

Addendum

Environmental Impact Assessment for Reach 6

This Addendum documents aims to supplement the EIA report developed for Reach 6 in 2017, with updated information and assessments based on the revisions carried out in the project design and planning during the subsequent period till September 2020.

The SIA and RP documents have been developed in August 2020 and include latest information on social impacts, land acquisition, resettlement and rehabilitation for Project Reach 6. Some of the updates on the land acquisition and lessons learnt on rehabilitation and resettlement from Phase I, are presented at the end of this Addendum.

The addendum refers to specific sections of the EIA report that has been revised in terms of updated data, impact assessment, or mitigation measures and provides recent available information as relevant on the same.

EIA for Reach 6

Executive Summary

Para 2 – BMRCL has requested JICA for the financing of its Rolling Stock and associated components for the project of line Reach 6. The elevated stretch is 7.50 km and the underground stretch is 13.92 km.

Para 3 – The project environmental and social category (Reach 6 line of BMRCL) as per JICA's E&S Policy is designated as "A".

This categorization is due to both the environmental risks and impacts as well as the magnitude of land acquisition and resettlement & rehabilitation (R&R) issues involved.

Para 6 - During the earlier planning stages of the project, the feasibility of several metro corridors (for Reach 6) was considered by BMRCL based on traffic and engineering studies. The criteria for selecting the final alignment included traffic demand/ridership, accessibility and integration with existing public transport nodes, available right of way within major roads, ground conditions, capital and operating costs, availability of land for the depot and stations, environmental impacts and proximity to sensitive receptors as well as minimum disturbance/avoidance of heritage structures.

A summary of the Analysis of Alternatives between various options is included later in this Addendum.

Para 7 – Key environmental impacts due to the Line R6, remain the same.

The total land area acquired for the project is 2,64,221.88 sq. m. Out of this, 56424.31 sq. m. belongs to State Government, Government Boards/ Corporation, and 3694.67 to Central Government and 204102.90 sq. m belongs to private parties. The project provides for award of compensation to both categories of owners-Government and Private and will be as per the rules of 2019. The total no. of properties affected is 625 [185 under elevated, 383 in the underground section and 57 in Kothanur Depot].

Para 9 – The key positive environmental impacts of the project include (1) reduced private vehicles due to modal shift and a corresponding reduction in air pollutants, noise and vibration due to traffic; road safety improvements for local community including women and vulnerable sections; and a modest reduction in greenhouse gas emissions.

Para 10 – The Grievance Redress Mechanism is in line with EIB, AIIB and JICA requirements and relevant national regulation

Para 11 - Quarterly environmental and social monitoring reports will be submitted to EIB and AIIB and will be disclosed publicly on the EIB, AIIB and JICA websites.

Chapter A – Introduction

The elevated stretch is 7.50 km and the underground stretch is 13.92 km.

Para 20 - The project environmental and social category (Reach 6 line of BMRCL) as per JICA’s E&S Policy is designated as “A”.

This categorization is due to both the environmental risks and impacts as well as the magnitude of land acquisition and resettlement & rehabilitation (R&R) issues involved.

Chapter B – Policy, Legal and Administrative Framework

Para 26 – The EIA is also aligned to the E&S policy of AIIB and JICA, under whose classification the Project has been categorized as “A”.

Table 1 – Summary of Environmental Legislation

The following regulations are included as applicable to the project, in this section:

- E-waste Management Rules, 2016
- Plastic Waste Management Rules, 2016
- Biomedical Waste Management Rules, 2016
- Construction and Demolition Waste Management Rules, 2016 (Section 3.16 only mentions Guidelines on this subject and not the rules)
- Karnataka Lake Conservation And Development Authority Act, 2014 (LDA)

The following regulatory requirements applicable to the project, have been updated (latest revision dates):

- Hazardous Waste (Management and Transboundary Movement) Rules, 2016
- Municipal Solid Waste (Management) Rules, 2016
- Central Motor Vehicles Act, 2019
- The Child Labour (Prohibition and Regulation) Amendment Act, 2016

Table 2: Applicable Permits and Clearances Required for the Project

Sl. No.	Subject	Relevant Act	Authority Granting Clearance/ In charge	When required	Responsibility	Remarks
1	Permission for felling of trees and transplanted on	Karnataka Preservation of Tree Act, 1976 & Forest Conservation Act, 1980	DCF-BBMP and DCF-Urban	Before Construction	BMRCL	Exact number and location of trees
2	Elevated Metro Corridor		South Western Railways,	Before Construction	BMRCL	

Sl. No.	Subject	Relevant Act	Authority Granting Clearance/ In charge	When required	Responsibility	Remarks
	Crossing Indian railway lines		Indian Railways			
3	No Objection Certificate (NOC) for Construction camp and Labor camp, Crushers, Batching Plants, Wet Mix Macadam plants, Hot mix plants	Air (Prevention and Control of Pollution) Act, 1981; Water (Prevention and control of Pollution) Act, 1974 and Noise Pollution (Regulation and Control) Rules, 2000	KSPCB, Karnataka	Before Construction	Contractor / Supplier	Appropriate forms, (Form I & Form XIII) with requisite fees, to be completed
4	Employing Labour/ Workers	The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996; Central Rules, 1998 and Karnataka Rules, 2006	District Labor Commissioner	Before Construction	Contractor	
5	Rehabilitation & Resettlement of Displaced families	KIADB Act with compensation at par with RFCTLARRA 2013.	GoK	Before Construction	BMRCL	The project will adopt the KIADB Act for acquisition and compensation will be paid at par with RFCTLARRA 2013
6	Permission for withdrawal of groundwater for construction	Guidelines for Evaluation of Proposals / Requests for ground water abstraction under Section 4 of Environmental Protection Act, 1986	Central Ground Water Board/BBMP	Before Construction	Contractor	
7	Installation of Generators	Air (Prevention and Control of Pollution) Act,	KSPCB	Before Installation	Contractor	

Sl. No.	Subject	Relevant Act	Authority Granting Clearance/ In charge	When required	Responsibility	Remarks
		1974 Noise Pollution (Regulation and Control) Amendment Rules, 2017				
8	Storage, handling and transport of hazardous materials	Hazardous and other Waste (Management and Transboundary Movement) Rules, 1989 (as amended in the year 2016) formulated under Environment (Protection) Act, 1986	KSPCB, Karnataka	During Construction	Contractor	If bituminous is used for rehabilitation of roads or any other hazardous wastes
9	Traffic Management and Regulation during operation	Local Traffic Police instructions/Regulations	Bengaluru Traffic Police	During Construction	Contractor	Prior permission from Bengaluru Traffic Police
10	License for storing Diesel/Fuel	Petroleum Rules, 2002 (as amended in the year 2011) of the Petroleum Act, 1934.	Chief Controller of Explosives, Petroleum and Explosives Safety Organization (PESO)	During Construction	Contractor	
11	Location/ layout of workers camp, equipment and storage yards	Environment Protection Act, 1986 The Building and Other Constructions Workers' (Regulation of employment & Conditions of Service) Act, 1996.	KSPCB, District Health Officer	During Construction	Contractor	
12	Disposal of Construction and Demolition wastes	Construction and Demolition Waste Management Rules, 2016	Bruhat Bengaluru MahanagaraPalike (BBMP)	During Construction	Contractor	By the contractor approved by BBMP

Section 1.3

Para 36 – Replaced with Karnataka Ground Water (Regulation and Control of Development and Management) Act, 2011 and Rules 2012

Chapter C – Project Description

Salient Features of Project Features at a glance (revised Table 3

Salient Features	Details of Gotigere to Nagavara Corridor
Length of the alignment	21.255 Km
Nature of alignment Elevated	7.50 km
Underground	13.92 km
Number of stations	06 (Elevated)
	12 (Underground)
Right of Way	20m
Project implementation	
- Start Date	August 2017
- Completion Date	June 2024
Rail capacity	2000 passengers / trip (6 coaches)
Frequency	1 train for every 4 minutes (peak hours)
Connecting Areas	Gottigere, Hulimaavu, IIMB, JP Nagar, Jaynagar, Wilson garden, Richmond Town, MG Road, Shivajinagar, Benson Town, Pulikeshnagar, Govindapura and Nagavara
Industry / Companies along the proposed alignment	Intech Telecom Systems, Adobe system Pvt Ltd, Oracle, Dharmaram College, Bangalore Dairy, Accenture
Educational Institutions	IIMB, PSBB Learning Leadership Academy, Govt Institute of Training, Dharmaram College, Baldwin Boys School, Sacred Heart/Good Shepherd School, St. Joseph Educational Institution, Hafiziya High School, Niswan Urdu School, Quwahtul Islam School, Gem High School, Government urdu school, Dr.Ambedkar Medical College
Hospitals along the proposed alignment	Wockhard Hospital, Apollo Hospital, Jayadeva Hospital, Government Hospital, Dr. HM Honnur Dental Clinic, Dr.Ambedkar Medical College
Flyover along the proposed alignment	Jayadeva Flyover, Dairy Circle Flyover, Phase I Metro viaduct
Major road approach the alignment	Marenahalli Road, Mari Gowda Road, Gen Thimmaiah Road, MG Road, Basaweshwara Main Road, Arabic College Road
Muck Generation from Tunnelling	About 1.1 Million cubic metres. A muck reuse and disposal plan has been prepared by BMRCL and included in the scope of the contractors.

Trees to be felled	About 1312 trees will be felled, 1192 enroute and 120 on the depot at Kothanur. BMRCL is carrying out compensatory plantation at the rate of 1:10 for every tree removed. Some trees may also be transplanted based on the recommendations of the tree authority.
Sensitive E&S Receptors	No sensitive or significant archaeological, heritage or environmental receptors impacted by the project. Southernmost point of Reach 6 (Gotigere) is about 2.5 km from the Eco-Sensitive Zone boundary of the Bannerghatta National Park. No regulatory approvals are required and no adverse impacts on the protected area are expected due to the project construction or operation

Section 3.3 Rolling Stock, Traction and Signaling

- 1) Rolling Stock to be procured for Reach-6, Phase-2A and Phase-2B of BMRCL's network shall be with the same specifications and design. The Rolling Stock shall be of modern design with emphasis on key aspects such as **lightweight body, high energy efficiency, low noise & vibration, electromagnetic compatibility, with optimization of subsystems.**
- 2) Rolling Stock shall be designed for 15T axle load. This shall result in considerable energy savings during the life cycle of the Rolling Stock.
- 3) As explained in section 11.2.6 (e) of DPRs for Phase-2A and Phase-2B, the propulsion system on the Rolling Stock shall adopt 3-phase propulsion technology using brush less 3 phase induction motors which are lighter in weight and ideally suited for rail-based Mass Rapid Transit applications. The motor tractive effort and speed shall be regulated by 'Variable Voltage and Variable Frequency' (VVVF) control using Insulated Gate Bipolar Transistors (IGBTs). This shall allow for precise and optimized control of the motor characteristics under different operating conditions along with very good regenerative performance during electro-dynamic (ED) braking. This energy can either be fed back to the third rail or utilized by the auxiliary circuit of the Rolling Stock thus improving the energy efficiency of the Rolling Stock.
- 4) Section 11.2.6 (k) of DPRs for Phase-2A and Phase-2B describes the design considerations for ensuring good noise and vibration performance. Tests shall be performed during commissioning of the Rolling Stock to ensure compliance to the noise and vibration criteria specified in the technical specifications.
- 5) The Rolling Stock shall be designed to meet all the requirements pertaining to electromagnetic compatibility specified in the applicable international standards such as EN-50121-1, EN-50121-2, EN50121-3-1, EN-50121-3-2, etc. Tests shall be performed during commissioning of the Rolling Stock to ensure compliance of the Rolling Stock and its various equipment to these international standards.
- 6) All subsystems and equipment on the Rolling Stock shall be optimized to have minimum weight and maximum energy efficiency. Tests shall be performed during commissioning of the Rolling Stock to ensure compliance to the Specific Energy Consumption criteria specified in the technical specifications.
- 7) A comparison of the key design aspects of the Rolling Stock proposed for Reach-6, Phase-2A and Phase-2B with the existing BMRCL Rolling Stock operating on Phase-1 lines is given below.

S. No.	Design Aspect	Phase-1 Rolling Stock	Rolling Stock for Reach-6, Phase-2A and Phase-2B
1.	Axle Load	15 T	15 T
2.	Propulsion Technology	3-Phase Propulsion	3-Phase Propulsion with improved capabilities and regeneration
3.	Noise and Vibration	Low Noise, Low Vibration	Low Noise, Low Vibration
4.	Electromagnetic Compatibility	Compliant to International Standards	Compliant to International Standards
5.	Specific Energy Consumption	Low Specific Energy Consumption around 60 Kwh per 1000 GTKM	Improved Specific Energy Consumption from Phase-1 Rolling Stock due to further optimization of equipment. It shall be proposed to endeavor improvement by 10 % in specific energy consumption

Figure 10

Para 71 – JICA is also included as one of the lenders to the project for the rolling stock

Para 83 - Seismicity Map for Bengaluru, Karnataka

As can be seen in the adjoining figure (sourced from Vulnerability Atlas of India, BMTPC, 2019) the Bengaluru city area comes under Zone II – Low Damage Risk Zone (MSK VI or less)

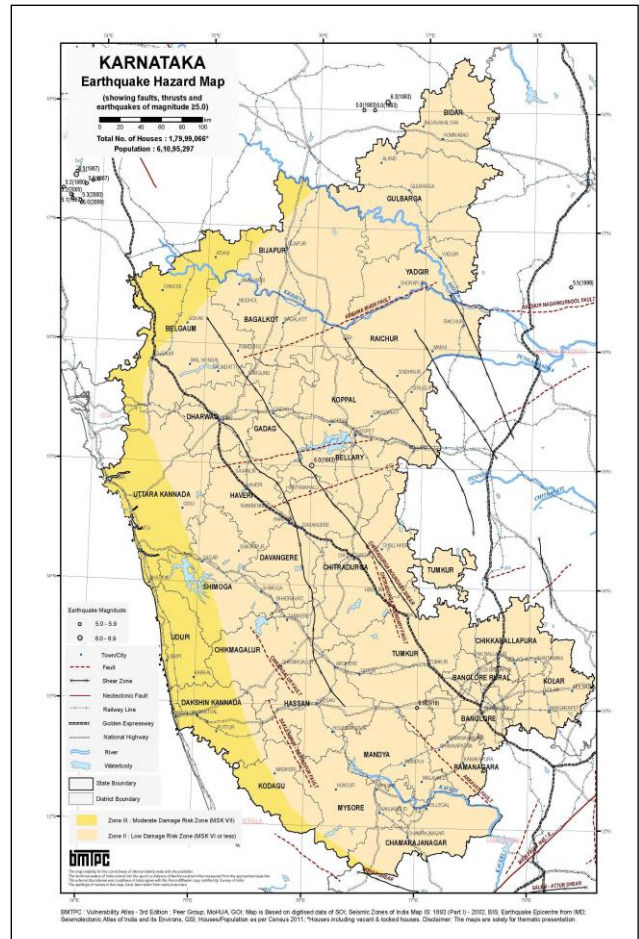
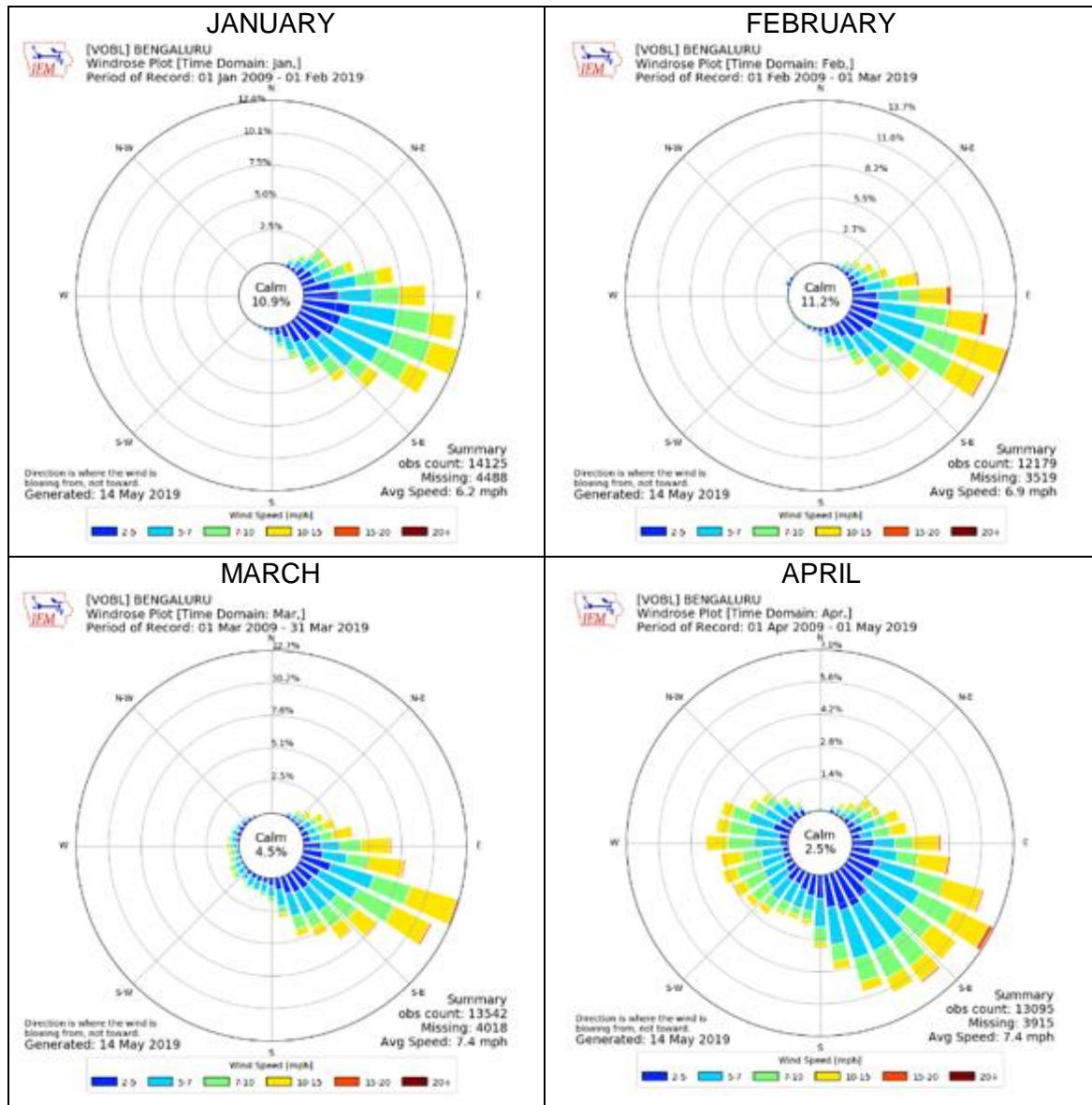
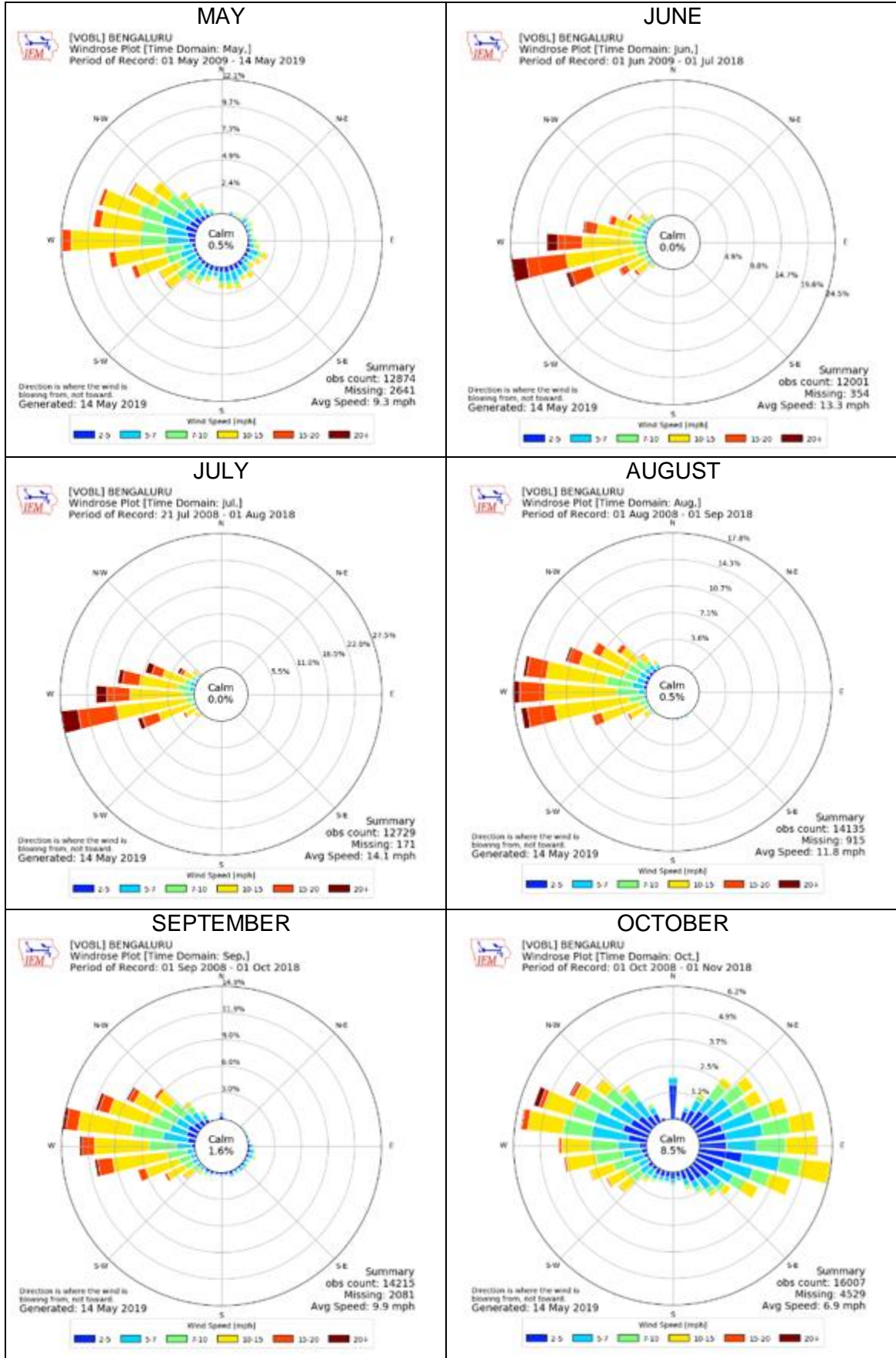
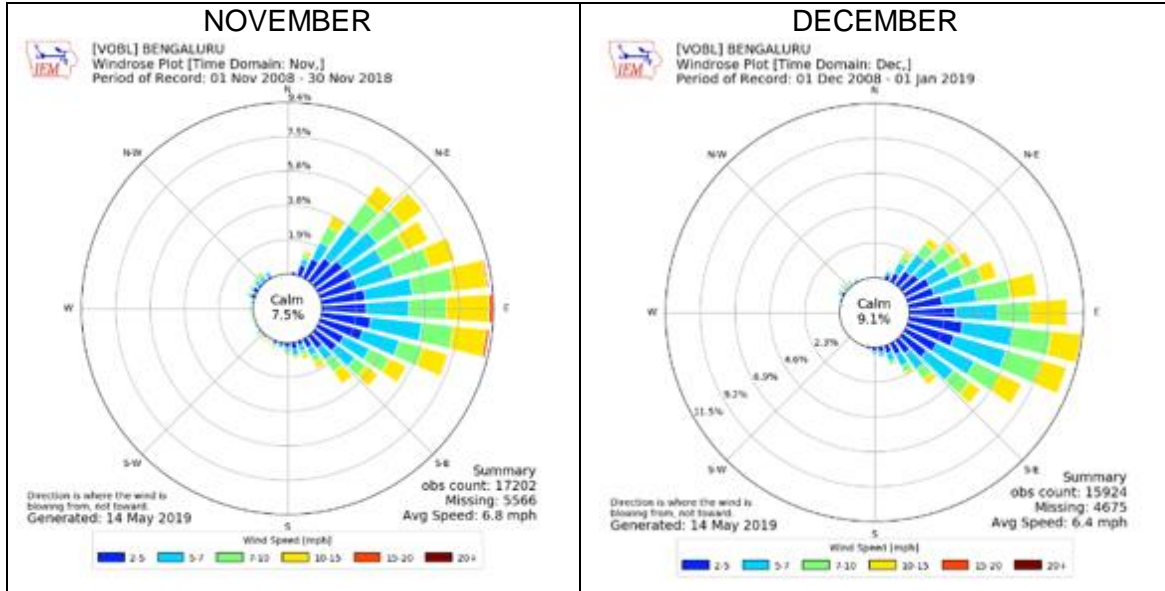


Figure 14 Wind Rose Plots for Bengaluru (for all seasons)

The figures below present the wind rose diagrams for all months based on data available for 2018. Predominant wind directions and intensities are seen from the easterly (summer and winter) and westerly (monsoon period) directions.







As seen, the predominant directions of the wind are from the south-east and west during most months of the year in Bengaluru.

Section 1.8 – Ongoing ambient air quality monitoring is being planned and carried out by BMRCL during the construction period (through contractors) and will be continued in the implementation period.

Section 1.9 – Vibration monitoring is being planned and carried out by BMRCL during construction period, particularly along the underground alignment. Similarly, a building survey has been carried out for identifying vulnerable / at risk structures (if any) along the project alignment. These structures will be monitored during the construction period for any risks to structural damage.

Chapter E Anticipated Impacts and Mitigation Measures

Section 1.2 Felling, Compensatory Plantation and Transplantation of Trees

Para 127 - About 13120 trees will be planted under Compensatory Plantation at areas as recommended by the DCF-BBMP and DCF- Urban Forest department (at 1:10 ratio) for 1312 number of trees to be felled.

The decision on tree transplantation will be as per the recommendations of the Tree Expert Committee constituted by Karnataka Government as per the order of Hon'ble High Court of Karnataka. BMRCL will accordingly develop a plan and take up the transplantation of the trees at the suitable locations.

Section 2.3 Para 145

The Tipu Sultan Summer Palace is not in the immediate vicinity of the underground section of the Reach 6 line (it is more than 3km as shown in figure) and hence is not expected to be impacted during the construction or operation phase of the Reach 6. No ASI approval was therefore necessary for Reach 6. No other site of archaeological importance is affected by Reach 6 line.



The para 145 in the EIA refers to Reach 2 of the existing East-West Metro line and not Reach 6 of the Phase II.

Section 3.2 Traffic Coordination

Traffic Diversion and Management Plans have been included in the scope of the contractors and these are inspected and pre-approved by BMRCL officials to ensure that traffic is not disrupted and citizens are not inconvenienced / endangered during the construction period.

Section 3.9.3 Noise and Vibration Impacts

As per FTA Standards, the criteria for environmental impact from ground-borne vibration and noise are based on the maximum root-mean-square (RMS) vibration levels for repeated events of the same source. This criteria account for variation in project types as well as the frequency of events, which differ widely among transit projects. Most experience is with the community response to ground-borne vibration

from rail rapid transit systems with typical headways in the range of 3 to 10 minutes and each vibration event lasting less than 10 seconds. It is intuitive that when there will be many fewer events each day, as is typical for commuter rail projects, it should take higher vibration levels to evoke the same community response. This is accounted for in the criteria by distinguishing between projects with varying numbers of events, where Frequent Events are defined as more than 70 events per day, Occasional Events range between 30 and 70 events per day, and Infrequent Events are fewer than 30 events per day¹.

The proposed Reach 6 project will fall into the infrequent events category.

Section 3.11 Impact on Protected Areas)

The southern-most point of the Reach 6 line, Gotigere, is about 2.5 km from the declared ESZ boundary of the Bannerghatta National Park (BNP). No approvals from the MOEFCC will be necessary for the project as it falls outside the PAs ESZ boundary.



Due to existing built-up area in the 2.5 km zone between Gotigere and the ESZ boundary, no significant adverse impacts are expected due to construction and operation activities of the metro on the BNP.

See adjoining Figure for details

Section 4.2 – Water and Sanitation Requirements at the Stations

¹Guidelines for Noise & Vibrations, Metro Rail Transit system. Ministry of Railways, India, 2015

Chapter F – Analysis of Alternatives for Reach 6

(1) Overview of Alternatives for Reach 6 Line of BMRCL

Analysis of Alternatives for Reach 6 was undertaken to support assessment done in the EIA 2017. The following alternative options were considered for the Route alignment of Reach 6:

- No project option (present road network will continue to be used)
- Option 1 of Viaduct plus Underground including a Depot at Kothanur
- Option 2 of Viaduct plus Underground including a Depot at Hulimavu
- Option 3 of only Viaduct option (without u/g section) and the Depot at Kothanur

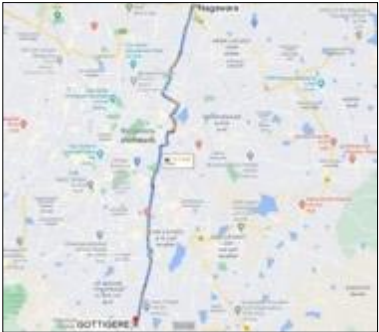

The guiding principles for the evaluation for each alternative, without affecting the overall objectives of BMRCL were:



- a) Minimal land acquisition, particularly private ownership;
- b) Minimal disturbance to existing properties along the alignment / option;
- c) Minimal disturbance to commuters and local neighbourhood communities;
- d) Minimum disturbance to existing trees, water bodies, local ecology and biodiversity.

The 'without' project scenario has been analyzed based on the need for reliable and quality transport infrastructure for safe and faster travel. Without this project, it is expected that there will be an increase in air pollution and exhaust emission due to slow-moving heavy traffic and congestion. Travel will take longer thus impacting productivity and reducing the economic growth of the area. Overloading of existing transport infrastructure will also affect safety and lead to loss of human life due to the increase in accidents. With the project alternative, is expected to provide a more sustainable, safer and faster connectivity and will ensure more effective people movement between origins and destinations.

The overview features / comparisons of all the alternatives are described in the table below.

Table Error! No text of specified style in document..1: Overview of Alternatives for Line Reach 6

Alternatives	Location map	Key Features of the Alternative
<p>No project option (present road network will continue to be used)</p>	<p>Existing Road Map of Bengaluru</p> 	<ul style="list-style-type: none"> • Concept: Existing road connectivity and widening • Project features: <ul style="list-style-type: none"> ▪ Most part of the existing road is 4 lane (2+2) ▪ 2 wheelers and 4 wheelers are more dominant as compared to other vehicles types on the road ▪ Entire road stretch is congested by vehicles with higher congestion index. • Total length: 22 km
<p>Option 1 of Viaduct plus Underground including a Depot at Kothanur</p>	<p>Alignment with key components (Viaduct/Tunnel/Depot/Station/Road, etc.)</p> 	<ul style="list-style-type: none"> • Concept: Metro rail with viaduct plus underground option • Project features: <ul style="list-style-type: none"> ▪ Gauge: Standard Gauge (1435 mm) ▪ Viaduct: 7.385 kms ▪ Tunnel: 13.2 kms ▪ Depot: 1 (at Kothanur) ▪ Stations: <ul style="list-style-type: none"> ▪ Elevated- 6 nos, ▪ Underground- 12 nos. ▪ Design speed: 80 kmph ▪ Train Capacity: 2004 passenger/trip (6 coach) ▪ Frequency: 1 train for every 4 minutes (peak hour) ▪ Land requirement: 50.26 ha • Total length: 21.275 km • Assumed cost: Rs. 11908.32 crores
<p>Option 2 of Viaduct plus Underground including a Depot at Hulimavu</p>	<p>Alignment with key components (Viaduct/Tunnel/Depot/Station/Road, etc.)</p>	<ul style="list-style-type: none"> • Concept: Metro rail with viaduct plus underground option • Project features: Other features same as Option 1 except the location of Dept <ul style="list-style-type: none"> ▪ Depot: 1 (Hulimavu)

Alternatives	Location map	Key Features of the Alternative
		<p>Depot)</p> <ul style="list-style-type: none"> ▪ Land requirement: 48.26 ha • Total length: 21.25 km • Assumed cost: Rs. 11163.30 Crores (based on 52.76% escalation of cost for Hullimavu option as mentioned in DPR for R6 in line with similar increase for Option 1 - Kothanur) – to be confirmed by BMRCL
<p>Option 3 of only Viaduct option (without u/g section) and the Depot at Kothanur based on Option 1</p>	<p>Alignment with key components (Viaduct/Tunnel/Depot/Station/Road, etc.)</p> 	<ul style="list-style-type: none"> • Concept: Metro Rail with Viaduct option • Project features: Other features same as Option 1 • Total length: 20.585 km to be confirmed by BMRCL • Assumed cost: to be estimated

Source: BMRCL, 2020

(2) Analysis of Alternatives for Line Reach 6

The following table, presents the comparative analysis of the various project (Reach 6) alternatives described above:

Table Error! No text of specified style in document..2: Comparative Analysis and Evaluation of Alternatives

Thematic Component	No project option present road network without upgrading	Option 1 Viaduct & Underground with a Depot at Kothanur	Option 2 Viaduct & Underground with a Depot at Hulimavu	Option 3 Entire Viaduct with a Depot at Kothanur
Overview of alternative plans	<p>Key Features / description of the alternative</p> <ul style="list-style-type: none"> ▪ Total length: 22 km ▪ Most part of the existing road is 4 lane (2+2) ▪ 2 wheelers and 4 wheelers are more dominant when compared to other vehicles on road ▪ Entire road stretch is overcrowded by vehicles with higher congestion index. 	<p>Key Features / description of the alternative</p> <p>Necessary Area/Length/Main Components, etc.</p> <ul style="list-style-type: none"> ▪ Gauge: Standard Gauge (1435 mm) ▪ Viaduct: 7.385 kms ▪ Tunnel: 13.2 kms ▪ Depot: 1 (Kothanur Depot) Area 33 Ha ▪ Stations: Elevated- 6 nos, Underground- 12 nos ▪ Design speed: 80 kmph ▪ Train Capacity: 2004 passenger/trip (6 coach) ▪ Frequency: 1 train for every 4 minutes (peak hour) ▪ Land requirement: 50.26 ha ▪ Total length: 21.275 km ▪ Assumed cost: Rs. 11908.32 crores 	<p>Key Features / description of the alternative:</p> <ul style="list-style-type: none"> ▪ Depot: 1 (Hulimavu Depot) ▪ Land requirement: 48.26 ha ▪ Total length: 21.25 km ▪ Assumed Cost: Rs. 11163.30 Crores (based on 52.76% escalation of cost for Hullimavu option as mentioned in DPR for R6 in line with similar increase for Option 1 – Kothanur 	<p>Key Features / description of the alternative</p> <ul style="list-style-type: none"> ▪ Viaduct: 20.585 km ▪ Depot: 1 (Kothanur Depot) Area 33 Ha ▪ Stations: Elevated- 18 nos. <p>The same components as Option 1, except tunnel sections and UG stations</p> <p>Assumed Cost: to be estimated but expected to be lower than Options 1 and 2</p>
Technical advantages/disadvantages	<p>A: no technical difficulties due to no-project scenario, but alternate transport infrastructure capacity upgrading could be a challenge</p> <ul style="list-style-type: none"> • Continual demand for new roads / flyovers, widening of existing roads, 	<p>B: limited to major tunnel contractor, otherwise common practice</p> <ul style="list-style-type: none"> • Challenges for traffic management and diversions during construction and difficulties in civil construction due to alignment along the existing congested roads. • Viaduct construction: one of the most common 	<p>B: limited to major tunnel contractor, otherwise common practice</p> <ul style="list-style-type: none"> • Same as Option 1 • No technical differences for the two depot options 	<p>A: most common practice</p> <ul style="list-style-type: none"> • Viaduct construction: one of the most common and popularly implemented options for linear projects

	<p>requiring higher costs and land acquisition.</p> <ul style="list-style-type: none"> Technically the above would lead to substantial disadvantages and difficulties in ensuring efficient transportation in the city. 	<p>and popularly implemented options for linear projects in the region having least technical issues as compared to tunnelling</p> <ul style="list-style-type: none"> Advantages expected by applying TBM technology for tunnelling to reduce impact area and structural damages along the alignment 		<p>in the region having least technical issues as compared to tunnelling</p>
Environmental Impact	<p>D: Without project option can aggravate present environmental problems</p> <p>Further congestion of road network between Gotigere and Nagavara corridor will significantly degrade the air & noise quality, in the influence area, which would lead to the further degradation of environmental quality.</p>	<p>B: Most preferred option as environmental impacts can be mitigated</p> <p>Key adverse Impacts on natural environment during construction phase:</p> <ul style="list-style-type: none"> Change of land use Loss of trees/forest Soil erosion impact Air pollution due to dust emission Disposal of construction and demolition waste and Muck Disposal (@ 1.1 Mi. cum from tunnelling) Noise pollution due to operation of construction equipments, drilling etc. Impact of labour camps Vibration impact due to tunnelling <p>Key positive impacts on the environment in operational phase:</p> <ul style="list-style-type: none"> Reduction in air and noise pollution due to modal shift from road traffic to metro rail Savings in fuel consumption and GHG emissions 	<p>B: Good alternative but depot location could pose problems</p> <p>All the adverse and positive impacts mentioned for Option 1 plus:</p> <ul style="list-style-type: none"> Hulimavu is reported to be on a "Tank Bed" area. Tanks are traditional water retaining structures seen extensively in and around Bengaluru (PWD order 82 IMB 85 dated 11.02.88 stated foreshore planting and water sheet to be maintained by the Forest department). 	<p>C: Other alternatives could be possible</p> <p>Adverse and positive impacts mentioned under Option 1 (except those due to u/g section)</p> <p>Viaduct would require substantial land acquisition in congested urban sprawls that would add to social issues as well as cost burden</p> <p>Key environmental impacts on the natural environment:</p> <ul style="list-style-type: none"> Potentially higher number of trees to be felled as compared to sections in u/g

			<ul style="list-style-type: none"> Building a depot on Hulimavu site could lead to environmental problems plus it would require additional regulatory approval from the Karnataka Tank Conservation and Development Authority <p>Source: DPR for Reach 6, 2011</p>	<ul style="list-style-type: none"> options Soil erosion potential More C&D waste generation Higher Noise and Vibrations
Social Impact	<p>D: Without project option can aggravate present social problems</p> <p>Due to the heavy traffic jams economic development opportunities would be continuously lost and worsen. Unavailability of safer and reliable transportation systems would discourage participation of economic activities particularly by socially vulnerable groups and female.</p> <p>No R&R required</p>	<p>A: Land acquisition, resettlement and rehabilitation required</p> <ul style="list-style-type: none"> Land Acquisition (33 Ha) for Depot at Kothanur <p>Expected Positive Social Impacts:</p> <ul style="list-style-type: none"> Reduction in traffic congestion, thereby increasing safety in travel on road as well as a safer travel in metro Safer travel for women and vulnerable sections of the society Lesser community health impacts due to reduction in vehicular emissions and better ambient air quality Improvement in social productivity and efficiency due to reduced travel time Overall area development due to metro Improvement in socio-economic 	<p>B: Similar to Option 1 except additional impact on depot site</p> <ul style="list-style-type: none"> Land Acquisition (15.26 Ha) for Depot at Hulimavu <p>All positive and adverse impacts of Option 1</p> <p>Land requirement of 15.26 Ha at Hulimavu Depot, in addition to the impacts of Option 1</p>	<p>C: Land acquisition requirements could be higher considering full viaduct</p> <ul style="list-style-type: none"> Land Acquisition (33 Ha) for Depot at Kothanur <p>All positive and adverse impacts of Option 1</p>

		<p>benefits of the local community through employment, trade and tourism.</p> <p>Adverse Social Impact:</p> <ul style="list-style-type: none"> Due to the project proposal and land acquisition requirement, various types of structures will be affected under the Project. 		
Project Cost (Capita l)	<p>C: Without project option could lead to higher cost burdens on the State</p> <p>In the absence of a mass transport option such as metro rail, generally, higher costs are expected to be incurred for improvements in urban road infrastructure, city health budgets, compensations due to accidents, etc.</p> <p>Supporting references: 1. Economic Analysis of Hyderabad Metro Rail Project, Ramakrishna Nathaliga, International Journal of Technology - December 2015 2. Promoting Low Carbon Transport in India, Case study of Metro Rails in Indian Cities, UNEP Risø Centre on Energy, Climate and Sustainable Development,</p>	<p>B: Not the best option based on the project costing</p> <p>Key factors impacting the cost</p> <ul style="list-style-type: none"> Higher cost due to underground section High land cost of Kothanur Depot site being in high value real estate zone <p>Assumed cost: Rs. 11908.32 Crores</p>	<p>B: Reduced cost as compared to Option 1 due to cheaper land cost for Depot at Hulimavu</p> <ul style="list-style-type: none"> Assumed Cost: Rs. 11163.30 Crores (based on 52.76% escalation of cost for Hullimavu option as mentioned in DPR for R6 in line with similar increase for Option 1 - Kothanur) 	<p>A: Most suitable from a project cost perspective, however Depot site continues to be as in Option 1</p> <p>Costs are expected to be relatively lower than the combined elevated and underground alternatives</p> <p>Assumed Cost: to be estimated but expected to be lower than Options 1 and 2</p>

	Technical University of Denmark			
Evaluation of Alternatives	D	A	B	C
	The least preferred option against others: No project option will continuously worsen the environmental health and road safety of the primary N-S movement in Bengaluru urban area. Also, further traffic jam will worsen economic losses and lose opportunity costs against other major cities in the nation despite having the most competitive advantages in the south central region at this moment. Socially vulnerable groups, in particular, low income households and female will remain discouraged to access to education, health care, and jobs without the low cost and safer metro.	The most preferred option against others to balance the negative and positive impacts, in particular, technically reliable and cost effective, environmentally sound, and socially beneficial.	The second best option against others followed by the option 1 due to the less advantaged of the possible depot site causing more resettlement impacts and unsuitable geological features for the depot use.	The third and not preferred option followed by option 2: Despite lower investment costs, option 3 will cause the highest social impacts by larger land acquisition and resettlement and higher environmental impacts by more tree felling, noise and vibration impacts along the viaduct alignment.
Thematic Component	No project option present road network without upgrading	Option 1 Viaduct & Underground with a Depot at Kothanur	Option 2 Viaduct & Underground with a Depot at Hulimavu	Option 3 Entire Viaduct with a Depot at Kothanur

Note: A: Highest score, B: Good, C: Other options could be desirable, D: Shall be avoided

Source: BMRCL

Chapter G - Consultations, Participation And Information Disclosure

Ongoing stakeholder consultations will be carried out by BMRCL during project construction and operational stages. The Stakeholder Engagement Plans will be in line with E&S policies of EIB, AIIB and JICA and will be also adopt the GRM established by BMRCL for resolution of any concerns or issues.

The revised EIA & Addendum disclosures will include an Executive Summary in Local language (Kannada)

Chapter I – Environmental and Social Management Plan

Section 2, Para 234 – The main objectives of the ESMP are: To ensure compliance with lenders (EIB, AIIB and JICA) applicable safeguardpolicies, and regulatory requirements of Karnataka State and the Governmentof India;

Section 3.1, Para 236 – Many of the 1312 trees to be felled fall on the median or the sides of the existing arterial roads and as such were not found to have avian nesting. Thus, no significant adverse impact is expected on the avian fauna in the area.

Section 3.2.4, Para 243 – Number of trees to be transplanted will be recommended by the Tree Committee based on their assessment and legal requirements.

Section 3.2.5 – Water requirement for the Project R6 is expected to be 450 m³ during construction and 300 m³During operational phase.

Section 3.2.8 – Vibration Impact during Construction and Operational Phases

Vibration monitoring is being planned and carried out by BMRCL during construction period, particularly along the underground alignment. Similarly, a building survey has been carried out for identifying vulnerable / at risk structures (if any) along the project alignment. These structures will be monitored during the construction period for any risks to structural damage and mitigation measures will be carried out as necessary.

Tests shall be performed during commissioning of the Rolling Stock to ensure compliance to the noise and vibration criteria specified in the technical specifications.