

RATIONALE

Following contents were prepared for the purpose of the JICA Environmental Review for Delhi Metro Phase IV Priority Corridors. Descriptions and analyses in this document are the most updated information against the Revised EIA for Priority Corridors of Delhi Metro Phase IV in June 2020.

Upon finalization of the contents based on the JICA environmental review, DMRC will compile all addendum and corrigendum into one document and disclose it on DMRC web site with the Revised EIA for Priority Corridors of Delhi Metro Phase IV. The addendum/corrigendum may also be disclosed at JICA website if it is required.

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2. PROJECT DESCRIPTION

2.2 ALTERNATIVE ANALYSIS

The purpose of analysis of alternatives is to find the most effective way of meeting the need and purpose of the project, either through enhancing the environmental benefits of the proposed activity and or through reducing or avoiding potentially significant negative impacts, so that project will become environment as well as people-friendly. The primary objectives of an analysis of alternatives are to identify alternate project options at a systemic (technology, route or alignment, etc.), and as well as engineering (materials, construction methods, operating practices, etc.) levels. An analysis of alternatives, conducted early into the project design and planning stage, helps identify more cost-effective alternatives, reduce adverse impacts and risks, improve performance and validate the appropriateness of the selected option.

In the present phase IV metro project, out of six corridors, three priority corridors of the proposed Delhi Metro Phase IV project have been finalized after taking into account of environmental and social concerns, considerations of traffic, integration with the existing system and importantly, the overall economic and financial viability. The underlying principles for evaluation for each corridor, without affecting the overall usefulness of the corridor, are:

- ❖ Minimum private land acquisition,
- ❖ Least disturbance to properties,
- ❖ Minimum disturbance to people and
- ❖ Minimum disturbance to existing trees and plans/localized ecology and biodiversity.

The 'with' and 'without' project scenarios are analyzed concerning the development of the metro routes by the backdrop of the requirement of reliable quality infrastructure for safe and faster travel. With project, it will provide better, safe and faster connectivity and will ensure that people from areas covered by the project can move in and out of the areas more efficiently.

Without this project, it is expected that there will be an increase in air pollution and exhaust emission due to slow-moving heavy traffic and congestion. Travel will take longer thus impacting productivity and reducing the economic growth of the area. Overloading of existing transport infrastructure will also affect safety and lead to loss of human life due to the increase in accidents.

2.2.1 Long Term Scenario "With" and "Without" Project

Qualitative analysis of the long-term scenarios likely to occur "with" and "without" project scenario is presented in **Table 2.2.1**. The "with" project scenarios will, however, occur only if the recommendations provided in mitigation measure and EMP for the construction stage will be followed and all construction activities will be carried out according to principles of Environment-Friendly Construction.

Table 2.2.1: “With” and “Without” Project Scenarios.

Scenario type	Long-Term Scenario “With” Project	Long-Term Scenario “Without” Project
Environment		
Physical Environment		
Atmosphere and Climate	Travel time and traffic congestion will reduce as a result of the proposed new metro corridor. Overall, an insignificant level of air pollution. Due to the small section of the route, no change in climatic condition is anticipated	Congested road will consume more travel time and will increase air pollution/ exhaust emission. No change in climatic condition
Noise and vibration	Noise will reduce due to the underground routes, but localized vibration will slightly increase	Both noise and vibration will deteriorate further
Soil and drainage	No major impact on existing soil conditions. There is a significant change in underground drainage pattern due to the proposed route which will adversely impact the localized environmental condition.	As it is there are no changes in present problems associated with inadequate drainage.
Geology and Seismology	No significant Impact envisages on seismology however, the geology will get impacted but as compared to the project benefit it will be negligible.	No change as it is
Ecological Environment		
Flora	Due to proposed project around 10,438 trees will be felled. However, 1,04,380 saplings will be planted (@1:10).	No change in vegetation and the number of trees. No change in present land use
Fauna	The proposed alignment either underground or elevated is running through the urban area because of that, there is no impact on fauna is envisage.	Continued, and possibly increased disturbance to the localized fauna
Social and Cultural Environment		

Scenario type	Long-Term Scenario <i>“With”</i> Project	Long-Term Scenario <i>“Without”</i> Project
Social and Cultural Environment	<p>Increased comfort and safety while travelling.</p> <p>An improved business environment for those living along the project corridor. Once the project becomes operational, it will result in the reduction of GHG emission. Significant reduction in fuel consumption due to expected modal shift in vehicles</p> <p>The proposed project will cause a permanent land acquisition of about 19.12 Ha.</p> <p>Due to the construction of the tunnel will save the impact on the archaeological site. Following archeological sites are within the regulated zone and the alignment in these areas is underground and construction is proposed by TBM except Tomb of Shah Alam where alignment is proposed as elevated.</p> <ol style="list-style-type: none"> 1. Tughlakabad Fort, 2. Ghiyasuddin Tomb, 3. Nai-ka-kot, 4. Adilabad Fort, 5. Tomb of Shah Alam, 6. Tripolia Gate, 7. Roshnara Bagh 	<p>Travelling may increase time, thereby transportation costs will increase.</p> <p>Reduction in comfort and safety due to congestion and deterioration in road condition.</p> <p>Business opportunities remain largely the same as before.</p> <p>No reduction in GHG emission reduction. Higher fuel consumption due to the increased number of private vehicles.</p>
Connectivity	Improve the connectivity between the various interlinked center	No change
Institutional Requirements		
Training of PIU	<p>Training needs to be provided to relevant PIU officials to improve their environmental monitoring capacity during and after project construction.</p> <p>More staff will need to be recruited at the PIU office to enable smooth flow of all paperwork with regard to implementation of environmental policies and regulations as per the MOEFCC and JICA guidelines</p>	No institutional strengthening is required.
Economic Situation		
Financial Implications	Higher capital costs for underground routes and using Environmentally Friendly techniques during civil work. Costs will also be incurred for the training of PIU officials if required.	No capital costs. However, increasing road maintenance and vehicle operating costs as road deteriorates and as travel times increase.
Development	Surrounding the project more development will take place	No change
Overall		

Scenario type	Long-Term Scenario “With” Project	Long-Term Scenario “Without” Project
	<p>Long term improved socio-economic and environmental conditions but an increase in expenses for project activities during project construction.</p> <p>However, with project scenario have lots of positive impacts like –reduced travel cost, reduced travel time, reduced exhaust emission, reduced fuel consumption, reduced GHG emission, also enhancing employment and economic growth of the area.</p>	<p>Small deteriorations in environmental conditions, no increase in economic opportunities and increased expenses associated with maintenance.</p>

In case the phase IV of Delhi Metro is not constructed, the city will be deprived of the following benefits:

- ❖ Employment Opportunities,
- ❖ Enhancement of Economy,
- ❖ Mobility,
- ❖ Safety,
- ❖ Traffic Congestion Reduction, Reduction in Number of Buses,
- ❖ Reduced Fuel Consumption,
- ❖ Reduced Air Pollution,
- ❖ Carbon Dioxide and Green House Gases (GHG)Reduction,
- ❖ Saving in Road Infrastructure.

Since the positive impacts are more than a few localized short-term negative impacts, consideration of ‘no development alternative’ is a non-starter and has thus not merited any further consideration.

Without the project, congestion constrains the long-term attractiveness and potential impact of the regular bus service and with project scenario avoiding congestion problems appear to be an excellent alternative for public transport. The construction of the project will offer more equitable access to transport choices for passengers wishing to access employment, education or commercial facilities.

Development of new high capacity, high-frequency public metro route system from Aerocity to Tughlakabad, Janakpuri West to R.K. Ashram and Mukundpur-Maujpur corridors have the potential to cater for existing and future passenger demand and will relieve congestion on the road corridor and the existing public transport network. Besides, this form of public transport will significantly benefit the environment. The project will, therefore, be of benefit to the population in the project area.

2.2.2 Alternative Scenarios for Mukundpur – Maujpur Corridor

This section deals with the rationales behind the preferred choice. The final proposed alignment option at the DPR Stage is named as Alternative 1, while the other alternate alignments which were studied at planning stage are named as Alternative 2 and Alternative 3.

Alternative 1—This corridor is an extension of Mukundpur- Rajouri Garden-INA- Nizamuddin - Anand Vihar–Shiv Vihar Corridor of Phase-III of Delhi Metro. The complete corridor is elevated and has eight stations. The corridor starts at Maujpur and terminates at Majlis Park station of Phase-III. In this case, alignment was changed from Yamuna Vihar to Khajuri Khas to save private property demolition and to meet the curve of 200m. Also, water pipeline under service road was saved by changing the alignment. Alignment from Soorghat to Burari was on the right side of the road to maximize the ridership. In the final alignment, location of Soorghat Station was shifted as it was coming within the 100 m periphery of Shah Alam Tomb. No new depot has been proposed for this corridor. The existing depot at Mukundpur will be augmented to fulfill the requirements from this corridor.

Alternate 2 - This alternative is the second alignment selected at the planning stage. This alignment is similar to Alternative 1 from Maujpur to Sonia Vihar station. In this option also, the corridor starts at Maujpur and terminates at Majlis Park. However, in this alternative scenario, Soorghat to Burari section of the alignment was on the left side of the road which had a negative impact in terms of ridership. In this scenario also the corridor was completely elevated and had eight stations.

Alternative 3 - This alternative is the initial alignment selected at the planning stage. In this option also, the corridor starts at Maujpur and terminates at Majlis Park. However, alignment was through the service road from Yamuna Vihar to Khajuri Khas resulting in demolition of several private buildings. The Khajuri Khas station was coming on the O-Zone. The rest of the alignment from Khajuri Khas to Majlis Park was on the left-hand side of the outer ring road. The alignment was passing through the prohibitory zone of ASI monument "Shah Alam Tomb". In this scenario also the corridor was completely elevated and had six stations.

Comparison of Alternatives

It is evident from the above that all the three alternatives have some advantage and disadvantage in terms of cumulative impact-environmental, social etc. On the assessment of the advantages and disadvantages of the three alternatives and certain limitation, it is considered that **Alternative 1** is the most preferred option. Since land acquisition is very less as compared to other options and also it will serve for more people. Cost of project is also low, however more trees are getting impacted as compare to other 2 options which will be compensated under compensatory afforestation so that impact on localized ecological balance will be negligible. The comprehensive comparison of three alternatives is summarized and presented in Table 2.2.2.

Table 2.2.2: Comprehensive Comparison of Three Alternatives

Sl. No.	Issues	Alternative 1	Alternative 2	Alternative 3
1.	Length and no. of stations	12.558 km and 8 stations	12.54 km and 8 stations	12.54 km and 6 stations
2.	Length of elevated section and no. of elevated stations	12.558 km and 8 stations	12.54 km and 8 stations	12.54 km and 6 stations
3.	Length of underground section and no. of underground stations	Nil	Nil	Nil
4.	No. of Depots	0	0	0
5.	Safety	High Safety Standard	High Safety Standard	High Safety Standard
6.	Permanent Land requirement	0.62 Ha	6.3 Ha	6.57 Ha
7.	No. of trees to be felled	1,990	Approx. 1100	Approx. 990
8.	No. of ASI protected archaeological structures within the 100m periphery (prohibitory zone) of the alignment	Nil (Shah Alam Tomb – 108m)	Nil (Shah Alam Tomb – 108m)	1 (Shah Alam Tomb – within 100m prohibitory zone)
9.	Construction duration	30 months	30 months	30 months
10.	Impact on the Environment	<ul style="list-style-type: none"> - No station construction on Yamuna Riverbed - C&D waste disposal - Cutting of 1990 trees 	<ul style="list-style-type: none"> - No station construction on Yamuna Riverbed - C&D waste disposal - Cutting of approx. 1100 trees 	<ul style="list-style-type: none"> - Station construction on Yamuna Riverbed - C&D waste disposal - Cutting of approx. 990 trees
11.	No. of structures affected	0	Approx. 2	Approx. 50
12.	Issues of noise and vibration	Issue of noise during construction and operation	Issue of noise during construction and operation	Issue of noise during construction and operation
13.	Approx. cost	Rs. 2190 Cr	Rs. 2897 Cr	Approx. Rs. 2500 Cr
14.	Conclusion	This is the most desirable plan.	This plan is inferior to ALT1.	This plan is inferior to ALT1 and ALT2.

2.2.3 Alternative Scenarios for Aerocity–Tughlakabad Corridor

The final proposed alignment option at the DPR Stage is named as Alternative 1, while the other alternate alignments which were studied at planning stage are named as Alternative 2 and Alternative 3.

Alternative 1 – This corridor originates from Aero City; adjacent to an existing station on the Airport Express line and passes through Mahipalpur, Vasant Kunj D-Block, Masoodpur, Kishangarh, Chattarpur, Chattapur Mandir, IGNOU, Neb Sarai, Saket G-Block, Khanpur, Tigri, Anandmayee Marg and terminates at Tughlakabad where it has passenger interchange with existing Tughlakabad Station of Line-6. This stretch is partially elevated and partially underground. From Aerocity till Saket-G Block the alignment is underground. It emerges out from underground section to elevated section after Neb Sarai Station. The first elevated station is Saket-G Block. Alignment continues to run along the Mehrauli

– Badarpur road as elevated section till Anandmayee Marg Station. Here the alignment further changes from elevated section to the underground section and remains underground till Tughlakabad. The corridor has eleven underground stations and four elevated stations. No new depot has been proposed for this corridor. The existing depot at Sarita Vihar will be augmented to fulfil the requirement from this corridor. This alignment completely excludes the Mehrauli Archaeological area and the Tughlakabad archaeological area.

Alternative 2 -This alternative is the first alignment selected at the planning stage. In this option also, corridor originates from Aero City; adjacent to an existing station on the Airport Express line and passes through Mahipalpur, Vasant Kunj D-Block, Masoodpur, Kishangarh, Mehrauli, Ladoo Sarai, Saket, Saket G-Block, Khanpur, Tigri, Anandmayee Marg and terminates at Tughlakabad where it has passenger interchange with existing Tughlakabad Station of Line-6. In this alternative also, no new depot was proposed. Like alternative-1 the alignment was partially elevated and partially underground. However, unlike alternative-1, this alignment was planned to pass through Mehrauli and Tughlakabad archaeological areas. Major Archaeological Survey of India (ASI) protected monuments along the corridor included Bhul Bhulliya, Qutub Minar and Tughlakabad Fort.

Alternative 3 -This alternative is the second alignment selected at the planning stage. This alignment is similar to Alternative-2 except for one major difference that a new depot was proposed at Rangpuri Pahari area. It is about 1.2 km away from Vasant Kunj D-block Station. Depot connectivity has been planned from Vasant Kunj D-block Station.

Comparison of Alternatives

It is evident from the above that all the three alternatives have some advantage and disadvantage in terms of cumulative impact-environmental, social etc. On the assessment of the advantages and disadvantages of the three alternatives and certain limitation, it is considered that **Alternative 1** is the most preferred option. Since land acquisition is less and very less structures are affected as compared to other options. It will also serve for more people. There are very less archeological structures compare to other options. However more trees are getting impacted as compare to alternative 2 which will be compensated under compensatory afforestation so that impact on localized ecological balance will be negligible or insignificant. The comprehensive comparison of three alternatives is summarized and presented in Table 2.2.3.

Table 2.2.3: Comprehensive Comparison of Three Alternative

Sl. No.	Issues	Alternative 1	Alternative 2	Alternative 3
1.	Length and no. of stations	23.622 km and 15 stations	20.234 km and 15 stations	21.34 km and 15 stations
2.	Length of elevated section and no. of elevated stations	4.29 km and 4 stations	5.72 km and 5 stations	6.83 km and 5 stations
3.	Length of underground section and no. of underground stations	19.343 km and 11 stations	14.52 km and 10 stations	14.52 km and 10 stations
4.	No. of Depots	0	0	1
5.	Safety	High Safety Standard	High Safety Standard	High Safety Standard
6.	Land requirement	7.4 Ha	8.851 Ha	28.851 Ha
7.	No. of trees to be felled	5,302	Approx. 823	Approx. 6000
8.	No. of archaeological structures	4 (non with in prohibitory zone)	15	15
9.	Construction duration	36 months	42 months	48 months
10.	Impact on the Environment	<ul style="list-style-type: none"> - Loss of trees (5302) - C&D waste management - No impact on Fauna 	<ul style="list-style-type: none"> - Loss of trees (approx. 823) - C&D waste management - No impact on Fauna 	<ul style="list-style-type: none"> - Loss of trees (approx. 6000) - C&D waste management - No loss on Fauna - Construction in Ridge area
11.	No. of structures affected	47	272	272
12.	Issues of noise and vibration	Noise pollution in elevated corridor and vibration issue in underground corridor	Noise pollution in elevated corridor and vibration issue in underground corridor	Noise pollution in elevated corridor and vibration issue in underground corridor
13.	Approx. cost	Rs. 8231 Cr	Rs. 7359Cr	Approx. 10,000 Cr
14.	Conclusion	This is the most desirable plan.	This plan is inferior to ALT1.	This plan is inferior to ALT1 and ALT2.

2.2.4 Alternative Scenarios for Janakpuri West - R K Ashram Corridor

The final proposed alignment option at the DPR Stage is named as Alternative 1, while the other alternate alignments which were studied at planning stage are named as Alternative 2 and Alternative 3.

Alternative 1 – This corridor is an extension of Kalindi Kunj-Janakpuri West Corridor of Phase-III of Delhi Metro. From Janakpuri West (operational underground station of Phase-III) this corridor takes left turn to fall on Dr. Hedgewar Marg (outer ring road) and first station in this corridor is Krishna Park Ext. The alignment becomes elevated after Krishna Park station and runs parallel to the outer ring road. From Mukundpur Red Light on outer ring road, this alignment takes a right turn towards Azadpur and passes through Majlis Park, Panch Vati and Gopal Nagar Area. Up to Ashok Vihar the corridor is elevated. After Ashok Vihar, the alignment becomes underground and generally passes under G.T. Road. The underground alignment passes through Model Town, Derawal Nagar, Ghanta Ghar, Subji Mandi, Pulbangesh, Sadar Bazar, Motia Khan and finally terminates at Ram Krishna Ashram Marg where it has passenger interchange with existing Ram Krishna Ashram Marg Station of Line-3. No new

depot has been proposed for this corridor. The existing depot at Mukundpur will be augmented to fulfill the requirement from this corridor. From the planning stage alignment has been modified between Derawal Nagar and Ghanta Ghar to avoid ASI monument Tripolia Gate. Rajpura station proposed in the planning stage has also been done away with. Another Major change is Krishna Park station has been changed from elevated to underground.

Alternative 2 – This alternative is the first alignment selected at the planning stage. Like alternative-1 the alignment was partially elevated and partially underground. However, monument Tripolia Gate. An underground station was proposed at Rajpura and Krishna Park unlike alternative-1, this alignment was planned to pass through Archaeological Survey of India (ASI) Ext station was elevated. In this alternative also, no new depot was proposed.

Alternative 3 - This alternative is the second alignment selected at the planning stage. This alignment is similar to Alternative-2 except for one major difference that a new depot was proposed at Mangol Puri Industrial Area by the side of Northern Railway Line for depot. The area requirement of the depot was 23 Ha.

Comparison of Alternatives

It is evident from the above that all the three alternatives have some advantage and disadvantage in terms of cumulative impact-environmental, social etc. On the assessment of the advantages and disadvantages of the three alternatives and certain limitation, it is considered that **Alternative 1** is the most preferred option. Since land acquisition and number of structures affected are also very less as compared to other options and also it will serve for more people. No archeological structures (within the prohibited zone) within the vicinity of alternative 1. Cost of project is also low, however more trees are getting impacted as compare to other 2 options which will be compensated under compensatory afforestation so that impact on localized ecological balance will be ---- consider as negligible. The comprehensive comparison of three alternatives is summarized and presented in Table 2.2.4.

Table 2.2.4: Comprehensive Comparison of Three Alternatives

Sl. No.	Issues	Alternative 1	Alternative 2	Alternative 3
1.	Length and no. of stations	28.92 km and 21 stations	28.92 km and 28 stations	28.92 km and 28 stations
2.	Length of elevated section and no. of elevated stations	21.18 km and 14 stations	21.18 km and 18 stations	21.18 km and 18 stations
3.	Length of underground section and no. of underground stations	7.74 km and 7 stations	7.74 km and 7 stations	7.74 km and 7 stations
4.	No. of Depots	0	0	1
5.	Safety	High Safety Standard	High Safety Standard	High Safety Standard
6.	Land requirement	11.09 Ha	21.41 Ha	38.03 ha
7.	No. of trees to be felled	3,829	Approx. 1,584	Approx. 1,584 + trees at the depot location
8.	No. of archaeological structures within the 100m periphery (prohibitory zone) of the alignment	0	2	2
9.	Construction duration	36 – 42 months	36 – 42 months	36 – 48 months
10.	Impact on the Environment	<ul style="list-style-type: none"> - Loss of trees (3829) - C&D waste management - No impact on Fauna 	<ul style="list-style-type: none"> - Loss of trees (approx. 1584) - C&D waste management - No impact on Fauna 	<ul style="list-style-type: none"> - Loss of trees (approx. 1584 + trees at depot area) - C&D waste management - No impact on Fauna
p11.	No. of structures affected	23	169	169
12.	Issues of noise and vibration	Noise pollution in elevated corridor and vibration issue in underground corridor	Noise pollution in elevated corridor and vibration issue in underground corridor	Noise pollution in elevated corridor and vibration issue in underground corridor
13.	Approx. cost	Rs. 9349 Cr	Rs. 9558 Cr	Approx. Rs. 10500 Cr
14.	Conclusion	This is the most desirable plan.	This plan is inferior to ALT1.	This plan is inferior to ALT1 and ALT2.

2.2.5 Conclusion of the Alternative Analysis with Environment and Social Considerations

Limited analysis of alternatives was done due to the limited option for the metro route. However, the alignment of the above corridors is so selected that they will serve the maximum population, will entail less private land acquisition, least demolition of private and government structures and will avoid impact on archaeological and historical structures. However, slightly more trees are getting impacted as compare to the other two options. Compensatory afforestation as well as station area plantation has been proposed to minimize the tree cutting impact on local ecology proposed development will become environment friendly. To achieve the above goals, the alignment suggested is mainly on the central verge of the road. In the highly densely populated area, the alignment is kept under the ground so as to lessen the social impacts that may have resulted from the acquisition of property. Similarly, to protect the archaeological/historical monuments, the proposed metro corridors near the monuments are

underground except Shah Alam Tomb where alignment is elevated. The entire underground section will be constructed by tunnelling through State of Art Tunnel Boring Machine (TBM). The existing depots will be utilized for these priority corridors. The details of phase IV priority corridors are given in Table 2.2.5.

Table.2.2.5: Details of Phase IV Part Priority Corridors

S.No.	Corridor	Under-ground	Elevated /at Grade	Total Length (km)	Stations (Nos)		
					Under-ground	Elevated	Total
1.0	Aerocity to Tughlakabad	19.343	4.279	23.622	12	4	16
2.0	Janakpuri West to R.K. Ashram	7.740	21.180	28.920	7	14	21
3.0	Mukundpur-Maujpur	0.000	12.558	12.558	0	8	8
Total		27.083	38.017	65.100	19	26	45

2.2 Maintenance Depots

The following contents have been added incorporated in the EIA report to describe the impacts due to augmentation/expansion of existing depots for Delhi Metro Phase-IV priority corridors:

Sl. No	Existing clause of EIA2020	Added in Section	Content (comment)
2.	2.5 Maintenance Depots (components)	2.5 – Maintenance Depots	In priority corridors of Delhi MRTS Phase – IV, Construction of New Depot is not planned. Existing depot at Mukundpur will be strengthened by augmenting facilities to serve the extension of Line – 7 (Maujpur – Mukundpur) and Line – 8 (Janakpuri West – R.K. Ashram) corridors. The existing depot of Line – 6 at Sarita Vihar will be used for Tughlakabad – Aerocity Corridor.
4.2 ENVIRONMENTAL IMPACTS			
3.	4.2.2 Impacts due to Project Design if any	--	<i>(No impacts are envisaged due to Project Design on account of augmentation of existing depot)</i>
4.	4.2.3 Impact due to Project Construction most likely minimal impacts but such statement within the depo area or limited to depo and surrounding area without any temporary land lease, etc.	5.2.3.M – Impact due to depot construction	5.2.3.M. Impact due to depot In priority corridors of Delhi MRTS Phase – IV, Construction of New Depot is not planned. Existing depot at Mukundpur will be strengthened by augmenting facilities to serve the extension of Line – 7 (Maujpur – Mukundpur) and Line – 8 (Janakpuri West – R.K. Ashram) corridors. The existing depot of Line – 6 at Sarita Vihar will be used for Tughlakabad – Aerocity Corridor. The expansion works will be carried out within the existing depot boundary. Therefore, no land acquisition and related impacts are envisaged. Also no major excavation and civil construction works are also proposed hence, no environmental impacts envisaged.
5.	4.2.4 Impacts due to Project Operation if any	5.2.4.F – Impact due to Depot Operation	5.2.4.F IMPACTS DUE TO DEPOT In priority corridors of Delhi MRTS Phase–IV, Construction of New Depot is not planned. Existing depot at Mukundpur will be strengthened by augmenting facilities to serve the extension of Line – 7 (Maujpur – Mukundpur) and Line – 8 (Janakpuri West – R.K. Ashram) corridors. The existing depot of Line – 6 at Sarita Vihar will be used for Tughlakabad – Aerocity Corridor. The provision of additional civil works has been made in Non – JICA financed civil works contracts. Other minor works as required will be met out of physical contingencies. The likely impacts due to strengthened by augmenting facilities at these existing depots are; Water Supply The water will be required for train washing purpose and for other requirement (Departments and Contractors office). A three day cycle is

		<p>assumed for outside Cleaning (wet washing on automatic washing plant). Estimated water demand for car washing in year 2041 is 1498 KLD at Mukundpur Depot and 108 KLD for Sarita Vihar Depot. This water will be sourced from the existing bore wells at each Depot. Hence, there will be no negative impact on the residents living in the vicinity of tube wells whose water demand is, in any case, met by municipal water.</p> <p>Effluent Generation</p> <p>The estimate effluent that will be generated from the washing of trains at the depots are about 1348 KLD at Mukundpur Depot and 97 KLD for Sarita Vihar Depot. The wastewater will be treated and will be recycled to use at depot horticulture purpose. Based on past experience in similar projects the wastewater characteristics could be as reported in Table 5.14.</p> <p style="text-align: center;">Table 0.6: Effluent Characteristics</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>S. NO.</th> <th>PARAMETER</th> <th>UNIT</th> <th>EFFLUENT</th> </tr> </thead> <tbody> <tr> <td>1.</td> <td>pH</td> <td>---</td> <td>6-8.5</td> </tr> <tr> <td>2.</td> <td>BOD</td> <td>mg/l</td> <td>150</td> </tr> <tr> <td>3.</td> <td>Suspended Solids</td> <td>mg/l</td> <td>500</td> </tr> <tr> <td>4.</td> <td>COD</td> <td>mg/l</td> <td>300</td> </tr> <tr> <td>5.</td> <td>Oil and Grease</td> <td>mg/l</td> <td>500</td> </tr> <tr> <td>6.</td> <td>Detergents</td> <td>mg/l</td> <td>100</td> </tr> </tbody> </table> <p>Oil Pollution</p> <p>Oil spillage during change of lubricants, cleaning and repair processes, in the maintenance Depot cum workshop for maintenance of rolling stock, is very common. The spilled oil should be trapped in oil and grease trap. The collected oil would be disposed off to authorised collectors, so as to avoid any underground/ surface water contamination.</p> <p>Noise Pollution</p> <p>The main source of noise from depot is the operation of workshop. The roughness of the contact surfaces of rail and wheel and train speed are the factors, which influence the magnitude of rail - wheel noise. The vibration of concrete structures also radiates noise. Due to less activity, no impact on the ambient noise is anticipated.</p> <p>Solid Waste</p> <p>It is estimated that about 0.18 Ton per month of solid waste will be generated from each of the</p>	S. NO.	PARAMETER	UNIT	EFFLUENT	1.	pH	---	6-8.5	2.	BOD	mg/l	150	3.	Suspended Solids	mg/l	500	4.	COD	mg/l	300	5.	Oil and Grease	mg/l	500	6.	Detergents	mg/l	100
S. NO.	PARAMETER	UNIT	EFFLUENT																											
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			Depot sites which will be taken by the cleaning contractor weekly and disposed to the MCD waste disposal sheds. Sludge will be generated from ETP, oil and grease will be produced from car maintenance and iron turning of the PWL for the wheel profiling will be generated from each of the metro Depot.
6.1 Mitigation Measures			
6.	6.1.2 Construction Material Management if any	--	<i>(Not applicable)</i>
7.	6.1.8 Utility Plan if any	7.1.8 – Utility Plan	<p><i>Following content has been added to the existing clause 7.1.8</i></p> <p>In priority corridors of Delhi MRTS Phase – IV, Construction of New Depot is not planned. Existing depot at Mukundpur and Sarita Vihar will be strengthened by augmenting facilities. The expansion works are within the exiting depot boundary hence, there will not be any utility shifting.</p>
8.	6.1.10-6.1.16 if any	7.1.21 – Management Plan for Depot	<p>7.1.21 Management Plan for Depot</p> <p>The management plan for depot site includes:</p> <ol style="list-style-type: none"> 1. Water Supply, 2. Oil Pollution Control, 3. Hazardous waste management, 4. Effluent Pollution Control, 5. Rainwater harvesting and 6. Solid waste management <p>Water Demand: Water will be required for operation and functioning of depot which could be collected from existing tube wells. If required more tube wells will be bored after approval from the concerned authority.</p> <p>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 will be utilized from the existing facility of depot. Such tanks usually employ compressed air to coagulate the oil and grease and cause it to rise promptly to the surface. Compressed air may be applied through porous plates located in bottom of the tank.</p> <p>Hazardous waste Management: Hazardous wastes that will be generated from Depot and train operation will mainly include sludge from ETP, waste oil from machinery and cotton soaked with grease. All of these wastes will be disposed</p>
9.	6.1.18 Water Supply, Sanitation and Solid Waste Management if any		
10.	6.1.20 Rainwater harvesting if any		

			<p>through authorized recyclers. As per Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016, the occupiers of facilities may store the hazardous and other wastes for a period not exceeding ninety days and shall maintain a record of sale, transfer, storage, recycling, recovery, pre- processing, co-processing and utilisation of such wastes and make these records available for inspection.</p> <p>Effluent Pollution Control: The effluent that will be generated from depot will be treated in the existing ETP up to the level so that it could be used for horticulture purpose in the campus. The existing ETP will easily cater the increased quantity of the effluent, another ETP may be constructed in future if needed. The effluent will have oil, grease and, detergent as main pollutants. This has to be treated as per requirement of Delhi Pollution Control Committee. The treated effluents from the maintenance depot will be used for horticulture purposes inside the depot, and no discharge will be allowed outside of the premises.</p> <p>Rainwater harvesting: To conserve and augment the storage of groundwater, it has been proposed to construct roof top rainwater harvesting structure of suitable capacity in the depots. Most of the area in depot will be open to sky and very less area is covered. The cost for the rainwater harvesting is included in the civil cost.</p> <p>Solid Waste Disposal: The solid waste generated from the Depot will be taken by the cleaning contractor weekly and disposed to the municipal waste disposal sites in accordance with relevant National and State laws and regulations. Cost is not included in EMP.</p>
7 Environmental Monitoring Plan			
11.	7.2 CONSTRUCTION PHASE EMoP add sampling points for relevant indicators	--	<i>(No major excavation work or civil works is proposed for the depot augmentation work. Therefore, construction phase monitoring is not proposed.)</i>
12.	7.3 OPERATION PHASE EMoP add sampling points for relevant indicators as same manner as JICA loan portion for initial 3 years	--	<i>(Since the environmental impact due to depot augmentation is nil or negligible during construction and operation. Operation phase environmental monitoring is not proposed.)</i>
8 Cost Estimates			
13.	8.1 SUMMARY OF COSTS add some additional costs related to depot, even out of JICA	--	<i>(No addition on environmental cost on account of depot expansion)</i>

	loan portion. It would be better to SEPARATE the cost to clearly distinguish JICA portion and non-JICA portion so that JICA HQ could easily understand inclusion of the depot matters....		
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6. ENVIRONMENTAL MANAGEMENT PLAN

The Delhi Mass Rapid Transit System (MRTS) Phase IV priority corridors will provide employment opportunity, quick mobility service and safety, traffic congestion reduction, less fuel consumption and air pollution on one hand and problems of muck disposal, traffic diversion, utility dislocation etc. on the other hand.

Protection, preservation and conservation of environment have always been a primary consideration in Indian ethos, culture and traditions. Management of Environment by the provision of necessary safeguards in the planning of the project itself can lead to a reduction of adverse impacts due to a project. This chapter, therefore, spells out the set of measures to be taken during project construction and operation to mitigate or bring down the adverse environmental impacts to acceptable levels based on the proposed Environmental Management Plan (EMP).

The most reliable way to ensure that the plan will be integrated into the overall project planning and implementation is to establish the plan as a component of the project. This will ensure that it receives funding and supervision along with the other investment components. For optimal integration of EMP into the project, there should be investment links for:

- ❖ Funding,
- ❖ Management and training, and
- ❖ Monitoring.

The purpose of the first link is to ensure that proposed actions are adequately financed. The second link helps in embedding training, technical assistance, staffing and other institutional strengthening items in the mitigation measures to implement the overall management plan. The third link provides a critical path for implementation and enables sponsors and the funding agency to evaluate the success of mitigation measures as part of project supervision, and as a means to improve future projects. This chapter has been divided into three sections:

- ❖ Mitigation measures,
- ❖ Disaster management, and
- ❖ Emergency measures.

For every issue discussed for the above measures, the implementing agency, as well as staffing, equipment, phasing and budgeting, have been presented as far as possible. All required funds will be channelled through the project authority. The Environmental Management Plans have been prepared and discussed in subsequent sections.

6.1 MITIGATION MEASURES

The main aim of mitigation measures is to protect and enhance the existing environment of the project. This section includes measures for:

- ❖ Compensatory Afforestation

- ❖ Construction Material Management
- ❖ Labour Camp
- ❖ Welfare and safety of labour during construction
- ❖ Energy Management
- ❖ Hazardous Waste Management
- ❖ Housekeeping
- ❖ Utility Plan
- ❖ Archaeological and Historical Preservation
- ❖ Air Pollution Control Measures
- ❖ Noise Control Measures
- ❖ Vibration Control Measures
- ❖ Traffic Diversion/Management
- ❖ Soil Erosion Control
- ❖ Muck Disposal
- ❖ Construction and Demolition waste
- ❖ Draining of Water from Tunnel
- ❖ Water Supply, Sanitation and Solid Waste management
- ❖ Rainwater harvesting
- ❖ Management Plans for Depot, and
- ❖ Training and Extension

6.1.1. Flora and Fauna

Compensatory Plantation

Due to the proposed project, 10,438 trees are likely to be lost. Out of the 10,438 trees, 626 trees are coming under the reserve forest area. As per the prevailing practice of the Forest Department, Delhi, 10 tree saplings are to be planted for every tree felled. Hence 1,04,380 trees need to be planted. Trees will be planted, maintained, and monitored by the Delhi Development Authority (DDA) on behalf of DMRC on their land. Plantation will be carried out by DDA with native plant species. Cost of the compensatory plantation will be about Rs 5949.66 Lakh considering Rs 57,000/- per tree. In addition to this, the same amount of Rs 5949.66 Lakh will be given to the Forest Department, Delhi as a security deposit, which will be refunded to DMRC after 7 years based on successful survival of the plantation. Therefore, the total cost of the compensatory plantation is Rs 11,899.32 lakh.

Compensatory Afforestation

Permission for use of 10.27 ha reserve forest land will be obtained under the Forest Conservation Act, 1980. An equivalent area will be made available to the forest department for carrying out compensatory afforestation. DMRC will arrange the land through DDA. Normally wasteland/ proposed green area land as per DDA's planning is made available for the purpose free of cost. The cost of compensatory afforestation will be calculated at the rate of 1100 tree per hectare at the rate of Rs. 5700/- the cost of raising per plant. Therefore, 11,297 trees will be planted by the forest department in the 10.27 ha of land. The cost of afforestation @ Rs. 5700/- per tree will be Rs 643.93 Lakhs. Furthermore, as per the FCA, the Net Present Value (NPV) of Forest Land lost due to non-forest activities, is also required to be worked out and compensated accordingly. This has been worked out as Rs 57.82 Lakhs. Hence, the total cost for the compensatory afforestation is estimated at Rs 701.75 Lakhs.

Sensitive Species within the Asola Bhatti WLS ESZ

The proposed Tughlakabad-Aerocity corridor passes through the Eco-Sensitive Zone (ESZ) of the Asola Bhatti Wildlife Sanctuary at a few places. However, the proposed alignment is underground and is quite far away from the core area of the wildlife sanctuary. The area, where the proposed alignment is within the ESZ, is surrounded by human settlements and utility infrastructures. The places where the alignment is within the ESZ is underground and therefore no direct or indirect impacts on the flora and fauna of the sanctuary are envisaged neither during construction nor operation of the proposed project. It is expected that during the construction and the operation the project will not have any direct or indirect adverse impact on Flora and Fauna due to noise and vibration.

However, necessary countermeasures during construction will be taken wherever required. It will be ensured that there will be no hunting, poaching, or unnecessary habitat destruction. The Forest Department will monitor the Flora and Fauna between the project boundary and the Asola Bhatti Wildlife Sanctuary boundary. In the case of any negative impact on account of the project, DMRC will consider the advice of the Forest Department in drafting a mitigation strategy for implementing measures to negate or minimise the negative impacts.

6.1.2. Construction Material Management

The major construction material to be used for the construction of Metro Corridor will be coarse aggregates, cement, coarse sand, reinforcement steel, structural steel, water supply, drainage and sanitary fittings etc. The material will be loaded and unloaded by engaging labour at both the locations by the contractor.

The duties of the contractor will include monitoring all aspects of construction activities, commencing with the storing, loading of construction materials and equipment to maintain the quality. During the construction period, the construction material storage site is to be regularly inspected for the presence of uncontrolled construction waste. Close liaison with the officer of the DMRC and the head of the construction crew will be required to address any environmental issues and to set up procedures for mitigating impacts. The scheduling of material procurement and transport shall be linked with the construction schedule of the project. The Contractor shall be responsible for the management of such construction material during the entire construction period of the project. Sufficient quantity of materials should be available before starting each activity. The contractor should test all the materials in the Government labs or Government approved labs to ensure the quality of materials before construction. This is also the responsibility of the contractor, which would be mentioned in the contractor's agreement.

6.1.3. Labour Camp

The Contractor during the progress of work will provide, erect and maintain necessary (temporary) living accommodation and ancillary facilities for labour to standards and scales approved by the DMRC. All temporary accommodation must be constructed and maintained in such a fashion that uncontaminated water is available for drinking, cooking and washing. Safe drinking water should be provided to the dwellers of the construction camps. Adequate washing and bathing places shall be provided and kept in clean and drained condition. Construction camps are to the responsibility of the concerned contractors and these shall not be allowed in the construction areas but sited away. Adequate health care is to be provided for the workforce.

Sanitation Facilities: Construction camps shall provide sanitary latrines and urinals. Sewerage

drains should be provided for the flow of used water outside the camp. Drains and ditches should be treated with bleaching powder regularly. The sewage system for the camp must be properly designed, built and operated so that no health hazard occurs and no pollution to the air, ground or adjacent watercourses takes place. Compliance with the relevant legislation must be strictly adhered to. Garbage bins must be provided in the camp and regularly emptied and the garbage disposed off in a hygienic manner

Shelter at Workplace: At every workplace, shelter shall be provided free of cost, separately for use of men and women labours. The height of shelter shall not be less than 3m from floor level to the lowest part of the roof. Sheds shall be kept clean and the space provided shall be on the basis of at least 0.5m² per head.

Canteen Facilities: A cooked food canteen on a moderate scale shall be provided for the benefit of workers wherever it is considered necessary. The contractor shall conform generally to sanitary requirements of local medical, health and municipal authorities and at all times adopt such precautions as may be necessary to prevent soil pollution of the site.

First aid facilities: At every workplace, a readily available first-aid unit including an adequate supply of sterilized dressing materials and appliances will be provided. Suitable transport will be provided to facilitate taking injured and ill persons to the nearest hospital.

Day Crèche Facilities: At every construction site, provision of a day crèche shall be worked out so as to enable women to leave behind their children. At construction sites where 20 or more women are ordinarily employed, there shall be provided at least a hut for use of children under the age of 6 years belonging to such women. Huts shall not be constructed to a standard lower than that of a thatched roof, mud walls and floor with wooden planks spread over mud floor and covered with matting. Huts shall be provided with suitable and sufficient openings for light and ventilation. There shall be adequate provision of sweepers to keep the places clean. There shall be two maidservants (or aayas) in the satisfaction of local medical, health, municipal or cantonment authorities. Where the number of women workers is more than 25 but less than 50, the contractor shall provide with at least one hut and one maidservant to look after the children of women workers. Size of crèches shall vary according to the number of women workers employed.

Security: Security guards shall be deployed at construction sites as well as labour camps. In connection with their behaviour, they shall be subject to conditions of their employment and criminal liability. To ensure that security guard involved in the project will not violate the safety of other individuals or local residents there will be an agreement of project contractor with security agency w.r.t rules and regulations, the guards will be confined within site only, no arms will be provided to them and formal training will be provided to them.

6.1.4. Welfare and safety of labour during construction

Construction works shall be executed as laid down in the Safety Health and Environment (SHE) Contract prepared by DMRC.

The SHE Contract Conditions

- i) Describes the SHE interfaces between the Employer and the Contractor.
- ii) Details the processes by which the contractor shall manage SHE issues while carrying out the work under the contract
- iii) Describes by reference, the practices and procedures

The construction works shall be undertaken in accordance with all applicable legislation and Indian statutory requirements and guidelines - OHSAS 18001-1999: Occupational Health and Safety Management System and ISO 14001-2004: Environmental Management Systems.

The key elements of the SHE Contract Conditions are as follows:

1. The unit responsible for coordinating and monitoring the Contractor's SHE performance;
2. Procedures for identifying and estimating hazards, and the measures for addressing the same; A list of SHE hazards anticipated
3. SHE training courses and emergency drills
4. SHE inspections to identify any variation in construction activities and operations, machineries, plant and equipment and processes against the SHE Plan and its supplementary procedures and programs: Planned General Inspection, Routine Inspection, Specific Inspection and Other Inspection
5. Safety Audit
6. SHE Audit to assess potential risk, liabilities and the degree of compliance of construction Safety, Health & Environmental plan and its supplementary procedures and programs against applicable and current SHE legalisation regulations and requirements of the employer.
7. Electrical Safety Audit External SHE Audit
8. SHE Communication to communicate the Safety, Occupational Health and Environment management measures through posters campaigns/billboards/banners/glow signs being displayed around the work site
9. SHE Reporting –reports, minutes, inspection reports, audit reports
10. Accident reporting and investigation
 - i) Reports of all accidents (fatal / injury) and dangerous occurrences to the Employer
 - ii) Reporting to Govt. organisations
11. Investigations of Accidents and Dangerous Occurrences, Near misses and minor accidents
12. Prepare an Emergency Response Plan for all worksites including injury, sickness, evacuation, fire, chemical spillage, severe weather and rescue.
13. The Contractor will be required to conduct awareness programs and other measures to prevent infectious diseases spreading.

Workplace safety and occupational health shall be ensured with special focus on the following areas:

- a) Housekeeping
- b) Working at Height and Falling objects and Danger areas
- c) Lifting Appliances
- d) Launching Operation
- e) Construction machinery, tools equipment - Safe worthiness
- f) employ qualified electrical personnel on-site and requirements of electrical equipment, distribution etc.
- g) Lighting
- h) Exposure of worker to use of exhaust or harmful gases in confined locations
- i) Fire prevention, protection and fighting system
- j) Corrosive substances

- k) Demolition
- l) Excavation and Tunnelling
- m) Traffic Management
- n) Personal Protective Equipment (PPEs)
- o) Reporting which will contain results of monitoring and inspection programs
- p) Process of response to Inquiries, complaints and requests for information from private and government entities
- q) Physical fitness of workmen
- r) Medical Facilities on site: Occupational Health Centre, Ambulance van and room HIV/ AIDS prevention and control
- s) Exposure to Noise – prevention measures
- t) Ventilation and illumination
- u) Welfare measures for workers: latrine, canteen, drinking water, living accommodation, creches
- v) Environmental issues during metro construction stage generally involve equity, safety and public health issues.

The construction agencies require complying with laws of the land, which include inter alia, the following:

- **Bonded Labour System (abolition) Act, 1976 (amended once in 1985):** An Act to provide for the abolition of bonded labour system with a view to preventing the economic and physical exploitation of the weaker sections of the people and for matters connected therewith or incidental thereto.
- **Building and other construction worker's (Regulation of Employment and conditions of service) Act,1996:** The Act provides for regulating the employment and conditions of service of building and other construction workers and also provides for their safety, health and welfare measures and other matters connected therewith or incidental thereto.
- **Building and Other Construction Worker's Welfare Cess Act, 1996:** The Act provides for levy and collection of cess on the cost of construction incurred by employers with a view to augmenting the resources of the Building and Other Constructions Workers Welfare Board. The Act provides for regulating the employment and conditions of service of building and other construction workers and also provides for their safety, health and welfare measures and other matters connected therewith or incidental thereto.
- **Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996:** The Rules provide for mandatory preparation of On-Site Emergency Plans by the industry and Off-Site Plans by the district collector and the constitution of four-tier crisis groups at the centre, district, and local levels for the management of the chemical disaster.
- **Child Labour (Prohibition and Regulation) Act 1986:** The Act prohibits employment of children below 14 years of age in certain occupations and processes and provides for the regulation of employment of children in all other occupations and processes. Employment of child labour is prohibited in the Building and Construction Industry.
- **Children Pledging of Labour Act,1933:** Pledging of Labour of children prohibited and a penalty for parents/guardians pledging child labour prescribed
- **Contact Labour (Regulation and Abolition) Act, 1970 (amended once in 1986):** The Act provides for certain welfare measures to be provided by the contractor to contract labour.
- **Employee's Provident Fund and Miscellaneous Provisions Act, 1952 (amended 14 times 1953,1956,1957,1958,1960,1962,1963,1965,1971,1973,1976,1988,1996,1998):** It is an important piece of Labour Welfare legislation enacted by the Parliament to provide social security benefits to the workers . At present, the Act and the Schemes framed there under provides for three types of benefits -Contributory Provident Fund, Pensionary benefits to the employees/ family members and the insurance cover to the members of the Provident Fund.
- **Employees PF and Miscellaneous Provision Act 1952:** The Act provides for monthly

- contributions by the employer plus worker.
- **Employees State Insurance Act, 1948 (amended 6 times in 1951, 1966, 1970, 1975, 1984, 1989):** This act envisage an integrated need based social insurance scheme that would protect the interest of workers in contingencies such as sickness, maternity, temporary or permanent physical disablement, death due to employment injury resulting in loss of wages or earning capacity. The Act also guarantees reasonably good medical care to workers and their immediate dependents.
 - **Employers Liability Act, 1938 (amended 3 times, in 1951 twice and 1970):** An Act to declare that certain defences shall not be raised in suits for damages in respect of injuries sustained by workmen whereas it is expedient to declare that certain defences shall not be raised in suits for damages in respect of injuries sustained by workmen.
 - **Equal Remuneration Act, 1976 (Amended once in 1987):** The Act provides for payment of equal wages for work of equal nature to Male and Female workers and not for making discrimination against Female employees.
 - **Fatal accidents Act, 1855:** The objective of this act is to provide compensation to families for loss occasioned by the death of a person caused by actionable wrong.
 - **Industrial Disputes Act, 1947:** The Act lays down the machinery and procedure for resolution of industrial disputes, in what situations a strike or lock-out becomes illegal and what are the requirements for laying off or retrenching the employees or closing down the establishment.
 - **Industrial Employment (Standing Orders) Act; 1946:** The Act provides for laying down rules governing the conditions of employment.
 - **Inter-State Migrant Workmen's (Regulation of Employment and Conditions of Service) Act, 1979:** The inter-state migrant workers, in an establishment to which this Act becomes applicable, are required to be provided certain facilities such as housing, medical aid, travelling expenses from home to the establishment and back, etc.
 - **Maternity Benefit (Amendment Bill) Bill 2006:** The Act provides for leave and some other benefits to women employees in case of confinement or miscarriage, etc.
 - **Minimum Wages Act, 1948 (amended 8 times in 1950, 1951, 1954, 1957, 1961, 1970, and 1986):** The employer is supposed to pay not less than the Minimum Wages fixed by appropriate Government.
 - **Motor Transport Worker's Act, 1961:** To provide for the welfare of motor transport workers and to regulate the conditions of their work.
 - **Payment of Bonus Act, 1965 (amended 3 times in 1976, 1980, 1995):** The Act provides for payments of annual bonus subject to a minimum of 83.3% of wages and maximum of 20% of wages.
 - **Payment of Gratuity Act, 1972 amended 5 times in 1984 twice, 1987, 1994, 1999):** Gratuity is payable to an employee under the Act on the satisfaction of certain conditions on separation if an employee has completed 5 years.
 - **Payment of Wages Act 1936 (amended 12 times in 1937 twice, 1940, 1951, 1957, 1960, 1964, 1971, 1974, 1976, 1977, 1982):** It lays down as to by what date the wages are to be paid when it will be paid and what deductions can be made from the wages of the workers.
 - **Personal Injuries (Compensation Insurance) Act, 1970:** An Act to impose on employers liability to pay compensation to workmen sustaining personal injuries and to provide for the insurance of employers against such liability.
 - **The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996 and the Cess Act of 1996:** All the establishments who carry on any building or other construction work and employs 10 or more workers are covered under this Act; the employer of the establishment is required to provide safety measures at the building or construction work and other welfare measures, such as canteens, first-aid facilities, ambulance, housing accommodation for Workers near the workplace, etc.
 - **The Factories Act, 1948:** The Act lays down the procedure for approval of plans before

setting up a factory, health and safety provisions, welfare provisions, working hours and rendering information-regarding accidents or dangerous occurrences to designated authorities.

- **Trade Unions Act, 1926:** The Act lays down the procedure for registration of trade unions of workers and employers. The trade unions registered under the Act have been given certain immunities from civil and criminal liabilities.
- **Workmen's Compensation Act 1923 (amended 4times in 1933,1959, 1962, 1995):** This Act provides for compensation in case of injury by accident arising out of and during the course of employment.

6.1.5. Energy Management

The contractor shall use and maintain equipment so as to conserve energy and shall be able to produce demonstrable evidence of the same upon the request of an officer of the Project Implementation Unit.

Measures to conserve energy include but not limited to the following:

- ❖ Optimizing the use of tools, plants and equipment to perform tasks with correct power.
- ❖ Optimizing cable size and the joint can control voltage drops
- ❖ Use of energy-efficient motors (90% efficiency or more) and pumps (at least 80% efficiency),
- ❖ Replacing inefficient lamps with the most efficient lamp for the purpose, taking into account the size, shape, colour and output of the lamp.
- ❖ Replacing standard choke ballasts with high-frequency electronic ballasts.
- ❖ Luminaries - retrofitting standard luminaries with high-efficiency specular reflectors or replacing standard luminaries with high-efficiency luminaries
- ❖ Adequate and uniform illumination level at construction sites suitable for the task,
- ❖ Use of energy-efficient air conditioner.
- ❖ The engines shall be capable of delivering specified prime power rating of variable loads for PF of 0.8 lag with 10% overload available in excess of specified output for one hour in every 12 hours.
- ❖ Engine of DG set shall comply with CPCB norms
- ❖ Planning in advance and selecting the location to receive and store material such that these are at the least distance from the place of use. Such an approach will result in less energy being consumed since optimum energy will be expended for the transport of material.
- ❖ Maintenance schedule - setting up a maintenance schedule to clean and replace lamps on a regular basis.
- ❖ Promoting employee's awareness of energy conservation
- ❖ Training staff on methods of energy conservation and to be vigilant to such opportunities
- ❖ The contractor shall design site offices for maximum daylight and minimum heat gain. The rooms shall be well insulated to enhance the efficiency of air conditioners and the use of solar films on windows may be used where feasible.

6.1.6. Hazardous Waste Management

Classification of waste as hazardous shall be in accordance with the Hazardous and Other Wastes (Management, Handling & Trans-boundary movement) Rules 2016. The contractor shall identify the nature and quantity of hazardous waste generated as a result of his activities and shall file an Application for obtaining authorization in "Form I" with Delhi Pollution Control Committee along with a map showing the location of storage area. Hazardous waste would mainly arise from the maintenance of equipment which may include used engine oils, hydraulic fluids, waste fuel, spent mineral oil/cleaning fluids from mechanical machinery, scrap batteries or spent acid/alkali, spent solvents etc. Outside the storage area, the contractor shall place a 'display board', which will display the quantity and nature of hazardous waste on the date. Hazardous Waste needs to be stored in a secure place. It shall be the responsibility of the contractor to ensure that hazardous wastes are stored, based on the composition in a manner suitable for handling storage and transport. The labelling and packaging are required to be easily visible and be able to withstand physical conditions and climatic factors. The storage of hazardous waste should not exceed 90 days and the contractor shall maintain a record of sale, transfer, storage of such waste and make these records available for inspection. The contractor shall approach only Authorized Recyclers for disposal of Hazardous Waste, under intimation to the DMRC. Used lubricants should be collected and stored in individual containers which are fully labelled in English and Hindi and stored in a designated secure place. These wastes should be sent to authorized recyclers, and the empty drums collected by appropriated companies for reuse or refill. The environmentally hazardous waste shall be stored in an impermeable surface with containment bounding to retain leaks, spills and ruptures.

6.1.7. Environmental Sanitation

Environmental sanitation also referred to as Housekeeping, is the act of keeping the working environment cleared of all unnecessary waste, thereby providing the first line of defence against accidents and injuries. Contractor shall understand and accept that improper environmental sanitation is the primary hazard in any construction site and ensure that a high degree of environmental sanitation is always maintained. Environmental sanitation is the responsibility of all site personnel, and line management commitment shall be demonstrated by the continued efforts of supervising staff towards this activity.

General environmental sanitation shall be carried out by the contractor and ensured at all times at Work Site, Batching Plant, Stores, Offices and toilets/urinals.

Towards this, the Contractor shall constitute a special group of environmental sanitation personnel. This group shall ensure daily cleaning at worksites and surrounding areas and maintain a register as per the approved format by the DMRC.

Team of environmental sanitation squad shall carry out:

- ❖ Full height fence, barriers, barricades etc. shall be erected around the site to prevent the surrounding area from excavated soil, rubbish etc, which may cause inconvenience to and endanger the public. The barricade especially those exposed to the public shall be aesthetically maintained by regular cleaning and painting as directed by the Employer. These shall be maintained in one line and level.
- ❖ The structure dimension of the barricade, material and composition, its colour scheme, logo and other details.
- ❖ All stairways, passageways and gangways shall be maintained without any blockages or obstructions. All emergency exits passageways, exits fire doors, break-glass alarm points, fire-fighting equipment, first aid stations, and other emergency stations shall be kept clean,

- ❖ unobstructed and in good working order.
- ❖ All surplus earth and debris shall be removed/disposed off from the working areas to officially designated dumpsites. Trucks carrying sand, earth and any pulverized materials etc. shall be covered while moving to avoid dust or odour impact.
- ❖ No parking of trucks/trolleys, cranes and trailers etc. shall be allowed on roads, which may obstruct the traffic movement.
- ❖ Roads shall be kept clear and materials like pipes, steel, sand boulders, concrete, chips and brick etc. This material shall not be allowed on the roads to obstruct free movement of road traffic.
- ❖ Waterlogging or bentonite spillage on roads shall not be allowed.
- ❖ Proper and safe stacking of material is of paramount importance at yards, stores and such locations where the material would be unloaded for future use. The storage area shall be well laid out with easy access and material stored/stacked in an orderly and safe manner.
- ❖ Flammable chemicals/compressed gas cylinders shall be safely stored.
- ❖ Unused/surplus cables, steel items and steel scrap lying scattered at different places within the working areas shall be removed to identify locations.
- ❖ All wooden scrap, empty wooden cable drums and other combustible packing materials, shall be removed from workplace to identified locations.
- ❖ Empty cement bags and other packaging material shall be properly stacked and removed.
- ❖ The Contractor shall ensure that all his sub-contractors maintain the site reasonably clean through provisions related to environmental sanitation (housekeeping).

6.1.8. Utility Plan

The proposed Metro alignment runs along major arterial roads of the city, which serve Institutional, Commercial and Residential areas. A large number of sub-surfaces, surface and overhead utility services, viz. sewers, water mains, stormwater drains, telephone cables, electrical transmission lines, electric poles, traffic signals etc. already exist along the proposed alignment. These utility services are essential and have to be maintained in working order during different stages of construction by temporary/permanent diversions or by supporting in position. As such, these may affect construction and project implementation time schedule/costs, for which necessary planning/action needs to be initiated in advance. The Organizations / Departments responsible for concerned utility services are reported in Table 7.1.

Prior to the actual execution of work at the site, detailed investigation of all utilities and location will be undertaken well in advance by making trench pit to avoid damage to any utility. While planning for diversion of underground utility services e.g. sewer lines, water pipelines, cables etc., during the construction of Metro, the following guidelines could be adopted:

- Utility services shall be kept operational during the entire construction period and after completion of project. All proposals should, therefore, ensure their uninterrupted functioning.
- The elevated viaduct does not pose any serious difficulty in negotiating the underground utility services, especially those running across the alignment. In such a situation, the spanning arrangement of the viaduct may be suitably adjusted to ensure that no foundation need be constructed at the location, where utility is crossing the proposed Metro alignment. In case of utility services running along the alignment either below or at very close distance, the layout of piles in the foundations shall be suitably modified such that the utility service is either encased within the foundation piles or remains clear of them. In priority corridors of Delhi MRTS Phase – IV, Construction of New Depot is not planned. The existing depot at Mukundpur and Sarita Vihar will

be strengthened by augmenting facilities. The expansion works are within the exiting depot boundary hence, there will not be any utility shifting.

Table 6.1: Organizations Responsible for Utilities and Services

S. No.	Organization/ Department	Utility/Services
1.	Delhi Jal Board	Sewerage and drainage lines. Water mains and their service lines, including hydrants and fountains etc, water treatment plants, pumping stations etc. in non NDMC area
2.	New Delhi Municipal Committee	Roads, surface water drains, nallahs, sewer lines, streetlights, high mast lights etc. in NDMC area etc.
3.	Central Public Works Department	Roads, surface water drains, nallahs etc.
4.	NHAI	Roads, surface water drains, nallahs etc.
5.	NDPL and BSES	Power cables and their appurtenances, pole mounted transformers, power cables of 33 & 11KV's
6.	Mahanagar Telephone Nigam Ltd. (MTNL)	Telecommunication cables, junction boxes, telephone posts, O.H. lines etc.
7.	Office of Commissioner of Police, Delhi	Traffic signal posts, junction boxes and cable connection etc.
8.	Reliance Mobile India Limited, Idea, Airtel and Tata Tele service India Limited	Telecommunication cables, junction boxes etc.
9.	Indraparastha Gas Limited	Gas Pipelines

6.1.9. Archaeological and Historical Preservation

Monuments located near the proposed alignment are listed in para 4.5.8. Prior to the initiation of construction, DMRC intends to review a resources protection plan for historic structures where it appears, they may be affected by the project. This plan will be developed by the contractor in consultation with the Archaeological Survey of India (ASI) and other parties. This plan will identify the sensitive resources as well as specify the construction monitoring requirement. These requirements may include ground vibration monitoring and recording any component subjected to impact.

The tunnel for the metro network is being constructed by using the state-of-the-art technology i.e. Tunnel Boring Machine (TBM) which gives negligible vibration. The stations are being constructed

by cut and cover method, which is widely accepted, and the safest technique being adopted by metros in India and abroad. The above technology has been adopted successfully by DMRC in the past while carrying out works in the regulated/prohibited areas (ASI protected monuments) as well as close to public and private buildings.

Where the alignment, runs within the prohibited/regulated zone of the monuments, DMRC have to apply for No Objection Certificate (NOC) from Director of Archaeology, Archaeological Survey of India as per provision of National Monuments and Archeological Sites and Remains (Amendment & Validation Act 2010). In this regard DMRC has been obtained the NOC for 5 ASI monuments and for the rest of the 2 monuments is under process.

6.1.10. Air Pollution Control Measures

During the construction period, the impact on air quality will be mainly due to increase in Particulate Matter (PM) along haul roads and emission from vehicles and construction machinery. Mitigation measures which shall be adopted to reduce air pollution are presented below:

- The Contractor shall take all necessary precautions to minimize fugitive dust emissions from operations involving excavation, grading, and clearing of land and disposal of waste. He shall not allow emissions of fugitive dust from any transport, handling, construction or storage activity to remain visible in the atmosphere beyond the property line of emission source for any prolonged period of time without notification to the Employer.
- Contractor's transport vehicles and other equipment shall conform to emission standards fixed by Statutory Agencies of Government of India or the State Government from time to time. The Contractor shall carry out periodical checks and undertake remedial measures including replacement if required, so as to operate within permissible norms.
- The Contractor shall cover loads of dust-generating materials like debris and soil being transported from construction sites. All trucks carrying loose material should be covered and loaded with sufficient freeboard to avoid spills through the tailboard or sideboards.
- The temporary dumping areas shall be maintained by the Contractor at all times until the excavate is re-utilized for backfilling or as directed by the Employer. Dust control activities shall continue even during any work stoppage.
- The Contractor shall place the material in a manner that will minimize dust production. Material shall be minimized each day and wetted, to minimize dust production. During dry weather, dust control methods must be used daily especially on windy, dry days to prevent any dust from blowing across the site perimeter.
- The Contractor shall water down construction sites as required to suppress dust, during handling of excavation soil or debris or demolition. The Contractor will make water sprinklers, water supply and water delivering equipment available at any time that it is required for dust control use. Dust screens will be used, as feasible when additional dust control measures are needed especially where the work is near sensitive receptors.
- The Contractor shall provide a wash pit or a wheel washing and/or vehicle cleaning facility at the exits from work sites such as construction depots and batching plants. At such facility, high-

pressure water jets will be directed at the wheels of vehicles to remove all spoil and dirt.

The Contractor shall design and implement blasting techniques so as to minimize dust, noise, and vibration generation and prevention fly rock.

6.1.11. Noise Control Measures

There will be an increase in noise level in the ambient air due to the construction and operation of the Metro corridors. However, noise levels in the core city are expected to go down during operation. The increase in noise levels is marginal; hence local population will not be adversely affected. However, the exposure of workers to high noise levels especially, near the engine, vent shaft etc. need to be minimized. This could be achieved by:

- ❖ Job rotation,
- ❖ Automation,
- ❖ Construction of permanent and temporary noise barriers,
- ❖ Use of electric instead of diesel-powered equipment,
- ❖ Use of hydraulic tools instead of pneumatic tools,
- ❖ Acoustic enclosures should be provided for individual noise-generating construction equipment like DG sets,
- ❖ Scheduling truck loading, unloading and hauling operation,
- ❖ Scheduling work to avoid simultaneous activities that generate high noise levels,
- ❖ Anti-drumming floor and noise absorption material,
- ❖ Low-speed compressor, blower and air conditioner,
- ❖ Mounting of under frame equipment on anti-vibration pad,
- ❖ Smooth and gradual control of door,
- ❖ Provision of GRP baffle on the via-duct for the elimination of noise transmission,
- ❖ Provision of sound-absorbing material in the supply duct and return grill of air conditioner,
- ❖ Sealing design to reduce the aspiration of noise through the gap in the sliding doors and piping holes, and
- ❖ Soundproof compartments control rooms etc.

Before the start of work at site DMRC should: 1) implement a low-noise procurement policy (purchase and hire) for machinery and work equipment; 2) set desired noise-control requirements in the tender specifications (meeting national legislation as a minimum); 3) plan the work process to minimize worker exposure to noise; 4) implement a noise-control programme (for example, by planning, training, induction, site layout, maintenance activities).

Control: There will be three steps to the protection of workers from noise, using technical and organizational measures:

- ❖ Control the noise at source
- ❖ Collective measures, including work organization;
- ❖ Personal hearing protection.

Control of noise at source: Such control measures will include:

- ❖ Using a machine with lower noise emissions;

- ❖ Avoidance of metal on metal impacts;
- ❖ Damping to reduce noise or isolating vibrating parts;
- ❖ Fitting silencers;
- ❖ Carrying out preventive maintenance: as parts become worn, noise levels can change.

Collective control measures: Actions should be taken to reduce the exposure to noise of all those who may be exposed, in addition to the steps above. On sites with more than one contractor, liaison between employers is essential. Collective measures will include:

- ❖ Isolating noisy procedures and restricting access to noisy areas;
- ❖ Interrupting the path of airborne noise through the use of noise enclosures and barriers;
- ❖ Using absorptive materials to reduce reflected sound;
- ❖ Controlling ground-borne noise and vibration by using floating slab measures;
- ❖ Organizing work so that the time spent in noisy areas is limited;
- ❖ Planning to have noisy work done when as few workers will be exposed as possible;
- ❖ Implementing work schedules that control exposure to noise.

Personal hearing protection: Personal hearing protection should be used as a last resort.

- ❖ The personal hearing protection must be worn and its use enforced;
- ❖ It should be suitable for the job, type and level of noise, and compatible with other protective equipment;
- ❖ Workers should have a choice of suitable hearing protection so that they can find the most comfortable;
- ❖ Training should be given on how to use, store, and maintain the hearing protection

The workers employed in high noise level area could be employed in low noise level areas and vice-versa from time to time. Automation of equipment and machineries, wherever possible, should be done to avoid continuous exposure of workers to noise. At workplaces, where automation of machineries is not possible or feasible, the workers exposed to noise should be provided with protective devices. Special acoustic enclosures should be provided for individual noise-generating equipment, wherever possible.

Workers in those sections where periodic adjustment of equipment/machinery is necessary should be provided with soundproof control rooms so that exposure to higher noise level is reduced. During construction, there may be high noise levels due to pile driving, use of compressors and drilling machinery. Effective measures should be taken during the construction phase to reduce the noise from various sources. The noise from the air compressor can be reduced by fitting exhaust and intake mufflers.

The pile driving operation can produce noise levels up to 100 dB (A) at a distance of 25-m from the site. Safety precaution as stipulated in IS: 5121 (1969) 'Safety Code for Piling and other Deep Foundation' need to be adopted.

The noise level from loading and unloading of construction materials can be reduced by usage of various types of cranes and placing materials on sand or sandy bag beds.

The ballast-less track supported on two layers of rubber pads can reduce track noise and ground vibrations. In addition, providing skirting of coach shell covering the wheel will screen any noise coming from the rail wheel interaction as of propagating beyond the viaduct. Ambient noise levels at all locations are more than the noise standards.

It is proposed that during the operation phase, for the receptors which are being affected by metro operations (especially the sensitive receptors) noise barrier may be provided of height varying from 1m to 3m. It is proposed to install absorptive barrier Perforated Aluminum sheet or Perforated aluminium sheet with glass wool or mineral wool inside with an NRC value of 0.80, sturdy and weather resistant. A noise mapping study for the elevated section should be carried out to find out the effect of the metro operation on ambient noise level with and without adopting noise barriers. The noise barrier will be provided along the viaduct at all the sensitive receptors. The estimated cost of the noise barrier is **Rs 2435.52 Lakh**.

6.1.12. Vibration Control Measures

The large forces between the wheel and rail are the primary cause of vibration. These forces fluctuate in response to wheel and rail roughness over a wide range of frequencies. The main frequency band of train excitation is between 10Hz and 150Hz with a maximum range at approximately 30 to 50 Hz. In a building, the higher range of this frequency is noticeable as a rumbling noise that radiates from walls and floors commonly referred to as ground-borne noise. The building floors usually respond (resonance) with a lower range of frequencies referred to as ground-borne vibration.

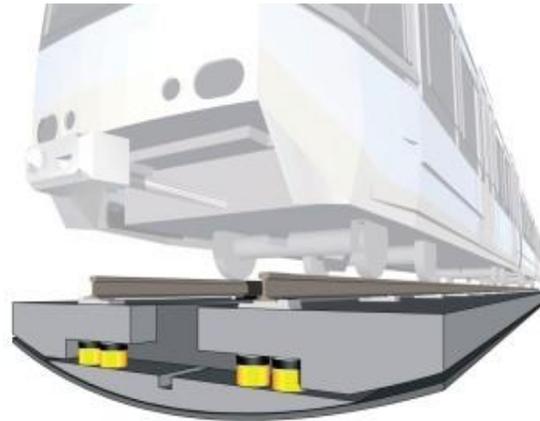
Vibration can be reduced by minimizing surface irregularities of wheel and rail, improving track geometry, providing elastic fastenings, and separation of rail seat assembly from the concrete plinth with the insertion of resilient and shock-absorbing pad.

While designing the track structure for Mass Rapid Transit System all the above points have to be taken into consideration in the following ways:

- ❖ To prevent the development of surface irregularities on the rail, a fairly heavy rail section of 60 kg/m, 90 UTS rail, supported at every 60 cms has been proposed. Further rail grinding at regular intervals by rail grinding machine and also lubrication of rail by vehicle-mounted lubricator have been contemplated.
- ❖ Rails will be continuously welded and also will be laid to fine tolerances so that any noise/vibration on account of track geometry could be reduced.
- ❖ The vibration generated from rail-wheel interaction will be greatly absorbed by the elastic fastening system proposed to be used.
- ❖ The lower vibration can be achieved by providing of bolster less type bogies having secondary air spring.
- ❖ In addition, locations where the alignment is close to sensitive/heritage structures, the contractor shall prepare a monitoring scheme prior to construction at such locations. This scheme shall include:
 - ❖ Monitoring requirements for vibrations at regular intervals throughout the construction period.
 - ❖ Pre-construction structural integrity inspections of historic and sensitive structures in project activity.
 - ❖ Information dissemination about the construction method, probable effects, quality control measures and precautions to be used.

Mass-spring system (MSS) may be used to reduce vibrations generated due to train movements and to protect the buildings at the surface. Mass Spring Systems (MSS) on the tracks help in reducing vibration from reaching the structures above these tunnels. MSS is the solution that helps

in mitigating vibrations generated by the passing trains at the source itself. MSS elastically separates the track slabs in the tunnels or on the viaducts from the supporting structure. The material used for isolation is a microcellular Polyurethane Elastomer. Use of MSS helps in minimizing the transmission of vibrations (structure-borne noise) to the surrounding establishments in the vicinity of tracks. In addition MSS also effectively reduces the development of audible secondary airborne noise, which is caused by the vibration of buildings and other infrastructure component. The mass-spring system, which uses soft steel coil springs in the concrete track slabs, helps in reducing vibrations and noise due to movements of the train. MSS with a floating permanent way as shown in figures below:



6.1.13. Traffic Diversion/ Management

During such construction, traffic is most likely to be affected. Hence Traffic Diversion Plans are required in order to look for options and remedial measures so as to mitigate any traffic congestion situations arising out due to acquisition of road space during Metro construction. Any reduction of road space during Metro construction will result in constrained traffic flow. In order to retain satisfactory levels of traffic flow during the construction period; traffic management and engineering measures need to be taken. They can be road widening exercises, traffic segregation, one-way movements, traffic diversions on influence area roads, acquisition of service lanes, etc.

Various construction technologies are in place to ensure that traffic impedance is done at the minimum. They are:

-
- 'Cut-and-Cover' method is proposed for construction of the underground stations. This means that the stretch between two points will have to be blocked during construction. However, temporary decking may be provided by blocking the road carriageway partially to permit traffic movement along the same stretch. Construction of switch-over-ramp also requires some road space.
- For elevated section wherever it is passing along the road, the requirement would be mainly along the central verge.
- As regards to the alignment cutting across a major traffic corridor, 'Continuous Cantilevered Construction Technology' would be applied to prevent traffic hold-ups or diversions of any kind.
- Wherever the stations are isolated, areas available around it should be utilized for road diversion purposes such as lay-byes and service roads.

Only temporary diversion plans will be required during the construction of the Metro corridor. At the onset, all encroachments from road ROW will have to be removed. These encroachments vary from 'on-street' parking to informal activities. During the construction of works on the underground section, it is proposed that temporary decking may be provided by blocking the road carriageway partially to permit 'through' as well as right-turning traffic movements. Total blockage of traffic along the underground section is not recommended.

Keeping in view the future traffic growth and reduction of carriageway due to Metro construction, implementation of traffic management/diversion plans shall become inevitable for ensuring smooth traffic movement and traffic diversion plans shall be formulated.

Traffic Management Guidelines: The basic objective of the following guidelines is to lay down procedures to be adopted by the contractor to ensure the safe and efficient movement of traffic and also to ensure the safety of workmen at construction sites.

All construction workers should be provided with high visibility jackets with reflective tapes at most of viaduct/tunnelling and station works or either above or under right-of-way. The conspicuity of workmen at all times shall be increased so as to protect from speeding vehicular traffic.

- ❖ Warn the road user clearly and sufficiently in advance.
- ❖ Provide safe and clearly marked lanes for guiding road users.
- ❖ Provide safe and clearly marked buffer and work zones
- ❖ Provide adequate measures that control driver behaviour through construction zones.
- ❖ The primary traffic control devices used in work zones shall include signs, delineators, barricades, cones, pylons, pavement markings and flashing lights.
- ❖ The contractor should hire a transportation consultant that carryout the traffic survey and suggest alternative routes for smooth flow of traffic.

6.1.14. Soil Erosion Control

Prior to the start of the relevant construction, the Contractor shall submit to the DMRC for approval, his schedules for carrying out temporary and permanent erosion/sedimentation control works as are applicable for the items of clearing and grubbing, roadway and drainage excavation, embankment/sub-grade construction and other structures across watercourses, pavement courses and shoulders. He shall also submit for approval his proposed method of erosion/sedimentation control on the service road and his plan for disposal of waste materials. Work shall not be started until the erosion/sedimentation control schedules and methods of operations for the applicable construction have been approved by the DMRC.

The surface area of erodible earth material exposed by clearing and grubbing, the excavation shall be limited to the extent practicable. The Contractor may be directed to provide immediate control measures to prevent soil erosion and sedimentation that will adversely affect construction operations, damage adjacent properties, or cause contamination of nearby streams or other watercourses. Such work may involve the construction of temporary berms, dykes, sediment

basins, slope drains and use of temporary mulches, fabrics, mats, seeding, or other control devices or methods as necessary to control erosion and sedimentation.

The Contractor shall be required to incorporate all permanent erosion and sedimentation control features into the project at the earliest practicable time as outlined in his accepted schedule to minimize the need for temporary erosion and sedimentation control measures.

Temporary erosion/sedimentation and pollution control measures will be used to control the phenomenon of erosion, sedimentation and pollution that may develop during normal construction practices but may neither be foreseen during design stage nor associated with permanent control features on the Project. Under no conditions shall a large surface area of credible earth material be exposed at one time by clearing and grubbing or excavation without prior approval of the DMRC.

The DMRC may limit the area of excavation, borrow and embankment operations in progress, commensurate with the Contractor's capability and progress in keeping the finish grading, mulching, seeding and other such permanent erosion, sedimentation and pollution control measures, in accordance with the accepted schedule.

Temporary erosion is sometimes caused due to the Contractor's negligence, carelessness or failure to install permanent controls. Sedimentation and pollution control measures then become necessary as a part of the work as scheduled or ordered by the DMRC, and these shall be carried out at the Contractor's own expense. Temporary erosion, sedimentation and pollution control work required, which is attributed to the Contractor's negligence, carelessness or failure to install permanent controls, will be performed as ordered by the DMRC.

6.1.15. Muck Disposal

Owing to the paucity of space in the busy cities and for safety reasons, elaborate measures need to be adopted for collection, transfer, storage and disposal of excavated muck. Muck shall be collected in containers from the construction sites, transported and consolidated at dumping ground and then transferred to disposal sites. Dumping areas are essential to store the excavated earth temporarily for backfilling at a later date and final disposal.

Disposal of excess soil will be permitted in low lying areas owned by land-owning agencies. The excess excavated soil will be reused at another site in consultation with DDA/other authority/agency. The excess soil disposal site will be those identified by land-owning agency and communicated to DMRC. The transfer and disposal of surplus soil may create air pollution and leached water problem. To mitigate these problems following mitigation measure are proposed to be adopted:

1. The disposal sites will be cleaned and then treated so that leached water does not contaminate the groundwater.
2. The material will be stabilized each day by watering or other accepted dust suppression techniques.
3. The height from which soil will be dropped shall be the minimum practical height to limit the dust generation.
4. The stockpiling of the earth in the designated locations with suitable slopes.
5. During dry weather, dust control methods such as water sprinkling will be used daily especially on a windy, dry day to prevent any dust from blowing.
6. Sufficient equipment, water and personnel shall be available on dumping sites at all times

- to minimize dust suppression.
7. Dust control activities shall continue even during work stoppages.
 8. The muck shall be filled in the dumping site in layers and compacted mechanically. Dumping sites on the sloping ground shall be protected adequately against any possible slide/slope failure through engineering measures.
 9. It is desirable to first clean the disposal area site for vegetation biomass exists over it. The faces and top should be treated/vegetated to avoid erosion. Once the filling is complete, the entire muck disposal area shall be provided with a layer of good earth on the top, dressed neatly, and covered with vegetation.
Before excavation, the Contractor will be required to test the soil quality including heavy metals and the results will be compared with US EPA standards. If the soil is contaminated, the polluter will be responsible for treatment and disposal.

6.1.16. Construction and Demolition Waste

The construction and demolition waste can be managed by the following ways;

- ❖ Construction & Demolition (C&D) waste shall be stored at a designated area.
- ❖ The contractor shall be responsible for collection, segregation and storage of construction and demolition waste, as directed or notified by the concerned local authority in consonance with the Construction & Demolition Waste Management Rules, 2016.
- ❖ The contractor shall ensure that other waste does not get mixed with this waste and is stored and disposed of separately.
- ❖ The contractor shall dispose of C&D waste only at authorized processing facilities and ensure that there is no littering or deposition of construction and demolition waste so as to prevent obstruction to the traffic or the public or drains.
- ❖ The requirement of concrete/RCC/PCC waste disposal, generated from the entire contract shall be either when 15 Tonnes of C&D waste has been generated or such C&D waste has been stored for 15 days (irrespective of quantity), of the two whichever is earlier.
- ❖ A minimum of 10% of C&D recycled products shall be used for external development and road works for finishing contracts. Before accepting recycled products, the same shall be tested as per required specifications. The recycled materials products shall be used in non-structural members like kerbstone, paver tiles in the footpath, earth filling, use of bricks in non-load bearing partition walls, boundary walls, toe walls, recycled aggregates in lean concrete/PCC etc.

6.1.17. Draining of Water from Tunnel

Problems of water flow associated with tunnelling are bound to take place where the water table is low. In cut and cover type construction continuous pumping is an economical alternative.

The wellpoint system is recommended for dewatering as the volume of water to be pumped out is not large. The deep well system is adopted where the water table has to be lowered over a large depth in a small area. The deep wells can be installed either inside or outside the diaphragm walls or inside the cut.

A suitable piezometer is installed to monitor the water table constantly and to see how much lowering has been effectively done. The dewatering should not be stopped unless it is ensured from design calculations that the load of the constructed box component has reached a stage where it will be able to counteract the hydrostatic pressure from below.

The dewatering can be achieved by:

- ❖ Leading the groundwater to a sump by drains and pump out the water from the sump.
- ❖ To prevent loss of fines, an inverted filter may have to be used.
- ❖ Dewatering as suggested above may not be effective in preventing sand flows. Lowering of the groundwater by properly designed single or double stage well points will be effective in such cases.
- ❖ The construction of diaphragm walls of concrete along the side of channels, before the commencement of excavation, will be required. The concrete walls are taken down to rest on bedrock or impervious strata or, in their absence, deep enough below the bottom of the excavation, to serve as an effective cut off for the inflow of groundwater into the proposed excavation. The trenches are made in lengths of 2.5 to 5m and kept continuously filled with a thixotropic material like Bentonite slurry, which has the effect of stabilizing the trench and preventing any subsidence. As the excavation proceeds, a concrete wall can be strutted mutually or anchored with surrounding rocks or soil with long tie rods.
- ❖ During the operation phase, seepage water has to be drained along the side of walls (retaining). A proper drainage system needs to be incorporated into the design and implemented during the construction phase.
- ❖ The pumped water from sump wells will be put into a stormwater drain to avoid any load to wastewater treatment plants. These stormwater drains finally join natural existing streams/nallahs.

6.1.18. Water Supply, Sanitation and Solid Waste Management

The public health facilities, such as water supply, sanitation and toilets are much needed at the stations. Water should be treated before use up to WHO drinking water standards. The collection and safe disposal of human wastes are among the most important problems of environmental health. The water carried sewerage solves the excreta disposal problems. The sewerage disposal systems should be adopted for sewage disposal. Drinking water and raw water requirement for underground and elevated stations shall be provided from a municipal source.

Wastewater from the station will either be treated by onsite STP or discharged to the existing sewage network after taking permission from the municipal corporation. The waste generated from stations is primarily solid waste comprising paper and plastic from eatables consumed by commuters. The waste shall be collected in bins marked for two types- bio-degradable and others. To avoid odour and the accumulation of fly-supporting materials, garbage containers shall be washed at frequent intervals. This shall be collected and transported to local municipal bins for onward disposal to disposal site by the municipality.

During construction wastewater (e.g. wash water) from the concrete batching plant and Casting yard will be collected into a sedimentation tank (2 chambers), and the treated water will be reused on-site (e.g. water sprinkling), No discharge will be allowed outside of the premises.

During construction, there will be excessive usage of groundwater. During operation, as mitigation measures, rainwater harvesting will be carried out at stations. To avoid excess usage of water during construction following measures will be taken to reduce water consumption.

1. Recycle of water consumed in wheel washing.

2. Recharge of discarded water from RO plant should be explored wherever practically feasible.
3. Water from dewatering will also be used for groundwater recharge.

6.1.19. Construction of Bridge on River Yamuna

Following measures will be taken to avoid impacts on the environment

- ❖ No polluting vehicles, construction machinery and plants allowed
- ❖ Use of ready-mix concrete for concreting
- ❖ Disposal of construction and demolition waste at the recycling plant at Burari and using recycled material such as paver blocks in the project.
- ❖ Using of nonpolluting polymer in the pile foundation
- ❖ No use of hazardous materials which can contaminate water/soil
- ❖ No harm to aquatic flora and fauna
- ❖ Vehicles carrying construction materials and debris shall also be covered
- ❖ Construction material stored on the site shall be fully covered to avoid dispersal of dust in the air
- ❖ Environmental quality monitoring at the site
- ❖ Prevention of riverbed scouring and protection of riverbank erosion

6.1.20. Rainwater harvesting

Seven out of the nine revenue districts of Delhi are considered critical in regard to groundwater resources. Taking into account the depleting groundwater resources in Delhi, Central Ground Water Authority had declared the whole of South and South-West districts of NCT Delhi as “Notified Areas” in August 2000 and imposed prohibition and restriction in these districts on the construction and installation of any new structure for extraction of groundwater resources to avoid further depletion and deterioration in water quality in the said districts. Central Ground Water Authority through its public notices issued between 3/2001 and 8/2004 has directed Group Housing Societies/ Institutions/ Schools/Hotels /industrial establishments/Farm Houses in South and South–West Districts and group housing societies located outside notified areas of NCT Delhi (where groundwater levels are more than 8 meters below the ground surface) to adopt Rooftop Rainwater Harvesting systems in their premises. Ministry of Urban Development & Poverty Alleviation (Delhi Division), Govt. of India by its notification dated 28.7.2001 had made modification/additions in the building Bye-laws 1983 as under:

- i) Water harvesting through storing of water runoff including rainwater in all new building on plots of 100 sq. meters and above will be mandatory. The plans submitted to the local bodies shall indicate the system of stormwater drainage along with points of collection of the water in surface reservoirs or recharge wells.
- ii) All buildings having a minimum discharge of 10,000 litres and above per day shall incorporate the wastewater-re-cycling system. The recycled water should be used for horticultural purposes.

To conserve and augment the storage of groundwater, it has been proposed to construct a rooftop rainwater harvesting structure of suitable capacity at the elevated stations and in the elevated alignment. Each pillar can have inbuilt downpipes to collect the rainwater from the viaduct and into the underground tanks on the median. A recharge tank shall be constructed at a suitable distance. The water collected will percolate down to the subsoil through numerous layers of sand, gravel and boulders. Total elevated length of the corridors is about 31 km. Annual rainfall of Delhi is

611.8mm per year. Considering a runoff coefficient of 0.85 the annual rainwater harvesting potential of elevated stations and elevated section is estimated as 1,65,605 cum.

6.1.21. Management Plan for Depot

The management plan for the depot site includes:

- Water Supply,
- Oil Pollution Control,
- Hazardous waste management,
- Effluent Pollution Control,
- Rainwater harvesting and
- Solid waste management

Water Demand: Water will be required for the operation and functioning of the depot which could be collected from existing tube wells. If required more tube wells will be bored after approval from the concerned authority.

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 will be utilized from the existing facility of the depot. Such tanks usually employ compressed air to coagulate the oil and grease and cause it to rise promptly to the surface. Compressed air may be applied through porous plates located in the bottom of the tank.

Hazardous Waste Management: Hazardous wastes that will be generated from Depot and train operation will mainly include sludge from ETP, waste oil from machinery and cotton soaked with grease. All of these wastes will be disposed of through authorized recyclers. As per Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016, the occupiers of facilities may store the hazardous and other wastes for a period not exceeding ninety days and shall maintain a record of sale, transfer, storage, recycling, recovery, pre-processing, co-processing and utilisation of such wastes and make these records available for inspection.

Effluent Pollution Control: The effluent that will be generated from the depot will be treated in the existing STP/ETP up to the level so that it could be used for horticulture purpose in the campus. The existing STP and ETP will easily cater to the increased quantity of the effluent. The effluent will have oil, grease and, detergent as the main pollutants. This has to be treated as per the requirement of the Delhi Pollution Control Committee. The treated effluents from the maintenance depot will be used for horticulture purposes inside the depot, and no discharge will be allowed outside of the premises.

Rainwater harvesting: To conserve and augment the storage of groundwater, it has been proposed to construct a rooftop rainwater harvesting structure of suitable capacity in the depots. Most of the area in depot will be open to the sky and very less area is covered. The cost for the rainwater harvesting is included in the civil cost.

Solid Waste Disposal: The solid waste generated from the Depot will be taken by the cleaning contractor weekly and disposed to the municipal waste disposal sites in accordance with relevant National and State laws and regulations. Since the solid waste is already disposed of off in the existing depot hence no separate cost under this head is included in EMP.

6.2 TRAINING

The training for engineers and managers will be imparted by DMRC on a regular basis to implement the environmental protection clauses of the tender document and to implement the best environmental practices during the construction phase. The course content can be drawn from past experiences of Delhi Metro. These training programs will be imparted through regular training workshops in which presentations will be made on a variety of issues pertaining to environmental management so as to sensitize the participants and raise their awareness on environmental issues in general and conditions of the contract on the environment, in particular. These programmes could be extended for the local population for their active participation in the project implementation. Apart from training, such programme should include guidelines for safety, methods of disaster prevention, action required in case of emergency, fire protection, environmental risk analysis etc. The cost involved for such a programme is presented in **Table 7.2**.

Table 6.2: Cost for Training Programme

S. No	Item	Cost (Rs)
1	Curriculum Development and course preparation 1 months Rs.50000/month	50,000
2	5 Environmental Trainer (1 year) Rs.35,000/ month	21,00,000
3	Instructor 10 sessions of 10 days each	3,00,000
4	Demonstration/Presentation Aids	50,000
5	Material etc.	50,000
Total		25,50,000

6.3 DISASTER MANAGEMENT

A disaster is an unexpected event due to sudden failure of the system, external threats, internal disturbances, earthquakes, fire and accidents. The first step is to identify the causes which develop/ pose an unexpected danger to the structural integrity of the Metro tunnel or overhead rail. The potential causes are excessive load, cracks, failure and malfunctioning of sensing instruments, accident, etc. These need to be looked into with care.

Preventive Action

Once the likelihood of a disaster is suspected, action has to be initiated to prevent a failure. Engineers responsible for preventive action should identify sources of repair equipment, materials, labour and expertise for use during an emergency.

Reporting Procedures

The level at which a situation will be termed a disaster shall be specified. This shall include the stage at which the surveillance requirements should be increased both in frequency and details. The Engineer-in-Chief should notify the officer for the following information:

- Exit points for the public,
- Safety areas in the tunnel/overhead rail, and
- Nearest medical facilities.

Communication System

An efficient communication system is absolutely essential for the success of any disaster management plan. This has to be worked out in consultation with local authorities. More often, the entire communication system gets disrupted when a disaster occurs. The damage areas need to be clearly identified and provided with a temporary and full proof communication system.

Emergency Action Committee

To ensure coordinated action, an Emergency Action Committee should be constituted. The civic administrator may be the Chairman of this Committee. The committee may comprise of:

- Station Master concerned,
- Police Officer of the area,
- Delhi Transport Corporation Representative,
- Home Guard representative,
- Fire Brigade representative,
- Health Department representative,
- Department of Information and Publicity, and
- Non-Governmental Organization of the area.

Emergency Action Committee will prepare the evacuation plan and procedures for implementation based on local needs and facilities available. The plan should include:

- Demarcation of the areas to be evacuated with priorities,
- Safe route to be used, adequacy of transport for evacuation, and traffic control,
- Safe area and shelters,
- Security of property left behind in the evacuated areas,
- Functions and responsibilities of various members of evacuation teams, and
- Setting up of joint control room.

All personnel involved in the Emergency Action Plan should be thoroughly familiar with all the elements of the plan and their responsibilities. They should be trained through drills for the Emergency Action Plan. The staff at the site should be trained for problem detection, evaluation and emergency remedial measures. Individual responsibility to handle the segments in an emergency plan must be allotted.

The success of an emergency plan depends on public participation, their response to warning notifications and timely action. The public has to be educated on the hazards and key role in disaster mitigation by helping in the planned evacuation and rescue operations.

It is essential to communicate by whom and how a declared emergency will be terminated. There should be a proper notification to the public on de-alert signals regarding the termination of the emergency. The notification should be clear so that the evacuees know precisely what to do when re-entering or approaching the affected areas.

6.4 EMERGENCY MEASURES

The emergency measures are adopted to avoid any failure in the system such as lights, fire, means of escape, ventilation shafts etc. The aim of the Emergency Action Plan is to identify areas, population and structures likely to be affected due to a catastrophic event of an accident. The action plan should also include preventive action, notification, warning procedures and coordination among various relief authorities. These are discussed in the following sections.

Emergency Lighting

The emergency lights operated on battery power should be provided at each station. The battery system should supply power to at least 25% of the lights at the station, platforms, tunnels/viaducts for a period of 2 hours. The underground station should have a transformer at each end of the platform. Both the transformers need to be kept energized and should feed independently alternate rows of lights so that in case of failure of one transformer, there will not be complete darkness. The tunnels need to be provided with fluorescent incandescent lamps at a spacing of 20 m.

Fire Protection

The building materials should be of appropriate fire resistance standard. For underground structures, the fire resistance period should be at least 4 hours, and 2 hours for surface or overhead structures. Wood shall not be used for any purpose, excluding artificial wood products, which are flame resistant. The materials which have zero surface burning characteristics need to be used. The electrical systems shall be provided with automatic circuit breakers activated by the rise of current as well as activated by over current. The design of a station will include provision for the following:

- Fire prevention measures,
- Fire control measures,
- Fire detection systems,
- Means of escape,
- Access for fireman, and
- Means of firefighting.

Accumulations of the refuse of any inflammable material like paper, plastic cartons constitute a major fire hazard and should not be permitted. Smoking should be strictly prohibited at all locations of MRTS.

All aspects of fire prevention and control will be dealt with in close collaboration with the city fire fighting authority. Smoke control will be achieved by the following means:

- Down stand bulkheads of a minimum depth of 600 mm to provide smoke containment. These will be provided around openings for escalators, lifts and stairs in underground stations,
- In underground stations the ventilation system will be designed to extract smoke in the event of a fire, and
- In enclosed public areas of above-ground stations (e.g. a concourse located below a platform)

arrangement for smoke extraction will be provided.

A minimum of 30 minutes supply of water is to be assured in the case of fire. The pumps/overhead tanks shall have the capacity to discharge the water at the rate of 1100 litres per minute at a head of 21 m at nozzle mouth.

The storage capacity in an underground or overhead tank may be divided into two parts i.e. dead storage and running storage. Firefighting pumps shall be provided with a diesel pump as a standby arrangement, in case of power failure.

The fire of electrical origin, water cannot be used until the electric system has been made dead and earthed. For electrical fires, non-aqueous agents like ABC Power Chloro Bromo Methane or CO₂ gas are utilized for firefighting. Fire extinguishers with these agents shall be liberally provided at static installations and on the rolling stock.

Generally, there are often more casualties from smoke inhalation than from burning. Smoke needs to be transported away from the site of the fire. In order to achieve this, both fresh air has to be introduced into the underground section and exhaust gases should be sucked out from other section.

Openings, including ducts and passages, between MRTS property and any adjoining structures which allow free access into the MRTS property will be protected by fire doors, fire shutters, fire dampers etc. as appropriate. Fire detection and alarm systems will be provided as per the prevailing state of art technology.

A. Fire Prevention and Safety Measures

Fire prevention measures will be designed and implemented to minimize the risk of an outbreak of fire by appropriate choice, location and installation of various materials and equipment. In stations planning, potential sources of fire can be reduced by:

i. Fire Prevention

- Use of non-combustible or smoke retardant materials where possible,
- Rolling stock is provided with fire retarding materials, low smoke zero halogen type electric cable is also provided,
- Provision of layout which permits ease of maintenance for equipment and cleaning of the station premises,
- Provision of special storage spaces for combustible materials such as paint and oil,
- Prohibition of smoking in fire-prone areas,
- Provision of cigarette and litter bins, and
- Good housekeeping.

ii. Safety

Following provisions will be required from a fire safety point of view:

- Automatic sprinkler/detection system to be provided if the floor area exceeds 750 sq.m
- One wet riser-cum-down comer per 1000 sqm floor area with static underground storage tank, overhead tanks and pumps of suitable capacity with hydrants, first-aid reel, etc.

- Portable fire non-aqueous extinguishers of Carbon di Oxide, chemical dry powder etc. at suitable places.
- Automatic smokes venting facilities.
- Two separate means of exit shall be provided if more than 10 persons are working and the area exceeds 1400 sq.m
- Fire resisting doors shall be provided at appropriate places along the escape routes to prevent the spread of fire and smoke.
- The travel distance for fire escape shall not exceed 20 m where escape is available in more than one direction; the distance could be up to 40 m.

B. Fire Alarm and Detection System

A complete fire detection system with equipment complying with the requirements of Delhi Fire Services shall be provided throughout each station and ancillary buildings including entrance passageways, subways and adits etc. to give a visual and audible indication of alarm conditions actuated by the operation of break glass contact or fire sensors e.g. detector heads, linear heat-detecting cables etc. The system shall be operated from 24 V DC Power sources.

Manually operated call points shall be provided at every hydrant and nose reel points, station headwall, tail wall and other locations. Alarm bells shall be installed in each plant room complex at both platform and concourse level and shall be clearly audible at all points in the room/area.

Beam detector or heat detector shall be installed at roof level, ceiling and floor cavity, whilst linear detecting cables shall be installed in under platform cable ducts and cable shafts.

Smoke probe units shall be installed in rooms/compartments. When an alarm point is operated, the fire pump shall start to operate automatically. A station fire control and the indicating panel shall be provided an installed in the station controllers room, for the control, indication and monitoring of the whole detection and firefighting systems. While designing the firefighting system, the zone of Delhi Fire Services shall be taken into account for linking with the same.

C. Fire Control Measures

Control of the spread of fire and smoke will be achieved by a partition of fire risk areas, planning for smoke extraction, and arrangement for smoke containment. Partition is aimed at limiting the extent of fire. The openings must be capable of being sealed in the event of a fire. With the exception of station public areas, a fire compartment will not exceed 1500 m². Partition of the public areas in stations is not practicable for operational reasons. The fire resistance period of this separated area should be about 3 hours.

D. Access for Fireman

Secondary access to the station, not used by passengers for evacuation, shall be available to fireman should the need arise. The entry point shall be easily accessible from the road. Access shall be available to all levels of the station. The minimum width of the stairs is 1.0 m and the maximum height should not exceed 60 cm.

Ventilation Shafts

The Environmental Control system for underground stations requires ventilation openings between

various plants, plant rooms and the atmosphere. The tunnel vent shafts of approximately 20 sq. m. area will be constructed at each end of the stations. There shall be supply shaft and exhaust shafts of similar dimensions at the stations. Three midshaft in Aerocity to Tughlakabad corridor may be required at three locations in between Mashoodpur to Kishangarh, Kishangarh to Mehrauli and Tigri to Anandmayee Marg and three midshaft in Inderlok to Indraprastha corridor may be required at three locations in between Ajmal Khan park to Nabi Karim, Nabi Karam to New Delhi and Delhi Gate to Delhi Sachivalaya.

Emergency Door

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

6.5 SUMMARY OF ENVIRONMENTAL MANAGEMENT PLAN (EMP)

The environmental impacts stemming out of the proposed project can be mitigated with a simple set of measures, dealing with careful planning and designing of the metro alignment and structures. Adequate provision of environmental clauses in work contracts and efficient contract management will eliminate or reduce significantly all possible problems. A common problem encountered during implementation of environmental management plans of such projects is lack of environmental awareness among engineers and managers concerned with day to day construction activities, which can be solved through regular environmental training programs. A set of preliminary EMP is presented in **Table 7.3**, which defines actions to be undertaken during the design stage, pre-construction, construction and operation stage of the project. The effectiveness of environmental considerations will, however, depend on the appropriate inclusion of these in the work contracts.

The major concern during the construction stage is that the contractors, due to lack of enforcement, would not practice good environmental sanitation (housekeeping), may intend to get unauthorized use of the easily available natural resources and other available infrastructures like roads and water resources. This would result in degradation of ambient air quality, water resources and land environment around the construction sites and workers camp. Improper management of earthwork and bridge construction activities would disrupt natural drainage and increase soil erosion. Improper management may result in spillage of explosives into the hands of unsocial elements. Finally, the implementation of the mitigation actions requires that the project implementation unit would record an end-of-construction mitigation checklist, before releasing the final payment of any work contract.

In addition to that DMRC, should prepare and established Environmental and Health Policy and Procedures as per Phase III and that should become an integral part of the contract document.

Operational phase mitigation would involve good environmental sanitation (housekeeping) practice at metro establishments including effective solid waste collection and disposal, wastewater disposal, the upbringing of plantations and green area. Protection of earth slopes in landslide-prone area would be a very important task. During the operation period, the metro operating unit will be required to confirm receipt of the construction period mitigation report through the PIU and prepare a follow-on timetable of actions.

Table 6.3: Environmental Management Action Plan (EMAP)

Environmental Impact	Mitigation Measures Taken or To Be Taken	Time Frame	Implementing Organization	Responsible Organization
DESIGN PHASE				
Metro Alignment	The proposed corridor alignment was selected to minimize the land disturbance to avoid archaeological sites, temples and other environmentally sensitive areas in least.	During Design	DPR and design consultant	PIU
Cultural Heritage	Avoided by adjustment of alignment.	During Design	DPR and design consultant	PIU
Flood	Bridges shall be well designed	During Design	DPR and design consultant	PIU
Loss of Water Bodies	Utmost care taken to avoid alignment crossing water bodies	During Design	DPR and design consultant	PIU
Inadequate design provision for safety against seismological hazard	Make sure that design provides for safety of structures against worst combination of forces in the probability of an earthquake likely to occur in seismic zone-III.	DPR and detailed design stage	DPR and design consultant	PIU
PRE –CONSTRUCTION STAGE				
Water requirement	The requirement of water shall be for construction purpose etc., shall be planned and shall be arranged in order to avoid digging of Tube wells.	Preconstruction stage	Contractor	PIU/EMP implementing agency
Disposal of final treated effluent from treatment plant	Options for final disposal shall be studied and the suitable disposal route shall be decided carefully to minimize the impact of receiving bodies. As far as possible zero discharge rules may be adopted.	During the design stage / and preconstruction of the treatment plant	Contractor	PIU/EMP implementing agency
CONSTRUCTION PHASE				
Environmental Management and Monitoring	This will include institutional requirements, training, environmental management and monitoring	During and after construction	Contractor	PIU/EMP implementing agency
Dust	Water should be sprayed during the construction phase and site clearing, wherever it is required to avoid dust. Vehicles delivering materials should be covered to reduce spills and dust blowing off the load.	During construction	Contractor	PIU/EMP implementing agency
Air Pollution	Vehicles and machinery are to be regularly maintained so that emissions conform to National and State AAQ Standards. Regulations covering emissions standards for ambient air quality are at Annexure 1.4 . Construction equipment vehicle emission norms are given in Annexure 7.1 .	Beginning with and continuing throughout the construction	Contractor	PIU/EMP implementing agency
Equipment Selection and maintenance and operation	Construction plants and equipment will meet recognized international standards for emissions and will be maintained and operated in a manner that ensures relevant air, noise, and discharge regulations are met.	During construction	Contractor	PIU/EMP implementing agency

Environmental Impact	Mitigation Measures Taken or To Be Taken	Time Frame	Implementing Organization	Responsible Organization
Noise	Noise standard will be strictly enforced at construction sites and during site clearing. Workers in the vicinity of strong noise will wear earplugs and their working time should be limited as a safety measure. At construction sites within 150m of sensitive receptors construction will be stopped from 22:00 to 06:00. Temporary noise barriers shall be installed for silence zones including schools and hospitals.	Beginning and through construction	Contractor	PIU/EMP implementing agency
Vibration	The vibration level limits at worksites adjacent to the alignment shall conform to the permitted values of peak velocity as given in the relevant tender document. As regards to the heritage structures, it is submitted that the spread of settlement due to vibration is modelled to be not more than 40 m on either side of the alignment, with a moderate TBM face pressure of 1.2 bar. Since the distance of all the monuments from the proposed alignment is more than 40m, therefore there will be no impact on such monuments.	Beginning and through construction	Contractor	PIU/EMP implementing agency
Disposal of debris from dismantling structures	The contractor shall be responsible for collection, segregation and storage of construction and demolition waste, as directed or notified by the concerned local authority in consonance with the Construction & Demolition Waste Management Rules, 2016.	Beginning and through construction	Contractor	PIU/EMP implementing agency
Under Ground Tunnelling Work				
Excavation of Tunnel Tubes	As per the tunnelling Method Statements	Beginning and through construction	Contractor	PIU/EMP implementing agency
Ventilation and Air Cooling in Underground Work	All working areas in a free air tunnel are provided with ventilation system as approved by the Director-General and the fresh air supplied in such tunnel is not less than 6 m ³ /min for each worker employed in the tunnel as per Rule 153 of BOCWR.	Beginning and through construction	Contractor	PIU/EMP implementing agency
Control of Dust, Noxious Gasses in Underground Work	Any flammable or explosive substance, including dust, vapours or gases, shall be protected as to prevent, so far as is reasonably practicable, the danger arising from such exposure.	Beginning and through construction	Contractor	PIU/EMP implementing agency
Energy Management	The contractor shall use and maintain equipment so as to conserve energy and shall be able to produce demonstrable evidence of the same upon DMRC request.	Through construction	Contractor	PIU/EMP implementing agency
WATER				

Environmental Impact	Mitigation Measures Taken or To Be Taken	Time Frame	Implementing Organization	Responsible Organization
Contamination from Wastes	All justifiable measures will be taken to prevent the wastewater produced in construction from entering directly into rivers and irrigation system	Throughout the construction period	Contractor	PIU/EMP implementing agency
Wastage of water	Measures shall be taken to avoid the misuse of water. Construction agency shall be instructed accordingly to follow strict procedures while using the water for construction and drinking	Beginning with and continuing throughout the construction	Contractor	PIU/EMP implementing agency
Construction water use and wastewater generation from construction yard and labour camps	Water for construction will be arranged by the contractor. Permission has to be taken from the concerned local govt. in case of groundwater extraction. Wastewater from the site is not discharged into the sewer without approval. Provision of Bio-toilet has been made extensively throughout the contract.	Beginning with and continuing throughout the construction	Contractor	PIU/EMP implementing agency
Ground Water management	The contractor shall obtain necessary permission for extracting groundwater from the relevant government agency. Rainwater harvesting pit has been developed in casting yard and depot to augment groundwater recharge. This will ensure groundwater is not depleted.	Beginning with and continuing throughout the construction	Contractor	PIU/EMP implementing agency
Sewerage disposal during construction at Service Centres	A minimum distance of any sewage or toilet facility from water sources should be 200 meters	Throughout the construction period	Contractor	PIU/EMP implementing agency
Sanitation and Waste Disposal in Construction Camps	Sufficient measures will be taken in the construction camps, i.e. provision of garbage tank and sanitation facilities. Waste in septic tanks will be cleared periodically. Drinking water will meet Indian National Standards. Garbage will be collected in a tank and disposed of daily. Special attention shall be paid to the sanitary condition of camps. Camps will be located at a minimum distance of 200 m from water sources.	Before and during the building of construction camps	Contractor	PIU/EMP implementing agency
SOIL				
Quarrying	Quarrying will be carried out at approved and licensed quarries only.	During construction	Contractor	PIU/EMP implementing agency
Contamination due to heavy metals	The heavy metal test will be done during the excavation for the underground station. In case of mental contamination, it will be handled & disposed off in an environment-friendly manner as per Hazardous Waste Management Rule 2016.	During construction	Contractor	PIU/EMP implementing agency

Environmental Impact	Mitigation Measures Taken or To Be Taken	Time Frame	Implementing Organization	Responsible Organization
Riverbed Scouring and Riverbank Erosion	<p>The proposed bridge over river Yamuna is only 400 m downstream of existing barrage. This barrage is maintained and monitored by the Irrigation and Flood Control Department of Govt. of Delhi. The piers and spans arrangement of the proposed DMRC bridge is aligned with the piers of the barrage. Therefore, there will be no hindrance to the river flow. Hence, the proposed bridge will not cause any riverbed scouring.</p> <p>The proposed alignment is completely on the viaduct and there will be no abutment of the bridge. Moreover, DMRC will not be constructing any structures at the riverbank. Therefore, there will be no erosion of riverbank due to the proposed bridge.</p> <p>Moreover, the Irrigation and Flood Control Department which maintains the barrage conducts regular monitoring of riverbed scouring and riverbank erosion.</p>	Before and during the construction	Contractor	PIU/EMP implementing agency
FLORA AND FAUNA				
Loss of trees and Avenue Plantation	Areas of tree plantation cleared will be replaced according to Compensatory afforestation Policy under the Forest Conservation Act. Trees will be planted against every tree cut as per norms.	After completion of construction activities	Forest Department	Forest Department
Sensitive Species within the ESZ	<p>The proposed alignment is underground and through habitat area, so no impact is envisaged.</p> <ul style="list-style-type: none"> - No hunting, poaching, or unnecessary habitat destruction is to be ensured. - The Forest Department will monitor the Flora and Fauna between the project boundary and the Asola Bhatti Wildlife Sanctuary boundary. In the case of any negative impact on account of the project, DMRC will consider the advice of the Forest Department in drafting a mitigation strategy for implementing measures to negate or minimize the negative impacts. 	Before and during construction	Forest Department	Forest Department/PIU
SOCIAL				
Loss of Access	Temporary access should be built at the interchange and other roads.	During construction	Contractor	PIU/ Traffic department
Traffic jams and congestion	If there are traffic jams during construction, measures should be taken to relieve the congestion with the co-ordination of transportation and traffic police department	During construction	Contractor	PIU/ Traffic department

Environmental Impact	Mitigation Measures Taken or To Be Taken	Time Frame	Implementing Organization	Responsible Organization
Safety with vehicles, people and livestock and signage	Safety education and fines. Allow for adequate traffic flow around construction areas Provide adequate signage, barriers and flag persons for safety precautions. Communicate to the public through radio, TV & newspaper announcements regarding the scope and timeframe of projects, as well as certain construction activities causing disruptions or access restrictions	During construction	Contractor	PIU/ Traffic department
Increase in disease Water-borne Insect-borne Communicable diseases	Make certain that there is good drainage at all construction areas, to avoid the creation of stagnant water bodies. Provide adequate sanitation and waste disposal at construction camps. Provide adequate health care for workers and locate camps away from vulnerable groups	During construction At start-up Throughout construction	Contractor	PIU/EMP implementing agency
Location of camps depots and storage areas	Location of camps depots and storage areas shall be as per the contract specifications.	Throughout construction	Contractor	PIU/EMP implementing agency
Establishment and Operation of the Labour Camps	The Contractor during the progress of work will provide, erect and maintain necessary (temporary) living accommodation and ancillary facilities for labour to standards and scales approved by the DMRC.	Throughout construction	Contractor	PIU/EMP implementing agency
Labour Health and Welfare- HIV/AIDS	Provide adequate health care for workers and locate camps away from vulnerable groups	Throughout construction	Contractor	PIU/EMP implementing agency
Emergency Preparedness and Response Management	The emergency measures are adopted to avoid any failure in the system such as lights, fire, means of escape, ventilation shafts etc.	Throughout construction	Contractor	PIU/EMP implementing agency
OPERATION PHASE				
Noise and Vibration	Noise barriers shall be installed on the viaduct at sensitive locations. The public shall be educated about the regulations of noise and vibration pollution and its implications.	After completion of construction	PIU/EMP implementing agency	PIU/EMP implementing agency
WATER				
Oil pollution	Suitable treatment shall be taken for treatment oil before discharging the wastewater especially in the depot areas.	During operation of the treatment plant	PIU/EMP implementing agency	PIU/EMP implementing agency
Maintenance of Storm Water Drainage System	The urban drainage systems will be periodically checked and cleared to ensure adequate stormwater flow.	Beginning and end of monsoon	PIU/EMP implementing agency	PIU/EMP implementing agency

Environmental Impact	Mitigation Measures Taken or To Be Taken	Time Frame	Implementing Organization	Responsible Organization
Disposal of final treated effluent from treatment plant	Options for final disposal shall be studied and the suitable disposal route shall be decided carefully to minimize the impact of receiving bodies. As far as possible zero discharge rules may be adopted.	During operation of the treatment plant	PIU/EMP implementing agency	PIU/EMP implementing agency
Sensitive Species within the ESZ	The Forest Department will monitor the Flora and Fauna between the project boundary and the Asola Bhatti Wildlife Sanctuary boundary. In the case of any negative impact on account of the project, DMRC will consider the advice of the Forest Department in drafting a mitigation strategy for implementing measures to negate or minimize the negative impacts.	During operation	Forest Department	Forest Department/PIU
SOCIAL				
Safety and noise disturbance s	New buildings should be prohibited within 50 m of the edge of the carriageway. No new schools and hospitals should be allowed within 200 m of the carriageway.	Throughout and after the project development period.	Planning Department /PIU	PIU/EMP implementing agency

7. ENVIRONMENTAL MONITORING PLAN

7.1 PRE-CONSTRUCTION PHASE

The environmental monitoring programme is a vital process of any Environmental Management Plan (EMP) of a development project for a review of indicators and for taking immediate preventive action. This helps in signalling the potential problems resulting from the proposed project activities and will allow for prompt implementation of corrective measures. Environmental monitoring should be an integral part of works towards better environmental management of air, noise, vibration, water quality etc both during construction and in operation phases of the project. Generation of dust and noise are two main issues during any large construction activity. Degradation of water quality is another. The parameters monitored in pre-construction, construction and operation phase are based on the need to evaluate the deviation of environmental conditions from baseline environmental conditions due to the construction and operation of the Metro. The environmental monitoring will be required during both construction and operational phases. The following parameters are proposed to be monitored:

- ❖ Water Quality, Air Quality,
- ❖ Noise and Vibration,
- ❖ Environmental Sanitation and Waste Disposal,
- ❖ Ecological Monitoring and Afforestation,
- ❖ Workers Health and Safety, and
- ❖ Riverbed scouring and Riverbank erosion.

Environmental monitoring during the pre-construction phase is important to know the baseline data and to predict the adverse impacts during construction and operations phases. Pre-construction phase monitoring has been done for the proposed project for air, noise, water, soil quality and ecology. The results so obtained are documented in **Chapter 4**.

7.2 CONSTRUCTION PHASE

During the construction stage, environmental monitoring will be carried out for air quality, noise levels, vibrations, water quality and ecology. At this stage, it is not possible to visualize the exact number of locations where environmental monitoring must be carried out. However, keeping a broad view of the sensitive receptors and also the past experience an estimate of locations have been made and are summarized in **Table 7.1**. These numbers could be modified based on need when the construction actually commences.

7.2.1. Water Quality

Since water contamination leads to various water-related diseases, the project authorities shall establish a procedure for water quality surveillance and ensure safe water for the consumers. The water quality parameters are to be monitored during the entire period of project construction to ensure that water is safe for drinking purpose. Monitoring should be carried out by NABL certified private or Government agency. Water quality should be analyzed following the procedures given in the standard methods. Parameters for monitoring will be as per BIS: 10500. The monitoring points could be ground and surface water. The purpose of monitoring quality of water is to ensure that output water meets standards for drinking and construction during the construction phase.

7.2.2. Air Quality

Air quality is regularly monitored by Delhi Pollution Control committee at a number of places in Delhi. In addition to these, air quality should be monitored at the locations of baseline monitoring. The parameter recommended is Particulate Matter (PM_{2.5} and PM₁₀), SO₂, NO_x, CO and HC. The contractor will be responsible for carrying out air monitoring during the entire construction phase under the supervision of DMRC.

7.2.3. Noise and Vibration

The noise and vibration will be monitored at construction sites for the entire phase of construction by the site contractor and under the supervision of DMRC.

7.2.4. Ecological Monitoring

Compensatory Plantation & Compensatory Afforestation: For 60Ha compensatory plantation adjacent to the CWG Village, the Department of Forest, Govt. of Delhi will monitor the status of the ecology of the saplings planted in lieu of the trees felled so as to ensure and maintain the ecological environment and to monitor the survival rate of saplings planted. For 10.27Ha compensatory afforestation designated as per the FCA1980, also the Department of Forest, Govt. of Delhi will monitor the status of the saplings or rehabilitation activities as per the FCA1980. Hence, the costs of ecological monitoring have not been considered.

Sensitive Species within the ESZ: The Department of Forest, Govt. of Delhi, as the competent authority of the Asola Bhatti WLS as well as its ESZ, will monitor the status of the sensitive species between the Asola Bhatti WLS and its ESZ close to project alignments.

7.2.5. Soil Quality

Soils quality monitoring is to be carried out at underground stations to ascertain the presence of soil polluting chemicals due to construction activities. The parameters required to be monitored are pH, Sodium, Potassium, Chloride, Nitrogen, Phosphorous, Organic Matter, Heavy Metals (Mercury, Cadmium, Arsenic, Cyanide, lead, chromium), Oil and Grease. The monitoring is to be carried out by the contractor through NABL accredited private or government agency.

7.2.6. Workers Health and safety

Monitoring of health risk issues that might arise throughout the project lifetime will be done. Epidemiological studies at construction sites will be performed to monitor the potential spread of diseases. Regular inspection and medical checkups shall be carried out to workers health and safety monitoring. Any reoccurring incidents such as irritations, rashes, respiratory problems etc shall be recorded and appropriate mitigation measures shall be taken. The contractor will be the responsible person to take care of health and safety of workers during the entire period of the construction and project proponent is responsible to review/audit the health and safety measures/plans. The monitoring Schedule for Water Air, noise, vibration, and water are presented in **Table 7.1**. The estimated cost for monitoring during construction is 117 Lakh.

7.2.7. Riverbed Scouring and Riverbank Erosion

Riverbed scouring and riverbank erosion will be monitored by the Irrigation and Flood Control Department, Govt. of Delhi, which is the nodal agency also maintaining the Wazirabad Barrage. This barrage is 400m upstream of the proposed bridge.

7.2.8. Waste

The quantity of waste generated from the construction site will be monitored during the entire phase of construction by the contractor. The contractor will monitor the generation and disposal of excavated muck/soil, C&D waste, hazardous waste, bio-medical waste and report the quantity every month to the client.

7.2.9. Groundwater Usage

Water requirement for construction of Metro will be met through the tube-wells bored specially for metro construction after taking approval from the competent authority. To have a check on the water consumption, the contractor shall monitor water consumption by installing water meters at key extraction and consumption points.

7.2.10. Traffic Jam

Traffic congestion on account of metro construction will be monitored by the contractor and report to DMRC on monthly basis. This monitoring will be carried out by the contractor's Safety team under the supervision of DMRC's Safety Department.

7.2.11. Transmitted Disease

To reduce the risk of transfer of the HIV virus between and among construction workers, their families and the local community, the contractor shall monitor the take up and effectiveness of anti-AIDS measures. This monitoring will be carried out by the contractor's Safety team under the supervision of DMRC's Safety Department.

7.2.12. Accident

All accidents and dangerous occurrences shall be informed reported to DMRC. This will enable DMRC to reach to the scene of accident/dangerous occurrences to monitor/assist any rescue work and/or start conducting the investigation process so that the evidences are not lost.

Table 7.1: Construction Stage Monitoring Schedule

ITEMS	DESCRIPTION
Air	
Parameters to be monitored	PM _{2.5} and PM ₁₀ , SO ₂ , NO _x , CO and HC
Locations and frequency	2x24 Hour, twice in a month at 15 locations for 5 years.
Standard	National Ambient air quality standards, 18 th November 2009
Responsible organisation	Contractor through NABL accredited lab
Noise	
Parameters to be monitored	Leq, L ₉₀ , L ₅₀ , L ₁₀ , L _{max} , L _{min} (for both day and night).
Locations and frequency	24 hours once a week at 15 locations for 5 years.
Standard	The Noise Pollution (Regulation and Control) Rules, 2000
Responsible organisation	Contractor through NABL accredited lab
Vibration	
Parameters to be monitored	ppV
Locations and frequency	24 hours once a week at 8 locations for 5 years.
Standard	ISO 8041:1990 (Day time and night time)
Responsible organisation	Contractor

Water	
Parameters to be monitored	pH, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Dissolved Solids, Chlorides, Nitrates, Sulphates, Iron, Calcium, Total Nitrogen, Lead, Total Phosphates, oils and grease.
Locations and frequency	Once in six months at 10 locations for 5 years.
Standard	CPCB (BIS 10500:2012)
Responsible organisation	Contractor through NABL accredited lab
Soil Quality	
Parameters to be monitored	pH, Sodium, Potassium, Chloride, Nitrogen, Phosphorous, Organic Matter, Heavy Metals (Mercury, Cadmium, Arsenic, Cyanide, lead, chromium), Oil and Grease
Locations and frequency	Once in six months at 10 locations (bridge and viaduct pier locations-100m and 200m downstream of the active bridge pier construction) for 5 years.
Responsible organization	Contractor through NABL accredited lab
Ecology (Compensatory Plantation & Afforestation)	
Parameters to be monitored	Number of saplings, number of survival trees
Locations and frequency	Plantation site adjacent to CWG Village (60Ha) and Designated afforestation site by Gov. of NCT (10.27Ha)
Responsible organization	Forest Department, Delhi
Ecology (Sensitive Species in ESZ of Asola Bhatti Wildlife Sanctuary)	
Parameters to be monitored	Monitoring for poaching, hunting and unnecessary habit destruction of forest products, flora and fauna
Locations and frequency	Once in six months between the project boundary and Asola Bhatti Wildlife Sanctuary boundary by the Forest Department
Responsible organization	Forest Department, Delhi
Riverbed scouring and riverbank erosion	
Locations and frequency	By Irrigation and Flood Control Department, Govt. of Delhi.
Waste	
Waste stream to be monitored	Excavated Muck/Soil, C&D waste, Hazardous waste, Bio-medical waste
Location and frequency	From all construction sites once in a month
Responsible organization	Contractor
Groundwater Use	
Parameter	Water extraction and consumption in kilo litres
Location and frequency	Daily from all water extraction and consumption points
Responsible organization	Contractor
Traffic Jam	
Location and frequency	At major traffic points on daily basis
Responsible organization	Contractor
Transmitted Disease	
Location and frequency	Once in six months at construction camps
Responsible organization	Contractor
Accident	
Parameter	All accident and incident
Location and frequency	Daily at all construction sites
Responsible organization	Contractor

7.3 OPERATION PHASE

Even though the environmental hazards during the operation phase of the project are minimal, the environmental monitoring will be carried out for air, noise, vibration, water and ecology during the operation phase of the project. The parameters monitored during operation will be Particulate Matter (PM_{2.5} and PM₁₀), SO₂, NO_x, CO and HC for air. Drinking water quality parameters will be monitored as per BIS 10500 to ensure that output water meets standards for drinking. Input and output water of treatment plants will be monitored to check the performance of the treatment plants so that water can be used for horticulture. The monitoring schedule is presented in **Table 7.2**. The estimated cost for monitoring during operation is 40.59 Lakh. The monitoring program shall be conducted by an external agency certified by NABL under the supervision of the Delhi Metro. Project Operator i.e. DMRC will be responsible for successful environmental monitoring of the proposed project during the operation phase.

Table 7.2: Operation Stage Monitoring Schedule

ITEMS	DESCRIPTION
Air	
Parameters to be monitored	PM _{2.5} and PM ₁₀ , SO ₂ , NO _x , CO and HC
Locations and frequency	2x24 Hour, once in a month at 8 locations for 3 years.
Standard	National Ambient air quality standards, 18 th November 2009
Responsible organisation	DMRC
Noise	
Parameters to be monitored	Leq, L90, L50, L10, Lmax, Lmin (for both day and night).
Locations and frequency	24 hours four time a year for 1 st year and that then once a year at 8 locations for 3 years.
Standard	The Noise Pollution (Regulation and Control) Rules, 2000
Responsible organisation	DMRC
Vibration	
Parameters to be monitored	ppV
Locations and frequency	At the boundary of ASI Monuments, 24 hours four time a year for 1 st year and that then once a year at 8 locations for 3 years.
Standard	ISO 8041:1990 (Day time and night-time)
Responsible organisation	DMRC
Water	
Parameters to be monitored	pH, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Dissolved Solids, Chlorides, Nitrates, Sulphates, Iron, Calcium, Total Nitrogen, Lead, Total Phosphates, oils and grease.
Locations and frequency	Once a year at 5 for 3 years.
Standard	CPCB (BIS 10500:2012)
Responsible organization	DMRC
Ecology	
Parameters to be monitored	Flora and Fauna
Locations and frequency	Once in six months for 3 years between the project boundary and Asola Bhatti Wildlife Sanctuary boundary by the Forest Department.
Responsible organization	Forest Department, Delhi
Riverbed scouring and riverbank erosion	
Locations and frequency	By Irrigation and Flood Control Department, Govt. of Delhi.

The results of air quality, water quality, wastewater, vibration will be submitted to management

quarterly during the construction phase and semiannually during the operation phase. Frequency and number of locations of monitoring shall be reviewed upon feedback during operation. The reporting formats of these results are presented at **Annexure 8.1**.

7.4 STRENGTHING OF ENVIRONMENTAL DIVISION

Delhi Metro already has an Environment Division. This division needs to be strengthened because of the upcoming Phase IV project. It is recommended to induct at least two Environmental Engineers at middle and junior levels. The inductee will assess in the task of the division which is to supervise and coordinate environmental studies, environmental monitoring and implementation of environmental mitigation measures. Organizational setups for Environmental Monitoring during construction and operation phase are shown in **Figure 8.1** and **Figure 8.2**. Progress of the division should be reviewed by an Environmental Advisor once in a year. The environmental Advisor should be an experienced expert familiar with environmental management in similar projects. Cost for the first five years (including a 10% annual increase has been) given **Table 7.3**.

Table 7.3: Environmental Division Costs

m	ITEM	COST (Rs)
A	Capital Cost	
	Office Furnishings (Computer, furniture etc) Lump sum	5,00,000
B	Recurring Cost	
	Manpower Cost (For 12 months)	
	One Environmental Officer @ Rs. 1,25,000/month	15,00,000
	Environmental Engineer/Assistant @ Rs. 80,000/month	9,60,000
	Environmental Advisor once in a year @ Rs. 3,00,000/year	3,00,000
	Office Maintenance and consumables @ Rs. 25,000/month	3,00,000
C	Sub Total (A+B)	35,60,000
	Miscellaneous and unforeseen expenses, LS (10 % of C)	3,56,000
	Total cost for establishment of the cell for 1 Year	39,16,000
	Total cost for 5 years with 10% annual increase	2,39,07,572

Figure 7.1: Organizational Setup during Construction Phase

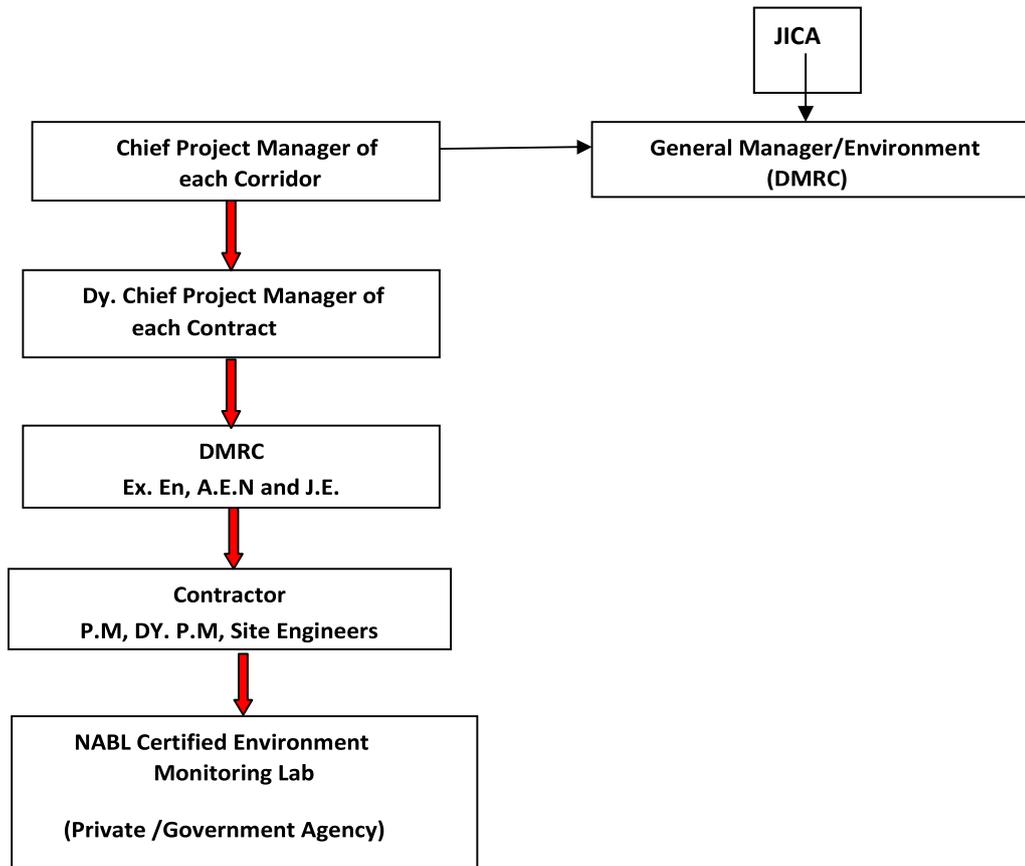
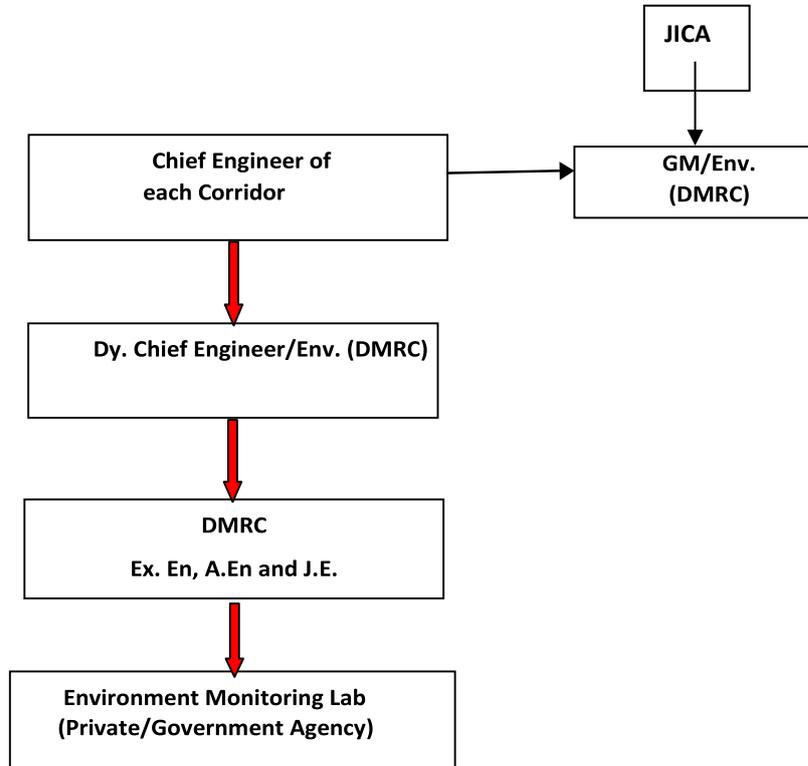


Figure 7.2: Organizational Setup during Operation Phase



9. INFORMATION DISCLOSURE AND PUBLIC CONSULTATIONS

In compliance with JICA Guidelines for Environmental and Social Considerations, April 2010 (JICA E&S GL), the project proponents are required to publicly disclose information about the environmental and social considerations of the projects and seek the opinion/suggestions of the stakeholders through Public Consultation. As a JICA loan proponent, Delhi Metro Rail Corporation Ltd. (DMRC) has been committed to the stakeholder engagement as per the JICA E&S GL.

As per the JICA E&S GL categorization, the proposed project, Phase IV priority corridors, is category “A” due to the projects in sensitive sectors-railway¹. Definition of the Category A project is given in the following box.

Category A: Proposed projects are classified as Category A if they are likely to have significant adverse impacts on the environment and society. Projects with complicated or unprecedented impacts that are difficult to assess, or projects with a wide range of impacts or irreversible impacts, are also classified as Category A. These impacts may affect an area broader than the sites or facilities subject to physical construction. Category A, in principle, includes projects in sensitive sectors, projects that have characteristics that are liable to cause adverse environmental impacts, and projects located in or near sensitive areas. An illustrative list of sensitive sectors, characteristics, and areas is provided in Appendix 3 of JICA Guidelines.

Source: JICA Guidelines for Environmental and Social Considerations, April 2010

9.1 Environmental Information Disclosure

The information disclosure and public consultation are important tools for disseminating information of the project, its environmental and social impacts and consulting all relevant stakeholders of the host country as per Sections 2.2 and 2.4 of JICA’s Guidelines.

DMRC’s information disclosure strategy includes wide dissemination of project-related information, in print and electronic media regarding significant project details. Such dissemination is carried out both during construction and operation by DMRC’s Public Relations Department and is aided by interviews and public discussions in which very senior DMRC management participate. The public is thus kept well informed and all significant issues concerning the public are incorporated in DMRC’s web site for the techno-savvy. Furthermore, the project EIA report is also accessible to the public. Copies of the report are available not only in the DMRC office but in other government offices. The report will also be web hosted by DMRC from where it can be downloaded.

As per information disclosure strategy, the details on the Environmental Impact Assessment Report were presented to the people living near the corridors through Environmental Public Consultation. The stakeholders were communicated about the venue, time and date in advance. These were fixed in consultation with the Resident Welfare Associations (RWA) and Shopkeepers Association (SA) of the area along the corridors.

In the subsequent sections, the outcomes of the public consultations organized have been discussed and presented.

9.2 Coordination and Holding Public Consultations

¹ Appendix 3. Illustrative List of Sensitive Sectors, Characteristics, and Areas, JICA Guidelines for Environmental and Social Considerations, 2010

Detailed and extensive consultations had been carried out during the environmental baseline and socio-economic survey stages as well as the draft report stage from 2013 to 2020 along the communities of Impacts with project affected persons such as traders, women, squatters, kiosks and other inhabitants within the COI (corridor of Impact). The objective of such consultations was to inform affected persons about the project, its features (such as nature of physical constructions, alignment *etc.*), expected impacts, policies that govern project-related land acquisitions and R&R benefits such as compensation, income restoration, employment generation, information flow, grievance redress *etc.* This report incorporates all issues raised during public consultations and recommends institutional strengthening measures in response to issues raised. The following methods were adopted for conducting public consultation:

- Informal individual/group consultation by the field surveyors that informed the PAPs about the project, purpose of survey and clarifications on their queries.
- In-depth individual interviews/discussion with key representatives RWAs, Trade Associations *etc.*;
- Public Consultation with the affected families' representatives RWAs, Trade Associations *etc.*

9.3 Methodology Adopted for Public Consultations

The methodology adopted for conducting public consultations included the following:

- **Information to PAPs:** The PAPs were informed before and about the purpose of the meeting.
- **Identification of Suitable Venue:** These venues were chosen in a way so that they can be easily approached by the PAPs/PAFs.
- **Formal Invitation to participants for the meeting:** A formal invitation was sent to all concerned about the public consultation 15 days in advance (**Annexure 9.1**). Further, follow up was done telephonically.

Conscious efforts were made to ensure higher representation of women, amongst the project affected persons. During the final draft stage consultation in 2019 and 2020, between 20-80 persons turned up for each consultation meeting. The procedure followed to ensure that participants represented the socio-economic strata of the project affected population.

During the public consultation, the public was informed about the project description, environmental baseline data, negative and positive environmental impacts, proposed mitigation measures and management plans. The public was also informed about the project benefits. The mode of information disclosure was PowerPoint Presentation in English and the mode of presentation was in Hindi (vernacular language). The environmental public consultations meeting on an average lasted 1 hour. Minutes of the public consultations were recorded on paper.

9.4 Public Consultation

The Public consultations had been carried out in three stages during the initial planning stage in 2013 and design and final design stages between 2019 and 2020. The details of public consultation in stages are presented below:

Initial Design Stage between August and October 2013:

During the initial planning stages of environmental survey process, multiple Focus Group Discussions (FGDs) were held with project affected people, resident welfare associations, trade associations *etc.* along the potentially impacted area along the Phase IV corridors summarized in the Table 9.1. During focus group discussion, the potential impacts due to the project during the construction and operation phases were explained. Issues related to air pollution, noise pollution, tree cutting, water supply, dust pollution, waste generations, traffic congestions, employment generation, safety, *etc.* were discussed. Also, the proposed methodologies for the survey were explained. Participants raised concerns and opinions and DMRC and its

technical consultants responded those concerns and opinions. There were approximately 10-12 participants in each FGD. The key participants included both individuals and groups namely (i) head of households; (ii) household members; (iii) small business entrepreneurs (SBEs); (iv) local people. Summary of FGD locations and dates are given in Table 9.1.

Table 9.1: Details of Focus Discussion Held

Sl. No.	Location	Date	No. of Participants
1.	Azadpur	14.08.2013	Approx. 10 to 12 per FGD (approx. 1 to 2 women)
2.	Peeragarhi	23.08.2013	
3.	Khanpur		
4.	Rangpuri village Mahipalpur		
5.	Jagatpur Village	02.09.2013	
6.	LNJP Hospital		
7.	Sheikh Sarai	10.09.2013	
8.	Andrews Ganj		
9.	Bawana Industrial Area	07.10.2013	
10.	Anajamandi Narela		

Final Design Stage in September 2019:

During the final planning stage of the EIA 2020 and SIA 2020, joint Focus Group Discussions (FGDs) for EIA and SIA were held with project affected people, resident welfare associations, trade associations etc. for each location on dates mentioned in the Table 9.2. During FGDs, the potential impacts due to the project during the construction and operation phases explained. Issues related to air pollution, noise pollution, tree cutting, water supply, dust pollution, waste generations, traffic congestions, employment generation, safety, etc. were discussed. The issues raised by participants were addressed. There were approximately 8-10 numbers of participants in each consultation. The key participants included both individuals and groups namely (i) head of households; (ii) household members; (iii) small business entrepreneurs (SBEs); (iv) local people. The details of such meetings are tabulated in Table 9.2.

Table 9.2: Details of Focus Discussion Held

Sl. No.	Location	Date	No. of Participants
1.	Pul Bangash Area	04.09.2019 – 05.09.2019	Approx. 8 to 10 per FGD (approx. 1 to 2 women)
2.	R K Ashram Area		
3.	Sadar Bazar Area	06.09.2019 – 07.09.2019	
4.	Ghanta Ghar Area		
5.	Khanpur Market Area	12.09.2019 – 14.09.2019	
6.	Anandmayee Marg Area		

Draft Final EIA & SIA Stage in February 2020:

In addition to above, during the draft final stage of the SIA2020 and EIA2020, six public consultations for EIA and SIA were conducted during February 2020. The outcomes of these public consultations had been recorded and analyzed for incorporation in both EIA and SIA Report in June 2020. Suitable recommendations have been made in project planning, design and operation based on the relevant outcomes of the consultation process. The venue, date and number of participants of such public consultations are presented in Table 9.3.

Table 9.3: Details of Public Consultations Held

Sl. No.	Location	Date	No. of Participants*
1.	Pul Bangash	01.02.2020	20(0)
2.	R K Ashram	01.02.2020	80(5)
3.	Sadar Bazar	01.02.2020	25(0)

4.	Ghanta Ghar	02.02.2020	30(3)
5.	Khanpur Market	09.02.2020	50(10)
6.	Anandmayee Marg	10.02.2020	20(6)

* No. in parenthesis denote female participants present in the meeting

During the public consultation, the public was informed about the project description, environmental baseline data, negative and positive environmental impacts, proposed mitigation measures and management plans. The public was also informed about the project benefits. The mode of information disclosure was Power Point Presentation in English and the mode of presentation was in Hindi (vernacular language).

9.5 Key Findings of Consultations

The key findings of the initial planning stage FGDs in 2013 are presented in Table 9.4. Minutes of consultations are placed at **Annexure 9.2**.

Table 9.4: Key Findings of Initial Planning Stage FGDs in 2013

Place & Date	Issues Discussed	Important views, questions & Suggestions	DMRC reply
Azadpur 14.08.2013	<ul style="list-style-type: none"> - Environmental issues - General issues 	<ul style="list-style-type: none"> - DMRC should take measures to control traffic during construction period - DMRC should take measures to control air pollution during construction - Extension of corridor till Sindhu Border - Tree cutting to be avoided - 	<ul style="list-style-type: none"> - Traffic control measures will be implemented before the start of construction - Measures will be taken to control air pollution during construction. Once metro becomes operational, air pollution will reduce drastically. - Corridor extension is not part of Phase-IV - Tree cutting will be minimized to the extent possible
Peeragarhi 23.08.2013	<ul style="list-style-type: none"> - Environmental issues - General issues 	<ul style="list-style-type: none"> - Issue of traffic jam - Need to connect both Punjabi Bagh stations - Improvement in metro route 	<ul style="list-style-type: none"> - Traffic control measures will be implemented before the start of construction - Connection of Line-5 and Line-7 Punjabi Bagh stations will be considered - New metro corridors will be considered in the subsequent phases
Khanpur 23.08.2013	<ul style="list-style-type: none"> - Environmental issues - General issues 	<ul style="list-style-type: none"> - DMRC should take measures to control air pollution during construction - Metro will result in time saving - Metro will reduce pollution - Journey by bus takes more time and creates traffic jams - Development of local places 	<ul style="list-style-type: none"> - Measures will be taken to control air pollution during construction. - DMRC confirmed that metro will result in pollution reduction, time saving etc. - Once metro becomes operational traffic jams will reduce - Metro will result in development of areas around metro stations and will bring in more economic activities.
Rangpuri Village Mahipalpur 23.08.2013	<ul style="list-style-type: none"> - Environmental issues - General issues 	<ul style="list-style-type: none"> - Metro will ease current transportation problems 	<ul style="list-style-type: none"> - DMRC confirmed that once metro will reduce traffic, pollution and save time.

		<ul style="list-style-type: none"> - Adequate compensation should be given where land will be taken for metro purpose - Mahipalpur to Chatterpur heavy traffic particularly during peak hours and metro will help to reduce traffic up to a great extent - Due to metro pollution will reduce however, during construction of metro there will be pollution 	<ul style="list-style-type: none"> - Compensation will be provided as per government policies. - Once metro becomes operational it will reduce traffic - Measures will be taken to control air pollution during construction.
Jagatpur Village 02.09.2013	<ul style="list-style-type: none"> - Environmental issues - General issues 	<ul style="list-style-type: none"> - If metro comes, other infrastructure will also build up - Metro construction should be environment friendly - Waste from the construction site should not be dumped in the area 	<ul style="list-style-type: none"> - Area development is an indirect benefit of metro system - DMRC follows green building norms for metro construction - Waste from construction will be disposed off as per norms
LNJP Hospital 02.09.2013	<ul style="list-style-type: none"> - Environmental issues - General issues 	<ul style="list-style-type: none"> - The proposed station should have inter connection with the under construction Delhi Gate station - DMRC should take measures to manage traffic during construction - Metro construction should not cause air and noise pollution - Road crossing facility to be provided during construction 	<ul style="list-style-type: none"> - Interconnection will be provided between both stations - Measures will be taken to minimize traffic issues during construction - Measures will be taken to mitigate air and noise pollution during construction - Traffic marshals will be provided at key intersection to streamline traffic and help pedestrians crossroads
Sheikh Sarai 10.09.2013	<ul style="list-style-type: none"> - Environmental issues - General issues 	<ul style="list-style-type: none"> - Due to metro pollution will reduce however, during construction of metro there will be pollution - Waste from the construction site should not be dumped in the area - Private land acquisition should be avoided 	<ul style="list-style-type: none"> - Measures will be taken to control air pollution during construction. - Waste from construction will be disposed off as per norms - Completely eliminating private land acquisition is practically not feasible. However, all efforts will be taken to minimize private land requirement
Andrews Ganj 10.09.2013	<ul style="list-style-type: none"> - Environmental issues - General issues 	<ul style="list-style-type: none"> - Metro will make travelling easier - Due to metro pollution will reduce however, during construction of metro there will be pollution - From Noida and Andrews ganj metro corridor is required 	<ul style="list-style-type: none"> - Measures will be taken to control air pollution during construction. - New corridors will be considered in the subsequent phases - Metro will make travelling easier

		<ul style="list-style-type: none"> - As compared to other modes of transport metro will save time 	
Bawana Industrial Area 07.10.2013	<ul style="list-style-type: none"> - Environmental issues - General issues 	<ul style="list-style-type: none"> - Metro will reduce traffic related accidents - Due to improvement in transportation local economy will boost - Due to industrial area many people come here, and it will be helpful for their smooth transportation - Present transportation system is inadequate 	<ul style="list-style-type: none"> - DMRC confirmed that these are the indirect benefits of metro system - Metro will improve the transportation system
Anajmandi Narela 07.10.2013	<ul style="list-style-type: none"> - Environmental issues - General issues 	<ul style="list-style-type: none"> - Present transportation system is inadequate - Due to metro, the existing market will be developed - Due to Bhawana Railway crossing, traffic jam is frequent. Metro will help to avoid traffic jam. 	<ul style="list-style-type: none"> - DMRC confirmed that these are the indirect benefits of metro system

The key findings of the public consultations during the draft final EIA and SIA stage are presented in Table 9.5. Minutes of consultations are placed at **Annexure 9.3**.

Table 9.5: Key Findings of Consultations

Place & Date	Issues Discussed	Important views, questions & Suggestions	DMRC reply
Pul Bangash 01.02.2020	On Environmental issues	<ul style="list-style-type: none"> - DMRC should take measures to control air pollution during construction - Noise pollution should be controlled during construction - Felling of trees should be minimized - Safety of structures during tunnelling should be ensured - Waste from the construction site should not pollute the area 	<ul style="list-style-type: none"> - Measures such as up to 10m high barricading, wheel washing, mist spraying and host of other measures will be taken during construction to minimize dust pollution - Proper care will be taken so that noise pollution does not cross the permissible limits during construction. This includes measures such as provision of noise barriers around construction sites which are in close proximity to the sensitive receptors. Felling of trees will be minimized to the extent possible. Ten saplings will be planted against every tree cut as per norms. - Proper safety measures will be taken during construction to avoid any mishappening. As a part of this extensive monitoring will be carried out during tunnelling - Waste from construction site will be disposed of only at authorized disposal facilities. For recycling C&D waste, DMRC has setup its own recycling plant

	On alignment, station design and R&R	<ul style="list-style-type: none"> - Private land acquisition should be avoided - Entry/Exit structure should be accommodated in the MCD dispensary 	<ul style="list-style-type: none"> - Completely eliminating private land acquisition is practically not feasible. However, all efforts will be taken to minimize private land requirement - Due to site constraints /land constraints, accommodating entry/exit structure in MCD dispensary is not feasible
	On other issues	<ul style="list-style-type: none"> - Pedestrian problem should be taken care of and construction should not affect day to day operation of their shops nearby. Walkways should be built for pedestrian movement - Traffic congestion around metro station should be controlled. - Underground parking area to be constructed - Construction should be completed fast - Metro should not damage the aesthetic view of the surrounding area 	<ul style="list-style-type: none"> - During construction, a route plan will be developed in consultation with a traffic/transportation expert. Proper barricading of works will be carried out for pedestrian safety. Access to the shops will not be obstructed and care will be taken so that construction does not affect day to day working of nearby shops. - Provision of providing parking space depends on land availability. Where there is availability of land parking will be provided - All efforts will be made to minimize the period of construction - Stations will be designed aesthetically keeping in view of the surrounding area.
R K Ashram 01.02.2020	On Environmental issues	<ul style="list-style-type: none"> - Construction should be environment and public friendly - Construction should be fast tracked near market area to minimize air and noise pollution - Malba (C&D Waste) from construction should not be dumped in the nearby locality - Safety of structures during tunneling should be ensured - Compensatory plantation should be carried out - Sanitation facilities should be provided to workers at construction site 	<ul style="list-style-type: none"> - Phase-IV of Delhi Metro is planned and designed as per green building norms. Phase-IV construction will be environment and public friendly. - All efforts will be taken to move the project on fast track project near residential and commercial areas. - Waste will be disposed at designated places only - Proper safety measures will be taken during construction to avoid any mishappening. As part of this extensive monitoring will be carried out during tunneling - Ten saplings will be planted against every tree cut as per norms. - Proper sanitation facilities will be provided with the construction site.
	On alignment, station design and R&R	<ul style="list-style-type: none"> - Station location should be shifted 300m backwards to avoid any disturbance 	<ul style="list-style-type: none"> - Due to site constraint, it is not feasible
	On other issues	<ul style="list-style-type: none"> - Distance between the existing station and the new station should be minimized - DMRC should start its own E-Rickshaw service - All necessary precaution may be taken during construction to avoid any mishappening. 	<ul style="list-style-type: none"> - This will be taken into consideration during station design subject to availability of land - Possibility for providing Metro E-Rickshaw facility will be looked into - Safety is paramount for DMRC and all measures will be taken to avoid any mishap

		<ul style="list-style-type: none"> - Efforts should be made that people should face less difficulties as far as possible - Area around metro station should be kept neat and clean 	<ul style="list-style-type: none"> - Efforts will be made that people will face least difficulties during construction - All efforts will be taken to keep area around metro station neat & clean
Sadar Bazar 01.02.2020	On Environmental issues	<ul style="list-style-type: none"> - Safety of structures during tunnelling should be ensured - Dust and noise pollution should be mitigated during construction - Construction should not affect sealing of tube-wells - What is the source of water for construction - Tree felling should be minimized, and compensatory plantation should be carried out. - Special precautions must be taken to protect animals during construction - 	<ul style="list-style-type: none"> - Proper safety measures will be taken during construction to avoid any mishappening. As part of this extensive monitoring will be carried out during tunnelling - Measures such as up to 10m high barricading, wheel washing, mist spraying and host of other measures will be taken during construction to minimize dust pollution - Proper care will be taken so that noise pollution does not cross the permissible limits during construction this includes measures such as provision of noise barriers around construction site - If tube-wells are coming on the alignment these tube-wells have to be sealed. However, alternate arrangements will be provided by DMRC - Water requirement for construction will be met either by extracting groundwater or sourcing water from outside. - Only those trees which are falling on the alignment will be cut. Ten saplings will be planted against every tree cut as per norms. - No impact on fauna is anticipated as the project is in urban area where there is no wildlife. Snakes rescued from construction site will be handed over to Wildlife NGOs.
	On alignment, station design and R&R	<ul style="list-style-type: none"> - The station should be constructed on the road - Shops for shop – All shop keepers should be rehabilitated by constructing market complex in the nearby area 	<ul style="list-style-type: none"> - Due to site constraint, it is not feasible - Compensation/ rehabilitation will be as per Entitlement matrix
	On other issues	<ul style="list-style-type: none"> - Construction should not affect day to day working of the market - Pedestrian problem should be taken care of - Road should not be blocked during construction - Construction should be fast tracked - UG parking to be provided 	<ul style="list-style-type: none"> - Access to the shops will not be obstructed and care will be taken so that construction does not affect day to day working of nearby shops. Proper barricading of work sites will be carried out for pedestrian safety. - As far as possible, road blockage will be avoided - All efforts will be made to minimize the period of construction

			<ul style="list-style-type: none"> - Provision of providing parking space depends on land availability. Where there is availability of land parking will be provided
Ghanta Ghar 02.02.2020	On Environmental issues	<ul style="list-style-type: none"> - Will the construction cause damage to Tripolia gate - Air and Noise pollution should be mitigated during construction - Will DMRC construct rainwater harvesting structures at metro stations - Safety during tunnelling to be ensured - The excavation period needs to be fast tracked near residential colonies to minimize air and noise pollution - Construction should be environment and public friendly - The project should not cause global warming - Tree felling should be minimized, and compensatory plantation should be carried out. 	<ul style="list-style-type: none"> - Tripolia Gate is approx. 138m from the alignment. There will not be any impact on the structure due to metro construction. Moreover, before any construction work at this area; permission from ASI will be obtained. Moreover, all precautions will be taken to avoid any mishap. - Measures such as up to 10m high barricading, wheel washing, mist spraying and host of other measures will be taken during to minimize dust pollution - Proper care will be taken so that noise pollution does not cross the permissible limits during construction this includes measures such as provision of noise barriers around construction sites which are in close proximity to the sensitive receptors. - Excavation near residential and commercial areas will be fast tracked to minimize disturbances - Phase-IV of Delhi Metro is planned and designed as per green building norms. Phase-IV construction will be environment and public friendly. - DMRC will provide Rainwater harvesting system at stations - No activity which will cause the global warming is anticipated. - Only those trees which are falling on the alignment will be cut. Ten saplings will be planted against every tree cut as per norms. - Felling of trees will be minimized to the extent possible. Ten saplings will be planted against every tree cut as per norms.
	On other issues	<ul style="list-style-type: none"> - Metro fares should be reduced - Traffic congestion around station to be managed better - Metro feeder bus facility should be available between residence and the metro stations - More rail cars to be increased during the peak hours 	<ul style="list-style-type: none"> - Metro fares are decided by a committee and DMRC has no role in fare fixation - Multi Model Integration (MMI) will be implemented to avoid congestion around operational metro station - Possibility for providing Metro feeder bus facility will be looked into. - People were informed that at the design stage itself, the basic unit of 6-car train is proposed for all the new upcoming corridors. The number of

		<ul style="list-style-type: none"> - Efforts should be made that people should face less difficulties as far as possible 	<ul style="list-style-type: none"> exclusive bogies for ladies, which is presently one, could be increased depending on the prevailing demand. - All efforts will be made to minimize the period of excavation during construction and all precautions will be taken to avoid air and noise pollution.
Khanpur Market 09.02.2020	On Environmental issues	<ul style="list-style-type: none"> - Construction should be environment and public friendly - Construction should be fast tracked near market area to minimize air and noise pollution - Noise barrier should be provided near residential areas during construction and operation - Precautions to be taken to prevent damage to archaeological structures around Tughlakabad Fort area - Waste dumping around construction site to be avoided - Tree felling should be minimized, and compensatory plantation should be carried out. 	<ul style="list-style-type: none"> - Phase-IV of Delhi Metro is planned and designed as per green building norms. Phase-IV construction will be environment and public friendly. - Excavation near residential and commercial areas will be fast tracked to minimize disturbances - Proper care will be taken so that noise pollution does not cross the permissible limits during construction this includes measures such as provision of noise barriers around construction site. Requirement of noise barrier will be studied. - Tughlakabad Fort is approx. 212m away from the alignment. There will not be any impact on the structure due to metro construction. Moreover, all precautions will be taken to avoid any mishap. - Waste from construction site will be disposed at authorized facility. - Feeling of trees will be minimized to the extent possible. Ten saplings will be planted against every tree cut as per norms.
	On alignment, station design and R&R	<ul style="list-style-type: none"> - All shop keepers should be rehabilitated in the nearby area before demolition 	<ul style="list-style-type: none"> - Shopkeepers will be rehabilitated within 500m distance.
	On other issues	<ul style="list-style-type: none"> - Construction should not affect day to day working of the market - Pedestrian problem should be taken care of - Road should not be blocked during construction - Metro fares should be reduced to make it more accessible to all sections of society - E-Rickshaw services to be provided at stations 	<ul style="list-style-type: none"> - Access to the shops will not be obstructed and care will be taken so that construction does not affect day to day working of nearby shops. - Proper barricading of works will be carried out for pedestrian safety. - Blockage of road will be avoided as far as possible. - Metro fares are decided by a committee and DMRC has no role in fare fixation - Possibility for providing Metro E-Rickshaw facility will be looked into.
Anandmayee Marg 10.02.2020	On Environmental issues	<ul style="list-style-type: none"> - Dust and noise from construction should be mitigated 	<ul style="list-style-type: none"> - Measures such as up to 10m high barricading, wheel washing, mist spraying and host of other measures

		<ul style="list-style-type: none"> - Malba (C&D Waste) from construction should not be dumped in the locality - Waste from the construction site should not pollute the area nearby - Rainwater harvesting needs to be carried out - Felling of trees should be minimized - Special precautions must be taken to protect animals during construction - 	<ul style="list-style-type: none"> will be taken during construction to minimize dust pollution - Proper care will be taken so that noise pollution does not cross the permissible limits during construction this includes measures such as provision of noise barriers around construction sites which are in close proximity to the sensitive receptors. - DMRC will provide Rainwater harvesting system at stations - For recycling C&D waste, DMRC has set-up its recycling plant at Ranikhera, Mundka. C&D waste from DMRC construction will be recycled at this plant. - Felling of trees will be minimized to the extent possible. Ten saplings will be planted against every tree cut as per norms. - No impact on fauna is anticipated as the project is in urban area where there is no wildlife. Snakes rescued from construction site will be handed over to Wildlife NGOs.
	On alignment, station design and R&R	<ul style="list-style-type: none"> - Jhuggies coming in the work area should be rehabilitated in the nearby area before demolition - FOT to be built during construction 	<ul style="list-style-type: none"> - Jhuggies will be rehabilitated within the nearby area. - Possibility of providing FOT will be looked into.
	On other issues	<ul style="list-style-type: none"> - Change from one station to another should be 'old age people friendly' - Metro feeder bus facility should be available between residence and the metro stations - Pedestrian problem should be taken care of and construction should not affect day to day operation of their shops nearby - More rail cars to be increased during the peak hours. Special ladies' bogies should be increased. - Metro should not damage the aesthetic view of the surrounding area. 	<ul style="list-style-type: none"> - The Station design shall take into consideration the features which will make the station to old and disabled people friendly. - Possibility for providing Metro feeder bus facility will be looked into. - Access to the shops will not be obstructed and care will be taken so that construction does not affect day to day working of nearby shops. - People were informed that at the design stage itself, the basic unit of 6-car train is proposed for all the new upcoming corridors. The number of exclusive bogies for ladies, which is presently one, could be increased depending on the prevailing demand. - Stations will be designed aesthetically keeping in view of the surrounding area.

ANNEXURE

Lessons Learned

As is the case with Phase-IV, in the previous phases also Environmental Impact Assessment (EIA) and Social Impact Assessment (SIA) including land acquisition were carried out as per the existing rules, regulations and laws. Since both studies were carried out as per rules there was no scope for deviation in procedure and process, as both EIA and SIA including Land Acquisition require significant involvement of district and state administrations. Close co-ordination with local and state and national administration is crucial for successful implementation of EMP and R&R. However, under the present circumstances due to the COVID-19 pandemic and the subsequent nationwide lockdown, the district and the state machinery have been involved in primarily containing the impact of the pandemic. This may or may not have an impact on the project execution, however, it is beyond the control of DMRC project team.

The only major difference from Phase-III is the introduction of the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 in place of the Land Acquisition Act 1894 amended in 1984. In previous phases, land acquisition and resettlement and rehabilitation were carried out as per the provisions of the Land Acquisition Act, 1894 and the National Resettlement and Rehabilitation Policy 2007. In light of the recent act, in Phase-IV the Entitlement Matrix has been prepared as per the new law.

Other than the issues discussed above, the project is not prone to have significant impacts which could have a bearing on the project implementation. Based on the experience from previous phases, necessary consideration has been given in the current project to overcome issues like traffic management/diversion, noise and vibration, resettlement & rehabilitation etc.

Names of the 19 species in Okhla Bird Sanctuary

Please identify the names of:

1. Critically Endangered (2)
2. Vulnerable (9)
3. Near Threatened (7)
4. Conservation Dependent (1)

Names of the 19 species in Okhla Bird Sanctuary

Names of the 19 species in Okhla Bird Sanctuary			
There are two Critically Endangered (CR) species (White-rumped Vulture and Indian Vulture), nine Vulnerable (VU) species (Baikal Teal, Baer's Pochard, Sarus Crane, Sociable Lapwing, Indian Skimmer, Pallas's Fish Eagle, Lesser Adjutant, Bristled Grassbird and Finn's Weaver), seven Near Threatened (NT) species (Ferruginous Pochard, Black-bellied Tern, Grey-headed Fish Eagle, Darter, Black-headed Ibis, Painted Stork and Blacknecked Stork) and one Conservation Dependent (CD) species (Dalmatian Pelican), report in Okhla Bird Sanctuary for which details are presented below.			
Category	Number	Name of the species	Scientific Name of the species
Critically Endangered	1	white-rumped vulture	<i>Gyps bengalensis</i>
	2	Indian vulture	<i>Gyps indicus</i>
Vulnerable	1	Baikal teal	<i>Sibirionetta formosa</i>
	2	Baer's pochard	<i>Aythya baeri</i>
	3	Sarus crane	<i>Antigone antigone</i>
	4	Sociable lapwing,	<i>Vanellus gregarius</i>
	5	Indian skimmer	<i>Rynchops albicollis</i>
	6	Pallas's fish eagle	<i>Haliaeetus leucoryphus</i>
	7	Lesser adjutant	<i>Leptoptilos javanicus</i>
	8	Bristled grassbird	<i>Schoenicola striatus</i>
	9	Finn's weaver	<i>Ploceus megarhynchus</i>
Near Threatened	1	Ferruginous pochard	<i>Aythya nyroca</i>
	2	black-bellied tern	<i>Sterna acuticauda</i>
	3	Grey-headed Fish eagle	<i>Haliaeetus ichthyaeus</i>
	4	Darter	<i>Anhinga melanogaster</i>
	5	Black-headed Ibis	<i>Threskiornis melanocephalus</i>
	6	Painted Stork	<i>Mycteria leucocephala</i>
	7	Blacknecked Stork	<i>Ephippiorhynchus asiaticus</i>
Conservation Dependent	1	Dalmatian Pelican	<i>Pelecanus crispus</i>

ENVIRONMENTAL MONITORING FORMAT

1. Air Quality (Emission Gas/Ambient Air Quality)

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Country's Standards	Referred International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
PM ₁₀						
PM _{2.5}						
SO ₂ ,						
NO _x						
CO						
HC						

2. A. Ground Water Quality (BIS: 10500)

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Country's Standards	Referred International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
As per BIS 10500						

B. Water Quality (effluent / Wastewater / Ambient Water Quality)

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Country's Standards	Referred International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
pH						
TSS						
BOD						
COD						
Oil / Grease						
DO						

3. Noise / Vibration

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Country's Standards	Referred International Standards (FTA-vibration)	Remarks (Measurement Point, Frequency, Method, etc.)
Noise level	dB(A)					
Vibration level	dBV					

4. Waste

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Country's Standards	Referred International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
pH						
Total Phenols						
lead						
cadmium						
chromium- VI						
Copper						
Nickel						
Mercury						
Zinc						
Fluoride						
Cyanide						
Calorific value						
Total Volatile						
Moisture						
Organic matter						
Total Ash						
Bulk Density						

5. Format for Flora Monitoring Report

Local Name of Species	Scientific Name of the species	IUCN Category	Location	Height (m)	Girth (cm)	Quantity (No.)	Storage Detail

**Impact of the proposed Tughlakabad – Aerocity Metro Corridor on
the Asola Bhatti Wildlife Sanctuary**