Ex-ante Evaluation (for for Japanese ODA Loan)

South Asia Division I, South Asia Department,
Japan International Cooperation Agency

1. Name of the Project

(1) Country: India
(2) Project Title: Delhi Mass Rapid Transport System Project (Phase 4 Additional Corridors) (I)
(3) Project Site/Target Area: National Capital Region of Delhi (Population: approximately 17 million) (2011 Census)
Loan Agreement Date: March 27, 2025

2. Background and Necessity of the Project

(1) Current State and Issues of Urban Transportation Sector and the Priority of the Project in India

In India, rapid urbanization has been progressing in recent years, and while the demand for road traffic is expanding in line with the rapid increase in the number of registered vehicles (from 55 million in 2001 to 230 million in 2016, according to the 2018 Statistical Year Book of India), the development of public transport infrastructure has not progressed. In particular, in the six major metropolitan areas of Delhi, Mumbai, Kolkata, Chennai, Bengaluru and Hyderabad, traffic congestion caused by the expansion of road traffic demand has become a serious problem, and economic losses and the deterioration of the urban environment and health problems caused by air pollution, noise and other forms of automobile pollution are becoming more serious.

To address the above issues, the Indian government has set a target of developing metro systems in 27 cities by 2025. In its Metro Rail Policy (the latest version of which was updated in 2017), the government has set out a policy to promote the development of public transport systems such as metros and railways in terms of safety and energy efficiency, as well as to meet transport demand and reduce traffic congestion in line with recent economic growth. In large cities, the construction of metro systems is particularly encouraged for reasons such as providing mass transportation without putting pressure on existing road capacity.

The number of registered vehicles in the National Capital Territory of Delhi was 10.38 million in 2016, but this figure has increased rapidly to around 12.25 million by 2021 (according to a survey by the National Capital Territory of Delhi),

and traffic congestion is becoming more serious as a result. According to a survey by the Dutch company TomTom, it takes approximately 1.48 times longer to travel by car in Delhi than it does when there is no traffic congestion, making it the most serious level of traffic congestion in the world (ranked 369th out of 387 cities in 55 countries as of 2023), and it is also said that traffic congestion causes economic losses of over 1 trillion yen per year (Indian Institute of Technology, 2017).

Delhi is also considered to be the capital city with the highest PM2.5 dispersion per cubic meter in the world, with dispersion levels recording at around 18 times the target level set by the World Health Organization (WHO) (annual average of 5 micrograms per cubic meter or less), and it is estimated that over 12,000 people die each year as a result of air pollution (2023, The Lancet Planetary Health). In addition, the amount of CO2 emissions from the road transportation sector in 2009 was the highest among the six major metropolitan areas (2015, Indian Institute of Science), and measures to combat air pollution have become an urgent issue in Delhi. In this situation, the Government of National Capital Territory of Dehli has planned and promoted urban transport development with a focus on introducing a mass rapid transport system to reduce congestion in the existing public transport system, such as buses and trains, and to mitigate air pollution in the National Capital Region (NCR) of Delhi. The "Delhi Master Plan 2021" (partially updated in May 2010), formulated by the Government of National Capital Territory of Delhi and approved by the Government of India (in 2007), sets the goal of having a mass rapid transport system play a central role in the transportation system of the Delhi metropolitan area. So far, Phases 1 to 4 of the plan to develop a mass rapid transport system have been formulated and implemented, and the goal is to achieve a daily transit capacity of approximately 10.8 million passengers by 2029, when Phase 4 is scheduled to be completed. The “Delhi Mass Rapid Transport System Project (Phase 4 Additional Corridors)” (hereinafter referred to as “the Project”) aims to respond to the increasing transport demand in the NCR of Delhi, one of the cities with the largest population in India, by developing three of the six metro lines planned for Phase 4 (extending Lines 1 and 5 and newly constructing Line 11), and is positioned as an important project in the urban transportation sector in India.

(2) Japan's and JICA's Cooperation Policy and Operations in the Urban Transportation Sector (especially in relation to key foreign policies such as the Free and Open Indo-Pacific Partnership (FOIP))

Japan’s Country Development Cooperation Policy for India (November 2023) identifies “strengthening multi-layered connectivity” through the development of transportation infrastructure as a priority area, and to remove infrastructure bottlenecks to investment and growth, railways (including high-speed rail and metro) are needed to strengthen connectivity within major industrial cities and economic regions, as well as between regions in India. Since this Project will also contribute to the low-carbonization of the transportation sector through the development of a transportation system in the NCR of Delhi, it is not only aligned with Japan's Country Development Cooperation Policy for India, but is also positioned as part of the “Addressing Challenges in an Indo-Pacific Way (Climate and Environment)” in the “New Plan for a Free and Open Indo-Pacific (FOIP)”. In addition, the JICA Country Analysis Paper on India (March 2018) analyzed that in order to resolve the bottlenecks to economic growth, it is necessary to provide support for infrastructure development, such as mainline railways, urban railways, roads, and ports, with a focus on industrial clusters including special economic zones and economic corridors located in the six major metropolitan areas and the Delhi-Mumbai Industrial Corridor, and this Project is in line with these policies and analyses. JICA's Global Agenda for Transportation also aims to create a society where everyone can move safely and freely, and where necessary goods can be distributed throughout the world, by promoting low-carbon and carbon-free transportation, improving transportation infrastructure and maintenance management technology, and ensuring safety. This project is in line with these policies.

The Project is also expected to contribute to the achievement of the following SDGs: Goal 8 “Promote sustained, inclusive and sustainable economic growth and full and productive employment and decent work for all”; Goal 9 “Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation”; Goal 11 “Make cities and human settlements inclusive, safe, resilient and sustainable”; and Goal 13 “Take urgent action to combat climate change and its impacts.”

For transportation sector, 90 Japanese ODA loans totaling 4,574,709 million yen have been extended to India as of December 2024, of which 57 ODA loans totaling 3,780,559 million yen had been committed as of December 2024, to the

railway sector, including the Delhi, Kolkota, Chennai, Bengaluru, Mumbai, Ahmedabad, and Patna metro projects. For Delih Metro, ODA loans have been provided since FY1996, and a cumulative total of 928,116 million yen has been approved for Phases 1 through 4 (II).

(3) Other Donors' Activities

The World Bank (WB) has identified the improvement of connectivity and logistics as a priority in its Country Partnership Framework (FY2018-FY2022), and in the railway sector, the WB has provided support for the Mumbai Urban Transport Project (2002 and 2010 approved, totaling US$972 million) and the Eastern Dedicated Freight Corridor Project (2011, 2014, 2015, and 2022 approved, totaling US$2,970 million). In recent years, the Asian Development Bank (ADB) has supported the "enhancing industrial competitiveness, a climate-resilient green growth strategy, and expanding social inclusion" as the three pillars of its Country Partnership Strategy (FY2023-FY2027). It promotes the improvement of regional connectivity and the decarbonization of the transportation sector, and has identified the decarbonization of the sector through the introduction of railways and public electric buses as a priority. In the railway sector, the ADB has so far provided loans for the Jaipur Metro (US$176 million approved, 2014), and, in a joint loan with the New Development Bank (NDB), for the Mumbai Metro Lines 2A, 2B, and 7 (US$926 million approved by the ADB (2019) and US$260 million by the NDB (2018)), and for the Chennai Metro Lines 3 and 4 (US$350 million by ADB (2022) and US$347 million by NDB (2022)). In addition, Germany's KfW provided support for Mumbai Metro Lines 4 and 4A (545 million euros approved). No support from other donors is expected for the Delhi Metro.

3. Project Description

（１） Project Description

1) Project Objective

The objective of the Project is to cope with the increase of traffic demand in Delhi by expanding the mass rapid transportation system, thereby promoting regional economic development, improving urban environment and eventually mitigating climate change, through relief of traffic congestion and decrease of pollution caused by increasing motor vehicles.

2) Project Components

The Project is to extend Lines 1 and 5, which were constructed in Phases 1

and 2, and to construct a new Line 11, as well as to procure rolling stock, etc., in the section positioned as the fourth phase of the Mass Rapid Transit System construction plan for the NCR of Delhi.

a) Civil engineering works for underground railway (about 11 km), elevated/at-grade railway (about 36 km), underground stations (9), at-grade station (1) and elevated stations (29).

b) Electrical, communication, and signaling systems, station facilities construction, new depot construction, existing depot expansion construction, automatic fare collection systems, etc.

c) Procurement of rolling stock (178 cars)

d) Consulting services (design review, construction supervision support, etc.)

Of these, the part covered by ODA loans is part of a), b), and c), and d).

3) Project Beneficiaries (Target Group):

Direct beneficiaries: Users of the sections covered by this Project (approx. 400,000 persons/day) (forecast for year 2031, approx. 2 years after completion)

Final beneficiaries: NCR of Delhi residents (approx. 17 million people) who will benefit from reduced traffic congestion, fewer traffic accidents, and reduced air pollution as a result of the metro development.

(2) Estimated Project Cost

298,358 million yen (including Japanese this ODA loan: 79,726 million yen)

(3) Schedule (Cooperation Period)

March/2025-March/2032 (85 months, including defect liability period)

The Project will be considered complete when all facilities are put into service (March 2029).

(4) Project Implementation Structure

1) Borrower: President of India

2) Guarantor: N/A

3) Executing Agency: Delhi Metro Rail Corporation Limited

4) Operation and Maintenance System:

After completion of the Project, Delhi Metro Rail Corporation Limited will directly manage the operation and maintenance of the system, except for rolling stock maintenance.

(5) Collaboration and Sharing of Roles with Other Donors

1) Japan's Activities: None in particular

2) Other Donors' Activities: None in particular

(6) Environmental and Social Considerations

1) Environmental and social considerations

① Category : A

② Reason for Categorization: The Project falls into the railway sector under the JICA Guidelines for Environmental and Social Considerations (hereinafter referred to as JICA Environmental Guidelines) (promulgated in January 2022).

③ Environmental Permit: Although preparation of an Environmental Impact Assessment (EIA) Report regarding the Project is not required under the domestic law in India, a report was prepared by DMRC in May 2018. A revised version based on the latest situation has already been approved by DMRC and was released in November 2024.

④ Anti-Pollution Measures: Regarding air quality, water quality, waste, soil contamination, noise and vibration during construction work, there are plans to ensure conformance to India's emissions standards and environmental standards by means of sprinklers and wastewater treatment, excavated earth treatment, and installation of noise barriers, etc. Regarding the impact on the ground during construction, no serious influence due to land subsidence is expected, since loose ground and the inflow of groundwater will be prevented by adopting the sheet pile construction method, etc. When the lines are in use, measures will be taken to improve air quality, water quality, waste, soil contamination, noise and vibration, including the installation of septic tanks, compliance with waste management laws and regulations, including hazardous waste, and grinding of wheels and rails.

⑤ Natural Environment: The Project area is not located in or around areas that are easily affected by the Project, such as national parks. With regard to the felling of trees (15,856 trees) that will take place under the Project, the executing agency and the Department of Forest and Wildlife, Government of the National Capital Territory of Delhi will plant replacement trees (158,560 trees) in accordance with the Delhi Preservation of Trees Act (1994) and Government of India guidelines (February 2010). During construction, there will be restrictions on night construction and restrictions on unauthorized entry of construction workers into conservation forests and secondary forests.

⑥ Social Environment: As the executing agency will acquire the

necessary land (public land) from the government agency, this Project will not involve the acquisition of private land or resettlement of residents. In addition, there are no confirmed unregistered residents in the area. During construction, the status of buried cultural heritage will be checked, and construction will be carried out with consideration for the landscape.

⑦ Others/Monitoring: During construction, the contractor will monitor air quality, water quality, soil contamination, waste, noise, vibration, etc., under the supervision of DMRC. Together with the Delhi State Forest Department, DMRC will monitor the ecosystem during construction and after the metro lines are in operation. During construction, the contractor will monitor cultural heritage (in the event of the discovery of underground deposits) and the status of consideration for the landscape.

(7) Cross-Sectoral Issues

1) Climate Change:

The Project is expected to contribute to climate change mitigation as it will help reduce GHG emissions by promoting modal shift. The Project is also considered important as the country's Nationally Determined Contribution (NDC), which aims to achieve net zero GHG emissions by 2070, includes the use of mass rapid transport systems as one of its mitigation strategies. Phase 2 and Phase 3 of the Project have been registered with the United Nations as Clean Development Mechanism (CDM) projects, and Phase 3 has been certified by Gold Standard, an independent carbon credit certification organization. Taking into account the situation regarding the establishment of new frameworks for emissions trading, etc. in the international community in the future, DMRC's intention to register this Project has been confirmed during the appraisal process. The climate change mitigation effect (estimated reduction in CO2 emissions) is expected to be approximately 26,550 tons of CO2 equivalent per year.

2) Disability Considerations:

In accordance with national laws and regulations in India, DMRC has adopted station buildings and passenger cars (including elevators, toilets, internal broadcasting, Braille blocks, wheelchair spaces, etc.) that are also designed for use by the elderly and disabled, and has provided customer care training for all front-line staff, including station staff and crew members.

3) Measures against AIDS/HIV and other infectious diseases:

For large-scale civil engineering packages that mobilize a large number of

workers to the construction site, DMRC will confirm that the contract with the construction operator will include the implementation of AIDS measures such as prevention and awareness activities for the workers.

(8) Gender Category:■ GI(S) Gender Informed (Significant)

<Details of Activities/ Reason for Categorization > The Project will take measures such as the introduction of women-only cars, priority seating for passengers requiring assistance (including women), and the installation of CCTV cameras in station buildings/trains to make women feel safe and comfortable when using the Metro, and will also use the distance travelled by women-only cars as an indicator of impact. In addition to ensuring equal wages for men and women on construction sites and providing facilities for women workers, women are also being appointed to senior positions in project implementation. In addition, DMRC is providing dormitories for female workers and conducting awareness activities to prevent gender-based violence. For these reasons, the Project is classified as a GI(S) project.

(9) Other Important Issues:

As part of the operational DX, DMRC has shown a high level of interest in introducing 7D Building Information Modeling (7D BIM), which can improve the efficiency of maintenance and management by centrally managing and integrating various information, such as design drawings, costs, and inspection results, which have been managed using different software, in a virtual space. It was agreed with DMRC that detailed discussions would be held in the future regarding the possibility of JICA's cooperation in introducing 7D BIM in the Delhi Metro project, in parallel with the implementation of this Project.

4. Targeted Outcomes

(1) Quantitative Effects

1) Outcomes (Operation and Effect Indicators)

Indicator	Baseline (Actual value in 2024)	Target (2031) [2 years after project completion]
Operating rate (%/year)		
Line 1 extension	-	96
Line 5 extension	-	96
Line 11	-	88

Running distance (thousand km/ year)		
Line 1 extension	-	10,153
Line 5 extension	-	6,924
Line 11	-	1,677
Running distance of women-only cars (thousand km/ year)		
Line 1 extension	-	2,538
Line 5 extension	-	1,731
Line 11	-	559
Number of trains (number of running trains/ day)		
Line 1 Extension	-	278
Line 5 extension	-	384
Line 11	-	190
Transportation volume (million passenger-km/day)		
Line 1 Extension	-	3.43
Line 5 extension	-	2.72
Line 11	-	0.58
Income from passengers (million Rupees/ day)		
Line 1 Extension	-	10.78
Line 5 extension	-	17.63
Line 11	-	5.53

(Note) All numerical values are for the sections to be constructed in this Project.

(2) Qualitative Effects: reduction of vehicle pollution in the NCR of Delih, mitigation of climate change, improvement of convenience through ensuring punctuality of movement, economic development of the NCR of Delhi, promotion of social advancement of women and persons with disabilities.

(3) Internal Rate of Return

Based on the assumptions listed below, the economic and financial internal rate of return for the Project is 22.94% and 10.43%, respectively.

[EIRR]

Cost: Project costs, operation and maintenance costs (all excluding taxes)

Benefit: Reduction in travel time for Metro users and users of other modes of transport, reduction in vehicle maintenance costs for Metro users and road users, reduction in road transport infrastructure development costs, reduction in

road traffic accidents, reduction in road transport emissions of pollutants

Project Life: 31 years (6 years construction + 25 years operation)

[FIRR]

Cost: Project costs, operation and maintenance costs

Benefit: Fare revenue, advertising revenue, in-station and station-front area development revenue

Project Life: 31 years (6 years construction + 25 years operation)

5. External Factors and Risk Control

（１） Prerequisites: None

（２） External Factors: None

6. Lessons Learned from Past Projects

Based on the ex-post evaluation results of the Metro Manila Strategic Mass Rail Transit Development Project, which is ODA loan project for the Republic of the Philippines (evaluation year: 2008), etc., the establishment of a financially independent project implementation structure is highlighted as an important issue from the viewpoint of ensuring suitable operation, management and maintenance.

In addition, the results of the ex-post evaluation of the “Delhi Mass Rapid Transport System Construction Project” and its Phase 2 (evaluation years: 2010 and 2015) were considered good practices, with the strengthening of DMRC's internal human resources in view of the implementation of subsequent projects in the continuation phase. By having internal staff gain experience working with ODA loan consultants from an early stage during the implementation of Phase 1 projects, they were able to cultivate know-how in areas such as construction management, and in Phase 2, they were able to reduce their reliance on external experts and improve their technical capabilities. In addition, it has contributed to the dissemination of metro technology in India and abroad by undertaking external projects, including JICA projects in India and abroad, such as the Mumbai Metro, Patna Metro, Dhaka Metro, and Jakarta Metro, and undertaking external requests such as training for other metro operating organizations.

In this Project, JICA has been supporting DMRC in strengthening its internal human resources until the completion of Phase 3. In light of this, JICA will continue to provide technical transfer to DMRC staff on project management and

other matters through the consulting services of this Project.

7. Evaluation Results

This Project aims to respond to the increasing demand for transportation by constructing a mass rapid transport system in the NCR of Delhi, and is consistent with India's development issues and development policies, as well as Japan's and JICA's cooperation policies and analysis. In addition, the Project is expected to contribute to the following SDGs: Goal 8 “Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all”, Goal 9 “Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation”, Goal 11 “Make cities and human settlements inclusive, safe, resilient and sustainable”, and Goal 13 “Take urgent action to combat climate change and its impacts”. For these reasons, there is a great need to support the implementation of this Project.

8. Plan for Future Evaluation

(1) Indicators to be Used

As indicated in Section 4.

(2) Future Evaluation Schedule

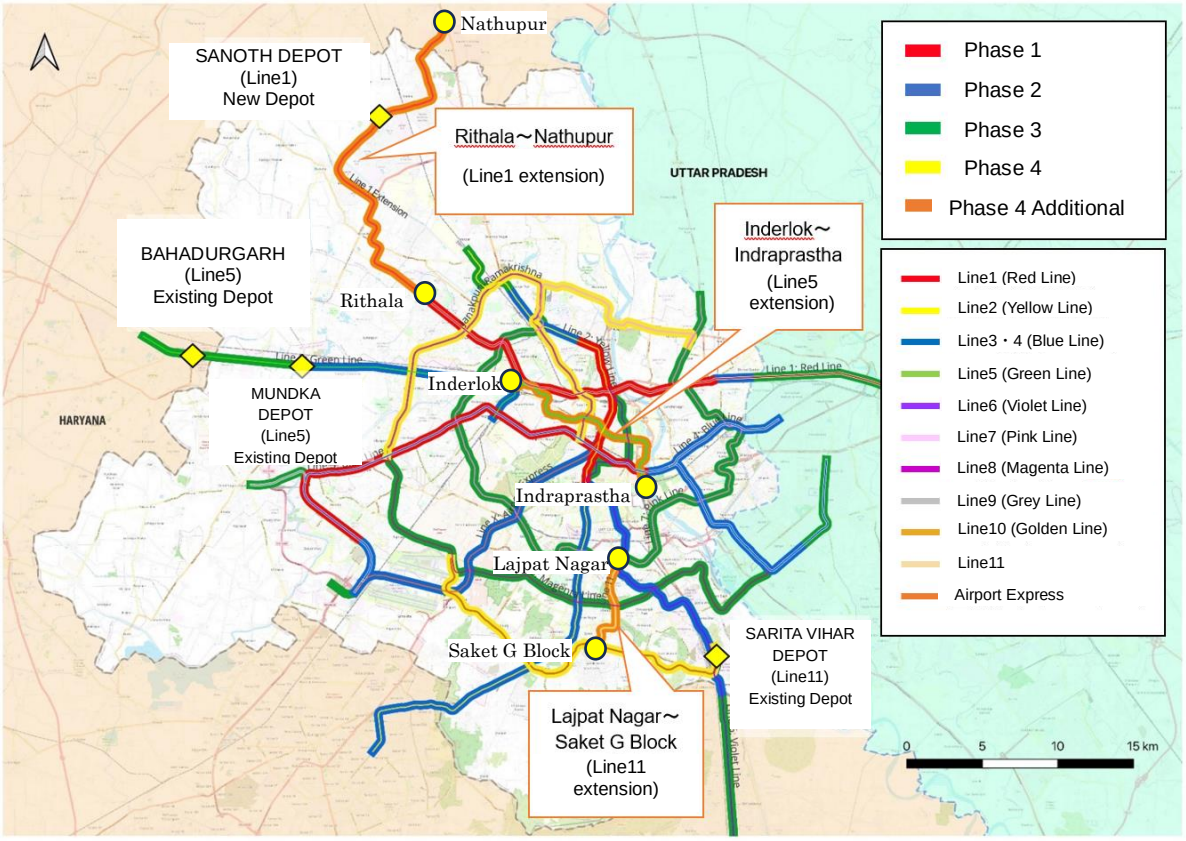
Ex-post evaluation: 2 years after the Project completion

END

Appendix: Map of the Delhi Mass Rapid Transport System Project (Phase 4 Additional Corridors) (I)

Appendix

Map of the Delhi Mass Rapid Transport System Project
(Phase 4 Additional Corridors) (I)
(Source: created by JICA based on data from Delhi Metro Corporation)



Section	Extension	Number of Stations
Line 1 (Red Line) extension (Rithala - Nathupur)	Approx. 26.5 km	21
Line 5 (Green Line) extension (Inderlok - Indraprastha)	Approx. 12.4 km	10
Line 11 (Golden Line) (Lajpat Nagar - Saket G. Block)	Approx. 8.4 km	8
Phase 4 Additional Corridors Total	Approx. 47.2 km	39

Note: Totals may not add up due to rounding.