of Cochin consists of tide, wave and wind induced components. As per observations the maximum current velocities at the Cochin Gut during the non-monsoon periods is of the order of 3 knots, which could increase to as high as 5.5 knots during the monsoon periods. Inside the Ernakulam Channel the current velocities are low, of the order of 0.5 knots only, with directions varying at different locations.

The littoral drift influenced by the monsoon is southwards during south-west monsoon period and northwards during non-monsoon period. Though this contributes to the siltation in the approach channel, it has no direct impact in the Ernakulam Channel.

Cyclones are not seen to affect the district in recent past but the impact due to gustna does and high velocity winds due to localized cyclonic or convective systems have caused damage to life and property in the district.

Many parts of the district get affected due to the flood. Flood prone taluka of the district are Kothamangalam, Kunnathunadu, Muvattupuzha, Aluva and Cochin. Floods are caused due to unusual high rainfall. Flood crisis management plan is prepared for the district which involves formation of crisis groups, flood warning system, safety shelters for people, fire and rescue service etc.

Kochi has experienced devastating floods in 2018 due to unusual high rainfall and release of water from various small dams in Kerala due to high rainfall. The rainfall was 116% more than the usual rainfall in Kerala as the State received 310 mm of rainfall in 48 hours. All the operation in the area was ceased including Kochi airport. This led to disturbance in the entire city and caused lot of damage to life and property both. Approx 483 people died and 140 are missing due to flood. This was declared as level 3 emergency/calamity of severe nature by the Government of India. This is worst flood in entire state after the floods of 1924.

However all the proposed infrastructure is elevated and thus is not likely to be directly affected by floods. But indirect impact due to inundation of streets, inaccessibility to metro stations etc may affect the proposed metro system during floods

8.14.8 Air Environment

As per the land use analysis for project influence area it is understood that most of the area is under settlement, i.e. 73.2% followed by vegetation and open scrub land.

The highest PM_{2.5} level was found at JLN Station (37.4 µg/m³) and lowest PM_{2.5} level was observed at Chembumukku 26.3µg/m³ while the conc. ranges between 37.4-26.3 µg/m³. The monitored PM_{2.5} level is found well within the permissible limit i.e. NAAQMS level 60µg/m³

The highest SO₂ level was found at JLN Station location as 7.4µg/m³ and lowest SO₂ level at Chembumukku 5.7µg/m³ while the conc. ranges between 5.7& 7.4 µg/m³. The monitored SO₂ level are found well within the permissible limit i.e. NAAQMS level 80µg/m³.

The highest NO_x level was found at Chittetukara Station (18.4 µg/m³) and lowest NO_x level were observed at Chembumukku 13.6 µg/m³ while the conc. ranges between 13.6 & 18.4 µg/m³. The monitored NO_x levels are found well below the permissible limit i.e. NAAQMS level 80µg/m³.

The highest CO level was found at JLN Stadium (Pump House)Station as 0.51 mg/m³ and lowest CO level was observed at Chembumukku as 0.27 mg/m³ while the conc. ranges between 0.27 & 0.51 mg/m³. The monitored CO levels are found well below the permissible limit i.e. NAAQMS level 04µg/m³.

8.14.9 Ambient Noise Levels

The highest CO level was found at JLN Stadium (Pump House)Station as 0.51 mg/m³ and lowest CO level was observed at Chembumukku as 0.27 mg/m³ while the conc. ranges

between 0.27 & 0.51 mg/m³. The monitored CO levels are found well below the permissible limit i.e. NAAQMS level 04µg/m³.

8.14.10 Hydrogeology

Project area is majorly covered with the Laterite of quaternary group and minor Dolerite of upper cretaceous group. The laterites are highly porous and permeable. It is extensively developed by dug wells in the mid land area for domestic and to a limited extent for irrigation. The depth of wells in laterite ranges from 3.4 to 14.8 mbgl and depth to water level ranges from 1.55 to 11.06 mbgl. Water level in project area during pre monsoon season it varies from 2-5 m bgl and during post monsoon season, it varies from 0-2 m bgl. Wells located on slopes and elevated areas go dry or have very small water column during summer season. The yield of well ranges from 0.5 to 6 m³ /day and sustain pumping for 3 to 4 hrs a day. All the blocks of the district are either falling in safe zone or semi-critical. Project area falls in safe category

8.14.11 Ground Water Quality

Overall the ground water quality of the study area is found well within the permissible limit of Indian Standard IS: 10500:2012. No metallic and bacterial contaminations were observed in ground water samples.

8.14.12 Surface Water Quality

Surface water quality was analysed against the Designate Best Use Criteria by CPCB. The quality of water matches with the category D and thus the water body is fit for propagation of wildlife and fisheries.

8.14.13 Traffic Survey and Estimated Traffic

As per the detailed project report of Kochi Metro, the registered vehicles in Ernakulam have increased significantly over the years. The number has climbed from 8.9 to 17.6 Lakh in six years (2009-10 to 2016-17). This high density and rapid growth of vehicles have worsened the transport situation to a significant extent. The growth has been phenomenal registering a growth of 10% p.a. in 3 years (2006-07 to 2009-10).It is significant to note that 10% of the vehicles now in Ernakulam are cars. Total registered vehicles in Ernakulam district by 2016-2017 are 1768869. The analysis of mode wise growth of registered vehicles as given DPR shows that the personalized mode of transport i.e. two wheelers and cars, have been growing tremendously with the annual increase of 9% and 14% respectively. The buses registered annual growth of 4% and auto rickshaws showed annual growth of 8%.

Daily traffic as per the city mobility plan of Kochi between JLN station to Infopark II, PHPDT for the year 2023, 2028, 2033, 2038, 2048.

Peak Hour Peak Direction Traffic (PHPDT)					
Year 2023	Year 2028	Year 2033	Year 2038	Year 2043	Year 2048
7340	8464	9745	11597	14029	16263

Source: DPR

8.14.14 Biological Environment

Proposed alignment traverses through the urban area and the flora in the study area (RoW& 500 m buffer zone) is in form of road side plantation, agriculture fields/plantations and homestead plantation. Major tree species found are Acacia, Kurangatti, Matti, Albizzia, Vaka, Cashew, Jack, Anjily, Neem, Mandaram, Poola (Elavu), Kulamavu, Cane, Kannikonna Yellow cassia, Casuarina Neermathalam, Veeti (rose wood), Sissu, Delonix, Beedi leaf, Nelli, Eucalyptus, Kanala, Kumbil, Silver oak, Pongu, Jacanranda, Senteak, Manimaruthu /pomaruthu, Subabool, Elengi, Peltophoram, Pepper, Ungu, Venga Red sandal, Rain tree, Ashokam, Spatodea, Mahogany, Najaval, Tamarind, Tecoma, Teak, Thanni, Badam, Thembavu, Maruthu, Mathagirivembu/ chandanavembu, Vellapine, Irul etc.

Due to urbanization and presence of human activities, no significant wildlife was observed/ reported in the area. There is no forest area or notified eco-sensitive zone or jungle within 500 m of the proposed RoW. No wildlife habitat or notified eco-sensitive zone under Wildlife Act. 1972 is present within the 10 km radius area of proposed RoW except Managlavanam bird sanctuary which is present at 3 km from JLN station. Thus fauna in study area is confined to the cattle/stray animals. A few common Butterflies seen/reported in the study area are Common Crow, Common Emigrant, Grey pansy, Grey pansy, Common Rose, Common Wanderer, Blue Tiger, Common Leopard, Common Wanderer, Common sailer, Common Mormon, Common Jezebel, Common Jezebel.

Manglavanam Bird Sanctuary is the only one coastal protected area in the State of Kerala with an extent of 2.74 hectare of tidal wet land supporting fragile mangrove vegetation which comprises of five species of mangroves and 25 of other floral species and the Manglavanam Bird Sanctuary also supports 3 species of mammals, 9 species of reptiles, 51 species of spiders, 2 species of amphibian, 72 species of birds and 7 species of fishes.

Proposed project traverses along the road. Trees with girth 15 cm and 1 m height are considered as trees. Total 3645 nos of trees fall in the area. As per DPR approx 345 trees may be cut. Compensatory plantation will be undertaken in ratio of 1:12 as per policy of KMRL which is more than the requirement of State Forest Department.

8.14.15 Socio-Economic Environment

Kochi metro Phase II is plan to introduced JLN station to infopark II. Proposed project and other planned linked project are planned in a way to cover entire Kochi region comprising of Kochi city, two municipalities and fourteen panchayat. The Kochi City Region has a population of 12, 55,733 as per Census 2011 figures. The growth rate for last decade in Corporation of Kochi area is 6.38% where as the nearby areas registered decadal growth of an average of 9.20%. The entire region has witnessed the average decadal growth of 8.51% over the last decade.

As per the census records 2011, the total population of the study area was recorded as 678819 persons living in urban part of the study area under Kochi Municipal Corporation (Ward no. 1 to 71) and two census towns namely Kakkanad (CT) and Vazhakkala (CT) under two Sub-District / Tehsil namely Kochi and Kanayannur of Ernakulum District of Kerala. Study zone is mainly falls in urban part of Ernakulum district in Kerala. Total number of 'Households' was observed as 169942 in the study zone. Male-female wise total population was recorded as 334732 males

and 344087 females respectively. Scheduled Castes’ population was observed as 27145 persons which accounts as 4.0% to the total population (678819 persons) and Scheduled Tribes’ population was observed as 2593 persons, accounting as 0.4% to the total population. Total literates population was recorded as 362143 persons (89.3%) in the study area.

Project area has urban land use and all the infrastructural facilities like roads, electrification, water supply, drainage, sewerage system, medical facilities, and educational institutes are available in the area. Project involves acquisition of the private as well as the Government land. Land is being acquired for road widening so as construction works of metro can be undertaken easily without impacting the existing road traffic and for establishment of entry/exit of metro stations and associated facilities. Total land to be acquired is 29424.69 m² out of which 11153.136 m² is private land and 18295.83 m² is Government land. As per DPR, approx 56 structures occupied by 40- 50 families would be affected for the proposed corridor. Out of the total affected structures, 16 structures are residential, 21 are commercial, and 17 are residential cum commercial structures the acquisition of land for the proposed project involves relocation of shops, residential buildings and one religious structure.

Community is well aware about the project and is in favor of project development. But people are concerned about the loss in business during construction and operation phase. Also people are concerned with the issue of traffic congestion during construction phase.

8.14.16 Environmental & Social Sensitivity along the Project Corridor

There is no forest area or notified eco-sensitive zone or jungle within 500 m of the proposed RoW. No wildlife habitat or notified eco-sensitive zone under Wildlife Act. 1972 is present within the 10 km radius area of proposed RoW except Managlavanam bird sanctuary which is present at 3 km from JLN station.

8.15 Legal Framework and Permissions Required

Screening is carried to assess the applicability of the various environmental and social legislations. Various permits required for the project are given in **Table 8.2**.

Table 8.2 Legal Framework and Permission Required

S. No	Legislations	Permission Required	Implementation	Supervision
1.	Air (Prevention and Control of Pollution) Act, 1981 with Rules, amended 1987	Consent to Establish and operate	Contractor	CSC & KMRL
2.	Water (Prevention and Control of Pollution) Act, 1974 with Rules.	Consent to Establish and operate	Contractor	CSC & KMRL
3.	Wildlife Protection Act, MoEF&CC 1972, amended 2010	Wildlife Clearance	KMRL to obtain and Contractor to follow the conditions	KMRL

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4.	Kerala Forest Act, 1961 as amended GO (P) No.85/86/F&WLD dated. 2nd September 1986 regarding felling of trees and GO (P) No.68/2010/F&WLD dated 10.02.2010 The Kerala Preservation of Trees Act, 1986 The Kerala Restriction of Cutting and Destruction of Valuable Trees Rules, 1974	Tree Cutting Permission	KMRL to obtain and Contractor to follow the conditions	KMRL
5.	Hazardous & Other Waste Rules, 2016	Authorization from SPCB	Contractor	CSC & KMRL
6.	Bio-medical Waste Management Rules, 2016	Authorization from SPCB	Contractor	CSC & KMRL
7.	Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989	License if there is storage of hazardous chemical above threshold limit as defined under schedule 2 & 3.	Contractor	CSC & KMRL
8.	Irrigation Department	Permission for withdrawal of water from surface water bodies	Contractor	CSC & KMRL
9.	State Groundwater Regulation	Permission for withdrawal of ground water	Contractor	CSC & KMRL
10.	Petroleum Rules, 2002	License to store petroleum beyond prescribed quantity	Contractor	CSC & KMRL
11.	The Gas Cylinder Rules 2004	License to store gas cylinder more than the regulated quantity	Contractor	CSC & KMRL

8.16 Analysis of Alternatives

Analysis of alternatives is carried for the various alignments/routes considered and for the Projects With & without scenario. As per the analysis, it is found that proposed alignment for Phase II, i.e. JLN Station to Infopark II via kakkanad is most preferable as it has minimal social and environmental impact. In with and without project scenario, it was found that the project is beneficial for both environment and community. However certain construction related impacts will be there during project construction but those can be mitigated with appropriate measures. Project in long term will improve the quality of life of people.

8.17 Anticipated Impacts

Impacts which may result due to development of project are analyzed and studied. It is found that the impacts anticipated vary from high to low significance and magnitude. Major anticipated impact of the project are due to resettlement and rehabilitation, increased noise levels, polluted air quality, tree cutting and disrupted traffic during the pre-construction & construction phase however major impact during operation phase is increased noise levels. The project also has various positive impacts like reduction in carbon emissions, improved overall air quality of the Kochi region, better transportation system and improved quality of the life. It is believed that the anticipated negative impacts can be normalized by taking the proposed mitigation measures.

8.18 Environment Management Plan

Environment management plan has been prepared for the construction and operation phase of the project. Management plan comprises of proposed pollution control measures, management plans and best practices for minimizing the pollution and safeguarding environment. EMP also includes institutional framework, grievance Redressal system, reporting mechanism, environment monitoring plan and environmental budget.

SHE Policy: KMRL has well developed SHE Policy for both the construction and operation phase. Contractor shall develop his SHE policy based on SHE Policy of KMRL and shall get it approved by KMRL. KMRL SHE Policy will be followed during the operation phase.

Grievance Redress Mechanism: A grievance mechanism should be established to receive the concerns and issues being faced by community in the project area both during construction and operation phase. Information of such system should also be made available to the public through consultations, notices, advertisements, displaying on website etc. Grievance redressal cell should be established by concessionaire, implementation agency and project proponent during the construction phase and by the proponent during the operation phase.

Through the grievance redressal mechanism, community is free to lodge their concerns and submit their suggestions. The grievance mechanism should be scaled to the risks and adverse impacts of the project. It should address concerns promptly, using an understandable and transparent process that is culturally appropriate and readily accessible to all segments of the affected communities, and at no cost and without retribution. The mechanism should not impede access to judicial or administrative remedies. The client will inform the affected communities about the mechanism. Grievance redressal system will include provision of a box at construction site, casting yard & workshop site, storage yard site & site office site, labeled as grievance redressal box. Grievances can be dropped by aggrieved into this box. Also a registered for

grievance redressal should be maintained at entry gate of all above mentioned areas where aggrieved can register its complaint along with his details like name, contact number and can take the reference complaint number. Grievance redressal box or register will be reviewed every week and first response to the grievance to the aggrieved should be given within 7 days of grievance submitted by the receiver.

8.19 Environment Monitoring Plan

A monitoring plan is prepared for construction and operation phase of the project and is given in **Table 8.3** below.

Table 8.3: Environment Monitoring Plan

S. No.	Key Indicators	Location of Monitoring	Frequency of Monitoring	Parameters to be monitored
Pre Construction & Construction Phase				
1.	Drinking water Quality	Construction sites, labour accommodation, casting yards, workshop & site office	Monthly	Parameters as per IS:10500
2.	Surface Water Quality	Kadambryar River	Monthly (for construction close to Kadambryar River)	BOD, COD, TSS, pH, DO, Heavy metals
3.	Air Quality	Construction site, casting yards & batching plant and workshop	Monthly	24 hourly monitoring of PM ₁₀ , PM _{2.5} , SO _x , NO _x & CO
4.	DG Set Stack	DG sets at stations and station	Six Monthly	Parameters: PM _{2.5} , SO _x , NO _x
5.	Noise levels	Construction site, casting yards & batching plant and workshop	Monthly	24 hourly Day time & Night time levels
6.	Occupational health & Safety	Construction site, casting yards & batching plant, workshop and labour accommodation	Daily & Monthly	Workers are wearing PPE, conditions of PPE, Availability of firefighting equipment, Availability of safety officers at site, frequency of safety meeting & PEP talks, Records of SHE meetings & Mock drills, Frequency of mock drills, accidents records, records at entry gate etc.

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7.	Community Issues	Study area	Monthly	Grievance readressal box and interaction with community to identify their issues, if any being faced due to project development
8.	Solid Waste (Municipal, hazardous & Other)	Construction site, casting yards & batching plant, workshop and labour accommodation	Daily	Storage, management, transportation & disposal, obtaining consents & authorization
9.	Construction vehicles	Construction sites	Monthly	Safety kit, first aid kit, maintenance & service records, DL (driving license), PUC, drivers training records, driver awareness
10.	Ambulance & First aid kits	Construction site, casting yards & batching plant, workshop and labour accommodation	Monthly	Inspection of condition of ambulance, first aid kits, certification of first aid practioner
11.	Heavy Lifting equipment	Construction site, casting yards & batching plant and workshop	Monthly	Third party certification, servicing & maintenance records, PUC, RC (as applicable), Load charts legibility, DL
12.	Fuel storage area	Construction sites	Monthly	Availability of fire-fighting equipment, drainage, oil interceptors, absence of electrical supply and OHE/UG cable
Operation Stage				
1.	Noise levels	Stations & depot	Monthly	24 hourly Day time & Night time levels
2.	Air Quality	Depot site	Six Monthly	24 hourly monitoring of PM ₁₀ , PM _{2.5} , SO _x , NO _x , CO & VOC
3.	DG Set Stack	DG sets at stations and station	Six Monthly	Parameters: PM _{2.5} , SO _x , NO _x
4.	Drinking water Quality/Ground Water Quality	Stations & depot	Monthly	Parameters as per IS:10500
5.	Occupational health & Safety	Station & Depot	Daily	Workers/staff are wearing PPE, conditions

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				of PPE, Availability of firefighting equipment, Availability of safety officers at site, frequency of safety meeting & PEP talks, Records of SHE meetings & Mock drills, Frequency of mock drills, accidents at site, Records at entry gate, work permits, LOTO system
6.	Community Issues	Study area	Monthly	Grievance redressal box and interaction with community to identify their issues, if any being faced due to project development, CSR activities
7.	Waste	Station & Depot	Daily & Monthly	Storage, management, transportation & disposal and authorization for hazardous waste and bio-medical waste
8.	Fuel storage area	Construction sites	Monthly	Availability of fire-fighting equipment, drainage, oil interceptors

8.20 Environment Management Budget

Environment management has been taken as major component while project planning. Budget has been allocated and is given in **Table 8.4**.

Table 8.4: Environment Management Budget

S. No.	Item No.	Capital Cost (INR)	Recurring Cost/Yr (INR)	Total Recurring Cost (2 years)
Pre Construction & Construction phase				
27.	Compensatory afforestation	5,78,688.7	--	--
28.	Maintenance of compensatory afforestation, monitoring and reporting for 5 years	12,00,000	12,00,000	24,00,000

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	(@INR1,00,000/month)			
29.	Toilets and Septic tanks (8 nos of toilets, 4 nos of septic tank) for construction labour and employee- 2 years	8,00,000	1,20,000	1,20,000
30.	Site barricading with LED lights on top (MS barricades)	40,00,000	0	0
31.	Noise barriers (500 m and 2 m height @ INR 550/sq ft)	59,20,150.5	0	0
32.	Muck Disposal and Demolition Waste Management (7108 MT of muck)-2 years	6,66,200	2,00,000	4,00,000
33.	Waste Collection, Segregation, Disposal & Management (provision of covered areas for waste storage, provision of dustbins, collection of waste through local body, and labour for waste management)-3years	5,00,000	2,00,000	4,00,000
34.	Temporary sheds and containers for material storage, paved areas and rest areas for workers-2 years	8,00,000	2,00,000	4,00,000
35.	Labour accommodation and the basic facilities-3 years	50,00,000	50,00,000	1,00,00,000
36.	Temporary storm water drainage (construction site, construction yards, labour camp sites), oil interceptors, silt fencing near water bodies for 3 years	15,00,000	2,00,000	4,00,000
37.	PPE Cost,	25,00,000	10,00,000	20,00,000

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	maintenance and repair for 1500labour for 3 years			
38.	Environmental Monitoring	5,12,000	5,12,000	10,24,000
	• Drinking water quality (monthly for 3 years)	1,20,000	1,20,000	2,40,000
	• Air quality (monthly for 3 years)	14,40,000	14,40,000	28,80,000
	• DG set stack (six-monthly for 3 years)	50,000	50,000	1,00,000
	• Noise quality (monthly for 3 years)	72,000	72,000	1,44,000
	• Surface water quality (monthly for 1 year to be undertaken if construction takes place close to water body)	1,20,000	1,20,000	2,40,000
39.	Trainings	20,00,000	10,00,000	10,00,000
40.	Audits and Monitoring	15,00,000	15,00,000	30,00,000
41.	Construction of Septic tanks for operation phase-11nos	33,00,000	0	0
42.	RWH pits construction - 33nos	66,00,000	0	0
43.	Provision of stacks with DG sets	Part of project cost		
44.	Provision of safety signage's	8,00,000	1,00,000	2,00,000
	S. Total	3,81,77,039.2	2,24,64,000	
Operation Stage (Calculated Annually)				
45.	Septic Tank Maintenance-11 stations		1,50,000	
46.	Maintenance of storm water drains and pits		3,00,000	
47.	Waste Collection, Segregation, Disposal & Management		22,00,000	
48.	Environmental		13,00,000	

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	Monitoring/Yr <ul style="list-style-type: none"> • Drinking water quality (monthly) 6,60,000 2,00,000 • Air quality (Once in year for 1 month at 3 locations) 2,20,000 2,64,000 • DG set stack (six-monthly-11 DG sets) • Noise quality (monthly at 11 stations -2 location at each station) 	
49.	PPE Provision maintenance and repair	10,00,000
50.	Trainings	10,00,000
51.	Audits and Monitoring	10,00,000
52.	Total-Operation Phase	69,50,000

Annexure – 2.1: NAAQS

Ambient Air Quality Standards

The MoEF&CC has the overall responsibility to set policy and Standards for the protection of environment along with Central Pollution Control Board (CPCB). Ambient Air Quality Standard given below:

Revised National Ambient Air Quality Standards (16th November 2009)

Pollutants	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural, other areas	Ecologically Sensitive Area (Notified Central Government) by
Sulphur Dioxide (SO ₂), µg/m ³	Annual * 24 Hours **	50 80	20 80
Nitrogen Dioxide (NO ₂), µg/m ³	Annual * 24 Hours **	40 80	30 80
PM ₁₀ , µg/m ³	Annual * 24 Hours **	60 100	60 100
PM _{2.5} , µg/m ³	Annual * 24 Hours **	40 60	40 60
Ozone (O ₃) µg/m ³	8 Hours * 1 Hour **	100 180	100 180
Lead (Pb) µg/m ³ in particulate matter	Annual * 24 Hours **	0.50 1.0	0.50 1.0
Carbon Monoxide (CO), mg/m ³	8 Hours ** 1 Hour **	02 04	02 04
Ammonia (NH ₃), µg/m ³	Annual * 24 Hours **	100 400	100 400
Benzene (C ₆ H ₆), µg/m ³	Annual *	05	05
Benzo(a)Pyrene (BaP) ng/m ³ in particulate matter	Annual *	01	01
Arsenic (As), ng/m ³ in particulate matter	Annual *	06	06
Nickel (Ni), ng/m ³ in particulate matter	Annual *	20	20

* 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 8 hourly or 1 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.

Annexure – 2.2: Noise Standards

Ambient Noise Standards

Ambient standard with respect to noise have been notified by the Ministry of Environment and forest vide gazette notification dated 26th December 1989 (amended in February 2000). It is based on ‘A’ weighted equivalent noise level (Leq). The ambient noise standards are presented in table below:

Ambient Noise Level Standards

Area code	Category of Area	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	Sensitive Area	50	40

Note: *Day time is from 6 am to 10 pm, Night time is 10 pm to 6.00 am; ** Silence zone is defined as area up to 100 meters around premises of hospitals, educational institutions and courts. Use of vehicle horns, loud speakers and bursting of crackers are banned in these zones.

Annexure – 2.3: OHSAS Standards

OSHAS Noise Exposure Limits for the Work Environment

Noise Levels in dB(A)	Permissible Exposure (hours & minutes)
85	16 hrs
90	8 hrs
96	3 hrs 30 minutes
102	1 hr 30 minutes
108	40 min
115	15 min
121	6 min
127	3 min
130	1 min

Source: Marsh, 1991, p.322

Annexure – 2.4: Drinking Water Standards

Standards For Drinking Water (IS:10500)

	Parameters	Unit	Acceptable Limit IS:10500	Permissible Limit IS:10500
1	Colour	Hazen units	5	15
2	Odour	-	Agreeable	Agreeable
3	Taste	-	Agreeable	Agreeable
4	Turbidity	NTU	1	5
5	Total Dissolved Solids	mg/l	500	2000
6	pH	-	6.5 to 8.5	No Relaxation
7	Total Hardness as CaCO ₃	mg/l	200	600
8	Iron as Fe	mg/l	0.3	No Relaxation
9	Aluminium	mg/l	0.03	0.2
10	Copper as Cu	mg/l	0.05	1.5
11	Manganese as Mn	mg/l	0.1	0.3
12	Zinc as Zn	mg/l	5	15
13	Magnesium as Mg	mg/l	30	No Relaxation
14	Barium	mg/l	0.7	No Relaxation
15	Calcium as Ca	mg/l	75	200
16	Silver	mg/l	0.1	No Relaxation
17	Selenium as Se	mg/l	0.01	No Relaxation
18	Molybdenum	mg/l	0.07	No Relaxation
19	Boron	mg/l	0.5	1.0
20	Nitrates as NO ₃	mg/l	45	No Relaxation
21	Sulphate	mg/l	200	400
22	Sulphide		0.01	No Relaxation
23	Fluoride as F	mg/l	1.0	1.5
24	Chlorides as Cl	mg/l	250	1000
25	Ammonia	mg/l	0.5	No Relaxation
26	Chloramines	mg/l	0.2	No Relaxation
27	Residual, Free chlorine	mg/l	0.2	1.0
28	Total Alkalinity as calcium carbonate	mg/l	200	600
29	Phenolic compounds (as C ₆ H ₅ OH)	mg/l	0.001	0.002
30	Mineral Oil	mg/l	0.03	No Relaxation
31	Anionic detergents (as MBAS)	mg/l	0.2	1.0
32	Chromium	mg/l	0.05	No Relaxation
33	Arsenic as As	mg/l	0.01	0.05
34	Mercury as Hg	mg/l	0.001	No Relaxation
35	Cadmium as Cd	mg/l	0.003	No Relaxation
36	Lead as Pb	mg/l	0.01	No Relaxation
37	Nickel as Ni	mg/l	0.02	No Relaxation
38	Cyanide as CN	mg/l	0.05	No Relaxation
39	Polynuclear Aromatic Hydrocarbons (as PAH)	mg/l	0.0001	No Relaxation

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40	Polychlorinated biphenyls	mg/l	0.0005	No Relaxation
41	Total Coliform	MPN/100ml	Nil	No Relaxation

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Annexure – 2.5: General Standards - Inland Water Quality

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¹[SCHEDULE – VI]
(See rule 3A)

**GENERAL STANDARDS FOR DISCHARGE OF ENVIRONMENTAL
POLLUTANTS PART-A : EFFLUENTS**

S. No.	Parameter	Standards			
		Inland surface water	Public Sewers	Land for irrigation	Marine coastal areas
1	2	3			
		(a)	(b)	(c)	(d)
1.	Colour and odour	See 6 of Annexure-I	--	See 6 of Annexure -I	See 6 of Annexure-I
2.	Suspended solids mg/l, Max.	100	600	200	(a) For process waste water-100 (b) For cooling water effluent 10 percent above total suspended matter of influent.
3.	Particulate size of suspended solids	Shall pass 850 micron IS Sieve	--	--	(a) Floatable solids, max. 3 mm. (b) Settleable solids, max. 850 microns.
² 4.	***	*	--	***	--
5.	pH Value	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0
6.	Temperature	shall not exceed 5°C above the receiving water temperature	--	--	shall not exceed 5°C above the receiving water temperature

¹ Schedule VI inserted by Rule 2(d) of the Environment (Protection) Second Amendment Rules, 1993 notified vide G.S.R. 422(E) dated 19.05.1993, published in the Gazette No. 174 dated 19.05.1993.

² Omitted by Rule 2(d)(i) of the Environment (Protection) Third Amendment Rules, 1993 vide Notification No.G.S.R.801(E), dated 31.12.1993.

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S. No.	Parameter	Standards			
		Inland surface water	Public Sewers	Land for irrigation	Marine coastal areas
1	2	3			
		(a)	(b)	(c)	(d)
7.	Oil and grease mg/l Max.	10	20	10	20
8.	Total residual chlorin mg/l Max.	1.0	--	--	1.0
9.	Ammonical nitrogen (as N), mg/l Max.	50	50	--	50
10.	Total Kjeldahl Nitrogen (as NH ₃) mg/l, Max.	100	--	--	100
11.	Free ammonia (as NH ₃) mg/l, Max.	5.0	--	--	5.0
12.	Biochemical Oxygen demand ¹ [3 days at 27°C] mg/l max.	30	350	100	100
13.	Chemical Oxygen Demand, mg/l, max.	250	--	--	250
14.	Arsenic (as As), mg/l, max.	0.2	0.2	0.2	0.2
15.	Mercury (as Hg), mg/l, Max.	0.01	0.01	--	0.01
16.	Lead (as Pb) mg/l, Max.	0.1	1.0	--	2.0
17.	Cadmium (as Cd) mg/l, Max.	2.0	1.0	--	2.0
18.	Hexavalent Chromium (as Cr+6), mg/l max.	0.1	2.0	--	1.0

¹ Substituted by Rule 2 of the Environment (Protection) Amendment Rules, 1996 notified by G.S.R.176, dated 2.4.1996 may be read as BOD (3 days at 27°C) wherever BOD 5 days 20°C occurred.

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S. No.	Parameter	Standards			
		Inland surface water	Public Sewers	Land for irrigation	Marine coastal areas
1	2	3			
		(a)	(b)	(c)	(d)
19.	Total chromium (as Cr.) mg/l, Max.	2.0	2.0	--	2.0
20.	Copper (as Cu) mg/l, Max.	3.0	3.0	--	3.0
21.	Zinc (As Zn.) mg/l, Max.	5.0	15	--	15
22.	Selenium (as Se.) mg/l, Max.	0.05	0.05	--	0.05
23.	Nickel (as Ni) mg/l, Max.	3.0	3.0	--	5.0
¹ 24.	***	*	*	*	*
¹ 25.	***	*	*	*	*
¹ 26.	***	*	*	*	*
27.	Cyanide (as CN) mg/l Max.	0.2	2.0	0.2	0.2
¹ 28.	***	*	*	*	*
29.	Fluoride (as F) mg/l Max.	2.0	15	--	15
30.	Dissolved Phosphates (as P), mg/l Max.	5.0	--	--	--
² 31.	***	*	*	*	*
32.	Sulphide (as S) mg/l Max.	2.0	--	--	5.0
33.	Phenoile compounds (as C ₆ H ₅ OH) mg/l, Max.	1.0	5.0	--	5.0

¹ Omitted by Rule 2(d)(i) of the Environment (Protection) Third Amendment Rules, 1993 vide Notification No.G.S.R.801(E), dated 31.12.1993.

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S. No.	Parameter	Standards			
		Inland surface water	Public Sewers	Land for irrigation	Marine coastal areas
1	2	3			
		(a)	(b)	(c)	(d)
34.	Radioactive materials :				
	(a) Alpha emitter micro curie/ml.	10 ⁻⁷	10 ⁻⁷	10 ⁻⁸	10 ⁻⁷
	(b) Beta emitter micro curie/ml.	10 ⁻⁶	10 ⁻⁶	10 ⁻⁷	10 ⁻⁶
35.	Bio-assay test	90% survival of fish after 96 hours in 100% effluent	90% survival of fish after 96 hours in 100% effluent	90% survival of fish after 96 hours in 100% effluent	90% survival of fish after 96 hours in 100% effluent
36.	Manganese (as Mn)	2 mg/l	2 mg/l	--	2 mg/l
37.	Iron (as Fe)	3 mg/l	3 mg/l	--	3 mg/l
38.	Vanadium (as V)	0.2 mg/l	0.2 mg/l	--	0.2 mg/l
39.	Nitrate Nitrogen	10 mg/l	--	--	20 mg/l
¹ 40.	***	*	*	*	*

¹ Omitted by Rule 2(d)(i) of the Environment (Protection) Third Amendment Rules, 1993 vide Notification No. G.S.R. 801(E) dated 31.12.1993

Annexure – 3.1: List of Road Crossing

LIST OF ROAD CROSSINGS

S.No	CHAINAGE (M)	TYPE OF ROAD	WIDTH(M)	REMARKS
1	149.0	VISANTH NAGAR ROAD	6.565	
2	161.2	GCDA SHOPING COMPLEX ROAD	6.57	
3	420.0	SOUTH TO NORTH JANATHA ROAD	8.623	
4	565.0	M.G.ROAD	16.403	
5	862.0	AIRPORT TO TAMANA ROAD	11.235	
6	977.0	PJANTONY ROAD	8.977	
7	1075.0	LANE	2.453	
8	1122.0	NELLI PARANSIL LANE	2.027	
9	1221.0	KULUMATHU ROAD	2.437	
10	1510.0	NH-47 BY PASS (PIPE LINE ROAD)	6.705	
11	1670.0	ALAPUZHA TO THRISURI ROAD	26.026	
12	1840.0	KOCHAPILLY APPACHAN ROAD	3.227	
13	1938.0	VENAL HIGH SCHOOL ROAD	5.346	
14	2067.0	EDAPALLY-ARKKADAVU ROAD	5.408	
15	2100.0	EDDAPALLY ROAD	4.95	
16	2230.0	PARTHIBA ROAD	3.95	
17	2990.0	PALIKILLAM WEST ROAD	6.491	

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S.No	CHAINAGE (M)	TYPE OF ROAD	WIDTH(M)	REMARKS
18	3085.0	LANE	3.108	
19	3159.0	V.K.V ROAD	4.88	
20	3248.0	THURUTHEPARAMBU ROAD	3.914	
21	3555.0	MARKET ROAD	3.508	
22	3645.0	LANE	3.719	
23	3655.0	LANE	4.563	
24	3972.0	RAJIV GANDHI ROAD	3.165	
25	4065.0	LANE	3.416	
26	4370.0	CHILAKKARA ROAD	4.249	
27	4500.0	ROAD	10.278	
28	4900.0	CAR WORK SHOP ROAD	7.25	
29	5073.0	SERVICE ROAD	5.898	
30	5230.0	SERVICE ROAD	5.841	
31	5250.0	CIVIL LINE TO INFO PARK ROAD	17.165	
32	10030.0	SERVICE ROAD	5.841	
33	5390.0	GREEN GURDENT ROAD	11.574	
34	5380.0	POYYACHIRA ROAD	4.453	
35	6019.0	JUSTICE KOCHUTHOMMMAN ROAD	12.705	

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S.No	CHAINAGE (M)	TYPE OF ROAD	WIDTH(M)	REMARKS
36	7200.0	SERVICE ROAD	17.96	
37	7540.0	ROAD	6.394	
38	7650.0	INFOPARK EXPRESS WAY	26.738	
39	7735	CHITHRAPUZA KADAVIL TO KONNATH ROAD	5.673	
40	8263	ROAD	10.926	
41	8680	JEWEL ROAD	5.792	
42	8710	ROAD	7.671	
43	8854	KEPIP ROAD	17.69	
44	9173	ROAD	3.977	
45	9480	ROAD	4.364	
46	9900	ROAD	2.816	
47	10000	ROAD	21.54	
48	10300	INFOPARK ROAD	39.55	
49	10750	EDACHIRA ROAD	3.568	

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Annexure – 3.2: List of Nallah

S.NO.	CHAINAGE(M)	TYPE OF DRAIN	SPAN(M)	BRIDGE TYPE	BED LEVEL	HFL
1	197.16	DRAIN	3.363	RCC BOX	0.737	
2	286.64	DRAIN	0.511	RCC BOX	0.632	
3	293.98	DRAIN	1.644	RCC BOX	0.71	
4	565.96	RIVER	72.216	RIVER BRIDGE	-3.232	0.63
5	2062.29	DRAIN	10.94		0.54	
6	2108.10	NALA	6.238	ROAD BRIDGE	0.202	0.85
7	2800.76	NALA	53.622	BRIDGE	-0.931	1.25
8	4873.16	DRAIN	3.115		0.92	
9	4977.40	DRAIN	0.649		1.521	
10	5079.41	DRAIN	3.188		1.89	
11	5551.74	DRAIN	2.405		0.920	
12	7171.69	RIVER	118.628	ROAD BRIDGE	-5.12	0.755
13	8120	NALA	16.935	ROAD BRIDGE	-0.53	0.855
14	8720	NALA	6.198	CULVERT	-0.32	0.81
15	9500	DRAIN	0.911	CULVERT	1.113	1.622
16	9575	DRAIN	3.739	CULVERT	9.25	
17	10003	DRAIN	2.459	RCC BOX	0.768	
18	10270	DRAIN	0.962	RCC BOX	1.225	
19	10591	DRAIN	4.794	CULVERT	0.52	

Annexure – 3.3: List of Power Lines

LIST OF POWER CROSSING

S.NO.	CHAINAGE(M)	Type of line	VERTICAL CLEARENCE(M)	OWNERSHIP
1	96.925	HT POWER LINE	18.2	KSEB
2	308.889	LT LINE	6.73	KSEB
3	344.908	LT LINE	6.25	KSEB
4	416.636	LT LINE	6.42	KSEB
5	610.599	LT LINE	8.320	KSEB
6	687.5	LT LINE	8.420	KSEB
7	695.655	LT LINE	7.1	KSEB
8	727.931	LT LINE	6.7	KSEB
9	813.671	LT LINE	7.021	KSEB
10	867.082	LT LINE	7.86	KSEB
11	985.232	LT LINE	6.7	KSEB
12	1074.974	LT LINE	7.34	KSEB
13	1124.240	LT LINE	7.32	KSEB
14	1153.313	LT LINE	8.357	KSEB
15	1195.984	LT LINE	7.021	KSEB
16	1217.765	LT LINE	7.86	KSEB
17	1291.532	LT LINE	5.95	KSEB

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S.NO.	CHAINAGE(M)	Type of line	VERTICAL CLEARANCE(M)	OWNERSHIP
18	1312.653	LT LINE	6.54	KSEB
19	1374.859	LT LINE	6.8	KSEB
20	1420.874	LT LINE	7.32	KSEB
21	1468.958	LT LINE	7.73	KSEB
22	1484.718	LT LINE	7.34	KSEB
23	1555.904	LT LINE	6.87	KSEB
24	1576.313	LT LINE	6.9	KSEB
25	1655.695	LT LINE	7.12	KSEB
26	1816.472	LT LINE	5.78	KSEB
27	1855.609	LT LINE	5.47	KSEB
28	1879.524	LT LINE	5.889	KSEB
29	1932.658	LT LINE	5.86	KSEB
30	1975.872	LT LINE	5.79	KSEB
31	2171.459	LT LINE	7.9	KSEB
32	2173.775	LT LINE	7.92	KSEB
33	2478.093	LT LINE	5.32	KSEB
34	2932.985	LT LINE	5.89	KSEB
35	3028.795	LT LINE	5.79	KSEB

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S.NO.	CHAINAGE(M)	Type of line	VERTICAL CLEARANCE(M)	OWNERSHIP
36	3036.339	LT LINE	5.52	KSEB
37	3375.671	LT LINE	5.63	KSEB
38	3551.489	LT LINE	6.2	KSEB
39	3595.924	LT LINE	5.32	KSEB
40	3632.431	LT LINE	5.65	KSEB
41	3747.279	LT LINE	6.4	KSEB
42	3787.556	LT LINE	5.01	KSEB
43	3790.083	LT LINE	7.55	KSEB
44	3857.269	LT LINE	6.23	KSEB
45	3894.837	LT LINE	5.98	KSEB
46	3960.000	LT LINE	6.9	KSEB
47	4013.856	LT LINE	7.49	KSEB
48	4093.211	LT LINE	5.76	KSEB
49	4288.504	LT LINE	6.4	KSEB
50	4359.743	LT LINE	5.9	KSEB
51	4481.870	HT POWER LINE	12.45	
52	4484.752	LT LINE	5.8	KSEB
53	4515.841	LT LINE	5.7	KSEB

**Environmental Impact Assessment (EIA) Report for Kochi Metro Rail Phase II
“JLN Station to INFOPark II”, Kochi, Kerala**

S.NO.	CHAINAGE(M)	Type of line	VERTICAL CLEARENCE(M)	OWNERSHIP
54	4599.772	LT LINE	6.62	KSEB
55	5253.634	LT LINE	5.9	KSEB
56	5483.908	LT LINE	5.2	KSEB
57	5542.553	HT POWER LINE	6.59	
58	5676.283	LT LINE	6.31	KSEB
59	5873.239	LT LINE	5.3	KSEB
60	6352.805	HT POWER LINE	12.26	
61	6638.599	LT LINE	9.25	KSEB
62	6827.522	HT POWER LINE	14.9	
63	6879.539	LT LINE	9.64	KSEB
64	6945.468	LT LINE	8.65	KSEB
65	7030.179	LT LINE	8.5	KSEB
66	7413.717	LT LINE	5.9	KSEB
67	7431.814	LT LINE	6.7	KSEB
68	7539.646	LT LINE	5.32	KSEB
69	7613.451	LT LINE	7.23	KSEB
70	8069.898	HT POWER LINE	10.597	
71	9465.511	HT POWER LINE	10.59	

**Environmental Impact Assessment (EIA) Report for Kochi Metro Rail Phase II
"JLN Station to INFOPark II", Kochi, Kerala**

Annexure – 4.1: Soil Quality Report



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TEST REPORT

Test Report Number	RSF1908105	Page Number	Page 1 of 1
Job Order Number	JPT/SF19/08105	Customer Ref. Number	-
Date of Issue	17.06.2019	Sample Received On	08.06.2019
Project Proponent: Kochi Metro Rail Ltd. Project Name: Development of Kochi Metro, Phase II (JLN Stadium to Infopark via Kakkanad)"			
NAME & ADDRESS OF CUSTOMER		SAMPLE DETAILS	
Issued to: M/s EQMS india Pvt. Ltd. 304 & 305, 3 rd floor, plot No. 16, Rishabh Towers, Community Centre, Karkardooma, Delhi		Sample Description : Soil Sample Sampling Location : Pallorivattam Junction Sampling Date : 02.06.2019 Sampling done by : JPT Lab Representative Sample Quantity : 1 kg Analysis Duration : 08.06.2019 to 15.06.2019	

TEST RESULTS

SOIL ANALYSIS

S.No.	PARAMETERS	RESULTS	UNIT	TEST METHOD
Physical Characteristics				
1.	Color	Reddish Brown	-	Soil Chemical Analysis by M.L. Jackson
2.	Texture Class	Clay Loam	USDA System	Soil Chemical Analysis by M.L. Jackson
3.	Particle Size Distribution:			
i)	Sand , >0.2-mm Dia	28	%	Soil Chemical Analysis by M.L. Jackson
ii)	Silt , 0.02 to 0.2-mm Dia	42	%	
iii)	Clay , < 0.002-mm Dia	30	%	
4.	Porosity	47.8	%	Soil Chemical Analysis by M.L. Jackson
5.	Bulk Density	1.38	gm/cc	IS: 2720 (part 3):1980 (R 2011)
6.	Water Holding Capacity	31.2	%	Soil Chemical Analysis by M.L. Jackson
7.	Permeability	0.42	cm/hr	Soil Chemical Analysis by M.L. Jackson
Chemical Characteristics				
8.	pH (at25°C) (1:2 suspension)	6.82	-	IS : 2720 (Part-26) : 1987 (RA 2011)
9.	Elec. Conductivity (at25°C) (1:2 suspension)	398	µmhos/cm	IS : 14767 : 2000 (RA 2016)
10.	CEC	19.5	meq/100g	IS: 2720 part 24:1976 (R 2015)
11.	Organic matter	0.88	%	IS:2720 part 22: 1977 (RA 2015)
12.	Organic Carbon	0.51	%	Soil Chemical Analysis by M.L. Jackson
13.	Copper as Cu	0.54	mg/Kg	Soil Chemical Analysis by M.L. Jackson
14.	Zinc as Zn	0.85	mg/Kg	Soil Chemical Analysis by M.L. Jackson
15.	Iron as Fe	12.8	mg/Kg	Soil Chemical Analysis by M.L. Jackson
16.	Boron as B	0.60	mg/Kg	Soil Chemical Analysis by M.L. Jackson
17.	Magnesium as Mg	8.12	mg/kg	Soil Chemical Analysis by M.L. Jackson
Available Nutrients				
i)	Nitrogen as N	391.5	kg/ha	Soil Chemical Analysis by M.L. Jackson
ii)	Phosphorus as P	18.2	kg/ha	Soil Chemical Analysis by M.L. Jackson
iii)	Potassium as K	179.2	kg/ha	Soil Chemical Analysis by M.L. Jackson



End of Report
For J P Test & Research Centre
Quality Manager

Authorized Signatory

Note 1. Sample will be retained for 15 days for chemical testing and 7 days for Bacteriological testing from the date of issue of test report, unless specified by the customer. The results given for noise/lux are related to the observed values at the time of monitoring. The customer asked for the above tests only. 2.The parameters marked as * are not accredited by NABL. 3. The results given above are related to the tested sample and mentioned parameters. Endorsement of product is neither inferred nor implied. 4. Total liability of our works is limited to invoiced amount. 5. This report can not be used as evidence in a court of law without the written approval of the lab. 6. Certificate shall not be reproduced, except in full, without prior written approval of the laboratory

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**Environmental Impact Assessment (EIA) Report for Kochi Metro Rail Phase II
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TEST REPORT

Test Report Number	RSF1908106	Page Number	Page 1 of 1
Job Order Number	JPT/SF19/08106	Customer Ref. Number	-
Date of Issue	17.06.2019	Sample Received On	08.06.2019
Project Proponent: Kochi Metro Rail Ltd. Project Name: Development of Kochi Metro, Phase II (JLN Stadium to Infopark via Kakkanad)"			
NAME & ADDRESS OF CUSTOMER		SAMPLE DETAILS	
Issued to: M/s EQMS india Pvt. Ltd. 304 & 305, 3 rd floor, plot No. 16, Rishabh Towers, Community Centre, Karkardooma, Delhi		Sample Description : Soil Sample Sampling Location : Chembumukku Sampling Date : 03.06.2019 Sampling done by : JPT Lab Representative Sample Quantity : 1 kg Analysis Duration : 08.06.2019 to 15.06.2019	

TEST RESULTS

SOIL ANALYSIS

S.No.	PARAMETERS	RESULTS	UNIT	TEST METHOD
Physical Characteristics				
1.	Color	Reddish Brown	-	Soil Chemical Analysis by M.L. Jackson
2.	Texture Class	Clay Loam	USDA System	Soil Chemical Analysis by M.L. Jackson
3.	Particle Size Distribution:			
i)	Sand , >0.2-mm Dia	24	%	Soil Chemical Analysis by M.L. Jackson
ii)	Silt . 0.02 to 0.2-mm Dia	41	%	
iii)	Clay , < 0.002-mm Dia	35	%	
4.	Porosity	51.3	%	Soil Chemical Analysis by M.L. Jackson
5.	Bulk Density	1.29	gm/cc	IS: 2720 (part 3):1980 (R 2011)
6.	Water Holding Capacity	30.2	%	Soil Chemical Analysis by M.L. Jackson
7.	Permeability	0.32	cm/hr	Soil Chemical Analysis by M.L. Jackson
Chemical Characteristics				
8.	pH (at25°C) (1:2 suspension)	6.84	-	IS : 2720 (Part-26) : 1987 (RA 2011)
9.	Elec. Conductivity (at25°C) (1:2 suspension)	385	µmhos/cm	IS : 14767 : 2000 (RA 2016)
10.	CEC	18.5	meq/100g	IS: 2720 part 24:1976 (R 2015)
11.	Organic matter	1.14	%	IS:2720 part 22: 1977 (RA 2015)
12.	Organic Carbon	0.66	%	Soil Chemical Analysis by M.L. Jackson
13.	Copper as Cu	0.72	mg/Kg	Soil Chemical Analysis by M.L. Jackson
14.	Zinc as Zn	0.81	mg/Kg	Soil Chemical Analysis by M.L. Jackson
15.	Iron as Fe	11.6	mg/Kg	Soil Chemical Analysis by M.L. Jackson
16.	Boron as B	0.58	mg/Kg	Soil Chemical Analysis by M.L. Jackson
17.	Magnesium as Mg	6.16	mg/kg	Soil Chemical Analysis by M.L. Jackson
18.	Available Nutrients			
i)	Nitrogen as N	384.5	kg/ha	Soil Chemical Analysis by M.L. Jackson
ii)	Phosphorus as P	22.6	kg/ha	Soil Chemical Analysis by M.L. Jackson
iii)	Potassium as K	182.8	kg/ha	Soil Chemical Analysis by M.L. Jackson



Checked By



For J P Test & Research Centre

Authorized Signatory

Form No. JPT-15-10E-07 Issue No. 01 Issue Date 15.06.2015 Rev. No. 00
Note 1. Sample will be retained for 15 days for chemical testing and 7 days for Bacteriological testing from the date of Issue of test report, unless specified by the customer. The results given for noise/lux are related to the observed values at the time of monitoring. The customer asked for the above tests only. 2. The parameters marked as * are not accredited by NABL. 3. The results given above are related to the tested sample and mentioned parameters. Endorsement of product is neither inferred nor implied. 4. Total liability of our works is limited to invoiced amount. 5. This report can not be used as evidence in a court of law without the written approval of the lab. 6. Certificate shall not be reproduced, except in full, without prior written approval of the laboratory

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TEST REPORT

Test Report Number	RSF1908107	Page Number	Page 1 of 1
Job Order Number	JPT/SF19/08107	Customer Ref. Number	-
Date of Issue	17.06.2019	Sample Received On	08.06.2019
Project Proponent: Kochi Metro Rail Ltd. Project Name: Development of Kochi Metro, Phase II (JLN Stadium to Infopark via Kakkanad)"			
NAME & ADDRESS OF CUSTOMER		SAMPLE DETAILS	
Issued to: M/s EQMS india Pvt. Ltd. 304 & 305, 3 rd floor, plot No. 16, Rishabh Towers, Community Centre, Karkardooma, Delhi		Sample Description : Soil Sample Sampling Location : Info Park Phase-2 Sampling Date : 04.06.2019 Sampling done by : JPT Lab Representative Sample Quantity : 1 kg Analysis Duration : 08.06.2019 to 15.06.2019	

TEST RESULTS

SOIL ANALYSIS

S.No.	PARAMETERS	RESULTS	UNIT	TEST METHOD
Physical Characteristics				
1.	Color	Reddish Brown	-	Soil Chemical Analysis by M.L. Jackson
2.	Texture Class	Clay Loam	USDA System	Soil Chemical Analysis by M.L. Jackson
3.	Partiele Size Distribution:			
i)	Sand , >0.2-mm Dia	26	%	Soil Chemical Analysis by M.L. Jackson
ii)	Silt , 0.02 to 0.2-mm Dia	40	%	
iii)	Clay ,< 0.002-mm Dia	34	%	
4.	Porosity	49.2	%	Soil Chemical Analysis by M.L. Jackson
5.	Bulk Density	1.35	gm/cc	IS: 2720 (part 3):1980 (R 2011)
6.	Water Holding Capacity	29.5	%	Soil Chemical Analysis by M.L. Jackson
7.	Permeability	0.33	cm/hr	Soil Chemical Analysis by M.L. Jackson
Chemical Characteristics				
8.	pH (at25°C) (1:2 suspension)	7.05	-	IS : 2720 (Part-26) : 1987 (RA 2011)
9.	Elec. Conductivity (at25°C) (1:2 suspension)	412	µmhos/cm	IS : 14767 : 2000 (RA 2016)
10.	CEC	17.6	meq/100g	IS: 2720 part 24:1976 (R 2015)
11.	Organic matter	1.17	%	IS:2720 part 22: 1977 (RA 2015)
12.	Organic Carbon	0.68	%	Soil Chemical Analysis by M.L. Jackson
13.	Copper as Cu	0.65	mg/Kg	Soil Chemical Analysis by M.L. Jackson
14.	Zinc as Zn	0.77	mg/Kg	Soil Chemical Analysis by M.L. Jackson
15.	Iron as Fe	14.2	mg/Kg	Soil Chemical Analysis by M.L. Jackson
16.	Boron as B	0.61	mg/Kg	Soil Chemical Analysis by M.L. Jackson
17.	Magnesium as Mg	5.24	mg/kg	Soil Chemical Analysis by M.L. Jackson
18.	Available Nutrients			
i)	Nitrogen as N	410.5	kg/ha	Soil Chemical Analysis by M.L. Jackson
ii)	Phosphorus as P	21.4	kg/ha	Soil Chemical Analysis by M.L. Jackson
iii)	Potassium as K	196.8	kg/ha	Soil Chemical Analysis by M.L. Jackson



Checked By


For J P Test & Research Centre
Authorized Signatory

Note 1. Sample will be retained for 15 days for chemical testing and 7 days for Bacteriological testing from the date of issue of test report, unless specified by the customer. The results given for noise/lux are related to the observed values at the time of monitoring. The customer asked for the above tests only. 2. The parameters marked as * are not accredited by NABL. 3. The results given above are related to the tested sample and mentioned parameters. Endorsement of products is neither inferred nor implied. 4. Total liability of our works is limited to invoiced amount. 5. This report can not be used as evidence in a court of law without the written approval of the lab. 6. Certificate shall not be reproduced, except in full, without prior written approval of the laboratory

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**Environmental Impact Assessment (EIA) Report for Kochi Metro Rail Phase II
"JLN Station to INFOPark II", Kochi, Kerala**

Annexure – 4.2: Air Quality Report



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TEST REPORT

Test Report Number	RAF1913102	Page Number	1 of 1
Date of Issue	13.06.2019	Study Period	June 2019
Project Proponent: Kochi Metro Rail Ltd.			
Project Name: Development of Kochi Metro, Phase II (JLN Stadium to Infopark via Kakkanad)"			
NAME & ADDRESS OF CUSTOMER		SAMPLE DETAILS	
Issued to: M/s EQMS India Pvt. Ltd., 304 & 305, 3 rd floor, plot No. 16, Rishabh Towers, Community Centre, Karkardooma, Delhi		Sample Description : Ambient Air Sample Location : Chembumukku Sample done by : JPT Lab Representative Weather Condition : Cloudy Sampling duration : 24 Hrs (Except for CO: 1 hr.)	


Ambient Air Quality Test Results

S. No	Date	PM ₁₀ (µg/m ³)	PM _{2.5} (µg/m ³)	SO ₂ (µg/m ³)	NO ₂ (µg/m ³)	CO (mg/m ³)
Test Method		IS:5182 (Part-23)	JPT/CH/SOP/ AIR/06	IS:5182 (Part-2)	IS:5182 (Part-6)	IS: 5182 (Part-10)
*NAAQS		100	60	80	80	04
1	03/06/2019	66	29.6	6.1	15.2	0.39
2	04/06/2019	59	26.3	5.7	13.6	0.27

End of Report



Checked By



For J.P. Test & Research Centre
Authorized Signatory

* Format No. JP/75/10F-01 Issue No. 01 Issue Date 16.10.2015 Rev. No. 00

Note 1. Sample will be retained for 15 days for chemical testing and 7 days for Bacteriological testing from the date of issue of test report, unless specified by the customer. The results given for noise/lux are related to the observed values at the time of monitoring. The customer asked for the above tests only. 2. The parameters marked as * are not accredited by NABL. 3. The results given above are related to the tested sample and mentioned parameters. Endorsement of product is neither inferred nor implied. 4. Total liability of our works is limited to invoiced amount. 5. This report can not be used as evidence in a court of law without the written approval of the lab. 6. Certificate shall not be reproduced, except in full, without prior written approval of the laboratory

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"JLN Station to INFOPark II", Kochi, Kerala**



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TEST REPORT

Test Report Number	RAF1913103	Page Number	1 of 1
Date of Issue	13.06.2019	Study Period	June 2019
Project Proponent: Kochi Metro Rail Ltd. Project Name: Development of Kochi Metro, Phase II (JLN Stadium to Infopark via Kakkanad)"			
NAME & ADDRESS OF CUSTOMER		SAMPLE DETAILS	
Issued to: M/s EQMS India Pvt. Ltd., 304 & 305, 3 rd floor, plot No. 16, Rishabh Towers, Community Centre, Karkardooma, Delhi		Sample Description : Ambient Air Sample Location : Chittetukara (Hyundai Showroom) Sample done by : JPT Lab Representative Weather Condition : Cloudy Sampling duration : 24 Hrs (Except for CO: 1 hr.)	

Ambient Air Quality Test Results

S. No	Date	PM ₁₀ (µg/m ³)	PM _{2.5} (µg/m ³)	SO ₂ (µg/m ³)	NO ₂ (µg/m ³)	CO (mg/m ³)
	Test Method	IS:5182 (Part-23)	JPT/CH/SOP/ AIR/06	IS:5182 (Part-2)	IS:5182 (Part-6)	IS: 5182 (Part-10)
	*NAAQS	100	60	80	80	04
1	05/06/2019	72	32.8	7.2	18.4	0.45
2	06/06/2019	65	30.3	5.7	13.9	0.39

End of Report



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* Format No. JPT/5.10F-01 Issue No. 01 Issue Date 16.10.2015 Rev. No. 00

For J P Test & Research Centre

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Note 1. Sample will be retained for 15 days for chemical testing and 7 days for Bacteriological testing from the date of issue of test report, unless specified by the customer. The results given for noise/lux are related to the observed values at the time of monitoring. The customer asked for the above tests only. 2. The parameters marked as * are not accredited by NABL. 3. The results given above are related to the tested sample and mentioned parameters. Endorsement of product is neither inferred nor implied. 4. Total liability of our works is limited to invoiced amount. 5. This report can not be used as evidence in a court of law without the written approval of the lab. 6. Certificate shall not be reproduced, except in full, without prior written approval of the laboratory

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TEST REPORT

Test Report Number	RAF1913101	Page Number	1 of 1
Date of Issue	13.06.2019	Study Period	June 2019
Project Proponent: Kochi Metro Rail Ltd. Project Name: Development of Kochi Metro, Phase II (JLN Stadium to Infopark via Kakkanad)			
NAME & ADDRESS OF CUSTOMER		SAMPLE DETAILS	
Issued to: M/s EQMS India Pvt. Ltd., 304 & 305, 3 rd floor, plot No. 16, Rishabh Towers, Community Centre, Karkardooma, Delhi		Sample Description : Ambient Air Sample Location : JLN Stadium (Pump House) Sample done by : JPT Lab Representative Weather Condition : Cloudy Sampling duration : 24 Hrs (Except for CO: 1 hr.)	

Ambient Air Quality Test Results

S. No	Date	PM ₁₀ (µg/m ³)	PM _{2.5} (µg/m ³)	SO ₂ (µg/m ³)	NO ₂ (µg/m ³)	CO (mg/m ³)
	Test Method	IS:5182 (Part-23)	JPT/CH/SOP/ AIR/06	IS:5182 (Part-2)	IS:5182 (Part-6)	IS: 5182 (Part-10)
	*NAAQS	100	60	80	80	04
1	01/06/2019	68	33.2	7.4	13.7	0.42
2	02/06/2019	76	37.4	6.7	16.8	0.51

End of Report



Checked By

* Format No. JPT/TS-109-01 Issue No. 01 Issue Date 16.10.2015 Rev. No. 00



For J. P. Test & Research Centre

Authorized Signatory

Note 1. Sample will be retained for 15 days for chemical testing and 7 days for Bacteriological testing from the date of issue of test report, unless specified by the customer. The results given for noise/lux are related to the observed values at the time of monitoring. The customer asked for the above tests only. 2. The parameters marked as * are not accredited by NABL. 3. The results given above are related to the tested sample and mentioned parameters. Endorsement of product is neither inferred nor implied. 4. Total liability of our works is limited to invoiced amount. 5. This report can not be used as evidence in a court of law without the written approval of the lab. 6. Certificate shall not be reproduced, except in full, without prior written approval of the laboratory

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**Environmental Impact Assessment (EIA) Report for Kochi Metro Rail Phase II
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Annexure – 4.3: Noise Monitoring

Locations Name	Pallorivattam Junction	Vazhakala	CSE Z	Chembumkku	JLN Stadium	Chittetukara Near Hyundai Showroom	Kakkanad	Info Park Gate	Info Pak Phase I- Sanskar School	Pallorivattam Bypass	Padamughal
Location Code	NQ4	NQ5	NQ6	NQ7	NQ8	NQ9	NQ10	NQ11	NQ12	NQ13	NQ14
Date of Monitoring	06-01-2019	06-02-2019	06-02-2019	06-03-2019	06-03-2019	06-04-2019	06-04-2019	06-05-2019	06-05-2019	06-06-2019	06-06-2019
Zone											
Noise Level (dBA)											
Time											
06:00-07:00	61.4	52.2	48.1	45.6	58.3	61.5	59.8	58.0	41.4	57.3	46.7
07:00-08:00	60.2	58.2	51.2	48.3	65.1	64.4	63.5	60.2	45.6	60.5	51.2
08:00-09:00	65.7	61.4	55.4	52.1	60.5	67.3	64.4	62.3	47.1	63.1	56.0
09:00-10:00	62.1	63.4	56.8	55.4	63.7	65.5	60.9	65.1	50.8	62.8	54.3
10:00-11:00	58.9	60.7	51.2	56.6	65.6	61.7	65.0	58.7	53.2	59.8	57.8
11:00-12:00	65.2	65.4	55.7	51.3	67.9	59.8	61.3	55.5	50.4	63.4	55.4
12:00-13:00	61.7	59.8	58.3	49.8	68.7	58.6	59.8	56.7	49.7	65.6	51.2
13:00-14:00	59.3	55.4	56.6	47.3	65.2	62.3	63.2	51.8	48.6	64.0	48.5

**Environmental Impact Assessment (EIA) Report for Kochi Metro Rail Phase II
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14:00-15:00	58.4	58.3	52.3	45.5	62.3	64.9	65.7	48.3	45.4	61.7	49.0
15:00-16:00	58.0	62.7	49.8	48.2	59.5	65.4	67.8	53.6	43.8	59.8	51.8
16:00-17:00	63.9	59.0	47.6	50.1	61.3	61.7	63.2	60.9	43.0	56.6	53.4
17:00-18:00	60.7	58.4	53.4	49.7	66.6	59.8	62.0	59.4	45.6	60.2	51.5
18:00-19:00	65.6	60.3	57.2	48.3	60.5	60.2	61.7	62.3	46.1	61.3	54.0
19:00-20:00	61.3	58.4	55.1	46.6	59.3	58.4	57.2	58.1	47.8	58.4	53.1
20:00-21:00	58.4	56.7	52.6	47.8	57.7	60.1	58.5	55.6	45.2	56.1	48.7
21:00-22:00	57.1	55.6	47.0	45.5	56.8	58.3	56.3	54.8	43.5	54.2	45.5
Max	65.7	65.4	58.3	56.6	68.7	67.3	67.8	65.1	53.2	65.6	57.8
Min	57.1	52.2	47	45.5	56.8	58.3	56.3	48.3	41.4	54.2	45.5
Leq Day	62	60.3	54.3	50.7	63.9	62.8	62.9	59.3	47.9	61.3	52.9
22:00-23:00	56.1	54.2	45.3	43.4	57.3	55.9	56.8	53.2	43.1	55.3	46.2
23:00-00:00	53.9	51.4	43.6	41.6	55.4	56.7	53.1	55.4	41.7	51.0	44.1
00:00-01:00	51.4	53.7	41.7	39.5	51.8	54.3	50.4	48.7	40.8	49.4	42.7
01:00-02:00	49.5	50.4	40.9	40.6	51.2	51.4	49.8	43.8	38.4	48.3	41.4
02:00-03:00	48.2	47.6	42.2	40.2	50.9	50.6	48.2	46.6	39.5	50.8	41.0
03:00-04:00	44.5	43.0	41.7	41.3	47.6	48.7	51.3	47.0	40.1	49.7	42.6
04:00-05:00	48.3	47.2	43.5	42.7	52.3	51.0	52.5	51.3	42.4	51.3	43.3
05:00-	54.0	52.4	47.6	43.5	53.7	53.8	54.1	52.7	43.0	53.6	44.5

**Environmental Impact Assessment (EIA) Report for Kochi Metro Rail Phase II
“JLN Station to INFOPark II”, Kochi, Kerala**

06:00											
Max	56.1	54.2	47.6	43.5	57.3	56.7	56.8	55.4	43.1	55.3	46.2
Min	44.5	43.0	40.9	39.5	47.6	48.7	48.2	43.8	38.4	48.3	41.0
Leq Night	51.2	51.2	43.9	41.8	53.4	53.6	52.8	51.3	41.4	51.7	43.5

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"JLN Station to INFOPark II", Kochi, Kerala**

Annexure – 4.5: Surface Water Quality Results



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TEST REPORT

Test Report Number	RWF1908104	Page Number	Page 1 of 2
Job Order Number	JPT/WF19/08104	Customer Ref. Number	-
Date of Issue	17.06.2019	Sample Received On	08.06.2019

Project Proponent: Kochi Metro Rail Ltd. Project Name: Development of Kochi Metro, Phase II (JLN Stadium to Infopark via Kakkanad)"	
NAME & ADDRESS OF CUSTOMER	SAMPLE DETAILS
Issued to: M/s EQMS India Pvt. Ltd., 304 & 305, 3 rd floor, plot No. 16, Rishabh Towers, Community Centre, Karkardooma, Delhi	Sample Description : One Samples of Water Described as "Surface Water Collected on 04.06.2019" Sampling done by : JPT Lab Representative Location : Kadambryar River Sampling Protocol : IS: 3025 Part-01, IS: 1622 Packing : Plastic Bottle + Glass Bottle Quantity : 5 Ltr + 500 ml Analysis done on : 08.06.2019 to 15.06.2019

RESULTS

WATER QUALITY ANALYSIS

S. No	Parameters	Unit	Results	Test Method
1	pH value	-	7.11	IS :3025(Pt-11)1983RA2017
2	Temperature	°C	25.0	IS: 3025(Pt-9)
3	Conductivity	µmhos/cm	3088	IS: 3025(Pt-14)
4	Turbidity	NTU	14	IS: 3025(Pt-10)1984RA2017
5	Total Dissolved Solids	mg/l	1976	IS : 3025(Pt-16)1984 RA 2017
6	Total Suspended solids	mg/l	4	IS-3025 (p-17) :1984 RA 2017
7	Total Hardness (as CaCO ₃)	mg/l	454	IS : 3025(Pt-21)2009R2014
8	Chlorides (as Cl)	mg/l	756	IS : 3025(Pt-32) 1988R2014
9	Total Alkalinity as CaCO ₃	mg/l	318	IS : 3025(Pt-23) 1986R2014
10	Sulphate (as SO ₄)	mg/l	132	IS : 3025(Pt-24) 1986R2014
11	Fluoride (as F)	mg/l	0.68	APHA 23 rd Ed, 4500 F (D)
12	Iron (as Fe)	mg/l	0.42	APHA 23 rd Ed, 3111
13	Zinc (as Zn)	mg/l	1.02	APHA 23 rd Ed, 3111



* Format No. JPT/5.10F-05 Issue No. 01 Issue Date 15.06.2015 Rev. No. 02 Rev Date. 15.05.2019



Note 1. Sample will be retained for 15 days for chemical testing and 7 days for Bacteriological testing from the date of issue of test report, unless specified by the customer. The results given for noise/lux are related to the observed values at the time of monitoring. The customer asked for the above tests only. 2. The parameters marked as * are not accredited by NABL. 3. The results given above are related to the tested sample and mentioned parameters. Endorsement of product is neither inferred nor implied. 4. Total liability of our works is limited to invoiced amount. 5. This report can not be used as evidence in a court of law without the written approval of the lab. 6. Certificate shall not be reproduced, except in full, without prior written approval of the laboratory

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TEST REPORT

Test Report Number	RWF1908104	Page Number	Page 2 of 2
Job Order Number	JPT/WF19/08104	Customer Ref. Number	-
Date of Issue	17.06.2019	Sample Received On	08.06.2019

S.No	Parameters	Unit	Results	Test Method
14	Calcium (as Ca)	mg/l	132	IS : 3025(Pt-40) 1991R2014
15	Magnesium (as Mg ²⁺)	mg/l	30.8	APHA 23 rd Ed, 3500 Mg B
16	Cadmium (as Cd)	mg/l	<0.01	APHA 23 rd Ed, 3111
17	Copper (as Cu)	mg/l	<0.01	APHA 23 rd Ed, 3111
18	Nickel (as Ni)	mg/l	<0.01	APHA 23 rd Ed, 3111
19	Lead (as Pb)	mg/l	<0.01	APHA 23 rd Ed, 3111
20	Mercury (as Hg)	mg/l	<0.001	APHA 23 rd Ed, 3112
21	Total Chromium (as Cr)	mg/l	<0.05	APHA 23 rd Ed, 3111
22	Total arsenic (as As)	mg/l	<0.025	APHA 23 rd Ed, 3114
23	Oil & Grease	mg/l	<2	IS : 3025(Pt-39)1991R2014
24	Chemical Oxygen Demand	mg/l	18	IS : 3025(Pt-58) 2006R2012
25	Bio-Chemical Oxygen Demand as BOD (for 3 Days 27 °C)	mg/l	3.4	IS : 3025(Pt-44) 1993R2014
26	Dissolved Oxygen	mg/l	5.2	IS : 3025(Pt-38) 1989R2003
Bacteriological Parameters				
27	Total Coliform	MPN/100ml	2.1 x 10 ³	IS : 1622-2003 RA - 2009

End of Report



* Journal No. JPT/5-10F-05 Issue No. 01 Issue Date 15.06.2015 Rev. No. 02 Rev Date: 15.05.2019



Sr. Microbiologist
(Authorized Signatory)




Chemical: Quality Manager
(Authorized Signatory)

Note 1. Sample will be retained for 15 days for chemical testing and 7 days for Bacteriological testing from the date of issue of test report, unless specified by the customer. The results given for noise/lux are related to the observed values at the time of monitoring. The customer asked for the above tests only. 2. The parameters marked as * are not accredited by NABL. 3. The results given above are related to the tested sample and mentioned parameters. Endorsement of product is neither inferred nor implied. 4. Total liability of our works is limited to invoiced amount. 5. This report can not be used as evidence in a court of law without the written approval of the lab. 6. Certificate shall not be reproduced, except in full, without prior written approval of the laboratory

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Annexure – 4.6: Ground Water Quality Results



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TEST REPORT

Test Report Number	RWF1908103	Page Number	Page 1 of 2
Job Order Number	JPT/WF19/08103	Customer Ref. Number	-
Date of Issue	17.06.2019	Sample Received On	08.06.2019

Project Proponent: Kochi Metro Rail Ltd.
Project Name: Development of Kochi Metro, Phase II (JLN Stadium to Infopark via Kakkanad)"


NAME & ADDRESS OF CUSTOMER		SAMPLE DETAILS	
Issued to: M/s EQMS India Pvt. Ltd., 304 & 305, 3 rd floor, plot No. 16, Rishabh Towers, Community Centre, Karkardooma, Delhi		Sample Description : One Samples of Water Described as "Ground Water Collected on 05.06.2019" Sampling done by : JPT Lab Representative Location : Hundai Showroom, Chittetukara Near Info Park Gate way Sampling Protocol : IS: 3025 Part-01, IS: 1622 Packing : Plastic Bottle + Glass Bottle Quantity : 5 Ltr + 500 ml Analysis done on : 08.06.2019 to 15.06.2019	

RESULTS


WATER QUALITY ANALYSIS

S.No	Parameters	Unit	Limit (IS10500-2012) Amnd 1		Results	Test Method
			Acceptable	Permissible in Absence of Alternate Source		
1	pH value	-	6.5-8.5	No Relaxation	7.58	IS :3025(Pt-11)1983RA2017
2	Temperature	°C	-	-	25.2	IS: 3025(Pt-9)
3	Conductivity	µmhos/cm	-	-	1314	IS: 3025(Pt-14)
4	Turbidity	NTU	1	5	<1	IS: 3025(Pt-10)1984RA2017
5	Total Dissolved Solids	mg/l	500	2000	841	IS : 3025(Pt-16)1984 RA 2017
6	Total Suspended solids	mg/l	-	-	<2	IS-3025 (p-17) :1984 RA 2017
7	Total Hardness (as CaCO ₃)	mg/l	200	600	222	IS : 3025(Pt-21)2009R2014
8	Chlorides (as Cl)	mg/l	250	1000	259	IS : 3025(Pt-32) 1988R2014
9	Total Alkalinity as CaCO ₃	mg/l	200	600	240	IS : 3025(Pt-23) 1986R2014
10	Sulphate (as SO ₄)	mg/l	200	400	39	IS : 3025(Pt-24) 1986R2014
11	Nitrate(as NO ₃)	mg/l	45	No Relaxation	19	IS : 3025(Pt-34) 1988R2014
12	Fluoride (as F)	mg/l	1	1.5	0.40	APHA 23 rd Ed, 4500 F (D)
13	Iron (as Fe)	mg/l	0.3	No Relaxation	0.22	APHA 23 rd Ed, 3111

Continued...



Checked By
Sahibabad
Format No. JPT/5-30-05 Issue Date 15.08.2015 Rev. No. 02 Rev Date: 15.05.2019



Chemical Quality Manager
(Authorized Signatory)

Note 1. Sample will be retained for 15 days for chemical testing and 7 days for Bacteriological testing from the date of issue of test report, unless specified by the customer. The results given for noise/lux are related to the observed values at the time of monitoring. The customer asked for the above tests only 2. The parameters marked as * are not accredited by NABL. 3. The results given above are related to the tested sample and mentioned parameters. Endorsement of the product is neither inferred nor implied. 4. Total liability of our works is limited to invoiced amount. 5. This report can not be used as evidence in a court of law without the written approval of the lab. 6. Certificate shall not be reproduced, except in full, without prior written approval of the laboratory

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TEST REPORT

Test Report Number	RWF1908103	Page Number	Page 2 of 2
Job Order Number	JPT/WF19/08103	Customer Ref. Number	-
Date of Issue	17.06.2019	Sample Received On	08.06.2019

S.No	Parameters	Unit	Limit (IS10500-2012) Amnd 1		Results	Test Method
			Acceptable	Permissible in Absence of Alternate Source		
14	Zinc (as Zn)	mg/l	5	15	0.95	APHA 23 rd Ed, 3111
15	Calcium (as Ca)	mg/l	75	200	73.4	IS : 3025(Pt-40) 1991R2014
16	Magnesium (as Mg ²⁺)	mg/l	30	100	9.4	APHA 23 rd Ed, 3500 Mg B
17	Sodium (as Na)	mg/l	-	-	194	APHA 23 rd Ed, 3500 Na (B)
18	Potassium (as K)	mg/l	-	-	18	APHA 23 rd Ed, 3500 K (B)
19	Cadmium (as Cd)	mg/l	0.003	No Relaxation	<0.01	APHA 23 rd Ed, 3111
20	Copper (as Cu)	mg/l	0.05	1.5	<0.01	APHA 23 rd Ed, 3111
21	Nickel (as Ni)	mg/l	0.02	No Relaxation	<0.01	APHA 23 rd Ed, 3111
22	Lead (as Pb)	mg/l	0.01	No Relaxation	<0.01	APHA 23 rd Ed, 3111
23	Mercury (as Hg)	mg/l	0.001	No Relaxation	<0.001	APHA 23 rd Ed, 3112
24	Total Chromium (as Cr)	mg/l	0.05	No Relaxation	<0.05	APHA 23 rd Ed, 3111
25	Total arsenic (as As)	mg/l	0.01	0.05	<0.01	APHA 23 rd Ed, 3114
26	Phenolic Compounds (as C ₆ H ₅ OH)	mg/l	0.001	0.002	<0.001	IS : 3025(Pt-43) 1992R2014
Bacteriological Parameters						
27	Total Coliform	MPN/100ml	Shall not be detectable		Not detected <2	IS : 1622-2003 RA - 2009

End of Report



(Checked By)

* Format No. JPT/05 Issue No. 01 Issue Date 15.06.2015 Rev. No. 02 Rev Date: 15.05.2019



SE Microbiologist
(Authorized Signatory)



Chemical Quality Manager
(Authorized Signatory)

Note 1. Sample will be retained for 15 days for chemical testing and 7 days for Bacteriological testing from the date of issue of test report, unless specified by the customer. The results given for noise/lux are related to the observed values at the time of monitoring. The customer asked for the above tests only. 2. The parameters marked as * are not accredited by NABL. 3. The results given above are related to the tested sample and mentioned parameters. Endorsement of product is neither inferred nor implied. 4. Total liability of our works is limited to invoiced amount. 5. This report can not be used as evidence in a court of law without the written approval of the lab. 6. Certificate shall not be reproduced, except in full, without prior written approval of the laboratory

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TEST REPORT

Test Report Number	RWF1908102	Page Number	Page 1 of 2
Job Order Number	JPT/WF19/08102	Customer Ref. Number	-
Date of Issue	17.06.2019	Sample Received On	08.06.2019

Project Proponent: Kochi Metro Rail Ltd.
Project Name: Development of Kochi Metro, Phase II (JLN Stadium to Infopark via Kakkanad)"

NAME & ADDRESS OF CUSTOMER	SAMPLE DETAILS
Issued to: M/s EQMS India Pvt. Ltd., 304 & 305, 3 rd floor, plot No. 16, Rishabh Towers, Community Centre, Karkardooma, Delhi	Sample Description : One Samples of Water Described as "Ground Water Collected on 03.06.2019" Sampling done by : JPT Lab Representative Location : Chembumukku Sampling Protocol : IS: 3025 Part-01, IS: 1622 Packing : Plastic Bottle + Glass Bottle Quantity : 5 Ltr + 500 ml Analysis done on : 08.06.2019 to 15.06.2019

RESULTS

WATER QUALITY ANALYSIS

S.No	Parameters	Unit	Limit (IS10500-2012) Amnd 1		Results	Test Method
			Acceptable	Permissible in Absence of Alternate Source		
1	pH value	-	6.5-8.5	No Relaxation	7.90	IS :3025(Pt-11)1983RA2017
2	Temperature	°C	-	-	25.0	IS: 3025(Pt-9)
3	Conductivity	µmhos/cm	-	-	767	IS: 3025(Pt-14)
4	Turbidity	NTU	1	5	<1	IS: 3025(Pt-10)1984RA2017
5	Total Dissolved Solids	mg/l	500	2000	487	IS : 3025(Pt-16)1984 RA 2017
6	Total Suspended solids	mg/l	-	-	<2	IS-3025 (p-17) :1984 RA 2017
7	Total Hardness (as CaCO ₃)	mg/l	200	600	214	IS : 3025(Pt-21)2009R2014
8	Chlorides (as Cl)	mg/l	250	1000	72	IS : 3025(Pt-32) 1988R2014
9	Total Alkalinity as CaCO ₃	mg/l	200	600	252	IS : 3025(Pt-23) 1986R2014
10	Sulphate (as SO ₄)	mg/l	200	400	45	IS : 3025(Pt-24) 1986R2014
11	Nitrate(as NO ₃)	mg/l	45	No Relaxation	18.3	IS : 3025(Pt-34) 1988R2014
12	Fluoride (as F)	mg/l	1	1.5	0.52	APHA 23 rd Ed, 4500 F (D)
13	Iron (as Fe)	mg/l	0.3	No Relaxation	0.28	APHA 23 rd Ed, 3111

Continued...



Form No. JPT/5, 14/15 Issue No. 01 Issue Date 15.09.2015 Rev. No. 02 Rev Date: 15.05.2019



Note 1. Sample will be retained for 15 days for chemical testing and 7 days for Bacteriological testing from the date of issue of test report, unless specified by the customer. The results given for noise/lux are related to the observed values at the time of monitoring. The customer asked for the above tests only. 2. The parameters marked as * are not accredited by NABL. 3. The results given above are related to the tested sample and mentioned parameters. Endorsement of product is neither inferred nor implied. 4. Total liability of our works is limited to invoiced amount. 5. This report can not be used as evidence in a court of law without the written approval of the lab. 6. Certificate shall not be reproduced, except in full, without prior written approval of the laboratory

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TEST REPORT

Test Report Number	RWF1908102	Page Number	Page 2 of 2
Job Order Number	JPT/WF19/08102	Customer Ref. Number	-
Date of Issue	17.06.2019	Sample Received On	08.06.2019

S.No	Parameters	Unit	Limit (IS10500-2012) Amnd 1		Results	Test Method
			Acceptable	Permissible in Absence of Alternate Source		
14	Zinc (as Zn)	mg/l	5	15	0.88	APHA 23 rd Ed, 3111
15	Calcium (as Ca)	mg/l	75	200	78	IS : 3025(Pt-40) 1991R2014
16	Magnesium (as Mg ²⁺)	mg/l	30	100	4.7	APHA 23 rd Ed, 3500 Mg B
17	Sodium (as Na)	mg/l	-	-	81	APHA 23 rd Ed, 3500 Na (B)
18	Potassium (as K)	mg/l	-	-	7	APHA 23 rd Ed, 3500 K (B)
19	Cadmium (as Cd)	mg/l	0.003	No Relaxation	<0.01	APHA 23 rd Ed, 3111
20	Copper (as Cu)	mg/l	0.05	1.5	<0.01	APHA 23 rd Ed, 3111
21	Nickel (as Ni)	mg/l	0.02	No Relaxation	<0.01	APHA 23 rd Ed, 3111
22	Lead (as Pb)	mg/l	0.01	No Relaxation	<0.01	APHA 23 rd Ed, 3111
23	Mercury (as Hg)	mg/l	0.001	No Relaxation	<0.001	APHA 23 rd Ed, 3112
24	Total Chromium (as Cr)	mg/l	0.05	No Relaxation	<0.05	APHA 23 rd Ed, 3111
25	Total arsenic (as As)	mg/l	0.01	0.05	<0.01	APHA 23 rd Ed, 3114
26	Phenolic Compounds (as C ₆ H ₅ OH)	mg/l	0.001	0.002	<0.001	IS : 3025(Pt-43) 1992R2014
Bacteriological Parameters						
27	Total Coliform	MPN/100ml	Shall not be detectable		Not detected <2	IS : 1622-2003 RA - 2009

End of Report



(Checked By)

* Form No. JPT/5-19-05 Issue No. 01 Issue Date 15.06.2015 Rev. No. 02 Rev Date: 15.05.2019



Microbiologist
(Authorized Signatory)



Chemical Quality Manager
(Authorized Signatory)

Note 1. Sample will be retained for 15 days for chemical testing and 7 days for Bacteriological testing from the date of issue of test report, unless specified by the customer. The results given for noise/lux are related to the observed values at the time of monitoring. The customer asked for the above tests only. 2. The parameters marked as * are not accredited by NABL. 3. The results given above are related to the tested sample and mentioned parameters. Endorsement of product is neither inferred nor implied. 4. Total liability of our works is limited to invoiced amount. 5. This report can not be used as evidence in a court of law without the written approval of the lab. 6. Certificate shall not be reproduced, except in full, without prior written approval of the laboratory

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TEST REPORT

Test Report Number	RWF1908101	Page Number	Page 1 of 2
Job Order Number	JPT/WF19/08101	Customer Ref. Number	-
Date of Issue	17.06.2019	Sample Received On	08.06.2019

Project Proponent: Kochi Metro Rail Ltd.
Project Name: Development of Kochi Metro, Phase II (JLN Stadium to Infopark via Kakkanad)"

NAME & ADDRESS OF CUSTOMER	SAMPLE DETAILS
Issued to: M/s EQMS India Pvt. Ltd., 304 & 305, 3 rd floor, plot No. 16, Rishabh Towers, Community Centre, Karkardooma, Delhi	Sample Description : One Samples of Water Described as "Ground Water Collected on 02.06.2019" Sampling done by : JPT Lab Representative Location : Pallorivattam Junction Sampling Protocol : IS: 3025 Part-01, IS: 1622 Packing : Plastic Bottle + Glass Bottle Quantity : 5 Ltr + 500 ml Analysis done on : 08.06.2019 to 15.06.2019

RESULTS

WATER QUALITY ANALYSIS

S.No	Parameters	Unit	Limit (IS10500-2012) Amnd 1		Results	Test Method
			Acceptable	Permissible in Absence of Alternate Source		
1	pH value	-	6.5-8.5	No Relaxation	7.24	IS :3025(Pt-11)1983RA2017
2	Temperature	^o C	-	-	25.2	IS: 3025(Pt-9)
3	Conductivity	µmhos/cm	-	-	608	IS: 3025(Pt-14)
4	Turbidity	NTU	1	5	<1	IS: 3025(Pt-10)1984RA2017
5	Total Dissolved Solids	mg/l	500	2000	384	IS : 3025(Pt-16)1984 RA 2017
6	Total Suspended solids	mg/l	-	-	<2	IS-3025 (p-17) :1984 RA 2017
7	Total Hardness (as CaCO ₃)	mg/l	200	600	198	IS : 3025(Pt-21)2009R2014
8	Chlorides (as Cl)	mg/l	250	1000	47	IS : 3025(Pt-32) 1988R2014
9	Total Alkalinity as CaCO ₃	mg/l	200	600	184	IS : 3025(Pt-23) 1986R2014
10	Sulphate (as SO ₄)	mg/l	200	400	42	IS : 3025(Pt-24) 1986R2014
11	Nitrate(as NO ₃)	mg/l	45	No Relaxation	7.6	IS : 3025(Pt-34) 1988R2014
12	Fluoride (as F)	mg/l	1	1.5	0.42	APHA 23 rd Ed, 4500 F (D)
13	Iron (as Fe)	mg/l	0.3	No Relaxation	0.24	APHA 23 rd Ed, 3111

Continued...



* Format No. JPT/8-10F-05 Issue No. 01 Issue Date 15.08.2015 Rev. No. 02 Rev Date: 15.05.2019



Note 1. Sample will be retained for 15 days for chemical testing and 7 days for Bacteriological testing from the date of issue of test report, unless specified by the customer. The results given for noise/lux are related to the observed values at the time of monitoring. The customer asked for the above tests only. 2. The parameters marked as * are not accredited by NABL. 3. The results given above are related to the tested sample and mentioned parameters. Endorsement of product is neither inferred nor implied. 4. Total liability of our works is limited to invoiced amount. 5. This report can not be used as evidence in a court of law without the written approval of the lab. 6. Certificate shall not be reproduced, except in full, without prior written approval of the laboratory

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Annexure – 7.1: Emergency Preparedness and Response Plan

1.0 Introduction

An emergency is a situation that poses an immediate risk to health, life, property, or environment. Emergency can arise out of several scenarios such as natural calamity, equipment failure and human error etc. Type of emergency will vary during construction and operation Phase and details of these are discussed in section below

2.0 OBJECTIVES

The objectives of Emergency Management Plan shall be to:

- a. Provide an Emergency Management organisation structure which will enable contractor to respond rapidly and efficiently to any emergency in order to prevent injury to personnel, damage to property or the environment as well as minimizing or eliminating the impact to neighbouring communities.
- b. Ensure all appropriate and relevant resources are identified in advance and made available as quickly as possible during an emergency.

3.0 TYPES OF POTENTIAL EMERGENCIES

For any development activities, potential emergencies can be categorized in to three types as listed below;

- Man Made (Heavy Leak, Fire, Explosion, and Design Deficiency etc.)
- Natural Calamities (Earth Quack, Flood, Land slide, Excessive Rains etc.)
- Extraneous (Riots/Civil Disorder/ Mob Attack, Terrorism, Sabotage and Bomb Threat etc.)

4.0 Emergency Preparedness and Response Plan During Construction Phase

4.1 Risks During Construction Phase

Construction phase involves working on height, working with heavy machinery, sharp equipment, working in sun, usage of inflammable substances, usage of gas cylinder etc. Risks which may be associated with various construction activities are listed below

- Fire and Explosion
- Total Spillage
- Toxic/flammable gas/vapour release
- Loss of containment
- Structure Collapse
- Dropped Object
- Landslide
- Flood

- Oil spillage in water body

Most emergencies require urgent intervention to prevent a worsening of the situation. To handle emergency situations efficiently and to mitigate the damage of potential events that could endanger an organization's ability to function, a course of action is developed which is defined in Emergency Preparedness and Response Plan.

5.0 Emergency Organization & Responsibilities For Construction Phase

Project will be developed by contractor thus contractor has to ensure that all the emergencies which may occur during construction phase are handled and managed. It shall be ensured by contractor that key personnel to combat emergency are nominated with specific responsibilities according to set procedures and make best use of the resources available. Emergency Organization shall meet the following objective;

- To promptly control problems as they develop at the scene
- To prevent or limit the impact on other areas and outside the site boundary.
- To provide emergency personnel, selecting them for duties compatible with their normal work functions wherever feasible. The duties and functions assigned to various people shall include making full use of existing organizations and service groups such as fire, safety, occupational health, medical, transportation, personnel, maintenance, and security.
- There should be an alternate arrangement for each function. A typical Incident Command Structure. This should at least include the following:
 - Chief Incident Controller (CIC)
 - Site Incident Controller (SIC)

5.1 Emergency Response Team Members For Construction Phase

- Administration and Communication Coordinator
- Fire Safety Coordinator
- Technical Services Coordinator
- Medical Team Coordinator
- Security Coordinator

Organisation Chart for Emergency Response Team

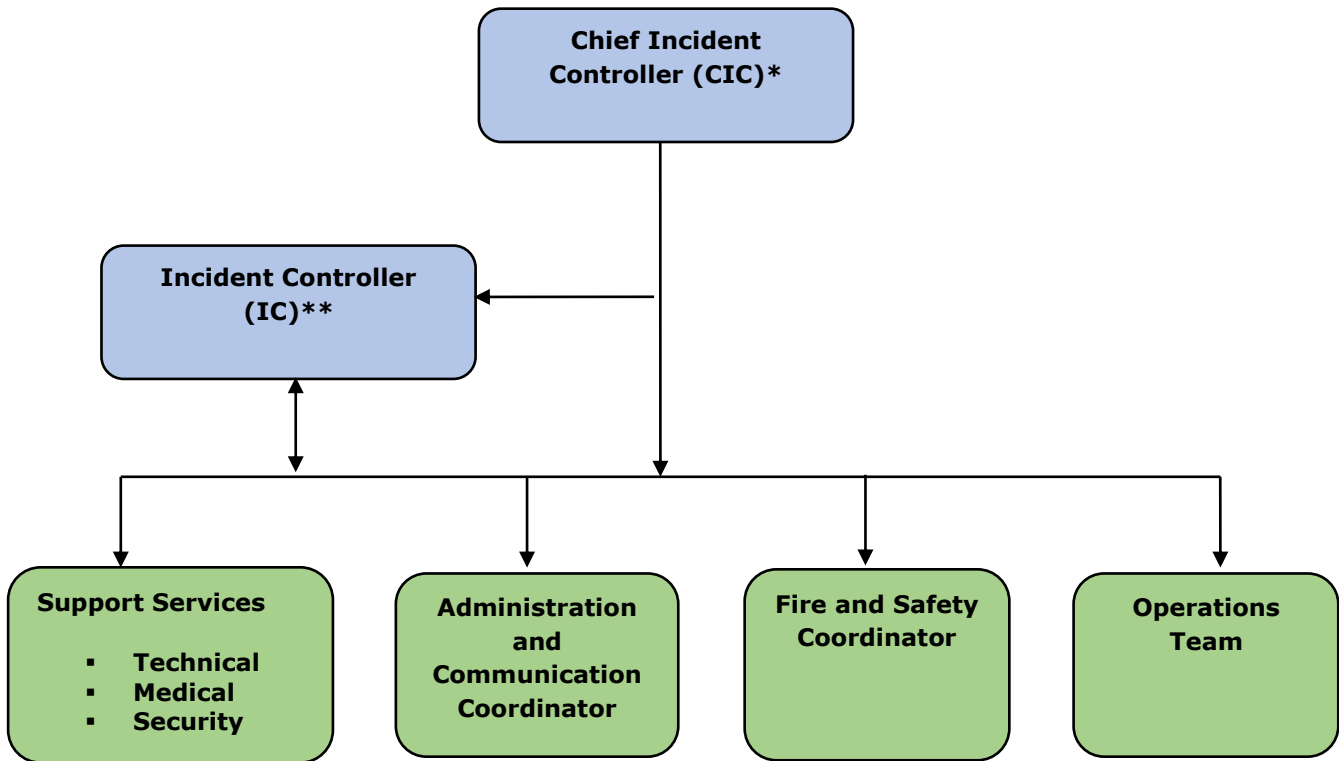


Figure 1: Emergency Organisation Structure-Construction Phase

NOTE

*** Project Director of the KMRL can be assigned for this role for construction phase**

**** Team Leader Construction contractor can be assigned for this role for Emergency Preparedness and Response Plan**

Chief Incident Controller (CIC)

The Chief Incident Controller (CIC) shall have overall responsibility to protect personnel, site facilities, and the public before, during, and after an emergency. The CIC shall be present at the main emergency control centre for counsel and overall guidance. Responsibilities of the Chief Incident Controller shall include the following: -

- Preparation, Review, and Update Emergency Preparedness and Response Plan
- Direct operational control over areas in the facility other than those affected
- Assess the situation and decide to evacuate from the assembly points to safe location
- Ensure that a log of the emergency is maintained in ECC
- Liaise with Police, Local Government, Pollution Board, and other agencies and appraise on possible affects to areas outside the facility premises
- Advise incident controller to close out the incident when the situation is under control
- Control rehabilitation of the affected persons after the emergency

Site Incident Controller (SIC)

The Site Incident Controller shall be identified by the Chief Incident Controller and will report directly to him. Responsibilities of the Chief Incident Controller shall include the following: -

- Take charge of the incident site
- Assess the situation and alert panel / field operators
- Inform Chief Incident Controller (CIC)
- Assess the level of emergency and instruct to actuate emergency siren
- Evacuate personnel to the assembly point and then to safe location
- Initiate action for isolation of source
- Direct all operations within the affected areas
- Advice firefighting & rescue personnel
- Preserve all evidences to facilitate any enquiry
- Assess damage & environmental / toxicity level before ALL CLEAR signal by CIC

Administration and Communication Coordinator

Responsibilities of the administration and communication controller shall include the following: -

- Liaise with the statutory authorities.
- Provide necessary support for the administration, welfare, transportation for control of emergency situation as requested by the CIC /SIC
- Mobilize all the available company vehicles along with the drivers for emergency use.
- Coordinate with neighboring agencies for mutual aid support
- Arrange for transport of victims to hospitals/ dispensaries on advice of medical services coordinator

Fire Safety Coordinator

Responsibilities of the Fire and Safety Coordinator shall include the following: -

- Take charge of all firefighting /Rescue operations
- Guide firefighting crew and provide logistics support for effectively combating the fire
- Organize relieving groups for firefighting
- Call mutual aid member/external help in fire fighting.
- Mobilize additional firefighting equipment /Consumable/PPEs in consultation with coordinator- Commercial

- Assist in assuming the risk and upgrade/downgrade the level of emergency

Medical Team Coordinator

- In case external medical assistance required, inform the nearest hospital for alertness and further assistance if required
- Initiation of the medical response plan and its monitoring
- Arrange for examination of the victim and his further treatment
- Ensure the availability of ambulance all the time at the facility

Technical Services Coordinator

- Provide all technical inputs to ECC
- Arrange for retrieval of necessary drawings and related documents if required.
- Coordinate with outside technical consultants and experts and seek help if required.
- Assist CIC with necessary information, support and resources.
- Communicate with pollution control authorities to provide / receive (if required) necessary information.

Security Coordinator

- Take charge of all security functions like mobilization of security personnel, traffic control/ barricading, evacuation of personnel, threat analysis etc.
- Assign evacuation coordinator & assembly point coordinator.
- Mobilize additional / off duty security force for help, if necessary.
- Liaise with local authorities in consultation with CIC for external help (as necessary) for evacuation of the neighboring areas. If necessary, arrange for announcement through the mobile PA system for alerting the population in the surrounding areas
- Depute security staff for managing gates and incident site.
- Arrange and carry out head controls at assembly point and report to CIC.

Operation Team

- The O & M (Operations and maintenance) personnel of the site being first line respondent at site shall attempt to control the emergency at the initial stage.
- Immediately inform about the emergency situation to the ECC.
- Review all operations carefully to ensure that systems in jeopardy are shut down.
- Ensure critical operations are brought down to safer mode. It shall be done by the skilled and experience staff.

- Evacuation of all non-responding staff from the areas in distress in crosswind direction
- Personnel responsible for rescuing victims shall don full protective equipment

Flow of Information

- Control Centre shall receive the information from field either in person or from the various systems available at the facility.
- On receipt of information, the control room shift In-charge shall actuate the EMP and notify the emergency to site incident controller.
- Control Room shift in-charge will act as site incident controller till arrival of designated person.

5.2 Emergency Control Centre

Emergency Control Centre shall be the focal point in case of an emergency from where the operations to handle the emergency are directed and coordinated. It shall be ensured that the centre is equipped with adequate resources to receive and transmit information and directions from the Chief Emergency Coordinator. It should be ensured that once the hazard is declared, communications systems immediately get activated.

An emergency control centre should therefore contain a well-designed communication system and required information such as:

- At least two external telephones (one incoming and the other one out going fitted with simultaneous/ selective broadcasting systems) with a PABX
- Wireless / Radio equipment (VHF/ walkie talkie/ pager/mobile)
- Inundation/vulnerability maps indicating risk zones, assembly points,
- Alternate evacuation routes, safe areas, rehabilitation centers, etc.
- Telephone directory of emergency response system
- List of all emergency equipment and personnel for evacuation, personnel protection, medical aid, etc., under the plan as well as with Govt. agencies in the district
- List of ambulances, base medical facilities, hospitals, rehabilitation centers, etc.
- Plan of the facility showing-
 - Storage area of hazardous materials
 - Storage of safety equipment
 - Firefighting system
 - Facility Entrance, roadway and emergency exist
 - Assembly points
 - Truck parking area
 - Surrounding location
- Reference Books/ Chemical Dossiers
- Copies of Disaster Management Plan

5.3 Alarm System

Contractor shall have and maintain an alarm system. Alarm system should use a distinctive signal for each purpose and comply with following requirements;

5.4 Assembly points

Contractor shall pre-determine and designate safe places far away from the risk prone areas of the facility where in case of emergency personnel evacuated from the affected areas shall assemble. Depending upon the location of the emergency and wind direction, the assembly points shall be selected. All assembly points should be clearly marked with directional display board along the route.

Following requirements shall be considered for the effective assembly and head count process;

- Establish a Head-Count system for employees at the Assembly Area
- A list of the names and last-known locations of missing employees should be made available on the assembly point as soon as possible after arriving at the assembly area
- Evacuation coordinator should take charge of assembly point and take roll call of the employees
- There should be an established method for the accounting of non-employees (contractors, supplier, visitors, vendors etc.
- Establish procedures for further evacuation in case the incident expands. This may consist of sending employees home by normal means or providing them with transportation to an off-site location.
- Identify Safe shelter space within facility or nearby safe area
- Establish procedures for sending evacuees to shelter
- Develop a list of necessary emergency supplies such as water, food, and medical supplies.
- Coordinate plans with local authorities.

5.5 Actuation of Emergency Management Plan and Declaration

In case incident goes beyond control, Emergency Management Plan shall be actuated by Chief Incident Controller at the appropriate stage as considered necessary. Other key persons shall also start performing their defined role as per the emergency organization chart and inform to various emergency controllers for guidance and control the situation.

When emergency becomes catastrophic and evacuation beyond the plant premises is considered necessary by the Chief Incident Controller, the situation will be handed over to district authorities for implementing the off-site emergency plan.

For on-site emergency plan, the relevant authorities shall enforce directions and procedures in respect of preparation of off-site emergency plan in consultation with other Government Agencies.

5.6 Post Emergency Actions

PMU/ Contractor shall appoint an investigation team to investigate the incident, find the direct and root causes and suggest corrective and preventive actions to prevent the re-occurrences of the same incident. They shall be responsible to keep all relevant evidence records of incident.

5.7 Incident Investigation

Contractor shall ensure that all incidents including “near-miss” should be recorded and analysed to prevent their recurrence in future. The system of accident investigation, reporting and documentation should be established and monitored. A system of communicating back the incident findings to employees and contract workers shall be ensured.

5.8 Communication System

PMU/Contractor shall ensure that after the assessment of risks and their possible environmental impacts, emergency, communication systems should be established. For advance communication on emergency preparedness, construction sites shall ensure that relevant information reaches to all employees, contractors, general public and local authorities. Through effective communication systems, emergency information should reach to:

- Affected area of the facility
- To key personnel outside normal working hours
- To the outside emergency services and authorities and
- To neighboring factories and public in vicinity.

The communication system shall initiate with raising the alarm, declaring the major emergency and then follow the procedure to make it known to others. Components of communication system are explained below in brief;

5.8.1 Raising the First Level Emergency Alarm (FLEA)

Any person noticing an Emergency should raise First Level Emergency Alarm (FLEA). All persons working at the facility shall be trained to operate such emergency alarms. There should be an adequate number of points from which the alarm can be raised either directly, by activating an audible warning or individual signal or message to a preliminary manned location. This has the advantage of permitting the earliest possible action to be taken to control the situation, which in turn, may avoid the development of a major emergency. All such points shall be distinctively marked and known to all employees.

5.8.2 Declaring the Major Emergency

Declaration of the major emergency shall be done by Incident Controller and his appointed deputy as early as possible and without wasting the time.

(Note: The declaration of major emergency puts many agencies on action and the running system may be disturbed which may be very costly at times or the consequences may be serious. Emergencies should be declared by skilled, knowledgeable person who is able to envisage emergencies scenarios).

5.8.3 Telephone Message

Telephone operator (or communication officer) shall play an important role while receiving the emergency message on phone. He should be precise, sharp, attentive, and quick in receiving and noting the message and then for immediate subsequent action of further communication.

5.9 Communication of Emergency

Contractor shall ensure establishment of effective system to communicate emergency. As minimum following routes of communications shall be followed;

- At the facility i.e. to the workers including key personnel and essential workers, on duty and inside during normal working hours
- To the key personnel and essential employees not on duty and outside during normal working hours
- To the outside emergency services and the government authorities and
- To the neighboring firms and the general public in the vicinity

5.10 Communication to the Employees

Emergency prevention and control related information (as per the statutory requirements) shall be made available (in the form of a safety manual or a separate safety booklet) to the employees so that they can prepare themselves to take prompt actions in case of emergency. As minimum following information should be communicated to the employees.

- Statutory Requirements
- Hazard Information

5.11 Communication to the outside emergency services and the authorities

Once the declaration of major emergency is made, construction sites shall ensure that the information is immediately communicated to the Government authorities such as local Authorities, Collectorate, Police and District Emergency Authority.

The statutory information to above authorities shall be supplied beforehand so that they can be will prepared to operate their off-site emergency control (contingent) plan. As per their advice or consultation your on-site plan should be modified and modified and updated also.

5.12 Communication to neighboring firms and the general public

Contractor shall notify about the major emergencies to general public. This can serve a dual purpose in that it will enable them to take prompt action to protect their own employees/labour and to take whatever measure may be possible to prevent further escalation of the emergency. The statutory information to the general public shall be supplied for their emergency preparedness. Such information is mentioned as under:

- The common names of the hazardous substance used which could give a rise to an accident likely to affect them, with an indication of their principal harmful characteristics.
- Brief description of the measures to be taken to minimize the risk of such an accident in compliance with its legal obligations under relevant safety statues.
- Salient feature of the approved disaster control measures adopted in the factory.
- Details of the emergency warning system for the General public.
- General advice on the action, members of the public should take on hearing the warning.
- Brief description of arrangements at the facility including liaison with the emergency services to deal with foreseeable accidents of such nature and to minimize their effects.
- Details of where further information can be obtained.

5.13 Test and Mock Drills

To evaluate the thoroughness & effectiveness of Emergency Preparedness and Response Plan, Mock Drills shall be conducted on construction sites at appropriate frequencies (onsite as well as offsite). These mock drills shall cover various levels of emergencies and variety of realistic emergency scenarios. The results of emergency drill exercises shall be communicated to appropriate personnel, including employees from the affected area.

A follow-up system shall be established at the facility to help ensure prompt and effective resolution of all emergency drill exercises. Resolution of drill recommendations shall be documented and maintained along with the drill or critique report.

The emergency mock drills shall be carried out on the objective of –

- To evaluate the awareness of Emergency Handling team members with respect to their responsibilities during Emergency as per on site emergency management plan.
- To evaluate the actions for effective mitigation of the emergency through team work.
- To check efficacy, availability & healthiness of Warning system, Fire Protection & Prevention System & Medical facilities.

5.14 Training and Awareness

Contractor shall have a process in place for the training of employees, sub-contractors & workers. This training should cover:

- Types of emergencies that may occur
- Potential threats, hazards, and protective actions
- Components of emergency preparedness and response plan
- Individual roles and responsibilities
- Relevant standards and Codes
- Notification, Warning, and Communications procedures
- Evacuation, Shelter, and Head Count procedures
- Location and use of common emergency equipment
- Mock Drill procedure and accounting for personnel
- Techniques of accident investigations

5.15 Fire Safety Plan and Response Plan-Construction phase

Fire Precautions will be provided and maintained to the requirements of the Health and Safety at work. A fire risk assessment will be completed for each site, including any temporary site offices, construction sites, labour camps, the fire risk assessment will be regularly reviewed to ensure that it remains valid and that the specified control measures are effective and are being implemented.

Fire extinguishers will be provided and located at strategic points throughout the workplace. Staff will trained for use of office extinguishers in order that they may use them safely and effectively. Third party shall be hired for inspection & maintenance of the fire-fighting system. Fire alarms/hooters shall be provided at the site to inform all the staff/labour about the fire. The names, locations and actions to take in the event of an emergency shall be posted at strategic positions throughout the construction site. There are 5 types of fires which are tabulated below

Class A	Solid Materials, Usually organic, such as paper, wood, coal and textiles.	Water Type, Powder
Class B	Flammable liquids, such as petrol, oil and solvents.	Foam Type, CO2
Class C	Gases, Such as methane, propane, and acetylene.	Powder
Class D	Metals, such as aluminum or magnesium.	Powder
Class F	High temperature fats and oils, such as cooking fat fire.	CO2

5.16 Response Plan for Oil Spillage-Construction phase

Oil storage, vehicle maintenance & repair facility, vehicle washing facility shall not be developed within 250 m of any water body. Vehicle washing/machinery cleaning shall not be carried out in/close to any surface water body/ground water structure. Even if any oil spill happens then following measures shall be adopted

- To stop the spill by Turning off nozzles or valves from the leaking container, if it can be done safely. Or use wooden plug, bolt, band or putty on a puncture-type hole.
- If it cannot be stopped, a pan or container shall be used to collect the oil.
- For the oil that has already spread, locally available sorbents shall be used like sand, straw, sawdust, wood chips or dirt from rail/bridge side shall be put on the oil contaminated location and removed after a while, immediately replacing it with a fresh layer of sorbent. This step shall be repeated based on the extent of oil spillage.
- All equipment operators and local personnel of the implementing agency shall be trained in immediate response for spill containment and eventual clean-up. Readily available, simple to understand and preferably written in the local language emergency response procedure, including reporting, shall be provided by the contractors
- In case the oil spill reaches the river water, Deploy floating booms immediately downstream from the release point to confine the spread.
- Skimmers or sorbents like sponge or the above mentioned can be used to absorb the oil after it has been confined
- Dispose of recovered product not suitable for on-site recycling with the rest of the waste collected during the response efforts as per Hazardous Waste Management and Handling Rules
- Oil spill management kits shall be available at each site

6.0 Emergency Preparedness and Response Plan During Operation Phase

6.1 Risks During Operation Phase

Operation phase involves working with metro systems which may associate risks and potential causes of risks are excessive load, cracks, failure and malfunctioning of sensing instruments, accident, natural disasters like earthquakes & floods etc. These needs shall be looked into with care

6.2 Prevention Action

Once the likelihood of a disaster is suspected, action has to be initiated to prevent failure. Engineers responsible for preventive action should identify sources of repair equipments, materials, labour and expertise for use during emergency.

6.3 Reporting Procedures

The level at which a situation will be termed a disaster shall be specified. This shall include the stage at which the surveillance requirements should be increased both infrequency and details. The Engineer-in-Chief should notify the officer for the following information

- Exit points for the public,
- Safety areas in the rail system
- Nearest medical facilities

6.4 Communication System

An efficient communication system is absolutely essential for the success of any disaster management plan. This has to be worked out in consultation with local authorities. More often, the entire communication system gets disrupted when a disaster occurs. The damage areas need to be clearly identified and provided with temporary and full proof communication system. Communication system is provided for the proposed project and details are given in chapter 2 of the report

6.5 Emergency Action Committee

To ensure coordinated action, an Emergency Action Committee should be constituted. The committee may comprise of:

- Station Master concerned,
- Police Officer of the area,
- RTO
- Home Guard representative,
- Fire Brigade representative,
- Health Department representative,
- Department of Information and Publicity, and
- Non-Governmental Organization of the area

Emergency Action Committee will prepare the evacuation plan and procedures for implementation based on local needs and facilities available. The plan should include:

- Demarcation of the areas to be evacuated with priorities,
- Safe route to be used, adequacy of transport for evacuation, and traffic control,
- Safe area and shelters,
- Security of property left behind in the evacuated areas
- Functions and responsibilities of various members of evacuation team
- Setting up of joint control room

All personnel involved in the Emergency Action Plan should be thoroughly familiar with all the elements of the plan and their responsibilities. They should be trained through drills for the Emergency Action Plan. The staff at the site should be trained for problem detection, evaluation and emergency remedial measures. Individual responsibility to handle the segments in emergency plan must be allotted. Success of an emergency plan depends on public participation, their response to warning notifications and timely action. Public has to be

educated on the hazards and key role in disaster mitigation by helping in the planned evacuation and rescue operations. It is essential to communicate by whom and how a declared emergency will be terminated. There should be proper notification to the public on de-alert signals regarding termination of the emergency. The notification should be clear so that the evacuees know precisely what to do when re-entering or approaching the affected areas.

6.6 Emergency Measures

The emergency measures are adopted to avoid any failure in the system such as lights, fire, means of escape, ventilation shafts etc. The aim of Emergency Action Plan is to identify areas, population and structures likely to be affected due to a catastrophic event of accident. The action plan should also include preventive action, notification, warning procedures and co-ordination among various relief authorities. These are discussed in following sections.

6.6.1 Emergency Lighting

The emergency lights operated on battery power should be provided at each station. The battery system should supply power to at least 25% of the lights at the station, platforms, and viaducts for a period of 2 hours. Provision of emergency lighting is kept in all the stations

6.6.2 Fire Emergency Management

Fire Protection

The building materials should be of appropriate fire resistance standard. The fire resistance period should 2 hours for surface or overhead structures and 4 hours for underground structures like basements. Wood shall not be used for any purpose, excluding artificial wood products, which are flame resistant. The materials which have zero surface burning characteristics need to be used. The electrical systems shall be provided with automatic circuit breakers activated by the rise of current as well as activated by over current. The design of a station will include provision for the following:

Fire prevention measures,

- Fire control measures,
- Fire detection systems,
- Means of escape,
- Access for fireman, and
- Means of fire fighting.

Accumulations of refuse of any inflammable material like paper, plastic cartons constitute a major fire hazards and should not be permitted. Smoking should be strictly prohibited at all locations of proposed metro project.

All aspects of fire prevention and control will be dealt in close collaboration with the city fire fighting authority. Smoke control will be achieved by the following means:

- Down stand bulkheads of a minimum depth of 600 mm to provide smoke containment. These will be provided around openings for escalators, lifts and stairs,
- In enclosed public areas of above ground stations (e.g. a concourse located below a platform) arrangement for smoke extraction will be provided.

A minimum of 30 minutes supply of water is to be assured in the case of fire. The pumps/overhead tanks shall have the capacity to discharge the water at the rate of 1100 liters per minute at a head of 21 m at nozzle mouth.

The storage capacity in an underground or overhead tank may be divided into two parts i.e. dead storage and running storage. Fire fighting pumps shall be provided with a diesel pump as a standby arrangement, in case of power failure.

For the fire of electrical origin, water cannot be used until the electric system has been made dead and earthen. For electrical fires, non-aqueous agents like ABC Power Chloro Bromo Methane or CO₂ gas are utilized for fire fighting. Fire extinguishers with these agents shall be liberally provided at static installations and on the rolling stock. Generally there are often more casualties from smoke inhalation than from burning. Smoke is needed to be transported away from the site of the fire. In order to achieve this, both fresh air has to be introduced into the underground section and exhaust gases should be sucked out from other section.

Openings, including ducts and passages, between project property and any adjoining structures which allow free access into the project property will be protected by fire doors, fire shutters, fire dampers etc. as appropriate. Fire detection and alarm systems will be provided as per the prevailing state of art technology

Fire Prevention and Fire Safety

Measure for fire prevention & safety are listed below

- Use of non-combustible or smoke retardant materials where possible,
- Providing rolling stock with fire retarding materials, low smoke zero halogen type electric cable,
- Provision of layout which permits ease of maintenance for equipment and cleaning of the station premises,
- Provision of special storage spaces for combustible materials such as paint and oil,
- Prohibition of smoking in fire prone areas,
- Provision of cigarette and litter bins, and
- Good housekeeping.
- Automatic sprinkler/detection system to be provided if floor area exceeds 750 m².
- One wet riser-cum-down comer per 1000 m² floor area with static underground storage tank, overhead tanks and pumps of suitable capacity with hydrants, first-aid reel, etc.
- Portable fire non-aqueous extinguishers of Carbon-di-oxide, chemical dry powder etc. at suitable places.
- Automatic smokes venting facilities.
- Two separate means of exit shall be provided, if more than 10 persons are working and the area exceeds 1400 m²
- Fire resisting doors shall be provided at appropriate places along the escape routes to prevent spread of fire and smoke.
- The travel distance for fire escape shall not exceed 20 m where escape is available in more than one direction; the distance could be upto 40 m

Fire Alarm and Detection System

A complete fire detection system with equipment complying with the requirements of Kochi Region Fire Services shall be provided through out each station and ancillary buildings including entrance passageways, basement etc. to give visual and audible indication of alarm conditions actuated by the operation of break glass contact or fire sensors e.g. detector heads, linear heat detecting cables etc.

Manually operated call points shall be provided at every hydrant and hose reel points, station head wall, tail wall and other locations. Alarm bells shall be installed in each plant room complex at both platform and concourse level and shall be clearly audible at all points in the room/area. Beam detector or heat detector shall be installed at roof level, ceiling and floor cavity, whilst linear detecting cables shall be installed in under platform cable ducts and cable shafts.

Smoke probe units shall be installed in rooms/compartments. When an alarm point is operated, the fire pump shall start to operate automatically. A station fire control and indicating panel shall be provided and installed in the station controllers room, for the control, indication and monitoring of the whole detection and fire fighting systems.

Provision of firefighting, fire protection, fire prevention & safety, fire detection and fire control system is incorporated in the project design and details are provided at the site are given in section 2.13 of chapter 2 of report.

Fire Control Measures

Control of the spread of fire and smoke will be achieved by partition of fire risk areas, planning for smoke extraction, and arrangement for smoke containment. Partition is aimed at limiting the extent of a fire. The openings must be capable of being sealed in the event of fire. The fire resistance period of this separated area should be about 3 hours.

Access for Fireman

A secondary access to the station, not used by passengers for evacuation, shall be available to fireman should the need arise. The entry point shall be easily accessible from the road. Access shall be available to all levels of the station. The minimum width of the stairs is 1.0 m and maximum height should not exceed 60 cm.

Emergency Door

The rolling stock should be provided with emergency doors at both ends of the cab to ensure directed evacuation of passengers in case of any emergency including fire in the train.

6.6.3 Earthquake Emergency Management

The entire infrastructure of proposed project has been designed to withstand earthquakes of the intensity of 7 on Richter scale. The structures of KMRL are not likely to be affected by low and moderate intensity earthquakes.

KMRL will follow standard laid down procedures as a precautionary measures in case of Low and moderate intensity earth quakes.

- Passengers will be requested not to panic and follow instructions given by Station & Train Operations staff in case of earthquake.
- Metro trains will be stopped during earthquake as per statutory guidelines for safety. Trains may be stopped in between stations or at stations. After the main shock subsides it is preferred to bring trains stopped between stations to a station at a precautionary speed. In case it is not possible to bring stopped train to station then passengers will be evacuated by metro officials/rescue team.
- Inside Metro Station: Message for the passengers during earthquake at station
 - Do not panic, keep calm
 - Listen patiently to the instructions given by Station Staff on Public Address System and follow them.
 - If you are in a crowded place, do not rush for cover or to doorways.
 - Slowly move to the corners or at a location close to pillars.
 - Drop on the floor and crouch.
 - Protect your head with your bags or clothes or similar objects or by your hands.
 - Stay away from hanging lights, electrical & civil fixtures, and signage at the time of an earthquake.
 - Stay away from where glass could shatter around or other heavy item could fall over
 - If inside an Elevator, you should push every floor button and get off at any floor it first stops at and then use a staircase to evacuate.
 - If the door of elevator doesn't open, use the emergency feature available in the elevator such as a phone, button or bell to inform someone outside that you are trapped.
 - Do not approach vending machines, kiosks.
 - Do not use Elevators/Escalators.
 - Do not try to force the elevator door to open from inside until the rescue service arrives.
 - Do not light a matchstick/lighter.
 - Do not use the telephone except to report an emergency or to obtain assistance.
- Message for the passengers after earthquake at station
 - Follow instructions from the Metro Official. It is important to evacuate to a designated shelter according to the KMRL officials' directions.
 - After the main shock ceases, head toward an exit on the ground level. Since many people may rush to and crowd the exit, you should be careful to avoid falling and being trampled by others.
 - Evacuate from the building by using the stairs (not Lifts).
 - Seek assistance if needed.
 - Stay out of severely damaged buildings as aftershocks may cause them to collapse.
 - Report any building damage to the authorities.
 - Know emergency telephone numbers (such as those of doctors, hospitals, the police, etc).
 - Educate yourself and family members.

- Do not spread and/or believe in rumors
- Inside a Metro Train: Message for the passengers during earthquake at station
 - Do not panic, keep calm
 - Listen patiently to the instructions given by Train Operator and follow them.
 - Exit from the train only when directed as track outside may be dangerous.
 - Protect your head with your bags or clothes or similar objects or by your hands.
 - Hold grab handle or bar to prevent yourself from falling
 - After the train stops, you should stay calm and wait for instructions from the Train Operator/Metro Official.
 - Rescue will be provided as soon as possible
 - Do not attempt to get out of the train by unlocking the emergency door lock or by jumping out from the window.
 - Do not become impatient.
 - Do not try to force doors/windows to open from inside.
 - Do not use matchstick/lighter.
 - Do not use the telephone except to report an emergency or to obtain assistance.
- Inside a Metro Train: Message for the passengers after the earthquake:
 - Follow instructions from the Train Operator/ Metro Official.
 - The train will be brought to the next station at a slow speed and you will be asked to evacuate the train.
 - If it is not possible to bring the train to next station, the train operator would request to evacuate the train.
 - Assist needy passengers like senior citizens, women, children or differently able passenger in evacuation.
 - Do not spread and/or believe in rumours