Government of the People's Republic of Bangladesh
Ministry of Road Transport and Bridges
Dhaka Mass Transit Company Limited

CONSULTANCY SERVICES FOR DESIGN, CONSTRUCTION SUPERVISION, PROCUREMENT SUPPORT AND MANAGEMENT OF DHAKA MASS RAPID TRANSIT DEVELOPMENT PROJECT

Environmental Impact Assessment
Main Report
January 2016

NKDM Association

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Nippon Koei India Pvt. Ltd.
Delhi Metro Rail Corporation Ltd.

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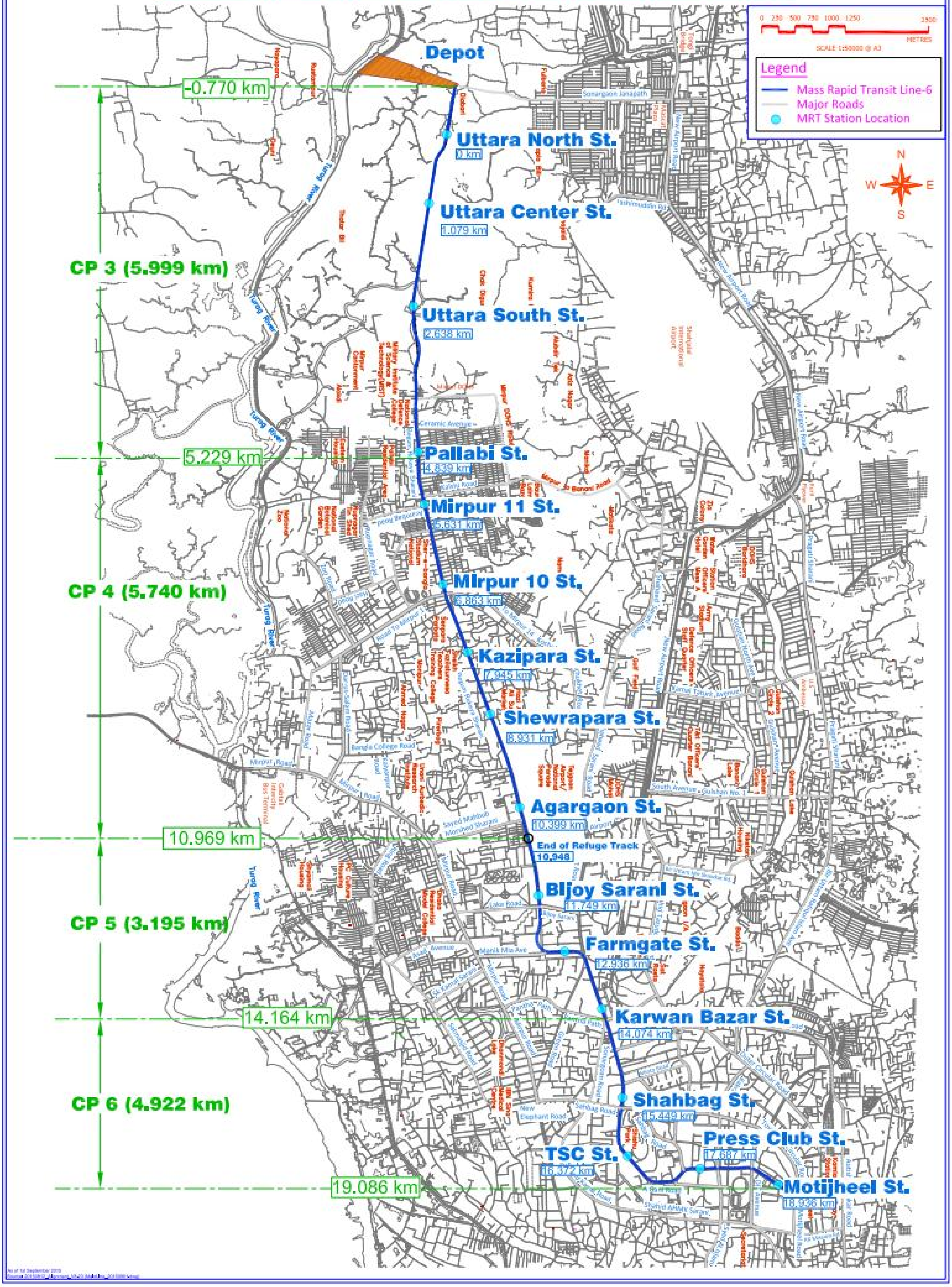
Preface

During the Feasibility Study of Dhaka Metro Line 6 conducted under JICA financed DHTUS 2 study of 2010-11, a preliminary Environmental Impact Assessment Report was prepared in 2011. Based on that, Department of Environment (DOE) issued an Environmental Clearance Certificate in 2011 allowing the Project to proceed into design phase. After securing the implementation finance from JICA, the General Consultant NKDM Association started the design work from February 2014. Based on the current and detail Project information, the updated EIA is prepared over one year period. Comments are collected from public and stakeholders through extensive consultation process. Comments of DMTC, JICA and DOE are also addressed. The draft final version was posted at DMTC and Road Transport and Highways Division website for public disclosure and comments during December 2015. Incorporating most current Project design information and relevant comments, this final version has been compiled.

A Bangla executive summary of this report is also available.

DHAKA MASS RAPID TRANSIT LINE-6 ROUTE MAP



Environmental Impact Assessment

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Abbreviations and Acronyms

BUET	:	Bangladesh University of Engineering and Technology
BCC	:	Basic Clinical Care
CP	:	Contract Package
DC	:	Dynamic Compaction
DEEP	:	Dhaka Elevated Expressway Project
DMRTDP	:	Dhaka Mass Rapid Transit Development Project
DMTC	:	Dhaka Mass Transit Company Ltd.
DOE	:	Department of Environment
DOT	:	Dept. of Transportation (USG)
DPP	:	Development Project Proposal
DTCA	:	Dhaka Transport Coordination Authority
EA	:	Executing Agency
ECA	:	Environmental Conservation Act, 1995
ECC	:	Environmental Clearance Certificate
ECR	:	Environmental Conservation Rules, 1997
ECS	:	Environmental Construction Specification
EIA	:	Environmental Impact Assessment
EMP	:	Environmental Management Plan
FTA	:	Federal Transport Authority (USA)
FIDIC	:	The International Federation of Consulting Engineers
GC	:	General Consultant
GHG	:	Greenhouse Gases
GOB	:	Government of Bangladesh
HRT	:	Heavy Rail Transit
IDC	:	Institutional Development Consultant
JICA	:	Japan International Cooperation Agency
MOF	:	Ministry of Finance
MOP	:	Ministry of Planning
MOC	:	Ministry of Communications (old; see MRTB)

MRT : (Dhaka) Mass Rapid Transit (Development Project)

MRTB : Ministry of Road Transport and Bridges

MSDS : Material Safety Data Sheet

NKDM : Acronym for association of firms providing general consultancy services for the MRT (Nippon Koei Dhaka Metro Association)

ODA : Official Development Assistance

O&G : Oil and Grease

SCP : Sand Compaction Piles

Transit Terms and Abbreviations

AVM : Add Value Machine

BRT : Bus Rapid Transit

OCC : Operations Control Center

PCU : Passenger Car Unit

PHPDT: peak hour peak direction traffic

TOM : Ticket Office Machine

Social and Resettlement Terms

AB : Acquiring Body

AP : Affected Person

BDT : Bangladeshi Taka

CCL : cash compensation under law

CBE : Commercial & Business Enterprise

CBD Central Business District

CPR : Common Property Resources

DLAC : District Land Allocation Committee

EA : Executing Agency

EC : Entitlement Card

EFAP : Emergency Food Assistance Project

EP : Entitled Person

IA : Implementing Agency

ID : Identification

IGA : Income Generating Activity

LAP	:	Land Acquisition Plan
LGD	:	Local Government Division
LGI	:	Local Government Institutions
MARV	:	Maximum Allowable Replacement Value
MIS	:	Management Information System
PAH	:	Project Affected Households
PAP	:	Project Affected Person
PAVC	:	Property Assessment and Valuation Committee
PD	:	Project Director
PMU	:	Project Management Unit
PWD	:	Public Works Department
RAP	:	Resettlement Action Plan
RAC	:	Resettlement Assistance Consultant
RB	:	Requiring Body
ROR	:	Record of Right
ROW	:	Right of Way
RRAP	:	Revised Resettlement Action Plan
RU	:	Resettlement Unit
RV	:	Replacement Value
UP	:	Union Parishad

Units

cmd	:	cubic meter per day
dB	:	decibels
dBA	:	A-weighted sound level (screens out low and high frequency noise)
Lmax	:	maximum noise level
Ldn	:	day-night sound level (Cumulative 24-Hour Exposure from All Events)
Leq(10)	:	equivalent sound level (10 min during peak hour)
Leq(h)	:	Hourly Equivalent Sound Level
SEL	:	sound exposure level (The Cumulative Exposure from a Single Noise Event)
VdB	:	Vibration Decibel

Executive Summary

EXECUTIVE SUMMARY

1.0. BACKGROUND

1.1. The Environmental Impact Assessment Report

The Environmental Impact Assessment (EIA) Report describes environmental and social considerations of the Dhaka Mass Rapid Transit Development Project (DMRTDP), which is an integral part of an overall scheme for improved transport for Dhaka. The purpose of the EIA is to establish a framework and related actions for evaluating and mitigating environmental and social impacts stemming from implementation of the Project.

1.2. The Project

A JICA funded Study of 2009-10 (known as DHUTS 1) examined the 2005 Strategic Transport Plan (STP) of Dhaka, and MRT Line 6 between Uttara and Motijheel was selected as the preferred route for initial development. A subsequent JICA Study (known as DHUTS 2) carried out feasibility of Line 6. A preparatory level EIA was prepared at that time and submitted to the Department of Environment (DOE). An environmental clearance certificate (ECC) was issued for the Project, which allowed it to progress to detailed design stage.

Organizational arrangements were put into place through formation of the Dhaka Mass Transit Company (DMTC) for implementation of the Project. A loan agreement was signed in 2013 between the Government of Bangladesh (GOB) and the Japan International Cooperation Agency (JICA) for implementation of the Project. A consortium of firms, NKDM Association, has been appointed for design, construction supervision, procurement support and management of the Project.

1.3. The Consultants

A consortium of 6 firms, NKDM Association, led by Nippon Koei of Japan, has been working as General Consultant for consultancy services from February, 2014.

1.4. Objectives of the Project

The Project aims to alleviate in part the lack of transport options available in a rapidly growing metropolis, and was identified as such in the original Dhaka Strategic Transport Plan (STP) of 2005. In that study, the Project was seen as one component of an urban transport development strategy that combines mass rapid transit (MRT) with Bus Rapid Transit (BRT), reclaiming the full capacity of the City’s roadways, and selected highway projects, along with safety and pedestrian improvements.

1.5. The Environmental Objectives

The Project’s environmental objectives are both local and global. They include reduction in congestion along roadways and lessened air pollution exposure for roadway users and people living and working along roadways. At national and global levels, the Project is expected to reduce consumption of fossil fuels leading to a reduction in the Nation’s Greenhouse Gas (GHG) inventory in comparison with a future case without the Project.

The Project is located along a north-south alignment, overall length of 20+ km, running roughly parallel to the Turag River in the western part of Dhaka. The 24 ha depot site is located at its northern extent at Uttara 3rd Phase. Toward the south the alignment turns eastward following the general curvature of the Buriganga River. The Map showing the route alignment and the stations for the Project is shown in

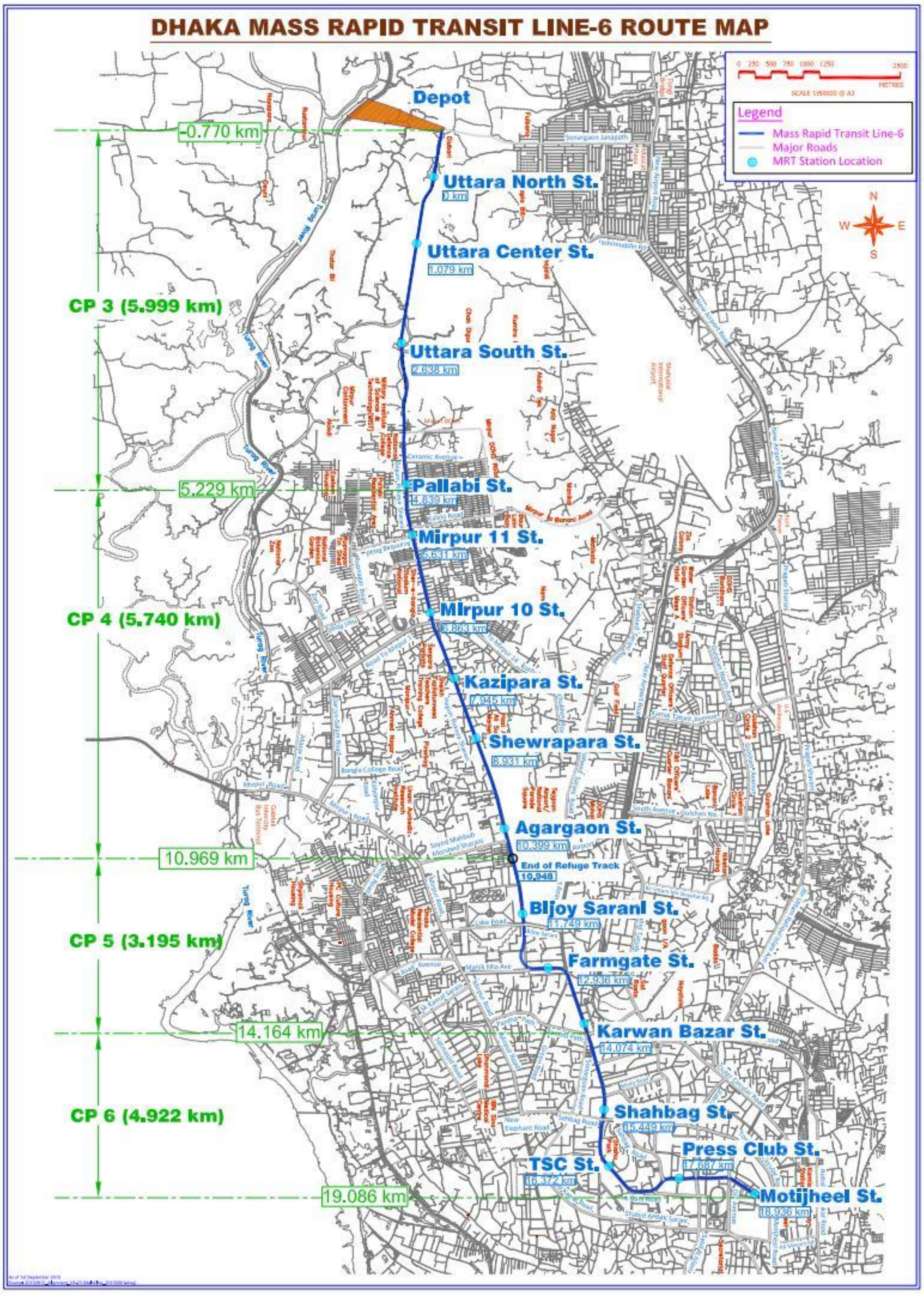

Figure ES 1 : Route Alignment and Stations of the MRT Line 6 Project

2.0. LEGAL FRAMEWORK FOR ENVIRONMENTAL MANAGEMENT

Key legislations related to environmental protection in Bangladesh include The Environmental Conservation Act (1995) and Environment Conservation Rules (1997). Together these laws authorize the Director General (DG) of Department of Environment (DOE) to undertake activities to conserve and enhance the quality of the environment. Main highlights relevant to the Dhaka Metro Project are:

a) Regulation of development activities from an environmental perspective

b) Categorization of development activities on the basis of anticipated environmental impact

c) Requirement for undertaking an EIA in keeping with the category of the proposed activity

d) Procedure for obtaining and renewing an environmental clearance over the project cycle

e) Promulgation of standards for air, water and noise quality, as well as effluent standards

f) Procedure for claiming damage by persons affected by polluting activities or actions that adversely affect the conduct of ordinary civic life

2.1. Laws Concerning Resettlement and Land Acquisition

Other laws and ordinances concerning resettlement, land acquisition and compensation are relevant to the Project. The current legislation governing land acquisition for Bangladesh is the Acquisition and Requisition of Immovable Property Ordinance 1982. The Ordinance provides certain safeguards for landowners and has provisions for payment of ‘fair value’ for the property acquired. However, it does not cover project-affected persons without title or ownership record such as informal settler/squatters, occupiers, and informal tenants and lease-holders (without document) and does not ensure replacement value.

2.2. JICA Guidelines for Environmental Social Conditions

JICA Guidelines for Environmental and Social Considerations (2010) define the overarching framework for environmental management on the DMRTDP. JICA’s policy is set out in the Guidelines: to “take steps to assure fairness,” to attend “to factors such as environmental and social impacts on developing countries,” and “inclusion of environmental and social costs in development costs [by means of a] social and institutional framework” that ensures “stakeholder participation, information transparency, accountability, and efficiency.” JICA guidelines support environmental impact assessment (EIA) that incorporates social assessment on a par with environmental assessment. JICA confirms an approach consistent with “the laws or standards related to the environment and local communities in the central and local governments of host countries” and “that projects do not deviate significantly from the World Bank’s Safeguard Policies.” The content and main elements for EIA Reports are provided in Appendix 2 of the Guidelines, which are consistent with the World Bank Operational Policy - OP 4.01, Annex B.

2.3. Dhaka Mass Transit Company Ltd and IDC

Dhaka Mass Transit Company Ltd. (DMTC) is the administrative body for implementation of the DMRTDP, and is constituted by an order from the Cabinet on 21 Jan 2013, with a capital of Tk 100 billion, and the Road Division of the Ministry of Road Transport and Bridges owning 98.8 per cent of shares, and balance owned equally by the Dhaka Transport Coordination Authority, the Prime Minister's Office, and finance, rail, home and local government ministries. Initially DMTC serves as a Project Implementation Unit for the Dhaka Metro. Technical and planning units are set up to work with the general consultant in implementing the Project. An Institutional Development Consultant (IDC) will recommend an organizational structure to manage and operate the Line 6 Metro and execute future projects to extend the system.

3.0. PROJECT DETAILS

The Project Description is based on information provided by the NKDM design team. Numerous changes are made to detailed design continually, and the EIA is not intended to precisely account for changes. Rather it highlights aspects of design that may adversely affect the environment; are designed to minimize or eliminate impacts; and introduce energy-saving and clean technology innovations.

The DMRTDP is squarely situated within the transport planning context that has been a priority in Dhaka for about 20 years. The 2005 Dhaka Strategic Transport Plan financed by the World Bank recommended a balanced mix of transport options including heavy rail transit. JICA's DHUTS 1 Study of 2009-10 recommended MRT Line 6 as the priority project for immediate implementation, and JICA's DHTUS 2 Study of 2010-11, which was completed in Oct 2011, carried out feasibility for Line 6.

3.1. Project Funding

As per The Government's Development Project Proposal (DPP), the Project cost was estimated as about BDT 220 billion (USD 2.82 billion), of which approximately 75 % is financed through Japanese ODA (BDT 166 billion, USD 2.13 billion) with the Government contribution at ~25% (BDT 54 billion, USD 0.69 billion). These numbers correspond to the amounts stated in the DPP. Additional financing in the form of grants for preparatory studies and training are also provided by JICA.

3.2. Salient Features of the Project

The salient features of the Project are as follows:

- Alignment between depot (on north end) and terminus at Motijheel: length of around 20 km. The viaduct is located within the right-of-ways of major roadways over its entire length. The width of ROW for the DMRT is undefined as such, since it is entirely within the public domain.
- Depot site: 23.85 ha.
- Stations: 16 stations along the alignment, each approximately 180 m in length; outside width of stations will vary to remain within the available public right-of-way. In general stations are 20-26 m in width.
- Electrical substations both on- and offsite
- Temporary facilities needed for construction, including casting yards, materials and equipment storage, labor camps and cordoned space.

3.3. Summary of the Project Description

The Project Description found in the main text covers environmental aspects of the depot site development; the viaduct, track and stations; rolling stock; instrumentation and mechanical (I&M) systems; and temporary construction facilities. Methods and timing of construction are also described briefly. Aspects of the depot covered in the main text include site development, buildings and architecture, equipment, tools and vehicles, power demand, water demand, wastewater treatment, byproducts and chemical recycling, and health and safety aspects of operations. Structural aspects of the viaduct include pier spacing, bridge locations at intersections and traffic circles, and erection methods. The description of the track system includes use of ballast (at ground level in depot), ballast-less (typical in elevated track) and vibration-less track, accomplished through use of the Mass Spring System (MSS), used to reduce noise and vibration at selected locations. Description of stations includes architectural considerations, typologies, and precise names and locations. Rolling stocks are described in terms of train configuration, energy-saving advances, noise and vibration reduction and safety features, incorporated into the rolling stock specification. Descriptions of Instruments and Mechanicals (I&M) systems include power supply for depot, traction and auxiliary power; signaling and communications including Communications-Based Train Control (CBTC) for train control, operations and protection; Supervisory Control and Data Acquisition (SCADA); overhead catenary cable; track-side signaling; automatic fare collection (AFC); and platform screen door (PSD). The Project Description provides an easily accessible summary of the Project for the nontechnical reader. Land acquisition procedures built into the project design are also described in this chapter.

4.0. SELECTION OF THE ALIGNMENT

After detailed deliberations and environmental consultations a number of alternatives were developed and the present alignment has been chosen. The selected alternative provides an advantage for entry of the track into the depot area, including better access for trains and easy extension of the line north to Gazipur.

Machinery and equipment alternatives were selected during the design process in light of environmental protection, health and safety, and energy conservation. Selection of preferred alternatives in these aspects can be found in the depot equipment, in the track system, rolling stock and electro-mechanical systems.

5.0. DESCRIPTION OF THE ENVIRONMENT (BASELINE DATA)

This section covers a large scope of topics under the four major headings of environment. Physical resources include geology, soils and groundwater, surface hydrology and water quality, meteorology and air quality, and noise. Biological resources cover protected areas, land cover, trees and valued flora, mammal and bird life. Socioeconomic resources describes administrative divisions and population, land use along the alignment, community infrastructure, housing, water and sanitation services, transport assets, religion, crime and criminal activities, gender based violence, in and out migration, and employment. The social impact survey conducted during the Preparatory EIA is also described in this Chapter. Finally a list is included of historical, cultural and archaeological sites based on the Historical Importance /Archaeological Survey results. Current and proposed development activities in the project area are described in brief.

6.0. AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

The scope of work specifies a high level of accountability for environmental design of equipment and facilities; construction management; and health and safety. Environmental features are incorporated into the project design. Development of environmental construction specifications (ECS) that are part of the tender documents requires that all aspects related to sequencing be considered. Some construction environmental impacts are mitigated through a process of pre-planning, traffic management planning being an example.

6.1. Mitigation Measures

Construction mitigation measures are required by good practice and should be undertaken by the construction contractor in a proactive fashion to get the most benefit in meeting the needs of local communities, which will be most affected. Proposed mitigation measures are appropriate for actual field conditions. DOE environmental quality standards for air, noise and water play an important role in determining the extent of mitigation measures that need to be applied by the Contractor.

Environmental impacts can be minimized in the planning and design of the Project, and mitigation measures can be applied during construction and operations phases. The EIA identifies numerous types of potential impact that require investigation. Noise and vibration impacts can occur both during construction and operations, whereas impacts on air quality due to the project are limited to its construction phase. Drainage and water quality impacts can occur both during construction and operations, but for the latter, potential impacts are mainly at the depot and are accounted for in the project design. As stated earlier, many environmental, health and safety issues are addressed through project engineering, design and planning, including landscape design around stations, traffic management, utility relocation, safety and health, HIV/AIDs and emergency response. These are included by reference and summaries are provided in Chapter 6 of the EIA. Additional recommendations are made in regard to these issues. Chapter 6 also describes analyses and provides mitigation measures for potential impacts associated with spoil disposal, solid waste and hazardous materials; removal of trees in the right-of-way; and silting/construction impacts related to the south receiving substation (RSS) and temporary construction yards. No significant potential impact on birds, mammals and groundwater was identified.

6.2. Noise Impacts

Noise impacts occur during construction and operations. Operations impacts are analyzed through a method proposed by K. Ishii that incorporates noise power levels from rolling motion of the train, structure noise and vehicle onboard equipment noise. These are converted to equivalent noise levels at 7.5 m distance, which represents a typical location for close-by receptors, then combined into an equivalent combined noise level (A rated decibels). Input variables include track curvature (200 m, 400 m and 600 m) and type (ballast-less or vibration-proof); and train operating variables (train length, speed and headway). Results are tabulated and compared with the project standard, which is based on the DOE ambient noise standard. Calculated noise emissions for trains traveling on ballast-less track through 200 m radius curves exceed the standard, so vibration-proof track (called Mass Spring System, MSS) is used along these sections (total length of sections about 5.9 km). Ambient noise that is present in addition to noise emissions from trains are considered to add another 3 dB, indicating that the daytime standard could potentially be exceeded along curves in the 300 – 600 m radius range. Further, a 1.5 m high sound barrier is provided along the entire alignment, which brings reduces noise levels below the standard.

6.2.1 Noise Generated by Construction

Noise generated by construction activity is analyzed based on combined equipment sound power level for different workplace conditions, converted into an equivalent noise level at 15-20 m distance, depending on the location, and assessed in comparison with a project standard of 85 dB in areas considered office, commercial and service enterprises; and 75/65 dB (day/night levels) in residential and hotel zones. If ambient noise (based on monitoring data) exceeds 65 dB, the standard is considered equal to ambient plus 10 dB. Analysis of data shows that excess construction noise above the standard is unlikely, except at night, when a more stringent standard is applicable. A general set of mitigation measures is set out that can be invoked in the event that measured noise levels exceed the standard, or complaints arise. Mitigation measures can be targeted under any particular construction package through the ECS for that contract. Noise monitoring is required by the contractor during conduct of the work. Special cases for noise impact during construction have been singled out and measures put into place to mitigate impact. A significant noise impact on one of the buildings of Milestone College from sand compaction pile (SCP) installation and dynamic compaction (DC) at the depot site will be compensated, and the college will be relocated for the period of construction after paying proper compensation.

6.3. Vibration Impact

Vibration impacts during operations depend on track type, curvature, and train speed. Equations are used to predict vibration decibels (VdB) at source (base of pier) and at a distance of 12.5 m. Bangladesh does not have a vibration limit, so the Japanese standard of 60 VdB is adopted for use on the project.

6.3.1 Vibration proof Track

Since vibration proof track (i.e., MSS) is already prescribed to mitigate noise impact on 200 m radius curves, no further measure is required to mitigate vibration impact. To provide a further factor of safety, pier locations are adjusted to provide maximum distance between the pier and historical structures near the track alignment, specifically Dhaka Gate. Other historical structures are evaluated to determine if vibration damage will occur. While the analysis indicates that the vibration level on 400 m radius curves could slightly exceed the standard (due to higher speeds), it is felt that a sufficient safety margin is present to not require further mitigation.

6.3.2 Vibration Impact an Adjacent Structures

The primary vibration impact during construction occurs with installation of SCP and DC at the depot site. A commercial college (Milestone College) is located close to the property boundary. A vibration standard of 90 VdB is adopted for the project based on US FTA construction vibration damage criteria, but cannot be met at the college while infilling the nearby area. It is clear that construction works with DC will create annoyance to the occupants, even if there is no damage. DMTC has elected to compensate the owners for temporarily relocating the college and demolition of a building. While vibration impacts may occur during construction of the viaduct and stations, these are expected to be minor.

6.4. Air Quality

Adverse impacts on air quality are expected to occur only during construction; in general the operation of the Metro will bring about a decrease in vehicle emissions and an improvement in ground level air quality. Suspended particulate matter (SPM), sulfur dioxide (SO2), carbon monoxide (CO), and oxides of nitrogen (NOx) are generated by construction activities and by equipment and transport vehicles used during construction. Existing ambient air quality is poor, with all but one (92%) of the 12 monitoring locations having daytime SPM values in excess of DOE's ambient air standard for residential areas, and six locations (50%) exceeding the standard for commercial and mixed land uses. NOx is exceeded in all samples, and CO is exceeded in seven out of 12 samples.

6.4.1 Mitigation Measures for Air Quality

Mitigation measures are proposed to control local air quality impacts, focusing on maintaining and cleaning roadway surfaces and transport vehicles. Contractors will be required to monitor air quality, and implement mitigation measures to maintain levels within the DOE ambient standards. Complaints from the community will also be a cause for intensifying use of mitigation measures.

6.4.2 Traffic Congestion

Traffic Congestion in construction zones is addressed through traffic management planning, undertaken in NKDM by various specialties under the overall direction of the Transport Planning Group. The findings are assembled into a Traffic Management Plan (TMP), which is in the process of refinement and agreement with DMCTL. Though the TMP is not yet finalized, the key recommendations are set out. Because traffic management involves the cooperation of a number of agencies, the process of agreement will be incremental, continuing until the start of construction. The main traffic management recommendations are summarized in the main text of the EIA. The EIA includes additional measures related to general traffic conditions along thoroughfares, and to the movement of over-weight/over-length (OW/OL) loads.

6.5. Drainage as an Environmental Issue

Drainage as an environmental problem is focused on preventing effects of standing water or flooding on people, whether workers at a site or people living/working in or passing through the area. Another concern has to do with water quality: whether discharge water (or standing water) contains pollutants that will affect beneficial uses of open water, public health (in the case of standing water) or aquatic ecosystems. The main impact during construction is from silt runoff that can inconvenience people and clog drainage systems. Silt-laden water will not be allowed to discharge from sites. Organic contamination in the form of spills of fuel, oil and chemicals will be strictly prohibited.

6.5.1 Detailed Drainage Plan

Drainage issues are important both during infilling, construction and operation of the depot. The lakes in the vicinity of the depot are created by the infilling of land around an original drainage course. Their ecological value is marginal; they serve no other function other than drainage. Water quality monitoring of these lakes indicate bacterial contamination from inflow of urban wastewater, high turbidity and high TSS from sediments in runoff from the surrounding unimproved ground. TSS averages 150 mg/L in the lakes; this should serve as a standard for any discharges from the depot site during infilling and construction. The Contractor will be responsible for monitoring TSS during operations. Specific controls apply, which are described in the EIA. Drainage from construction sites needs to be controlled to prevent water crossing roadways or interfering with pedestrian movement. The Contractor will be required to keep the site clean and free of mud/silt, so that runoff from rainfall can enter the local drain system without negative effect. The Contractor is required to prepare a drainage plan that incorporates mitigation measures described in the EIA.

6.5.2 Drainage During Operations

Drainage during operations (from the viaduct, station canopies and the depot site) is accounted for in the design of facilities, as documented in the EIA. Water quality is unlikely to be affected. The EIA recommends three locations at the boundary of the depot site for drainage and effluent monitoring during operations, and identifies monitoring parameters for these locations.

6.6. Solid and Hazardous Waste

The EIA describes the sources of solid and hazardous waste that might be generated by construction and operations. Trash and construction waste is not a significant impact. Hazardous materials and waste will be managed accordingly. About 250,000 cubic meters of spoil material can be generated during construction of the viaduct. Contractors will be required to identify locations for disposal according to strict guidelines. The material is acceptable for fill so long as it does not contain hazardous waste. Responsibilities for solid waste handling and public toilets in the vicinity of stations can be assigned to some specific agencies during the operation phase.

6.6.1 Site for Electrical Substations

Final sites for the electrical substations and temporary construction facilities do not present special problems in respect to mitigation measures. Many of the mitigation measures incorporated under the above headings will apply to construction activities at these sites; and additional site-specific mitigation measures are described in the main text of the EIA.

6.7. Impact on Habitats

The Project is not expected to have a significant impact on habitats, whether arboreal (along the alignment) or aquatic (in the Uttara area). A discussion of these issues is found in the EIA.

6.8. Impact on Trees in the Centerline of Roadways

Trees found in the centerlines of roadways used for the rail alignment are relatively small and offer no significant habitat for birds. These trees will need to be removed to make way for construction, but can later be replanted elsewhere.

A few larger trees will need to be removed at the entry of the viaduct onto Parliament grounds and for passage of the viaduct through the Farmgate area. These are unavoidable losses that are made up by planting of trees at other, nearby locations. Some of the trees to the right and left sides of the alignment from Shahbag Station to Press Club Station overhang into the roadway and will need to be trimmed to provide clearance for construction equipment. Some bird habitat will be temporarily sacrificed, but is made up for by trees away from the right of way, and rapid re-growth. Species of trees to be replanted under the viaduct are listed in the EIA.

Installation of pier foundations and other sub-grade work can damage existing utilities. A utility survey and relocation plan for utilities is undertaken by NKDM as an essential part of project implementation. Additional construction and operations issues related to public infrastructure are described in the EIA.

6.9. Risk Avoidance

Various risks including fire and earthquake, as well as more mundane risks, are associated with operation of the Metro. These risks are accounted in the design and pre-planning of systems and the operations of those systems, as described in the EIA.

6.10. Emergency Response Planning

Emergency response planning is done by the Electrical and Mechanical (E-M) Systems Group to set up procedures for responding to any type of emergency that poses risk for the public and Metro employees. These materials constitute the Emergency Response Plan for operation of the Metro, found in Appendix 3 of the EIA.

6.11. Health and Safety Issues

Planning for the construction sequence also addresses health and safety issues for the community. In order to facilitate pedestrian movement and traffic, and prevent entry to worksites, a set of mitigation measures are proposed. During operations, public facilities (roads, walkways, toilets, benches and other features) near stations will need to be maintained and operated by a joint effort of DMTC, the City Corporations and DWASA; otherwise they become unusable and a public liability.

6.12. Occupational Health & Safety

An occupational health and safety specification is prepared by GC to be adopted by contractors. The health and safety specification is incorporated into the contract bid documents alongside environmental specifications. The contractor will be required to prepare a construction phase occupational health and safety plan that conforms to the contents of the specification, inclusive of additional measures described in the EIA. Employee health and safety during operations is addressed through the Safety Management System (SMS), which is being developed by the IDC as part of the overall Quality Management System for DMTC.

6.13. Impacts Due to Uncontrolled Development

Potential cumulative impacts include uncontrolled development of the outlying area designated as Uttara Ph III, if current land use plans do not materialize. Development of informal settlements along the water front and on the embankment in the Uttara Ph III area due to increased access to work opportunities could be considered an impact. The conditions for these impacts to occur are discussed in the EIA. DMRTDP mitigates these impacts by making it more likely that developments will be implemented rapidly and will be built to a high standard.

6.14. Reduction in Greenhouse Gas Emissions

The Project mitigates climate change by bringing about a reduction in greenhouse gas emissions in comparison with a base case scenario without the project. The approach for estimating the magnitude of emissions savings is based on assumptions concerning trip length, vehicle factors and other considerations taken from the Traffic Demand Estimate report (NKDM 2014a) and published sources. Annual emission reduction is calculated to be 173,000 and 500,000 tons CO2 equivalent per annum for years 2021 and 2051, respectively.

6.15. Social Impacts

Various types of social impact are possible, such as vendors near construction sites that must vacate, shops that must be barricaded due to construction, noise impacts that affect customer arrivals, and other potential impacts affecting income and livelihood. The Resettlement Action Plan (RAP) will catalogue these impacts if any. Since the RAP is not yet complete, information contained in the EIA is of a general nature at this stage.

6.16. Social Benefits

Social benefits stem from transport as a household asset that materially benefits families. Access to health care (hospitals, clinics, emergency facilities and diagnostic centres) will become more convenient. Traffic congestion will be mitigated to an extent; and using the Metro, people facing emergencies can access emergency facilities within a short time. Businesses and commerce benefit similarly through better access to services for customers and greater ease of movement.

7.0. COORDINATION AND CONSULTATION

7.1. Stakeholder Analysis

The EIA contains a Stakeholder Analysis, which identifies the organizations and groups as stakeholders in the project development. Stakeholders include governments, institutions and groups of individuals affected either beneficially or adversely, directly or indirectly, by the Project. JICA finances the project at 80% through soft loans, and is a major stakeholder. Government national and city-wide stakeholders that benefit from the Project include MRTB and Dhaka Mass Transit Company, owner of the Project, RAJUK and Dhaka North and South City Corporations, and other agencies within the Government of Bangladesh. Local stakeholders are citizen groups in Dhaka, groups of individuals living, operating businesses and working in proximity to the alignment, and existing transport operators. Those adversely affected by environmental impact include those directly exposed to construction impacts, those entitled to compensation for structures and land (currently thought to be none), those along haul routes of construction materials, and those who may be affected by long term impacts stemming from the Project during its operation. Stakeholders benefiting from the Project include virtually all groups which are engaged in educational, economic and cultural pursuits in the area. Local governments benefit through the increase in economic activity due to the Project.

7.2. Public Consultations

The EIA reports on the extensive public consultation undertaken during the preparation surveys. Two environmental public consultation meetings were held during the design phase targeting a cross-section of interest groups. Following introductory presentations, the GC presented project details along with key findings of the environmental impact assessment, and highlighted control measures incorporated into the design and recommended by the EIA in the Environmental Management Plan. After the presentation, the floor was opened for questions and suggestions from the attendees. A number of key points were raised by stakeholders that have been taken into consideration in the EIA.

Public consultation should be held at the start of each of the individual construction packages. The Grievance Redress Mechanism prepared by resettlement assistance consultant (RAC) as part of the RAP also provides a venue for individuals and local communities to make themselves heard regarding performance of the Project.

7.3. Roles and Responsibilities

A description of roles and responsibilities of the DMTC and GC for environmental management was provided.

8.0. ENVIRONMENTAL MANAGEMENT PLAN

The Environmental Management Plan describes institutional proposals, mitigation measures aimed at specific types of impact, and systems for monitoring and reporting on contractor performance in implementation. An institutional framework for environmental management is proposed that addresses the needs of the DMRTDP through its operations phase, a two year period following early commissioning, and into the period of full operability for DMTC. The presentation of mitigation measures aims at confirming use of best practicable technology in planning and design, setting out measures for mitigating construction impacts that conform to good international practice, and more general recommendations related to operations.

8.1. Construction Mitigation Measures

The construction mitigation measures specified in the EMP cover a broad range of issues, which are reflected in the Environmental Construction Specification (ECS) for a particular contract. Each ECS is tailored to fit the specific needs of a construction package. The Contractor for each contract package will prepare a Construction Environmental Management Plan (CEMP) that describes the means for implementing the mitigation measures described in the EIA.

8.2. Monitoring System

The monitoring system will provide periodic monitoring (at least quarterly), data compilation and reporting of results. The system will utilize checklists that cover mitigation measures set out in the ECS and any special mitigation measures identified through impact analysis and described in the EMP.

8.3. Checklist

The checklists serve primarily as guides for reviewing performance to determine general compliance with broad indicators.

8.4. Monitoring Report

Monitoring reports will also summarize the status of complaints (registered/resolved) under the GRM, as well as results of air, water and noise monitoring conducted by the Independent Monitoring Group (IMG).

9.0. CONCLUSIONS

a) Dhaka Metro Line 6 Project is compliant with GOB and JICA guidelines concerning environment, social impact, resettlement and compensation, and local administration.

b) Sector guidelines related to the environment, public transit design and construction, systems and traffic safety, and public health are complied with through completion of project preparatory and detailed studies.

c) The EIA Report and EMP provide a means for environmental management through the implementation phase.

d) The Metro Line 6 Project provides one of several means for alleviating Dhaka transport problems. A clear right of way in the public domain allows the project to be built with no land acquisition. The project provides improved access to the Uttara Ph III area for more rapid development by allowing the GOB to invest freely in residential infrastructure, much needed in Dhaka.

e) The alignment serves the core of the City, and provides direct access to the CBD.

f) The selection of the Line-6 alignment for the first phase of the Dhaka Metro was conditioned on use of BRT and improved roadways for transport improvements in the other core areas of the City, leaving the current alignment for Line 6 as the logical first choice.

g) Greenhouse Gas (GHG) emissions are reduced by removing vehicles from the roadway, assuming a passenger equivalence between metro use and vehicle numbers. It is estimated that the Project CO2 emission reduction is 170,000 t.p.a (2021) to 499,000 t.p.a. (2051).

h) Metro Line 6 Project has no long term adverse environmental impacts; once constructed and in operation the Metro will enhance its local environment and improve mobility for local communities. Other aspects of the Facility once in operation do not pose environmental impact if correctly operated and maintained.

i) The project design incorporates measures for reducing the impact or footprint of the Project. Modern equipment and facilities are designed into the system for environmental protection, rider comfort and safety, and energy efficiency.

j) Social impacts on local transport providers due to the competitive nature of the Metro is unlikely. The Metro once operational becomes a member of the set of transport alternatives for Dhaka that is always functioning at capacity.

k) Employees and entrepreneurs are people that adjust to changing times, and just as the Metro may temporarily disadvantage some, to others it offers both jobs and new transport opportunities.

l) The mitigation measures proposed for application to individual construction and supply contracts minimize adverse effects that occur during construction. Air, noise and water pollution levels will be monitored periodically.

m) Social impacts are minimized by relocating street-side vendors to predefined locations so their occupations can be continued, otherwise they will be properly compensated.

n) The Project seeks to minimize impact on permanent storefronts along the alignment by maintaining access and pedestrian movement, since most activity (except station construction) takes place in the roadway.

o) Traffic congestion will be offset through designation of alternative routes. Some compensation may be paid in specific instances related to disturbance that affects livelihood, or temporary relocation out of the line of work. Any such instances will be identified in the RAP and adjudicated in keeping with its guidelines.

p) No compensation has been identified strictly related to environmental impacts of construction, with the exception of possible temporary relocation of a building of one college located on the north boundary of the depot property.

10.0. RECOMMENDATIONS

a) Maintaining clean work space;

b) Pedestrian and vehicle access around and through work areas;

c) Enclosed or piped drainage from work sites;

d) Roadways used for haul roads and lanes adjacent to work spaces free of dust and in good repair;

e) Visible signage and traffic directional controls; worker visibility and mandatory use of traffic vests and PPE equipment;

f) Maintenance of drainage, lighting and dust at temporary yards and spaces needed in the construction;

g) Features included in the EMP serve to minimize impacts to an acceptable level.

h) There is no use of irreplaceable resources in relation to the Metro Line-6 Project.

i) A systematic approach for surveillance and monitoring is required by means of a management framework, and monitoring and reporting protocol.

j) Follow-up public consultation is recommended to provide future input to the identification of environmental impact during the construction phase as well as a grievance redress mechanism for project affected persons.

k) The EMP be incorporated into individual contract bidding documents in the form of Environmental Construction Specifications (ECS), which form the basis for the contractor's environmental performance.

l) Periodic monitoring will be undertaken by DMTC supported by the GC, and quarterly reports provided to the financing agency (JICA).

Main Report

CHAPTER 1 INTRODUCTION

1.1 Purpose of the Report

This Environmental Impact Assessment (EIA) report describes environmental and social considerations of the Dhaka Mass Rapid Transit Development Project (DMRTDP). The Project was conceived in 2005 as a recommendation found in the Dhaka city urban Stategic Transport Plan (STP) financed by the World Bank for a heavy rail transit (HRT) commuter facility that would serve as an integral part of an overall scheme for improved transport for Dhaka. A study funded by Japan International Cooperation Agency (JICA) during 2009-10 (known as DHUTS 1) examined the 2005 STP, and MRT Line 6 between Uttara and Motijheel was selected as the preferred route for initial development. A subsequent phase of that study during 2010-11 known as DHUTS 2, feasibility was carried out for Line 6. A preparatory level EIA was prepared at that time and submitted to the Department of Environment (DOE). An environmental clearance certificate (ECC) was issued for the Project, which allowed it to progress to detailed design stage. Organizational arrangements were put into place through formation of the Dhaka Mass Transit Company (DMTC) for implementation of the Project. A loan agreement was signed in 2013 between the Government of Bangladesh (GOB) and the JICA, representing the Government of Japan, for implementation of the Project. A consortium of six firms, NKDM Association, led by Nippon Koei of Japan, was recruited for general consultancy services for design, construction supervision, procurement support and management of the Project, which is a time-bound and objective-oriented undertaking for the first phase of a commuter rail facility for Dhaka. The general consultancy services for the DMRTDP started from February 2014 and are expected to run for nine years. NKDM assists DMTC in project development, including technical support for preparing the EIA and implementing recommendations. The EIA is a document of DMTC, which is familiar with its preparation, contents and recommendations.

The purpose of the EIA is to establish a framework and related actions for evaluating and mitigating environmental and social impacts stemming from implementation of the Project. Mitigation involves avoiding and minimizing adverse impacts on the environment and affected people, when possible; and compensating affected people when avoidance is not possible. The EIA also serves the purpose of disclosure by documenting public consultation on the Project's environmental and social impacts, and by summarizing the rationale for appropriate levels of mitigation. To complete the disclosure process, the EIA is made available at JICA's website as well as DMTC's website for review and comment.

1.2 Project Environmental and Social Objectives

The Project aims to alleviate in part the lack of transport options available in a rapidly growing metropolis, and was identified as such in the original STP (2005): "The impact of such rapid growth has major consequences on the ability of the transport sector to provide mobility for people as they take advantage of employment, education, health and social opportunities."

In that study, the Project was seen as one aspect of an urban transport development strategy that combines an integrated mass rapid transit (MRT) system with bus rapid transit (BRT), reclaiming the full capacity of the City's roadways, and selected highway projects, along with safety and pedestrian improvements. The strategy aimed to bring about overall improvement in the quality and amount of transport options available to the people of Dhaka. These components once realized represent a form of social capital in the form of transport assets at the household level, and collectively add to the nation's store of physical infrastructure and human resources.

Most of these components are now in the process of being realized through a combination of institutional means and capital investment. Through government initiative, coordinating bodies have been formed to integrate transport projects, and new organizations created to execute and operate them. The financial means for capital intensive projects are made possible through international lending. The projects themselves are equitable in that they benefit virtually all socioeconomic groups, as identified by age, sex, income and occupation. In contrast, there are few if any groups that stand to be marginalized as a result of the project components of Dhaka's urban transport strategy, including the Dhaka Mass Rapid Transport Components.

The Project's environmental objectives are both local and global. They include reduction in congestion along roadways and lessened air pollution exposure for roadway users and people living and working along roadways. At national and global levels, the Project is expected to reduce consumption of fossil fuels leading to a reduction in the nation's greenhouse gas (GHG) inventory in comparison with a future case without the Project. This issue is taken up in the EIA. JICA sets out the environmental and social objective of the Project to "alleviate traffic congestion and improve air quality in Dhaka by constructing a mass rapid transit system (MRT), thereby contributing to regional economic development and an improved urban environment."

(http://www.jica.go.jp/english/our_work/social_environmental/id/asia/south/bang_a01.html)

1.3 Zone of Influence

The Project is located along a north-south alignment, overall length of 20+ km, running roughly parallel to the Turag River in the western sector of Dhaka. The 24 ha depot site is located at its northern extent. Toward the south the alignment turns eastward following the general curvature of the Buri Ganga River. Temporary construction facilities also are part of the project and contribute to its zone of influence. Direct environmental impacts are restricted to a corridor of approximately 200 m width along the Project's length and in the vicinity of the proposed depot. This zone of influence is defined in terms of environmental factors such as traffic congestion, noise and air pollution during construction as well as some aspects of operations. Cumulative and indirect impacts and benefits resulting from operation of the Project will affect land use, economic development and physical aspects of the urban environment. Changes in traffic flow can be expected both during construction and operations, intensifying along the main roadways near the alignment.

The Environmental Base Map for the Project is shown in Figure 1-1. It shows the principal features of the Project and surrounding environment, including urbanized area, green space, water bodies, and administrative boundaries.

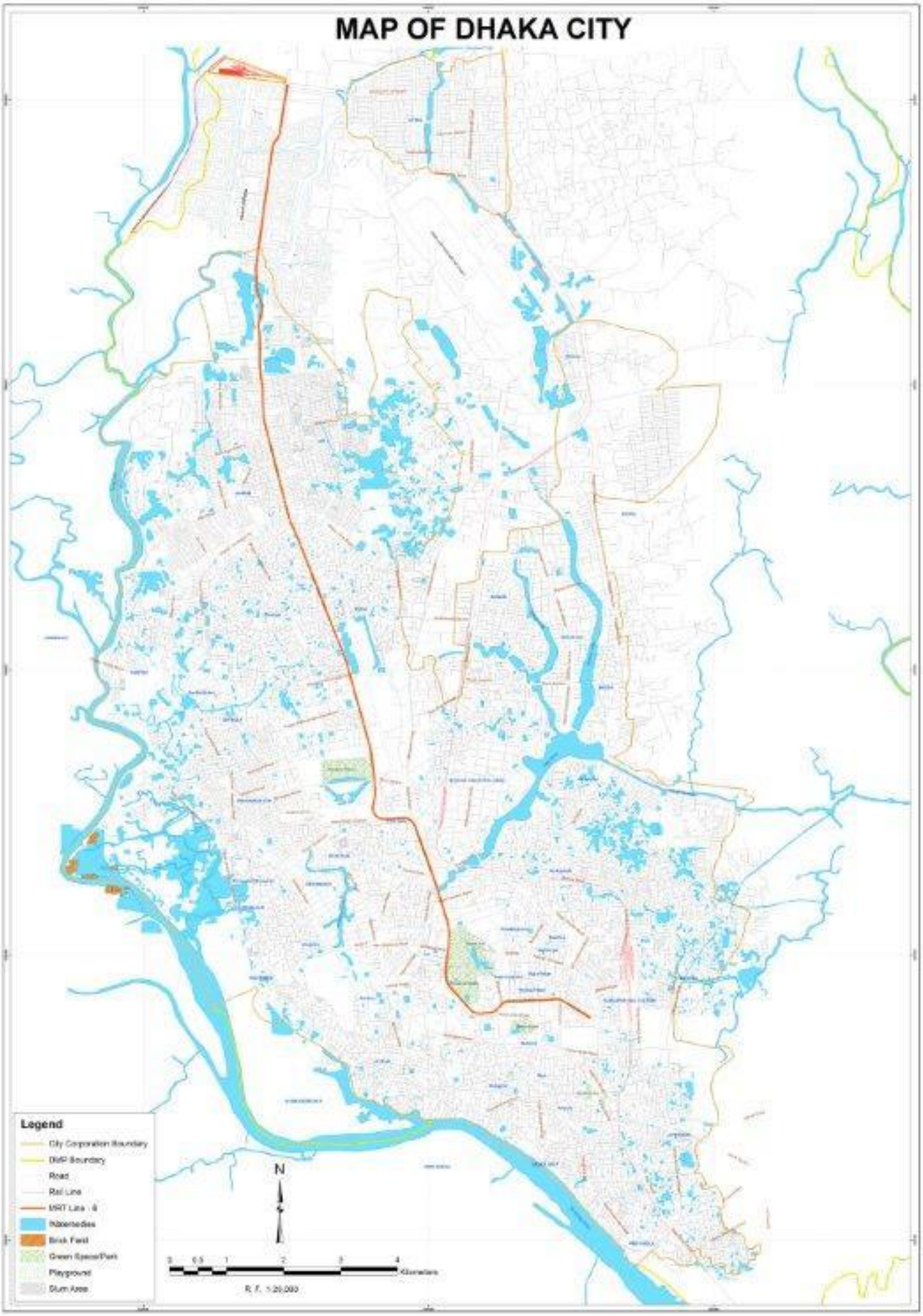

Figure 1-1: Environmental Base Map

1.4 Financing and Implementation

On 20 February 2013, an official development assistance (ODA) loan of JPY 70.693 billion was signed between the Governments of Japan and Bangladesh. The JICA loan package assigns JPY 10.477 billion for funding the DMRTDP. The loan has a 10 year grace period and 40 year repayment period.

Loan financing for ~ 75% of the cost is provided through JICA, with the balance from Government funds. Disbursements are passed through the Ministry of Finance and approved by the Executing Agency (EA), the Dhaka Mass Transit Company (DMTC). DMTC is a Government-owned corporate entity administered through the Ministry of Road Transport and Bridges[1] (MRTB). DMTC currently operates as a project implementation unit for the DMRTDP. DMTC recruited a general consultant (GC) for design, construction supervision, procurement support and operations management over a two year startup period. The consultant NKDM, a consortium of six consulting companies[2], commenced work in late February 2014. A project organization chart prepared by NKDM (Figure 1-2) shows the relationship of government and donor agencies and technical support, including technical assistance outside the NKDM contract for legal, planning, fare rates and other matters. Institutional development for DMTC and preparation of a resettlement action plan are also administered by DMTC under separate contracts.

[1] Previously the Ministry of Communications.

[2] These are: Nippon Koei Co. Ltd. (the lead firm), Nippon Koei India Pvt. Ltd., Delhi Metro Rail Corporation Ltd., Mott MacDonald Ltd., Mott MacDonald Pvt. Ltd., and Development Design Consultants.

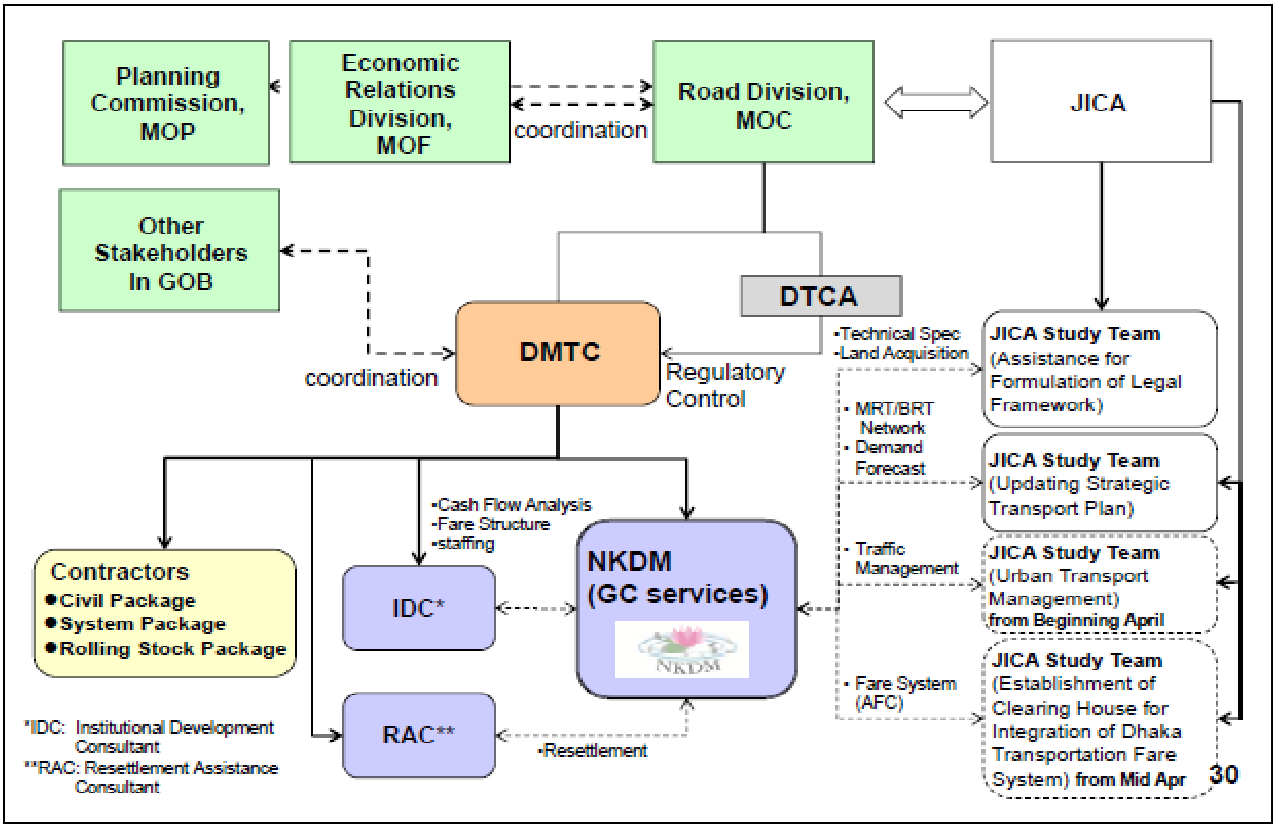

Figure 1-2: Project Organization

1.5 Organization of the Report

Chapter 2 of the report, “Policy and Legal Framework for Environmental Management” sets out the relevant laws, regulations and permits for the Government of Bangladesh (GOB) and more specifically Department of Environment (DOE). It provides key elements of underlying policy for both GOB and JICA.

Chapter 3 of the report describes the project in sufficient detail to highlight environmental aspects, while describing technical features. The Project contains an aggregate of high-level, state-of-the-art design know-how that is reflected somewhat superficially in the description summary. Methods of construction and scheduling are addressed in brief; construction environmental management will depend on readiness of contractors to implement the Environmental Management Plan (EMP).

Chapter 4 describes current alternatives (discussed during the detailed design period), while reviewing the history of alignment selection over the past 10 years. Other ‘selection’ issues are described that have environmental implications.

Chapter 5 provides a general overview of perspectives on the background environment that support impact analysis. The level of detail of information is determined by what is available from secondary sources and primary data obtained by sampling and analysis, and is oriented to the problem of impact.

Chapter 6 provides an evaluation of a variety of potential impact scenarios across more than 10 major headings. A brief methodology and applicable criteria are presented. Additional project information and background data are presented to support the analyses. Mitigation measures are presented, and unmitigated effects are noted and explained. The chapter summarizes the Project's greenhouse gas (GHG) emission reduction potential, and has a section on cumulative impacts.

Chapter 7 covers public consultation, disclosure and the grievance mechanism. The history of public consultation for the Project is reviewed, and descriptions of the two events held during detailed design are provided, along with a summary of comments. Future public consultation is suggested. The disclosure and grievance redress mechanisms are described.

Chapter 8 describes the environmental management plan (EMP) for the Project: the organizational framework for environmental management; factors related to implementing mitigation measures, such as responsibility, conditionality, stage in project development, and source of mitigation in project documentation; a monitoring plan for implementation during the construction stage; capacity building; and cost aspects. Various appendices are related to the EMP and are referenced therein.

Chapter 9 concludes the EIA by summarizing recommendations and providing certification of compliance from the owner's point of view regarding certain critical aspects of international concern (use of irreplaceable resources, endangered species and other).

1.6 Data Sources

Data are taken from various sources, including NKDM in-house planning and engineering outputs that are continuously updated during detailed design, web sources that generally tap the open-source international development literature, and secondary data from Government sources and from authenticated data sources, including the outputs of models. The latter includes FAO's local climate estimator and noise prediction methods from the Japanese literature and from the US Federal Transport Authority. The approach for data collection is to source information where it is needed to present a clear picture of baseline conditions, project interventions and impacts. Government sources are numerous, and data were formally solicited from departmental offices. Secondary data and graphics taken from other reports are accompanied by a reference. Some information comes from the preparatory EIA (2011). Reports and other bound materials cited in the text (including e-copies) are listed in Appendix 1. Web references are footnoted in the main text where possible. Preparers of the EIA gratefully acknowledge the support of the NKDM design team in providing valuable information for the EIA.

1.7 Status of EIA and Further Additions

An EIA was performed for the Project during the Preparatory stage (2010-11), on the basis of which an ECC was issued on 11 July 2011 (DOE/Clearance/5034/2011/767). An extension of the ECC was obtained in 2014. Further extension of the ECC issued by DOE for the Dhaka Mass Transit Line 6 Project will be based on the updated EIA.

The updated EIA is being prepared during the detailed design phase of the Project. The work takes place over a year time frame (10/2014 - 10/2015) during which most of the bid packages for major engineering works are being finalized. Aspects of the design are subject to revision, and data are provisional, meant to serve the purpose of impact analysis only. The EIA has been prepared before bidding commences for any of the main construction packages[3]. The EIA has been submitted to JICA and DOE for comment and a response from JICA was received dated 30 August 2015 and that from DOE on 10 Nov 2015. This final version of the EIA incorporates responses to comments from JICA and DOE. The final draft was also posted on Ministry website for public comments during December 2015.

[3] This is with the exception of CP-1 construction package, as explained in Sec.3.4.

CHAPTER 2 POLICY AND LEGAL FRAMEWORK FOR ENVIRONMENTAL MANAGEMENT

2.1 Government of Bangladesh

2.1.1 Environment

National Environmental Policy, 1992: the Bangladesh National Environmental Policy, approved in May 1992, sets out the basic framework for environmental protection together with a set of broad sector guidelines. Key elements of the policy are:

- Maintaining ecological balance and ensuring sustainable development of the country through protecting and conservation of the environment
- Protection from natural disasters
- Identifying and regulating activities that pollute the air and water
- Ensuring environmentally sustainable development of the economy
- Ensuring sustainable management of natural resources
- Maintaining active association with international initiatives related to environment

The National Environmental Policy also seeks to ensure that transport systems, including roads, railways and inland waterways, do not pollute the environment or degrade resources. The policy states that an Environmental Impact Assessment (EIA) should be conducted before any large scale transport development project is undertaken.

National Environmental Management Action Plan (NEMAP), 1995: the National Environmental Management Action Plan (NEMAP) is a wide-ranging and multi-faced plan developed in response to international initiatives for such plans worldwide. NEMAP was a 10 year action plan covering the period 1995 to 2005, and set out a framework and recommendations for pollution control and protection of the Nation's resources. NEMAP was developed based on the following broad objectives:

- Identification of key environmental issues affecting Bangladesh
- Identification of actions necessary to halt or reduce the rate of environmental degradation
- Improvement of the natural environment
- Conservation of habitats and biodiversity
- Promotion of sustainable development
- Improvement of quality of life for Bangladesh citizens

The Environmental Conservation Act, 1995 (subsequent amendments in 2000 and 2002): the provisions of the Act authorize the Director General (DG) of Department of Environment (DOE) to undertake any activity he deems fit and necessary to conserve and enhance the quality of environment and to control, prevent and mitigate pollution. The main highlights of the act are:

- Declaration of Ecologically Critical areas
- Obtaining Environmental Clearance Certificates
- Regulation with respect to vehicles emitting harmful smoke into the environment
- Regulation of development activities from an environmental perspective
- Promulgation of standards for air, water and noisequality for different land uses and purposes
- Promulgation of acceptable limits for discharging and emitting wastewater
- Formulation of environmental guidelines relating to control and mitigation of environmental pollution, conservation and improvement of environment

Environment Conservation Rules, 1997 (subsequent amendments in 2002 and 2003): the Environment Conservation Rules are the first set of rules promulgated under the Environment Conservation Act, which provides for the following:

- National Environmental Quality Standards (EQS) for ambient air, surface water and groundwater; drinking water; industrial effluents; and air, noise and vehicular exhaustemissions
- Categorization of industries, development projects and other activities on the basis of anticipated environmental impact
- Procedure for obtaining and renewing an environmental clearance over the construction phase, and obtaining an environmental clearance for operation of the Project
- Requirement for undertaking IEE and EIA in keeping with the category of the proposed activity
- Procedure for claiming damage by persons affected by polluting activities or actions that adversely affect the conduct of ordinary civic life

The ECA also gave rise to preparation of EIA guidelines directed primarily at industrial projects. DOE prepared these guidelines that address such issues as industrial siting and the process for preparing and submitting for approval an EIA report for an industry. There also is an environmental guideline published in 2004 by and related to the activities of the Road and Highway Department, which focuses primarily on land acquisition and compensation. Other national legal instruments listed in Table 2-1 are in part relevant to social and environmental considerations of the proposed Project. The EIA is prepared in compliance with these instruments.

Table 2-1 National Policies, Legislation and Rules Relevant to DMRTDP

Policy or Legal Instrument	Agency	Key Features
The Sound Pollution (Control) Rules, 2006	Department of Environment	Provides mechanism for bringing noise complaints before local authorities for adjudication of injury
Environment Court Act, 2000 and subsequent amendments in 2002	Ministry of Environment and Forest	To facilitate environment-related legal proceedings
National Land Transport policy, 2004	Ministry of Communications	Reduction of pollution from all kinds of vehicles Environmental protection management Mass transit plans developed in conjunction with institutional strengthening of the transport sector
The National Water Policy, 1999	Ministry of Water Resources	Protection, restoration and enhancement of water resources Protection of water quality, including strengthening regulations concerning agro-chemicals and industrial effluent Sanitation and potable water Fish and fisheries; and Participation of local communities in all water sector development
The Vehicle Act, 1927 The Motor Vehicle Ordinance, 1983 The Bengal Motor Vehicle Rules, 1940	Bangladesh Road Transport Authority	Exhaust emissions Vehicular air and noise pollution Road/traffic safety Vehicle licensing and registration Fitness of motor vehicles Parking bylaws

Water Supply and Sanitation Act, 1996	Ministry of Local Government, Rural Development and Cooperatives	Management and Control of water supply and sanitation in urban areas
National Land Use Policy, 2001	Ministry of Land	Land use policy for agriculture (crop production, fisheries and livestock), housing, forestry, industrialization, railways and roads, tea and rubber.
Draft Wetland Policy, 1998	Ministry of Environment and Forest	Establishment of principles for sustainable use of wetland resource Maintenance of existing level of biological diversity Maintenance of the function and value of wetlands in resource management and economic development

2.1.2 Resettlement and Land Acquisition

Land Acquisition

The current legislation governing land acquisition for Bangladesh is the Acquisition and Requisition of Immovable Property Ordinance 1982 (hereinafter, "the Ordinance") and subsequent amendments (1989, 1993, 1994 and 2004). The Ordinance provides certain safeguards for landowners and has provisions for payment of 'fair value' for the property acquired. The 1994 amendment also made provision for payment of crop compensation to tenant cultivators. However, it does not cover project-affected persons without title or ownership record such as informal settler/squatters, occupiers, and informal tenants and lease-holders (without document) and does not ensure replacement value of the property acquired. It does not permit the affected persons to take the salvageable materials for which compensation have been paid by the Deputy Commissioner (DC). It has no provision for resettlement assistance and transitional allowances for restoration of livelihoods of the non-titled affected persons.

In all cases, the DC determines (i) market value of acquired assets on the date of notice of acquisition (based on the registered value of similar property bought and/or sold in the area over the preceding 12 months); and (ii) 50% premium on the assessed value (other than crops) due to compulsory acquisition. The DC payment "awarded" to owners is called cash compensation under law (CCL). The value thus paid is invariably less than the "market value" as owners customarily report undervalued land transaction prices in order to pay a lower stamp duty and registration fee. As a result, compensation for land paid by DC, including premiums, remains less than the real market price or replacement value (RV). As of this writing, land acquisition is not required under the Project.

The land owner has to establish ownership by producing a record-of-rights (RoR) in order to be eligible for compensation under the law. ROR records prepared under Section 143 or 144 of the State Acquisition and Tenancy Act 1950 (revised 1994) are not always updated and as a result legal land owners have faced difficulties trying to “prove” ownership. The Affected Persons (APs) must also produce a rent receipt or receipt of land development tax. Khas (government owned) lands should be acquired first in preference to private land. If a project acquires only khas, the land will be transferred through an inter-ministerial meeting following the preparation of an acquisition proposal submitted to DC/Ministry of Lands (MOL). Places of worship, graveyards and cremation grounds may not be acquired for any purpose.

The DC processes land acquisition under the Ordinance and pays compensation to the legal owners of the acquired land. The MOL is authorized to deal with land acquisition through the DCs.

The Ordinance including its subsequent amendments will be applied for this Project. In addition to the 1982 Ordinance the Project will also use Padma Multipurpose Bridge Project Land Acquisition Act 2009 for the process of land acquisition. These rules are mainly applied for formal land title holders.

<u>Involuntary Resettlement</u>

The Government of Bangladesh has prepared a draft national policy on involuntary resettlement, which is consistent with the general policy of the Government that the rights of those displaced by a development project shall be fully respected, and persons being displaced shall be treated with dignity and assisted in such a way that safeguards their welfare and livelihoods irrespective of title, gender, and ethnicity.

The Policy on involuntary resettlement recognizes that:

a) All those displaced involuntarily by either project or non-project impacts must be resettled and rehabilitated in a productive and sustainable manner.

b) People who are resettled must be able, through their own efforts and/or with support as may be required, to restore or improve upon their level of living.

c) Cash compensation shall be paid to those displaced in a development project at replacement value for land and other assets acquired based on established prior ownership and/or user rights. In addition to cash compensation and resettlement, benefit sharing will be considered where feasible.

d) Cultural and customary rights of people affected by project are to be protected, particularly those belonging to adibasis (indigenous people) and ethnic minorities.

e) Gender equality and equity in all stages and processes of resettlement and rehabilitation will be fully respected.

f) Affected persons will be informed and consulted in a transparent manner, including formal disclosure of project impacts and mitigation measures.

g) Vulnerable groups, including landless, adibasis, poor women-headed households, physically challenged people, elderly and those falling below the nationally defined poverty line (by the government) displaced by project or non-project impacts, are entitled to additional benefits and assistance in a manner that addresses their specific needs related to socio-economic vulnerability.

h) Similarly, affected persons and/or businesses on government leased land will be eligible for compensation for loss of access to land and sites.

The draft Policy was submitted to the Government in November 2007. It has been approved by the Ministry of Land on 1 January 2008 and was submitted to the Cabinet later in February 2008. As of now, this policy is still in the process of evaluation and approval by the Government. The Ministry of Land enacted “The Padma Multipurpose Bridge Project (Land Acquisition) Act 2009” and “Dhaka Elevated Expressway Project Land Acquisition Act, 2011”, which apply to these specific projects.

2.2 JICA Guidelines

2.2.1 Overview of Guidelines

The Guidelines for Environmental and Social Considerations (JICA 2010) define the overarching framework for environmental management on the DMRTDP. In those Guidelines, JICA sets out the international imperative for environmental management and social equity as applied to technical cooperation, loan and grant aid projects; and formulation and adoption of guidelines via committee and public consensus, in keeping with those of other multilateral and bilateral development agencies. JICA’s policy is set out in the Guidelines: to “take steps to assure fairness,” to attend “to factors such as environmental and social impacts on developing countries,” and “inclusion of environmental and social costs in development costs [by means of a] social and institutional framework” that ensures “stakeholder participation, information transparency, accountability, and efficiency.”

JICA guidelines support environmental impact assessment (EIA) that incorporates social assessment on a par with environmental assessment. JICA identifies seven principles to guide the assessment process:

a) A wide range of impacts must be addressed

b) Measures for environmental and social considerations must be implemented from an early stage to a monitoring stage

c) JICA is responsible for accountability when implementing cooperation projects

d) JICA asks stakeholders for their participation

e) JICA discloses information

f) JICA enhances organizational capacity

g) JICA makes serious attempts at promptness

JICA confirms an approach consistent with “the laws or standards related to the environment and local communities in the central and local governments of host countries” and “that projects do not deviate significantly from the World Bank’s Safeguard Policies.” JICA categorizes projects in a way that does not materially differ from the methods of other international and national agencies. Category Aprojects are those that, among other criteria, are found in sensitive sectors, which includes (Appendix 3) “roads, railways, and bridges.” JICA lists a number of environmental considerations to be assessed through EIA, with additional emphasis on “social impacts, including migration of population and involuntary resettlement, local economy such as employment andlivelihood, utilization of land and local resources, social institutions such as social capital and local decision-making institutions, existing social infrastructures and services, vulnerable social groups such as poor and indigenous peoples, equality of benefits and losses and equality in the development process, gender, children’s rights, cultural heritage, local conflicts of interest, infectious diseases such as HIV/AIDS, and working conditions including occupational safety.”

Degrees of uncertainty and absences of information are taken into consideration in the JICA Guidelines. JICA recognizes the integrated role of EIA in the process of project development through preparatory survey, project formulation, classification and disclosure. Details of requirements for consideration in the EIA are provided in Appendix 1 of the Guidelines, including “multiple alternatives examined in order to avoid or minimize adverse impacts,” “appropriate follow-up plans and systems, such as monitoring plans and environmental management plans prepared,” “impacts on human health and safety, as well as on the natural environment,” and “derivative, secondary, and cumulative impacts.” Further, “Projects must be adequately coordinated so that they are accepted in a manner that is socially appropriate to the country and locality in which they are planned. For projects with a potentially large environmental impact, sufficient consultations with local stakeholders, such as local residents, must be conducted via disclosure of information at an early stage, at which time alternatives for project plans may be examined. The outcome of such consultations must be incorporated into the contents of project plan,” and “Appropriate consideration must be given to vulnerable social groups, such as women, children, the elderly, the poor, and ethnic minorities….”

Monitoring is a key feature of the Guidelines and JICA sets out that “after projects begin, project proponents etc. monitor whether any unforeseeable situations occur and whether the performance and effectiveness of mitigation measures are consistent with the assessment's prediction. They then take appropriate measures based on the results of such monitoring."

The content and main elements for EIA Reports are provided in Appendix 2 of the Guidelines, which are consistent with the World Bank Operational Policy - OP 4.01, Annex B. The JICA Guidelines are comprehensive and practical; this cursory review does not cover all aspects. Further details on the JICA Guidelines can be obtained by consulting the Guidelines themselves.[4]

2.2.2 JICA Requirements related to Land Acquisition and Compensation

The key principles of JICA policy on involuntary resettlement, land acquisition and compensation are summarized below:

a) Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives.

b) When population displacement is unavoidable, effective measures to minimize the impact and to compensate for losses should be taken.

c) People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels.

d) Compensation must be based on the full replacement cost as much as possible.

e) Compensation and other kinds of assistance must be provided prior to displacement. For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. It is desirable that the resettlement action plan include elements laid out in the World Bank Safeguard Policy, OP 4.12.

f) In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people.

g) Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans.

h) Appropriate and accessible grievance mechanisms must be established for the affected people and their communities.

The above principles are complemented by World Bank OP 4.12, since it is stated

[4] http://www.jica.go.jp/english/our_work/social_environmental/guideline/.

in JICA Guideline that "JICA confirms that projects do not deviate significantly from the World Bank's Safeguard Policies". Additional key principles based on World Bank OP 4.12 are as follows.

i) Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advantage of such benefits.

j) Eligibility of Benefits include the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who do not have formal legal rights to land at the time of census, but have a claim to such land or assets, and the PAPs who have no recognizable legal right to the land they are occupying.

k) Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based.

l) Support should be provided for the transition period (between displacement and livelihood restoration.

m) Particular attention must be paid to the needs of vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children and ethnic minorities.

In addition to the above core principles on the JICA policy, it also emphasizes a detailed resettlement policy inclusive of all the above points; project specific resettlement plan; institutional framework for implementation; monitoring and evaluation mechanisms; time schedule for implementation; and detailed Financial Plan.

2.3 Administrative Framework for the Dhaka Metro

DMTC is the administrative body for implementation of the DMRTDP, and is constituted by an order from the Cabinet on 21 Jan 2013, with a capital of Tk 100 billion, and the Road Division of the Ministry of Road Transport and Bridges owning 98.8 per cent of shares, and balance owned equally by the Dhaka Transport Coordination Authority, the Prime Minister's Office, and finance, rail, home and local government ministries.[5] The Government's Project Development Proposal (DPP) illustrates the project management setup, which is shown in part in Figure 2-1 to show the relationship of the Environmental and Rehabilitation Section within the organization.

This figure shows the main technical units for planning and engineering, as well as an arm for finance and administration. The Environmental and Rehabilitation

[5] Financial Express 22 January 2013, Dhaka.

Section is under the Chief Engineer for Civil Works, and has four staff positions.

Initially DMTC serves as a Project Implementation Unit for the Dhaka Metro. Technical and planning units are set up to work with technical units of the general consultant in implementing the Project. The Institutional Development Consultant (IDC) will recommend an organizational structure to manage and operate the Line 6 Metro and execute future projects to extend the system.

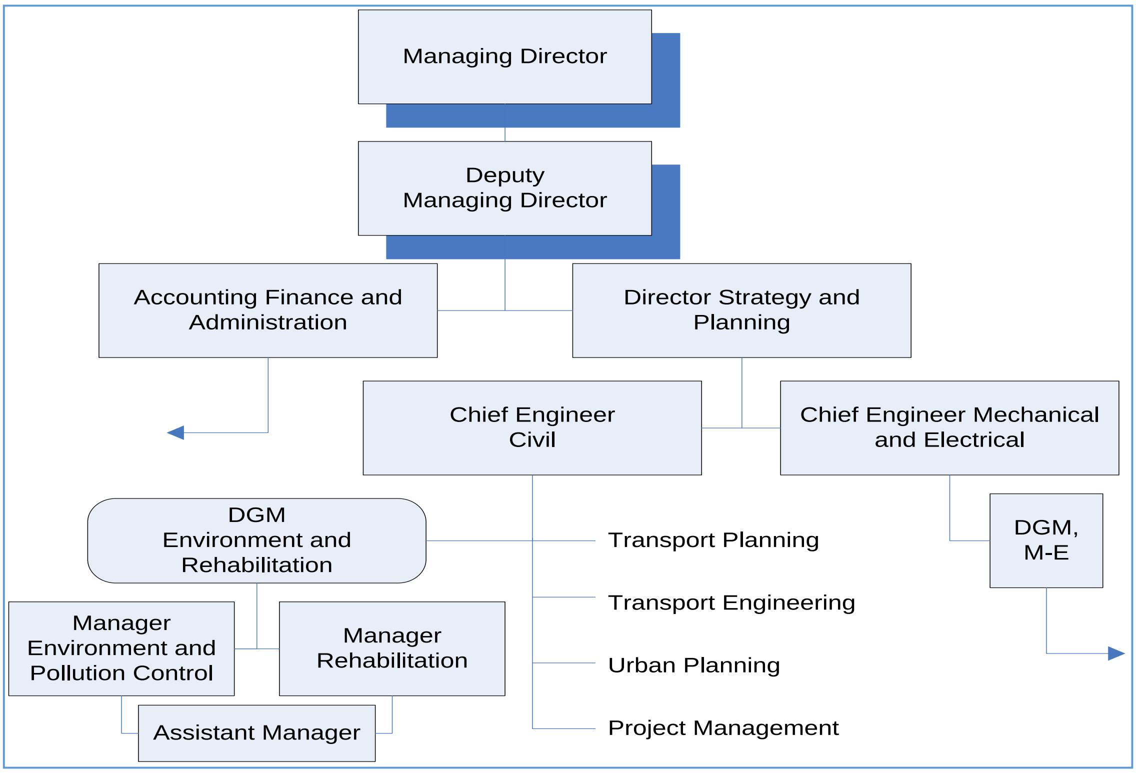

Figure 2-1: Administrative Setup for DMRTDP

CHAPTER 3 PROJECT DESCRIPTION

3.1 Transport Planning Context

Transport planning has been a priority in Dhaka for about 20 years. The 2005 Dhaka Strategic Transport Plan (STP) financed by the World Bank is an early outcome of that thinking. The recommendations stemming from that study have undergone steady progress over the last 15 years. These recommendations call for a balanced mix of transport options including improving capacity of existing roads and assuring pedestrian safety. Major infrastructure improvements were called for that include mass transit (heavy rail transit (HRT) preferred over light rail), bus rapid transit, and priority limited access roadways, mostly elevated, all of which are currently under development. JICA undertook the first phase of preparatory planning in 2009-2010, known as DHUTS 1 Study. The study recommended Line 6 for development under a phased approach, shown in Figure3-1. Phase 2 of the JICA preparatory study conducted during 2010-2011 (known as DHUTS 2 Study), which was completed in Oct 2011, carried out feasibility of Line 6.

Thus the HRT proposal for Dhaka Metro is well integrated into previous planning as well as other transport modal options. All have been facilitated by the Government's willingness to form institutional structures to make these projects happen. For instance, on the Metro, about 1,000 staff will be appointed and trained under the NKDM contract during its pre-commissioning and early operations stages. The institutional structure houses the overarching system that takes the Project through design and into sustainable operations. Interagency coordination through the Dhaka Transport Coordination Authority (DTCA) provides the means to optimize benefits and prevent spatial conflicts among elements of infrastructure.

3.2 Cost, Magnitude and Extent

The Project cost, according to the Government's Development Project Proposal (DPP), is about BDT 220 billion (USD 2.82 billion), of which approximately 75 % is financed through Japanese ODA (BDT 166 billion, USD 2.13 billion), with the Government contribution at ~25% (BDT 54 billion, USD 0.69 billion). Additional financing in the form of grants for preparatory studies and training are provided by JICA. These numbers correspond to the amounts stated in the Development Project Proposal. The footprint for the Project is as follows:

- Alignment between depot (on north end) and terminus at Motijheel: length of around 20 km. The viaduct is located within the Right of Way (ROW) of major roadways over its entire length. The width of ROW for the DMRT is undefined as such, since it is entirely within the public domain.
- Depot site: 23.85 ha.

- Stations: 16 stations along the alignment, each approximately 180 m in length; outside width of stations will vary to remain within the available public right-of-way. In general stations are 20-26 m in width.
- Electrical substations both on- and offsite
- Temporary facilities needed for construction, including casting yards, materials and equipment storage, labor camps and cordoned space.

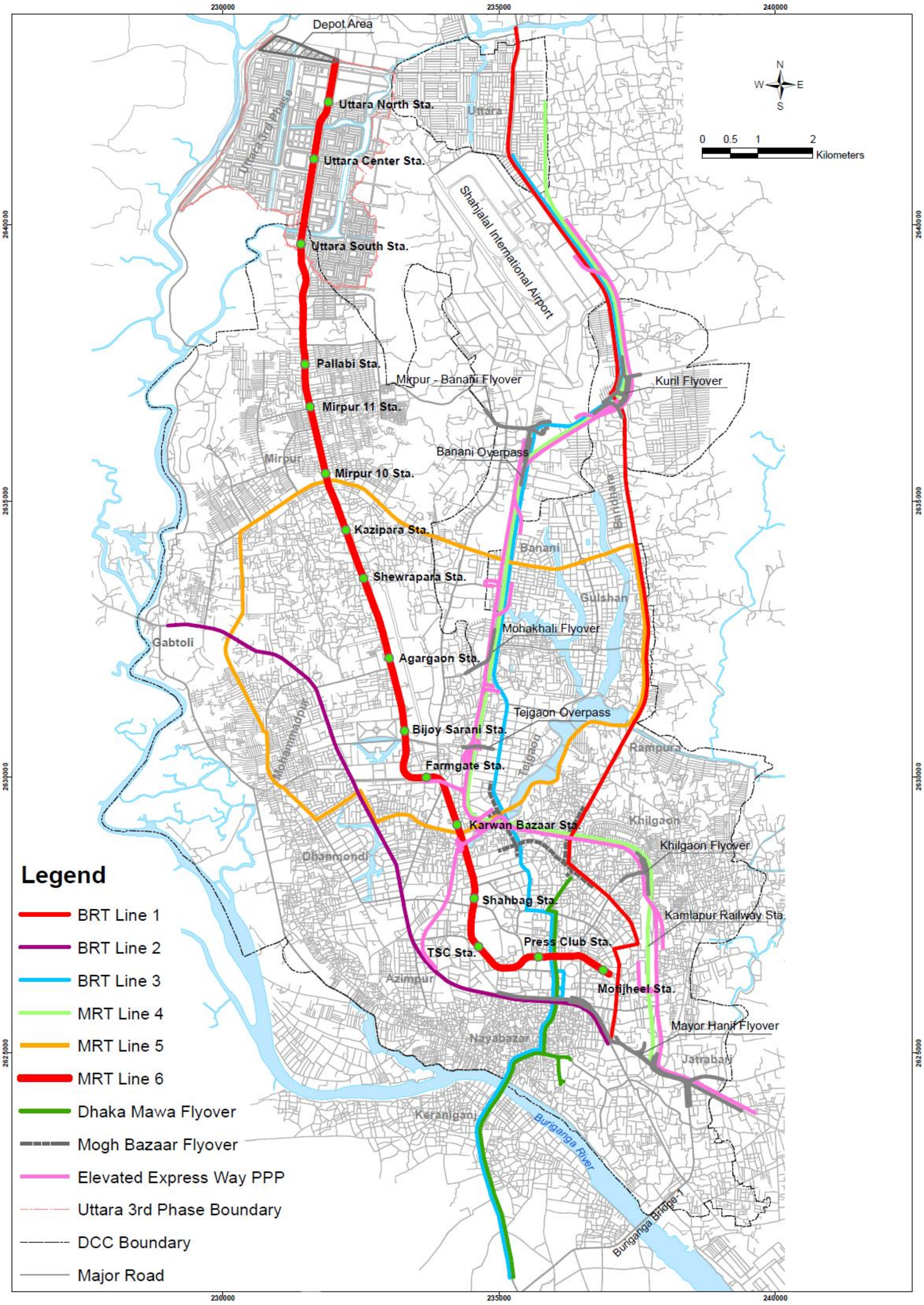

Figure 3-1: Dhaka Metro Long Term Development Plan

3.3 Main Features

3.3.1 Depot

3.3.1.1 Site Development

The depot site is located within the embankment of the Turag River in Uttara Phase III RAJUK development. The general location of the depot site with respect to the urbanized area of Dhaka is shown in Figure 3-2. This Google Earth image shows the original and new alignments (red and green, respectively) as described in Sec. 4.2.

Figure 3-2: Depot Location and Surrounding Land Use

RAJUK Phase III development has not been built, and with the exception of roads there is little built up space near the depot site, though some apartments are being constructed to the northeast and there is a commercial college located nearby.

Site development will involve clearing and grubbing, infilling of a submerged area, and overall earth fill to a grade equal to the 100 yr flood elevation plus freeboard, or approximately7.2 MASL (7.7 PWD elevation reference).Information provided in the project design describes the analysis for setting the formation level of the depot and drainage within the surrounding area, including extensive analysis of flood probabilities. Freeboard is set at 20% of storage volume at high water level, or 0.9 m. About 650,000 CM of select sand fill will be imported from Sylhet, or other areas where materials conform to the specification: material graded sand of D50>/= 0.5 mm with uniformity coefficient of at least 30. Sources and methods of transport will be determined by the contractor. Sand compaction piles (SCP) and dynamic compaction as shown in Figure 3-3 will be used to stabilize the fill. SCP will cover some 10.76 ha of area, and dynamic compaction another 14.08 ha, or 43% and 57% of the area, respectively. The site development includes installation of 2,000 m of primary open-channel drainage, 2.86 km of perimeter retaining wall and boundary wall, and a gate. The final work demarcation depends on site condition and can vary from the above mentioned numbers.

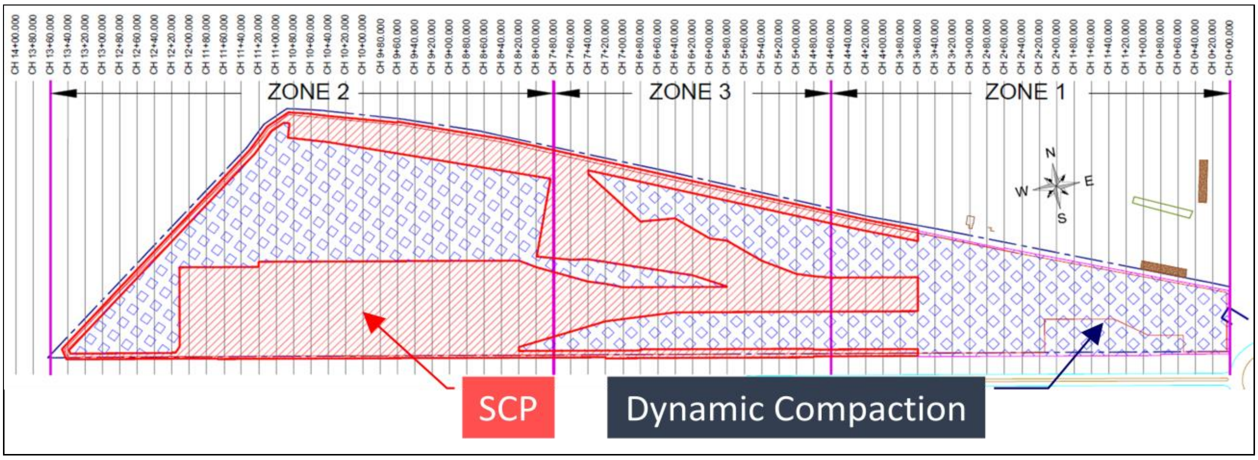

Figure 3-3: Depot Site Development Compaction Methods (tentative)

3.3.1.2 Buildings and Architecture

The Depot is the receiving and maintenance station for train sets positioned at the north end of Line 6. The Depot will consist of workshop and maintenance facilities, the Administrative Office housing the Operations Control Center (OCC), stabling shed with capacity to stable thirty-six 8-car trains, a training center and dormitory, machine shops and utility buildings, as well other enclosed space. Maintenance facilities include four 8-car train inspection lines and six lines for heavy lifting. The OCC will house the facility SCADA (supervisory control and data acquisition) system. A preliminary list of buildings and covered unit operations at the depot site is shown in Table 3-1. Area under roof will be about 122,000 sq m, of which 24% is taken up by the stabling shed. Around 60% of the land area at the depot site will be enclosed space.

Table 3-1: Depot Buildings and Covered Unit Operations

Stabling shed	**Support buildings**
Stabling shed	Crew booking and stabling shed office
Heavy cleaning shed	Canteen &medical center
Blow down plant area	Central store
Workshop	Heavy metal park
IOH/POH shed	Path way store

Workshop	Communication center and tower
Workshop maintenance office	
Inspection	**Office& training center & dormitories**
Depot transport garage & maintenance workshop & office	Administrative offices
Washing	Auditorium & parking
Auto train wash plant	Parking
Wash plant m/c & office water recycling plant	Mosque
Machining workshops	Training center
OHE car & eng. Tn & psi OHE workshop & offices	Security office & fire station
Under floor wheel lathe shed	Dormitory
Shunting loco shed	Security access control
Treatment plant & water storage	
Waste water treatment plant	**Utility buildings**
Pump house filter	Air compressor
Overhead tank	Oil & lubricant store
Electrical buildings	Industrial gas store
Substation & switch gear yard	Scrap yard
Dg set	Incinerator
Lt panel room	Coach unloading area
OHE section panels & switches	

A full description of building functions can be found in the project design. A preliminary layout of the Depot is shown in Figure 3-4.The layout configuration may change in the final stages of design.

3.3.1.3 Equipment, Tools and Vehicles

The long list of equipment includes numerous items summarized as follows:

- Machine tools and units for turning, lifting, purging and washing, including vacuum cleaners, filter cleaners, high pressure washers and ultrasonic cleaners. These latter items generate solid waste and spent chemicals that will be disposed of according to standard procedures.
- General purpose machine tools (lathe, pipe threading, grinding)

- Specialized tools for specific train repair operations and for all purpose diagnostics
- Paint booth, oven and ultrasonic cleaning plant
- Road and in-plant vehicles

Maintenance vehicles for requisition and use both within the Depot and along the track include shunting locos, road trucks, vans and a Jeep, and Overhead Electric (OHE) maintenance vehicles. Final selection of equipment purchases for the Depot and for track maintenance will be made at various milestones in the development of the Project, and the items listed herein are for descriptive purposes only.

3.3.1.4 Water Demand

The detailed design will determine the final usage and provide a point-by-point estimate of water requirements at the Depot. The preliminary estimate of daily average demand is 525 cmd (cubic meters per day), based on allocations for staffing and occupancy, expected wash water requirements and other needs, as shown in Table 3-2.

Table 3-2: Depot Daily Average Demand for Water

Usage Type	cmd
Train and parts wash water requirements (assuming reuse and make-up)	125
Domestic and sanitary use on a 24 hour basis among those living and working at the Depot	300
Daily make-up requirement of the fire water system	50
Grounds watering (assuming conjunctive use of recycled wastewater)	50
Total	525

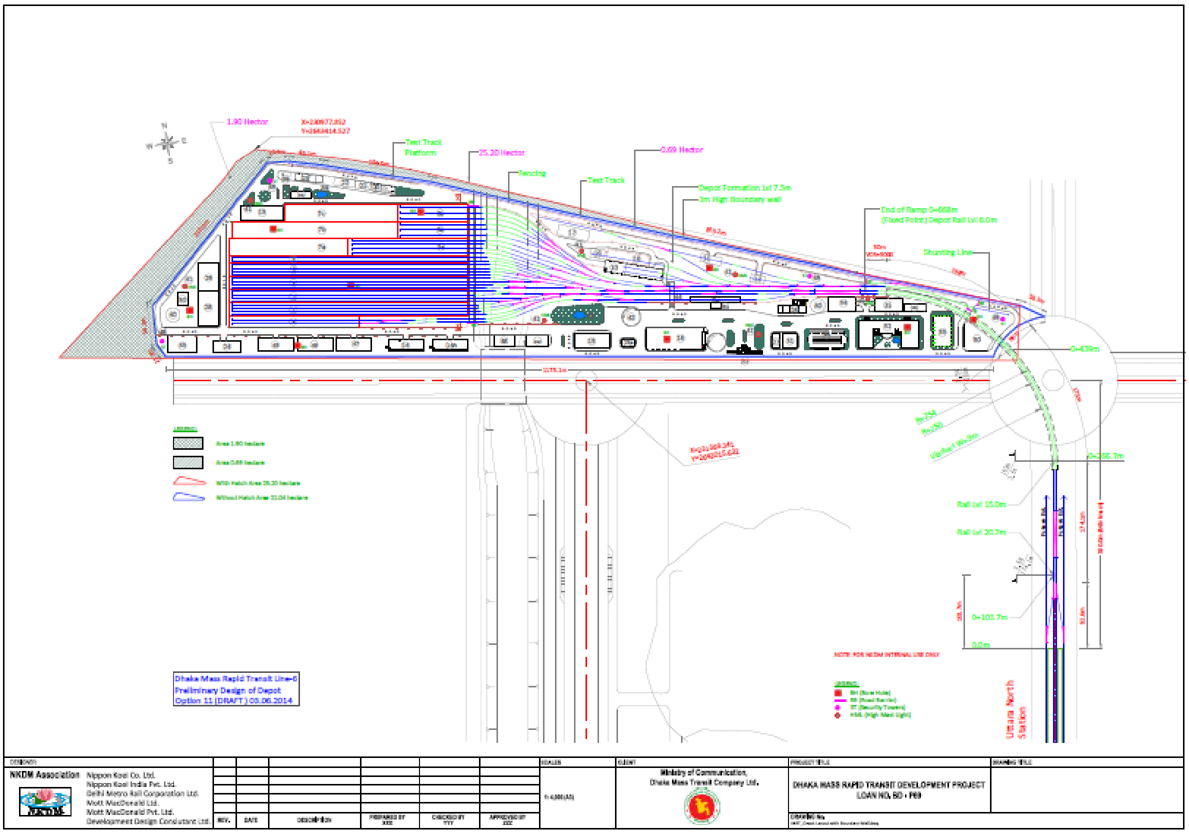

Figure 3-4: Depot Preliminary Layout Plan

3.3.1.5 Wastewater Treatment

Flow-designed traps for oil and grease (O&G) and grit removal will be installed on drain lines originating from wash stands, contaminated areas and canteens, as appropriate. Wastewater treatment will consist of dedicated units for recycling wash water, chemical precipitation of solids, and neutralization of alkaline cleaning compounds, followed by biological treatment using extended aeration activated sludge for removal of BOD and trace chemical compounds from all blowdown waters, waste originating from sanitary and food sources, and concentrated wash water.

3.3.1.6 Byproducts and Chemical Recycling

Metal powder, chips, lathe turnings and metal scrap and other forms of waste will be generated in the machine shop. Train and parts washing will produce water heavy in sediment and O&G. Dedicated treatment units for washing units will produce sludge that will be handled as a solid waste.

Machine parts cleaning utilizes chlorinated organic chemical compounds (such as trichloroethylene) that are effective in removing grease. Unit operations that use chemicals will be equipped with closed-loop recycling systems. Periodic blowdown is still required and the waste chemicals will need to be disposed of offsite at a registered facility, generally by incineration. Recycling units also produce sludge/solids that will be handled as a hazardous waste.

Dedicated storage areas will be provided for individual waste and byproduct material streams suitable for safe storage and guaranteed chain-of-custody, through allocation of physical space and design, and recordkeeping.

According to the design description, a "separate storage arrangement is provided for storing oils, paints, gases and other hazardous material in depot. Such storage is away from main store. Fire prevention/suppression arrangement, ventilation arrangements as required are provided in such storage area. The consumption level of such substances is not expected to be very high. As such to avoid cost of carrying large inventory a system of periodical replenishment from suppliers based on requirement is planned to be followed."

Also: "Suitable arrangements for temporary storage of waste and scrap materials shall be provided for meeting the requirements of Depot. This shall include but not limited to wastes from:

- Train external and internal cleaning
- Domestic waste from workshop and shed areas, offices and personnel amenities
- Cleaning of roadways and walkways
- Oil separators
- Scrap materials
- Used drums and cans
- Waste water treatment
- Steel swarfs from wheel turning shed, machine shop and wheel shop

Large open areas with partial covered shed shall be provided for temporary storage of selective wastes, such as rejected steel spares and scraps, cartons and waste paper, lightbulbs and broken glass, empty containers and drums/cans, nonferrous materials, condemned electrical and electronic spares, cables and wires etc.

The storage area shall be under the control of Store manager. Suitable road access shall be provided for removal of waste by service vehicle. The waste handling facility and waste disposal facility shall be provided in depots."

3.3.1.7 Health and Safety Aspects of Operations

A Health and Safety Plan is being developed by specialized members of the project design team, which will apply to the operation of all facilities inclusive of the depot. This plan is described later in the EIA.

3.3.2 Viaduct and Rail

3.3.2.1 Structural Aspects

The viaduct, consisting of normal span elements and bridge sections, supports the rail and the train motion. Considering whether standard or special provisions prevail, one of four types of span superstructure are proposed. Special provisions, each requiring adaptation of a standard design, include crossings of road or highway and connection to a station, and locations where multi-track arrangements are necessary. The viaduct consists of:

- Normal span length of 30 m with segmental box-girder superstructure
- Substructure consisting of independent pier and portal frame design
- Foundation consisting of a cast-in-place pile or steel pipe pile, mono pile or group pile.

Monopiles are preferred due to ease of construction. A monopile foundation utilizes a single, generally large-diameter, foundation structural element to support all the loads (weight, thrust, etc.) imposed by the superstructure and live loads. Final selection of the foundation type is determined by the civil engineering design team.

Two types of structural elements for bridge assemblages were considered:

a) A simple beam bridge and precast girder with sections consisting of pre- or post-tensioned T-section or box girder bridges; erected by crane, erection beam or stationary false work.

b) A continuous beam bridge consisting of box-girder sections erected by cantilever method.

The PC box-girder (see Figure 3-5) was preferred due to the following factors:

- Segments are cast in advance at a casting yardand pre-stressing done in situ
- Easy to construct span by span with minimal in-situ concrete construction (segments joined with epoxy)
- Better resistance to twisting (torsion), necessary on short radius curves, as well as other structural advantages

An erection gantry will be used to lift the segments into place (see Figure 3-6).

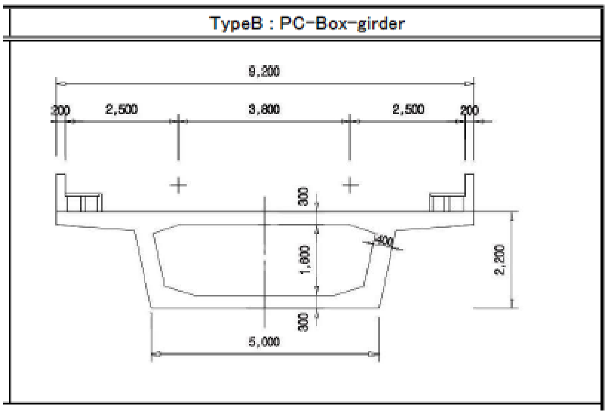

Figure 3-5: PC box-girder

Figure 3-6: Erection gantry

The typical bridge span length is 30m with the exception of road crossings that have span lengths of 70 to 80 m, accompanied by shorter transition spans ranging from 24 to 50 m preceding and following the longer span. The standard 30 m length accounts for 92 % of the spans from Uttara North (Sta. 0+00) to Motijheel. There are 10 road intersections some with traffic circles along the alignment requiring span lengths of 70 m and upwards to bridge as listed in Table 3-3.

Table 3-3: Locations for Bridge Spans Exceeding 30 m

No.	Type	Starting Chainage	30m Span	Begin Short Span	Begin Long Span	Long Span	End Long Span	End Short Span	End Chainage
1	Starting Viaduct	0 K 300 M		(in m)	(in m)	(in m)	(in m)	(in m)	
2	Bridge No 3	0 K 420 M	4		45	70	45		0 K 580 M
3	Bridge No 8	2 K 294.4M	57	25+24	50	80	50	24.2	2 K 547.6M
4	Lake Canal	2 K 977.6M	14		45	70	45		3 K 137.6M
5	DOHS Road Crossing	3 K 527.6M	13		45	70	45	25+25+40	3 K 777.6M
6	Mirpur 10 Road Xing	6 K 922.8M	105		45	70	45	27	7 K 109.8M
7	Bijoy Sarany Rd Xing	11K 838.7M	158		45	70	45		11K 998.7M
8	Khamar Bari Rd Xing	12K 445.7M	15	25	50	80	50	40+35	12K 725.7M
9	Traffic Circle MRT-5	14K 163.6M	48		45	70	45	30+30+35	14K 358.6M
10	Paltan Road Xing	17K 776.5M	114	32+32	45	70	45		18K 032.5M
11	Dainik Bangla Xing	18K 362.5M	11	28	45	70	45	35	18K 585.5M
12	Motijheel End Point		16						

3.3.2.2 Track

The track is a ballastless plinth-type track except at the depot where the at-grade track will be ballasted. Track spacing is 1435 mm (see Figure3-7), and geometric design standards adopted by the technical working group control slope of the track gradient, radii of vertical and horizontal curves and other factors developed within the industry to insure rider comfort and safety, and reduce maintenance on equipment. These are as follows:

- Maximum gradient: 35/1,000
- Vertical curve radius: 2,000 m
- Minimum horizontal curve radius: 400 m (normal case),200m (extreme case in transit viaduct), 160 m (exceptional case in depot area)

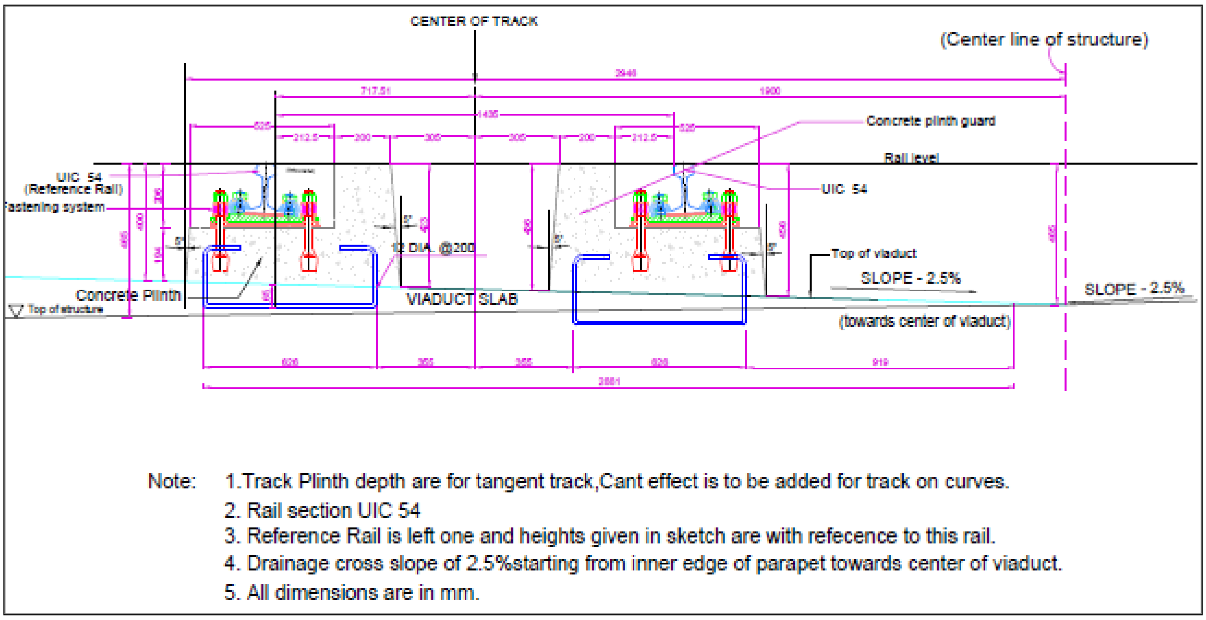

Figure 3-7: Typical Section of Rail in Ballastless Track (Tangent Section)

The track is proposed to be joint-less Long Welded Rails (LWR)/Continuously Welded Rails (CWR) in order to improve maintainability and rider comfort, and to reduce vibrations and noise levels. Ballasted track in the Depot area consists of rails fastened to Mono Bloc Prestressed Concrete (PSC) sleepers using an elastic fastening system. Sleepers rest on a compacted bed of track ballast.

Continuously Welded Rail Track is incorporated into the design. Rails consist of 60E1, R350 HT Head hardened on Main Line & 60 E1, and R260 in Depot. All rail joints are welded to provide a smooth track without fish plate joints. The joints are welded using a flash butt weld to make a Continuously Welded Rail (CWR) track that is continuous through turnouts. This type of track is sometimes referred to as the “Long Rail Method” of track placement.

Ballastless or direct fixation track will be installed along the viaduct. The rails are supported on a precast concrete plinth with derailment guards that rests on the box girder forming the viaduct. Fastening is achieved at some locations through provision of a Mass Spring System (MSS) using a proprietary elastomeric material, which is installed between the track slab and viaduct along curves where the radius is less than 300 m.

Noise and vibration mitigation measures such as CWR Track and the MSS fastening systems help ensure that prescribed limits are not exceeded. Dhaka Metro alignment passes some locations where there are sensitive receptors and noise and vibration mitigation becomes necessary.

Preventive rail grinding during maintenance will remove irregularities in the railhead and gauge face to ensure smooth running and decreased noise and vibrations.

3.3.3 Stations

Three basic designs or typologies provide the flexibility needed for structural design of the 16 stations, which are distinguished by clear platform width.Type A stations are typical. The platform is located in the center for Type I stations. Type T, the Uttara North Terminus station, will be 10 m clear platforms on either side of a center rail. Otherwise the structural design utilizes the same grid layout for all typical stations. The main station superstructure will be connected to edge columns and prop supported on the viaduct. The platform will be supported by floating columns bearing on the main transverse beam, which rests on the pier supports. Cast-in-place reinforced concrete is used for all main support members. The list of Stations by type is shown in Table 3-4. Station locations are shown in Figure 3-8.

Table 3-4: Metro Stations Designated for Line 6

No	Name	Type	Levels in MSL		Width (m)	Height (m) from PCL to			Remarks
			Rail Level	Pile Cap		Concourse	Platform	Retail Floor	
1	Uttara North	T	18.9	5.3	33.4	7.8	14.7		Two island Platform having tracks on both side
2	Uttara Center	A1	18.9	5.3	25.5	7.8	14.7		
3	Uttara South	A1	19.9	5.3	25.5	7.8	14.7		Curve Station R=600m
4	Pallabi	A1	22.9	8.6	25.5	8.5	15.4		Curve Station R=600m
5	Mirpur 11	A1	24.4	9.3	25.5	9.3	16.2		
6	Mirpur 10	A1	21.7	7.4	25.5	8.5	15.4		
7	Kazipara	A1	20.2	5.8	24.6	8.6	15.5		
8	Shewrapara	A1	20.2	6.1	24.6	8.3	15.2		
9	Agargaon	I	22.7	6.3	25.1	8.8	17.5		Interchange Station/Turn back/Curve Station
10	Bijoy Sarani	A1	21.4	7.5	25.5	8.1	15		Skywalk connecting to Parliament ground
11	Farmgate	H1	26.8	7.9	23.8	13.1	20	8.2	One Retail floor between grade & Concourse level
12	Karwan Bazar	H2	26.1	6.7	25.6	13.6	20.5	8.7	One Retail floor between grade & Concourse level
13	Shahbag	A1	21.9	6.8	24.6	9.3	16.2		
14	TSC	A3	21.5	7.5	23	8.2	15.1		Skywalk connecting to Dhaka University
15	Press Club	A2	20.7	6.3	23.8	8.6	15.5		Curve Station R=800m
16	Motijheel	A1	19.4	5.4	24.6	8.2	15.1		

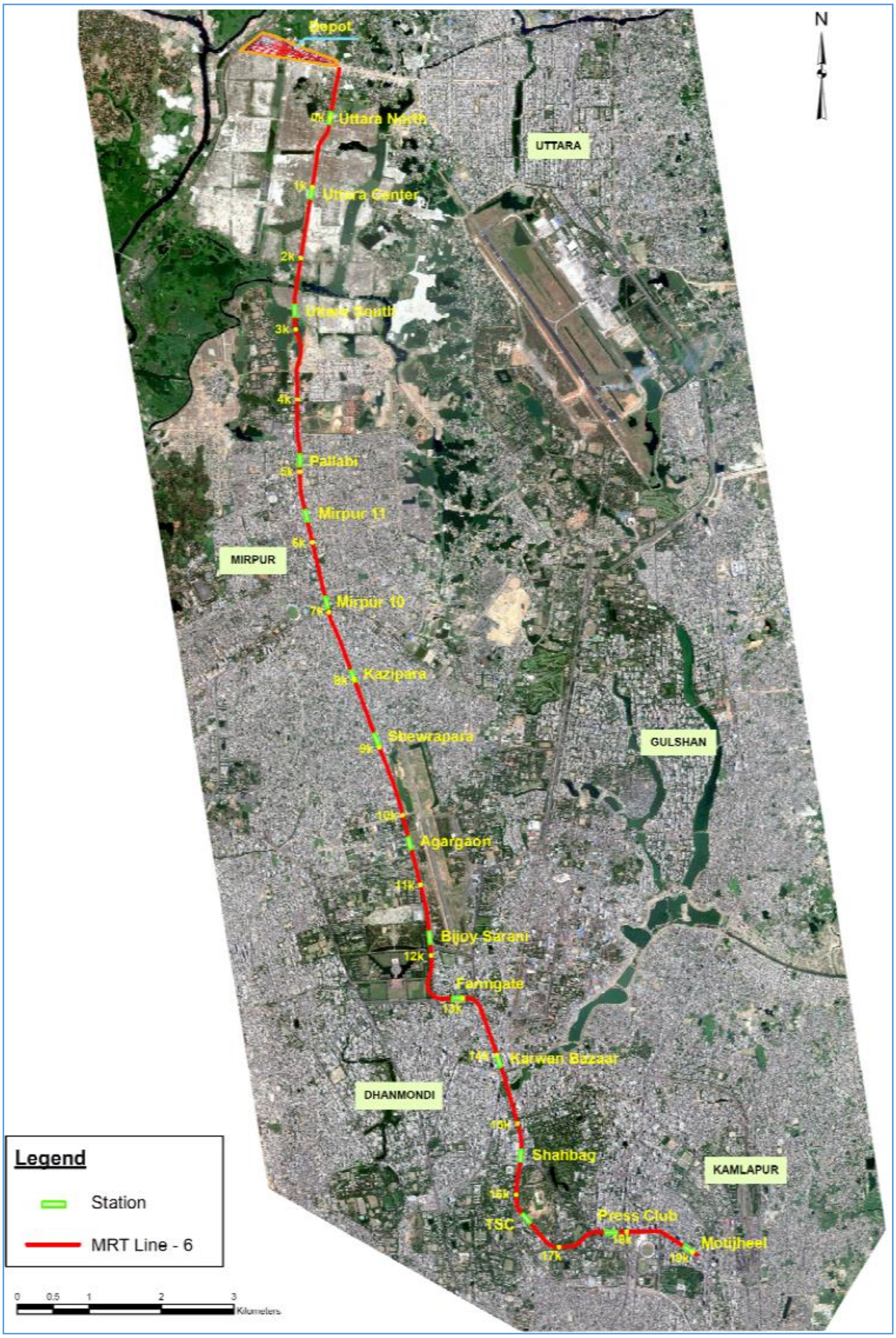

Figure 3-8: Locations of Stations within Surrounding Land Use

Different architectural envelopes have been explored for the station superstructure, including arched, framed, lattice, hybrid and sculptural shapes. Station envelopes have been designed and selected to be affordable, adjustable, responsive, modular, respectful of surrounding land uses, and recognizable. The various designs were weighed against these and additional criteria such as ease of construction, erection phasing, passive environmental controls, and maintenance. Façade materials were taken into account in the process of selection. A preliminary design for station superstructure is shown in Figure 3-9; the appearance of the station interior is shown in Figure 3-10.

Figure 3-9: Architectural Rendering of Dhaka Metro Station

Figure 3-10: Appearance of Station Interior

Design was made in a way that all entry/exit from the stations can be placed on the existing footpath without the need of any land acquisition. A typical render of entry/exit facilities is shown in Fig 3-11.

Figure 3-11: Appearance of Station Entry/ exit Facilities

3.3.4 Rolling Stock

A six-car train will be manufactured to meet the initial traffic forecast demand for Line 6 of the Dhaka Mass Rapid Transit System. This train will be easily expanded to an eight car train when the traffic demand calls for the additional capacity.

The six-car configuration will have a trailer car with driving cab, designated Tc, on each end of the train. Four motor cars, designated M, will be positioned between the Tc cars. The M cars will be outfitted with the latest proven energy saving technology, including variable voltage variable frequency (VVVF) inverters that use solid-state transistors to drive the alternating current (AC) traction motors. This combination is much more energy efficient than the direct current (DC) drives that they replace. As an added benefit, the combination of the VVVF inverter and AC traction motor generates power during braking, putting energy back into the system while braking the train. This is termed regenerative braking. The traditional friction braking systems waste the braking energy as heat, which cannot be recovered. The use of the regenerative brake system will further reduce carbon emissions for the transit system.

All six cars will be provided with a pneumatic, or air, secondary suspension system that replaces the coil spring suspension used in older designs. The air suspension is quieter and more vibration free than the coil spring suspensions, and it provides for automatic leveling of the car with changes in passenger load, a safety feature.

The solid-state technology used for the VVVF inverters and the air suspension also serve to reduce the noise generated by the train, when compared with older generation trains.

Use of the most recent proven technology for the trains will provide a high comfort level for passengers, a quieter wayside environment, and a reduction in overall energy requirements for the system. Train body and system specifications are shown in Table 3-5.

Table 3-5: Rolling Stock Specifications

Item	Description	Value
Car Body Dimensions (approximate)	Body Length (over body end to end of M Car)	19,500mm
	Body Width	2,950mm
	Vehicle Gauge - Width	3,000mm
	Roof Height	3,650mm
	Floor Height	1,150mm
	Gap between Platform Edge & Car Entrance Floor, Maximum	70mm
Seating Arrangement	Longitudinal	-
Wheel chair position	One wheel chair position on Tc Car	-
Passenger Doors	Bi-parting pocket type sliding doors	-
	Drive System - Pneumatic single cylinder or Electric motor driven	-
	Number of Passenger Doors per Car Side	4
	Width of Passenger Door	1,300mm
	Height of Passenger Door	1,850mm
	Door Spacing between 4 Doors of a Car	4,820mm
	Door Spacing between End Door Center to the Next Car Door Center	5,540mm
Driving Cab Doors	Tc Car - Each side of Driving Cab	-
Dropping of Window – Opening	-	400mm

Item	Description	Value
Materials of Car Body Structure	Stainless Steel or Aluminum Alloy	-
Body Structure	Design Load at Coupler	490kN
Accuracy of Stopping at Stationwith ATO, ATP & PSD.	-	<350mm
Bogie	Bolsterless Type with Air Spring Secondary Suspension	-
	New Wheel Diameter	860mm
	Fully Worn Wheel Diameter	780mm
	Bogie Wheel Base	2,100mm
	Distance between Bogies, CL to CL	13,800mm
Brakes	M Car – Tread Brake & Regenerative Brake	-
	Tc& T Car – Tread Brake and/or Disc Brake, and Parking Brake	
Formation	Beginning (6-car): Tc - M - M - M - M - Tc	-
	Future (8-car) : Tc - M - M - T- T- M - M – Tc	
Axle Load, Maximum	-	15.2 Tons
Passenger Capacity	Tc Car - Seated (AW1)	45 Pax
(Pax = passengers)	Tc Car – Standing	108 Pax
	M Car – Seated (AW1)	54 Pax
	M Car - Standing	111 Pax
	6-Car Train, Seated & Standing, with Normal Capacity of 3.3 Passengers per m2 (AW2)	966 Pax
	6-Car Train, Seated & Standing, with 180 % congestion of 7 Passengers per m2 (Target Passenger Number, TPN)	1738 Pax
	6-Car Train, Crush Load Design with 239 % congestion of 10 Passengers per m2 (AW3)	2308 Pax
Tare Weight Plan (AW0)	Tc Car	28.5 Tons
(Approximate)	M Car	36 Tons
	T Car	27.3 Tons

Item	Description	Value
6 Car Train Weight Plan (Approximate)	Total Weight (AW3)	339.48 Tons
Train Performance	Acceleration	0.92 m/s2
	Deceleration (Service Brake)	0.97 m/s2
	Deceleration (Emergency Brake)	>1.25 m/s
	Design Speed	110 km/h
	Operating Speed	100 km/h
Catenary Voltage (VDC)	Rated	1,500 V
	Range	900 – 1,800 V
Pantograph	Single Arm raised by Spring and lowered by Air	-
	Rated Current (Approximate)	1,500 A
Power Requirements	Peak per Train (Approximate)	6.0 MW
	Average per Train (Approximate)	4.2 MW
Maximum Current	-	4000 Amp
Traction Motor	3-Phase Induction Motor 140 – 200 KW (Estimated)	-
	Maximum Rated Voltage	1,100 V
	Battery Charging Circuit	110 VDC
Lighting	Level in Saloon	>200 Lux
	Level in Driving Cab	>100 Lux
Air Conditioning	Self-Contained Package Type	-
	Saloon Interior Temperature	24˚C
	Saloon Interior Relative Humidity	60%
Ventilation	Fan Capacity	13m3 /min
Air Compressor	Three phase 380 VAC motor driven unit	-
	Capacity (estimated)	2,000 liters/min
Train Information System	On Board Information for the Train Driver and On-Board diagnostics for Maintenance	-

3.3.5 Electro-mechanical Systems

Power supply and telecommunication are integrated systems, the components for which can be found throughout all main facility locations, and are properly organized under the heading of electro-mechanical systems. These systems interface with physical elements and their operation, and are generally divided into the components described in this section.

3.3.5.1 Electrification (Power Supply)

A receiving substation (RSS) will be installed at Motijheel, to provide traction power utilizing the extra high voltage (EHV) supplies available through the Power Supply Authority (PSA) network. Gas Insulated Switchgear (GIS) at the RSS will convey 132 kV incoming power to 132/33kV auxiliary main transformers (AMT) located at the RSS. The power passes 33kV indoor-type switchgear at Auxiliary Main Substations (AMS) installed at each RSS. The AMS will feed the 33 kV supply to designated Auxiliary Substations (ASS), the Auxiliary + Traction substations (ASS+TSS) and local transformers. The traction substations located along the alignment will transform the 33kV supply to 1500 V DC for the Traction Overhead Catenary (TOC) System. The auxiliary substations transform the 33kV supply to 415V for use by auxiliary services including the SCADA. All remote controlled switchgear for the entire power supply system will be equipped with local/remote switches to enable operation and control from both locations.

The AMS receiving substations are indoor 132kV GIS-type, and will be located at Uttara North inside the depot boundary and at Motijheel. The substations are designed with two incoming supply cables that pass through dual transformer bays by means of a double bus bar arrangement. Items of equipment will be equipped with measurement and protection devices.

The RSS substation consists of a building with boundary wall, approach road, cable trenches, foundations, supports, drainage and other civil works. The property requirement is ~ 2,000 sq m.A second RSS substation will be installed at the depot.

Power will be provided at the Depot through a 132/33 kV transformer located at the depot site. Power supply will be brought in through the Dhaka Electric Supply Company (DESCO) grid.

3.3.5.2 Signaling and Telecommunications

The following sections cover the electronic and computerized systems that control movement of the trains and passenger access.

<u>Communications-Based Train Control</u>

A communications-based train control (CBTC) system will serve as the primary system for controlling train movements and ensuring the safety of passengers. The physical components of the CBTC consist of onboard control equipment, computer and antenna; wayside and station-side radio transponders; and station-based computers. The operating system capacity will provide for 45 train sets, using the 2051 demand forecast and margin allowance, which includes a headway (time allowance between passage of trains) of 2 min: 15 sec, which is consistent with the 2051 forecast operations scenario. Given that the design train length is eight cars or 160 m, the required interval of communication between train and wayside station will be less than or equal to 0.5 sec. The system incorporates SIL4[6] rated systems as a measure of risk reduction.

The CBTC system will incorporate ATP and ATO functions in conjunction with any necessary interface with other systems for a full-fledged ATC system. Automatic Train Control, or ATC, is an integrated signaling system that guarantees the secure movement of trains. ATC integrates various subsystems positioned on-board and wayside. In addition to a full interlocking system, a complete ATC system consists of three subsystems: (i) ATP, (ii) ATO and (iii) ATS, the latter being a systems envelope for the former two sub-systems. Automatic Train Operation, or ATO, is an ATC subsystem which performs on-board, non-vital functions normally performed by a train driver, including ensuring a smooth acceleration of the train to the running speed, speed regulation and smoothly stopping the train at the proper position at station platforms or in front of stopping signals. ATO subsystems are primarily located on-board and represent one of the principal components of a driverless system. Additionally, ATO subsystems report vehicle health status to the central control offices. Automatic Train Protection, or ATP, is an ATC subsystem responsible for the safe operation of a signaling system. It imposes speed limits on trains, both to maintain a safe operating distance between them and to comply with safety and speed requirements. The ATP system is designed to be a fail-safe (vital) system. The trains operate in a driverless mode though a driver/conductor is present to monitor functioning of the ATO system.

The ATP functions on the Dhaka Metro to ensure safe separation distance between trains, determine and delimit the maximum permitted speed, and to authorize the movement of the train in real time. The ATP supervises the train movement and overall routing pattern under both normal and emergency situations. It protects against overrun at the station (correct stop positioning) with an accuracy of +/-350 mm of exact positioning of the platform sliding door (PSD)[7], imposes any emergent temporary speed restrictions and enforces track closure and possession[8] in the event necessary. Speed restrictions come into play from

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[6]Safety Integrity Level (SIL) is defined as a relative level of risk-reduction provided by a safety function, or to specify a target level of risk reduction. In simple terms, SIL is a measurement of performance required for a Safety Instrumented Function (SIF), with SIL 4 being the most dependable and SIL 1 being the least.

[7] PSD opening is coincident with train door opening and controlled by the CBTC.

[89] Possession is the term used by railway maintenance contractors (or network rail) to indicate that they have taken possession of the track (usually a [signal] block of track) for maintenance or repair purposes, and no trains are running, or a limited service is running.

environmental conditions, such as wind and rain, which reduce permitted operating speed. ATP includes an emergency stop procedure and braking equipment that is activated by the onboard computer without going through a wayside computer. It is activated through an onboard transponder that signals in the event the end of the platform is overrun by the train. Supervisory control of the ATC is exercised both onboard each train and at station locations.

<u>Supervisory Control and Data Acquisition (SCADA)</u>

The MRT will be equipped with a SCADA (supervisory control and data acquisition) system for remote centralized monitoring of railway facilities, stations and waysides. Normal facility operations or failure conditions recognized through real-time monitoring and operational stop control is implemented when an abnormality is detected. Feedback is provided for temperature and humidity measurements and SCADA is equipped with functions to support automatic data logging of measured data prioritized in the maintenance plan for the rolling stock.

3.3.5.3 Automatic Fare Collection

The purpose of the AFC system is to provide an efficient ticketing and passenger control system as a convenience to passengers; least work for the railway operator in collection of fares; verification of travel rights; least work to analyze passenger flow and card status conditions; and interface with other planned services such as bus service, park-and-ride, and e-cash. The AFC system will have equipment located at each of the 16 stations, the Administration Building and/or Operation Control Center.

The main components of the AFC system include ticket vending and office machines; the passenger gates; AVM (Add Value Machine); station and line control units; and network facilities including cable, hub and switching hub, router, bridge, and converter; as well as other necessary facilities and equipment.

3.3.5.4 Platform Screen Door (PSD)

The PSD system consists of a series of fixed panels separated by sliding doors that effectively separate the passengers waiting on the platform from the rail.ThePSD interfaces with the CBTC to open at the arrival and positioning of the train and concurrently with train car door opening. It is a safety feature that prevents access to the tracks.

Half-height type PSD system will be provided for platforms at all elevated stations to include structural frames, sliding doors, fixed screens, exit/entrance screen doors for train drivers, emergency release, detection sensors, a control/monitoring system, alarms, signs, power supply and other necessary components.

3.3.5.5 Traction Power

The traction power distribution system is through a 33 kV ring main cable network from Receiving Substations (RSS) for supply to Auxiliary Substations (ASS) and rectifier substations. These provide the 1500V DC traction power through rectifier transformers, rectifiers, high speed circuit breakers and associated switches, and are protected through grounding and negative return panels. The main line will have a minimum of seven rectifier substations, and a dedicated supply to the depot catenary is provided through a rectifier substation installed inside the RSS premises at the Depot. The final number and location of rectifier substations may change through the design period as operational requirements to meet the design life of 30 years are refined. The 1500 V DC power is distributed through the catenary for feeding power to the rolling stock.

The Traction Overhead Catenary (TOC) System operates at 1500 V DC to provide power to the rolling stock according to rated power requirements. The catenary includes devices and structural equipment for supporting the overhead contact line, feeder wire assembly and associated facilities, contact wires, catenary wire, tensioning devices, and grounding.

The design takes into account the safety risks and corrosion resulting from stray currents flowing in the rails and track connections at the depot and stations. Various means were considered to overcome safety and corrosion concerns; the selected approach prioritizes safety factors. The design calls for a stray current mitigation and monitoring system that includes grounding/bonding systems, and stray current management equipment providing stray current and EMC protection throughout the entire system (depot and viaduct) and connection at interface points along the rail and viaduct.

The viaduct is protected against stray currents by insulated shear connectors to isolate track plinth reinforcement from U-girder reinforcement. The stray current cable is connected to sacrificial bars of track plinth to prevent the stray current from flowing into the U-girder. A 95 mm2 bare conductor will be provided on the viaduct, and all metallic structures on the viaduct connected to it and to the station earth mat. Testing and Commissioning is a requirement of the installation of this equipment.

3.3.6 Temporary Construction Facilities

Seven locations have been selected for temporary construction facilities that are suitable for use under contracts (CP-3 – CP-6, see the next section). The use of these sites is almost decided and signing (full commitment) is underway. The seven identified sites are shown in Figure 3-12. Environmental aspects of these sites are evaluated in Chapter 6.

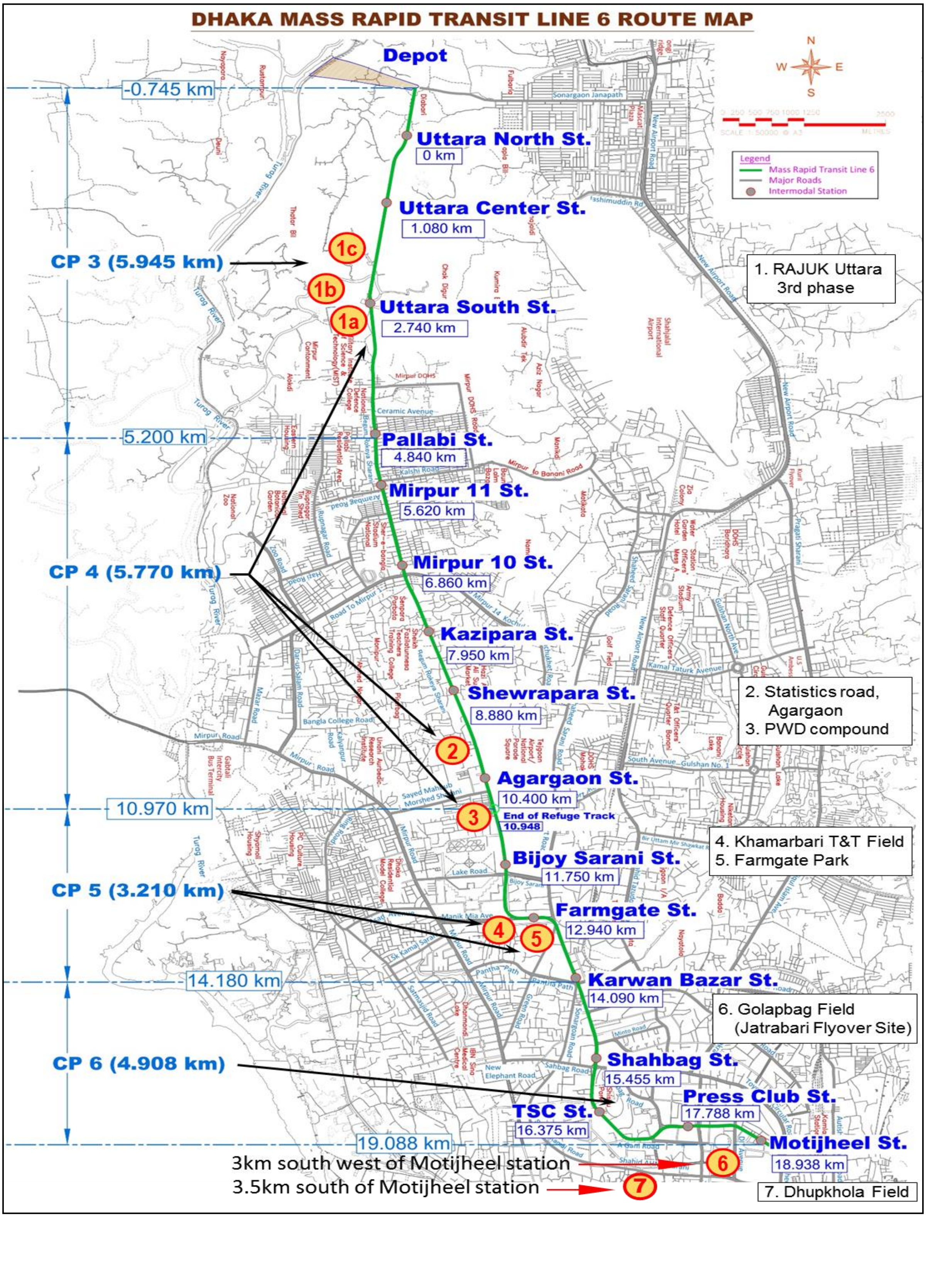


Figure 3-12: Proposed locations for Construction Yards

3.4 Implementation Schedule

3.4.1 Implementation Schedule

The construction of the Dhaka Metro is divided into eight contracts as follows:

- CP-1: Construction of Civil Works for Land Development, Retaining Wall and Boundary Wall etc. at Uttara Depot of MRT Line 6
- CP-2: Civil and Building Works in Depot
- CP-3 &4: Civil Works (Viaduct and Stations from Uttara North to Agargaon)
- CP-5 & 6: Civil Works (Viaduct and Stations from Bijoy Sarani to Motijheel) CP- 5 & 6 is expected to be complete a year later than CP-3 &4).
- CP-7: Electrical-Mechanical (E-M) System and RSS Substations
- CP-8: Rolling Stock & Depot Equipment for Maintenance and Repair of Rolling Stock

CP1 through 6 are design – bid – build contracts (NKDM provides the design), with the bidder qualified to bid any one or more contracts simultaneously. CP-7 and 8 rolling stock and systems are bid - design - build contracts (bidder responsible for the design). The current target schedule of the works (as of Nov 2015) for early commissioning by 2019 is shown in Figure 3-13.

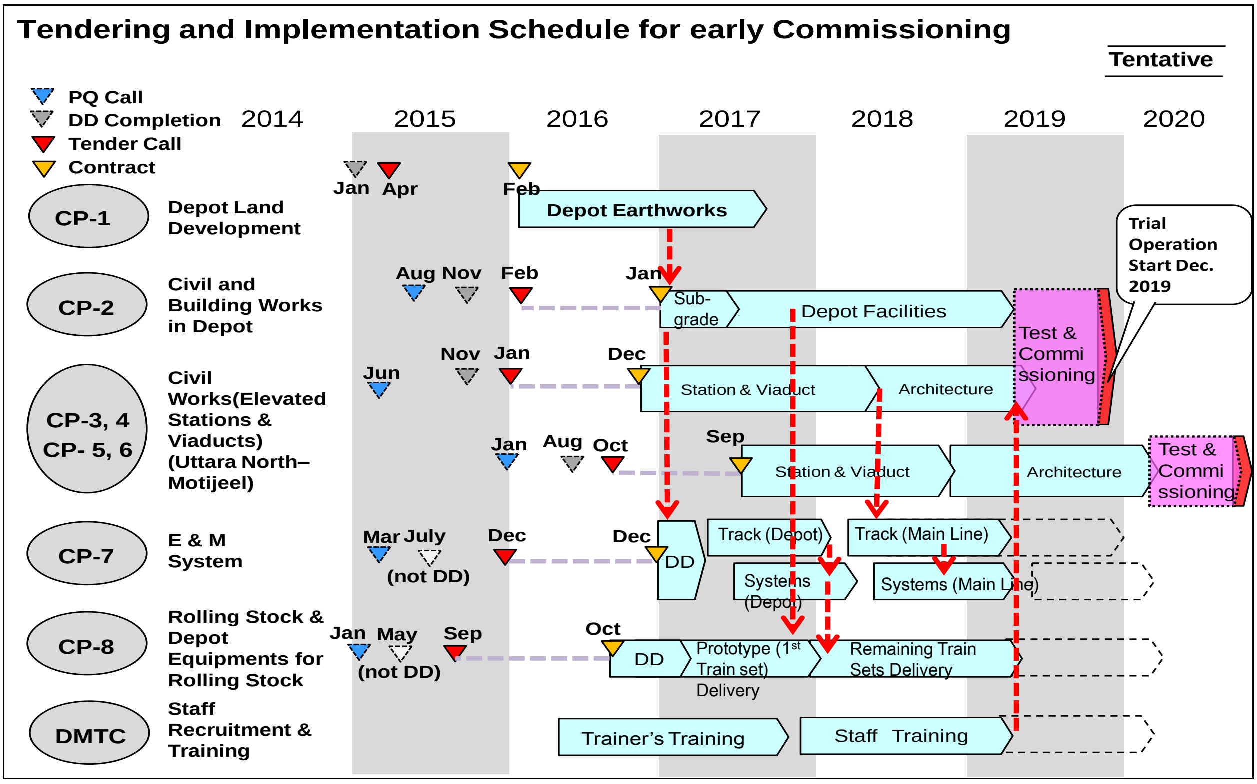


Figure 3-13: CP-1 - CP-8 Tendering and Implementation Schedule for Early Commissioning

3.5 Summary of Resettlement Action Plan

The information presented in this section is based on a preliminary reading of the contents of the resettlement action plan (RAP) and related documents, and more accurate information will be obtained once final versions of these reports are available.

A detailed right-of-way survey was used to determine land acquisition requirements, in preface to preparation of the RAP. There is no land acquisition planned for the Project. The lands to be used for the project are government land; through judicious arrangement of exits and entries to the station platforms so that no private land is required. There may be small and medium business enterprises and road-side vendors that will be temporarily displaced due to project interventions. Most of the identified business enterprises are on government land as squatters or tenants.

3.5.1 Surveys

The Resettlement Assistance Consultant (RAC) collected information from the potentially affected people and conducted extensive field visits for the preparation of RAP on the final alignment of the MRT Line-6. During the surveys, emphasis was mostly given on the affected properties especially buildings and other structures being used for residential and/or commercial purposes.

a) Inventory of affected assets: The inventory of affected assets includes information on the size and type of structures affected, tenure status, ownership of land and structures, place of work, and potential loss of incomes and livelihoods.

b) Property valuation survey: A property valuation survey was conducted through a structured questionnaire to determine the replacement value of the affected land, structures and other assets. Different types of people were interviewed to know the price of affected lands and structures.

c) Video-documentation: A video recording of all the structures within the project sites and the project affected area was conducted during the survey to document all affected structures, type of construction, and land use to be used as evidence for any fraudulent claims that may be made by households at a later stage in project preparation. Video filming has been edited and converted into DVD.

3.5.2 Cut-off Date

The census and inventory of losses survey (date of commencement) established the cut-off date for entitlement of compensation for the affected person on government land: squatters, owners, tenants, vendors and others.

3.5.3 Land Acquisition Procedure

The RAP details the land acquisition procedure. However, there is no land acquisition planned for the Project.

3.5.4 Land Acquisition Amounts and Project-Affected Persons

There is no involuntary resettlement of households due to the project and land acquisition has been kept eliminated through rearrangement of the project footprint, so that there is no involuntary land acquisition required under the Project. The depot site is acquired through voluntary purchase (from RAJUK). All of the viaduct falls within the public right-of-way of roads owned by DCC, with the exception of a few locations where the curvature of the track requires passing through the airspace of government owned land outside the roadway, though piers are positioned to remain within the roadway area. Stations likewise fall within the street right-of-way, and in a few instances have been redesigned and relocated to be maintained in public space. Access stairways and lifts to stations have likewise been kept within the public right-of-way, and access points have been redesigned at locations where additional space is required to accommodate access to the stations and clear pathways at ground-level.

3.5.5 Provisions for Land Acquisition, Resettlement and Compensation

Provisions for land acquisition and compensation are described in the RAP.

3.5.6 RAP Implementation and Monitoring

The RAP sets out procedures for compensating for loss of income, and for redress.

CHAPTER 4 DESCRIPTION OF ALTERNATIVES

4.1 No Build Alternative

Detailed design and preparation of construction bid packages are underway on the basis that the no-build alternative was decided against at an earlier stage of project development. The Project evolved through a series of planning decisions that recommended the sequence of work leading up to the present effort. The 2009-10 Dhaka Urban Transport Network Development Survey (DHUTS 1) recommended development of a heavy rail mass transit system in Dhaka. The DHUTS 1 Study completed in March 2010 recommended short-term, medium-term and long-term projects for implementation. Included in the first phase of DHUTS implementation to be started by 2015 was MRT Line 6. GOB, JICA and other relevant agencies signed Minutes of Discussions (MOD) in 2010 on proceeding with a Phase 2 Feasibility Survey (DHUTS 2) including a project implementation plan addressing technical, economic, environmental and social aspects. The DHUTS 2 Study compared traffic conditions on selected roadways for the no build alternative and concluded that “travel speed [under the no-build alternative] will decrease to 2.8km/hr in 2025, while it is expected that the travel speed will improve to 7.6km/hr when the Project is carried out.”

Extensive deliberation and decision criteria has gone into selection of alternative locations, designs and operational aspects for the Dhaka Metro Line 6. The following sections describe aspects of this process.

4.2 Depot Location

The location of the depot is the result of a lengthy selection process in which two alternatives (north and south end of the line) were considered and the final selection hinged primarily on social and environmental factors. The southern location at Shishu Park was in many respects similar, though the land area is smaller. However it involved forsaking recreational benefits available at the park and removing the trees. Public resistance to use of the site, though it never emerged, likely would have been strong. Table 4-1 shows the alternative rankings according to main decision factors.

Table 4-1: Alternatives for Depot Location

Item	Alternative A (Uttara Area)	Alternative B (Shishu Park)
Location	Far from Pallabi Station to the northern east approx. 1.0 km.	Far from Shahbag Station to the southern east approx. 1.5 km.
Current Land Use	Waste land	City park
Land Owner	RAJUK, MOD, NHA, BWDB	Dhaka City Corporation (DCC)
Available Area	More than 20 ha	Less than 20 ha

Item	Alternative A (Uttara Area)	Alternative B (Shishu Park)
Land Acquisition	Not necessary	Not Necessary
Socio-environmental Effects	Limited effects because there are no trees and no residents.	High effects due to cutting down of many trees and reducing the recreation area.
Future Expansion	Easy to expand in the future.	Very difficult because of the limited available land.
Evaluation	o (Recommended)	× (Not Recommended)

4.3 Grade and Alignment Alternatives

The location and alignment for Line 6 was set during the DHUTS 2 study. An above grade structure was proposed for the alignment south of Pallabi. Later the decision was made to use an above grade structure for the Uttara section as well, considering the scope of urban development anticipated for the area. A number of alignment alternatives were considered during the DHUTS 2 Study that were described in the Preparatory EIA. These included:

- Alternative routes from Chandrima Uddan to Farmgate
- Alternative routes from Hotel Ruposhi Bangla to Bangladesh Bank
- A new route proposed by the GOB

Following the DHUTS 2 Study, GOB took into consideration the advice of consultants and decided on preferred alignments over the intervening time until the start of detailed design. Small adjustments in alignment and station locations have been made up to the present. However, GOB made a major decision regarding the route between Chandrima Uddan to Farmgate. The route was initially proposed to follow Bijoy Sharony road by the side of Tejgaon Airport, which was presented in the 2011 EIA. GOB later decided to change the route to follow the Khamarbari road, which was subsequently included in the DPP. A letter issued in this regard from the Ministry of Communication to DTCA on 31/01/2012 can be found in Project's approved DPP document. (Appendix R: Approval of Route Alignment, Development Project Proposal (DPP) of Dhaka Mass Rapid Transit Development Project, Ministry of Communication, Nov, 2012). The DPP has later been approved by the Governemnt on 18 December 2012. The alignment passing the Farmgate area was settled by providing easement on the Parliament grounds that allows a curve onto the Khamarbari Rd right-of-way. The Farmgate Station was relocated to Khamarbari Rd in order to avoid the congestion on Airport Rd at Farmgate. The final alignment is shown in Figure 4-1.

Some adjustments have been made under the DMRTDP. The most significant alignment change occurring during detailed design of ~ 5.6 km of track north of Pallabi, as well as the line's point of entry onto depot property. The alignment change is reflected in Figure 4-2, and Figure 4-3 illustrates the comparative advantages for entry of the track into the depot area, including better access for trains (no switchback) and easy extension of the line north to Gazipur. Small adjustments were made in the locations for Press Club and Motijheel Stations to better facilitate human movements. Other adjustments were made based on engineering considerations. Minor corrections in alignment were done to facilitate changes in road alignment in Uttara Phase III. Pier locations were adjusted to reduce vibration at critical structures

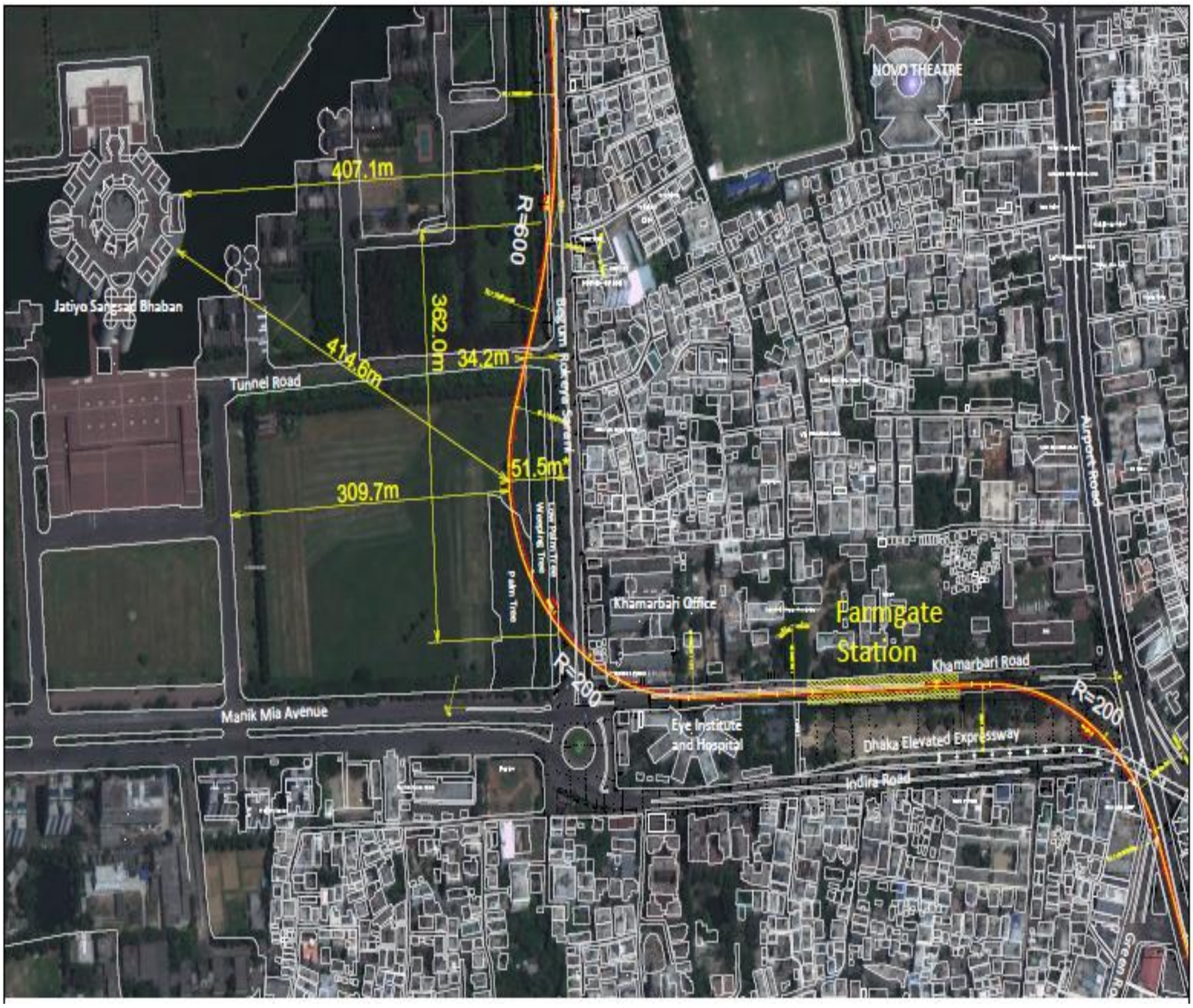


Figure 4-1: Alignment and Location of Farmgate Station

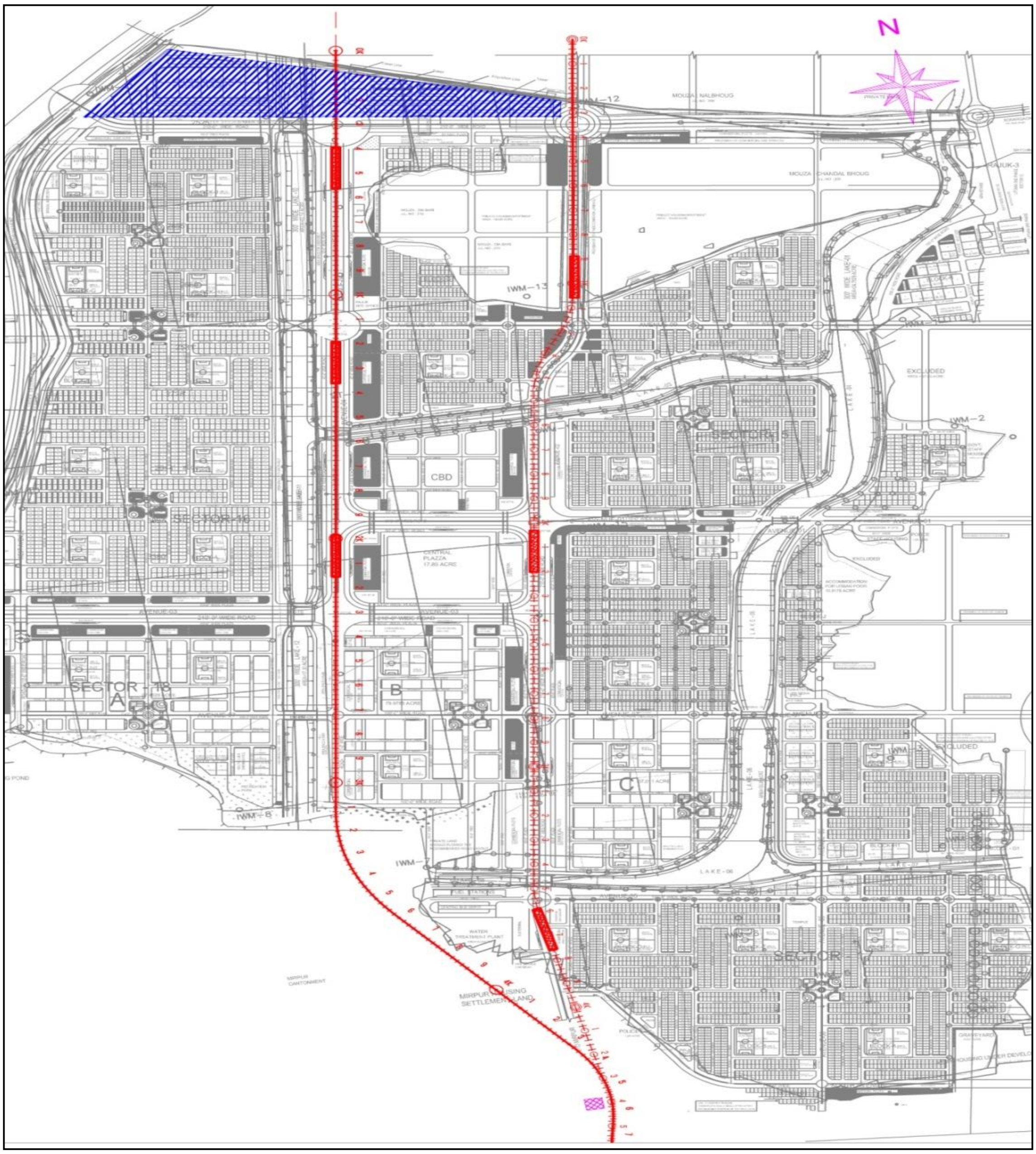


Figure 4-2: Alignment Change between Depot and Pallabi Station

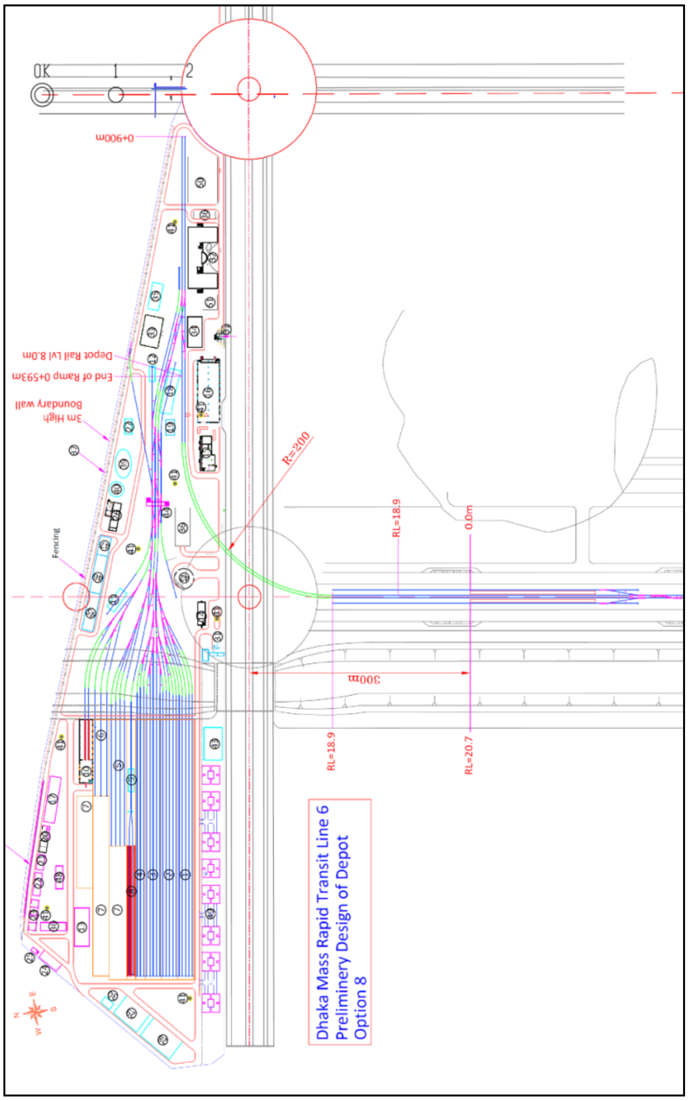
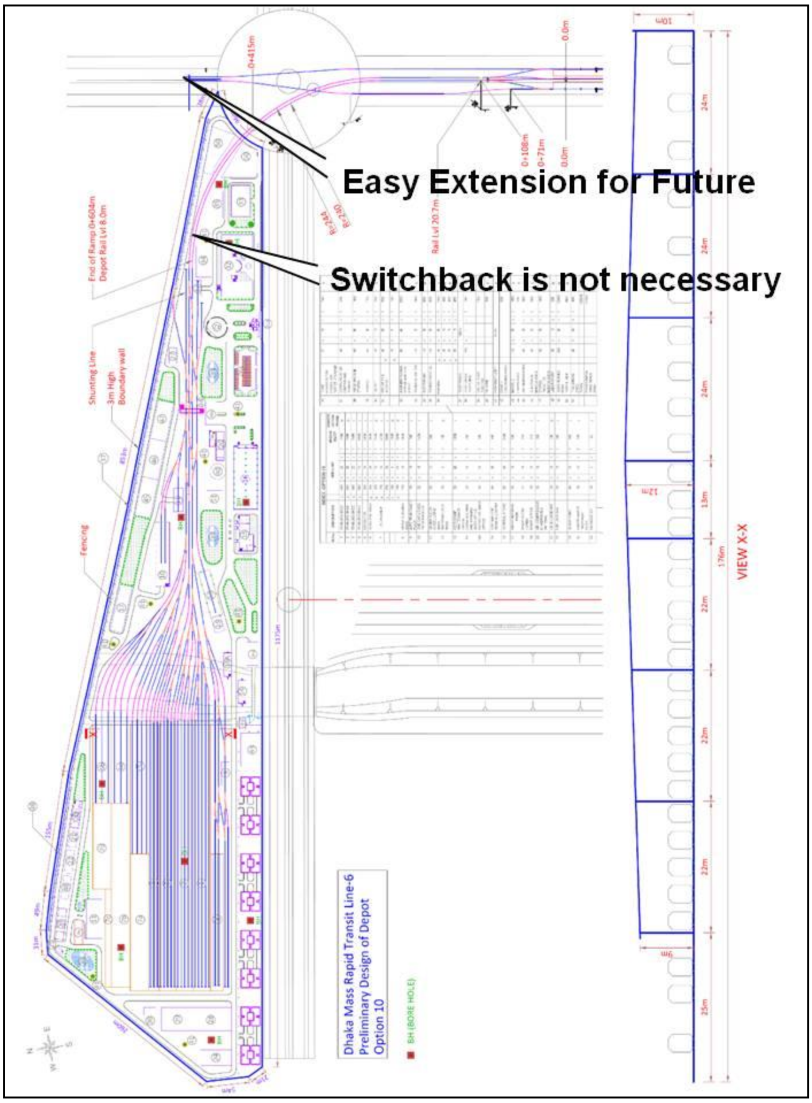
Original Arrangement	Recommended Arrangement
	

Figure 4-3: Depot Entry Alternatives

4.4 Machinery and Equipment Alternatives

Alternatives were selected during the design process in light of environmental protection, health and safety, and energy conservation. Selection of preferred alternatives in these areas can be found in the depot equipment, in the track system, rolling stock and electro-mechanical systems.

Depot equipment in which waste minimization principles are applied include train washing systems, machine parts cleaning, and metals recycling. Wastewater treatment will consist of dedicated units for recycling wash water; metal powder, chips, lathe turnings and metal scrap generated in the machine shop will be recycled. Unit operations that use chemicals will be equipped with closed-loop recycle systems.

The track is proposed to be joint-less Long Welded Rails (LWR)/Continuously

Welded Rails (CWR) in order to improve maintainability and rider comfort, and to reduce vibrations and noise levels. Fastening is achieved through provision of a Mass Spring System (MSS) using a proprietary elastomeric material, which is installed between the track slab and viaduct along curves where the radius is less than 300 m in order to reduce noise and vibration.

Rolling stock incorporate safety, energy conservation and environmental protection features. The combination of the VVVF inverter and AC traction motor generates power during braking, putting energy back into the system while braking the train. The use of the regenerative brake system reduces energy consumption hence carbon emissions for the transit system as a whole. The air suspension provides for automatic leveling of the car with changes in passenger load, a safety feature. Solid-state technology used for the VVVF inverters and the air suspension also reduce noise generated by the train, when compared with older generation trains.

In respect to electrical-mechanical systems, installation of the platform screen door (PSD) system was not required other than for safety considerations. The stray current protection of the OCC system maximizes stray current protection, and safety, in exchange for additional cost and operational efficiency. Numerous other features of the electrical-mechanical systems include built in and heightened safety features that were considered necessary in the current situation.

CHAPTER 5 DESCRIPTION OF THE ENVIRONMENT (BASELINE DATA)

This chapter provides a general overview of aspects of the existing environment that could be affected by the Project, or could affect the project's functioning.

5.1 Physical Resources

5.1.1 Geology, Soils and Groundwater

Geology and Soils

Dhaka lies in the extreme south of the Madhupur Tract, which is situated in the central-eastern part of Bangladesh. The planning area is covered mainly by the Pleistocene Madhupur Clay, a yellowish brown to the highly oxidized reddish brown silty clay; and by Holocene sediments to the south, west and east made up of alluvial silt and clay, and marshy clay and peat.

The moisture content and liquid limit results obtained for the Madhupur clay show that it is normally consolidated to slightlyover-consolidated, perhaps due to groundwater pumping. The clay has intermediate to high plasticity, and is overlain by the Dupi Tila formation of medium to coarse sand.The incised channels and depressions within the city are floored by recent alluvial flood plain deposits. Geomorphic units identified by Kamal and Midorikawa (2006) for surface features are given in Table 5-1.

Table 5-1: Geomorphic Units identified for the Dhaka Terrace[9]

Higher Pleistocene Terrace (HPT)	Moderately Higher Pleistocene Terrace (MHPT)
Moderately Erosional Pleistocene Terrace (MEPT)	Highly Erosional Pleistocene Terrace (HEPT)
Erosional Terrace Edge (ETE)	Old Natural Levee (ONL)
Younger Natural Levee (YNL)	Old Inactive Floodplain (OIF)
Point Bar (PB)	Younger Floodplain (YF)
Deep Marshy land (DML)	Shallow Marshy Land (SML)
Deep Alluvial Valley (DAV)	Moderately Deep Alluvial Valley (MDAV)
Shallow Alluvial Valley (SAV)	Inundated Abundant Channel (IAC)
Abundant River Bed (ARB)	River System (RS)

[9] The Dhaka Terrace is found along the southern edge of the Madhupur Tract. The area is includes Mirpur, Kurmitola (old Dhaka Airport), Dhaka and Demra, between the Buriganga on the west and the Sitalakhya on the east.

Lithology in the area of the project can be inferred from the logs shown in Figure 5-1. In general a surface clay layer is found throughout, underlain by layered medium to very fine sands.

Earthquake Risk

Faults and lineaments that have occurred due to tectonic movements appear along the edge of the Dhaka terrace on the east, trending south-west and along the Tongi Khal in Tongi-Uttara-Uttar Khanarea, trending east-west.

Dhaka city falls in seismic zone II of the seismic zoning map of Bangladesh. It is classified as being on the upper end of the scale for moderate risk. Significant damaging historical earthquakes have occurred in and around Bangladesh, and damaging moderate-magnitude earthquake occur every few years. The country's position adjacent to the very active Himalayan subduction plate in the north, moving east, and the westward movement of the Burma deformation produce the potential for earthquakes. A history of earthquake activity in Bangladesh, focusing on probable effects for Dhaka, can be found in Akhter (undated).Apparently the risk of a large magnitude quake is fairly great. Vulnerability to damage and to loss of life is increased due to the lack of an effective earthquake building code.

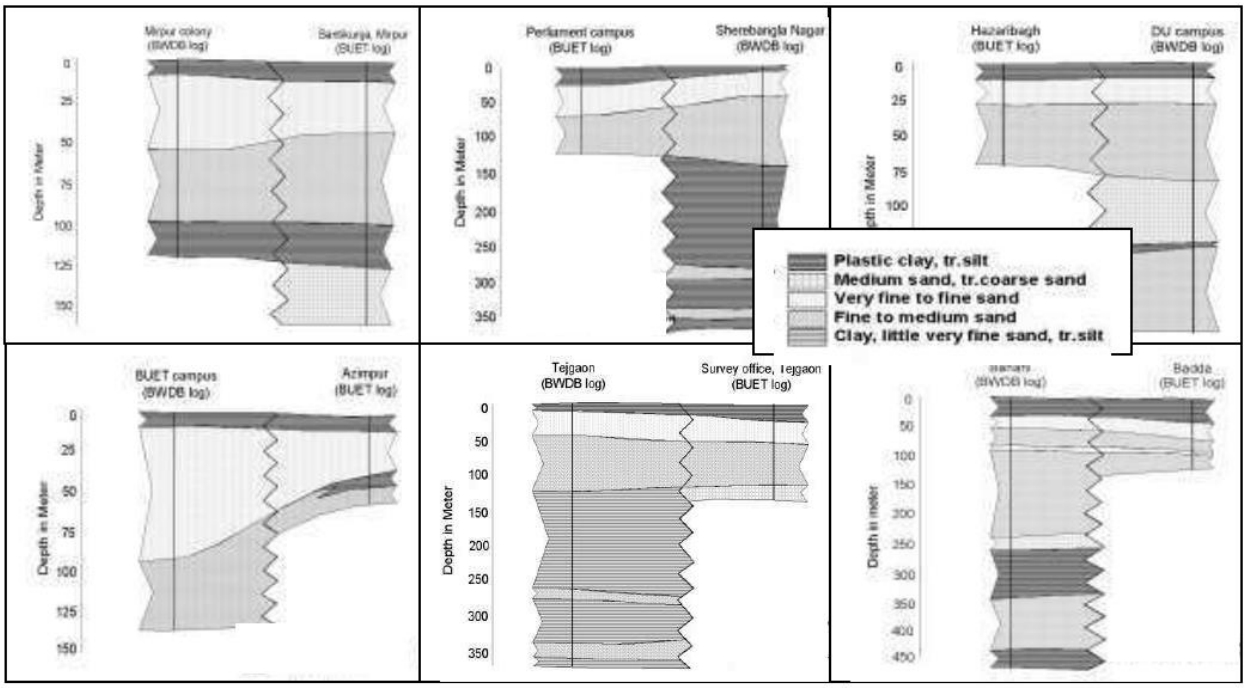


Figure 5-1: Lithology of Dhaka Area

Subsidence

According to Higgins (2014) land subsidence in Dhaka occurs at the rate of 0 to > 10 mm/y, and is likely related to groundwater abstraction. Variations in the rate of subsidence correspond to local variations in shallow subsurface sediments. Outside of the city, rates vary from 0 to > 18 mm/y, with the lowest rates appearing primarily in Pleistocene Madhupur Clay and the highest rates in

Holocene organic-rich muds. Subsidence is primarily controlled by local stratigraphy, with rates varying by more than an order of magnitude depending on lithology. According to surveyed data subsidence rates on the order of 2-4 mm/yr are typical in the project area.

<u>Groundwater</u>

The total groundwater abstraction from licensed production wells operated by the DWASA and private (mainly industrial) operators is around 700 MCM per year. In addition to DWASA tube wells, there are more than 1,000 privately managed deep tube wells that are primarily unlicensed and for which no abstraction data are available. Most deep tube wellsreach to greater than 400 m. The quantity of water abstracted by unlicensed tube wells is not known but estimated to be significant since it meets the demands for areas that are not connected to the DWASA water-supply network. Groundwater quality data taken from wells within the project area, sampled and analyzed under the Project, is shown in Table 5-2.

Table 5-2: Groundwater Quality Data from the Project Area

(a) Locations

Sample ID	Location	Coordinates
GW-1	Deep Tube well in Milestone College	23°52'38.31"N, 90°22'2.35"E
GW-2	Shallow Tube well in Sholohati Village (200 m towards west side from the Uttara 3rd phase RAJUK office)	23°51'39.51"N, 90°21'43.40"E
GW-3	Deep Tube well in SPARSO	23°46'52.88"N, 90°22'41.54"E
GW-4	Deep Tube well in Farmgate	23°45'30.60"N, 90°23'10.42"E
GW-5	Deep Tube well in South Kamlapur (SardarColony)	23°43'33.03"N, 90°25'29.07"E
GW-6	Golapbag construction yard deep tube well	23°43'3.68"N, 90°25'46.44"E

(b) Results

Sample ID	COD (mg/L)	pH	Conductivity (ms/cm)	TDS (ppt)	Nitrate (mg/L)	Arsenic (mg/l)	Iron (mg/l)	Manganese (mg/L)
GW-1	0.8	7.32	0.4	0.2	1.6	<0.005	0.5	0.05
GW-2	0.8	6.46	0.55	0.25	2.7	0.01	0.7	0.07
GW-3	0.9	7.02	0.3	0.15	1.9	<0.005	0.8	0.03
GW-4	0.8	7.52	0.44	0.22	0.8	<0.005	0.4	0.03

Sample ID	COD (mg/L)	pH	Conductivity (ms/cm)	TDS (ppt)	Nitrate (mg/L)	Arsenic (mg/l)	Iron (mg/l)	Manganese (mg/L)
GW-5	0.7	6.92	0.64	0.32	2.2	<0.005	0.8	0.06
GW-6	0.9	7.13	0.34	0.17	1.3	<0.005	0.6	0.07
Drinking water STD of BD	<4.0	6.5-8.5		1.0	10	0.05	0.3-1.0	0.1

COD results are low, even for deep wells. Fe and Mn are well below World Health Organization limits. High arsenic level in well #2, a shallow well, limits use of shallow groundwater in the area for drinking water supply; otherwise as levels are low in the remaining deep wells. Deep well water seems very fresh, not mineralized at all (with low conductivity and TDS), implying that the residence time or age of the water is short and groundwater velocity in the area is high. For most parameters, the variance is less than 5% of the mean, indicating high degree of similarity and homogeneity for the water. This also indicates the lack of influence from pollution sources at a depth of 400 m.

Groundwater levels throughout the City have fallen drastically over the last 15-20 years. Data tabulated by Zahid et.al (undated) indicate groundwater levels have fallen from 23 to 47 m in three areas of the City near the alignment over the years 1980 to 2007. Isopleths for groundwater plotted by the Bangladesh Water Development Board that reflect year 2007 levels show a cone of depression that centers along the alignment for the Metro (Figure 5-2).

Figure 5-2: Groundwater Contours for Dhaka (2007)

5.1.2 Surface Hydrology and Water Quality

<u>Drainage</u>

A generalized drainage map for Dhaka is shown in Figure 5-3. This map shows the main drainage channels for the project area, which are as follows:

- Drainage north of Pallabi is not yet fully developed. Digun Khal in the north drains the Depot area and Uttara Ph III, discharging through the Goran Chatbari Pump Station into the Turag River.
- The section from Pallabi to Mirpur is drained through the Sec. 6 Digun Khal (Rupnagar) and flows north to discharge through the same pump station to the Turag River.
- The section of the alignment through Mirpur to Agargaon drains through the Kallyanpur Khal and into the Buriganga through the Kallyanpur Khal Pump Station. Much of this length is traversed by a large diameter storm sewer line in Begum Rokeya Sarani Rd.
- Begun Bari Khal drains the area in the vicinity of Sonargaon and Shahbag toward the east to the Shitalakhya River.
- Debdhulai Khal that is connected to the upper south reach of the Begun Bari Khal
- Segunbagicha Khal intercepts a series of storm culverts that drain the area around Motijheel.

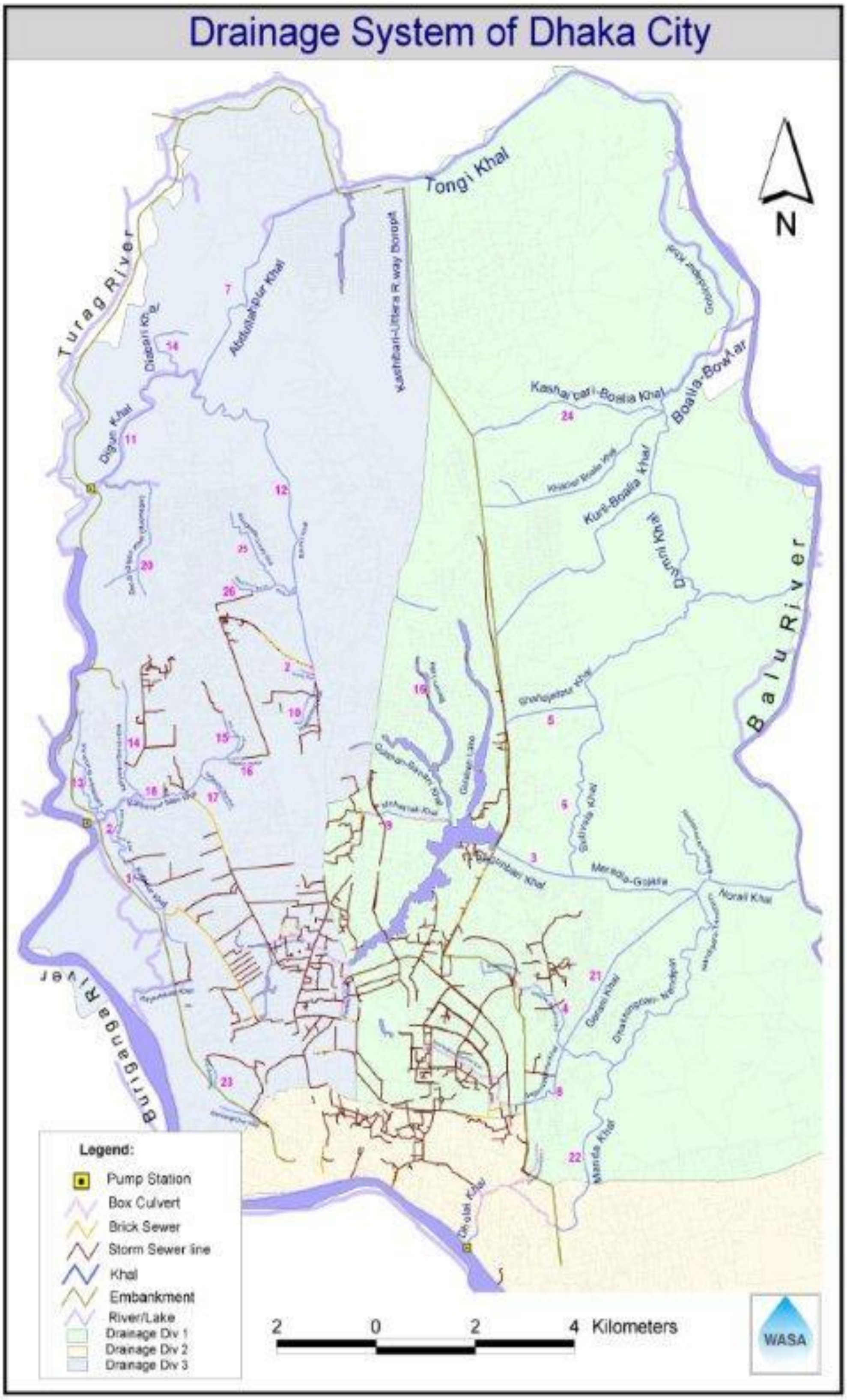


Figure 5-3: Drainage System of Dhaka City (DWASA)

The Turag River is the major drainage for the north part of the Metro line, whereas the Buri Ganga and Shitalakhya Rivers (the latter by way of Begum Bari Khal) drain the areas toward the center and south. Most drains flowing into these rivers and the Khal are covered concrete culverts.

DWASA conducted the Storm Water Drainage Master Plan for Dhaka City, which was updated in April 2014. (DWASA 2014) Detailed drainage drawings called base maps were assembled under that work. An example for the Mirpur area is shown in Figure 5-4. This map is included to illustrate the detail for drainage drawings available through DWASA.

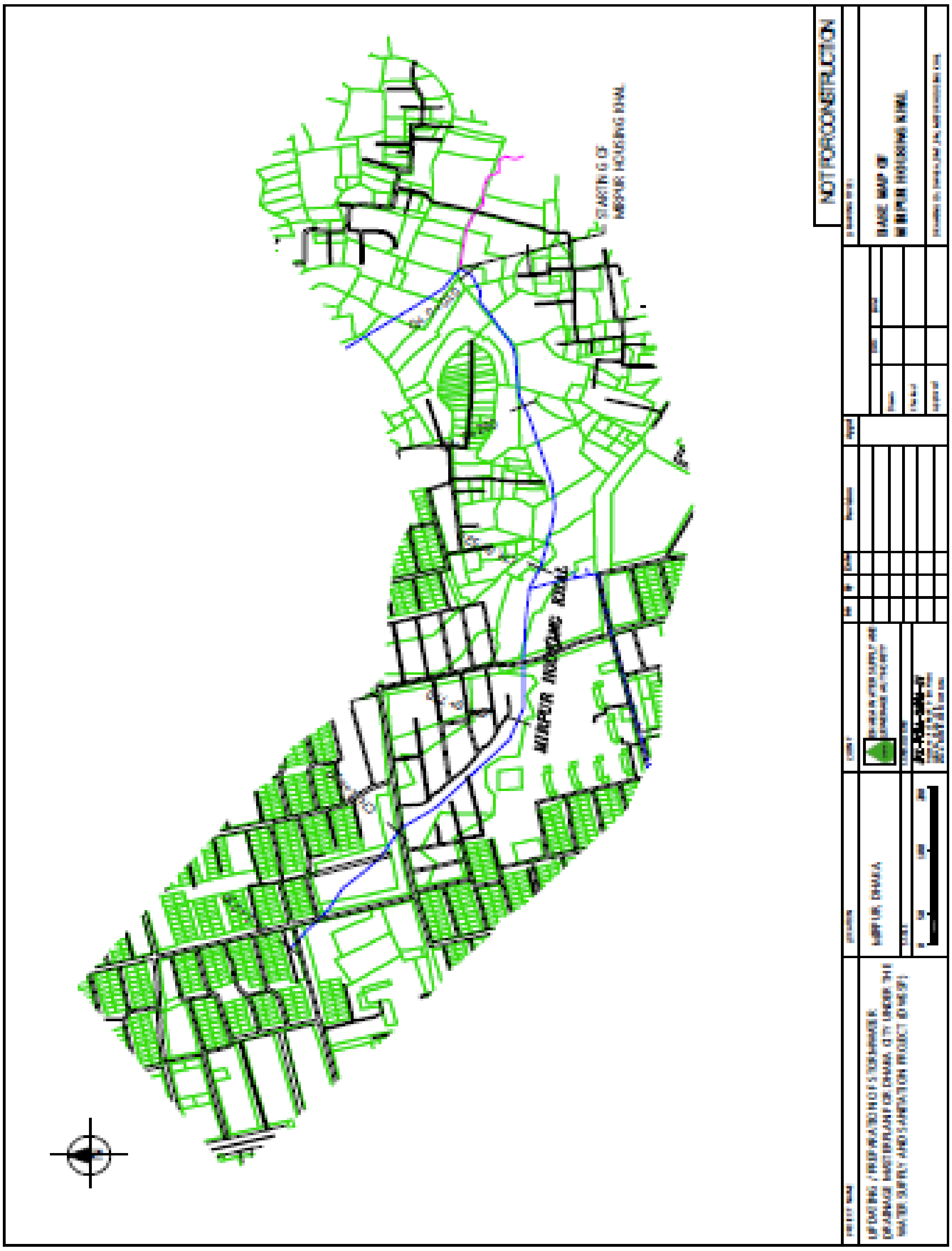


Figure 5-4: Mirpur Housing Khal (detail from DWASA 2014)

Extensive work was done to account for drainage from the depot area and documented in the Technical Report on Depot Land Formation Level (NKDM

2014). As part of that work, rainfall intensity-duration curves were developed based on historical records, as shown in Figure 5-5.

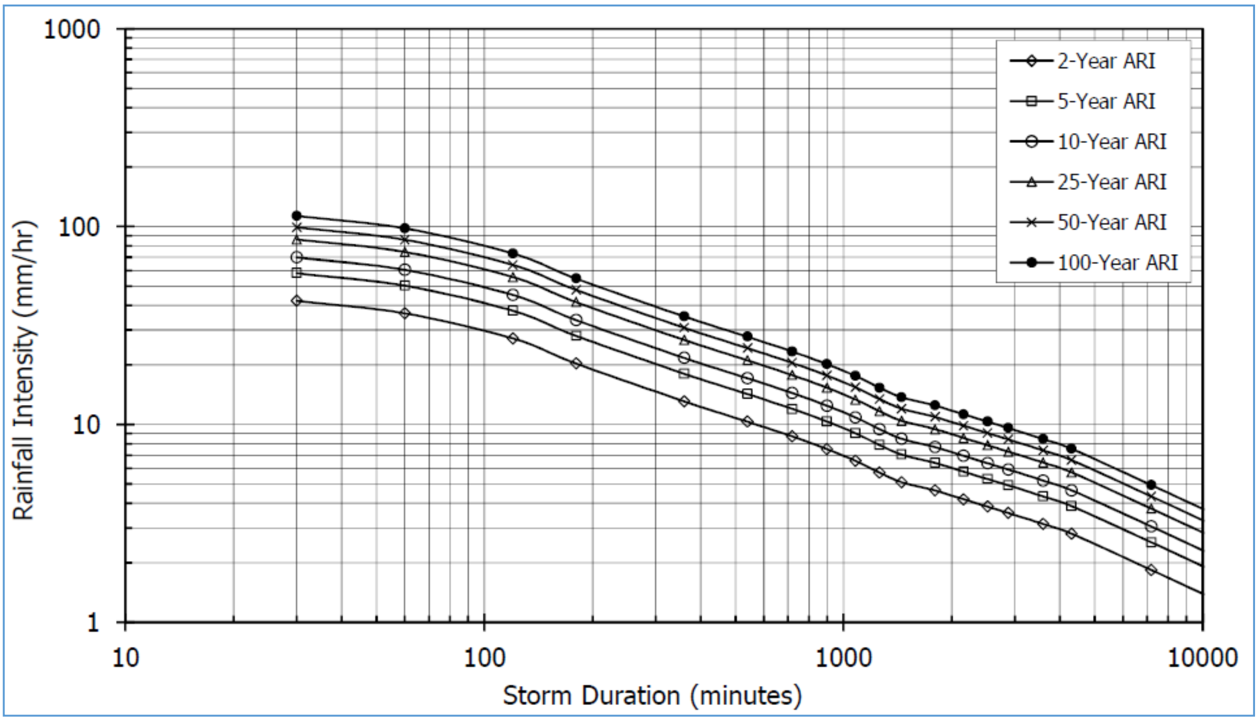


Figure 5-5: Intensity-Duration of Rainfall for Dhaka City

Wetlands

Open water bodies of natural origin are found in the north part of the project area near the depot and along the alignment between the depot site and Pallabi. Originally much of the area was subject to flooding, but is now drained through a series of pumped discharge canals (khals), since construction of the Dhaka Flood Control Embankment bordering the Turag River in the early 1990s. The khals or lakes are natural drainage channels, or river meanders that were cut off from the main channel. The land was filled adjacent to the khals, which helped to define them and increase their cross-sectional areas. Uttara Phase III area is under rapid transition and will retain few if any natural features. No wetland of ecological importance is present in the area.

Water Quality

Quoting WB (2006), Chapter 3, Management of Water Quality in Dhaka:

“Dhaka is surrounded by rivers and inter-connected with canals which have always formed a life-line for city residents. In the last twenty years, a convergence of unregulated industrial expansion, rural-to-city migration, encroachment of the rivers, overloaded infrastructure, confusion about institutional responsibility for the quality of Dhaka’s water bodies, and very ineffective enforcement of environmental regulations have all taken their toll on surface water quality. There is only one sewage treatment plant at Pagla which is currently operating below capacity because of sewerage system failures, and few industries operate effluent treatment systems. Almost all the waste from humans, industry, and millions of farm animals, along with tones of pesticides and fertilizers, make their way into Dhaka's surface water untreated, and a percentage of these wastes infiltrate to the groundwater. As a result, pollutant levels in the groundwater are increasing, and many sections of the rivers and canals in the city and surrounding areas, especially the Buriganga and Sitalakhya, are biologically dead during the dry season, spurring widespread public concern."

Working with DOE in 2006, the World Bank assembled a map of water quality hotspots surrounding Dhaka, which is reproduced in Figure 5-6. DOE criteria for inland surface waters covering pH, BOD, DO and total coliform bacteria(see Table 5-3) provide for the following beneficial uses, which are met only slightly, though surface water continues to be used for a variety of purposes:

a) Source of drinking water supply with disinfection

b) Water suitable for recreational activity

c) Source of drinking water supply after conventional treatment

d) Water supporting fisheries

e) Water usable by various process and cooling industries

f) Water usable for irrigation

Surface water quality surrounding Dhaka is generally unsuitable for some uses.

Table 5-3: DOE Water Quality Classification Criteria

Best Practice based classification	Parameter			
	pH	BOD mg/l	DO mg/l	Total Coliform number/100
a. Source of drinking water for supply only after disinfecting:	6.5-8.5	2 or less	6 or above	50 or less
b. Water usable for recreational activity :	6.5 – 8.5	3 or less	5 of more	200 or less
c. Source of drinking water for supply after conventional treatment :	6.5 – 8.5	6 of less	6 or more	5000 or less
d. Water usable by fisheries:	6.5 – 8.5	6 of less	5 or more	---
e. Water usable by various process and cooling industries :	6.5 – 8.5	10 or less	5 or more	5000 or less
f. Water usable for irrigation:	6.5 – 8.5	10 or less	5 or more	1000 or less

Notes:

1. In water used for pisiculture, maximum limit of presence of ammonia as Nitrogen is 1.2 mg/l.

2. Electrical conductivity for irrigation water – 2250 μmhoms/cm (at a temperature of 25°C); Sodium less than 26%; boron less than 0.2%.

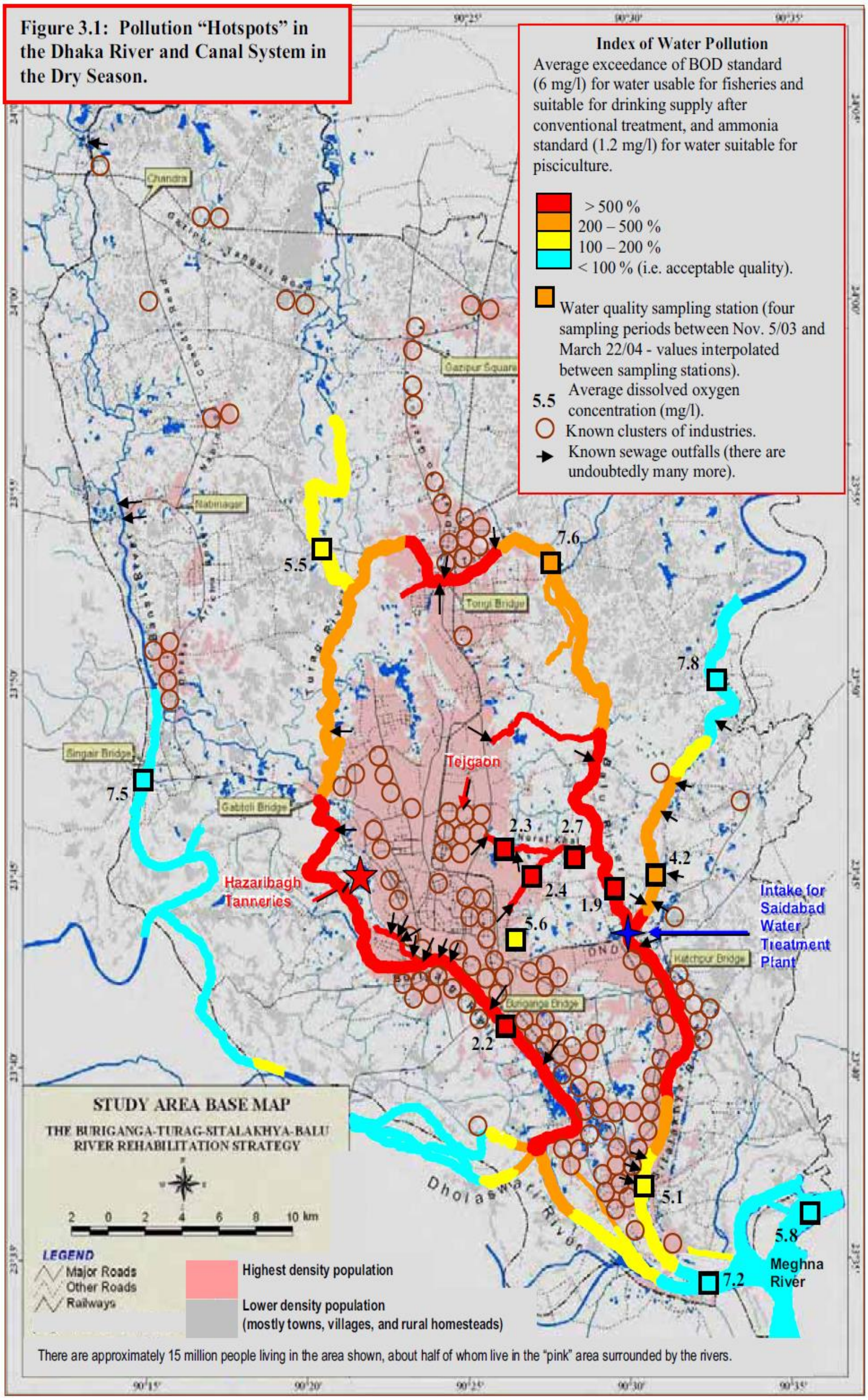


Figure 5-6: Water Quality Hotspots in Surface Waters around Dhaka

Water quality for three water bodies along the proposed MRT Line 6 was surveyed on 2 October and 12 December 2010 by the JICA Study Team for the Preparatory EIA under DHUTS 2. Table 5-4 contains the results of sampling analysis during that time. The pH values at three different points met the environmental standard. Otherwise, channels and drains in urban areas were heavily polluted. D.O. was low, with high total coliform values in excess of the ambient standard at all locations, indicating contamination from domestic wastewater and other forms of organic matter.

Table 5-4: Surface Water Quality Data Collected during the Preparatory EIA

No.	Location	Date (2010)	pH	Dissolved Oxygen (DO) ppm	Chemical Oxygen Demand (COD) ppm	Total Suspended Solids (TSS) mg/l	Total Coliform number/100ml
1	Pond in Northern Pallabi	2 Oct.	7.5	5.8	45.6	288	500,000
2	Mirpur Khal	2 Oct.	7.3	0.6	164.0	636.4	500,000
3	Begunbari Drain	2 Oct.	7.6	1.4	141.6	502.1	1,100,000
1	Pond in Northern Pallabi	12 Dec.	7.6	7.2	64	149	1,000
2	Mirpur Khal	12 Dec.	7.7	Under DL*	480	392	910,000
3	Begunbari Drain	12 Dec.	7.7	Under DL*	448	367	960,000
Bangladesh Standard for Inland Surface Water Quality (Water usable by various process)			6.5-8.5	5 or more	Not yet set	Not yet set	5,000 or less

Sampling points for data collected during field surveys for the current EIA are shown in Table 5-5. The locations in the area of the depot are shown in Figure 5-7.

Table 5-5: Sampling Locations for Surface Water Quality Monitoring

Location	Sampling ID	Geographic Coordinate
Uttara 3rd Phase Lake 10	SW1	23°52'28"N, 90°21'39"E
Uttara 3rd Phase Lake 2	SW2	23°51'52"N, 90°21'52"E
Uttara 3rd Phase Lake 12	SW3	23°51'29"N, 90°21'30"E
Uttara 3rd Phase Lake 6	SW4	23°50'54"N, 90°21'54"E
Cantonment Water Body	SW5	23°50'19"N, 90°21'50"E
Nearest Lake of Golapbag (Manda Khal crossing Atishdeepankar Road)	SW6	23°43'26"N, 90°25'44"E

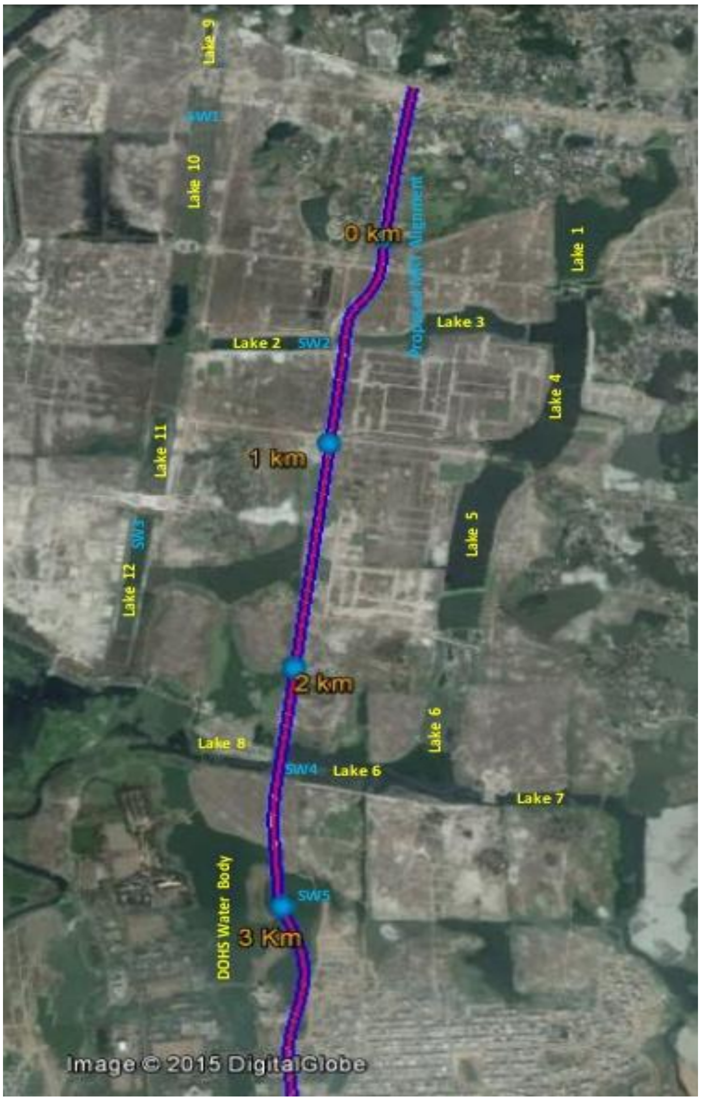


Figure 5-7: Lakes in the Area of Uttara and the Depot

Data collected during field surveys for the current EIA are shown in Tables 5-6 and 5-7. Samples taken along the north end of the alignment are from the lakes in Uttara Phase III and the cantonment area. These serve as drainage channels for storm water from Uttara as well as the depot site. The Turag River northwest of the depot is separated from adjacent land areas by the Dhaka embankment, and was not sampled. Another sample was taken from a khal in Motijheelnear the Golapbag construction yard.

Table 5-6: First Round of Surface Water Quality Monitoring (dry season)

Sample ID	DO (mg/l)	pH	Cond. (ms/cm)	Temp. (°C)	TDS (ppt)	COD (mg/l)	TSS (mg/l)	Turbidity (JTU)	Total Coliform n/100 ml
SW1	6.5	8.34	0.30	22.0	0.15	24.5	162	208	11000
SW2	6.0	7.40	0.44	22.9	0.22	39.25	172	328	17000
SW3	6.2	7.62	0.34	21.5	0.17	22.3	157	176	7000
SW4	4.2	6.63	0.72	24.8	0.36	48.7	183	209	23000
SW5	6.2	8.42	0.50	27.8	0.25	20.8	81	127	13000
SW6	0.8	6.63	0.87	25.2	0.44	32.6	183	205	12000

Table 5-7: Second Round of Surface Water Quality Monitoring (wet season)

Sample ID	DO (mg/l)	pH	Cond. (ms/cm)	Temp. (°C)	TDS (ppt)	COD (mg/l)	TSS (mg/l)	Turbidity (JTU)	Total Coliform n/100 ml
SW1	6.8	7.31	0.22	29.9	0.11	10.2	121	165	6000
SW2	6.5	7.28	0.28	30.4	0.19	8.15	138	178	7000
SW3	6.3	7.26	0.23	29.6	0.12	13.2	129	135	6000
SW4	5.1	6.13	0.46	30.5	0.23	21.6	145	157	7000
SW5	6.1	7.17	0.39	30.2	0.2	12.7	103	105	9000
SW6	1.3	6.81	0.74	30.1	0.37	28.1	173	210	18000

DO is generally high, near saturation, in all the lakes, but near zero in the khal in Motijheel. pH in the lakes is neutral to slightly alkaline, depending on the season; whereas the khal is slightly acidic, approaching DOE's lower limit for pH. Conductivity and Total Dissolved Solids (TDS) are consistently low in lake water. The khal contains twice the amount of TDS, and conductivity is two times higher than the average of all lake samples. These are indicators of inorganic salts present in water from human activity, which are not generally present in lake samples.

COD, TSS, turbidity and coliform bacteria are high in lake samples during the dry period sampling, but reduce significantly in the second set of samples taken after the beginning of the wet season. COD is indicative of organic pollution, perhaps from septic tank connections to storm drains and from street runoff. Average COD in the lakes is 31 mg/L and 13 mg/L, for dry and wet seasons respectively. The DOE does not set an ambient standard for COD; BOD is set at 6 mg/L. Dry season TSS is an average of 151 mg/L in the Lakes and turbidity is high; these reduce somewhat in the wet season. TSS and turbidity indicate inflow of sediment from surrounding areas. Coliform bacteria counts are high, exceeding in the dry season by a factor of 14 the most relaxed water quality classification of the DOE. Coliform bacteria indicate contamination from human activities.

5.1.3 Meteorology and Air Quality

General Weather Conditions

Dhaka experiences a hot, wet and humid tropical climate. The city is within the monsoon climate zone, with an annual average temperature of 25 °C (77 °F) and monthly means varying between 18 °C (64 °F) in January and 29 °C (84 °F) in August. Nearly 80% of the annual average rainfall of 1,854 millimeters (73 in) occurs between May and September.

The FAO Climate Estimator[10] is used to estimate average temperature and rainfall for the Project (see Figures 5-8 and 5-9). The standard error of the estimate is shown on the charts. Note the near convergence of high and low estimates for temperature, indicating low variation in the historical data.

Monthly average evapotranspiration is shown in Figure 5-10. High rates of evapotranspiration in the hot months even in the presence of rainfall, along with generally porous fill material upon which Dhaka is built, account for the general absence of standing water on unpaved surfaces. Number of days of sunshine and wind speed are shown in Figures 5-11 and 5-12, respectively. Data vary widely for wind speed and the standard error is high.

[10] The UN Food and Agriculture Organization (FAO) Climate Estimator composites data from weather stations nearest to the point of interest. The nearest meteorological station in this case is the Dept. of Meteorology in Dhaka. The Estimator can be found at: http://www.fao.org/nr/climpag/pub/en3_051002_en.asp.

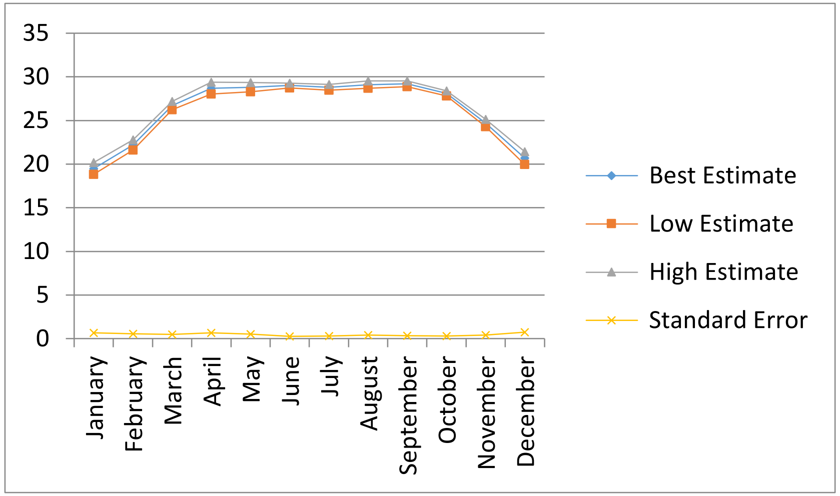


Figure 5-8: Average Monthly Temperature (C)

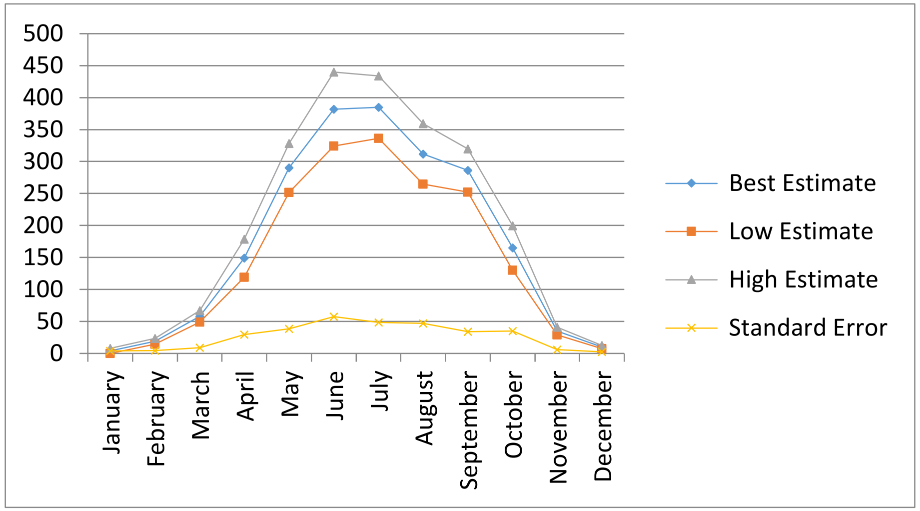


Figure 5-9: Average Monthly Rainfall (mm)

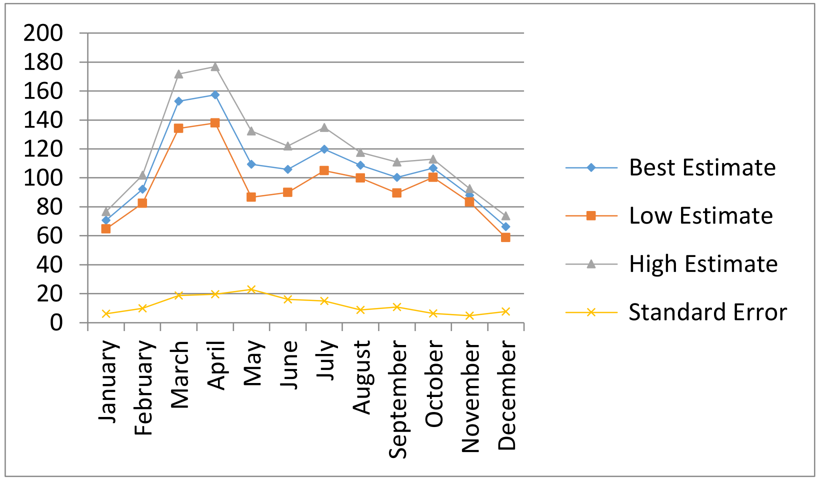


Figure 5-10: Monthly Evapotranspiration (mm)

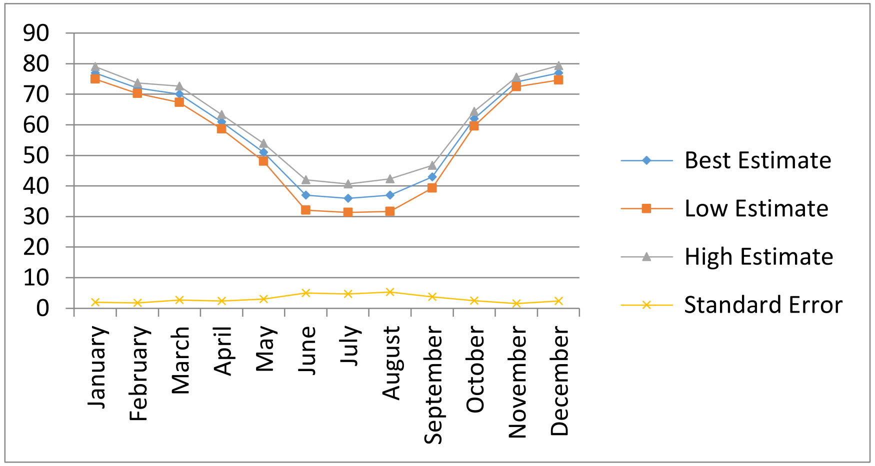


Figure 5-11: Monthly Days of Sunshine (%)

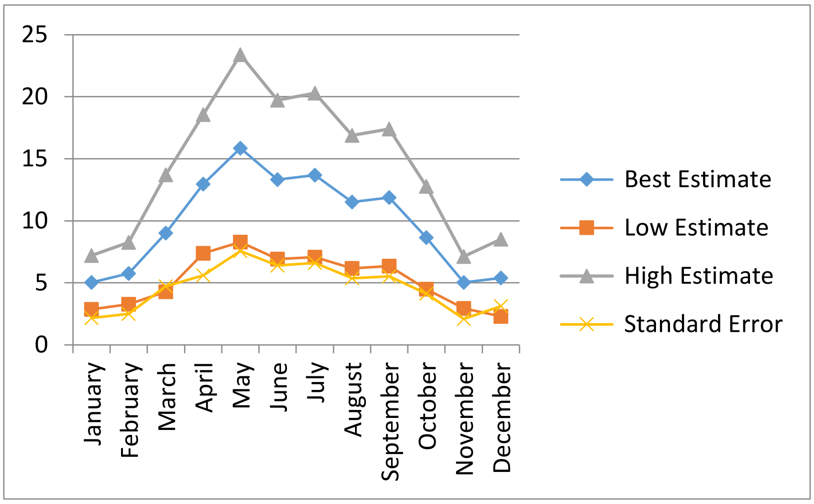


Figure 5-12: Monthly Average Wind Speed (km/hr)

Weather Extremes

Storm event frequency based on 30 years of data from the Bangladesh Meteorological Department Climate Division is shown in Figure 5-13. Thunderstorms are most frequent in May, though rainfall is greater in both June and July.

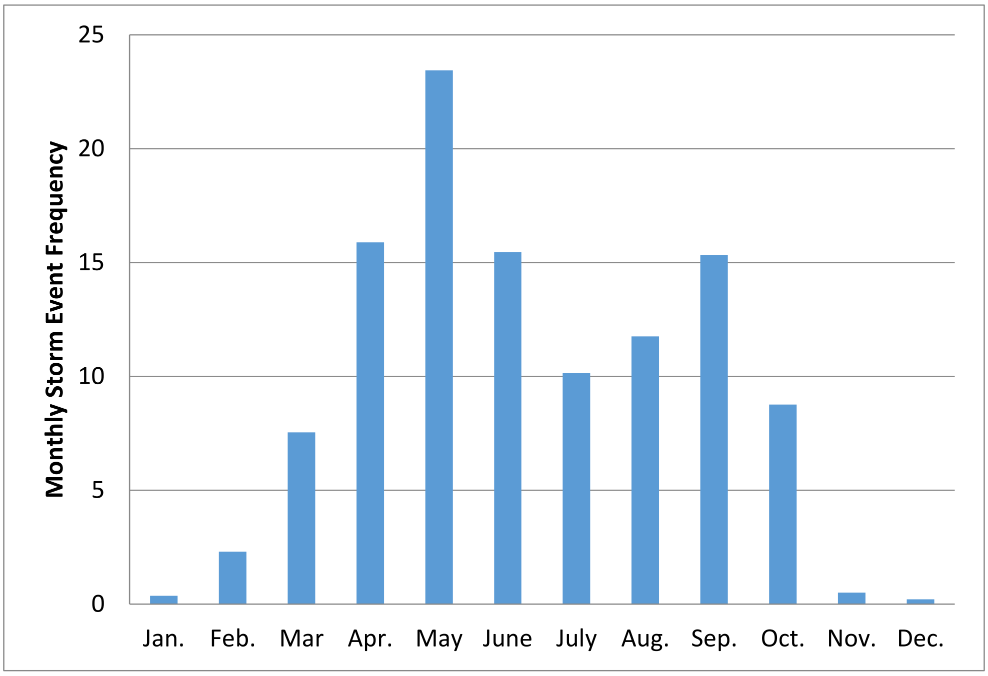


Figure 5-13: Historical Storm Event Frequency for Dhaka (1984—2013)

Air Quality

Some data exist from previous studies that reflect air quality conditions along the alignment and at similar locations. Data collected during the preparatory survey (DHUTS 2) are shown in Table 5-8.

Table 5-8: Air Quality Monitoring Data collected during the DHUTS 2 Study

Location	µg/cu m				
	PM10	PM2.5	SO2	NOx	Pb
Pallabi along Begum Rokeya Sarani (Oct 19 2010)	124.17	54.21	5.68	76.90	0.1823
South side of Farmgate along Airport Road (Oct 20 2010)	107.22	59.52	17.15	126.08	0.1916
South side of Banga Bhaban along Folder Street (Oct 26 2010)	141.60	61.39	8.44	142.45	0.2420
DOE standards	50 (annual)	15 (annual)	80 (annual)	100 (annual)	0.5 (annual)
	150 (24 hr)	65 (24 hr)	365 (24 hr)		

Further AQM data collected during the present effort are presented along with the analysis of air quality impacts in Chapter 6.

5.1.4 Noise

Typical Noise Levels in Dhaka

A number of sources report high noise levels at urban locations throughout theCity. Equivalent noise levels also were measured during the Preparatory Survey (DHUTS 2) as shown in Table 5-9. The Preparatory EIA (2011) reports that "according to a WHO survey at 45 locations of Dhaka city, most of the traffic points and many of the industrial, residential, commercial, silent and mixed areas are suffering noise levels exceeding the standard limits of Bangladesh. WHO found noise levels of 70 dB at Dhaka Medical College, 75 dB at Shakhari Patti, 90 dB at English Road, 88 dB at RAJUK Avenue and 85 dB in Tejgaon, though the standard limit for those areas are 50, 55, 60, 70 and 75 dB respectively."

The noise levels measured under the Project is shown in Table 5-10.

Table 5-9: Noise EquivalenceLevels measured during the DHUTS 2 Study (Leq dBA)

	Location	Day (6:00-21:00 hr)	Night (21:00 – 6:00 hr)
1	Pallabi Near to Police Station, Mirpur:	83	78
2	South Side of Farmgate on ground level, Farmgate:	90	85
3	South Side of Farmgate on foot over bridge (7m above ground), Farmgate:	89	85
4	South Side of Bangla Academy along Sir Sayed Road:	76	68
5	South Side of Banga Bhaban along Folder Street:	91	89

Table 5-10: Ambient Noise Levels at Various Receptors in dBA

SL NO	Location of Receptors	Track dist.	Mar' 15 Date	1st Quarter 6:00 to 12:00 AM: 1 hr Recording Time	to	1st Quarter: Leq_{10} of	1st Quarter: Period	2nd Quarter 12:01 to 6:00 PM: 1 hr Recording Time	to	2nd Quarter: Leq_{10} of	2nd Quarter: Period	3rd Quarter 6:00 to 12:00 PM: 1 hr recording time	to	3rd Quarter: Leq_{10} of	3rd Quarter: Period	4th Quarter 12:01 to 6:00 AM: 1 hr Recording Time	to	4th Quarter: Leq_{10} of	4th Quarter: Period	$L_{dn}=L_{eq}$ Σ(3*Peak;12*Mid day;9*Late night)
	(L_{eq}Peak day:Max value of the Hr between 7am - 7Pm , L_{eq} Mid day:of Hr btwn7pm - 10pm , L_{eq} Late Night:of Hr btwn 10pm - 7am)																			
1	NW corner of Depot(Beri Band)	-	17	7:08	8:07	**72.45**	7:48 - 7:57	16:30	17:19	**72.93**	17:14-17:23	18:10	19:09	**70.18**	18:40 - 18:49	4:00	4:59	**56.94**	4:15 - 4:24	**67.79**
2	Workshop at Depot area	-	17	8:35	9:34	**51.21**	9:00 - 9:09	14:37	15:36	**52.39**	14:54 - 15:03	19:40	20:39	**47.27**	20:08 - 20:17	2:35	3:34	**45.02**	3:25 - 3:34	**50.24**
3	Depot beside Milestone Colleg	7.5	17	9:42	10:41	**57.72**	9:43 - 9:52	13:30	14:29	**50.26**	14:08 - 14:17	20:43	21:42	**47.82**	20:50 - 20:59	1:30	2:29	**45.86**	1:46 - 1:55	**51.96**
4	Uttara Station	7.5	17	10:56	11:55	**60.59**	11:28 -11:37	12:06	13:05	**60.44**	12:26 - 12:35	22:10	23:09	**50.13**	22:14 - 22:23	0:04	1:03	**47.17**	0:19 - 0:28	**53.91**
5	Uttara Central Station	7.5	23	7:15	8:14	**47.86**	7:44 - 7:53	12:04	13:03	**47.3**	12:36 - 12:45	18:11	19:10	**45.13**	18:32 - 18:41	0:01	1:00	**45.52**	24:25-24:35	**49.98**
6	Uttara South Station	7.5	22	8:37	9:36	**53.88**	9:21 - 9:30	13:29	14:28	**53.27**	13:36 - 13:45	19:36	20:35	**50.21**	20:04 - 20:13	1:23	2:22	**48.98**	1:46 - 1:55	**53.79**
7	DOHS East (by Chandramollik)	7.5	18	7:02	8:01	**57.05**	7:32 - 7:41	16:20	17:19	**58.39**	16:43 - 16:52	18:00	18:59	**49.38**	18:00 - 18:09	4:00	4:59	**46.25**	4:17 - 4:26	**52.59**
8	National Defence College	25	17	8:22	9:21	**67.96**	8:42 - 8:51	14:37	15:36	**69.43**	14:43 - 14:52	19:29	20:18	**69.27**	19:45 - 19:54	2:32	3:31	**55.68**	2:42 - 2:51	**66.27**
9	Mimi General Hospital	15	17	9:41	10:40	**74.88**	9:57 -10:06	13:28	14:27	**69.91**	14:12 - 14:21	20:42	21:41	**72.54**	20:58 - 21:07	1:28	2:27	**67.88**	1:45 - 1:54	**73.55**
10	Pallabi Station	7.5	17	10:58	11:57	**76.78**	11:13 -11:22	12:05	13:04	**75.1**	12:05 - 12:14	22:00	22:59	**70.95**	22:19 - 22:28	0:04	1:03	**64.67**	0:33 - 0:42	**71.65**
11	Islami Bank Hospital	25	18	7:03	8:02	**71.91**	7:45 - 7:54	16:20	17:19	**74.89**	16:26 - 16:35	18:03	19:02	**74.11**	18:19 - 18:28	3:59	4:58	**60.63**	3:59 - 4:08	**71.3**
12	Mirpur-11 Station	7.5	18	8:22	9:21	**75.84**	8:57 - 9:06	14:37	15:36	**72.09**	14:37 - 14:46	19:32	20:31	**74.84**	19:54 - 20:03	2:31	3:20	**64.29**	2:31 - 2:40	**72.79**
13	Rahima Maternity Hospital	20	18	9:42	10:41	**74.34**	9:42 - 9:51	13:27	14:26	**70.02**	13:36 - 13:45	20:41	21:40	**74.35**	21:09 - 21:18	1:22	2:21	**61.19**	1:51 - 2:00	**71.41**
14	Alok Health Care	16	18	11:00	11:59	**73.06**	11:40 -11:49	12:05	13:04	**74.07**	12:49 - 12:58	22:00	22:59	**72.19**	22:07 - 22:16	0:02	1:01	**62.56**	24:04-24:13	**70.61**
15	Mirpur-10 Station	7.5	18	7:05	8:04	**74.85**	7:08 - 7:17	16:20	17:19	**75.82**	16:35 - 16:44	18:01	19:00	**71.63**	18:35 - 18:44	3:58	4:57	**62.44**	4:18 - 4:27	**70.7**
16	Alhelal Specialized Hospital	16	18	8:23	9:22	**76.51**	8:28 - 8:37	14:41	15:40	**73.15**	15:31 - 15:40	19:29	20:28	**72.64**	19:47 - 19:56	2:32	3:31	**59.76**	2:32 - 2:41	**70.63**
17	Life Aid Specialized Hospital	17	18	9:42	10:41	**74.19**	10:16 -10:25	13:30	14:29	**72.73**	13:55 - 14:04	20:42	21:41	**71.86**	20:42 - 20:51	1:19	2:18	**62.06**	1:21 - 1:30	**68.4**
18	Kazipara Station	7.5	18	11:00	11:59	**75.16**	11:29-11:38	12:05	13:04	**73.21**	12:16 - 12:25	21:59	22:58	**69.77**	22:07 - 22:16	0:01	1:00	**66.7**	24:11-24:20	**72.22**
19	Exim Bank Hospital	17	19	7:00	7:59	**72.32**	7:41 - 7:50	16:24	17:23	**74.77**	16:41 -16:50	18:00	18:59	**77.28**	18:12 - 18:21	4:00	4:59	**58.1**	4:32 - 4:41	**73.17**
20	Shewrapara Station	7.5	19	8:22	9:21	**73.71**	8:57 - 9:06	14:40	15:39	**75.34**	15:01 - 15:10	19:32	20:31	**75.12**	19:44 - 19:53	2:31	3:30	**61.77**	3:15 - 3:24	**72.18**
21	Lion Eye Hospital	16	19	9:42	10:41	**76.44**	9:45 - 9:54	13:27	14:26	**79.34**	13:59 - 14:08	20:43	21:42	**71.35**	21:15 - 21:24	1:22	2:21	**60.01**	2:04 - 2:13	**71.3**
22	Agargaon Station	7.5	19	11:01	12:00	**73.99**	11:15-11:24	12:06	13:05	**73.46**	12:09 - 12:18	22:00	22:59	**69.54**	22:31 - 22:40	0:02	1:01	**64.45**	24:03-24:12	**70.57**
23	Bijoy Sharani Station	7.5	19	7:04	8:03	**73.12**	7:20 - 7:29	16:23	17:22	**76.62**	16:55 - 17:04	18:04	19:03	**75.73**	18:16 - 18:25	4:00	4:59	**62.31**	4:14 - 4:23	**72.89**
24	Khejur Bagan Sangsad Bhaban	15	19	8:22	9:21	**75.4**	8:46 - 8:55	14:38	15:37	**68**	14:56 - 15:05	19:32	20:31	**74.58**	19:32 - 19:41	2:31	3:30	**62.18**	2:52 - 3:01	**71.96**
25	Farmgate Station	7.5	19	9:42	10:41	**76.35**	10:10 -10:19	13:27	14:26	**74.25**	14:16 - 14:25	20:41	21:40	**73.35**	21:14 - 21:23	1:22	2:21	**67.52**	2:11 - 2:20	**73.73**
26	FarmgateR=200	7.5	19	10:59	11:58	**76.98**	11:32 -11:41	12:06	13:05	**75.55**	12:09 - 12:18	22:00	22:59	**71.83**	22:30 - 22:39	0:03	1:02	**69.45**	24:38-24:47	**74.71**
27	Tejjgaon Govt. Girls School & College	15	20	7:01	8:00	**74.93**	7:04 - 7:13	16:06	17:05	**78.82**	16:20 - 16:29	18:00	18:59	**74.66**	18:29 - 18:38	3:59	4:58	**60.93**	4:17 - 4:26	**72.59**
28	Kawran Bazar Station	7.5	20	8:17	9:16	**77.49**	8:39 - 8:48	14:47	15:46	**75.3**	15:09 - 15:18	19:33	20:32	**76.72**	19:55 - 20:04	2:32	3::3	**69.2**	3:06 - 3:15	**75.9**
29	Shahbag Station	7.5	20	9:52	10:51	**76.19**	10:09 -10:18	13:17	14:16	**72.55**	14:04 - 14:13	20:42	21:41	**73.19**	20:46 - 20:55	1:23	2:22	**65.69**	1:36 - 1;45	**72.7**
30	D.U.Central Library	15	20	11:00	11:59	**70.6**	11:50 -11:59	12:06	13:05	**71.66**	12:53 - 13:02	22:01	23:00	**68.21**	22:10 - 22:19	0:24	1:01	**60.05**	24:52 - 1:01	**67.51**
31	TSC station	7.5	20	7:02	8:01	**69.35**	7:46 - 7:55	15:45	16:44	**71.68**	15:52 - 16:01	18:00	18:59	**74.32**	18:45 - 18:54	3:44	4:43	**52.22**	4:10 - 4:19	**70.04**
32	Deoel Chattar R=200	7.5	20	8:16	9:15	**70.82**	8:36 - 8:45	14:31	15:30	**71.99**	15:20 - 15:29	19:14	20:13	**68.72**	20:01 - 20:10	2:32	3:31	**61.13**	2:40 - 2:49	**68.24**
33	High Court Morh R=200	7.5	20	9:29	10:28	**72.11**	9:57 - 10:06	13:17	14:16	**69.94**	13:18 - 13:27	20:29	21:27	**72.14**	20:53 - 21:02	1:17	2:16	**62.55**	1:39 - 1:48	**70.29**
34	Kadam Fountain R=200	7.5	20	10:44	11:43	**74.59**	11:10- 11:19	12:02	13:01.1	**76.17**	12:08 - 12:17	21:46	22:45	**69.78**	21:50 - 21:59	0:24	1:00	**62.35**	24:20-24:29	**70.14**
35	Press Club Station	7.5	21	7:04	8:03	**78.28**	7:31 - 7:40	12:02	13:01.1	**74.77**	12:25 - 12:34	18:01	19:00	**77.05**	18:39 - 18:48	0:24	1:00	**67.39**	24:16-24:25	**75.35**
36	Baitul Mukarram Mosq	15	21	8:33	9:32	**62.03**	8:46 - 8:55	13:32	14:31	**73.19**	13:55 - 14:04	19:32	20:31	**72.74**	19:37 - 19:46	1:32	2:31	**57.57**	1:45 - 1:54	**69.51**
37	Daik Bangla Mor R=200	7.5	21	10:01	11:00	**75.68**	10:05 -10:14	15:00	15:59	**74.64**	15:48 - 15:57	21:00	21:59	**71.51**	21:30 - 21:39	3:00	3:59	**58.52**	3:26 - 3:35	**69.58**
38	Motijheel Station	7.5	21	7:01	8:00	**70.74**	7:13 - 7:22	12:02	13:01.1	**70.08**	12:13 - 12:22	18:02	19:01	**72.61**	18:14 - 18:23	0:02	0:01	**64.2**	24:10-24:19	**71.11**
39	Golap Bag Const. Yard	-	21	8:32	9:31	**79.39**	9:09 - 9:19	13:33	14:32	**78.51**	13:42 - 13:51	19:32	20:31	**78.27**	20:04 - 20:13	1:33	2:32	**67.7**	1:34 - 1:43	**76.23**
40	Kamlapur RSS	60	21	10:00	10:59	**72.48**	10:06 - 10:15	14:59	15:58	**71.82**	15:13 - 15:22	21:00	21:59	**67.22**	21:00 - 21:09	2:59	3:58	**60.5**	3:01 - 3:10	**67.57**

DOE's Standards for Ambient Noise (Schedule 4 of the ECR) are shown in Table 6-1. Existing ambient noise levels in the project area generally exceed the standards for residential, mixed and commercial uses, as shown in Figure 5-14. Peak ambient noise levels shown in Table 5-10 are combined with transit noise in the predictive analysis in Chapter 6 to determine expected overall noise levels during operation.

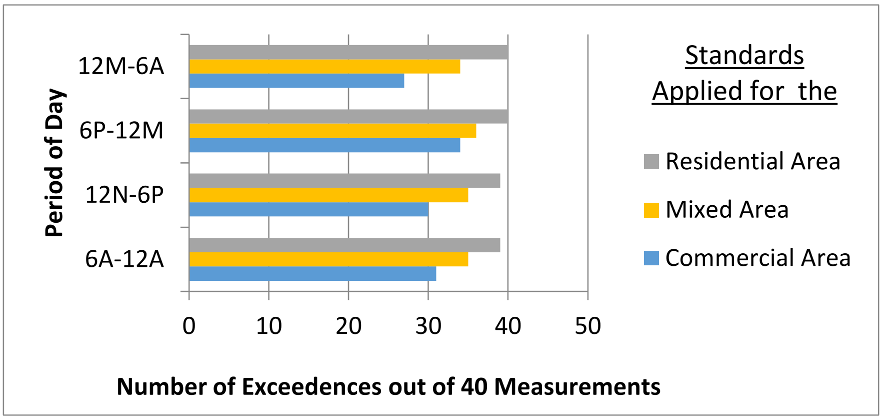


Figure 5-14: No. in Excess of Standard out of 40 Noise Measurements taken on 17-23/3/2015

5.2 Biological Resources

5.2.1 Protected Areas

DOE designation of Ecologically Critical Area (ECA) is intended to identify an environmental protection zone. None of these have been defined for urban areas, though the Environmental Conservation Act allows for such. There is no protected area or ECA within or near the Project area.

5.2.2 Land Cover, Trees and Valued Flora

Because Dhaka city is urbanized, there are few natural forest areas remaining. Significant natural forest areas exist only in limited areas. Still the vegetation of Dhaka city has a variety of indigenous and exotic species especially in parks and gardens. It is estimated that there are nearly 41-46 parks/gardens covering for 310 hectares such as Osmani Uddyan, Bahadur Shah Park, National Botanical Garden, Zia Uddyan (Garden), Baldha Garden, Suhrawardi Uddyan, Ramna Park. Baldha garden and National Botanical Garden have a wide variety of plants and trees.

Besides local species, many exotic species were planted along the roadside in the old secretariat area and in residential bungalows for the beautification of the city during 1905-06 when Dhaka was the capital of East Bengal and Assam. About 50 species were then planted, of which Aswath (Ficus religiosa), Debdaru (Polyalthia longifolia), Narikel (Cocos nucifera), Ashok (Saraca indica), Mahogany (Swietenia sp.), Shegun (Tectona grandis), Sissu (Dalbergia sissoo) were very common.

A detailed survey was conducted of trees along the alignment and near station locations. A summary is provided in Table 5-11. A detailed list of trees identified along the alignment is available in the survey report.

5.2.3 Mammal and Bird Life

5.2.3.1 Mammals

Mammals present in Dhaka include domesticated cats, dogs and farm animals, rats, house shrews and fruits bats. Most academic reporting on mammals present in Dhaka emphasize the risk of rats, feral cats and fruit bats to transmit bacterial and viral pathogens. Bats of the family Pteropodidae can be seen in Dhaka and are known to transmit Nipah virus. Outbreaks in Bangladesh have linked the disease in humans with bats. Rats and shrews transmit Bartonella, a family of bacteria most commonly associated with cat scratch disease. Bartonella has drawn the attention of researchers concerned with whether these agents might be responsible for human cases of febrile illness of unknown etiology in Bangladesh and elsewhere in south Asia. (Bay et.al. 2007) Ecological and bacteriologic observations of small mammals captured in Dhakaindicated that Bartonella infections occurred in high prevalence among lesser bandicoot rats (Bandicota bengalensis), black rats (Rattus rattus), and house shrews (Suncus murinus).

Bartonella bacteria cause several diseases in humans. The three most common are cat scratch disease, caused by B. henselae; trench fever, caused by B. quintana; and Carrión's disease, caused by B. bacilliformis. Ubiquitous to an extent, species of Bartonella have been found in mammals ranging from mice to sheep to sea otters to dolphins. According to one epidemiologist, there are at least 30 different species of Bartonella that have been identified, and 13 of those are found to infect human beings.

5.2.3.2 Birds

The green spaces in Dhaka are home to a variety of avian fauna. A field study (Chowdhury, Aich and Shahadat, 2014) to classify the birds identified over a period of nine months on the Dhaka University campus confirmed the presence of 78 bird species belonging to 39 families. Of those species, House Sparrow, Common Myna, Pied Myna, House Crow, Oriental Magpie Robin, Vented Bulbul, Spotted Dove, Asian Palm Swift, House Swift and Rose Ringed Parakeet were the most common. Other species (Vulture, Griffon, Vulture and Hoopoe) were seen only once. Similar urban habitats as that of Dhaka University are found near the alignment at Ramna Park, Parliament, Old Airport and other isolated locations.Other observers report the presence of House Sparrow, House Crow, Black Kite, Rock Pigeon, Oriental Magpie Robin and Common Myna in urban residential areas and hotel gardens in Dhaka.

Residential and commercial areas dominated by multi-story flats and office rentals provide some space for nesting birds of these common species. The presence of kitchen and household waste is an inducement for flocks of crows, eagles and vultures to feed. Major attractants for birds include waste disposal operations, wastewater management facilities, wetlands, dredge spoil containment areas, agricultural activities and golf courses. Species include the House Crow, Black or Pariah Kite (see comparative photos in Figure 5-15) and White Rumped Vulture.

**Table 5-11: Summary Results of Tree Survey
(see notes at end of table)**

Scientific Name	Common Name	Local Name	Family	Type	Location	Small	Medium	Large
Datura metel L.	Angel's Trumpet	Dutura	SOLANACEAE	M	CL	14	0	0
Terminalia arjuna (DC) Wight & Arn.	Arjun	Arjun	COMBRETACEAE	M	1	6	24	0
Casuarina equisetifolia Forst.	Australian Pine	Jhau	CASUARINACEAE	O	CL	29	7	0
Musa paradisiaca L.	Banana	Kola	MUSACEAE	F	CL		10	
Ficus benghalensis Linn.	Banyan Tree	Bot	MORACEAE	T,M	CL	23	12	31
Aegle marmelos (L.) Corr.	Bel	Bel	RUTACEAE	F,T	RS		2	
Terminalia catappa L.	Bengla Almond	Kat badam	COMBRETACEAE	F,T			1	
Areca catechu L.	Betelnut Palm	Supari	ARECACEAE	F	RS	2	3	
Callistemon citrinus (Curtis) Skeels	Bottle Brush	Bottle Brush	MYRTACEAE	O,T	RS		5	
Bougainvillea spectabilies Willd.	Bougainvillea	Bagan Bilash	NYCTAGINACEAE	O	CL	UN*		
Artocarpus altilis (Park.) Fos.	Bread fruit	Bread fruit	MORACEAE	F	RS		1	
Mimsops elengi L.	Bullet Wood	Bakul	SAPOTACEAE	O,T	CL	21		
Madhuca longifolia (Koenig)	Butter Tree	Mohua	SAPOTACEAE	M	RS		2	

Scientific Name	Common Name	Local Name	Family	Type	Location	Small	Medium	Large
MacBride								
Bauhinia variegata L.	Camel's Foot Tree	Rokto Kanchon	CAESALPINIACEAE	O	RS	1		
Hopea odorata Roxb.	Cengal Pasir	Telsur	DIPTEROCARPACEAE	T,O			27	
Mesua ferrea L.	Ceylon Ironwood	Nageshwar	CLUSIACEAE	O,T	RS		5	
Cocos nucifera L.	Coconut Tree	Narikel	ARECACEAE	F	RS		10	
Tectona grandis L. f.	Common Teak	Shegun, Teak	VERBENACEAE	T	RS	2	2	
Tabernaemontana corymbosa Roxb. ex Wall.	Crape Jasmine	Tagar	APOCYNACEAE	O	CL	UC*		
Phoenix sylvestris Roxb.	Date Palm	Khejur	ARECACEAE	F	CL		5	
Ficus elastica Roxb. ex Hornem	Decora Rubber	Rubber Bot	MORACEAE	O	RS	1		
Pedilanthus tithymaloides (L.) Poiteau	Devil's Backbone	Rongchita	EUPHORBIACEAE	O	CL	UC*		
Moringa oleifera Lamk.	Drumstick	Sajina	MORINGACEAE	V	RS	2	2	
Acacia auriculiformis A. Cunn.exBenth. & Hook.	Earleaf acacia	Akashmoni	MIMOSACEAE	T	CL	5		
Phyllanthus emblica L.	Emblic	Amloki	EUPHORBIACEAE	F	CL	3		

Scientific Name	Common Name	Local Name	Family	Type	Location	Small	Medium	Large
Eucalyptus camaldulensis Dehn.	Eucalyptus	Eucalyptus	MYRTACEAE	T	RS	3		
Delonix regia Rafin.	Flame of Forest	Krishnachura	CAESALPINIACEAE	O,T	RS	1	3	
Cassia fistula L.	Golden Shower Tree	Sonalu	CAESALPINIACEAE	O,T	RS	1	5	
Psidium guajava L.	Guava	Peyara	MYRTACEAE	F	RS	5		
Alstonia scholaris (L.) R. Br.	Indian Devil Tree	Chatim	APOCYNACEAE	T	RS		7	
Elaeocarpus floribundus Blume	Indian Olive	Jalpai	ELAEOCARPACEAE	F	RS		2	
Zizyphus mauritiana Lamk.	Indian Plum	Boroi	RHAMNACEAE	F	RS	04		
Canna indica L.	Indian Shoti	Kolabati	CANNACEAE	O	CL	UC*		
Artocarpus heterophyllus Lamk.	Jackfruit	Khanthal.	MORACEAE	F,T	RS		2	
Syzygium cumini (L.) Skeels	Jambolan	Kala-jam.	MYRTACEAE	F,T	CL	1	5	
Ixora chinensis Roxb.	Jungle Geraniun	Rongon	RUBIACEAE	O	RS	5		
Neolamarckia cadamba (Roxb.) Bosser	Kadam	Kodom	RUBIACEAE	O,T	CL	02		
Butea monosperma (Lamk.) Taub.	Kingshuk, Palash	Palash, Dhak	FABACEAE	T,O	RS	2		

Scientific Name	Common Name	Local Name	Family	Type	Location	Small	Medium	Large
Lagerstroemia thorelii	Lancasteri Cheri	Barsha Jarul	LYTHRACEAE	O	RS		2	
Lantana camara L.	Lantana	Lantana	VERBENACEAE	O	RS	7		
Leucaena leucocephala (Lamk.) de Wit.	Lead Tree	Ipil-ipil	MIMOSACEAE	F,T	RS	5	5	
Albizia lebbeck (L.) Benth. & Hook.	Lebbeck Tree	Siris	MIMOSACEAE	T,O	RS		12	
Mangifera indica L.	Mango	Aam	ANACARDIACEAE	F,T	CL	1	3	
Calotropis procera (Ait.) Ait. f	Milkweed	Akondo	ASCLEPIADACEAE	M	RS	15		
Azadirachta indica A. Juss.	Neem	Neem	MELIACEAE	M	RS	8	5	
Nyctanthes arbor-tristis L.	Night Flowering Jasmine	Sheuli	VERBENACEAE	O	RS	UC*		
Plumeria obtusa L.	Pagoda Tree	Champa	APOCYNACEAE	O	RS	2	2	
Borassus flabellifer L.	Palm	Tal	ARECACEAE	F	CL		1	
Carica papaya L.	Papaya	Pepe	CARICACEAE	F	CL	04		
Caesalpinia pulcherrima (L.) Swartz	Peacock Flower	Radhachura	CAESALPINIACEAE	O	CL	50		
Jatropha integerrima Jacq.	Peregrina	Jayati	EUPHORBIACEAE	M,O	RS	1		
Michelia champaca L.	Perfume Tree	Champa	MAGNOLIACEAE	O,T	RS		1	

Scientific Name	Common Name	Local Name	Family	Type	Location	Small	Medium	Large
Lagerstroemia speciosa (L.) Pers.	Pride of India	Jarul	LYTHRACEAE	O,T	CL	1	2	
Samanea saman (Jacq.) Merr.	Rain Tree	Randi-koroi	MIMOSACEAE	T	RS		1	1
Roystonia regia (H. B. & K.) O. F Cooke	Royal palm	Royal palm	ARECACEAE	O	RS			50
Ficus religiosa L.	Sacred Tree	Aswoth	MORACEAE	T,M	RS	2	1	
Citrus grandis (L.) Osbeck.	Shaddock	Jambura	RUTACEAE	F	RS	2		
Streblus asper Lour.	Shakhotaka	Sheora	MORACEAE	T	CL	2	1	
Bombax ceiba L.	Silk Cotton Tree	Simul	BOMBACACEAE	T	CL	2		
Magnolia grandiflora L.	Southern Magnolia	Udoypoddo	MAGNOLIACEAE	O	RS			1
Annona reticulate L.	Sugar Apple	Ata	ANNONACEAE	F	RS	1		
Tamarindus indica L.	Tamarind	Tetul	CAESALPINIACEAE	F,T	RS	1	2	
Polyalthia longifolia Thw. cv. Wipping	Telegraph Pole Tree	Debdaru	ANNONACEAE	T,O	RS	33	37	
Erythrina variegate L.	Tiger’s Claw	Bichitro Monder	FABACEAE	O	RS			3
Washingtonia robusta H. Wendl.	Washington Palm	Washington Palm	ARECACEAE	O	CL		15	

Scientific Name	Common Name	Local Name	Family	Type	Location	Small	Medium	Large
Washingtonia robusta H. Wendl.	Washington Palm	Washington Palm	ARECACEAE	O	CL		20	
Albizia procera (Roxb.) Benth.	White Siris	Siris	MIMOSACEAE	T	RS	2		
Peltophorum pterocarpum (DC.) K. Heyne	Yellow Gold Mohur	Halud Krishnachura	CAESALPINIACEAE	O,T	CL		2	

Notes:

Small: DBH < 15 cm; Medium: DBH 15-30 cm; Large: DBH > 30 cm

Location: CL- Central Line, RS- Roadside

Type: Medicinal- M, Fruit Yielding- F, Timber Yielding- T, Ornamental- O; UC- Uncountable

a: Black Kite at Mateuil Landfill	b: Photo of Black Kite from web

Figure 5-15: Photo of Black Kite

Birdlife International identifies 434 species of avian fauna in Dhaka of which 15 are globally threatened species and 4 are introduced. This listing is compiled from historical information and probably does not reflect the species currently found in Dhaka.

5.3 Socioeconomic Resources

5.3.1 Administrative Divisions and Population

Administrative Divisions

Administrative zones serve to order socioeconomic data, such as population statistics, social services and social infrastructure. Two separate types of administrative division are prominent in Dhaka City. Wards are identified within the City Corporation boundary that are further subdivided into mouza. In the greater Dhaka Metropolitan Area, the prominent division is thana, used also within DCC, but subdivided further outside the DCC into unions. (Pervin 2013) For the most part, the alignment of the Project falls within DCC and both thanas and wards are identified, though boundaries are not necessarily contiguous. For instance Pallabi thana consists of wards nos. 2, 3, 5, 6, and parts of 7 and 15. Ward boundaries within the project area are shown in Figure 5-16. The area to the north along the alignment and at the depot location until recently lay outside the DCC boundary and was part of Turag Thana and Harirampur Union within Dhaka Zila.(MOP 2012) Due to boundary expansion, the incorporation of Uttara Ph III and formulation of development plans by RAJUK places this area squarely within the urbanized zone and has led to an implicit inclusion within the DCC jurisdiction of Uttara thana. Table 5-12 lists the wards adjacent to the alignment in North and South Dhaka and their proximities to stations.

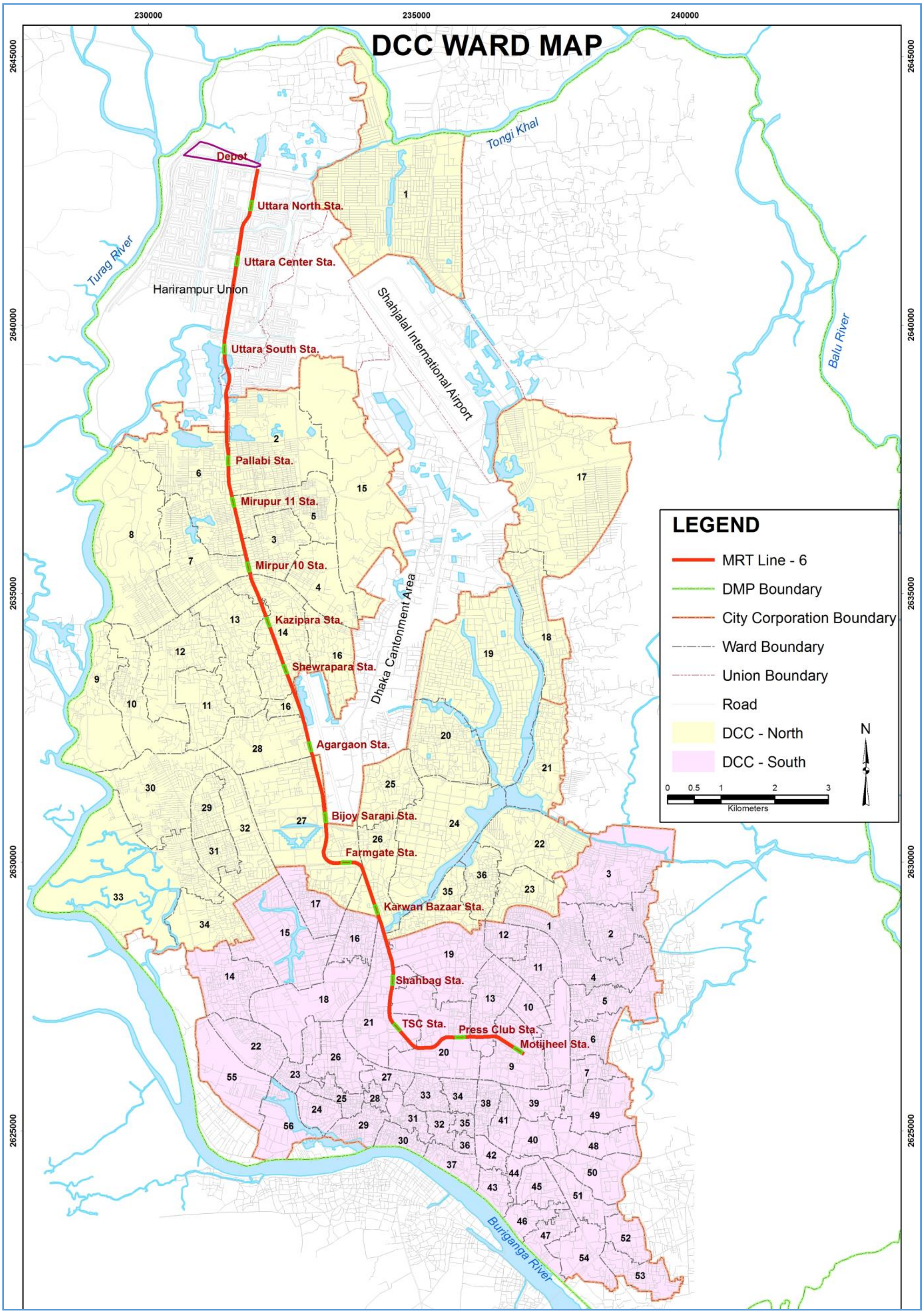


Figure 5-16: DCC Wards along the MRT Line-6 Alignment

Table 5-12: Wards Adjacent to MRT Alignment
(a) Dhaka North)

Ward	Thana Area/Road Name	Nearest Station
Ward – 2	Mirpur Section 12, Mirpur – 12/ West, Kaalshi North	Pallabi Station
Ward – 3	Mirpur Section -10 , Mirpur Section – 11, Block - C	Mirpur – 10
Ward – 5	Mirpur section – 11, Block – A, B, D, E, Bawniya Bheri Badh, Polash Nagar	Mirpur - 11
Ward – 6	Mirpur Section – 7, , Pallabi Wapda Colony, Digun Senanibash, Albody RupNagar Tin shade, Duwari Para, Section – 6, Block – C, D, J, T	No provision of station
Ward – 7	Mirpur Section – 2, Mirpur Section – 6, Block – A & B , Rupnagar , Govt. Housing Estate	No provision of station
Ward - 13	Boro Bagh, Pirer Bagh, Monipur	No provision of station
Ward - 14	Kazi Para, Shewra Para, Sen Para Porbota	Kazipara Station
Ward – 16	Ibrahim, Kafrul	Shewrapara Sta
Ward - 26	Kawran Bazar, Tejtori Para, Tejkuni Para, Railway Colony	Farmgate Sta
Ward - 27	Raja Bazar, Indira Road, Monipuri Para, Sher-e-Bangla Nagar, Green Road.	Bijoy Sarani Sta
Ward - 28	Agargaon Staff Quarter, West Agargaon, Kafrul, Taal Tola Staff Quarter , Shamoli Road no. 1, Space Science Building, G Type.	Agargaon Sta
Ward - 35	Bara Mogh Bazar, Dilu Road, New Eskaton Road, West Malibagh, Middle Peyara Bagh & Green way, North Noyatola.	No provision of station

Note: The area under Dhaka North will also include Uttara North, Uttara Central and Uttara South; yet to be demarcated by RAJUK

(b) Dhaka South

Ward	Thana area/ Road Name	Nearest Station
Ward – 16	Free school St. Kathal Bagan, North Road , Circular Rd. Green Corner, Green Rd. Green Rd West, West Street , Al Amin Rd, North Circular Rd. Free School Street Hatir Pool, Crescent Rd.	No provision of station
Ward – 19	Mintu Rd, Kakrail , Circuit House rd, Shiddeswari rd & lane,	No provision of

	Mogh Bazar Elephant Rd, MoghBazar Ishpahani Kalani, New Eskaton Rd, Eskatan Garden Rd, Aminabad Housing & Eastern Housing Apartment , Baily Square & Baily Rd, Kakrail, D.I.T. colony & West Malibagh	station
Ward – 21	Dhaka University Residential Area, Jahurul Haq Hall, ShaliMullah Hall, Sir Afm Rahman Hall, Shahmsunahar Hall, Jagannath Hall,Kabi Jasimuddin Hall, Mukktijaddha Ziaur Rahman Hall, Surja Sen Hall, Haji Mohammad Mohsin Hall, Bangabandhu Sheikh Majibur Rahman Hall, Mymensingh Lane, Mymensingh Road, PG Institute , National Museum Officers Quarter , PG hospital, Central Public Library, Habibullah, International Student residents, Rokeya Hall, Paribagh Shah Saheb Rd.	Shahbagh & TSC Tsa
Ward – 20	Shegun Bagicha, Top Khana Rd, Bangabandhu Avenue & Rest House, TB clinic Area , Dhaka Medical College Hospital, High court Staff Quarter, Shohrowardi Uddan , Fulbraiya Station west area, West Fulbariya & Secretariat area, Abdul Gani Rd, & Shachibaloi Staff Quarter , West pld Railway Colony , Rail way Hospital Area , Eastern Housing & Toynabi circular Rd, Ramna Green House, Engineering University and residential area, Nazrul Islam Hall, Ahsanullah Hall, Titumir Hall, Dhaka Medical college hostel – Fazle Rabbi Hall, Sher – e – Bangla Hall, Shohrowardi Hall, Shahidullah Hall, Fazlul Haq Hall, Dr. MA Rashid Hall, Shahid Srity Hall, Engineering University Ladies hostel .	Press Club Sta
Ward - 13	ChameliBag& Aminbagh, Rajarbagh Police Line, Purana Paltan, GPO, Baitul Mukaram, Stadium (Swimming Pool, Sports Council) Outer Stadium, Bijoy Nagar, Naya Paltan, Purana Paltan Line, Traffic Police Barack, Police Hospital , C&B Field, Shantinagar & Shantinagar Bazar Area.	No provision of station
Ward – 9	Arambagh, Fakirapool, Fakirapool Bazar area, Motijheel C/A, Dilkusha C/A. Bangabhaban	Motijheel Sta

Source: Dhaka City Corporation

<u>Population</u>

The greater Dhaka metropolitan area has a population of 15 million and covers an approximate area of 1,353 sq km, made up of areas administered by Dhaka City Corporation (DCC) as well as suburban and exurban areas. Over the past decade, both population and core areas administered by DCC have increased (Figure 5-17).

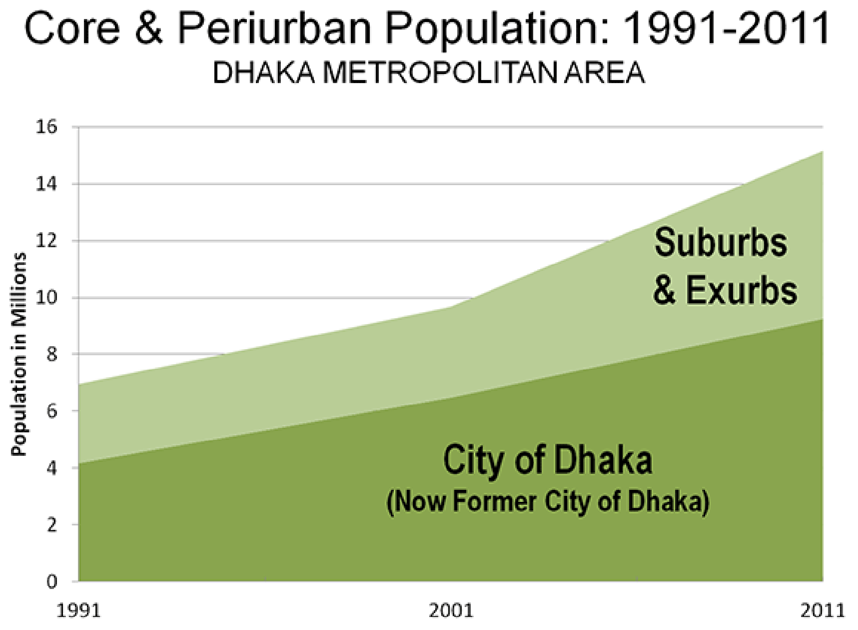


Figure 5-17: Dhaka Metropolitan Area Population Growth 1991-2011

On the basis of the Population and Housing Census 2011, the number of households, and male and female components of the population of wards crossed by the Project are shown in Table 5-13. The sex ratio (male/female) is high in the project area, which is likely the result of in-migration by males without their female counterparts in order to participate in income generating activities and education. The census reports that about 51% of the female population of Dhaka city are married while about one percent are either divorced or separated/widowed. About 46% of males are married while about 53% are unmarried, while 0.78 per cent are either divorced or separated/widowed. The Mean age of marriage for males stands at about 24 years whereas that of females is 17.5.The project interacts with socioeconomic factors and population in a number of ways and at varying distances from the alignment and services.

According to the data shown in Table 5-13, residential areas within the project influence are almost exclusively in the administrative area of North Dhaka (86%), inferring that most morning trips on the Metro will be inbound, returning in the evening, with a mix of travel both in- and out-bound in the afternoon.

Table 5-13: No. of Households and Population for Thana/Wards crossed by the Project

Dhaka North		Population			Dhaka South		Population		
Ward No	Households	Male	Female	Total	Thana/ward	Households	Male	Female	Total
Ward – 2	37,388	79,637	72,231	151,868	Ward – 16	16,220	46,344	33,639	79,983
Ward – 3	22,275	49,093	45,571	94,664	Ward – 19	10,590	27,709	28,211	55,920
Ward – 5	28,346	61,601	56,509	118,110	Ward – 21	3,832	21,857	11,656	33,513
Ward – 6	38,690	86,232	77,538	163,770	Ward – 20	4,875	23,200	11,427	34,627
Ward – 7	12,577	27,018	24,412	51,430	Ward - 13	881	3,500	2,378	5,878
Ward - 13	37,124	83,505	73,701	157,206	Ward – 9	9,394	30,203	11,902	42,105
Ward - 14	21,692	49,272	43,017	92,289	TOTAL	45,792	152,813	99,213	252,026
Ward – 16	35,008	75,213	67,200	142,413					
Ward - 26	12,201	40,739	27,137	67,876					
Ward - 27	13,958	39,962	31,627	71,589					
Ward - 28	15,694	36,028	29,956	65,984					
Ward - 35	10,590	27,709	28,211	55,920					
TOTAL	285,543	656,009	577,110	1,233,119			Male	Female	
Grand Total	331,335	808,822	676,323	1,485,145	Percent		54%	46%	

Literacy rates are available by ward as shown in Table 5-14 alongside sex ratio. The correlation coefficient between these variables is .28, inferring there is little relationship. However if outliers are removed, the coefficient is .63 (see Fig. 5-18), as might be expected given the higher levels of literacy among males.

Table 5-14: Sex Ratio and Literacy Rate by Ward

Ward	Sex Ratio	Literacy Rate (%)	Ward	Sex Ratio	Literacy Rate (%)
Ward – 2	110	69.6	Ward - 26	150	72.7
Ward – 3	108	72.3	Ward - 27	126	84.4
Ward – 5	109	62.6	Ward - 28	120	71.3
Ward – 6	111	74.6	Ward – 16	138	81.3
Ward – 7	111	73.5	Ward – 19	98	84.8
Ward - 35	98	84.8	Ward – 21	188	90.4
Ward - 13	113	78.9	Ward – 20	203	79.11
Ward - 14	115	81.0	Ward - 13	147	78.5
Ward – 16	112	77.1	Ward – 9	254	80.0

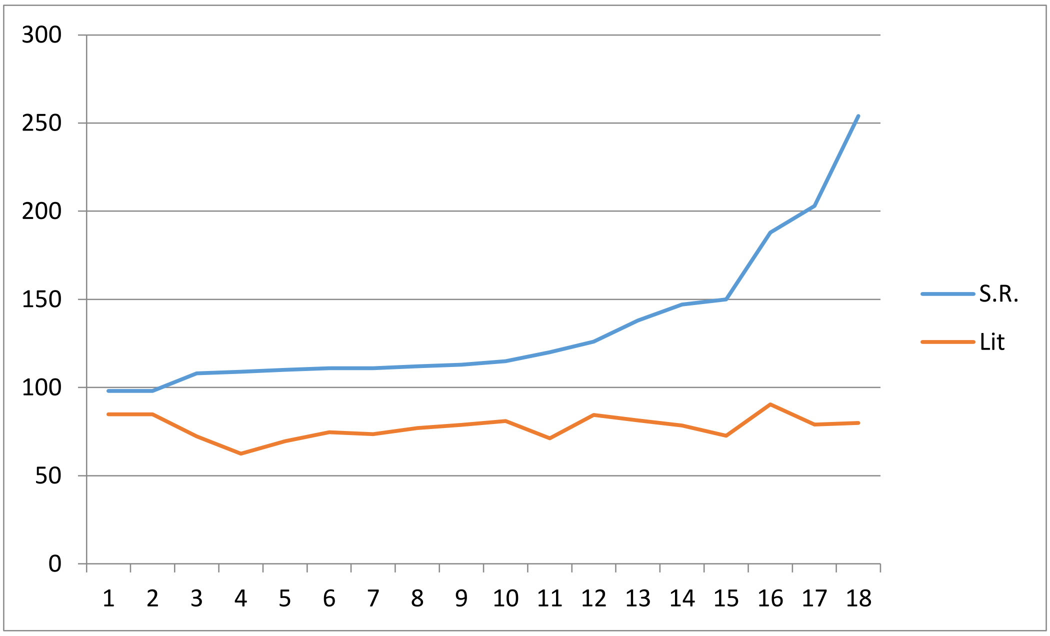


Figure 5-18: Correlation of Sex Ratio and Literacy

5.3.2 Land Use along Rail Alignment

Land use classification in general provides an understanding of the types of permanent land use activity (business, commercial, institutional and residential) underway along the alignment and in the vicinity of the Depot and construction sites (the Project Area). Land use classification is also used in the analysis of noise impacts, since threshold criteria (or standards) depend on the types of land uses near noise sources. Finally changes in land use in a broad sense provide good background for understanding the need and justification for the Project.

Land uses in Dhaka have been classified through academic and government efforts. Different scales are used to describe relevant aspects of land use, depending on the types of available data. Much data are available regarding Dhaka land use change, a topic of great interest and concern, and a source of research interest. One report (Mamun et.al 2013) provides a vivid illustration of land use change in the Dhaka Metropolitan Area (DMA) from 1990 – 2010 (Figure 5-19).

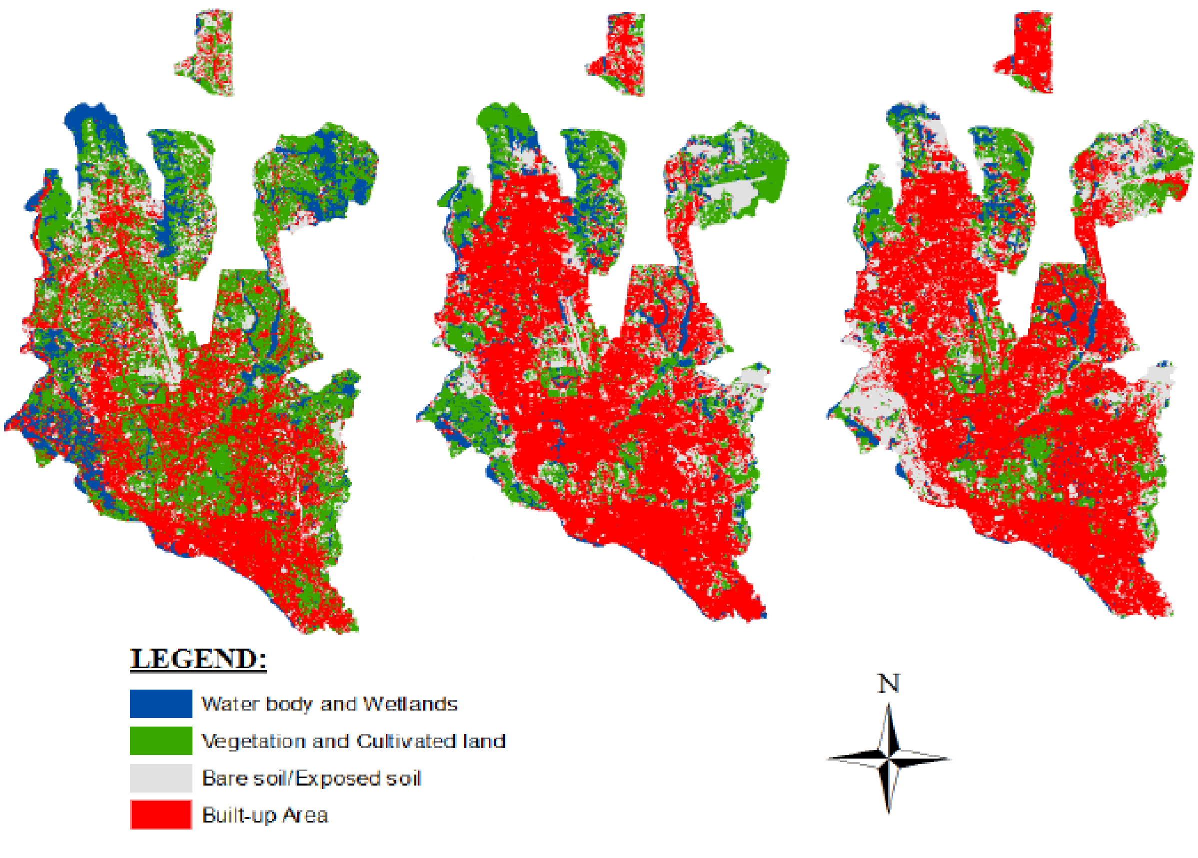


Figure 5-19: Land Cover Map of the Years 1990, 2003 and 2010

As can be seen, urbanization, which generally comes to mean development of office and commercial space as well as infilling of residential areas, has progressed rapidly throughout the City, so that most areas within the DMA are now ‘built up areas’. The type of land use visualization shown in Figure 5-19 is based on wave length filtering of satellite imagery and provides a very basic and realistic depiction of land use change.

Dhaka city growth is moderated and directed according to land use classification and zoning set up by RAJUK (Rajdhani Unnayan Kartripakkha, the Capital Development Authority of the Government of Bangladesh). RAJUK publishes land use maps referred to as “Comprehensive Detailed Area Plan on RS Mauza [base] Map” that both fix and designate land uses. The first phase of the Dhaka Metropolitan Development Plan (DMDP) was prepared in 1997. It is seen as a progressive plan that will provide order to the structure and growth of the City. The preparation of Detailed Area Plans (DAP) is the third and last tier of the Development Plan, done in 2010. These covered growth areas with detailed studies and developed detailed maps for the urbanized area. Most areas along the alignment are outside already urbanized with the exception of the Uttara Phase III, for which a detailed planning study was prepared in 2008. (BRTC and BUET 2008)

The general characteristics of land use in the Dhaka Metropolitan area may be divided into six geographic zones as follows:

a) DCC and Inner City Zone

Most of the areas in this zone are already urbanized and urban services are provided by DCC and also other organizations. Approximate 65% of the land is already built up and the remaining is a part of open space, park, unclassified/restricted area and water body.

b) DMA Fringe Zone

This zone is outside of DCC but within the boundary of the Turag and Balu rivers. Approximate 35% of the land is urbanized and other areas are mostly occupied by low lying land with agriculture ponds or open spaces. Some areas are undergoing land reclamation to develop housing by private developers.

c) RAJUK Northern Zone

Most of the areas in this zone are higher ground. The Dhaka-Mymensingh corridor is especially suitable for industry. Approximate 45% of the areas in this zone has already developed and the remaining is used as cultivated agricultural/open space/forest.

d) RAJUK Southern Zone

This zone is mainly low lying and flood prone. Some 37% of the land has been built up, 44% of the area belongs to the open space/forest/cultivable land. Approximate 16% belongs to char/island/swamp/ marshy land.

e) RAJUK Eastern Zone

Agriculture predominates in this area. Approximate 32% of the land is built up area and 61% of total land belongs to the cultivated land/open space/forest. The Government has initiated housing projects along with private developers.

f) RAJUK Western Zone

Only 35% of the land is built up and another 53% of the land is agriculture and/or flood prone; the road network is very poor.The land use classification maps (Figure 5-20) prepared by RAJUK provides the classifications shown in Table 5-15, which reflect current and transitional uses.

Table 5-15: Land Use Classifications by RAJUK

Commercial Zone (Business)	Commercial Zone (Office)
Flood Flow Zone	General Industrial Zone
Heavy Industrial Zone	Institutional Zone
Mixed Use Zone (Commercial-General Industrial)	Mixed Use Zone (Residential-Commercial)
Mixed Use Zone (Residential-Commercial-General Industrial)	Mixed Use Zone (Residential-General Industrial)
Non-Conforming Use	Open Space
Overlay Zone (non-conforming use allowed to continue)	Proposed Road Network
Rural Settlement Zone	Urban Residential Zone
Water Retention Area	Waterbody

Though legends on the RAJUK maps are difficult to interpret, areas adjacent to the alignment appear to be classified as follows:

- Uttara alignment north of Pallabi is classified as Mixed Use (commercial and general-industrial) and Residential: the latter is based on a planned apartment complex in Uttara Ph III consisting of approximately 240 – 16 storey apartment buildings housing some 20,000 units.[11]
- The class “Overlay Zone” reflects transitions in land use within an otherwise urban and built up area. Much of the land adjacent to the alignment south of Mirpur Rd to the location for the Agargaon Metro Station is thus classified, perhaps indicating a transition from business to office space and/or institutional use. Current land uses along this stretch include commercial and institutional land uses.
- Government low-cost housing that was provided at the time of slum removal at Agargaon is residential but most activity in the vicinity is day use only.
- Land use to the east of the alignment from Pallabito Bijoy Sarani Stations is taken up with the Cantonment and old Airport

[11] www.rajukdhaka.gov.bd/rajuk/projectsHome?type=uap.

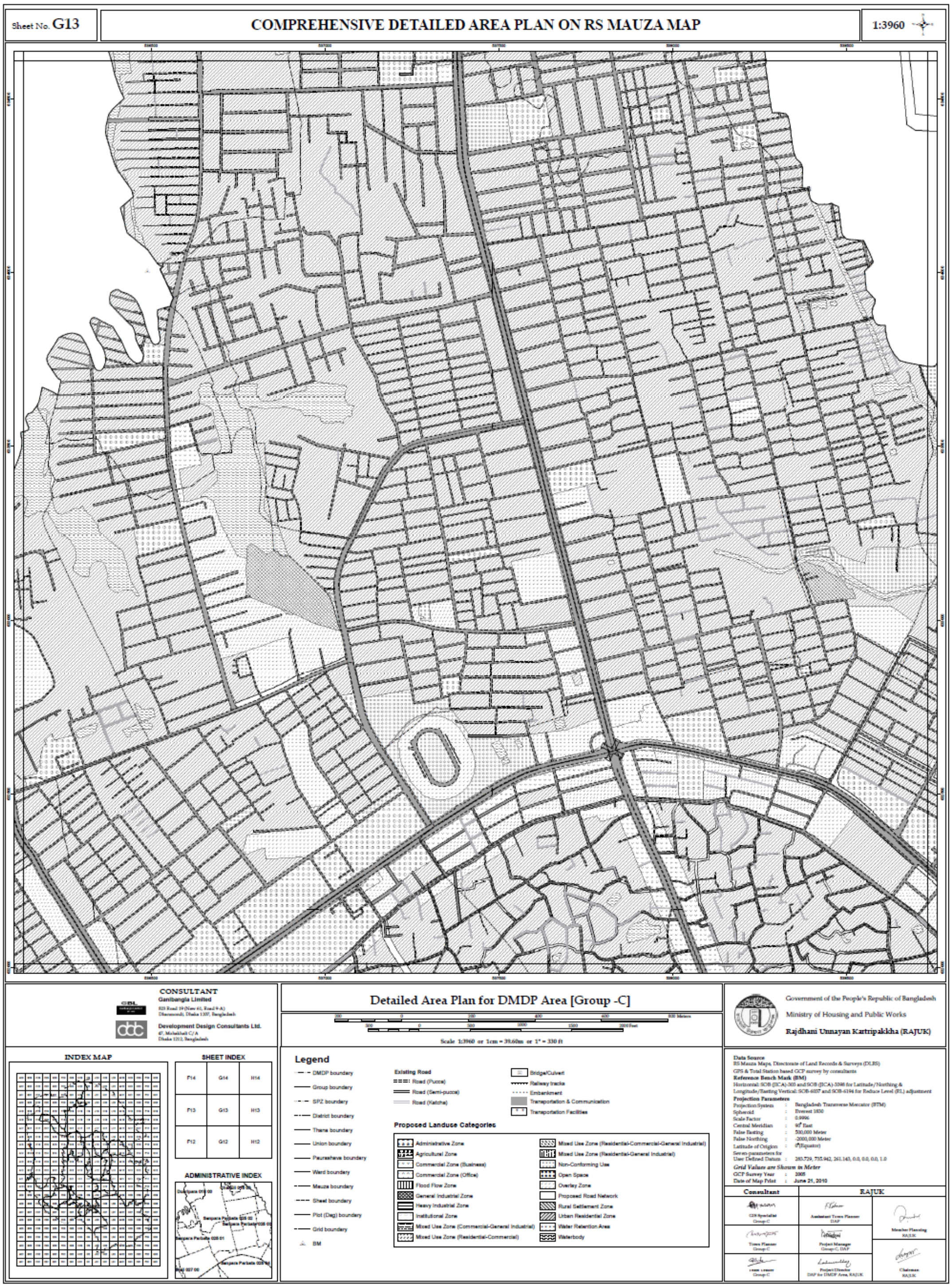


Figure 5-20: Example of RAJUK Area Planning Map

5.3.3 Community Infrastructure

The major community infrastructure in the areas adjacent to the MRT line include educational institutes, hospitals, clinics and diagnostic centers, religious institutions, entertainment facilities, and commercial and business enterprises. Some of these institutions and their locations are given below. Educational institutions are shown in Table 5-16. Probably of greatest importance for the

Metro Project are educational facilities associated with Dhaka University. Health care facilities are listed in Table 5-17, and religious facilities, commercial and entertainment complexes and other forms of community infrastructure are shown in Tables 5-18, 19and 20, respectively.

Table 5-16: Educational Institutions located near Dhaka Metro Line 6

Institute Name	Location
Singapore school Kinder land	Depot Area
Milestone School & College	Depot Area
National Defence College	Cantonment Area
Dhaka Medical Assistance Training School	Pallabi
Candour Intl. School	Mirpur
Juvenile Eng. Med. School	Mirpur
Mirpur Bangla High School	Mirpur
Kazipara Siddikia Fajil Madrasa	Kazipara
ICMC College	Shewrapara
Dhaka International Music School & College	Shewrapara
Agargaon Adarsha High School	Agargaon
Agargaon Govt. Boys' High School	Agargaon
Tejgaon Govt. Girls' High School	Tejgaon
Northern University	Farmgate
London College	Farmgate
Public Library	Dhaka University
Central Library	Dhaka University
Fine Arts Institute	Dhaka University
Curzon Hall	Dhaka University

Table 5-17: Hospitals and Health Care Facilities located near Dhaka Metro Line 6

Health Care Center	Location
Proposed Uttara Crescent Medical College	Uttara
National Defense College	Cantonment
Mini General Hospital	Pallabi
Islami Bank Hospital	Mirpur-2
Rahima Maternity Hospital	Mirpur
Helal Diagnostic Center	Mirpur
Alok Health Care	Mirpur-10
Medicomplex Diagnostic	Mirpur-10
Al- Helal Specialized Hospital	Sen para pabata
Family health Diagnostic	Kazipara
Life Aid Specialized Hospital	Kazipara
Family Central Care	Kazipara
Exim Bank Hospital	Kazipara
Shewrib Dental Clinic	Shewrapara
Lions' Eye Hospital	Agargaon
Henoda Orthodontic & Dental Clinic	Monipuripara
Dental Clinic	Monipuripara
Islamia Eye Hospital	Khamarbari
Ibrahim Medical Hospital (BIRDEM)	Shahbag
BSMMU	Shahbag

Table 5-18: Religious Facilities located near Dhaka Metro Line 6

Name	Location
Mosque	Mirpur 10
Shewra Para Jame Mosque	Shewrapara
Mosque	Bijoy sarani
Mosque	Farmgate

Mosque	Karan Bazar
Baitul Mukarram	Motijheel
Temple	Depot (Uttara North)

Table 5-19: Other Government and Community Infrastructure

Name of the Structure	Location
Sonargaon Hotel	Karwan Bazaar
Hotel Ruposhi Bangla	Shahbag
High Court	Ramna
Bangabandhu International Conference Center	Agargaon

Table 5-20: Commercial and Entertainment Facilities

Name	Location
Appayon Community Center	Mirpur 12
Children's Park	Shahbag
Shohrowardi Uddan	Dhaka University
Shishu Academy	Dhaka University
Shilpokola Academy	Dhaka University
CIRDAP	Press Club
IDB Building	Agargaon
BCS Computer Center	Agargaon
Mirpur Stadium	Mirpur

5.3.4 Housing

According to the 2011 census, Dhaka residents occupy apartments (6.5%), row houses/barracks (16.5%) and free-standing houses (77.7%). No similar data are available for the wards adjacent to the alignment. Middle and upper class people live in apartments and houses while lower classes live in semi-pucca houses built in part of substantial material such as stone, brick, cement, concrete, or timber, and tin-shed barracks. A significant amount of floating population lives in squatter settlements and slums, especially those who migrate from rural areas; and there are homeless that live in the streets and in open spaces. The distribution of households by room size is shown in Table 5-21.

Table 5-21: Distribution in Dhaka of Dwelling Size by Number of Rooms

House Hold Size	No. of RoomsOccupied by Household					
	1	2	3	4	5	6
4.29 Average	46.8%	18.7%	14.4%	9.6%	7.3%	3.4%

5.3.5 Water and Sanitation Services

Water supply coverage in Dhaka stands at about 89%, with the balance using alternative supplies (wells, surface water, hauling). WASA sewerage collection and treatment coverage stands at about 40%, mostly in the areas toward the south of the City. Buildings and homes are typically equipped with onsite systems that release sullage water to local drainage. According to Wikipedia, "about 38% of the population is covered by a sewerage system. There is one wastewater treatment plant with a capacity of 120,000 m^3 per day. About 30% of the population uses conventional septic tanks and another 15% uses bucket and pit latrines. During the rainy season, sewage overflows are common." Most buildings adjacent to the arterial roads that serve as the alignment for the metro are equipped with working onsite sewage treatment systems. Dhaka produces some 3,000 MT of solid waste per day, mostly going to Mateuil Landfill that is located on the east side of the City in Demra. Garbage collection is done by the City Corporations and by private contractors. There is also a large waste recycling industry undertaken by small and medium sized operators. NGOs and charitable organizations also play a role in solid waste management by introducing and testing innovative technology.

5.3.6 Transport Assets

Growth of transport vehicles is shown in Table 5-22. Overall growth of passenger vehicles is 49% over the last five years. Recurring growth is gradually falling from 13% to 3.3% which shows that the saturation level (0% growth) may be reached in the next five years. Congestion on roads, and lack of road space for driving and parking will force people not to buy more vehicles.

Motor cycles (76.4% growth over the last five years) will supersede cars and other 4-wheelers soon. Many old buses and mini buses are operating on the roads and cause air pollution. They are planned to be replaced in phases. Growth in the public transportation system is not high.

Growth of goods vehicles is very high. In last 5 years, their combined growth is 177%. The number of trucks has increased 2.5 times over the last five years. While the increase in freight traffic is a sign of prosperity, maintenance of the National and Regional highways needs to be improved, and development of new regional roads is needed to cope with the challenges of growing freight traffic.

Table 5-22: Growth in Number of Motor Vehicles

Type of Vehicles	Upto-2009	2010	2011	2012	2013	May-14
Public Transport Vehicle Numbers						
CAR JEEP TAXI	197660	218535	231708	241179	251521	258019
BUS	15552	16783	18284	19502	20473	20967
MINI BUS	9341	9490	9629	9732	9815	9846
MICRO BUS	40503	46202	49742	52385	54612	56245
MOTOR CYCLE	179383	210081	244789	277599	303930	316370
AUTO TEMPO	1659	1662	1663	1663	1663	1663
AUTO RICKSHAW	7612	7664	7775	7835	7837	7868
TOTAL	451710	510417	563590	609895	649851	670978
RECURRING	GROWTH	13.0%	10.4%	8.2%	6.6%	3.3%
CUMULATIVE	GROWTH	13%	25%	35%	44%	49%
Goods Vehicle Numbers						
LGV	30557	39979	50463	57637	65780	70510
TRUCK	22299	26922	68972	71796	75318	78599
TANKER	719	817	969	1059	1195	1277
OTHER TYPES	9152	12224	16590	19573	22135	23315
Total	62727	79942	136994	150065	164428	173701
RECURRING	GROWTH	27.4%	71.4%	9.5%	9.6%	5.6%
CUMULATIVE	GROWTH	27%	118%	139%	162%	177%

Accidents and Injury on Roadways

Statistics available from the NKDM traffic demand study indicate that economic losses due to traffic accidents are on the order of 2 to 3 percent of GDP. Police reported accidents on Bangladesh roads causing at least 3,000 fatalities annually, and grievous and simple injuries of around 3500. Other sources estimate fatalities as high as from 12,000 per year, which is severe by international standards. There are some 60 to 150 fatalities per 10,000 motor vehicles in Bangladesh compared to round 25, 16, 2 and 14 in India, Sri Lanka, USA and UK respectively.

5.3.7 Religion

Islam is the dominant religion in Bangladesh, followed by Hinduism, Christianity, Buddhism, Animism and various tribal belief systems. Dhaka is a cosmopolitan, secular city and the majority of its inhabitants are Muslim. The traits of secularism are ensconced in Dhaka, based on education, enlightenment and engagement in the global economy. The dwellers of Dhaka maintain their religions in harmony and fraternity irrespective of religious beliefs.

5.3.8 Crime and Criminal activities

Dhaka has been the scene of a variety of violent crimes, including drug trafficking, organized crime and sexual abuse. Some of these behaviors are associated with affluence, while others stem from unemployment, under-employment, deprivation, frustration and political motive. The pattern and types of crime have changed over the years along with a shift in the stratification of society. Crime and violence affect all members of society regardless of sex, age, and income, but are more prevalent in urban areas, especially among the poor living in marginalized neighborhoods. Crime intrudes into homes, schools, commercial establishments, public transport, and sports and other public venues. Fear of crime changes the living habits of people. Concern about crime pushes wealthier populations out of city centers and into segregated, enclosed, private and fortified enclaves. Apart from the human suffering inflicted, crime acts as a stumbling block for social development.

The causes of crime may lie with the mastans (local gang-members), which are blamed for more than half of the crimes committed. Government activists are also responsible for acts of arson and murder.

The city administration has recently taken several measures to combat crime and criminal activities. Community policing and community-based organizations such as volunteer committees, clubs and organizations take part in public awareness and corrective measures, which have seen an increase that has lowered the crime rate. Special branches of the police force and paramilitary, such as Rapid Action Battalion, have been given special responsibility to increase awareness among communities and to combat crime and criminal activities at the local level.

5.3.9 Gender Based Violence

Patriarchal norms still shape the gender relations of the country to a significant extent. However, this attitude has been challenge both in urban and rural areas. Changes in patriarchal, gender-based relations to create a more equitable balance is a remarkable achievement of post-independence Bangladesh. Reducing patriarchal influence in gender relations implies that social justice is being achieved and empowered women are contributing to national reconstruction.

The current participation status of women in different sectors of the economy needs to be better understood to ensure equal participation of women in economic development. Gender disaggregated data is essential for formulating an effective plan for women's empowerment and to monitor the progress of women in different sectors.

5.3.10 In and Out Migration

Migration is described as the movement of persons who change place of residence for a period of six months or more. Internal migration is the process of migration that takes place within the country. Migration is an important component influencing growth and redistribution of population and resources.The analysis of data on migration is essentialfor the socioeconomic planning process. Migration takes place in different ways. In case of permanent migration, the migrant leaves the place of birth once-and-for-all and remains at the place of destination; whereas repeated changes of residence may take place in the case of temporary migration.

In and out-migration rate for 1985-2010 is presented in Table 5-23. In-migration for both sexes, for women, and for men was found to be 35.3, 41.4 and 26.1 per 1000 population, respectively in 2010; while out-migration was found to be 36.1, 41.8 and 30.3. There is an increasing trend for out-migration from urban to rural areas.

Table 5-23: In-out Migration per 1000 Population, 1985-2010

YEAR	In-migration			Out –migration		
	Both	Women	Men	Both	Women	Men
1985	9.8	-	-	8.0	-	-
1990	16.2	-	-	10.1	-	-
1995	18.6	-	-	13.4	-	-
2000	22.2	-	-	15.8	-	-
2006	33.5	38.9	28.3	28.9	34.1	23.8
2008	30.6	34.2	25.5	28.6	29.3	23.3
2010	35.3	41.4	26.1	36.1	41.8	30.3

5.3.11 Employment

Research findings and BBS data show a significant number of the labor force employed in Dhaka city both formally and informally. The percentage of formally employed is higher in Dhaka city in comparison with the informal sector. Employment includes white collar work, business entrepreneurship, transport workers, garment workers, industrial laborers, petty traders, floating business people, maid servants, hotel operators and servers, vendors, hawkers, welders, rickshaw drivers and van pullers.

Readymade garments is the leading sector in terms of women workers' employment in Dhaka city. At least 2.7 million women workers are employed in Dhaka city and its peripheral sub-urban areas in this sector. The female labor force has radically transformed the socioeconomic setting of Dhaka city. Women are empowered through this employment opportunity which improves their status and helps them maintain better livelihoods in terms of education, health, housing, sanitation, safety and security.

A number of self-employed people in various professions and occupations have developed in Dhaka and its peri-urban areas. There are significant numbers of service providers in small-scale and advanced technologies related to areas of the internet and cable services.

5.3.12 Social Impact Survey

A social impact survey was conducted in 2011 for the Preparatory EIA and the results are described in this section.

5.3.12.1 Bus Owner Interview Survey

a) Objectives of the Survey

Bus transport in Dhaka is a trunk system for public transport. When the MRT Line 6 is completed, the bus transport system along UTTARA Phase-3 – Saidabad corridor will be compete with MRT Line 6.

The Phase 1 Study (DHUTS 1) conducted a social and traffic survey of bus transport through interviewing selected bus owners/operators that have competitive routes with MRT Line 6.

b) Bus Owner to be Interviewed

Bus routes were identified through spatial analysis to identify those which were competitive with the proposed MRT Line 6. Total competitive bus routes were 76 in number and bus routes were owned by different companies. Out of 76 companies who are more or less affected by MRT Line 6, the Preparatory EIA Study Team selected 34 bus companies for interview.

c) Results of the Survey

Targeted bus owners were all private operators. The companies have operated their businesses for periods ranging from 2 to 36 years and their distribution is shown in Table 5-24.

Table 5-24: Years in Business for Bus Operators

No. of Years in Business	No. of Companies
Below 10	22
11-20	1
Over 21	11
Total	34

d) Impact by MRT Line 6 Projects

Out of 34 respondents, 31 or 91% considered that there would be some impact from MRT Line 6 on their business. However the perceived impact varied. Most of the respondents answered that their profits will be less due to competition with MRT, and the number of bus users would decrease. Responses are shown in the bar chart in Figure 5-21.

e) Project Acceptance

Despite the perception there would be competition between the MRT Line 6 and bus services, all the bus operators indicated acceptance of the project without any hesitation.

f) Countermeasures by Bus Owners

When survey respondents anticipated severe effects from competition with MRT Line 6, the survey methodology attempted to find out what countermeasures operators might take to minimize the effect. The bus operators arrived at a mix of countermeasures as shown in Figure 5-22.

5.3.12.2 Bus Driver Interview Survey

a) Objectives of the Survey

Bus transport in Dhaka City is the only means of public transportation mode for middle and low income people from one place to another. Accessibility and mobility are two important needs of city dwellers that have to be met through public transport. The public transport system in Dhaka suffers due to traffic congestion that undermines these transport objectives. Still the MRT Line 6 once completed will be in competition with the bus transport system. A bus driver interview survey was carried out as part of the social impact survey by the JICA Study Team under the Preparatory EIA (2011) in order to determine perceptions of potential economic impact among this group.

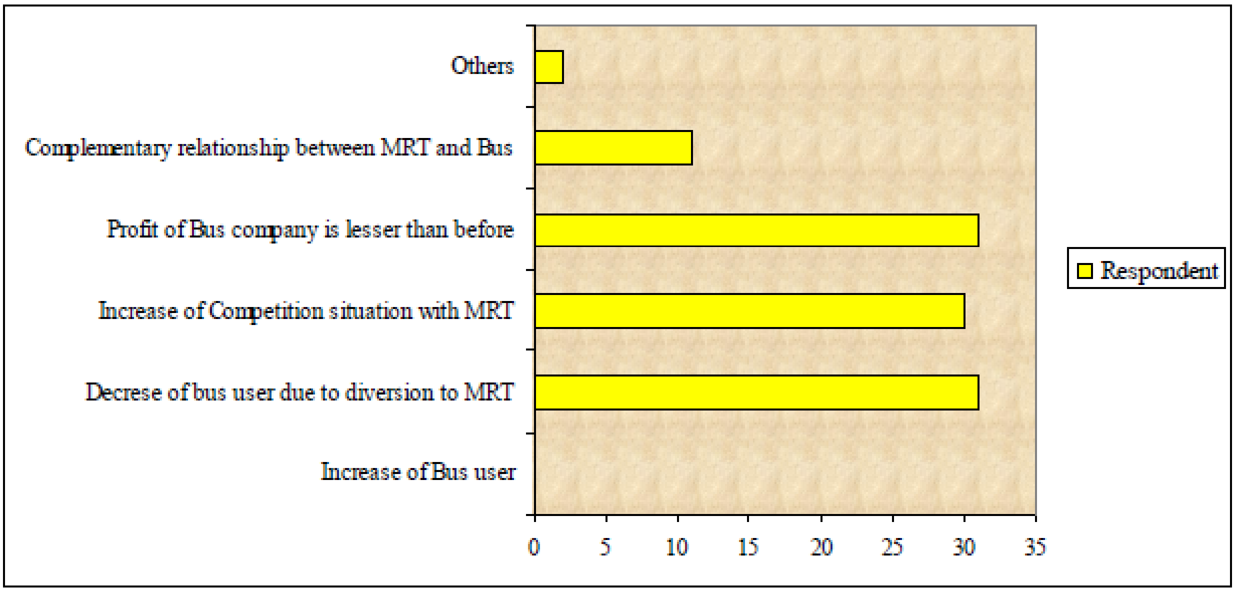


Figure 5-21: Perceived Impact from MRT Line 6 on Bus Operators

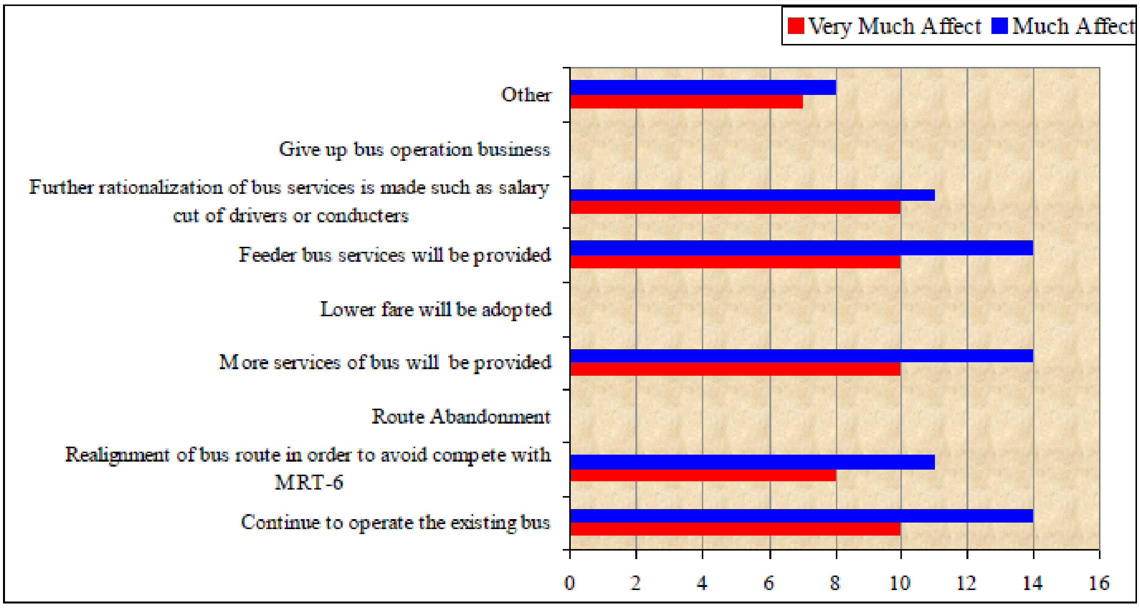


Figure 5-22: Selected Countermeasures by Bus Owners

b) Characteristics of Bus Drivers

All the bus drivers interviewed were male (in Bangladesh usually the drivers in public bus services are male), employed by the bus company owner and their age range is 20-48 years (see Table 5-25).

All bus drivers are directly employed and none drives under lease arrangements due to the liability in case of accident, and associated expenses and risk (business risk). Their preferred option is to be employed, in which case the drivers are paid on the basis of daily trips (round trip, 100.00 to 120.00 BDT/trip) and their average working days are 20 days in a month.

Table 5-25: Age Range of Bus Drivers

Age Range	Drivers Interviewed
20-30	24
31-40	23
41-50	13
Total	60

c) Impacts from MRT Line 6

The introduction of MRT Line 6 was perceived by 55 respondents (92%) to have an impact on their employment.

d) Project Acceptance

Project acceptance, based on responses from bus drivers, was very positive. Although the project might negatively affect their employment, for the sake of the community and sense of social responsibility, all respondents accept the project.

e) Countermeasures by Bus Drivers

Possible countermeasures by bus drivers were suggested during the interview and the results are shown in Figure 5-23.

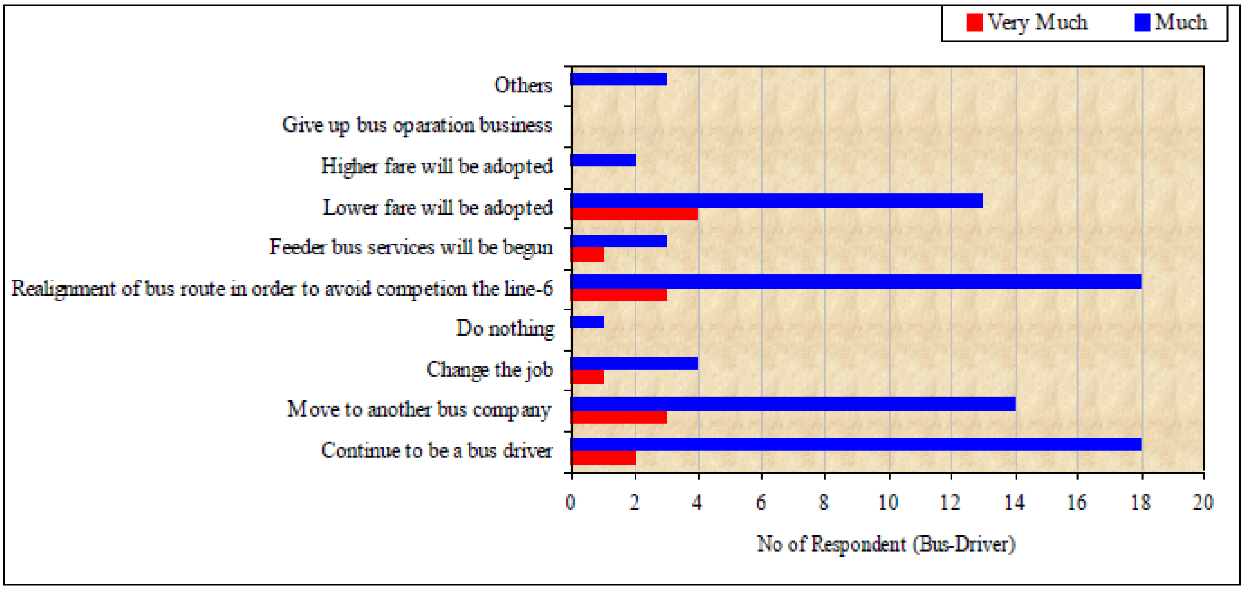


Figure 5-23: Countermeasures by Bus Drivers

5.3.12.3 Rickshaw Owner Interview Survey

a) Objective of the Survey

Rickshaws are an important means for short distance travel in Dhaka and a means of connectivity to bus transport. When the MRT Line 6 is complete, rickshaws will operate similarly as a means of access and connectivity with the trunk transport provided by MRT Line 6. Social and traffic surveys of rickshaw owners, pullers and users were conductedalong with the bus transport survey.

b) Rickshaw Owner to be interviewed

Fifty (50) rickshaw owners out of 100 rickshaw owners were randomly selected from the address collected during the pre-interview survey. These samples had been collected from the vicinity of Pallabi, Kazipara, Agargaon, and Motijheel stations along the MRT Line 6.

c) Results of the Survey

Most of the rickshaw owners have operated their businesses for lengthy periods, as shown inTable 5-26.

Table 5-26: No. of Years in Operation for Rickshaw Operators

Business Year	Number
Below10	7
11-15	10
16-20	16
Over 21	17
Total	50

Out of 50 respondents, 38 respondents or 76% of rickshaw owners think that the project will affect their business. Project acceptance was however unanimous among the interviewed operators.

d) Countermeasures by Rickshaw Owners

Responses to the possible countermeasures suggested to the rickshaw operators are shown in Figure 5-24.

5.3.12.4 Summary of Social Impact Surveys

A further survey was taken of CNG drivers that is not reported here, as well as user demand and willingness-to-pay surveys that have been superseded by the work done during the project design phase by the transport planning group. The conclusions are that while existing transport operators can perceive a potential impact on their employment and livelihood, all agree on the need for the Metro. Further, interest in using the Metro was high as of 2011 when the surveys were performed.

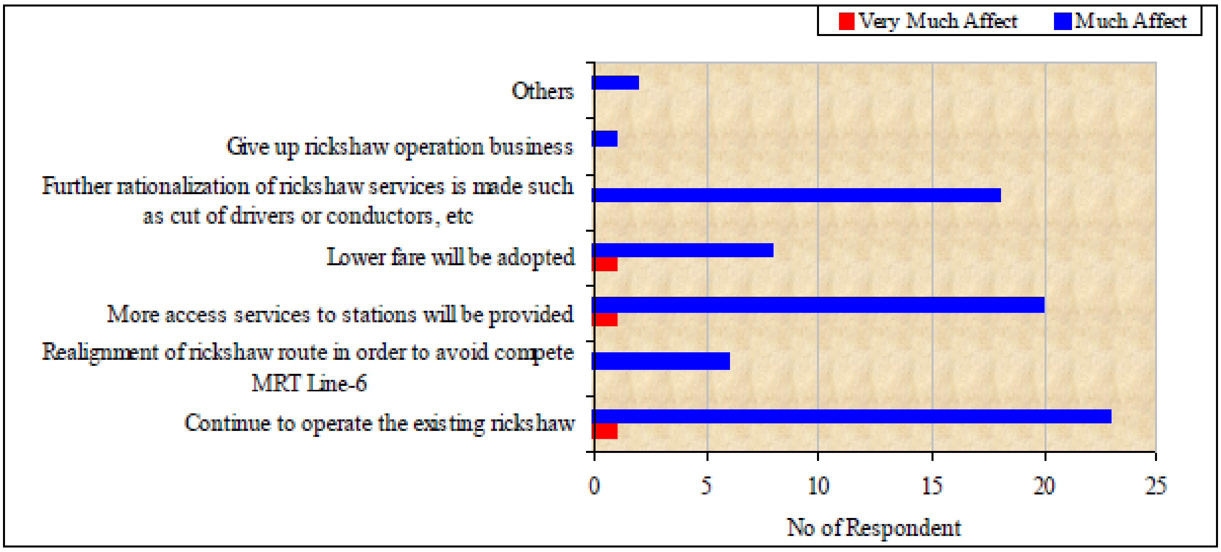


Figure 5-24: Countermeasures by Rickshaw Drivers

5.4 Historical, Cultural and Archeological Sites

A survey of was conducted to identify historical and archeological sites of interest within one km of the Metro Line 6. A total of 20 important sites were identified within the range of the survey, which are listed in Table 5-27. Figure 5-25 shows the main concentration of these sites to be along the southern portion of the Metro line.

Historical and archeological sites can be affected by excess ground vibrations. These sites are well known to the design team and are accounted for and protected in the design proposals for the Metro. See Sec. 6.2.1 for further comment on the effect of vibrations on historical structures.

Table 5-27: Important Historical and Archeological Sites Close to MRT Line 6

SL	Site Name	Importance
1	Haji Khawaja Shahbaj Mosque	Ancient religious monument containing Mughal features.
2.	Haji Khawaja Shah baj Tomb	Ancient religious monument containing Mughal features.
3.	Tin Netar Majar	Monument to three renowned political leaders of the sub-continent.
4.	Dhaka Gate	Example of Mughal architecture located along the MRT Line 6 alignment.
5.	Doyel Chattar	Monument of national symbolic importance, expressed by Doyel bird.
6.	Curzon Hall	British-era building; example of aesthetic architecture of that time.
7.	Musha Khan Mosque	Ancient religious monument built during Mughal Period by Musa Khan.
8.	Kadom Fuwara	Fountain of national symbolic importance, expressed by Kadom flower.
9.	Chamerry House	British-era building; example of aesthetic architecture of that time.
10.	Old High Court Building	Historical building important for the history, culture and heritage of country.
11.	Bangladesh National Museum	National museum representing the national history, culture and heritage.
12.	Bangla Academy or Bardhaman House	Building of historical and culturalimportance.
13.	Khawja Ambar Mosque	Ancient religious monument containing Mughal features.
14.	Suhrawardy Uddyan or Ramna Racecourse	Historical place with historical links with national independence.
15.	Greek Monument	Example of Greek architecture in Dhaka.
16.	Jatiya Sangsad Bhaban	Building with significance for Bangladesh national heritage.
17.	British Bungalow	British-era building; example of aesthetic architecture of that time.

18.	Old Dhaka Airport	Historical importance as the first airport in the Bangladesh.
19.	Baitul Mokarram Mosque	Important religious structure.
20.	Shapla Chattar	Monument of national symbolic importance, expressed by Shapla flower.

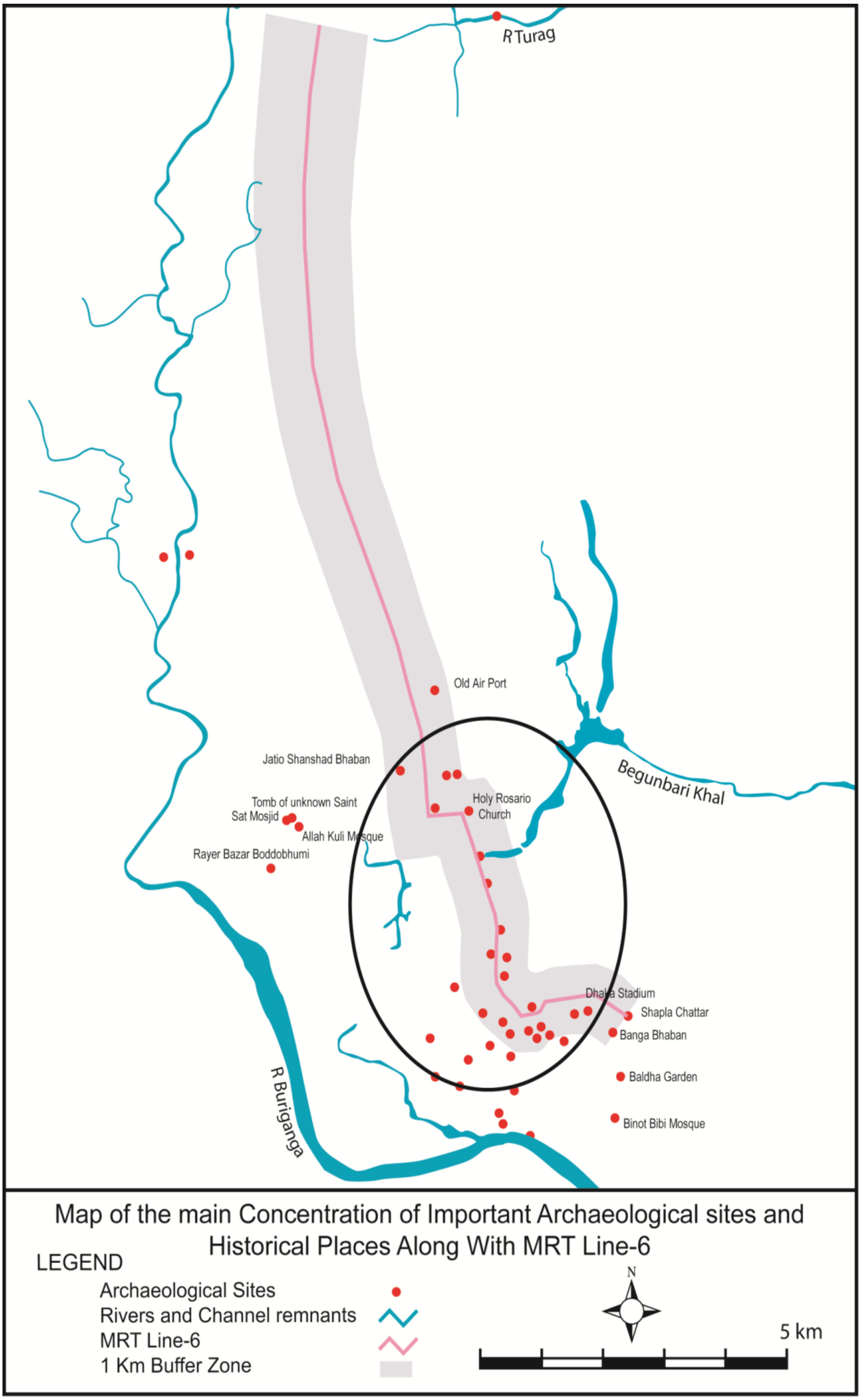


Figure 5-25: Historical and Archeological Sites along MRT Line 6

5.5 Current and Proposed Development Activities in Project Area

Uttara Phase III Development by RAJUK

The development plan for Uttara Ph III is shown in Figure 5-26. According to RAJUK, the development is the largest ever planned apartment project in the country, and will provide more than 20,000 flats in 14-15 storey buildings, to be constructed under RAJUK's supervision (40 of the total of 79 Type A apartment buildings), and the remainder by the Public Works Department, for a total of 6,636 flats. The balance of flats are in Type B and C buildings, for which "the Malaysian Government and many other foreign developers and investors are showing their interest."

Dhaka Elevated Expressway (DEE)

The Dhaka Elevated Expressway will run from Hazrat Shahjalal International Airport alongside New Airport Road, then follow the rail alignment through Mohakhali, Tejgaon and Moghbazar to Kamalapur Rail Station. The Expressway then passes through Golapbag south of the Kamalapur Stadium and east of Jatrabari to connect to the Dhaka-Chittagong Highway near Kutubkhali. The DMRTDP crosses the DEE at two locations: near Farmgate where an access ramp for the DEE will pass under the Metro viaduct; and between Karwan Bazaar and Shahbag Stations.

A series of meetings and joint working sessions were held between the MRT design team and DEE design team. Finally it was decided that MRT will go over the DEE fly-over. Because of this, the elevations of 2 MRT stations, namely, Farmgate and Kawran Bazar will be higher than other MRT stations. Moreover, both team jointly worked out to finalize the locations of the piers for both the Projects at and near the crossing points.

5.6 Conclusion

The Metro project is compatible with the baseline conditions along Line 6, and is a well-suited environment for operation of the Metro. Those conditions will pose challenges to construction of the Metro, due to soil conditions at the depot site, and existing traffic conditions and adjacent land uses along the alignment. The EIA approach provides a means of highlighting conditions where adverse effects are possible; the NKDM design team is fully aware of baseline conditions and provides important information, plans and designs for mitigating impacts.

Social survey results in the description of baseline conditions (Sec. 5.3.12) that describe impacts on employment and livelihoods are a natural consequence that occurs when a preferred transport mode overtakes an existing arrangement. The factors considered as impacts by the survey, if they were not to occur, would indicate a noncompetitive condition for the metro, inclusive of lost opportunity for mitigating climate change through GHG abatement.

Socioeconomics and land use are in transition in an increasingly urbanized space along the alignment, which is primarily commercial, but with a sizable share of day-time institutional use in buildings along the alignment. There is little night time use, which contributes to ease of construction during night time hours.

Figure 5-26: Uttara Phase III Plan Layout

CHAPTER 6 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

Environmental assessment involves weighing the likelihood of an event and the magnitude of its impact on an affected resource. Environmental impacts can be minimized in the planning and design of the Project, and mitigation measures can be applied during construction and operations phases.

The scope of work for NKDM in its contract with DMTC specifies a high level of accountability for environmental design of equipment and facilities; construction management; and health and safety. Environmental design aspects are described in Chapter 3. Development of the construction tender documents requires that all aspects related to sequencing be considered. The owner through NKDM seeks to mitigate construction environmental impact. NKDM has prepared extensive plans to address traffic management and other issues including health and safety, and HIV/AIDs awareness. The RAP and land acquisition plan also are separate documents. The plans and reports are at various stages of completion while the EIA is being prepared. The findings of specific studies are summarized in this chapter and included by reference. Copies of reports are available through DMTC.

Construction mitigation measures are required to reduce adverse impacts. The specific situation, or context for an impact, determines which set of mitigation measures should be undertaken by the contractor for a particular impact. In general these measures are implemented in a progressive fashion from the standpoint of cost-effectiveness (highly effective, at less cost, is best), where “effective” refers to reducing the impact on the receptor. Mitigation measures also should be appropriate for actual field conditions. DOE environmental quality standards for air, noise and water play an important role in determining the extent of mitigation measures that need to be applied by the Contractor.

Use of the terms significant and insignificant in the following sections denote impacts that are investigated through analysis, and impacts that are so minor as to not require further analysis.

6.1 Noise

Noise is measured in a weighted decibel units, typically 10 minute averages, but may also be one hour, or day-night (24 hour) averages. Other units of sound measurement may also be used on occasion.

Depot: Noise issues during the construction phase are significant, in particular during site infilling, and to a lesser extent during above-grade construction. Noise emissions during operations are insignificant; noise levels measured outside the perimeter of the site are expected to be quiet except for occasional instantaneous noises due to switchyard activity. Machine shop operations are enclosed in a building, and the site is enclosed by a 3 m high peripheral wall.

Further, there are few receptors in the vicinity of the depot site, and land use within a 50 m distance of the depot boundary can be considered industrial.

Alignment: Noise issues are significant along the alignment both during construction and operations. Construction of foundations and piers, and erection of precast viaduct sections, will generate moderate noise. Construction of stations will be relatively quiet as the work is elevated.

Train transit operations is a significant noise source; station operations are quiet.

Temporary construction sites and haul routes: Activities at temporary construction sites will generate noise from within the property boundary; degree of impact depends on the distance from a noise source to the receptor. Noise will be generated on haul routes from passage of heavy trucks. Presence of receptors depends on selection of the route. Routes can be selected along major roads already affected by high noise levels and no residences.

This section proceeds with analysis of transit noise levels during operations, followed by analysis of construction-related noise sources and impacts.

6.1.1 Train Operations

6.1.1.1 Procedure

The movement of trains along the viaduct produces a transit noise that is described in this section. The analysis relies on comparing combined ambient and predicted noise levels with DOE's ambient noise standard. A simplified diagram reflecting the approach is shown in Figure 6-1. A target noise level is set based on prevailing ambient noise standards, calculations are performed to predict noise levels using input parameters that reflect the speed of the train, curvature of the rail and structural configuration of the viaduct (height, parapet walls and other features). Comparison is made with ambient noise levels measured during the project (Section 5.1.4), and noise components are added logarithmically for a combined noise level. Mitigation measures include use of special mass spring system (MSS) track and noise barriers.

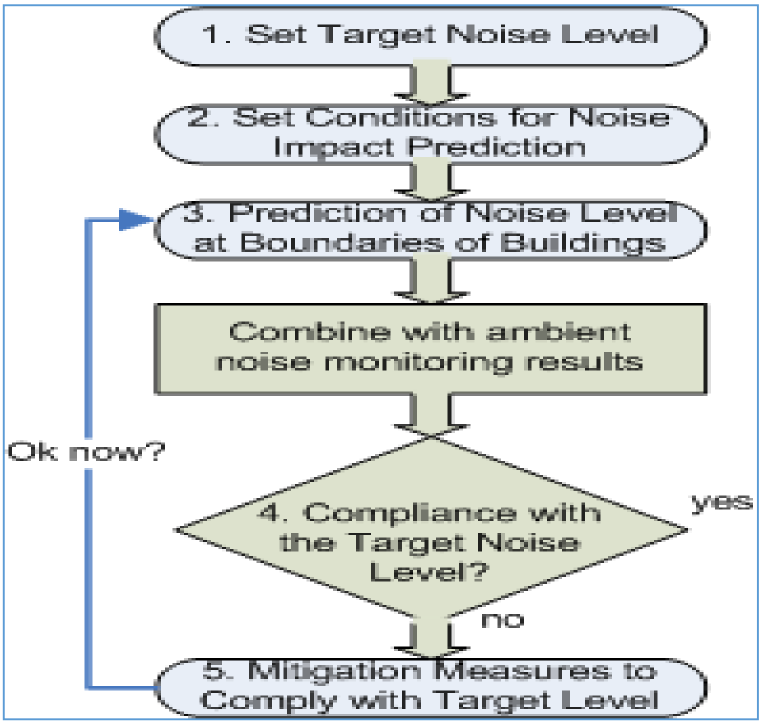


Figure 6-1: Procedure of Noise Impact Analysis during Operations

6.1.1.2 Target Level

DOE ambient noise criteria are shown in Table 6-1.

Table 6-1: DOE Ambient Noise Standard (dBA)

	Category	Day	Night
a.	Silent zone	45	35
b.	Residential area*	50	40
c.	Mixed area	60	50
d.	Commercial area	70	60
e.	Industrial area	75	70

*Mainly residential area, and also simultaneously used for commercial and industrial purposes.

Neither sound receiving point nor receptor height is specified in the DOE regulation. Japanese Noise criteria “Noise Reduction for Newly-established or Massive Improvement of Regular Railway Lines” published by MoE, Japan provide the following guidance:

a) Sound receiving point shall be 12.5 m distance from center of track and the height shall be 1.2 m above ground.

b) Leq shall be less than 60dB during day time (7:00~22:00) and less than 55dB during night time (22:00~7:00).

Japanese guidance also requires that "necessary noise reductions shall be put into place in case of existing facilities in proximity to track such as school, hospital or other facility, which requires silence." This analysis assumes Leq (A rated equivalent noise level) standard to be 60 (daytime) and 55 (night time), with attention to sensitive receptors along the alignment that could be affected by excessive noise.

6.1.1.3 Conditions

The general input conditions for the analysis of noise impacts during operations are shown in Table 6-2. These vary in special cases as described in the following sections.

Table 6-2: Conditions for Predicting Operations Noise Levels

Item	Condition
Rail Type	> 400 m radius of curvature, or curve radius
Track Structure	Ballast-less track with or without MSS bearing
Height of Bridge Railing	1.0 m (increased as necessary with sound barrier, 0.5m)
Prediction Point	12.5 m (Japanese standard) and at sensitive receptors
Operating Speed	per CBTC system
Train length	160 m
Number of trains per day	based on 2026 and 2051 operating scenarios

6.1.1.4 Method for Predicting Transit Noise

The approach follows generally that prescribed in "Draft Proposal of the Prediction of Noise from Elevated Railway" written by Dr. K.Ishii et. al.[12], and has been used on numerous elevated metro rail projects. The noise from a moving train on an elevated railway is categorized into the three types, Rolling Noise, Structure Noise, and Vehicle Device Noise. This method predicts peak level dB and uses a conversion formula to obtain Leq-10 (equivalent 10-minute A-weighted sound pressure level, in busy hour). Combined noise levels and ambient noise measurements are calculated for the receptors.

[12] K. Ishii (Institute of Industrial Science, University of Tokyo), M. Koyasu (Kobayashi Institute of Physical Research), Y. Cho and H. Koba (Bureau of Construction, Tokyo Metropolitan Government), Journal of the Institute of Noise Control, Japan 1980.

Rolling Noise Power Level (L_{W1})

Rolling Noise Power Level (L_{W1}) is determined by applying the following formulas that are dependent on the velocity of the moving train, radius of curvature of the track and use of ballast-less versus vibration-proof, or mass spring system supported (MSS) track. Steep curves in the alignment produce a condition under which excessive noise is generated. Curvature is a key variable in determining noise levels, as is velocity of the moving train.

a) Ballast-less track: straight section and relaxed curve (R>=400m) section

L_{W1}= 13.7 log10V+75.7, where V = velocity of the moving train

b) Ballast-less track: sharp curve (R<400m) section

L_{W1}= 13.7 log10V+75.7+4.6

c) Vibration-proof: straight section and relaxed curve (R>=400m) section

L_{W1}= 13.7 log10V+72.7

d) Vibration-proof: sharp curve (R<400m) section

L_{W1}= 13.7 log10V+72.7+4.6

L_{W1} is converted to LA1 (Rolling Noise (dB)) using the following formula:

$$L_{A1} = L_{W1} - 8 - 10\log_{10} r_1 + 10\log_{10}\left[\frac{(l/2r_1)}{1+(l/2r_1)^2} + \tan^{-1}(l/2r_1)\right] + \alpha_d$$

dB, where

r1: Distance between track center and sound receiving point (m)

l: Train length (m)

αd: Effect of straight rail versus curving section.

Distances and relationships are shown on the following Figure 6-2.

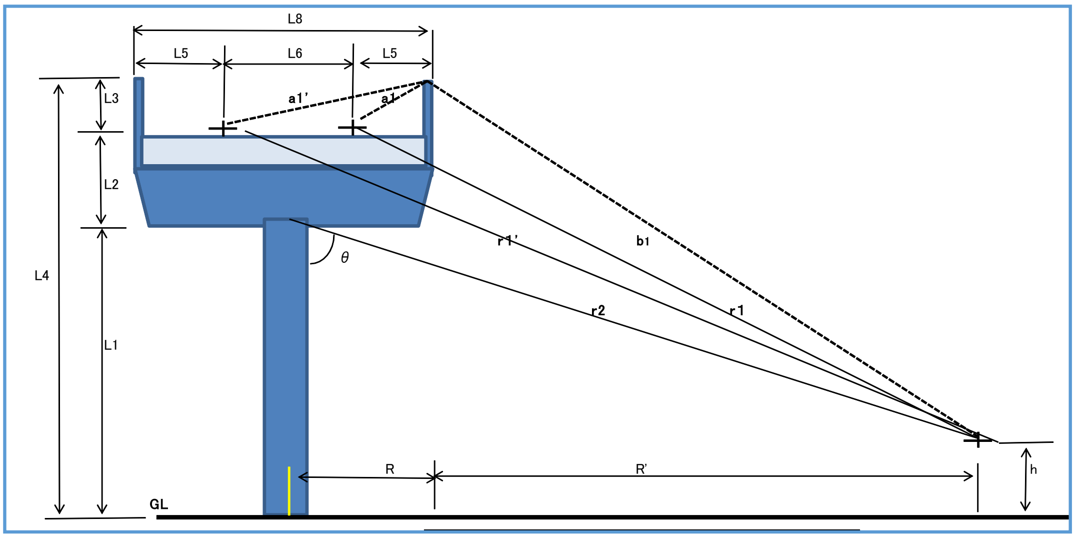


Figure 6-2: Sound Pathways

The longer path for deflected sound introduces a differential that reduces the overall sound level according to the graph in Figure 6-3.

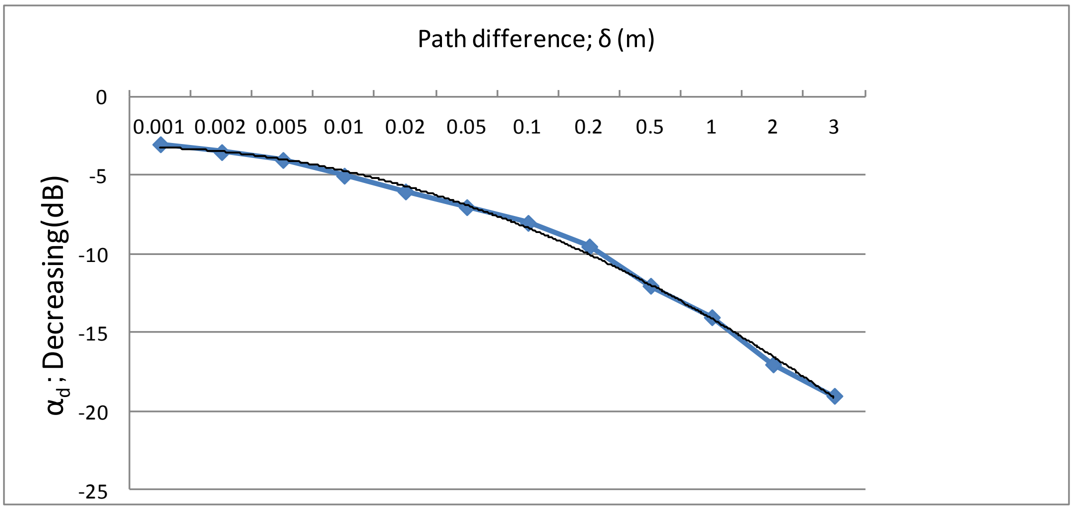


Figure 6-3: Path Difference and Sound Reduction

Structural dimensions of the viaduct configuration (e.g. dimensions in Figure 6-2) are shown in Table 6-3. A 1.5 m high parapet wall (L3) will be installed as noise barrier at locations along the route. Structural dimensions are used to calculate coefficients.

Table 6-3: Input factors Related to Structural Dimensions of the Viaduct

Receptor Ht, m		Factors of str for receptor dist R'									10logn1	10logn2	
h	R'	r_1	r_2	L_3	a_1	b_1	$\delta=a_1+b_1-r_1$	α_1	$l/2r_1$	$l/2r_2$	$\sum l/2r_1$	$\sum l/2r_2$	θ=acos n'
1.2	0.5	12.28	9.06	1	3.08	12.81	3.61	(-)21.1	6.51	8.83	1.57	1.17	0.63
1.2	0.5	12.28	9.06	1.5	3.28	13.31	4.30	(-)22.0	6.51	8.83	1.57	1.17	0.63
1.2	0.5	12.28	9.06	2	3.54	13.81	5.06	(-)25.0	6.51	8.83	1.57	1.17	0.63
1.2	7.5	15.74	14.36	1	3.08	14.84	2.18	(-)17.3	5.08	5.57	1.57	0.71	1.04
1.2	7.5	15.74	14.36	1.5	3.28	15.27	2.81	(-)18.4	5.08	5.57	1.57	0.71	1.04
1.2	7.5	15.74	14.36	2	3.54	15.71	3.50	(-)20.8	5.08	5.57	1.57	0.71	1.04
1.2	12.5	19.41	18.84	1	3.08	17.89	1.56	(-)15	4.12	4.25	1.56	0.52	1.17
1.2	12.5	19.41	18.84	1.5	3.28	18.25	2.12	(-)17	4.12	4.25	1.56	0.52	1.17
1.2	12.5	19.41	18.84	2	3.54	18.62	2.74	(-)18	4.12	4.25	1.56	0.52	1.17
4.2	0.5	9.44	6.88	1	3.08	9.813	3.46	(-)20.4	8.47	11.63	1.57	0.93	0.90
4.2	0.5	9.44	6.88	1.5	3.28	10.31	4.15	(-)21.7	8.47	11.63	1.57	0.93	0.90
4.2	0.5	9.44	6.88	2	3.54	10.81	4.91	(-)23.5	8.47	11.63	1.57	0.93	0.90
4.2	7.5	13.64	13.09	1	3.08	12.34	1.79	(-)16.3	5.87	6.11	1.57	0.46	1.24
4.2	7.5	13.64	13.09	1.5	3.28	12.74	2.39	(-)17.7	5.87	6.11	1.57	0.46	1.24
4.2	7.5	13.64	13.09	2	3.54	13.15	3.05	(-)19.8	5.87	6.11	1.57	0.46	1.24
4.2	12.5	17.75	17.89	1	3.08	15.88	1.22	(-)14.5	4.51	4.47	1.56	0.32	1.33
4.2	12.5	17.75	17.89	1.5	3.28	16.2	1.73	(-)16.1	4.51	4.47	1.56	0.32	1.33
4.2	12.5	17.75	17.89	2	3.54	16.52	2.30	(-)17.5	4.51	4.47	1.56	0.32	1.33

Structure Noise Power Level (L_{W2})

Structure Noise Power Levels (LW2) are determined as follows:

e) Ballast-less track: straight section and relaxed curve (R>=400m) section

L_{W2}=92.5

f) Ballast-less track: sharp curve (R<400m) section

L_{W2}= 94.6

g) Vibration-proof: straight section and relaxed curve (R>=400m) section

L_{W2}=85.0

h) Vibration-proof: sharp curve (R<400m) section

L_{W2}= 86.4

For g) and h), it is assumed that the rail support coefficient is less than 10MN/m/rail fastening (MSS track).

L_{W2} is converted to Structure Noise (L_{A2}) using the following formula:

$$L_{A2} = L_{W2} - 8 - 10\log_{10} r_2 + 10\log_{10}\left[(\cos\theta)\left(\tan\frac{l}{2r_2}\right)\right]$$ dB, where

L_{A2}: Structure Noise (dB)

L_{W2}: Structure Noise power level (dB)

r2: Distance between center of floor slab and sound receiving point (m)

θ: The angle of center of floor slab to ground and center of floor slab to sound receiving point (°)

Vehicle Device Noise Power Level (L_{W3})

For inner fan-type motive unit:

$$L_{w3} = 60\log_{10}(nV/100) + 10\log_{10}(l_m/l) + B$$, where

Ballast-less track: B=57

n: Gear ratio = 6.06 (JR-East 233)

V: Train speed (km/s)

l: Train length (m)

lm: Length of motor car (m)

L_{W3} is converted to Vehicle Device Noise (dB) (L_{A3}) using the following formula:

$$L_{A3} = L_{w3} - 5 - 10\log_{10} r_1 + 10\log_{10}\left\{\frac{(l/2r_1)}{1+(l/2r_1)^2} + \tan^{-1}\left(\frac{l}{2r_1}\right)\right\} + \alpha_1$$ db, where

Other Factors

Soundproof Wall Effect (sound absorbing material): subtract 2 dB

6.1.1.5 Evaluation of Noise Impact

The previous equations were set up in spreadsheet format with the primary and secondary input variables being radius of curvature (greater or lesser than 400 m) and anticipated travel velocity based on the CBTC operations schedule. Table 6-4 shows the predicted noise levels derived by use of the previously described formulae. Table 6-5 provides somewhat similar information, but combines predicted transit noise with observed ambient noise level measurements described in Sec. 5.1.4.

Table 6-4: Predicted Noise Levels

Prediction/Assumption	Radius of curvature,R<400m,L_{w1}=13.7log V +80.3					R>=400m,L_{w1}=13.7 log V+75.7		
SRC[1] of Radious in (m)	160	200	230	250	350	400	500	over 550
Max^{m} controlled speed in (km/hr)	45	50	60	70	80	85	95	100
Ballastless track[2] , (L_{w1})	102.9	103.6	104.7	105.6	106.4	102.1	102.8	103.1
Vibration Proof BLT,($L_{w1'}$)	99.9	100.6	101.7	102.6	103.4	99.1	99.8	100.1
Structure noise [3],(L_{w2})	94.6	94.6	94.6	94.6	94.6	92.5	92.5	92.5
Vibration Proof Str. noise,($L_{w2'}$)	86.4	86.4	86.4	86.4	86.4	85.0	85.0	85.0
Vehicle Device Power L. noise[4],(L_{w3})	80.1	82.9	87.6	91.7	95.1	96.7	99.6	100.9
BLT Rolling noise[5],L_{A1}=L_{w1}- 36.18 (Parapet ht 1 m)	66.8	67.4	68.5	69.4	70.2	66.0	66.6	66.9
VP BLT Rolling noise,$L_{A1'}$ =$L_{w1'}$ -36.18 (Para Ht 1 m)	63.8	64.4	65.5	66.4	67.2	63.0	63.6	63.9
BLT Structure noise[6] ,L_{A2}=L_{w2}-22.48	72.1	72.1	72.1	72.1	72.1	70.0	70.0	70.0
VP BLT Structure noise,$L_{A2'}$ =$L_{w2'}$ -22.48	63.9	63.9	63.9	63.9	63.9	62.5	62.5	62.5
Vehicle Device noise[7], L_{A3}=L_{w3}-33.18 (Para ht 1 m)	47.0	49.7	54.5	58.5	62.0	63.5	66.4	67.8
Peak Level noise,L_{Amax}=10 log [$\sum^{n}_{i=1}10^{LAi/10}$]	73.2	73.4	73.7	74.1	74.5	72.1	72.8	73.2
Sound Exposure[8] Level, L_{AE} =L_{Amax}+10 log(576/V)	84.3	84.0	83.6	83.3	83.1	80.4	80.6	80.8
Predicted value[9],L_{eq}=10 log[0.0074*$10^{(LAE/10)}$]	63.0	62.7	62.2	61.9	61.8	59.1	59.3	59.5
Peak Lev VPT noise,L'_{amax}=10 log [$\sum^{n}_{i=1}10L^{Ai/10}$]	66.9	67.3	68.0	68.8	69.7	67.8	69.3	70.1
Sound Ex.of VPT Level, L_{AE} =L_{Amax} + log (576/V)	78.0	77.9	77.8	77.9	78.2	76.1	77.1	77.7
VPT Predicted Val,L'_{eq}=10 log(o.oo74*$10^{(LAE/10)}$)	56.7	56.6	56.5	56.6	56.9	54.8	55.8	56.4
BLT Rolling noise[5],L_{A1}=L_{w1}- 36.18 (Parapet ht 1.5 m)	64.8	65.4	66.5	67.4	68.2	64.0	64.6	64.9
Vehicle Device noise[7], L_{A3}=L_{w3}-33.18 (Para ht 1.5 m)	45.0	47.7	52.5	56.5	60.0	61.5	64.4	65.8
Peak Level noise,L_{Amax}=10 log [$\sum^{n}_{i=1}10^{LAi/10}$]	72.9	73.0	73.2	73.5	73.8	71.4	72.0	72.3
Sound Exposure[8] Level, L_{AE} =L_{Amax}+10 log(576/V)	83.9	83.6	83.0	82.6	82.4	79.8	79.8	79.9
Predicted value[9],L_{eq}=10 log[0.0074*$10^{(LAE/10)}$]	62.6	62.3	61.7	61.3	61.0	58.4	58.5	58.6
BLT Rolling noise[5],L_{A1}=L_{w1}- 36.18 (Parapet ht 2 m)	62.8	63.4	64.5	65.4	66.2	62.0	62.6	62.9
Vehicle Device noise[7], L_{A3}=L_{w3}-33.18 (Para ht 2 m)	43.0	45.7	50.5	54.5	58.0	59.5	62.4	63.8
Peak Level noise,L_{Amax}=10 log [$\sum^{n}_{i=1}10^{LAi/10}$]	72.6	72.7	72.8	73.0	73.2	71.0	71.3	71.6
Sound Exposure[8] Level, L_{AE} =L_{Amax}+10 log(576/V)	83.7	83.3	82.7	82.2	81.8	79.3	79.2	79.2
Predicted value[9],L_{eq}=10 log[0.0074*$10^{(LAE/10)}$]	62.4	62.0	61.4	60.9	60.5	58.0	57.9	57.9
VP BLT Rolling noise,$L_{A1'}$ =$L_{w1'}$ -36.18 (Para Ht 1.5 m)	61.8	62.4	63.5	64.4	65.2	61.0	61.6	61.9
Vehicle Device noise[7], L_{A3}=L_{w3}-33.18 (Para ht 1.5 m)	45.0	47.7	52.5	56.5	60.0	61.5	64.4	65.8
Peak Lev VPT noise,L'_{amax}=10 log [$\sum^{n}_{i=1}10L^{Ai/10}$]	66.0	66.3	66.9	67.5	68.3	66.5	67.8	68.5
Sound Ex.of VPT Level, L_{AE} =L_{Amax} + log (576/V)	77.1	76.9	76.7	76.7	76.9	74.8	75.6	76.1
VPT Predicted Val,L'_{eq}=10 log(o.oo74*$10^{(LAE/10)}$)	55.8	55.6	55.4	55.4	55.6	53.5	54.3	54.8
VP BLT Rolling noise,$L_{A1'}$ =$L_{w1'}$ -36.18 (Para Ht 2 m)	59.8	60.4	61.5	62.4	63.2	59.0	59.6	59.9
Vehicle Device noise[7], L_{A3}=L_{w3}-33.18 (Para ht 2 m)	43.0	45.7	50.5	54.5	58.0	59.5	62.4	63.8
Peak Lev VPT noise,L'_{amax}=10 log [$\sum^{n}_{i=1}10L^{Ai/10}$]	65.4	65.6	66.0	66.5	67.1	65.4	66.5	67.1
Sound Ex.of VPT Level, L_{AE} =L_{Amax} + log (576/V)	76.4	76.2	75.8	75.7	75.7	73.7	74.3	74.7
VPT Predicted Val,L'_{eq}=10 log(o.oo74*$10^{(LAE/10)}$)	55.1	54.9	54.5	54.4	54.4	52.4	53.0	53.4

Notes :(1) Speed restriction curves (SRC) have their max Speed (km/hr)
(2) Ballastless track (BLT); If Vibration Proof Track (VPT) is used ,the value of L_{wi} decreases by 3.0 dB
(3) Use of vibration proof track (VPT) reduces Structure Noise 7.5 dB in straight section and relaxing curves, and 8.2 dB in sharp
curves with radious of curvature less than 400 meter.
(4) Vehicle Device Noise is calculated by the Equation, L_{w3}=60 log (n V/100) + 10 log (l_m/l) + B = 60 log (0.0606V) + 54, with the
values of constants , Gear Ratio n=6.06 ,Length of motor car l_m=80 , Train length l=160 and Correction value B = 57 (?? 52) for
Ballestless track
(5) Rolling noise L_{A1}= L_{w1}-8-10 log r1 + 10 log [(l/2r1)/(1+(l/2r1)^2 + tan^{-1}(l/2r1)] + α_d = L_{wi1}-19.17, with values of train length l=160,
Dumping number α_d = (-)17,7714 ,Distance between track center and sound receiving point, r1=17.1898 with horizontal 7.5m
(6) Structure Noise L_{A2} = L_{w2} -8 - 10 log r1 + 10 log [(cos θ)(tan^{-1}(l/2r2))] = L_{w2} - 20.301 , with value r2=16.19 with horizontal 7.5 m
(7) Vehicle Device Noise L_{A3} = L_{w3} -5 -10 log r_1 + 10 log [(l/2r1)/(1+l/2r1)^2+tan^{-1}(l/2r1)] + α_d = L_{w3} - 16.17 , with the values as in (5)
(8) Sound Exposure Level L_{AE}= L_{Amax} + 10 log t = L_{Amax} + 10 log (576/V), with t = train passing time (sec)=2.15 sec, V= velocity km/hr,
(9) Predicted Value (as per DOE) $L_{eq.10}$=10 log (nx $10^{LAE/10}$ / T) = 10 log (0.0074 * $10^{(LAE/10)}$), with values, number of train n=4.444
in 10 minutes , T = 600 (ie,10 minutes)

To summarize the methodology, noise monitoring locations are preselected to reflect "sensitive receptors", and predictive analysis is applied to those locations. Ambient monitoring results (Table 5-10) and predicted results (Table 6-4) are combined. Mitigation measures – use of Mass Spring System (MSS) track and noise barriers (parapet wall) – are accounted for in the equations. The combined sound level predictions are shown in Table 6-5; the table also shows the contribution of transit noise. Table 6-6 lists sensitive receptors and their locations, the distance in meters from the rail centerline, and the contribution to the noise level attributable to transit noise. Conclusions reached from the data include the following:

a) The predicted noise levels from transit operations are generally in the range of ambient noise levels. Transit noise is on average 1.1 dB greater than peak ambient noise levels, and 4.7 dB greater than observed LD/N levels. Median values are 0.17 and 3.8 dB respectively.

b) Transit noise, when added to ambient noise levels, provides a combined noise level that is, on average, 2% greater than observed ambient peak noise levels and 7.3% greater than observed day/night noise levels. Most increases are on the order of 0.2% and 5%, respectively (median values). The exceptions are in the Uttara Phase III area, where ambient noise levels are at present low, and the contribution from transit noise greater.

Combined noise levels at sensitive receptors are listed in Table 6.6 and the percentage noise increase at each location above peak ambient noise level is shown, averaging 0.58%. While combined noise levels exceed the ambient standard (60 and 70 dB for mixed and commercial, respectively), the increase in combined noise level due to transit noise over ambient conditions is small, for all but two locations, less than 0.3%. Given the levels of ambient noise, the contribution from transit noise is insignificant. The analysis takes into account mitigation measures described in the next section.

6.1.1.6 Mitigation Measures

The principal mitigation measures for noise impact due to operations are use of vibration-proof track (MSS cushion) and noise barriers. A total of 5,868 m of vibration proof MSS track is installed for incoming and outbound tracks, as shown in Table 6-7. The areas where noise barrier is required along sections of track in areas of sensitive receptors is shown in Table 6-8, however, as a further remedial measures, noise barriers along the entire alignment are installed.

Table 6-5: Noise Levels at Elevated Sections with respect to Receptors

Name of Receptor	NW Corner of Depot	Work shop at Depot	Beside M.S. Coll. at Depot	Uttara North Station	Uttara Central Station	Uttara South Station	Mirpur DOHS East	National Defence College	Mimi General Hospital	Pallabi Station	Islami Bank Hospital	Mirpur-11 Station	Rahima Materni. Hospital	Alok Health Care
Aprx. Chainage of the Receptor				0K000	1K080	2K740	3K476	4K250	4K655	4K838	5K590	5K618	6K705	6K815
Distance from Track Centre			7.5	7.5	7.5	7.5	7.5	25	20	7.5	18	7.5	20	16
Ambient Peak(7am-7pm), L_{eq}	72.9	52.4	57.7	60.6	47.9	53.9	58.4	69.4	74.9	76.8	74.9	75.8	74.3	74.1
Ambient Noise Level, L_{dn}	67.8	50.2	51.2	53.9	50.0	53.8	52.6	66.3	73.6	71.7	71.3	72.8	71.4	70.6
Train Speed (Km/h)at R>500m					100			100	100	100	100	100	100	100
BLT Transit Noise at R>500, L_{eq}					61.1			61.1	61.1	61.1	61.1	61.1	61.1	61.1
Train Speed at 500>R>300m				70		85	85							
BLT T.Noise at 500>R>300, L_{eq}				59.9		59.7	59.7							
Train Speed (Km/h)at R<=300m		45	45											
VPT Transit Noise at R<=300, L_{eq}		56.7	56.7											
Combined Noise Impact Levels acting on Receptors		58.0	60.2	63.3	61.5	60.7	62.1	70.0	75.1	76.9	75.1	76.0	74.5	74.3
Increase over Peak Ambient		5.7	2.5	2.7	13.6	6.8	3.7	0.6	0.2	0.1	0.2	0.1	0.2	0.2
Increase over D/Nt Ambient		7.8	9.0	9.4	11.5	6.9	9.5	3.8	1.5	5.2	3.8	3.2	3.1	3.7
Pct Increase over Peak Ambient		10.8%	4.4%	4.4%	28.4%	12.7%	6.4%	0.9%	0.2%	0.2%	0.2%	0.2%	0.3%	0.3%
Pct Increase over D/Nt Ambient		15.5%	17.6%	17.3%	23.0%	12.9%	18.1%	5.7%	2.1%	7.3%	5.3%	4.4%	4.4%	5.2%

Name of Receptor	Mirpur-10 Station	Al-helal Special. Hospital	Life-Aid Special. Hospital	Kazi-para Station	Exim Bank Hospital	Shawra-para Station	Lion Eye Hospital	Agar-gaon Ssation	Bijoy Sharani Station	Khejur Bagan S. Bhaban	Farm-gate Station	Farm-gate R=200 m	Tejgaon Gov.Girls School	Kawran Bazar Station	Shah-bag Station
Aprx. Chainage of the Receptor	6K858	7K530	7K825	7K948	8K290	8K878	10K260	10K398	11K748	12K275	12K938	13K175	13K380	14K073	15K453
Distance from Track Centre	7.5	16	17	7.5	17	7.5	16	7.5	7.5	15	7.5	7.5	15	7.5	7.5
Ambient Peak(7am-7pm), L_{eq}	75.8	76.5	74.2	75.2	74.8	75.3	79.3	74.0	76.6	75.4	76.4	77.0	78.8	78.0	76.2
Ambient Noise Level, L_{dn}	70.7	70.6	68.4	72.2	73.2	72.2	71.3	70.6	72.9	72.0	73.7	74.7	72.6	75.9	72.7
Train Speed (Km/h)at R>500m	100	100	100	100	100	100	100	100	100	100	100		100	100	100
BLT Transit Noise at R>500, L_{eq}	61.1	61.1	61.1	61.1	61.1	61.1	61.1	61.1	61.1	61.1	61.1		61.1	61.1	61.1
Train Speed at 500>R>300m															
BLT T.Noise at 500>R>300, L_{eq}															
Train Speed (Km/h)at R<=300m												50			
VPT Transit Noise at R<=300, L_{eq}												56.6			
Combined Noise Impact Levels acting on Receptors	76.0	76.6	74.4	75.3	75.0	75.5	79.4	74.2	76.7	75.6	76.5	77.0	78.9	78.1	76.3
Increase over Peak Ambient	0.1	0.1	0.2	0.2	0.2	0.2	0.1	0.2	0.1	0.2	0.1	0.0	0.1	0.1	0.1
Increase over D/Nt Ambient	5.3	6.0	6.0	3.1	1.8	3.3	8.1	3.6	3.9	3.6	2.7	2.3	6.3	2.2	3.6
Pct Increase over Peak Ambient	0.2%	0.2%	0.3%	0.2%	0.2%	0.2%	0.1%	0.3%	0.2%	0.2%	0.2%	0.1%	0.1%	0.1%	0.2%
Pct Increase over D/Nt Ambient	7.4%	8.5%	8.8%	4.3%	2.4%	4.6%	11.4%	5.2%	5.3%	5.0%	3.7%	3.1%	8.7%	2.9%	5.0%

Name of Receptor	D. U. Central Library	TSC Station	Doel Chattar Morh	High Court Morh	Kadam Fountain Morh	Press Club Station	Baitul Mukarm Mosque	Dainik Bangla Morh	Moti-jheel Station	Glapbag Construc-tion Yard	Kamla -pur RSS
Aprx. Chainage of the Receptor	16K100	16K373	16K390	17K240	17K470	17K689	18K170	18K470	18K935	-	-
Distance from Track Centre	15	7.5	7.5	7.5	7.5	7.5	15	7.5	7.5	-	60
Ambient Peak(7am-7pm), L_{eq}	71.7	71.7	72.0	72.1	76.2	78.3	73.2	75.7	70.7	79.4	72.5
Ambient Noise Level, L_{dn}	67.5	70.0	68.2	70.3	70.1	75.4	69.5	69.6	70.0	76.2	67.6
Train Speed (Km/h)at R>500m	100	100				100	100		100		
BLT Transit Noise at R>500, L_{eq}	61.1	61.1				61.1	61.1		61.1		
Train Speed at 500>R>300m											
BLT T.Noise at 500>R>300, L_{eq}											
Train Speed (Km/h)at R<=300m			65	50	50			50			
VPT Transit Noise at R<=300, L_{eq}			56.5	56.6	56.6			56.6			
Combined Noise Impact Levels acting on Receptors	72.0	72.0	72.1	72.2	76.2	78.4	73.5	75.7	71.2		
										Aver	Median
Increase over Peak Ambient	0.4	0.4	0.1	0.1	0.0	0.1	0.3	0.1	0.5	1.10	0.17
Increase over D/Nt Ambient	4.5	2.0	3.9	1.9	6.1	3.0	3.9	6.2	1.2	4.67	3.81
Pct Increase over Peak Ambient	0.5%	0.5%	0.2%	0.2%	0.1%	0.1%	0.4%	0.1%	0.6%	2.0%	0.2%
Pct Increase over D/Nt Ambient	6.7%	2.9%	5.7%	2.8%	8.7%	4.0%	5.7%	8.8%	1.7%	7.3%	5.5%

Table 6-6: Sensitive Receptors along the Metro Line 6 Alignment

Sl no.	Name of Receptor	Chainage (0+000 km)	Distance (m) to Receptor	Ambient Noise Level (May 2015)	Combined Noise Levelat Receptors	Percentage Increase from Transit Noise / Peak Ambient
1	Mirpur DOHS East	3K476	7.5	58.4	62.1	6.4
2	National Defense College	4K250	25	69.4	70.0	0.9
3	Mini General Hospital	4K655	15	74.9	75.1	0.2
4	Islami Bank Hospital	5K590	18	74.9	75.1	0.2
5	Rahima Maternity Hospital	6K705	20	74.3	74.5	0.3
6	Alok Health Care	6K815	16	74.1	74.3	0.3
7	Al-Helal Specialized Hospital	7K530	16	76.5	76.6	0.2
8	Life Aid Specialized Hospital	7K825	17	74.2	74.4	0.3
9	Kazipara Siddikia Fajil Madrasa	8K180	17	75.2	75.3	0.2
10	Axim Bank Hospital	8K290	17	74.8	75.0	0.2
11	Shewra Para Jame Mosque	8K830	17	75.3	75.5	0.2
12	Lions' Eye Hospital	10K260	16	79.3	79.4	0.1
13	Agargaon Boys' High School	10K400	15	74.0	74.2	0.3
14	Sangsad Bhaban	12K275	15	75.4	75.6	0.2

15	Islamia Eye Hospital	12K800-12K995	16-20 m	76.4	76.5	0.2
16	Tejgaon Govt. Girls' High School	13K380	15	78.8	78.9	0.1
17	Ibrahim Medical Hospital	15K453	27-35	76.2	76.3	0.2
18	BSMMU	15K455	28-25	76.2	76.3	0.2
19	Public Library	16K100	23	71.7	72.0	0.5
20	Baitul Mokarram Mosque	18K170	15	73.2	73.5	0.4
			Average			0.58%

Table 6-7: Locations for Use of MSS Track

SL No	Beginning of Curve	Location	Radius of Curvature	End of Curve	Length of MSS1(m) (two tracks)
1	0K132M165	Uttara Phase III	265	0K250M239	296
2	0k340m388	Uttara Phase III	250	0k457m643	294
3	3k400m000	Mirpur Cant.	Cantonment	4k020m000	1,300
4	3k537m511	Mirpur DOHS	300	3k658m046	302
5	12k200m000	Monipuripara	S.Bhaban	12k346m473	352
6	12k346m473	Khamarbari	201.95	12k725m883	818
7	13k050m854	Farmgate	201.95	13k309m334	576
8	16k116m726	TSC Morh	201.95	16k245m187	316
9	16k777m193	Doel Chattar	240	16k991m459	488
10	17k151m464	High Court	201.95	17k314m531	386
11	17k398m544	Kadam Foara	201.95	17k576m392	416
12	18k387m063	Dainik Bangla	201.95	18k518m750	324
				TOTAL	5,868

Additional MSS length of 30 m added to each track section as transition (15 m each end) except as noted below.

Mild curve (400 m radius) after long straight section does not require 15 m transition lengths.

MSS along this section is for increased noise suppression in the parliament area; the additional transition lengths of 15X2=30 m provided for curved sections is not required.

Table 6-8: Recommended Locations for Use of 1.5 m high Parapet Noise Barrier

SL No	Location of Receptors Apr.Chainage	Name of the Receptor	Name of Location	Receptor side of track East/North	West/South	Length of Barrier (m) Receptor	Total	Radius of Curve (m)
1	2K917M-3K048M	Curvature Radius R <500 m				131	262	400
2	3K497M-3K666M	Curvature Radius R <500 m				169	339	400
3	4K265M	National Defence College	Mirpur DOHS		West	18	25	
4	4K660M	Mini General Hospital	Pallabi		West	13	20	
5	5K590M	Islami Bank Hospital	Mirpur 11	East		13	20	
6	6K710M	Rahima Maternity Hospital	Mirpur 11 / 10		West	13	20	
7	6K770M	Alok Health Care	Mirpur 10	East		18	25	
8	7K540M	Al-helal Specialized Hospital	Sen P/Kazipara	East		20	27	
9	7K825M	Life Aid Specialized Hospital	Kazipara	East		13	20	
10	8K290M	Axim Bank Hospital	Kazipara	East		21	28	
11	10K260M	Lion Eye Hospital	Agargaon		West	13	20	
12	12K700M	Islami eye Hospital	Khamarbari		South	55	62	Less 50m for curveR=200
13	13K675M	Tejgaon Govt Girls Scool & Northern University	Farmgate	East		90	97	
14	13K675M	London College	Farmgate		West	90	97	
15	15K241M-15K344	Curve Radious R<500	Shahbag			103	206	450
16	15K380M	BSMMU & hospital	Shahbag		West	112	112	
17	15K450M	BIRDEM Hospital	Shahbag	East		133	133	
18	15K780M	Public Library /Central Libray	University Area		West	41	48	
19	16K100M	Dhaka U. Central Library	University Area		West	60	67	
20	16K700M	Dhaka U. Science Library	University Area		West	16	23	
21	15K982M-16K049	Curve Radius R<500	Paltan			67	134	
22	17K690M-17K920	Secretariat Buildings	Paltan		South	240	240	
23	18K170M	Baitul Mokarram Mosque	Paltan		South	126	133	
				TOTAL LENGTH OF BARRIER			2,158	METERS

NOTE: The sound barrier is placed for entire length of alignment

6.1.2 Construction Noise Analysis

This section addresses noise levels expected from various combinations of equipment required to perform construction tasks as follows:

Depot:

- Sand compaction piles and vibratory compaction used to stabilize the fill
- Heavy equipment operations during infilling and construction

Alignment:

- Foundation, pier and viaduct construction
- Station construction

6.1.2.1 Approach

Prediction of construction noise is based on sound power levels of equipment required to perform the work. Point of impact on the receptor is taken to be 15-20 m from the sound source. Predicted values are compared with ambient noise levels. Ambient and predicted noise levels are superimposed; comparisons are made with the DOE's ambient noise standards.

6.1.2.2 Applicable Standards

Construction noise is not regulated by a standard in Bangladesh; target noise limits for construction depend on ambient noise conditions and standards used in other countries, which are reviewed in Table 6-9. Note that ambient noise levels along the MRT corridor (see Table 5.8) already exceed these values in most cases.

Table 6-9: Noise Criteria and Standards Considered in Setting Limits for Metro Line-6

	Standard or Criteria	Day Time (Leq)	Night Time (Leq)
New Zealand	Residential (less than 14 hr per weekday)	65 dB (6.30 -7.30 am) 80 dB (7.30 am-6 pm)	75 dB (6-8 pm) 45 dB (8 pm-6.30 am)
	Residential (less than 20 hr per weekday)	60 dB (6.30 -7.30 am) 75 dB (7.30 am-6 pm)	70 dB (6-8 pm) 45 dB (8 pm-6.30 am)
	Residential (more than 20 hr per weekday)	55 dB (6.30 -7.30 am) 70 dB (7.30 am-6 pm)	65 dB (6-8 pm) 45 dB (8 pm-6.30 am)
	Commercial/industrial area (less than 14 days)	80 dB (7.30 am – 6 pm)	85 dB (6 pm-7.30 am)
	Commercial/industrial area (less than 20 weeks)	75 dB (7.30 am -6pm)	80 dB (6 pm-7.30 am)
	Commercial/industrial area (more than 20 weeks)	70 dB	75 dB

		(7.30 am -6pm)	(6 pm-7.30 am)
Japan	Using heavy equipment with high noise level (piling, excavating etc.)	85 dB (Maximum)	-
Singapore	Hospitals, schools, institutions of higher learning, homes for the aged sick, etc.	60dB (7 am-7 pm, 12 hrs)	50 dB (7 pm-7 am, 12 hrs)
	Residential buildings located less than 150m from the construction site where the noise is being emitted	75 dB (7 am-7 pm, 12 hrs)	60dB (7- 10 pm, 55 dB)
	Other Buildings	75 dB (7 am-7 pm, 12 hrs)	65 dB (7 pm-7 am, 12 hr)
UK	In rural, suburban and urban areas away from main road traffic and industrial noise	70 dB (8.00-18:00)	-
	Urban Areas near main roads	72 dB (8.00-18:00)	-
USA criteria	Residential	80 dB (8 hrs)	70 dB (8 hrs)
	Commercial	85 dB (8 hrs)	85 dB (8 hrs)
	Urban Area with high ambient noise level (>65 dB)	Ambient Noise Level +10 dB	

New Zealand Standard NZS 6803:1999* Acoustics-Construction Noise"
Noise Regulation Act, Japan (law no 98, 1968, Amended No 33, 2006)
Environmental Protection and management Act in Singapore (Chap. 94 A, Section 77, revised in 2008)
British standard 5228:1997 "Noise and vibration control on open and construction sites"
Transit Noise and Vibration Impact Assessment, U.S. Department of Transportation in USA, 1995

The USA criteria states that "noise levels from construction should not exceed the existing ambient level +10 db in urban areas with existing high ambient noise levels". Target criteria for noise limits during construction in commercial areas and areas with high background noise is set at 85 dB. Japanese criteria also refers to the value of 85 dB. Target noise limits are therefore set for construction as follows:

- Construction activity near residential areas and hotels where it is necessary to sleep shall comply with a standard of 75 dB and 65 dB, for day and night times, respectively.
- Noise levels at "office and commercial" and "commercial and service" areas shall be limited to 85 dB), applied to day and night, since these are not residential areas.
- Where ambient noise levels are high, the noise standard of "existing ambient level + 10 db" is adopted, in accordance the US DOT Noise and Vibration Impact Assessment Manual.

Table 6-10 summarizes the standards proposed for construction noise control for the Project. These target noise levels are similar to noise standards for construction in use in other countries.

Table 6-10: Target Noise Level at Construction Phase

Category	Day Time (Leq)	Night Time (Leq)
Sensitive Areas and Hotel	75 dB	65 dB
Office and Commercial	85 dB	85 dB
Commercial and Service	85 dB	85 dB
Areas with ambient noise level (>65 dB)	Ambient Noise Level +10 dB	-

Notes: Evaluation point is at boundary of buildings
Daytime: 6:00-22:00, Night time: 22:00-6:00
Sensitive areas: residential areas, hospitals, schools, places of religious worship

Despite the use of standards, construction noise is difficult to regulate. The "Bangladesh Sound Pollution Rules" (SRO212-Law/2006) provides alternative means for bringing noise complaints before local authorities for resolution. Local citizens affected by noise can register a complaint through the local authority. This provides the means to identify a specific problem that otherwise would not be apparent, and enact control measures directed specifically at the problem.

6.1.2.3 Heavy Equipment and At-Source Noise Levels

Noise impact predictions from construction activities are based on heavy equipment clusters for each type of construction site, as described in contract tender documents, and sound power levels for equipment available in the literature. Noise levels at source are calculated based on ambient noise levels, operating times and the combination of equipment types in use, as shown in the following formula

L_{source}= 10 $\log_{10}(a*10^{Lp/10}+(1-a)*10^{Lambient/10})$ $L_{source\_combined}$ =10 $\log_{10}(\sum_{i=1}^{n} 10^{Leqi/10})$, where	*L_p : Sound Power Level [dB]* *$L_{ambient}$: Ambient noise level [dB]* *L_{source}: Noise level at source [dB]* *$L_{source\text{-}combined}$: combined noise level at source [dB]* *a: Ratio of operating hours with noisy work (0-1)*

6.1.2.4 Impact Prediction

Methods used by the Institute of Noise Control Engineering in Japan are used to predict noise levels from construction activities, the following formula is used. This formula can also be used to predict the effect of soundproof barriers erected around noisy pieces of equipment.

Lc=L source-8-20 log 10 (r/r0)+∆L, where

$$\Delta L = \begin{cases} -10\log\delta - 18.4 & \delta \geq 1 \\ -5 - 15.2\ \sinh^{-1}(|\delta|^{0.42}) & 0 \leq \delta < 1 \\ -5 + 15.2\ \sinh^{-1}(|\delta|^{0.42}) & -0.069 \leq \delta < 0 \\ 0 & \delta < -0.069 \end{cases}$$

Lc: noise level at evaluation point [dB]
r0: Distance from source to measurement point [m]
r: Distance from source to evaluation point [m]
∆L: Effect of soundproof barrier (panel or sheet) [dB]

δ: Difference in sound propagation routes [m]

Table 6-11 shows heavy equipment sound power levels for various types of construction work at the depot and along the alignmentusing typical equipment; and combined noise levels produced by equipment working in tandem. Equipment sound power levels are taken from the literature.

Combined noise levels of construction equipment are then determined at a specified distance from the activity (15-20 m) and further combined with ambient noise levels that were measured at the locations.

Table 6-12 shows results for depot site development (soil compaction) and construction. Combined noise levels are lower than the established standard (areas with ambient noise level (>65 dB), standard is ambient noise level +10 dB) for the NW corner of the depot site and the workshop. Combined noise levels are higher than the established standard (75 dB daytime, 65 dB nighttime) at Milestone College. However Milestone College will be temporarily relocated during construction and compensated. The arrangement is described in the next section under Vibration.

A similar procedure was followed to determine combined equipment and ambient noise levels at all remaining locations where ambient monitoring was conducted (29 locations). The average combined noise level is 79 dB; the standard is typically 85 dB. Combined noise levels are on average 5 dB lower than the ambient standard. If a lower standard of 75 dB is applied for nine selected sensitive locations, the standard is exceeded at four out of nine locations between 1 and 3 dB. Nighttime standard of 65 dB may however be exceeded at some times and locations.

Table 6-11: Heavy Equipment Noise Power Level and Combined Leq

SECTION	Kind of Construction	Heavy Equipment Used	Power Level Noise	Comb.L_{eq}
Depot Area	Compacting Ground	Sand Compaction Pile (SCP)	105	
		Dynamic Compaction (DC)	110	
		Compacting Roller	108	112.9
	Ground Work	Hydraulic Vibatory Hammer	106	
		Excavator (0.4) Dump Truck	103	
		Rough Terrain Crane	105	109.6
Depot & Track Prep.	Ground Work	Drilling hole, reinf. & casting	106	
	Concrete Casting	Excavator (0.4) Dump Truck	103	
		Rough Terrain Crane	105	109.6
	Framework Construc.	Rough Terrain Crane	105	
	& Track Preparation	Concrete Mixer Truck	105	108.0
Elevated Track	Girder Installation	Crawler Crane	100	
	& Track Preparation	Concrete Mixer Truck	105	106.2
Elev Track & Station	Preparation	Hand Breaker	109	
		Excavator (0.4) Dump Truck	103	110.0
	Ground Work	Hydraulic Vibatory Hammer	106	
		Excavator (0.4) Dump Truck	103	
		Rough Terrain Crane	105	109.6
	Girder Inst.& Frame-	Rough Terrain Crane	105	
	work Constraction	Concrete Mixer Truck	105	
		Crawler Crane	100	108.6

Table 6-12: Expected Noise Levels at Depot during Site Development and Construction

			DEPOT AREA		
			NW Cor.of Depot	*Work Shop of Depot*	*Mile-Stone College*
	Ambient noise (Leq10)		73	52	58
	Distance from Source		30	8	8
Target Noise Level(Leq)		Day	83	85	75
		Night	83	85	65
	Compacting Ground	Leq10	75	85	85
	Ground Work	Leq10	72	82	82
Depot & Track Prep.	Concrete Casting	Leq10	72	82	82
	Framework Construc.	Leq10	72	80	80
Elevated Track	Girder Installation	Leq10	71	79	79
Elev Track & Station	Preparation	Leq10			
	Ground Work	Leq10			
	Girder Inst.& Frame-	Leq10			

Noise levels during construction along the alignment are not expected to exceed the standard adopted through a review of international practice. The nighttime standard of 65 dB may however be exceeded at times. Mitigation measures are proposed to reduce noise impacts from construction:

- Use heavy equipment with built in noise abatement, especially pavement breakers, crawler cranes, excavators and concrete cutters
- Construct temporary noise barriers between noisy activities and noise-sensitive receivers
- Site equipment on construction and casting yards as far away from noise-sensitive sites as possible
- Construct walled enclosures around especially noisy activities or clusters of noisy equipment
- Combine noisy operations to occur in the same time period if possible
- Avoid nighttime activities where there is sensitivity to noise, such as hospitals
- Provide noise-dampened equipment, such as quieted and enclosed air compressors and properly working mufflers on all engines

6.1.2.5 Conclusion

Construction activities used to develop sites and to construct the project include land preparation, soil stabilization, installation of piling, and construction of viaduct foundations and piers, erection of precast viaduct sections, and construction of stations and overpass structures. These activities will contribute to noise levels along the project corridor. The combination of equipment and ambient noise levels are not likely to exceed the standard. Still, mitigation measures can be employed that involve scheduling times of operation, shielding pieces of equipment and/or sensitive receptors, and altering construction approaches. Construction noise impacts will need to be closely monitored during the construction cycle to identify specific problem locations.

In the event of excessive noise the 2006 DOE Sound Control Ordinance provides a mechanism for bringing noise complaints before local authorities for adjudication of injury. Complaints will trigger the use of increased measures for limiting noise impacts in any given situation. This is seen as the most effective way to regulate construction noise given the need to implement the project, the temporary nature of activities generating noise during construction, and the special situations in which noise control issues arise.

The contractor should be required to carry out mitigation measures as necessary to limit noise in the vicinity of worksites, and should prepare a Noise Abatement Strategy at the outset of construction work under any of the civil works packages. Citizens should be made aware of their right to complain and seek redress, either through the grievance mechanism set up under the project, or under the 2006 Sound Control Ordinance.

6.2 Vibration

Vibration is measured in Vibration decibels (VdB) and in Peak Particle Velocity (PPV, mm/sec).

Depot: Vibration like noise is significant during site infilling, and analyzed in this section. Vibration during depot construction is considered insignificant. Vibration outside the perimeter boundary of the depot site during operations is considered insignificant.

Alignment: Vibration during transit operations is significant, and analyzed in this section. Vibration during construction of the viaduct is considered insignificant.

6.2.1 Train Operations

6.2.1.1 Method

The Japanese method established by Toei (都営) and used for analyzing the Tsukuba Express Line (つくばエクスプレス) is used to calculate expected vibration levels along the alignment.

The formula for vibration at-source (Lv) is based on ballast-less track: $Lv = 10\log V + 47 + 7.5$

If R<=400m, the following equationshould be used: $Lv = 10\log V + 47 + 7.5+2.1$
where,

a) Lv; Vibration level at source(VdB)

b) V ; Train speed (km/h)

In the case of vibration-proof track: Lv = 10logV + 47

If R<=400m, following equation shall be used: Lv = 10logV + 47 + 2.1

In these formulas, an additional 2.1 VdB is added to account for vibrations generated when the train passes through curves of radius <= 400 m. Further, use of vibration-proof track (MSS bearing) reduces the vibration level by 7.5 VdB.

Prediction equation for vibration:

L_P = Lv– 10log(r / r0) – 10logexp(α (r - r0)), where,

- L_P ; Vibration level at target point(VdB)
- Lv; Vibration level at reference point(VdB)
- r ; Distance from center of structure to target point (m)
- r0; Distance from center of structure toreference point(m)
- α; Correction factor for internal dampening（assumed α=0.04）

6.2.1.2 Applicable Criteria

Bangladesh has not established a regulation for vibration; therefore Japanese criteria are adopted, of which there are two: 70 VdB for Shinkansen and 60 VdB for railways (Act No 1049, Vibration Regulation Act of 1977, Article 16, Section 1). The stricter value of 60 VdB will be applied for this Project. The value of 60 VdB approximately corresponds to 1.4 mm/sec of peak particle velocity (PPV).

The proposed standard is strict compared to many international standards. For example, the USA regulation mentions that “vibration damage threshold criteria is 0.20 in (5 mm)/sec (approx. 100 VdB) for fragile buildings or 0.12 in (3 mm)/sec (appro. 95 VdB) for extremely fragile historic buildings” (Transit Noise and Vibration Impact Assessment, FTA 2006). The Australian Standard A-2183 mentions that for “historical building and monuments and buildings of special value”, the allowable limit is 2 mm/sec PPV. The Indian CMRI Standard mentions that the applicable vibration limit is 2 mm/sec PPV for “objects of historical importance, very sensitive structures, more than 50 years old construction and structures in poor state condition”. The adopted value for MRT Line 6 of 60 VdB (1.4 mm/sec PPV) is stricter than many international standards. The vibration level should be calculated at 12.5 m from the piers along the alignment.

6.2.1.3 Analysis

The formulas were applied for three curve radii and related train speeds. Table 6-13 shows results for ballast-less and vibration proof (with Mass Spring System, MSS) track; for sections of curvature <200 m, between 200 - 400 m, and straight sections; for locations at the base of the pier and at 12.5 m distance.

Table 6-13: Expected VibrationLevels for Track Radii (VdB)

	R=200m	R=400	Straight(R>=600m)
At Pier Face:			
Ballast-less track	65.0	68.3	66.9
Vibrationproof track	57.4	60.7	59.3
At 12.5 m from Pier:			
Ballast-less track	57.5	60.8	59.4
Vibrationproof track	49.9	53.2	51.8

Due to the sharp curvature, locations in the proximity of piers near 200 m radius curves (such as Farmgate) may exceed the standard when ballast-less track is used. All locations where curvature approaches 200 m have been evaluated, and vibration-proof track installed at locations where building occupancy and use may be affected.

Vibration induced by 85 km trains moving through curves of 400 m radius also exceeds the standard slightly; however buildings located along these stretches are generally 20-30 m from the centerline of the alignment, and the 12.5 m used in the calculation is conservative. It is not recommended to install vibration-proof track through these sections.

Dhaka Gate poses a special case, as it is an old structure that straddles the MRT-6 line near Press Club Station, and great care needs to be taken to limit vibration impacts on the structure. The radius of alignment near Dhaka Gate is 240 m, but for purposes of calculation, a more strict condition is used of R = 200 m and V, the design speed, of 40 km/h. Results are shown in Table 6-14.

Table 6-14: Vibration Level near Dhaka Gate (R=200 M)

Track Type	At the closest point to the pier	At 12.5 m from pier
Ballast-less	65.0	57.4
Vibration-proof, with MSS	57.5	49.9

Vibration intensity using MSS track at the closest point from the pier is within the Japanese standard, and at 12.5 m from the pier is found to be 57.4 VdB for ballast-less track and only 49.9 VdB for MSS track. Vibration is well within the tolerable limit for Dhaka gate with MSS track installed still, the piers will be placed as far as possible from the gate. Pier locations were modified in the design to provide the maximum distance on both sides of the gate to the nearest pier (more than 15 m).

Other special cases where historical buildings are in close proximity to the rail line were investigated by measuring distances from the nearest pier to the structure, as shown in Table 6-15. In addition to Dhaka Gate, three additional locations are close enough to cause concern, Nos. 14, 15 and 21 in the list. In all instances, the distance from the nearest pier is sufficient to prevent damage to the structure from excess ground vibrations.

Table 6-15: Distance from Nearest Pier to Historical Structures

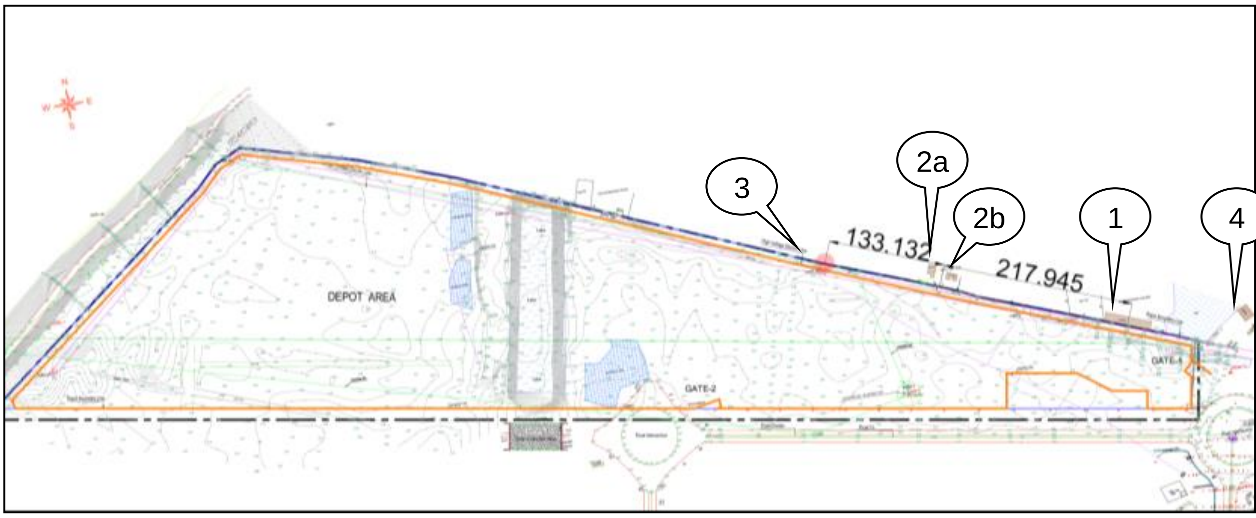
Sl.	Site Name	Location	Coordinates		Distance from the nearest pier, m
			N	E	
1	Haji Khawaja Shahbaj Mosque	Behind Dhaka High Court, east of the tomb complex of the three leaders (Teen Netar Mazar)	23.729268	90.400282	86.1
2	Haji Khawaja Shah baj Tomb	Behind Dhaka High Court, adjacent to Mosque	23.729407	90.400586	117.5
3	Tin Netar Majar	Adjacent to Khwaja Shahbaz mosque	23.7289	90.3999	24.59
4	Dhaka Gate	Dhaka University near Doyel Chattar	23.728536	90.39984	14.45
5	Doyel Chattar	Dhaka University Near Karzon Hall	23.728049	90.400325	29.8
6	Carzon Hall	Dhaka University	23.727509	90.401865	55.16
7	Musha Khan Mosque	West side of Shahidullah Hall, Dhaka University	23.726809	90.400784	145
8	Kadom Fowara	Opposite High Court Building and adjacent to Chamerry House	23.729951	90.405152	31.18
9	Chamerry House	Opposite High Court building and adjacent to Kadom Fowara	23.72935	90.405395	37.75
10	Old High Court Building	On High Court Street, opposite Curzon Hall.	23.7293	90.4023	110.3
11	Bangladesh National Museum	Shahbag	23.73748	90.3951	78.15
12	Bangla Academy or Bardhaman House	Dhaka University	23.73015	90.39795	25.45

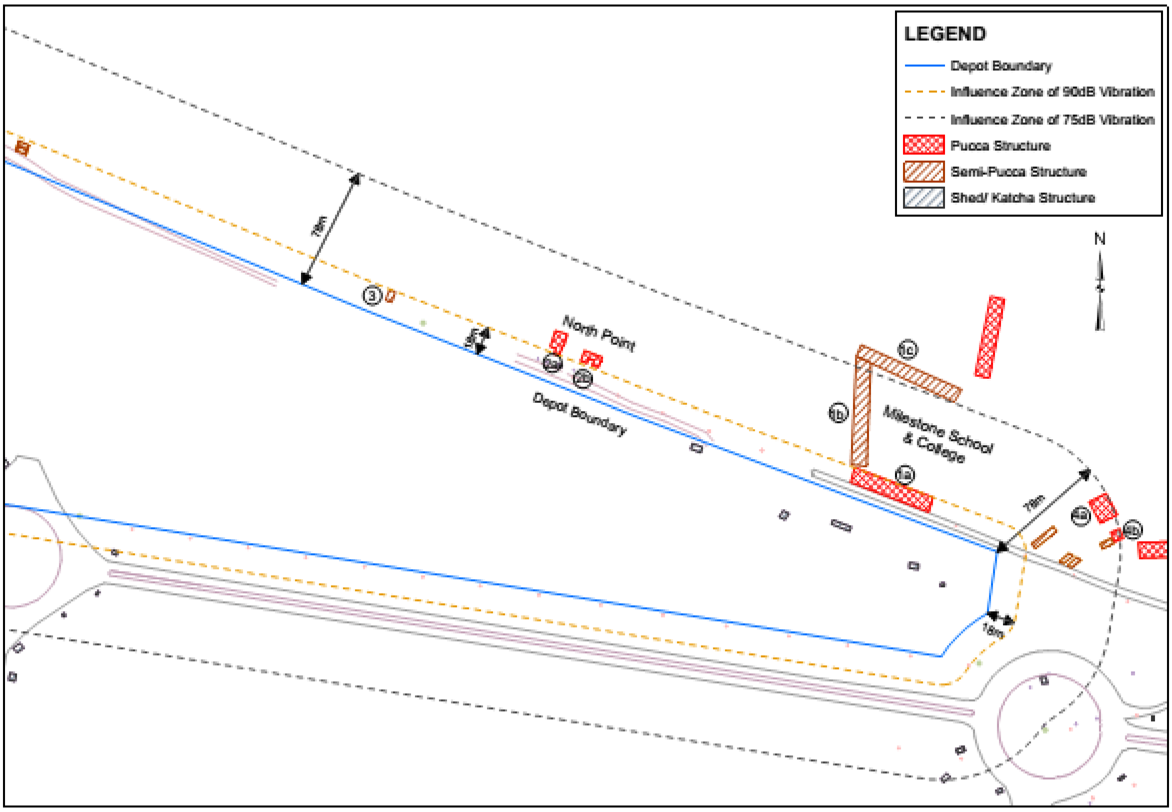
Sl.	Site Name	Location	Coordinates		Distance from the nearest pier, m
			N	E	
13	Khawaja Ambar Mosque	Karwan Bazar	23.751999	90.393097	64
14	Suhrawardy Uddyan	North of Mausoleum of Three Leaders and e. of Bangla Academy	23.7292	90.39918	12
15	Greek Monument	TSC, Dhaka university	23.731837	90.396414	18.4
16	Jatiya Sangsad Bhaban	Sher-e-Bangla Nagar	23.762333	90.379283	401
17	British Bungalow	Farmgate	23.759117	90.384983	24.6
18	Old Airport, Dhaka	Tejgaon	23.776717	90.3853	16.2
19	Baitul Mokarram Mosque	Gulistan-Paltan area	23.73002	90.412117	29.4
20	Shapla Chattar	Motijheel	23.726618	90.421662	150.8
21	Hindu Temple	Mirpur, near DOHS	23.837701	90.363634	18.85
22	Raju Bhaskoryo	TSC, Dhaka university	23.732691	90.395683	22.81

6.2.2 Vibration Impacts during Construction

Depot Site Development

Vibration induced by installation of sand compaction piles and dynamic compaction at the depot site during infilling is significant. Buildings are located to the north of the site, shown in Figure 6-4.





		
1. Milestone college	2a. North point office	2b. North point cottage
		
3. Temporary buildings	4. Buildings at north east	

Figure 6-4: Location Map and Buildings on North Side of Depot Property

The buildings are described as follows:

Location 1. Milestone College - Business School 3 storied structure

Location 2 Resort -

a) Office single storied structure

b) Cottages 2 nos each 2 storied structure connected to each other.

Location 3 Newly constructed single storied structure - looks like temporary house.

Location 4 Buildings located at North-East Corner of the Depot

Milestone College is the major vibration receptor, as buildings at location 4 are more distant and are unlikely to undergo severe impact. The building at location 3 is a small temporary structure; buildings at location 2 - resort, according to information gathered, consists of an office and resort cottages - sparingly occupied. The building at location 1, Milestone College is critical as it is the classroom of the college and regularly occupied. The distance is 7.5 m from the depot boundary.

Vibration Standards

There is no vibration standard in Bangladesh. Vibration standards for different countries are shown in Table 6-16.

Table 6-16: Vibration Standards for Construction in Different Countries

Country	Standard
India (CMRI) Historical buildings Domestic site development Industrial site development	 2 mm/sec PPV 5 mm/sec PPV 12.5 mm/sec PPV
Australia Historical buildings Residential development Commercial development	 2 mm/sec PPV 10 mm/sec PPV 25 mm/sec PPV
USA (Construction Vibration Damage Criteria, FTA) RCC CC Timber/ Mason Extremely susceptible to vibration	 0.5 in/sec (12.7 mm/s, 102 VdB) 0.3 in/sec (7.6 mm/s, 98 VdB) 0.2 in/sec (5 mm/s, 94 VdB) 0.12 in/sec (3 mm/s, 90 VdB)
Jakarta Metro During Construction	 85 VdB
Japan During Construction	 75 VdB

The Japanese standard is the most strict (as it gives more importance to human perception). US FTA standard for “extremely susceptible to vibration” is recommended in this Project as 90 VdB, approximately corresponding to 3 mm/s PPV, which is adopted as the Project standard.

Current construction method

The current design calls for dynamic compaction near the north edge. The vibrations at various distances are shown in Table 6-17.

Table 6-17: Vibration with respect to Distance at the School

7.5 m	95 Vdb
20 m	85 VdB
40 m	80 VdB
75 m	75 VdB

Based on New York Department of Transport (NY DOT) Geotechnical Design Manual, 2014; using impulse-momentum equation, equations for velocity wave propagation in soils, and energy dampening; the range for particle velocity at 10 m from point of impact, corresponding to drop heights of 10 – 20 m and weights of 118 – 196 kN, for collapsible silt, loose sand and loose sand fill are ~ 3 – 10 mm/sec, which corresponds to a “strongly perceptible” vibration, but on the low side of “disturbing”. We can conclude from this that physical damage to the buildings will not likely occur, but occupants will likely be disturbed bythe vibrations.

Conclusion

According to the USA FTA standard, the target building vibration at 7.5 m distance from the construction activity is well within the limit, though the Japanese standard is not met. Irrespective of any standard, it is clear that the construction works using dynamic compaction will create annoyance to the occupants, even if there is no damage. It can be seen that some measures are required for Milestone college building mitigate impact or compensate.

Recommendation

Temporary closure of the class rooms is required during the construction period, so that soil compaction can be carried out using the dynamic compaction technology. Milestone College and DMTC have signed a Memorandum of Understanding (MOU) to demolish the building, and to relocate the college for a period of years, for which DMTC will compensate Milestone College. The level of compensation will be determined by the Resettlement Action Consultant (RAC) and those amounts will be set out in the Resettlement Action Plan (RAP).

6.3 Air Quality

Air quality is measured directly as suspended particulate matter as total SPM and PM_{10}, the fraction smaller than 10 µm, nitrous oxides (NOx), sulfur oxides (SOx), carbon monoxide (CO), and lead (Pb). DOE sets ambient standards for four of these pollutant parameters.

Depot: Particulate matter from wind-entrained dust can be generated during site infilling and construction. Construction equipment exhausts contain NOx and CO that can be transported offsite. There are few receptors in the area of the depot, so the impact on receptors is moderate. Air emissions from operations at the depot are not likely significant beyond the property boundary.

Alignment: Air emissions can be generated during construction of the viaduct and stations by equipment operations and entrainment of dust along roadways near construction sites, yards and haul routes. Operation of the transit system and stations do not generate air pollution.

6.3.1 Impact Scenario, Methods and Standards/Criteria

Air pollutants have potential adverse impact on human health and maintenance of surfaces, structures and indoor space. DOE regulates these pollutants under Schedule 2 of ECR (2007), reproduced in Table 6-18a. Limits on vehicle tailpipe emissions, also from Schedule 2, are shown in Table 6-18b. Tailpipe emission limits are for on-road passenger and transport vehicles, and are based on distance traveled, so a more appropriate set of standards was sought for non-road diesel engines. A comparison was made between the US Tier 1 and 2 non-road diesel standards and Indian heavy diesel engine standards, which is shown in Table 6-19. The Bangladesh standard is also shown, assuming a 200 kW engine capacity and 40 km/hr speed of travel, for purposes of comparison. It can be seen that the Indian BS-1 standard of year-2000 falls between the Tier 1 and 2 US standard, and is approximately equivalent to the Bangladesh standard. Hence the Indian BS-1 standard is adopted as the standard for the Project.

Air quality standards set by DOE could be exceeded during construction of the Metro because of:

a) Existing conditions, especially regarding SPM and NOx, which often exceed DOE ambient standards (see Tables 6-21 and 22).

b) Onsite construction activities: dust entrainment and exhaust emissions from equipment operations at construction sites. Measurement is at boundaries of depot and temporary construction sites, and at receptor points for work sites along the alignment.

c) Transport: SPM and exhaust emissions from transport vehicles traveling on broken roadways.

Table 6-18: DOE Standards

a: DOE Ambient Air Standards (µg/cu m)

Land Use Category	SPM	SO2	CO	NOx
a. Industrial and mixed	500	120	5000	100
b. Commercial and mixed	400	100	5000	100
c. Residential and rural	200	80	2000	80
d. Sensitive	100	30	1000	30

b: DOE Tailpipe Emission Standards

Parameter	Unit	Standard Limit
Black Smoke	Hart ridge Smoke Unit (HSU)	65
Carbon Monoxide	g/km	24
	percent area	04
Hydrocarbons	g/km	02
	PPM	180
Oxides of Nitrogen	g/km	02
	PPM	600

* As measured at two thirds of maximum rotating speed.

Table 6-19: Comparison of Non-road Exhaust Emission Standards

Tier	Year	CO	HC	NMHC+NOx	NOx	PM
US-Tier 1	1996	11.4	1.3	-	9.2	0.54
US-Tier 2	2003	3.5	-	6.6	-	0.2
IN-1996	1996	11.2	3.5		14.4	N.A.
IN-BS-1	2000	4.5	1.1		8.0	0.36
Bd-ECR1	1996	4.8	0.4		0.4	

1 Based on 200 kW engine and 40 km/hr speed of travel.

6.3.2 Air Quality Monitoring

During design stage, ambient air quality monitoring (AAQM) was conducted at 12 locations near the depot, along the alignment and at the Golapbag temporary construction yard (Table 6-20). The results of the two rounds of monitoring (dry and wet seasons) are shown in Tables 6-21 and 6-22.

Samples were taken using a high volume air sampler. Samples were taken continuously over a 24 hour period with filters and vials changed out at 12 hour intervals, to provide both day and nighttime measurements. Measured levels for pollutants are higher in the daytime than at night, with increases ranging from 6% to 166%. SPM daytime levels are twice as high nighttime values.

Table 6-20: Locations for Air Quality Monitoring under the Present Study

S.N.	Location
AQ1.	1st Roundaboutof Depot
AQ2.	North Western Corner of Dhaka Embankment
AQ3.	Avenue 1 (Between CBD and Central Plaza)
AQ4.	Nearest Location of Bridge 8
AQ5.	Mirpur DOHS-Osmani Hall
AQ6.	Pallabi Station
AQ7.	Mirpur 10 Station
AQ8.	Parliament Khejurbagan
AQ9.	Shahbag Station
AQ10.	Nearest location of Carzon Hall
AQ11.	Motijheel Station
AQ12.	Current Construction yard of Jatrabari flyover in Golapbag

For pollutants that have specific limits set by DOE (SPM, CO, NOx and SO2):

- All but one (92%) of the monitoring locations produced daytime SPM values in excess of the residential standard, and six locations (50%) exceed the standard for commercial and mixed land uses. Nighttime values are within the limit set by DOE for commercial and mixed land uses.
- The DOE NOx standard for commercial and mixed land uses is exceeded in eight out of 12 samples (66%) for both day and night values.
- The CO standard for commercial and mixed land uses is exceeded in seven out of 12 samples (58%) taken during daytime hours, and six out of 12 samples (50%) taken at night.
- SO2 is generally within the limits set by DOE, with none of the monitoring results exceeding the residential standard. Daytime SO2 levels are generally 66% higher than nighttime levels.
- Air quality is better during the rainy season (second data set), with values typically 50 -- 70 % lower than dry season results.

Air quality is degraded along the alignment especially during dry periods of the year. For these conditions, NOx exceeds the standard at nearly all locations. Daytime values for SPM exceed the mixed use standard at all locations south of Mirpur, as does CO. Only SO2 is within the limits set by DOE. During the rainy season, 25% of the daytime values for NOx, and 50 % of daytime SPM values, exceed the DOE ambient limits; other parameters are within the DOE ambient air standard.

Table 6-21: First Round Air Quality Monitoring Results (dry season)

ID	Date (2015)	PM10 -24hr (µg/m3)			NOx -24hr (µg/m3)			SOx -24hr (µg/m3)			CO (ppm)			Lead (Pb) (µg/m3)			SPM (µg/m3)		
		7 AM – 7 PM	7 PM – 7 AM	Aver.	7 AM – 7 PM	7 PM – 7 AM	Aver.	7 AM – 7 PM	7 PM – 7 AM	Aver.	7 AM – 7 PM	7 PM – 7 AM	Aver.	7 AM – 7 PM	7 PM – 7 AM	Aver.	7 AM – 7 PM	7 PM – 7 AM	Aver.
AQ1	22/02	135	60.7	97.8	35.9	67	51.4	19.1	7.5	13.3	2.9	1.2	2.0	BDL	BDL	BDL	248	112	180
AQ2	27/02	209	271	240	211.7	173	192.3	43.1	33.8	38.4	7.9	5.2	6.5	0.07	0.01	0.04	364	295	329.5
AQ3	27/02	127	60.4	93.7	36.7	72	54.3	17.4	6.3	11.8	2.4	1.5	1.9	BDL	BDL	BDL	230	123	176.5
AQ4	28/02	58	10.2	34.1	9.9	50	30	2.6	2.1	2.35	0.2	0.2	0.2	BDL	BDL	BDL	82	74	78
AQ5	22/02	225	79.5	152.2	65.4	158	111.7	18.3	2.1	10.2	3.2	0.8	2	BDL	BDL	BDL	348	232	290
AQ6	22/02	306	295.4	300.7	249.3	182	215. 6	55.7	30.8	43.2	12.5	7.3	9.9	0.08	0.03	0.05	487	258	372.5
AQ7	23/02	330	320.8	325.4	305.1	219	262.1	70.2	24.5	47.3	10.3	6.8	8.5	0.12	0.08	0.1	504	324	414
AQ8	23/02	282	315.5	298.7	292.8	165	228.9	35.1	11.5	23.3	8.5	4.2	6.3	0.09	0.02	0.05	456	232	344
AQ9	23/02	352	377.1	364.5	328.8	205	266.9	40.6	12.9	26.7	9.8	5.3	7.5	0.13	0.07	0.1	561	312	436.5
AQ10	18/02	219	253.5	236.2	175.8	92	133.9	19.5	2.8	11.1	2.8	1.7	2.2	BDL	BDL	BDL	320	114	217
AQ11	18/02	270	305.9	287.9	230.6	105	167.8	45.7	9.3	27.5	11.6	5.2	8.4	0.14	0.01	0.07	495	130	312.5
AQ12	18/02	361	367.1	364.0	264.7	165	214.8	65.3	19.2	42.2	12.7	7.1	9.9	0.25	0.13	0.19	623	190	406.5

Table 6-22: Second Round Air Quality Monitoring Results (wet season)

ID	Date (2015)	PM10 -24hr (μg/m3)			NOx -24hr (μg/m3)			SOx -24hr (μg/m3)			CO (ppm)			Lead (Pb) (μg/m3)			SPM (μg/m3)		
		7 AM – 7 PM	7 PM – 7 AM	Aver.	7 AM – 7 PM	7 PM – 7 AM	Aver.	7 AM – 7 PM	7 PM – 7 AM	Aver.	7 AM – 7 PM	7 PM – 7 AM	Aver.	7 AM – 7 PM	7 PM – 7 AM	Aver.	7 AM – 7 PM	7 PM – 7 AM	Aver.
AQ1	22/6	55.8	38.4	47.1	29.6	20.1	24.9	5.1	4.2	4.7	1.3	0.5	0.9	BDL	BDL	BDL	65.0	38.0	51.5
AQ2	22/6	82.7	98.1	90.4	90.1	85.2	87.7	6.7	5.2	6.0	3.6	2.1	2.9	BDL	BDL	BDL	102.0	56.0	79.0
AQ3	21/6	50.1	30.6	40.4	20.1	15.7	17.9	3.2	1.3	2.3	1.1	0.6	0.9	BDL	BDL	BDL	71.0	42.0	56.5
AQ4	21/6	10.1	8.2	9.2	7.3	6.1	6.7	0.8	0.2	0.5	BDL	BDL	BDL	BDL	BDL	BDL	28.0	17.0	22.5
AQ5	20/6	64.1	28.3	46.2	49.1	30.2	39.7	4.1	2.1	3.1	1.3	0.3	0.8	BDL	BDL	BDL	76.0	52.0	64.0
AQ6	20/6	89.5	70.4	80.0	102.1	78.5	90.3	6.5	4.7	5.6	5.1	3.2	4.2	0.0	0.0	0.0	112.0	90.0	101.0
AQ7	19/6	135.8	107.5	121.7	113.1	89.3	101.2	8.0	6.9	7.4	4.3	2.2	3.3	0.1	0.0	0.0	141.0	103.0	122.0
AQ8	19/6	90.4	50.2	70.3	96.1	47.8	72.0	5.3	4.2	4.7	3.7	1.7	2.7	0.0	0.0	0.0	82.0	57.0	69.5
AQ9	18/06	112.5	78.2	95.4	90.2	67.4	78.8	6.5	4.7	5.6	3.9	1.8	2.9	0.1	0.0	0.0	130.0	97.0	113.5
AQ10	17/6	70.2	30.1	50.2	58.2	36.1	47.2	4.2	2.9	3.5	1.2	0.3	0.8	BDL	BDL	BDL	85.0	55.0	70.0
AQ11	16/6	103.7	80.4	92.1	98.3	67.4	82.9	6.3	5.1	5.7	4.1	1.9	3.0	0.1	0.0	0.0	105.0	78.0	91.5
AQ12	15/6	137.4	102.3	119.9	104.3	83.4	93.9	13.1	9.6	11.3	6.2	3.5	4.9	0.1	0.1	0.1	153.0	117.0	135.0

6.3.3 Analysis and Results

Construction activities generate PM10 and PM2.5 (mostly dust) that can become entrained in the air depending on prevailing site and meteorological conditions. The problem is made worse during the dry season. Mud and particulates from trucks may be deposited along main transport corridors and in residential neighborhoodswhere construction trucks are routed, either from uncovered loads or by shedding from the undercarriage. Particulate if uncontrolled is bothersome to pedestrians and people passing in open vehicles; small diameter particulates contribute to respiratory disease.

Heavy trucks and construction equipment powered by gasoline and diesel engines generate CO and NOx in exhaust emissions. These emissions are temporary and limited to the immediate area surrounding the construction site. Heavy trucks and construction equipment are expected to conform to the Indian BS-1 2000 Diesel Exhaust emissions standards provided in Table 6-19. Contractors will be required to certify their equipment and heavy trucks in use on the job.

6.3.4 Findings and Mitigation Measures

Air quality impacts associated with construction activities should be minimized by the following measures:

- Clean exposed surfaces at work sites along the alignment, within the confined space
- Maintain roadway surfaces adjacent to the ongoing work on the alignment to prevent the development of broken pavement and potholes
- Remove mud and windblown dust deposited on roadways at construction sites and haul routes
- Spray water at work sites and on unpaved surfaces within fabrication yards
- Cover and/or wet down materials onsite
- Loads will be covered during transport of loose sand, aggregate and spoil materials by truck
- Provide washing facilities at the gates of casting yards and materials storage sites if necessary to remove mud from wheels and undercarriages
- Provide certification that construction equipment brought onto the job complies with IN-BS-1 exhaust emissions standards, and assure equipment is properly maintained.

These mitigation measures shall be implemented by the contractor to limit airborne dust and exhaust emissions in the vicinity of worksites. The Contractor is required to address systematically air emissions abatement at the outset of construction work under any of the civil works bid packages.

6.3.5 Monitoring

The Contractor will be required to monitor particulate matter in the vicinity of construction sites, temporary sites including casting yards and storage areas, and access routes. Because areas along the alignment already exceed DOE's air quality standards at different times, the measured air quality during construction should be set at a level greater than the DOE's ambient standard. If SPM at a level greater than 25% greater than DOE's standard, or community complaints arise, the contractor will intensify use of mitigation measures to minimize air quality impacts. The Contractor is required to certify construction equipment and vehicles used in the work.

6.3.6 Operations

Vehicle exhaust emissions and entrained dust could increase in the vicinity of stations due to increased movements of people. Losses of chemical cleaning fluids and odors from various sources could be present at the depot area, generated by train maintenance activities. Neither of these sources is expected to be significant, and no mitigation measure is proposed.

6.3.7 Unavoidable Environmental Effects

Construction activity will generate air pollutants that cannot be controlled below a minimum threshold level, but these are temporary, limited in extent, and an unavoidable consequence of construction.

6.4 Impacts due to Traffic Congestion

Traffic Congestion in construction zones is addressed through traffic management planning, undertaken in NKDM by various specialties under the overall direction of the Transport Planning Group. The planning effort has emphasized various aspects of traffic problems that could develop along the alignment during construction of the viaduct and stations. The findings are assembled into a Traffic Management Plan Report (TMP, NKDM 2015), which was prepared in close cooperation of DMCTL. Key recommendations of TMP were also explained to all stakeholders through a presentation and discussion meeting held at Ministry of Road Transport and Bridges in November 2015. Because traffic management involves the cooperation of a number of agencies, the process of agreement will be incremental, continuing until the start of construction. The main traffic management recommendations are summarized in this section, and the overall recommendation is to implement individual measures as feasible under prevailing constraints.

Depot: traffic management at the depot site during construction is not significant. Importation of materials and equipment to the site may cause (or be constrained by) traffic congestion along haul routes. There are no traffic management issues related to operations of the depot.

Alignment: The TMP addresses, for the roadways where the alignment is located, demand, traffic behavior patterns and insufficient capacity, and specific problem-areas along the alignment, with the overall objective to maintain traffic flow on roads in the vicinity of construction sites.

Traffic management also is significant during operations, primarily in the vicinity of stations, due to vehicle and pedestrian traffic congestion. This is addressed by a separate initiative in the Transport Planning Group, along with the Architecture Group at NKDM. A separate report on "Traffic Integration" is expected to be finalized before the start of the operation.

6.4.1 Traffic Management during Construction

Traffic planning has resulted in eight main interventions that can reduce traffic congestion in construction zones (TPM, NKDM, 2015):

a) Restrictions of Rickshaw and other NMV entering into specific Road

b) Prohibition of on street parking / loading / unloading along MRT Alignment

c) Enhance the capacity of Important Intersections

d) Defining the Bus Stop with Bus Bay

e) Temporary Relocation of Pallabi Bus Terminal

f) Demand Management

g) Enhancement of Public Transport Use

h) Diversion of Traffic (Bus & Private)

The first five interventions are capacity related and apply to the general problem of reducing traffic congestion along alignment (and other) roadways, somewhat independently of Metro construction, since traffic conditions are poor at many locations in Dhaka. A combination of these will also assist in improving traffic flow around work sites. The last three items are demand related and designed specifically to maintain traffic flow during construction of the Metro, and would not otherwise be recommended. The findings and recommendations of traffic studies are summarized below. Figure 6-5 shows the arrangement of traffic lanes and work corridors in construction zones.

Restrictions of Rickshaw and other NMV entering into specific Road

Prohibition of on street parking / loading / unloading along MRT Alignment

Enhancement of Public Transport Use

These recommendations require coordination with Dhaka transport authorities, and will be expedited by the DMTC working through DTCA, to reach agreement and coordinate actions. Their primary purpose is to reduce congestion and maintain traffic flow. Included with them are parallel measures to improve traffic signage and enforce – or support observance of – traffic regulations.

Defining the Bus Stop with Bus Bay

The TMP has identified 14 existing bus stop locations along the alignment. Space is a constraint for installing bus bays. It is not possible to install a bus bay at five of the existing locations; for the remaining nine, four can be installed in the road without interference of traffic and two in the road and footpath. The benefit of bus bays is contingent on whether operators can be forced to use them, whether jams would form at the entry, and other factors currently under consideration. A number of agencies need to be engaged in the decision to install bus bays.

Enhance the capacity of Important Intersections

The Mirpur 10 Intersection is a major congestion location affected by a small radius roundabout in the center, lack of traffic signals (traffic controlled manually by policemen at site), buses stopping in customary locations, rickshaws parked along curbs, and pedestrian crossing at random locations. The TMP recommends removing the traffic circle, redesigning the intersection along with the plan of the Mirpur 10 Metro Station, including bus bays, use of a four-phase signal that distinguishes straight and right turns, refurbishing the pedestrian bridge, and restricting rickshaw access and buses from random stops. Preliminary design of the intersection can be found in the TMP. Cost, scheduling and implementation arrangements need to be resolved in order to proceed with this work.

Temporary Relocation of Pallabi Bus Terminal

A study has been conducted for temporary relocation of the Pallabi Bus Terminal. Three potential sites were identified and compared. Consideration of these options is before the DMCTL, who will take it up with the DTCA. Bus operators were interviewed for their opinion on a preferred location, and views have been tallied and are taken into consideration in the selection of a preferred option.

Diversion of Traffic (Bus & Private)

A study was conducted to determine best possible routes for diverting traffic around construction areas. A traffic flow computer model was prepared using input date for present traffic volumes from the transport planning study done by NKDM in 2014. Recommendations are mixed on traffic diversion. Small mini-buses can be diverted whereas large buses should remain on the original routes. Diversion would depend on a publicity campaign in advance. Bus diversion would depend on improving specific alternate routes, making some roads one-way, and removing unauthorized structures that impede traffic. Some construction projects are still underway that impede traffic along proposed diversions, and these should be expedited and completed. Improving service efficiency and capacity of the existing commuter rail from Tongi would relieve traffic on Airport Road.

Demand Management

A number of recommendations related to demand management are included in the Traffic Management Plan. These are Rescheduling of the office hour between private and public offices, Rescheduling of the market operation hour, Rescheduling of the educational center locations, Introduction of school bus system, etc.

Conclusion

Existing traffic conditions along the alignment are typically poor. The TMP contains effective proposals for reducing congestion, which are necessarily difficult to implement. The proposals generally require two or more agencies to agree before they can be put in place; costs and human resources also are factors. These facts could not be otherwise; real traffic solutions are not simple. The TMP systematically addresses needs and opportunities for alleviating congestion in construction zones, and the EIA supports adoption of TMP recommendations where and when feasible.

6.4.2 Mitigation Measures Recommended in the EIA

The EIA includes additional measures related to general traffic conditions along thoroughfares, and to the movement of over-weight/over-length (OW/OL) loads.

General Traffic Conditions

- Traffic police should be regularly on duty during rush hours at sites of congested traffic
- Flagmen should be stationed at temporary work obstructions in the line of traffic, at the start of construction, and points of vehicle access into the work site.
- Contractor should keep operations within the workplace boundaries, to the extent possible.
- Contractor should assure that traffic lanes are free of obstructions during rush hours and heavy daytime traffic.

Over-Weight/Over-Length (OW/OL) Loads

- The contractor will plan and clearly mark routes through urban areas for movement of over-weight/over-length (OW/OL) loads of heavy equipment and other types of transport vehicles.
- The contractor will provide front and rear escort vehicles, equipped with flashing light, for movement of OW/OL vehicles, and auxiliary flagmen along the route and onboard to assure clearance.
- Movement of OW/OL loads preferably will be done at night.

6.4.3 Operations

Traffic on the main road or side streets may be affected in the vicinity of stations due to concentrations of people, rickshaw, CNG and private vehicles, illegally parked cars and vendors. Traffic integration planning at stations and identification of parking areas are addressed by NKDM architectural and transport planning working groups, and have been incorporated into project planning. The redesign of Khamarbari Rd. at Farmgate Station is an example, as shown in Figure 6-6, as well as the redesign of Mirpur 10 Intersection.

DMTC can support improved traffic management around the stations, but final responsibility for improving public infrastructure near stations lies with the City Corporations. Coordination among agencies for a common purpose will be necessary to improve usability of the stations and metro service.

Mitigation measures include:

- Redesign of intersections and roadway areas to accommodate stations, as has been done at Farmgate and Mirpur 10 Stations
- Provide connectivity through access points for bus and other forms of public transport
- Repair and maintain sidewalks that connect to points of access and egress
- Prohibit Rickshaw access on main roads, but develop and promote use of rickshaw queues on appropriate side roads near stations.

6.4.4 Footpath Padestrian Capacity

After commencement of MRT Line-6 operation, it is expected that pedestrians around stations will increase. Moreover, due to entry/ exit facilities placed on the existing footpath (See Sec 3.3.3), there would be capacity reduction of the footpaths at some point. The cumulative effect of these two might cause exceeding the current footpath capacity. To evaluate this aspect, NKDM prepared a separate “Future Pedestrian Study at MRT Station”, which was submitted to DMTC in September 2015.

That study calculated current footpath capacity, estimated future pedestrian demand near the stations, and assessed the capacity reduction due to placement of station entry/ exit structures. The Report concluded that there would no capacity failure at any stations in 2021. However, it also mentioned that the footpath pedestrian demand at 8 stations will exceed the carrying capacity. Subsequently, the Report prepared design of increasing pedestrian capacity with detail drawings. It is expected that DMTC will implement these measures in due time.

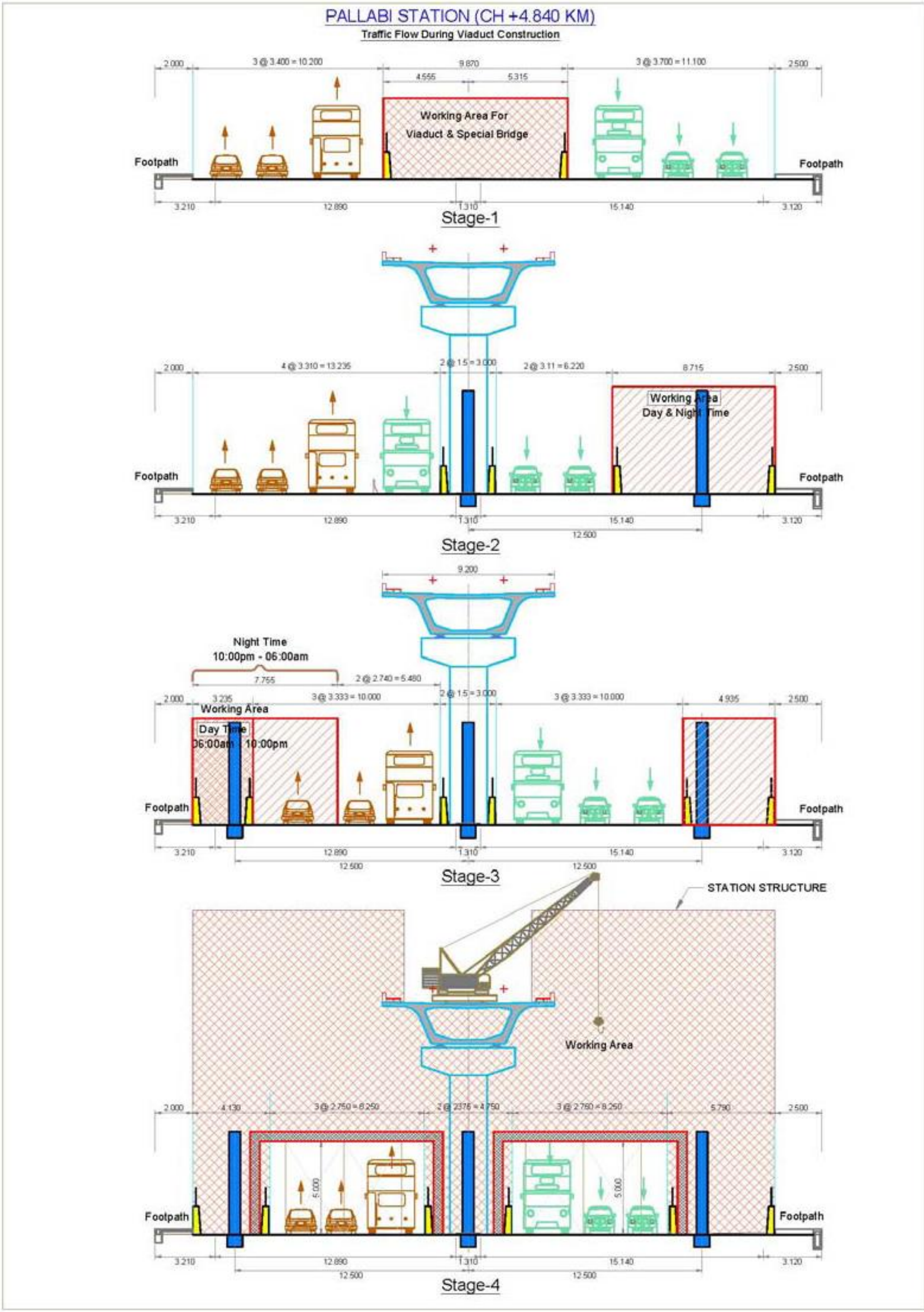


Figure 6-5: Traffic Management Detail for Construction of Pallabi Station (Typical)

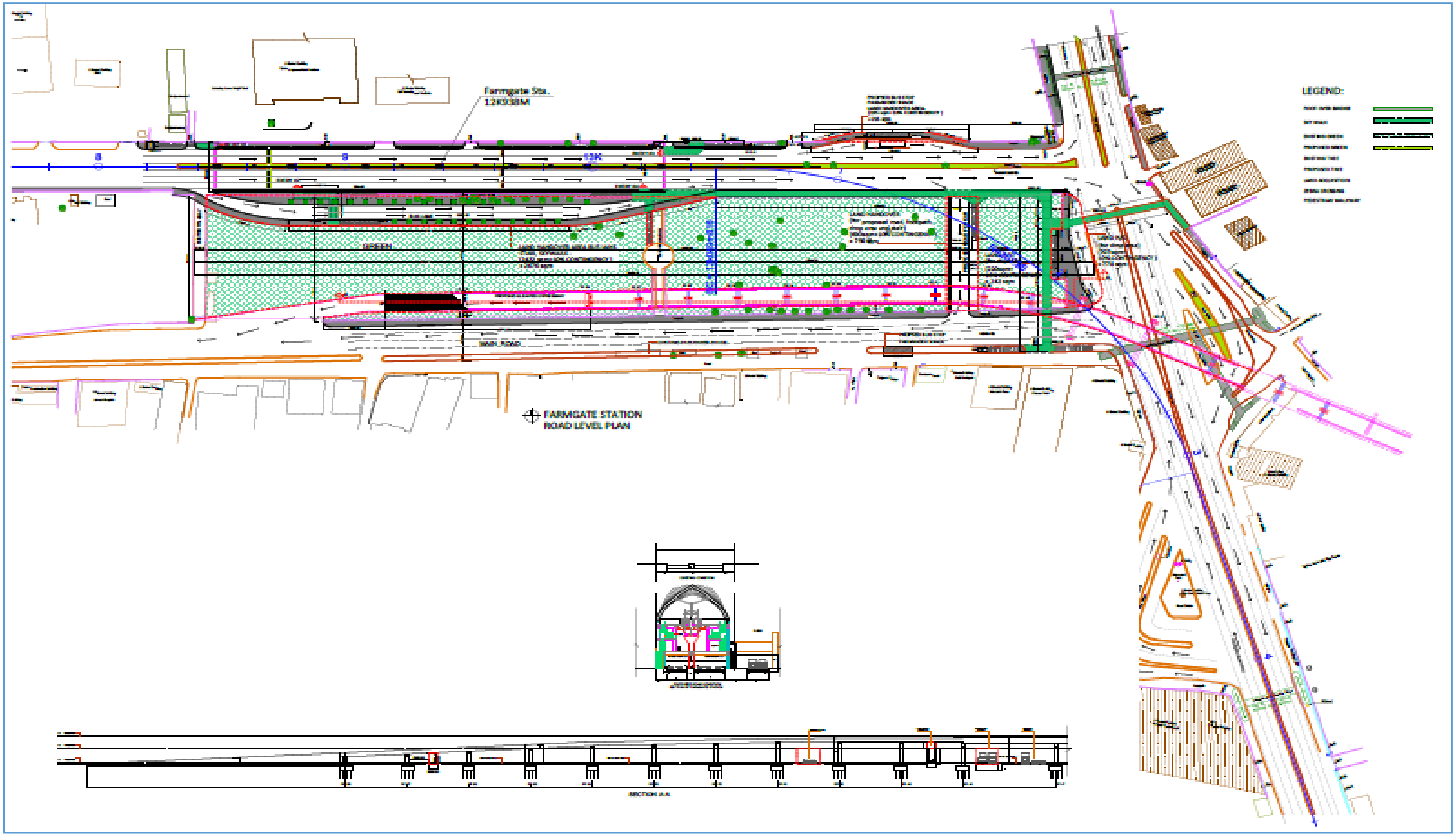


Figure 6-6: Redesign of Khamarbari Rd. and Farmgate Stati

6.5 Drainage and Water Quality

Drainage design is aimed at preventing standing water and flooding in the vicinity of homes and work sites by providing positive drainage to a point of outfall to river or lake. Poor water quality at the point of discharge or open water can affect public health and aquatic ecosystems. The main impact during construction is due to suspended solids entrained in runoff that can soil surfaces and clog drainage systems.

<u>Depot</u>: Drainage issues are important both during infilling, construction and operation of the depot. Both quantity and quality issues are addressed in this section.

<u>Alignment</u>: Drainage from construction sites needs to be controlled to prevent water crossing roadways or interfering with pedestrian movement. Drainage water needs to be discharged to a free point of discharge. Muddy water and cuttings produced during foundation construction will be contained and removed by vacuum truck. Station and transit operations do not cause significant drainage problems, and are addressed through engineering design.

<u>Construction yards and haul routes</u>: The Contractor should maintain a work site free of standing water, mud and silt so that these materials are not transported offsite on the wheels of trucks, and deposited along roadways; and overall drainage needs to be routed to an outfall in order to avoid affecting surrounding land uses (roads, shops, residential areas).

6.5.1 Construction

Various impacts related to surface drainage could occur during construction, as follows:

<u>Depot infilling and site preparation</u>: The area will be raised in elevation and drainage structures installed as part of the site development. During infilling, excessive rainfall could cause washouts and heavy silt loads into local drainage channels. Conduct of work could also be affected by ponded water within the site.

The lakes in the vicinity of the depot site serve as drainage channels for Uttara, but are undeveloped. These lakes are created by the infilling of land around an original drainage course. Some of the lakes eventually will be enclosed to stabilize the banks and use adjacent land. Some will be preserved and their ecological and recreational value developed as part of the Uttara development plan.

Water quality sampling was five of the lakes in Uttara and the cantonment area. The results indicate bacterial contamination from inflow of urban wastewater, with high turbidity and TSS from sediments in runoff from the surrounding unimproved ground. TSS averaged 150 mg/L during dry season sampling and 127 mg/L in the wet season.

The Contractor will be responsible for controlling suspended solids in drainage from the site. The Contractor will monitor TSS once per quarter at three (3) locations around the perimeter: the return flow from fill drying/dewatering operations and two other surface drainage channels. Total suspended solids content will be limited to 100 mg/L, the DOE standard of (ECR Schedule – 9: Standards for Sewage Discharge).

Construction Yards: These sites will need to be developed for good drainage, especially to support the movements of heavy equipment. While the sites are not selected yet, it is likely that most will need infilling and development of internal drainage. The contractor will be responsible for improving drainage to assure the site is freely drained, standing water is removed by internal drains, and raised and reinforced driving and working surfaces are in place.

Viaduct Construction: Construction sites along the alignment are small in terms of overall area and will not intercept large amounts of rainwater. Drilling mud and cuttings from foundation placement will be removed from the site by vacuum truck. With the exception of small amounts of runoff during rainfall events, drainage problems along the alignment are not likely to develop.

So long as the site is kept clean and free of mud/silt, runoff from rainfall can enter the local drain system without negative effect. Because construction zones along the alignment are small, the quantity of water will not be significant. Spillage and leakage of fuel, crankcase oil and drilling fluids at work sites is strictly prohibited. The contractor will prepare a Drainage Plan for each of the contract packages.

The Contractor will follow a risk avoidance approach that minimize standing water, sediment loss and spillage of waste oil and fuel. The contractor will need to minimize impacts through use of mitigation measures to the satisfaction of the superintending engineer.

Mitigation Measures:

- At the start of construction, a Drainage Plan should be developed by the Contractor for construction sites, fabrication/casting yards, materials storage areas and administration/worker housing. The Plan should be checked and approved by the Supervising Engineer.
- Discharge of waste water into water bodies is prohibited as is the discharge of wash water from concrete trucks to waterways.

Depot Site

- The contractor will be responsible for controlling drainage discharges from the site and restricting discharge to no more than three locations.
- The Contractor will periodically monitor drainsat the property boundary and maintain suspended solids content (TSS) in within the DOE limit of 100 mg/L.

Construction Sites along the Alignment

- Concentrated solids will not be washed into receiving drainage structures or openchannels.
- Sediment and fine debris will be removed as solids by cleaning/scraping work areas and removing piles of debris in a solid form.
- Portable sanitation facilities will be set up at construction sites and regularly cleaned by vacuum truck.

Temporary Construction Yards

- Fabrication/casting yards and material storage areas where vehicles operate or materials are stored should be established on well drained fill.
- Free-flowing points of discharge for storm water should be identified nearby the boundaries of materials storage/fabrication yards for gravity or pump-assisted dewatering and yard drainage.
- Local drainage channels should have sufficient capacity for handling discharge flows, with clear discharge points to open khals/drainage courses.
- Temporary worker quarters and erection yards should include self-contained waste treatment with removal of excess by vacuum truck or approved discharge point
- Drainage from fuel storage tank locations, refueling areas, and equipment service areas should be segregated from other runoff; discharge should be routed through an oil/water separator
- Fuel storage tanks should be surrounded by secondary containment equal to at least half the volume of the tanks
- Sediment should be removed as solids by cleaning/scraping work areas and removing piles of debris in a solid formMonitoring

Contractors will be required to observe drainage conditions during dewatering operations and storm events to assure positive drainage. If flooding occurs in neighborhoods, or community complaints arise, the contractor will undertake a combination of the above mitigation measures to minimize drainage and water quality impacts.
The contractor will monitor total suspended solids (TSS) of outfalls from construction sites where these discharge to local drainage channels, and comply with a limit of 100 mg/L TSS.

6.5.2 Operations

6.5.2.1 Depot

Drainage from the depot site will concentrate runoff and could contain hazardous substances. Treated effluent from the wastewater treatment plant (WWTP) will be discharged to Digun Khal that discharges through the Goran Chatbari Pump Station located near the embankment at the Turag River.Drainage conveyance and waste treatment at the Depot are incorporated into the project planning and design. The general drainage plan for the depot area is divided into three sub-areas that drain to Digun Khal or to the east through a proposed drainage culvert to be installed by RAJUK. Sub-drainage is designed within these subareas, as shown in Figure 6-7 (for Subarea A). Some of the principles incorporated into drainage planning and the operational approach are as follows: (see also Sec. 3.3.1.4

- Graded and compacted crushed-stone back-fill will be placed along the inner face of the retaining wall to a depth from the water-stop at the base to the yard formation level to achieve the desired perimeter drainage for the embankment. The drainage discharge exits from the embankment through a series of PVC pipes embedded in the retaining wall
- Yard drainage will be designed to segregate clean and contaminated runoff from the site, and provide appropriate levels of treatment for drainage from areas producing contaminated runoff
- Waste treatment systems will be operated to obtain consistently high quality effluent
- Depot waste treatment systems are designed to produce effluent in compliance with DOE regulations
- Materials recovery systems are designed to prevent discharge of hazardous materials
  to air and water, and to recover sediment and remove surfactants from car washing
  facilities
- Drainage and wastewater discharge points are designated, agreed by local authorities
  and indicated on DOE's operating ECC Monitoring

Relevant DOE regulations applicable to the Depot are found in Schedule 10 of the ECR (1997), includes some 34 indicators, elements and compounds, and sets limits for discharge to inland waters, to a public sewerage treatment system, or to be applied to land. The category "discharge to inland waters" is applicable to the depot, and limits for some of the more common monitoring parameters are shown in Table 6-23. This list of parameters is proposed provisionally for monitoring the outfalls at the depot.

Table 6-23: DOE Effluent Standards applicable to the Depot Wastewater Outfall

S.N.	Parameter	Limit Value (mg/L unless otherwise stated)
1.	BOD-5	50
2.	COD	200
3.	pH	6-9 (pH units)
4.	Oil and grease (O&G)	10
5.	Total Suspended Solids (TSS)	150
6.	Total Kjeldahl Nitrogen (TKN)	100
7.	Dissolved Phosphorous (P)	8
8.	Chromium (total)	0.5
9.	Total Dissolved Solids (TDS)	2100
10.	Total Phenols (TP)	1.0

The Depot operator will monitor water quality of stormwater outfalls and effluent discharge points. A selection of these parameters is appropriate for any one outfall (see Figure 6-8 and Table 6-24). If quantities of pollutants at stormwater and effluent discharge points exceed levels permitted by DOE, a remedial action plan will be put into place to improve waste treatment operations and/or reduce non-point pollution loads from the Depot grounds.

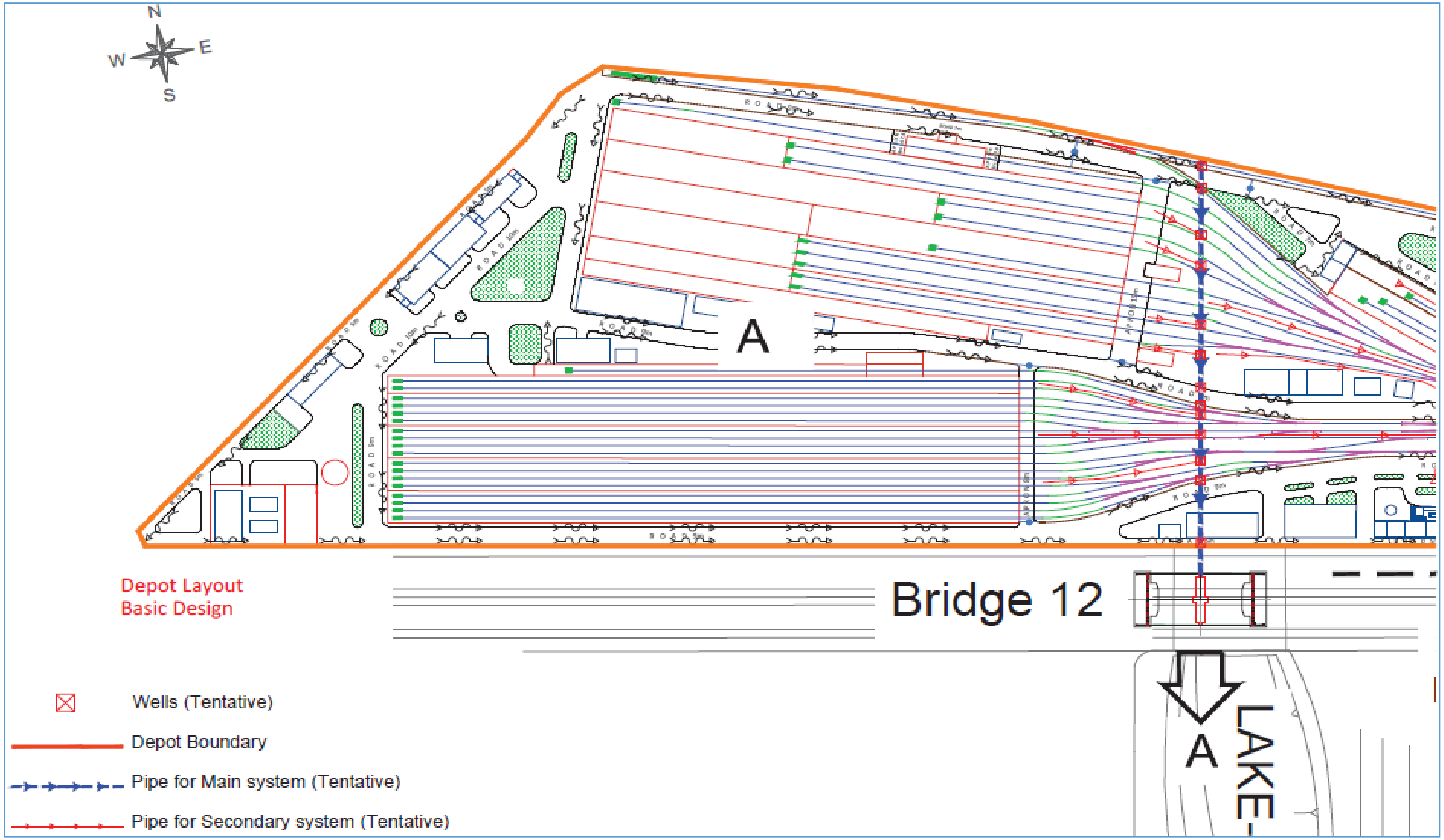


Figure 6-7: Drainage Schematic for Subarea A of Depot

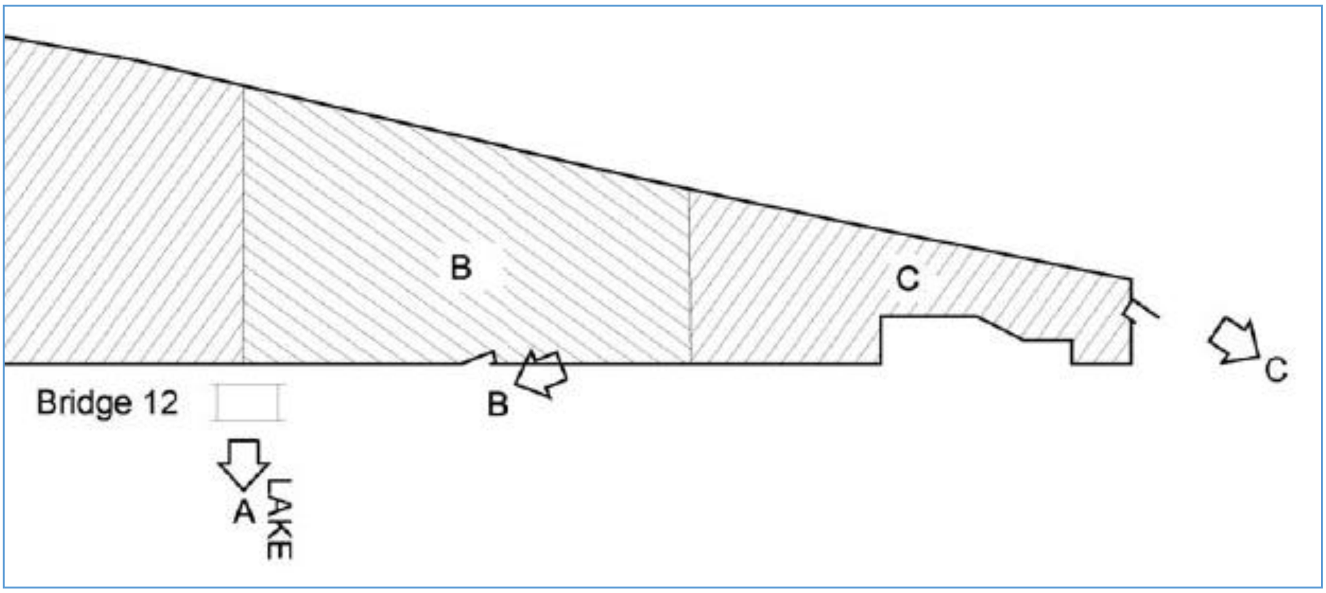


Figure 6-8: Provisional Location of Outfalls to be monitored at the Depot

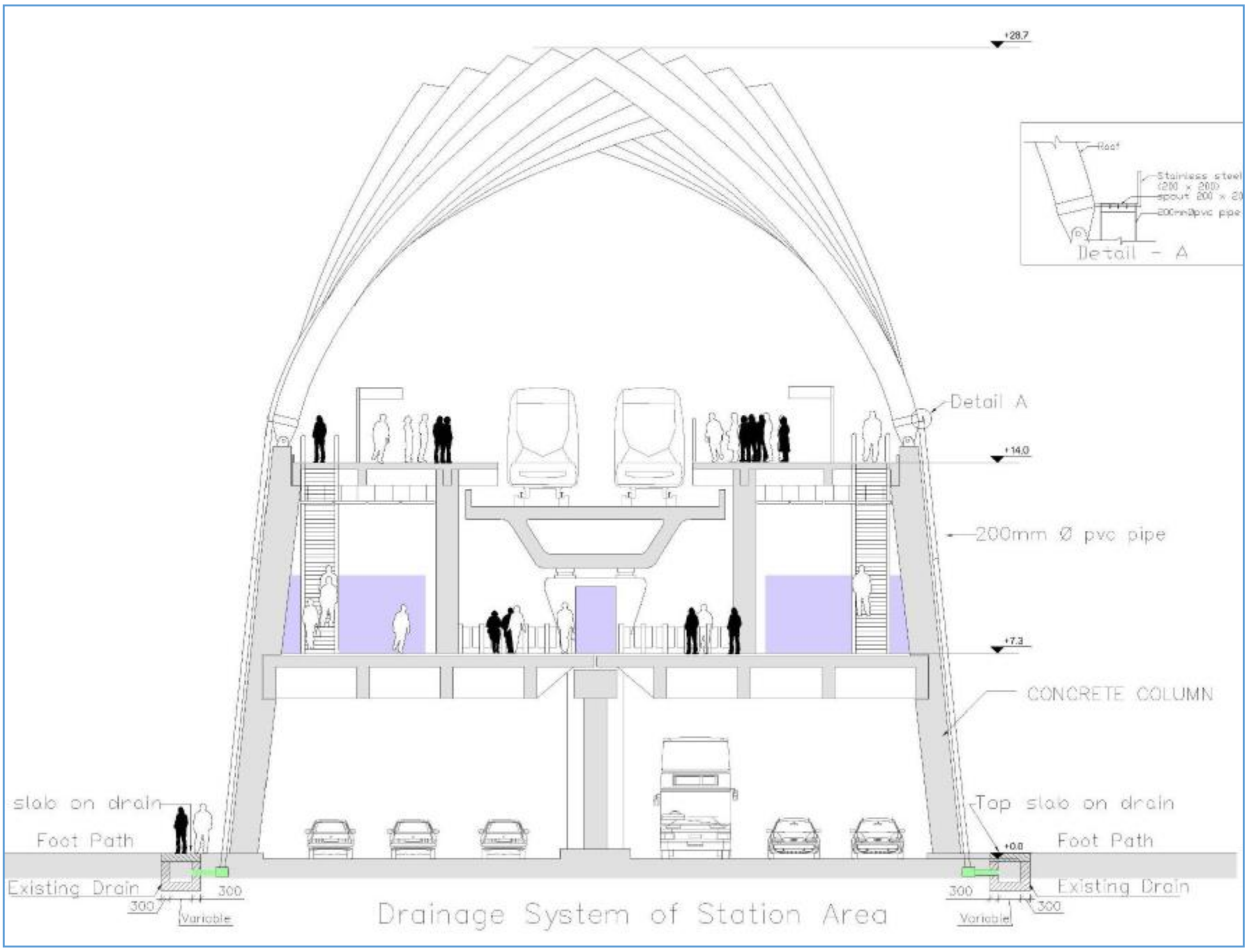
Table 6-24: Parameters Indicative of Contamination at Specific Outfalls

Outfall	Description	BOD-5	COD	pH	O&G	TSS	TKN	P	Cr	TDS	TP
A	Discharge from WWTP	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
B	Stormwater		✓		✓	✓					✓
C	Stormwater				✓	✓					✓

6.5.2.2 Viaduct and Stations

Roof drainage is accounted for in the design of stations. Station canopies will concentrate rainfall to localized points of discharge, where the flow will enter the DWASA drainage system as shown in Figure 6-9. (Please note final station roof shape may vary from the one shown in the figure, however, the roof drainage mechanism will be essentially same). Viaduct sections are drained similarly, and will be equipped with drains at every pier location as shown in Figure 6-10. Drainage is routed to the nearest RC drain with sufficient capacity. The adequacy of downstream drainage conveyances is confirmed through the NKDM design process. Stations will not be equipped with public toilets, hence onsite treatment units are sized for the workforce only.

Physical verification and consultation of survey data and maps indicate that there are only two stations where public drains are not available for drainage of the Station area. Those stations are Uttara Center and Chandrima Uddan. Rain water from the other 14 Stations may be discharged to the existing public drains. The remaining two stations will require development of new drainage systems in their areas. This is likely to be addressed under separate contract arrangements by constructing new side drains. Monitoring of rainfall runoff from the viaduct and stations is not required, as there is no contamination present in the runoff.



Note: Roof shape is tentative

Figure 6-9: Drainage Design for Station Canopy

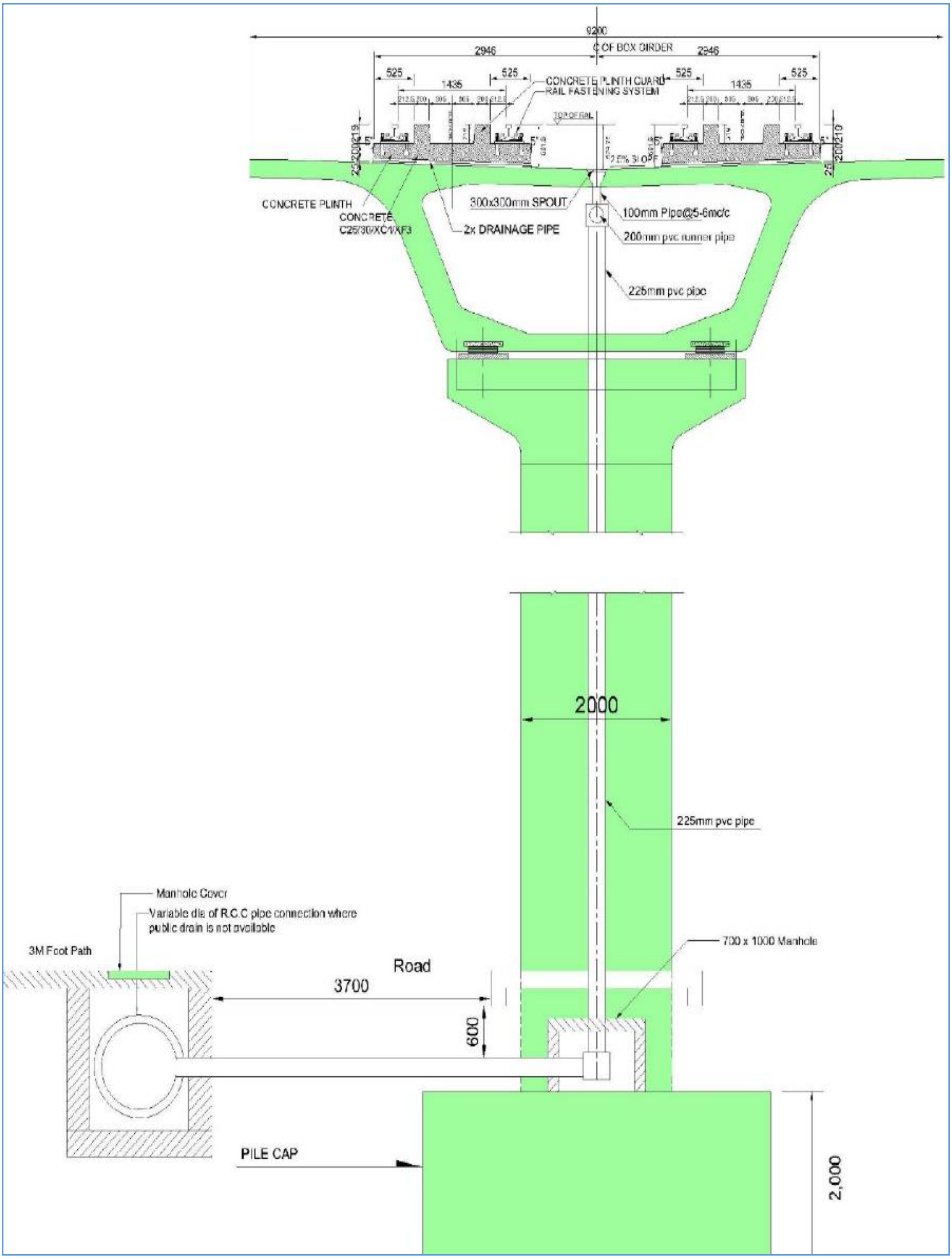


Figure 6-10: Viaduct Drainage Typical Detail

6.6 Groundwater

6.6.1 Construction

Potential impacts on groundwater are insignificant. DWASA takes its water from depths of over 400 m. Groundwater samples (see Sec. 5.1.1) indicate little effect on groundwater quality at that depth from surface activity.

The groundwater table is located at depths of 300-500 m and is unlikely to be affected by surface activity related to construction of the Metro. Concerning improper disposal of construction waste, a number of mitigation measures have been applied to spoil and solid waste disposal during the construction period that are described in Sec 6.7.

6.6.2 Operations

Impacts on groundwater could occur at the depot during operations: herbicides used to control weed growth in the train yard could potentially affect groundwater. Spills of hazardous chemicals, or uncontrolled drainage from contaminated areas at the depot, could potentially affect groundwater quality.

An evaluation of planned types of herbicide and frequency of use should be conducted as part of the depot operations plan, along with a risk analysis to determine the potential for groundwater contamination. Operations procedures related to the handling of hazardous chemicals and drainage from contaminated areas should be reviewed to highlight their safety and environmental aspects.

<u>Mitigation Measures</u>

Use of herbicides to control weed growth along tracks in the depot during operations will accompanied by applications training and supervisory controls, including inventories of chemicals matched to appropriate application rates.

6.7 Solid Waste and Hazardous Materials

6.7.1 Construction

<u>Depot</u>: Minor amounts of solid waste will be generated at the depot site during construction: packaging, empty drums, solid waste from site occupancy by workers, and broken and unused materials. Minor amounts of hazardous materials could be generated consisting of oily rags, empty drums containing residues, and packaging materials for parts and machinery with grease and oil adhered to the surface.

<u>Alignment</u>: Minor amounts of solid waste will be generated during construction of the viaduct and stations. A large quantity of debris will be removed from the alignment to prepare for construction as shown in Table 6-25.

Table 6-25: Inventory of Materials Generated in Construction of Viaduct and Stations (m3)

Source Materials	Viaduct	Stations
Earth and bentonite slurry from column excavation	140,000	42,000
Earth removal from median strip	1,200	360
Earth removal for pile cap placement	43,900	13,170
Bricks and rubble from removal of median strip	790	237
Bituminous scrap from removal of roadway sections	4,000	1,200
Total	189,890	56,967

Note: Volume is tentative, subject to method applied by Contractor

Temporary Construction Sites: Minor amounts of solid waste will be generated during site occupancy, including trash, construction debris, and discarded and unused materials. Hazardous waste could be generated consisting of waste oil, parts cleaning fluid, oily rags and discarded containers.

Countermeasures for disposal of spoil, solid waste and hazardous materials during construction include:

General

- Contractors are required to prepare a Spoil and Solid Waste Disposal Plan that identifies the following: material types sites, estimated quantities and methods for disposal; locations onsite for collection and storage; locations for disposal. A recordkeeping system for all wastes and a tracking and manifest system for hazardous and recycled materials will be included in the plan. Necessary enclosed facilities, containers and equipment will be provided in keeping with the Plan. The Plan should be updated as necessary with actual quantities, locations for disposal and additional information in accordance with the Plan.
- Waste will be segregated in recordkeeping and physically, at construction sites, into the following general categories: spoil, construction debris and drilling mud/cuttings (Class C non-putrescible wastes); trash and other forms of degradable but non-hazardous wastes (Class B); hazardous wastes and spent materials, including liquids (Class A); materials determined to be recyclable with identified takers (Class R).
- Class A waste material containers will be stored on a raised platform in dry condition for no longer than one week unless kept in an enclosed and secured location, in which storage of up to 3 mo is allowed.
- The Contractor will promptly collect, store, transport and dispose of

Class B solid waste generated at the project site. No solid wastes will be allowed uncollected at the jobsite or accumulated in storage for periods in excess of a month. Transport and disposal will be by recognized means approved by the Engineer.

- Class C spoil materials, cuttings and wastage from the site that are unsuitable for use in construction shall be disposed of at locations specified in the CEMP and approved by the Engineer. Methods of placement and compaction, and limits on the types of materials to be placed therein are subject to prior review and approval by the Engineer, who may at times require testing of materials to verify the absence of chemical residue and excess organic matter. Such review and restriction can occur at anytime during the spoil placement activity at a site.
- Deposition of spoil materials shall be approved where clear land titles are in place, in areas designated on the Dhaka City Plan as suitable for fill, and in line with guidance provide by the Dhaka Development Authorityand the Local Government Agency. In no case shall spoil materials be placed in or near rivers, drainage channels, lakes, beels, khals and other forms of wetland.
- Class R recyclables may be stockpiled for up to one month while identifying a taker; otherwise the materials will be treated as a waste product and removed from the site.
- Material Safety Data Sheets (MSDS) for purchased chemical additives, reagents and compounds will be kept at the work site.
- Maintain trash receptacles at construction sites, and designate areas for stockpiling used/discarded materials temporarily.
- The Contractor will handle and dispose of, or recycle, unused and spent hazardous materials at a licensed facility to prevent losses to the environment.

<u>Alignment</u>

- Quantities of spoil, construction debris and drilling mud/cuttings will be estimated beforehand, and locations for disposal identified and agreed with the Superintending Engineer. Most of these materials can be used as fill, or as cover material in a landfill; prior agreement with overseeing bodies or land owners is required; contact information for entities agreeing to take the materials will be provided for verification purposes.
- Solid waste, trash, broken forms and equipment parts, waste oil, and oil-soaked rags, soil and absorbent will not be disposed of along with earth spoil.
- No waste materials will be stored at a construction site for periods longer than one day.

- The Contractor will assure that used materials, debris and solid waste are removed daily from construction sites along the alignment, and that no such material is allowed to interfere with the passage of traffic or construction work.

6.7.2 Operations

Depot: Certain types of wastes will be generated during the normal course of operations: trash and canteen waste (Class B); metal parts and cuttings from lathes that will be recycled through metal brokers (Class R); spent solvents from parts washing, waste oil and other organic chemical compounds (Class A).

Stations: Litter not directly attributable to operations could increase in the vicinity of stations as a result of human movement. Trash will be discarded by people passing through the stations.

Mitigation measures that apply to solid waste handling and disposal during operations include:

Depot

- The Depot operator will institute a Waste Management System taking into account materials to be disposed of and recycled, estimated quantities and methods for collection, storage, treatment and disposal or recycling. Material Safety Data Sheets (MSDS) for purchased chemicals, reagents and compounds will be kept current. A recordkeeping system will account for all wastes and recycled materials, and length of time and locations for storage; a tracking and manifest system for hazardous and recycled materials will be maintained.
- The site design and equipment procurement will provide necessary enclosed facilities, containers and equipment for managing wastes.
- The Depot operator will dispose of spent hazardous materials and wastes by means and at locations acceptable to the DOE.
- The Depot operator will not store hazardous and recyclable materials indefinitely at the site, as this is a hidden liability for the owner. No waste material should remain in storage for more than a year.
- The Depot operator will develop recycling systems and linkages for metal scrap and for waste oil, and will inspect uses and processing beforehand to assure environmental soundness.

Stations

- DMTC will coordinate with DN/DSCC to improve solid waste handling in the vicinity of stations.
- DMTC will assure that station waste receptacles are available and kept in good condition, emptied regularly, and maintained periodically.

- DMTC will maintain the interior of stations free of trash and refuse, post signs against littering, and keep the track area within the station free of trash.

6.8 Vegetation, Wildlife and Aquatic Habitat

6.8.1 Construction

Depot: Infilling of the north end of Lake 10 in Uttara Phase III is necessary, as the area is within the Depot property boundary. Some habitat for aquatic species will be lost, but the submerged area is small (a few ha) and any fish, reptiles or amphibians inhabiting the area will migrate downstream, and in any case their speciation is not likely to be unique; so the impact is insignificant. Some loss of habitat will occur for birds and small mammals at the depot site due to infilling and occupation. The area of Uttara Phase III is undergoing rapid development and its entire face will change over the next 5-10 years.

Alignment: Temporary and limited habitat loss for birds will occur due to removal of trees; bird habitat could be temporarily degraded in nearby ‘garden’ areas from construction noise; Trees will be trimmed on properties next to the alignment to make way for construction, causing temporary loss of habitat. These impacts are temporary and of limited extent; no significant impact is likely for any species.

Trees found in the centerlines of roadways used for the rail alignment are relatively small and offer no significant habitat for birds. These trees will need to be removed to make way for construction, but can later be replanted under the viaduct, so long as the mature tree does not exceed 2-3 m in height. Some larger trees will need to be removed at the entry of the viaduct onto Parliament grounds and for passage of the viaduct through the Farmgate area. These are unavoidable losses that are made up by growth of trees at other, nearby locations.

Some of the trees to the right and left sides of the alignment from Shahbag Station to Press Club Station overhang into the roadway and will need to be trimmed to provide clearance for construction equipment. It will be up to the contractor to determine locations and extent of tree trimming. In general, 13 m clear width is needed along the viaduct for erection of the precast sections. Clearance to be provided at station locations is generally 25 m. Some bird habitat will be temporarily sacrificed, but is made up for by trees away from the right of way, and rapid re-growth.

Trees to be removed from the centerlines of roads used for the alignment have been categorized and counted (see Table 5-11). It is the responsibility of the Contractors to replant trees according to the quantities specified in the bid documents. A list of recommended tree species for planting in the median strip beneath the viaduct is provided in Table 6-26. These species were selected on the basis of their common use in urban environments throughout tropical Asia, and their availability and prior use for roadway beautification in Dhaka.

Table 6-26: Tree Species Recommended for planting under Viaduct

Scientific Name	Common Name	Local Name	Family
Casuarina equisetifolia Forst.	Australian Pine	Jhau	CASUARINACEAE
Bougainvillea spectabilies Willd.	Bougainvillea	Bagan Bilash	NYCTAGINACEAE
Mimsops elengi L.	Bullet Wood	Bakul	SAPOTACEAE
Delonix regia Rafin.	Flame of Forest	Krishnachura	CAESALPINIACEAE
Cassia fistula L.	Golden Shower Tree	Sonalu	CAESALPINIACEAE
Syzygium cumini (L.) Skeels	Jambolan	Kala-jam.	MYRTACEAE
Azadirachta indica A. Juss.	Neem	Neem	MELIACEAE
Nyctanthes arbor-tristis L.	Night Flowering Jasmine	Sheuli	VERBENACEAE
Michelia champaca L.	Joy Perfume Tree	Swarnachapa	MAGNOLIACEAE
Caesalpinia pulcherrima (L.) Swartz	Peacock Flower	Radhachura	CAESALPINIACEAE
Lagerstroemia speciosa (L.) Pers.	Pride of India	Jarul	LYTHRACEAE
Polyalthia longifolia Thw. cv. Wipping	Telegraph Pole Tree	Debdaru	ANNONACEAE
Gardenia jasminoide	Gardenia Jasmine	Gandharaj	RUBIACEAE
Diospyros peregrina	Malabar ebony	Gaub	EBENACEAE
Spondias pinnata	Hog-plum	Amra	ANACARDIACEAE

6.8.2 Operations

Alignment: Electromagnetic radiation (EMR) could affect avian fauna. EMR occurs around cell phone towers, inductive motors, power lines and other line conductors carrying currents. EMR bridges potentials through the atmosphere at varying frequencies (called EMF), and is measurable using EMR/EMF meters. Nesting migratory birds and their offspring have been known to be affected by phone towers emitting EMR in the 900 and 1800 MHz frequency ranges. EMR also can affect radio transmissions.

EMR potential of about 1 mV at the stations and track alignment is minimized by grounding (earthing) of all metal parts and conductor supports, station hardware and equipment and the tracks. Grounding is used to reduce electrostatic charge and to ground stray currents that result from EMR buildup. EMR in the atmosphere is thus shunted to ground. EMR fields are attenuated and kept near the catenary, where they may act to repel birds from the structure. No further mitigation measure is needed.

6.9 Public Infrastructure and Utilities

6.9.1 Utility Relocation along the Alignment

Installation of pier foundations and other sub-grade work can damage existing utilities. A thorough utility survey and relocation plan for utilities is undertaken by NKDM and is an essential part of project implementation. The utility survey involves the following steps:

a) Identification of utility agencies involved along the alignment

b) Collection of underground utility data from the concerned agencies

c) Plotting the utility data on NKDM topographic alignment CAD drawings

d) Review of NKDM data by utility agencies

e) Checking of pier locations to avoid shifting of major utilities

f) Field verification by GPR system/trench excavation

g) Identification of utilities for relocation

The agencies that have utilities that could be affected by construction of the Metro are listed in Table 6-27. Meetings have been conducted with these agencies and information gathered that is collated by the NKDM team. Data received from all agencies have been superimposed on drawings. An example is shown in Figure 6-11. Utility survey and verification continues in parallel with civil design work, including field verification of critical utility locations. Design teams are weighing costs and design options where conflicts appear unavoidable. The effort provides a high degree of certainty regarding locations and means for resolving utility conflicts. Still there could be disruptions; the Contractor will be responsible for preparing and implementing an emergency response plan that will include repairing damaged utilities and restoring service in the shortest time possible.

Table 6-27: Interface Agencies for Utility Relocation

SN	Authority	Concerned Utility
1	Cantonment Board (CB)	Water, Electric, Gas Line and communication lines
2	Dhaka North City Corporation(DNCC)	Street lighting (overhead), Road-side drain, Signaling cables.
3	Dhaka South City Corporation(DSCC)	Street lighting (overhead), Road-side drain, Signaling cables.
4	Dhaka Water Supply & Sewerage Authority (DWASA)	Water, Sewerage & Drainage Pipelines.

5	Dhaka Electric supply Ltd. (DESCO)	Electric Lines, over-head & underground
6	Dhaka Power Distribution Company Ltd (DPDCL)	Electric lines in conduit and trench
7	Titas Gas Transmission & Distribution Co. Ltd	Gas pipeline
8	Bangladesh Telecom. Company Ltd (BTCL)	Telephone line (copper cables and optical fiber cables)
9	Power Grid Company Ltd.	Under Power Cables from Agargaon to Mirpur 10 Stn.
10	M/s Fiber @ Home, Gulshan, Dhaka.	Optical Fiber line for Telecommunication
11	M/s Summit Communication Ltd.	Optical Fiber cables for communications
12	M/s Bangla Phone, Gulshan, Dhaka.	Optical Fiber line for communications.

6.9.2 Other Construction Issues

Roadways used for haul routes during construction, as well as main thoroughfares where the alignment passes, can become degraded from passage of heavy trucks and from fraying and breakage of paved surfaces adjacent to excavations. Existing public infrastructure near stations and viaduct (overhead walkways, sidewalks and road surfaces) may not be finished out entirely at the completion of construction, and left in semi-usable states.

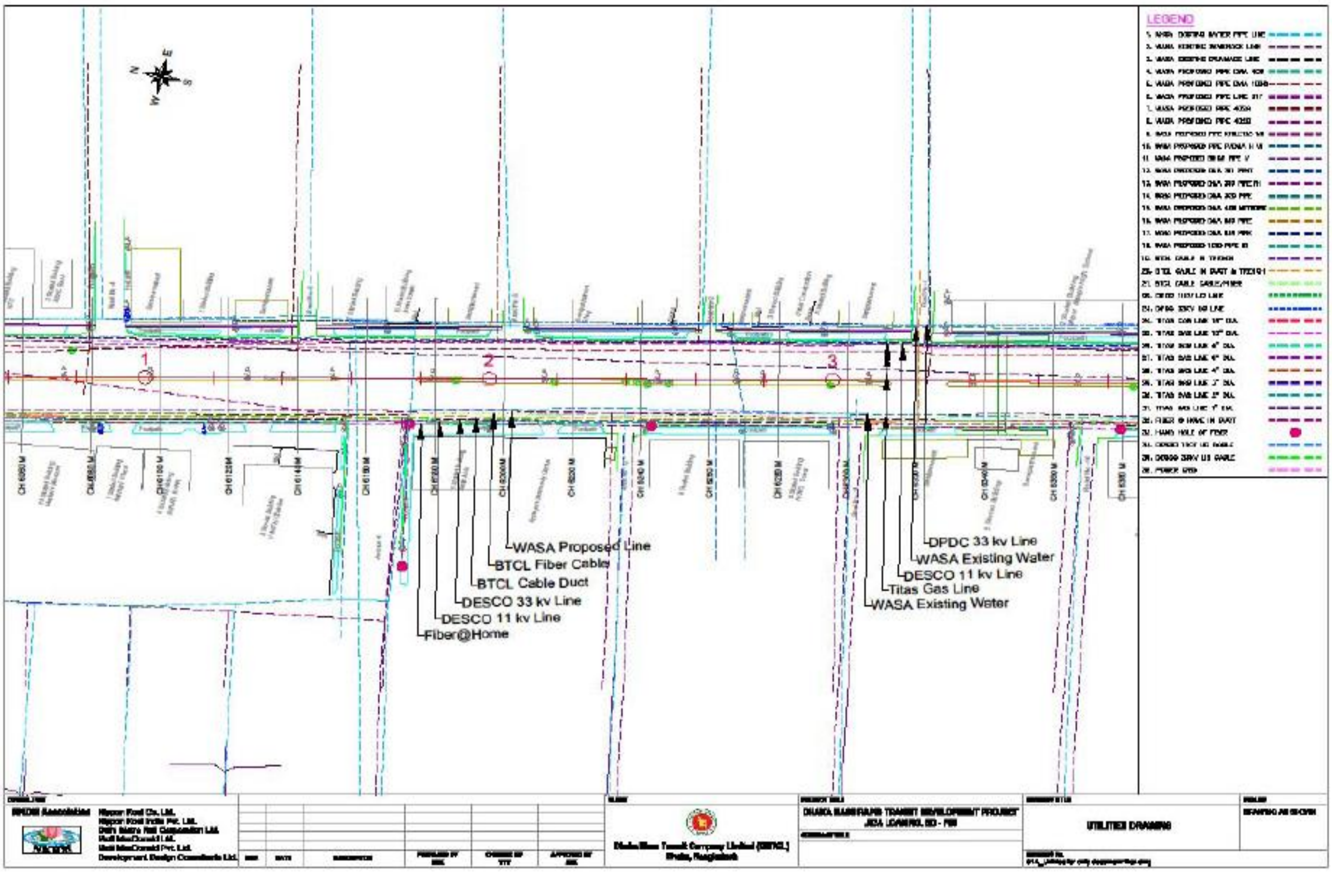


Figure 6-11: Example Utility Survey CAD Drawing

Mitigation measures that minimize construction impacts on public infrastructure include:

- A provisional sum will be included in contract documents for repair and maintenance of roadways used for haul routes and main thoroughfares where the viaduct passes, to allow them to be maintained during construction
- Bill of quantities will include reinstallation of median strips, planting of trees and repair of road pavements near the piers and along the viaduct prior to completion of contract, and sufficient bid bond, to insure that the contractor finishes out and ties in the existing medians, roadways and sidewalks near stations and viaduct.

6.9.3 Operations

It is recommended that public facilities (roads, walkways, toilets, benches and other features) near stations be maintained and operated by a joint effort of DMTC, the City Corporations and DWASA; otherwise they become unusable and a public liability. Responsibilities for solid waste handling and public toilets in the vicinity of stations need to be assigned among these agencies.

The impact on the Project of poorly maintained public infrastructure is minimized in design by:

- Ground level urban site planning of areas around stations by the NKDM architecture group, which considers the condition of public walkways and space to insure accommodation of increased pedestrian traffic.

- Development of Operations and Maintenance Rules, institutional development and staffing provide the skills for maintenance of public infrastructure during operations.

- Determining the respective responsibilities ofthe DCCs, DWASA and DMTC for maintenance of solid waste, public toilets and walkways in the vicinity of stations, and resolve cost sharing arrangements.

6.9.4 Aesthetics

To minimize the adverse aesthetics and visual impact from elevated viaduct and stations, the architecture team of General Consultant will integrate suitable landscaping like color, motif and greenery throughout the alignment. This is particularly important for the portion encroaching the parliament area. It is recommended that particular portion blends well into the surroundings.

6.10 Earthquake, Fire and other Forms of Risk

Various risks are associated with operation of the Metro. These risks are accounted for by NKDM in the design and pre-planning of systems and their operation.

<u>Fire Protection</u>: Fire protection addresses the potential for onboard or station fire during operations; the potential for a Metro station to interfere with access to nearby buildings, with consequent risk of conflagration with Metro facilities; and firefighting systems, procedures and design modifications to comply with international standards for fire protection, which are described briefly in this section.

<u>Systems to address Onboard or Station Fire during Operations</u>

Design standards are adopted that conform to Japanese and US standards. Systems are developed to address the following: operational procedures for evacuation of a train if stopped on the viaduct or at a station; means of access for firefighting equipment in case of fire on the viaduct or at a station; location and provision of fire hydrants at stations and along the viaduct; assurance regarding use of non-combustible materials in the fabrication of train car interior space and station interiors; development of fire risk scenarios (fire on rolling stock, arson attack and retail shop fire at station); firefighting and evacuation procedures to account for scenarios; time and motion studies combined with smoke concentration and dynamics; fire water requirements (quantities and locations); and firefighting equipment schematics at stations (platform and concourse).

<u>Interference with Firefighting Access to Nearby Buildings</u>

Clearances for different types of firefighting equipment, and available space between stations and adjacent buildings go into the consideration of fire risk.

Station locations were surveyed for increased risk due to proximity of high rise buildings near stations. Locations with apparent risk (seven out of 16 stations) were evaluated using CAD overlays that provided visualization of problem areas. Profile drawings depicting these locations introduced firefighting equipment to determine clearance limitations. Countermeasures were developed to address space constraints and fire risk. These include upgrading building fire escapes and interior firefighting equipment, and restrictions on construction that limit the height of adjacent buildings and require means of access for fire trucks. In one instance, the location of one station is shifted few meters to ensure adequate fire fighting provision for a nearby building.

Earthquake: Earthquake risk is addressed in the design of structures. Structural design has followed the Bangladesh National Building Code (BNBC) requirements for level 2 earthquake risk (Dhaka), which is sufficiently rigorous to guard against structural failure in the event of a moderate earthquake. Also, earthquake risk is incorporated into emergency response planning.

Other Forms of Risk and Emergency Response Planning: Emergency response planning is done by the Electrical and Mechanical (E-M) Systems Group of NKDM, to set up procedures for responding to any type of emergency that poses risk for the public and Metro employees. General rules have been developed for responding to accidents and unusual occurrences in the operation of the Metro. These rules address response according to the following order of priority:

a) Save life, prevent further injury, and alleviate suffering;

b) Protect the Metro Railway property and equipment;

c) Take steps for preservation of clues;

d) Inform the public of the effect on train services and the availability of alternative transport;

e) Restore safe operation of train services as quickly as practicable; and

f) Restore other normal services.

Appendix 3 contains information for emergency response to accidents and unusual occurrences. The information is included in the EIA to document procedures and are part of the General Rules for operation of the Dhaka Metro System. For purposes of the EIA, these materials constitute the Emergency Response Plan for operation of the Metro.

6.11 Community/Occupational Health and Safety

6.11.1 Construction Impacts on Community-use Values

Depot: Community-use values affected by construction of the depot are as follows: relocation of Milestone College (addressed in Sec. 6.2.2), street congestion due to added traffic in Uttara and Pallabi (gateway communities) from materials and equipment hauling. This is addressed by the following:

- The Contractors will identify haul routes in the Construction Environmental Management Plan; describe numbers of trips and time of day; and identify the duration of the hauling activity; and obtain approval for routes, schedules and durations from the Superintending Engineer.

<u>Alignment</u>: Community-use values affected by construction along the alignment are as follows: damaged utilities and downtime in the service area; restricted pedestrian movements in localized areas around worksites where pathways are constricted or blocked; noise and air pollution cause discomfort and injury; the public risks injury by entry into the construction zone; and traffic congestion.

Utilities, noise and air pollution and traffic congestion are addressed in previous sections (noise and air quality, traffic and public infrastructure). Planning for the construction sequence also addresses health and safety issues for the community. In order to facilitate pedestrian movement and traffic, and prevent entry to worksites, the following mitigation measures are proposed:

- Provide clear pathways for pedestrians around construction sites
- Barricade buffer areas to exclude waiting vehicles and rickshaws
- The Contractor will clearly barricade work areas at ground elevation that are accessible to the public, while ensuring passage for pedestrians around the work area
- Relocate vendors away from construction sites
- Place flagmen at intersections along haul routes
- Provide clear, visible signage to communicate risks at points of contact and to local communities
- Remove hazardous conditions on construction sites that cannot be controlled effectively with site access restrictions, such as covering openings to excavations.
- Flagmen will be stationed at obstructions in the line of traffic, including start of construction and points of vehicle access.
- The Contractor will avoid blocking access to land, homes and businesses; where unavoidable, the Contractor will provide temporary access to affected properties and reinstate permanent access on completion of work
- The Contractor will promptly reinstate any services and reinstall any physical facilities that are cut, disconnected or damaged during construction activities, and shall maintain or provide temporary services that are interrupted by construction. The Engineer shall inspect and certify the adequacy of all reinstated services and facilities

6.11.2 HIV/AIDs Prevention

An HIV Prevention Program is built into the design of the project to establish mechanisms and institutional capacity to implement regular HIV/AIDS prevention; facilitate a non-discriminatory work environment for HIV infected workmen engaged in construction; and create linkages with mainstream HIV Prevention Organizations for referral purposes. HIV prevention activities are included in the contract bid documents. Health organizations in Dhaka are recruited to provide Training for Trainers (TOT) for Contractors and staff. Monitoring and post-assessment methodologies are in place for evaluating results.

The HIV Prevention Program Report (NKDM 2015a) describes the services that will be offered through the HIV prevention program:

- Clinical services consisting of medical services delivered by qualified and registered surgical nurses and paramedics.
- Basic Clinical Care (BCC) will be delivered by BCC workers, peer educators and to a lesser degree clinical services providers after being trained by a competent and experienced national BCC organization. BCC services are aimed at changing existing harmful (HIV risk) behavior to more positive, less risky behaviors.
- HIV awareness will be promoted using banners, posters, leaflets, brochures, discussions, AV media, and competitions.
- Voluntary group counseling by BCC workers, and basic one-on-one counseling by peer educators at the field level will be provided; full one-on-one counseling by staff at the mini clinic.
- Condom Distribution to insure correct and consistent use of condoms is one of the most effective HIV prevention activities. A fixed number of condoms will be supplied for free and additional condoms will be available at heavily discounted prices.
- Health Card System will be set up to contain initial relevant health data of each worker and will be updated during clinical visits. Workers will be required to register to access any health service.
- Referral/Linkage: in case of emergency, workers will be triaged to higher level NGO or government health facility after provision of first aid or emergency procedures.
- Confidential (HIV) Testing: as testing requires a higher level of lab facilities, such requirements will be referred to the nearest accredited NGO or government facility.
- Blood Transfusion: as blood transfusion requires higher level of lab facilities and medical supervision, such requirements will be referred to an accredited NGO, government or private facility.

Service delivery points and mechanisms include:

On Site Mini Clinic for diagnosis and treatment of common ailments, BP monitoring, one-on-one HIV counseling, rapid STI testing, TT vaccination, first aid, wound care including emergency suturing and bandaging, IV channel opening, 5% DNS infusion, basic surgical care including emergency mini surgeries before triaging to higher level health facilities, basic medicine, critical supplements and supplies for women.

Outreach: medical and BCC services delivered by a team of nurse and BCC workers trained in basic clinical services and group counseling.

Peer Education (PE): PE modules will be developed by a competent and experienced organization. Peer educators will be selected from among the workers using a suitable checklist. Peer educators will conduct BCC with suitable job-aids and provide one-on-one counseling at field level.

6.11.3 Community Operational Considerations

Facility safety is assured through correct application of codes during design of viaduct, stations and depot. All structures accessible to the public should be designed, constructed, and operated in compliance with local building codes, local fire department regulations, local legal/insurance requirements, and in accordance with an internationally accepted life and fire safety (L&FS) standard. Appropriate fire prevention, emergency egress, detection and alarm systems, fire suppression and control systems, and an emergency response plan are part of the physical and operational designs of the project. Operation and maintenance should perform mandatory regular maintenance and testing of life and fire safety features to ensure that mechanical, electrical, and civil structures and systems are in conformance with design criteria and operational readiness. Various parties are responsible for this scope of work, including NKDM, DMTC, and the Institutional Development Consultant (IDC).

6.11.4 Occupational Health and Safety during Construction

The Health and Safety Specification (NKDM 2015b) is prepared by NKDM to be adopted by contractors. This is an occupational health and safety specification that is incorporated into the contract bid documents alongside environmental specifications. Contents of the specification are as follows:

1. Safety Training and Safety Promotion	2. Safety Inspections and Follow-up Actions
3. Contactor's Site Safety Committees	4. Reporting of Accidents and Dangerous Occurrences
5. Accident Investigation	6. Accident Statistics
7. Hazard Identification and Risk Assessment	8. Emergency Preparedness Plans
9. Safety Signage	10. Industrial Health and Welfare

11.	Working at Height	12.	Excavations
13.	Lifting Operations	14.	Work in Confined Spaces
15.	Site Electricity	16.	Welding and Cutting
17.	Compressed Gases	18.	Machinery
19.	Falsework/Formwork	20.	Piling and Diaphragm Walls
21.	Work Adjacent to Live Roadways	22.	First Aid
23.	Fire Precautions	24.	Site Planning
25.	Traffic Management	26.	Visitors to Site

The Contract Health and Safety Specification also includes pre-contract checklists, inspection report forms, accident reporting and near-miss report forms, induction training recordkeeping forms, application forms for working at height and with electrical equipment, forms for site excavation permit and storage of oil onsite, statistics record reporting, and other types of reporting forms. The contractor will be required to prepare a construction phase occupational health and safety plan that conforms to the contents of the specification.

The occupational health and safety specification is comprehensive and provides details concerning health and safety on the jobsite. It complies with the International Finance Corporation (IFC) General Environmental Health and Safety Guidelines (WB/IFC 2007), which are applicable to the Metro Line 6 Project. The reader is referred to that document for further details on its contents.

Further requirements regarding onsite worker housing are set out below:

The Contractor is required to maintain accurate counts of workers living offsite and those housed at onsite facilities, and to provide and implement a plan for housing onsite workers that encompasses food preparation and sanitation facilities, potable water supply, suitable sleeping arrangements and solid/liquid waste management.

The Health and Safety Specification prepared by NKDM addresses the requirements of the IFC and the International Labor Organization (ILO). Construction contractors are required to conform to the Health and SafetySpecification, develop implementation procedures that conform substantially to it.

6.11.5 Occupational Health and Safety Aspects of Operations

Employee health and safety is likewise critical for operations of the Project. While design factors determine safety of users, and are addressed in specification of rolling stock, and in architectural design and planning studies, employee health and safety are addressed through the Safety Management System (SMS), which is being developed by the IDC as part of the overall Quality

Management System for DMCTL.

6.11.6 Heat Accumulation by Concrete Structures

Dhaka is already showing the tendency of heat island; it remains hotter in summer nights compared to surrounding areas. The concrete facilties under the Project (viaduct and stations) will add cumulative effect to the situation, though the incremental addition is very less compared to current situation. Usually large water bodies and greeneries can offset the adverse impacts to some extend. Along the alignment, there is one water body within the Cantonment area and a huge greeny in the Parliament area. It is confirmed that there is no plan to change both these landscapes; thus it can be said that the heat accumulation by the concrete used in the Project will be offset by some extend by these landscape features.

6.12 Construction and Installation of Electrical Substations

There are two Receiving Substations (RSS) planned; one is located at the depot, its construction and outfitting will be done along with the depot, and has no added significant impact. The remaining RSS will be located at a site in Motijheel some 0.5 km direct distance from the terminus of Line 6 on a 4,000 sq m parcel of land currently owned by Bangladesh Railway. The site is currently used as a truck stand, parking and storage area. There is no permanent building at the location. The site, opposite the Kamalapur Sher-E-Bangla High School is shown in Figure 6-12. Environmental issues related to the site and the routing of the high voltage cables between the site and the rail line are addressed in this section.

Figure 6-12: Location for RSS in Motijheel

Construction Noise and Vibration: Land use except to the south is industrial; the area is used in conjunction with the Kamalapur Railway Station, which is a freight depot some 50 ha in area that is to the immediate north of the site. Shops and high-rise buildings border the road to the south. Construction of the RSS follows standard practice; and no significant impact from noise and vibration is expected for receptors in the area. General mitigation measures related to air pollution, noise and vibration apply.

The contractor will be required to conform to construction noise and vibration limits.The noise limit is 85 dB measured at 20 m from the boundary of the property. The vibration limit is 75 VdB at the face of the building nearest to the ongoing pile installation work or other vibration-inducing activity. If the noise standard cannot be met, the contractor will mitigate using methods described in Sec. 6.1.2. If the vibration limit cannot be met the Contractor will mitigate by installing cut-off trenches, or by other means available to the contractor.

Drainage: Drainage at the site will be improved through permanent use as the RSSsite. Engineering design will account for site drainage during construction and use. No significant impact is anticipated.

Routing and installation of High Voltage (HV) Cables: The high voltage cables will run 1.4 km along the following roadways to the connection at the Motijheel Station and terminus of the rail line:

- Culvert Road: This road is so named because it is built over a 7 m wide and 6 m deep culvert. The HV cables will pass a distance of some 170 m along this road.
- Sadek Hossain Kokah Rd. and Connector Rd. (~360 m): The road section is 5-6 m wide, lined with trees along some portions, with generally sparse use of road frontage. Adjacent land use is institutional and buildings are set back from roadway.
- Toyenbee and Motijheel Rds:Toyenbee Rd. is a major thoroughfare some 24 m in width. The duct will run ~230 m along the east side of the road, cross perpendicularly to the west side and continue ~140 m, traverse the southwest boundary of the traffic circle (~50 m), and continue ~100 m along the south side of Motijheel Rd.

Six (6) 5” diameter HV cables will be installed together in a 1 m wide X 1.5 to 2 m deep trench along the above route. The trench will be cut on sides of roads, cable will be installed and the trench backfilled; the road surface will be reinstated.

Installation of the cable trench could temporarily interfere with traffic and pedestrian movements, and block access to adjacent buildings. Mitigation measures related to traffic management and community health and safety apply.

6.13 Temporary Construction Facilities

6.13.1 Need

Between 4 and 6 ha of land area are needed under the viaduct/station contracts (CP-3—CP-6) for temporary use during construction. About 1.5 ha land area is needed for the E&M stockyard (CP-7). A typical construction yard will provide space for:

- Storage of construction equipment
- Storage of construction materials
- Space for casting
- Space for storage of the pre-cast PC beam segments
- Temporary accommodation for workers and staffs of contractors
- Site office for GC and DMTC staff representatives

6.13.2 Sites and Locations

Seven temporary construction sites (TCS) have been selected as locations for construction-related activities and are described herein.

Uttara

Vacant land adjacent to the alignment in Uttara is available for use as a temporary construction site. Depending on the choice of parcel, sites vary in size from 4 to 8.6 ha with one location at 23 ha; otherwise the differences among the sites are minor. The selected location will be used to provide facilities for CP 3 and CP 4 contract bid packages. Sites lack access via connecting roadways to Mirpur; otherwise there are few disadvantages to the sites.

Statistics Road

This 2 ha site owned by PWD is a narrow strip of land adjacent to the alignment in Agargaon. Since it is a roadway that has not been put into use, the area is level, paved and easy to manage. This convenient location will provide facility space for CP 4 contract bid package.

PWD Compound

The site referred to as “PWD Compound” is located in Agargaon, at the intersection of Syed Mahbub Morshed and Begum Rokeya Avenues. It is a small 0.3 ha strip of land 100m X 30m wide owned by the Public Works Department, which is currently used as a temporary plant nursery and is otherwise unoccupied except for temporary sheds. Though adjacent to the MRT alignment, the site is narrow, and is best used for office space and for high-grade materials stockpilesunder CP-4.

T & T Field

T & T (Telephone and Telegraph) Field is also under the authority of PWD. This small site (52 X 60 m or 0.3 ha) is located on the SW corner of the Khamarbari Intersection and is best used for office space and short term storage of high-grade materialsunder CP-4.

Farmgate

Khamarbari Park at Farmgate is a 1.7 ha site currently in use as public space. It is a convenient location adjacent to the alignment that will be used for CP-5.

Golapbag

The Golapbag site is currently in use as a construction yard, and will be vacated in time for construction to begin on CP-06. The 1.4 ha site is owned by DSCC. It is located 3 km southeast of the alignment at Motijheel.

Dhupkhola Field

This location is about 3.5 km south of Motijheel Station. The total area of 2.7 ha is owned by DSCC. One part of the field (0.84) ha is used a ball field, and another part (.77 ha) is used as a playground. The remaining area of 1.1 ha earlier used as a construction site by SIMPLEX and is now empty land. The area is surrounded by a wall, and there is an access road to the site. It is located 3 km south of the alignment at Motijheel.

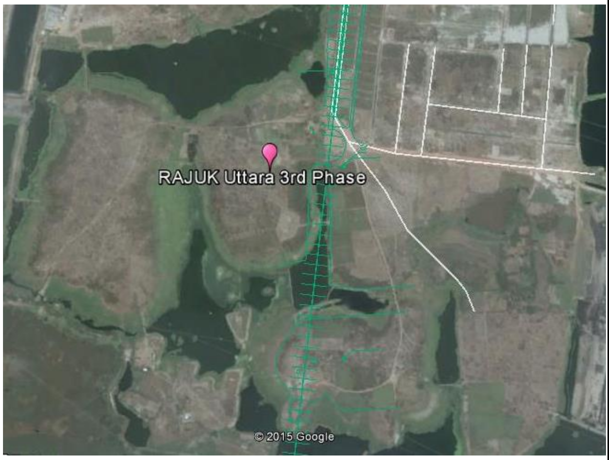
6.13.3 Potential Impacts and Mitigation Measures

Uttara

The site is located on partially raised land in the undeveloped sector of Uttara as shown in Figure 6-13. Air emissions, noise and vibration, and traffic impacts are not significant at this site. Controlled site drainage is necessary. Land use is transitional; currently a portion of the site is used for vegetable farming under temporary agreement with RAJUK, which ends with the harvest. Some ecological values (grasses, birds) are present, but their occurrence is temporary, since the area comes under RAJUK's Uttara 3rd Phase development plan.

Drainage: The site will drain into the nearby Lake No. 6. The following precautions are necessary to prevent significant impact on the lake:

- Maintain a 10 m buffer zone between site development and open water; maintain grasses and hedges in the buffer zone to filter runoff into the lake.
- Segregate drainage at the site; fabrication activities, aggregate/materials storage and roads will be enclosed by berms, slot drains or other controls to direct storm water runoff to no more than three outfall locations. Develop sheet runoff in remaining areas.
- An independent monitoring group will sample outfalls quarterly; TSS shall not exceed 100 mg/L.



a: Uttara TCS Location

b: Photograph of Uttara Site

Figure 6-13: Uttara Location

The general provisions of the environmental management plan (EMP, next chapter) apply to other aspects of this facility.

Statistics Road

This is a developed site in an urban setting. It is a broad constructed thoroughfare or roadway for which use has been occasional (there is no road outlet to the west). Its current use is as a parking area for lorries and buses as shown in Figure 6-14.

Air and noise emissions could affect surrounding land uses, which are institutional. Vibration impacts are insignificant. Traffic in and out of the site will need special management provisions to be provided as part of traffic management planning. Controlled site drainage is necessary.

a: Statistics Road TCS Location

b: Photograph of Site

Figure 6-14: Statistics Location

Air and noise emissions: measures to reduce air and noise emissions from the site are described in Secs. 6.1.2 and 6.3, which will be implemented selectively to control these emissions. In particular:

- Walled enclosures will be constructed around especially noisy activities or clusters of noisy equipment.
- Noise-dampened equipment will be standard, including enclosed air compressors and properly-working mufflers on all engines.
- Mud and windblown dust deposited on paved surfaceswill be removed by sweeping, scraping and washing, as appropriate, on a daily basis.
- Cover and/or wet materials on material stockpiles.
- Construction equipment will be equipped with required pollution-control devices, and regularly checked and maintained.

Drainage: Site runoff will flow to the existing sub-grade pipe network. The following precautions are necessary to prevent significant impact on the drainage system:

- Sub-areas used for aggregate storage, fabrication and transit will be isolated and means provided for removing solids from drainage outflow, either by maintaining surfaces by scraping and cleaning, or by cordoning the drainage flow for solids settling.
- Concrete trucks will not discharge wash water to the drain; and sand and aggregates will not be flushed to the drain.

- An independent monitoring group will sample outfalls quarterly; TSS shall not exceed 100 mg/L.

The general provisions of the EMP, next chapter, apply to other aspects of this facility.

PWD Compound

The location is currently under temporary use by locals to propagate ornamental plants, though much of the area is vacant and unused (see Figure 6-15). It is thus available for use, but because of its restricted size is most suited for offices and short term storage. Contractor activities will be limited to access and egress, movement of typically light passenger vehicles, and occasional medium duty trucks. Potential drainage and air quality impacts are within an acceptable range so long as some initial conditions are met, which include:

- Provide compacted coarse gravel fill for all driving surfaces and raised platforms, blocks or fill for storage of materials.
- Apply water spray to driving surfaces regularly in the event dust generation becomes a concern.
- Maintain surface drainage from the interior of the site intercepted at the point of discharge with silt fencing or other means to trap sediment.
- Do not route drainage across footpaths; provide other means for introducing runoff into the local storm drain system at the roadway.
- Assure that plumbing from toilets and canteens is routed via a dedicated pipe to drain, with intermediate treatment for grease and solids removal, including a septic tank as necessary.
- Do not permit the storage of bulk compounds, chemicals, hazardous substances or any soluble materials at the site.

Noise levels generated at the site are expected to be below the threshold level for annoyance, and hence do not pose a significant impact.

Traffic may be a concern due to entry and exit to the site at the immediate location of a busy intersection. The Contractor should post a permanent guard and traffic signaler at the entrance to ease traffic congestion and facilitate access.

In addition, the general provisions of the EMP apply to this facility.

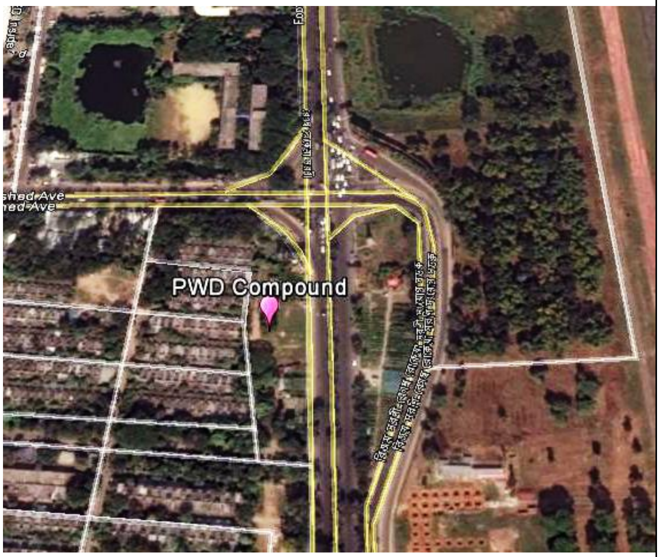
	
a: PWD Compound	**b: Photograph of Site**

Figure 6-15: PWD Location

T & T Field

T & T Field, at the Khamarbari Intersection near Farmgate is adjacent to the Metro Line alignment and thus provides an excellent location for strategic communications and management oversight, as well as a location for short term storage of high value materials. In almost all respects the site is similar to the PWD Compound site. Access may be easier to facilitate as the site is at the terminus of Indira Rd. where unused or “dead” road space can be found at the nearby traffic circle (see Figure 6-16). Government offices and high rise buildings are located to the south and west of the property; potential noise generation at the site is unlikely to affect occupants of nearby buildings. Drainage will be to subsurface drainage appurtenances in the roadways located to the north and east.

Drainage and Air Quality: provisions set out for PWD Compound (above) apply to the T & T Field Site. The site should be raised with fill to provide for positive drainage away from any activities carried out by the contractor at the site.

Traffic Management: as with the PWD Compound location, the Contractor should post a permanent guard and traffic signaler at the entrance to ease traffic congestion and facilitate access.

In addition, the general provisions of the EMP apply to this facility.

a: T & T Field	b: Photograph of Site

Figure 6-16: Photograph T & T Field Location

Farmgate

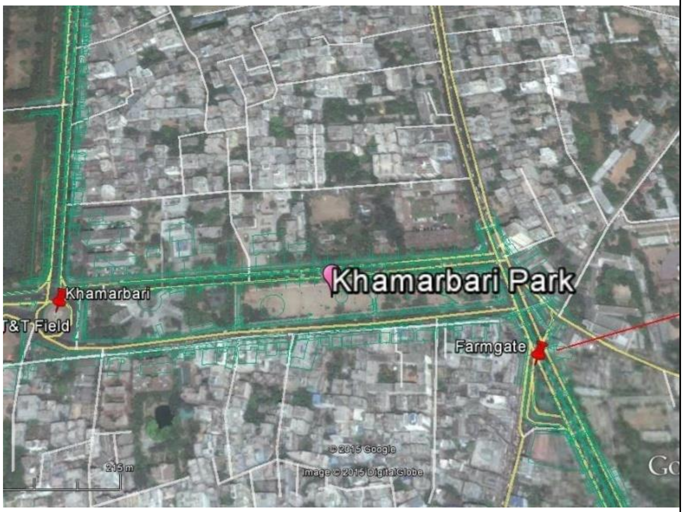
The area is currently in use as a city park, or public open space (see Figure 6-17). The area is planned for redevelopment, as the Farmgate Metro Station will be built nearby and will extend partially into the space planned for use as a construction yard. Impacts from noise and air emissions are significant. Traffic in and out of the site will need special management provisions to be provided as part of traffic management planning. Controlled site drainage is necessary. Some trees will be removed; this is an unavoidable loss that can be made up for through replanting.

Noise and air emissions: as with Statistics Road (see above).

Drainage: as with Statistics Road (see above).

Tree removal: Replant trees in accordance with the general landscaping plan for the area.

The general provisions of the EMP apply to other aspects of this facility.



a: Farmgate TCS Location	b: Photograph of Site

Figure 6-17: Farmgate Location

<u>Golapbag</u>

The area is currently in use as a construction yard, hence its land use is already established (see Figure 6-18). Impacts from noise and air emissions are significant. Traffic in and out of the site will need special management provisions to be provided as part of traffic management planning. Controlled site drainage is necessary.

a: Golapbag TCS Location	b: Photograph of Site

Figure 6-18: Golapbag Location

<u>Noise and air emissions</u>: as with Statistics Road (see above).

<u>Drainage</u>: as with Statistics Road (see above).

The general provisions of the EMP apply to other aspects of this facility.

Dhupkhola Field

Figure 6-19 provides an aerial image and photograph of the site. Part of the area has been in use as a construction yard; whereas the remaining area is used as recreational areas by local youth. Impacts from noise and air emissions are significant. Traffic in and out of the site will need special management provisions to be provided as part of traffic management planning. Controlled site drainage is necessary. Displacement occurs if the land areas used for recreation are handed over for use for construction, for which compensation may be considered under the RAP.

Noise and air emissions: as with Statistics Road (see above).

Drainage: as with Statistics Road (see above).

The general provisions of the EMP apply to other aspects of this facility.

a: Dhupkhola Field TCS Location	b: Photograph of Site

Figure 6-19: Dhupkhola Field Location

6.14 Cumulative Effects

Dhaka Metro is an important milestone in infrastructure development for the City of Dhaka. Its operation will have many effects on the community within its range of influence, primarily in people's perception of mobility and access. Land use will change in ways dictated by the market for commercial and residential space, augmented by an alternative mode of transport.

A cumulative effect refers to an impact arising from a synergism among projects, policies and conditions. Transport planning gave rise to the Dhaka Metro within the context of a vision for growth, along with a community vision, expressed in the language of movement: how improved mobility could improve daily life and provide pathways for growth. The accumulating effect is beneficial, and was conceived in that light. Still some cumulative adverse impacts are possible in an environment distorted by imperfect social structural mechanisms. The following paragraphs highlight various types of uncontrolled development that should be taken into consideration by the governing bodies for land use.

Scenario: The MRT Line 6 will be a driver for uncontrolled development of the outlying area designated as Uttara Ph III, if current land use plans for that area do not materialize concurrently with the development of the Metro.

Assessment: The planned development at Uttara Ph III (described in Sec. 5.5) provides a mechanism for managing growth and mitigating cumulative effects that could develop alongside the MRT Line 6 project. The land use plan provides for high rise structures that, if built according to plan, eliminate any possibility that lack of zoning codes and enforcement of ordinances would allow substandard development on individual plots of land. Still there is the possibility the plan will not be in place soon enough, or will be poorly constructed and maintained.

Still, the Metro Line 6 would not be the cause of substandard development in Uttara Phase II, rather the implementation of the DMRTDP mitigates these outcomes by adding value to the area through rapid transport linkages to downtown Dhaka. In the short term, the Metro enhances GOB's position among potential investors in the Uttara Phase III development and makes it more likely that developments will be implemented rapidly and will be built to a high standard.

Scenario: Informal settlements could develop along the water front and on the embankment along the Turag River due to increased ease of access to work opportunities in the City.

Assessment: Uncontrolled development can occur if the Water Development Board and BIWTA (Bangladesh Inland Water Transport Authority) allow the gradual increase of informal settlements beyond the boundaries of the Uttara Phase III development. Both these agencies need to prohibit informal settlement on the embankment if indeed the Government decides this is an undesirable outcome. RAJUK may also be able to exert restrictions on such development.

Scenario: Infilling of land with new development can occur from Pallabi to Agargaon.

Assessment: This effect is likely to occur regardless of whether the Metro is built; land values will continue to increase in Dhaka, and as a result the tendency is to construct higher buildings. Whether the Metro causes this development is perhaps a matter of degree, as is the question of whether it is an undesirable outcome, or a natural consequence of urban growth.No other negative cumulative effect has been suggested for the Dhaka Metro Line 6 Project.

6.15 Greenhouse Gases (GHG) and Climate Change Adaptation

6.15.1 Mitigation: Estimated Reduction in GHG Emissions

The Project mitigates climate change by bringing about a reduction in greenhouse gas emissions in comparison with a base case scenario without the project. The estimate of emissions reduction due to the project is based on trip length, vehicle factors and other considerations taken from the Traffic Demand Estimate (TDE) report (NKDM 2014a) and published sources from the web, including DEFRA and US EPA. Power generation emission factors are taken from the DOE's carbon emissions inventory, which provides a combined margin CO2 emission factor for grid connected power that includes operating and build-margin components for the years 2012 – 2015. Energy is used for traction power and for lighting, air conditioning and station equipment according to percentages of peak power, and peak power is factored for off-peak and weekend loads. Other simplifying assumptions were used in the analysis:

- Methane and nitrous oxide are not counted in the calculations
- Leakage is ignored, (reduced load factor of buses, minis and cars in baseline emissions)
- Rebound effect is ignored (reduced congestion on affected roads, provoking higher average vehicle speed)
- Auxiliary power consumption is constant (station lighting, air conditioning and equipment)
- Indirect project emissions are not counted due to lack of survey data

Table 6-28 summarizes results of the analysis.

Table 6-28: Potential GHG Emission Reductions from Metro Line 6

emission factor:	0.67	tCO2/MWHr			
CO2 reduction factor:	1200.0	gm CO2 per day/rider			
Target Year		2021	2026	2046	2051
Peak power	(MW)	18	25	32	36
daily ridership		482940	583063	1133177	1311737
Baseline Emissions					
Vehicle Mix	%	CO2 baseline emissions per vehicle type (tons/day)			
Bus & Mini	21%	53.8	64.9	126.1	146.0
IPT	23%	33.7	40.7	79.0	91.5
Private vehicles	56%	492.1	594.1	1154.6	1336.6
Total		579.5	699.7	1359.8	1574.1
Project Emissions		MW/hr per day			
Combined traction power		151	210	269	303
Auxiliary Power		4.8	4.8	4.8	4.8
Total Power		156	215	274	308
CO2 generated (per day)		104.7	144.2	183.6	206.2

Emissions Reduction	(tons CO2 eq per day)			
	2021	2026	2046	2051
Baseline Emissions	579.5	699.7	1359.8	1574.1
Project Emissions	104.7	144.2	183.6	206.2
Emissions Reduction	474.8	555.5	1176.2	1367.9

Figure 6-20 illustrates the general growth of CO2 emission reduction possible through operation of Metro Line 6. Annual emission reductions (tons CO2 eq) are as follows: Further information is found in Appendix 4.

2021	2026	2046	2051
173,312	202,762	429,308	499,286

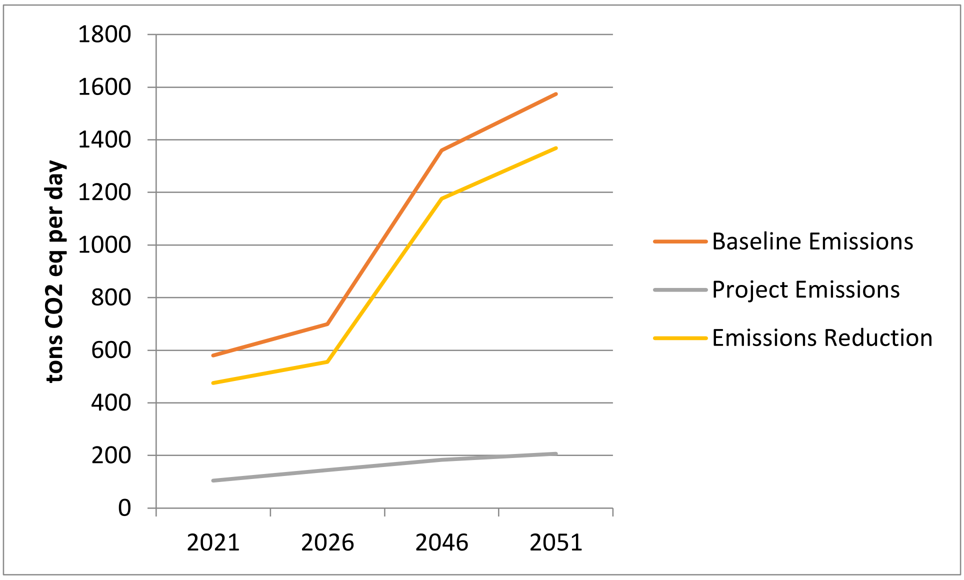


Figure 6-20: CO2 Emission Reduction for Metro Line 6

6.15.2 Adaptation Measures

The Project provides an indirect adaptive contribution by providing transport that will not be affected by floods. Conceivably the stations could serve as shelters or provide standing space that is above flood elevation.

Dhaka is subject to flooding; its intensity and duration could be due to climate change. North Dhaka in Mirpur and along the northern part of the alignment can be ‘underwater’ at different times of the rainy season, depending on the intensity of rainfall and river stage. While the situation has changed over the years due to infilling of land, the Google Earth image of the area (Figure 6-21) for 13 Nov 2004 gives a telling example of the type of flooding that can occur. Much of the area shown to be flooded in this image will be filled to a higher formation level and urbanized. Still the problem is exacerbated by infilling of drainage courses, with worsening flooding effects in the future. Much of the drainage for Uttara Ph II area must pass through the Goranchatbari Pump Station, current capacity 22 cu m/sec. Quantification of flood events is not attempted, as historical records are unavailable and prediction of future conditions uncertain; nevertheless the Project provides alternative means of travel during floods.

Figure 6-21: Flooding in Mirpur and Surrounding Areas (13 Nov 2004)

6.16 Social Impacts and Land Acquisition

6.16.1 Loss of Income and Livelihood due to Construction

6.16.1.1 Types of Community Impact that may require Compensation

Types of social impact are addressed in the Initial Social Assessment (ISA) prepared by NKDM and in the Resettlement Action Plan (RAP) prepared by RAC. Short term impacts can occur during construction, such as vendors near construction sites that must vacate, shops that must be barricaded due to construction, noise impacts that affect customer arrivals, and other potential impacts affecting income and livelihood. The SIA and RAP will catalogue these impacts if any.

6.16.1.2 Determining PAPs

Specific project affected persons (PAP) groups are associated with specific types of/locations for impact; based on the cutoff date and basis for measurement survey for most likely types of impact. Whether any compensation will be granted for this type of impact is determined by the RAP and catalogued in that document.

Temporary relocation of the Milestone Business College near the depot site (see

Sec. 6.2.2) is necessary because of potential noise and vibration impacts. Removal of one building adjacent to the depot property is also necessary. The level of compensation for the owners of the college is set out in the RAP.

6.16.1.3 Compensation

The full description of entitlements for lost income and property (if any) can be found in the Resettlement Action Plan (RAP).

6.16.2 Long-term Loss of Employment and Income (Operations)

The preparatory EIA (2011) identifies the potential for long-term loss of employment and income during operations, primarily for transport owners, operators and drivers. Other long term changes in income for vendors and storekeepers could occur with changes in consumer buying habits due to a new mode of transport and changes in market locations. These considerations should go into preparation of the RAP.

6.16.3 Public Acceptance of the Project

The information in the Preparatory EIA, presented along with the previously cited information regarding social survey (Sec 5.3.12), addresses project acceptance. The degree of public acceptance was expressed in public consultations conducted under the DMRTDP. Acceptance appears to be generally universal among interview groups.

6.16.4 Review of Transport Benefit from the Project

The conclusions of the Initial Social Assessment (ISA) confirm benefits of Metro Line 6. The reader is referred to that document.

6.16.5 Gender Impact/Benefit

DMTC prepared a Gender Action Plan and a Gender Action Plan. The reader is referred to those documents.

CHAPTER 7 COORDINATION AND CONSULTATION

7.1 Stakeholder Analysis

Stakeholders include governments, institutions and groups of individuals affected either beneficially or adversely, directly or indirectly, by the Project. Those affected adversely are commonly referred to as Project Affected Persons (PAPs). PAPs may experience environmental impact or be entitled to compensation due to land taken or property lost. Their numbers are few, whereas the groups are working for success of the project, and beneficially affected, are many, given the nature of the project, the project financing agency and project proponent, and other national and local agencies supporting the strategic transport development plan for Dhaka. Table 7-1 summarizes stakeholder interests as currently defined for the Dhaka Metro Line 6 Project.

The Japan International Cooperation Agency (JICA) finances the project at 75% through soft loans, and is a major stakeholder. Effective safeguards are the key element in JICA's stakeholder engagement with respect to environmental and social issues, to be effective in the workplace and in the community environment, avoidance of impacts that are typical in construction work in Dhaka, avoidance of accidents and reasonable settlements with PAPs, and smooth execution of the project to the greatest extent possible.

Government national and city-wide stakeholders that benefit from the Project include MRTB and Dhaka Mass Transit Company, owner of the Project, RAJUK and Dhaka North and South City Corporations, and other agencies within the Government of Bangladesh. There are no readily identified adversely affected groups at this scale. Benefit for these groups stem from increasing connectivity between homes, businesses, places of work and commercial centers and improved city-wide transit.

Local stakeholders are citizen groups in Dhaka, groups of individuals living, operating businesses and working in proximity to the alignment, and existing transport operators. In the short term, those traveling along roadways affected by construction are stakeholders. Those adversely affected by environmental impact include those directly exposed to construction impacts, those entitled to compensation for structures and land (currently thought to be none), those along haul routes of construction materials, and those who may be affected by long term impacts stemming from the Project during its operation (i.e. by displacing employment opportunity). Stakeholders benefiting from the Project include virtually all groups which are engaged in educational, economic and cultural pursuits in the area. Local governments benefit through the increase in economic activity due to the Project.

The list of local stakeholder groups thus is comprised of a) those directly affected by adverse environmental impact during construction, b) those entitled to compensation due to relocation of buildings and taking of land, c) those indirectly affected over the long term due to various forms of cumulative impact, d) groups that benefit from an improved economic environment due to better transport, and e) local governments. Women also form an identifiable stakeholder group in that given specific circumstances, women may be adversely affected during construction, and in general benefit from improved transport options.

Table 7-1: Stakeholder Groups, Roles and Interests

Stakeholders (target groups/intermediaries/institutions)	Role of Stakeholder	Interest in the Project	Potential Effect on Stakeholder	Level of Influence in Project Decision Making
JICA	Funding	Optimize implementation at affordable price	Positive –benefits from international cooperation	High
Government of Bangladesh and Local Authorities				
Ministry of Road Transport and Bridges	Leadership and coordination	Development of infrastructure for public transport	Positive –benefits from accomplishing agency objectives	High
DMTC	Implement project (design, construction and operations)	Assured contribution to improvement of transport systems	Positive –benefits from accomplishing agency objectives	High
RAJUK	Expedite project through provision of space and facilities	Improved transport for Dhaka residents	Positive –benefits from improved transport	Medium
Dhaka Police Department	Assist in traffic management during implementation	Improved future conditions for traffic congestion and accidents	Positive – benefits from accomplishing agency duties and tasks	Medium
DESCO Electric Utility	Provides electricity for operation of trains	Sale of electricity	Positive – benefits from accomplishing agency duties and tasks	Low
Ward Committees	Support project through information and public awareness	Improved transport forward community; protection of community interest	Positive – benefits from accomplishing agency duties and tasks	Medium
Citizen Groups, Representatives and Informal Groups				

Stakeholders (target groups/intermediaries/institutions)	Role of Stakeholder	Interest in the Project	Potential Effect on Stakeholder	Level of Influence in Project Decision Making
Bus Owner associations	To promote the interests of their members	Interface of project with bus operations to maintain optimal business environment	Positive provided all concerns are addressed	Medium – project can influence bus routing considerations
Rickshaw association owners and operators	Alternate transport provider whose income can be affected	Continued operation in new transport milieu without loss of income	Positive provided all concerns are addressed	Low
Households affected by new transport options provided by the metro line	Representation on committees and participation during project preparation	Compensation for actual damages and household benefits from improved transport	Positive provided all concerns are addressed	Medium
Businesses, shopkeepers and street vendors affected by construction and operations	Representation on committees and participation during project preparation	Compensation for actual damages and economic benefits from improved transport to their locales	Positive provided all concerns are addressed; relocation and disruption of businesses can incur loss	Medium
Students at schools, colleges and universities	Beneficiary	Easier means to commute	Provide secure transport means	Medium
NGOs working in urban areas	Mass organization for interest groups including women and other forms of support	Public interest	Positive provided all concerns are addressed	Low

7.2 Public Involvement

7.2.1 Early Screening

The Project conforms to the Strategic Transport Plan (STP, 2005) and the two preparatory studies (DHUTS 1 AND 2) of 2009-10 and 2010-11 that prioritizes completion of Line 6 first among the various metro rail alignments. These documents were reviewed and approved by government stakeholders, indicating broad consensus in the GOB for the proposed metro and Line 6 as the first to proceed with construction. The structure of government assures that local community representatives are aware of master plans that include the Project.

Extensive public and government agency consultation was held during the preparation stage of project development by the JICA study team, as documented in the Preparation EIA (2010) and summarized here. Five roundtable meetings were held with Government agencies (Table 7-2). Many issues related to project location and implementation were resolved at this early stage, including:

- Alternative routing of the line
- Need for – and options related to – partial resettlement of government and private facilities/property
- Depot location in Uttara
- Design criteria and coordination with local communities
- Public Review of the Preparatory EIA

Table 7-2: Coordination Meetings with Government Agencies during Preparation Phase

Stakeholder Meeting	Date of Meeting	List of Participants
1st Meeting	24th June, 2010	DTCB, RAJUK, DCC, RHD, RRD of MOC, BUET, JICA Bangladesh, JICA Headquarter, BIWTA, DMP, BRTA, BRTC
2nd Meeting	5th August, 2010	DTCB, Deputy Commissioner (DC) of Dhaka, CCDB, Titas Gas, Fire Service and Civil Defense, BRTA, BUET, Planning Commission, DCC, LGED, DPDC, DESCO, BR, BRTC, GIBR, DMP
3rd Meeting	16th September, 2010	DTCB, RAJUK, MOC, BUET, JICA
4rd Meeting	27th September, 2010	RRD of MOC, DMP, BRTC, DCC, BR, BRTA, DTCB, BUET, BIWTA, ERD, RHD, LGED,

		RAJUK, JICA
5rd Meeting	8th February, 2011	RRD of MOC, DTCB, RAJUK, BR, RHD, BRTA,BIWTA, BRTC, LGED, DCC, DMP, JICA

An extensive stakeholder engagement process was conducted at the local level to engage the affected communities. The process involved targeted interest groups (see Table 7-3) and 24 public meetings held in three roundsthat directly engaged some 2,219 persons in public consultation (see Table 7-4).

Table 7-3: Targeted Interest Groups in Preparation EIA

Stakeholder Type	Gender
Ordinary people living adjacent MRT station	Male and Female
Local elites	Male and Female
Local (school/college/university) teachers	Male and Female
Affected persons	Male and Female
Imams of the mosque	Male
Owners of the bus	Male and Female
Rickshaw pullers/Auto-rickshaw puller	Male
Shop keepers (small/medium/large)	Male and Female
Retired Persons	Male and Female
NGO representatives	Male and Female

Table 7-4: PC Meetings Held regarding Environment during Preparation EIA

S.N.	Date	Time	Place	Number of Participants
1	September 09, 2010	4 :00 pm	Model High School, Mirpur	115
2	October 11, 2010	4:00 pm	Science College, Tejigaon	183
3	October 27, 2010	12:00 noon	Sutrapur Community Center, Pallabi	249
4	October 30, 2010	3:00 pm	Pallabi Community Center, Pallabi	146
5	November 11, 2010	11:00 am	Siddique Bazar Community Center,	131

6	December 21, 2010	11:00 am	Ward Commissioner Office, Pallabi	52
7	December 23, 2010	4:00 pm	Ward Commissioner Office, Mirpur 11	91
8	December 28, 2010	4:00 pm	Ward Commissioner Office, Mirpur 10	45
9	December 30, 2010	11:00 pm	Ward Commissioner Office, Kazipara, Mirpur	55
10	January 01, 2011	4:00 pm	Office of the Member of Parliament, Farmgate	57
11	January 03, 2011	11:00 am	Ward Commissioner Office, Lalbag, Mirpur	60
12	January 06, 2011	11:00 am	Ward Commissioner Office, Sutrapur	57
13	January 08, 2011	11:00 am	Dhaka University Campus	54
14	January 10, 2011	11:00 am	Ward Commissioner Office, Saidabad, Dhaka	46
15	January 13, 2011	11:00 am	Office of the Rajdhani Super Market, Tikatoli Dhaka	63
16	February 19, 2011	11:00 am	Ward Commissioner Office, Pallabi	45
17	February 26, 2011	4:00 pm	Ward Commissioner Office, Mirpur 11	51
18	February 28, 2011	4:00 pm	Monipuri Primary School, Farmgate	60
19	April 30, 2011	11:00 am	National Sports Council Office, Purana, Paltan	312
20	June 09, 2011	11:00 am	Paltan Community Centre, Paltan	70
21	June 10, 2011	4:00 pm	Ward Commissioner Office, Arambag, Motijheel	88
22	June 23, 2011	11:00 am	Paltan Community Centre, Paltan	75
23	June 27, 2011	4:00 pm	Councilor Office, Arambag, Motijheel	70
24	July 04, 2011	11:00 am	Dhaka University, Vice Chancellor Room	44

Issues raised primarily concerned need for and levels of compensation related to land acquisition:

- That the elevated railway should be designed on such a way that it affects the minimum properties and minimizes effects on the wider community

- That land valuations be set at 50% greater than market values due to the difficulty in obtaining land for businesses
- Business losses should be covered to certain levels
- Employment loss should be compensated
- Land should be provided in Uttara Ph III development for resettled families; schools should be improved in those areas, and shops allocated in new DMC market developments for resettled businesses

Extensive public consultation during the preparation phase provides a foundation for PC during the design phase.

7.2.2 Public Consultation held during the design phase of the Project

Two environmental public consultation meetings were held during the design phase targeting a cross-section of interest groups. Meetings were facilitated by a GC subcontractor, which supported DMTC and NKDM staff in conducting the meetings. The first meeting was held on 23rd march 2015 at North Point, Diabari, Adjacent to the Depot area in Uttara-3rd Phase. The proceedings commenced at 3:00 pm and were presided over by the DMRTDP Project Director, Honorable Mr. Md. Mofazzel Hossain. The meeting was attended by a total of 42 people, representing government officials, non-government organizations, and local people including women, senior citizen and local school teachers. The second public consultation meeting was held on 06th May 2015 at the Seminar Room at the Public Library located at Shahbag, Dhaka. The proceedings commenced at 10:00 am and also were presided over by the Honorable Project Director. The meeting was attended by a total of 70 people representing the government officials, non-government organization, local people including women and senior citizen, local school teachers, and local mosque imams. Contents of the presentations, comments and questions raised during the open discussion periods, and lists of participants are provided in Appendix 4.

Presentations proceeded as follows: A representative of the GC subcontractor welcomed all the government officials and local people in the Public Consultation Meeting. The DMTC DGM for Environmental Safeguards gave a brief introduction of the proposed Metrorail project, addressing both the MRT-6 line and the Government's strategy for mass transport in Dhaka. This was followed by a presentation of the environmental impact assessment findings. The GC subcontractor presented project details along with key findings of the environmental impact assessment, and highlighted control measures incorporated into the design and recommended by the EIA in the Environmental Management Plan. A description of roles and responsibilities of the DMTC and GC for environmental management was provided, which will be taken up during project construction and operations phases. After the presentation, the floor was opened for questions and suggestions from the attendees.

7.2.2.1 Summary of Information Disclosed

The following general information was presented at the public consultation meetings:

- Overview of proposed Dhaka MRT Line-6 Development Project
- Need for mass transit in Dhaka due to increasing population density
- Project description focusing on environmental mitigation measures incorporated into the design
- Implementation schedule for early commissioning per instruction of Honorable Prime Minister
- Description of tender packages
- Key findings of the environmental impact assessment
- Environmental Management Plan (EMP) focusing on control measures, androles and responsibilities of the DMTC and contractors
- Key commitments of the DMTC as project sponsor, to be taken up during construction and operations phases
- Concluding remarks and request for popular support,since mass transportation in Dhaka City is a key requirement for national development

7.2.2.2 Summary of Questions, Comments and Opinion

Open discussion ensued after the presentationswith questions and suggestions from attendees. Participation was good and a number of key points were raised by stakeholders that have been taken into consideration in the EIA. The full transcripts of the open discussions are found in Appendix 4 and are summarized in Table 7-5.

Table 7-5: Summary of Open Discussion during Public Consultation

Issues Raised by Participants	Summary of Response	EIA Reference
Noise and vibration during site development and construction of the depot	Correct management approach will mitigate impact	Sections 6.1.2 and 6.2.2
Project impact on historical monuments and important buildings	Historical survey completed and has resulted in improvements to the design	Section5.4
Assure public safety around construction zones	Design changes have been made in critical areas to reduce impact	Sections 6.4 and 6.11.1

Rain will intensify impacts in construction zones	Prefabricated sections significantly reduced the impact of construction	Section 6.5.1
Parking facilities in the Uttara area will facilitate usage for people traveling to Motijheel	Discussion is ongoing about inclusion of parking, though some limits on what can be done	Not addressed in the EIA
Traffic management during construction	Ongoing studies for alternative traffic routes and other provisions	Section 6.4
Land acquisition	No land acquisition is planned under the project	
Congestion along walkways near stations and the BSMMU and BIRDEM hospitals during operations	Buildings will be connected via overhead walkways; dedicated walkways for patients will be provided; the metro will facilitate patient access; discussions with hospital management for planning	Section 6.9.3
Encroachment into National Parliament area due to change in route from DHUTS 2 study	The route change is approved by the highest authority of the government before the start of design phase. Employ design adjustment and environmental mitigation measures to minimize the impacts.	
Effect on National Parliament	Employ landscaping to reduce impact and replace trees	Section 6.8
Extent of Social impact	Studies underway to determine social impact	Addressed in Social Impact Assessment
Depot infilling	Source of sand being identified	Section 3.3.1.1
Depot site drainage	Detailed drainage plan being worked out	Section 6.5.2.1
Effect on utilities (buried water lines)	Utility survey being carried out	Section 6.9.1
Construction debris left in roadway and footpaths	Special consideration given to this	Section 6.11.1

Effects of construction on normal business activity	Necessary measures are being taken to limit impacts	Section 6.11.1

7.2.3 Stakeholder Consultation held during the design phase of the Project

Numerous meetings were held during the design phase with concerned stakeholders, sometimes with single entity and sometimes with multiple entities, in order to finalize alignment, construction procedure, utility identification, verification and relocation planning, traffic management, etc. Minutes all these meetings are recorded and regularly included in the Consultant's Monthly Progress Reports submitted each month to DMTC.

For instance, to finalize the alignment within the Cantonment Area, 7 consultation meetings were held with Cantonment Authority over a period of one year. Those consultations resulted fine tuning of alignment, construction procedure, road widening within Cantonment area, etc.

Similarly, more than 30 consultation meetings were held with RAJUK. Topics covered, among others, confirmation of boundaries, construction detailing, lane and footpath configuration, etc. A series of consultation meetings were held with utility agencies like DWASA, DESCO, PGCB, Titas Gas, etc. In many consultation meetings Police were invited in addition to one exclusive consultation meeting with DMP. Regular consultation were carried out with DCC (North) and DCC (South). Also, consultation meetings were held with Dept. of Agriculture Extention, Meteorological Agency, Civil Aviation Authority, DTCA, Relevant Ministries, BUET, Dhaka University, Khamarbari, LGED, RHD, BBA, Bangladesh Railway, Parliament Standing Committee, Parliament Speaker, Fire Brigade, etc. It may be noted that such consultation will continue for the entire Project implementation period.

7.2.4 Further Milestones in Public Involvement

Consultation with affected parties should be held at the start of construction for all construction contracts (CP-1 – CP-6). Periodic meetings should be held if serious grievances arise. Requirements for public consultation will be included in the construction contract tender documents for major construction contracts.

CHAPTER 8 ENVIRONMENTAL MANAGEMENT PLAN

8.1 Purpose

The Environmental Management Plan describes institutional proposals and mitigation measures aimed at specific types of impact. Institutional aspects are proposed for a framework for environmental management that encompasses the DMRTDP through its operations phase, a two year period following early commissioning. The presentation of mitigation measures aims at confirming use of best practicable technology in planning and design, setting out measures for mitigating construction impacts that conform to good international practice, and more general recommendations related to operations.

8.2 Acquisition of Prior Clearances and No Objection Certificates

The DMRTDP is the end effort of a long term transport planning process that included the Preparatory Survey undertaken under JICA funding in 2010-11 (DHUTS 2), which produced the Preparatory Survey EIA. An Environmental Clearance Certificate (ECC) was granted to DMTC on the basis of that EIA, as described in Sec. 1.7. An application for renewal of the ECC will be submitted again in 2015, accompanied by the present EIA report.

No objection certificates (NOCs) are being sought from the following local government units: Dhaka North and South City Corporations, RAJUK, and the Cantonment Authority. Other NOCs will be required where the viaduct encroaches on adjacent land. Drawings have been submitted to DNCC and DSCC, meetings held with the Mayors, and applications are under review. RAJUK has granted NOC for the Depot site; NOC for the alignment is under review by RAJUK. NKDM has submitted drawings and held meetings with the Cantonment Authority, and issuance of the NOC is expected soon.

8.3 Environmental Management Framework

8.3.1 Environment and Rehabilitation Division

DMTC is a Project Implementation Unit for the Dhaka Mass Rapid Transit Development Project (DMRTDP). The Environmental and Rehabilitation Section (ERS) at DMTC was formed to be responsible for environmental and social impacts, and resettlement, land acquisition and compensation during the design, construction and early commissioning of the Project. The Institutional Development Consultant (IDC) will recommend a structure for the government-owned independent corporation, DMTC.[13]Current Institutional setup

[13] The institutional and capacity building program is designed by institutional Development Consultants (IDC) under a separate contract with DMTC. Its terms of reference calls for a general review of institutional set ups across the transport sector and coordination with other agencies; design of an organizational set up for DMTC; staffing, personnel recruitment, procedural rules and training; financial organization, procurement,

can be seen in Figure 2-1, Section 2.3 IDC should take into consideration recommendations herein in its proposal for an organizational setup, capacity building and budget.

8.3.2 Vision

It is recommended there be an Environmental and Rehabilitation Division (ERD) within DMTC once full operation commences, reporting directly to the Director General or a deputy. This is because the vision for ERD can be essential for the long term good of the enterprise. That vision should span project implementation and facility operations. It should aim at full public acceptance on the basis of good management in the planning, design, execution, operations and maintenance of the metro system. A vision statement for the ERD might be as follows:

To provide a total management system that maximizes value for users and owners through environmental protection and social acceptability over all phases of project development.

8.3.3 Organization

The section is currently headed by a Deputy General Manager (DGM) with a total of four professional staff positions over the design period. It is recommended that titles for current positions as shown in Figure 2-1 be changed, and total number of staff positions be increased to eight. In addition to the position of General Manager (GM), Deputy GMs for Project Development and Facility Operations should be established. After operations begin at the depot, a Depot Environmental Superintendent should be appointed with skills in treatment plan operations and laboratory analysis. An open organizational structure is proposed (see Figure 8-1), as this is likely to provide the greatest degree of flexibility in use of staff time. However, it is to be noted that final decision on ERD organization depends on IDC recommendation and DMTC acceptance.

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finance, budgeting and accounting; and operations management systems for personnel, safety, information, quality control and risk.

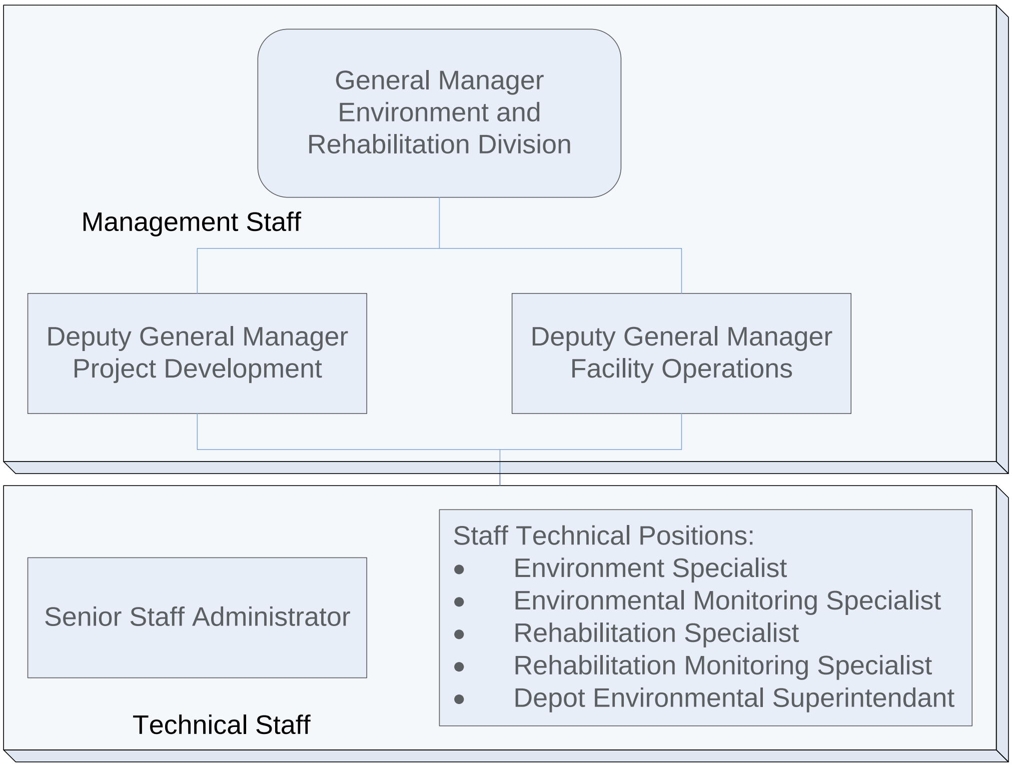

Figure 8-1: Proposed Organizational Arrangement for ERD

8.3.4 Staff Responsibilities and Training

Staffing of technical positions will occur gradually, and staff assignments should be flexible, allocated to fit mid-range needs. Staff can be assigned to project development or operations, depending on current work requirements. Staff may specialize in execution or monitoring, and move between project development and operations as needed. Both will be important activities over the long term, as operations get into full swing and additional metro rail lines are constructed.

8.3.5 Equipment Resources and DMTC Operations Costs

An initial list of equipment is proposed for metro development projects (see Table 8-1), which can be supplemented under future projects. These costs total 52 Lakh Taka (current 2015 amount) and are part of EMP implementation.

Table 8-1: ERD First Phase Equipment List

Item	Unit	No.	Cost, lac taka
Moving equipment (pickup truck, SUV or other)	Each	2	24
Computer equipment to support staff needs	Set	8	10
Field equipment			

GPS	Each	1	0.5
Noise Dosimeter	Each	1	1.5
Field WQ testing equipment	LS	1	3
Lab equipment at depot for water quality analysis	LS	1	7
Lab equipment for hazardous materials testing	LS	1	6

8.3.6 Budget

A budget for ERD operations includes salaries for staff and monthly operations costs, for vehicle fuel, field per diems, and other items. The operations budget is shown in Table 8-2. This preliminary budget and equipment list should not be considered conclusive, as the work by the IDC is not complete and not all needs can be anticipated in advance. In any case operations costs and salaries will be set and allocated through the annual budget at DMTC. These are annual recurring costs that are part of EMP implementation and total 61 Lakh Taka per annum (current 2015 amount).

Table 8-2: ERD First Phase Annual Operating Budget

Staff salaries	Unit	Amount, lac taka
General Manager	Yr	10
Deputy General Manager (1)	Yr	7
Deputy General Manager (2)	Yr	7
Senior Staff Administrator	Yr	7
Technical Staff (5 staff)	Yr X 5	25
Operations cost	Yr	5

IDC will determine staffing and set benchmarks for operations budgets. In addition, equipment needs may change, and an accurate assessment is difficult in advance. In any case, operations costs and salaries will be set and allocated through the annual budget at DMTC.

8.3.7 Role of NKDM during Design/Construction

NKDM Safeguards Group prepares documentation through the process of environmental assessment, and prepares the environmental construction specification (ECS) for inclusion in bidding packages; assists DMTC in public consultations and in communications with DOE; and supports DMTC in monitoring of mitigation measures undertaken by the Construction Contractors. NKDM natural and social environment staff also will provide training for DMTC

ERD staff, as described above.

8.3.8 Role of Construction Contractors

Each Contractor will appoint a responsible individual as the contact person for environmental protection. The Contractor's Project Manager or an appointed management/ technical staff who reports directly to the Project Manager will serve as Environmental Management Officer (EMO) to oversee environmental management functions. Each contractor is expected to mobilize necessary staff to carry out mitigation measures described in the EIA; to supervise skilled/unskilled labor; and to manage, review and periodically report on performance related to implementation of mitigation measures.

Within twenty eight (28) days of receipt of the Letter of Acceptance but in no case later than the Commencement Date, the Contractor shall prepare and submit to the Engineer for his approval of a Construction Environmental Management Plan (CEMP) to comply with the environmental protection and mitigation requirements contained in the EIA. The CEMP shall in principle be in general compliance with ISO 14001. All potentially affected areas within and in the vicinity of the Site, as agreed with the Engineer, shall be covered by the CEMP.

The Contractor shall prepare and provide the CEMP which will demonstrate the manner in which he will implement, manage and control environmental mitigation measures that are applicable to the Contract. The Engineer, supported by findings in Chapter 6 of the EIA (Environmental Impacts and Mitigation Measures), will have the final decision over the applicability of a particular measure. The CEMP applies to the construction phase and is to be implemented over the time duration provided in the contract bid documents.

The Contractor shall prepare his CEMP considering the following main points as required for the work to be undertaken:

- General requirements of the ECS
- Noise and vibration control
- Control of dust and air pollution from equipment exhaust
- Traffic management and materials transport
- Water pollution control and site drainage
- Solid waste and hazardous materials
- Community health and safety
- Occupational health and safety
- Housing, services and facilities for labour camps
- Air, water, noise and vibration monitoring during construction
- Equipment certification (air and noise emissions)

8.3.9 Relationship among Groups during Construction

The organizational framework during construction consists of three operational groups: ERD, NKDM environment staff, and the Contractor's EMO and support team. These are proposed to be organized as shown in Figure 8-2.

8.3.10 Environmental Construction Specification

The impact mitigation framework consists of measures specified in the EMP of the EIA (this chapter), which are carried over to the individual construction contract packages (CPs) in the form of an Environmental Construction Specification (ECS). All mitigation measures are not applicable to every CP, since the measures were derived based on location and type of activity, which differ among the packages.

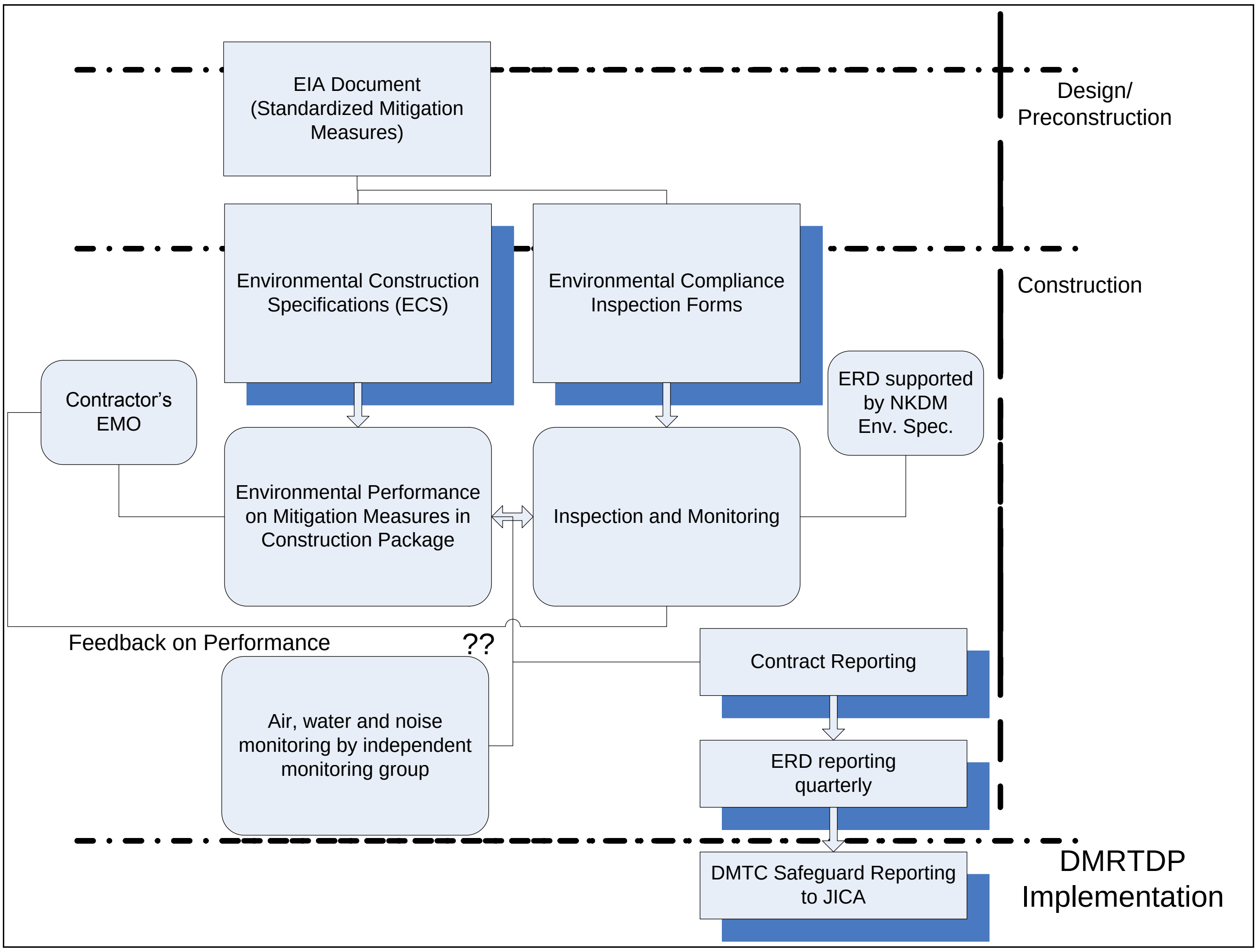

Figure 8-2: Organization for Environmental Management during Construction

The ECS is a general specification and it will be the Contractor's responsibility to determine which measures are applicable to a particular CP, and to include those measures in its CEMP. The Engineer, in reference to Chapter 6 of the EIA (Environmental Impacts and Mitigation Measures) will have the final decision over the applicability of a particular measure. The provisional ECS is found in

Appendix 2, which will undergo revision up to the time the contract bid packages are let.

The ECS is incorporated into the bid documents as part of the General Conditions. Other specifications for are also attached to the bid documents. The requirements that are set out in the ECS are additional to requirements contained in the Health and Safety Specification, Traffic Management Specification, and HIV/AIDs Awareness Specification. Monitoring and reporting for health and safety and traffic management issues may be conducted independently of monitoring of ECS requirements. Specific aspects of monitoring and reporting will be resolved prior to award of any particular contract package.

8.3.11 Inspection and Reporting during Construction

A system of monitoring compliance with environmental mitigation measures will be set out prior to mobilization of any construction package, which will conform to the general arrangement shown in Figure 8-3. The system provides periodic inspection (at least quarterly), data compilation, and reporting of results. The system will utilize check lists for use in inspecting compliance with mitigation measures. Different checklists are used to draw attention to requirements for pre-start up and the Contractor's CEMP, the contract period, and completion stages.

The checklists serve primarily as guides for reviewing performance to determine general compliance with broad indicators. DMTC's ERD field representative, the GC's Environment field staff and the Contractor's EMO will review performance against selected indicators. Indicators will include:

a) General conduct of work

b) Labor Provisions

c) Noise and Vibration Control

d) Air Quality

e) Drainage and wastewater

f) Traffic management

g) Solid and hazardous Waste Generation and Disposal

h) Use of land for Construction Purposes

i) Protection of Community Values
and other indicators selected for the work at hand.

ERD supported by the GC will prepare periodic reports that reflect performance of each contract over the period. Reports will be submitted to JICA as part of the periodic project performance reporting requirement. Monitoring reports also will summarize the status of complaints (registered/resolved) under the GRM, as well as results of air, water and noise monitoring conducted by the Independent

Monitoring Group (IMG). Table 8-3 summarizes the types of monitoring and reporting activities and identifies those responsible for undertaking tasks.

8.3.12 Grievance Redress Mechanism

The Contractor will consult with the affected community before starting work that has the potential to cause adverse impact, to inform the community and obtain comments on means for minimizing impact.

A Grievance Redress Mechanism (GRM) will be established by the Employer which is described in full in the Resettlement Action Plan (RAP). The Contractor will participate in the Grievance Redress Committee (GRC) alongside the Employer's representative as Chairman; a Representative of the local ward; and Representative of the Engineer. Costs related to disclosure and GRM are part of EMP implementation borne by DMTC and total 14 Lakh Taka (current 2015 amount).The GRM will be used to receive and respond to complaints from individuals and the general community. Full details of the GRM is found in the RAP.

Public notice of the GRM will be posted at the ward office and construction site in large print on durable material, stating the purpose of the GRM and phone numbers of persons to contact. The Employer and the Engineer will maintain a record of the status of any community complaints brought before the GRM.

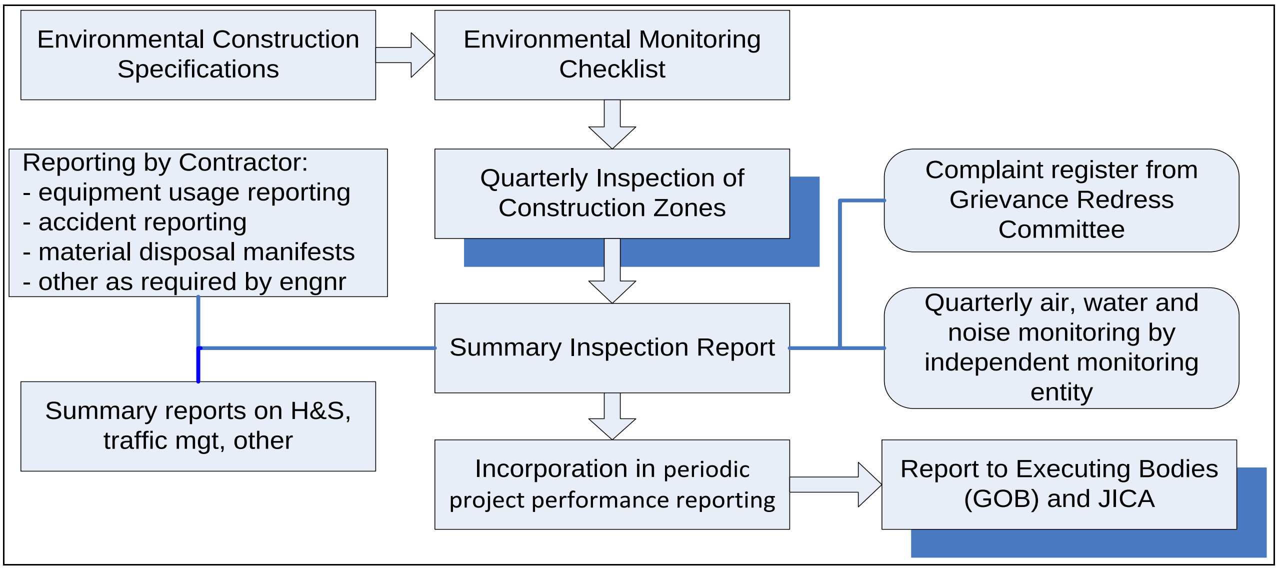

Figure 8-3: Flowchart for Environmental Monitoring and Reporting during Construction

Table 8-3: Summary of Monitoring Requirements, Location and Frequency

Entity	Requirement	Location	Frequency
Contractor	Various job and labor monitoring requirements per good practice and specifications	Typically at job sites; records held at main headquarters of contractor	Continuous
DMTC	ECS and general workplace conditions	Job sites	Quarterly
NKDM	Support DMTC in monitoring of ECS	Job sites	Quarterly
IMG	Air, water, noise and vibration monitoring	Job sites	Quarterly, or more frequently in response to incidents

8.4 Mitigation Measures

8.4.1 Periods of Applicability

This section is arranged in the design, construction and operations sequence, in which measures are implemented by a) NKDM planning and design groups; b) construction contractors; and c) DMTC and other agencies following commissioning.

8.4.2 Mitigation Measures applied during Design

NKDM has incorporated project design features addressing environmental concerns, health and safety, and energy conservation, which have been incorporated into the Project. These are described in previous sections of the EIA. NKDM conducted special studies to ensure safe, reliable project execution, such as the Traffic Management Plan, Systems Safety and Health and Safety, and an implementation framework for commissioning and operations. Some of the measures that have been incorporated into the design to mitigate specific types of impact are listed in Table 8-4.

Table 8-4: Environmental Protection Measures accounted for in Design

Responsibility: NKDM (Mitigation Measures applied in Design Stage)	Cost Component
Operations Noise and Vibration Abatement	
Use of vibration-proof track (MSS cushion) (estimated 5,868 m)	2,946 lakh Tk
Use of noise barriers	22.4 lakh Tk

Include in operations plan speed restrictions in locations near sensitive receptors	Operations plan: no added cost
Modified pier locations in the design to provide maximum distance from historical monuments, to avoid damage due to vibration during train operation	Design correction: no added cost
Relocate Milestone College for a temporary period and pay compensation; demolish building	Cost to be determined by RAC
Depot Operations Drainage and Water Quality	
Depot yard drainage segregates clean and contaminated runoff from the site, and provides treatment for drainage from areas producing contaminated runoff	Integrated into design; no added cost
Depot waste treatment systems produce effluent in compliance with DOE regulations	No added cost
Materials recovery systems prevent discharge of hazardous materials to air and water, and recover sediment and remove surfactants from car washing facilities	Integrated into design; no added cost
Drainage and wastewater discharge points are designated and agreed by local authorities	No added cost
Drainage: Stations and Viaduct	
Roof drainage is accounted for in the design of stations	Design standard
Viaduct sections are drained by routing to the nearest RC street drain	Design standard
Repair and replace street drains where existing systems are inadequate	50 lakh Tk
Construction: Public Infrastructure	
A provisional sums included in bid documents for repair and maintenance of roadways used for haul routes and main thoroughfares where alignment passes, to prevent them becoming degraded in construction	To be determined for individual contracts
Bill of quantities will include reinstallation of median strips, planting of trees and repair of road pavements near the piers and along the viaduct prior to completion of contract, and sufficient bid bond, to insure that the contractor finishes out and ties in the existing medians, roadways and sidewalks near stations and viaduct	To be determined for individual contracts
Operations: Public Infrastructure	
Ground level site planning around stations considers the condition of public infrastructure to accommodate increased pedestrian and rickshaw traffic	Design standard

Development of Operations and Maintenance Rules (OMR), institutional development and staffing insure maintenance of public infrastructure	Design standard
Determine responsibilities for maintenance of solid waste, public toilets and walkways in the vicinity of stations, and resolve cost sharing arrangements	Design standard
Operations: Risk	
Structural and architectural designs of the viaduct, stations and facilities at the depot follow appropriate earthquake codes	Design standard
Emergency response planning sets out procedures for dealing with accidents and unusual occurrences	Design standard

<u>Costs</u>

The costs associated with incorporating these measures are covered in the contract bid price for the project. Installed costs are estimated for the RSS track fastening system, noise barriers, and improvement in drainage systems near station stotaling 3,018 Lakh Taka (2015 current cost). These are incremental costs (over and above a system without the improvement). Other costs include compensation (determined by the RAC), and provisional sums for road repair and utility reinstatement that have not been determined.

8.4.3 Construction

Mitigation measures are applied to contract packages by means of the Environmental Construction Specification (ECS) (Appendix 2). ERD supported by NKDM will monitor to insure good performance of mitigation measures. The ECS is typical of civil works construction contracts to be implemented under the Project, and is modified to fit the circumstances of individual bid packages. The scope of construction mitigation measures included in the ECS provides an overarching framework for environmental management during the construction phase:

- Standard clauses provide general requirements that are applicable to all CPs
- Technical clauses describe technical requirements that are generally applicable for every CP
- Site and location-specific requirements related to one or a few CPs, or work packages within the overall scope for the contractor
- Carry-over/external requirements that are set out in other project documents and included as specifications in the bid documentation (health and safety, and traffic are examples); these are included by reference in the ECS.
- Monitoring and reporting requirements

The contractor should incorporate all relevant mitigation measures into the Construction Environmental Management Plan (CEMP) prior to the start of work. The CEMP should be reviewed and approved by DMTC, assisted by NKDM. The CEMP should address the following subcomponents:

- General requirements of the ECS
- Noise and vibration control
- Control of dust and air pollution from equipment exhaust
- Traffic management and materials transport
- Water pollution control and site drainage
- Solid waste and hazardous materials
- Community health and safety
- Occupational health and safety
- Housing, services and facilities for labour camps
- Air, water, noise and vibration monitoring during construction
- Equipment certification (air and noise emissions)

The Contractor is required to monitor air, water and noise through an independent monitoring group (IMG); monitoring requirements are described in the ECS.

Table 8-5 lists the mitigation measures to be undertaken by the Contractor during construction.

Table 8-5: Environmental Mitigation Measures during Construction

	Impact Mitigation Measure
A.	**General Provisions**
1.	All construction machinery and vehicles shall be of proven efficiency and shall conform to the relevant standards for emissions and noise levels.
2.	The Contractor will obtain approval from land owners for temporary use of land for ancillary sites such as labor camps, storage sites and construction yards. Local authorities will be consulted on locations, which will in no case be within 100 m of sensitive receptors such as hospitals, schools and residential communities. Temporary use of land is subject to approval by the Engineer.
3.	After completion of occupancy, all affected areas within the general project boundary and temporary sites will be graded to their final elevation, conforming to the drainage plan specified in the design. Temporary sites will be graded to drain. Final road surfaces along the alignment shall be reinstated. Machinery, equipment, structures, contaminated earth, plant matter and waste or unused materials will be removed and disposed of at locations approved by the Engineer. Temporary pits and sumps will be backfilled and compacted.

4.	The Contractor shall avoid excavating and trenching near roads, buildings, walls, and existing buried utilities. If unavoidable, the Contractor shall provide adequate shoring to prevent damage. Backfill and sealing of construction trenches shall be done promptly.
5.	The Contractor will avoid blocking access to land, homes and businesses; where unavoidable, the Contractor will provide temporary access to affected properties and reinstate permanent access on completion of work; minimize the area under construction at any one time and the duration of works at any one location; and minimize impacts on infrastructure, access and services.
6.	The Contractor will install a gate, signs and lighting at the entrance to the site and at movable sites, and restrict access to sites along the alignment by erecting temporary walls and barricades.
7.	The Contractor will promptly reinstate any services and reinstall any physical facilities that are cut, disconnected or damaged during construction activities, and will maintain or provide temporary services that are interrupted by construction. The Engineer will inspect and certify the adequacy of all reinstated services and facilities.
8.	After completion of the work at a location, all construction-related machinery and equipment, and waste or unused materials, will be removed, relocated, and disposed of as necessary at locations subject to the approval of the Engineer.
9.	The Contractor will submit an application to, and obtain consent from, the local governing body (DNCC and DSCC) for the removal and trimming of trees in public right-of-ways. Applications must be accompanied by information on numbers, locations, sizes as reported in the EIA or determined by onsite inspection, and photographs, as necessary to document the scope of removal. Compensatory replanting is not required under the contract.
10.	The Contractor will stop construction on discovery of objects of archaeological origin; and notify the owner, who will contact the Department of Archaeology, Ministry of Cultural Affairs to investigate and, if desirable, undertake recovery. Work must remain halted at the specific location until investigation is complete.
B.	**Labor Provisions**
1.	GOB criteria for minimum age, wage and living provisions, benefits, hours of work, overtime arrangements and overtime compensation, and leave for illness, maternity, vacation or holiday should be met for all workers. The Contractor will conform to National Law in relation to hiring and employment; and will comply with the principle of equal opportunity, fair treatment, and non-discrimination with respect to the employment relationship.
2.	The contractor shall implement a safety and accident prevention program involving provision, training and use of safety equipment; minimum skills qualifications for operators and drivers; and record keeping related to accidents, as described in the Health and Safety Specification.
3.	The Contractor will provide Personal Protective Equipment (PPE) to workers that offer adequate protection to the worker without incurring unnecessary inconvenience in its use. Proper maintenance of PPE, including cleaning when dirty and replacement when damaged or worn out; and proper use of PPE should be part of training programs, as appropriate.

4.	The contractor will maintain first aid kits onsite along with instructions for use, and personnel trained in basic first aid emergency response measures. In case of injury, the contractor shall arrange treatment of the injured worker(s) and bear the cost of treatment.
5.	Laborers and others that are resident at the site will be provided with lodging in a camp setting, free of insects and standing water, with potable water supply, food service and facilities for relaxation in a group setting, and adequate means for maintaining personal hygiene and solid/liquid waste disposal.
6.	Safe drinking water will provided at the worksite and worker camps with sufficient numbers of access points to assure availability for workers. Water will be periodically tested for and assured safe from bacteriological contamination.
7.	HIV/AIDS awareness will be incorporated into the contractor's policy and outreach toward workers.
C.	**Noise and Vibration Control**
1.	The Contractor is responsible for complying with the Department of Environment's Noise Control Regulation (2006). The allowable noise limit at the perimeter of the site has been set at 85 dB. In the event of noise levels exceed the threshold limit, the Contractor shall mitigate noise by use of the following measures.
2.	Heavy equipment will be equipped with built in noise control devices, especially pavement breakers, crawler cranes, excavators and concrete cutters. The Contractor will regularly maintain construction machinery and vehicles so that aggregate noise levels fall within the Project standard.
3.	Temporary noise barriers will be constructed between noisy activities and noise-sensitive receivers.
4.	Equipment on construction yards will be located away from noise-sensitive receptors.
5.	Walled enclosures will be constructed around especially noisy activities or clusters of noisy equipment at construction yards.
6.	Noisy operations can be combined to occur in the same time period.
7.	Nighttime activities will be avoided near sensitive noise receptors, such as residential neighborhoods.
8.	Noise-dampened equipment will be standard, including enclosed air compressors and properly-working mufflers on all engines.
9.	Noise emissions must be kept within the range specified by DOE, and noise monitoring done on a quarterly basis.
10.	The vibration limit applicable to the contractor for vibration-producing activity is 90VdB (vibration decibel units) at the face of the nearest building closest to the ongoing vibration-inducing activity. If the standard cannot be met, the contractor will mitigate by installing cut-off trenches at depths and locations necessary to maintain this level, or by other means available to the contractor.

D.	**Air Quality**
1.	Areas within the construction site and material storage areas where vehicles operate or materials are stored will be established on well drained fill.
2.	Vehicles hauling sand, gravel and other friable materials will be covered during transport on public roadways.
3.	Washing facilities will be provided at points of entry and egress from the site as necessary to remove mud from wheels and undercarriages.
4.	Mud and windblown dust deposited on haul roads by the movement of transport vehicles will be removed by sweeping, scraping and washing, as appropriate.
5.	Material stockpiles that could generate windblown dust will be covered or kept wet with a spray of water.
6.	The contractor will operate water trucks to provide a water film over exposed surfaces within the site. The Contractor will maintain sufficient water content on working surfaces at the construction site to prevent the occurrence of windblown dust.
7.	Provide certification that construction equipment brought onto the job complies with IN-BS-1 exhaust emissions standards, and assure equipment is properly maintained.
E.	**Traffic Management**
1.	The Contractor will plan and clearly mark routes through urban areas for movement of materials and equipment.
2.	Truck traffic will be routed away from residential streets to through routes with the least residential land use.
3.	Flagmen will be stationed at main intersections along haul routes during periods of intense transport activity, at points of vehicle access into the worksite, at obstructions in the line of traffic, and at the start and end of construction. Traffic detours will be set up if necessary and clearly marked.
4.	The contractor will provide front and rear escort vehicles, equipped with flashing light, for movement of vehicles carrying over-weight/over-length (OW/OL) loads of heavy equipment, and provide auxiliary flagmen along the route and onboard to assure clearance.
5.	Movement of OW/OL loads preferably will be done at night.
F.	**Drainage and Water Quality**
1.	The CEMP will include a drainage strategy and plan to be developed by the Contractor for the construction site, temporary construction yards, materials storage areas and administration/worker housing, as applicable, to be checked and approved by the Supervising Engineer, and implemented by the Contractor.
2.	The contractor will be responsible for controlling drainage discharges from the site and restricting discharge to no more than three locations.

3.	No return flows from materials dewatering or drains are allowed to leave the property boundary with suspended solids content (TSS) in excess of 100 mg/L.
4.	The contractor will monitor TSS in outfalls where these leave the site boundary or at the point of discharge to a local drainage channel, and comply with the 100 mg/L TSS limit.
5.	Portable sanitation facilities will be set up at the construction site and regularly cleaned by vacuum truck. No wastewater nor chemical discharge to the environment shall be permitted, except as contained in portable facilities at the worksite.
6.	Sanitation facilities at temporary worker quarters should include self-contained waste treatment with removal of excess by vacuum truck or approved discharge point.
7.	Drainage from fuel storage tank locations, refueling areas, and equipment service areas should be segregated from other runoff; discharge should be routed through an oil/water separator.
8.	Fuel storage tanks should be surrounded by secondary containment equal to at least half the volume of the tanks.
9.	Sediment should be removed as solids by cleaning/scraping work areas and removing piles of debris in a solid form.
10.	Wash water from concrete trucks will not be flushed into drainage channels.
G.	**Waste Generation and Disposal**
1.	The Contractor will include in its CEMP a plan for solid waste management that identifies the following: material types sites, estimated quantities and methods for disposal; locations onsite for collection and storage; locations for disposal. A recordkeeping system for all wastes and a tracking and manifest system for hazardous and recycled materials will be included in the plan. Necessary enclosed facilities, containers and equipment will be provided in keeping with the Plan. Recordkeeping should be kept up-to-date with actual types, quantities, locations for disposal, and other information.
2.	Waste will be segregated in recordkeeping and physically, at the construction site, into the following general categories: spoil, construction debris and drilling mud/cuttings (Class C non-putrescible wastes); trash and other forms of degradable but non-hazardous wastes (Class B); hazardous wastes and spent materials, including liquids (Class A); materials determined to be recyclable by identified takers (Class R).
3.	Class A waste material containers will be stored on a raised platform in dry condition for no longer than one week unless kept in an enclosed and secured location, in which storage of up to 3 mo is allowed.
4.	The Contractor will promptly collect, store, transport and dispose of Class B solid waste generated at the project site. No solid wastes will be allowed uncollected at the jobsite or accumulated in storage for periods in excess of a month. Transport and disposal will be by recognized means approved by the Engineer.
5.	Class C spoil materials, cuttings and wastage from the site that are unsuitable for use in construction shall be disposed of at locations specified in the CEMP and approved by the

	Engineer. Methods of placement and compaction, and limits on the types of materials to be placed therein are subject to prior review and approval by the Engineer, who may at times require testing of materials to verify the absence of chemical residue and excess organic matter. Such review and restriction can occur at anytime during the spoil placement activity at a site.
6.	Deposition of spoil materials shall be approved where clear land titles are in place, in areas designated on the Dhaka City Plan as suitable for fill, and in line with guidance provide by the Dhaka Development Authority and the Local Government Agency. In no case shall spoil materials be placed in or near rivers, drainage channels, lakes, beels, khals and other forms of wetland.
7.	Class R recyclables may be stockpiled for up to one month while identifying a taker; otherwise the materials will be treated as a waste product and removed from the site.
8.	Material Safety Data Sheets (MSDS) for purchased chemical additives, reagents and compounds will be kept at the work site.
9.	Trash receptacles will be installed and maintained at construction sites, and areas designated for temporarily stockpiling used/discarded materials.
10.	The Contractor will handle and dispose of, or recycle, unused and spent hazardous materials at a licensed facility to prevent losses to the environment.
11.	The contractor will provide prepared locations for, and demarcation of, stockpiles of used packaging and wrapping materials, in conjunction with and approved by the engineer.
12.	The contractor will provide prepared receptacles for grease impregnated wrapping materials and wipes.
13.	The contractor will inventory all by-product materials and report to owner for disposition.
14.	Disposition may include sale or donation of packing materials free of oil and grease, or other forms of contamination, as agreed by the Engineer.
15.	Empty lubricant containers shall not be sold or recycled, except as approved by the Engineer.
16.	Un-recycled materials must be disposed of in a suitable manner, as approved by the Engineer. No materials shall be burned onsite, or otherwise.
17.	No fuel, oil, or parts cleaning fluids shall be spilled, wasted or disposed of at the project site.
18.	Defective or excess electronic parts and equipment, as well as any residual parts, cuttings or shavings, are the property of the contractor and must be removed from the Country.
H.	**Protection of Community Values**
1.	The Contractor will identify haul routes in the CEMP; describe numbers of trips and time of day; identify the duration of the hauling activity; and obtain approval for routes, schedules and durations from the Local Government and Superintending Engineer.
2.	The Contractor shall protect, conserve and maintain access to social and cultural properties in the project area including schools, mosques, hospitals, temples, shrines, graveyards, tourism

	sites and other public places.
3.	The Contractor will post flagmen at intersections of transit paths for construction vehicles and local traffic, and along traffic lanes where work is in progress. Traffic detours will be clearly marked.
4.	The Contractor will avoid blocking access to land, homes and businesses; where unavoidable, the Contractor will provide temporary access to affected properties and reinstate permanent access on completion of work.
5.	Clear pathways will be provided for pedestrians around construction sites.
6.	Work areas that are accessible to the public will be barricaded, while ensuring passage for pedestrians around the work area.
7.	Buffer areas will be established around construction sites along the alignment, and barricaded to exclude waiting vehicles and rickshaws.
8.	Vendors will be relocated away from, or otherwise prevented from setting up near to, construction sites.
9.	Clear, visible signage will be provided to communicate risks at the point of contact and to the local community.
10.	Hazardous conditions will be removed on construction sites that cannot be controlled effectively with site access restrictions.
11.	The Contractor shall promptly reinstate any services and reinstall any physical facilities that are cut, disconnected or damaged during construction activities, and shall maintain or provide temporary services that are interrupted by construction. The Engineer shall inspect and certify the adequacy of all reinstated services and facilities.

Costs

The costs associated with implementing these measures have been estimated for each of the major divisions of activity as shown in Table 8-6. The measures represent an accepted construction performance standard and are recovered by the Contractor as part of its general overhead costs included in the unit prices bid for items in the bill of quantities.

Table 8-6: Summary of EMP Construction Contractor Costs (Lakh Taka, current 2015)

Construction Contractor Costs	One-time-only	Annual Recurring
General Provisions	61	
Labor Provisions	387	
Noise and Vibration Control	108	
Air Quality	40	
Traffic Management	402	

Drainage and Water Quality	106	
Waste Generation and Disposal	635	
Monitoring During Construction		21
Total	1,739	21

8.4.4 Operations

Table 8-6 lists mitigation measures for the operations phase. DMTC is generally responsible for these measures, supported by the City Corporations and other agencies.

Table 8-7: Environmental Mitigation Measures during Operations

Responsibility: DMTC
Operations: Noise and Vibration
Wheels on rolling stock will be maintained by trying to eliminate wheel flats from the treads and restore the wheel profile.
Operations Traffic Management
Traffic Management Planning measures will be implemented to maintain traffic flow in the vicinity of stations.
Rickshaw access on main roads will be prohibited, but DMTC working with DS/NCCs will develop and promote use of rickshaw queues on side roads near stations.
Sidewalks that connect to points of access and egresswill be repaired and maintained.
Transport connectivity will be provided by access points for bus and other forms of public transport.
Operations Drainage and Water Quality
Waste treatment systems will be operated to obtain consistent high quality effluent.
Discharge points will be monitored to assure compliance with the ECC and waste discharge permit.
Material Safety Data Sheets (MSDS) for purchased chemicals, reagents and compounds will be kept current and readily accessible for use.
Operations Groundwater Protection
Use of herbicides to control weed growth along tracks will be accompanied by applications training and supervisory controls, including inventories of chemicals matched to appropriate application rates.
Operations Solid Waste and Hazardous Materials
Depot

The Depot operator will institute a Waste Management System taking into account materials to be disposed of and recycled, estimated quantities and methods for collection, storage, treatment and disposal or recycling. A recordkeeping system will account for all wastes and recycled materials, and length of time and locations for storage; a tracking and manifest system for hazardous and recycled materials will be maintained.
The site design and equipment procurement will provide necessary enclosed facilities, containers and equipment for managing wastes.
The Depot operator will dispose of spent hazardous materials and wastes by means and at locations acceptable to the DOE.
The Depot operator will not store hazardous and recyclable materials indefinitely at the site, as this is a hidden liability for the owner. No waste material should remain in storage for more than a year.
The Depot operator will develop recycling systems and linkages for metal scrap and for waste oil, and will inspect uses and processing beforehand to assure environmental soundness.
Stations
DMTC will coordinate with DN/DSCC for an improved level of maintenance of solid waste in the vicinity of stations.
DMTC will assure that station waste receptacles are available and kept in good condition, emptied regularly, and maintenance is periodically performed on the equipment.
DMTC will maintain the interior of stations to be free of trash and refuse; post signs against littering, keep the track area within the station free of trash.
Operations: Public Infrastructure
N/SDCC, DWASA and DMTC will identify and share responsibilities for maintenance of solid waste, public toilets and walkways in the vicinity of stations, and resolve cost sharing arrangements.
Operations: Vegetation and Wildlife
DMTC working with local authorities will undertake a tree replanting program along the alignment.
Operations Risk
DMTC will train in emergency response procedures of the General Rules for O&M before operations begin by staging drills and assuring physical features are in place (signage, emergency stairwells etc.).

<u>Costs</u>

Estimated operations and maintenance costs are shown in Table 8-8. These costs should be included in the annual budgets for the DMTC.

Table 8-8: Summary of EMP Recurring Costs during Operations (Lakh Taka, current 2015)

Operations Activities (DMTC)	Annual Cost Lakh Taka
Track operation	
Noise control	45
solid waste	92
health and safety	15
Depot Operation	
WW and solid waste mgt	8
noise control (rolling stock)	9
WW treatment	8
water conservation	0.1
solid waste	8
Monitoring During Operation	21
Total	206

8.5 Project Environmental Monitoring during Construction

8.5.1 Summary of Project Standards

Ambient Air Quality (DOE Standard, µg/cu m)

Land Use Category	SPM	SO2	CO	NOx
a. Industrial and mixed	500	120	5000	100
b. Commercial and mixed	400	100	5000	100
c. Residential and rural	200	80	2000	80
d. Sensitive	100	30	1000	30

Drainage discharges (DOE Standard)

Total suspended solids content will be limited to 100 mg/L (ECR Schedule – 9: Standards for Sewage Discharge). Discharge of water contaminated with organic waste or chemicals is prohibited.

Ambient Noise Limits (Project Standard)

Category	Day Time (Leq)	Night Time (Leq)
Sensitive Areas and Hotel	75 dB	65 dB
Office and Commercial	85 dB	85 dB
Commercial and Service	85 dB	85 dB
Areas with ambient noise level (>65 dB)	Ambient Noise Level +10 dB	-

Notes: Evaluation point is at boundary of buildings

Daytime: 6:00-22:00, Night time: 22:00-6:00

Sensitive areas: residential areas, hospitals, schools, places of religious worship

Non-road and heavy Truck Exhaust Emissions Standards

Construction equipment brought onto the job will comply with IN-BS-1 exhaust emissions standards:

Ref.	Year	CO	HC	NOx	PM
IN-BS-1	2000	4.5	1.1	8.0	0.36

Vibration (Project Standard)

90 VdB, approximately corresponding to 3 mm/s PPV, measured at building face

8.5.2 Air, Water and Noise Monitoring

The Contractor will arrange at his own cost to perform regular air, water and noise monitoring in the vicinity of construction sites, as specified in the ECS. Sampling and testing will be performed by an Independent Monitoring Group (IMG), such as BUET or an equivalent organization subject to prior approval by the Engineer. The IMG will report results of periodic monitoring directly to the Engineer and the Contractor. The data will be used to assess progress in implementing the CEMP. Vibration monitoring will be required in special cases.

The Contractor will provide in its CEMP a plan and schedule, including locations, frequencies and parameters, for monitoring air and water quality, and noise and vibration levels, at the boundary of the site, subject to the approval of the Engineer.

Air quality: sample air quality over two consecutive twelve hour periods and analyze for suspended particulate matter (SPM) and PM10, oxides of nitrogen (NOx), Sulphur dioxide (SO2) and carbon monoxide (CO); once per quarter-annum, at sufficient downwind locations near the perimeter of work sites. An investigative program will be required of the contractor in the event there are complaints concerning air quality from the community, which will require more frequent monitoring to determine causes.

Water quality: Obtain samples from drains at predetermined locations around the site each quarter-annum for measurement of Total Suspended Solids (TSS) using grab samples. Locations for monitoring will be identified and agreed with the contractor. More frequent monitoring will be required of the contractor in the event there are complaints from the community.

Noise: obtain one minute noise level readings (dBA) for a period of one hour during typical operations; and report maximum Leq – 10 min; once per quarter-annum; at predetermined locations around the perimeter of the site.

The Contractor will be responsible for complying with the Department of Environment's Noise Control Regulation (2006). In the event of noise levels at the perimeter of the site exceed the DOE noise standard of 85 dBA (ECR Schedule – 5: Standards for Sound originating from Motor Vehicles or Mechanized Vessels and its amendment of 2006), the Contractor may be required to initiate more frequent monitoring or monitor at locations of sensitive receptors.

Costs

Costs for air, noise and water quality monitoring during construction are included in the contractor's construction cost bid estimate. Total cost depends on the duration of the contract, number of samples taken and locations. Periodic monitoring during construction and operations is estimated at 21 Lakh Taka annually, as shown in previous cost tables.

8.6 Summary of Costs

Costs associated with implementation of the EMP are described in Secs. 8.3.5, 8.3.6, 8.4.2, and 8.4.3 (Costs). These amounts are summarized in Table 8-9, which also includes a summary of costs by party as well as by period that the cost will be expended. Total one-time-only costs are Lk Tk 4,823 and for the most part are incurred during construction and are included in the construction contract price. Annually recurring costs are Lk Taka 288 per annum, and are primarily borne by DMCTL during operations.

Table 8-9: Summary of EMP Costs (Lakh Taka, current 2015)

	One-time-only	Annual Recurring
Environmental Design Features with Costs Identified	3,018	
ERD Operations and Equipment Costs	52	61
DMTC Preliminary Activities	14	
Construction Contractor Costs	1,739	21
Operations Activities (DMTC)		206
Total Cost	4,823	288

Total Costs by Party		
Design Innovation Costs	3,018	
Contractor Costs	1,739	21
DMTC Costs	66	267
Total Costs by Period		
Preconstruction Period	3,032	
Construction Period	1,739	21
Operations Period	52	267

CHAPTER 9 CONCLUSIONS AND RECOMMENDATIONS

9.1 Compliance with Relevant Sector Guidelines of JICA and GoB

Dhaka Metro Line 6 Project is compliant with GOB and JICA guidelines concerning environment, social impact, resettlement and compensation, and local administration. Sector guidelines related to the environment, public transit design and construction, systems and traffic safety, and public health are complied with through completion of project preparatory and detailed studies. The EIA Report and EMP provide a means for environmental management through the implementation phase.

9.2 Gains That Justify Project Implementation

The Metro Line 6 Project provides one of several means being used in tandem for alleviating Dhaka transport problems. A clear right of way in the public domain allows the project to be built without any land acquisition. The project provides improved access to the Uttara Ph III area for more rapid development by allowing the GOB to invest freely in residential infrastructure, much needed in Dhaka. The alignment serves the core of the City, and provides direct access to the CBD. The selection of the Line-6 alignment for the first phase of the Dhaka Metro was conditioned on use of BRT and improved roadways for transport improvements in the other core areas of the City, leaving the current alignment for Line 6 as the logical first choice.

Greenhouse Gas (GHG) emissions are reduced by removing vehicles from the roadway, assuming a passenger equivalence between metro use and vehicle numbers. It is estimated that the Project CO2 emission reduction is 170,000 tons/yr (2021) to 499,000 tons/yr (2051).

9.3 Adverse Effects

Metro Line 6 Project has no long term adverse environmental impact; once constructed and in operation the Metro will enhance its local environment and improve mobility for local communities. The visual profile of the viaduct will merge with the environment’s structural and biophysical aspects (buildings and trees with similar height dimensions); the homogenous face of the viaduct is undemanding to the eye and over time merges with the background visual environment. Other aspects of the Facility once in operation do not pose environmental impact if correctly operated and maintained.

The project design incorporates measures for reducing the impact or footprint of the Project. Modern equipment and facilities are designed into the system. An extensive CBTC and other interlinked systems assure complete control of train movements and passenger safety. Stray current protection protects equipment, passengers and surrounding infrastructure from sparks. The environmental work was interfaced with project design to assure incorporation of needed features, such as the MSS vibration resistant track (also known as Floating Track

System) at locations where noise and vibrations exceed tight thresholds.

Social impacts on local transport providers due to the competitive nature of the Metro is discounted: a) the Metro once operational becomes a member of the set of transport alternatives for Dhaka that is always functioning at capacity; and b) employees and entrepreneurs are people that adjust to changing times, and just as the Metro may temporarily disadvantage some, to others it offers both jobs and new transport opportunities.

9.3.1 Adverse Effects Minimized

The mitigation measures proposed for application to individual construction and supply contracts minimize adverse effects that occur during construction. Air, noise and water pollution levels will be monitored periodically. Requirements for maintaining clean work space; pedestrian and vehicle access around and through work areas; enclosed or piped drainage from work sites; roadways used for haul roads and lanes adjacent to work spaces free of dust and in good repair; visible signage and traffic directional controls; worker visibility and mandatory use of traffic vests and PPE equipment; maintenance of drainage, lighting and dust at temporary yards and spaces needed in the construction; and other features included in the EMP serve to minimize impacts to an acceptable level. Transport management planning, the health and safety specification for construction, and the HIV prevention program mitigate impacts during construction. Emergency response planning mitigates potential risk during construction and operations.

Social impacts are minimized by relocating street-side vendors to predefined locations so their occupations can be continued. The Project seeks to exert minimum impact on permanent storefronts along the alignment and to minimize the effect on access and pedestrian movement, since most activity (except station construction) takes place in the roadway.

9.3.2 Adverse Effects Offset

No environmental impact was identified to be offset on the project.

9.3.3 Adverse Effects Compensated

Some compensation may be paid in specific instances related to disturbance that affects livelihood, or temporary relocation out of the line of work. Any such instances will be identified in the RAP and adjudicated in keeping with its guidelines. No compensation has been identified strictly related to environmental impacts of construction, with the exception of temporary relocation of Milestone Business College on the north boundary of the depot property. Minor amounts of land are acquired to make way for access and egress at stations; land parcels are listed in the RAP, and the means of acquisition described.

9.4 Use of Irreplaceable Resources

There is no use of irreplaceable resources in relation to the Metro Line-6 Project.

9.5 Provisions for Follow-up Surveillance and Maintenance

A systematic approach for surveillance and monitoring is provided by means of a management framework, and monitoring and reporting protocol. Follow-up public consultation is intended to provide future input to the identification of environmental impact during the construction phase as well as a grievance redress mechanism for project affected persons. The social component of the project has identified the numbers of affected persons, household sand businesses, that there are no locations requiring either total or partial land acquisition and the amount of any damage costs for special situations where livelihoods are temporarily interrupted. The EMP will be incorporated into individual contract bidding documents in the form of Environmental Construction Specification (ECS), which form the basis for the contractor's environmental performance. Periodic monitoring will be undertaken by DMTC supported by the GC, and quarterly reports provided to the financing agency (JICA).

Appendices

APPENDIX 1 REFERENCES

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APPENDIX 2 ENVIRONMENTAL CONSTRUCTION SPECIFICATION

2.1 ENVIRONMENTAL PROTECTION REQUIREMENTS

The Contractor shall minimize, as far as is practicable, the adverse effects of all his and the Subcontractors' activities upon the environment throughout the execution of the Works. The Contractor shall conform to the Bangladesh Environmental Laws and codes as applicable.

2.2 Construction Environmental Management Plan (CEMP)

Within twenty eight (28) days of the Commencement Date, the Contractor shall prepare and submit to the Engineer for his approval of a Construction Environmental Management Plan (CEMP) to comply with the environmental protection and mitigation requirements contained in this Chapter. The CEMP shall in principle be in general compliance with ISO 14001. All potentially affected areas within and in the vicinity of the Site, as agreed with the Engineer, shall be covered by the CEMP. The Contractor shall prepare and provide the CEMP which will demonstrate the manner in which he will implement, manage and control environmental mitigation measures that are applicable to the Contract. The Engineer will have the final decision over the applicability of a particular measure. The CEMP applies to the construction phase and is to be implemented over the time duration of the Contract.

A detailed Environmental Impact Assessment (EIA) has been prepared by the General Consultant and copies of the Report can be obtained from the office of the General Consultant. The Contractor is advised to refer to the EIA while preparing his CEMP.

The Contractor shall prepare his CEMP considering the following main points as required for the work to be undertaken:

a) Environmental concerns due to construction

b) Acquisition of prior clearances and No Objection Certificates

c) Compliance with environmental laws and regulations

d) Framework and organisation for CEMP implementation

e) Details of CEMP implementation

- Noise and vibration control
- Control of dust and air pollution from equipment exhaust
- Traffic management and materials transport
- Water pollution control and site drainage
- Solid waste and hazardous materials
- Community health and safety

- Occupational health and safety
- Housing, services and facilities for labour camps

f) Grievance Redress Mechanism

g) CEMP work schedule

h) Air, water, noise and vibration monitoring

i) Reporting

2.3 Acquisition of Prior Clearances and No Objection Certificates

The Project is categorized as Category “Red” according to DOE Environmental Conservation Rules and Category “A” in accordance with JICA’s Guidelines for Environmental and Social Considerations (2010). An EIA was prepared along with the “Dhaka Urban Transport Network Development Study Phase 2 (DHUTS-2)”, and was submitted to the Department of Environment (DOE). On that basis, an Environmental Clearance Certificate was issued (ECC No. 767 dated 11 July 2011 under file No. DOE/Clearance/5034/2011). The ECC was renewed on 20/11/2014 and will be renewed periodically to remain valid over the construction period. The detailed Environmental Impact Assessment (EIA) shall serve as the basis for ECC renewal. The Contractor should be familiar with the terms of the ECC and NOC relevant to the work, note any restrictions and covenants therein, and account for them in its CEMP.

The Contractor will submit an application to, and obtain consent from, the local governing body (DNCC and DSCC) for the removal and trimming of trees in public right-of-ways, as described in Clause 2.5.5.

2.4 Environmental Management Framework

The Contractor will appoint an Environmental Management Officer (EMO) as specified in Volume 1- Section IV – Bidding Forms - Personnel as the person responsible for environmental protection. He shall report to the Contractor’s Project Manager and oversee environmental management functions. The Contractor shall also mobilize necessary staff to carry out mitigation measures (refer to the EIA); and to manage, review and periodically report on performance related to implementation of mitigation measures.

The framework includes mitigation measures specified in the EMP of the EIA, which are included in these specifications (Sub-Clause 2.6). The requirements that are set out in these specifications are additional to the requirements contained in the Health and Safety Specifications, Traffic Management Specifications, and HIV/AIDs Awareness Specifications.

The Contractor will arrange at his own cost to perform regular air, water and noise monitoring in the vicinity of construction sites, as specified in Sec. 2.6. Sampling and testing shall be performed by an Independent Monitoring Group (IMG), such as BUET or an equivalent organization subject to prior approval by the Engineer.

The IMG will report results of periodic monitoring directly to the Engineer and the Contractor. The data will be used to assess progress in implementing the CEMP. Vibration monitoring will be required in special cases.

2.5 Public Consultation and Grievance Redress Mechanism

The Contractor will consult with the affected community before starting work that has the potential to cause adverse impact, to inform the community and obtain comments on means for minimizing impact.

A Grievance Redress Mechanism (GRM) will be established by the Employer to receive and respond to complaints from individuals and the general community.

The Grievance Redress Committee (GRC) probably will consist of:

a) Employer's representative as Chairman

b) Representative of the local ward

c) Representative of the Contractor and

d) Representative of the Engineer

Public notice of the GRM will be posted at the ward office and construction site in large print on durable material, stating the purpose of the GRM and phone numbers of persons to contact. The Contractor, Employer and the Engineer will maintain records of the status of any community complaints brought before the GRM.

2.6 Measures to Minimize Environmental Impact

2.6.1 General Conduct of Work

a) All construction machinery and vehicles shall be of proven efficiency and shall conform to the relevant standards for emissions and noise levels.

b) The Contractor will obtain approval from land owners for temporary use of land for ancillary sites such as labour camps, storage sites and construction yards. Local authorities will be consulted on locations, which will in no case be within 100 m of sensitive receptors such as hospitals, schools and residential communities. Temporary use of land is subject to approval by the Engineer.

c) After completion of occupancy, all affected areas within the general project boundary and temporary sites will be graded to their final elevation, conforming to the drainage plan specified in the design. Temporary sites will be graded to drain. Final road surfaces along the alignment shall be reinstated. Machinery, equipment, structures, contaminated earth, plant matter and waste or unused materials will be removed and disposed of at locations approved by the Engineer. Temporary pits and sumps will be backfilled and compacted.

d) The Contractor shall avoid excavating and trenching near roads, buildings, walls, and existing buried utilities. If unavoidable, the Contractor shall provide adequate shoring to prevent damage. Backfill and sealing of construction trenches shall be done promptly.

e) The Contractor will avoid blocking access to land, homes and businesses; where unavoidable, the Contractor will provide temporary access to affected properties and reinstate permanent access on completion of work; minimize the area under construction at any one time and the duration of works at any one location; and minimize impacts on infrastructure, access and services.

f) The Contractor will install a gate, signs and lighting at the entrance to the construction site, at movable sites, and at temporary construction yards, and will restrict access to sites along the alignment by erecting temporary walls and barricades.

g) The Contractor will promptly reinstate any services and reinstall any physical facilities that are cut, disconnected or damaged during construction activities, and will maintain or provide temporary services that are interrupted by construction. The Engineer will inspect and certify the adequacy of all reinstated services and facilities.

h) After completion of the work at a location, all construction-related machinery and equipment, and waste or unused materials, will be removed, relocated, and disposed of as necessary at locations subject to the approval of the Engineer.

i) The Contractor will stop construction on discovery of objects of archaeological origin; and notify the Employer, who will contact the Department of Archaeology, Ministry of Cultural Affairs to investigate and, if desirable, undertake recovery. Work must remain halted at the specific location until investigation is complete.

2.6.2 Labour Provisions

a) GOB criteria for minimum age, wage and living provisions, benefits, hours of work, overtime arrangements and overtime compensation, and leave for illness, maternity, vacation or holiday should be met for all workers. The Contractor will conform to National Law in relation to hiring and employment; and will comply with the principle of equal opportunity, fair treatment, and non-discrimination with respect to the employment relationship.

b) The Contractor shall implement a safety and accident prevention program involving provision, training and use of safety equipment; minimum skills qualifications for operators and drivers; and record keeping related to accidents.

c) The Contractor will provide Personal Protective Equipment (PPE) to workers that offer adequate protection to the worker without incurring unnecessary inconvenience in its use. Proper maintenance of PPE, including cleaning when dirty and replacement when damaged or worn out; and proper use of PPE should be part of training programs, as appropriate.

d) The Contractor will maintain first aid kits onsite along with instructions for use, and personnel trained in basic first aid emergency response measures. In case of injury, the Contractor shall arrange treatment of the injured worker(s) and bear the cost of treatment.

e) Labourers and others that are resident at the site will be provided with lodging in a camp setting, free of insects and standing water, with potable water supply, food service and facilities for relaxation in a group setting, and adequate means for maintaining personal hygiene and solid/liquid waste disposal.

f) Safe drinking water will provided at the worksite and worker camps with sufficient numbers of access points to assure availability for workers. Water will be periodically tested for and assured safe from bacteriological contamination.

g) HIV/AIDS awareness should be incorporated into the Contractor's policy and outreach toward workers, as described in Clause 43 of the Particular Conditions.

2.6.3 Transport

a) The Contractor will plan and clearly mark routes through urban areas for movement of materials and equipment.

b) Truck traffic will be routed away from residential streets to through routes with the least residential land use.

c) Flagmen will be stationed at main intersections along haul routes during periods of intense transport activity, at points of vehicle access into the worksite, at obstructions in the line of traffic, and at the start and end of construction. Traffic detours will be set up if necessary and clearly marked.

d) The Contractor will provide front and rear escort vehicles, equipped with flashing light, for movement of over-weight/over-length (OW/OL) vehicles, and auxiliary flagmen along the route and on board to assure clearance.

e) Movement of OW/OL loads preferably will be done at night.

2.6.4 Waste Generation and Disposal

a) The Contractor will include in its CEMP a plan for solid waste management that identifies the following: material types sites, estimated quantities and methods for disposal; locations onsite for collection and storage; locations for disposal. A recordkeeping system for all wastes and a tracking and manifest system for hazardous and recycled materials will be included in the plan. Necessary enclosed facilities, containers and equipment will be provided in keeping with the Plan. Recordkeeping should be kept updated as necessary with actual types, quantities, locations for disposal, and other information.

b) Waste will be segregated in recordkeeping and physically, at the construction site, into the following general categories: spoil, construction debris and drilling mud/cuttings (Class C non-putrescible wastes); trash and other forms of degradable but non-hazardous wastes (Class B); hazardous wastes and spent materials, including liquids (Class A); materials determined to be recyclable by identified takers (Class R).

c) Class A waste material containers will be stored on a raised platform in dry condition for no longer than one week unless kept in an enclosed and secured location, in which storage of up to one mo is allowed.

d) The Contractor will promptly collect, store, transport and dispose of Class B solid waste generated at the project site. No solid wastes will be allowed uncollected at the jobsite or accumulated in storage for periods in excess of a month. Transport and disposal will be by recognized means approved by the Engineer.

e) Class C spoil materials, cuttings and wastage from the site that are unsuitable for use in construction shall be disposed of at locations specified in the CEMP and approved by the Engineer. Methods of placement and compaction, and limits on the types of materials to be placed therein are subject to prior review and approval by the Engineer, who may at times require testing of materials to verify the absence of chemical residue and excess organic matter. Such review and restriction can occur at any time during the spoil placement activity at a site.

f) Deposition of spoil materials shall be approved where clear land titles are in place, in areas designated on the Dhaka City Plan as suitable for fill, and in line with guidance provide by the Dhaka Development Authority and the Local Government Agency. In no case shall spoil materials be placed in or near rivers, drainage channels, lakes, beels, khals and other forms of wetland.

g) Class R recyclables may be stockpiled for up to one month while identifying a taker; otherwise the materials will be treated as a waste product and removed from the site.

h) Material Safety Data Sheets (MSDS) for purchased chemical additives, reagents and compounds will be kept at the work site.

i) Following site clearing and before construction, the Contractor shall remove all trash, debris, rubbish, plants and other weeds.

j) Trash receptacles will be installed and maintained at construction sites, and areas designated for temporarily stockpiling used/discarded materials. The Contractor shall ensure that the work place is kept free of trash, garbage, debris, rubbish, plants and weeds, and shall provide and ensure use of metal or heavy-duty plastic refuse containers at the site with tight fitting lids for disposal of garbage and trash. Specific locations shall be designated for consuming food and snacks, and signs posted requiring use of the refuse containers. Containers shall be emptied at least once daily by the Contractor.

k) The Contractor will handle and dispose of, or recycle, unused and spent hazardous materials at a licensed facility to prevent losses to the environment.

l) No fuel, oil, or parts cleaning fluids shall be spilled, wasted or disposed of at the project site.

m) The Contractor will promptly collect, store, transport and dispose of solid waste generated at the project site. No solid wastes will be allowed uncollected at the jobsite or accumulated in storage for periods in excess of a month. Transport and disposal will be by recognized means approved by local authorities.

2.6.5 Removal and Trimming of Trees in Public Right-of-way

The Contractor will submit an application to, and obtain consent from, the local governing body (DNCC and DSCC) for the removal and trimming of trees in public right-of-ways. Applications must be accompanied by information on numbers, locations, and sizes as reported in the EIA or determined by onsite inspection, and photographs, as necessary to document the scope of removal. Compensatory replanting is not required under the contract.

2.6.6 Ambient Air Quality

The DOE Standard for ambient air quality is given In Table 2.1. The Contractor is obliged to conform to ambient air quality guidelines of DOE at the perimeters of work locations and along vehicle haul routes.

Table 2.1 DOE Ambient Air Quality Standard (μg/cu m)

Land Use Category	SPM	SO2	CO	NOx
Industrial and mixed	500	120	5000	100
Commercial and mixed	400	100	5000	100
Residential and rural	200	80	2000	80

Land Use Category	**SPM**	**SO2**	**CO**	**NOx**
Sensitive	100	30	1000	30

Construction equipment brought onto the job will comply with IN-BS-1 exhaust emissions standards set out in Table 2.2.

Table 2.2: IN-BS-1 Exhaust Emissions Standards (μg/cu m)

Ref.	Year	CO	HC	NOx	PM
IN-BS-1	2000	4.5	1.1	8.0	0.36

a) The Contractor shall submit to the Engineer an Air Control and Monitoring Plan (ACMP) as part of the Construction Environmental Management Plan. It shall establish procedures to control air pollution through dust suppression and control of vehicle exhaust emissions. This plan shall contain a description of activities that may degrade air quality, environmental mitigation measures to reduce pollutants, a monitoring programme, record keeping and reporting.

b) Areas within the construction site and material storage areas where vehicles operate or materials are stored will be established on well drained fill.

c) Vehicles hauling sand, gravel and other friable materials will be covered during transport on public roadways.

d) Washing facilities will be provided at points of entry and egress from the site as necessary to remove mud from wheels and undercarriages.

e) Mud and windblown dust deposited on haul roads by the movement of transport vehicles will be removed by sweeping, scraping and washing, as appropriate.

f) Material stockpiles that could generate windblown dust will be covered or kept wet with a spray of water.

g) The contractor will operate water trucks to provide a water film over exposed surfaces within the site and along haul routes. The Contractor will maintain sufficient water content on working surfaces at the construction site to prevent the occurrence of windblown dust.

h) The Contractor shall water down work sites as required to suppress dust, during handling of excavated soil and debris, or during demolition.

i) The Contractor will make water sprinklers, water supply and water delivery equipment available at any time that it is required for dust control use, and dust control activities shall continue as necessary during work stoppages.

j) The Contractor will provide certification that construction equipment brought onto the job complies with IN-BS-1 exhaust emissions standards (Table 2.2), and assure equipment is properly maintained.

k) The Contractor shall establish and maintain records of routine maintenance of internal combustion engines used on the project, and shall keep records available for inspection by Engineer.

l) In the event that remedial measures are not being implemented and serious impacts persist, the Engineer may direct the Contractor to suspend work until the measures are implemented, as required under the Contract.

m) The Contractor shall be responsible for ensuring that no earth, rock or debris is deposited on public or private right of ways as a result of its operations, including any deposits arising from the movement of loaded/unloaded trucks and/or other construction vehicles.

n) The Contractor shall remove and transport all excavated spoil materials from the site on a continuous basis. Stockpiling of materials will only be allowed at sites designated by the Engineer.

o) Temporary dumping areas shall be maintained by the Contractor until excavated materials are re-utilised. The Contractor shall place material in a manner that will minimise dust emissions. Material shall be stabilised and wetted each day, especially during dry weather.

p) The locations of air monitoring stations will be near sensitive receptors adjoining construction sites, such as residences, schools, and hospitals; and placement of monitoring equipment shall be agreed with the Engineer prior to commencement of the air monitoring programme.

2.6.7 Drainage and Water Quality

a) The Contractor shall comply with all Bangladesh Government legislation insofar as it relates to water pollution control and monitoring.

b) The Contractor's CEMP will include a drainage strategy and plan for the construction site, temporary construction yards, materials storage areas and administration/worker housing, as applicable, to be checked and approved by the Supervising Engineer, and implemented by the Contractor.

c) The Contractor shall provide adequate precautions to ensure that no spoil or debris of any kind is pushed, washed, falls or deposited on land adjacent to the site perimeter.

d) The Contractor shall prevent soil particles and debris from entering water discharge points by use of filters and sedimentation basins as required.

e) The Contractor shall at all times ensure that all existing stream courses and drains within and adjacent to the site are kept safe and free from any debris and any excavated materials arising from the Works. The Contractor shall ensure that earth, bentonite, chemicals and concrete agitator washings etc. are not deposited/drained in the watercourses but are suitably treated and effluents and residue disposed off in a manner approved by local Regulatory Authorities.

f) All water and waste products (surface runoff and wastewater) arising on the site shall be collected and removed from the site via a suitable and properly designed temporary drainage system and disposed of at a location and in a manner that will cause neither pollution nor nuisance.

g) The Contractor shall obtain prior approval from DWASA for discharge of wastewater arising out of the site office, canteen or toilet facilities at any occupied site. Enclosed piping shall be provided to drain wastewater into the sewerage system.

h) The Contractor shall take measures to prevent discharge of oil and grease from accidental spills or normal operations from reaching drainage systems or water bodies. Means for doing so shall be described in the Contractor's Construction Environmental Management Plan. Oil-water separators shall be provided to remove oil and grease from drainage flows originating from fuel storage tank locations, refueling areas, equipment service areas, workshop areas and canteens.

i) Total suspended solids content will be limited to 100 mg/L (ECR Schedule – 9: Standards for Sewage Discharge). Discharge of water contaminated with organic waste or chemicals is prohibited.

2.6.8 Noise

The Ambient Noise Limits (Project Standard) are given in Table 2.3.

Table 2.3: Ambient noise Limits

Category	Day Time (Leq)	Night Time (Leq)
Sensitive Areas and Hotel	75 dB	65 dB
Office and Commercial	85 dB	85 dB
Commercial and Service	85 dB	85 dB
Areas with ambient noise level (>65 dB)	Ambient Noise Level +10 dB	

Notes: Evaluation point is at boundary of buildings Daytime: 6:00-22:00, Night time: 22:00-6:00

Sensitive areas: residential areas, hospitals, schools, places of religious worship

a) The Contractor shall submit to the Engineer a Noise Control and Monitoring Plan (NCMP) which shall be submitted as part of the Construction Environmental Management Plan. It shall include full and comprehensive details of all powered mechanical equipment, which is proposed for use, limitations on timing of use, and proposed working methods and noise level reduction measures. The NCMP shall include calculations to demonstrate anticipated noise levels that may be generated by the Contractor. Monitoring locations shall be decided in consultation with the Engineer.

b) The NCMP shall be approved by the Engineer and shall guide the implementation of construction activity. The NCMP will be reviewed on a regular basis and updated as necessary to assure that current construction activities are addressed.

c) The Contractor is responsible for complying with the Department of Environment's Noise Control Regulation (2006), and noise emissions must be kept within the range of the ambient noise standards given in Table 2.3. In the event complaints arise, the Contractor shall monitor noise levels, and mitigate noise by insuring that housing doors of internal combustion engines are kept closed during operation, by covering compressors, pumps, generators and other stationary equipment with noise insulating fabric that does not interfere with use of the equipment, and by preventing engine idling.

d) The Contractor shall regularly maintain construction machinery and vehicles so that noise levels conform to GOB's relevant standards.

e) The Contractor shall consider noise as an environmental constraint in his design, planning and execution of the Works. The Contractor shall, at his own expense, take all appropriate measures to ensure that work carried out by the Contractor and by his sub-Contractors, whether on or off the Site, will not cause any unnecessary or excessive noise which may disturb the occupants of any nearby dwellings, schools, hospitals, or premises with similar sensitivity to noise.

f) Without prejudice to the generality of the foregoing, noise level reduction measures shall include the following:

- The Contractor shall ensure that all mechanical equipment and vehicles used in the Works shall be equipped with factory installed noise control devices, including but not limited to mufflers, shock absorbers, flywheel balancing, and elimination of friction between moving parts.
- The Contractor shall construct acoustic screens or enclosures around any parts of the Works from which excessive noise may be generated.

g) The Contractor shall ensure that noise generated by work carried out by the Contractor and his sub-Contractors during day time and night time shall not exceed the maximum permissible noise limits, as set out in Table 2.3. Variations may be granted from time to time by the Engineer. In the event noise limits are exceeded, the Contractor shall re-deploy or adjust the relevant equipment or take other appropriate measures to reduce and maintain noise levels that do not exceed prescribed limits. Such measures may include temporary or permanent cessation of use of certain items of equipment.

h) The Engineer may require the removal from the site of any equipment or plant that fails to comply with the required noise levels.

i) The Contractor will schedule and conduct operations in a manner that will minimize the disturbance to the public in areas adjacent to construction activities and to occupants of buildings in the vicinity.

2.6.9 Vibration (Project Standard)

The Project Standard Limit is 90 VdB, approximately corresponding to 3 mm/s PPV, measured at the face of the nearest building. If the standard cannot be met, the contractor will mitigate by installing cut-off trenches at depths and locations necessary to maintain this level, or by other means available to the contractor.

2.6.10 Protection of Community Values

a) The Contractor shall protect, conserve and maintain access to social and cultural properties in the project area including schools, mosques, hospitals, temples, shrines, graveyards, tourism sites and other public places.

b) The Contractor will post flagmen at intersections of transit paths for construction vehicles and local traffic, and along traffic lanes where work is in progress. Traffic detours will be clearly marked.

c) The Contractor will avoid blocking access to land, homes and businesses; where unavoidable, the Contractor will provide temporary access to affected properties and reinstate permanent access on completion of work.

d) Clear pathways will be provided for pedestrians around construction sites.

e) Work areas that are accessible to the public will be barricaded, while ensuring passage for pedestrians around the work area.

f) Buffer areas will be established around construction sites along the alignment, and barricaded to exclude waiting vehicles and rickshaws.

g) Vendors will be relocated away from, or otherwise prevented from setting up near to, construction sites.

h) Clear, visible signage will be provided to communicate risks at the point of contact and to the local community.

i) Hazardous conditions will be removed on construction sites that cannot be controlled effectively with site access restrictions.

j) The Contractor shall promptly reinstate any services and reinstall any physical facilities that are cut, disconnected or damaged during construction activities, and shall maintain or provide temporary services that are interrupted by construction. The Engineer shall inspect and certify the adequacy of all reinstated services and facilities.

2.7 Monitoring Requirements

A system of monitoring compliance with environmental mitigation measures will be agreed between the Contractor and the Project Engineer, and described in the Contractor's CEMP. The system will incorporate data obtained directly from the Contractor, air/water/noise monitoring results from an Independent Monitoring Group (IMG), the record of complaints under the Grievance Redress Mechanism (GRM, see Sec. 2.4) and the results of periodic inspections (at least quarterly) by the Engineer, data compilation, and reporting of results. The Engineer will review the Contractor's performance of the mitigation measures in these specifications. Checklists will be used to draw attention to requirements for pre-start up and the Contractor's CEMP, during the contract period, and completion stages.

Monitoring and reporting for health and safety and traffic management issues may be performed independently of monitoring of ECS requirements.

Specific aspects of monitoring and reporting will be resolved before the start of the contract package. The general arrangement of for monitoring and reporting is shown in Figure 2.1

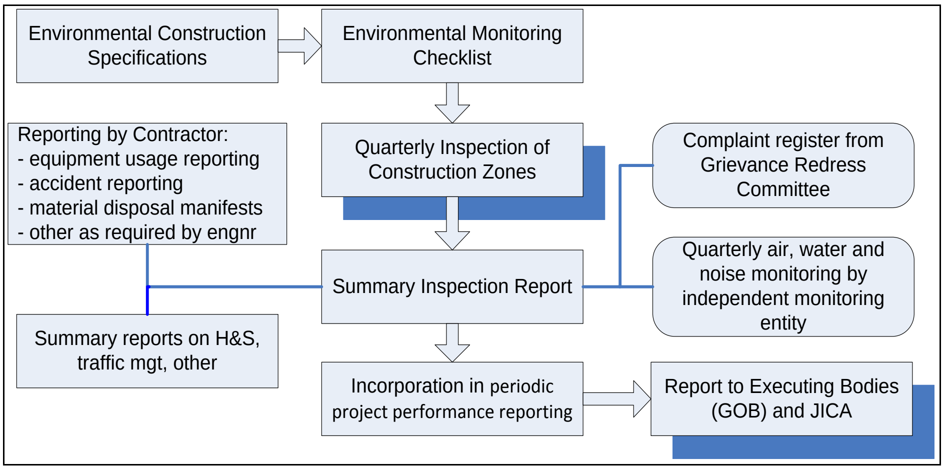


Figure 2.1: General Monitoring and Reporting Sequence

The Contractor will provide in its CEMP a plan and schedule, including locations, frequencies and parameters, for monitoring air and water quality, and noise and vibration levels, at the boundary of the site, subject to the approval of the Engineer.

2.7.1 Types of monitoring:

a) Air quality: sample air quality over two consecutive twelve hour periods and analyze for suspended particulate matter (SPM) and PM10, oxides of nitrogen (NOx), sulphur dioxide (SO2) and carbon monoxide (CO); once per quarter-annum, at sufficient downwind locations near the perimeter of work sites. An investigative program will be required of the Contractor in the event there are complaints concerning air quality from the community, which will require more frequent monitoring to determine causes.

b) Water quality: Obtain samples from drains at predetermined locations around the site each quarter-annum for measurement of Total Suspended Solids (TSS) using grab samples. More frequent monitoring will be required of the Contractor in the event there are complaints from the community.

c) Noise: obtain one minute noise level readings (dBA) for a period of one hour during typical operations; and report maximum Leq – 10 min; once per quarter-annum; at predetermined locations around the perimeter of the site.

d) The Contractor will be responsible for complying with the Department of Environment's Noise Control Regulation (2006). In the event of noise levels at the perimeter of the site exceed the DOE noise standard of 85 dBA (ECR Schedule – 5: Standards for Sound originating from Motor Vehicles or Mechanized Vessels and its amendment of 2006), the Contractor may be required to initiate more frequent monitoring or monitor at locations of sensitive receptors.

e) Vibration monitoring: The Contractor may be required to monitor vibration intensity during the conduct of the work through spot checks at building walls nearby areas during installation of piling or other vibration inducing activity.

2.8 Avoidance of Nuisance

The Contractor shall take all precautions to avoid any nuisance arising from his operations. This shall be accomplished wherever possible by suppression of nuisance at source rather than abatement of the nuisance once generated.

2.9 Environmental Audits

The Contractor shall ensure that audits of all the activities detailed in his Construction Environmental Management Plan are carried out at weekly intervals or at such intervals as the Engineer may require to ensure the continuing effectiveness and compliance with the Construction Environmental Management Plan. The Contractor shall make available on request any document, which relates to his recent internal audits.

The Engineer may audit the Contractor's implementation of the Construction Environmental Management Plan at any time, but shall be done at least quarterly. During the audit by the Engineer, the Contractor shall provide suitably qualified staff to accompany the Engineer's staff.

Milestone payments will be linked with successful execution by the Contractor of its Construction Environmental Management Plan and issuance of a Notice of No Objection or a Notice of No Objection subject to comments by the Engineer.

APPENDIX 3 EMERGENCY RESPONSE PLAN

Sources:

Metro Operations: Chapter VII of the General Rules for Operation

Metro Construction: Safety and Health Specification

<table>
<tr><td colspan="3"><u>METRO OPERATIONS</u>
Chapter VII
ACCIDENT AND UNUSUAL OCCURRENCES</td></tr>
<tr><td rowspan="2">SL. No.</td><td colspan="2">Proposed GR</td></tr>
<tr><td>Rule No.</td><td>Description</td></tr>
<tr><td>1.</td><td>49.</td><td>Report of the accident and unusual occurrences —
(1) Any accident or incident shall be reported by the Metro Railway employee concerned or any other person who notices it with utmost expediency to the Traffic Controller or the nearest Station Controller as soon as practicable.
(2) On receipt of a report under sub-rule (1), the Station Controller shall inform the Traffic Controller and vice versa.</td></tr>
<tr><td>2.</td><td>50.</td><td>Duties of Metrorail staff —
(1) On receipt of a report of an incident or accident or emergency, as the case may be, under sub-rule (1) of rule 48, the Traffic Controller shall first ascertain the extent of injury to passengers and others and take prompt action to prevent further injuries and he shall also assess the potential effect on the train services and then take all reasonable measures to maintain the train services, prevent delay or damage to property and equipment.
(2) If the incident is an emergency, the traffic controller shall report it to the Chief Controller and the Chief Controller shall arrange for the assistance of the Metro Railway emergency response staff and where necessary, arrange the assistance of the Police, fire and the Ambulance services.
(3) The Traffic Controller shall keep a log of all reports and requests received, action taken and other relevant information obtained or distributed.
(4) A Station Controller, in the event of an accident at his station, shall take measures to prevent the situation becoming worse, render first aid if possible, arrange for the injured to be hospitalised and inform the Traffic Controller for outside help, if required.
(5) If the accident is an emergency, the Station Controller shall evacuate the area concerned and take measures to prevent access to the area other than by the emergency services, and in extreme cases, the station may be closed and the Traffic Controller requested to arrange for trains to pass the station without stopping.
(6) A full record of events and actions shall be entered in the Station log and if video recording is for preservation of the clues then request traffic controller who may further inform Communication System Supervisor to save the footage.
(7) All staff of the metro railway shall deal with the accidents and emergencies expeditiously and with the following priorities—</td></tr>
</table>

		(a) save life, prevent further injury, and alleviate suffering; (b) protect the Metro Railway property and equipment; (c) take steps for preservation of clues; (d) inform the public of the effect on train services and the availability of alternative transport facilities; (e) restore the safe operation of the train services as quickly as practicable; and (f) restore normal services.
3.	51.	**(1) Train stopped between stations —** (i) If a Train Operator cannot isolate a defect on his train and is unable to move it under its own power, he shall secure the train and request the Traffic Controller for assistance; (ii) the Traffic Controller shall, if possible, instruct the Train Operator of the following train to detrain passengers at the station and then to drive as close to the stalled train as possible under Coded Manual mode/ATP upto the limit of movement authority under cab signaling; (iii) the Traffic Controller shall then instruct the Train Operator of the assisting train to change to Restricted Manual mode, and to proceed at reduced speed and stop about ten meters short of the stalled train; (iv) in case it is more convenient to provide assisting train from the leading end direction, the Traffic Controller shall instruct the Train Operator of the assisting train, to detrain the passengers at the station, to change the cab and proceed in the direction of the stalled train under Coded Manual mode/ATP as far as limit of authority under cab signaling and thereafter change to Restricted Manual mode and stop short of about ten meters of stalled train; (v) the Traffic Controller shall instruct the Train Operator of defective train to **inform the passengers about rescue operation and maintain his position in Cab** and instruct the Train Operator of the assisting train **to move with slow speed (coupling speed) as specified in special instructions** and couple to the defective train by mechanical means ; (vi) once the trains are confirmed as coupled, the Traffic Controller shall instruct the Train Operator of the defective train to release the brakes of his train; (vii) "the traffic controller shall then authorize the Train Operator of the assisting train, if in front, to once again change the cab and to drive forward in restricted Manual mode **at speed as specified in special instruction** while exchanging communication with the front cab of defective train until the assisting train has completely reached on platform of the next station"; (viii) The combined consist shall then be moved forward until the defective train has completely reached on platform and then, the passengers of the defective train shall be detrained at the station and the combined consist shall be moved to the depot; (ix) "The train operator of assisting train, if in the rear, will drive the combined consist in Restricted Manual mode at a speed **as specified**

in special instructions, while exchanging communication with the train operator of the defective train in the lead cab until defective train is at the platform of the next station;"

(x) all passengers shall be detrained from the defective train, and the combined consist shall then be moved further until the assisting train is completely on the platform;

(xi) "All passengers of assisting train shall then be detrained at the station and the combined consist worked to the depot **/nearest siding** in Restricted Manual mode at a speed **as specified in special instructions** with defective train and assisting Train Operators exchanging communication on cab to cab telephone**/train radio** particularly if being assisted from rear.

(2) (i) If traction power is lost, all trains shall coast as far as the momentum of the train and the signaling system permits. The objective is to get every train to a platform or as close to the platform as possible where passengers can be detrained if the incident is likely to be prolonged;

(ii) If traction power has not been restored within fifteen minutes, passengers shall be detrained from all trains at stations, and the process of detraining passengers from any trains stopped between stations shall be initiated after **ensuring safety precautions necessary for detraining passengers as specified in approved special instructions** as the case may be, and the Train Operator shall also take suitable measures of securing his train;

(iii) the traffic Controller shall advise the Station Controller of the adjoining station to which evacuation is planned, who shall in turn make suitable arrangement for assisting the evacuation process and, if applicable, in-train baggage tagging for identification of passenger baggage later;

(iv) after evacuation of passengers, the Traffic Controller shall take appropriate action of working the stranded trains to nearest station siding or depot using other suitable shunting vehicles.

(3) (i) If a train cannot be moved as a result of derailment or a mechanical failure, leading to possible infringement, the Train Operator of the stalled train shall switch on the flasher light, secure the train, and immediately inform the Traffic Controller advising him of any infringement on other track (if any) and possibility of injuries to passengers among other things, and also inform him that he is unable to move his train;

(ii) the traffic controller in consultation with the Train Operator shall decide the most appropriate method of evacuation, assistance needed and working of failed train cars taking into account proximity of stations, availability of trains and other local conditions and, advise the Train Operator the direction from which assistance is to be provided and inform the Station Controller at the station to which passengers shall be evacuated;

(iii) the following methods of evacuation, as the case may be, shall be followed, namely: —

(a) evacuation to a train on the same track;

(b) evacuation to a train on an adjacent track (except in twin tunnel sections);

(c) evacuation to train on adjacent track (in twin tunnels);

(d) evacuation on foot to the nearest station;

(e) evacuation by climbing down the viaduct or climbing up the evacuation shaft in tunnels;

(4) Evacuation to a train on the same track:

(a) (i) Wherever considered necessary, the traffic on the adjacent track may be stopped, as prescribed under Special Instructions;

(ii) If being assisted by an assisting train from the rear, passengers shall, if possible, be first detrained from the assisting train at station and the Traffic Controller shall instruct the Train Operator to drive in Coded Manual mode/ATP until the limit of authority under cab signaling;

(iii) the Traffic Controller shall, thereafter, instruct the Train Operator to change to Restricted Manual mode and drive at not more than twenty five kilometer per hour to stop about ten meter short from the stalled train;

(iv) if assistance from the rear is not possible, assistance may be provided from the front end direction, following similar procedure once the Train Operator has changed the cab for driving in the other direction as provided in the special instructions;

(b) the Train Operator of the assisting train shall report to the Operations Control Centre when he has reached this location and the Traffic Controller shall then instruct him to move his train slowly and stop it ten meters short of the stalled train;

(c) the Train Operator of the assisting train shall secure his train, and open the appropriate side or end door and ramps (if any), and the Train Operator of the stalled train shall open the corresponding door on his train and the two Train Operators shall assist passengers to shift from the stalled train to the assisting train and where applicable the assisting metro staff or the Train Operator of the stalled train shall also take appropriate measures for in-train baggage tagging for identification of passenger baggage later;

(d) when all passengers have been transferred, the doors and ramps(if any), of both the trains shall be closed and secured;

(e) the Train Operator of the stalled train shall remain with his train and the Train Operator of the assisting train shall move to the other cab and report to the Traffic Controller that all passengers have been transferred and that his train is ready to move;

(f) only after receiving the instructions from the Traffic Controller, the Train Operator of the assisting train shall select Restricted Manual mode and drive the train to the station from which he came where passengers can be detrained.

(5) Evacuation to a train on an adjacent track (except in twin tunnel sections):

(a) if assistance cannot easily be given by a train on the same track, a

		train on the adjacent track may be used; (b) on receipt of a request for assistance, the Traffic Controller shall inform the Station Controllers at the station on the either side of the location of the incident; (c) the Passengers may be detrained from the assisting train at a station; (d) the Traffic Controller shall instruct the Train Operator of the assisting train to select Coded Manual mode/ATP and proceed towards the stalled train in consultation with the Traffic Controller and drive his train to a point, near the stalled train; (e) the Train Operator of the assisting train shall secure his train and open the appropriate door of his train and report completion to the Traffic Controller. (f) the Traffic Controller shall then instruct the Train Operator of the stalled train to open appropriate door and ramp (if any) of his train; (g) the two Train Operators shall then supervise the transfer of passengers via the ramps or step ladders and the track from the stalled train to the assisting train taking particular care to inform passengers of the dangers of tripping on rails and other equipment, and where applicable, the assisting metro staff or the Train Operator of the stalled train shall also take appropriate measures for in-train baggage tagging for identification of passenger baggage later; (h) once all passengers have been transferred, the doors and ramps (if any), shall be secured and completion reported to the Traffic Controller by the Train Operator of the assisting train; (i) the Train Operator of the stalled train shall remain with his train; (j) the Traffic Controller shall then authorise the Train Operator of the assisting train to proceed to the next station in the normal direction of traffic, where normal service may be resumed. (6) Evacuation to train on an adjacent track (in twin tunnels): (a) In twin tunnel sections, if assistance cannot easily be given by a train on the same track, a train on the adjacent track may be used; (b) on receipt of request for assistance, the Traffic Controller shall inform the Station Controllers at the station on the either side of the location of the incident; (c) Passengers may be detrained from the assisting train at a station; (d) The Traffic Controller shall instruct the Train Operator of the assisting train to select Coded Manual mode/ATP and proceed cautiously toward the direction of stalled train as near as permissible to an appropriate Cross Passage as advised by Traffic Controller ; (e) The Train Operator of the assisting train shall secure his train and open the appropriate door and ramp (if any), of his train and report completion to the traffic controller; (f) the Traffic Controller shall then instruct the Train Operator of the stalled train to open its appropriate door and ramp (if any), as applicable, which is nearest to this Cross Passage;

		(g) the two Train Operators shall then supervise the transfer of passengers via the Cross Passage and the track from the stalled train to the assisting train taking particular care to inform passengers of the dangers of tripping on rails and other equipment, and the hazards of walking through the Cross Passage, and the two Train Operators shall ensure that all passengers have been safely transferred and accounted for. Where applicable, the assisting metro staff or the Train Operator shall also take appropriate measures for in-train baggage tagging for identification of passenger baggage later. (h) once all passengers have been transferred, the appropriate doors and ramps (if any), of assisting train shall be closed, secured and completion reported to the Traffic Controller by the Train Operator of the assisting train; (i) the Train Operator of the stalled train shall close the doors and ramps (if any), and return to his train cab; (j) the Traffic Controller shall then authorize the assisting train to select appropriate mode and proceed to the next station where normal service may be resumed. (7) Evacuation on foot to the nearest station: (a) In case of evacuation on foot, the Traffic Controller shall decide as to which station, passengers are to be evacuated which shall normally be the nearest station subject to other factors, such as the location of the trains, ventilation consideration in tunnel sections and any damage to track, train or structures which may make it desirable to use an alternative station; (b) The Traffic Controller shall inform the Station Controller at the station designated to receive the passengers and the Station Controller shall clear the platform concerned of waiting passengers and, if necessary, stop incoming passengers, open all emergency doors, manual secondary doors and platform screen doors, where provided, and he shall position himself and his security staff on the platform to receive the arriving passengers; and if a tunnel section is involved, **authorised staff or BMS controller at station or Auxiliary system controller at OCC shall switch on tunnel lighting.** (c) the Station Controller shall prepare to render assistance or first aid to any passenger who may have had difficulty or met an accident during the evacuation; (d) the Traffic Controller may arrange for traffic to be suspended on the adjacent track for the duration of the evacuation, and in case of Third Rail Traction system instruct the Traction Power Controller to switch off the Third Rail power supply and take any further measures for safety of passengers; (e) the Traffic Controller shall verify with the Train Operator that the train has been secured and then instruct him to deploy the appropriate door and ramp (if any) of the train, nearest to the designated station; (f) passengers shall be informed of the procedures to be followed and given explicit warning on tripping hazards, where to walk, or hazards of walking on the raised walkway, not to raise any object above head level, and what to expect at the station; (g) wherever applicable, the Train Operator or assisting metro staff shall take appropriate measures for in-train baggage tagging for identification of

		passenger baggage later; (h) passengers shall be de-trained on the track, or on the raised walkway, as applicable, , by the Train Operator and directed to the station and the Train Operator shall count passengers as they leave the train; (i) the Station Controller shall count the passengers as they arrive at the platform; (j) the Train Operator shall ensure that the last passenger has left the stalled train, The Train Operator shall then proceed to the designated station following the evacuation route ensuring that no passenger is left on the route; OCC/TC shall also arrange to check that there are no stray passengers on track; (k) the Train Operator and Station Controller shall check their respective count of passengers' numbers and satisfy themselves that all passengers have reached the platform and thereafter the Train Operator shall return to his train and secure the end door and ramp (if any) or the side doors, as the case may be; (l) the Station Controller shall record in the station log the details of the incident, in particular, the number of passengers detrained, and then report the statistics to the Traffic Controller. (8) Evacuation on foot by climbing down on via-duct or climbing up the evacuation shaft in tunnels: (a) If the train is near a suitable location designated for evacuation of passengers by climbing down the via-duct or climbing up the evacuation shaft in tunnels, the Train Operator of stalled train shall consult the Traffic Controller and on instructions from Traffic Controller, secure his train; (b) the Traffic Controller shall intimate the Station Controllers of concerned stations for assisting in the evacuation, who shall depute competent metro staff and security personnel at the safe evacuation point to assist the evacuation; (c) the assisting metro staff shall prepare to render assistance or first aid to any passenger who may have had difficulty or accident during the evacuation; (d) the Traffic Controller may arrange for traffic to be suspended on the adjacent track for the duration of the evacuation; (e) on the advice of the Traffic Controller, the Train Operator of stalled train shall open the appropriate door or ramp (if any) of the stalled train; (f) passengers shall be informed of the procedures to be followed and given explicit warning on tripping hazards, where to walk and not to raise any object above head level, and what to expect at the evacuation point; (g) the assisting metro staff or the Train Operator shall take appropriate measures, where applicable, for in-train baggage tagging for identification of passenger baggage later; (h) passengers shall be de-trained on the track/walkway by the Train Operator and directed to the evacuation staircase or rescue vehicle and the Train Operator shall count passengers as they leave the stalled train; (i) the passengers shall again be counted as they arrive at the safe location after evacuation by the assisting metro staff at the safe evacuation

		point; (j) the Train Operator shall ensure that all passengers have left the stalled train. OCC/TC shall arrange to get evacuation route checked to ensure that all passengers have cleared the route and there are no stray passengers on track. ; (k) the Train Operator and the assisting metro staff at the safe evacuation point or vehicle shall check their respective count of passengers' numbers and satisfy themselves that all passengers have reached the safe evacuation point or vehicle and report the same to Traffic Controller. The Train Operator shall, thereafter, secure the end door, and seek further instructions from Traffic Controller; (l) the evacuated passengers shall be brought to nearest station; (m) the concerned Station Controller shall record in the station log the details of the incident, and, in particular, the number and other details of passengers detrained, and transfer of their luggage and repeat the complete incidence details to the Traffic Controller. (9) If a train cannot be moved as a result of failure of Traction system the Train Operator shall consult the Traffic Controller who in turn shall consult the Traction Power Controller, and after ensuring that it is not possible to restore Traction power, shall arrange to cut off Traction power in the affected section and take any further measures for safety of passengers and then action, in accordance with sub-rules (5) to (8), wherever applicable, shall be taken to evacuate the passengers from the stalled train. (10) Notwithstanding, anything contained in sub-rules (1) to (9), in the case of Third Rail Traction system, the Third Rail power supply shall be 'switched off' in all cases of evacuation in which passengers are required to come on the raised walkway or the track.
4.	52.	**Train divided —** (1) If a train is stopped by an irrevocable emergency brake application and cab signaling indications are normal, the Train Operator shall examine the Train Control Monitoring System panel, or Train Integrated Management System panel, as the name given, to ascertain the cause, if indication of faults in multiple circuits affecting the whole train or rear cars of the train are present, the train shall not be moved until, it has been verified that the train is complete and coupled. (2) After the verification about complete arrival and the integrity of the train is completed under sub rule (1), the Traffic Controller may authorise the Train Operator to make appropriate isolations and proceed. If the train is not divided, but is still unable to move on its own, the train shall be worked in accordance with sub rule (1) of rule 50. (3) If the train is found to have parted, the Train Operator shall first satisfy himself that no passenger has been injured or has fallen from the train, and then - (i) the passengers shall be cleared of the open ends of the train and train re-coupled with the help of assisting staff as per special instructions, if possible, in consultation with Traffic Controller and Rolling Stock Supervisor.

		(ii) if the Train has been successfully re-coupled the train operator shall return to the leading cab, report the circumstances to the Traffic Controller and seek permission to proceed to the next station following the instructions given by the Traffic Controller. (4) The train shall be withdrawn from passenger service at the next station and worked to depot for investigation of the incident. (5) If train cannot be recoupled, the Train Operator shall inform the Traffic controller and then traffic controller shall initiate passenger evacuation on foot to the nearest station in accordance with sub-rule (7) of rule 51. (6) On completion of evacuation, the two portions of the train shall then be worked to the depot for investigation under the supervision of rolling stock engineer.
5.	53.	**Unusual occurrences —** (1) All Metro Railway employees shall be conversant with the location and use of fire alarms and firefighting equipment at their place of work. (2) All Metro Railway employees observing the smoke or fire shall raise the alarm by means of the equipment provided or by informing the Station Controller and Traffic Controller as may be most appropriate and expeditious. (3) If smoke or fire is reported on a train between stations, the Train Operator shall inform the Traffic Controller, drive his train to the next station and detrain passengers. Traction power shall then be switched off, and in overhead traction territory the pantographs of the affected train lowered, or in the third rail traction territory the current collection devices of the affected train retracted, before traction power is restored to other trains. (4) If the fire on a train or on the track causes a train to stop between the stations, passengers shall be evacuated as per the provisions specified in sub-rules (3) to (8) of rule 50, as applicable. (5) If the incident occurs in a tunnel, the Traffic Controller shall arrange with the Auxiliary Systems Controller for the ventilation system to supply fresh air to the chosen route for evacuation before authorizing detrainment of passengers. (6) If the fire alarm on a station is actuated or a verbal report is received of smoke or fire on the station, the Station Controller shall inform the Traffic Controller and then verify for himself by closed circuit television or actual inspection whether or not the alarm is genuine. (7) If smoke or fire is present, the Station Controller shall inform the Traffic Controller and arrange for passengers to be evacuated from the area concerned preventing further access and if necessary, the station may be completely evacuated and the traffic controller may be requested to arrange for trains not to stop. (8) The Traffic Controller shall inform the Chief Controller who shall arrange for the attendance and assistance of the fire fighting services and if necessary the ambulance services. (9) If a Train Operator or Station Controller observes a fire in adjacent

		premises that could affect the property of the Metro Railway he shall report the circumstances to the Traffic Controller and the Traffic Controller shall inform the Chief Controller and the Security Controller and maintain normal services unless or until a local inspection confirms that a potential danger exists.
6.	54.	**Flooding —** (1) Any Train Operator or Station Controller or the other member of the staff, who observes water accumulating on the track, shall report to the Traffic Controller giving as much detail as possible with respect to location, distance of track affected, and approximate level of water with respect to the rail. (2) The Traffic Controller shall inform all trains required to pass through the area and requests reports of the state of the water level and if the water level is below the level of rail fastenings, the Traffic controller shall instruct the Train Operator to reduce the speed of their trains to twenty five kilometer per hour when passing through the affected area. (3) If the water level rises above rail fastenings, passenger train service shall only be permitted under special instructions.
7.	55.	**Other unsafe conditions —** (1) All Metro Railway employees, and, in particular, Train Operators and Station Controllers shall keep a look out for unsafe conditions on or in the vicinity of the railway track which are as follows:- (a) damaged or dislodged fixed equipment within the railway right of way; (b) broken or buckled rails; (c) displaced or damaged overhead traction power conductors or third rail power conductors, as the case may be; (d) construction activities adjacent to the track including use of cranes which can swing within 6 metres of the track; (e) road accidents which might cause or have caused damage to bridges and viaducts; (f) road accidents which might cause or have caused vehicles or their loads to encroach on the metro railway right of way; and (g) any other obstruction on the track. (2) If the Train Operator observes any unsafe condition, he shall report to the Traffic Controller immediately so that action can be taken to minimise the effect and remove the cause. (3) In the event of an earthquake, the Traffic Controller shall instruct all trains to stop immediately and after such earthquake has subsided, the Traffic Controller may instruct each stranded Train Operator to proceed in Restricted Manual mode at walking speed after examining that the track is safe for train movement and free from obstruction up to the next station: Provided, that in such event, the normal operation of trains may be resumed if all the track and structures are examined, as per Special Instructions.

8.	56.	**Accidents —** (1) In case of accidents, arrangements for medical aid, evacuation of sick, injured passengers, access for ambulance, staff and vehicles shall be made and included as per the provisions specified in special instructions. (2) In the event of serious accident, the Chief Controller may, in consultation with senior management, declare the situation an emergency, as per the provision specified in special instructions. (3) A senior member of the management shall be appointed as an emergency officer and shall set up an emergency control either at Operations Control Centre or at the site depending on the nature of the occurrence. (4) The emergency officer shall be in over all charge of all the Metro Railway resources of staff and materials for the handling of the emergency and the coordination between the Metro Railway and external emergency agencies, such as fire, ambulance and police and utility services.

3.1 METRO CONSTRUCTION

3.1.1 Emergency Preparedness Plans

3.1.1.1 Emergency Situations

Every Contractor shall formulate an Emergency Preparedness Plan for each of his sites. These plans will address foreseeable emergencies that may arise during the construction activities. Examples of activities for which plans should be prepared include amongst other things:

a) An Accident Which Results in Death or Major Injury (Major Injury as defined in other Section)

b) A Serious Fire That Threatens Life

c) A Flush Flood or Rain Water Accumulation That Threatens Life

d) Leakage of Any Dangerous Materials or Chemicals

e) Leakage / Short Circuit of any Electrical supply

f) Major Engineering Failures such as:

- collapse of tunnels or structures
- major utility collapse
- unintended explosions
- subsidence causing damage to structures or services

3.1.1.2 An Emergency Preparedness plan should include details of the following;

a) The name, location and phone number of the Emergency Co-coordinator;

b) Designated Personnel with locations and phone numbers;

c) Details of the Emergency Response Team with locations and phone numbers;

d) Functions of the Emergency response Team;

e) The means of Escape;

f) Communication with the Emergency Services;

- Police
- Fire Services
- Ambulance and Hospital Services
- First-Aid Facilities;
- Site plans;
- Suppliers of emergency equipment such as sump pumps, lighting, craneage, pipings, discharge points, etc.

Copies of the emergency procedures and the Contractor's rescue organisation (reviewed without objection by the Employer’s Representative) should be displayed at each place of work and notice boards. This information should be reviewed and updated as often as is required, but at least once annually. Drills should be arranged to test the efficiency in mobilising the necessary personnel and equipment. These Drills should be carried out at least every three months intervals.

Regular joint exercises or mock drills between the Contractor's rescue teams and the Fire and Emergency Services should also be carried out for the major contracts.

APPENDIX 4 GREENHOUSE GASSES

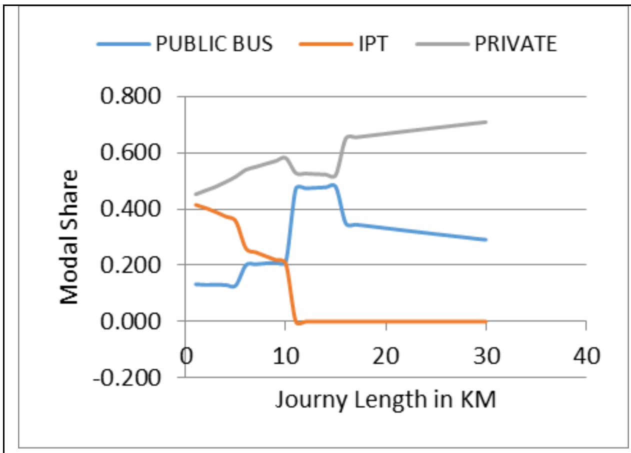
GHG Reduction Potential for Metro Line 6

Vehicle occupancy, trip length and mode share are presented in Table 1. Quotes are taken from the Transport Demand Study (NKDM)

Table 4.1 Vehicle occupancy, trip length and mode share

Vehicle Occupancy						
"The average PCUFp factor for all sites is 0.098 and the average PCUFc factor for all sites is 0.416." (Traffic demand study)						
Nos. per public vehicle	10.2	Use 20 since the lower number is skewed due to small vehicles on the road				
Nos. per private vehicle	2.4	Use 1.2 since the higher number is skewed due to private vehicles carrying multiple passengers (IPT)				
Trip length						
Trip length by car (private) is 8.08 km, by bus (public) 7.66 km, work trip length is 7.39 km and business trip length is 8.38 km are salient features.						
it is felt average trip length should be about 8 km when more residential and employment locations will be developed						
Mode share		8 km trip length				
	w/o Metro	w/ metro	Difference			
Bus & Mini	0.207	0.16	0.047	0.21		
IPT	0.232	0.179	0.053	0.23		
2 Wheeler	0	0		-		
Private vehicles	0.56	0.432	0.128	0.56		
Metro	0	0.229				
		Total/percentage	0.228	1		

Mode share with and without the project are represented by the ordinates on the trend lines shown in the following two figures (Figures 1 (baseline) and 2 (project)).



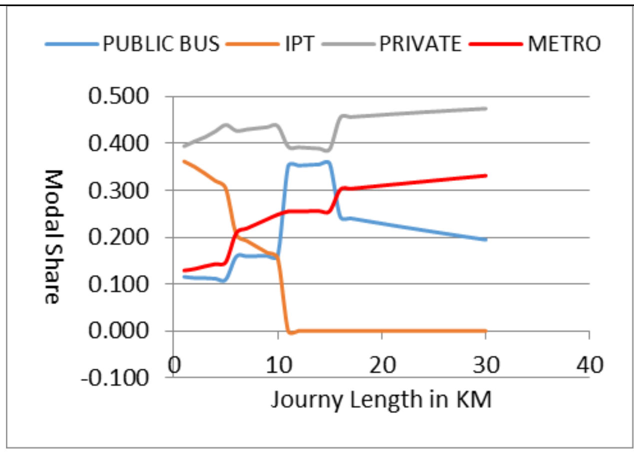


Table 4.2 Sources for vehicle emission factors and values used in calculations.

Summary of emission factors			
	gm/veh/km		
Emission factors USEPA protocol	364	car	kg/veh-mi
pb13988-emission-factor-methodology-130719 UK	134	average petrol car	
pb13988-emission-factor-methodology-130719 UK	1196	Bus (10.8 passengers * 110.7 g/passenger-km)	
DEFRA emissions factor calculator (2015)	194	average petrol car	
DEFRA from "Carbon Offset Factors" (2012)	242	average petrol car	
Use:			
Bus & Mini	1200		IPT defined as:
IPT	200		Shared Tempo
Private vehicles	242		Cycle Rickshaw

Table 4.3. Baseline emissions

#of vehicles		2021	2026	2046	2051
	Mode share				
Bus & Mini	0.21	4,978	6,010	11,680	13,520
IPT	0.23	18,710	22,589	43,902	50,820
Private vehicles	0.56	225,937	272,778	530,141	613,678
		CO2-	MT/d/veh type		
Bus & Mini		54	65	126	146
IPT		34	41	79	91
Private vehicles		492	594	1,155	1,337

	Total	580	700	1,360	1,574
total gm CO2 per day/rider		1,200.00	1,200.00	1,200.00	1,200.00

Table 4.4. Energy use in the form of direct project emissions

Energy Use			Peak				Off-peak			
<u>Traction</u>			2021	2026	2046	2051	2021	2026	2046	2051
Peak Power (MW)			18	25	32	36	10.8	15	19.2	21.6
	hrs	P.F.	MW-hr/work day				MW-hr/weekend-day (60%)			
Peak Time	5	1	90	125	160	180	54	75	96	108
Daytime	5.5	0.5	49.5	68.75	88	99	29.7	41.25	52.8	59.4
Morn/nht	7	0.25	31.5	43.75	56	63	18.9	26.25	33.6	37.8
	17.5	(sums)	171	237.5	304	342	102.6	142.5	182.4	205.2
			Daily average MW-hr/day				**151**	**210**	**269**	**302**

Table 5. Auxiliary power

<u>Auxiliary</u>	KW	Duration	hrs			KW-hr/day
Lighting	50	0.5	8.75			437.5
A/C	100	1	17.5			1750
Eqpt	150	1	17.5			2625
MWHr/day auxiliary power use (constant over the years)						4.8

Table 6 combines the above factors:

Combined power emission factor:		0.67 tCO2/MWHr			
CO2 reduction factor:	1200.0	total gm CO2 per day/rider			
		2021	2026	2046	2051
Peak power	(MW)	18	25	32	36
daily ridership		482940	583063	1133177	1311737
	%	CO2 reduction per vehicle type (tons/day)			
Vehicle Mix	Share of vehicle emissions				
Bus & Mini	9%	53.8	64.9	126.1	146.0
IPT	6%	33.7	40.7	79.0	91.5
2 Wheeler	0%	0.0	0.0	0.0	0.0
Private vehicles	85%	492.1	594.1	1154.6	1336.6
Total		579.5	699.7	1359.8	1574.1
		(MW/hr per day)			
Combined traction power input		151	210	269	303
Auxiliary Power Input		4.8	4.8	4.8	4.8
Total power input		156	215	274	308
CO2 generated (per day)		104.7	144.2	183.6	206.2
		(tons CO2 eq per day)			
Summary		2021	2026	2046	2051
Baseline Emissions		579.5	699.7	1359.8	1574.1
	Project Emissions	104.7	144.2	183.6	206.2
Emissions Reduction		474.8	555.5	1176.2	1367.9

Check project emissions					
gm CO2/PKM Metro		27	31	20	20
Check MWHr/yr		57,038	78,537	100,035	112,320
Check passenger trips/MWHr		3,090	2,710	4,135	4,263
Annual emission reduction:		tCO2eq/annum			
		2021	2026	2046	2051
		173,312	202,762	429,308	499,286

APPENDIX 5 PUBLIC CONSULTATION

Summary of Public Consultation Sessions

Two environmental public consultation meetings were held during the design phase targeting a cross-section of interest groups. Meetings were facilitated by a GC subcontractor, which supported DMTCL and NKDM staff in conducting the meetings. The first meeting was held on 23rd march 2015 at North Point, Diabari, Adjacent to the Depot area in Uttara-3rd Phase. The proceedings commenced at 3:00 pm and were presided over by the DMRTDP Project Director, Honorable Mr. Md. Mofazzel Hossain. The meeting was attended by a total of 42 people, representing government officials, non-government organizations, and local people including women, senior citizen and local school teachers.

The second public consultation meeting was held on 06th May 2015 at the Seminar Room at the Public Library located at Shahbagh, Dhaka. The proceedings commenced at 10:00 am and also were presided over by the Honorable Project Director. The meeting was attended by a total of 70 people representing the government officials, non-government organization, local people including women and senior citizen, local school teachers, and local mosque imams. Contents of the presentations, comments and questions raised during the open discussion periods, and lists of participants are provided in Appendix 4.

Presentations proceeded as follows: A representative of the GC subcontractor welcomed all the government officials and local people in the Public Consultation Meeting. The DMTC DGM for Environmental Safeguards gave a brief introduction of the proposed Metrorail project, addressing both the MRT-6 line and the Government's strategy for mass transport in Dhaka. This was followed by a presentation of the environmental impact assessment findings. The GC subcontractor presented project details along with key findings of the environmental impact assessment, and highlighted control measures incorporated into the design and recommended by the EIA in the Environmental Management Plan. A description of roles and responsibilities of the DMTCL and GC for environmental management was provided, which will be taken up during project construction and operations phases. After the presentation, the floor was opened for questions and suggestions from the attendees.

Presentation Materials (First and Second Public Consultation)

PUBLIC CONSULTATION ON ENVIRONMENTAL IMPACT

PROJECT NAME: METRO RAIL PROJECT (MRT LINE-6)
DATE: 6TH MAY 2015
ORGANIZED BY
DHAKA MASS TRANSIT COMPANY LIMITED(DMTCL)
NKDM ASSOCIATION
ENVIRONMENT QUALITY AND MANAGEMENT SYSTEM(EQMS)

1

SHORT DETAILS OF PROJECT

প্রকল্পের সংক্ষিপ্ত বিবরণ

প্রকল্পের নাম	:	ঢাকা ম্যাস র‍্যাপিড ট্রানজিট ডেভেলপমেন্ট প্রজেক্ট (DMRTDP)
প্রকল্প বাস্তবায়নকারী	:	ঢাকা পরিবহন সমন্বয় কর্তৃপক্ষ (DTCA)
মন্ত্রণালয়ের নাম	:	সড়ক পরিবহন ও মহাসড়ক বিভাগ সড়ক পরিবহন ও সেতু মন্ত্রণালয়
প্রকল্প ব্যয়	:	২১,৯৮৫.০৭ কোটি টাকা (প্রকল্প সাহায্য ১৬,৫৯৪.৫৯ কোটি টাকা জিওবি ৫,৩৯০.৪৮ কোটি টাকা)
অর্থায়ন	:	বাংলাদেশ সরকার ও Japan International Cooperation Agency (JICA)
মেট্রোরেলের দৈর্ঘ্য	:	২০.১ কিলোমিটার
অবকাঠামোর ধরণ	:	এলিভেটেড
রুট এলাইনমেন্ট	:	উত্তরা ৩য় ফেইজ-পল্লবী-রোকেয়া সরণীর পশ্চিম পাশ দিয়ে খামারবাড়ী হয়ে ফার্মগেইট-হোটেল সোনারগাঁও-শাহবাগ-টিএসসি-দোয়েল চত্বর প্রেসক্লাব-বাংলাদেশ ব্যাংক পর্যন্ত।

3

SHORT DETAILS OF PROJECT

স্টেশনের সংখ্যা	:	১৬ টি
স্টেশনের নাম	:	উত্তরা উত্তর, উত্তরা সেন্টার, উত্তরা দক্ষিণ পল্লবী, মিরপুর-১১, মিরপুর-১০, কাজীপাড়া, শেওড়াপাড়া, আগারগাঁও, বিজয় সরণী, ফার্মগেট, কারওয়ান বাজার, শাহবাগ, টিএসসি, প্রেসক্লাব এবং মতিঝিল।
যাত্রী পরিবহনের ক্ষমতা	:	প্রতি ঘন্টায় উভয় দিকে ৬০ হাজার
যাতায়াতের সময়	:	৩৭ মিনিট (উত্তরা থেকে মতিঝিল পর্যন্ত)
ট্রেনের সময়	:	৫ মিনিট (দুইটি ট্রেনের মধ্যে সময়)
মেট্রোরেলের যাত্রা শুরু	:	২০১৯ সাল
প্রকল্পের সময় কাল	:	জুলাই ২০১২-জুন ২০২৪
মেট্রোরেল পরিচালনায়	:	ঢাকা ম্যাস ট্রানজিট কোম্পানি লিমিটেড (ডিএমটিসিএল)

4

ABOUT GENERAL CONSULTANT

- **NKDM Association** has been appointed as **General consultant (GC)** of the project to carry out basic design, detail design, procurement assistance, construction supervision, operation support and management support
- **NKDM Association** consists of Nippon Koei Co. Ltd. (Japan), Nippon Koei India Pvt. Ltd., Delhi Metro Rail Corporation Ltd., Mott Macdonald Limited (UK), Mott Macdonald Pvt. Limited (India) and Development Design Consultants Ltd. (BD)

5

ABOUT ENVIRONMENTAL BASELINE SURVEY (EBS)

- **EQMS** has been appointed by **NKDM** to carry out Environmental Baseline survey
- The survey includes sampling and testing of –
  - Ground water
  - Surface water
  - Air Quality
  - Noise level
- The survey also includes Public Consultation

6

ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

- **EIA** is the tool to identify the project impact, which are then mitigated by proper Environmental Management Plan (EMP)
- An EIA for this Project was prepared in 2011 and subsequently, DOE issued Environmental Clearance Certificate (ECC)
- A design stage EIA update is now going on, which is expected to be ready by July, 2015
- The EIA will be made public and posted to website
- This consultation is part of information disclosure under EIA updating.

7

POTENTIAL ENVIRONMENTAL IMPACT

- Noise
- Vibration
- Air Quality
- Traffic Management
- Drainage and Water Quality
- Public and private Infrastructure
- Community/Employee Health and Safety
- Solid Waste and Hazardous Materials
- Groundwater
- Earthquake and Fire Risk
- Vegetation and Wildlife

8

STAGE OF IMPACT

- During Construction – when Construction activities going on
- During Operation – When trains move on the track

9

NOISE

- During Construction
  - Source
    - Construction Yard
    - Via Duct & Station Construction
    - Depot Area
  - Mitigation
    - Target: to follow Noise Act of 2006
    - Not to exceed Japanese std of 85dB at source
    - Use of less noise generating Equipment
    - Noise Barrier in the construction yard & Depot

10

NOISE

- During Operational Stage
  - Source
    - Speed, acceleration and track curvature

Mitigation

- Target: to follow 2006 Noise Act (eg., for commercial area - 70 dB)
- Use of Long Welded Track
- Speed Limit in the curve area
- (eg. Straight section 100 km/ hr, R-200m – 50 km/hr)

11

NOISE

- During Operational Stage - Cont
- Mitigation
  - Noise proof tract - Mass Spring System (MSS)(*all sections with R less than 300 m, all portion within parliament and cantonment area*)

12

NOISE

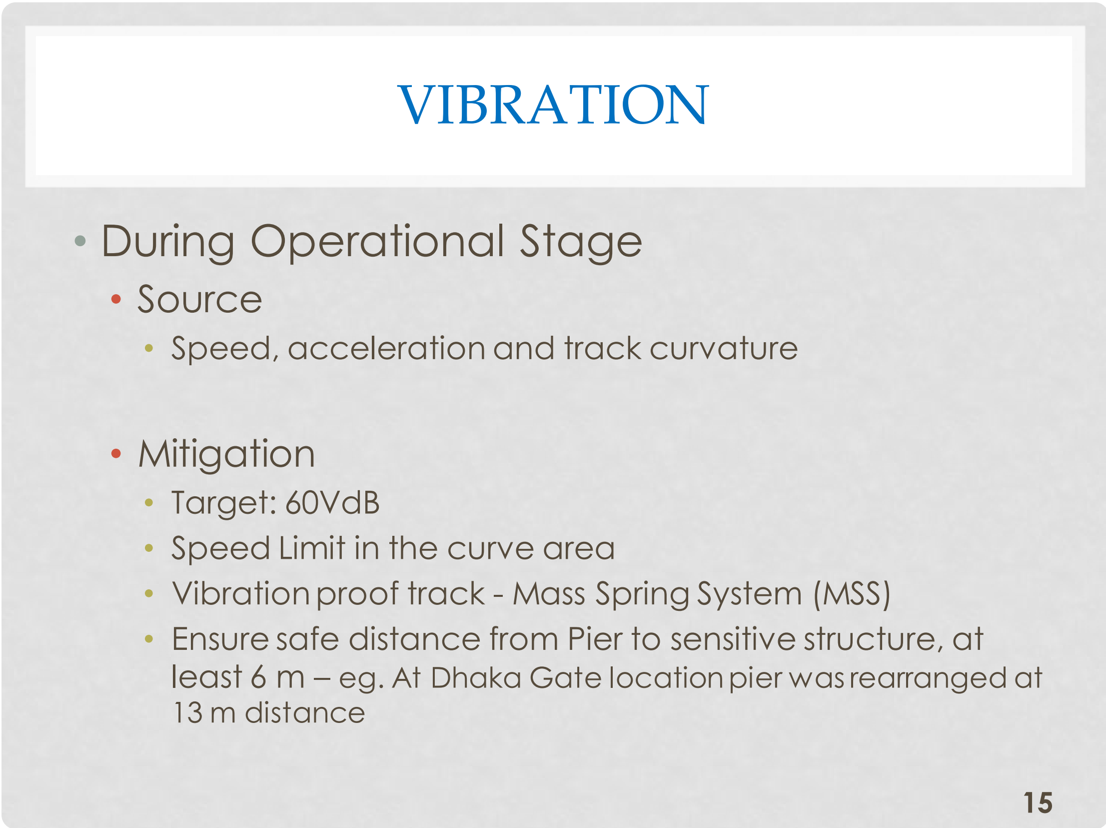
- During Operational Stage - Cont
  - Mitigation
    - Noise barrier in the Sensitive areas along the MRT line *(Hospital, school, all sections with R in between 300 & 500 m)*

13

VIBRATION

- During Construction
  - Source
    - Construction Yard
    - Depot
    - Via Duct and Station Construction along the MRT line
  - Mitigation
    - Target 90 VdB
    - Operational process of equipments
    - Mitigation measures like separation trench
    - Removal of Structure near depot – (an extreme case)

14


VIBRATION
During Operational Stage
Source
Speed, acceleration and track curvature
Mitigation
Target: 60VdB
Speed Limit in the curve area
Vibration proof track - Mass Spring System (MSS)
Ensure safe distance from Pier to sensitive structure, at least 6 m – eg. At Dhaka Gate location pier was rearranged at 13 m distance
15


AIR QUALITY
During Construction
Source
Construction yard
Via duct and station construction along the MRT ine
Depot
Mitigation
Barrier of construction yard & Depot
Water spray
Use of low emission construction equipments
During Operation
No Air Pollution Expected
16

TRAFFIC MANAGEMENT

- During Construction
  - Source
    - Via Duct and station construction along the MRT line
  - Mitigation
    - Proper Traffic management system is now under development (traffic management along route and traffic integration at the surrounding areas)
- During Operation
  - No impact Expected

17

DRAINAGE AND WATER QUALITY

- During Construction
  - Source
    - On site drainage at construction yards;
    - temporarily flooding during heavy rains;
    - Construction barricades ;
  - Mitigation
    - Proper Drainage Plan with silt trap
    - Fabrication/casting yards and material storage areas should be established on well drained area with silt trap;
    - Free-flowing points of discharge for storm water;
- During Operation
  - No impact Expected

18

PUBLIC & PRIVATE INFRASTRUCTURE

- During Construction
  - Source
    - No impact Expected
- During Operation
    - No impact Expected

Project Planning and Design was carried out avoiding public & Private structure including Common properties

(*Depot land allocated from RAJUK, design modification to avoid land acquisition*)

19

COMMUNITY/EMPLOYEE HEALTH AND SAFETY

- During Construction
  - Source
    - Construction activities can cause Health and Safety issues.
  - Mitigation
    - Proper HS manual will be prepared and implemented during construction
- During Operation
    - No impact Expected

20

SOLID WASTE AND HAZARDOUS MATERIALS

- During Construction
  - Source
    - Solid wastes and hazardous materials will be generated by construction activity.
    - Debris will need to be removed .
  - Mitigation
    - Proper Solid Waste disposal and Management by Contractor
- During Operation
  - No impact Expected

21

GROUND WATER

- During Construction
  - Source
    - Construction activity might affect Groundwater at Construction yard and depot
  - Mitigation
    - Proper Management will be taken care
  - During Operation
    - No impact Expected

22

EARTHQUAKE RISK

- Design: Earthquake risk has been addressed in the design of structures as per Bangladesh National Building Code (BNBC).

23

FIRE RISK

- Source
  - Train
  - Stations
  - Surrounding Buildings near to stations
- Mitigation
  - Self Sufficient fire protection measures at stations
  - Egress (fire exit) Facilities from the train
  - Station location has been modified confirming fire protection of surrounding buildings (*eg. Kazipara station shifted 30 m*)

24

VEGETATION AND WILDLIFE

- During Construction
  - Source
    - Trees need to be removed
  - Mitigation
    - Tree plantation in depot, road median & another area
- During Operation
    - No impact Expected

25

THANK YOU

QUESTION/ SUGGESTION ON ENVIRONMENTAL IMPACT

26

1. Presentation Materials (Second Public Consultation only)

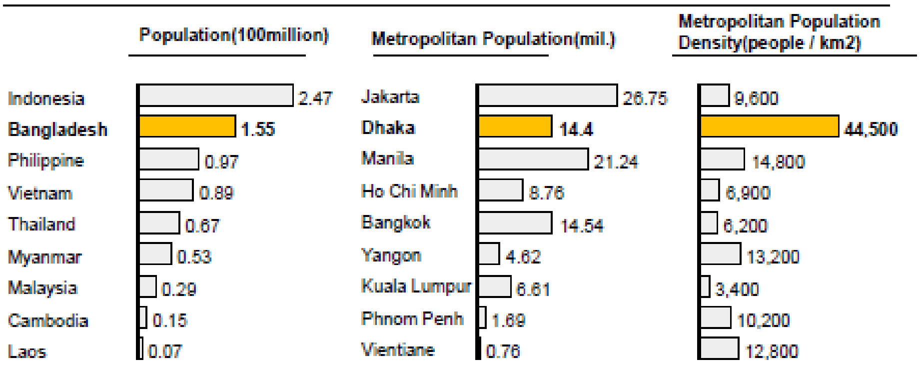
Consultancy Services for Design, Construction Supervision, Procurement Support and Management of Dhaka Mass Rapid Transit Development Project

Project Outline

NKDM Association
(Nippon Koei Japan-NK India-DMRC India-MOTT UK-MOTT India-DDC Bangladesh)

Need for Mass Transit in Dhaka

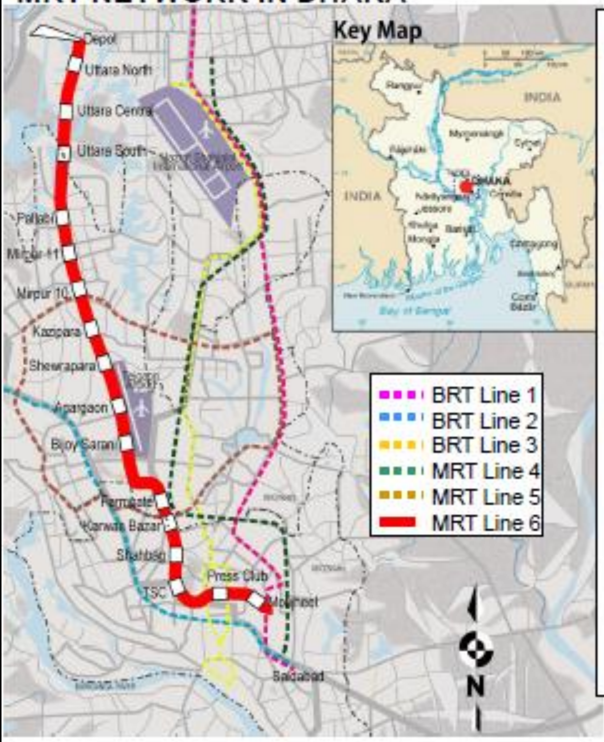
Population and Population Density of ASEAN and Adjacent Countries



Source: World Bank, Demographia

1

MRT NETWORK IN DHAKA



Project Time-Line

- In 2005, Dhaka Transport Coordination Authority (DTCA), formulated a **"Strategic Transportation Plan (STP)"** in cooperation with the World Bank.
- In 2008, Japan International Cooperation Agency (JICA) implemented the **Dhaka Urban Traffic Project Formulation Study (DHUTS 1).**
- JICA has conducted a feasibility study on the MRT Line 6 in 2010-2011 **(DHUTS2)**
- Feb. 2013, the first phase **loan agreement (L/A)** has been agreed between the GOJ and GOB.
- In June. 2013, **DMTC** has been formed.
- In Nov 2013, the **General Consulting (GC) Services** are contracted.
- In Feb 2014, the **General Consulting (GC) Services** commences the service.

2

Key Information of the Project

Project Name	Dhaka Mass Rapid Transit Development Project (DMRTDP)
Implementing Agency	Dhaka Mass Transit Company Limited (DMTCL)
Approval by ECNEC	18/12/2012
Loan Agreement with JICA	20/02/2013
Project Cost (as DPP)	Total 21,985 cr JICA: 16,595 cr GOB: 5,390 cr
Project Duration (as DPP)	July 2012 – June 2024
GC Service Agreement	19/11/2013
GC Service Started	25/02/2014

This is one of the FAST TRACK PRIORITY Project of the Government

3

SALIENT FEATURES OF DHAKA METRORAIL (1/3)

	items	Specifications
General	Gauge	1,435 mm (standard gauge)
	Length	20km x double tracks (all elevated)
	No. of Stations	16 stations (all elevated)
Demand Forecast	Daily Ridership	483,000 pax/day (in 2021), 583,000 pax/day (in 2026), 1.3 million (2051)
	Peak Hour Peak Directional Traffic (PHPDT)	22,530(in 2021), 25,560 (in 2026), 60,979 (2051)
Train Operation	Headways (peak time)	4.5min. (2021), 4min.(2026)
	Train Compositions	6 cars (4 motorized 2 trailer) (24 train sets)
	Maximum Speed	100 km/h
	Travel time (Motijheel to Uttara North)	About 37 min.
	Protection	Moving block (CBTC) with Automatic Train Operation (ATO)
Depot	Depot	North of Uttara North sta.

4

SALIENT FEATURES OF DHAKA METRORAIL (2/3)

	Item	Specifications
Structures	Main Track	PC Box Girder (for standard section)
	Station	Portal Frame Structure (Main track Girder + Rigid Frame for Station)
	Design Standard	Japanese Design Standards for Railway Structures(Viaduct), Bangladesh Design Code(Station)
Traction System	Type	Overhead Catenary
	Power	Electric, DC 1500 V
Rolling Stock	Car body Material	Stainless Steel or Aluminum Alloy
	Rolling Stock Gauge	3000mm
	Seating	Long seat, 2 wheelchair spaces per train
	Door	4 doors/car each side, W: 1.3 m, H: 1.85 m
	Air conditioning	Yes, 24C
	Carrying capacity	1,738 at 180% congestion
Fare Collection	Automatic Fare Collection (AFC)	Contact less IC ticket

5

SALIENT FEATURES OF DHAKA METRORAIL (3/3)

	Item	Specifications
Stations	Platform Legth	170 m
	Protection	Platform Screen Door (PSD): Half Height
	Elevators	From Ground level and from Concourse level
	Escalators	From Concourse level only
Safety/ Environment	Fire	Sprinklers and Hydrants
	Evacuation	System Planned
	Noise	Noise barrier and MSS system, where required
	Vibration	Vibration proof track where required
	Safety code	Japanese Standard
	Rescue Operation	System Planned

6

DEPOT LAYOUT

7

Image of Perspective (Elevated Station)

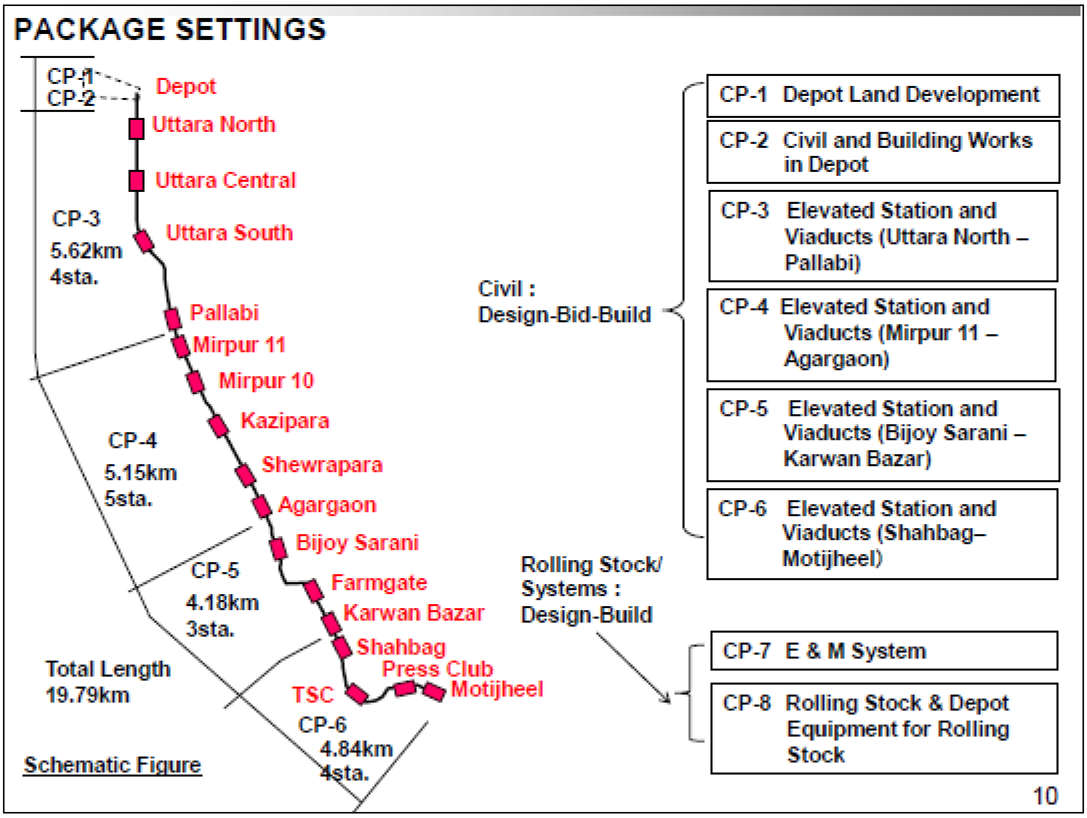
Not finalized yet

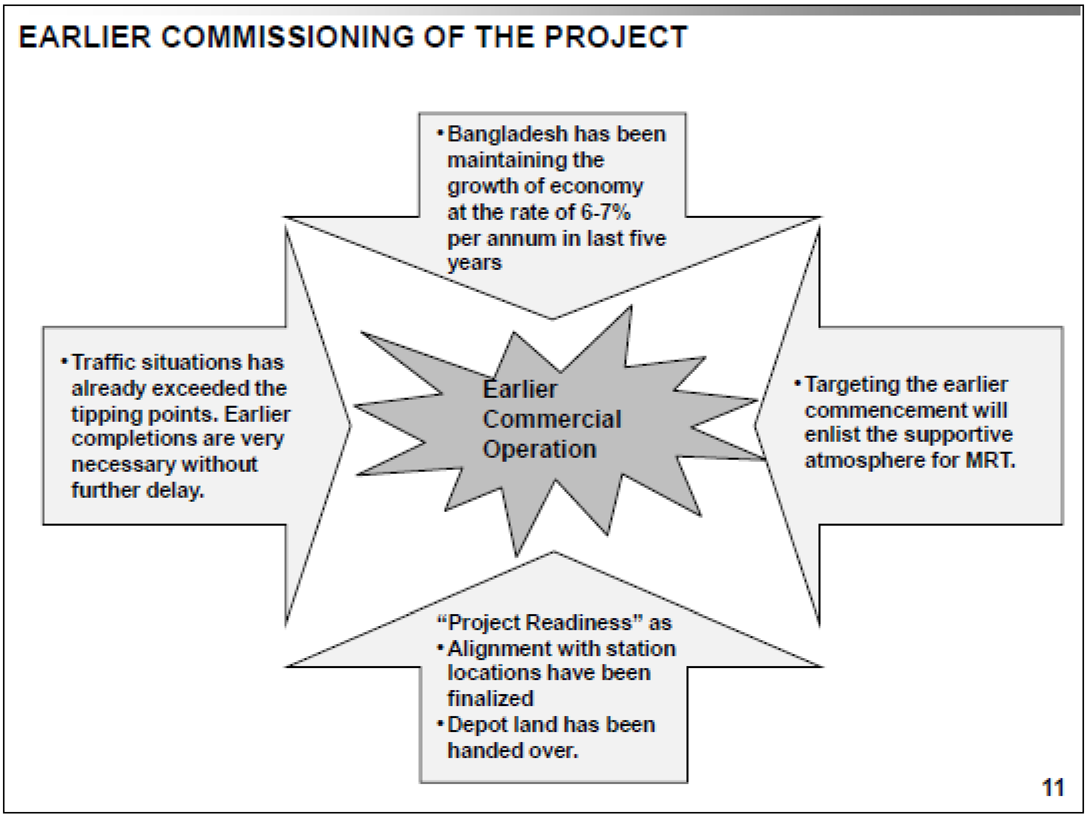
8

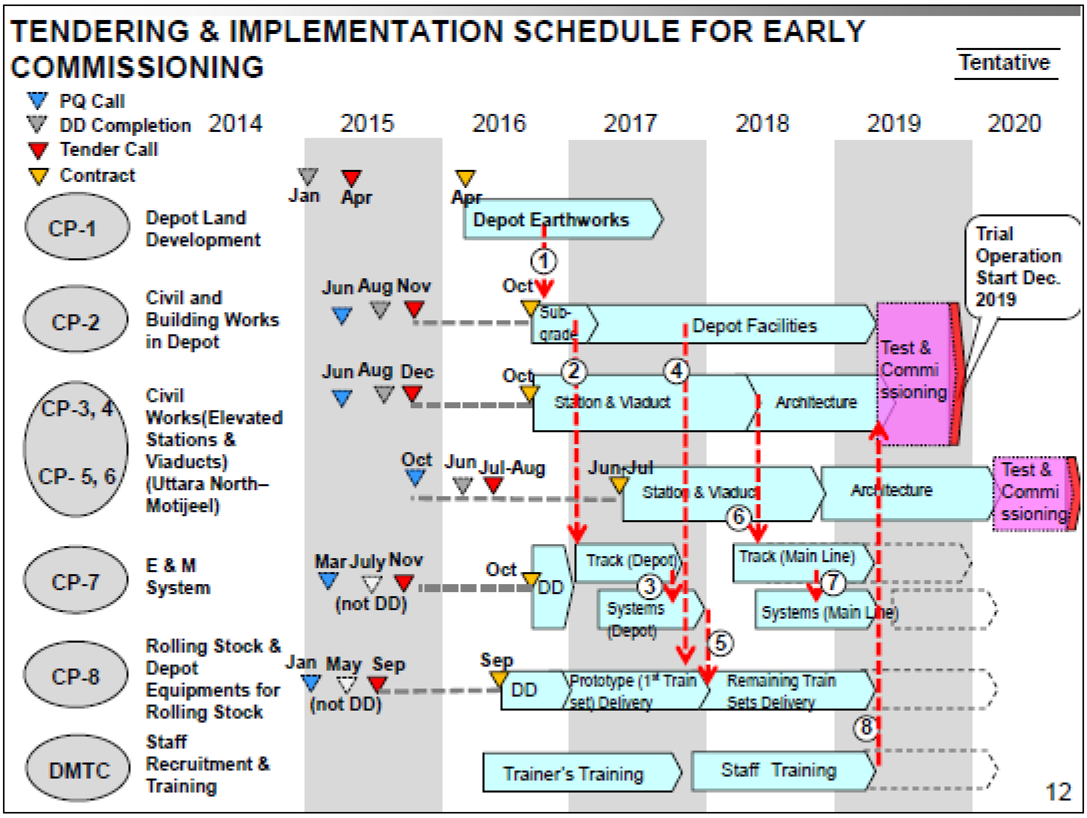
Station and Viaduct Image (Uttara South Sta. and Station Plaza)

Not finalized yet

9


PACKAGE SETTINGS
CP-1
CP-2
Depot
Uttara North
Uttara Central
Uttara South
CP-3
5.62km
4sta.
Pallabi
Mirpur 11
Mirpur 10
Kazipara
CP-4
5.15km
5sta.
Shewrapara
Agargaon
Bijoy Sarani
CP-5
4.18km
3sta.
Farmgate
Karwan Bazar
Shahbag
Press Club
TSC
Motijheel
CP-6
4.84km
4sta.
Total Length
19.79km
Schematic Figure
Civil :
Design-Bid-Build
Rolling Stock/
Systems :
Design-Build
CP-1 Depot Land Development
CP-2 Civil and Building Works in Depot
CP-3 Elevated Station and Viaducts (Uttara North – Pallabi)
CP-4 Elevated Station and Viaducts (Mirpur 11 – Agargaon)
CP-5 Elevated Station and Viaducts (Bijoy Sarani – Karwan Bazar)
CP-6 Elevated Station and Viaducts (Shahbag–Motijheel)
CP-7 E & M System
CP-8 Rolling Stock & Depot Equipment for Rolling Stock
10


EARLIER COMMISSIONING OF THE PROJECT
• Bangladesh has been maintaining the growth of economy at the rate of 6-7% per annum in last five years
• Traffic situations has already exceeded the tipping points. Earlier completions are very necessary without further delay.
Earlier Commercial Operation
• Targeting the earlier commencement will enlist the supportive atmosphere for MRT.
“Project Readiness” as
• Alignment with station locations have been finalized
• Depot land has been handed over.
11



Field Surveys carried out by GC

Survey Items	Expected Completion
Topographic Survey Basic Re measurement	 Completed June 2015
Traffic Survey	Completed
Geotechnical Survey Field Laboratory	 May 2015 August 2015
Right Of Way (ROW) Survey	May 2015
Historical Importance/ Archeological (HIA) Survey	May 2015
Environmental Baseline (EBL) Survey	June 2015
Utility Verification Survey	Dec 2015

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THANK YOU
NKDM
NKDM Association
(Nippon Koei Japan-NK India-DMRC India-MOTT UK-MOTT India-DDC Bangladesh)
14

First Public Consultation

Results of Open Discussion

Sl	Name	Address	Comment/Questions	Response
1.	M.d Abdul Hamid	Project Engg. Milestone College.	There is a college campus beside the Depot area. Lots of students doing classes regularly in the campus. Noise and vibration during construction will be a possible interruption of the study during campus hour. So is there any chance to consider the location?	**Md. Mofazzel Hossain, PD** For noise & Vibration prevention we will use proper equipment. A proper management will be taken for decreasing noise & vibration.
2.	Akhter Mahmud	Jahangirnagar University	• EIA presentation need to be more elaborate on Design issue. • What will be the mitigation plan for Historical site like national parliament? • How do you assure Public safety and technical support at TSC, Farmgate and all other critical area? • There is many way for public participation, most less is putting information on website.	**Dr. Nurul Islam, NKDM** This is just a preliminary public consultation as a part of EIA preparation. EIA report will be uploaded to BMTCL website for any public comments. NKDM is currently doing Historical assessment survey and after getting preliminary result, some changes has been incorporate in the design. A compromised has been done in design about Farmgate area to make sure less impact. Bangladesh Govt. also considers the selected spot inside the national parliament.

Sl	Name	Address	Comment/Questions	Response
3.	Mosharrof Hossain	Local businessman	• Will this project take any land? • Now a day's some survey work going on, what is the output of the survey?	**Md. Mofazzel Hossain** There will be no Land accusation for this project. They were there for surveying houses of the depot surrounding areas for basement condition analysis.
4.	Md. Sharifur Rahman	WASA	During construction lots of people may get affected. Problems get increased in rainy day. What is the prevention step for this problem?	**Md. Mofazzel Hossain** Everything is precast. So there will be no problem during construction.
5.	Md. Shahiduzzaman	PR Officer	• Most of the people will travel from Uttara to Motijhil. So is there any parking station in the three station of Uttara? • Can we touch Mohakhali from Farmgate?	**Md. Mofazzel Hossain** Huge discussion is going on. We may not be able to follow the foreign country's design but there will be a parking in main road or may be some alternative.
				Md. Mofazzel Hossain We are following the STP strictly. There is a plan connecting east-west for MRT Project. Everything is in planning considering traffic system of Dhaka.
6.	Aftar Mahmud	Nongovernmental organization	• Who are doing traffic management work? • Can be there any management training	**Dr. Nurul Islam**

Sl	Name	Address	Comment/Questions	Response
			program during construction time?	Study is going on regarding supporting route during construction phase.
7.	Ali Ahmed	Local Residence	• Is there any issue to take their house for acquisition? • Do they get chance to work during construction stage?	**Dr. Nurul Islam** No plan for acquisition and requisition for the project. It will be incorporate in the EIA report.
8.	Mohammad Idris	Local residence	• There is a possibility of vibration and noise during operation of the Metro Rail. So they will be affected.	**Dr. Nurul Islam** During construction, appropriate measure will be taken to remedy noise and vibration impact.
9.	Krishna Kanta Biswas	DGM (Environment and Rehabilitation) DMRTDP	• We are very much committed to do the project in a environmental friendly process. • DMTCL will committed to do the 1st phase by 2019.	-

Attendance

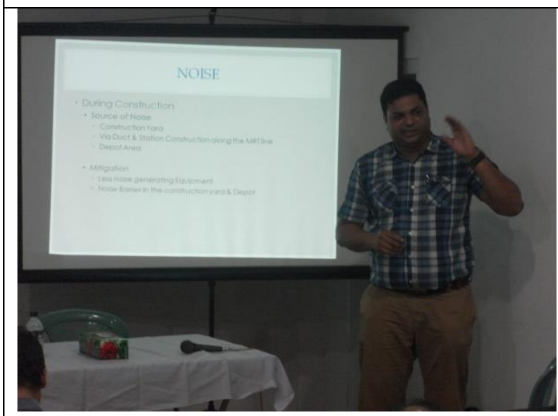
List of Participants

Name/নাম	Occupation/ পেশা	Address/ঠিকানা	Mobile No/ মোবাইল নম্বর
Md. Mofazzel Hossain	PD, DMRTDP		01711117880
Krishna Kanta Biswas	DGM (Environment & Rehabilitation) DMRTDP	Probashi Kalyan Bhaban Eskaton Road	01715241330
Nurul Islam	Eng.	NKDM	0171312144
Md. Saifulla Dostogir	RS, DMRTDP	DMRTDP	01713349715
Prof. Dr.Akter Mahmud	GS,BIP	Sector 11, Uttara	01717001010
Asm Shofiuzzaman	Business	North point, uttora	01713035080
Maj (rtd) Obaidul Haq	Asst.Dir.Proj. manager	Diabari	01716877818
Md. Islamia Hossain	Asst. project manager	Milestone college	01819160804
Md. Kamaruzzaman	Business	North point	01711354658
Md. Abdul Hamid	Project Engg.	Milestone College	01712235218
Aftab Mahmud	P&G	NKDM	01713140062
Md. Abdul Hashem	Admin Officer	UAMCH Uttara	01814291601
Kiron			
A.J.M. Alamgir	NKDM	3/1 Shah alibag	01552391712
Md.Shariful Rahman	Service	Zone-9 Dhaka WASA	01711849782
Md. Abdul Kashem	Business	Diabari, Turag, Dhaka	01819184106
S.K. Faruk	Service		01624722658

Name/নাম	Occupation/ পেশা	Address/ঠিকানা	Mobile No/ মোবাইল নম্বর
Md. Jaman Ahmed	Business	Diabari,Turag,Dhaka	01674186422
Niger Sultana	NKDM Jr.Engg.	Uttara	01552392317
Mukut	Job	Mohakhali	01714069177
Fakhrul Islam	Business	Uttara	01851015367
Md. Abu Bokor	Business	Uttara (Local)	
Khokon	Business	Uttara (Local)	
Ibrahim	Business	Uttara (Local)	
Motiur Rahman	Guard	Uttara (Local)	01785012618
Md. Shahiduzzaman	PR Officer NKDM Association	Gulshan Dhaka	01710359029
Touqi Tahmed	Assistant Consultant	EQMS	0170171269
Rofiul Karim	Assistant Consultant	EQMS	01711383496
Tonmoy Lahiry	Assistant Consultant	EQMS	01723406813
Shohid			01911331358
Moniruzzaman	Business	Uttara	01712601190
Kazi Rashadul Islam	Assistant Consultant	EQMS	01917876590
Rubel	Assistant Consultant	EQMS	01728148077
Ali Ahmed	Businessman	Local	01756048132
Jafar Mondol		Local	
Md. Idris	Businessman	Local	
Abu Sayed Ahmed	Businessman		

Name/নাম	Occupation/ পেশা	Address/ঠিকানা	Mobile No/ মোবাইল নম্বর
Abul Kashem	Businessman	Local	01811383496
Ahmed Khan	Job	Local	01916528910
Tawhidul Hasan	Consultant	EQMS	01721346853

Photographs



Second Public Consultation

Results of Open Discussion

Sl no	Name	Occupation	Comment/Question	Answer and Policy of Counter-measure
01.	Srikanta Roy	BSMMU	There will be a station between the BSMMU and BIRDEM hospital so there will be too much public rush then the Hospitals will be affected. We have future plan to extend Hospital building of BSMMU if there is a station built here then we will face a lot of problem to build Hospital due to extra public rush. In year 2010 everyday about 1200 to 1300 patient visited our Hospital but today about 4000 patients visits our hospital every day, so if possible then build the station near the Museum.	Due to the station your Hospital will be most benefitted because we have plan to connect the exit of the Station to the Hospital. The station which will be situated here will carry 80% of your patients of both the Hospitals, so you will be the most benefitted here, we also have plan to build sidewalk for both the hospitals, which only patients of the Hospitals will use. We will have a brief discussion with both the hospital Representatives in the future about all the details and plan. We will try our best to build a metro Rail which will be Environment friendly and passenger friendly.
02.	Iqbal Habib	BAPA (Architect/ Activist)	There is no information about the Floral, Faunal species in the EIA report. There should have been information about the Geographical Impact Assessment and Urban Impact Assessment. We had previous discussion about changing the existing route of Metro rail with the Prime Minister and Air Force but the route has not been changed. According to the existing road the Metro rail will pass through Sangshad Bhaban which will destroy the beauty of this National Heritage and	We will not be able to give the answer to your entire question. We will give the EIA report about the suitable route. We are doing separate report of Historical and Archeological survey. We will see to that the surroundings are matched with the route. We will build solar panels at the roof top of the stations and also vegetation facility in the Dipo area to keep it Eco friendly. We will also imply landscaping facility to save Floral

Sl no	Name	Occupation	Comment/Question	Answer and Policy of Counter-measure
			also it will destroy many existing trees in the area. The Metro rail will also pass through the Park in farmgate, it will also destroy the existing Park and the trees in the Park. The Depo which will be constructed in Uttara Phase-III will create a problem in the land, as it is a wetland which is not suitable for construction. Because of the Depo we will face a lot of problem in the future for other construction work, because it will harm the land. If you do not disclose these important measures to the public then the project will not be Environment friendly. You should give all this information in the EIA report briefly also ensure traffic management measure.	and Faunal species.
03.	Masud Iqbal Shamim	Government Officer(DOE)	EIA report does not have detailed information. As the project is in City there will be less Bio logical Impact than Social Impact but the information about Social Impact is very less. There should be a detailed social Impact report with the EIA report or separately. There is no information about the soil which is needed for the land development of the DIPO. There is no information about the drainage pattern in the DIPO area whether it will create	A separate Social impact assessment report is being made. There is information about the Drainage system in the report given to you. As the Dipo area in Uttara Phase-III is a wet land we will need a special type of sand but we have not yet decided the exact origin of the sand as it is special. We have not yet thought about the traffic Management problem during the operation stage but we are working on it.

Sl no	Name	Occupation	Comment/Question	Answer and Policy of Counter-measure
			problem to the existing drainage system. There is no information about the Traffic management problem in the EIA report which will take place during the Construction stage and Operational stage.	
04.	Kazi Kamrul Hasan	Environmental specialist (CEGIS)	The presentation is too general there is not much information about the DIPO and stations. There should have been specific analysis and information in the report location wise. What will happen to the existing over bridge / Foot over bridge in the route?	The Route of Metro rail will be over the Over bridge / Foot over bridge. The route will be 30 ft high from the ground level so it will not affect the existing over bridge / Foot over bridge. There will be another report with specific analysis and information location wise.
05.	MD. Ruhul Amin	Dhaka WASA	Due to Metro Rail there should not be any problem in the water line system in the route. During the construction of Hanif Fly over one of our water line got damaged in the area which caused many problems to the people living there. If any problem occurs during the construction of Metro rail then there will be too much problem, so you have to be concerned and cautious about this matter. You have to be concerned about the traffic hazard during the construction. You should do a Utility survey about the existing drainage system in the route.	For doing the Utility survey of the existing drainage system we have already taken the entire map from all the utility institution. We will take necessary measure for the Traffic hazard and the drainage system.

Sl no	Name	Occupation	Comment/Question	Answer and Policy of Counter-measure
06.	MD. Locman Hossain	Shahbag Flower market Association	During the construction of Fly over many waste materials were dumped in the road due to which we were badly affected, take necessary measure for this waste materials during the construction of Metro Rail. During rainy season one road is constructed 4-5 times constantly due to which we are badly affected. We welcome this Metro Rail Project humbly but see to it we do not get affected by it. We will provide all the help we can give but take care of our business see to it that the construction does not harm our business or we do not loss our flower shops which are our only mean of livelihood. We request you to take necessary measure for the problems stated above.	We will take special consideration for this matter. We will take necessary measure for the protection of your flower shops.
07.	Sadik Rahman	Vice President (Shahbag Flower market Association)	Take necessary measure for the protection of our shops near the project. We will provide all the help we can give but take care of our business see to it that the construction does not harm our business or we do not loss our Flower shops which are our only mean of livelihood.	We will take special consideration for this matter. We will take necessary measure for the protection of your flower shops.

Attendance

List of Participants – Second Public Consultation

Sl no	Group	Name	Designation/Address
1.	DMRTDP	Md. Mofazzel Hossain	Project Director
2.	DMRTDP	Md. Mahbubul Alam	Assistant Project Director
3.	DTCA	Md. Gulzar Hossain	Executive Director
4.	DMRTDP	Md. Nurul Amin	Director(Finance & Admin)
5.	NKDM	Dr.Nurul Islam	Safeguard Expert,NKDM
6.	NKDM	A.S.M. Alamgir	Environmental Expert
7.	CCDB	Sarker Muhammad Ramzan Ali	88 Senpara,Mirpur,Dhaka
8.	DMRTD	Khan Md.Mizanul Islam	Manager & Legal Advisor, Probashi Kallayan vaban,Eskaton
9.	Dept. of Environment	Masud AL Md Shamim	Govt. Officer
10.	Dept. of geography & Environment, University of Dhaka.	Md.Anear Hossain	Teacher
11.	Dept. of geography & Env. Univercity of Dhaka	Dr.Fatima Akter	Teacher
12.	Vice principal T & T University collage,Dhaka	Amir Mohd. Zakaria	Service
13.	Mohona TV	Shaik Omi Rahdur	Producer
14.	Ideal School And College ,Motijhiel.Dhaka	MD.Wazed Ali	Teacher
15.	Asst. Racehorses Officer	Sultana Afrose	Shushilan
16.	BGMEA	Monowar Hossain	Service

17.	BAPA	Iqbal Habib	Architect/Activities
18.	Join Secretary BAPA	Mihir Biswas	Environmental Actives
19.	Fire Service & Civil Defense	Rabiul Islam	Service Holder
20.	BSMMU	Srikanta Roy	Service (CB)
21.	DMRTDP	MD. Saidur Rahim	Govt. Service
22.	DGM (E&R) DMRTDP	Krishna Kanta Biswas	Govt. Service
23.	Notor Dame college	Somer B Caetee	Service
24.	PWD	Md Tomizuddin	15, Abdurgoni Road.
25.	Dhaka Medical college	Dr. Mokddam	Safeguard expert
26.	NKDM	Jceegluies Letecer	Social
27.	SE Dhaka WASA	MD. Ruhul Amin	Service
28.	B.R.P.D.K	MD. Misu Hoque	Reporter
29.	Bangladesh Bank	Kazi Mahabub Alom	Service
30.	Civil Engr.	Engr.Sirazul Islam	Mir akther connotation 35/1,Zigatola ,Dhaka.
31.	Business	MD.Lokman	Flower Shop .Shabaugh
32.	Business	MD.Abdul Kalam	Flower Shop .Shabaugh
33.	Business	Gazi Nazem	Flower Shop .Shabaugh
34.	Business	MD.Saidur Rohman	Flower Shop .Shabaugh
35.	Business	Mrs.Rokea	Flower Shop .Shabaugh
36.	Business	Pintu	Flower Shop .Shabaugh
37.	Business	Amzad Hosain	Flower Shop .Shabaugh
38.	Business	MD. Dolar	Flower Shop .Shabaugh

39.	Business	Mrs.Shakina	Flower Shop .Shabaugh
40.	Business	Mr.Sobur Uddin	Flower Shop .Shabaugh
41.	Business	MD. Khalal	Flower Shop .Shabaugh
42	Business(Local People)	MD.Hosen	Flower Shop .Shabaugh
43.	Business(Local People)	Ashikur	Flower Shop .Shabaugh
44.	Business(Local People)	Subas	Flower Shop .Shabaugh
45.	Business(Local People)	Babu	Flower Shop .Shabaugh
46.	Business(Local People)	Jewel	Flower Shop .Shabaugh
47.	Business(Local People)	Shovon	Flower Shop .Shabaugh
48.	Business(Local People)	Farid Ahmade	Flower Shop .Shabaugh
49.	Top Layer Company Ltd.(Local People)	MD. Idris Ali shah	Business(Local People)
50.	Business(Local People)	Md Monir Hossain	Fresh Flower.Shabaugh
51.	Business(Local People)	MD. Babul Hossain	Flower Shop .Shabaugh
52.	Business(Local People)	MD.Khokon	Flower Shop .Shabaugh
53.	Business(Local People)	Saiful Islam Ripon	Shahabaugh
54.	Business(Local People)	Md.Rumman	Flower Shop .Shabaugh
55.	Student (Local People)	Zubayer Ahmad	Dhaka college
56.	Student	Farhana Sharmin	Azimpur,Dhaka
57.	Student	MD.Sohel Rana	Khilkhet
58.	Student	MD.Farhod	Dhanmondi
59.	Service	Farhana Najnin	8/B,R#29,Gulshan-1
60.	Service	MD. Samsul Haque	203/3 Nowabpur,Dhaka

61.	Service	MD. Rabiul Islam	Nowabpur Road,Dhaka
62.	Service	MD.Selim	Dhanmondi
63.	NILL	Somir	NILL
64.	EQMS	Kazi Farhed Iqubal	Executive Director
65.	EQMS	Tonmoy Lehiry	Service
66.	EQMS	Tofazzal Hossain (Rubel)	Service
67.	EQMS	Rofiul Islam	Service
68.	EQMS	Kazi Rashadul Islam	Service
69.	EQMS	Touqi Tahmed Rahman	Service
70.	EQMS	Engr.Monzurul Islam (Rizvi)	Service

Photographs

Photo 1:Participants in the Meeting

Photo 2: Participants in the Meeting

Photo 3: Participants in the Meeting

Photo 4: Participants in the Meeting

Photo 5: Participants in the Meeting

Photo 6: Participants in the Meeting

Photo 7:Masud Iqbal Shamim(DOE)

Photo 8:Kazi Kamrul Hasan(CEGIS)

	
Photo 9:Iqbal Habib(BAPA)	Photo 10:Krishna Kanta Bishwas(NKDM)
	
Photo 11:Md. Ruhul Amin(WASA)	Photo 12:Dr.Nurul Islam(NKDM)
	
Photo 13:Md.Mofazzel Hossain(DMRTDP)	Photo 14: Md. Ruhul Amin(WASA)

NKDM Association

Nippon Koei Co. Ltd.
Nippon Koei India Pvt. Ltd.
Delhi Metro Rail Corporation Ltd.

Mott MacDonald Ltd.
Mott MacDonald Pvt. Ltd.
Development Design Consultants Ltd.