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November 20, 2017

PROJECT DOCUMENT

OF

THE ASIAN INFRASTRUCTURE INVESTMENT BANK

Republic of India

Bangalore Metro Rail Project – Line R6

CURRENCY EQUIVALENTS
(Effective as of July 25, 2017)

Currency Unit	–	Indian rupee (INR)
INR 1.00	=	$0.0155
US$1.00	=	INR 64.66

FISCAL YEAR
January 1 – December 31

ABBREVIATIONS

AFC	Automatic Fare Collection
AFD	Agence Française de Développement
AIIB or the Bank	Asian Infrastructure Investment Bank
ATL	Average Trip Length
BDA	Bangalore Development Authority
BMRCL	Bangalore Metro Rail Corporation Limited
BMTC	Bengaluru Metropolitan Transport Corporation
CAAA	Controller of Aid Accounts and Audit
C&AG	Comptroller and Auditor General
CATC	Continuous Automatic Train Control System
CDP	Comprehensive Development Plan
CTTP	Comprehensive Traffic and Transportation Plan for Bengaluru
DEA	Department of Economic Affairs
DMC	Driving Motor Car
DMRC	Delhi Metro Rail Corporation
DPR	Detailed Project Report
E&M	Electrical and Mechanical
ECS	Environment Control System
EIA	Environmental Impact Assessment
EIB	European Investment Bank
EIRR	Economic Internal Rate of Return
ENPV	Economic Net Present Value
ESMP	Environmental and Social Management Plan
ESP	Environmental and Social Policy
FIRR	Financial Internal Rate of Return
GDP	Gross Domestic Product
GfP	Guidelines for Procurement
GHG	Greenhouse Gas
GoI	Government of India
GoK	Government of the State of Karnataka
GSDP	Gross State Domestic Product
GST	Goods and Services Tax
IDC	Interest During Construction
IFY	Government of India Fiscal Year
JICA	Japan International Cooperation Agency
km	Kilometer
M	Meter
MC	Motor Car
MoF	Ministry of Finance

MoU	Memorandum of Understanding
MoUD	Ministry of Urban Development, Government of India
NPV	Net Present Value
NUTP	National Urban Transport Policy
O&M	Operation and Maintenance
OEM	Original Equipment Manufacturer
PHPDT	Peak Hour Peak Direction Traffic
RAP	Resettlement Action Plan
RPF	Resettlement Policy Framework
SCF	Standard Conversion Factor
SCS	Shadow Cash Support
SEMU	Social and Environmental Management Unit
SIA	Social Impact Assessment
TBC	To Be Confirmed
TBM	Tunnel Boring Machine
TC	Trailer Car
TVS	Tunnel Ventilation System
UMTA	Unified Metropolitan Transport Authority
VOC	Vehicle Operating Cost
VOT	Value of Time
WPR	Workforce Participation Rate

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1. PROJECT SUMMARY SHEET

Republic of India
Bangalore Metro Rail Project – Line R6

Project No.	000038
Borrower Implementation Entity	Republic of India Bangalore Metro Rail Corporation Limited (BMRCL)
Sector/Subsector	Transport/Urban Rail
Project Objectives/Brief Project Description	The objective of the Project is to provide efficient and high-capacity north-south connectivity through the center of Bangalore by expanding the city's metro system. Following are the planned activities under the proposed Project: (i) construction of 7.5 km of elevated viaduct and 6 elevated stations; (ii) construction of 14.5 km of underground tunnels and 12 underground stations; (iii) construction of a depot; and (iv) creation of a tunnel ventilation system and environment control system.
Project Implementation Period (Start Date and End Date)	Start Date: September 1, 2017 End Date: December 31, 2021
Expected Loan Closing Date	June 30, 2022
Project cost and Financing Plan	Project Cost: US$1,785 million Financing: • AIIB = US$335 million (19%) • EIB Tranche A = €300 million (20%) (US$350 million equivalent) • EIB Tranche B = €200 million (13%) (US$233 million equivalent) • Government of India = US$255 million (14%) • Government of Karnataka = US$612 million (34%)
AIIB Loan (Size and Terms)	US$335 million with a final maturity of 15 years, including a grace period of 5 years, at Bank's standard interest rate for sovereign-backed loans
Co-financing (If any) (Co-financier(s), Size and Terms)	• EIB Tranche A: €300 million (US$350 million equivalent) with a final maturity of 20 years, including a grace period of 4 years • EIB Tranche B: €200 million (US$233 million equivalent). It is expected that the EIB's Finance Contract for Tranche B will be signed within eighteen months from the date of signature of the contract for Tranche A.
Environmental and Social Category	A
Project Risk (Low/Medium/ High)	High
Conditions for Effectiveness and Disbursement (if any)	1. Effectiveness Conditions: (i) Effectiveness of the EIB loan agreement; and (ii) Execution of the Project co-lenders' agreement on behalf of the Bank and the EIB 2. Disbursement Conditions: (i) For the Bank's funds corresponding to the EIB's Tranche A, disbursement will be made

	upon confirmation by the EIB that disbursement conditions included in the EIB Finance Contract have been complied with; and (ii) For the Bank's funds corresponding to the EIB's Tranche B, disbursement will be made upon timely confirmation that the EIB Finance Contract for Tranche B credit has been concluded between the Borrower and the EIB.
Key Covenants	The Project will be carried out in accordance with the environmental and social documents (ESMP, RPF and RAP(s)). The Project Implementing Entity will submit semi-annual progress reports, semi-annual interim unaudited financial reports for the Project, and annual audited Project financial statements
Policy Assurance	The Vice President, Policy and Strategy, confirms an overall assurance that the Bank is in compliance with the policies applicable to the Project.

President	Jin Liqun
Vice-President	D.J. Pandian
Director General, Operations	Yee Ean Pang
Manager, Operations	Ke Fang
Project Team Leader	Soon-Sik Lee, Senior Investment Operations Specialist
Project Team Members	Alexander I. Ugut, Principal Risk Specialist Baihui Sun, Project Assistant Chongwu Sun, Senior Environmental Specialist Ian Nightingale, Procurement Advisor Jang Ping Thia, Senior Economist Jessana A. Yanuario, Finance Officer Kishlaya Misra, Operations Support Specialist Kishor Uprety, Senior Counsel Maria João Kaizeler, Financial Management Specialist Somnath Basu, Senior Social Development Specialist Sunil Choukiker, Environment and Social Consultant Thakur Singh, Technical Consultant

2. STRATEGIC CONTEXT

A. Country Context

1. India is a fast-growing and large developing economy, averaging around 7% growth per year in the past few years. Its Gross Domestic Product (GDP) was US$2.1 trillion in 2016, with a per capita GDP of around US$1,613[1]. However, inadequate infrastructure remains a key constraint to economic growth and urban development.

2. The estimated Gross State Domestic Product (GSDP) of the State of Karnataka for Indian Fiscal Year (IFY) 2017-18 [2]is US$198 billion.[3] From IFY2011-12 to IFY2015-16, its GSDP grew at an annual rate of 7.1% (at constant prices). Karnataka has the third largest GSDP in India and contributes 7.3% to the country's GDP as estimated in 2017. The key drivers of Karnataka's economy are the services and manufacturing sectors. Its economy is among the few in India with a revenue surplus; the State had no revenue deficit in its IFY2017-18 budget estimate. The fiscal deficit stands at 2.6% and the total liabilities of the Government of Karnataka (GoK) are 18.9% of the GSDP for IFY2017-18. Bangalore, one of India's fast-growing cities, is the capital as well as the economic center of the State. Bangalore is known as the Silicon Valley of India and is the major contributor to India's growth in the software sector. The GDP per capita of the city was US$5,051[4] in 2015, which was the fifth largest in India on purchasing power parity terms.

3. Urban Indians now form about one-third of the population and produce more than three-fifths of India's GDP. It is estimated that by the year 2050, 50% of the population will be living in cities.[5] A High-Powered Expert Committee appointed by the Ministry of Urban Development (MoUD), Government of India (GoI) observed that about INR 39 lakh crore (at IFY2009-10 prices) (approx. US$603 billion in current dollar terms) will be required for creation of urban infrastructure in India over the next 20 years.[6] It is estimated that by 2031, the urban population in India will reach 600 million.[7]

4. Karnataka is among the most urbanized states in India, with 38.57% of its population living in urban areas[8]. As per the 2011 Census, Bangalore is the third most populous city in India, behind Mumbai and Delhi, with a population of 9.6 million, accounting for about 16% of the State's population. The city grew 35.09% between 1991 and 2001 and 47.18% in the following ten years, making it one of the top cities in India for population growth. Its population is expected to reach 14.2 million by 2021 This growth can be seen in Bangalore's increasing population density: in 2001, it was 2,985 persons per square km; by 2011 this had risen to 4,381.

5. The MoUD formulated its National Urban Transport Policy (NUTP) in April 2006. The policy calls for developing safe, affordable, quick, comfortable, reliable and sustainable urban transport systems for Indian cities. Following global best practice, the NUTP encompasses the following policy directives: (i) integration of land use and transport planning; (ii) equitable allocation of transport corridor space; (iii) prioritization of public transport; (iv) integration of systems; (v) prioritization of non-motorized users; (vi) private vehicle demand management through parking

[1] CEIC, A Euromoney Institutional Investor Company
[2] Government of India's Fiscal Year 2017-2018 (IFY2017-2018) begins on April 1, 2017 and ends on March 31 2018.
[3] PRS Legislative Research: Karnataka Budget Analysis 2017-18.
[4] Global Metro Monitor, Brookings, 2015
[5] Country Profile: India, Population Division, Department of Economic and Social Affairs, United Nations.
[6] Ministry of Urban Development, Government of India http://MoUD.gov.in/cms/urban-infrastructure.php
[7] UN Habitat 2016 Report: World Cities Report 2016 – Urbanization and Development: Emerging Futures.
[8] Karnataka Census 2011Profile, Office of Registrar General & Census Commissioner, Ministry of Home Affairs, GoI

controls; (vi) measures to separate freight flows; (vii) urban governance improvements; (viii) capacity building; (ix) application of cleaner technologies; and (x) innovation in finance.

6. The NUTP proposes the development of a metro rail system in every city of India with a population of more than 2 million. To date, metro lines are already operating or under construction in a number of Indian cities, including Delhi; Noida and Lucknow in Uttar Pradesh; Kochi in Kerala; Ahmedabad in Gujarat; Jaipur in Rajasthan; Hyderabad in Telangana; Nagpur, Pune and Mumbai in Maharashtra; Chennai in Tamil Nadu; Kolkata in West Bengal; and Bangalore in Karnataka.

B. Sectoral and Institutional Context

7. **Increasing travel demand.** With the rapid expansion of the population of Bangalore, there has been phenomenal growth in travel demand and the number of vehicles in the city. The "Comprehensive Traffic and Transportation Plan for Bengaluru" (CTTP), prepared in 2011[9], forecasts travel demands in 2025 with and without the metro system in the city, in comparison with a 2005 survey. Details of daily trips and modal share are summarized in Table 1. The Plan estimates that the daily trips (about 6.3 million in 2005) will increase by about 75% by 2025. In the without metro system scenario in 2025, public transport (buses only) will decrease from its 54% share in 2005 to about 49% in 2025. These figures indicate that the existing road network will be overloaded beyond capacity due to the high number of vehicles on the roads and the public transport share will fall further. In the with metro system scenario in 2025, on the other hand, the public transport share will increase to about 61%, which is a desirable modal split for the city.

Table 1: Travel Demand and Transport Mode Split Forecast in Bangalore (CTTP)

Mode	Without Metro – 2025		With Metro – 2025	
	Daily Trips	Modal Share (%)	Daily Trips	Modal Share (%)
Car	778,159	7.0	603,081	5.4
Two-Wheeler	3,363,559	30.3	2,916,718	26.3
Auto Rickshaws	1,449,958	13.1	798,040	7.2
Public Transport	5,515,380	49.7	6,789,218	61.1
Total	11,107,056	100.0	11,107,057	100.0

8. A recent traffic survey carried out by RITES Primary Surveys shows that the number of daily trips in the city was about 9.2 million and the public transport share was about 43% in 2015, which is a significant drop compared to 2005. The car share was about 9.5% and the two-wheeler share about 36.6%. This indicates that the private transport share has grown faster than was forecast in the 2011 CTTP, further underlining the need for expanding public transportation systems in the city.

9. **Road-based public transportation system in Bangalore.** Karnataka State Road Transport Corporation, the nodal state public transport corporation, was divided into 4 corporations in 1997 to serve different geographic regions in the State. One of those, the Bengaluru Metropolitan Transport Corporation (BMTC), is the nodal agency for public bus transportation in Bangalore. The BMTC offers around 10 types of public transportation services in Bangalore, varying from an ordinary bus service to air-conditioned Wi-Fi buses. As of July 2017, BMTC has a total fleet of 6,388 buses with a daily passenger carrying capacity of 4.91 million.[10] However, the public bus

[9] Directorate of Urban Land Transport, Urban Development Department, Government of Karnataka.
[10] BMTC website https://www.mybmtc.com/en/bmtc_glance

system has not been able to address the demand for a fast, reliable and safe public transportation system.

10. **High increase in private vehicle usage**. Sustained high levels of economic growth over the last two decades have, inter alia, led to strong growth in transport demand and in ownership and use of private vehicles, especially motorcycles. Following recent trends, passenger car and motorcycle sales are forecast to grow by 12% per year over the next decade. The number of motor vehicles registered in Karnataka in 2000 was 3,691,000; by February 2017, this had risen to 17,706,102. Details of vehicle registration are presented in Table 2. Transport vehicles (including two-wheelers and private cars) for personal use account for almost 90% of the total number of vehicles in the Bangalore urban area and 75% in the Bangalore rural area. Around 40% of all transport vehicles for personal use in Karnataka are in Bangalore. The high reliance on personal vehicles for transportation is substantiated by the growth in the number of such vehicles in Bangalore.

Table 2: Total Vehicles Registered in Bangalore and Karnataka (as of February 2017)

	Bangalore Urban	Bangalore Rural	State of Karnataka
Transport Vehicles for personal uses	6,113,011	1,123,681	16,036,320
Transport Vehicles for commercial and public transportation	661,156	354,075	1,669,782
Total	6,774,167	1,477,756	17,706,102

Source: Transport Department, Government of Karnataka

11. **Growing traffic concerns**. Public transport supply has not kept pace with travel demand; this, together with the high dependency on and growth of personal transport, has exacerbated the traffic situation in Bangalore, which is characterized by constant traffic jams that contribute to economic losses. The fourth annual IBM Commuter Pain Survey in 2011 ranked Bangalore as the sixth worst city in the world for commuting. Average travel time via public transport is also high, compared with private, as a result of inadequate supply as well as increased traffic congestion. In addition, the increase in personal vehicles has led to severe air pollution and noise in Bangalore. The Karnataka State Pollution Control Board found that transportation is a principal source of air pollution in Bangalore, contributing around 42% of the total air pollution in the city.

12. **Development plan of Bangalore**. The Bangalore Development Authority (BDA) is the planning authority for the Bangalore metropolitan area. The BDA is required by law to prepare and periodically update a Comprehensive Development Plan (CDP). The first such CDP was approved in 1984 and the second in 1995. The latter identified several potential mass transit corridors. This led to the preparation in 2003 of a first phase of metro construction. As a result, two lines, totaling 42 km, have come into operation in stages since 2011, with the entire Phase I operational as of June 2017. Bangalore now has the second longest operational metro system in India, after Delhi.

13. Alongside the investment in Phase I of the metro and other improvements, the authorities have commissioned studies and developed plans to address the severe mobility problems faced by the city. The most relevant of these is the 2011 CTTP that recommended, inter alia, further phases of metro construction, including a second phase comprising the extension of the two Phase I lines (four line extensions) and construction of two new lines, totaling 72 km, at an investment cost of about US$4 billion. Both the CTTP and CDP are being updated through to 2031.

14. **Bangalore metro administration.** The Bangalore Metro Rail Corporation Limited (BMRCL) was established as a GoI-GoK joint venture company with equal shares, to undertake the task of developing the Bangalore metro. BMRCL was formed under the Companies Act, 1956

on 12 September 2005. It has 5 representatives from the two respective Governments and 2 Functional Directors of BMRCL on its Board of Directors. The Chairman of the Board of Directors of BMRCL is the Secretary, MoUD, GoI and the Managing Director of BMRCL is the GoK representative. BMRCL has a well-defined organizational structure to plan new metro lines and to operate and maintain existing lines that meet the objectives of the NUTP. BMRCL is also working together with BMTC to provide adequate feeder bus services for the suburbs by shifting buses from the metro's routes to the ends of the lines.

15. **BMRCL metro development**. The Delhi Metro Rail Corporation Limited (DMRC) prepared and submitted a detailed report for Phase I in 2003. The GoI approved Phase I of the project on 25 April 2006; construction began in April 2007, with financial support from the Japan International Cooperation Agency (JICA) and Agence Française de Développement (AFD) and was completed in June 2017. The objective of the Phase I project was to connect the metro to the outer ring roads to provide better connectivity in the city and to cover the industrial area of Peenya in the northwest of Bangalore. The Phase I project was divided into two lines: the Purple Line (running horizontally across the city and connecting to the outer ring roads), and the Green Line (running vertically from the northwest to the south of the Bangalore). More details of Phase I are shown in Table 3.

Table 3: Bangalore Metro Phase I

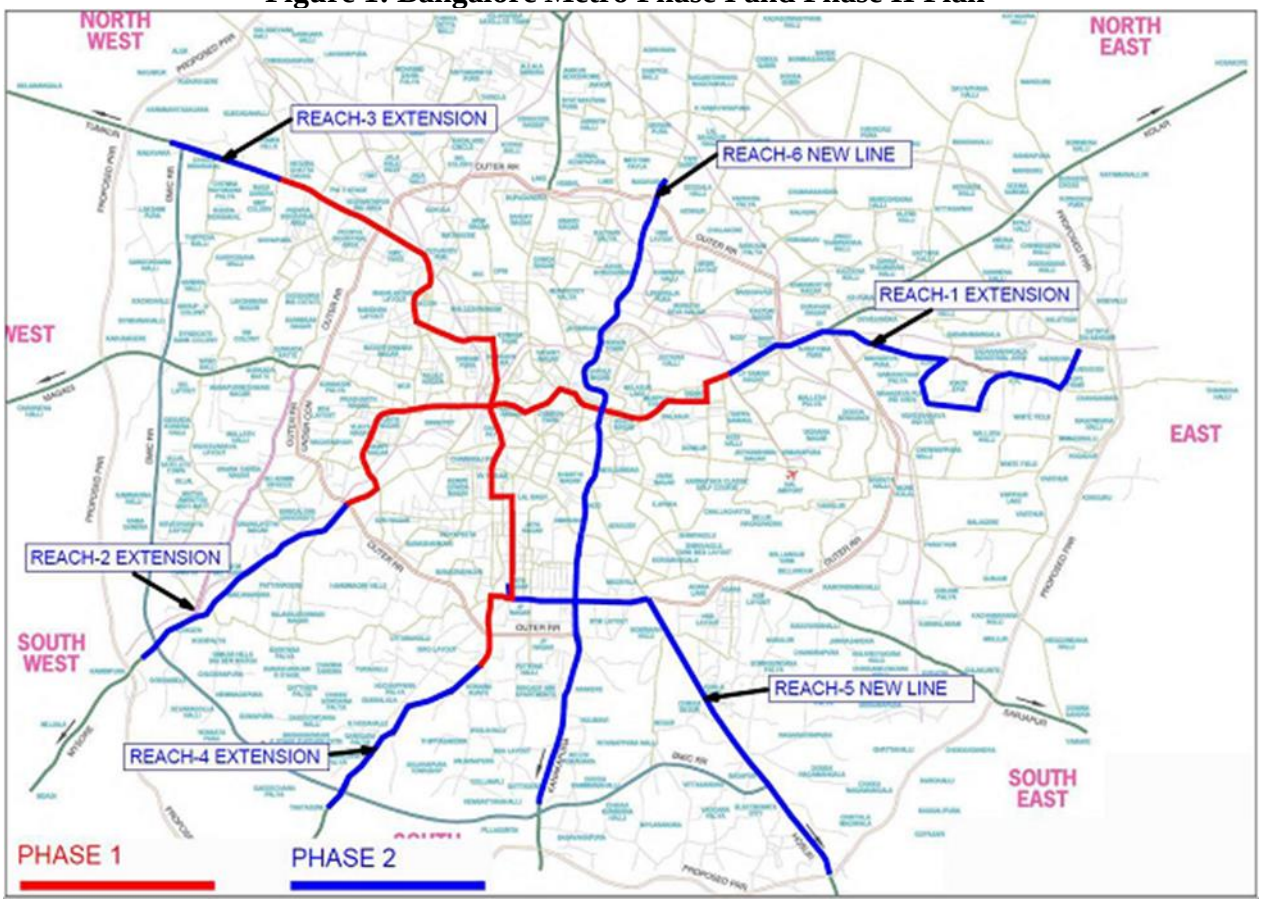
Line	Elevated length (km)	Underground length (km)	Total length (km)	Stations
Purple Line	13.10	4.80	17.90	17
Green Line	20.20	4.00	24.20	25
Total	33.30	8.80	42.10	42

16. **Phase II project.** To enhance coverage and extend the metro system to other important areas of Bangalore, per the 2011 CTTP, the Phase II project was approved by the GoK on 21 February 2012 and subsequently by the GoI on 21 February 2014. Phase II covers a total distance of 72.84 kilometers, with 61 stations (49 elevated and 12 underground). It includes four extensions of the Phase I lines – one at each line end – and two new lines. The Project proposed to be financed by the Bank is one of the new lines, known as Reach 6, which runs north to south across the center of the city and connects some of its most important nodes of development. More details of the Phase II project are shown in Table 4. The metro plan including the Phase I and Phase II projects is shown in Figure 1.

Table 4: Details of Phase II Metro Project of BMRCL

Reach No.	Corridor Name	Length (km)	Stations	Status
1 (Extension)	Baiyappanahalli to ITPL-Whitefield	15.50	14	Two civil packages awarded
2 (Extension)	Mysore Road Terminal to Kengeri	6.46	5	Two civil packages awarded
3 (Extension)	Hesaraghatta cross to BIEC	3.77	3	One civil package awarded
4 (Extension)	Puttenahalli to NICE Road Junction	6.29	5	One civil package awarded
5 (New)	R.V. Road to Bommasandra	18.82	16	Three civil packages awarded
6 (New)	Gottigere to Nagavara	22.00	18	Elevated section civil package awarded
Total		72.84	61	

Figure 1: Bangalore Metro Phase I and Phase II Plan



3. THE PROJECT

A. Rationale

17. **Strategic fit**. The metro system has become an essential element of public transportation in mega cities and metropolitan areas around the world, because it is capable of providing fast, safe, comfortable, convenient, high capacity, and environmentally friendly connectivity to the public. The Project will improve overall mobility and travel times, and help to reduce the traffic congestion, air pollution and noise that have resulted from the rapid growth of the population and the economy of the city. Traffic diversion to an efficient and fast metro system and decongestion of the existing road network will lead to considerable saving in passenger travel time and a modest reduction in Greenhouse Gas (GHG) emissions in the region. The Project operations will be entirely electric, thereby further enhancing GHG emission reductions and helping mitigate climate change effects. The Project is fully aligned with the Bank's support for connectivity and its emphasis on green infrastructure.

18. The Phase I project initiated the metro system in Bangalore. However, the reach of the Phase I lines is limited. The proposed Phase II project will make the metro available as a city-wide public transportation mode. With more lines and connections between lines as well as with other transport modes, Phase II will help to make the city's transportation seamless and integrated. The proposed Project thus will provide reliable, safe and environmentally friendly connectivity to the residents of Bangalore. It will also stimulate residential, economic and commercial development along the metro corridors, enhancing the city's socio-economic development.

19. The proposed Project is consistent with the NUTP and the draft updated CDP for Bangalore. It is also consistent with the 2011 CTTP that proposed the metro lines, complemented by bus and auto rickshaw feeder services to facilitate access. Moreover, Bank support for the proposed Project is in line with the United Nation's Sustainable Development Goals, specifically Goal 9 on building resilient infrastructure and Goal 11 on sustainable cities and communities.

20. **Rationale for public sector financing.** Public sector financing is the appropriate vehicle for the Project due to the high capital cost and relatively low financial return on investment, which is usual for rail based urban public transport schemes. There will nonetheless be wider positive spillovers. Meanwhile, the GoI is considering alternative financing options to attract private sector financing for financially sound metro projects.

21. **Value addition by the Bank.** The Bank has provided critical inputs to the preparation of environmental and social safeguards for the Project. The Bank identified gaps in environmental and social safeguards prepared by BMRCL and has supported BMRCL to develop mitigation measures. The support includes the preparation of a program to reflect implementation of Resettlement Action Plans (RAPs) prior to the initiation of civil works, revision of the Environmental Impact Assessment (EIA), and preparation of an Environmental and Social Management Plan (ESMP) with budgetary provisions.

22. The Bank also supported BMRCL to put in place an effective supervision mechanism for implementation monitoring and to enhance its operation and maintenance (O&M) system. The Bank, with its technical expert, reviewed BMRCL's organization structure, O&M plan, and quality plan and identified possible enhancement for better Project implementation and O&M.

23. **Value addition for the Bank.** The Bank's participation in its first metro project will provide the necessary experience that will bring more opportunities to finance metro projects that are in high demand in other major cities of India and in the region more broadly. Furthermore, it will support the Bank in diversifying its portfolio in the transport sector.

B. Project Objectives

24. The objective of the Project is to provide efficient and high-capacity north-south connectivity through the center of Bangalore by expanding the city's metro system.

25. **Project beneficiaries.** The primary beneficiaries are the commuters who travel along the corridor for economic and social activities since the metro is faster and more reliable than road-based transport modes. Improved mobility will have a positive impact on productivity, quality of life and the overall economy. In addition, the Project will improve the livelihoods of the socially disadvantaged population[11] by enhancing their mobility and thus their access to education, jobs and other services. The secondary beneficiaries are residents and commercial establishments along the corridor, who are expected to benefit from reduced vehicle emissions, noise, and traffic accidents and, for the commercial establishments, the increased business that the metro commuters will bring.

26. **Project result indicators.** The Results Framework and Monitoring, presented in Annex 1, will be used to monitor and evaluate the achievement of the proposed key Project objective indicators. These include:

[11] The scheduled caste population constitutes 12.5% and the scheduled tribe population 2% of the total population of Bangalore. 2011 Census,

(i) Number of passengers carried – as measured by the average daily ridership;
(ii) Average trip length – as measured by the total trip length divided by the number of passengers carried; and
(iii) Employment generation during operation – as measured by the number of direct employees to be hired for metro O&M.

27. The Project intermediate output indicators will be measured semi-yearly during Project implementation to ensure that the Project is progressing in accordance with the implementation plan. The indicators include:

(i) Construction of metro line;
(ii) Construction of a depot; and
(iii) Installation of tunnel ventilation and environmental control systems.

C. Project Description and Components

28. The Reach 6 line to be supported by the proposed Project runs from Gottigere to Nagavara in Bangalore and the length of the proposed corridor is approximately 22 km, with 6 elevated stations and 12 underground stations. The Project consists of four components that are expected to be jointly co-financed by the Bank and the EIB.

- **Component 1: Construction of Elevated Viaduct and Stations.** The component consists of 7.5 km of elevated metro section and 6 elevated stations. The elevated section will run along the median of existing roads in most areas and diversion of traffic on these roads will be required during construction. The station platforms will be 135 m long to accommodate planned 6 car trains. Average inter-station distance for elevated section is approximately 1.31km varying from 767 m to 1,701 m.

- **Component 2: Construction of Underground Section Tunnel and Stations**. The component consists of 14.5 km of underground metro line and 12 underground stations. The underground section between stations is planned to be constructed as twin bored tunnels using ten mix-shield Tunnel Boring Machines (TBMs) and two Earth Pressure Balance TBMs. The stations would be standard cut and cover underground construction. Average inter-station distance for the underground section is approximately 1.14 km, ranging from 897 m to 1.377 km.

- **Component 3: Construction of Depot.** The component consists of a maintenance depot for the Reach 6 line at Kothanur, to be constructed in an area of about 16 hectares. The depot will include an administrative building and maintenance facilities. The component does not include the electrical and mechanical (E&M) works and depot equipment, which will be financed by the GoI and GoK.

- **Component 4: Tunnel Ventilation System (TVS) and Environmental Control System (ECS).** The component consists of supply, installation, testing and commissioning of TVS and ECS for the underground section and stations. The TVS will provide an acceptable environment within the tunnel for the operation of the trains under normal, congested operation conditions, and will control smoke flow during any emergency. TVSs will be installed at each end of the underground station, ramp areas and operation control center. The ECS will provide an acceptable and safe environment within the station for both passengers and station operational personnel. ECS equipment will be installed at the concourse level and chillers will be installed at the ancillary building.

29. Other components, including signaling, telecom, power, Automatic Fare Collection (AFC), operation control center, and rolling stock for the Reach 6 line will be financed by the GoI and GoK.

D. Cost and Financing

30. The Project is estimated to cost US$1,785 million, and will be jointly co-financed by the Bank and the EIB. The financing plan comprises (i) a sovereign-backed loan of US$335 million from the Bank, (ii) a sovereign-backed loan of €300 million (US$350 million equivalent) from the EIB's Tranche A, (iii) a sovereign-backed loan of €200 million (US$233 million equivalent) from the EIB's Tranche B, (iv) US$255 million from the GoI, and (v) US$612 million from the GoK. The indicative Project cost and financing plan is shown in Table 5.

Table 5: Cost and Financing (US$ million, rounded)

Item	Cost	AIIB		EIB (Tranche A + Tranche B)		GoI		GoK	
		Amount	Share	Amount	Share	Amount	Share	Amount	Share
Component 1: Construction of Elevated Viaduct & Stations	89	31	34%	54	60%	3	3%	3	3%
Component 2: Construction of Underground Section Tunnel & Stations	818	282	34%	490	60%	23	3%	23	3%
Component 3: Depot	21	7	34%	12	60%	1	3%	1	3%
Component 4: Tunnel Ventilation System & Environmental Control system	44	15	34%	27	60%	1	3%	1	3%
Sub total Cost	**973**	**335**	**34%**	**583**	**60%**	**27**	**3%**	**27**	**3%**
Other items including land acquisition, track, system, rolling stock, etc.	812	0	0%	0	0%	227	28%	585	72%
Total Cost	**1,785**	**335**	**19%**	**583**	**33%**	**255**	**14%**	**612**	**34%**

31. **Financing terms.** Final maturity of 15 years, including a grace period of 5 years, at Bank's standard interest rate for sovereign-backed loans.

32. **Co-financing arrangement.** The Project will be co-financed by the Bank and the EIB, providing an opportunity for mutual sharing of experience between the two banks. The Bank will co-finance about 37% of the total loan amount to be provided by the co-financiers. The EIB's financing consists of €300 million (Tranche A) and €200 million (Tranche B). It is expected that the Finance Contract for Tranche B will be signed within eighteen months after the date of signature of the Finance Contract for Tranche A. The Project co-lenders agreement is being finalized between the Bank and the EIB. It is expected that the EIB will partially administer the Project, and provide procurement, and environmental and social safeguards monitoring and reporting services. The EIB's policies and procedures on environmental and social risks and impacts, procurement,

project monitoring, and reporting are considered materially consistent with the Bank's corresponding policies. As permitted by the Bank's policies, it is proposed that the EIB's above mentioned policies will be used for the Project. The Bank will also provide adequate support to Project implementation, particularly regarding environmental and social aspects. The Bank will administer its own disbursements in accordance with its own policies.

E. Implementation Arrangements

33. **Implementation period.** The Project is expected to be implemented from September 2017 to December 2021.

34. **Project implementation management**. BMRCL will be the project implementation entity for the proposed Project. BMRCL will also act as "Engineer" for the works and supplies, quality control, timeliness of delivery and certification of payments under the Project. BMRCL has a well-defined organizational management structure, with clear roles and responsibilities. The Managing Director heads BMRCL. To support the Managing Director, there are Directors for Finance; Rolling Stock, Electrical and Signaling & Telecommunication; and Project and Planning, each with their respective teams. The Director (Rolling Stock, Electrical and Signaling & Telecommunication) leads all system engineering works, and is supported by 187 professionals. This Director is also in charge for the O&M activities of BMRCL. The Director (Project and Planning) leads the civil engineering work of BMRCL, is supported by 282 professionals and has two Chief Engineers for the proposed Project. The Chief Engineers for the Project are supported by a team of more than 150 professionals, including Deputy Chief Engineers, Executive Engineers and Assistant Executive Engineers.

35. **Results monitoring and evaluation.** The Results Framework and Monitoring, presented in Annex 1, will be used to monitor and evaluate the achievement of the Project objective and intermediate output indicators. The overall responsibility for monitoring Project results will be with BMRCL, which will receive internal, regular monthly progress reports from the field and on O&M.

36. During Project implementation, a semi-yearly progress report will be prepared regularly by BMRCL and shared with the Bank and the EIB. It is expected that the first report will be prepared by end of April 2018. This report will form one of the main means of monitoring implementation of the proposed Project, and will be prepared in a format agreed with the Bank and the EIB. It will highlight status of achievement of agreed targets for various monitoring indicators and detail the implementation progress of all aspects of the Project. After Project completion, a project completion report following the opening of the line to traffic will be prepared by BMRCL. In addition, after 3 years of operation, a report containing the update on the Project objective indicators will be submitted to the Bank and the EIB. The Project objective indicators will be evaluated by comparing the actual results against planned target values.

37. **Quality monitoring management.** BMRCL has deployed a railway engineer with extensive experience in tunnel and viaduct construction as head of quality assurance. He is supported by at least three quality assurance engineers for each contract. In addition, BMRCL has engaged the Indian Institute of Science, Bangalore for third-party design and construction quality assurance.

38. **Bank supervision.** The EIB plans to visit the Project sites twice a year to monitor progress. The Bank team will join the EIB team in these supervision missions. Appropriate resources will be made available to match the frequency of the EIB supervision missions. In addition to the semi-yearly supervision missions, the EIB and the Bank will engage local consultants to carry out more

frequent supervision of the design, construction, and environmental and social management activities in the early stages of Project implementation.

39. **Operation and maintenance.** BMRCL will be the O&M agency and has prepared an O&M plan for the Project, based on the O&M experience gained during Phase I (all of Phase I O&M is being carried out by more than 1,600 staff, managed by the O&M Director). More than 620 staff will be deployed for the O&M activities of the Project. Some maintenance activities will be outsourced, including maintenance of civil structures, elevators, escalators, fire detection and firefighting equipment, etc.

40. **Procurement**. The EIB will be the lead co-financier for the Project and procurement will be conducted in accordance with the EIB's "*Guidelines for Procurement"* (GfP) as applied to *"Operations outside the European Union."* The GfP is materially consistent with both the Bank's Articles of Agreement and the Bank's Procurement Policy. A common procedure framework for the proposed Project is being jointly developed by the Bank and the EIB. In accordance with the GfP, eligibility to participate in tendering for the proposed Project will be open to firms and individuals from all countries and conducted in accordance with the EIB's Open Procedures, which are fully consistent with the Bank's International Open Competitive Tender procedures. The Bank will rely on the EIB's determination of compliance with the GfP for all procurement conducted under the proposed Project.

41. **Fund flow management.** The Department of Economic Affairs (DEA), Ministry of Finance (MoF) of the GoI will be responsible for administration and management of the Bank's loan proceeds through the Office of the Controller of Aid Accounts and Audit (CAAA). BMRCL will maintain the financial management system of the proposed Project and will ensure that financial management is carried out in accordance with the Project's legal agreements.

42. The fund flow and disbursement process will be as per the provisions of budgeting and accounting for externally aided projects in General Financial Rules 2017 of the Department of Expenditure, MoF, GoI. The Bank's loan proceeds will be transferred to BMRCL through a Pass Through Assistance process under the line ministry of MoUD, GoI. The fund flow arrangement is as follows:

(i) Based on the Project requirements and disbursement schedule, BMRCL will prepare a detailed annual budget estimate and submit it to MoUD for inclusion in the MoUD annual budget;

(ii) MoUD will make a provision for Pass Through Assistance, based on BMRCL's estimate, in its annual budget estimate;

(iii) MoF, GoI, will allocate the annual budget as per MoUD's annual budget estimate;

(iv) MoUD will release the funds to BMRCL based on the annual budgetary allocation;

(v) BMRCL will submit a disbursement request to CAAA in MoF, GoI as per the mutually agreed disbursement schedule; BMRCL will send the disbursement request and supporting documents as per loan agreement to CAAA for onward transmission to the Bank;

(vi) CAAA will submit the disbursement request to the Bank, and submit the required supporting documents; and

(vii) The Bank will review and accordingly disburse the funds to CAAA upon satisfactory compliance with the Bank's requirements.

43. **Disbursement arrangement.** The disbursements from the Bank will be made in accordance with the Bank's General Conditions for Sovereign-Backed Loans, the Bank's loan agreement and disbursement letter, the disbursement manual and other relevant polices and guidelines.

44. The Loan proceeds will be disbursed using the advance method and following the report-based replenishment every 6 months. The initial advance will be equal to the next 6 months of the Bank's share of eligible expenditures. No additional advances will be disbursed unless at least 70% of the preceding advance and 100% of the amounts of all previously disbursed advances prior to the preceding advance have been expensed, and all disbursement conditions have been satisfied. It is expected that the amounts disbursed by the EIB and the Bank will follow the ratio of 63:37 of the EIB co-financing and the Bank's loan, respectively. The estimated disbursement plan is as shown in Table 6.

Table 6: Disbursement Plan (US$ million)

Period	2018	2019		2020		2021		2022	
	Q2	Q1	Q3	Q1	Q3	Q1	Q3	Q1	Q2
Disbursement	50	30	30	30	31	32	32	50	50
Cumulative	50	80	110	140	171	203	235	285	335

45. **Retroactive financing.** All eligible expenditures under the Project, incurred in compliance with the Bank's procurement policies and guidelines and in respect of which payments were made not more than 12 months prior to the date of the loan agreement, up to an amount of US$67 million (20% of the amount of the Loan), may be financed retroactively. The IUFR will clearly indicate the amount claimed under retroactive financing along with the details of the expenditure incurred. Such IUFRs will be subject to audit during the annual Project audit.

4. PROJECT ASSESSMENT

A. Technical

46. **Traffic demand forecast.** Traffic demand studies were performed by DMRC in 2011 and were recently updated by BMRCL, using a four-stage traffic model populated with adequate data on households, trip origin/destination, current traffic flows and economic projections, which is standard industry practice. The detailed project report (DPR) prepared by DMRC projected daily ridership for Reach 6 as 403,000 passengers per day in 2021 and 558,000 passengers per day in 2031, whereas the study updated by BMRCL, taking current ridership in Phase I[12] into account, projected 300,000 passengers per day in 2021 and 423,000 passengers per day in 2031. The Bank team considers that the ridership projections of BMRCL are more realistic and robust. The updated ridership projections are as shown in Table 7.

[12] The average ridership of Phase I from June 1 to June 17, 2017 (before the completion of Phase I) was 178,167 passengers per day. The average ridership after full operation of Phase I has increased substantially, to 320,000 passengers per day. BMRCL forecasts that the daily ridership will increase to 525,000 passengers per day by June 2018. However, the current ridership in Phase I is only about 61% of the projected ridership and it is uncertain that the ridership will meet the projection because the full operation of Phase I commenced only recently.

Table 7: Project Ridership Projections (Reach 6)

Year	Total Daily Ridership
2021-22	300,000
2026-27	376,000
2030-31	423,000
2036-37	500,000
2040-41	541,000
2046-47	609,000
2050-51	660,000

47. Passenger growth has been assumed at 5% per year during initial 5 years from 2021 to 2025, followed by 3% from the sixth to fifteenth year of operation (2026 to 2036) and then 2% till the thirtieth year of operation in 2051. Based on the observations of Phase I ridership, the ridership number appears achievable once Phase II becomes fully operational. The proposed Project will connect important residential, commercial, educational, and medical parts of the city, and provide a much-needed north-south access.

48. Until annual ridership data in Phase I is available, the Bank team considers that actual ridership of the Project may be lower than the ridership projections of BMRCL. Therefore, economic and financial sensitivity analyses were carried out by varying further reduction in estimated ridership by 10% and 20%. The economic and financial analyses are presented in paragraphs 69-74.

49. Planned train operation is based on the projected Peak Hour Peak Direction Traffic (PHPDT), as summarized in Table 8. No service is proposed between 11:00 PM and 5:00 AM, when maintenance of infrastructure and rolling stock will take place. All trains will have 6 cars. Peak hour headway will be 6 minutes and off-peak 10 minutes. It is expected that the headway will be gradually reduced to 3 minutes as the ridership increases after the commencement of operation (the number of rakes – trains of 6 cars each – is also planned to double from 16 to 32). Phase I headway is currently 4 minutes on the East-West corridor and 6 minutes on North-South corridor. With planned PHPDT capacity accounting for 6 persons per square meter of standee area, optimum utilization of rolling stock, which is designed for 8 persons per square meter, will be achieved.

Table 8: Capacity planned for Reach 6 – Gottigere to Nagavara

Year	Car Trains	Peak Hour Head Way (minutes)	No. of Rakes	PHPDT Capacity	Max. PHPDT Demand
2021	6	6	16	15,740 (20,980*)	16,381
2031	6	3	32	31,480 (41,960*)	22,806
2041	6	3	32	31,480 (41,960*)	25,315

*PHPDT capacity at 8 persons per square meter of standee area

50. **Alignment criteria.** The proposed Project will be constructed using standard gauge (1,435 mm) track and geometric design criteria based on international practices adopted for similar metro systems with a maximum design speed of 90 km/h. The alignment and station locations have been

designed to connect densely populated areas. The elevated stations are located in areas with educational institutions, hospitals, high rise apartment complexes, IT centers and trade centers. In the underground section, the alignment passes through central commercial area and one station (MG Road) connects to the existing Phase I elevated metro station. Other underground stations will serve the densely populated area along Tannery Road, a narrow road that experiences heavy traffic jams. The Bank team is of the view that the alignment has been designed in a way to serve the highest number of people and decongest existing roads. In addition, the connections with two other metro lines will result in a seamless and integrated metro network.

51. **Elevated section.** The 7.5 km of elevated section will comprise box girders, most of which will be 25 to 28 m long (with some 22 or 31 m in length due to site constraints), constructed using a segmented technique. In Phase I, a similar segmented construction method was adopted because it both required less space and was quicker to build. This type of construction is now common in India and no major technical or construction related issues are envisaged. The substructure will be a double D-shaped pier supported by piles socketed in rock. Open foundation will be laid where the rock layer is close to the ground level. The elevated section will be constructed per the detailed design provided by BMRCL and the contractors will be paid as per actual quantity based on unit rates quoted.

52. **Underground section.** The 14.5 km of underground section will be built as a twin bored tunnel and 12 underground stations will be constructed using the cut and cover method. This has been packaged in four contracts. Since the strata encountered will be a mixture of soil, gravel, boulder and rock, a mix shield TBM has been proposed in three packages and an earth pressure balance TBM in the fourth package. A total of 12 TBMs will be deployed to reduce tunneling duration and mitigate unforeseen risks, such as breakdown or encountering hard rocks. The availability of mix shield TBM is limited in India and it may take significant time to design, manufacture, transport and install all 12 TBMs. BMRCL has planned to deploy TBMs in a phased manner in consideration of the lead time required. In addition, BMRCL is supporting TBM experts and geologists to strengthen construction management capacity, per the Bank team's recommendation given the construction complexity. The Bank team anticipates that BMRCL, which has gained experience from the Phase I underground work, can effectively manage the underground works with the deployment of additional experts to support the use of multiple TMBs.

53. **Stations.** The station locations take into account maximum traffic demand nodal points and congestion issues. An AFC system will be implemented, with passenger operated machines and smart cards. The elevated section from Gottigere to Swagath Road Cross includes 6 elevated stations with 135 m platforms to accommodate 6-car trains. The stations will comprise concourse and platform levels and entry/exit will be from pedestrian passages next to service roads on both sides of the stations. The stations will be disabled-friendly with wheelchair ramps and elevators. To meet passenger flow demand, six escalators and four staircases will be installed at each station. Provision has been made to construct bus bays and taxi / auto drop off locations in the service roads.

54. The underground stations have been planned and designed in consideration of the availability of land, surrounding constraints, traffic congestion, operational requirements and geological conditions. The station boxes will be the entry and exit points of the TBMs during tunneling. The underground stations will also be disabled-friendly, with elevators. Adequate provision has been made for fire evacuation. The Bank team is satisfied that the station design is fit for purpose.

55. **Depot.** The main depot will handle regular and heavy maintenance functions, including major overhauls of trains, routine scheduled maintenance and repairs, lifting for replacement of

heavy equipment and testing thereafter, and repair of heavy equipment. All stabling yards and maintenance platforms will have the capacity to accommodate 6-car trains.

56. **Multimodal traffic integration.** Ridership depends on integration with other transport modes and easy accessibility. It will be enhanced by adequate feeder services to facilitate door to door time/cost reductions. The Bank team has emphasized the importance of last-mile connectivity to adequately serve passengers and sustain ridership. BMRCL is aware of the importance of last-mile connectivity and is coordinating with concerned agencies to ensure adequate feeder services. In addition, easy accessibility has been reflected in the station design, by providing service roads for bus stops and taxi/auto stands at the stations.

57. BMRCL and BMTC are jointly working to enhance feeder services and have initiated such services along the Phase I metro lines. BMRCL is undertaking further studies on how best to achieve this for the Project. BMRCL has already implemented a contactless card payment facility (about 32% of riders use the facility) and plans to integrate its ticketing with the municipal bus service to further improve convenience of payment for its customers.

58. **Project implementation period.** The Project is expected to be implemented from September 2017 to December 2021. Though BMRCL plans to complete the Project by December 2020, the Bank and the EIB anticipate a longer implementation period due to the Project starting later than planned (original start date was April 2017), the potential for unforeseen ground conditions for the underground works, and potential resettlement-related issues.

59. **Project implementation capacity.** BMRCL, with a team of at least 546 professional staff for Phase II, is the project implementation agency and will act as Engineer. There will be more than 150 professional staff dedicated to the elevated and underground works of the proposed Project. Based on the experience and lessons learned from Phase I implementation, BMRCL will carry out planning, design review, supervision services, system integration, etc. with qualified in-house staff, many of whom have relevant experience from Phase I, DMRC, India Railways and local urban bodies. Per the Bank team's assessment and recommendation, a few critical positions, including TBM specialist and interface manager, will be added to the planned organization to strengthen BMRCL's management and technical capacity. With these added positions, BMRCL will have suitable capacity for Project implementation.

60. **Interface management capacity.** For adequate integration of metro components, interface management is a critical activity and BMRCL is employing an interface manager per the Bank's recommendation. The interface manager will prepare a matrix to manage the interface/integration of the metro components including civil, system, E&M, and rolling stock. Each contractor will have an interface management team which will continuously interact with one another to ensure that all interfaces are managed in a professional manner. The interface manager of BMRCL will oversee activities per the interface matrix.

61. **Quality and performance monitoring system.** The Bank team reviewed BMRCL's quality assurance plan and organization as well as the employer's quality requirements in the civil tender documents and is satisfied with BMRCL's quality monitoring system.

62. The performance of contractors will be measured through the contractors' weekly and monthly progress reports and regular management review meetings to ensure their progress meets the three-month rolling plan and overall Project program. The reports will be verified by BMRCL supervision engineers on the ground. The monthly reports will include progress status, updated construction program, and deployment of material, equipment and manpower. It will also include

a recovery plan if any activity falls behind by more than one month. The Chief Engineers of the Project will be responsible for performance monitoring and the Department of Project Monitoring and Budgeting will prepare periodic appraisal reports.

63. **Operation and maintenance capacity.** The Bank team assessed the O&M capacity of BMRCL through various discussions with BMRCL and review of the O&M plan for the proposed Project. The Bank team is satisfied with the O&M capacity of BMRCL for the following reasons:

(i) BMRCL is currently operating the 42-km Phase I metro system with 4 minutes' headway. The entire Phase I O&M is being carried out by more than 1,600 in-house staff, managed by the Director, O&M of BMRCL.

(ii) Based on the experience of Phase I O&M, BMRCL has prepared an O&M plan for the proposed Project, which details train operation, in-house and outsourced maintenance, staffing and training requirements. BMRCL will deploy more than 620 staff, who will be hired through an independent agency and government provisions.

(iii) The new staff will go through an intensive training program in BMRCL's own training institute. Only trainees who complete the training program successfully will be deployed for their assignments.

64. **Resilience to climate change.** Bangalore is at an average elevation of 900 m above sea level and has a tropical savanna climate with distinct wet and dry seasons. The average high temperature is 35 degrees Celsius and average low 15 degrees Celsius. Bangalore has moderate rainfall, with an average 990 mm per year. As indicated in the Karnataka Climate Change Action Plan,[13] by 2050, the maximum temperature could increase by 2.1 degrees Celsius and annual rainfall by 3.7%.

65. The Project has taken into consideration the climate change effects of higher temperature and increased rainfall in future. The design criteria of the Project require the structures to be designed for at least 20 degrees Celsius higher than the highest recorded to date. System components will be designed for a temperature up to 70 to 80 degrees Celsius. The drainage systems will be designed for a 50-year storm event, with the highest daily rainfall record (178 mm). Moreover, it is expected that the Project will help mitigate the climate change effects caused by automobile usage and road repair and maintenance.

66. **Sustainability.** The Bank team considers three drivers of sustainability of the Project.

(i) **Sustained ridership.** The proposed Project will enhance connectivity within the city of Bangalore and consequently increase ridership. The planned future expansions of the Bangalore metro system, in addition to Phase I and Phase II and the integration of transport will further enhance ridership. Details of the Bangalore metro expansion plan are presented in Annex 6.

(ii) **Sustained support of the GoK.** The trilateral Memorandum of Understanding (MoU) between the GoK, GoI and BMRCL for Phase I and Phase II will ensure that BMRCL is a financially sustainable institution and fulfills its mandate of offering services to enhance public transportation in Bangalore. The financial sustainability and MoU arrangements are detailed in Annex 3.

[13] Karnataka Climate Change Action Plan, Bangalore Climate Change Initiative – Karnataka (BCCI-K), May 2011.

(iii) **Sustainable O&M.** BMRCL has operated and maintained the second longest metro rail network in India. BMRCL is further enhancing O&M capacity through adequate O&M planning and in-house staff training.

67. **Lessons learned from Bangalore metro Phase I:** The total cost to complete Phase I was US$2.14 billion, compared to the initial cost estimate of US$1.4 billion. The major component of the cost overrun was the escalation in land acquisition costs. The cost of steel and cement also appreciated during Phase I implementation. The land price escalation was entirely covered by the GoK, while the other elements were covered equally by the GoI and GoK. The cost overrun, together with unexpected hard rock ground conditions, prolonged the Phase I implementation.

68. The Bank team observed that BMRCL has incorporated numerous lessons from Phase I implementation in the proposed Project. Salient lessons incorporated into Phase II planning include the following:

(i) The land acquisition costs for the Project comprise about 22% of the total cost estimates, conservatively, whereas those costs in Phase I accounted for about 16% of total completion costs. In addition, unexpected land price escalation will be entirely financed by the GoK, as per the MoU.

(ii) Geotechnical investigations and surveys have been carried out every 25 m to minimize unforeseen risks associated with the ground condition for tunneling. In addition, 12 TBMs will be deployed to expedite the underground works.

(iii) BMRCL will monitor and supervise Project implementation on the ground daily, whereas project management was outsourced for Phase I.

B. Economic and Financial Analysis

69. **Project cost.** The capital cost has been estimated on the basis of various contracts recently awarded by BMRCL for ongoing works. As per BMRCL's latest estimates, the capital cost, excluding inflation, is approximately US$1,785 million at 2017 prices, which is inclusive of tax refunds, contingencies and interest during construction (IDC). Capital cost excluding IDC is considered for the financial analysis whereas completion cost is considered for the economic analysis. Tax refunds are added back to the capital cost and land acquisition and rehabilitation and resettlement cost is deducted from the capital cost to estimate the completion cost. Completion cost of the Project at 2017 prices is approximately US$1,577 million. A standard conversion factor (SCF) of 0.90, generally used for infrastructure projects in India, is applied to correct for refunds, subsidies, adjustments and distortions. After applying the SCF, the economic cost of the Project investment is estimated US$1,419 million.

70. **Traffic demand forecast and fare structure.** Ridership for the Project is estimated as described in paragraphs 46-48. Once Phase I became fully operational in June 2017, metro fares were increased by 10% and rounded off to the higher INR 5 increment. The Average Trip Length (ATL) for the Project is estimated at 10 kilometers. The increased fare corresponding to the ATL is INR 30. As per the proposed increase of 10% once every two years and rounding upward by INR 5 increments, the fare will be INR 35 in year 2019 and INR 40 in 2021. Hence, the average fare for the Project in 2021 is considered as INR 40. The fare escalation of 10% every two years is based on: (i) the estimated inflation of 6% per year in Bangalore; and (ii) the fare escalation trend for the public bus transportation system in Bangalore. Non-fare revenue has been calculated

as 15% of the fare revenue in 2021-22. Thereafter, an escalation of 6% has been assumed on non-fare revenue. The non-fare box revenue resources include automatic teller machine fee, income from property development, income from technical training, income from utilities, royalty and tender document fees, etc.

71. **Economic analysis.** Economic evaluation of the Project was carried out to assess its economic viability. In the evaluation, O&M cost is derived from the financial estimates after deducting inflation cost and applying the SCF of 0.90. The proposed Project is expected to yield both tangible and non-tangible savings. It will result in reductions in number of buses, use of private vehicles, and air pollution, and will increase the speed of road-based vehicles. Savings in vehicle operating cost (VOC), value of time (VOT), emission cost, road maintenance cost and accident cost have been quantified under the with-Project and without-Project scenarios.

72. In the base case scenario with a discount rate of 9%,[14] the Project investment yields an economic net present value (ENPV) of US$108.8 million, and an economic internal rate of return (EIRR) of 9.65%. The investment is thus economically justified. Savings in VOT account for 74% of the benefits. Most of the remaining benefits come from savings in VOC. At the 9% discount rate, the Project has a payback period of 12 years, inclusive of the 4-year construction period. The sensitivity analysis was carried out by varying the economic cost of the Project investment and benefits, and the discount rate. The analysis suggests that, if a more conservative discount rate were chosen, the economic viability of the investment would be robust to withstand variations in the economic cost and reduction in traffic. Further details of the economic analysis are presented in Annex 3.

73. **Financial analysis.** O&M cost includes staff wages, energy, and repair and maintenance costs. These various O&M costs have been estimated as per the actual costs incurred in Phase I. Inflation for permanent staff is assumed to be 6% per year and for outsourced staff 7% per year. Energy cost estimated for Phase I in 2018-19 is based on route length, with yearly inflation of 5%. Similarly, maintenance cost for Phase I in 2018-19 is based on route length.

74. Based on the above-mentioned assumptions, calculations for the financial internal rate of return (FIRR) were carried out. The evaluation results show that the FIRR is 6.29% for the proposed Project, with projections of cash flow for 34 years (including the initial 4 years of amortization). Details of the financial analysis are presented in Annex 3.

75. **Counterpart funds.** A trilateral MoU was signed by the GoK, GoI and BMRCL on February 24, 2017 to ensure availability of counterpart funding for the Phase II project. As per this MoU, the GoI will contribute 20% of the estimated completion cost of Phase II and 34% will be contributed by the GoK through a well-defined scope of financing for each participating institution. A similar format was adopted for Phase I financing in 2010 and it was successfully executed. BMRCL mentioned to the Bank team that it had not faced any concerns regarding the required funding from either government for Phase I. The well-defined MoU contributed to better coordination between the governments and their agencies for mobilizing required resources for Phase I execution. The financial assessment of BMRCL and GoK, and the MoU arrangements are detailed in Annex 3.

[14] A discount rate between 6% and 9% has been observed recently for large public transportation projects with long-term benefits. Moreover, it is not possible to quantify all positive externalities from the Project, particularly as it is a section of a larger transport network with long-term benefits and possible spillover effects. For these reasons, a discount rate of 9% was considered for the analysis.

C. Fiduciary and Governance

76. **Anti-corruption.** The Bank and the EIB both have a "zero tolerance" approach to Prohibited Practices involving activities funded by them. The Bank and the EIB also have similar definitions of the Prohibited Practices of fraud, corruption, collusion, coercion, and obstruction. The Bank also includes theft and misuse of resources in its Prohibited Practices list, whereas the EIB lists money laundering and financing of terrorism as part of its Prohibited Conduct list. The Bank and the EIB have separate individual institutional obligations and applicable policies and procedures when responding to allegations concerning their respective activities. Within the Bank, the Managing Director of the Compliance, Effectiveness and Integrity Unit, and within the EIB, the Fraud Investigations Division, Inspectorate General, are responsible for receiving and responding to allegations of Prohibited Practices or Conduct.

77. The Bank and the EIB will require BMRCL to immediately refer any allegations of Prohibited Practices or Conduct to both the Bank and the EIB. The Bank and the EIB may also receive information about Prohibited Practices or Conduct directly from other sources, or through their own enquiries. In accordance with their respective policies and procedures regarding access to information in relation to investigations, the Bank and the EIB agree that they will immediately share information concerning such allegations. The Bank and the EIB also agree on the proposed conduct of an investigation into the allegations, with the EIB taking the lead. For investigations into allegations that are not covered by either the Bank or the EIB, each institution may choose to undertake its own investigations jointly or in parallel with the other.

78. **Governance and accountability of BMRCL.** BMRCL has a set of rules and regulations and follows GoI and GoK statutes and regulations for procurement and contracting, administration, etc. BMRCL is required to follow the provisions of Karnataka Transparency in Public Procurement Act, 1999 and its rules, as amended from time to time, and Central Vigilance Commission guidelines for all tenders and contracts; it is also required to follow the guidelines of the Department of Public Enterprises, in respect of its investments, to strengthen its Corporate Governance. The Central Vigilance Commission is conceived to be the apex vigilance institution, free of control from any executive authority, to monitor all vigilance activity under the central government and advise various authorities in central government organizations in planning, executing, reviewing and reforming their vigilance work.

79. BMRCL is subject to audit by the Comptroller and Auditor General (C&AG). BMRCL's activities are subject to scrutiny by parliament (GoI) and state legislature (GoK). Serious irregularities, if any, are disclosed by C&AG in the form of an audit report and the same are placed in the parliament and state legislature.

80. **Procurement.** The EIB will be responsible for the fiduciary oversight of the procurement process and the Bank will engage directly with the EIB on any procurement-related matters associated with the Project's procurement process. The procurement plan for the proposed Project (see Annex 7) comprises four components, all of which are subject to international open tendering. The tenders for both the largest value contracts, the elevated and underground sections of the Project, are being conducted on an advanced contracting basis. The contracts will be awarded on a design-build basis and BMRCL will be the supervision engineer for the implementation of both contracts. BMRCL's tender procedures are being conducted in accordance with the requirements of the GoI e-tendering portal. Use of this portal for international competitive tendering has been reviewed and approved by the EIB, WB and ADB. BMRCL's tender procedures and tender documents have been subject to the EIB's prior review process and determined to be consistent with the requirements of its GfP. In the case of the elevated section, the tender evaluation process is at

an advanced stage and a no objection to BMRCL's technical evaluation has been provided by the EIB.

81. The Bank has conducted its own preliminary due diligence on the tender documents and is satisfied that they are fit for purpose and that the resulting contracts will deliver a value for money outcome for the Project. The Bank also conducted its own due diligence on BMRCL's capacity and capability to manage the procurement and contract administration process. Based on BMRCL's previous experience of successfully implementing the Phase I project and BMRCL's management structure and staff available to implement the project, the Bank is satisfied that BMRCL has satisfactory in-house resources and experience to implement the proposed Project. A lender's engineer will be appointed to assist the co-financiers in their fiduciary oversight of contract implementation progress. The Bank procurement specialists will participate with the EIB in joint implementation supervision missions.

82. **Financial and fund flows management**. The Project will use the existing financial management arrangements of BMRCL. BMRCL has implemented other projects financed by international financial institutions such as JICA and AFD. The Bank team's assessment of BMRCL's institutional arrangements in place for financial management, funds-flow arrangements and accounting/financial reporting arrangements, indicates that its financial management arrangements are satisfactory to meet the essential fiduciary requirements.

83. **Institutional arrangement for financial management.** Institutional arrangements are as follows: the DEA, MoF, GoI, represents BMRCL and assumes overall responsibility for the management and supervision of the loan utilization; BMRCL is the ultimate borrower of the Bank's loan and will implement the Project and take primary responsibility for the financial management of Project implementation, making financial plans and budgeting, preparing loan withdrawal applications, and preparing and submitting the Project unaudited financial reports. BMRCL has a Director (Finance) office, which is currently held by the managing director of BMRCL. The office is subdivided into project finance, finance and accounts and taxes and resources, each of which is headed by a general manager. They are supported by respective BMRCL staff members. The finance office is well staffed with clear responsibilities for each position. The Project's unaudited financial reports will be submitted to the Bank, together with a semi-yearly progress report, and will have as minimum content: (i) a statement showing for the period and cumulatively actual and planned cash receipts and payments by income (the EIB, the Bank, GoK, and GoI) and by expenditure classification (categories and components/subcomponents) and (ii) beginning and ending cash balances of the Project.

84. BMRCL has an audit committee. The charter of the audit committee is in line with the Companies Act 2013 of India. The Additional Chief Secretary to the GoK, urban development department, is the chairman of the BMRCL audit committee. The other members of the committee are Additional Chief Secretary to the GoK, finance department; Principal Secretary to the Chief Minister; and Executive Director-Works (Planning) railway board, Ministry of Railways, GoI. The audit committee meets once each quarter and discusses the internal audit report, along with comments, if any, by the statutory auditors (see below). Audit committee minutes are presented to BMRCL's Board of Directors.

85. The internal audit is outsourced to a firm of chartered accountants, which will independently verify (pre-audit) all contractors' bills before payment. The chartered accountant firm will also conduct post-audit on a quarterly basis and submit its reports to the audit committee. In addition to the internal audit, two types of external audits are to be conducted: (i) financial audit by

independent financial auditors (chartered accountant firm) appointed by the C&AG under the provisions of the Company's Act; and (ii) supplementary audit by the C&AG. Since BMRCL is a public institution under the GoI and GoK, the transactions and performance of the company are regularly audited by the C&AG under the C&AG (Duties, Powers and Conditions of Service) Act 1971, read with the provisions of the Company's Act 2013.

86. The GoK will provide Shadow Cash Support (SCS) to BMRCL to meet (by funding the SCS account) any shortfall or bridge a cash gap during the operational phase. Cash support would comprise any incremental cash shortfall faced by the company along with repayment of any senior debt if the same cannot be provided by BMRCL. There are two sub-divisions for the implementation of SCS;

(i) **Reimbursement of cash loss.** This is generally done to cover the operating loss of the company. BMRCL submits its annual audited accounts on a yearly basis and requests reimbursement of the annual operating cash loss.

(ii) **Step-in Cash support.** BMRCL prepares the required support request three months in advance with the updated financial status and submits it on a quarterly basis to the GoK.

D. Environmental and Social

87. **Environmental and social policies.** The Bank has decided to use the EIB's Statement of Environmental Principles and Standards 2009 (Statement), since (i) it is consistent with the Bank's Articles of Agreement and materially consistent with the provisions of the Bank's Environmental and Social Policy (ESP) and relevant Environmental and Social Standards; and (ii) the monitoring procedures that the EIB has in place to ascertain compliance with its Statement are appropriate for the Project. According to the legislative provisions, rules and regulations in India, the metro rail project does not require that an EIA be conducted or environmental clearance sought from the Government. However, after reviewing the environmental and social aspects of the Project, the Bank has assigned it to Category A, consistent with the ESP. This categorization is due to both the environmental risks and impacts and the magnitude of land acquisition and resettlement and rehabilitation issues involved. The Project categorization recognizes the need for in-depth environmental and social impact assessment and preparation of a series of detailed planning instruments to support involuntary resettlement and land acquisition. The EIA, including an assessment of the potential resettlement and rehabilitation activities, has already been conducted.

88. **Environmental and social review.** The Bank has reviewed the environmental and social due diligence undertaken by the EIB and key documentation, such as the EIA, resettlement planning instruments and the ESMP prepared by BMRCL, for the Project, conducted site visits and held intensive discussions with the developer. The Bank team also made recommendations for modifications in the environmental and social documentation to support more effective implementation, supervision and monitoring.

89. **Key environmental issues.** During the earlier planning stages of the Project, the feasibility of several metro corridors 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, as well as minimum disturbance/ avoidance of heritage structures. The selected alignment follows the central median of a major road artery in the south of the city, with the underground

portion of the alignment in the most densely populated central and northern areas. Station locations have been selected to maximize ridership and ease intermodal connections.

90. The main negative environmental impacts of the Project include: (i) permanent conversion of about 33 ha of open land to a depot; (ii) removal of about 810 trees (690 for the alignment and 120 for the depot); (iii) noise, vibration and visual intrusion for properties adjacent to the alignment; and (iv) generation of about 1.1 million cubic meters of waste material excavated from the tunneling work. All other negative impacts are temporary and localized. The Project does not affect any nature conservation areas, urban parks or known sites of historical/archeological importance.

91. The main mitigation measures proposed are as follows: (i) compensatory afforestation in line with local rules; (ii) various energy saving measures such as regenerative braking and use of solar panels; (iii) noise reduction measures (i.e., rubber dampers on the rails and use of a U girder for the elevated part of the alignment, which acts in part as a noise barrier); and (iv) reuse of excavated material where feasible; and (v) disposal of construction waste in a regulated manner. As noted above, an ESMP has been prepared by BMRCL. Potential physical settlement of buildings situated above the tunnel alignment will be monitored and adequate insurance cover put in place to compensate for or address potential damage, if any.

92. The key positive environmental impacts of the Project include reduced use of private vehicles and an associated reduction in pollutants, noise and vibration due to traffic; road safety improvements; and a modest reduction in GHG.

93. **Key social issues.** The main adverse social impacts are related to involuntary resettlement. The Project entails the acquisition of about 22.4 ha of land held by private owners and about 3.2 ha of land held by various public entities. A complete assessment of land acquisition and Project Affected People will be known once the census survey of affected households for all sections is completed. All attempts will be made during the final execution of the Project to minimize land acquisition, resettlement and adverse impacts on people in the Project area through careful localized engineering design.

94. In addition to private commercial and residential buildings, there are approximately 27 common property assets, such as religious structures and local utilities, which may be affected due to the proposed alignment. The unavoidable loss of such assets will be compensated through replacement elsewhere or a suitable financial mechanism.

95. The ESMP will also address issues of labor health and safety and ensure that (i) relevant labor standards and employee working conditions during construction and operation are maintained; and (ii) occupational and community health and safety parameters during the construction phase are adhered to. These will be addressed primarily through the inclusion of contractual obligations for the first-tier suppliers and contractors, which will be enforced by BMRCL's supervision team.

96. A Resettlement Policy Framework (RPF) has been prepared to address the involuntary resettlement under the Project. The RPF has been subject to consultation with Project Affected People and disclosed, in English and local language, on the websites of BMRCL[15] and the EIB.[16] The RPF will need further review and updating to ensure that all resettlement allowances are

[15] http://english.bmrc.co.in/FileUploads/e12b9f_CareerFiles.pdf
[16] http://www.eib.org/infocentre/register/all/76857397.pdf

aligned with national standards. BMRCL, with support of the GoK, has agreed to conduct a review of the RPF on a priority basis, update it and arrange for all necessary funds based on the revised rates of resettlement allowances. The RAP will be prepared concurrently with detailed designs and then implemented in a manner consistent with the handover of sites to works contractors. To avoid any disproportionate negative environmental and/or livelihood impacts on vulnerable groups, identified vulnerable households will receive additional financial and in-kind assistance.

97. In order to implement and monitor RAPs effectively, a Social and Environmental Management Unit (SEMU) of four officers has been constituted in BMRCL. The roles and responsibilities of the SEMU are outlined in the RPF.

98. **Gender.** Commuting in urban areas, particularly for women, is a concern in many Indian cities. The concerns are related to safety, comfort in travel, long travel time, accessibility and availability of transport in a timely manner. Metros have emerged as a solution to these woes, not only for women but also for the disabled and senior citizens. Improved connectivity will support women in the workforce who share responsibilities at work and home. Also, it has been noted that India's workforce participation rate (WPR) for women has actually declined from 29% (2004-05) to 24% (2015-16). While this might not be as true for economically vibrant metropolitan areas like Bangalore, availability of convenient transportation will support improved WPR for women.

99. **Public consultations and citizen engagement.** The Project has adopted a citizen engagement plan that includes (i) SIA consultations with all the relevant stakeholders; (ii) moving beyond consultations into consent in the slum areas; (iii) external bodies overseeing the conducting of SIA, ESMP and RAPs; (iv) sharing of all plans and engaging in extensive discussions and deliberations with all the stakeholders, especially Project-affected persons; (v) multiple layers of grievance redressal arrangements; and (vi) full adoption of India's Right to Information Act. The monitoring and evaluation arrangement provides for indicators reflecting on citizen engagement. BMRCL undertook several rounds of administrative consultation as well as several rounds of public consultation during preparation of the various design reports, SIA, EIA and RAP reports in 2011 and 2017. The draft RPF was also consulted upon in 2017. The issues raised by the public, which focused on resettlement and construction management aspects, are being addressed by BMRCL.

100. As with the RPF, the EIA report has been made public on the websites of BMRCL[17] and the EIB[18] as well as at suitable local offices, and a period of time allowed for interested parties to comment.

101. **Grievance redress.** Communities and individuals who believe that they are adversely affected may submit complaints to existing project-level grievance redress mechanisms. A Project-level grievance redress mechanism is included in the Project design to assist affected people to resolve their queries and complaints. A Grievance Redressal Committee has been established for the Project. Grievances will be brought first to the attention of field-level staff of BMRCL. Grievances not redressed at that level will be brought to the Grievance Redressal Committee for resolution.

102. **Supervision and monitoring.** The Bank and the EIB will undertake joint environmental and social supervision of the Project. Specialists from both Banks will be complemented by part-

[17] http://english.bmrc.co.in/FileUploads/862da0_CareerFiles.pdf
[18] http://www.eib.org/infocentre/register/all/76122315.pdf

time local environmental and social consultants to support monitoring. In addition, third party monitoring using an independent consultant will be adopted by and reported to the EIB.

E. Risks and Mitigation Measures

103. Based on the Bank's technical and financial assessments, due diligence results and observations during site visits, the Bank assigns a *High* overall risk rating to the proposed Project mainly due to its placement in environmental and social Category A and potential implementation delay. The EIB has undertaken due diligence on the Project and assigned *Medium* risk ratings to the principal risks it identified.

104. The potential risks identified and the mitigation measures proposed by the Bank team are summarized in Table 9. The Bank will monitor the implementation of the mitigation measures during Project implementation through the progress reports from BMRCL and the Bank's consultants, and the joint supervision mission with the EIB.

Table 9: Summary of Risks and Mitigating Measures

Risks	Assessment	Mitigating Measures
Environmental and Social: High social impact and resettlement and rehabilitation activities. About 838 households (126 residential and 712 commercial households) are expected to be affected. Need to revise resettlement allowances in the RPF with reference to national standards in a timely manner. Area specific environmental impacts.	High	RPF to be complemented by a series of RAPs. The Bank and the EIB will closely monitor the application of the RPF, preparation of the RAPs and their implementation. BMRCL, with support of the GoK, has agreed to revise the resettlement allowances prior to signing of the Loan and Project Agreements. Environmental and social mitigation and monitoring measures will be included in the ESMP.
Project Implementation: Long stretch of underground tunneling and hard rock ground condition	Low	A total of 12 TBMs will be deployed to expedite the tunneling and mitigate unforeseen risks, such as breakdown of a TBM or encountering hard rocks. In addition, geotechnical investigations and surveys were carried out every 25 km along the corridor. The high number of TBMs for the short length of tunneling and the intensive ground survey will mitigate the risk.
Project Implementation: Timely execution of the Project	High	Phase I project implementation was delayed for both the elevated and underground sections. BMRCL has formulated the Phase II execution plan based on lessons from Phase I. However, the Project implementation period planned

Risks	Assessment	Mitigating Measures
		by BMRCL is too optimistic. Therefore, the Bank considers that the implementation period will be longer. The Bank will monitor implementation progress through BMRCL's progress report, the Bank consultant's report and supervision missions.
Financial risks: Project cost overrun due to higher land acquisition cost than estimated.	Low	Per the MoU, the GoK will provide the required contribution for any cost escalations in the Project (the land price escalation was entirely financed by the GoK for Phase I). The GoK will also extend structural support to BMRCL to ensure financial buoyancy. In addition, the land acquisition and R&R cost has been estimated conservatively compared to it of Phase I.

Annex 1: Results Framework and Monitoring

Project Objective: The objective of the Project is to provide efficient and high-capacity north-south connectivity through the center of Bangalore by expanding the city's metro system.

PROJECT DEVELOPMENT OBJECTIVE INDICATORS

Indicator Name	Core	Unit of Measure	Baseline	Target Values			Monitoring Frequency	Data Source/ Methodology	Responsibility for Data Collection	Description (indicator definition, etc.)
			2017	2022	2023	2024				
No. of passengers carried	**X**	People million	0	0.3	0.315	0.331	Annual	Project completion report and a report after 3 years of operation	BMRCL	Average daily ridership
Average trip length	**X**	Km	0	10	10	10	Annual	Project completion report and a report after 3 years of operation	BMRCL	Total trip length divided by the number of passengers carried
Employment generation during operation		People	0	450 - 620	450 - 620	450-620	Annual	Project completion report and a report after 3 years of operation	BMRCL	As measured by the number of direct employees

INTERMEDIATE RESULTS INDICATORS

Indicator Name	Core	Unit of Measure	Baseline	Target Values				Monitoring Frequency	Data Source/ Methodology	Responsibility for Data Collection	Description (indicator definition, etc.)
			2017	2018	2019	2020	2021				
Construction of metro line		Km	0	0	5	9	8	Semi-yearly	Progress reports	BMRCL	Completed metro line construction

Construction of a depot		No.	0	0	0	0	1	Semi-yearly	Progress reports	BMRCL	Completed depot construction
Installation of TVS and ECS		No.	0	0	0	2	10	Semi-yearly	Progress reports	BMRCL	Completed installation of TVS and ECS

Annex 2: Detailed Project Description

A. Transport Sector in Bangalore

1. **Transport Sector in Bangalore Draft Revised Master Plan 2031.** At present, Bangalore is experiencing substantial economic losses due to traffic congestion. Fuel losses are estimated at 280,000 liters per hour and man hours at 600 million/year. In monetary terms, this translates to a loss of US$575 million per year – US$210 million for fuel and US$365 million for work hours.[1] Bangalore's draft Revised Master Plan 2031 identifies the current challenges associated with the transportation sector, such as the decline in journey speeds from 18km/h (2008) to 11km/h (2015), leading to a severely overburdened road network and longer commute time; the present trip rate of 0.9 per capita per day leading to around 9 million trips per day; the absence of a clearly defined road network hierarchy; the movement of freight/ goods inside the city area; and disorganized parking in most parts of the city. The transport strategy in the draft Revised Master Plan 2031 seeks to address the concerns of all segments of the commuting population by emphasizing the pre-eminence of public transport and non-motorized modes of travel; adopting various elements of travel demand management; and integrating transport with the land use development scenarios. This is in line with the NUTP.

2. Three master plan scenarios and options were prepared, which considered existing developments and the present situation, regional growth directions, and population trends and projections. The three scenarios, namely containment, transit oriented development and differentiation have been prepared based on the estimated population, vehicular trips, public transportation share, street congestion, average network speed, and pollution levels. The master plan is currently in the public consultation phase and is expected to be finalized by the end of 2017, but all three scenarios have incorporated the Project as an integral part of city transport strategy.

3. As per GoI (Allocation of Business) Rules 1961,[2] the following activities, inter alia, have been allocated to the MoUD: (i) planning and coordination of urban transport systems, with technical planning of rail-based systems being subject to the items of work allocated to the Ministry of Railways (i.e., metro systems); and (ii) fixing of maximum and minimum rates and fares for rail-based urban transport systems other than those funded by the Indian Railways. Accordingly, MoUD is the nodal ministry for metro projects in India and is a key stakeholder in the Project. The MoUD developed and promulgated the NUTP in 2006.

4. The NUTP also had a provision for establishment of a Unified Metropolitan Transport Authority (UMTA) in cities with a population of more than 1 million, to holistically oversee formulation of proposals by multiple agencies involved in provision and management of urban transport. It is currently in the inception stage as a committee under the GoK, comprising concerned government departments. The GoK is exploring the possibility of forming legislation to establish an independent UMTA. This will help develop unified urban transport in Bangalore.

B. Project Components

5. The Project is to construct a north–south metro corridor from Gottigere to Nagavara, including a maintenance depot at Kothanur. For the first 7.5 km, from Gottigere to Swagath Road Cross, the alignment is elevated. There are six elevated stations in this stretch – Gottigere. Hu-

[1] Information for Preparation of Revised Master Plan for Bengaluru 2031, Bangalore Development Authority
[2] http://MoUD.gov.in/cms/mandate.php

limavu, IIMB, J P Nagar, Jayadeva Hospital Interchange and Swagath Road Cross. After the elevated section, 14.5 km of alignment is underground. In the underground section, there are 12 stations that will be constructed using the cut and cover method. These stations are named Dairy Circle, Mico Industries, Langford Town, Vellara Junction, MG Road, Shivaji Nagar, Cantonment Station, Pottery Town, Tannery Road, Venkateshpura, Arabic College and Nagavara. All the stations will be designed to accommodate 6-car trains.

6. Salient features of the Project are as follows:

(i)	Gauge:	1435 mm Standard Gauge
(ii)	Route Length:	22 km (7.5 km elevated and 14.5 km underground)
(iii)	Number of Stations:	18 (6 elevated, 12 underground)
(iv)	Design Speed:	90 km/h
(v)	Operating Speed:	80 km/h
(vi)	Average Speed:	34 km/h
(vii)	Traction:	750 Volt DC
(viii)	Current collection	Third Rail Bottom Current Collection System
(ix)	Rolling Stock:	2.8 m wide air-conditioned
(x)	Rake composition:	6 Cars. Carrying capacity of 6-car train – 1,574 passengers
(xi)	Headway	6 minutes at initial service
(xii)	Signaling:	CATC (Continuous Automatic Train Control)
(xiii)	Rail Section	Head Hardened UIC 60.

7. **Elevated section.** The 7.5 km of elevated section will comprise box girders, most of which will be 25 to 28 m long (with some 22 or 31 m in length due to site constraints or to avoid utilities), constructed using a segmented technique. In Phase I, a similar segmented construction method was adopted because it both required less space and was quicker to build. Most of the foundations will be bored cast in situ piles of 1.2 m diameter socketed in rock. At some locations where the rock is at shallow depth, the foundation will be open. BMRCL designed the foundations based on geotechnical investigations conducted every 25 m. The substructure will be double D shaped pier. The entire elevated portion is to be constructed with the detailed design provided by BMRCL as a "to build contract" and will be paid as per actual quantity based on unit rates quoted. BMRCL will offer land for a casting yard. However, a contractor may consider its own arrangements. After the review of design, site conditions and capability of two technically qualified bidders, no major construction risk is envisaged. The typical cross and longitudinal sections are shown in Figures A2.1 and A2.2, respectively.

Figure A2.1: Typical Cross Sectional View of Box Girder

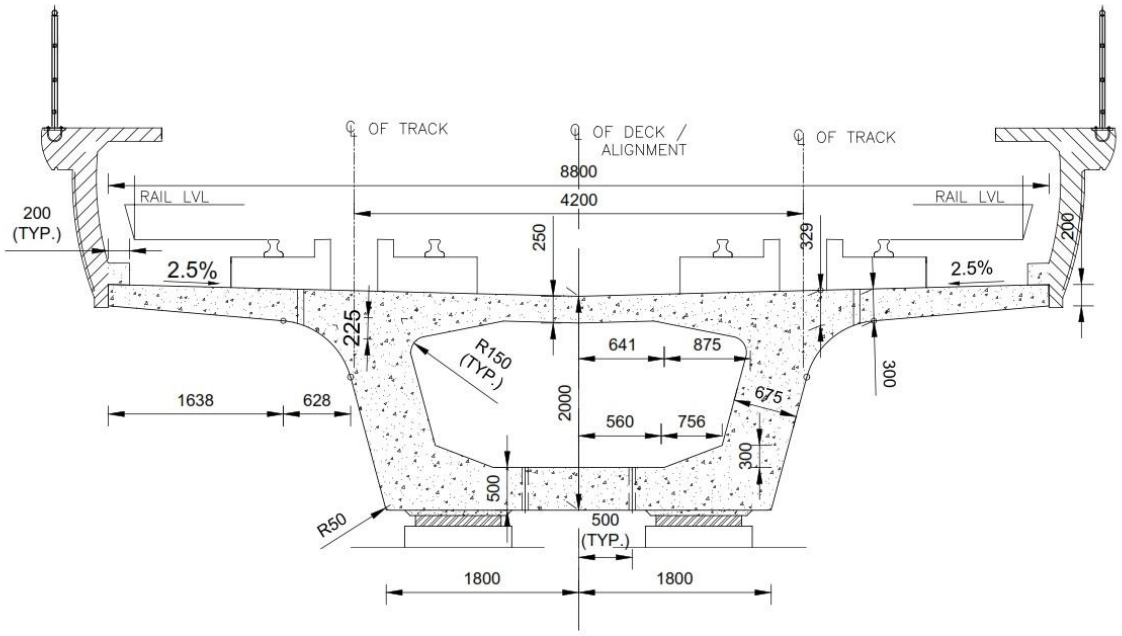
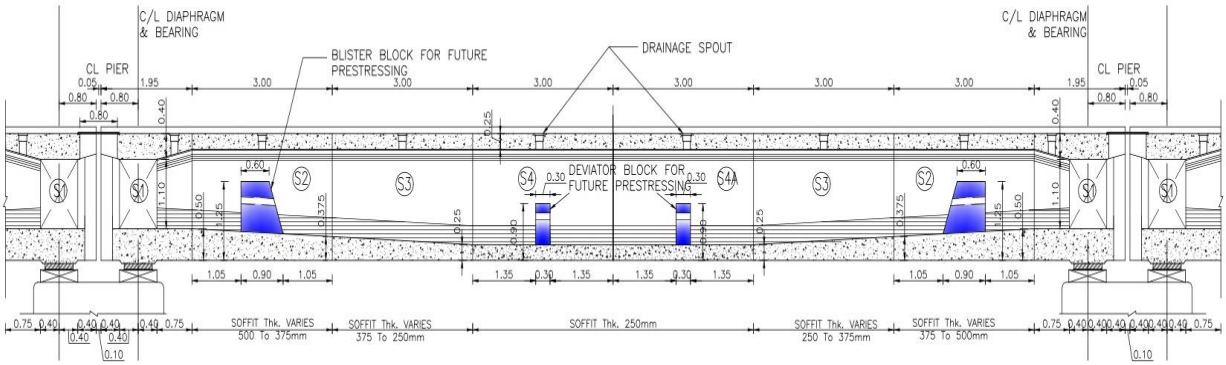


Figure A2.2: Typical Longitudinal Section of 22M Span



8. **Underground section.** The 14.5 km of underground section will be built as a twin bored tunnel and the 12 underground stations will be constructed using the cut and cover method. This has been packaged in four contracts. Since the strata encountered will be a mix of soil, gravel, boulder and rock, mix shield TBMs have been proposed for three packages and earth pressure balance TBM for the fourth package. A total of 12 TBMs will be deployed for the Project. The typical cross section with cross passage is shown in Figure A2.3.

(i) Package 1: This package consists of 3.8 km of tunneling and three underground stations at Dairy Circle, Mico Industries and Langford Town. Strata encountered is soil and granite. Four mix shield TBMs will be deployed.

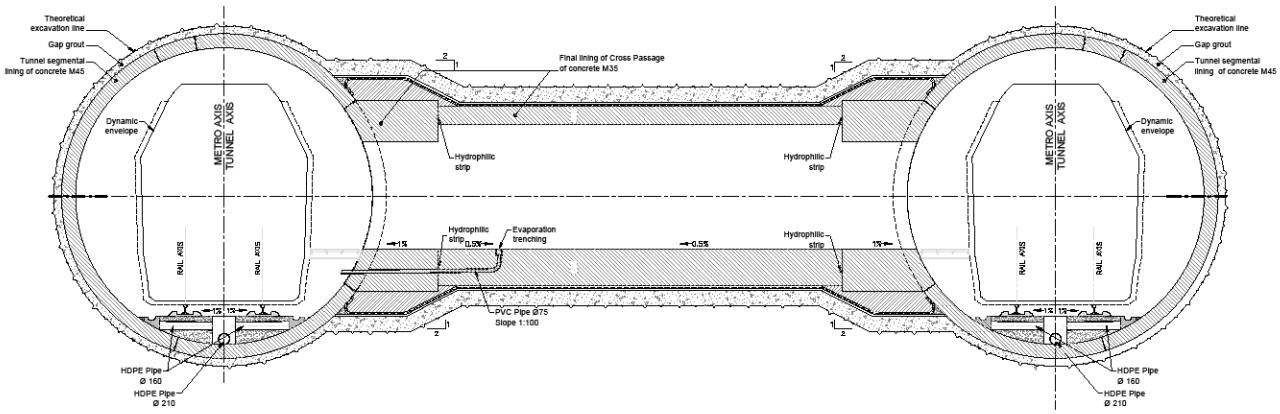
(ii) Package 2: This package consists of 3.8 km of tunneling and three underground stations at Vellara Junction, MG Road and Shivaji Nagar. Strata encountered is soil, weathered rock and granite. Three mix shield TBMs will be deployed.

(iii) Package3: This package consists of 3.4 km of tunneling and three underground stations at Cantonment, Pottery Town and Tannery Road. Strata encountered is

mixed condition of soil and different grades of weathered rock. Three mix shield TBMs will be deployed.

(iv) Package 4: This package consists of 3.5 km of tunneling and three underground stations at Venkateshpura, Arabic College and Nagawara. Strata encountered is sandy clay and silty sand with some weathered rock. Two earth pressure balance TBMs will be deployed.

Figure A2.3: Typical Cross Sectional View of Underground Section with Cross Passage



9. **Stations.** The station locations take into account maximum traffic demand nodal points and congestion issues. An AFC system will be implemented, with passenger operated machines and smart cards. All elevated station platforms are 135 m long to accommodate 6-car trains. The stations will comprise concourse and platform levels and entry/exit will be from pedestrian passages next to service roads on both sides of the stations. The stations will be disabled-friendly with wheelchair ramps and elevators. To meet passenger flow demand, six escalators and four staircases will be installed at each station. At Jayadeva Hospital interchange station, Reach 6 passes over the Reach 5 platform. These two platforms will be connected through paid corridors. Provision has been made to construct bus bays and taxi / auto drop off locations in the service roads.

10. The underground stations have been planned and designed in consideration of the availability of land, surrounding constraints, traffic congestion, operational requirement and geological condition. The cut and cover construction method will be utilized to build the station boxes, which will also be the entry and exit points of TBMs during tunneling. The underground stations disabled-friendly, with elevators. Adequate provision has been made for fire evacuation.

11. **Depot.** A maintenance depot will be established on 16 hectares of land at Kothanur. Maintenance activities in the depot include service checks, intermediate overhaul, periodic overhaul, heavy repair, regular and heavy cleaning, etc. The following facilities will be constructed in the depot:

(i) Inspection shed with four tracks
(ii) Stabling lines for testing of coach air conditioning and pre-cooling
(iii) Automatic coach washing plants with capacity of 10 trains per hour
(iv) Heavy cleaning shed for manual cleaning
(v) Work shop for unit replacement of bogies, wheels, E&M equipment
(vi) Building for pit wheel lathe
(vii) Auxiliary power substation
(viii) Workshop for traction and E&M

(ix) Train operators booking office with attached parking area
(x) Depot office complex
(xi) Store
(xii) Ancillary work shop
(xiii) Security posts.

12. **Tunnel Ventilation System.** The TVS plant room will be located at each end of the concourses of the underground stations. The approximate area for the TVS fan room will be 600 square meters. The tunnel vent shafts of approximately 20 square meter area will be constructed at each end of the stations. There will be a supply shaft and an exhaust shaft with similar dimensions. Two tunnel ventilation fans will be installed in each plant room. The fan capacity will vary from 60 to 100 cubic meters/second depending on inter-station distance.

13. **ECS.** The large quantity of heat generated in metro underground stations cannot be extracted by simple ventilation. Platform and concourse areas at all underground stations will be air-conditioned using air handling units located in ECS plant rooms. Each platform will be served by two separate air handling units with a combined distribution system.

14. A Trackway Exhaust System will be installed in the track area of each station to directly capture heat generated by vehicle propulsion, braking and air conditioning systems when the train is at the station. The Trackway Exhaust System will include both an under-platform exhaust duct and an over-track area exhaust duct. All ancillary spaces, including staff room and equipment room, will be mechanically ventilated and air conditioned as per desired air change rate and temperature. The station air conditioner plant rooms will be located at both ends of the concourse. The approximate area of the rooms will be 800 square meters, with supply and exhaust shafts of 10 square meters each.

C. Other Metro Components Not Funded by the Bank

15. **Track.** The metro will adopt a standard gauge of 1435 mm. Track structure will be ballast-less track with continuous welded rail. It will provide easy maintenance, riding comfort and less noise and vibration. Ballasted track will be installed at the depot only. Head hardened UIC 60 rails will be installed per international practice. Flash butt welding technique will be used to weld the rails. 1 in 9 fan-shaped turnouts will be installed at crossing locations.

16. **Traction system.** The system of electric traction selected for the metro corridor is 750 Volt DC third rail bottom current collection. The same system was installed in Phase I.

17. **Signaling.** For a high level of safety and reliable operation, a service-proven CATC system, based on Communication Based Train Control System, including Automatic Train Protection, Automatic Train Operation and Automatic Train Supervision subsystems, will be installed. The train control and signaling system has been designed for headway of 90 seconds.

18. **Telecommunication.** The bulk of the communication network will be a fiber optic system. The network will act as the communication backbone for the signaling and other systems. A minimum of 96-fiber optic cable will be installed in ring configuration with path diversity.

19. **AFC.** Contactless smart token/card equipment will be provided at each station counter and booking office. Passenger-operated ticket vending machines and retractable flap type control gates will be installed at each station. The system will provide high throughput.

20. **Rolling stock.** As per peak hour traffic forecast, 6-car trains will be operated. All the platforms and maintenance facilities will be built to accommodate 6-car trains. The optimum size of coaches will be 2.8 m wide and 3.8 m high. The Driving Motor Car (DMC), Trailer Car (TC) and Motor Car (MC) will be 21.05, 20.8 and 20.8 m long, respectively. A longitudinal seating arrangement has been adopted to maximize passenger carrying capacity. Criteria for the calculation of standing passengers are 3 persons per square meter of standing area during normal hours and 6 persons per square meter of standing area during peak hours. Accordingly, one 6-car train with composition as DMC + TC + MC + MC + TC + DMC can carry up to 1,574 passengers. Sixteen rakes (96 cars) will be operated once the Project is completed.

21. The cars will be designed in consideration of energy efficiency, reliability, availability, maintainability, safety and passengers with reduced mobility. The material of the car body will be stainless steel, which is lower-maintenance and lighter in weight. Each car will be provided with two air conditioning units capable of cooling, heating and dehumidifying.

22. **Utility diversion.** A large number of sub-surface, surface and overhead utility services like sewers, water mains, storm water drains, telephone cables, gas pipelines, overhead electrical transmission lines, electric poles, and traffic signals cross the proposed alignment. BMRCL has reviewed them with the responsible departments or organizations and prepared appropriate plans. It is planned that utility diversion works will be carried out by BMRCL through relevant utility companies. BMRCL will deposit the estimated amount in those utility companies and monitor progress. This will be undertaken so as to match the time schedule of civil contractors. BMRCL will monitor the progress of utility diversion works through a separate monthly review mechanism to ensure timely execution.

23. **Power supply.** Karnataka Power Transmission Company will supply the power to the metro and two receiving substations will be constructed at Kothanur depot and Pottery Town. These will cater to power requirement for traction as well as auxiliary services. Auxiliary substations are proposed at each station and in the depot for local power requirements. In addition, there will be stand-by generators at all stations to provide essential services like lighting, signaling, firefighting needs, and tunnel ventilation in case of complete power failure.

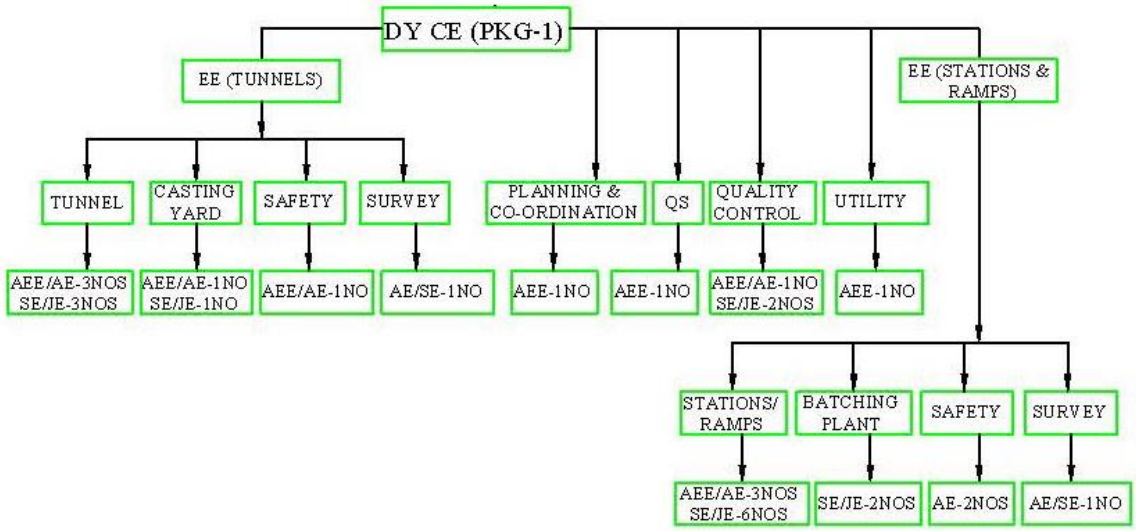
24. The entire system of power supply (receiving, traction and auxiliary supply) will be monitored and controlled from a centralized operation control center through SCADA. Several measures will be adopted to save energy, which is a major operational cost. Most important is procurement of lightweight stainless steel cars with Variable Voltage Variable Frequency (VVVF) drive and regeneration facility. About 30% of total traction energy can be regenerated. In addition, lifts and escalators will have a 3-phase VVVF drive, which is highly energy efficient.

D. BMRCL Organization

25. BMRCL will be the project implementation agency for the Project. BMRCL will also act as "Engineer" for the works and supplies, quality control, timeliness of delivery and certification of payments for the Project. BMRCL has a well-defined management organizational structure with clear roles and responsibilities. The Managing Director heads BMRCL. To support the Managing Director, there are Directors for Finance; Rolling Stock, Electrical and Signaling & Telecommunication; and Project and Planning, each with their respective teams. The Director (Rolling Stock, Electrical and Signaling & Telecommunication) leads all system engineering works, and is supported by 187 professionals. This Director is also in charge for the Operations and Maintenance activities of BMRCL.

26. The Director (Project and Planning) leads the civil engineering work of BMRCL, is supported by 282 professionals and has two Chief Engineers for the Project. The Chief Engineers for the Project are supported by a team of more than 150 professionals, including Deputy Chief Engineers, Executive Engineers, Assistant Executive Engineers and Assistant Engineers. A Deputy Chief Engineer is responsible for a construction package and supported by Executive Engineer (Tunnels) and Executive Engineer (Station and Ramps). The organization chart of the underground construction package 1 is presented in Figure A2.4.

Figure A2.4: BMRCL Organization Chart of Underground Package 1



E. Operation and Maintenance

27. **O&M plan.** BMRCL has prepared an O&M plan for the Project. Salient features of the plan are as follows:

(i)	Train composition	6 cars (DMC + TC + MC + MC + TC + DMC)
(ii)	Carrying capacity	1,574 passengers
(iii)	Scheduled speed	34 km/h
(iv)	Headway	6 minutes during peak hours (8 to 11 & 17 to 20 hours) 10 minutes during non – peak hours
(v)	Hours of operation	Morning 5.00 till night 23.00
(vi)	Total train service	132 train service per direction
(vii)	Coach required	96.

28. Maintenance activities include periodic inspection, cleaning, preventive maintenance, testing, troubleshooting, equipment repair and replacement. The maintenance regime consists of a time-based schedule, periodic replacement of components as recommended by Original Equipment Manufacturer (OEM), and maintenance periodicity. The maintenance will be undertaken by in-house and outsourced staff.

29. Core assets will be maintained in-house, which include rolling stock, traction and power supply, signaling and train control, track, telecom, etc. The maintenance of non-core assets, including E&M, civil structures, and firefighting system will be outsourced.

30. **Manpower Planning.** Based on the experience of Phase I, BMRCL has prepared a plan for executive posts and non-executive posts for the Project. The executive posts consist of one Deputy General Manager, 4 managers, and 8 assistant managers. The summary of non-executive posts is presented in Table A2.1.

Table A2.1: Summary of O&M Non-Executive Posts

Position	Manpower
Signaling, Telecom, AFC & Operation Control Center	90
Electric traction, E&M, elevator and escalator	88
Permanent way	58
C&S work	42
Operating staff	187
Rolling stock maintenance	139
Finance, HR, Stores	18
Total	622

31. **Training.** These positions will be filled through Karnataka Employment Exchange. The new staff will go through an intensive training program at BMRCL's own training institute. The training includes institutional training, safety and first aid, communication skills, customer handling, specialized training by OEMs, etc. Minimum driving experience will be required for train operators. The trainees will be issued competency certificates only after successful completion of training and written evaluation. Only trainees with the certificate will be deployed for their assignments.

Annex 3: Economic and Financial Analysis

A. Introduction

1. The economic and financial analysis of the Project was undertaken to assess its economic and financial viability. For the economic evaluation, the applied methodology includes cost-benefit analysis, the Project financial cost converted into economic costs, analysis of the Project benefits, calculation of the EIRR of the Project; and a sensitivity analysis. A social discount rate between 6% and 9% has been observed recently for large public transportation projects with long-term benefits. Moreover, it is not possible to quantify all positive externalities from the Project, particularly as it is a section of a larger transport network with long-term benefits and possible spillover effects. For these reasons, a discount rate of 9% was considered for the analysis. In the base case scenario with a discount rate of 9%, the Project investment yields ENPV of US$108.8 million, and EIRR of 9.65%. Therefore, the Project is economically viable. In addition, a financial analysis of the Project and a financial assessment of BMRCL and the GoK were undertaken.

B. Economic Analysis

2. **Cost-benefit analysis and key assumptions.** A cost-benefit analysis was carried out to assess the economic viability of the Project on a with- and without-Project basis. Net Present Value (NPV) has been calculated using a social discount rate of 9%. The EIRR for the proposed investments linked with the Project has been calculated. All costs and benefits are estimated in constant 2017 prices with an average exchange rate of INR 64.66/US$.

3. **Project cost.** Economic prices of capital works and annual O&M are derived from the financial cost estimates with adjustments to allow for transfer payments, tax refunds and subsidies, IDC and corrections for any market distortions. A SCF of 0.90 is applied to the domestic portion of the investments to correct for refunds, subsidies, adjustments and distortions. Infrastructure projects in India generally use a SCF equal to 0.90. The economic costs of the Project comprise the following components:

(i) **Capital cost.** As per BMRCL's latest estimates, the capital cost, excluding inflation, is approximately US$1,785 million at 2017 prices, which is inclusive of tax refunds, contingencies and IDC. Capital cost excluding IDC is considered for the financial analysis whereas completion cost is considered for the economic analysis. Tax refunds are added back to the capital cost and land acquisition and rehabilitation and resettlement cost is deducted from the capital cost to estimate the completion cost. Completion cost of the Project at 2017 prices is approximately US$1,577 million. An SCF of 0.90, generally used for infrastructure projects in India, is applied to correct for refunds, subsidies, adjustments and distortions. After applying the SCF, the economic cost of the Project investment is estimated US$1,419 million.

Table A3.1: Economic Cost of the Project (US$ million)

Project Name	Total Project Cost (1)	State Taxes and Refunds (2)	Land Acquisition Cost (3)	Completion Cost (4) [(4) = (1) + (2) – (3)]	Economic Cost with SCF of 0.9
Bangalore Metro Reach 6	1,785	137	345	1,577	1,419

(ii) **O&M cost.** Economic O&M cost of the Project includes energy cost and repair and maintenance cost. Manpower cost is not included in the analysis because the Project will create additional employment whose monetary social benefits are assumed to cancel out the associated costs. Economic O&M cost is derived from the financial estimates after making adjustment for exclusion of inflation and applying a SCF of 0.90 to revise for refunds, subsidies, adjustments and distortions.

4. **Project benefits.** The Project is expected to yield tangible and non-tangible savings. The Project will result in a reduction in the number of buses, use of private vehicles, and air pollution, and an increase in the speed of road-based vehicles. This, in turn, will result in significant social benefits due to reduction in fuel consumption, VOC and travel time of passengers. Reductions in accidents, pollution and road maintenance costs will be some additional benefits from the Project. Savings include:

(i) **Savings in VOC.** Due to the absence of vehicles otherwise used by metro passengers, there will be savings in VOC, which is mainly comprised of costs for vehicle maintenance, fuel and depreciation. In the absence of the metro (i.e., without the Project), passengers would have used two-wheelers, cars and buses as alternate mode of transport. Shares of alternate modes of transport are assumed at 30%, 20% and 50% for two-wheelers, cars and buses, respectively, based on the trip information provided in the DPR. Average occupancy has been taken as 1.5 (for two-wheelers), 2.25 (for cars) and 35 (for buses). To arrive at VOC rates of different vehicle categories, reference has been made to the Manual on Economic Evaluation of Highway Projects in India (Indian Road Congress Special Publication 030). VOC rates, brought to 2017 price levels (from 2009, the year used in the manual) after adjusting for inflation at a rate of 5% per year, are INR 3.38 per km (US$0.052) for a two-wheelers, INR 7.78 per km (US$0.12) for cars, and INR 18.65 (US$0.29) per km for buses, as per industry standards; these were found to be within acceptable limits. In the analysis, the ATL on metro is taken at 10 km and factors are applied to calculate the ATL of respective vehicles on road. ATL of two-wheelers is calculated as 11 km whereas ATLs for cars and buses are calculated as 12 km. Number of operational days in a year is assumed at 340 days.

(ii) **Savings in VOT.** The metro system will be faster than alternate transport modes, i.e., road transport modes. This will lead to considerable saving in passenger travel time on the metro. Savings in VOT can be calculated as the difference of the time spent in the alternate mode and on the metro, multiplied by the value of passenger time. VOT for passengers will vary depending on the choice of alternate mode. Values of VOT on primary routes provided in the Indian Road Congress Special Publication 030 for different categories of vehicles are first multiplied by a factor of 1.45 (calculated as the ratio of Wholesale Price Indices in 2017 and 2009) to arrive at the values of VOT on primary routes in 2017. Based on these calculations, VOTs on primary routes are INR 46.4 per hour (US$0.72) for two-wheelers, INR 90.6 per hour (US$1.40) for cars, and INR 57.3 per hour (US$0.89) for buses. VOT for individuals in Bangalore city is arrived at by applying a half of a factor of 3.12 (calculated as ratio of per capita income of Bangalore city and of India, based on the estimates provided in the Economic Survey of Karnataka 2015-16) on benchmark VOT values on primary routes. Average speed of the metro is considered as 34 km/hour whereas average speed of alternate modes of transport without the Project is taken as 18 km/hour (for two-wheelers), 12 km/hour (for cars) and 10 km/hour (for buses) in the analysis.

(iii) **Savings in emission cost.** Factors such as fewer vehicles due to diversion to an efficient metro system and decongestion of the existing road network, would lead to a reduction in the GHG emissions in the region. Unlike the existing transport system, which runs on a combination of petrol, diesel and compressed natural gas, the proposed Project will be operated entirely through an electric system, thereby further enhancing the GHG emission reduction potential of the Project. In the analysis, carbon emissions from the metro as well as alternate modes of transport of diverted passengers have been calculated. Defra emission factors[1] are considered in the analysis because the Bharat Stage norms[2] are in accordance with the European emission norms. Emission factors for driving vehicles are considered for two-wheelers and cars whereas emission factors for commuting are taken for buses and metro. Emission factors of two-wheelers and cars are approximately 142.4 gCO_2e per km and 233.3 gCO_2e per km, respectively. Emission factors of buses and metro are around 135.5 gCO_2e per km and 76.59 gCO_2e per km, respectively. An uplift factor of 15% is applied to emissions from diverted traffic to account for real-world driving effects. The social price of carbon emission is assumed as US$ 37.03 per tCO_2e based on International Panel on Climate Change estimated value for the year 2017. Saving in emission cost is calculated as the difference of emissions from metro and alternate modes of transport, multiplied by social price of carbon emission in 2017.

(iv) **Savings on road maintenance cost.** As specified above, the Project is expected to contribute to a modal shift. This would lead to savings in infrastructure costs such as road maintenance costs. Annual expenditure on roads is assumed at INR 0.5 per vehicle km (US$0.00776) based on the industry standard in India. In the analysis, the calculation for estimated savings in road maintenance costs is done using the with-Project scenario.

(v) **Savings in accident cost.** The reduction in traffic volumes on the road owing to modal transfer to the metro system is expected to reduce accidents on the Project corridor. Further, reduction in accidents will lead to savings from avoided damage to vehicles and savings of avoided medical and insurance expenses for persons involved in accidents. As per the road accident statistics published by the Ministry of Road Transport and Highways (MORTH), GoI in the year 2015, 27 accidents per ten thousand motor vehicles happen on Indian roads, with a severity of 29.1%. The number of injuries is approximately 27 per ten thousand motor vehicles. Cost of accidents includes components like gross loss of future output due to death/major injury, medical treatment expenses, legal expenses, and administrative expenses for police and insurance companies. As per industry standards, the cost of a fatal accident (person killed) is approximately INR 1.25 million (US$19,383) and average cost of vehicle repair and injuries is approximately INR 0.07 million (US$1,058) per incident.

5. **Non-quantitative benefits.** In addition to the quantifiable Project benefits considered in the economic analysis, the expected non-quantitative benefits of the Project are the following:

(i) Economic stimulation in the micro-region of the infrastructure;

[1] Greenhouse gas report – Conversion factors, Department for Environment Food & Rural Affairs, UK

[2] Bharat stage emission standards are the emission standards instituted by the GoI to normalize the productivity of air pollutants from internal combustion engine equipment. The standards and the timeline for implementation are set by the Central Pollution Control Board under the Ministry of Environment & Forests and Climate Change, Government of India. Bharat Stage norms are based on the European regulations.

(ii) Increased business opportunities;

(iii) Reduced air pollution (in addition to GHG emissions) and noise;

(iv) Reduced traffic congestion on the existing roads;

(v) Social empowerment of women in the region through safe public transport;

(vi) Increased access to educational institutions for children in the Project area;

(vii) Overall increased mobility of the city; and

(viii) Facilitation of better planning and up-grading of the Project area

6. **Outcome of the economic analysis.** In the base case scenario, with a discount rate of 9%, the Project investment yields an ENPV of US$108.8 million, and EIRR of 9.65%. The investment is thus economically justified. Savings in VOT account for 74% of the benefits. A major portion of the remaining benefits comes from savings in VOC. At the 9% discount rate, the Project has a payback period of 12 years, inclusive of the 4-year construction period.

Table A3.2: Economic Evaluation Base Case Scenario

Project Name	**EIRR (%) Base Case**	**ENPV at 9% (US$ million)**
Bangalore Metro Line Reach 6	9.65%	108.8

7. **Sensitivity analysis.** The sensitivity analysis of the EIRR was carried out by varying the Project costs and benefits, and the discount rates (9%, 8% and 6%). The considerations for the sensitivity analysis include:

(i) Increase in economic cost of the Project (completion cost and O&M cost) by 10% or 20%;

(ii) Reduction in estimated traffic by 10% or 20%;

(iii) Exclusion of savings on road maintenance cost;

(iv) Exclusion of savings on accident costs;

(v) Inclusion of manpower cost; and

(vi) Combined scenario of increase in economic cost and decrease in economic benefits.

8. The analysis suggests that, if a more conservative discount rate were chosen, the economic viability of the investment would be robust to withstand variations in the economic cost and reduction in traffic. The economic evaluation and sensitivity analysis are shown in Table A3.3 and the detailed cash flows of the EIRR calculation are shown in Table A3.4.

Table A3.3: Economic Evaluation and Sensitivity Analysis

Parameter	EIRR (%)	ENPV at 9% (US$ million)	ENPV at 8% (US$ million)	ENPV at 6% (US$ million)
Base case scenario	9.65%	108.8	305.3	838.3
Increase in economic cost by 10%	8.78%	-38.8	154.5	679.7
Increase in economic cost by 20%	8.02%	-186.5	3.6	521.1
Reduction in estimated traffic by 10%	8.69%	-49.7	123.9	595.9
Reduction in estimated traffic by 20%	7.67%	-208.3	-57.5	353.4
Inclusion of manpower cost	8.68%	-52	124.1	603.9
Without savings on road maintenance cost	9.47%	78.9	271.1	792.5
Without savings on accident costs	9.54%	90.7	284.6	810.5
Without savings on road maintenance cost and savings on accident costs	9.37%	60.8	250.3	764.7
Increase in economic cost by 10% and reduction in traffic by 10%	7.86%	-197.4	-26.9	437.3
Increase in economic cost by 20% and reduction in traffic by 10%	7.12%	-345.0	-177.8	278.7
Increase in economic cost by 20% and reduction in traffic by 20%	6.15%	-503.6	-359.2	36.2
Increase in economic cost by 20% and reduction in traffic by 20% and without savings on road maintenance cost and savings on accident costs	5.90%	-542.1	-403.2	-22.6
Increase in economic cost by 20% and reduction in traffic by 20% and including manpower cost	4.94%	-696.7	-576.6	-245.0
Increase in economic cost by 20% and reduction in traffic by 20% and including manpower cost and without savings on road maintenance cost and savings on accident costs	4.67%	-735.1	-620.7	-303.8

Table A3.4: The Project EIRR Calculation in US$ million (Base Case Scenario)

Year	Capital Cost	O&M Cost	Total Costs	Savings in VOC	Savings in VOT	Savings in Emis-sion	Savings on Infra-struc-ture mainte-nance	Sav-ings due to acci-dent reduc-tion	Total Savings	Net Cash Flow	Dis-counted Cash Flow
2017-18	491.1	-	491.1	-	-	-	-	-	-	-491.1	-491.1
2018-19	593.3	-	593.3	-	-	-	-	-	-	-593.3	-544.3
2019-20	239.9	-	239.9	-	-	-	-	-	-	-239.9	-201.9
2020-21	95.1	-	95.1	-	-	-	-	-	-	-95.1	-73.4
2021-22	-	20.9	20.9	30.0	106.7	3.1	2.7	1.7	144.1	123.2	87.3
2022-23	-	20.9	20.9	31.5	112.0	3.2	2.9	1.7	151.3	130.4	84.8
2023-24	-	20.9	20.9	33.0	117.6	3.4	3.0	1.8	158.9	138.0	82.3
2024-25	-	20.9	20.9	34.7	123.5	3.6	3.2	1.9	166.9	145.9	79.8
2025-26	-	20.9	20.9	36.4	129.7	3.7	3.3	2.0	175.2	154.3	77.4
2026-27	-	20.9	20.9	37.5	133.6	3.9	3.4	2.1	180.5	159.5	73.5
2027-28	-	20.9	20.9	38.7	137.6	4.0	3.5	2.1	185.9	164.9	69.7
2028-29	-	20.9	20.9	39.8	141.7	4.1	3.6	2.2	191.4	170.5	66.1
2029-30	-	20.9	20.9	41.0	146.0	4.2	3.7	2.3	197.2	176.3	62.7
2030-31	-	20.9	20.9	42.2	150.4	4.3	3.8	2.3	203.1	182.2	59.4
2031-32	-	20.9	20.9	43.5	154.9	4.5	4.0	2.4	209.2	188.3	56.3
2032-33	-	20.9	20.9	44.8	159.5	4.6	4.1	2.5	215.5	194.5	53.4
2033-34	-	20.9	20.9	46.2	164.3	4.7	4.2	2.5	221.9	201.0	50.6
2034-35	-	20.9	20.9	47.5	169.2	4.9	4.3	2.6	228.6	207.7	48.0
2035-36	-	20.9	20.9	49.0	174.3	5.0	4.4	2.7	235.5	214.5	45.5
2036-37	-	20.9	20.9	49.9	177.8	5.1	4.5	2.7	240.2	219.2	42.6
2037-38	-	20.9	20.9	50.9	181.4	5.2	4.6	2.8	245.0	224.0	40.0
2038-39	-	20.9	20.9	52.0	185.0	5.3	4.7	2.9	249.9	228.9	37.5
2039-40	-	20.9	20.9	53.0	188.7	5.4	4.8	2.9	254.9	233.9	35.1
2040-41	-	20.9	20.9	54.1	192.5	5.6	4.9	3.0	260.0	239.0	32.9
2041-42	-	20.9	20.9	55.1	196.3	5.7	5.0	3.0	265.2	244.2	30.9
2042-43	-	20.9	20.9	56.2	200.2	5.8	5.1	3.1	270.5	249.5	28.9
2043-44	-	20.9	20.9	57.4	204.2	5.9	5.2	3.2	275.9	254.9	27.1
2044-45	-	20.9	20.9	58.5	208.3	6.0	5.3	3.2	281.4	260.5	25.4
2045-46	-	20.9	20.9	59.7	212.5	6.1	5.4	3.3	287.0	266.1	23.8
2046-47	-	20.9	20.9	60.9	216.7	6.3	5.5	3.4	292.8	271.8	22.3
2047-48	-	20.9	20.9	62.1	221.1	6.4	5.6	3.4	298.6	277.7	20.9
2048-49	-	20.9	20.9	63.3	225.5	6.5	5.8	3.5	304.6	283.7	19.6
2049-50	-	20.9	20.9	64.6	230.0	6.6	5.9	3.6	310.7	289.7	18.4
2050-51	-	20.9	20.9	65.9	234.6	6.8	6	3.6	316.9	296.0	17.2
Total	**1,419.3**	**627.8**	**2,047.1**	**1,459.6**	**5,195.8**	**150**	**132.5**	**80.4**	**7,018.3**	**4,971.2**	**108.8**
									EIRR (%)		**9.65%**
									ENPV at 9% (US$ million)		**108.8**

C. Financial Analysis

9. **Capital Costs.** The capital costs have been estimated on the basis of various contracts recently awarded by BMRCL for Phase I. The methodology adopted for the capital cost estimation is:

(i) Cost/route km for elevated alignment, permanent way, third rail, signaling & telecom;
(ii) Cost/unit for station structures, electrical at stations, AFC installation, rolling stock, lifts, escalators etc.; and
(iii) Absolute estimated numbers for other costs like land, utility diversions, rehabilitation, etc.

10. The assumed methodology for the capital cost estimation is aligned with the current industry practice. As per the industry sources, within India at present cost rates, the capital cost for elevated metro systems is in the range of INR 2,250–3,000 million/km (US$35–46 million/km) and for underground sections INR 4,500–5,000 million/km (US$70–80 million/km). The estimated capital cost per km for the Project is INR 4,200 million/km (US$65 million/km).

11. **O&M cost.** O&M cost includes staff wages, energy and repair & maintenance costs. O&M cost under various categories has been estimated as per the actual costs incurred in Phase I. Escalations in O&M cost have been considered in line with Phase I operational experience and associated inflationary trends:

(i) **Staff cost.** Staff cost for Phase I is estimated at US$15 million for the entire 42.30 km in 2018-19. The staff cost on a route length basis from Phase I has been used for the Project, along with yearly inflation of 6%.

(ii) **Outsourced staff.** The activities including security, ticket operating machines, housekeeping, etc. will be outsourced. The cost for 2018-19 for Phase I is estimated at US$22 million with escalation of 7% per year. This cost per route km has been applied to the Project, with yearly inflation of 7%.

(iii) **Energy cost.** Energy cost for Phase I is estimated at US$9.3 million for 2018-19. The same rate has been used on a route length basis for the Project, with yearly inflation of 5%.

(iv) **Maintenance cost.** The maintenance cost includes the cost of spares, repairs, consumables, insurance, civil and structural works, etc. and administrative and contingency expenses (overhead). The maintenance cost for Phase-I for 2017-18 has been considered for estimation of projections. The maintenance cost for 2018-19 has been assumed to be US$35.5 million per year at 10% (flat) on capital cost of US$673 million for operational assets, excluding E&M, traction and signaling & telecommunication for Phase I. For the Project, the maintenance cost has been extrapolated based on route length.

12. **Ridership.** Daily ridership numbers are based on the traffic studies in the DPR and then later revised by BMRCL. The ridership numbers used for financial projections are as per Table A3.5. Passenger growth has been estimated at 5% per year during the initial 5 years from 2021 to 2025, followed by 3% per year from the sixth to fifteenth year of operation (2026 to 2036) and then 2% per year till the thirtieth year of operation in 2051.

Table A3.5: Project Ridership for Financial Calculations

Year	Total Daily Ridership
2021-22	300,000
2026-27	376,000
2030-31	423,000
2036-37	500,000
2040-41	541,000
2046-47	609,000
2050-51	660,000

13. **Fare box revenue.** The current fare structure of BMRCL has been adopted for the Project financial analysis. The current fare structure for Phase I, approved by BMRCL, is shown in Table A3.6. The fare will be subsequently fixed through the Fare Fixation Committee, which comprises three members, including one from the State concerned, appointed by the GoI.

Table A3.6: BMRCL Fare Structure in August 2017

Distance in km	Metro Fare (INR)	Distance in km	Metro Fare (INR)
1	10	13	38
2	15	14	40
3	15	15	42
4	18	16	45
5	20	17	45
6	22	18	50
7	25	19	50
8	28	20	52
9	30	21	55
10	30	22	58
11	35	23	60
12	35		

14. The fares were increased once Phase I became fully operational in June 2017. The previous fares were increased by 10% and rounded off to the higher INR 5 increment. The Average Trip Length (ATL) for Reach 6 is estimated at 10 kilometers. The increased fare corresponding to this ATL is INR 30. As per the proposed increase of 10% once every two years and rounding upward by INR 5 increments, the fare will be INR 35 in 2019 and INR 40 in 2021, respectively. Hence, the average fare for the Project in 2021 is considered as INR 40. The fare escalation of 10% every two years is based on: (i) the estimated inflation of 6% per year in Bangalore; and (ii) the fare escalation trend of the public bus transportation system in Bangalore.

15. **Non-fare revenue.** Non - fare revenue generally varies from 20 to 25 percent of the fare revenue for similar projects in India. The non-fare revenue has been calculated as 15% of the fare box revenue in 2021-22. Thereafter, an escalation of 6% per year has been considered to account for the inflation. The non-fare box revenue resources include automatic teller machine fee, income from property development, income from technical training, income from utilities, royalty and tender document fees, etc.

16. **Outcome of the financial analysis.** Based on the assumptions mentioned above, calculations for FIRR were carried out. The evaluation results show that the FIRR is 6.29% for the Project, with the projections of cash flow for 34 years (including initial 4 years of amortization). Given fare box revenue being the main benefit stream from the investment, the fare escalation and ridership will thus have crucial impact on the FIRR. The details of the FIRR calculations are presented in Table A3.7.

Table A3.7: FIRR Calculation in US$ million (Base Case Scenario)

Year	Capital Cost excl. IDC	Man-power Cost	Out-sourced Man-power Cost	Energy Cost	Repair & Mainte-nance Cost	Total O&M Cost	Fare Box Revenue	Non-Fare Box Revenue	Total Revenue	Net Cash Flow
2017-18	607.1	-	-	-	-	-	-	-	-	-607.1
2018-19	733.9	-	-	-	-	-	-	-	-	-733.9
2019-20	296.4	-	-	-	-	-	-	-	-	-296.4
2020-21	117.6	-	-	-	-	-	-	-	-	-117.6
2021-22	-	9.0	13.5	5.4	17.8	45.8	63.3	9.5	72.8	27.1
2022-23	-	9.5	14.5	5.7	17.8	47.5	66.5	10.1	76.6	29.0
2023-24	-	10.1	15.5	6.0	17.8	49.4	78.6	10.7	89.2	39.8
2024-25	-	10.7	16.6	6.3	17.8	51.4	82.5	11.3	93.8	42.4
2025-26	-	11.4	17.7	6.6	17.8	53.5	96.2	12.0	108.2	54.7
2026-27	-	12.0	19.0	6.9	17.8	55.8	99.1	12.7	111.8	56.1
2027-28	-	12.8	20.3	7.3	17.8	58.2	112.3	13.5	125.8	67.6
2028-29	-	13.5	21.7	7.6	17.8	60.7	115.7	14.3	130.0	69.2
2029-30	-	14.4	23.2	8.0	17.8	63.4	140.8	15.1	155.9	92.5
2030-31	-	15.2	24.9	8.4	17.8	66.3	145.0	16.1	161.1	94.7
2031-32	-	16.1	26.6	8.8	17.8	69.4	172.4	17.0	189.4	120.0
2032-33	-	17.1	28.5	9.3	17.8	72.7	177.5	18.0	195.6	122.9
2033-34	-	18.1	30.5	9.8	17.8	76.2	207.2	19.1	226.3	150.2
2034-35	-	19.2	32.6	10.2	17.8	79.9	213.4	20.3	233.7	153.8
2035-36	-	20.4	34.9	10.8	17.8	83.8	245.7	21.5	267.2	183.4
2036-37	-	21.6	37.3	11.3	17.8	88.0	250.6	22.8	273.4	185.4
2037-38	-	22.9	39.9	11.9	17.8	92.5	282.6	24.1	306.7	214.2
2038-39	-	24.2	42.7	12.5	17.8	97.3	288.2	25.6	313.8	216.5
2039-40	-	25.7	45.7	13.1	17.8	102.3	336.0	27.1	363.1	260.8
2040-41	-	27.2	48.9	13.7	17.8	107.7	342.7	28.7	371.4	263.7
2041-42	-	28.9	52.4	14.4	17.8	113.5	393.2	30.5	423.7	310.2
2042-43	-	30.6	56.0	15.1	17.8	119.6	401.1	32.3	433.4	313.8
2043-44	-	32.4	59.9	15.9	17.8	126.1	454.6	34.2	488.8	362.7
2044-45	-	34.4	64.1	16.7	17.8	133.0	463.7	36.3	500.0	366.9
2045-46	-	36.5	68.6	17.5	17.8	140.4	520.2	38.5	558.7	418.3
2046-47	-	38.6	73.4	18.4	17.8	148.3	530.6	40.8	571.4	423.1
2047-48	-	41.0	78.6	19.3	17.8	156.7	606.9	43.2	650.1	493.4
2048-49	-	43.4	84.1	20.3	17.8	165.6	619.0	45.8	664.8	499.2
2049-50	-	46.0	89.9	21.3	17.8	175.1	699.6	48.6	748.2	573.1
2050-51	-	48.8	96.2	22.4	17.8	185.2	713.6	51.5	765.1	579.9
Total	**1,755.0**	**711.9**	**1,277.9**	**360.9**	**534.6**	**2,885.3**	**8,918.8**	**751.1**	**9,669.9**	**5,006.4**
							FIRR (%)			**6.29%**
							Project NPV at 8% (US$ million)			**-72.4**

17. FIRR and Project NPV's sensitivity to drop in revenue amount (reduced passengers / fare), increase in capital and O&M cost is provided in Table A3.8. FIRR is more susceptible to decrease in revenue than to increase in capital or O&M costs.

Table A3.8: Financial Evaluation and Sensitivity Analysis

Scenario	Project FIRR	Project NPV (US$ million)
Base Case	6.29%	-72.4
Revenue decrease by 10%	5.45%	-308.6
Revenue decrease by 20%	4.51%	-544.9
Increase in Capital Cost by 10%	5.79%	-235.6
Increase in Capital Cost by 20%	5.35%	-398.8
Increase in O&M Cost by 10%	6.01%	-152.7
Increase in O&M Cost by 20%	5.73%	-233.0
Increase in Capital Cost and O&M Cost by 10%	5.53%	-315.9
Increase in Capital Cost and O&M Cost by 20%	4.84%	-559.3
Increase in Capital Cost and O&M Cost by 10% and reduction in revenue by 10%	4.69%	-552.1
Increase in Capital Cost and O&M Cost by 20% and reduction in revenue by 10%	3.98%	-795.5
Increase in Capital Cost and O&M Cost by 20% and reduction in revenue by 20%	3.01%	-1,031.7

D. Financial Assessment of BMRCL

18. BMRCL is a special vehicle company, promoted as a joint venture by the GoI and GoK to implement metro rail projects in the city of Bangalore. As per audited financials for IFY2015-16, BMRCL's balance sheet size increased from US$1.88 billion in IFY2014-15 to US$2.17 billion in IFY2015-16. The current liabilities (inclusive of trade payables, short term provisions) of BMRCL has increased from US$73.6 million in 2014-15 to US$114 million in IFY2015-16. The current assets (inclusive of cash and cash equivalents, short term loan and advances, trade receivables) has increased from US$83.5 million in IFY2014-15 to US$189.5 million in IFY2015-16.

19. Gross revenue has increased from US$6.638 million in IFY2014-15 to US$8.4 million in IFY2015-16. Revenue from operations increased by 60% from US$2.7 million in IFY2014-15 to US$4.3 million in IFY2015-16, as the incremental inauguration of Phase I was undertaken. The fare box revenue in IFY2014-15 was 41% of the Gross revenue which increased to 53% of the gross revenue in IFY2015-16. The fare box revenue is estimated to further increase and stabilize after the recent commencement of the full Phase I operation.

20. The net loss has increased from US$40.7 million to US$55.8 million over the last year because of the additional portions of Phase I opened for commercial operation. The net cash flow used in operating activities has increased from US$54.7 million in IFY2014-15 to US$102.7 million in IFY2015-16. BMRCL is expected to have increases in revenue, operating cost and expense, asset class, the long-term liabilities and the loss, until Phase I and Phase II operations grow and stabilize to have sustained income and expense. Thereafter, BMRCL will be able to incrementally pay off its debt on its own.

21. The financial projection of BMRCL for next 10 years after the Project completion indicates that until 2025, BMRCL will continue to experience net losses due to expected disbursements under ongoing projects, high finance cost, and low operation income. However, BMRC is at least forecast to have a positive operating margin with operating costs during the period. BMRCL will be profitable and financially sustainable from 2026 provided that the fare escalation and ridership projection are achieved as planned. BMRCL financial projection is presented in Table A3.9.

22. Apart from debt and equity contribution from the GoI and GoK, and lending from multilateral institutions, BMRCL has issued the Namma Metro Bond Series I in the amount of INR 3,000 million (US$46.5 million) with a maturity period of 10 years. Brickworks Ratings (BWR) has assigned a rating of "BWR AA" with stable outlook for the existing bond. The bond proceeds were used in Phase I financing. BMRCL plans to raise a further INR 3,000 million (US$46.5 million) through a proposed fresh issue of non-convertible debentures. The Bond issuance is one of the financial strategies of BMRCL to independently raise resources to meet its financing requirement.

Table A3.9: BMRCL Financial Projection (US$ million)

Financial Year	2021-2022	2022-2023	2023-2024	2024-2025	2025-2026	2026-2027	2027-2028
A. Revenue:							
Revenue from Operations-(FBR)	359	372	424	439	499	514	583
Other Operating Income-(NFBR)	55	58	62	65	69	73	78
Other Income							
A. Total Revenue	**414**	**430**	**485**	**504**	**568**	**587**	**660**
B. Expenses:							
Operating Expenses							
- Energy Cost	(29)	(31)	(32)	(34)	(35)	(37)	(39)
- Repairs & Maintenance, Admin & other	(96)	(96)	(96)	(96)	(96)	(96)	(96)
Employee Cost	(48)	(51)	(54)	(58)	(61)	(65)	(69)
Outsourced-Manpower Cost	(73)	(78)	(83)	(89)	(95)	(102)	(109)
B. Total of Expenses	**(246)**	**(255)**	**(265)**	**(276)**	**(287)**	**(299)**	**(312)**
C. Profit Before Interest, Taxes & Depreciation	168	175	220	229	281	288	348
Finance Cost (Interest)	(137)	(127)	(118)	(107)	(94)	(85)	(71)
D. Profit Before Taxes & Depreciation	**32**	**48**	**103**	**122**	**187**	**203**	**278**
Depreciation	186	186	186	186	186	186	186
E. Profit Before Taxes	**(154)**	**(138)**	**(83)**	**(64)**	**1**	**17**	**92**
Taxes	-	-	-	-	-	-	-
F. Profit/ (Loss) for the period	**(154)**	**(138)**	**(83)**	**(64)**	**1**	**17**	**92**

23. A trilateral MoU was entered into between the GoK, GoI and BMRCL on February 24, 2017. The MoU mentions that:

(i) The GoK will provide SCS to BMRCL (by funding the SCS account) to meet any shortfall or bridge the cash gap during the operational phase. The cash support would comprise any incremental cash shortfall faced by BMRCL along with the repayment of any senior debt if the same cannot be provided by BMRCL. The SCS for the financial year 2015-16 provided by the GoK to BMRCL was US$27.4 million.

(ii) BMRCL is not required to bear the amount of foreign exchange variation. Any cost escalation due to statutory levies and duties, exchange rate variation, or price escalation within the approved Project time cycle will be shared equally between the Project promoters.

(iii) The GoK will exempt BMRCL from its state/ local taxes and duties/ levies or reimburse the same and the same will not be included in the Project cost.

(iv) The GoK to repay the Senior Term Debt on account of cash losses, in case BMRCL is not able to repay the same to the GoI.

(v) Any cost escalation due to changes in the statutory central duties / levies and exchange rate variation will be shared equally between the GoK and GoI; any other cost escalation, including price escalation, will be entirely borne by the GoK.

E. Financial Assessment of Government of Karnataka

24. The GSDP of Karnataka for IFY2017-18 at current prices is estimated to be US$ 198 billion, which is 15% higher than the revised budget estimates for IFY2016-17. The total expenditure for IFY2017-18 is estimated at US$29.11 billion which is 13.4% higher than the revised estimates of IFY2016-17. The capital expenditure is budgeted at US$6.53 billion and revenue expenditure is budgeted at US$ 22.58 billion.

25. The total receipts excluding borrowings for the year 2017-18 are estimated at US$22.62 billion, an increase of 9% over the revised estimates for IFY2016-17. The total revenue receipts comprise US$22.6 billion and capital receipts (excluding borrowings) US$21 million. The borrowings (public debt) is budgeted at US$5.78 billion.

26. The revenue surplus for IFY2017-18 is targeted at US$21.38 million (around 0.01% of GSDP). The revenue surplus was 0.2% of GSDP in 2015-16, 0.1% of GSDP in IFY2016-17 revised estimates. The fiscal deficit is targeted at US$5.2 billion (2.6% of the GSDP). The fiscal deficit was 2.6% in IFY2015-16 and 2.2% in IFY2016-17 revised estimates. The fiscal deficit is below the prescribed limit of 3% as per the Karnataka Fiscal Responsibility Act, 2002. The debt to GSDP ratio of Karnataka has increased from 21.6% in 2012-13 to 24.1% as per IFY2015-16 budget estimates. The liability to GSDP of the GoK is still lower comparative to other Indian states with a GSDP over US$100 billion.

27. The GoK has supported BMRCL since the commencement of Phase I. A trilateral MoU was executed between the GoK, GoI and BMRCL for Phase I financing in December 2010. The MoU had a provision that the GoK would contribute 30% of the estimated project cost of Phase I in the form of equity and subordinate debt. The GoK contributed 36.7% of the Phase I project completion cost. Details of Phase I financing are shown in Table A3.10.

Table A3.10: Phase I Financing (Amount in US$ million)

Source	Fund received as per MoU (Amount)	Fund received as per MoU (Percentage)
GoI (equity, sub debt)	475	22.3
GoK (equity, sub debt, additional interest free sub debt, senior debt)	783	36.7
Senior Debt	791	37
GoK (reimbursement of state taxes)	87	4
Total	2,136	100

28. A similar trilateral MoU was executed between the GoK, GoI and BMRCL for the Phase II financing in February 2017. Phase II financing plan is presented in Table A3.11. The annual commitment of GoK is based on BMRCL budget requirement as per the cash flow projection submitted to the Urban Development Department, GoK. The Urban Development Department processes and submits it to the Finance Department, GoK. The Finance Department, GoK after scrutiny and discussion with BMRCL allocates the required funds.

Table A3.11: Year wise Phase II Financing from GoI and GoK (Amount in US$ million)

Source	Amount received until 31 March 2017	2017-18	2018-19	2019-20	2020-21
GOI	138.6	224.7	285	106.3	61.8
GOK	349	1090	420	72	46.3
Senior Debt	47.6	311.6	519	372.8	37.8
Total	535.2	1626.3	1224	551.1	145.9

29. The Urban Transport Fund of GoK is another provision to support BMRCL. As per the GoI, Phase II project sanction order dated February 2014, the interest payable beyond 2% will be shared by GoK with the dedicated Urban Transport Fund. The fund was established in 1994 and is currently named as Bangalore Metro Rail Corporation Limited Fund. The fund was established with an objective to establish, operate and maintain the rapid rail transit system. Twenty-eight percent of the infrastructure development cess from motor vehicle tax, stamps and registration, and state excise is allocated and transferred to this fund. The Infrastructure Cess account of BMRCL is maintained by GoK under Public Account under 8829, hence no budgetary provision is required to be made for receipts/ release of funds out of the account to BMRCL. As per the Accountant General of Karnataka, Bangalore, US$665 million is available in this fund account as of 31 March, 2017.

Annex 4: Sovereign Credit Fact Sheet

A. Recent Economic Development

India is a lower-middle-income country, with a population of 1.31 billion. Indian real GDP expanded at an average annual rate of 7.3% between FY2003 and FY2012, however, growth had slowed to 5.6% and 6.5% in FY2012/13 and FY2013/14 because of growing imbalances, binding supply constraints, and subdued sentiment. Since 2014, the Indian economy has been on a gradual cyclical recovery, helped by lower commodity prices bringing about an improvement in the current account. The Indian economy is also supported by structural reforms, such as a new bankruptcy code and the implementation of the pan-India goods and services tax (GST). A range of supply-side measures (including release of surplus grain buffer stocks), an appropriate monetary stance and lower oil price have also contributed to the decline in inflation, from an average of about 9.8% during the period 2011–2013 to 4.9% in FY2015/16. Nevertheless, the demonetization initiative[3] resulted in slower growth in FY2016/17. The Rupee also weakened with global capital outflow from emerging market assets.

B. Economic Indicators

Selected Macroeconomic Economic indicators (2013/14-2017/18)

Economic Indicators	2013/14	2014/15	2015/16	2016/17*	2017/18*
National income and prices (change %)					
Real GDP	6.5	7.2	8.0	7.1	7.2
Inflation (change %, average)	9.4	5.9	4.9	4.9	4.8
Central government operations (% of GDP)					
General government overall balance	-7.6	-7.3	-7.0	-6.8	-6.6
External debt (% of GDP, EOP)	23.9	23.3	23.4	22.9	22.7
Nominal gross public debt (% of GDP)		68.3	69.8	69.6	68.8
Money and credit					
Broad money (% annual change, EOP)	13.4	10.9	10.5	12.0	13.4
Direct investment in India (net, % of GDP)	-1.2	-1.5	-1.7	-1.7	-1.7
Gross reserves (months imports)	6.7	8.5	8.6	8.1	7.9
Current account balance (% of GDP)	-1.7	-1.3	-1.1	-0.9	-1.5
Exchange rate (Rupee/$, end period)	61.0	62.6	66.6	68.4	

Note: * denotes projected figures. Source: IMF Country Report No. 17/54, February 2017, WEO April, July 2017.

C. Economic Outlook and Risks

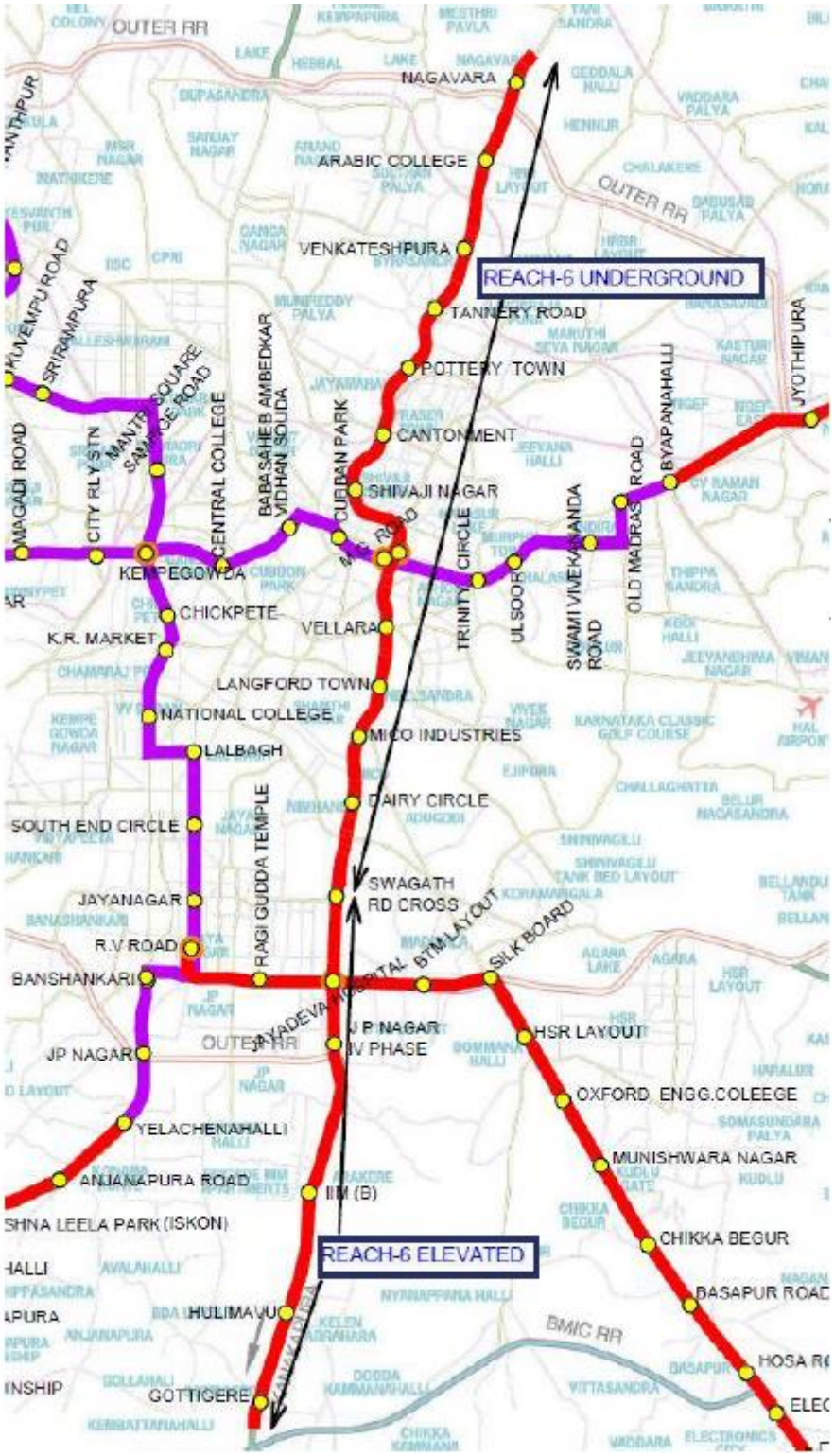
Looking ahead, India's growth is projected to slow to 7.1% in FY2016/17 before rebounding to 7.7% in FY2018/19. This is due to the temporary disruptions, particularly in private consumption, caused by cash shortages accompanying the demonetization. The current account deficit is expected to widen to about 2% of GDP over the medium term on the back of stronger domestic demand and possible increase in commodity prices. External risks include financial market volatility and slower growth in China, EU and US. Internally, India faces some risk arising from potential deterioration of corporate and public bank balance sheets, and setbacks in the reform process including implementation of GST on the domestic side. India's public debt remains sustainable given manageable interest rate costs and robust growth outlook. Assuming gradual fiscal

[3] Demonetization initiative: On Nov. 8 2016, India's government announced withdrawal of the legal tender of INR500 and INR1000 notes, which accounted for 86 percent of the value of currency in circulation, and introduction of new INR500 and INR2000 notes.

consolidation and implementation of GST, the public debt-to-GDP ratio is forecast to decline gradually to around 61% of GDP in the medium term from the current level of almost 70%. Negative growth shocks represent one of the major risks to the debt outlook. India's external debt, currently at 23.5% of GDP, remains sustainable.[4]

[4] International Monetary Fund (IMF), 2017. Country Report No. 17/54– 2017 Article IV Consultation—Press Release; Staff Report; and Statement by the Executive Director for India, February, 2017.

Annex 5: Bangalore Metro Phase II Reach 6 Stations



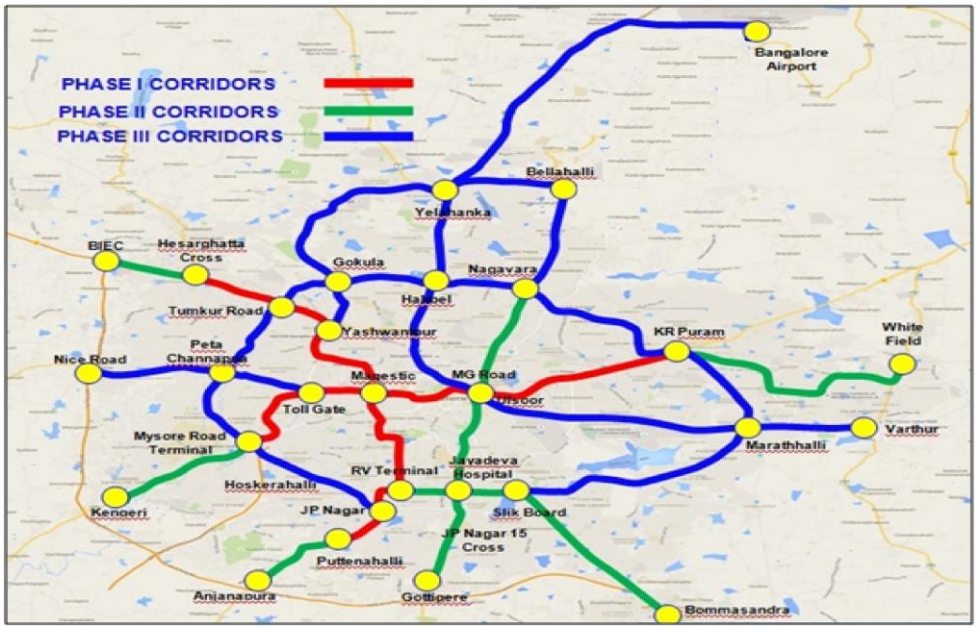
Annex 6: Bangalore Metro Expansion Plan

1. BMRCL has proposed a Phase III plan, consisting of a network which will connect important areas and the Phase I and Phase II lines passing through the Outer Ring Road, Magadi Road, Old Madras Road, Kormangala, Sarjapur, Yelahanka and the Airport. The proposed Phase III planned lines, especially the Circle Line (Ring Road), will not only connect the new areas but also help to optimize ridership for the entire network. The construction of Phase III is proposed to start in 2025. Phase III is expected to further enhance the ridership of Reach 6, by connecting Reach 6 with the Outer Ring Road and to the Airport in the north of the city. Phase III will lead to a holistic development of the metro in the city and establish it as the prime driver of public transportation in Bangalore. The details of Phase III are summarized in Table A6.1 and Figure A6.1 below.

Table A6.1: Phase III Proposed Network

Sl. No	Routes	Km
1	Nagawara to Airport	23.37
2	Outer Ring Road from Silk Board to Hebbala (Eastern portion)	33.00
3	Outer Ring Road Hebbala to Silk Board (Western Portion)	31.37
4	Hoskerehalli to Outer Ring Road via Old Airport Road	21.31
5	PRR to Tollgate (Magadi Road)	8.89
6	Sarjapur Layout to Yelahanka (via Central College, Palace Guttahalli, Mekri Circle and Hebbal)	33.00
	Total	144.34

Figure A6.1: Phase III Proposed Network



2. BMRCL has submitted a DPR to the GoK for the Outer Ring Road Metro Line. The proposed metro line would be an 18-km all elevated line and would run from the Central Silk Board junction to KR Puram, with 13 proposed stations and an estimated cost of US$650 million. The DPR proposes various scenarios for the financing of the project, the decision on which will be taken by the GoK. The project was approved by the Cabinet of the GoK in March 2017.

Annex 7: The Project Procurement Plan

Nº	Contract Name	Prom Tender Identifier	Contract Type	Estimated amount (US$)	Financing		Procurement Method	Tender Documents	Published in OJEU?	Estimated publication date	Estimated submission of bids date	Estimated contract award date	Estimated contract end date	Procurement Status
					% financed by AIIB	Other Financier (EIB)								
1	Construction of Elevated Viaduct & Stations	R6-CC-01	Works	89,000,000.00	34%	60%	Open International procedure	Standard National Tender Document	Yes	3/8/2017	5/18/2017	Sep-17	Dec-19	Ongoing
2	Construction of Underground Section Tunnel & Stations	R6-CC-01	Works	818,000,000.00	34%	60%	Open International procedure	Standard National Tender Document	Yes	6/29/2017	9/27/2017	Feb-18	Aug-21	Ongoing
3	Depot & Stabling Works and E&M	R6-CC-01	Works	21,000,000.00	34%	60%	Open International procedure	Standard National Tender Document	No	Jan-17	Dec-17	Jul-18	Jun-20	Ongoing
4	Tunnel ventilation System (TVS) & Environment Control system (ECS)	R6-CC-01	Supplies	44,000,000.00	34%	60%	Open International procedure	Standard National Tender Document	No	Jun-18	Aug-18	Nov-18	Dec-19	Ongoing