

Contribution of Delhi Metro Rail Corporation (DMRC) towards Betterment of Delhi's Environment

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Abstract—Delhi Metro has changed the very face of Mass Rapid Transport Sector (MRTS) of Delhi. Widely recognized as one of the most efficient Public Sector undertaking, the Metro, as it is popularly known, has affected the lives of Delhites in many ways – including a significant impact on the environment as a whole. An attempt has been made in this paper to conduct this Environmental Impact Analysis of Metro. We start with a brief introduction of Metro and how the need arose for it. Then the Environmental Impact Assessment (EIA) is done covering the aspects of ground water hydrology, flora and fauna, air quality, noise levels and socio-economics. Potential negative and positive impacts are identified and summarized in form of a checklist. Finally, we discuss in brief an environmental management plan and a suitable monitoring program for the same.

1. INTRODUCTION

Delhi Metro Rail Corporation. (DMRC/ Metro)

In India, DMRC has been regarded as one of the finest examples of efficiently run Public Sector Undertaking (PSU) In fact, today it is difficult to imagine life in Delhi without Metro today because of the tremendous amount of Social Benefits it has bestowed upon Delhi people during the short spell of just six years (2003 to 2009).

Metro did not exist before December 25, 2002 and the public transportation system in Delhi was in utter chaos. The general Public was left at the mercy of poorly maintained DTC buses or the privately, run Blue Line Buses- better known as killer buses. Now DMRC has not only made the journey for the masses a pleasant experience, but also enabled them to complete the same journey in less than half the time it used to take earlier. Metro has thus made every journey of ours, a journey to remember. Here are some important, milestones covered by Metro before reaching to this glorious stage.

DECEMBER 25, 2002 - A DREAM COMES TRUE FOR DELHI

Over a million people join the first day rush for a Metro ride.

The first section of the Delhi metro from Shahdara to Tis Hazari which was inaugurated by Shri Atal Bihari Bajpayee,

the then Prime Minister of India, on December 24, 2002 at Seelampur Metro Station.

On Christmas Day, December 25, 2002 Delhi got a wonderful gift when commercial operations on the Shahdara – Tis Hazari section began at 6 a.m. On the first day itself, about 1.2 million people turned up to experience this modern transport system. As the initial section was designed to handle only 0.2 million commuters, long queues of the eager commuters wishing a ride formed at all the six stations on the line i.e., Shahdara, Welcome Colony, Seelampur, Shastri Park, Kashmere Gate and Tis Hazari. The rush was so massive that extra police had to be deployed to restrict entry into the Metro stations for the first week. For the first time in Delhi, commuters were introduced to the contact-less tokens for travel. Anticipating difficulty in using the new system, DMRC also prepared paper tickets to act as a temporary/ emergency substitute. These paper tickets were used on the first day, while the use of the automatic fare collection system stabilized. A large number of youngsters were also hired during the first two months as volunteers by DMRC to help commuters get used to the new system and technologies at (AFC) gates, escalators and on the platform.

After this, there was no looking back for the Metro and it kept on completing one project after another well within the schedule earmarked for them and some of them even ahead of their scheduled date of completion.

Some important Dates of commencement for commercial operations of Delhi Metro:-

- December 25, 2002: Shahdara-Tis Hazari Section of Line I
- October 3, 2003: Tis Hazari – Inderlok section of Line I
- March 31, 2004 Inderlok – Rithala section of Line I
- December 20, 2004: Vishwavidyalaya Kashmiri Gate Section of Line II
- July 3, 2005: Kashmiri Gate – Central Secretarial, Line II
- December 31, 2005: Barakhamba Road – Dwarka Section of Line III
- April 1, 2006: Extension into Dwarka subcity of Line III

- November 1, 2006 Barakhamba Road – Indraprastha Extn. Of Line III
- June 4, 2008: Shahdara – Dilshad Garden Line of Phase II

In fact, the name DELHI – METRO has now become synonymous with EFFICIENCY & RELIABILITY.

2. RATIONALE FOR METRO OR WHY THE NEED AROSE FOR METRO

Till 2001- 02, Delhi was the only big city in the world where the major part of the transportation needs of its people were met by only road-transport i.e., by buses, Autos & cars. Efforts have been made to increase this road network of Delhi as well as the fleet of buses, in a bid to keep pace with the ever increasing population as depicted below:-

Year	Length of Road Network
(>30 meters wide)	
1981	652 Kms.
1993	994 Kms.
2001	1122 Kms.
2021*	1340 * Kms. (*Project estimate)
Source RITES – 2005	

It is estimated that to meet the future transport demand by buses, the number of buses will increase by two and a half times and personal vehicles, by three (3) times. It is also estimated that approximately 150 kms of additional roads will be required to meet this future transport demand. Assuming these future roads will be 45 meters wide and taking into consideration the associated infrastructure such as fly-overs, bus terminals, bus depots, car parking areas etc., approximately 981 hectares of land will be required for this purpose. It would be very difficult to acquire so much of land in a place like Delhi. Hence the road related bus system alone is quite incapable of meeting the future demands of transport. Keeping the above in view, Govt. of India got many studies conducted to suggest a suitable MRTS (Mass Rapid Transit System) for Delhi. Delhi Metro emerged as a particularly viable MRTS in studies conducted by RITES. (1995 & 2005).

3. ENVIRONMENTAL IMPACT ASSESSMENT (EIA) OF DELHI METRO

The EIA of Metro involves collection of Baseline data which includes:-

3.1 Ground Water Hydrology

3.2 Flora & Fauna

3.3 Air Quality

3.4 Noise Levels

3.5 Socio-economics and Land use Pattern

3.6 Land Use/ Settlement

3.1 Ground Water Hydrology

The annual average rainfall in Delhi is about 660 mm-spread over two seasonal rainfalls. These are due to south-west and

north-east monsoon. About 75% of rainfall occurs due to south-west monsoon in the months of July to September. The depth of water table is observed between 3 to 7 meters below ground level. The slope of the water table is away from the ridge on either side. Hydraulic gradient is gentle and of the order of 1.8 to 2.0 meter per km. The ground water quality has not indicated any parameter likely to affect the under ground structures.

3.2 Flora & Fauna

There is no wildlife park/ reserve in DMRC Project area. Similarly no forest exists along the track in different Metro corridors. About 5000 trees of Neem, Pipal, Kikar, Eucalyptus, Bhor etc. are existing enroute. No rare or endangered species of trees has been noticed there.

DMRC is committed to maintain the greenery and nurturing trees. Route alignment has been modified to save about 15% of trees on the original routes, which would have been felled or cut. Also, as a matter of its environmental policy, DMRC plants 11 times the number of trees it is forced to cut during construction.

3.3 Air Quality

The main source of air pollution in Delhi are vehicles, thermal power plants and industry. Vehicles contribute about 70% of total ambient air pollution and they generally use petrol, diesel and CNG as fuel.

The Delhi Metro Project has resulted in tremendous environmental benefits for the city. The Metro has already taken the share of 40,000 vehicles (as per a study conducted in Oct. 2008). Apart from resulting in a saving of 60,000 tonnes of fuel, it has also resulted in that much reduction in air pollution (due to these 40,000 vehicles)

3.4 Noise Levels

A survey was conducted by British Railways to find out the difference between the noise levels created by Electric trains and Diesel handled trains & buses. The survey analysis indicated that the noise from electric trains drawing power from overhead wires like Metro causes Less Annoyance than equivalent noise from diesel hauled trains & buses.

3.5 Socio-Economics

Most of the routes of Delhi Metro are on Government lands. For future projects, about 4.25 hectares of land will be acquired from private owners and 300 jhuggis in Yamuna river area have to be removed. They have occupied the area illegally and may create rehabilitation/ resettlement problems.

The socio-economic pattern was assessed for these areas and the findings are:-

About 45% are squatters and have been staying on Govt. land.

30% have structures on leased land

25% have structures on their own land.

3.6 Land Use/ Settlement

Delhi Metro has added a 'Midas-touch' to each and every area of Delhi where it has reached so far. This is evident in view of the significant jump in the prices of real estate in those areas inspite of Global economic meltdown of 2008-2009. This has in turn resulted in a change in settlement pattern with people preferring to settle in areas as near to a Metro Station as possible.

4. NEGATIVE ENVIRONMENTAL IMPACTS

Following aspects have been considered here:

4.1 Impact due to project location

- (a) Rehabilitation & Resettlement
- (b) Drainage & Utility problems

4.2 Impact due to Project Design

4.3 Impact due to Project Construction.

- a) Soil erosion, pollution & Health Risk
- b) Traffic diversion and Risk to Existing Building
- c) Problem of Excavated Soil Disposal
- d) Dust Generation
- e) Increased Water Demand
- f) Impact due to supply of Construction Material
- g) Loss of Historical & Cultural Monuments
- h) Impact due to construction near Qutab Minar

4.4 Impact due to Project Operation

- a) Noise Levels
- b) Water demand & Sanitation
- c) Pedestrian Issues

4.5 Impact due to Depot

- a) Water Supply
- b) Sewage & Effluent
- c) Oil Pollution
- d) Noise Pollution
- e) Loss of Livelihood
- f) Impact due to filling of Area
- g) Impact on River Regime
- h) Surface Drainage

5. POSITIVE ENVIRONMENTAL IMPACTS

Based on project particulars and the baseline environmental conditions, potential impacts have been identified. Positive impacts have been discussed, under the following headings:

5.1 Employment Opportunities

The project is likely to be constructed and commissioned progressively over 5 years. About 5303 persons are likely to work during the peak period of construction activity. In post-construction phase, about 2300 people will be employed for operation and maintenance of the system. In all about 26,500 man year will be employed due to the project construction. In addition to these, more people would be indirectly employed in allied activities.

5.2 Enhancement to Rural Economy

The metro project corridors will facilitate the rural population to move from one end of the city to another end and from one State to another State in the NCR to buy and sell off their produce. With the development of Metro it is likely that more people will be involved in trade, commerce and allied services. The project will make it convenient for people to move in rural areas. This will reduce population pressure in Delhi Urban Area and will be a boon to rural economy.

5.3 Quick Service and Safety

The optimized network is estimated to carry 22.5 and 28.70 million passenger-trips per day in year 2011 and 2021 respectively. The optimized network is estimated to save passenger time by about 50%. It is reported that on an average, six persons die in road accidents everyday in Delhi. This is likely to increase to 8 by year 2021. Metro will provide, improved safety and will lower the accidental deaths.

5.4 Less Fuel Consumption

Upon the implementation of Metro project, both petrol and diesel consumption will be reduced significantly. The savings will be due to two factors namely:

- Reduction in vehicles, and
- Decongestion on roads.

It is estimated that about 7 million litres of Diesel, 31.5 million litres of petrol and 18.68 million kg of CNG will be saved due to the Metro project phase – II. This will benefit in foreign exchange savings to the tune of Rs. 1722.24 million.

5.5 Reduction in Air Pollution

It is estimated that yearly there will be a reduction of air pollutants upto 5884.35 tonnes due to implementation of phase – II. The total reduction of air pollution due to Phase I & II will be around 22755 MT/ year.

6. ENVIRONMENTAL ASSESSMENT

Environmental assessment can be effectively used for inter-comparison various alternative systems. Based on environmental impacts a checklist is prepared as follows:

CHECKLIST OF IMPACTS

S. No.	Parameter	No Impact	Negative Impact	Positive System
A Impacts due to Project Location				
1.	Rehabilitation and Resettlement		*	
2.	Change of land use and Ecology		*	
3.	Impact on Historical/Cultural Monuments	*		
4.	Drainage and utilities problems		*	
B Impacts Due To Project Design Construction				
1.	Platforms inlets and outlets	*		
2.	Ventilation and lighting	*		
3.	Railway Station Refuse		*	
4.	Risk Due to Earth Quakes	*		
C Impact Due To Project Construction				
1.	Soil Erosion pollution and health risk at construction site		*	
2.	Traffic diversions and risk to existing buildings		*	
3.	Soil disposal problem and seepage risk		*	
D Impact Due To Project Operation				
1.	Oil Pollution		*	
2.	Noise and Vibration		*	
3.	Water Demands		*	
E Positive Environmental Impacts				
1.	More Employment Opportunities			*
2.	Enhancement of Economy			*
3.	Quick service and safety			*
4.	Traffic Congestion Reduction			*
5.	Less Fuel Consumption			*
6.	Less Air Pollution			*
7.	Carbon dioxide reduction			*
8.	Reduction in Number of buses			*
9.	Saving in Road infrastructure			*

7. ENVIRONMENTAL MANAGEMENT PLAN

Most of the environmental issues are likely to arise during construction and operation phases. These will be mitigated or reduced by incorporating an environmental management plan into the project cycle as follows:

7.1 Rehabilitation and Resettlement

The project involves the displacement of 300 Jhuggis in unauthorized areas, and 358 families likely to be affected due to land acquisition. These will affect about 2632 people. About Rs. 330.2 million will be paid as compensation for relocation of shops, commercial cum residential buildings and hutments likely to be affected due to the project along the alignment.

7.2 Compensatory Afforestation

According to the results of the present study, it is found that about 5147 trees are likely to be lost due to the project. Ten trees have to be planted for each tree cut. Hence 51470 trees to be planted. These trees would have occupied about 43 hectares in the forest. No non-forest land is available, hence 43 hectares have to be re-afforested in degraded forests in Delhi. In addition to these efforts need to be made to plant trees at appropriate places on completion of the works along the road and rail alignment. Cost of afforestation is about Rs. 35,880/- per hectare. Compensatory re-afforestation cost will thus be about Rs. 15.42 lakhs including road side plantation. The indigenous tree species such as Neem, Sisso, Eucalyptus, Acacia, Ashok and Jamun are recommended for plantation.

7.3 Draining of water from tunnel

The water table generally varies from 3 to 7 meters which rises to about 2 meters during monsoon season in low lying areas. Suitable piezometers will be installed to monitor the water table constantly and to see how much it gets lowered and recharged accordingly. About 3.6 m³/hr per meter length seepage water is likely to come into the tunnel which will be pumped out and discharged into storm water drains. Suitable water collection drain, need to be constructed on the side retaining structure to collect seepage water during operation phase.

7.4 Soil Disposal

As noted earlier, construction activities will generate 1.20 MM³ (Million Cubic Meter) of soil causing excavated soil disposal problem. This can be mitigated by utilizing around 0.3 MM³ in filling and the balance will be disposed of at suitable location.

7.5 Utility Restoration

These are mainly water supply and sewer pipe, storm water drains, telephone cables, over head transmission lines, electric poles, traffic signals etc. These utilities are essential and have to be maintained in working conditions during different stages

of construction, by temporary/ permanent diversions or by supporting in position.

7.6 Noise & Vibration control

For elevated corridors, ballast less track structure is supported on two layer of rubber pads to reduce noise and vibrations. In addition, baffle wall as parapets will be constructed up to the rail level so as reduce sound levels. Noise at source will be controlled or reduced by incorporating suitable feature in the design of structures and layout of machines and by use of resilient mounting and dampers etc.

To reduce the harmful effects of point sources of high levels of noise, operators duty hours in the vicinity must be restricted and personal protection measures such as ear plugs could be issued to them for use. Periodical automatic examination of such personnel for testing hearing ability would also become necessary.

7.7 Management Plans for Depot

- (i) **Water Supply and Sanitation:-** About 1056 m³ (cubic meter) of water per day will be required for operation and functioning of depot. This could be either collected from Municipal Corporation or through boring tube well into the ground.
- (ii) **Oil Pollution control:-** The oil tends to form scum in sedimentation chambers, clog fine screens, interfere with filtration and reduce the efficiency of treatment plants. Hence oil and grease removal tank has to be installed at initial stage of effluent treatments.
- (iii) **Effluent Pollution Control:-** About 80% of domestic water supply will available as sewage, hence about 25 m³ of sewage is likely to be generated. The sewage could be treated up to the level so that it could be used for horticulture purpose in the campus and can also be discharged into the stream.
- (iv) **Provision for Green belt development:-** In addition to augmenting present vegetation, it will also check soil erosion, make the ecosystem more diversified and functionally more stable, make the climate more conducive and restore balance.
- (v) **Provision of Rainwater harvesting:-** It has been proposed to construct roof top rainwater harvesting structure of suitable capacity in the construction depot site.

7.8 Disaster Management

To ensure proper disaster management, an Emergency Action Committee will be constituted, consisting of officers from Metro, Railway, Police, Health, Central and Delhi Governments.

7.9 Emergency Lighting

The emergency light operated on battery power is to be provided for each station.

7.10 Fire Protection

The building materials will be of appropriate fire resistance standard. The materials which have zero surface burning characteristics will be used to the extent possible. The design of stations will include provision for fire prevention and control measures, Fire detection systems, Means of escape, Access for firemen and Means of fire fighting. All aspects of fire prevention and control will be dealt in close liaison with the city fire fighting authority.

8. ENVIRONMENTAL MONITORING PROGRAMME

Environmental monitoring programmes are vital to assess the effectiveness of environmental management plans. The monitoring will be required during construction and operational phases for the following:-

Rehabilitation and Resettlement programme,

Afforestation,

Water quality

Soil disposal and conservation, and

Sanitation and waste disposal.

An Environment Division is proposed in Metro Authority to effectively carryout above activities.

9. CONCLUSION

- The following main benefits of the Metro have been reported in this paper:-
- Delhi Metro will reduce the need for personalized transport.
- This will lead to reduction in growing road congestion which causes slow movement of vehicular traffic and results in fuel wastage and increased emissions.
- Thus, Delhi Metro will arrest the rapidly increasing road transport pollution load.
- This will bring about substantial saving in fuel consumption (about 7 million litres of diesel, 31.5 million liters of petrol and 16.68 million kgs of CNG as reported in the text)
- This will finally lead to huge saving in foreign exchange to the tune of Rs. 1722 million.

Impacts as discussed above on natural resources, terrestrial and ecology of the area do not appear to be significant and could be mitigated with available know-how in technology. Based on environmental baseline data, prediction of positive and negative impacts and assessment, it could be concluded that the project will bring benefit at local and global levels. In nutshell it could be concluded that the Delhi Metro project is environmentally sustainable and eco-friendly.

REFERENCE

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