# 0.1 EXECUTIVE SUMMARY

## 0.1.1 Policy, Legal & Administrative Framework

**0.1.1.1** The proposed Corridor, Central Secretariat – Badarpur was proposed by DMRC to be part of 2nd Phase on the instance of Sports Authority of India, and Delhi Police. The proposed alignment was examined by a Committee set up by GNCTD and headed by Principal Secretary/Power in the month of July-August, 2006.The Committee strongly recommended this Corridor to be included in Phase-II.

**0.1.1.2** The proposed project would be governed by various Acts, Rules and regulations set by the Ministry of Environment and Forests (MoEF) at the Central level and other regulatory agencies at the State and local level. Various environmental standards, specifications and guidelines of Central Pollution Control Board (CPCB) and state level agencies will also be applicable.

**0.1.1.3** As per the most recent EIA Notification (September 2006), new, expansion or modernization of any activity falling within the eight categories of developmental and industrial activities shall be undertaken in any part of India only after it has been accorded environmental clearance by the MoEF in accordance with the procedures specified in the notification. Since urban transportation projects such as the Delhi Metro Project are not included in the Schedule of the notification, hence conducting an EIA or carrying out Public Hearing are not mandatory.

## 0.1.2 Project Description

**0.1.2.1** The Metro corridor line from Central Secretariat to Badarpur Border is 20.16 km with the following stations namely (1) Central Secretariat (2) Khan Market (3) J.L.N Stadium, (4) Jangpura (5) Lajpat Nagar, (6) Mool Chand, (7) East of Kailash, (8) Nehru Place (9) Kalkaji Mandir, (10)Govindpuri, (11) Okhla, (12) Jasola, (13)Sarita Vihar, (14) Mohan Estate, (15) Tughlakabad and(16) Badarpur.

**0.1.2.2** Central Secretariat is an interchange station, which is a connecting Central Secretariat- Vishwavidyalaya (Already operational) section in the north and Central Secretariat- Qutab Minar- Arjangarh- Gurgaon (Proposed) in the south with the proposed corridor .This corridor is also important because this section will eventually be extended upto in Faridabad which is growing very fast in terms of population and industrialization and requires a high capacity public transport link to connect main activity areas of Delhi. Tughlakabad

station on this section will also become an interchange station with Northern railway Tughlakabad Station.

## 0.2 Environmental Baseline Data

**0.2.1** The compilation of environmental baseline data is essential to assess the impact on environment due to the project activities. In the present case, the baseline data include establishing the present status of physico - chemical, biological and socio - economic aspects of the study area relevant to the proposed construction of metro corridor between Central Secretariat and Badarpur.

**0.2.2** The average elevation of Delhi and surrounding areas is about 178-200 M.S.L. The terrain has a slope of 1-3 m/km. The area receives two seasonal rainfalls. These are due to South – East and North - East monsoon. The ground water occurs in silty to sandy layers of the alluvial sediments.

**0.2.3** Selected water quality parameters describing physico - chemical properties of the water have been carried out for describing the water environment and assessing the impact of the proposed project. The main source of water for drinking purpose, along this corridor is the Municipal water. Most of the parameters are within the permissible limits.

**0.2.4** Representative soil samples were collected from the nearby locations along the proposed metro corridor from a depth ranging from 0.50m to 1.00m. The soil samples collected from the project area were evaluated for its engineering properties.

**0.2.5** The proposed alignment along Central Secretariat - Badarpur corridor will be underground, at grade but mostly elevated tracks at the median (i.e. at the central verge). Since, a lot of green cover in the form of well grown trees and bushes exists, it is expected that the trees and other plantations, mainly at the existing median will be affected during the site clearing operation (i.e. construction phase). In view of the above, manual count of the existing trees on the medians have been carried to know the numbers of the trees which are likely to be affected/cut during the construction phase. These number 4401 in all.

**0.2.6** A study to evaluate the existing noise levels was carried out along the corridor at all station locations. It could be concluded that the noise levels recorded near the project site are higher than prescribed permissible levels of 65-dBA (day) and 55-dBA (night).

**0.2.7** The study on base line air quality status in the vicinity of the proposed project has been done. The air quality measurements were carried out during June

2006, at four locations along the proposed metro corridor and results of SPM exceed the national standards.

## 0. 3 Negative Environmental Impacts

**0.3.1** Some of the negative impacts associated with the metro rail project have been summarized below under the following headings:

- Impacts due to project location,
- Impacts due to construction works, and
- Impacts due to project operation.

**0.3.2** The alignment is mostly elevated. Both the land requirement and change of land use is minimum. The change in land use is estimated to be 54.36 Hect. (includes both government and private land).

**0.3.3** While there will be no encroachment into nature reserves, as the project area is in the urban centre, 4401 trees likely to be lost. The total value of these trees lost is Rs. 30.8 lakhs.

**0.3.4** No historical/cultural monuments will be affected as a result of the proposed development of project.

**0.3.5** The project involves resettlement and rehabilitation of 589 families. Since EIA is not mandatory for such projects in India, no public consultation has been done and hence public response has not been solicited as of yet. However, the affected public is made aware during the socio-economic study..

**0.3.6** The alignment is mostly planned to run through the urban area, underground and above ground. The alignment will cross drains/nalas large number of sub-surface, surface and utility services, viz. sewer, water mains, storm water drains, telephone cables, overhead electrical transmission lines, electric pipes, traffic signals etc.

**0.3.7** The total quantity of earthwork in excavation would be about 9,75,000 cum for which a large number excavators and dumper trucks would be required to excavate and transport to earmarked areas of disposal. Excavate would most likely include rock, sandy silt, mica, schist, etc. This quantity would have to be transported to the sites as suggested by Delhi Development Authority (DDA) or other municipal agencies requiring earth filling.

**0.3.8** Health risks include disease hazards due to lack of sanitation facilities (water supply and human waste disposal) and insect vector disease hazards of local workers and disease hazards to the local population.

**0.3.9** During construction, traffic diversions on roads will be essentially required. As most of the construction activities will be confined to centre of the road and

most of the roads are double lane, it will be appropriate that the side lanes may also be utilised for traffic and also for smooth progress of construction activities.

**0.3.10** Problems could arise from dumping of construction spoils (Concrete, bricks) waste materials (from contractor camps) etc. causing surface and ground water pollution. Pollution risks may also arise from accidental leakage and spillage of oil or fuel, which may contaminate soil. The overall impact of waste disposal during construction phase is insignificant.

**0.3.11** Construction activities may have impact on water bodies due to disposal of waste. The waste could be due to the spillage of construction materials, dumping of used water from the stone crusher, oils and greases, and labour camp. But the quantities of such spills are very negligible.

**0.3.12** During construction phase, SPM is expected to be the main pollutant associated with the earthwork activities and material handling, mainly confined to the project site, within a few metres from the source and within the site .

**0.3.13** The impact of noise produced during the construction will be limited to a distance of about 75 meters at which the noise level of various equipment will come down below 55 dB (A). Construction activities would not have a significant impact on existing ambient noise levels. During operation, the maximum noise level is thus estimated as 64 dB (A) at 5.5m. Noise level at a distance of 12.5m, 25m, and 50m from the alignment has been calculated and these come out to be 57.2, 54.2 and 45.2 dB (A) respectively.

**0.3.14** The water demand on each stations and depot will be about 18 kl/day. No water provisions have been made for passengers. The platform washing requirement has been worked out at the rate of 5 litres / sq.m. An additional consumption of 70 kl/day has been taken at the depot for car washing, horticulture works etc..

**0.3.15** About 1045 m3 of water will be required at Depot for different uses. This will be collected from fresh ground water aquifers. About 17.28 m3 of sewage and 14.4m3 of process effluent are expected to be generated. Based on past experience in similar projects a treatment plant of 50 $m^3$/day would be appropriate.

**0.3.16** The refuse from railway station during the operation phase is estimated at about 40kg of municipal solid waste @ every day, for all stations and depot put together, which need be disposed effectively.

## 0.4 Positive Environmental Impacts

**0.4.1** Some of the positive impacts of this project activity include, reduced travel time, increased accessibility, safe and comfortable mode of transportation, reduced congestion on roads, reduced fuel consumption, reduction in vehicular emission loads resulting in improved air quality of the region, reduction in road accidents, increased job/employment opportunities (direct and indirect both), sense of pride to the city and country having a world-class facility.

## 0.5 Environmental Management Plan

**0.5.1** The adverse environmental issues likely to develop during project construction and operation phases could be minimized by making necessary provision in the project design and adopting Environmental Management Plan (EMP).

**0.5.2** The total land to be acquired permanently is around 54 ha . This land will be acquired and compensation will be paid. The land compensation is included in the project cost.

**0.5.3** The Compensation for Loss of Trees works out to Rs. 3.08 million**.** Thus, the total cost of compensatory Afforestation and fencing works out to Rs. 10.50 million.

**0.5.4** For acquisition of shops and industrial units and also resettlement of PAPs etc,, compensation shall be paid by land acquisition department and resettled as per the existing government policy and compensated for land and structure as per concurrent government norms respectively.

**0.5.5** Provision of Rs 7.5 million has been kept for construction of treatment plant at Sarita Vihar Depot. Elaborate measures to reduce noise and vibration during construction and operation have been suggested.

**0.5.6** A provision of Rs 1.0 million (excluding the cost of storage tank) has been suggested for rain water harvesting structures at the Depot. in the cost estimate. It has also been recommended to have a lump sum provision of Rs. 2.0 million in the cost estimate for the green belt development at the depot.

**0.5.7** However, a provision of Rs. 10.0 million have been proposed for health related issues and its control for this project.

## 0.6 Environmental Monitoring Programme

**0.6.1** Environmental monitoring programme is a vital process of any management plan of the development project. The environmental monitoring will be required for the construction and operational phases.

**0.6.2** The following parameters have been recommended for monitoring :

- Rehabilitation and Resettlement Programme,
- Afforestation,
- Water Quality and Public Health,
- Air and Noise Quality and

Soil Conservation Measures.

## 1.1 POLICY, LEGAL & ADMINISTRATIVE FRAMEWORK

The 1972 UN Conference on Human Development at Stockholm influenced the need for a well developed legal mechanism to conserve resources, protect the environment and ensure the health and well being of the people in India. Over the years, the Government of India has framed several policies and promulgated number of Acts, Rules and Notifications aimed at management and protection of the environment. During last three decades an extensive network of environmental legislation has grown and presently it has a fairly complex body of environmental legislation aimed at ensuring that the development process meets the overall objective of promoting sustainability in the long run. Moreover, at a higher level, the Indian Constitution has also incorporated specific articles to address environmental concerns through the 42nd Constitutional Amendment of 1976. As stated in the Constitution of India, it is the duty of the state (Article 48 A) to protect and improve the environment and to safeguard the forests and wildlife of the country. It imposes a duty on every citizen (Article 51 A) 'to protect and improve the natural environment including forests, lakes, rivers and wildlife'. Reference to the environment has also been made in the Directive Principles of State Policy as well as the Fundamental Rights.

### 1.1.1 ENVIRONMENTAL POLICIES

Several environment policy statements have been formulated in the last few decades as a part of the Government's approach to integrate environmental and developmental aspects of planning. The policies reflect a gradual shift in emphasis from pollution abatement and control to proactive and voluntary approaches for pollution prevention in keeping with global paradigm shifts and trends in environment management. Following are some of the key policies that have been laid down by the Central Government:

- National Forest Policy, 1988;
- National Conservation Strategy and Policy Statement on Environment and Development, 1992;
- Policy Statement on Abatement of Pollution, 1992.

Despite these policy documents a need for a comprehensive policy statement had been evident for some time in order to infuse a common approach to the various sectoral and cross-sectoral, approaches to environmental management. As a result, a National Environment Policy (NEP, 2006) has

been drawn up as a response to our national commitment to a clean environment, mandated in the Constitution in Articles 48 A and 51 A (g), strengthened by judicial interpretation of Article 21. The policy is intended to mainstream environmental concerns in all development activities in the country.

### 1.1.2 LEGAL PROVISIONS RELATED TO INFRASTRUCTURE PROJECTS

The proposed project would be governed by various Acts, Rules and regulations set by the Ministry of Environment and Forests (MoEF) at the Central level and other regulatory agencies at the State and local level. Various environmental standards, specifications and guidelines of Central Pollution Control Board (CPCB) and state level agencies will also be applicable. It is important to mention over here that the Central government framed an 'umbrella law', called the Environment (Protection) Act, 1986 to broadly encompass and regulate an array of environmental issues. The overall purpose of EPA was to establish an overall coherent policy and provide a basis for the coordinated work of various government agencies with operational responsibility for the environment and natural resources. The legislation also invests authorities with regulatory powers to address specific issues affecting the environment. The Act also does not allow any person to carry on an industry, operation or process that discharge or emit any environmental pollutants in excess of standards prescribed under specific rules and notifications.

#### 1.1.2.1 Environmental Clearance of Development Projects

The permitting requirement involved in the setting up of select development projects (projects with potential to cause significant environmental impacts) in India is through the Environmental Clearance (EC) Process effected on the basis of an Environmental Impact Assessment study. The EC process is mandated by the EIA notification (as amended) of 4th May 1994 and is administered by the state level regulatory and government bodies (as the State Pollution Control Board and the Environment Departments) and the Ministry of Environment and Forests at the Central Government level.

**Table 1.1: Summary Of Environmental Legislation For The Project**

| Legislation | Area/Activity Covered |
|---|---|
| Environment (Protection) Act, 1986 with Rules. | • Overall Environment Protection<br>• Compliance to environmental (Air, Water, Noise)Standards issued under EPR |
| EIA Notification, 2006 (as amended) | • Prepare EIA/ EMP report<br>• Obtain Environmental Clearance from MoEF<br>• Take part in Environmental Public Hearing (EPH) |
| Air (Prevention and | • Protection of Air Quality |

| | |
|---|---|
| Control of Pollution) Act, 1981 with Rules. | • Consent to Establish (NOC) for establishing and Consent to Operate (CTE) for activities causing air pollution from DG sets from SPCB<br>• Compliance to National Ambient Air Quality Standard |
| Water (Prevention and Control of Pollution) Act, 1974 with Rules. | • Protection of Water Quality<br>• Discharge of sewage from project<br>• Obtaining Consent to Establish (NOC) for establishing and Consent to Operate (CTE) for activities causing water pollution from SPCB |
| Noise Pollution (Regulation and Control) Rules, 2000 | • Compliance with Ambient Noise Standards in accordance to land use of the area |
| Hazardous Waste (Management and Handling Rules, 2002 (as amended) | • Obtaining Authorization from SPCB for handling and storing of hazardous waste like waste oil and lubricants<br>• Following guidance for handling and storing of such hazardous waste |

Source: GOI Publications

As per the most recent EIA Notification (September 2006), new, expansion or modernization of any activity falling within the eight categories of developmental and industrial activities shall be undertaken in any part of India only after it has been accorded environmental clearance by the MoEF in accordance with the procedures specified in the notification. As per the procedures, anybody who desires to undertake any project in any part of India or expansion or modernization of any existing industry shall submit an Environmental Impact Assessment study report along with a Detailed Project Report to the EIA Division of the Ministry of Environment Forests (MoEF), New Delhi.

As per the notification all projects listed under Schedule -1 are required to obtain prior environmental clearance from the MoEF, subject to certain requirements criteria. Additionally, projects requiring environmental clearance are subject to environmental public hearing as part of EIA process per notification SO 318 (E) dated 10 April 1997.

Accordingly, the environmental public hearing process shall precede the grant of Consent to Establish (also termed as the No Objection Certificate or NOC) under the Air and Water Acts. On receipt of application of Environmental Public Hearing (EPH) and Consent to Establish, the SPCB constitutes Public Hearing Panel comprising of members representing:

- State Pollution Control Board;
- State government department dealing with the subject;
- District Collector or his nominee;
- State government department dealing with the Environmental matters;
- Members (maximum 3) of Municipality/ Panchayat; and

• Senior Citizens from local area.

Following panel constitution, SPCB issues notice for the EPH in two local newspapers inviting objections from the bona fide people likely to be affected by the project covered under the EIA notification. Following conduct of EPH, its proceedings are then issued by SPCB to MoEF with a copy to the project proponent.

Since urban transportation projects such as the Delhi Metro Project are not included in the Schedule of the notification, hence conducting an EIA or carrying out Public Hearing are not mandatory.

### 1.3.4 Usage of Water and Water Pollution

The use of water resources as also the discharge of polluted water (sewerage) is primarily regulated by the Water Cess Act, 1977 and the Water (Prevention and Control of Pollution) Act, 1974.

The Water Cess Act, 1977 including Rules 1978 and 1991 provides for levy and collection of Cess on water consumed by the local authorities and by persons carrying on certain industrial activities with a view to generate resources for prevention and control of water pollution. It also covers specifications on affixing of meters, furnishing of returns, assessment of Cess, interest payable for delay in payment of Cess and penalties for nonpayment of Cess within the specified time.

The Water (Prevention and Control of Pollution), Act, 1974 including Rules, 1975 (as amended up to 1988) provides for the prevention and control of water pollution and maintaining or restoring good water quality for any establishment. The Act assigns functions and powers to the CPCB and SPCBs for prevention and control of water pollution and all related matters.

The Environment (Protection) Rules under the EPA also lays down specific standards for quality of water effluents to be discharged into different type of water bodies (sewers, surface water bodies like lakes and rivers, marine discharge). Additionally, the water supplied to users of IT Park for drinking shall also conform to the National Drinking Water Standard, IS-10500.

Table 1.2 summarizes the general standards for discharge of effluent in Inland Surface Water Bodies. To ascertain and categorize the existing water quality, the results of the analysis of water quality need to be compared with the water quality standards given in Table 1.3

**Table 1.2: Effluent Discharge Standards (Inland Surface Water)**

| S. No. | Parameter | Unit | Standards |
|---|---|---|---|
| 1 | Colour & Odor | -- | All efforts should be made to remove colour and unpleasant odor as far as practicable. |

| S. No. | Parameter | Unit | Standards |
|---|---|---|---|
| 2 | Suspended Solids, Max. | Mg/l | 100 |
| 3 | Particle size of Suspended Solids | -- | Shall pass 850 micron IS Sieve |
| 4 | pH value | -- | 5.5 to 9.0 |
| 5 | Temperature, Max. | °C | Shall not exceed 5°C above the receiving water temperature |
| 6 | Oil and grease, Max. | Mg/l | 10 |
| 7 | Total residual Chlorine, Max. | Mg/l | 1.0 |
| 8 | Ammonical Nitrogen (as N), Max. | Mg/l | 50 |
| 9 | Total Kjeldah Nitrogen (as N), Max. | Mg/l | 100 |
| 10 | Free Ammonia (as $NH_3$), Max. | Mg/l | 5 |
| 11 | Biochemical Oxygen Demand (5 days at 20°C), Max. | Mg/l | 30 |
| 12 | Chemical Oxygen Demand Max. | Mg/l | 250 |
| 13 | Arsenic (as As), Max. | Mg/l | 0.2 |
| 14 | Mercury (as Hg), Max. | Mg/l | 0.01 |
| 15 | Lead (as Pb), Max. | Mg/l | 0.1 |
| 16 | Cadmium (as Cd), Max. | Mg/l | 2.0 |
| 17 | Hexavalent Chromium (as $Cr^{+6}$), Max. | Mg/l | 0.1 |
| 18 | Total Chromium (as Cr) Max. | Mg/l | 2.0 |
| 19 | Copper (as Cu), Max. | Mg/l | 3.0 |
| 20 | Zinc (as Zn), Max. | Mg/l | 5.0 |
| 21 | Selenium (as Se), Max. | Mg/l | 0.05 |
| 22 | Nickel (as Ni), Max. | Mg/l | 3.0 |
| 23 | Cyanide (as CN), Max. | Mg/l | 0.2 |
| 24 | Fluorides (as F), Max. | Mg/l | 2.0 |
| 25 | Dissolved phosphates (as P), Max. | Mg/l | 5.0 |
| 26 | Sulphides (as S), Max. | Mg/l | 2.0 |
| 27 | Phenolic compounds (as $C_6H_5OH$), Max. | Mg/l | 1.0 |
| 28 | Radioactive Materials<br>α Emitters, μcurie/ml, Max.<br>β Emitters, μcurie/ml, Max. | | <br>$10^{-7}$<br>$10^{-6}$ |
| 29 | Bio-assay test | -- | 90% survival of fish after 96 hours in 100% effluent |
| 30 | Manganese (as Mn) | Mg/l | 2.0 |
| 31 | Iron (as Fe) | Mg/l | 3.0 |
| 32 | Vanadium (as V) | Mg/l | 0.2 |
| 33 | Nitrate Nitrogen | Mg/l | 10.0 |

**Table 1.3: Tolerance Limits For Inland Surface Water Quality**

| Characteristic | Designated Use Class of Inland Waters | | | | |
|---|---|---|---|---|---|
| | A | B | C | D | E |
| pH value | 6.5 to 8.5 | 6.5 to 8.5 | 6.5 to 8.5 | 6.5 to 8.5 | 6.0 to 8.5 |
| Dissolved Oxygen, mg/l, Min. | 6 | 5 | 4 | 4 | - |
| Biochemical Oxygen Demand (5 days at $20^0$C), mg/l | 2 | 3 | 3 | - | - |
| Total coliform organisms, MPN/100 ml. Max. | 50 | 500 | 5000 | - | - |
| Colour Hazen units | 10 | 300 | 300 | - | - |
| Chlorides (as Cl), mg/l Max. | 250 | - | 600 | - | 600 |
| Sodium Adsorption ratio Max. | - | - | - | - | 26 |
| Boron (as B), mg/l. Max. | - | - | - | - | 2 |
| Sulphates (as $SO_4$), mg/ l | 400 | - | 400 | - | 1000 |
| Nitrates (as NO), mg/l Max. | 20 | - | 50 | - | - |
| Free Ammonia (as $NH_3$), mg/l | - | - | - | 1.2 | - |
| Conductivity at 25° C microhm / cm Max. | - | - | - | 1000 | 2250 |
| Arsenic (as As), mg/l. Max. | 0.05 | 0.2 | 0.2 | - | - |
| Iron (as Fe), mg/l | 0.3 | - | 50 | - | - |
| Fluorides (as F), mg/l | 1.5 | 1.5 | 1.5 | - | - |
| Lead (as Pb), mg/l. Max. | 0.1 | - | 0.1 | - | - |
| Copper (as Cu), mg/l | 1.5 | - | 1.5 | - | - |
| Zinc (as Zn) mg/l/ Max. | 1.5 | - | 1.5 | - | - |
| Manganese (as Mn), mg/l | 0.5 | - | - | - | - |
| Total Dissolved Solids, mg/l | 500 | - | 1500 | - | 2100 |
| Total Hardness ($CaCO_3$), mg/l | 300 | - | - | - | - |
| Magnesium (as Mg), mg/l | 100 | - | - | - | - |
| Chlorides (as Cl), mg/l | 250 | 600 | - | - | 600 |
| Cyanides (as CN), mg/l | 0.05 | 0.05 | 0.05 | - | - |

A: Drinking Water Source without conventional treatment but after disinfections;

B: Outdoor bathing organized;

C: drinking water source with conventional treatment followed by disinfections;

D: propagation of wildlife and fisheries;

E: irrigation, industrial cooling, controlled waste disposal.

Off late, with rapid depletion of groundwater resources in several areas of the country, efforts have been initiated to regulate the use of groundwater resources. The focus of such acts and rules (many are which are still in draft form) is to provide for mechanisms that would lead to replenishment of groundwater reserves through techniques like ground water harvesting. The

Central Ground Water Board, the statutory authority set up by the Central government has also restricted the drilling of tube wells and bore wells in certain water scarce areas in the country.

### 1.3.5 Air Quality

The Air (Prevention and Control of Pollution) Act, 1981 (also commonly known as the Air Act) including Rules 1982 and 1983 was enacted to prevent, control and reduce air and noise pollution. According to Section 21 of the Act, no person shall establish or operate any activity which can cause air pollution without obtaining Consent to Establish (CTE) as per the Air Act. The Act also lays down national ambient air quality standards for common pollutants like SPM, Sulphur dioxide, Oxides of Nitrogen, Carbon monoxide and Lead with the intent of managing air quality for different category of areas (residential, industrial and sensitive).

Ambient Air Quality Standards have been notified by the CPCB vide Gazette Notification dated 11th April 1994, which have been presented as Table 1.4.

**Table 1.4: National Ambient Air Quality Standards**

| Pollutant | Time | Concentration in $\mu g/m^3$ | | |
|---|---|---|---|---|
| | | Industrial Area | Residential, Rural & Other Areas | Sensitive Area |
| Sulphur Dioxide ($SO_2$) | Annual<br>Avg.<br>24 Hours | 80<br>120 | 60<br>80 | 15<br>30 |
| Oxides of Nitrogen as $NO_2$ | Annual<br>Avg.<br>24 Hours | 80<br>120 | 60<br>80 | 15<br>30 |
| Suspended Particulate Matter (SPM) | Annual<br>Avg.<br>24 Hours | 360<br>500 | 140<br>200 | 70<br>100 |
| Respirable Particulate Matter (RPM) size<10$\mu$m | Annual<br>Avg.<br>24 Hours | 120<br>150 | 60<br>100 | 50<br>75 |
| Lead (Pb) | Annual<br>Avg.<br>24 Hours | 1.0<br>1.5 | 0.75<br>1.00 | 0.50<br>0.75 |
| Carbon Monoxide (CO) | 8 Hours<br>1 Hour | 5000<br>10000 | 2000<br>4000 | 1000<br>2000 |

Source: Central Pollution Control Board Notification dated 11.4.1994

The EPR also specifies source emission standards determined on the basis of the impact of pollutants on human health, vegetation and property for activities, which can pollute the air. The SPCBs, on a case-to-case basis, can also make the emission standards more stringent on the considerations of the carrying capacity of a specific air-shed and the existing pollution levels of ambient air quality.

### 1.3.6 Noise Quality

With the objective of regulating ambient noise quality in the environment, the Central Government has notified the Noise Pollution (Regulation and Control) Rules, 2000 under the EPA. The noise standards for different category of areas are based on the weighted equivalent noise level (Leq). The EPR also lays down equipment specific noise emission standards for DG sets, Air conditioners and Construction Equipment, which would be in use for the project. Specific standards for control of noise from DG sets and measures to be taken for reduction of noise by using acoustic enclosures, acoustic treatment of rooms or exhaust mufflers have also been specified through the Environment (Protection) Second Amendment Rules 2002 notified through notification GSR 371 (E) on 17th May 2002. Ambient Noise level standards have been notified by the MoEF vide Gazette Notification dated 26th December 1989 and also in the Schedule III of the Environmental (Protection) Rules 1986. It is based on the 'A' weighted equivalent noise level (Leq). These are presented in Table 1.5.

**Table 1.5 : National Ambient Noise Standards**

| Category of Zones | Leq in dB (A) | |
|---|---|---|
| | Day * | Night |
| **Industrial** | 75 | 70 |
| **Commercial** | 65 | 55 |
| **Residential** | 55 | 45 |
| **Silence Zone **** | 50 | 40 |

Source: Central Pollution Control Board

* Day Time is from 6.00 AM to 9.00 PM.

** **Silence Zone** is defined as an area up to 100m around premises of Hospitals, Educational Institutions and Courts. Use of vehicle horn, loudspeaker and bursting of crackers is banned in these zones.

### 1.3.7 Hazardous Waste Management

The Hazardous Waste (Management and Handling) Rules, 2000 require facilities to classify wastes into categories, manage them as per the prescribed guidelines and obtain prior authorization from the SPCB for handling, treatment, storage and disposal of Hazardous Wastes. There is no potential source for hazardous waste generation from the project other than waste oil from rolling stock maintenance. Some negligible quantity of hazardous waste may be generated during construction phase of the project like spent oil and lubricants from DG sets and paint residues during painting of the buildings. Such waste generation should be properly monitored and managed.

## 1.1.3 INSTITUTIONAL FRAMEWORK

Whereas the legislative branch of the government (Parliament) is responsible for the enactment of environmental law and the judiciary for its enforcement in the case of transgression, it is the function of the executive branch (ministries, regional and local authorities) to determine policies and administer environmental law in actual practice. Also, since an environmental dimension has now become a part of all economic activities, an effective mechanism of coordination and control is the responsibility of the central environmental agency so that environmental policies can be translated into action.
The government of India took a major step in 1972 when it constituted the National Committee on Environmental Planning and Coordination (NCEPC). Later in 1980, the Government of India established a new Department of Environment on the recommendation of a committee constituted by the Indian Parliament. The Central and State Pollution Control Boards were set up and entrusted with the task of air and water pollution control in 1974.

### 1.1.3.1 Ministry Of Environment and Forests

In view of the growing importance of environmental affairs, the Government of India set up a Department of in November 1980 under the portfolio of the Prime Minister. The Department, later renamed as the Ministry of Environment and Forests (MoEF) plays a pivotal role in environmental management for sustained development and for all environmental matters in the country. The major responsibilities of MoEF include:

- Environmental resource conservation and protection, including environmental impact assessment of developmental projects;
- Co-ordination with the other ministries and agencies, voluntary organizations and professional bodies on environmental action plans; Policy-planning;
- Promotion of research and development, manpower planning and training and creation of environmental awareness;
- Liaison and coordination with international agencies involved in environmental matters.

Developmental project proponents are also required to submit Environmental Impact Statements/Assessments to establish that preventive measures are planned by installing adequate pollution control and monitoring equipment, and that effluent discharged into the environment will not exceed permissible levels. The MoEF appraises these statements/ assessments and approves the project from the environmental angle. The respective State Pollution Control Board is to give a No Objection Certificate (NOC) before the EIA exercise is undertaken.

### 1.1.3.2 Central and State Pollution Control Boards

The Central Pollution Control Board is directly responsible for pollution control throughout the national territory. In addition to the control of air, noise and water pollution it is also responsible for to ensure effective control on disposal of hazardous wastes and storage and handling of hazardous chemicals and

substances. Additionally, with the enactment of air and water pollution laws, states have set-up their own Pollution Control Boards (SPCBs) to monitor industrial emissions and effluents and to approve the operation of new industries after careful scrutiny. The functions of the SPCBs include:

- The planning of comprehensive state programs for the prevention and control of air and water pollution and to ensure the implementation thereof;
- Inspection of control equipment, industrial plants, etc.;
- Establishing norms in consultation with the Central Board and having regard to national air quality standards, gaseous emission standards from industrial plants, automobiles, etc. Different emission standards may be laid down for different industrial plants, having regard to the quantity and composition of emissions into the atmosphere from such plants and the general pollution levels in the area; advising the State Government on siting of new polluting industry.

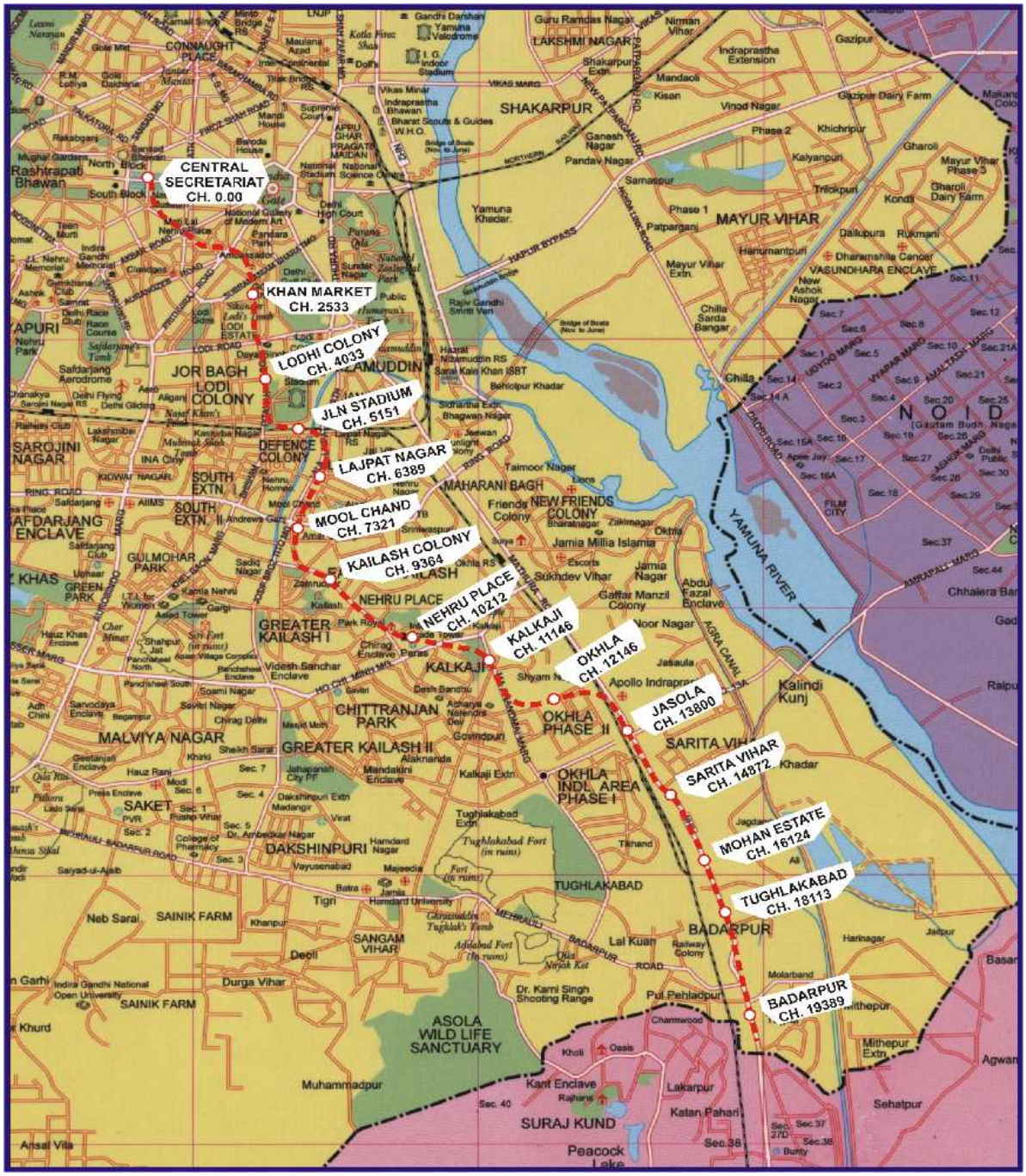
## 1.2 PROJECT DESCRIPTION

The Metro corridor line from Central Secretariat to Badarpur Border is 20.16 km with the following stations namely (1) Central Secretariat (2) Khan Market (3) J.L.N Stadium, (4) Jangpura (5) Lajpat Nagar, (6) Mool Chand, (7) East of Kailash, (8) Nehru Place (9) Kalkaji Mandir, (10)Govindpuri, (11) Okhla, (12) Jasola, (13)Sarita Vihar, (14) Mohan Estate, (15) Tughlakabad and (16) Badarpur.

Central Secretariat is an interchange station, which is a connecting Central Secretariat- Vishwavidyalaya (Already operational) section in the north and Central Secretariat- Qutab Minar- Arjangarh- Gurgaon (Proposed) in the south with the proposed corridor .This corridor is also important because this section will eventually be extended upto in Faridabad which is growing very fast in terms of population and industrialization and requires a high capacity public transport link to connect main activity areas of Delhi. Tughlakabad station on this section will also become an interchange station with Northern railway Tughlakabad Station.

Alignment of the Central Secretariat to Badarpur is shown in figure 1. 1.

**FIGURE 1. 1.**




The proposed Corridor, Central Secretariat – Badarpur was proposed by DMRC to be part of 2nd Phase on the instance of Sports Authority of India, and Delhi Police. The proposed alignment was examined by a Committee set up by GNCTD and headed by Principal Secretary/Power in the month of July-August, 2006.The Committee strongly recommended this Corridor to be included in Phase-II.

### 1.2.1 URGENCY AND JUSTIFICATION OF THE PROJECT

- This MRTS project will cater to Jawaharlal Nehru Stadium that is not only a venue of opening and closing ceremonies of Common Wealth Games 2010 but shall also host number of events.
- At present no MRTS station is close to Jawahar Lal Nehru Stadium therefore it will require minimum 200 buses to cater to the require-ments. It is not possible to handle such large number of buses at one destination in congested area.
- The organising committee Common Wealth games 2010 while clearing the alignment of this corridor near Jawahar Lal Nehru Stadium has committed that accessibility of Jawahar Lal Nehru stadium from most part of the city would become easy for the sports person and general public and have hoped that the corridor will be commissioned before Common Wealth Games 2010.
- The proposed Tughlakabad station on this corridor shall also cater to Dr.Karni Singh Shooting Range at Tughlakabad.
- Besides the legacy left after Common Wealth Games, the corridor shall cater to various important Government offices congested residential and commercial areas on this route.
- The corridor can further be extended from Badarpur to Faridabad to cater to daily traffic from Faridabad to Delhi and back.

### 1.2.2 PROJECT AREA

1.2.2.1 The Detailed Project Report (DPR) is prepared for the alignment from Central Secretariat to Badarpur border. Keeping in view the connectivity with JLN Stadium and Dr. Karni Singh Shooting Range at Tuglakabad. The proposed alignment starts from the Central Secretariat MRTS Station on Rafi Marg, then goes on Moti Lal Nehru Marg, Maharishi Raman Marg, Bhishma Pitamah Marg, South gate of JLN Stadium, Lala Lajpat Rai Path, LSR College, Astha Kunj behind Park Royal Hotel, Kalkaji Devi Temple, Ma Anandmayee Marg, Harkesh Nagar, Mathura Road upto Badarpur (Okhla) border.

1.2.2.2 The colonies and important points covered along this route are:

Government Offices on Rafi Ahmad Kidwai Marg, Offices on Shahjahan Road, Taj Mahal Hotel, Residential area of Maharishi Raman Marg, Lodhi Estate, Lodhi Colony, Lodhi Institutional Area, Dayal Singh College, CGO Complex, JLN Stadium, Defence Colony, Lajpat Nagar Part I, Lajpat Nagar Part II, Lajpat Nagar Part III, Vikram Nagar, LSR College, Greater Kailash Part I, East of Kailash, Zamrudpur, Sant Nagar, Nehru Place Office Complex, Kalkaji Devi Temple, Lotus Temple, Banarsi Das Chandiwala Eye Institute, Giri Nagar, Govindpuri, Okhla Industrial Area Phase III, Sanjay Colony,

Harkesh Nagar, Okhla Industrial Area Phase II, Appollo Hospital, Sarita Vihar, Mohan Cooperative Industrial Estate, NTPC Colony, Integral with Tuglakabad Railway Station, Badarpur (Okhla) border.

## 2.1 ENVIRONMENTAL BASELINE DATA

2.1.1 The baseline environmental status is established by determining the baseline levels of significant environmental parameters, which could be affected by the implementation of the project. The baseline study is a cornerstone of EIA, since it defines the existing status of the ecosystem(s) potentially threatened by the developmental activities. Baseline data serve as reference points against which potential or actual project-induced changes can be measured.

The compilation of environmental baseline data is essential to assess the impact on environment due to the project activities. In the present case, the baseline data include establishing the present status of physico - chemical, biological and socio - economic aspects of the study area relevant to the proposed construction of metro corridor between Central Secretariat and Badarpur. Accordingly, following important parameters were identified for the detailed baseline data collection through field studies;

- Air Environment
- Noise Environment
- Water Environment
- Soil Environment
- Green Cover Survey
- Socio – Economic component
- Land – use pattern along the proposed corridors

Along with the primary data, secondary data (i.e., Seismicity, groundwater, soil characteristics, geological setting, climate etc.) has also been collected from different sources.

## 2.2 GENERAL ENVIRONMENT

2.2.1 The average elevation of Delhi and surrounding areas is about 178-200 M.S.L. The terrain has a slope of 1-3 m/km. The area receives two seasonal rainfalls. These are due to South – East and North - East monsoon. About 75% of the rainfall occurs during July to September due to South – West monsoon. North – East monsoon is generally active during December – April. The annual rainfall is 714mm. The ground water occurs in silty to sandy layers of the alluvial sediments. The permeability varies from 0.5 to 8m/day and transmissivity from 10 to 100 $m^2$/ day. The hydraulic gradient is

approximately 1.3 Km/m to 2.0 Km/m. The mean monthly maximum temperature are highest in April-May –June (43 – 45 Degree C) and lowest during January months. Air humidity varies throughout during the year but seldom drops below 20%. The Winds are light to moderate and vary from 0.9 to 4.1 m/sec. Wind directions are mostly from North, Northeast and North – West. The sky is moderately cloudy during July – August and generally free of clouds for the rest of the year.

## 2.3 WATER QUALITY

Selected water quality parameters describing physico - chemical properties of the water have been carried out for describing the water environment and assessing the impact of the proposed project. The main source of water for drinking purpose, along this corridor is the Municipal water. Physico-chemical analysis of ground water collected from nearby areas along the corridor was carried. The ground water quality in a region does not change drastically and is characterized by the geological formation and soil characteristics. The ground water from five sampling sites on the corridor was tested for physico-chemical characteristics during August 2006. The results so obtained are summarised in Table 2.1(a)

**Table 2.1(a): Physico-Chemical analysis of Ground Water**

| Sl. No | Test Parameter | Units | Results of Bore Hole Nos. | | | | |
|---|---|---|---|---|---|---|---|
| | | | 1 (Ahuja Park Near NBCC) | 2 (West Gate JLN Stadium) | 3 (South Gate JLN stadium) | 4 (Nallah Road JLN stadium) | 5 (Nallah Road JLN stadium) |
| 1 | pH value | - | 8.1 | 8.0 | 7.8 | 8.10 | 8.00 |
| 2 | Acidity (Vol. of 0.1 'N' NaOH used to neutralize the 200ml of water sample. | ml | 0.3 | 0.35 | 0.25 | 0.25 | 0.32 |
| 3 | Chloride as Cl | Mg/L | 227 | 225 | 235 | 230 | 223 |
| 4 | Sulphate as $SO_4$ | Mg/L | 154 | 150 | 146 | 151 | 160 |
| 5 | Suspended material | Gm/L | 53 | 60 | 50 | 55 | 68 |

The depth of ground water along the route alignment is given in Table 2.1(b)

**Table 2.1(b) Depth of Ground Water**

| Location | Water Table |
|---|---|
| Central Secretariat | 9.2m |
| Motilal Nehru Marg | 8.5m |
| Mansingh Road | 6.5m |
| Humayun Road | 3.5m |
| Maharishi Raman Marg | 6.5m |
| Nehru Stadium | 14.5-16.5m |
| Lajpatrai Marg | 19m |

| | |
|---|---|
| Kalkaji to Badarpur | > 30m |

Most of the parameters are within the permissible limits. Based on this data, it could be concluded that sub soil and underground water are unlikely to undergo any deteriorating effect due to proposed Metro structures and foundation.

## 2.4 SOIL SURVEY

Representative soil samples were collected from the nearby locations along the proposed metro corridor from a depth ranging from 0.50m to 1.00m. The soil samples collected from the project area were evaluated for its engineering properties. The results are given in Table 2.2**.** The pH value of the soil is found to be varying from 7.8 to 8.20.

**Table 2.2: Engineering Properties of Soil**

| S. No. | Test Parameter | Units | Results of Bore Hole Nos. | | | | |
|---|---|---|---|---|---|---|---|
| | | | 1 (Ahuja Park Near NBCC) | 2(West Gate JLN Stadium) | 3(South Gate JLN stadium) | 4 (Nallah Road JLN stadium) | 5 (Nallah Road JLN stadium) |
| 1 | pH Value | - | 8.20 | 8.10 | 8.05 | 8.00 | 7.8 |
| 2 | Organic matter | % | 0.16 | 0.20 | 0.15 | 0.16 | 0.10 |
| 3 | Chloride As Cl | % | 0.08 | 0.10 | 0.09 | 0.10 | 0.07 |
| 4 | Sulphate as $SO_4$ | % | <0.01 | <0.01 | <0.01 | <0.15 | <0.01 |
| 5 | T. Soluble solids. | MILLI Mhos/cm | 0.11 | 0.13 | 0.15 | 0.18 | 0.10 |

## 2.5 FLORA OF THE PROJECT AREA

The proposed alignment along Central Secretariat - Badarpur corridor will be underground, at grade but mostly elevated tracks at the median (i.e. at the central verge). Since, a lot of green cover in the form of well grown trees and bushes exists, it is expected that the trees and other plantations, mainly at the existing median will be affected during the site clearing operation (i.e. construction phase). In view of the above, manual counts of the existing trees on the medians have been carried to know the numbers of the trees which are likely to be affected/cut during the construction phase. Results of tree enumeration are reported in Table 2.3 below.

**Table 2.3: Affected Trees in the proposed alignment**

| Sr. No. | Location: Station to Station | No. of trees affected |
|---|---|---|
| 1 | Central Secretariat to Khan Market | 258 |
| 2. | Khan Market to Lodhi Road | 596 |

| | | |
|---|---|---|
| 3. | Lodhi Road to Jawaharlal Nehru Stadium | 944 |
| 4. | Jawaharlal Nehru stadium to Lajpat Nagar | 283 |
| 5. | Lajpat Nagar to Mool Chand | 70 |
| 6. | Mool Chand to Kailash Colony | 408 |
| 7. | Kailash Colony to Nehru Place | 401 |
| 8. | Nehru Place to Kalkaji | 173 |
| 9. | Kalkaji to Jasola | 280 |
| 10. | Jasola to Sarita Vihar | 536 |
| 11. | Sarita Vihar to Mohan Estate | 214 |
| 12. | Mohan Estate to Tughlakabad | 175 |
| 13. | Tughlakabad to Badarpur | 63 |
| **Total Affected Trees** | | **4401** |

## 2.6 AIR QUALITY

The study on base line air quality status in the vicinity of the proposed project is an essential and primary requirement for assessing the impacts on air environment due to any proposed developmental activity. The air quality measurements were carried out during June 2006, at four locations along the proposed metro corridor. Results are summarized in Table 2.4.

**Table 2.4: Summary of Air pollution Survey along the Corridor**

| Sr. No. | Location | SPM (µg/m3) | RSPM (µg/m3) | SO2 (µg/m3) | $NO_x$ (µg/m3) | CO (µg/m3) |
|---|---|---|---|---|---|---|
| 1. | Central Secretariat | 302.8 | 69.2 | 11.3 | 54 | 914 |
| 2. | Dayal Singh College | 306.1 | 66.95 | 9.1 | 46.8 | 1038 |
| 3. | East of Kailash | 363.2 | 85.15 | 13.2 | 60.6 | 928 |
| 4. | Okhla Phase II | 645.25 | 180.2 | 23.45 | 89.1 | 1710 |
| 5. | Badarpur Border | 465.7 | 141.5 | 19.7 | 70.95 | 1172 |

## 2.7 SEISMICITY

The project area falls in **Zone-IV** of Seismic Zoning Map of India. Delhi region shows active and prolonged seismic history. Earthquakes of 3 to 6.7 magnitude on Richter scale have occurred in past around Delhi. Suitable seismic factor as per the India Meteorological Department (IMD) to be adequate needs to be considered for design purpose for Civil Engineering structures and while finishing civil designs.

## 2.8 NOISE

Any developmental activity (particularly related to civil engineering construction projects) will have significant impact on the existing or baseline noise levels. The existing noise levels are particularly likely to increase during pre - construction and construction phase of the activities, involving site clearing and construction operations. In view of the above, a study to evaluate the existing noise levels was carried out along the corridor. The measurements were carried out with the help of a calibrated Sound Level Meters for the 24 - hour duration at each sampling site. The summary of noise pollution survey has been given in Table 2.5.

**Table 2.5: Noise levels along the Corridor**

| S. No | Location | Day Time | | | | | Nigh Time | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lmax | Lmin | Leq | L10 | L90 | Lmax | Lmin | Leq | L10 | L90 |
| 1 | Central Secretariat | 81.10 | 50.60 | 69.52 | 72.95 | 56.27 | 74.80 | 51.20 | 62.14 | 64.81 | 55.17 |
| 2 | Khan Market | 80.30 | 53.20 | 70.99 | 74.95 | 57.23 | 74.49 | 52.60 | 62.94 | 65.08 | 57.30 |
| 3 | Lodhi Colony | 84.40 | 52.40 | 69.90 | 73.33 | 56.29 | 70.10 | 52.80 | 60.01 | 62.81 | 55.56 |
| 4 | Jawaharlal Nehru Stadium | 76.90 | 51.10 | 64.15 | 67.97 | 55.39 | 78.40 | 51.10 | 60.31 | 61.57 | 54.75 |
| 5 | Lajpat Nagar | 98.00 | 58.50 | 83.48 | 86.10 | 63.08 | 85.10 | 57.20 | 78.78 | 82.76 | 60.14 |
| 6 | Moolchand | 95.20 | 55.20 | 79.06 | 81.82 | 6.62 | 81.00 | 52.10 | 72.84 | 76.41 | 56.61 |
| 7 | Kailash Colony | 95.60 | 60.10 | 82.56 | 85.69 | 69.87 | 82.90 | 52.10 | 75.25 | 79.83 | 57.91 |
| 8 | Nehru Place | 95.60 | 60.10 | 82.56 | 85.69 | 69.87 | 82.90 | 52.10 | 75.25 | 79.83 | 57.91 |
| 9 | Kalkaji | 89.40 | 58.20 | 76.12 | 79.44 | 60.06 | 88.30 | 57.00 | 71.98 | 75.70 | 63.38 |
| 10 | Okhla | 102.20 | 59.60 | 84.86 | 86.10 | 63.49 | 95.10 | 58.50 | 81.01 | 82.76 | 60.21 |
| 11 | Jasola | 93.60 | 61.20 | 82.35 | 85.69 | 69.87 | 86.00 | 53.10 | 75.74 | 79.89 | 58.23 |
| 12 | Sarita Vihar | 75.90 | 52.10 | 64.09 | 67.97 | 55.39 | 70.40 | 51.50 | 59.51 | 61.57 | 54.75 |
| 13 | Mohan Estate | 78.90 | 65.2 | 64.15 | 67.97 | 55.39 | 78.40 | 51.10 | 60.31 | 61.57 | 54.75 |
| 14 | Tughlakabad | 98.8 | 59.6 | 83.6 | 86.1 | 63.22 | 88.1 | 58.5 | 79.1 | 82.6 | 60.14 |
| 15 | Badarpur | 102.2 | 60.30 | 86.78 | 86.10 | 63.79 | 104.6 | 59.30 | 86.3 | 82.78 | 60.56 |

It could be concluded that the noise levels recorded near the project site are higher than prescribed permissible levels of 65-dBA (day) and 55-dBA (night).

## 3.1 NEGATIVE ENVIRONMENTAL IMPACTS

The primary function of an environmental impact assessment study is to predict and quantify the magnitude of impacts, evaluate and assess the

importance of the identified changes and formulate plans to monitor and mitigate the actual changes. Environmental impacts could be positive or negative, direct or indirect, local, regional or global, reversible or irreversible.

The process began by identifying the development and operational activities resulting from the proposed project as contained in section- 1. Section- 2 was dedicated for providing information on the baseline environmental conditions for various parameters. This section discusses the potential negative impacts on environment. As far as possible attempts have been made to quantitatively predict the impacts due to proposed project. For non-quantitative impacts qualitative assessment has been done.

While, most of the positive benefits would during the operation phase of the proposed metro rail facility on the proposed corridors, the most of the negative impacts would take place during the pre-construction (design) and construction phase. Some of the negative impacts associated with the metro rail project have been summarized below under the following headings:

- Impacts due to project location,
- Impacts due to construction works, and
- Impacts due to project operation.

## 3.2 IMPACTS DUE TO PROJECT LOCATION

### a) Change of Land use

The alignment is mostly elevated. Both the land requirement and change of land use is minimum. The development on the study area will not bring any significant changes in the land use pattern, since the new proposed depot is planned in mostly vacant area. The development of station buildings will not have any significant impact on the land use in future; however, it will enhance the aesthetics due to development of a modern building and surrounding horticulture. The change in land use is estimated to be 54.36 Hect. (includes both government and private land) as given in Table 3.1

**Table 3.1: Change in Land Use**

| S.No. | Station Name | Area of land (ha) | Ownership of land which must be acquired (Private/DMRC/MOUD/DDA/MCD etc) |
|---|---|---|---|
| 1 | Central Secretariat | 0.1 | GOVT LAND |
| 2 | Khan Market | 0.26 | PRIVATE & NDMC LAND |
| 3 | JLN Stadium | 0.24 | GOVT LAND |
| 4 | Jangpura | 0.24 | GOVT LAND |
| 5 | Lajpat Nagar | 0.18 | GOVT LAND |
| 6 | Mool Chand | 0.53 | GOVT LAND |
| 7 | East of Kailash | 0.05 | PRIVATE LAND |

| | | | |
|---|---|---|---|
| 8 | Nehru Place | 1.45 | DDA LAND |
| 9 | Kalkaji Mandir | 1.15 | DDA LAND |
| 10 | Govind Puri | | PWD ROAD |
| 11 | Okhla | 2.06 | DDA LAND |
| 12 | Jasola | 0.65 | DDA LAND |
| 13 | Sarita Vihar | 0.2 | DDA |
| 14 | Mohan Estate | 0.87 | GOVT LAND |
| 15 | Tughlakabad | 6.66 | GOVT LAND |
| 16 | Badarpur | 0.94 | PRIVATE LAND |
| 17 | Sarita Vihar Depot | 38.78 | DDA/UP IRRIGATION/STATE GOVT/DJB./PRIVATE |

### b) Loss of Trees

The details of 4401 trees likely to be lost are reported in Table 2.3. The total value of these trees lost is Rs. 30.8 lakhs as reported in Table 3.2.

**Table 3.2: Loss of Forest Product**

| | |
|---|---|
| Total loss of Trees (Nos.) | 4401 |
| Average cost of one tree (Rs.) | 700 |
| **TOTAL LOSS (RS. LAKHS)** | **30.80 LAKHS** |

There will be no encroachment into nature reserves, as the project area is in the urban centre.

### c) Loss of Historical and Cultural Monuments

No historical/cultural monuments will be affected as a result of the proposed development of project.

### d) Socio-Economic Impacts

Land required for construction of the project is around 54 Ha. It does involve acquisition of both government and private land, and also involves social issues such as resettlement and rehabilitation of 589 families. Since EIA is not mandatory for such projects in India, no public consultation has been done and hence public response has not been solicited as of yet. However, the affected public is made aware during the socio-economic study. Consultations and discussions with the Project Affected People (PAPs) have taken place and are recorded in the socio-economic report for the corridor, which is being submitted separately. However, it is not the practice to 'consult' with drivers of buses, taxies etc. of other modes of transport that may be affected by the project, hence this has not been done. As explained above, EIA is not required to be conducted for such projects in India, hence public

response from drivers of buses, taxies etc has not been solicited, as part of public consultation.

Details of consultations such as venue, date and time are found in the socio-economic report as mentioned earlier. A video-recording of consultation and discussions with PAPs, in local language viz. hindi, is also available for display and record. Details are found in a separate socio-economic report.

**e) Utilities / Drainage Problem**

The alignment is mostly planned to run through the urban area, underground and above ground. The alignment will cross drains/nalas large number of sub-surface, surface and utility services, viz. sewer, water mains, storm water drains, telephone cables, overhead electrical transmission lines, electric pipes, traffic signals etc. These utilities/ 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. In addition, cross drainage works such as bridges, culverts etc. will be required. Since these affect construction and project implementation time schedule/ costs for which necessary planning/ action needs to be initiated in advance. The details on affected utilities are available in DPR for this corridor. Existing drainage system along the route alignment is adequate to cater to construction run off. However during construction, care has to be exercised by the contractors to ensure that debris, silt and bentonite are not deposited in the drains, which could block the drains.

**f) Risk due to Earthquakes**

The project area falls under seismic zone IV as per the Seismic Zoning Map of India (IS 1893, Part-I, 2002). Necessary seismic factors suggested by Indian Meteorology Department (IMD) shall be incorporated suitably while designing the structures to safeguard against earthquake risks.

## 3.3 IMPACTS DUE TO PROJECT CONSTRUCTION

**a) Soil Erosion at Construction Site**

The total quantity of earthwork in excavation would be about 9,75,000 cum for which a large number excavators and dumper trucks would be required to excavate and transport to earmarked areas of disposal. Excavate would most likely include rock, sandy silt, mica, schist, etc. Assuming 80% earth would render surplus, this quantity would have to

be transported to the sites as suggested by Delhi Development Authority (DDA) or other municipal agencies requiring earth filling. Disposal will be through dumper trucks and proper precautions need to be taken during transport so that the public is not affected.

Run off from unprotected excavated areas, and underground tunnel faces can result in excessive soil erosion, especially when the erodability of soil is high. Mitigation measures include careful planning, timing of cut and fill operations and re-vegetation. The top soil shall be disturbed during the construction stage due to excavation and movement of vehicles and equipment specially at Sarita Vihar depot. Exposure of loose soil to rain water will increase turbidity in the run-off, however this impact is limited to the possibility of excavated surfaces prevailing in the rainy season. On completion of the construction activity at the depot, all the unpaved area shall be paved, which will reduce soil erosion. No significant impact is expected on the soil, on and around the site.

**b) Health Risk at Construction Site**

Health risks include disease hazards due to lack of sanitation facilities (water supply and human waste disposal) and insect vector disease hazards of local workers and disease hazards to the local population. HIV contamination is also possible amongst the labour force. Mitigation measures should include proper water supply, sanitation, drainage, health care and human waste disposal facilities. In addition to these, efforts need to be made to avoid water spills, adopt disease control measures and employment of local labour. Education of workforce in HIV awareness, its spread and its control will go a long way in preventing this dreadful infection. Problems could arise due to difference in customs of imported workers and local residents. These risks could be reduced by providing adequate facilities in worker's camps and by employment of preferably local labour.

**c) Traffic Diversions and Risk to Existing Buildings**

During construction, traffic diversions on roads will be essentially required. As most of the construction activities will be confined to centre of the road and most of the roads are double lane, it will be appropriate that the side lanes may also be utilised for traffic and also for smooth progress of construction activities. Advance information on communication systems will be an advantage to users of any particular road. As most of the proposed sections are elevated and located in the middle of the road with deck width being much less than the existing road width, hence risk to the existing buildings all along the route will be practically negligible. In underground portion, whether by cut and cover

or by tunnelling, the building line is considerably away from the proposed cut and cover and tunnels. Also the buildings are not very old and hence there are less chances of collapse provided the tunnelling techniques are sound. Hence, no risk is foreseen to adjacent buildings.

**d) Impact due to Solid Waste Disposal**

Problems could arise from dumping of construction spoils (Concrete, bricks) waste materials (from contractor camps) etc. causing surface and ground water pollution. However, it is proposed to have mix concrete directly from batching plant for use at site. The other construction material such as steel, bricks, etc. will be housed in a fenced yard. The balance material from these yards will be removed for use/disposal. Mitigation measures include careful planning, cleaning redressing, landscaping and re-vegetation.

Inorganic solid waste generated during the construction phase like waste concrete, and mortar, left over aggregate and debris etc. shall be recycled for use in the base layers of paved area i.e. parking pavement. Municipal waste from labor camps can lead to land pollution, but no labor camps are allowed at site, hence no potential risk on this account. Pollution risks may also arise from accidental leakage and spillage of oil or fuel, which may contaminate soil. The overall impact of waste disposal during construction phase is insignificant.

**e) Impact on Water Quality**

Construction activities may have impact on water bodies due to disposal of waste. The waste could be due to the spillage of construction materials, dumping of used water from the stone crusher, oils and greases, and labour camp. But the quantities of such spills are very negligible. Care, however, needs to be taken to provide adequate sanitary facilities and drainage in the temporary colonies of the construction workers. Provision of adequate washing and toilet facilities with septic tanks and appropriate refuse collection and disposal system should be made obligatory. Contamination of ground water can take place, if the dump containing above substances gets leached and percolate into the ground water table. This is not the case with the present project, as the activity does not involve usage of any harmful ingredients. Moreover, activities are of short duration. Hence, no impact on either ground or surface water quality is anticipated during construction. Oil spillage during change of lubricants, cleaning and repair processes, in the maintenance of rolling stock, is very common. The spilled oil should be trapped in grit chamber for settling of suspended matter. The collected oil should be disposed off in approved manner so as to avoid any underground water contamination.

Water requirement for the construction purposes shall be met from bore wells to be bored along the route alignment. Though there will be no provision of labour camps at construction site, however, provision of adequate drinking water and toilet facilities will be made. Estimated requirement of water for various construction activities would be about 2.3 lakh KL for a construction period of 35 months. No considerable impact on water table is envisaged due to the withdrawal.

**f) Impact on air quality**

In such type of projects, air pollution occurs mainly due to fugitive emissions/dust generation from various construction activities during construction period and vehicular emission during operation period. The impacts on air environment, which will be during project construction phase are briefly discussed below.

During construction phase, SPM is expected to be the main pollutant associated with the earthwork activities and material handling. This would involve dumper trips every day for transportation of earth. The total consumption of diesel for earth excavation and transportation machinery would have to be worked out per day. Based on the emission factor for the various parameters like SPM, $SO_2$, $NO_X$ etc, prediction of pollution load could be made. SPM generation due to handling of earth and movement of vehicle will be another source of air pollution. This can be reduced by installing hoardings alongside the construction area as was dome during Phase- I construction.

With the above mentioned emissions during construction, mainly confined to the project site, it is inferred that minor negative impact within a few metres from the source and within the site would occur on ambient air quality. Mitigation measures for the same have been suggested in the Environmental Management Plan.

**g)** Like air environment, impact on noise is also anticipated during construction and operation phase of the project cycle. Noise at a construction site varies relative to the particular operation in progress. Operation can be divided into five consecutive phases;

1. Ground Clearing
2. Excavation
3. Foundation
4. Erection
5. Finishing

Table 3.3 shows typical energy equivalent noise levels at construction site.

**Table 3.3: Typical Energy Equivalent Noise Levels At Construction Site**

| S. No. | Phase | Noise Level When All Pertinent Equipment Present at Site dB(A) | Noise Level When Minimum Required Equipment Present at Site dB(A) |
|---|---|---|---|
| 1 | Ground clearing | 84 | 84 |
| 2 | Excavation | 89 | 79 |
| 3 | Foundation | 78 | 78 |
| 4 | Erection | 87 | 75 |
| 5 | Finishing | 89 | 75 |

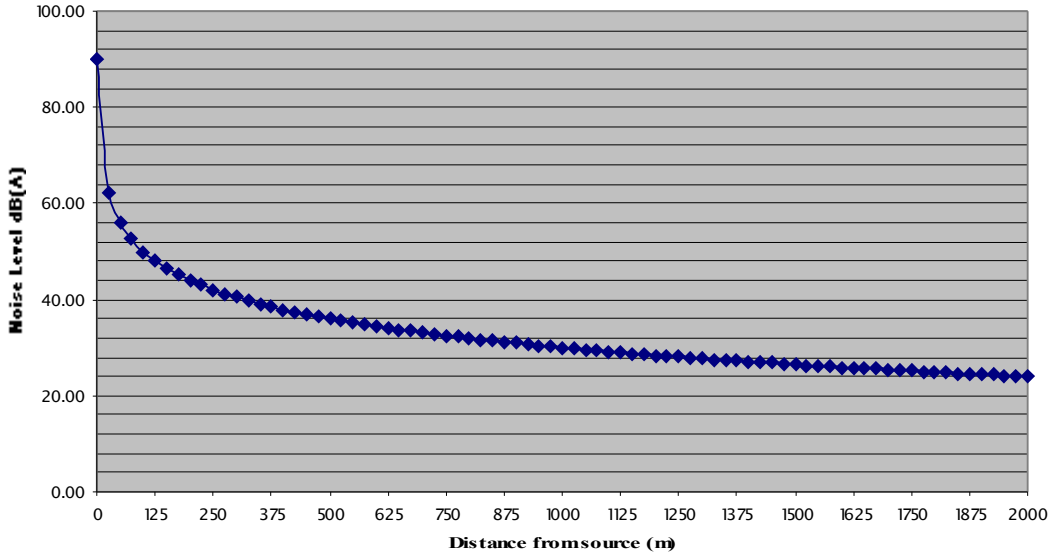
*Source: US Environmental Protection Agency, 1972*

As seen from the above table, construction activities are expected to produce noise levels at source in the range of 75-90 dB (A), which will decrease with increase in distance. For an approximate estimation of dispersion of noise in the surroundings form the source point a standard mathematical model for sound wave propagation is used. The equation for sound wave propagation used is as follows:

$$Noise_{(receptor)} = Noise_{(source)} - 20Log[distance_{(receptor)}/distance_{(source)}]$$

For modeling purposes, flat terrain is considered and environmental attenuation factors are not considered so as to formulate the worst case scenario. The noise levels predicted by logarithmic equation upto a receptor location of 2 km are presented in Figure 1.2

**FIGURE 1.2**
**IMPACT ON RECEPTOR OF NOISE GENERATED DURING CONSTRUCTION PHASE**



The construction works will be carried out during the day time. The impact of noise produced during the construction will, however, be limited to a distance of about 75 meters at which, as seen from the figure, the noise level of various equipment will come down below 55 dB (A). It could therefore be concluded that the construction activities would not have a significant impact on existing ambient noise levels. Due to the high noise levels of construction machinery, the personnel operating the machines and the workers stationed close to the machines are prone to exposure of high levels of noise.

## 3.5 IMPACTS DUE TO PROJECT OPERATION

### a) Oil Pollution

Oil spillage during change of lubricants, cleaning and repair processes, in the maintenance of rolling stock, is very common. The spilled oil should be trapped in grit chamber for settling of suspended matter. The collected oil should either be auctioned or incinerated, so as to avoid any underground water contamination.

### b) Noise

The main sources of noise are traction motors, cooling fans, wheel-rail interaction, electric generator and miscellaneous noise from rolling stock. An attempt is made to predict the rise in ambient noise at different distances. In the present study, following assumptions are adopted:
Track is standard, and
- Maximum speed 80 km per hour.

The noise produced by the train has been split into:
- Noise due to rolling stock, and
- Traction motor noise at full powers: 90-dB (A)

The continuous point source model has been used. The ambient noise in railways increases with train speed. The roughness of the contact surfaces of rail, wheel and train speeds is the factors, which influences the magnitude of rail wheel noise. The contact surface of rail-wheel noise proposition two ways side is approximately by the continuous point should model, using the following relations.

$$LAWr = 30 \log_{10} (V/V_0) + 60 \text{ dB} \quad (1)$$

Where;

LAWr - sound pressure level,
V - rail car speed, km/hr
$V_o$ - reference sound, 24 km/hr.

The vibration, of concrete structures also radiates noise. This noise has lower frequencies than rail wheel noise. Contribution of this noise at wayside is

generally insignificant in tracks. When a train is running, definite gear noise is generated at a frequency equal to the number of gear in unit time. The dependence of gear noise level on train velocity is rather intense, so it overcomes the rail wheel noise at the speed higher than 270 km/hr. However in the case of MRTS train velocity will be far below this speed.

Traction motor (Latm.) and gear noise (Laq) have been estimated using the following relationship:

$Latm. = 60 \log_{10} (V) + C_1$ (2)

$Laq = 10 \log_{10} (v) + C_2$ (3)

Where $C_1$ and $C_2$ are the constants and have values of -4.6 and 66.7 respectively.

Using the above relationships the noise at a distance of 2.0 m from the main three sources of noise i.e. motor, gear and wheel rail interaction has been computed as follows:

Average rail car Speed (V) = 32 km/hr
Reference sound (Vo) = 24 km/hr
$C_1$ = -4.6
$C_2$ = 66.7

a) The Motor Noise:
Latm = $60\log_{10}(V)+C1$
Latm = $60\log_{10}(32)+-4.6$
**Latm = 85.7dB(A)**

b) Gear Noise :
Laq = $10\log_{10}(V)+C_2$
Laq = $10\log_{10}(32)+66.7$
**Laq = 81.7 dB(A)**

c) Wheel – Rail Contact Noise:
LAWr = $30\log_{10}(V/V_0)+60$
LAWr = $30\log_{10}(32/24)+60$
**LAWr = 63.74 dB(A)**

Each aerodynamic noise mentioned above is generated from the local structure of the car surface. Magnitudes, numbers and distribution of noise sources are different from each other. These noise sources can be approximated as point sources, when we estimate the influence of these on wayside. Each aerodynamic noise from the solid surface is radiated strongly in the direction normal to the surface.

Presently, a hemispherical sound wave propagation model through a homogeneous loss free medium is used. The mathematical representation of the model is given below:

$L(P) = Lps - 20 \log (d) - 8$

Where,

LP - sound pressure level, at a distance d,
D - distance in meters of the receptors,
LPS - point noise source

The cumulative impact of all these different sources in a particular place is calculated by the logarithmic addition model as:

LP (Total) = 10 log ($10^{LPQ1/10}$ + $10^{LPQ2/10}$ + $10^{LPQ3/10}$)

Using the above formula maximum noise level is calculated as follows at a distance of 5.5m form source.

At a distance of 5.5m sound pressure due to motor noise is given by

L(P) = Lps – 20log(d) – 8
L(P) = 85.7 – 20log(5.5) – 8
L(P) = 62.9 dB(A)

At a distance of 5.5m sound pressure due to gear noise is given by

L(P) = Lps – 20log(d) – 8
L(P) = 81.7 –20log(5.5) – 8
L(P) = 58.9 dB(A)

At a distance of 5.5m sound pressure due to wheel – rail contact noise is given by

L(P) = Lps – 20log(d) – 8
L(P) = 63.7 – 20log(5.5) – 8
L(P) = 40.9 dB(A)

The cumulative impact of this entire source is given by logarithmic addition model

LP (Total) = 10 log ($10^{LPQ1/10}$ + $10^{LPQ2/10}$ + $10^{LPQ3/10}$)
LP (Total) = 10 log ($10^{6.29}$ + $10^{5.89}$ + $10^{4.09}$)
**LP (Total) = 64.3 dB (A)**

The maximum noise level is thus estimated as 64 dB (A).

Noise level at a distance of 12.5m, 25m, and 50m from the alignment has been calculated similarly and these come out to be 57.2, 54.2 and 45.2 dB (A) respectively.

For these sections of the rail, which are underground, there will be no impact on the ambient noise. Where ever vehicular parking is being proposed at stations, there noise levels are expected to increase substantially during the morning and evening hours due to starting, idling and roaring of vehicles. However, the predominant noise on the route alignment is due to the traffic and noise levels from the metro operations are less than the ambient noise levels. However, because of the metro wherever there is reduction of vehicular traffic, the road traffic noise will come down.

It could be concluded that noise in the operation phase of the project would have minor or no negative impact.

### c) Accidental Hazards

In view of the hazards potential involved due to failure of system and accident the on-site and off- site emergency measures have been formulated and will be implemented.

### d) Water Supply

Public Health facilities such as water supply, sanitation and toilets are very much needed at the stations; CPHEEO has recommended 45 litres per day, water supply to persons working at stations. The people working on stations will be about 20. Another 80 persons will work at the depot. The water demands on stations will be for following components:

- Personal use of Railway staff,
- Fire demands, and
- Wastage.

The water demand on each stations and depot will be about 18 kl/day. No water provisions have been made for passengers. The platform washing requirement has been worked out at the rate of 5 litres / sq.m. An additional consumption of 70 kl/day has been taken at the depot for car washing, horticulture works etc..

The fire fighting water requirements have been taken as per IS 9688-1980 at the rate of 1800 l/min. for one hour. It is proposed to have hydrants at an interval of 50 m. The desired static head available at nozzle point should be 2 m of water. Each pipe should supply 35,000 lit/m. The summary of total water supply at stations is reported in Table 3.4.

**Table 3.4: Water Requirement At Each Station**

| S.NO. | ITEM | WATER REQUIREMENT ($M^3$) | |
|---|---|---|---|
| | | TOTAL | DAILY |
| 1. | Personal Use | 0.9 | 0.9 |
| 2. | Makeup Water for Fire Fighting | 108.00 | 10.80 |
| 3. | Washing of plat form | 6.75 | 6.75 |
| 4. | For AC/Ventilation | 1.50 | 1.50 |
| 5. | Wastage | 11.71 | 1.99 |
| | **Total** | **128.86** | **21.94** |

The maximum water demand on a station will be about 128.86 $m^3$ /day. However one the fire tanks are filled, about 10% of fire demand need to be replenished. Hence daily water demand will be 21.94 $m^3$/day. This could be developed from existing ground water source or municipal water supply. The construction and operation of the proposed project will not have any major impact on the surface/ ground water quality in the area. Contamination of water may result due to spilling of construction materials, oil, grease, fuel and

paint in the equipment yards. But the quantities of such spills are very negligible. Water should be treated before use upto WHO drinking water standards. Ground water shall be used for this purpose. In addition, water will be required for contractor's camps during construction.

### e) Railway Station Refuse

The refuse from railway station includes; Garbage, Rubbish, and Floor Sweepings. The collection and removal of refuse in a sanitary manner from the Station is of importance for effective vector control, aesthetic improvement, and nuisance and pollution abatement. About 20 persons will be working at each station building during operation phase. Another 80 persons will be engaged in maintenance activities (day and night) at the depot. The refuse from railway station includes; Garbage, Rubbish, and Floor Sweepings. The collection and removal of refuse in a sanitary manner from the Station is of importance for effective vector control, aesthetic improvement, and nuisance and pollution abatement. Major activities at the stations and depot will be carried out through electronic medium and, minimal use of paper is expected, which makes the major part of solid waste during operation. It is considered that about 40kg of municipal solid waste @ 100gm/day/person will be generated every day during the operation phase, for all stations and depot put together, which need be disposed effectively. For the maintenance of adequate sanitary facilities, containers/collection bins not exceeding 120-litres and equipped with side handles will be appropriately designed and installed at stations and platforms.

### f) Visual Impact

The construction of the above corridor will bring about a change in visual look of the streets through which it will operate. An architecturally well-designed structure, which could be aesthetically pleasing and able to reduce impact due to visual disfiguration have been incorporated in present corridor. Since a low profile would cause least intrusion, the basic elevated section should be optimised at the design stage itself.

### g) Pedestrian Issues

There is a feeling that MRTS will increase the pedestrian in CBD. As has been demonstrated in several countries, notably in Western Europe and North America, Pedestrian station of certain localities is a desirable change in CBD's of the city. While initial reactions of the residents or commercial establishments are sometimes 34nfavourable to the concept, in no case has dissatisfaction been expressed, or a reversal of Pedestrainisation instituted, once an area has been so developed. The benefits are seen to out weigh any disadvantages of increased

movements for access etc. There is a strong case for pedestrianising and banning two/three wheelers in several parts of the city.

The main aim of MRTS system is to decongest the road traffic in Central Business Districts. The connections will further reduce the pedestrian number, which are available now on the roads.

## 3.9 IMPACTS DUE TO DEPOT

There is provision for one depot for this corridor which is at Sarita Vihar, in south Delhi. This depot, with an area of 38.79 Ha shall consist of the Stabling Shed, Inspection Shed, Heavy repair workshop, Blow Down Plant, Interior Cleaning Plant, Automatic Washing Plant, Emergency Building, Tower Wagon Shed, Emergency Train Unit (ETU) Workshop/ OHE workshop, Depot control Centre (DCC) building, DCO Store, Wiring train shed, Time & Security Offices, Light Vehicle parking area, Depot Substation, Canteen, Workshop Manager Office, Training school & P. Way Office cum workshop. These facilities will generate water and noise pollution problems. The problems anticipated at depot site are:

- Water supply requirement,
- Sewage and effluent generation,
- Oil Pollution,
- Noise Pollution

Additional water will be required. For processes special care need to be taken for water treatment as per requirement. In additional wastewater treatment facilitates have to be created.

### a) Water Supply

The water supply will be required for the following purpose in the depot. The demands are summarised in Table 3.5.

**Table 3.5: Water Demand In Depot**

| S.NO. | PURPOSE | QUANTITY | UNIT | DEMAND | TOTAL (LITRES) |
|---|---|---|---|---|---|
| 1. | Drinking Water | 80 | Nos. | 45 lit/c/day | 3600 |
| 2. | Water for Toilet | 18 | Nos | 1000lit/day | 18000 |
| 3. | Washing Train | 28 | Nos. | 2000 lit/carriage | 56000 |
| 4. | Horticulture | 38.79 | Ha. | 20,000 l/ha. | 872775 |
| 5. | Wastage / Losses | 10% | | 10% | 95037.5 |
| | | | | **Total** | **1045412.5** |

About 1045 $m^3$ of water will be required at Depot for different uses. This will be collected from fresh ground water aquifers.

There will be a need of water treatment plant to meet water quality standards. The water after conventional treatment can be processed through Reverse Osmosis (RO) technology for specific use such as drinking/ cooking and final washing of equipment/ trains. RO plant of about 8 litres/ minute capacity plant may be sufficient and sewage treatment at depot site to avoid / prevent any water pollution. The main pollutant will be detergent, oil and grease, need to be treated before reuse/ disposal in water bodies.

**b) Sewage and Effluent**

About 17.28 $m^3$ of sewage and 14.4$m^3$ of process effluent are expected to be generated. Based on past experience in similar projects a treatment plant of 50 $m^3$/ day would be appropriate and the wastewater characteristics could be as reported in Table 3.6.

**TABLE 3.6: SEWAGE AND EFFLUENT CHARACTERISTICS**

| S. NO. | PARAMETER | UNIT | SEWAGE | EFFLUENT |
|---|---|---|---|---|
| 1. | PH | --- | 6-8 | 6-8.5 |
| 2. | BOD | Mg/l | 250-350 | 150 |
| 3. | Suspended Solids | Mg/l | 200-450 | 500 |
| 4. | COD | Mg/l | 600-800 | 300 |
| 5. | Oil and Grease | Mg/l | Upto 50 | 500 |
| 6. | Detergents | Mg/l | --- | 100 |

**c) Oil Pollution**

The construction and operation of the proposed project will not have any major impact on the surface/ ground water quality in the area. Contamination of water may result due to spilling of construction materials, oil, grease, fuel and paint in the equipment yards. But the quantities of such spills are very negligible. 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 should either be auctioned or incinerated, so as to avoid any underground/ surface water contamination.

**d) Noise Pollution**

The main sources of noise from depot are the operation of workshop. 28 trains will be required for year 2011, which will be coming to depot for washing and maintenance. 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, and hardly any speed of train in the workshop/depot, no impact on the ambient noise is anticipated.

## 4.1 POSITIVE ENVIRONMENTAL IMPACTS

The Metro rail project being an infrastructure project is designed to promote an efficient and commuter friendly transport sector for the benefit of the urban community. It is expected to bring in a number of positive impacts on the environment and the general public. Depending upon their significance and magnitude, some of them could be considered as tangible while others could be viewed as intangible benefits. There are several positive impacts (both tangible and intangible), which are expected from the proposed metro corridor. Most of the positive benefits would occur during the operation phase, some of the positive benefits expected from the proposed metro corridors have been given below:

(i) Reduced travel time resulting in increased accessibility

(ii) Safe and comfortable mode of transportation

(iii) Reduced traffic resulting in reduced congestion on roads due to the probable shifting of significant proportion of private vehicles to the metro

(iv) Reduced fuel consumption from the transport sector resulting in precious foreign exchange

(v) Reduction in vehicular emission loads resulting in improved air quality of the region

(vi) Reduction in road accidents resulting in reduced death and injury during road accidents

(vii) Increased job/employment opportunities (direct and indirect both)

(viii) Sense of pride to the city and country having a world-class facility

**4.2** An attempt has been made to quantify the above benefits based on the estimated ridership and current traffic volume. Based on the CPCB emission and deterioration factors and assuming 3.5% annual traffic growth rate on the corridor, Table 4.1 below provides the current emissions and gives the reduction in emissions in the year 2012 with and without metro for the Central Secretariat-Bdarpur corridor.

**Table 4.1: Estimation of Vehicular Emission Loads for Different Scenarios**

| S. No. | Pollutant(s) | Emission Loads (tonnes/day) | | | | |
|---|---|---|---|---|---|---|
| | | Year 2007 | Year 2012 (without Metro) | Year 2012 (with Metro) | Reduction with Metro) | Reduction with Metro in 2012 (%) |
| 1 | CO | 4.01 | 3.97 | 3.78 | 0.20 | 5.18 |

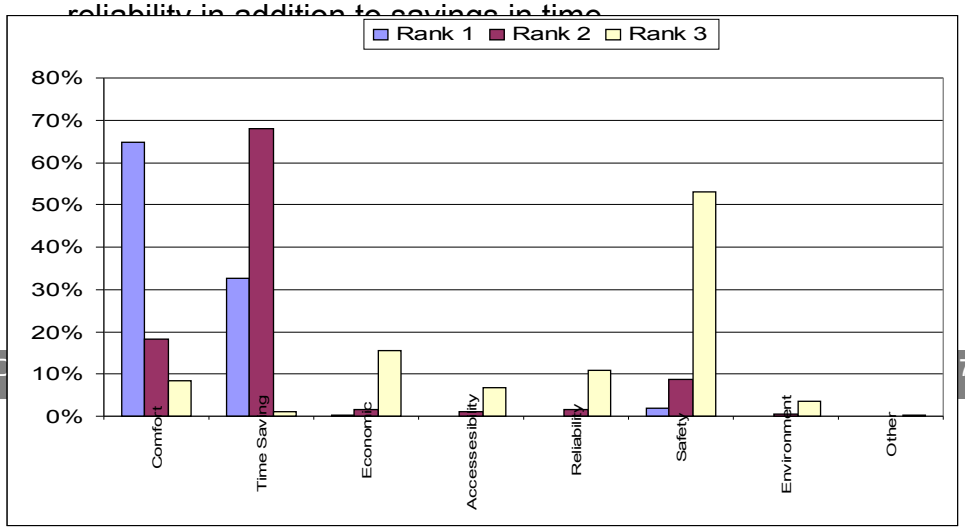
| | | | | | | |
|---|---|---|---|---|---|---|
| 2 | **NOx** | 1.11 | 1.88 | 1.82 | 0.06 | 3.56 |
| 3 | **HC** | 1.02 | 1.41 | 1.32 | 0.09 | 6.60 |
| 4 | **PM** | 0.11 | 0.14 | 0.13 | 0.01 | 4.94 |
| **Total** | | **6.25** | **7.41** | **7.05** | **0.35** | **5.02** |

Table 4.2 below quantifies the projected benefits for a ten year period from 2011 to 2021. It is clear from the table that there is a study increase in the savings over the years. There could be several reasons for the owth in benefits over the time horizon. Due to increased ridership on metro trains, benefits are sure to increase. Improved ridership is expected because of better connectivity to other parts of Delhi when the entire Phase-II of Delhi Metro would become operational.

**Table 4.2: Quantification of Benefits**

| Quantity Saved | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2019 | 2021 |
|---|---|---|---|---|---|---|---|---|
| Total Road Passkm | 4086402 | 4164562 | 4286658 | 4412335 | 5035603 | 5148818 | 5503965 | 6421721 |
| Daily Vehicle KM Saving (Road) | 546913 | 557373 | 573714 | 590535 | 673951 | 689103 | 736635 | 859465 |
| Daily Vehicle Demand (Metro) | 11557 | 11778 | 12123 | 12478 | 14241 | 14561 | 15566 | 18161 |
| Average Travel Time Saving /Trip (Metro) | 36 | 36 | 36 | 36 | 37 | 37 | 37 | 37 |
| Daily Travel Time Saving Min (Metro) | 12964392 | 13212359 | 13465068 | 13722611 | 15819091 | 16014604 | 16615760 | 18714119 |
| Travel Time Savings in min by Road Pass | 928728 | 1014098 | 1082489 | 1193813 | 1430569 | 1481248 | 1596895 | 1900367 |
| Daily Fuel Saved in Liter (Metro) | 43633 | 44468 | 45771 | 47113 | 53768 | 54977 | 58769 | 68569 |
| Annual Fuel Saved in Tonne (Metro) | 15926 | 16231 | 16707 | 17196 | 19625 | 20067 | 21451 | 25028 |
| Daily Fuel Savings due to decongestion (Liter) | 54071 | 64965 | 72189 | 84697 | 105101 | 109702 | 118884 | 143120 |
| Annual Fuel Savings due to decongestion(Tonne) | 19736 | 23712 | 26349 | 30914 | 38362 | 40041 | 43393 | 52239 |
| Annual No of all accidents saved | 104 | 105 | 106 | 107 | 114 | 115 | 117 | 120 |

In a recent study commissioned by DMRC on Phase –I corridor, commuters were asked of their preference and reasons for shifting to metro trains. Their response is presented in Figure 4.1 below. The response of commuters on Central Secretariat Badarpur line will not be much different from this response which reinforces the belief that metro travel offers better comfort, safety and reliability in addition to savings in time.



## 4.3 CHECKLIST OF IMPACTS

A typical checklist identifying anticipated environmental impacts is shown in Table No. 4.3

**Table 4.3: Checklist of Impacts**

| S. NO. | PARAMETER | NO IMPACT | NEGATIVE IMPACT | POSITIVE IMPACT |
|---|---|---|---|---|
| **A** | **Impacts Due To Project Location** | | | |
| 1. | Rehabilitation and Resettlement | | * | |
| 2. | Change of land use | | * | |
| 3. | Impact on Historical/Cultural Monuments | | * | |
| 4. | Drainage and utilities problems | | * | |
| 5. | Loss of Trees | | * | |
| 6. | Risk Due to Earth Quakes | * | | |
| **B** | **Impact Due to Project Construction** | | | |
| 1. | Soil Erosion pollution and health risk at construction site | | * | |
| 2. | Traffic diversions and risk to existing buildings | | * | |
| 3. | Soil disposal problem | | * | |
| 4. | Employment Opportunities | | | * |
| **D** | **Impact Due to Project Operation** | | | |
| 1. | Oil Pollution | | * | |
| 2. | Noise and vibration | | * | |
| 3. | Water Demands | | * | |
| 4. | Employment Opportunities | | | * |
| 5. | Benefits to Economy | | | * |
| 6. | Quick service and safety | | | * |
| 7. | Less Fuel Consumption | | | * |
| 8. | Less Air Pollution | | | * |
| 9. | Carbon dioxide Reduction | | | * |
| 10. | Reduction in Number of buses | | | * |
| 11. | Reduction in Traffic Congestion | | | * |

## 5.1 ENVIRONMENTAL MANAGEMENT PLAN

The proposed Central Secretariat-Badarpur Metro Corridor will provide quick service and safety, traffic congestion reduction, less fuel consumption, employment opportunity, and less air pollution on one hand and problems of Rehabilitation and Resettlement (R&R), soil disposal, etc. on other hand. The environmental issues likely to develop during project construction and

operation phases could be minimized by making necessary provision in the project design and adopting Environmental Management Plan (EMP).

Based on Environmental conditions (Section-3), and impact assessed in earlier sections (section 4 and 5), this section enumerates the set of measures to be taken during implementation and operation to eliminate or avoid offset adverse environmental impacts or to reduce them to acceptable levels, together with the action which need to be taken to implement them.

The Environmental Management Plans have been prepared and discussed in subsequent sections.

## 5.2 MITIGATION MEASURES

The main aim of mitigation measures is to protect and enhance the existing environment of the project. These measures should have positive effects on environment. Environmental mitigations are essential and shall be undertaken in various phase of project cycle viz. pre-construction (including those already undertaken), construction and operation stage of the project. Some of these have been described in the following section, which includes measures for:

a) Compensation for Loss of Land,
b) Compensation for Loss of Trees,
c) Compensatory Afforestation and Fencing,
d) Compensation for Relocation/Resettlement,
e) Water Supply and Sanitation,
f) Oil Pollution Control,
g) Noise Control,
h) Vibration Control,
i) Soil Disposal,
j) Rain Water Harvesting at Construction Depot Site,
k) Green Belt Development, and
l) Occupational Health Hazards and Control

### a) Compensation for Loss of Land

The alignment is on the major roads where the right of way is 22m to 50m. In order to avoid rehabilitation and land acquisition problems the alignment is kept on the median of road in elevated portion of the corridor. Hence the land acquisition is bearest minimum. The total land to be acquired permanently is around 54 ha (Refer Table 3.1). This land will be acquired and compensation will be paid. The land compensation is included in the project cost.

### b) Compensation for Loss of Trees

There are 4401 trees on the proposed alignment, which are required to be uprooted. The Compensation for Loss of Trees works out to **Rs. 30.80 lakhs.**

### c) Compensatory Afforestation and Fencing

According to the survey, about 4401 trees are likely to be lost due to the project. 10 times the number of trees are to be planted as per the Department of Forests stipulations. Hence, about 44010 plants are required to be planted. The recommended plant species may be as per the following Table 5.1.

**Table 5.1: Recommended Tree Species For Reafforestation**

| S. NO. | LOCAL NAME | BOTANICAL NAME |
|---|---|---|
| 1. | Neem | Azadirachta indica |
| 2. | Sisso | Dalbergia sisso |
| 3. | Eucalyptus | Eucalyptus |
| 4. | Kikar | Acacia nilotica |
| 5. | Ashok | Sarasca indica |
| 6. | Jamun | Syzygium cumini |

These trees will occupy about 1,200 trees/ha. Hence the total area required for Afforestation of these trees comes to about 36.67 ha. It is presumed that government land will be provided for Afforestation; hence no land cost will be involved. It is estimated that afforestation cost is about Rs. 150,000 per ha. Hence compensatory Afforestation cost (excluding fencing) for 40.74 ha will be about Rs. 5.50 million. Fencing shall be provided in order to save the saplings from the animals. The cost towards fencing is estimated as Rs. 5.00 million. Thus, the total cost of compensatory Afforestation and fencing works out to **Rs. 10.50 million.**

### d) Compensation for Relocation/Resettlement

The project involves relocation of a few shops, part industrial units and hutments along the alignment. Compensation shall be paid by land acquisition department to the industrial units as per existing policy. For hutments and Jhuggies, these will be resettled as per the existing government policy and compensated for land and structure as per concurrent government norms.

### e) Water Supply & Sanitation

The public health facilities, such as water supply, sanitation and toilets are much needed at project location. Water should be treated before use upto WHO/ Indian drinking water standards. In addition, water will be required for contractor's camps during construction, for which additional arrangements have to be made in consultation with the Delhi Jal Board /Municipal Corporation of Delhi. The collection and safe disposal of human wastes are among the most important environmental health requirements. Out of these, mobile toilet may be used by connecting them with local sewerage system. Solid waste generation is less in metro system. However to cater to train washings, a provision of Rs. 7.5 million for construction of treatment plant has been proposed at Sarita Vihar depot site. The treatment technology shall be designed based on the affluent characteristics and the final discharge options of the effluent. The total of 100 bins for all stations of 50-120 litres capacity will be required which can be accommodated at different stations and platforms. The total cost for bins works out to be Rs. 0.2 million. Total cost on this account is estimated at **Rs.7.52 million**.

### f) Oil Pollution Control

Oil tends to form scum in sedimentation chambers, clog fine screens, interfere with filtration and reduce the efficiency of treatment plants. Hence oil and grease removal tank has to be installed at source. Such tanks usually employ compressed air to coagulate oil and grease and cause it to rise promptly to surface. Compressed air may be applied through porous plates located at the bottom of the tank. The tank may be designed for a detention period of 5 to 15 minutes. The treatment technology shall be designed based on the influent characteristics and the final discharge options of the effluent. Cost provisions have been incorporated in previous section.

### g) Noise

There may be an increase in noise level in ambient air due to construction and operation of this corridor. The increase in 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 can be achieved by job rotation, automation, protective devices, noise barriers, and sound proof compartments and control rooms etc.,

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 work places, 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 equipments, wherever possible.

Pile driving operation can produce noise levels upto 100 dB (A) at a distance of 25-m from site. The noise levels could be reduced by using a suitable sound absorbent, which can reduce the noise levels upto 70 dB (A) at a distance of 15m from the piles. Safety precautions as stipulated in IS: 5121 (1969) 'Safety Code for Piling and other Deep Foundation need to be adopted.

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. Sound barriers are usually effective along route having fast traffic. The reduction in noise level increases with height of barrier. Ballast-less track is supported on two layers of rubber pads to reduce track noise and ground vibrations.

### h) Vibration Control

Vibration emanates from rail - wheel interaction and the same 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 insertion of resilient and shock absorbing pad.

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

- To prevent development of surface irregularities on the rail, a fairly heavy rail section of 60-kg/m, 90 UTS, supported at every 60-cm. 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.

- Rail will be continuously welded and also will be laid to fine tolerances, so that any noise/vibration on account of irregular 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.

In sensitive areas, track on floating slab can be provided so as to avoid propagation of noise/vibration to adjacent structures. Additional screening of noise/vibration can be arranged by providing parabolic noise/vibration reflecting walls on each sides of the track.

### i) Soil Disposal

Owing to paucity of space in the busy cities and or safety reasons, elaborate measures need to be adopted for collection, transfer and disposal of excavated soil. Soil collection, transportation, disposal and its treatment need to be carried out in a systematic manner. Soil collection should be in containers from the dredging sites / places. These containers should be such that soil should not spill during movement to disposal site. The excavated soil will be first collected at dumping ground and then transferred to an identified disposal sites.

### j) Provision of Rain Water Harvesting

To conserve and augment the storage of groundwater and arrest depletion in groundwater level, if any, it has been proposed to construct roof top rainwater harvesting structure of suitable capacity in the Sarita Vihar depot. A provision of **Rs 1.0 million** (excluding the cost of storage tank) has been kept in the cost estimate.

### k) Provision for Green Belt Development

The greenbelt development / plantation in the Sarita Vihar depot area will not only function as landscape feature resulting in harmonizing and amalgamating the physical structures of proposed depot buildings with surrounding environment but also acts as pollution sink / noise barrier. In addition to augmenting present vegetation, it will also check soil erosion, make the ecosystem more diversified and functionally more stable, make the climate more conducive and restore balance. It is recommended to have a lump sum provision of **Rs. 2.0 million** in the cost estimate for the green belt development.

### l) Occupational Health Hazards and Control

Exposure to air pollutants and higher noise levels, increased levels of heat & humidity at work place depot site may lead to occupational health disorder and diseases. It is therefore necessary to provide safe and clean working environment for the control/prevention of such health hazards. Care shall be taken to provide good working conditions during operation of depot area and also the metro corridor. Provision of conditions in contract and good construction practices will take care of any occupational health and safety hazard issues and provide environmentally safe work areas. However, a provision of **Rs. 10.0** million have been proposed for health related issues and its control for this project.

## 5.3 Implementation of Environmental Management Plan

The environmental impacts stemming out of the proposed project can be mitigated with 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.

The major concern during the construction stage is that the contractors, due to lack of enforcement, would not practice good housekeeping, may intend to get unauthorized use of the easily available natural resources and other available infrastructure 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 the 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.

Operation period mitigation would involve good housekeeping practice at metro establishments including effective solid waste collection and disposal, wastewater disposal, upbringing of plantations and green area.

## 6.1 ENVIRONMENTAL MONITORING PLAN

Environmental monitoring programme is a vital process of any management plan of the development project. This helps in signaling the potential problems that resulting from the proposed project and will allow for prompt implementation of effective corrective measures. The environmental monitoring will be required for the construction and operational phases. The main objectives of environmental monitoring are:

- to assess the changes in environmental conditions,
- to monitor the effective implementation of mitigation measures,
- to warn significant deteriorations in environmental quality for further prevention action.

In order to meet the above objectives the following parameters need to be monitored:

- Rehabilitation and Resettlement Programme,
- Afforestation,
- Water Quality and Public Health,
- Air and Noise Quality and
- Soil Conservation Measures.

### 6.1.1 Rehabilitation and Resettlement Programme

The rehabilitation and Resettlement Programme needs to be monitored during the project construction phase. The entire programme is supposed to be completed before operation phase. Sufficient care needs to be taken to ensure that money reaches the project-affected people. The quality of life of rehabilitated people should not fall below their present status.

### 6.1.2 Afforestation and Ecology

Afforestation should commence with the start of project cycle. The Forest Department of Delhi Administration should implement the afforestation programmes. The MRTS should transfer the cost of afforestation to Forest Department, government of Delhi. The trees need to be planted on the present routes before the construction is over.

### 6..1.3 Water Quality & Public Health

Water quality and public health parameters shall be monitored for one year before and for at least one year after the completion of the project thus for total 5 years. Monitoring should be carried out at least four times a year to cover seasonal variations by any recognized private or Government agency. Water quality shall be analyzed by applying the standard technique. The parameters for monitoring would be:

1. pH
2. Dissolved Oxygen (DO)
3. Biochemical Oxygen Demand (BOD)
4. Chemical Oxygen Demand (COD)
5. Total Dissolved Solids (TDS)
6. Chlorides
7. Nitrates
8. Sulphates
9. Total nitrogen
10. Total Phosphate
11. Oils and Grease

The monitoring points could be ground and surface waters if any. The ground water sampling could be in Metro corridor. Surface and ground water need to be monitored near soil disposal sites. The cost of water sampling is expected to be **Rs. 0.35 Million** as per the break up given in Table 6.1.

**Table 6.1: Cost Of Water Quality Monitoring**

| SNo | Parameter | Frequency | Cost |
|---|---|---|---|
| 1 | Water Quality monitoring | Quarterly | Four (4) Samples per year x Five (5) years x four (4) locations x Eleven (11) Parameters x Rs. 400/- for each parameters<br><br>= 4 x 5 x 4 x 11x 400 = 0.35 Million |
| Total | | | **Rs 0.35 Million** |

### 6.1.4 Air Quality and Noise

Ambient air quality and Noise levels should be monitored one year before the construction, during the construction phase and for at least three years after the completion of the project (total 7 years). It is proposed to have the monitoring programme at four locations as suggested above in water quality monitoring. The parameters recommended for monitoring are:

- Particulate Matter,
- Sulphur-di-oxide,
- Carbon monoxides,
- Nitrogen Oxides and
- Noise levels dB (A).

The cost for ambient air quality and Noise levels monitoring works out to be Rs 3.92 Million as per the break up given in Table 6.2.

**Table 6.2: Cost Of Air And Noise Quality Monitoring**

| SNo | Parameter | Frequency | Cost |
|---|---|---|---|
| 1 | Air Quality monitoring | Seasonal | Twice (2) in a week x Four (4) weeks in a season x Four (4) seasons in a year x Seven (7) years x four (5) locations x Rs. 2000/- per monitoring per location for all parameters<br><br>= 2 x 4 x 4 x 7x 5 x 3500 = Rs. 3.92 Million. |
| 2 | Noise monitoring | Seasonal | Once (1) in a season x Four (4) seasons in a year x seven (7) years x eighteen (18) locations x Rs. 1200/- per monitoring per location<br><br>= 1 x 4 x 7 x 18 x 1200 = Rs. 6.04 Million |
| **Total** | | | **Rs. 9.96 Million say Rs 10.00 Million** |

### 6.1.5 Soil Conservation

Soil erosion rates, slope stability of land faces, water sediments load, effectiveness of soil conservation measures, changes in soil texture and structure should be monitored at frequent intervals. This study could be done by the Environmental Management cell, twice a year. This should be studied for the entire length of alignment.

## 6.2 SUMMARY OF ENVIRONMENTAL MONITORING PROGRAMME

The environmental monitoring programs are presented in Table 6.3 of this section. The section briefly highlights the summary of these programs along with parameter and frequency.

**Table 6.3: Summary of Environmental Monitoring Programme**

| S. NO. | ITEM | PARAMETERS | FREQUENCY | LOCATION |
|---|---|---|---|---|
| *DURING PROJECT CONSTRUCTION PHASE* | | | | |
| 1. | Soil Quality | Heavy Metals: Arsenic, Cadmium, Chromium, Lead and Mercury, | Once before excavation for underground section | One sample at each u/g station location |
| 3. | Noise Quality | $L_{eq}$, $L_{max}$, $L_{10}$, $L_{90}$ | As per DMRC Environmental Manual | As per DMRC Environmental Manual |
| 4 | Vibration | Ppv/dB | 24 hour sample, during construction activities that are | Sensitive receptors(socially important places like hospitals, schools, library etc) |

| | | | | |
|---|---|---|---|---|
| | | | prone to cause vibration or when complaints are received. | which are 25m from the elevated track . |
| 5. | Air Quality | SPM and RPM | As per DMRC Environmental Manual | As per DMRC Environmental Manual |
| *DURING PROJECT OPERATION PHASE* | | | | |
| 6. | Treated Effluent from STP/ETP | pH, BOD, COD, TSS, Oil and Grease | Once every three months | Before and after treatment from STP/ETP |
| 7. | Noise Quality | $L_{eq}$, $L_{max}$, $L_{10}$, $L_{90}$ | 24 hour sample, Once a year | Sensitive receptors(socially important places like hospitals, schools, library etc) which are 25m from the elevated track . |
| 8. | Vibration | Ppv/dB | 24 hour sample, twice a year for next three years | Sensitive receptors(socially important places like hospitals, schools, library etc) which are 25m from the elevated track . |
| 9. | Air Quality | SPM, RPM | Two samples of 24 hrs each, once in a month. | Depot Site/ every 5km (Total 5 locations) |

The cost for environmental monitoring program has to be worked out and budgeted for in the project estimates.