PEOPLE'S REPUBLIC OF BANGLADESH
Dhaka Mass Transit Company Limited

Updating of the Environmental Impact Assessment (EIA) Report for Dhaka Mass Rapid Transit Development Project (Line 5): Northern Route

Final Report

October 2022

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- Nippon Koei Bangladesh Ltd.

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www.dmtcl.gov.bd

PREFACE

Dhaka Mass Transit Company Ltd (DMTCL) is now implementing Dhaka Metro Rail MRT Line 5: Northern Route Project. An Environmental Impact Assessment (EIA) report of the Project was prepared in 2017 under the Feasibility Study of the project. Based on the report, an Environmental Clearance Certificate (ECC) for the Project was issued by the Department of Environment (DoE) on 05th November 2017. Later, the ECC was renewed on an annual basis. The latest renewal of ECC was issued on 26th October 2021 which is valid until 04th November 2022.

As the project entered the detailed design stage, many of the project components and elements were specified and confirmed, thus an Updated version of the EIA report has been prepared (this report). This version of the report supersedes the 2017 preparatory EIA report and it is submitted to DoE for further renewal of ECC.

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ABBREVIATIONS

AIDS	:	Acquired Immunodeficiency Syndrome
AQI	:	Air Quality Index
BDT	:	Bangladesh Taka
BLT	:	Ballastless Track
BMD	:	Bangladesh Meteorological Department
BOD	:	Biochemical Oxygen Demand
BR	:	Bangladesh Railway
BCSIR	:	Bangladesh Council of Scientific and Industrial Research
BRT	:	Bus Rapid Transit
BUET	:	Bangladesh University of Engineering and Technology
CCL	:	Cash Compensation under Law
CEMP	:	Construction Environmental Management Plan
COD	:	Chemical Oxygen Demand
COVID	:	Coronavirus Disease
DC	:	Deputy Commissioner
DG	:	Director General
DHUTS	:	Dhaka Urban Transportation Network Development Study
DMA	:	Dhaka Metropolitan Area
DMRTDP	:	Dhaka Mass Rapid Transit Development Project
DMTCL	:	Dhaka Mass Transit Company Limited
DNCC	:	Dhaka North City Corporation
DO	:	Dissolved Oxygen
DOE	:	Department of Environment
DC	:	Dynamic Compaction
DPP	:	Development Project Proposal
DSCC	:	Dhaka South City Corporation
DTCA	:	Dhaka Transport Coordination Authority
DEE		Dhaka Elevated Expressway
DWASA	:	Dhaka Water and Sewage Authority
EC	:	Electric Conductivity
ECC	:	Environmental Clearance Certificate
ECA	:	Ecologically Critical Area
ECR	:	Environment Conservation Rules
ECS	:	Environmental Construction Specifications

EHS	:	Environment Health Safety
EIA	:	Environmental Impact Assessment
EMO	:	Environmental Management Officer
EMP	:	Environmental Management Plan
EQS	:	Environmental Quality Standards
ERR	:	Emergency Response Plan
ES	:	Engineering Service
FST	:	Floating Slab Track
GC	:	General Consultant
GHG	:	Greenhouse Gas
GOB	:	Government of Bangladesh
GRM	:	Grievance Redress Mechanism
HIA	:	Historical Importance and Archaeological
HIV	:	Human Immunodeficiency Virus
IEE	:	Initial Environmental Examination
IMG	:	Independent Monitoring Group
IUCN	:	International Union for Conservation of Nature
JICA	:	Japan International Cooperation Agency
KII	:	Key Informant Interview
LA	:	Land Acquisition
LAP	:	Land Acquisition Plan
MRT	:	Mass Rapid Transit
MIST	:	Military Institute of Science and Technology
MSS	:	Mass Spring System
NEMAP	:	National Environmental Management Action Plan
NGO	:	Non-government Organizations
NOC	:	No Objection Certificate
PAP	:	Project Affected Person
PVD	:	Prefabricated Vertical Drain (PVD)
PM	:	Particulate Matter
RAP	:	Resettlement Action Plan
RSS	:	Receiving Sub-station
ROW	:	Right of Way
RSTP	:	Revised Strategic Transport Plan
RAJUK	:	Rajdhani Unnayan Kartripakkha
SRC	:	Speed Restriction Curves

SCP	:	Sand Compaction Pile
SSCP	:	Static Sand Compaction Pile
STP	:	Strategic Transport Plan for Dhaka
TBM	:	Tunnel Boring Machine
TC	:	Total Coliform
TDS	:	Total Dissolved Solid
TSS	:	Total Suspended Solid
UG	:	Underground
UNO	:	Upazila Nirbahi Officer
UP	:	Union Parishad
USA	:	United States of America
USD	:	United States Dollar
USEPA	:	United States Environmental Protection Agency
VPT	:	Vibration Proof Track
VSCP	:	Vibratory Sand Compaction Pile
WARPO	:	Water Resource Planning Organization
WB	:	World Bank

EXECUTIVE SUMMARY

E1 INTRODUCTION

E1.1 Project Background

DHUTS 1 study funded by JICA 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 in 2009-10. A subsequent JICA study (known as DHUTS 2) carried out feasibility of MRT Line 6. STP was revised in 2015 with grant from JICA and approved by the GoB in 2016. According to the Revised Strategic Transport Plan (RSTP), MRT Line 1 and MRT Line 5N was identified as the next priority Project. The feasibility study of the MRT Line 5N was conducted between 2016 and 2018 following the JICA mission in 2016. A preparatory level EIA was prepared at that time and submitted to the Department of Environment (DoE) for Environmental Clearance Certificate (ECC). An Environmental Clarence Certificate (ECC) was issued on 05th November 2017 for the Project.

This project will be implemented through Dhaka Mass Transit Company Limited (DMTCL). First slice loan agreement for the Project was signed with JICA on 14th June 2018 (Loan No BD-P101). A consortium of firms, Metro Five Consultants Association (MFCA), has been appointed for basic design, detailed design, preparation of bidding documents, tender assistance, updating of Environmental Impact Assessment (EIA) & Resettlement Action Plan (RAP), preparation of Land Acquisition Plan (LAP), assisting implementation of LAP & RAP, assisting institutional development and utility relocation planning of non-rail business strategy design and support for defect notification period and construction supervision of the Project.

E1.2 Project Status

The project is currently under detailed design phase. A consortium of eight consulting firm MFCA, led by Nippon Koei Co., Ltd, Japan, is working as consultant from 5th August 2020. Many of the project components and elements have now been specified and confirmed.

E1.3 Purpose of the Study

The main purpose of the Environmental Impact Assessment (EIA) is to identify, evaluate and report the environmental and socio-economic effects. The process includes identification of mitigative measures that will be used to reduce or eliminate potential adverse effects, where appropriate.

An EIA report was prepared by the JV of KS Consultants and EQMS Consulting Limited in 2017 under the JICA Feasibility Study for MRT Line-5N. Since the project is under the detail design stage, therefore, an updated version of the report, including a new baseline study is required. This updated version of the report will also serve the purpose of the renewal of ECC from DOE. EQMS Consulting Limited has been contracted by MFCA to carry out the study.

E1.4 Methodology

Methodology adopted for the preparation of this updated EIA report are as follows:

- Study of the relevant documents on policy, legal and administrative framework and their review, particularly on environmental aspects and effluent discharge limits, health and safety requirements, identification of sensitive areas and endangered species, land use, land acquisition etc.
- Pilot survey has been conducted to collect baseline information in devised formats;

- Analysis of collected data has been conducted;
- Documentation of baseline conditions has been conducted through on-site environmental monitoring and sampling in the project area;
- Application of simplified noise and vibration modeling to determine the noise and vibration level at the receptor due to construction activities and train operation;
- Estimation of the Green House Gas (GHG) emission due to implementation of the project
- Identification of major project activities, both during construction and operational phases of the project.
- Identification and prediction of environmental and social impacts of the project activities on the surrounding environment and suggestions for mitigation measures in order to reduce/eliminate negative impacts and to enhance positive impacts.
- Arrangement of public consultation meeting, Key Informant Interview (KII) and disclosure meeting to consult with potentially affected people as well as community people;
- Development of Environmental Management Plan (EMP) and Environmental Monitoring Plan (EMoP) for both construction phase as well as operational phases of the project.

E2 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

According to the Section 12 of the Environment Conservation Act 1995, no project can be established or undertaken without obtaining Environmental Clearance Certificate from the Director General, in the manner prescribed by the Environment Conservation Rules 1997. Therefore, every development projects/industry, which are specified under the Schedule–1 of the Environment Conservation Rules 1997, require obtaining site and environmental clearance from the Department of Environment. According to the Rule 7 (1) of the Environment Conservation Rules 1997; for the purpose of issuance of Environmental Clearance Certificate (ECC), every project, in consideration of their site and impact on the environment and will be classified into the four categories, i.e., green, orange A, orange B and red. According to Environment Conservation Rules, 1997 (ECR, 97) the project (MRT Line-5N) does not make any reference to the category list of DoE. Nevertheless, regarding its activity and infrastructure development, this project is likely similar to the 'RED' category listed project. Thus, EIA study is required to be carried out for the project which have already been carried out and the ECC are being renewed every year since 2017.

In addition to ECC, other laws and ordinances concerning resettlement, land acquisition and compensation are relevant to the project. The principal legal instrument governing land acquisition in Bangladesh is the Acquisition and Requisition of Immovable Property Act-2017.

E3 PROJECT DESCRIPTION

MRT line 5N has a length of 20.00 km with 14 stations and one depot in Hemayetpur area. The alignment of MRT Line 5N connects Hemayetpur with Vatara. This route runs through 14.1 km underground stretch to cover high-density areas and 5.9 km elevated section. The line will follow the underground section following the Gabtoli-Darus salam-Mirpur 1-Mirpur 10-Kochukhet-Banani- Gulshan 2- Notun Bazar. The elevated section will start from Hemayetpur to Aminbazar station and after Notun Bazar station the line again be elevated till Vatara station. The route of the MRT Line-5N is shown in **Figure E0-1**.

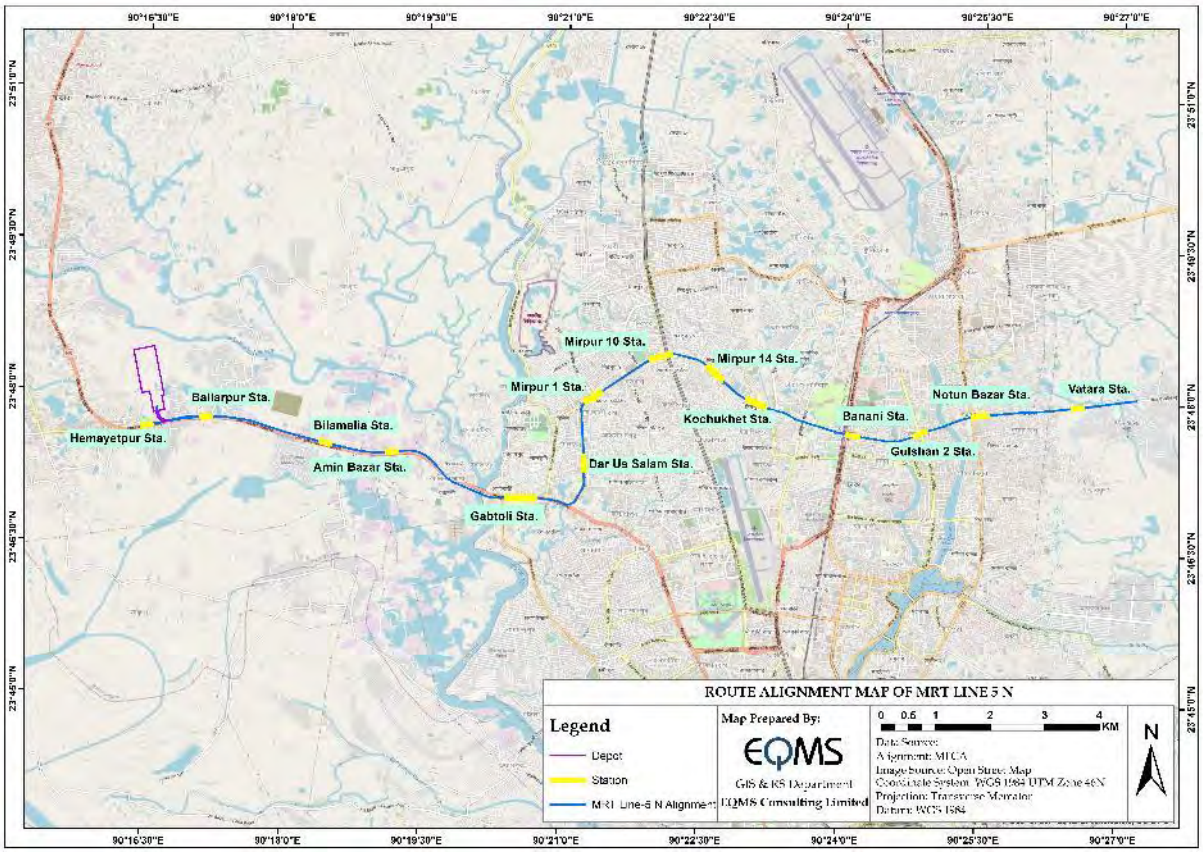


Figure E0-1: Map Showing the MRT Line-5N Alignment with Station Locations

E3.1 Need of the Project

Traffic jam causes massive economic loss in Bangladesh. According to a BRAC Institute of Governance and Development study, the average speed of vehicles on Dhaka's roads in 2004 was about 21 (21.2 km/h), but it dropped to 6 (6.8 km/h) in 2015. It is anticipated that implementation of MRT would play an important role in the country's economic growth by reducing travel time and transforming people's lifestyles as well as improving productive time without any strain. This will also provide multi-faceted benefits to the residents of Dhaka.

E3.2 Analysis of Alternatives

In no project scenario, chronic traffic congestion has become significant problem in Dhaka Metropolitan area. Expected population increase and economic growth will cause expansion of traffic congestion, deterioration of environment and economic loss. In case that MRT Line 5N is not implemented, no land acquisition and involuntary resettlement are expected. However, sustainable growth of local industry will be hampered. The environment of the area will deteriorate further by the traffic congestion and air pollution.

Comparison of structure has also been conducted for MRT 5N. The JICA study team (2017) studied three structures i.e. (1) Section between Kochukhet and Notun Bazar, (2) Section between Dar-Us-Salam and Notun Bazar and (3) Section between Gabtoli and Notun Bazar, which have different underground sections. Since the project is a railway which passes through the urban area of Dhaka city, major criteria are avoidance or minimization of living environment of local resident, pollution control and social environment including land acquisition and involuntary resettlement. Long viaduct options cause significant land acquisition and involuntary resettlement. The third option (Gabtoli-Notun bazar) is

superior to the other options on the air pollution, noise and vibration. Although (3) occurs most excavation soil than the other options, (3) option can minimize negative impacts to the environment and health.

Alternative route analysis has also been conducted for a restricted area (cantonment area) between Banani Station and Kochukhet Station on the route of MRT Line 5N (**Figure *3-22***). Three route options were examined on this section. Route A is the shortest route connecting Banani Station and Kochukhet Station. Route B which mitigates interference with the buildings comparing the route A has minor curves. Route C does not interfere with the buildings. Considering pros and cons, JICA study team recommended the underground route A considering magnitude of involuntary resettlement.

E4 ENVIRONMENTAL BASELINE DATA

E4.1 Physical Environment

Seismicity: According to Bangladesh National Building Code (BNBC), Dhaka city falls in seismic zone 2 of the seismic zoning map of Bangladesh which means the city is at moderate risk (zone coefficient is 0.20).

Topography: The surface elevation of the area Dhaka ranges between 1 and 14 m and most of the built-up areas located at the elevations of 6-8 m.

Land use: Land use of the MRT-5N alignment is dominated by built-up area followed by water body and vegetation.

Urban Drainage and Water Resource: In recent years, major inundations occurred in 1988 and in 1998, bringing about significant damages to infrastructures. During these inundations, water level in Buriganga River in the western part of Dhaka exceeded 7.0 m. The maximum depth to water table in the central part of the city i.e. Tejgaon and Sabujbagh areas, observed from BWDB piezometers, is about 67 to 57 m below ground surface that is about 55 m at Mirpur and 20-34 m at Mohammadpur, Dhanmondi and Sutrapur areas close to the river periphery.

Climate: The monthly variation of the maximum temperature is between 40.2°C to 31.0°C. The monthly variation of the minimum temperature is 22.5°C to 6.5°C. The average total annual rainfall from 1990-2019 is 1990 mm/month.

E4.2 Ecological Environment

Different tree species, birds, amphibians, reptiles and mammals were found during the preparatory study in 2017 around the depot area. Bengal Monitor (*Varanus bengalensis)* has been found Near Threatened according to the IUCN red list status 2015 whereas rests of the species are least concern.

E4.3 Environmental Quality

An environmental baseline study was conducted during the preparation of preparatory EIA report in 2017. And a second round of baseline study have been conducted during this updating of the EIA report in 2021. The findings of both studies as well as a comparison of findings in similar locations are available in main part of the report. Here, a brief description of the findings of both studies is given.

Air Quality: In 2017, the concentration of ambient air pollutants was monitored in 05 locations. Air Monitoring was carried out for seven parameters, including $PM_{2.5}$, PM_{10}, NO_2, SO_2, O_3, CO, and Lead (Pb). The results show that all the parameters are within permissible limits, except for the concentration of PM_{10}, $PM_{2.5}$ and NO_2. In 2021, the same number of parameters were monitored during the second-round baseline survey. However, the number of monitoring locations were increased to 17. The findings show

that the levels of air pollutants in all monitoring locations were found within the national standard, except the concentration of $PM_{2.5}$ and PM_{10} in Mirpur-10 Station area. Total 5 monitoring stations are same between initial baseline study and EIA updating baseline study. The comparison study shows that the concentrations of particulate matter have been reduced in most of the monitoring locations, except in Vatara Station where the concentration of PM_{10} and $PM_{2.5}$ have increased in EIA updating baseline study compared to initial baseline study.

Noise Level: In 2017, the noise level monitoring has been conducted in 09 locations along the alignment. The result indicates that the equivalent noise levels at 07 locations are higher than the prescribed limit. On the other hand, the number of noise monitoring locations were increased to 23 during the EIA updating baseline study in 2021. In this second round of monitoring, the noise levels are found more than standard limits in 21 monitoring stations. Comparison between two monitoring result shows that noise level has been increased at 5 locations during EIA updating baseline study compared to the initial baseline study in 2017 whereas in Bilamalia, Gabtoli, Mirpur 14 and Vatara station noise level has been decreased.

Surface Water Quality: Total five surface water samples were collected from different locations along the alignment in 2017. It was found that the concentrations of BOD, COD, and Faecal Coliform in all samples were very high. In contrast, Dissolved Oxygen level in all the samples were less compared to the national standard. In 2021, six samples were taken during the EIA updating baseline survey. In this study, the concentration of DO at four samples have been found less than the standard and pH level at four samples have been found higher than the standard. The other parameters are within the standard range.

Ground Water Quality: A total of nine ground water samples were collected once during 2017 baseline. Ground water quality of all samples were found within the standard in accordance with the Environmental Conservation Rules, 1997. In 2021, Groundwater samples were collected from 10 locations along the route alignment and depot area. The results show that, temperature at four locations were slightly higher than the standard, whereas pH level at one location was slightly lower than the standard. Temperature and pH at other locations were found within the standard. Rest of the monitoring parameters at all the locations were also found within the standards of ECR'97.

E4.4 Social Environment

The data provided in this section are mostly based on the Population and Housing Census 2011. Although these data are very old, but these are the latest available data that may differ from the current situation. According to 2011 Census, there are 375541 households (HHs) including squatters with a total population of 1566290 in the project area. The average household size is 4.2.

E5 SCREENING AND SCOPING

According to Environment Conservation Rules, 1997 (ECR, 97) the project (MRT Line-5N) does not make any reference to the category list of DoE. Nevertheless, regarding its activity and infrastructure development, this project is likely similar to the 'RED' category listed project and "A" according to the JICA Environmental Guidelines, and thus EIA is necessary to be conducted.

In order to assess the likely significant environmental and social impacts, potential environmental and social impacts of the Project were preliminarily identified based on the project description and overall environmental and social conditions in and around MRT Line-5N project. The impacts of pollution, natural and social environments, health and safety, emergency risk, and others were classified as A to D in accordance with the following criteria, assuming no specific measures toward the impacts are taken:

1) A-/A+: Significant negative/positive impact
2) B-/B+: Some negative/positive impact
3) C-/C+: Impacts are not clear, require more investigation
4) D: Impacts are negligible, no further study required

Scoping matrix can be found under section 5.3.

E6 ANTICIPATED ENVIRONMENTAL IMPACTS AND THEIR MITIGATION MEASURES

All the identified environmental components with their impacts have been discussed in detail in chapter 6 with the mitigation measures and residual impacts. Potential impacts due to the construction and operation of the MRT line-5N are presented below.

E6.1 Noise Impacts

Noise generated by construction activity is analyzed based on combined equipment sound power level for different workplace conditions. The equivalent noise level at the receptors is determined based on the distance of the receptors. The following criteria have been set for this project noise level standard during construction:

- the noise standard of “existing ambient level + 10 db” or 85 dB, whichever is higher has been adopted

Analysis of the data shows that there is no additional noise that goes above the project noise level standard for construction work.

Noise impacts occur during operation are analyzed through a method proposed by K. Ishii (used in MRT Line 6 and MRT Line 1) 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 and the receptors level, then combined into an equivalent combined noise level (A rated decibels). Input variables include track curvature (200 m, 400 m and >500 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. At the elevated section (Hemayetpur to Aminbazar and Notunbazar to Vatara), 1.5 m parapet wall will be adopted to control the noise level. From the above discussion it is seen that no additional mitigation measures other than parapet wall will be required during train operation.

E6.2 Vibration Impact

During the construction period, major sources of vibration are sand compaction pile, operation of Hoe Ram, Caisson drilling. Normally Sand Compaction Pile (SCP) is used for sand compaction. For the Depot area, separate vibration level analysis has been done based on soil improvement interventions. Vibrating SCP, static SCP, dynamic compaction and Prefabricated Vertical Drain (PVD) will be used during MRT line-5N depot development. For vibrating SCP and dynamic compaction, 90 VdB will reach at almost 15m distance whereas for static SCP, 90 VdB vibration will reach only at 0.005m distance. Therefore, static SCP would be used near boundary areas of Depot. The resident near the depot area will not experience of 90 VdB whereas they may experience 75 VdB.

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 USFTA vibration standard of 90 VdB for construction period and Japanese standard of 60 VdB for operation period are adopted for use on the project which have also been adopted for MRT line 6 project.

As like as the noise level, vibration proof track is also not required for the elevated section. At the pier face, the vibration will be quite higher than the 60 VbB. But at the 12.5 distance, all the range in three curvatures are within the standard range. In the elevated section, the receptor point is quite far from the sources. Minimum distance will be at least 25m, where all the predicted vibration level is well below the standard range. So, no additional measures are needed for the elevated section. For the underground portion, there could be natural resonance while running the train. So, vibration proof track has been proposed at all along the underground route line.

E6.3 Air Pollution

Air pollution is the major concern during the construction phase. The major concern under the air pollution is mainly the black smoke from the construction equipment and dust from the mismanagement of spoil. Proper mitigation measures are proposed to control the air pollution during construction phase. In the operation period, the impact will be positive as the emission and dust could be reduced as the project will use electricity for the operation instead of diesel and due to decrease of traffic number in this route.

E6.4 Surface Water Pollution

Surface water might be polluted during both construction stage and operation stage. During the construction stage, major sources of polluting the surface water are the storage site of hazardous material, workshop area, effluents from the construction yard, sewages from the office and camp area. During the operation phase, major source will be the sewages from the station area and the Depot area and washout from the workshop area in the Depot area. Proper mitigation measures have been proposed to avoid such impact which need to be followed strictly during both construction and operation stage.

E6.5 Ground Water Pollution

There will be limited impact on the ground water due to the construction and operation stage of the MRT Line 5N. In the Dhaka city area, normally ground water extraction started from a depth of 100m and up to 300m. Also, the construction will be continued in the built-up area and to be built-up area. So, no disturbance at all expected on the ground water table. Only the limited impact will be pressure on the ground water table in some limited place where ground water will be extracted for both construction and operation purpose. Also, there will be very limited chance to deteriorate the quality of the groundwater from the washout of the of the workshop area if the mitigation measures are properly implemented.

E6.6 Soil Pollution

During the construction phase there will be possibility of leakage of hazardous material into the soil which may deteriorate the soil quality. So, proper mitigation measures have been proposed to mitigate the impact.

During the operation phase, the impact will be limited in the depot area where the workshop will be located. Mitigation measures are also provided for the operation period also to avoid the impact.

E6.7 Waste

During the construction stage, there will be several sources of waste from the construction activities. Main concern of waste is large amount of soil which will come from the tunnel boring activities, piling in the elevated section area and open cut method from the underground station construction work. Besides

these wastes, there will be domestic wastes also which will come from the accommodation camp, site offices and construction yard area. Also, there will be hazardous wastes and biomedical wastes also during the construction period. Separate management plan has been proposed for managing all kind of wastes in the construction sites.

During the operation phase, the sources will be very limited and will be only in the station area and the depot area. Separate mitigation measures provided for managing the wastes during the operation period in subsection 6.7. These need to be followed to avoid the impact.

E6.8 Urban Drainage

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.

Drainage during operations (from the viaduct, station canopies and the depot site) is accounted for in the design of facilities. Water quality is unlikely to be affected. There will be STP to treat the sewage water prior to discharge.

E6.9 Protected Area

The underground structure (tunnel) of MRT line-5N will pass under the Turag River and Gulshan-Banani-Baridhara lake which are designated as Ecologically Critical Area (ECA). So, no mitigation measures are required in this case for both the construction and operation period.

E6.10 Biota and Ecosystem

The Project is not expected to have a significant impact on the biota and ecosystem, whether arboreal (in the Depot area) or aquatic (in the adjacent Banani-Gulshan-Baridhara Lake and Turag River). Trees found in the centerlines of roadways in the Notunbazar to Vatara area used for the MRT 5N 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. The list of trees is not finalized yet, will be finalized in the final report under study of the RAP. In the operation stage, there will be no impact on the biota and ecosystem.

E6.11 Involuntary Resettlement

Displacement will occur within the depot area. Also, some property will be affected for the construction of the elevated section. The final number is not confirmed yet as updating of RAP is ongoing. Proper compensation will be provided to them under the RAP. In the operation phase, there will be no issue of the involuntary resettlement.

E6.12 Local Economics

There will be few businessmen in the underground station area who will be affected during the construction period. They will be compensated as per the RAP study. In the operation phase, it is expected that new employment opportunity will come in or around the MRT Line 5N project area. So, there will be positive impact in the operation period.

E6.13 Cultural heritages

According to the cultural assets/historical importance/archeological place survey, there are three (3) monuments/structures namely (I) Mazar of Shah Md. Abdus Samad Bangalai Wayeshi, (II) Dewan Bari Mosque and (III) Dewan Bari were finally identified for their historical importance and having the likeliness

of being impacted by the project activity. Among them Dewan Bari Mosque and Dewan Bari are listed as heritage monument by RAJUK which are located 36 and 50 meter distance from the MRT line 5N alignment respectively. Mazar of Shah Md. Abdus Samad Bangalai Wayeshi, which is not listed as heritage site neither by DoA nor by RAJUK, is located at 10.77 m distance from the nearest pier. According to the US FTA standard, the applicable vibration limit is 90 VdB, which reflects to 12.5 m distance from the pier [typical pile driver (sonic)] for "extremely susceptible to vibration". Also, according to same US FTA, for non-engineered masonry building, the construction building vibration damage criterion is 94 VdB (0.2 in/sec) PPV [Peak Particle Velocity], which is considered safe and would not result in any construction vibration damage. Considering the structure type and construction materials used, US FTA standards for non-engineered masonry building is more relevant for the Mazar of Shah Md. Abdus Samad Bangalai Wayeshi, which was built in 1983 and the structure is modern. At a distance of 10 m from pile location, the resulting vibration is expected to be 89 VdB, which is within the limit for non-engineered masonry building. Thus, impact will be negligible for the structure. Therefore, it can be stated that the monument has only minor susceptibility for vibrational impact [as it is made of modern and masonry structure] which can be further reduced by taking appropriate cautionary measures.

MRT Line-5N operation will enhance the development of the concerned area. The underground section will go through a developed area, while the elevated section will be in developing area. It is expected that the benefits of this MRT will be enjoyed by the people in catchment area without any discrimination. Also, developed communication will make many cultural/historic places more accessible, which will be a positive impact of the project in regards of tourism sector.

E6.14 Local Conflict of Interest

In the construction phase, local conflict may arise between the local people and the project's staff and labor (who will come from different parts of the country). However, separate security plan has been proposed in the construction phase to avoid such issue. In the operation phase there will be no unskilled labor. All the staff will be recruited following the local law. So, there shouldn't be any discrimination during the operation period.

E6.15 Infectious disease

Infectious disease may arise during the construction phase as many workforces will come from the different parts of the country. So, to avoid such infectious disease, mitigation measures discussed in section 6.20.1.1 need to be implemented. During the operation period, there is no possibility of such infectious diseases.

E6.16 Working Condition

In the construction phase, there will be risks related to occupational health and safety related issue. So separate management plan related to working condition needs to be prepared which will include all the safety related instructions to all workers and staffs. In the operation stage, there will be also possibility of the safety related issues. But for mitigating such impact, several teams will work.

E6.17 Children Rights

Due to the construction of the elevated area and depot adjacent area, some children will be displaced with their family. Also, institutions will be affected. So, this will be taken care under the RAP study. No additional mitigation measures are required. In the operation phase, the children can move from one place to another for their education purpose. So, this a good positive impact on children.

E6.18 Global Warming

During the construction phases there will be emission of GHG gases from the construction equipment. But regular maintenance of the equipment will reduce the GHG emission. During the operation phase, total CO_2 emission reduction has been calculated as 91,857 tCO_2/year in 2028 whereas project CO_2 emission/generation due to power consumption for MRT line-5N operation in 2028 is 88,283 tCO_2/year. Hence, net CO_2 reduction due to MRT line-5N operation will be 3,574 tCO2/year in 2028. Similarly, the net reductions will be 47,237 tCO_2/year in 2038, 102,641 tCO2/year in 2048, and 130,149 tCO_2/year in 2058.

E6.19 Traffic Congestion

The construction of MRT line 5N will interrupts the business as usual in terms of traffic congestion trough the alignment. During the construction of underground station and elevated section throughout the median gap, a temporary bottleneck will be created, and traffic congestion will be increased. However, it is expected that the implementation of MRT line 5N will decrease the existing traffic congestion at a large-scale during operation period.

E6.20 Accident

During the construction phase, there might be accidents from different construction activities. So proper mitigation measures are required to avoid such accidents.

During the operation stage, there will be only possibility of fire in the station area. But there will be firefighting measures to avoid such impact.

E7 EVALUATION OF IMPACT

In this chapter, impact evaluation has been carried out considering mitigation measures and without mitigation measures. Evaluation scoring has been given for individual impact so that the effectiveness of mitigation measures can be justified. Detail of the scoring is given in section 7 of this report.

E8 ENVIRONMENTAL MANAGEMENT PLAN

E8.1 Management Plan

Prior to start of site works, Site Specific Environmental Management Plans in the form of the following specific management plans shall be prepared by the contractor and submitted to the project supervision consultant for approval. Detail management plan is presented in section 8.3.

- Air Quality Management Plan
- Noise and Vibration Management Plan
- Water Pollution Prevention Plan
- Waste Management Plan
- Spoil Management Plan
- Traffic Management Plan
- Occupational Health and Safety Plan
- Emergency Response Plan

E8.2 Monitoring Plan

The Contractor and the DMTCL will allocate separate budget for environmental and social management plan implementation, training, environmental monitoring, analysis and reporting, verification monitoring and capacity building. It should be noted that cost for many in-built mitigation measures, such as, air pollution control measure, acoustic enclosures for noise control, water and water treatment etc. need to be included in the contractor's contract and / or operating costs.

Air quality, noise, water quality monitoring will be conducted for regular basis before construction, during the construction and operation period. Detail of the environmental monitoring plan has been depicted in the section 8.4 of this report.

E8.3 Reporting

The environmental contract specifications will be prepared following this EIA and EMP and all the mitigation and monitoring measures included in this report will be implemented by the Contractor. The Environmental Supervision Consultant will strongly monitor the activities and proposed mitigation measures. Flowchart for environmental monitoring and reporting during construction is presented in subsection 8.5 of this EIA report.

E9 STAKEHOLDER CONSULTATION

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. Stakeholders benefiting from the Project include virtually all groups who 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 EIA reports on the extensive public consultation undertaken during the baseline surveys. Two environmental public consultation meetings were held during the design phase targeting a cross-section of interest groups in two area. Following introductory presentations, MFCA 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. Several key points were raised by stakeholders that have been taken into consideration in the EIA. The detail of the

public consultation meeting is given in section 9.1 of this report. Besides of the public consultation meeting, key informant interview also has been performed during the baseline study. Respective ward local representatives of the alignment and some identified sectoral experts has been interviewed for their valuable opinion and it's included under the section 9.2 of this EIA report.

E10 CONCLUSIONS AND RECOMMENDATIONS

This main objective of the present study is to update the initial EIA report which was prepared in 2017 for MRT Line 5N following the JICA's Environmental and Social Consideration Guidelines. Different data collection techniques have been used to conduct the baseline study which include literature review, observation, and environmental baseline survey. The EIA is prepared through identifying the potential impacts, assessing them and recommending possible mitigation measures for adverse impacts. The potential adverse environmental impacts of the Projects include air pollution, soil pollution, land acquisition, involuntary resettlement, loss of livelihood, noise and vibration pollution, loss of vegetation, water pollution, etc. On the other hand, there would be some positive impacts of the project that include utilization of local resources, social infrastructure and services, mobility and safety, development of local economy, reduction in GHG emission, reduction of traffic congestion etc. The project also has a positive impact in terms of employment opportunities during both construction and operational phase. In addition, there will be enhancement of economic activities around the stations of the MRT Line 5N. It can be concluded on positive note that after the implementation of Environmental Management Plan and Monitoring Plan, the project will have negligible impact on environment and will also lead to sustainable transport development of the Dhaka city.

CHAPTER 1

1 INTRODUCTION

1.1 Project Background

Dhaka is the capital and the most populated city of Bangladesh having a population of 21,006,000 as of 2020, a 3.56% increase from 2019 (Source: Macrotrends, who prepared the estimate based on UN World Population Prospect)[1]. The metro area population of Dhaka in 2019 was 20,284,000, a 3.61% increase from 2018[1]. The huge population in a small area with limited transport infrastructure and services poses a challenging situation for the transport sector. With the ongoing population and economic growth, the number of vehicles will also be increased and will ultimately worsen the scenario.

Considering the trend in few years back, the government of Bangladesh (GOB) formulated the "Strategic Transport Plan for Dhaka" (STP) in 2005 in cooperation with the World Bank (WB). The STP was officially approved by the GoB and it was expected that the projects outlined in STP will be implemented gradually to improve the urban transportation situation. In continuation of this, Japan International Cooperation Agency (JICA) conducted the Dhaka Urban Transportation Network Development Study (DHUTS) Phase 1 from March 2009 with the DTCA as its counterpart agency. The study's objectives were to conceptualize the basic urban development scenario for the DMA by 2025 and to select priority projects that would help to build such a scenario. That study recommended the MRT Line 6 as a priority project. As a result, JICA conducted the feasibility study on MRT Line 6 under DHUTS Phase 2. Following these studies, the GOB and JICA concluded the loan agreement on the "Dhaka Mass Rapid Transit Development Project" on February 2013 to construct MRT Line 6.

STP was revised in 2015 with grant from JICA and Revised Strategic Transport Plan (RSTP) was approved by government in 2016. According to the Revised Strategic Transport Plan (RSTP) 2016, it has been proposed to build two BRT lines and five MRT lines to develop public transport in Dhaka city by 2035. RSTP identified MRT Line-1 and MRT Line 5N as next priority projects. Accordingly, JICA dispatched a mission to the GOB from March 7, 2016 to March 10, 2016 to facilitate the scope and implementing arrangements for conducting the feasibility study of the project. The feasibility study of the MRT Line-1 and MRT Line-5N was conducted between 2016 and 2018.

Subsequently, JICA pledged to finance the implementation of MRT Line-1 and MRT Line-5N to abate air pollution by reducing traffic congestion and building a mass rapid transit system in and around Dhaka city, thereby contributing to economic growth and improvement of urban environment. These projects will contribute to the achievement of SDGs Goals 9 and 11 as well. Now, MRT Line 1 is also under implementation, and construction works is expected to be started from mid-2022. First slice loan agreement for MRT Line 5N project was signed with JICA on 14th June 2018 (Loan No BD-P101).

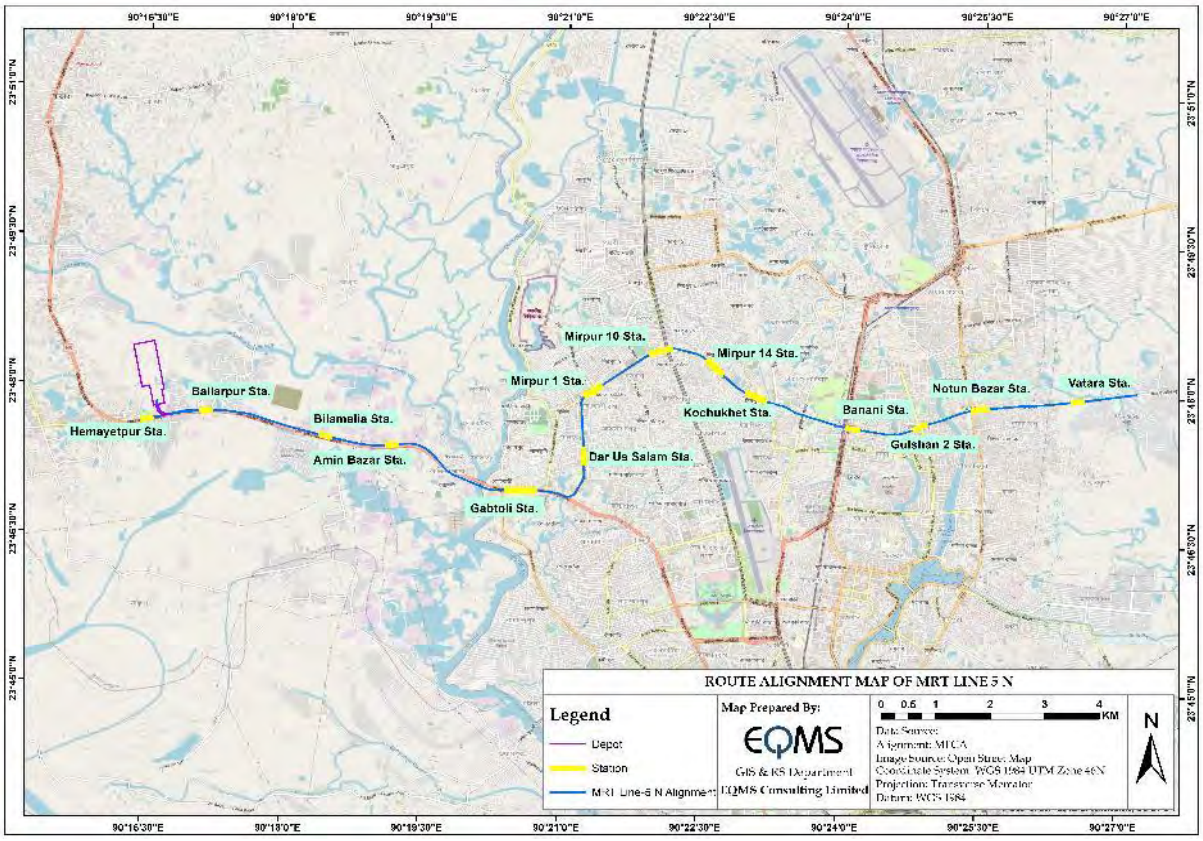
A contract for basic design, detailed design, preparation of bidding documents, tender assistance, updating of Environmental Impact Assessment (EIA) & Resettlement Action Plan (RAP), preparation of Land Acquisition Plan (LAP), assisting implementation of LAP & RAP, planning of non-rail business strategy, assist in traffic management, assist in utility relocation, support for defect notification period and construction supervision was signed on 10th June, 2020 between DMTCL and Metro Five Consultants

[1] Dhaka, Bangladesh Metro Area Population 1950-2021. https://www.macrotrends.net/cities/20119/dhaka/population. Retrieved 2020-12-30.

Association (MFCA), which is a eight firm joint venture group led by Nippon Koei Co., Ltd, Japan. The services started from 05th August 2020.

1.2 Description of the Project

MRT line-5N has a length of 20.00 km with 14 stations and one depot in Hemayetpur area. The alignment of MRT Line-5N connects Hemayetpur with Vatara. This route runs through 14.1 km underground stretch to cover high-density areas and 5.9 km elevated section. The line will follow the underground section following the Gabtoli-Darus salam-Mirpur 1-Mirpur 10-Kochukhet- Gulshan 2-Notun Bazar. The elevated section will start from Hemayetpur to Aminbazar station and after Notun Bazar station the line again be elevated till Vatara station. The route of the MRT Line-5N is shown in **Figure 1-1**.



Source: MFCA

Figure 1-1: Map Showing the MRT Line-5N Alignment with Station Locations

1.3 Project Status

This project has now entered detailed design stage. Previously, the JV of KS Consultants and EQMS Consulting Limited was prepared the EIA for this project. The EIA had designated locations along the alignments and depot area for air quality monitoring, noise level measurement and water quality analysis. Since many of the project components and elements have now been specified and confirmed, it has been deemed necessary to update the baseline data previously gathered, for future monitoring and comparison during the construction phase. The EIA has been updated by the Project's consultant MFCA.

1.4 Purpose of the Study

The main purpose of the Environmental Impact Assessment (EIA) is to identify, evaluate and report the environmental and socio-economic effects of the MRT line-5N project. Another important purpose of the study is to assess the baseline environmental condition of the project location, including different

parameters of several components of the environment. The process includes identification of mitigative measures that will be used to reduce or eliminate potential adverse effects, where appropriate.

A preparatory EIA report was prepared in 2017 under the JICA Feasibility Study for MRT Line-5N. The previously prepared report was based on feasibility study of the project. Now, under the detail design stage of the project alignment, stations and depot are being finalized. Besides, the environmental components are changing over the time as their influencing factors are also changing. Therefore, an updated version of the report as well as a new baseline study is required. This updated version of the report will also serve the purpose of the renewal of ECC from DOE. EQMS Consulting Limited has been contracted by MFCA to carry out the study.

1.5 Scope of the Work

The major scope of work under the EIA updating are as follows:

- A baseline survey for Noise level, Air Quality and Water Quality (Surface Water & Groundwater) following the same sampling stations mentioned in the previous EIA conducted for the Project, as well as at some additional locations.
- Upgrading EIA for new/modified/confirmed facilities following the EIA process as prescribed by the EIA Rules and Regulations of Bangladesh.
- Identification of the locations of Floating Slab Track (FST) like Mass Spring System (MSS) as a measure of noise reduction, using a simplified noise analysis model based on ambient noise and anticipated operational noise.
- Consideration of construction environmental standards based on MRT Line 6 and MRT Line 1 examples.
- Conduct Public Consultations at two (02) locations along with Key informant interview (KII) and information disclosure seminar involving all the stakeholders to explain the project outline, its environmental impacts and mitigations, obtain inputs from the stakeholders, and spread the outcome of the updated EIA.
- Estimation of the Green House Gas (GHG) emission reduction potential of MRT line-5N.
- Development of Environmental Management Plan (EMP) and Environmental Monitoring Plan (EMoP).
- Assisting in renewal of issued Environmental Clearance Certificate (ECC) for the project.

1.6 Methodology

Methodology adopted for the EIA updating study is as follows:

- Study of the relevant documents on policy, legal and administrative framework and their review, particularly on environmental aspects and effluent discharge limits, health and safety requirements, identification of sensitive areas and endangered species, land use, land acquisition etc.
- Pilot survey has been conducted to collect baseline information in devised formats;
- Analysis of collected data; Documentation of baseline conditions has been conducted through on-site environmental monitoring and sampling;
- Application of simplified noise and vibration modeling to determine the noise and vibration level at the receptor due to construction activities and train operation;
- Estimation of GHG emission reduction due to implementation of the project.

- Identification and prediction of environmental and social impacts of project activities on the surrounding environment and suggestions for mitigation measures in order to reduce/eliminate negative impacts and to enhance positive impacts.
- Arrangement of public consultation meeting, Key Informant Interview (KII) and disclosure meeting to consult with potentially affected people as well as community people;
- Development of Environmental Management Plan (EMP) and Environmental Monitoring Plan (EMoP) for both construction phase as well as operational phase of the project.

Flowchart of the methodology adopted for the EIA updating study is as follows:

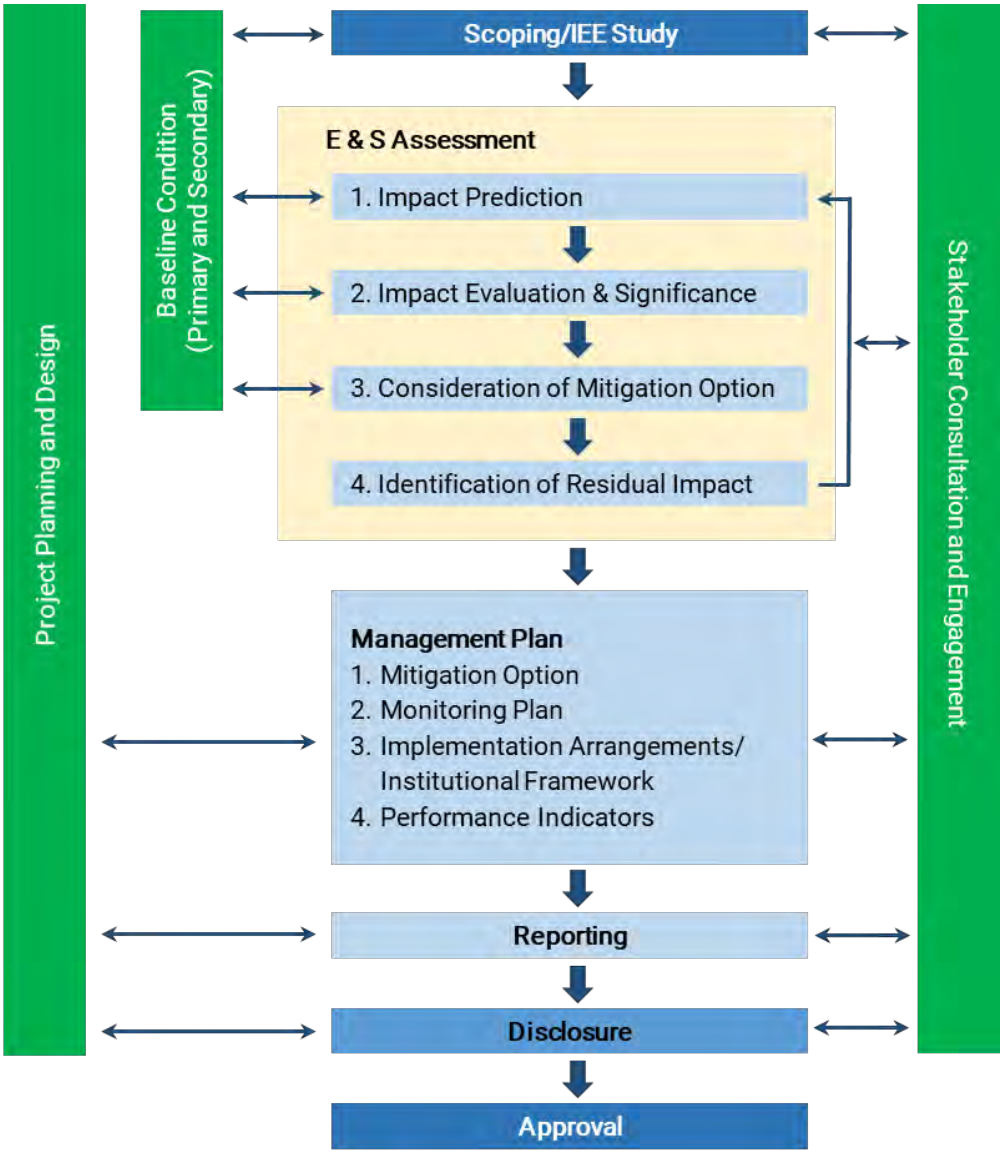


Figure 1-2: Methodology flowchart for EIA updating study

1.7 Outline of the Report

All the activities have been chronologically organized in this report which is a great assistance to the reader for better understanding. **Table 1-1** represents the outline of this report.

Table 1-1: Outline of the Report

Chapter	Description
Chapter 1	Focuses on project background, brief description, project status, and purpose of the study, scope of work, and methodology.
Chapter 2	Provides an insight on policy, legal and administrative framework that are applicable for this project.
Chapter 3	Discusses about the details of the project activity along with alternative options of the project.
Chapter 4	Discusses about the findings of the monitoring of supplemental environmental baseline study.
Chapter 5	Screening and Scoping for this EIA Report
Chapter 6	Discusses about the potential environmental and socio-economic impacts during construction and operation period and mitigation measures of identified impacts.
Chapter 7	Presents the evaluation of impacts assigning a score for each impact according to JICA guidelines.
Chapter 8	Discusses about the environmental management and monitoring plan for construction and operation period.
Chapter 9	Includes the outcomes of the public consultation and Key Informant Interview (KII) undertaken as part of the EIA updating study.
Chapter 10	Formulates an emergency response plan and disaster impact assessment.
Chapter 11	Presents conclusion of the study as well as some recommendations.

CHAPTER 2

2 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

2.1 Introduction

To address the environmental and social risks of any project and its associated components; to protect and conserve the environment from any adverse impacts, the GoB has specified regulations, policies and guidelines.

According to Environment Conservation Rules, 1997 (ECR, 97) the project (MRT Line-5N) does not make any reference to the category list of DoE. Nevertheless, regarding its activity and infrastructure development, this project is likely similar to the 'RED' category listed project. Thus, the project needs to conduct EIA studies to obtain site and Environmental Clearance from the DoE. In addition, as it is a JICA funded project, the Environmental and Social Guidelines of JICA is applicable for this project.

A preparatory EIA study has already been conducted for the project complying with the approved ToR from DoE in August 2017 and DoE issued an Environmental Clearance Certificate (ECC) in favor of DMTCL for the MRT Line-5N project on 5th November 2017. After obtaining the ECC, yearly renewal has been made in 2018, 2019, 2020, and 2021. The copy of the latest ECC (2021) can be found in **Appendix-A**. An updated EIA report has been prepared as the project entered into design phase and the environmental baseline data became outdated.

In this chapter, the following activities are presented.

- Identification of national legal obligations, legislative provisions, and policy guidelines in relation to the interventions which will be required to review under the EIA study of the MRT Line-5N project;
- Identification of the international legal obligations and relevant provisions of multilateral environmental agreements related to the project interventions.

2.2 Metro Rail Act (2015) in Bangladesh

The Metro Rail Act, 2015 includes the legal obligations for the construction, operation, maintenance, control and associated rules and regulations for Bangladesh. The act is initially applicable in Dhaka, Narayanganj, Munshiganj, Manikganj, Gazipur and Narsingdi district since 2nd February 2015. It will be applicable in other districts from second phase. License will be issued for metro rail construction and operation under this act. It also includes all technical aspects, entry, fare, insurance and all other associated penal code that are connected with metro rail.

2.3 Environment and Social Related Legislation and Policy in Bangladesh

The main Acts and Regulations guiding environmental protection and conservation in Bangladesh are outlined in the following subsections.

2.3.1 Bangladesh Environmental Conservation Act, 1995 (subsequent amendments in 2000 and 2002)

The provisions of the Act authorize the Director General of the Department of Environment (DOE) to undertake any activity that is deemed 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 Certification;
- Regulation with respect to vehicles emitting smoke harmful for the environment;
- Regulation of development activities from environmental perspective;
- Promulgation of standards for quality of air, water, noise, and soils for different areas and for different purposes;
- Promulgation of acceptable limits for discharging and emitting waste; and
- Formulation of environmental guidelines relating to control and mitigation of environmental pollution, conservation and improvement of the environment;

2.3.2 Environment Conservation Rules (ECR), 1997 (subsequent amendments in 2002 and 2003)

The Environment Conservation Rules, 1997 are the first set of rules promulgated under the Environment Conservation Act, 1995. These Rules provide for, inter alia, the following:

- Provision of the National Environmental Quality Standards (EQS) for ambient air, surface water, groundwater, drinking water, industrial effluents, emissions, noise and vehicular exhaust;
- Categorization of industries, development projects and other activities on the basis of actual (for existing industries/development projects/activities) and anticipated (for proposed industries/development projects/activities) pollution load;
- Procedure for obtaining Environmental Clearance;
- Requirements for undertaking IEE and EIA's as well as formulating EMP's according to categories of industries/development projects/activities; and
- Procedures for damage-claim by persons affected or likely to be affected due to polluting activities or activities causing hindrance to normal civic life.

Depending upon the location, size and severity of pollution loads, projects/activities have been classified in ECR, 1997 into four categories as Green, Orange A, Orange B and Red respectively.

2.3.3 National Environmental Policy, 2018

The Bangladesh National Environmental Policy, 2018, sets out the basic framework for environmental action together with a set of broad sectoral action guidelines. Key elements of the Policy are:

- Encourage collection and promotion of low carbon emission technology in the country;
- Identifying and controlling all types of environmental pollution and degradation activities;
- Ensure sustainable, long-term and environmentally friendly use of all-natural resources;
- Taking action to accept PPP for the development of the environment;
- Maintain and streamline the environmental policies and strategies among other policy strategies in the interest of sustainable development;
- Ensure the EIA and SEA in all necessary sectors;
- Take action to reduce poverty through environmental protection;
- Strengthen observations on proper compliance with environmental laws and regulations.

The policy also states that EIA's should be conducted before projects are undertaken and the DoE is directed to review and approve all Environmental Impact Assessments.

2.3.4 The Acquisition and Requisition of Immovable Property Act 2017

The principal legal instrument governing land acquisition in Bangladesh is the Acquisition and Requisition of Immovable Property Act-2017. The 2017 Act requires that compensation be paid for (i) land and assets permanently acquired (including houses, trees, and standing crops,); and (ii) any other impacts caused by such acquisition. The Act stipulates some rules and considerations for ensuring fair compensation of acquired properties. According to the Act-2017, the Deputy Commissioner (DC) determines and considers:

i. market price of acquired land by averaging corresponding price of previous 12 months from the date of serving notice under section-4 (u/s-4) for each type of land within the vicinity;
ii. Fair compensation for structures, trees and standing crops on the acquired land during Joint Survey.
iii. Compensation for detachment from the residual productive land.
iv. Compensation for loss of income generated from the acquired land.
v. Shifting cost of housing and commercial structures in case of displacement.
vi. May undertake appropriate step/action to resettle households displaced from homestead with living /housing structures.
vii. If acquired land has standing crops cultivated by tenant (*bargadar*), the law requires that part of the compensation money be paid in cash to the tenants.

Compensation payments or "awards" determines by the Deputy Commissioner popularly known as Cash Compensation under Law (CCL).

The Acquisition and Requisition of Immovable Property Act-2017 have some provisions adjusting determined value with the current market price of acquired properties. These are as follows:

a. The Deputy Commissioner will pay additional 200% of assessed/determined price for land.
b. The Deputy Commissioner will pay additional 100% of assessed/determined value for structures, trees, standing crops and other affected properties.

2.3.5 Applicability of Legislation Related to the Project

The GoB has developed a policy framework that requires environmental issues to be incorporated into economic development planning. Key environmental legislation with their applicability for the project is presented in **Table 2-1**.

Table 2-1: Applicability of Key Environmental Legislation at a Glance

Name	Summary of Legislation	Applicability to this Project	Applicable Permit and Requirement
Acts/Rules			
Environment Conservation Act, 1995 and its amendment in 2000, 2002 and 2010	• Declaration of Ecologically Critical Areas (ECAs); • Obtaining Environmental Clearance Certificate (ECC); • Regulation for vehicles emitting smoke harmful for the environment;	Applicable	According to the Act "no industrial unit or project shall be established or undertaken without obtaining an ECC from DoE. Therefore, the provisions of the act

Name	Summary of Legislation	Applicability to this Project	Applicable Permit and Requirement
	• Regulation of development activities from an environmental perspective; • Promulgation of standards for quality of air, water, noise and soils for different areas and different purposes; • Promulgation of acceptable limits for discharging and emitting waste; • Formulation of environmental guidelines relating to control and mitigation of environmental pollution, conservation, & improvement of the environment.		apply to all of the project intervention phases during the project life cycle.
Environment Conservation Rules, 1997 and its amendment in 2002, 2003, 2005, 2007, 2008, 2010, 2017 and 2020	• NEQS for ambient air, surface water, groundwater, drinking water, industrial effluents, emissions, noise, & vehicular exhaust; • Categorization of industries, development projects and other activities based on actual (for existing industries/development projects/ activities) and anticipated (for proposed industries/development projects/activities) pollution load; • Procedure for obtaining ECC; • Requirements for undertaking IEE and EIA's as well as formulating EMP according to categories of industries/ development projects/activities; and • Procedure for damage-claim by persons affected or likely to be affected due to polluting activities or activities causing hindrance to normal civic life.	Applicable	The subject project falls under the "Red" category according to its infrastructure development and requires clearance before the commencement of any project activities. Besides, it is stipulated that environmental quality standards and other relevant requirements shall be complied during the project life cycle.
Environment Court Act, 2010	• Establishment of one or more environment courts in each district and one or more special magistrate courts in each district; • Also provides the jurisdictions of environment court, the penalty for violating courts order, trial	Applicable	The court has jurisdiction, under the act's provisions, over trial for an offense or compensation under environmental law, imposing penalties for violation, etc.

Name	Summary of Legislation	Applicability to this Project	Applicable Permit and Requirement
	procedure in special magistrate court, power of entry and search, procedure for investigation, procedure and power of environment court, authority of environment court to inspect, appeal procedure and formation of the environment appeal court.		
Wildlife (Conservation and Security) Act, 2012	• Prohibition related to capturing, killing, shooting, or trapping wildlife. No person shall hunt any wild animal without a license; • Determination of threatened flora and fauna in four (4) schedules; • Prohibitions, entry and declaration procedure of protected areas (sanctuary, national park, community conservation area, safari park, eco-park, botanical garden, wild animal breeding center, landscape zone or corridor, buffer zone, core zone, special biodiversity conservation area, national heritage, memorial tree, sacred tree, and kunjaban, etc.); • No person, institution, or company shall establish or operate any industrial factory or brick-field within 2 (two) kilometers from the boundary of a sanctuary.	Not Applicable	No project activities are going to undertake within the buffer zone of the eco-sensitive zone notified in this act.
Bangladesh Water Rules, 2018	• Provision of No Objection Certificate for the establishment of projects related to flood control and management project; surface water extraction, supply and use related project and part of the project; irrigation project using surface water; construction of hydraulic structures; water conservation project; flood-affected plain land and wetland development project; groundwater for industrial use; riverbank protection and river control; river excavation and dredging project; canal	Applicable	Applicable- As the subject project will required surface/ground water extraction during construction period. Therefore, a NOC will be required prior to use surface/ground water.

Name	Summary of Legislation	Applicability to this Project	Applicable Permit and Requirement
	excavation and re-excavation project; fisheries development in surface water project; groundwater extraction, supply, & use related project & part of the project; and others project; • According to the Clause-16 of the rules, a NOC should be taken from DG of WARPO, District Committee/DC, Upazila Committee/UNO, and Union Committee/Chairman based on the total investment of the specific project.		
The Forest Act 1927, Amendment 2000 (Protected, village Forests and Social Forestry)	• Declare any forests land or wasteland as protected forests. • May stop public or private way or watercourse in the interest of preservation of the forest. • Declare a reserved forest area as Village Forests • Declare an area as social forests or launch a social forestry programme in Govt. land or private land with permission.	Not Applicable	No forestland will be required to be diverted;
The Private Forests Ordinance, 1959	• Conservation of private forests and for the afforestation on wastelands;	Applicable	Many trees will be cut down in depot area. Detail survey is going on under RAP; proper compensation will be paid as per RAP entitlement policy.
The Penal Code	• Chapter XIV of the Penal Code provides offences affective public health, safety, convenience, decency and morals; Section 277: Falling Water or Public Spring or Reservoir; Section 278: Making Atmosphere Noxious to Health; • Section 284: Negligent Conduct with Respect to Poisonous Substance; Section 285: Negligent Conduct with Respect to Fire or Combustible Matter;	Applicable	It is required to take all the measures proposed and suggested by DoE, Bangladesh during both construction and operation phase to minimize the environmental pollution

Name	Summary of Legislation	Applicability to this Project	Applicable Permit and Requirement
	• Section 286: Negligent Conduct with Respect to Explosive Substance. • Section 277: whoever voluntarily corrupts or fouls the water of any public spring or reservoir, to render it less fit for the purpose for which it is ordinarily used will be punished under the law. • Section 278: whoever voluntarily vitiates the atmosphere in any place so as to make it noxious to the health of persons in general dwelling or carrying on business in the neighborhood or passing along a public way will get punishment.		
The Protection and Conservation of Fish Act, 1950 and The Protection and Conservation of Fish Rules, 1985	• Prohibit or regulate the construction, temporary or permanent of weirs, dams, bunds, embankment and other structures	Not Applicable	No dam or embankment is required for the project activity
The Explosive Act, 1884	• To prevent any accident due to explosive storage, use or transportation due to careless handling/management	Applicable	Possibly Applicable depending on quantity of fuel storage. Fuel will be stored and used at site for running various construction machinery and equipment
Water Pollution Control Ordinance 1970	• Prevention of water pollution	Applicable	Applicable primarily during construction stage (e.g., sewage and equipment washing and maintenance liquid waste discharges from construction camps) Operation Stage: In depot area, there will be Wastewater Treatment Plant. The wastewater will go through an oil-water separator before coming to the treatment plant. In stations, the sewage will be discharged to the existing sewage line of

Name	Summary of Legislation	Applicability to this Project	Applicable Permit and Requirement
			DWASA wherever it is available. Otherwise, aerator or septic tank will be installed in the stations if any sewage line is not available.
Water Supply and Sanitation Act, 1996	• Management and Control of water supply and sanitation in urban areas	Applicable	Required for all development projects. Regulatory authority is Ministry of Local Government, Rural Development and Cooperatives
The ground Water Management Ordinance 1985	• Management of Ground Water Resources; • Tube well shall not be dug in any place without permission from Upazila Parishad.	Applicable	Applicable, if tube wells boring required to develop water supply system at construction camps. Permission should be taken if ground water is needed to be used, before digging tube wells.
The Embankment and Drainage Act 1952	• An Act to consolidate the laws relating to embankment and drainage and to make better provision for the construction, maintenance, management, removal and control of embankments and water courses for the better drainage of lands and for their protection from floods, erosion and other damage by water.	Applicable	Required for the construction of drainage facility at the Construction Yard and the Depot Area. Regulatory authority is Ministry of Water Resources and Flood Control Department (FCD).
Wetland Protection Act 2000	• Adhere to a formal environmental impact assessment (EIA) process, as set out in EIA guidelines and manuals for water sector projects or related to alteration of natural drainage. • No construction of roads if likely to affect the flow of navigable waterways without clearance from concerned authority's Upland flow in water channels to preserve eco-system.	Not Applicable	Site is not situated at wetland area
Antiquities Act 1968	• Governs preservation of the national cultural heritage,	Not applicable	No structure of national cultural heritage will be affected due to project

Name	Summary of Legislation	Applicability to this Project	Applicable Permit and Requirement
	protects and controls ancient monuments, regulates antiquities as well as the maintenance, conservation and restoration of protected sites and monuments, controls planning, exploration and excavation of archaeological sites		development. Regulatory authority is Ministry of cultural Affairs.
The Building Construction Act 1952 (with amendments)	• An Act to provide for the prevention of haphazard construction of building and excavation of tanks which are likely to interfere with the planning of certain areas in Bangladesh.	Applicable	The project involves development of infrastructure. Regulatory authority is Ministry of Public Works.
The Vehicle Act, 1927 The Motor Vehicles Ordinance, 1983 The Bengal Motor Vehicle Rules, 1940	• To regulate vehicular exhaust emissions.	Applicable	Heavy vehicle movement is involved during construction and operation phase. Regular maintenance of the vehicles should be carried out. Regulatory authority is BRTA.
Acquisition and Requisition of Immovable Property Act, 2017	• Current GOB Act and Guidelines, relating to acquisition and requisition of land; • According to the law, the affected person will get an additional 200% of assessed value for land and an additional 100% for structures, trees, crops, and other assets; • This law deals with social and economic impacts as a consequence of land acquisition;	Applicable	Land acquisition will be carried out at Depot Area. Regulatory authority is Deputy Commissioner.
Bangladesh Labour Law, 2006, Bangladesh Labour Act, 2013 and Bangladesh Labour Rules, 2015	• Provides health, safety, and well-being of workforce during project life cycle. In addition, it also stipulated that child under 18 years are not allowed to be employed during project life cycle and therefore, this law requires to be complied.	Applicable	Skill, semiskilled and temporary workers are likely to be involved in the project
Noise Pollution (Control) Rules 2006	• Prevention of Noise pollution • Standards for noise levels	Applicable	Noise will be generated due to the construction activity

Name	Summary of Legislation	Applicability to this Project	Applicable Permit and Requirement
Public Health Emergency Provisions Ordinance, 1994	• Calls for special provisions with regard to public health. In case of emergency, it is necessary to make special provisions for preventing the spread of disease, safeguarding the public health, and providing adequate medical service, and other services essential to the health of respective communities and workers during construction-related work.	Applicable	This will be needed for all the employees during the construction period.
The Employees State Insurance Act, 1948	• Health, injury, and sickness benefit should be paid.	Applicable	Needed for the all employees.
Employers Liability Act, 1938	• It is expedient to declare that certain defenses shall not be raised in suits for damages in respect of injuries sustained by workmen.	Applicable	Covers accidents, risks and damages with respect to employment injuries.
Dhaka Metropolitan Building (Construction, Development, Protection and Removal) Rules, 2008	• Under the Section 18 of Building Construction Act, 1952 (Act no. II of 1953), Bangladesh Government published the Dhaka Metropolitan Building (Construction, Development, Protection and Removal) Rules 2008 as gazette. The act will be considered for the area of Dhaka Metropolitan under the Town Improvement Act, 1953 (Act No. XIII of 1953). Under this act, land related NOC, special project related NOC, Design related approval NOC for special project etc. are included	Applicable	NOC needs to obtain for the MRT Line-5N as per the section 9 of chapter 2. Also, section 3, 4 and 8 under chapter 2 refers the approval for design of any project, NOC for land use and NOC for special project respectively.
Detailed Area Plan (DAP)	• 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	Applicable	Covers the area which could be filled for development purpose and which area is restricted to fill for any development activities.

Name	Summary of Legislation	Applicability to this Project	Applicable Permit and Requirement
	Development Plan, done in 2010. These covered growth areas with detailed studies and developed detailed maps for the urbanized area.		
Bangladesh National Building Code (BNBC)	• BNBC was first drafted in 1993 but not formally reviewed and updated. In 2006 the Building Construction Act was amended to include a new section 18 A, empowering the government to promulgate the building code as a legally binding document. The new edition of Bangladesh's building code is the Bangladesh National Building Code 2020 (BNBC 2020). • The provisions of this Code shall extend to the design, construction, usage or occupation, modification, movement, demolition and repair of any building or structure and any equipment installed or related therein or attached therein, except as otherwise provided for in other laws and regulations governing and regulating buildings. • If, in any event, various parts of this Code have different specifications for materials, design or construction methods, or other conditions, then the most restrictive specification shall be governed. • The special provision shall be applicable in the event of any discrepancy between a general requirement and a particular requirement.	Applicable	Cover the requirement for the structural design
Policies			
National Environment Policy, 2018	• For sustainable development	Applicable	The proposed project has likeliness of having an impact on the surrounding environment.

Name	Summary of Legislation	Applicability to this Project	Applicable Permit and Requirement
National Land use Policy, 2001	• Deals with several land uses including agriculture (crop production, fishery, and livestock), housing, forestry, industrialization, railways and roads, tea and rubber • Identifies land use constraints in all these sectors	Applicable	Potential land use change from seasonal cultivable land, water retention area to urban area
National Environment Management Action Plan 1995	• Conservation of natural habitats, bio-diversity, energy, sustainable development and improvement of life of people	Applicable	Usage of energy efficient material, green building techniques, reduction of carbon footprints etc.
National Conservation Strategy	• Sustainable development for project activity	Applicable	Usage of energy efficient material, green building techniques, reduction of carbon footprints etc.
National Fisheries Policy, 1998	• Preservation, management, and exploitation of fisheries resources in inland open water • Fish cultivation and management in inland closed water. • Prawn and fish cultivation in coastal areas • Preservation, management, and exploitation of sea fishery resources	Not Applicable	No areas of fish production are likely to be impacted by the project
The National Forest Policy (1994)	• Conserve the existing forest areas and to increase forest cover of country and increase the reserve forest.	Not Applicable	No diversion of forest land is involved
The National Energy Policy, 1995	• Protecting the environment by requiring an EIA for any new energy development project, introduction of economically viable and environment friendly technology.	Not Applicable	Energy efficient materials and techniques should be explored
The National Water Policy, 2000	• To ensure efficient and equitable management of water resources, proper harnessing and development of surface and ground water, availability of water to all concerned and institutional capacity building for water resource management.	Applicable	Applicable, if Ground water is required to be withdrawn for fulfilling water requirement at construction phase, conjunctive use of water should be explored

Name	Summary of Legislation	Applicability to this Project	Applicable Permit and Requirement
The National Water Management Plan, 2001	• Addresses options for water quality, considerations behind measures to clean up wastewater pollution, where effluent discharge monitoring and zoning regulations for new projects are emphasized;	Applicable	This is an infrastructure development project and are likely to be generate wastewater from batching plant. Installation of effluent treatment facility within the premises.

2.4 Regulatory Requirements for the Project

The Government of Bangladesh has framed various laws and regulation for protection and conservation of Biological Environment. These legislations with applicability to this project are summarized in below.

2.4.1 Environmental Clearance from DoE, Bangladesh

Department of Environment (DoE) under the Ministry of Environment, Forest and Climate Change is responsible for granting the environmental clearance to a project. In addition, there are other ministries to deal with specific area of importance to the country like Forests, Water, etc. According to the Section 12 of the Environment Conservation Act 1995, no project will be established or undertaken without obtaining permission, in the manner prescribed by the Environment Conservation Rules 1997, an Environmental Clearance Certificate from the Director General of DoE. Therefore, every development projects/industry, which are specified under the Schedule–1 of the Environment Conservation Rules 1997, require obtaining a Site Clearance Certificate and Environmental Clearance Certificate (ECC) from DoE. According to the Section 7 (1) of the Environment Conservation Rules 1997; for the purpose of issuance of Environmental Clearance Certificate (ECC), every project will be classified into the four categories considering their site and impact on the environment, such as Green, Orange A, Orange B, and Red. According to Environment Conservation Rules, 1997 (ECR, 97) the project (MRT Line-5N) does not make any reference to the category list of DoE. Nevertheless, regarding its activity and infrastructure development, this project is likely similar to the 'RED' category project. Thus, EIA study is required to be carried out to satisfy the requirements of ECC of the project. An EIA study has already been conducted for the project complying with the approved ToR from DoE in 2017 and DoE issued an Environmental Clearance Certificate (ECC) in favor of DMTCL for the MRT Line-5N project on 5th November 2017. After obtaining ECC, yearly renewal has been made in 2018, 2019, 2020 and 2021, and the current ECC is valid until 04 November 2022. The copy of the latest ECC (2021) can be found in **Appendix-A.** As the project entered into detailed design stage, many of the project components and elements were specified and confirmed, thus an Updated version of the EIA report has been prepared which will serve the purpose of further ECC renewal. The steps for obtaining environmental clearance certificate (ECC) from DoE have been provided in **Figure 2-1**.

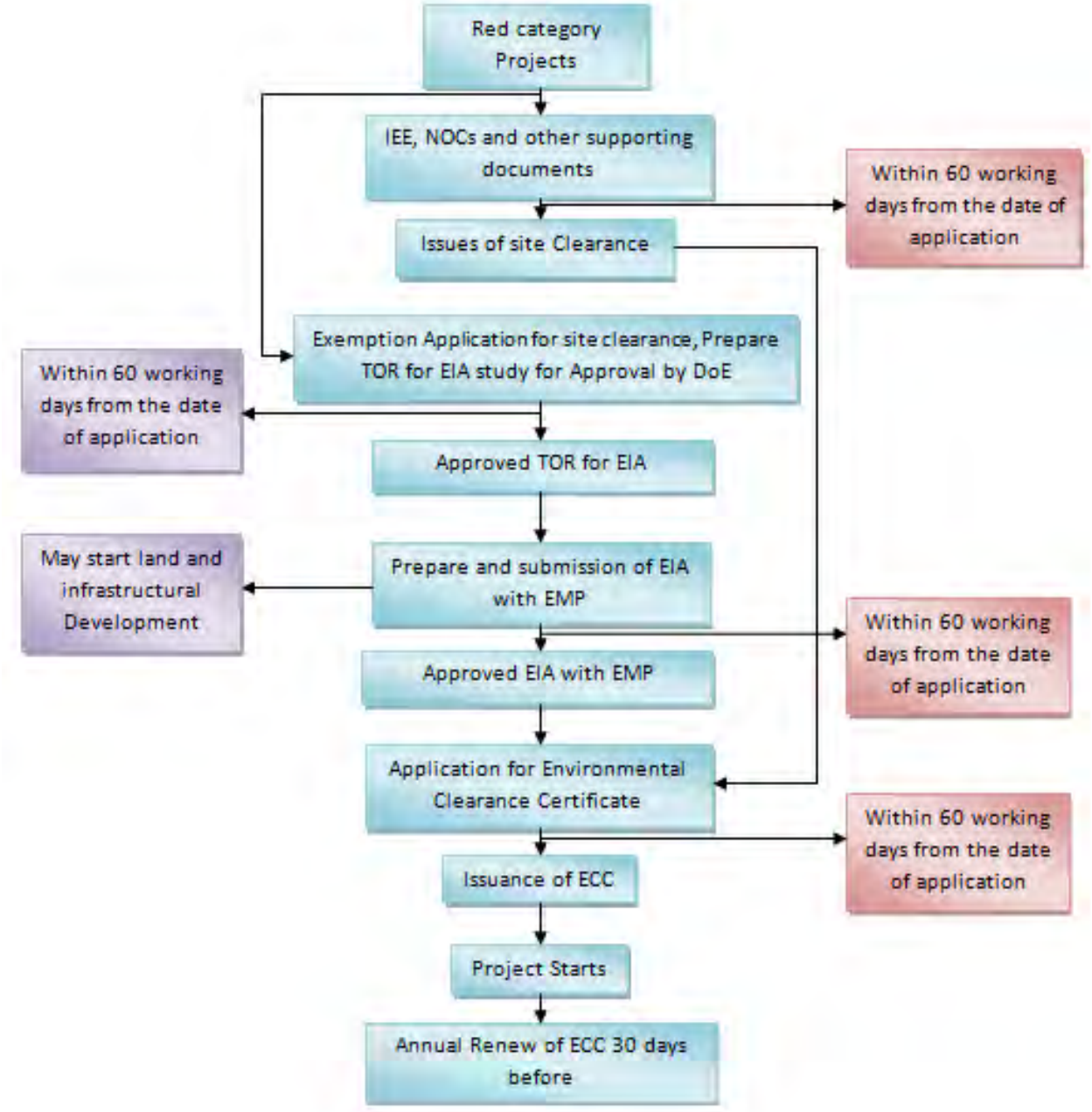


Figure 2-1: Steps for Obtaining Environment Clearance from DoE

2.4.2 Social Compliance in Bangladesh

Bangladesh has the Acquisition and Requisition of Immovable Property Act 2017. The act must be followed during acquisition or requisition of land for any development purpose. Accordingly, affected person gets the compensation for land and other assets. Since the JICA will finance for the project, the JICA guidelines for environmental and social consideration must also be complied. Therefore, a Resettlement Action Plan (RAP) for the project was prepared in 2018 in compliance with the Acquisition and Requisition of Immovable Property Act 2017, the JICA Guidelines for Environmental and Social Considerations and World Bank OP 4.12.

Now a Social Consulting Firm is engaged by General Consultant (Metro Five Consultants Association) for updating the original RAP which was prepared in 2018 under the F/S and RAP Implementation for the MRT Line-5N project. Subsequently, the updated RAP will be implemented after obtaining relevant approvals.

2.5 JICA Guidelines

2.5.1 Overview of Guidelines

JICA environmental Guidelines which is applied to the Project is "Guidelines for Environmental and Social Considerations" (April 2010).

The JICA Guidelines confirm that project proponents are undertaking appropriate environmental and social considerations, through various measures, so as to prevent or minimize the impact on the environment and local communities which may be caused by the projects for which JICA provides funding, and not to bring about unacceptable effects. It will thus contribute to the sustainable development of developing regions. In its confirmation of environmental and social considerations, JICA places importance on dialogue with all involved partners (e.g. the host country, local governments, borrowers and project proponents) regarding environmental and social considerations. Transparent and accountable processes, as well as active participation of key stakeholders (e.g. local residents and local NGOs affected by the project) in all stages of the project are highly considered. The JICA Guidelines has been formulated keeping consistency to the World Bank Operational Policy. In many cases, the JICA Guidelines referred the World Bank Operational Policy.

The JICA Guidelines provide following four categories of projects as per its environmental classification system.

- Category A: A proposed project is classified as Category A if it is likely to have significant adverse impact on the environment and society. Borrowers and related parties must submit Environmental Impact Assessment (EIA) reports. For projects that will result in large-scale involuntary resettlement, basic resettlement plans must be submitted. EIA and other reports need to be submitted through the borrower before the JICA environmental reviews.
- Category B: A proposed project is classified as Category B if its potential adverse environmental impact is less adverse than that of Category A projects. Generally, they are site-specific; few if any are irreversible; and in most cases, normal mitigation measures can be designed more readily
- Category C: A proposed project is classified as Category C if it is likely to have minimal or little adverse impact on the environmental and society.
- Category FI: A proposed project is classified as Category FI if it satisfies all of the following:
    - JICA's funding of the project is provided to a financial intermediary or executing agency etc.;
    - the selection and appraisal of the sub-projects is substantially undertaken by such an institution only after JICA's approval of the funding, so that the subprojects cannot be specified prior to JICA's approval of funding (or assessment of the project); and
    - Those sub-projects are expected to have a potential impact on the environment.

The Project, as per the above categorization, falls under Category A for the purpose of environmental investigations. Final EIA report approved by DoE needs to be laid open for public inspection at the JICA headquarter 120 days before a loan agreement for category A projects.

2.5.2 JICA Requirements Related to Land Acquisition and Compensation

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

- Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives;
- When population displacement is unavoidable, effective measures to minimize the impact and to compensate for losses should be taken;
- 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;
- Compensation must be based on the full replacement cost as much as possible;
- 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;
- 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;
- Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans;
- 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 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.

- 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;
- 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;
- Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based;
- Support should be provided for the transition period (between displacement and livelihood restoration;
- 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.

2.5.3 Gaps Between Environmental Regulations of GoB and the JICA Guidelines

There are gaps about categorization process, necessity of alternative study and information disclosure as shown in **Table 2-2**.

Table 2-2: Major Gaps between Environmental Regulations of GoB and the JICA Guidelines

Aspect of Operational Framework	JICA	GoB	Harmonized Operational Framework
Environmental Policy and Regulations	JICA Guidelines for Environmental and Social Consideration 2010	• Environment Conservation Act (1995) • Environment Conservation Rules (1977) • EIA Guidelines for Industries	-
Analysis of Alternative	Environmental impact must be assessed and examined from the earliest possible planning stage. Alternative studies shall be made to avoid or minimize adverse impact and must be examined and incorporated into the project plan.	ECA (1995) and ECR (1997) do not clearly ask for identification and assessment of alternatives.	Alternative study shall be made to minimize the project impact
Public Consultation Meeting & KII	In case of projects with potential adverse effects on environment, information on projects needs to be known at early stage and stakeholders, such as local people, should be adequately consulted. The consultation results need to be considered in projects. (Holding consultations is highly desirable, especially at scoping stage and when	No public disclosure is required as per ECR. Although there are descriptions recommending public participation in EIA, any detailed regulation for local consultation is not laid down.	Public consultation shall be implemented throughout the preparation and implementation stages of the Project. During preparation of the EIA report, consultations were implemented at scoping stage and when the draft

Aspect of Operational Framework	JICA	GoB	Harmonized Operational Framework
	the draft report is being prepared)		report was prepared.
Disclosure of EIA report	According to the guideline, EIA report shall be disclosed 120 days before the loan agreement. The stakeholders should have access to the report.	There is no regulation for the time of EIA disclosure.	Setting up the time of EIA disclosure can guarantee people to access the report

2.6 Administrative Framework for the Metro Rail

The Dhaka Mass Transit Company Limited is the administrative body for the implementation of the Dhaka Mass Rapid Transit Development Project, 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.

As per the MRT Line-5N project organogram, there is a position of Additional Project Director (E&HS, LA and Resettlement). Under him, there are positions of Deputy Project Director (E&HS), Deputy Project Director (LA and Resettlement), Assistant Project Director (E&HS), and Assistant Project Director (LA and Resettlement). This section of DMTCL will monitor and coordinate all environmental related activities.

CHAPTER 3

3 PROJECT DESCRIPTION

3.1 Project Location

MRT Line-5 Northern Route is one of the high prioritized lines of metro rail network of Dhaka city. This line will be consisting of both elevated and underground sections. The project location covers Dhaka North City Corporation and Savar Upazila of Dhaka District. The depot of the line will be established at Hemayetpur in Savar Upazila. The location of the alignment and depot area is shown in the following **Figure 1-1.**

The MRT Line-5: northern route, referred herein as MRT Line-5N, will be 20km long, extending from Hemayetpur to Vatara via Baliarpur, Bilamalia, Amin Bazar, Gabtoli, Darus Salam, Mirpur 1, Mirpur 10, Mirpur 14, Kochukhet, Banani, Gulshan-2 and Notun Bazar including a 40.42 ha depot area at Hemayetpur. This line includes a 14.1 km underground section going through the high-density areas from Gabtoli to Notun Bazar with 9 nos. underground stations and the remaining 5.9 km elevated section from Hemayetpur to Aminbazar and Notun Bazar to Vatara with 5 nos. elevated stations. Underground section has planned different depth from ground level considering the control point. The underground section Rail Level (RL) varies between 15 and 35 meters below the ground, whereas the GL to RL for elevated section varies between 13 and 20 meters. The elevated stations are Hemayetpur, Baliarpur, Bilamalia, Amin Bazar, and Vatara stations. On the other hand, the underground stations are Gabtoli, Darus Salam, Mirpur-1, Mirpur-10, Mirpur-14, Kochukhet, Banani, Gulshan-2, and Notun Bazar station. Hemayetpur and Vatara station will be the starting and ending terminal point of the line, respectively.

3.2 Need of the Project

Traffic Jam and Dhaka have become synonymous. The reality of traffic congestion has reached a such level that one may know the journey time for sure, but never knows the arrival time. According to a BRAC Institute of Governance and Development study, the average speed of vehicles on Dhaka's roads in 2004 was about 21 (21.2 km/h), but it dropped to 6 (6.8 km/h) in 2015. As a result, the bus ride from Uttara to Motijheel takes more than 3 to 4 hours. By Metrorail, it will take only 40 minutes to reach Motijheel from Uttara. It is anticipated that, this form of transportation would play an important role in the country's economic growth by transforming people's lifestyles and improving their productive time without any strain.

Traffic jam causes massive economic loss in Bangladesh. According to a study of BUET conducted in 2018, traffic congestion of Dhaka city costs $4.4 Bn annually, which is more than 10% of the national budget. According to a World Bank report of 2017, 3.8 million working hours are being wasted every day for traffic jams in Dhaka. If the value of wasted working hours is being taken into account, the loss becomes huge which creates a negative impact on the national economy. According to Accident research institute, Bangladesh can save $2.6 Bn by reducing 60% traffic congestion in Dhaka.

Metro Rail will provide multi-faceted benefits to the residents of Dhaka. These are: 1. This will free the residents of Dhaka city from the traffic jam; 2. It will save the precious time of the residents of Dhaka city; 3. The journey will be very comfortable and safe; 4. Passengers will feel very comfortable as the train is air-conditioned; 5. City dwellers will be able to reach their destination in a short time and at low rent; 6. Passengers do not have to wait long at the station for the train; 7. There will be no opportunity to travel

by train without fare which will ensure transparency; 8. Each coach of the Metrorail will be well-equipped, and cozy; 9. Passengers will be able to travel very comfortably on the Metrorail even while standing; 10. Each Metrorail station will be sophisticated and spacious where there is no possibility of gathering and 11. It will be possible to maintain this communication system in a good way by protecting the environment. Apart from that, Metro Rail will ease the transportation for more than 15 million people of Dhaka and speed up daily life, which will create a bigger positive impact on the economy.

3.3 Existing Transportation System

The elevated section of the line started from Hemayetpur to Amin Bazar station will be along the Dhaka-Aricha Highway (N5). The underground section started from Gabtoli station to Notun Bazar station will go through Dhaka city (Dhaka North City Corporation) area mostly under urban road network except the cantonment area. The existing transport system along the alignment of this line includes bus, car, microbus, CNG auto rickshaw, leguna, rickshaw, motorcycle, and bicycle for human transportation as well as truck, pickup, van, covered van, etc. for transportation of goods. The location of Gabtoli station is one of the main inter-district bus terminals of Dhaka, which connects northwestern, southern, and southwestern districts of the country with Dhaka. There is also a truck terminal in Gabtoli besides the bust terminal. There are several bus stops along the alignment of MRT-5 line, which mainly serves city commuters for their everyday travels. From Hemayetpur to Gabtoli, both inter-district bus and truck as well as local buses and cars are moved. This route is mainly used by long distance travelers (Hemayetpur to Gabtoli) and city commuters (from Gabtoli to Vatara) for business and education purpose. The long distance and inter-district travelers take city bus or CNG or cars after arriving in Gabtoli.

A traffic survey was conducted by the consultant during December 2020 to March 2021 to assess the existing traffic movement scenario along the alignment and to generate data for future modelling. The existing bus stops along the alignment of Line-5N are Hemayetpur, Gabtoli, Technical, Mirpur-1, Mirpur-10, Mirpur-14, Banani/Kakoli, Gulshan-2, and Notun Bazar. Travel time and speed along the alignment route and some associated routes have been assessed as part of traffic survey. The findings show that the average travel speed in Gabtoli-Azimpur, Gabtoli-Notun Bazar, Uttara to Saidabad, Mohakhali-Gulistan, and Kakoli-Kakrail is 13.8, 9.8, 14.8, 9.9, and 12.61 km/hr, respectively. The average running time in these routes is 19.8, 15.02, 18.4, 13.4, and 15.3 km/hr, respectively. These data clearly show that the internal travel in Dhaka takes long time.

3.4 MRT Line-5: Northern Route

It is expected that the existing transportation infrastructure will not be able to accommodate the future increasing of passengers and vehicles. Therefore, a Mass Rapid Transport System consisting of elevated and underground metro rail is planned for construction. The metro rail is considered as a sustainable approach for increasing city commuters that will minimize the environmental impact as well as traffic congestion of existing transportation system. This MRT Line-5 Northern Route will connect Gabtoli bus stand, one of the Dhaka's busiest bus terminals, with other MRT lines. It will facilitate the inter-district travelers from northwestern, southern, and southwestern part of the country to travel inside Dhaka.

The underground line will be constructed by Tunnel Boring Method (TBM), while the underground station will be constructed through open cut method. The underground tunnel will be consisting of shielded tunnels for single track rail. Typically, tunnels running directly beneath the roads will be arranged horizontally in two rows side by side. However, if there are any underground obstacles, the tunnels will be built with two tiers configuration.

After starting as an elevated section from Hemayetpur, the line will run as elevated until Amin Bazar station. Then, the line will go underground and will run as underground line until Notun Bazar Station. The underground section will pass under the Turag River after Aminbazar, the residential area of Banani DOHS and Gulshan-Baridhara lake as well. Later, the line will raise above the ground again after Notun Bazar and will run until Vatara Station as elevated section. Vatara Station will be the terminus point of this line.

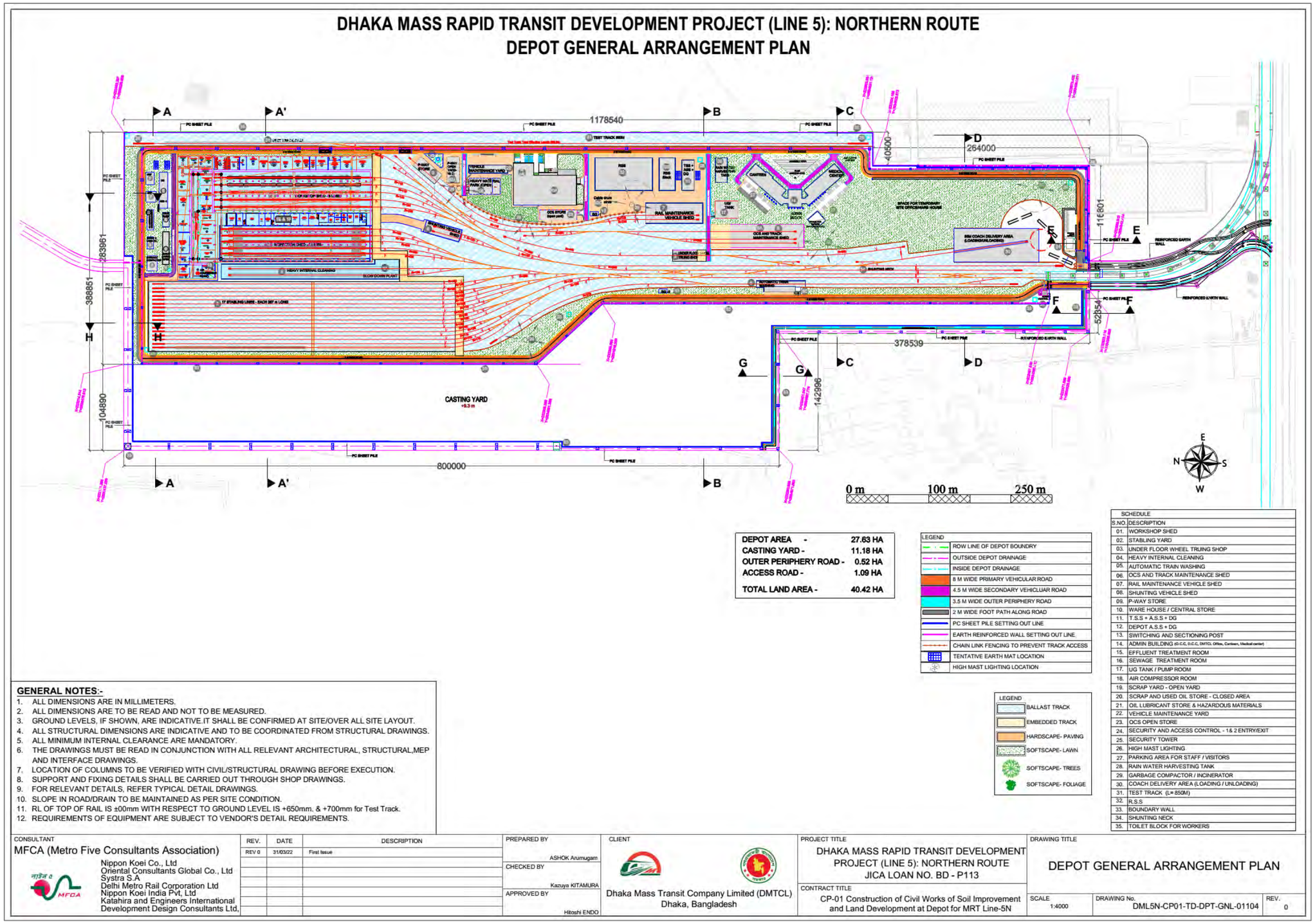
3.5 Facilities of MRT Line-5: Northern Route

For smooth operational activities of MRT line 5: Northern Route, various facilities are planned such as telecommunications, fare control, fire detection and control etc. These will include:

- Use of Noncombustible Material (Noncombustible bench)
- Fire Detection System and Thermal Detection System
- Ventilation Tower and Ventilation Fans in UG area
- Smoke Curtain
- Firefighting Equipment
- Disaster Prevention Control Center
- Proper Signage System in ELE/UG Station
- Telecommunication based on Optical Fiber
- AFC (Contact-less IC ticket), Full PSD for underground & half PSD for viaduct, Lift, Escalator, Barrier free facilities
- Customer care center
- Ticket vending machine

3.6 Depot

The depot of MRT Line-5N will be established in the north-east side of Hemayetpur station. The site is situated on the bank of Karnatali river and at the distance of 20km Northwest of Dhaka City. The site can be approached through the Dhaka – Aricha Highway. The land of depot site is not inhibited and a significant portion of the land is wet land. There are some residential areas with semi-urban and rural setting around the depot site. **Figure 3-1** shows the layout of depot. A parcel of land in the west side of depot will be used as construction yard during construction period. In future, this land will be used for depot expansion. Total land area in this site is 40.42 ha where depot will be established on 27.63 ha land and the construction yard will take 11.18 ha. In addition, 0.52 ha and 1.09 ha land will be used for constructing outer periphery road and access road. The location of the depot is very near to Hemayetpur station, which will reduce out-of service time of rolling stock.



Source: MFCA

Figure 3-1: Layout Plan of Depot

3.6.1 Infrastructures in Depot

Several types of infrastructure will be constructed in depot area to facilitate the mechanical, electrical, administrative, and other relevant works related to MRT operations. **Table 3-1** shows the infrastructures to be built in depot area. In addition to this structure, there will be several types of road network inside the depot. The primary roads will be 8 m wide mainly in the peripheral sides of the depot. There will be secondary road, mainly will serve the purpose of internal connectivity, with 6 m width. In addition, a periphery road will be constructed with 3.5 m width. A chain link fence around the depot will be built to ensure security and to prevent track access. Two types of tracks will be installed in depot, including ballast less track and embedded track. There will be a trial track in the eastern side of depot which will be a ballast less track.

Infrastructures in depot area includes sewage treatment plant and effluent treatment plant. There will also be storeroom for hazardous materials and scraps. In addition, an open yard will be facilitated for keeping non-hazardous scraps. Various types of workshop and maintenance tracks will be built in the depot for MRT operation and maintenance. The office building will accommodate the workspace of depot personnel as well as canteen and restroom. The control and signal panel of MRT-5N will also be installed in this building.

Table 3-1: Infrastructures to be built in Depot

Sl.	Infrastructure	Sl.	Infrastructure
1	Workshop shed	18	Air compressor room
2	Stabling yard	19	Scrap yard (open)
3	Under floor wheel truing shop	20	Scrap and used oil store (closed)
4	Heavy internal cleaning	21	Oil lubricant store and hazardous materials
5	Automatic train washing	22	Vehicle maintenance yard
6	OCS and track maintenance shed	23	OCS open store
7	Rail maintenance vehicle/Derail shed	24	Security and access control – 1 & 2 entry/exit
8	Shunting vehicle shed	25	Security tower
9	P-way store	26	High mast lighting
10	Warehouse/ central store/ depot manager	27	Parking area for staff/visitors
11	T.S. S	28	Rainwater harvesting tank
12	Depot A.S. S	29	Garbage compactor
13	Switch gear station	30	Coach delivery area (loading/unloading)
14	Admin building	31	Test track (L=850 m)
15	Effluent treatment room	32	R.S.S
16	Sewage treatment room	33	Boundary wall
17	UG tank/ pump room	34	Shunting neck

Source: MFCA

3.6.2 Geology and Topography

The depot area lies in the southern parts of Madhupur Tract, according to physiographic map of Bangladesh, published by Geological Survey of Bangladesh. Clayey soil layers are predominant in the upper part of the ground and immediately below the fill. **Figure 3-2** shows the soil profile of the depot area. Topographical elevation of the site varies from maximum +4.96m to +4.88m MSL (In North and South entry) and minimum of +0.17 MSL in the Swamp area (at the center). There is dense plantation area in the North and South end and Wetland with aquatic habitat in the center. As per Inundation survey, the 100-year flood water level is +8.21m MSL and considering freeboard of 1m as per Codal provisions, it is planned to fill entire site to achieve the Depot formation level as +9.3m MSL (depot and casting yard).

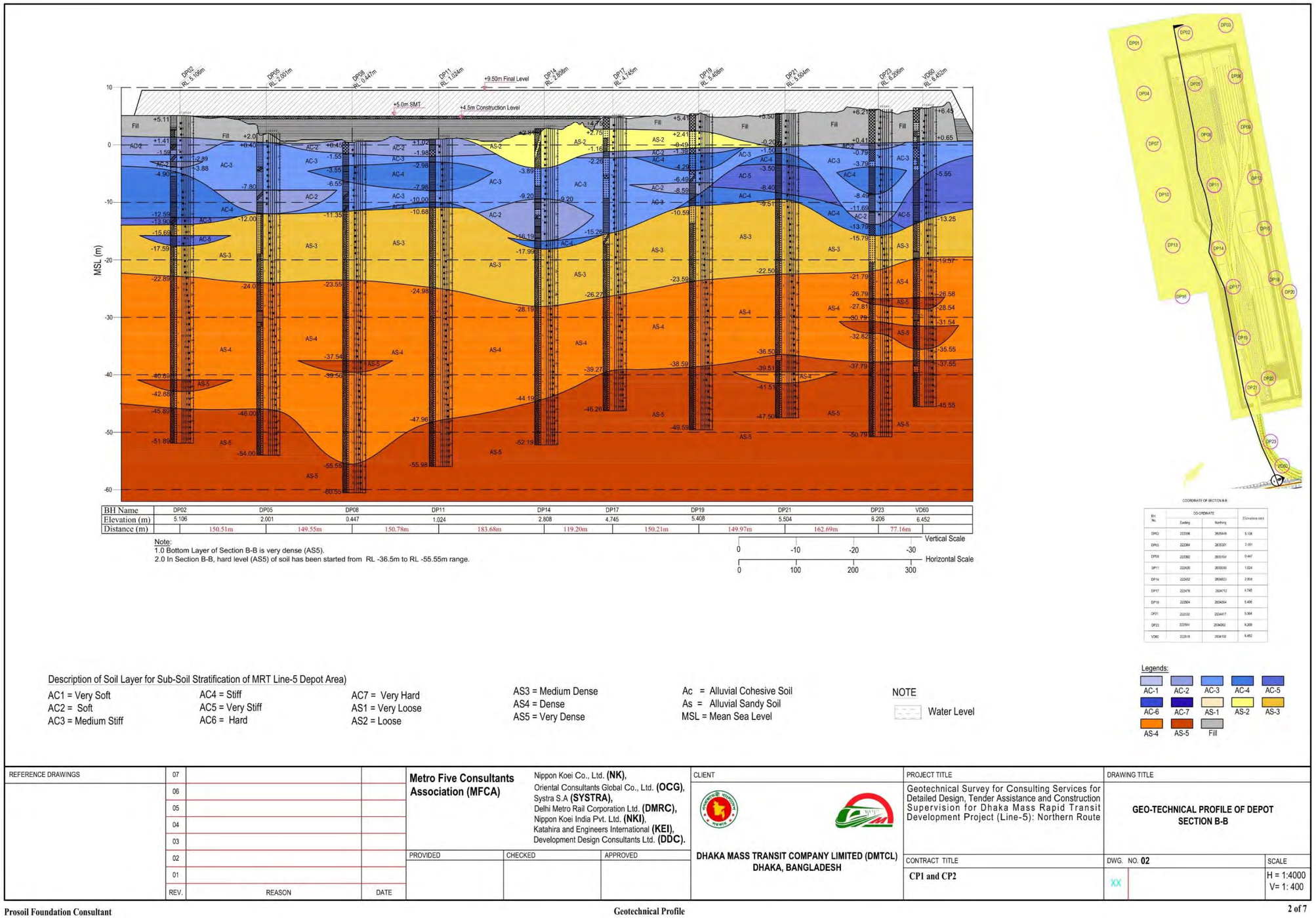


Figure 3-2: Soil Profile of the Depot Area

3.7 Elevated Section

The elevated section of MRT-5N comprises two segments, including one portion from Hemayetpur station to Amin Bazar station. The length of this sub-section is 5.0 km. There is another sub-section at the end of the line from Notun Bazar to Vatara Station with a length of 0.9 km. In total, the length of elevated section of MRT-5N is 5.9 km. Elevated section will be built by viaducts on piers. This alignment will be constructed along the northern side of Dhaka-Aricha Highway (N5). After Amin Bazar station, the alignment will go underground and will run as underground section until Notun Bazar Station. Some specifications related to elevated section are given in following **Table 3-2**.

The length of a viaduct would be 30 m in normal case, however, some long span will be constructed wherever necessary if there are any obstacles like river, canal or traffic intersection. The viaducts will be installed on individual piers and or portal frame. The viaducts will be constructed by joining several pre-cast segments. Besides, I-girder will also be used wherever necessary. The foundation of piers will be cast-in-situ pile. The long spans will be constructed by cast-in-situ balanced cantilever.

Table 3-2: Salient features of elevated section

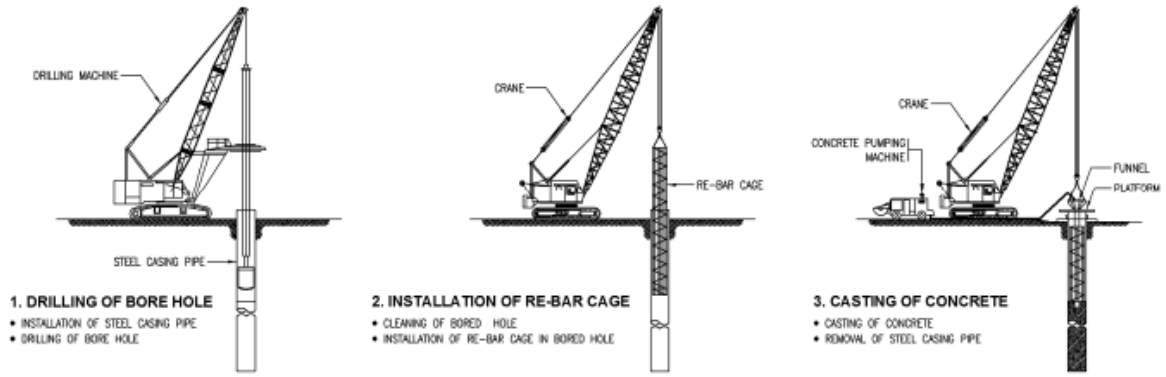
Item	Description
Viaduct Super Structure	Normal span 30m Segmental Box type
Sub Structure	Independent Pier and Portal Frame
Foundation	Cast-in-situ pile
Bridges	Cast-in-situ balanced cantilever rigid type PC Bridge; Nominal spanning; 75m+125+75m
Stations	Track and stations are partially connected structure type
Clearance for outer structure: elevated structure	2.85 m at standard section

Source: MFCA

3.7.1 Construction Method of Elevated Section

Construction of Pile

The viaduct foundation will be constructed by cast in place RC piles (bored). After installation of temporary steel casing into the ground using vibrator, the soil inside the casing will be removed, and bentonite slurry may be used to stabilize the soil and prevent the excavated hole from collapsing. After installation of the reinforcement cage into the bored hole, the concrete is poured into the excavated hole using a tremie pipe. At the end of the casting operation, the temporary steel casing will be removed (**Figure 3-3**).

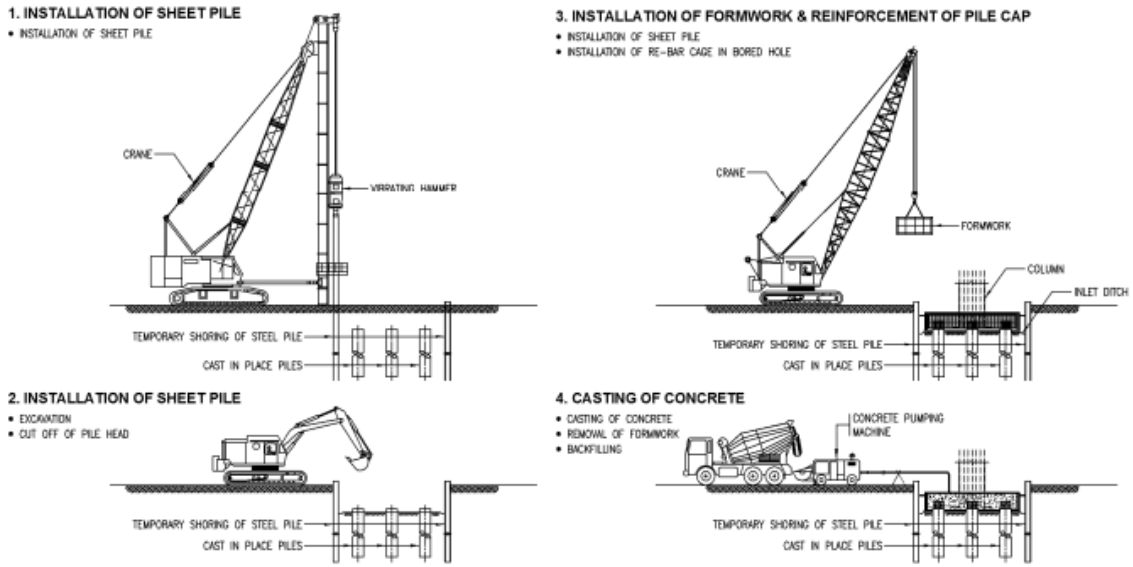


Source: MFCA

Figure 3-3: Construction Method for Cast-in-place RC Piles

Construction of Pile Cap

After installation of steel sheet piles, excavation works will be carried out up to the required level. Then, bricks chips bedding and blinding concrete will be proceeded so as to prepare a plane surface on which the formwork and re-bar can be installed. After casting the pile cap and removal of the formwork, the backfill work will be carried out up to the top surface of pile cap shortly afterwards (**Figure 3-4**).

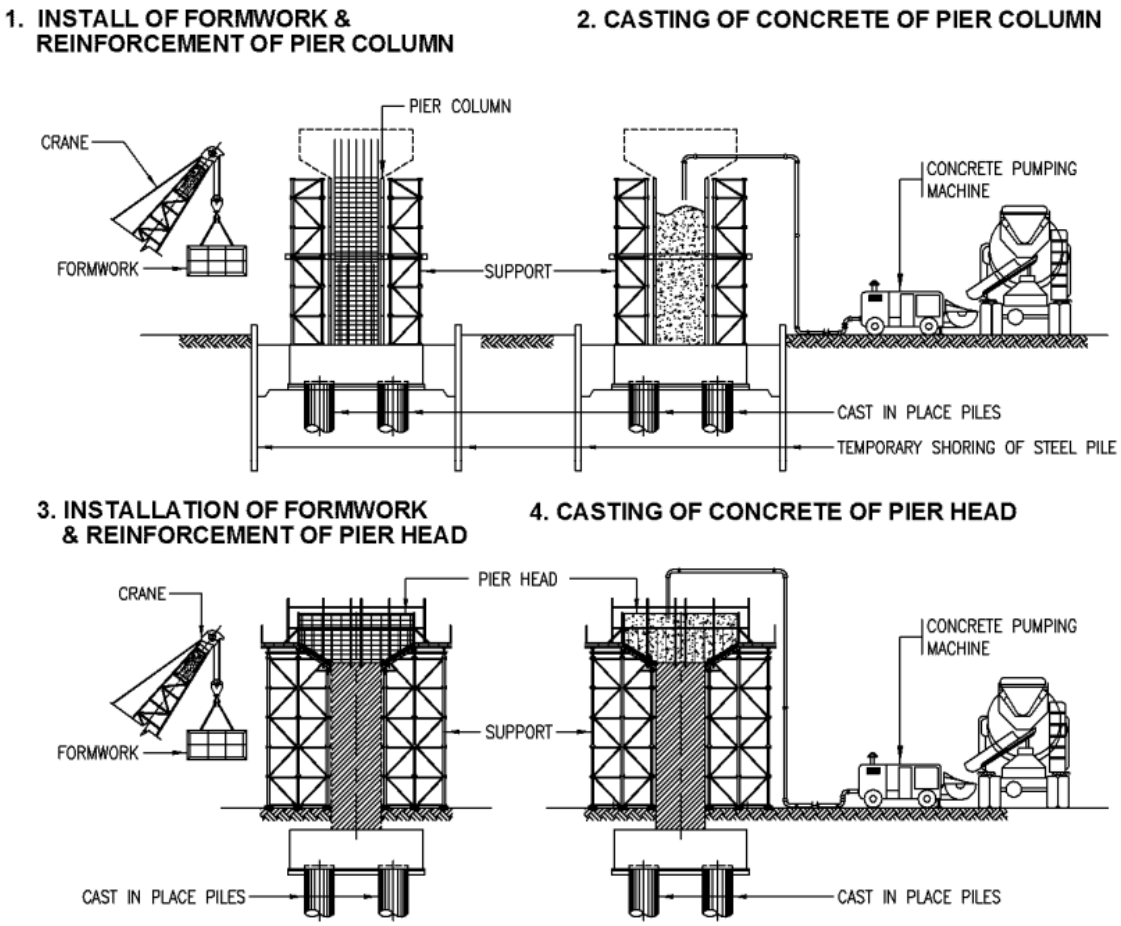


Source: MFCA

Figure 3-4: Pile Cap Construction

Construction of Sub-structure

After installing re-bars overlapping the starter bars of the pile cap, vertical formwork will set up and concrete casting will be done eventually. For the pier head, support should be assembled from the ground and the formwork will then be installed on top of pier head. After that the installation of re-bars and the pier head casting will be done sequentially (**Figure 3-5**).

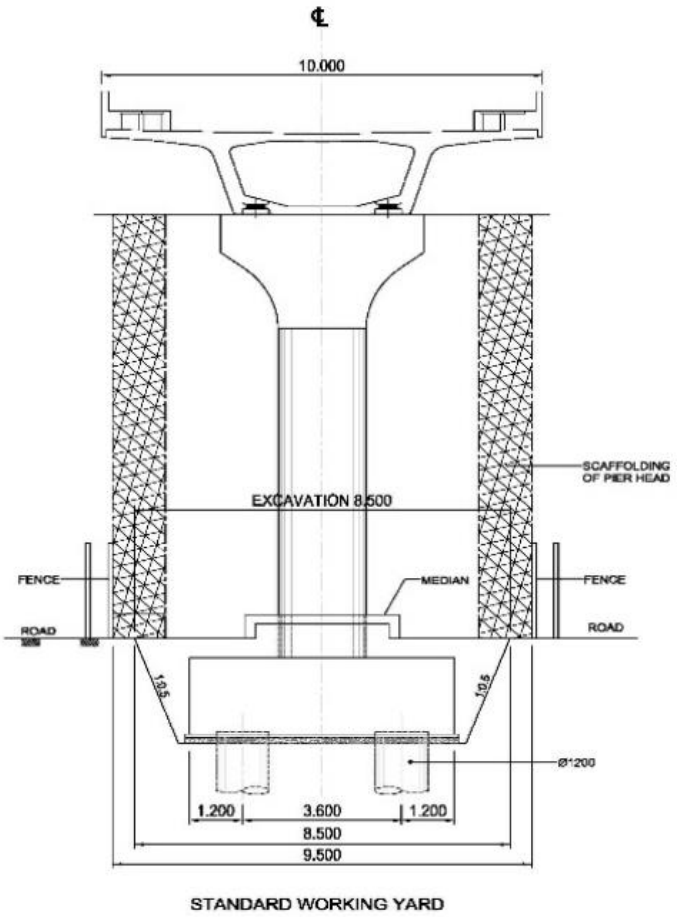


Source: MFCA

Figure 3-5: Construction Method for Substructure

Standard Working Yard

Standard working yard will be around 10 m, considering the phases of construction, the working yard can vary from 8.5 m to 10 m. The width of working yard will be approximately 8.5, 9.5, and 10 m during foundation phase, pier phase with formwork, and super structure phase (**Figure 3-6**).

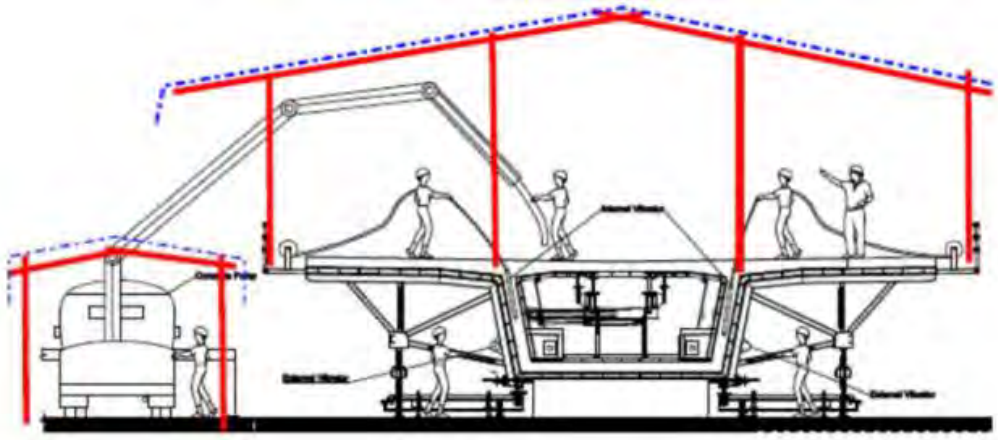


Source: MFCA

Figure 3-6: Standard Working Yard

Construction of Super Structure

The girder segments will be prefabricated and stored in the girder plant yard. The size of the plant yard and the production capacity is governed by the size of the job and the required. Casting plan will follow the sequence of producing each type of segment as per production schedule (**Figure 3-7**).



Source: MFCA

Figure 3-7: Construction method for super structure

Girder Segment Transportation and Launching

PC-Box Segmental Beam Erection using Span by Span method will be employed (**Figure 3-8**). This method will be used for span ranging from 20 to 50 m. The advantages of this method are: (1) False works are not required to support the deck during construction, (2) Improved concrete quality and formwork as the deck is casted in small segments, (3) Repetitive work resulting manpower efficiency, (4) Construction time saving as several spans can be erected simultaneously, (5) The impact of transportation can be minimized.

Source: MFCA

Figure 3-8: Span by Span Constructing Method

3.8 Underground Section

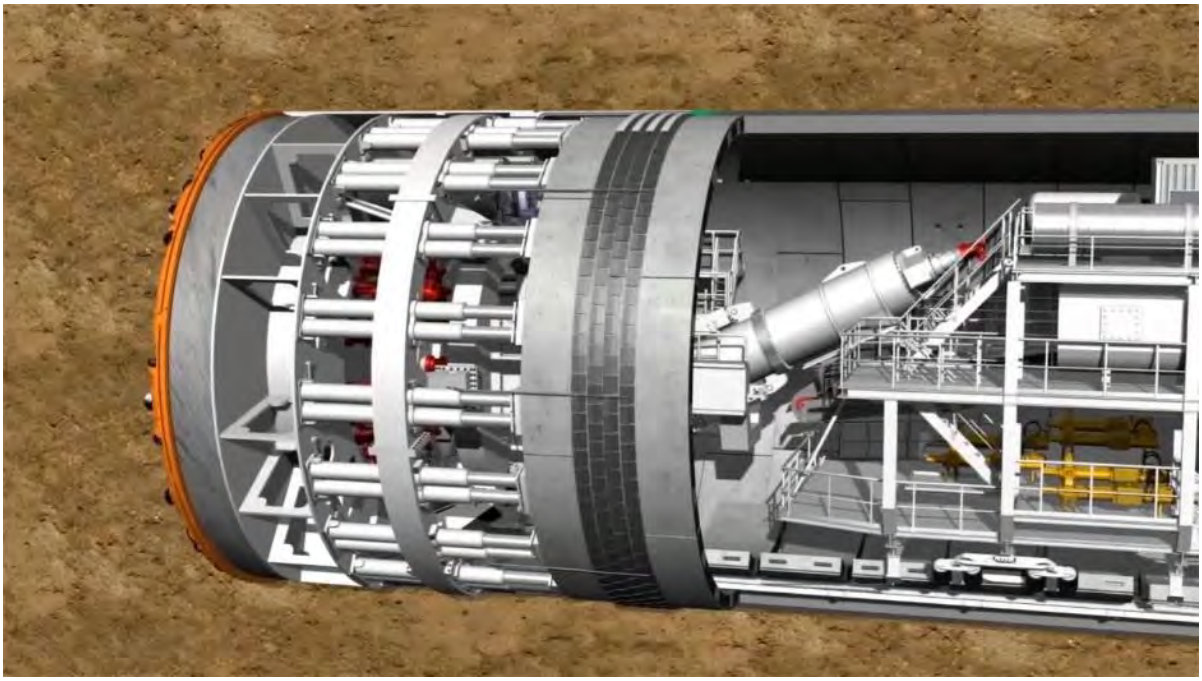
The underground section will start after Amin Bazar Station and it will run as underground section until Notun Bazar Station. Total length of underground section will be 14.1 km. This section will mostly follow the existing road network, except the cantonment area where the line will go under many buildings. There will be nine underground stations in this section. They are: Gabtoli, Darus Salam, Mirpur-1, Mirpur-10, Mirpur-14, Kochukhet, Banani, Gulshan-2, and Notun Bazar Station.

3.8.1 Tunnel Construction Method

The tunnel construction method will adopt the shield method, which is a non-excavation method. The EPB (Earth Pressure Balance) shield machine (figure 3-8) excavates the ground while stabilizing the face by pressurizing the muddy soil inside the chamber through shield thrust force and discharges the excavated soil through the screw conveyor. This type of shield machine can be categorized into two, namely, EPB shield machine, which has an inlet for additives to improve the properties of the excavated soil, and normal earth pressure shield machine, which is not equipped with the mechanism that the EPB shield machine has. However, this time, soil layers with different conditions will be excavated, so it is necessary to inject additives. The characteristics of the face stabilizing mechanism of the earth pressure shield machine are as follows:

1) For EPB, excavated soils are to be improved to contain plastic flow and water tightness by adding additives and by forcing them to mix using the cutter head and blades. Additive will not be applied in the normal earth pressure shield machine, and only mixing is applied.

2) Muddy soil is filled into the chamber and screw conveyor, and by pressurizing the muddy soil through shield jack thrust, the machine can resist the earth pressure and water pressure acting on the face.

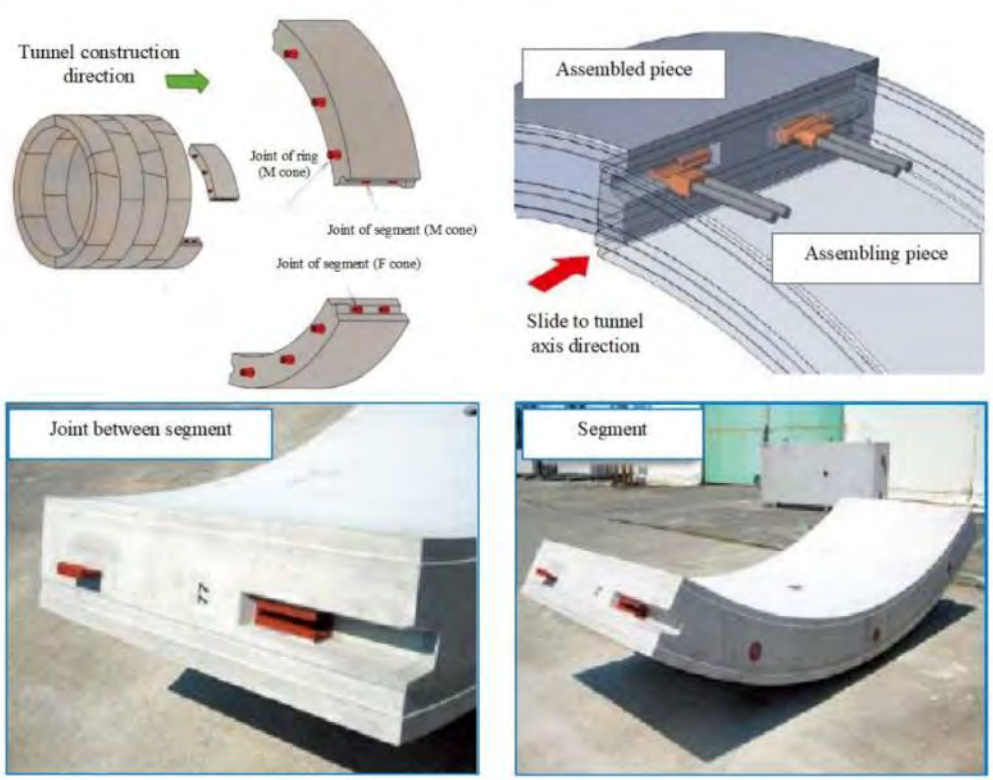


Source: MFCA

Figure 3-9: A Reference Photo of Earth Pressure Balance (EPB) Shield Machine

3.8.2 Tunnel Segment

The tunnel segment is a material of a factory product used for the primary lining of a shield tunnel. Segment types are divided into reinforced concrete segments, steel segments, and composite segments. The segment thickness is generally more than 4% of the outer diameter based on experience. In addition, the current outline study results require a thickness of about 300 mm. (When the thickness is 300 mm, h/Do=4.5%). The segment width of the general part will be 1.5 m in consideration of transportation and direction change in the underground. The segment width is set separately for the curved portion of R=180 m that becomes a sharp curve. It is planned to use one-pass joints for the segment joints in MRT Line-5N. One-pass joints are mechanical joints that do not use bolts, stronger than bolted joints, have less deformation of the joints, and a structure that is unlikely to cause a mistake and opening that causes water leakage. Since the joint is embedded in the concrete, it does not fall loose like a bolt-type joint after use and does not rust and maintenance is easy.



Source: MFCA

Figure 3-10: Segment Assembling by one-pass Joint

3.9 Stations

Total 14 stations will be constructed in MRT Line-5N, including both elevated and underground stations. The number of elevated and underground stations is 05 and 09, respectively. The line will start with an elevated station in Hemayetpur and it will end with another elevated station in Vatara. After Hemayetpur Station, there will be another three elevated stations in a row. They are: Baliarpur, Bilamalia, and Amin Bazar Station. Then the line will go underground before Turag River and will continue as an underground section until Notun Bazar Station. The underground stations include Gabtoli, Dar-us-Salam, Mirpur-1, Mirpur-10, Mirpur-14, Kochukhet, Banani, Gulshan-2, and Notun Bazar. After Notun Bazar station the line will emerge again and will continue as an elevated section until its terminus point in Vatara Station. **Table 3-3** shows the characteristics of stations, including their type, number of floors, number of platforms, and number of tracks.

Table 3-3: Characteristics of Stations

No.	Station Name	Station Type	Storied	No of Platform	No of Tracks
St1	Hemayetpur	Elevated	3 Storied	2	2
St2	Baliarpur	Elevated	3 Storied	2	4
St3	Bilamalia	Elevated	3 Storied	2	2
St4	Amin Bazar	Elevated	3 Storied	2	2
St5	Gabtoli	Underground	3 Storied	2	3
St6	Dar-us-Salam	Underground	2 Storied	1	2

No.	Station Name	Station Type	Storied	No of Platform	No of Tracks
St7	Mirpur 1	Underground	2 Storied	1	2
St8	Mirpur 10	Underground	3 Storied	1	2
St9	Mirpur 14	Underground	2 Storied	1	2
St10	Kochukhet	Underground	2 Storied	1	2
St11	Banani	Underground	4 Storied	2	2
St12	Gulshan 2	Underground	4 Storied	2	2
St13	Notun Bazar	Underground	4 Storied	1	2
St14	Vatara	Elevated	3 Storied	2	2

Source: MFCA

Note: Subject to change as detail design is ongoing.

3.9.1 Platform Type and Width

The platform type and width of each station are shown in the **Table 3-4**.

Table 3-4: Platform Type and Width of Stations

Section	Station	Platform Type	Platform Width (m)	Remarks
Elevated	Hemayetpur	Lateral	7.0	
	Baliarpur	Island	10.65	2 platforms with 4 tracks
	Bilamalia	Lateral	7.0	
	Amin Bazar	Lateral	7.0	
Underground	Gabtoli	Island	8.0	2 platforms with 3 tracks
	Dar Us Salam	Island	10.0	
	Mirpur 1	Island	10.0	
	Mirpur 10	Island	10.0	
	Mirpur 14	Island	10.0	
	Kochukhet	Island	10.0	
	Banani	Lateral	7.0	Vertical parallel station
	Gulshan 2	Lateral	7.0	Vertical parallel station
	Notun Bazar	Island	10.0	
Elevated	Vatara	Lateral	7.0	

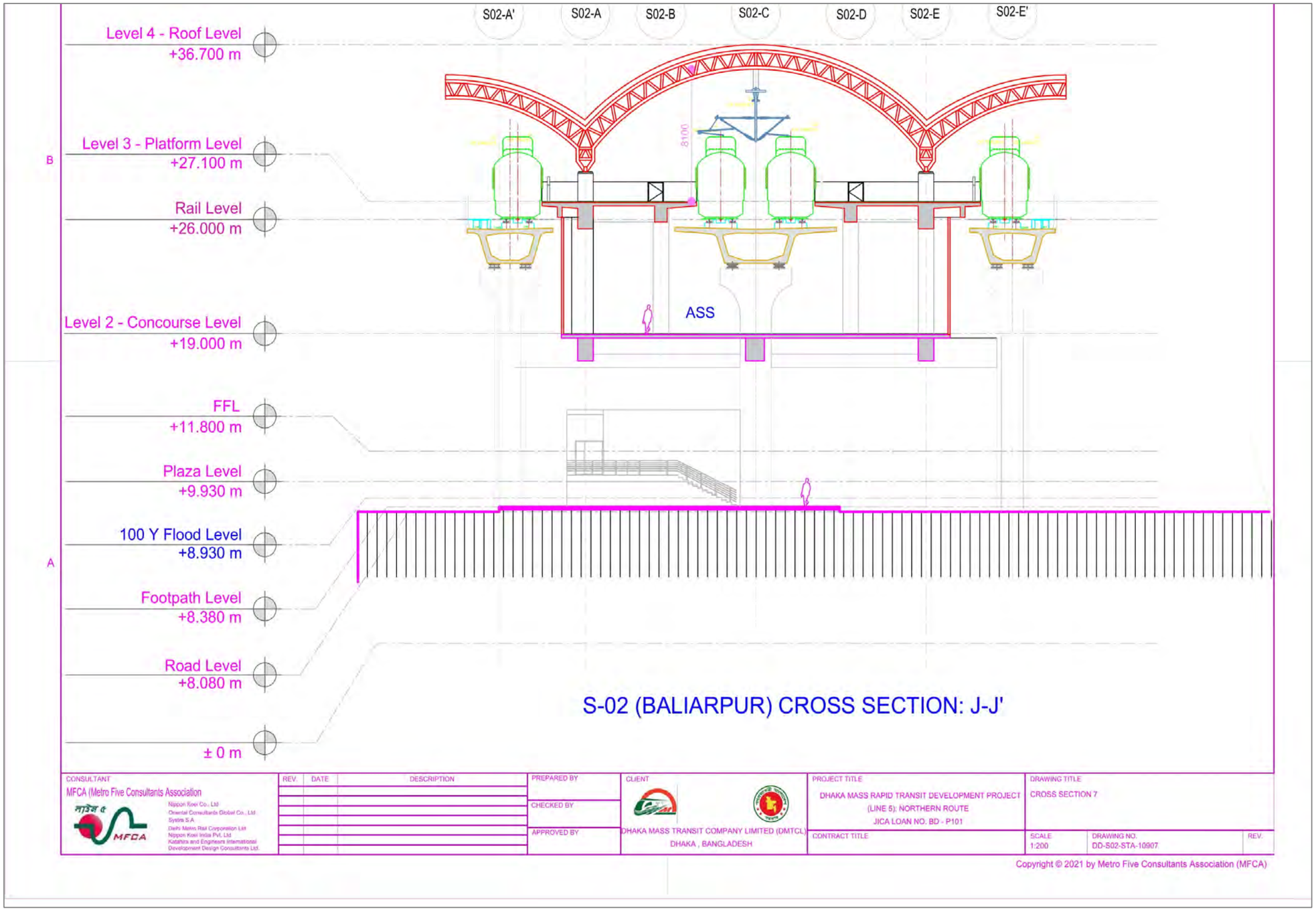
Source: MFCA

Note: Subject to change as detail design is ongoing.

3.9.2 Construction of Elevated Station

The construction method for elevated station will be cast-in-situ construction. Firstly, construction of bored pile and pile cap will be conducted by cast-in-situ method. Secondly, the station columns along the footpath and on median (along viaduct centerline) at 15 m spacing will be constructed. Thirdly, cordon the area and install temporary portal frames support at certain intervals to support the scaffolding and formworks required for the casting of concourse beams and slabs. After the construction of the concourse beams and slab have been done, the temporary supports can be removed. The concourse columns; ground level stairs can be constructed at this stage. Then, Construct the platform beams and slabs. This can include the construction of stairs from concourse to platform.

The elevated section from Hemayetpur to Amin Bazar will not be constructed on the median or central line of existing Dhaka-Aricha Highway (N5) as there is a provision of future elevated expressway. Instead, the MRT line will be constructed in the northern side of N5 highway to facilitate space for the elevated expressway. The elevated stations will also be constructed in the northern side of the highway. A typical cross section of the elevated station is shown in **Figure 3-11**.



Source: MFCA

Figure 3-11: Typical Cross Section of Elevated (Baliarpur) Station

3.9.3 Construction of Underground Station

Construction Methods

All underground station structures will be mainly composed of reinforced concrete diaphragm walls (d-wall) and slabs. The station box will be constructed within d-walls by using “Top-Down” construction technique. The construction sequence of this main box is briefly described as follows;

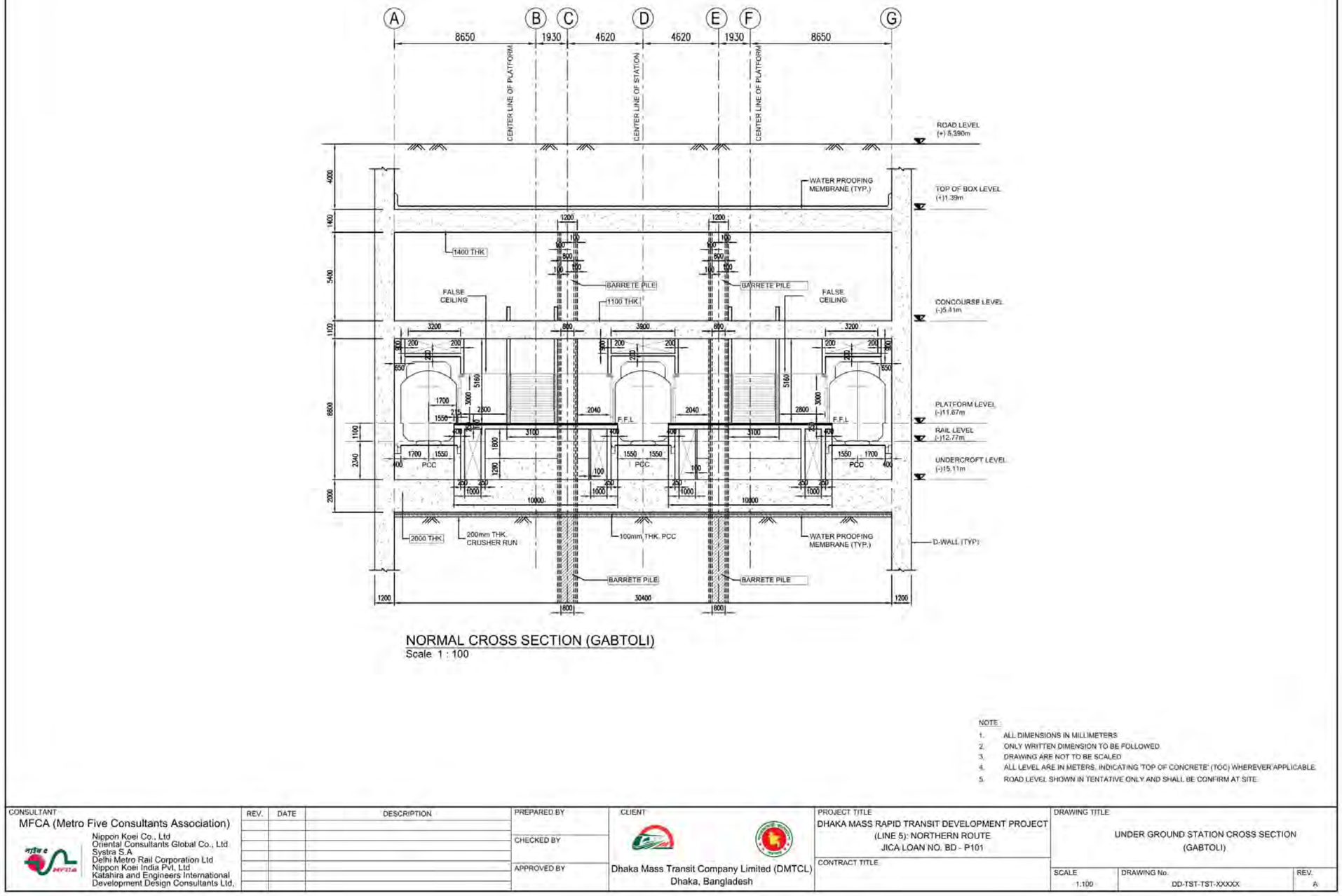
1) Construct guide wall then construct all d-wall along perimeter of the station box.
2) Soil excavation to the depth 1.50m below road level, then demolish the unsound concrete on the top of diaphragm wall and demolish the interior guide wall.
3) Construct the capping beam on top of diaphragm wall.
4) Excavate to depth not more than 3.00m from road level then install temporary platform or temporary steel bracing.
5) Construct reinforced concrete roof slab but some portions of slab will be opened for soil removal.
6) Soil excavation to the depth of B1F then construct reinforced concrete slab with some opening.
7) Repeat the soil excavation and construct concrete slab for B2F, B3F or PFF until concrete bottom slab has been poured. In case of the soil excavation depth is deeper than 6.00m, the temporary steel bracing shall be provided.

Once the d-wall and all floor slabs are completed, the other concrete structures inside station can be casted as normal practice.

For the entry/exit of the station, the “Bottom-Up” method may be adopted depending on the vicinity land use. In case of the entry/exit, has been constructed by "Bottom-Up" method the construction procedure can simply explain as follows.

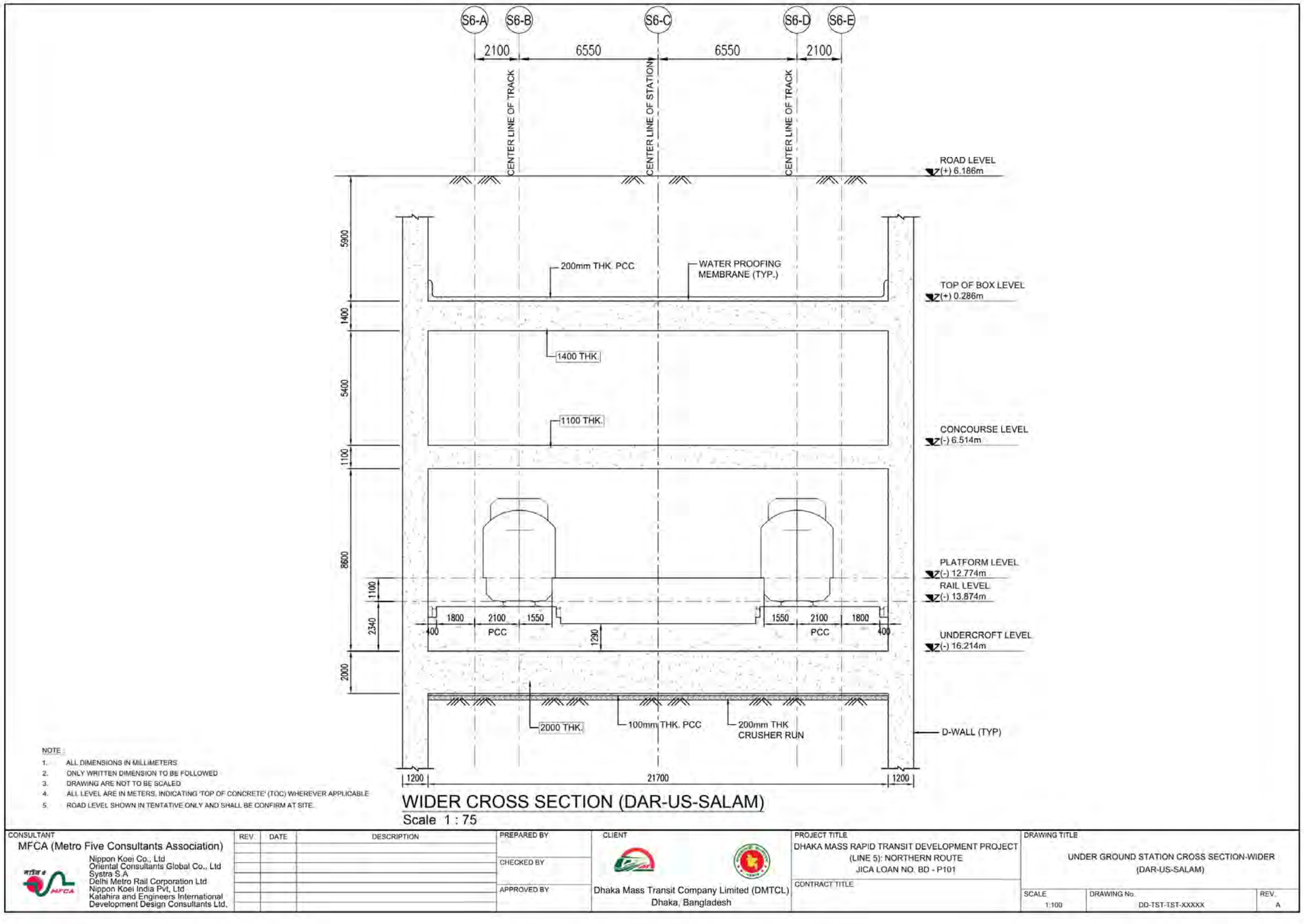
1) Installation of temporary steel sheet pile around the perimeter of the entry/exit.
2) Soil excavation and temporary steel bracing will be provided at every 3-4m deep.
3) Once the excavation reaches the desired depth (12 up to 14m deep), the reinforced concrete bottom slab will be constructed.
4) The reinforced concrete wall (RC wall) will be constructed, then the temporary steel sheet pile and bracing can be removed.
5) Cast in-situ reinforced concrete roof slab and the other concrete structures inside entry/exit of station

Typical cross section of the underground station is shown in **Figure 3-12** to **Figure 3-19**.



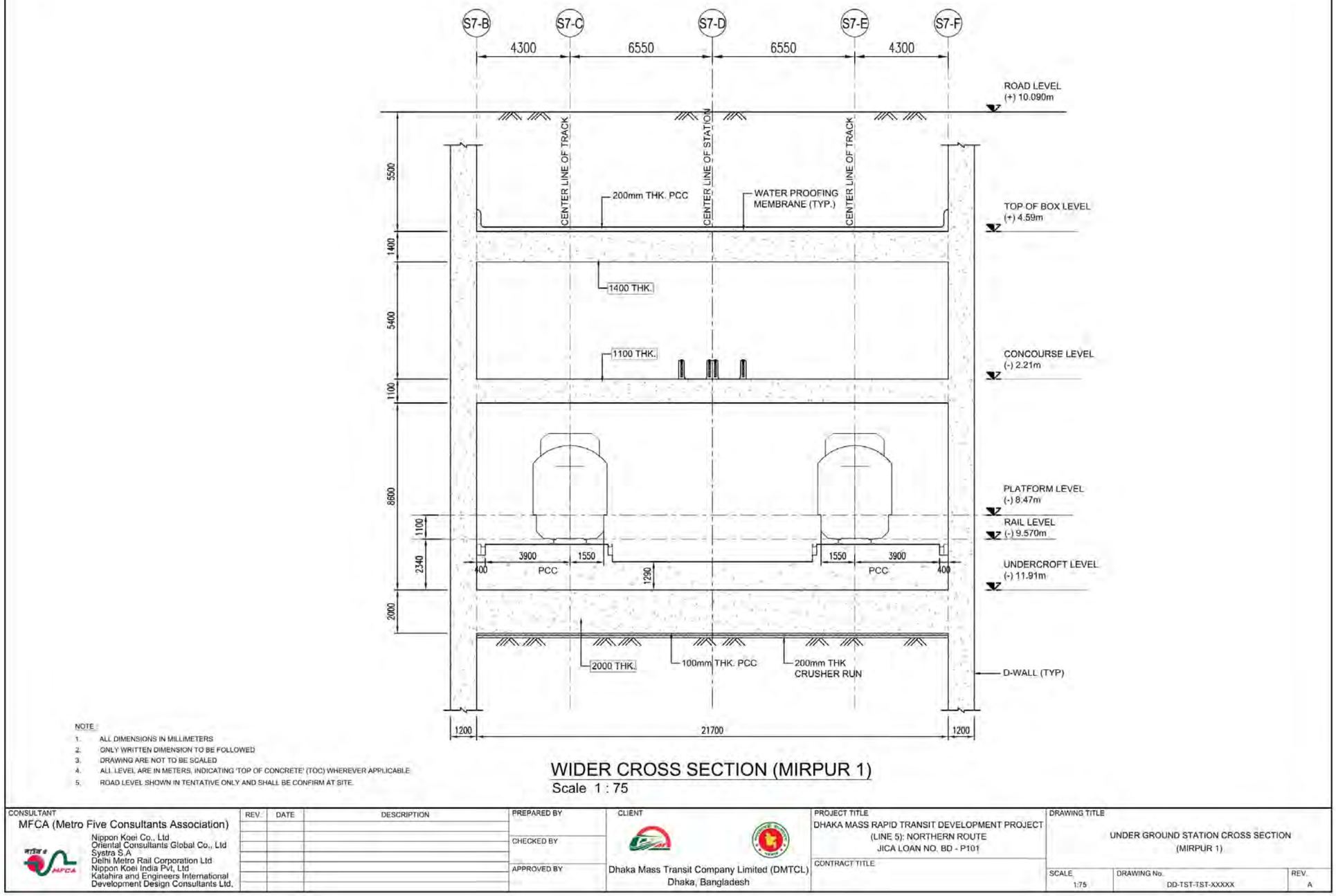
Source: MFCA

Figure 3-12: Typical Cross Section of Underground (Gabtoli) Station



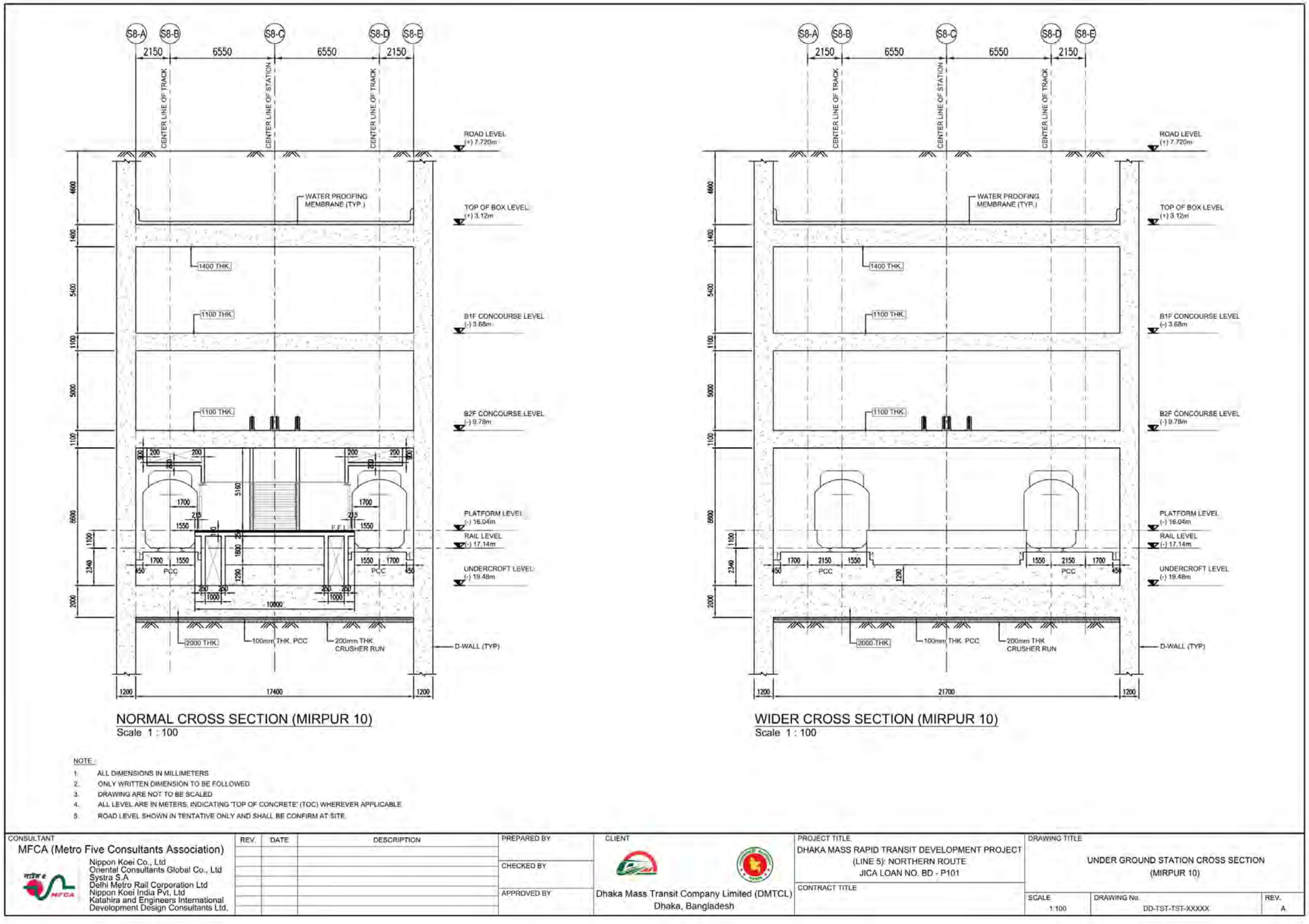
Source: MFCA

Figure 3-13: Typical Cross Section of Underground (Dar-Us-Salam) Station



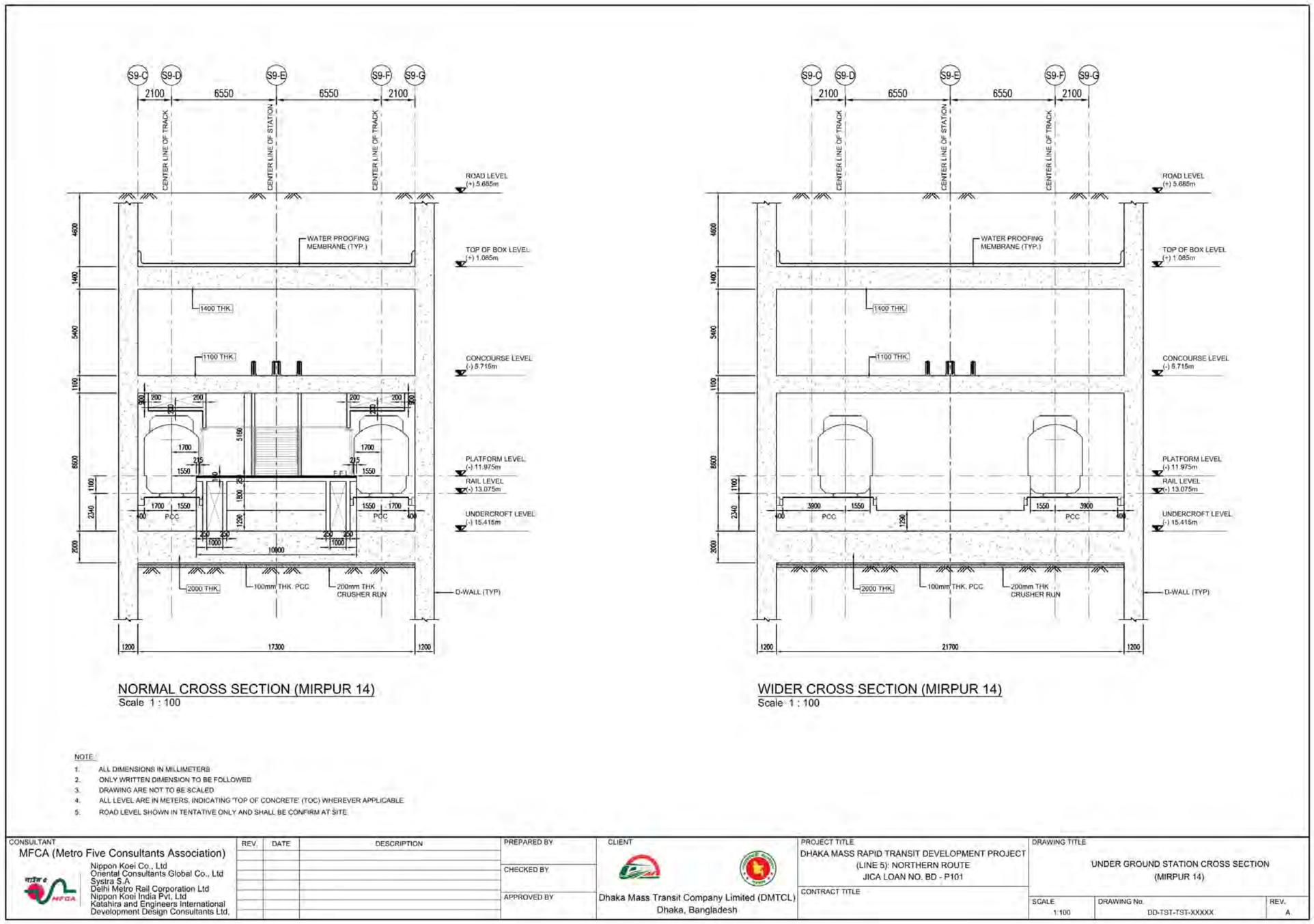
Source: MFCA

Figure 3-14: Typical Cross Section of Underground (Mirpur 1) Station



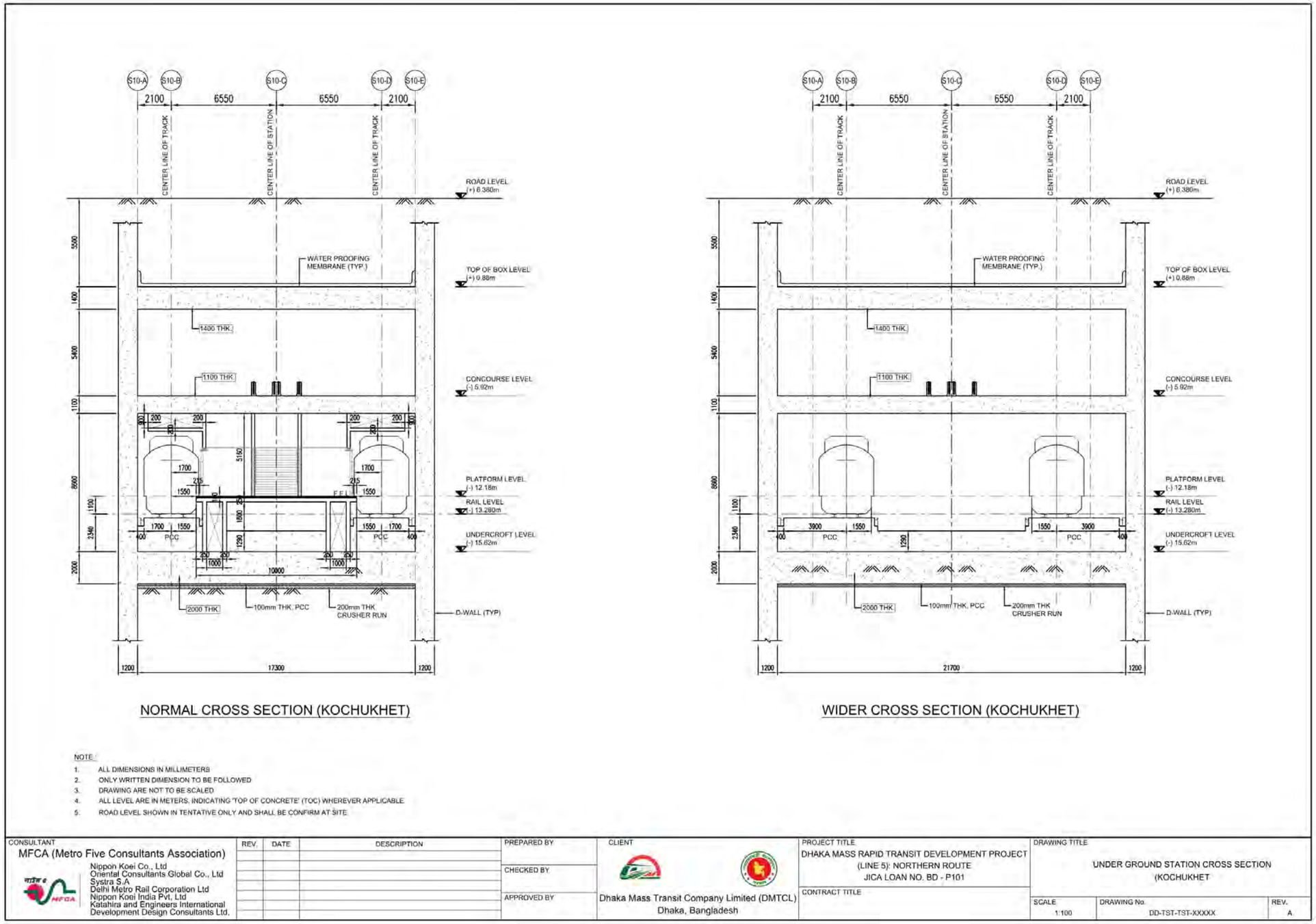
Source: MFCA

Figure 3-15: Typical Cross Section of Underground (Mirpur 10) Station



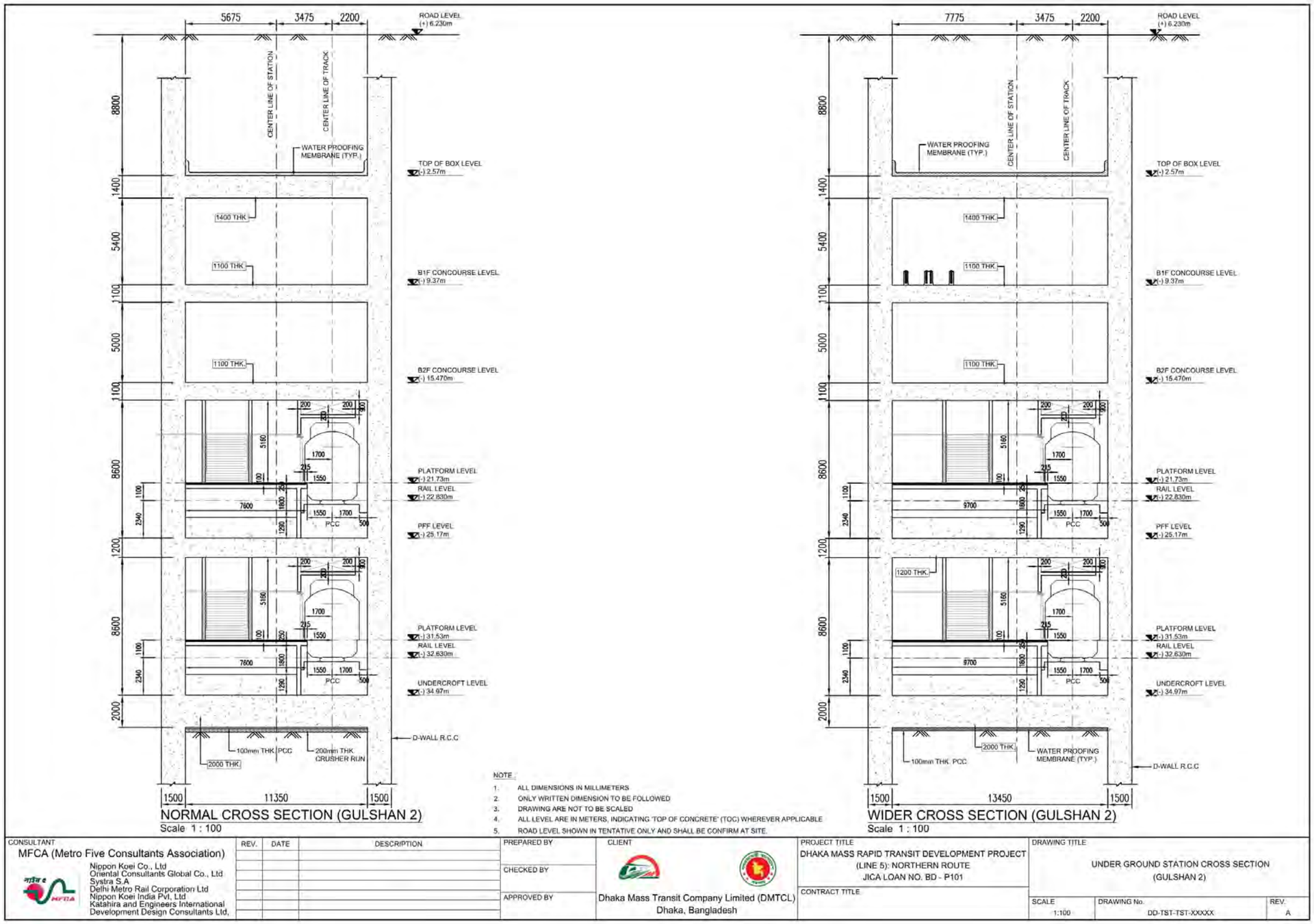
Source: MFCA

Figure 3-16: Typical Cross Section of Underground (Mirpur 14) Station



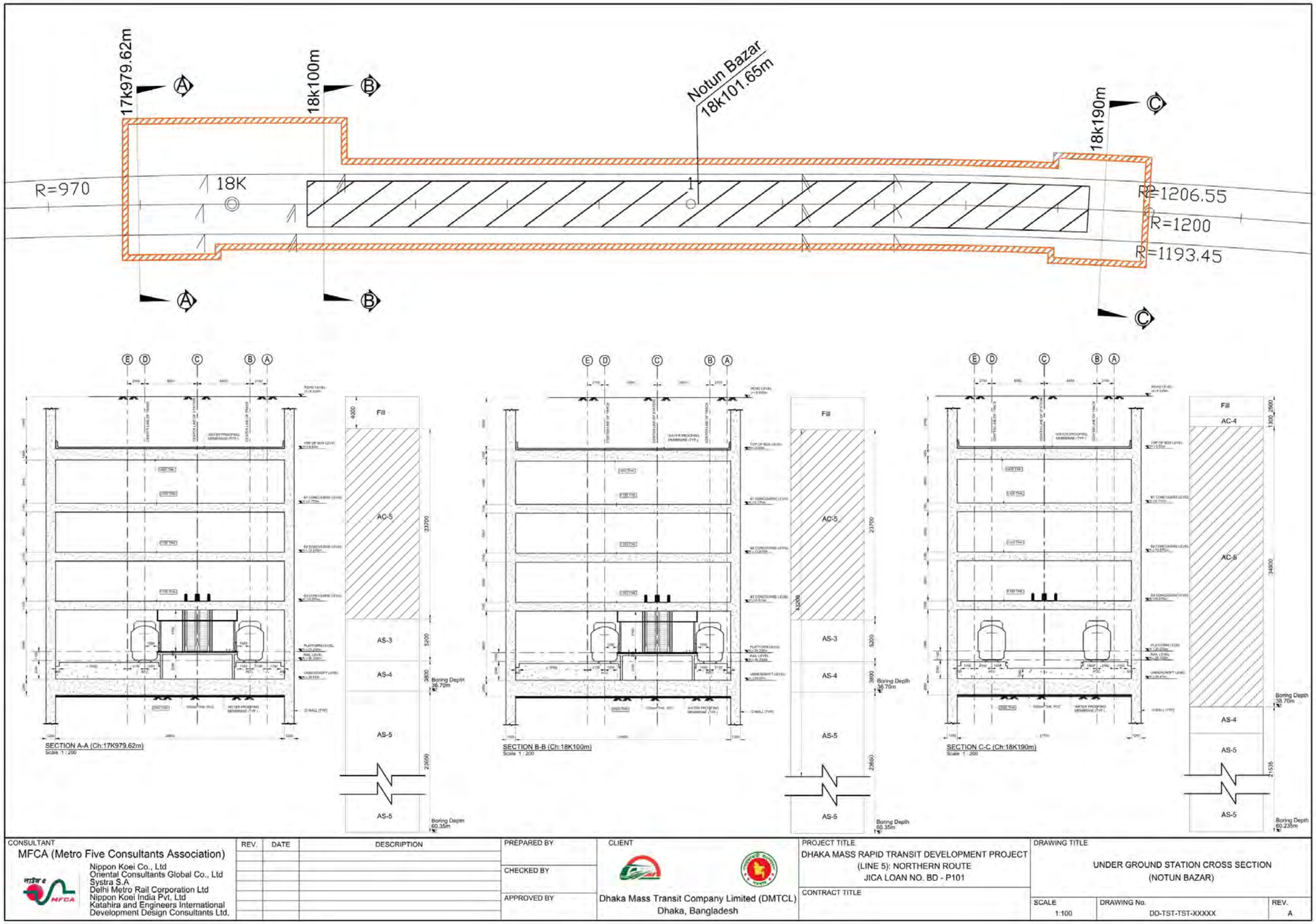
Source: MFCA

Figure 3-17: Typical Cross Section of Underground (Kochukhet) Station



Source: MFCA

Figure 3-18: Typical Cross Section of Underground (Gulshan 2) Station



Source: MFCA

Figure 3-19: Typical Cross Section of Underground (Notun Bazar) Station

3.10 Track

The type and characteristics of rail track will be like other MRT lines, such as MRT-6 and MRT-1. In elevated section, ballastless MSS track will be used. On the other hand, floating slab will be used in underground section. This type of track will create less noise and vibration. **Table 3-5** shows the characteristics of track to be installed in MRT Line-5N.

Table 3-5: Characteristics of Track

Item	Line 6	Line 1	Line 5N
Horizontal curvature a) Min. radius except station	160m	160m	160m
b) Min radius at station	400m	400m	400m
c) Siding	100m in depot	100m in depot	100m in depot
Vertical Alignment a) Max. gradient	35%	35%	35%
on running lines	35%	35%	35%
on non-running lines	5%, but areas where rolling stock are not stored or not coupled / decoupled – 10%	5%, but areas where rolling stock are not stored or not coupled / decoupled – 10%	5%, but areas where rolling stock are not stored or not coupled / decoupled – 10%
Along platform	5%, but desirable gradient at station – 0%	5%, but desirable gradient at station – 0%	5%, but desirable gradient at station – 0%
b) Vertical curve (minimum radius)	3000m[2000m] 4000m[3000m] (in case the horizontal curve radius is 600m or less) Value in [ ] shows absolute minimum case.	3000m[2000m] 4000m[3000m] (in case the horizontal curve radius is 600m or less) Value in [ ] shows absolute minimum case.	3000m[2000m] 4000m[3000m] (in case the horizontal curve radius is 600m or less) Value in [ ] shows absolute minimum case.
Main line: Elevated	Ballast less track, Plinth type	Ballast less track, Plinth type	Ballast less track, Plinth type
Main line: Underground	N/A	Floating Slab Type	Floating Slab Type
Depot	Ballast track on PC sleepers	Ballast track on PC sleepers	Ballast track on PC sleepers

Source: MFCA

3.11 Rolling Stock

The train of MRT Line-5N will consists of 08 cars. The cars will be made of stainless-steel structure with fixed type windows. The maximum operating speed of train will 100 km/hr with 3.3 km/h/s acceleration rate and 3.5 km/h/s deceleration. **Table 3-6** shows the characteristics of rolling stock.

Table 3-6: Characteristics of rolling stock

Item	Features (MRT 5N)
Train formation	8 cars
Train composition	6M2T
Propulsion system	VVVF inverter system
Traction motor rating	170 kW
Braking	Mechanical and electrical (regenerative) Mechanical brake type is TBD (To be Decided)
Coach construction	Structure is stainless steel
Windows	Fixed type
Seating arrangements	Long seat, two wheelchair spaces per train Wheelchair space: #4 & 6 car
Operating speed	Max. operating speed: 100km/h
Acceleration	3.3km/h/s (0.92m/s2)
Deceleration	Service:3.5km/h/s (0.97m/s2) Emergency: 4.5km/h/s (1.25m/2)
Adhesion	Less than 20%
Axle load	Max. 16 t
Vehicle dimension	- Width: Within 3000mm Vehicle gauge - Length: Maximum 20400mm (End car), 20000mm (Middle car)
Floor height	1130 mm
Bogie wheelbase	2100 mm and 13800 mm center distance
Wheel diameter	860mm
Door	W: 1500mm, H: 1850mm, 4 door/car each side
Ventilation arrangement	Forced air ventilation, 13m^3/h per person.
Air conditioning	Outside: 37℃75% RH Inside: 22℃60% RH With 180% congestion.
Carrying capacity of coaches	2336 pax. At 180% congestion ratio
Required number of trains	Not determined yet

Source: MFCA

3.12 Control Points for Alignment Design

There are some physical structures along the alignment of MRT Line-5N that influences the design. The design has been conducted based on the technical standard for the MRT of Bangladesh. Design team has considered all the relevant aspects and analyzed different alternative options during the design stage. The obstacles or controlling factors have been considered carefully during design to minimize the impacts on the surface structure as well as considering the resettlement cost. Further details can be found in the design report.

3.12.1 PPP Expressway Parallel Section (Hemayetpur to Turag River)

There is a proposal for PPP expressway in parallel to the alignment of MRT Line-5N. So, it is important to consider the PPP expressway to arrange the MRT alignment within the ROW including the station section. Design team has considered relevant aspects of PPP expressway during the detailed design stage of the MRT line-5N.

3.12.2 Intersection of Main Line and Depot Access Line

At the intersection, the depot access line runs over the service road of the PPP expressway. The height of the depot access line needs to keep clearance of the service road, and also, the height of the main line needs to give clearance to the depot access line. Design team has considered these aspects during the detailed design of the MRT line-5N.

3.12.3 Turag River Section

The new 8-lane Amin Bazar Bridge is planned on the south side of the existing bridge over theTurag River. Design team has considered both the bridges during the detailed design to avoid any interfere with the bridges and the tunnel of MRT Line-5N.

3.12.4 8-story Building at the Intersection of Dar-Us-Salam Road and Mazar Road

There is an 8-story building at the intersection of Dar-us-Salam Road and Mazar Road. During the detailed design stage, design team finalized the alignment of Line-5N avoiding the building.

3.12.5 Banani Cantonment Area

In Banani Cantonment Area, pile foundations of the Residential buildings, and those of Dhaka Elevated Expressway (DEE) (expansion) are the control points for the MRT line 5N alignment. As per the detailed design, Line-5N tunnel will pass under the residential buildings. However, it will not affect the pile foundations. The design team prepared the design considering pile length and future development.

3.12.6 Notun Bazar Area

In Notun Bazar area, (1) Thai Embassy and (2) Intersection with Line-1 are the control points for the MRT line 5N alignment. Design team has considered both points during the detailed design stage to avoid any interfere.

3.12.7 Bridge Height Near Vatara Station

There is a river near the Vatara Station. So, the design team has considered the river and existing bridge height during the detailed design.

3.12.8 Required Height/Depth of Station

During the detailed design stage, the design team has considered required height and depth of the elevated and underground station and designed accordingly.

3.12.9 Tunnel Depth for passing Gulshan-Baridhara Lake

The Line-5N tunnel will pass under the Gulshan-Baridhara Lake, which is designated as ECA by the department of Environment. During the detailed design, the design team has considered the lake and finalized the tunnel depth between Gulshan 2 station and Notun bazar station as deeper than the other underground station to avoid any significant impact on ECA.

3.13 Alternative Analysis

3.13.1 No Action Option

No action option is a case that MRT Line 5N is not implemented. In that case, in Dhaka Metropolitan Area (DMA), chronic traffic congestion would cause significant problem. Expected population increase and economic growth will cause expansion of traffic congestion, deterioration of environment and economic loss.

In case that MRT Line 5N is not implemented, no land acquisition and involuntary resettlement are expected. However, sustainable growth of local industry will be hampered. The environment of the area will deteriorate further by the traffic congestion and air pollution.

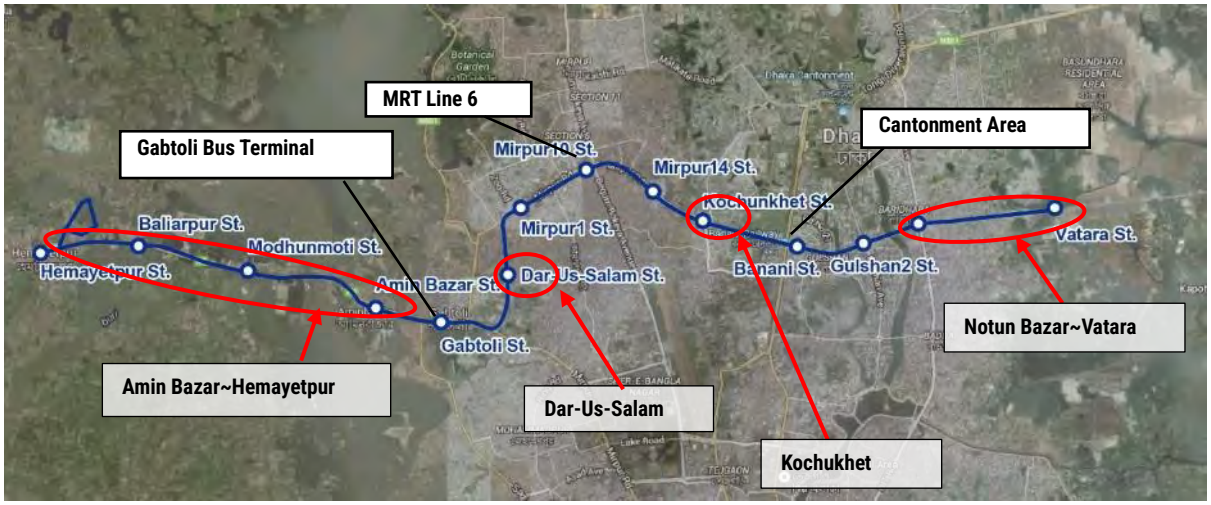
3.13.2 Comparison of Structure Types

The JICA study team for F/S (2017) studied following three structures which have different underground sections. (See Figure 3-21)

(1) Section between Kochukhet and Notun Bazar
(2) Section between Dar-Us-Salam and Notun Bazar
(3) Section between Gabtoli and Notun Bazar

Since the project is a railway which passes through the urban area of Dhaka city, major criteria are avoidance or minimization of living environment of local resident, pollution control and social environment including land acquisition and involuntary resettlement.

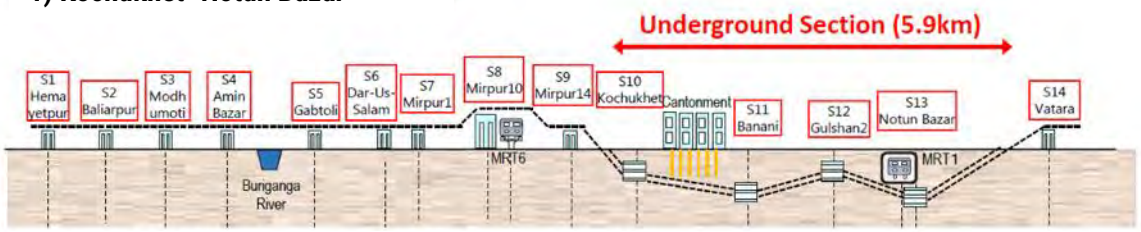
Long viaduct options cause significant land acquisition, involuntary resettlement and landscape because length of viaduct section in the centre of the city is longer. (3) option (Gabtoli-Notun bazar) is superior to the other options on the air pollution, noise and vibration. Although (3) occurs most excavation soil than the other options, (3) option can minimize negative impacts to the environment and health. Therefore (3) option is recommended on pollution control. (See **Table 3-7**)



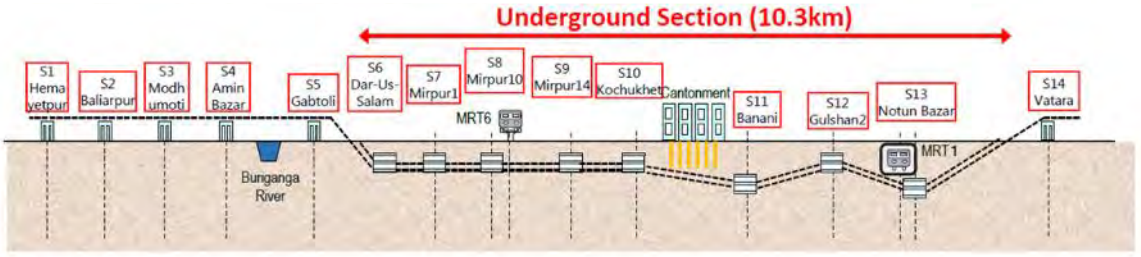
Source: JICA Study Team, 2017

Figure 3-20: Location of Underground Section of Alternative Routes

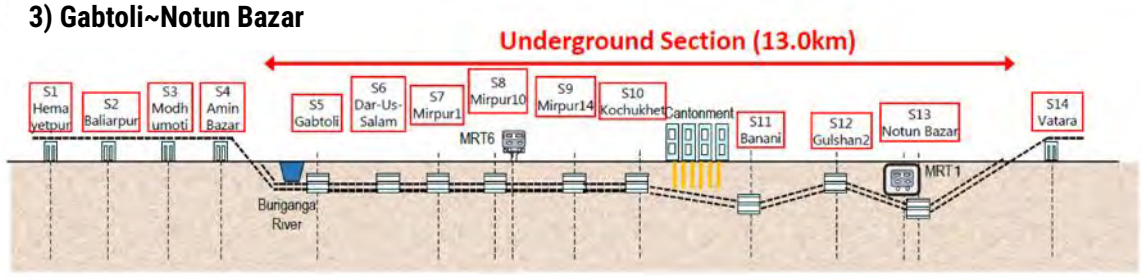
1) Kochukhet~Notun Bazar



2) Dar-Us-Salam~Notun Bazar



3) Gabtoli~Notun Bazar



Source: JICA Study Team, 2017

Figure 3-21: Underground Section of Alternative Route

Table 3-7: Comparisons of Underground Sections of MRT Line 5N

Options / Items	1) Section between Kochukhet and Notun Bazar	2) Section between Dar-Us-Salam and Notun Bazar	3) Section between Gabtoli and Notun Bazar
Construction/Project			
Length	19.7km (Viaduct 13.8km, underground 5.9km)	19.7km (Viaduct 9.4km, underground 10.3km)	19.7km (Viaduct 6.7km, underground 13.0km)
Stations	14 (Viaduct 10, Underground 4)	14 (Viaduct 6, Underground 8)	14 (Viaduct 5, Underground 9)
Construction Cost	280 billion Yen	330 billion Yen	360 billion Yen
Feature of Structure	△: Length of underground section is shortest. The viaduct at the intersection with MRT Line 6 needs high rise structure exceeding 30m.	○: The centre of Dhaka except Gabtoli takes a tunnel structure. Suburb takes a viaduct structure.	◎: The centre of Dhaka takes a tunnel structure. Suburb takes a viaduct structure.
Difficulty of Construction	△: The section of underground needs construction spaces at stations alone. Viaduct section is long and needs a	○: The section of underground needs construction spaces at stations alone. Because Gabtoli and the vicinity is	◎: The section of underground needs construction spaces at stations alone. On the viaduct section,

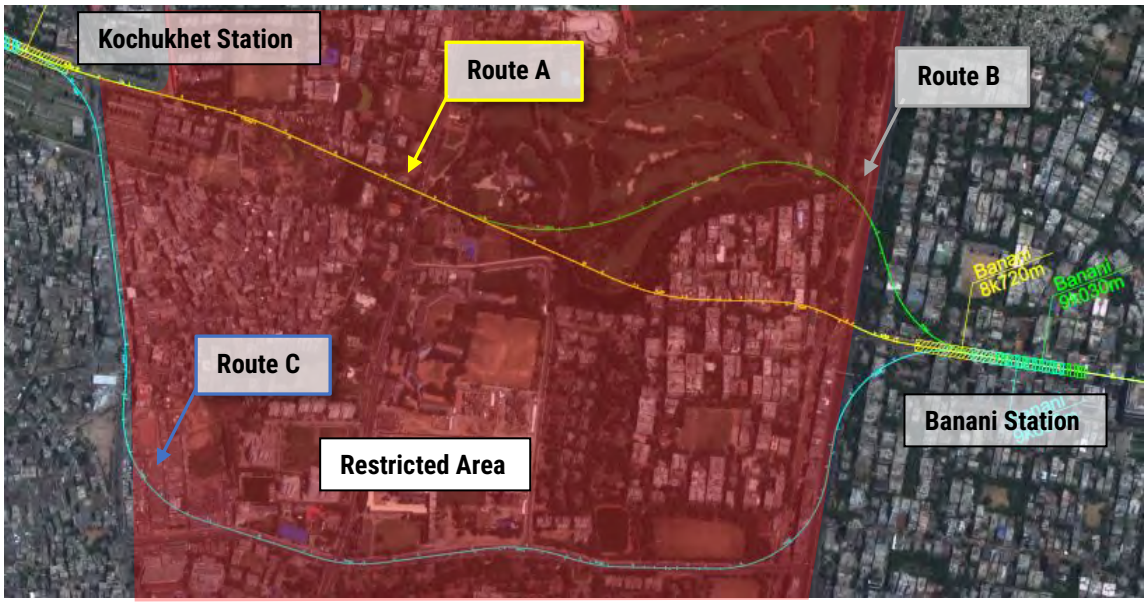
Options / Items	1) Section between Kochukhet and Notun Bazar	2) Section between Dar-Us-Salam and Notun Bazar	3) Section between Gabtoli and Notun Bazar
	lot of construction space.	crowded, construction of viaduct is difficult.	construction spaces are kept easily because it is located on suburb.
Traffic	△: During construction, negative impacts to traffic is most because road lanes by viaduct construction are regulated widely.	○: Lane control by construction of viaduct causes traffic congestion around Gabtoli.	◎: Construction of viaduct needs lane control. However, negative impacts to traffic is small because the area of construction is located on suburb.
Damage to the project by inundation	◎: No inundation on viaduct structures expected. Because there is a possibility of inundation from an entrance and exit, appropriate measures are required. This option has least negative impacts comparing the other options.	○: No inundation on viaduct structures expected. Because there is a possibility of inundation from an entrance and exit, appropriate measures are required.	○: No inundation on viaduct structures expected. Because there is a possibility of inundation from an entrance and exit, appropriate measures are required.
Liquefaction by earthquake	△: Less damage by liquefaction is expected on underground structures. Liquefaction may damage footings of viaduct installed on long section.	○: Less damage by liquefaction is expected on underground structures. Liquefaction may damage footings of viaduct.	○: Less damage by liquefaction is expected on underground structures. Liquefaction may damage footings of viaduct.
Social Environment			
Land Acquisition and Involuntary Resettlement	△: On the underground section, land acquisition and involuntary resettlement are expected at the entrance and exit of stations and construction site. Moreover, on the centre of Dhaka, land acquisition and involuntary resettlement is expected at stations and viaduct. Therefore, negative impacts is most among three options.	◎: On the underground section, land acquisition and involuntary resettlement are expected at the entrance and exit of stations and construction site. Land acquisition on viaduct sections is easy because the area is within ROW of RHD.	◎: On the underground section, land acquisition and involuntary resettlement are expected at the entrance and exit of stations and construction site. Land acquisition on viaduct sections is easy because the area is within ROW of RHD.
Dividing of local community	◎: Underground structure does not divide local communities.	◎: Underground and viaduct structures do not divide local communities.	◎: Underground and viaduct structures do not divide local communities.
Landscape	△: Negative impacts to landscape is most among the options because viaducts are installed on density areas.	◎: There is no impact to landscape because structure in the centre of Dhaka is underground. Although viaduct sections may affect landscape, it will	◎: There is no impact to landscape because structure in the centre of Dhaka is underground. Although viaduct sections may affect landscape, it will

Options / Items	1) Section between Kochukhet and Notun Bazar	2) Section between Dar-Us-Salam and Notun Bazar	3) Section between Gabtoli and Notun Bazar
		be insignificant because the areas are not density areas.	be insignificant because the areas are not density areas.
Safety	○: Because there is no railroad crossing, traffic accident is not expected. A Fire of a station building is expected.	○: Because there is no railroad crossing, traffic accident is not expected. A seismic disaster of viaduct is expected.	○: Because there is no railroad crossing, traffic accident is not expected. A seismic disaster of viaduct and a fire of a station building are expected.
Pollution Control			
Air Pollution	△: Negative impacts to air pollution is most among three options because construction area is very wide.	◎: Negative impacts to air pollution is less than (1) because viaducts are constructed on suburb.	◎: Negative impacts to air pollution is less than (1) because viaducts are constructed on suburb.
Noise and Vibration	△: Construction noise of stations and viaducts is expected. Negative impacts are comprehensive than the other options. Railway operation causes noise along viaduct sections.	○: Although construction noise of stations and viaducts is expected, negative impacts are small. Although railway operation causes noise along viaduct sections, negative impacts are limited.	○: Although construction noise of stations and viaducts is expected, negative impacts are small. Although railway operation causes noise along viaduct sections, negative impacts are limited.
Groundwater	○: Negative impacts to underground water are expected. However, it is expected that negative impacts are small because the length of underground section is shorter than the other options.	△: Negative impacts to underground water are most among three options because the length of underground sections is long.	△: Negative impacts to underground water are significant because the length of underground sections is long.
Waste	◎: Volume of excavation soil is least.	△: Volume of excavation soil is large.	△: Volume of excavation soil is most.
Total Evaluation	△: Construction cost is cheap. Impacts on inundation area is less. On the other hand, negative impacts to resettlement and the environment is large. Traffic condition and Volume of excavation soil is least. Traffic congestion during construction and seismic safety should be considered.	○: This option almost follows (3) option. However, congestion around Gabtoli during viaduct construction should be considered.	◎: Underground structure on the centre of Dhaka and viaduct structure on suburb maximize merits, this option is most suitable for the project.

Note- ◎: most suitable ○: suitable △: required more considerations; Source: JICA Study Team, 2017

3.13.3 Comparisons of Alternative Routes on Cantonment Area

There is a restricted area (cantonment area) between Banani Station and Kochukhet Station on the route of MRT Line 5N. Three route options were examined on this section. The route options include viaduct plan and underground plan. Route A is the shortest route connecting Banani Station and Kochukhet Station. The route A secures running performance, however, interferes a lot of building in the area. Therefore, it is hard to adopt viaduct plan. Route B which mitigates interference with the buildings comparing the route A has minor curves. Route C does not interfere with the buildings. However, since the route have more curves than other routes and longer alignment, running performance and comfort is inferior to the other routes. From stated above, the route B as viaduct plan is recommended because the route B has less interference with the buildings than the other plans and better running performance. The route A as underground plan is recommended because the route A has no interference with the buildings and better running performance. Finally, the study team recommended the underground route A considering magnitude of involuntary resettlement.



Source: JICA Study Team, 2017

Figure 3-22: Comparisons of Alternative Routes on Cantonment Area

CHAPTER 4

4 ENVIRONMENTAL BASELINE

4.1 Introduction

This section includes the existing environmental baseline status of the MRT line-5N project study area, covering both the natural and social environments. The analysis was completed by using a combination of secondary data sources in addition to extensive on-ground reconnaissance and baseline studies to establish an environmental and socio-economic baseline of the project area. Data for this chapter were collected from:

- **Primary Sources:** This included gathering information from field surveys, laboratory analysis, public consultations and Key Informant Interview (KII) in the project area;
- **Secondary Sources:** This included data from literature reviews, maps and monitoring reports.

The baseline condition of environmental quality in the project site serves as the basis for identification, prediction and evaluation of impacts. The baseline environmental quality is assessed through field studies within the impact zone for various components of the environment like air, noise, water and socio-economic etc.

Data was collected from secondary sources for the macro-environmental setting like climate (temperature, rainfall and humidity), physiography, geology etc. Firsthand information has been collected to record the micro-environmental features within and adjacent to the project area. Collection of primary information includes extrapolating environmental features on the project design, location and assessment of socio-cultural features adjoining project area. Ambient air, noise and water quality samples were collected in terms of environmental quality to prepare a baseline database. Public consultation and Key informant Interview (KII) were another source of information to explain local environmental conditions, impacts and suggestions etc. The following section describes the baseline environment into four broad categories:

- **Physical Environment:** Geology and Soil, Seismicity, Topography, Land-use, Drainage, Climate and Hydrology;
- **Biological Environment:** Factors related to life such as habitats, aquatic life, fisheries, terrestrial habitats, flora and fauna;
- **Environmental Quality**: Air, Water Quality (Surface and Ground) & Noise level
- **Socio-economic Environment:** Anthropological factors like demography, income and infrastructure.

4.2 Environmental Setting of Project Area

4.2.1 Depot Area

The depot of MRT-5N is located in Hemayetpur area. It is geographically located between 23°48'22"N and 23°47'46"N latitude and 90°16'27"E and 90°16'38"E Longitude. Hemayetpur is a neighborhood in Savar Upazila of Dhaka District having rural and semi-urban setting. The area is marshy land and rural in nature with most of land are vacant and unused agricultural land. There is a stream located in the northern side of this depot that serve as the drainage channel of this area. There is a residential area with urban setting in the eastern side of depot area. There is also residential area with rural setting in the western and

southern side of the depot area. There are some schools, mosque within the close proximity of depot location.

4.2.2 Elevated Alignment

There are two segments of elevated section. The first segment is in-between Hemayetpur and Amin Bazar. Another segment is located in-between Notun Bazar and Vatara. The surrounding areas of Hemayetpur-Amin Bazar section is mostly unpopulated. There are some natural features like water body, park, wetland, cropland, river, etc. within the area of influence of this section. On the other hand, the Notun Bazar-Vatara section goes through urban and to-be-urban areas. In both sections, there are some culturally important establishments like mosques, schools, church etc. beside the alignment.

4.2.3 Underground Alignment

The underground section of MRT Line-5N will go through a built-up area. Most of the section will follow the existing road network, except the cantonment area. There are many sensitive receptors besides the alignment of underground section like hospitals, mosques, schools, etc. There is a lack of vegetation, water bodies, open spaces besides alignment route. There are some other sensitive areas from the perspective of security like cantonment and embassies of different foreign countries.

4.3 Physical Environment

4.3.1 Geology and Soil

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 slightly over-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 4-1.** Soil category map showing the project area is given in **Figure 4-1**.

Table 4-1: Geomorphic Units Identified for Dhaka Terrace[2]

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)

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

Fault Zone

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.

Figure 4-2 shows the Tectonic framework map of the project area. According to BNBC 2020, 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. Apparently, the risk of a large magnitude quake is great. Seismic Zone map of the project area are given in **Figure 4-3**.

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, 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, varying by more than an order of magnitude depending on lithology. According to surveyed data for MRT line 6, subsidence rates on the order of 2-4 mm/yr are typical in the project area.

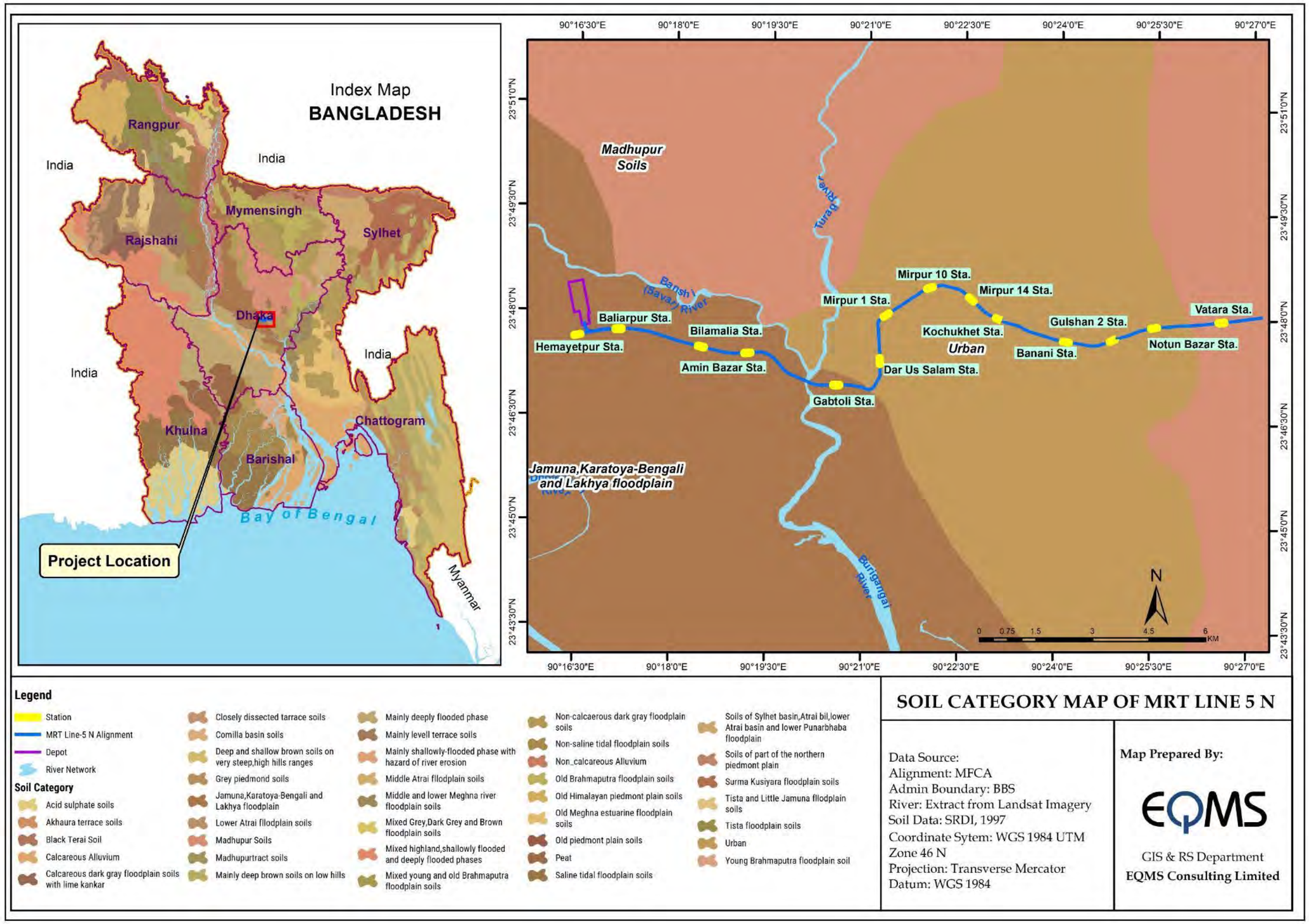


Figure 4-1: Soil Category Map of the Project Area

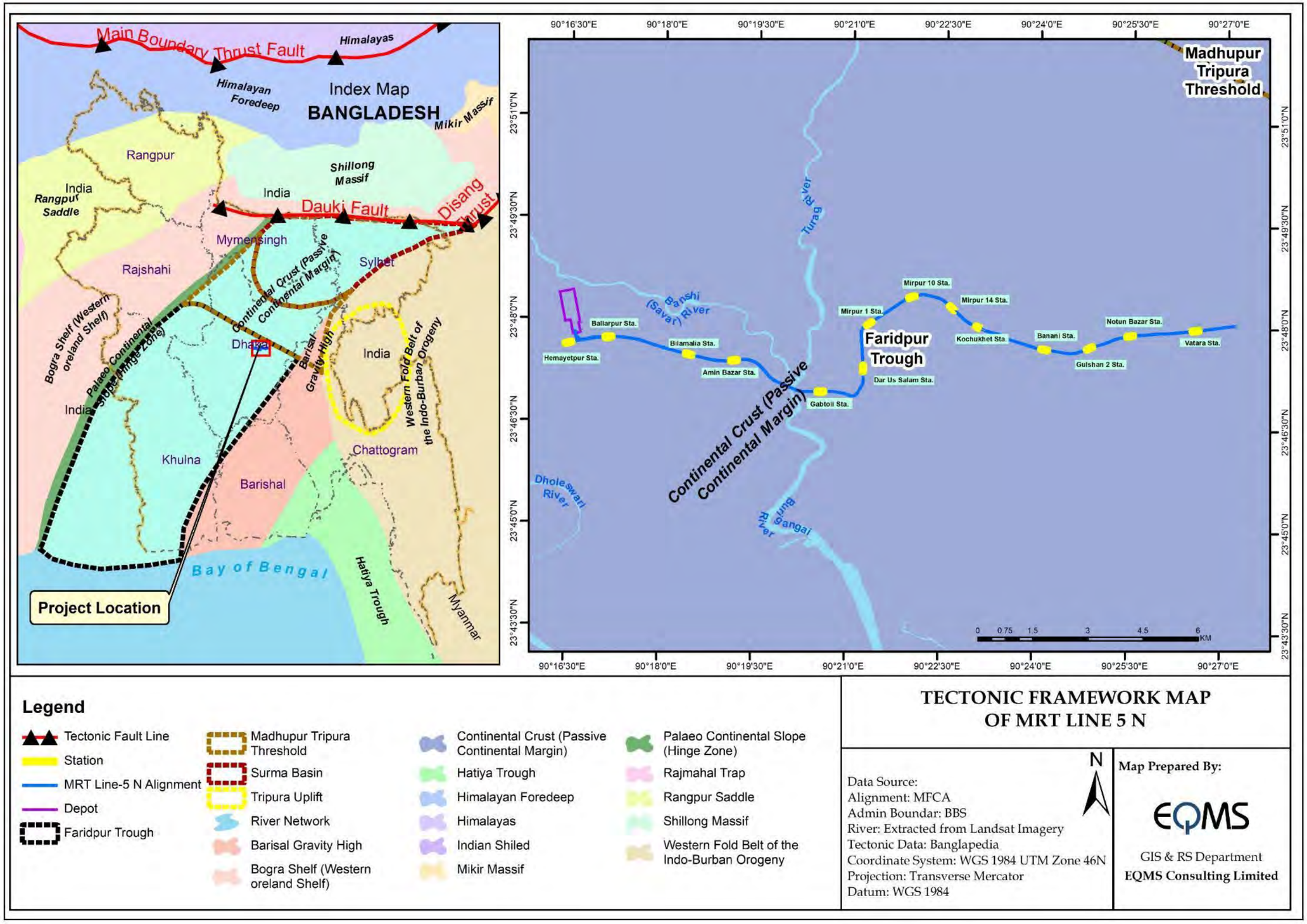


Figure 4-2: Tectonic Framework Map of the Project Area

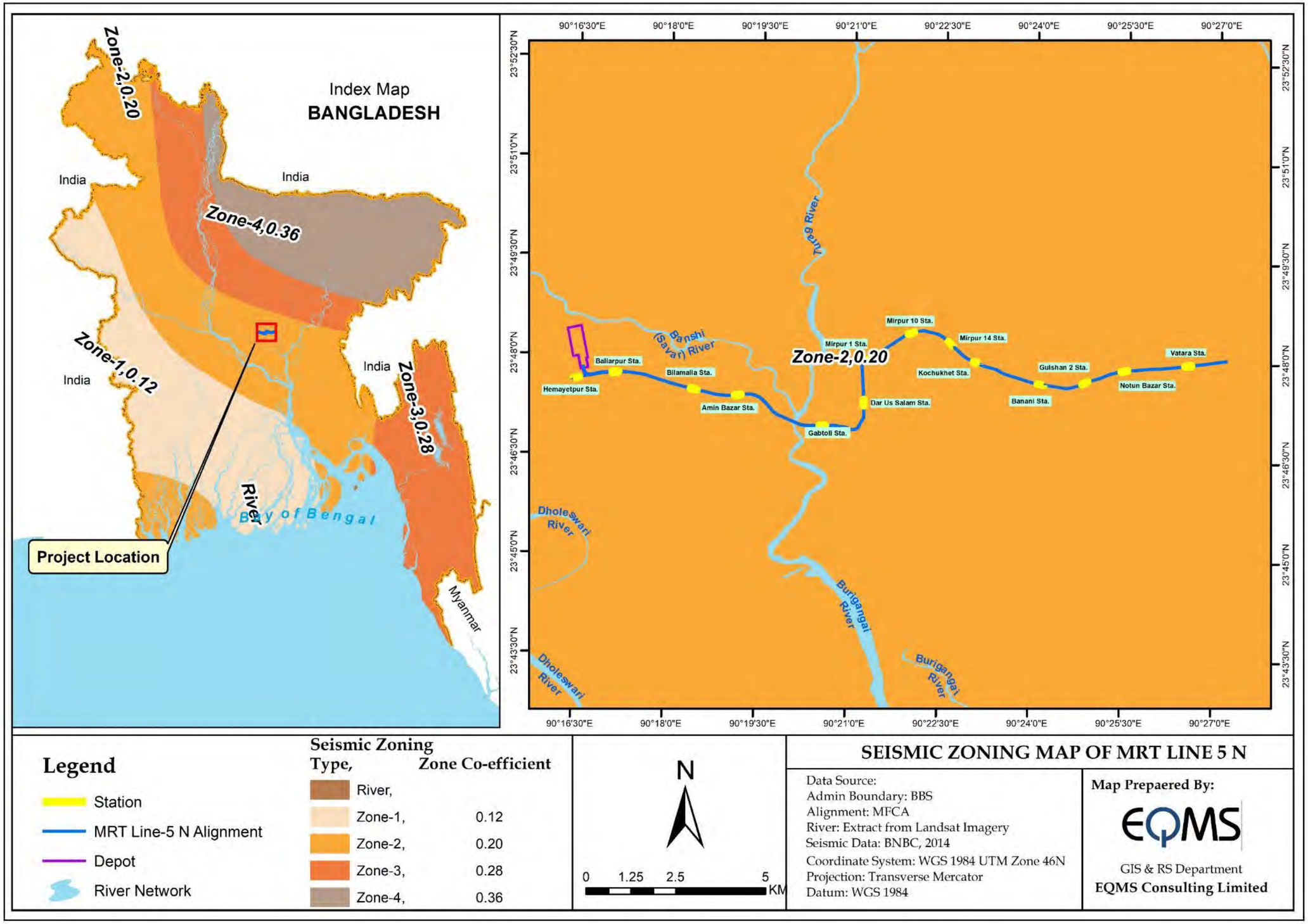


Figure 4-3: Seismic Zone Map of the Project Area

4.3.2 Physiography

The Dhaka city is surrounded by four major river systems, namely the Buriganga, Turag, Tongi and Balu, which are flowing to the south, west, north and east sides, respectively. The edges of the high lands are flanked by marshes and old riverbeds.

The surface elevation of the area Dhaka is ranging between 1 and 14m and most of the built-up areas are located at the elevations of 6-8m. The land area above 8 meters msl covers about 20 square kilometers. While 170 square kilometers of Greater Dhaka is below 6 meters (FAP 1991). Outside the main Dhaka City towards the west direction through Dhaka-Aricha Highway, the elevation level is comparatively lower than that in the main city. The MRT Line-5N route falls under the Madhupur Tract, Old Brahmaputra floodplain, Jamuna (Young Brahmaputra) floodplain and Old Meghna estuary physiographic units. Major Physiographic division of the project area is shown in **Figure 4-4**.

4.3.3 Land Use

Due to rapid urban growth of Dhaka city, Dhaka's land use has been changing since 1967. While the vegetation of area is almost fixed at 70,000 ha in the past 40 years, the current water body has reduced to a quarter since 1967, which is 5,520 ha in 2010 from 206,868 ha in 1967. The built-up area increased by about 5,000 ha in the period of 1989 to 1999 and by 7,500 ha in the period of 1999 to 2010. The land use map of the project area is shown in **Figure 4-5**. It shows that the project area is a mix of settlement, waterbody and vegetated area. It is seen from the **Figure 4-5** and **Figure 4-6** that majority of the stations outside the main city (near Savar Upazila), particularly station 02 (Baliarpur), station 03 (Bilamalia) and station 04 (Amin Bazar), have low-lying areas around them. There are also low-lying areas around the west and east transition stations, station 13 (Notun Bazar) and station 14 (Vatara). Besides, higher elevation data can be observed at Station 7 (Mirpur 1), Station 8 (Mirpur 10) and Station 9 (Mirpur 14).

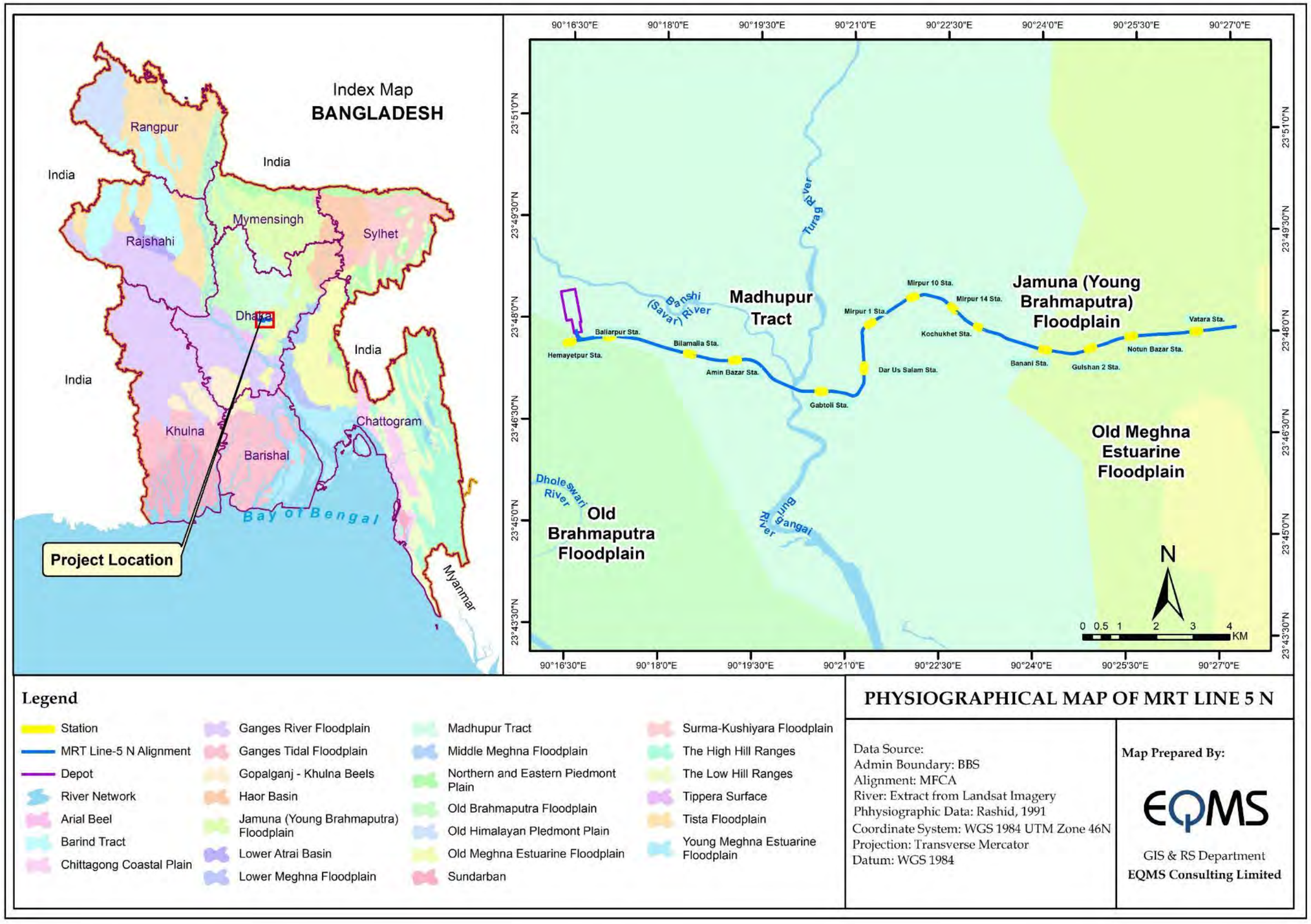


Figure 4-4: Physiographic Map of the Project Area

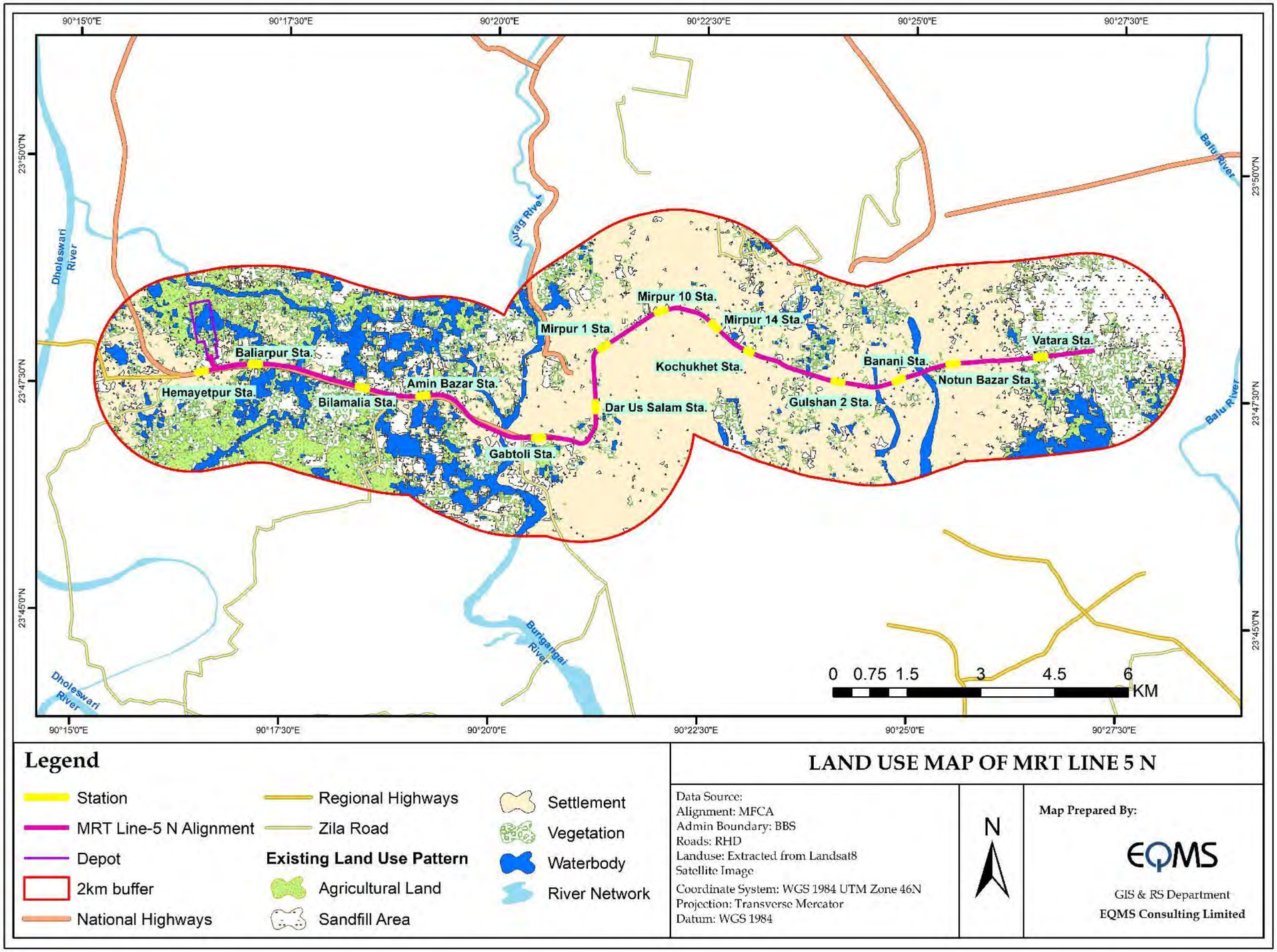
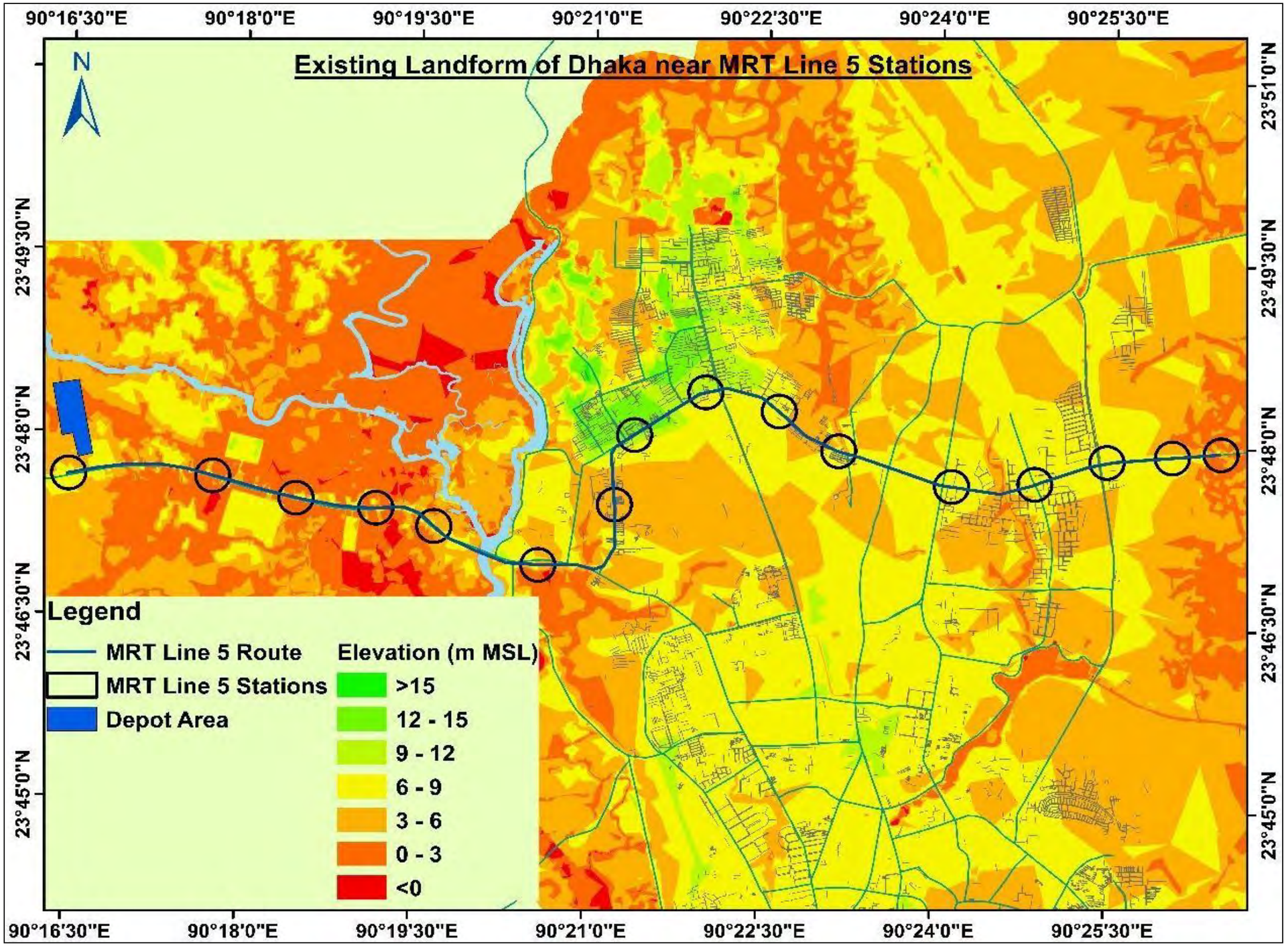


Figure 4-5: Land Use Map of the Project Area



Source: MFCA

Figure 4-6: Landform of Dhaka City around the MRT Line 5: Northern Route

4.3.4 Meteorology

Climatic Sub-zones of Bangladesh

Climatic sub-regions of Bangladesh are presented in **Figure 4-7** and the alignment of MRT Line-5N falls under the South-Central Region. The Bangladesh Meteorological Department monitors different climate component in 35 weather stations in Bangladesh. The climatic data for the study area was obtained from the meteorological station located in Dhaka which is nearest to the project site.

South-central zone (G), rainfall is abundant, being above 1,900 mm. The range of temperature is much less than to the west but somewhat more than in South-eastern zone. This is a transitory zone between the South-eastern, North-western and South-western zones and most of the severe hailstorms, nor 'westers and tornadoes are recorded in this area.

The climate of Bangladesh is heavily influenced by Asiatic monsoon. The monsoonal influence results in three distinct seasons:

- Pre-monsoon hot season (from March to May);
- Rainy monsoon season (from June to September); and
- Cool dry winter season (from October to February).

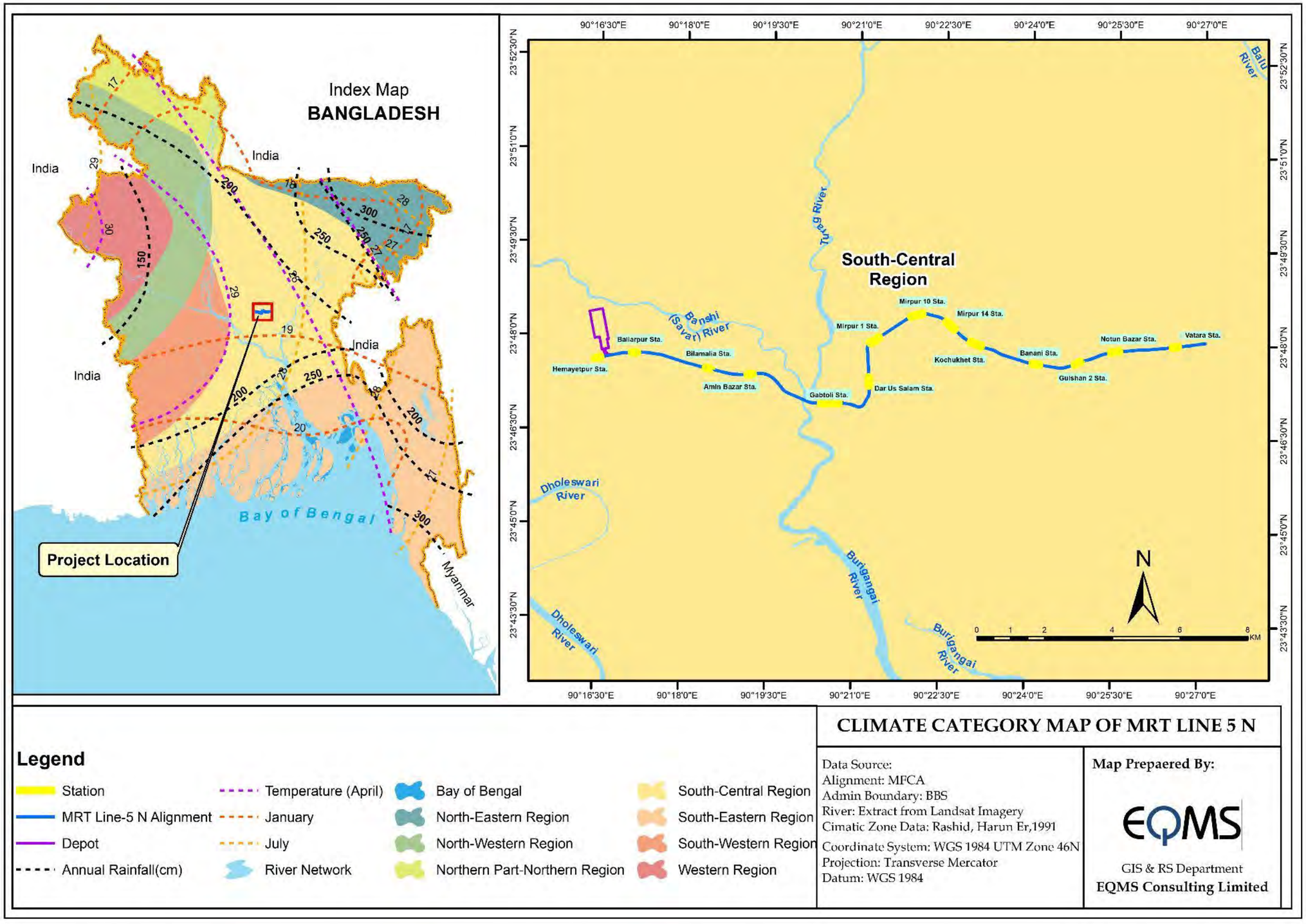
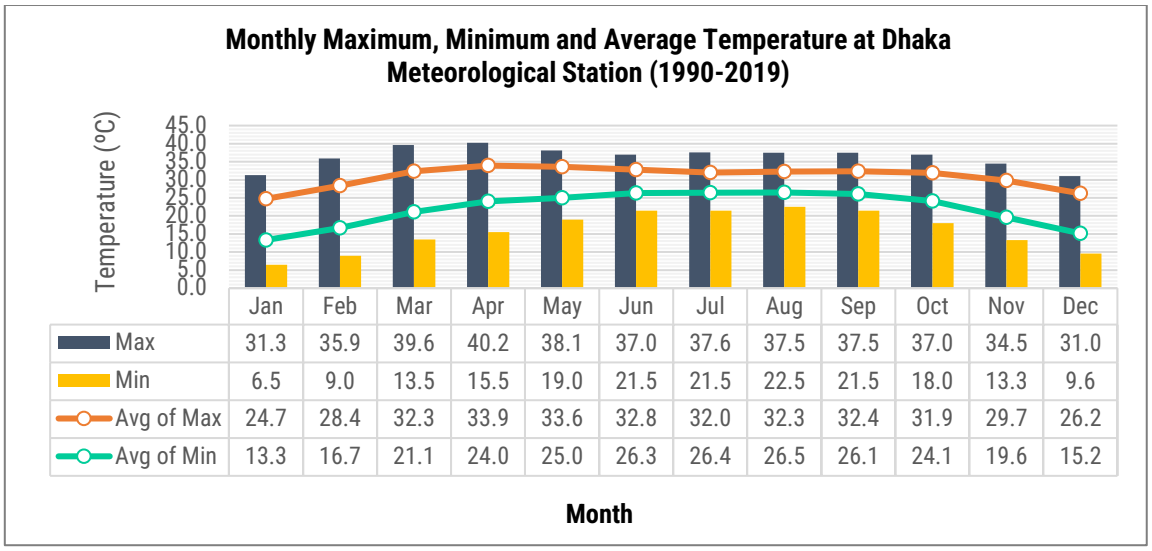


Figure 4-7: Location of Project Area in Climatic Zones of Bangladesh

4.3.4.1 Temperature

The monthly average minimum and maximum temperatures recorded at the Dhaka weather station are presented in **Figure 4-8**. The lowest monthly temperature recorded in the past 30 years was in January 1995 (6.5°C). The highest monthly temperature was 40.2 °C in April 2014. Throughout the year, the highest temperatures are generally in March through October, and the lowest temperatures are in December through February.



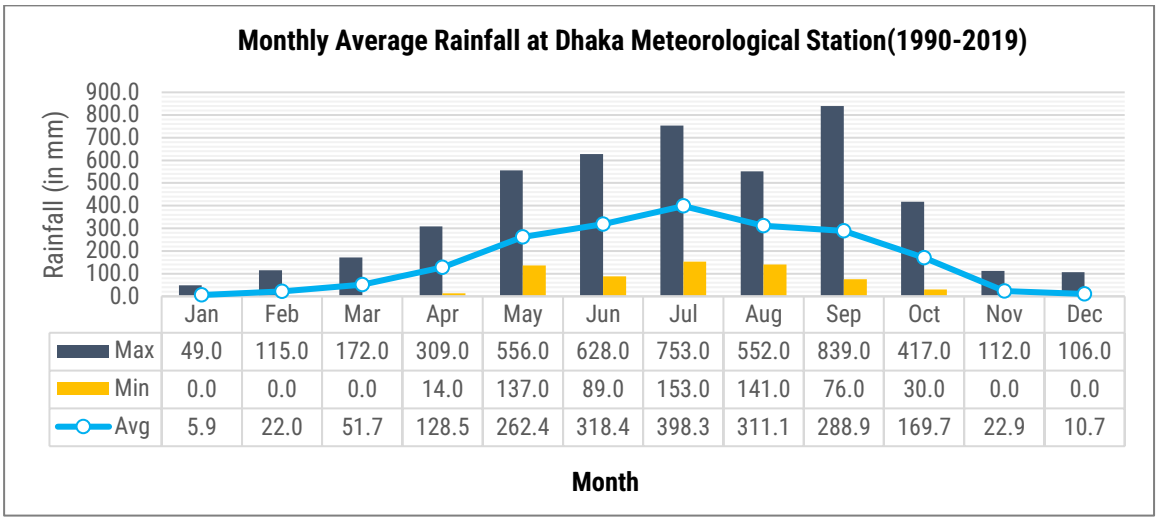
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max	31.3	35.9	39.6	40.2	38.1	37.0	37.6	37.5	37.5	37.0	34.5	31.0
Min	6.5	9.0	13.5	15.5	19.0	21.5	21.5	22.5	21.5	18.0	13.3	9.6
Avg of Max	24.7	28.4	32.3	33.9	33.6	32.8	32.0	32.3	32.4	31.9	29.7	26.2
Avg of Min	13.3	16.7	21.1	24.0	25.0	26.3	26.4	26.5	26.1	24.1	19.6	15.2

Source: Bangladesh Meteorological Department (BMD)

Figure 4-8: Temperature variation at Dhaka Station (1990 to 2019)

4.3.4.2 Rainfall

During the monsoon (June to September), wind direction from the southwest brings moisture laden air from the Bay of Bengal, when the heaviest rainfall occurs. About 80% of the total rainfall occurs in this period. Average annual total rainfall at Dhaka station is about 1990 mm from 1990 to 2019. Highest annual rainfall is recorded 2892 mm in 2017. The highest monthly rainfall recorded as 839 mm in September 2004. An insignificant amount of rainfall has also been recorded in winter (November to February). Monthly average rainfall recorded at the Dhaka station (1990 to 2019) is shown in **Figure 4-9**.



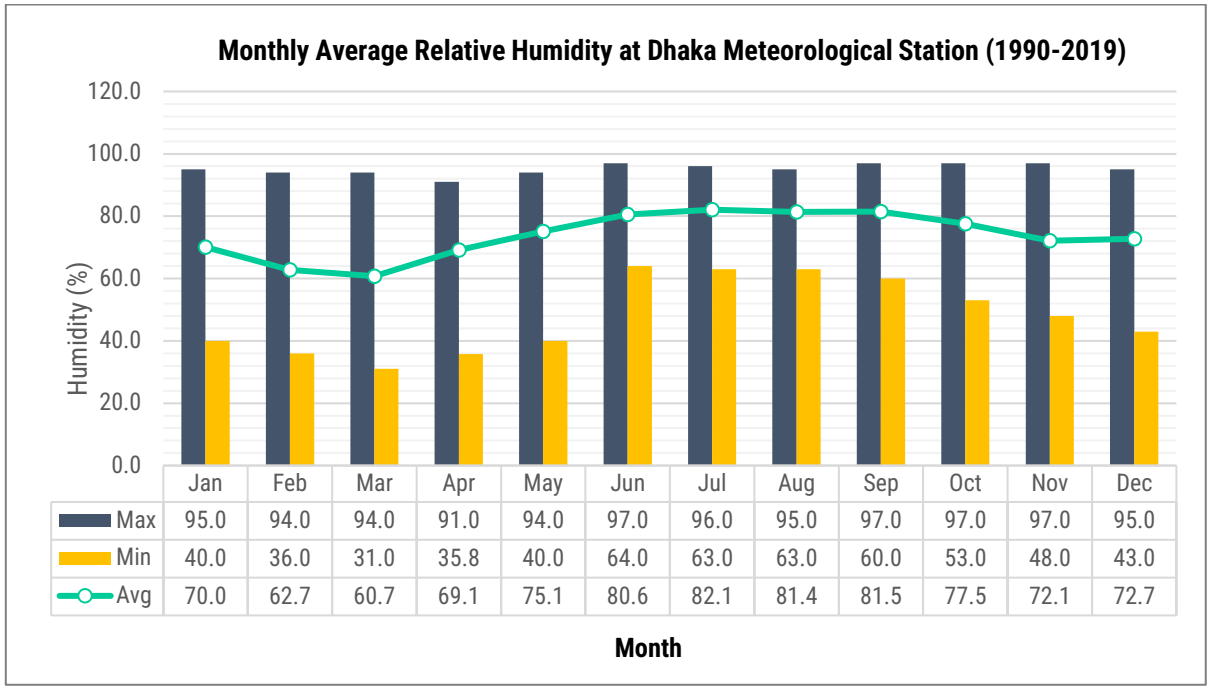
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max	49.0	115.0	172.0	309.0	556.0	628.0	753.0	552.0	839.0	417.0	112.0	106.0
Min	0.0	0.0	0.0	14.0	137.0	89.0	153.0	141.0	76.0	30.0	0.0	0.0
Avg	5.9	22.0	51.7	128.5	262.4	318.4	398.3	311.1	288.9	169.7	22.9	10.7

Source: Bangladesh Meteorological Department (BMD)

Figure 4-9: Average of Total Monthly Rainfall in mm (1990-2019) at Dhaka Station

4.3.4.3 Humidity

Monthly average relative humidity at the Dhaka Metrological station is shown in **Figure 4-10**. Humidity during the wet season is naturally the highest compared to those occurring at other times of the year. Humidity is also responsible for the fluctuation of temperature in the region. The monthly average relative humidity varies from 60.7% to 82.1%. Annual average humidity is 73.8%.



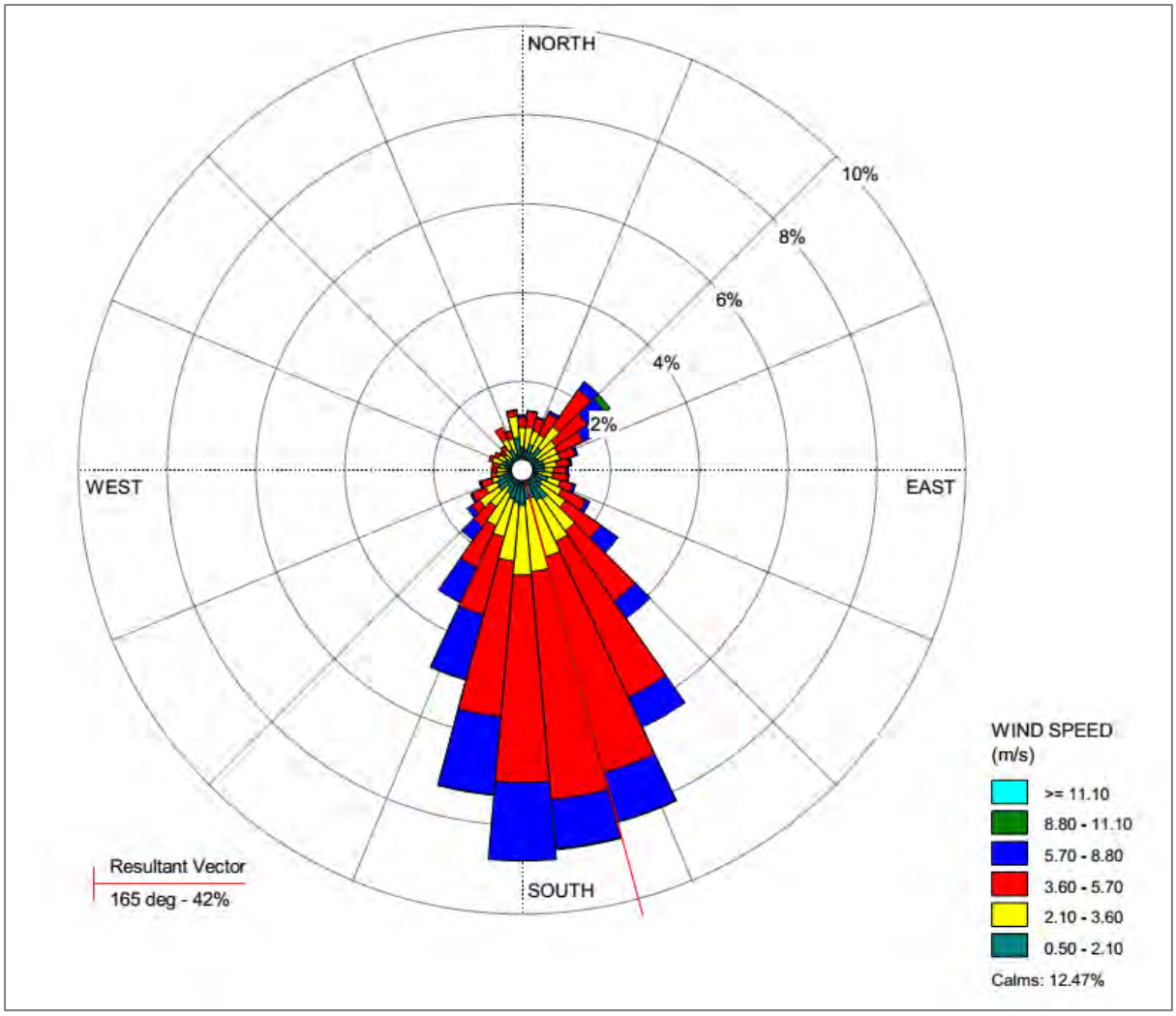
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max	95.0	94.0	94.0	91.0	94.0	97.0	96.0	95.0	97.0	97.0	97.0	95.0
Min	40.0	36.0	31.0	35.8	40.0	64.0	63.0	63.0	60.0	53.0	48.0	43.0
Avg	70.0	62.7	60.7	69.1	75.1	80.6	82.1	81.4	81.5	77.5	72.1	72.7

Source: Bangladesh Meteorological Department (BMD)

Figure 4-10: Average Monthly Relative Humidity in % (1990-2019) at Dhaka Station

4.3.4.4 Wind Speed and Direction

The wind direction in the Dhaka meteorological station is generally from south to north and south-east to north-west direction. Average annual wind speed in 2019 was 3.25 m/s with 12.47% calm wind. Highest wind speed varies between 3.60-5.70 m/s (36.7%). Annual wind rose of 2019 is shown in **Figure 4-11**.



Source: https://www.weblakes.com/services/met_order.html

Figure 4-11: Annual Wind Rose diagram at Dhaka, 2019

4.3.5 Hydrology and Drainage

4.3.5.1 Hydrology

Dhaka city is surrounded by four major river systems. The south of Dhaka city is surrounded by the Buriganga River. The western part of Dhaka is bounded by the Turag River which is connected by small Tongi Khal to the north. The eastern part of Dhaka is bounded by the Balu River which is also hydrologically connected with Tongi Khal.

The surface water area of Dhaka City is about 10-15% of total land area. The major lakes are Dhanmondi lake, Ramna lake, Baridhara-Gulshan lake, Hatirjheel lake and Crescent Lake. It has been known from different government and non-government organizations and available surface water drainage map that there were more than 35 canals within Dhaka city area (Khan 2001). The conditions of some of the canals are very critical at present and some of them are already vanished. The major canals which are till used as open channel is Begunbari Khal, Abdullahpur Khal, Diabari Khal, Manda Khal, Digun Khal, Meradia-Gazaria khal and Kallyanpur Khal (DoE, BCAS and UNEP 2006).

Water level data of one major station in each of the four surrounding rivers of Dhaka city has been analyzed. Data from Dhaka station in the Buriganga river, Mirpur station in the Turag river, Tongi station

in the Tongi Khal and Demra station in the Balu river were used to compare flood situation. **Table 4-2** shows water level hydrographs of surrounding rivers for four major flooding years, namely 1988, 1998, 2004 and 2007.

Table 4-2: Comparison of characteristics of Flood 2007, 2004, 1998 and 1988[3]

Parameters	River	Gauge Stn.	2007	2004	1998	1988
Danger Level in meters above PWB datum	Buriganga	Dhaka	6	6	6	6.1
	Turag	Mirpur	5.94	5.94	5.94	5.94
	Tongi Khal	Tongi	6.08	6.08	6.08	6.08
	Balu	Demra	5.75	-	-	-
Date of crossing Danger Level at rising stage	Buriganga	Dhaka	07.08.07	20.07.04	26.07.98	29.08.88
	Turag	Mirpur	03.08.07 & 16.09.07	17.07.04	18.07.98	24.08.88
	Tongi Khal	Tongi	01.08.07 & 18.09.07	21.07.04	22.07.98	28.08.88
	Balu	Demra	02.08.07 &16.09.07	-	-	-
Date of crossing Danger Level at falling stage	Buriganga	Dhaka	07.08.07	05.08.04	20.09.98	20.09.88
	Turag	Mirpur	18.08.07 & 24.09.07	11.08.04	24.09.98	22.09.88
	Tongi Khal	Tongi	21.08.07 & 25.09. 2007	11.08.04	24.09.98	21.09.88
	Balu	Demra	16.08.07 & 20.09.07	-	-	-
Height of peak flood level in meter above Danger Level	Buriganga	Dhaka	0.02	0.7	1.23	1.58
	Turag	Mirpur	0.68	1.35	2.03	2.41
	Tongi Khal	Tongi	0.78	1.05	1.46	1.75
	Balu	Demra	0.5	-	-	-
Duration of floods in days above Danger Level	Buriganga	Dhaka	1	17	56	22
	Turag	Mirpur	25	26	69	30
	Tongi Khal	Tongi	29	22	65	25
	Balu	Demra	20	-	-	-

Source: MFCA

[3] Islam S. A. K. M, Haque A., Bala S. K (2008) Hydrological Aspects of Flood 2007. Institute of Water and Flood Management, BUET.

4.3.5.2 Existing Natural Drainage System in Dhaka City

The existing internal drainage systems of the Dhaka city comprise of storm sewer lines, surface drains and open channels also known as khals that mainly carry the stormwater as well as a part of wastewater generated in the city to the surrounding rivers. There are few open channels in the city area that play a vital role to provide stormwater drainage to the city. Also, there was sufficient low land around the city which acted as floodplain of the concerned command area to retain the excess water for time being. With the rapid urbanization and unplanned development, most of these khals and floodplains have been filled up and the capacity of natural drainage has diminished dramatically.

According to the Dhaka Drainage Master Plan of Dhaka Water Supply and Sewerage Authority (DWASA), there are approximately 45 natural khals, a total of about 142 km in length, that are part of the khal system. In addition to the open channels and lakes, there are about 380 km of storm sewer lines that cover about 140 km^2 of the Dhaka city, 8.75 km of box culverts and a total of 4 pump stations under DWASA making up the stormwater drainage system of Dhaka (DWASA, 2011).

The entire Master Plan area has been divided into 13 Drainage Zones, which are based on the delineation of the catchment areas. Each of the Zones is divided into several sub-catchments. The zones are Goranchatbari, Kallayanpur, Dolaikhal & Old Dhaka, DND, Kamalapur, Rampura, Badda, Uttarkhan, Gazipur & Tongi, Savar, Keraniganj, Narayanganj and Purbachal. **Figure 4-12** shows the drainage management zones in the Dhaka city.

Source: Drainage Master Plan, 2016

Figure 4-12: Drainage Management Zones in the Dhaka City

From DWASA Annual Report 2018, a summary of the existing drainage system of the Dhaka city can be depicted as follows **Table 4-3**.

Table 4-3: Summary of existing drainage system of Dhaka city

Description	Length
Storm water drainage line (dia of 450 mm to 3000 mm)	350 km
Box culvert	10.5 km
Open channel (Khal)	74 km
Storm water pumping stations (Nos.) Stormwater pumping capacity:	4
Kallyanpur	$20m^3/s$
Dholaikhal	$22m^3/s$
Rampura	$25m^3/s$
Kamalapur	$15m^3/s$
Area under drainage facility	$140km^2$

Source: MFCA

4.3.5.3 Drainage System of MRT Line 5N

There is no drainage network around the depot of MRT 5N. Therefore, the drainage for depot of MRT 5N shall be designed with consideration for surrounding environment. The depot area, stations 1-4 & 13-14, and the two transition sections are in unprotected floodplains of the Karnatali, Turag and Balu rivers. The remaining stations 5-12 are within the Drainage Division-1 of DWASA which are in the protected floodplains of the Turag River and Tongi Khal and are in densely populated urban areas of the Dhaka City. These stations are subject to riverine flooding or waterlogging due to heavy rainfall. In addition, inadequate drainage capacity or improper maintenance bears the risk of temporary inundation.

The Karnatali river is non-tidal river which flow eastward. The floodplain located in the right bank of the river also generally flow down eastward. There are two catchment areas flow into the depot area which located in west and south sides of the depot. The Tatulzhora Khal flows from east side of the national highway to westward to the Dhaleswari River. Muddy flood from the Karnatali River flowed into the depot area via the connection channel located in north side of the depot.

The main drainage in depot is planned on both side of the depot from south to north along the depot area boundary. The length of main drainage for east and west side is 1,546 m and 1,354 m, respectively. The approximate catchment area of main drainage for east (Ae) and west (Aw) side is 18.38 ha and 8.74 ha, respectively (total area of the depot = 27.63 ha). The outlet drainage from the depot will be connected to the Karnatali River. The alignment of outlet drainage was set by bending eastward so as not to face the flood direction of the Karnatali River. The length of the outlet drainage is 315 m.[4] **Figure 4-13** shows the existing drainage pattern map of the project area. Drainage characteristics of the MRT 5N depot and station area is given in **Figure 4-14.**

[4] Drainage Design, Basic Design Report, Consulting Services for Detailed Design, Tender Assistance and Construction Supervision for Dhaka Mass Rapid Transit Development Project (Line 5): Northern Route

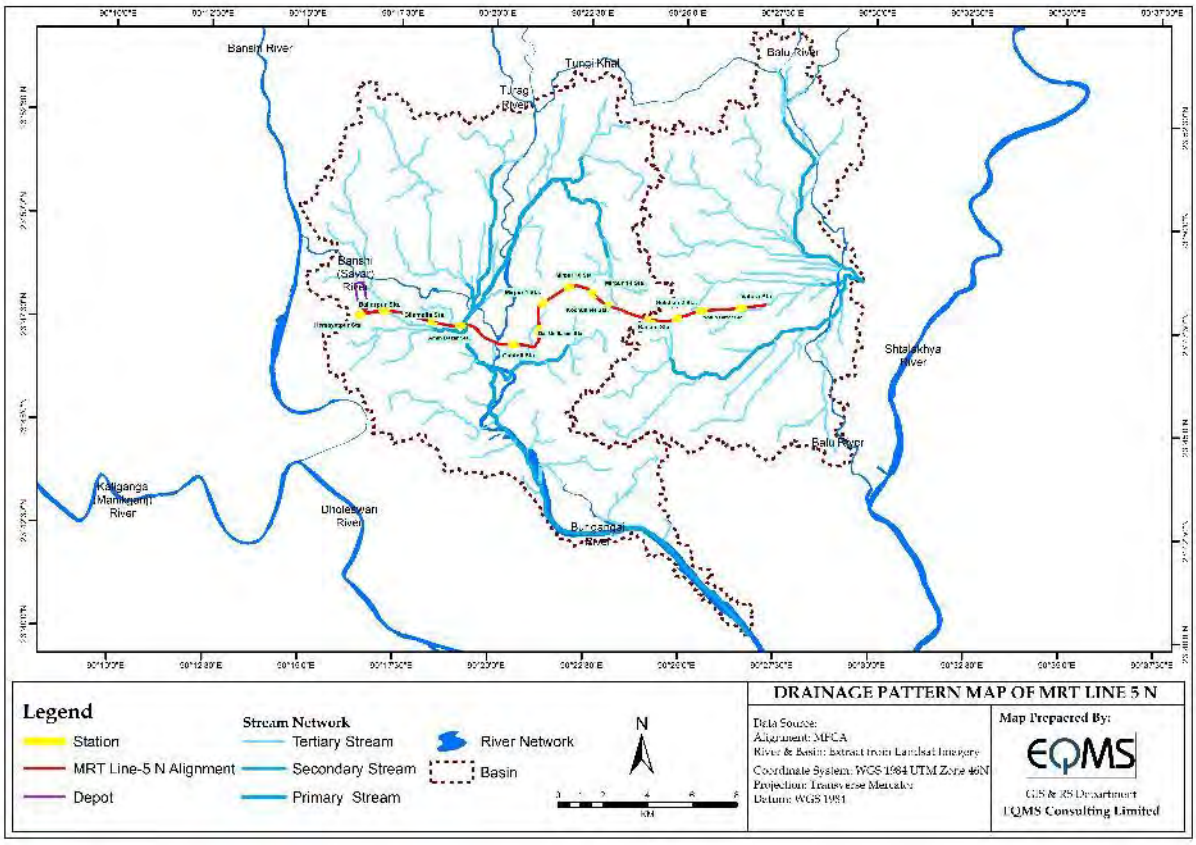
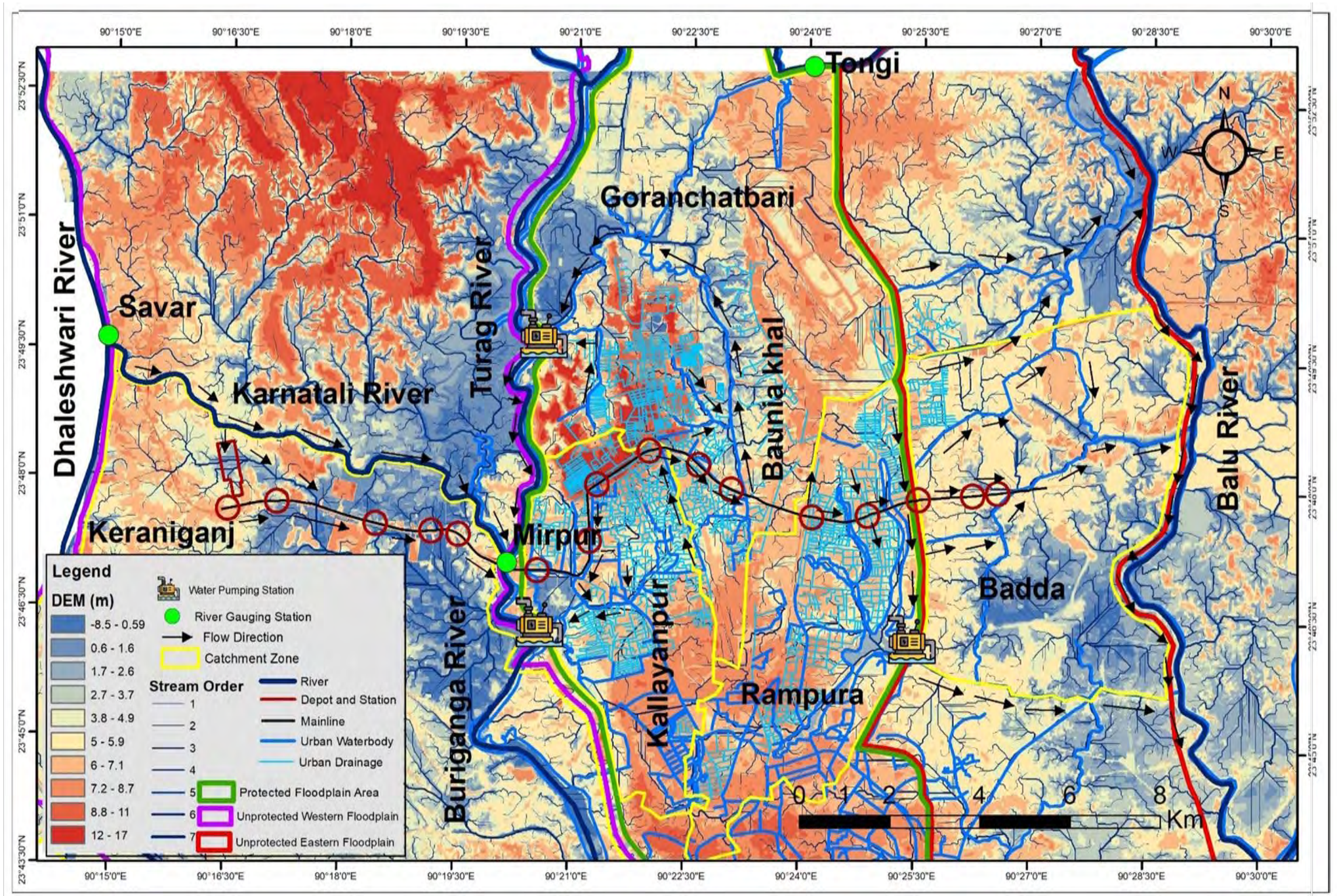


Figure 4-13: Existing Drainage Network Map of the Project Area



Source: MFCA

Figure 4-14: Existing Drainage Characteristics of MRT Line 5 area (Based on DWASA Drainage Master Plan and Sewerage Master Plan, 2016)

4.3.5.4 Categorization of Flood Area

Annual place of inundations are flood flow zones. A river in its flow regime maintains a width within which the flows occur during flooding time. Main flood flow zone is thus the cross- sectional area of a river that carries the dominant flood flow, whereas sub flood flow zone is that area which conveys the floodwater only during high tide and storms (RAJUK, 2011). The drainage system of the Dhaka city was traditionally developed to manage urban floods mainly based on conveyance-oriented approach. This type of system basically collects runoff and immediately and rapidly conveys it to the discharge points. **Figure 4-12** shows the drainage management zones in the Dhaka city. Connectivity and categorization of MRT-5 stations with the nearby drainage management zones can be as shown in **Table 4-4**.

Four MRT-5 stations, namely Hemayetpur, Baliarpur, Bilamalia and Amin Bazar, are in the Keraniganj zone. In this zone, water flow towards the Dhaleshwari and Karnatali rivers. Most of these stations have no water logging problems. Gabtali, Dar-us-Salam and Mirpur-1 stations are in the Kallayanpur zone. In this zone, water flows towards the Buriganga river through the Kallayanpur Branch Khal. Mirpur-10 station is in both the Kallayanpur and Goranchotbari zones. But its water flows towards the Digun Main Khal and then to the Turag river. Mirpur-14 and Kochukhet stations are in the Goranchotbari zone. Brick sewer and pipe drain are used to drain stormwater to the Baunia Khal and finally to the Turag river. Banani and Gulshan-2 stations are located in the Rampura zone. In these stations, brick sewers are used to drain water to Hatir Jheel, Begunbari Khal, and finally to the Balu river. Notun Bazar and Vatara stations are located in the Badda zone. In this zone, brick sewer carries water to Shahajadpur Khal, Begunbari Khal, Sutivola Khal, and finally to the Balu river.

Table 4-4: Connectivity and Categorization of MRT Line-5 Stations with nearby Drainage Management Zones

MRT Line-5 Station Name	Drainage Zone	Movement towards Drainage Canal	Ground Condition	Reaching Main Channel/ River	Water Logging problem*
Hemayetpur	Keraniganj	Water flows towards Dhaleshwari and Karnatali rivers	60% settlement area	Dhaleshwari and Karnatali rivers	Present but not severe
Baliarpur		Water flows towards Dhaleshwari and Karnatali rivers	30% settlement area		No water logging
Bilamalia		Water flow towards Dhaleshwari and Karnatali rivers	15% settlement area		No water logging
Amin Bazar		Water flows towards Dhaleshwari and Karnatali rivers	20% settlement area		No water logging
Gabtali	Kallayanpur	Water flows towards Kallayanpur Main Khal	90% settlement area	Buriganga river	Present but not severe
Dar-us- Salam		Water flows towards Kallayanpur Branch Khal	80% settlement area		Severe

MRT Line-5 Station Name	Drainage Zone	Movement towards Drainage Canal	Ground Condition	Reaching Main Channel/ River	Water Logging problem*
Mirpur 1		Water flows towards Kallayanpur Branch Khal	90% settlement area	Buriganga river	Severe
Mirpur 10	Kallayanpur and Goranchotbari	Pipe drain to Digun Main Khal	90% settlement area		Severe
Mirpur 14	Goranchotbari	Brick sewer and pipe drain to Baunia khal	70% settlement area	Turag river	Severe
Kochukhet		Brick sewer and pipe drain to Baunia khal	70% settlement area		Present but not severe
Banani	Rampura	Gulshan Lake	90% settlement area	Balu river	Present but not severe
Gulshan2		Brick sewer to Hatir Jheel, further to Begunbari khal	90% settlement area		Present but not severe
Notun Bazar	Badda	Brick sewer to Shahajadpur khal, further to Begunbari khal	80% settlement area		Present but not severe
Vatara		Pipe drain and brick sewer to Sutivola khal	20% settlement area		No water logging

Source: MFCA

* Water logging problem near different stations was based on Flood Inundation Survey conducted by BUET in 2020 and 2021.

4.3.5.5 Areas Inundated in the Past Floods

Severe flooding in Dhaka is mainly the result of spillover from surrounding rivers that flow to and from the major rivers of the country. The 1988, 1998 and 2004 floods were the most damaging floods in recent history in Dhaka City. Another reason for flooding is internal waterlogging. It is a severe problem in certain parts of the city. Those areas remain inundated for several days mainly due to drainage congestion and inadequate pumping facilities to remove the stagnant water.

The flood in 1988 was one of the most severe floods in recent history which inundated 85% of the Dhaka City. All of eastern Dhaka and all the low-lying areas of western Dhaka were under flood water. Only parts of Mirpur, Tejgaon, Banani, Sher-e-Bangla Nagar, Azimpur, and the Old Town were not flooded (Alam & Rabbani, 2007).

Excessive rainfall over the catchment area of the GBM river basins was the main reason for the flood in 1998. Though there was embankment for protecting the Dhaka City, but due to hydraulic leakage, failure of operating regulators and lack of timely pumping of accumulated water upstream from the Rampura regulator, the city got flooded. Also, the excessive rainfall in Dhaka made the situation worse. Due to drainage problems, there was a short duration flooding in Shantinagar, Nayapaltan, Rajarbag, Dhanmondi, Azimpur and Green Road areas (Alam & Rabbani, 2007). The river water level was higher than the water level inside the protected area. So, the accumulated runoff in low-lying areas remained stagnant until the river water level receded. As a result, there was extensive waterlogging in Dhaka, especially on the west side.

In 2004, another devastating flood seriously affected Bangladesh. In the beginning, the northern and west-central districts were affected by the flood which continued to spread and eventually reached Dhaka. After some days, a localized low-pressure depression swept over Bangladesh, resulting in excessive rainfall (three times the normal levels) and caused another round of flooding in Dhaka (Alam & Rabbani, 2007). So, in 2004 the city experienced prolonged flooding.

(Dewan & Yamaguchi, 2008)estimated the flooded area of greater Dhaka for three greatest floods of the year 1988, 1998 and 2004 by using Landsat TM and RADARSAT SAR image data. They found that about 47% area was flooded in 1988, 53% area was flooded in 1998 and 43% area was flooded in 2004. **Figure 4-15** shows the inundation map of greater Dhaka for 1988, 1998 and 2004 floods.

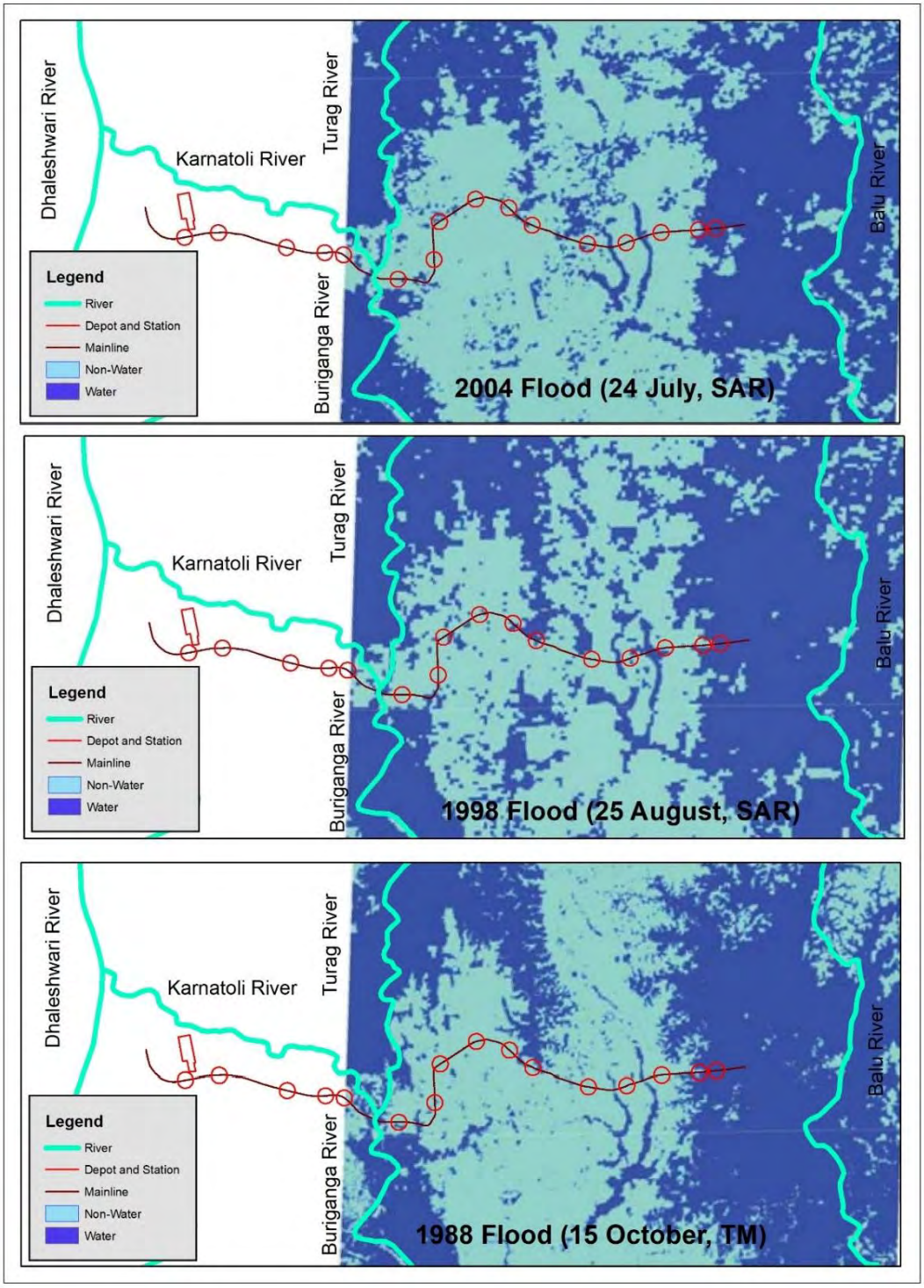
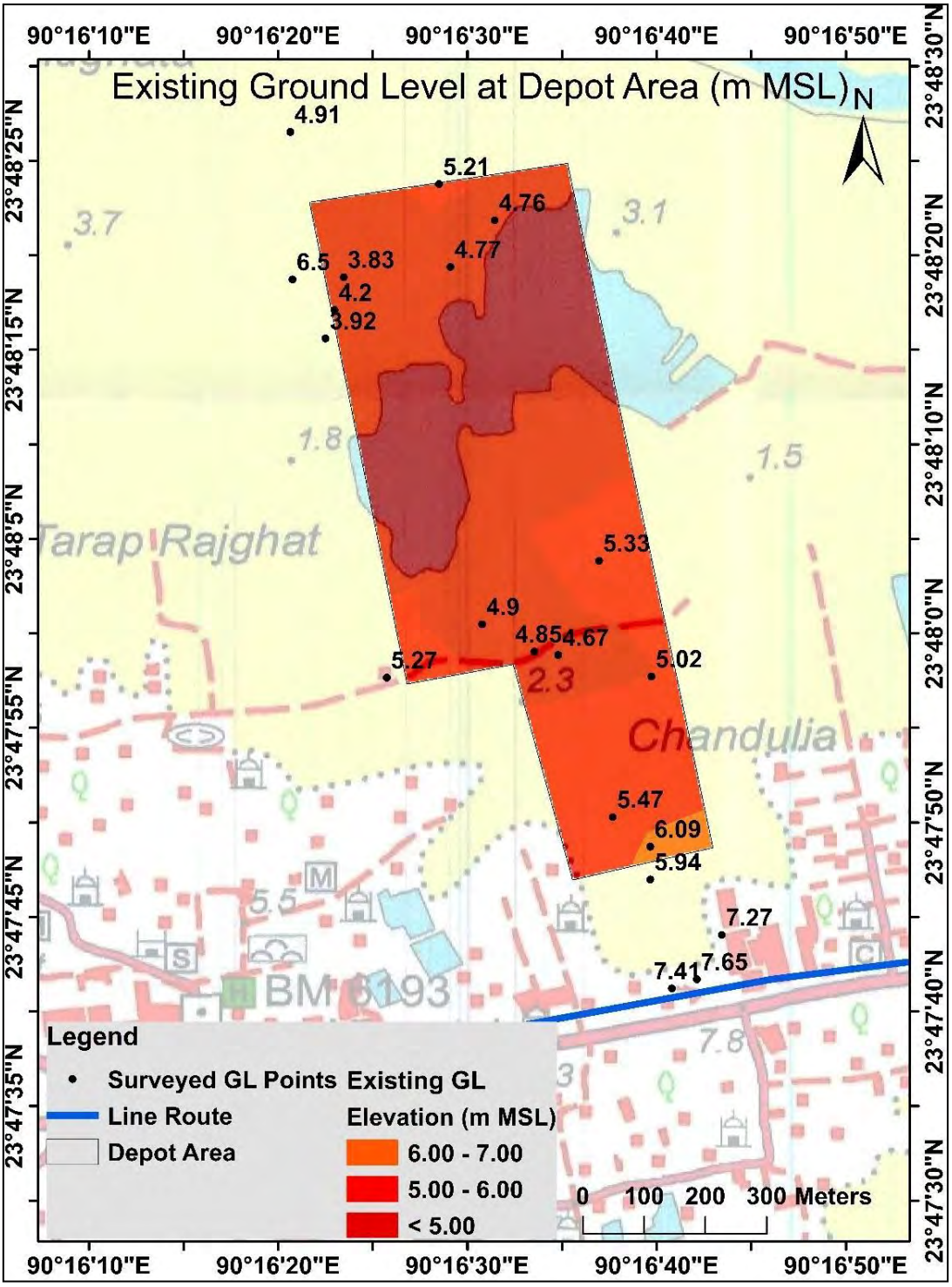


Figure 4-15: Inundation map of greater Dhaka (Source: Dewan and Yamaguchi, 2008)

4.3.5.6 Flood Level Analysis of Depot Area

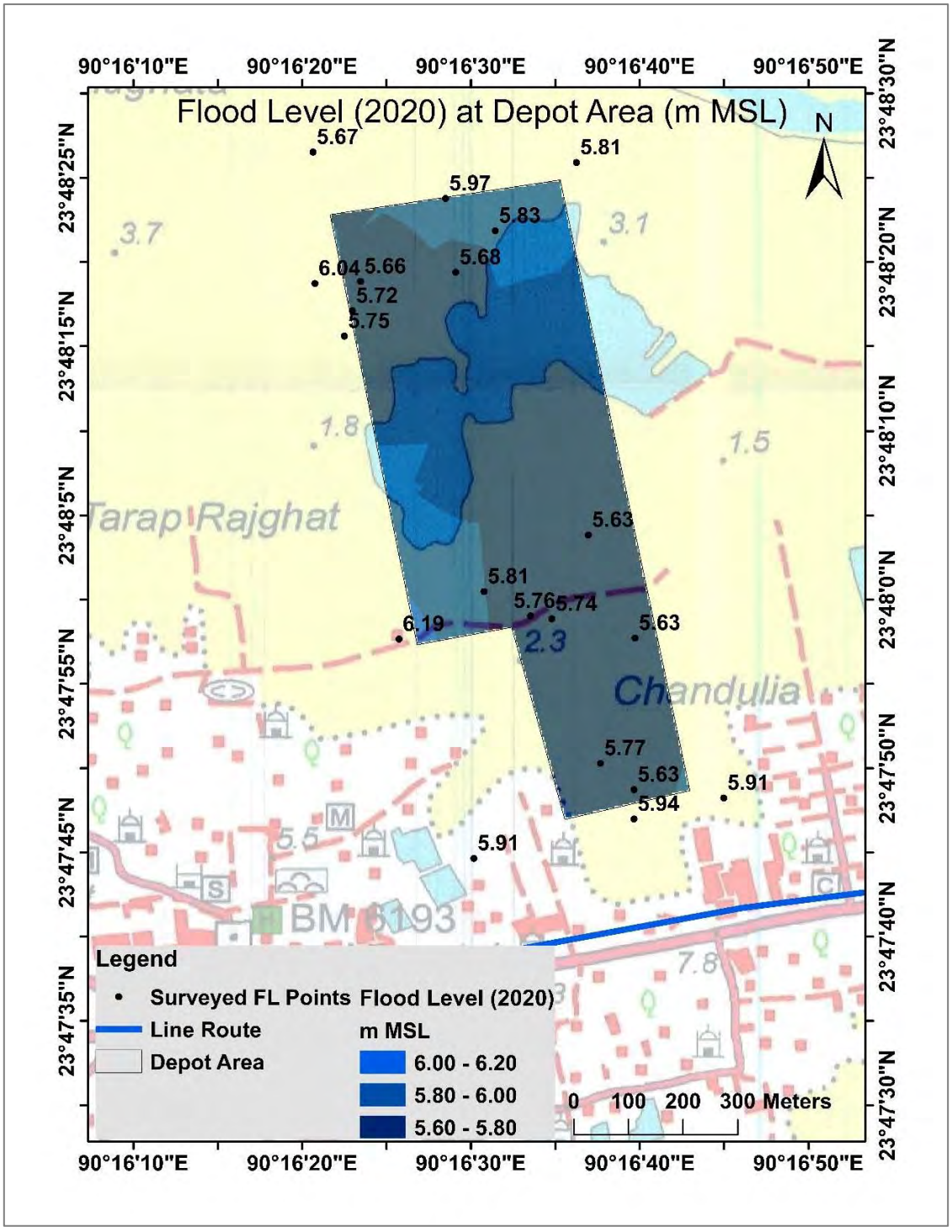
MFCA has conducted a flood inundation study in 2021 through a sublet contract to Bangladesh University of Engineering and Technology (BUET). With ground level data provided by the survey team for each station, a ground level (GL) map was prepared using Geographic Information System (GIS) platform to understand the land topography and identify high, medium and lowlands. **Figure 4-16** shows the ground level map for the depot area. The existing ground level of the depot area varies between 3.83-6.09 m MSL.



Source: MFCA

Figure 4-16: Existing ground level map for the Depot Area

For each point of a certain station area, flood depth was added to the ground level to obtain the flood level at that point. Then a generalized flood level map was prepared in GIS for that station. **Figure 4-17** depicts the 2020 flood level for the Depot Area.



Source: MFCA

Figure 4-17: Flood level map for the Depot Area

4.3.5.7 Summary of the Probable Flood Levels at Station Areas

After fixation of the 100-year flood level at overground stations in the west beyond urban area (station 1 Western Transition), the flood levels at different return periods were estimated for the stations. The estimates (**Table 4-5**) made use of the relation between a particular return period flood and the 100-year flood of the stations. For the remaining stations, the following equation was used to estimate the flood level at a return period:

$$\frac{X_{100} - X_T}{X_{100} - X_{2.33}} = \frac{Y_{100} - Y_T}{Y_{100} - Y_{2.33}}$$

where, X_T indicates flood level at T-year return period at a nearby river and Y_T indicates urban flood level at T-year return period at a MRT Line-5 station.

The final estimated flood levels are given in **Table 4-6**. It is seen from the table that there is a break in water levels from the western transition to Gabtali. This is due to the high ground level at Gabtali, which causes a high urban flood level at normal rainfall condition and a low urban flood level in extreme rainfall condition when compared with the nearby western transition.

Table 4-5: Relation between a particular return period flood to the 100-year flood at the MRT Line-5 overground stations in the west

Station No./Id.	Station Name	2.33-year	5-year	10-year	20-year	50-year
1.	Hemayetpur	0.69	0.76	0.81	0.87	0.94
	Depot Area	0.69	0.76	0.81	0.87	0.94
2.	Baliarpur	0.69	0.76	0.82	0.87	0.94
3.	Bilamalia	0.69	0.76	0.82	0.87	0.94
4.	Amin Bazar	0.69	0.76	0.82	0.87	0.94

Source: MFCA

Table 4-6: Estimated flood levels at different return periods at MRT Line-5 stations

Station No./Id.	Station Name	Flood Level (mSoB)					
		2.33-year	5-year	10-year	20-year	50-year	100-year
1.	Hemayetpur	5.70	6.27	6.76	7.21	7.82	8.29
	Depot Area	5.64	6.21	6.68	7.14	7.75	8.21
2.	Baliarpur	5.64	6.20	6.67	7.12	7.71	8.17
3.	Bilamalia	5.57	6.11	6.56	7.01	7.60	8.05
4.	Amin Bazar	5.51	6.03	6.48	6.92	7.50	7.95
	Western Transition	5.49	6.01	6.45	6.89	7.47	7.92
5.	Gabtali	6.89	6.92	6.95	6.97	7.00	7.03
6.	Dar-us-Salam	7.31	7.37	7.41	7.46	7.52	7.57
7.	Mirpur 1*	13.42	13.48	13.52	13.57	13.63	13.68
8.	Mirpur 10*	9.29	9.36	9.41	9.47	9.54	9.60
9.	Mirpur 14	6.94	7.01	7.07	7.12	7.20	7.26
10.	Kochukhet	7.42	7.43	7.44	7.45	7.47	7.48
11.	Banani	7.48	7.53	7.56	7.60	7.65	7.69
12.	Gulshan 2	7.36	7.40	7.44	7.47	7.51	7.55

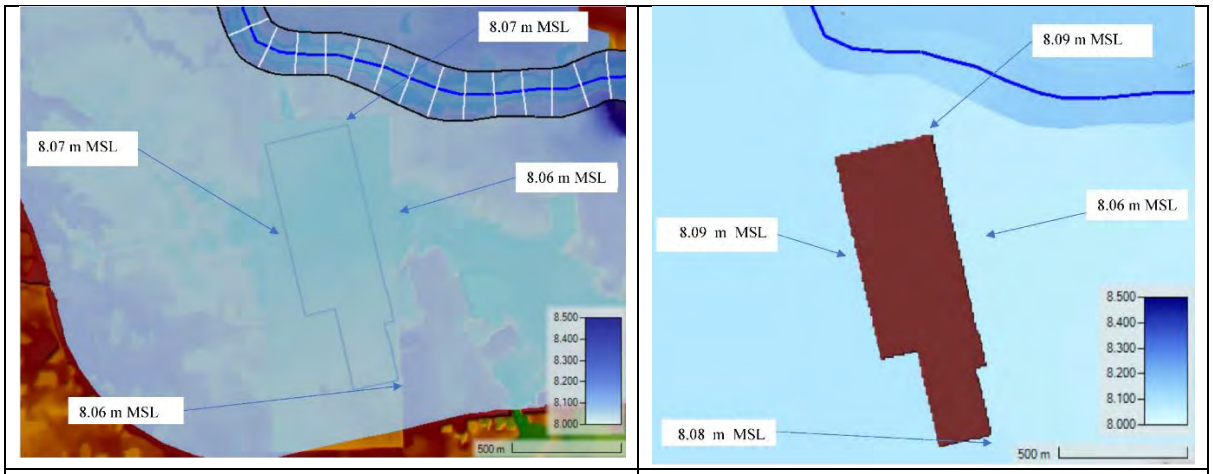
Station No./Id.	Station Name	Flood Level (mSoB)					
		2.33-year	5-year	10-year	20-year	50-year	100-year
13.	Notun Bazar	7.26	7.30	7.33	7.36	7.40	7.43
	Eastern Transition	7.15	7.18	7.21	7.24	7.27	7.30
14.	Vatara	7.14	7.17	7.20	7.23	7.26	7.29

Source: MFCA

Note: * indicates that ground levels at these stations are very high and hence the urban flood levels.

4.3.5.8 Hydrodynamic Model Study (1D-2D Coupled Model) for Simulation of Flood Level

To see the effect of floodplain on flood level of the Karnatali River, a 1D-2D coupled model setup was prepared including the floodplain which contained the Depot Area. The first simulation with the coupled model was carried out for the year of 1988 under existing condition, i.e., without a Depot Area. Another hydrodynamic simulation was carried out with the coupled 1D-2D HEC-RAS model. In this simulation, only the Depot Area was raised above the highest flood level and the remaining areas were as under the existing condition. However, this simulated scenario is less than the critical scenario in which the Depot Area as well as the areas surrounding the Depot Area will be raised. **Figure 4-18** to **Figure 4-19** show the simulation results. It is seen from the figures that there will not be any major effects of the Depot Area raising on most of the hydrodynamic conditions of the surrounding areas. The areas under inundation may remain almost the same. The maximum flood level may rise by 2 cm in the northeastern side of the Depot Area, 2 cm in the southeastern side, 0 cm in the middle-eastern side and 2 cm in the middle-western side (**Figure 4-18**).

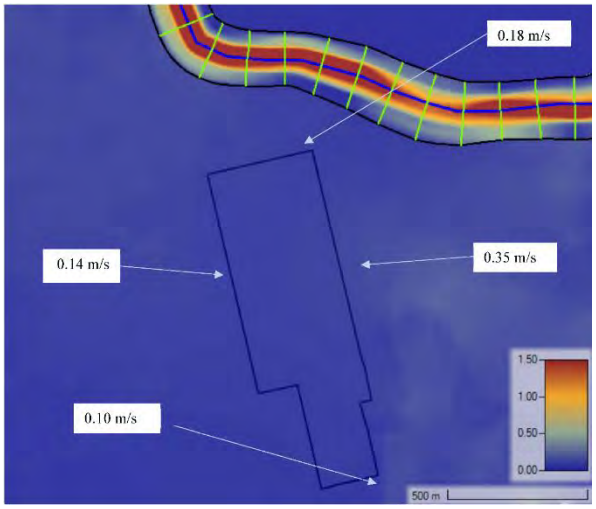


Before Depot construction | After Depot construction

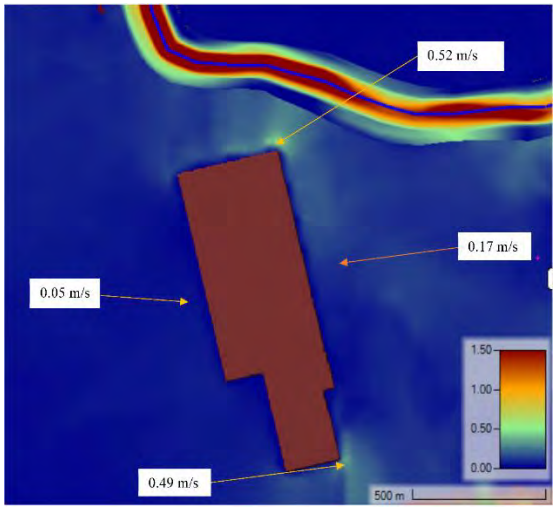
Source: MFCA

Figure 4-18: HEC-RAS model simulated maximum water level near the Depot Area for the 1988 Flood

The maximum flood depth may increase by 2 cm. But there would be some significant effect on the flow velocity. The velocities in the northeast and southeast areas surrounding the Depot Area would increase much, and the velocities in the middle-west and middle east areas would decrease to some extent (**Figure 4-19**).



Before Depot construction



After Depot construction

Source: MFCA

Figure 4-19: Simulated velocity near the Depot Area for 1988 Flood

However, the maximum velocity after the raising of the Depot Area would not be very high (0.52 m/s). Thus, the impact of construction of the Depot Area on hydraulic would not be much. The increase in velocity as found is due to the reduction in flow area, modification of streamlines and increase in flow concentration. **Table 4-7** summaries the changes in hydraulic parameters when only the Depot Area is raised.

Table 4-7: Changes in Hydraulic Parameters when only the Depot Area is Raised

Location	Flood Level (m PWD)			Flood Depth (m)			Velocity (m/s)		
	Before	After	Difference	Before	After	Difference	Before	After	Difference
Northeast corner of Depot Area	8.07	8.09	0.02	5.00	5.02	0.02	0.18	0.52	0.34
Southeast corner of Depot Area	8.06	8.08	0.02	3.60	3.62	0.02	0.10	0.49	0.39
Middle east Side of Depot Area	8.06	8.06	0	5.60	5.60	0	0.35	0.17	-0.18
Middle-west Side of Depot Area	8.07	8.09	0.02	5.30	5.32	0.02	0.14	0.05	-0.09

Source: MFCA

4.3.6 Ground Water Table of Dhaka City

The maximum depth to the water table in the central part of the city i.e. Tejgaon and Sabujbagh areas, observed from BWDB piezometers, is about 67 to 57m below the ground surface that is about 55m at

Mirpur and 20-34m at Mohammadpur, Dhanmondi and Sutrapur areas close to the river periphery. The depth of the water table moves seasonally with annual recharge and discharge conditions. The amount of seasonal fluctuations varies from less than a meter to more than 10m depending on the local hydrological conditions, amount of ground water abstraction and natural discharge of ground water. In recent years, there is a declining trend in the water table due to large amount of ground water withdrawal (Bangladesh Water Development Board, 2007).

4.3.7 Ground Water Depletion of Dhaka City

In Dhaka City, ground water extraction started from a depth of 100m and in some extreme condition the well goes up to 300 meters to reach the main aquifer. The depletion rate varies from area to area as in Mirpur the ground water level dropped 53.75 meters between 1991 and 2008 at a rate of 3.2m per year. While the decline was 1.1m/y in Mohammadpur, 2.2m/y in Sabujbag, 0.5m/y in Sutrapur and 0.8 m/y in Dhaka Cantonment during the same period. The city's groundwater level has dropped about 20m over the last seven years at a rate of 2.81m per year, from the year of 2000, the rate is increasingly high.

Long term hydrographs from different parts of the Dhaka city indicate the drop-in water level is increasing very rapidly throughout the city. For assessing hydrographs, eight groundwater monitoring station of BWDB and BADC have been selected at different locations i.e. Gulshan, Sabujbagh, Lalbagh, Sutrapur, Mohammadpur, Dhanmondi, Tejgaon and Mirpur. Ground water levels at different locations of Dhaka city are given below **Table 4-8.**

Table 4-8: Ground water level at different locations of Dhaka city (2001 and 2007)

Year	Location							
	Gulshan	Sabujbagh	Lalbagh	Sutrapur	Mohammadpur	Mirpur	Dhanmondi	Tejgaon
2001	38.5	51.78	39.3	19.5	25.17	45.5	42.5	40.13
2007	62.0	58.75	47.5	20.5	37.56	68.5	67.0	60.42

Source: (BWDB, 2007)

The maximum depth to water table in the central part of the city i.e. Tejgaon and Sabujbagh areas, observed from BWDB piezometers, is about 67 to 57m below ground surface that is about 55m at Mirpur and 20-34m at Mohammadpur, Dhanmondi and Sutrapur areas close to the river periphery. This continuous decline of water table with little or even no fluctuation is typical of over exploited aquifers (Bangladesh Water Development Board, 2007).

The declining rate of groundwater level is alarming as well at Tejgaon (60.42 m), Gulshan (62 m), and Sabujbagh (58.75 m). In these areas the water abstraction rate is higher than the recharge. The level of groundwater table of upper aquifer (<170 m depth) is declining about 2-3meter in every year. The overall groundwater level in the city is below 50 m (DWASA, 2006).

Groundwater level is comparatively high in periphery and low in the central portion of the city. Among the periphery, the Northern portion of the city has comparatively higher water level than Southern portion of the city. Because Northern portion have large open space, many small surface water bodies disperse

there and moreover, the low rate of withdrawal of groundwater. Groundwater level fluctuation patterns had abruptly changed and steeply declined after 1990.

4.3.8 River Morphology

The base line information study by JICA 2000[5] is the only account which describes the morphological changes in the rivers surrounding Dhaka. As part of the JICA study, additional cross section surveys were carried out, and historical satellite images retrieved and analyzed. With this information, the study determines the changes in top width and bank line changes of the river system. The table below summarizes the observed changes in cross section top width and bank line changes as reported in (JICA 2000).

Table 4-9: Morphological Changes on the Rivers around Dhaka

River Name	Changes in Riverbed Elevation (m)	Changes in top Width (m/year)	Left/Right Bank Line Change (m/year)
Turag (1989-2009)	-0.01 to -9.0	0.4-3.2	LB: 0.7-3.9 RB: 0.1-2.5
Buriganga (1989-2009)	-6.3 to -16.2	7.3-12.4	LB: 1.7-5.8 RB: 1.3-6.8
Tongi Khal (1991-2009)	None	0-0.6	LB: 0.1-3.6 RB: 0.2-3.4
Balu (1991-2009)	None	0.2-1.8	LB: 0.3-6.6 RB: 0.0-6.7
Lakhya (1985, 1989,1995, 1999, 2009)	-0.4 to 14.1	3.3-9.67	LB: 0.125-6.6 RB: 0.04-7.3
Dhaleswari (1989, 11990, 1993, 2009)	-0.25 to -13.4 0.15 to -5.6	18-45 10-60	LB: 0.56-5.4 RB: 0.4-1.5

Source: JICA, 2000

The JICA study (JICA 2000) reports that even though limited data have been available for the study, the following indications have been obtained:

- The river system is not highly morphologically dynamic.
- The rivers are more or less stable.
- The bank line and top width changes are not high.
- The rivers are more or less straight.
- Sediment concentrations are not very high.
- Bed sediment of most of the rivers is non-cohesive in nature and the rivers are not braided.

4.4 Environmental Quality

4.4.1 Air Quality

Ambient air quality has been monitored two times. At first, air quality was monitored during preparatory EIA study in 2017. Later, ambient air quality was monitored again in 2021 during updating the environmental baseline survey. The findings from both monitoring are given below.

[5] JICA, 2000. Baseline Information Study of the Dhaka Combined Flood Control cum Eastern Bypass Road Project. Final Report. Volume I – Main Report. March 2000. JICA for BWDB.

4.4.1.1 Methods

During the initial baseline study for EIA, 5 locations were considered for ambient air quality monitoring. Considering the sensitive receptors in and around the alignment depot area, air quality monitoring has been conducted at additional 12 locations during the EIA updating study in 2021. A total of 17 ambient air quality monitoring locations were considered during the survey period, including the initial 5 locations. Ambient air quality has been monitored at the end of Dry period (06-11 May 2021) when the air quality generally remains poor condition than that of wet period. In mid-April of 2021, it was reported that the Dhaka air quality was one of the poorest in the world[6]. The portable wireless HAZ-SCANNER™ HIM-6000 Hazardous Incident Monitor shown in **Figure 4-20** was used to scan, measure, and document critical pollutants including nitrogen dioxide, carbon monoxide, sulfur dioxide, ozone, carbon dioxide, and particulates.

Figure 4-20: Ambient Air Quality Monitoring Equipment (Haz Scanner: HIM 6000)

Sampling rate or air quality data was measured automatically every one to five minutes and directly recorded onsite for measured parameters (SO_2, NO_x, CO, O_3, PM_{10}, $PM_{2.5}$ and Lead) as shown in **Table 4-10**. Different analysis methods are integrated in the instrument, such as Particulates 90° Infrared Light Scattering for particulate matters (PM_{10}, $PM_{2.5}$), filter for lead analysis and electrochemical sensors for toxic gases (CO, NO_x, SO_2 and O_3). Sampling and analysis of ambient air quality was conducted by referring to the recommendation of the United States Environmental Protection Agency (USEPA).

Table 4-10: Methods of Air Quality Sampling and Analysis

Parameter	Machineries Name	Methods of Testing	Analysis Method
$PM_{2.5}$	Hazz Scanner HIM 6000	On Site Recording	Light Scattering Nephotometer
PM_{10}	Hazz Scanner HIM 6000	On Site Recording	Light Scattering Nephotometer
Oxides of Nitrogen	Hazz Scanner HIM 6000	On Site Recording	High Sensitivity Electrochemical
Sulfur dioxide (SO_2)	Hazz Scanner HIM 6000	On Site Recording	High Sensitivity Electrochemical

[6] https://aqicn.org/city/bangladesh/dhaka/us-consulate/m/

Parameter	Machineries Name	Methods of Testing	Analysis Method
Carbon monoxide (CO)	Hazz Scanner HIM 6000	On Site Recording	High Sensitivity Electrochemical
Ozone (O_3)	Hazz Scanner HIM 6000	On Site Recording	Mixed Metal Oxide
Lead (Pb)	Hazz Scanner HIM 6000	In house Lab and DPHE Lab	ED-XRF using Teflon filter

As per the national standard, CO and O_3 was monitored for 8 hours to compare with the national standard. For PM_{10}, $PM_{2.5}$ and SO_2, the standard duration is 24-hour data whereas the standard duration for Pb and NO_x is annual. The Hazz scanner HIM 6000 was operated for 8 hours in peak traffic time (mostly from 10.00 am to 6.00 pm) and a conversion equation (given below) was used to convert the data from specific period to expected time period. Many agencies (e.g. New York State Dept. of Environmental Conservation, California Office of Environmental Health Hazards Assessment, USEPA, Ontario Ministry of Environment) used a conversion process by applying Pasqual's (1961) air mass dispersion tables defining six air mass stability classes (**Table 4-11**) and a set of meteorological conditions (**Table 4-12**). Using the simple power law principal Schroeder and Jugloff (2012) described the steps for converting eight-hour readings to 24-hour/annual values (Schroeder & Jugloff, 2012). The stability classes (**Table 4-11**) are related to average wind speed, daytime solar radiation and night-time cloud cover (**Table 4-12**), refining these relationships, was also developed by Pasquill.

Table 4-11: Pasquill-Gifford Air Dispersion Stability Classes and Associated Dispersion Exponents[7]

Stability Class	P	Definition
A	0.5	Very Unstable
B	0.5	Unstable
C	0.333	Slightly Unstable
D	0.2	Neutral
E	0.167	Slightly Stable
F	0.167	Stable

Table 4-12: Meteorological Condition define the P-G Stability Classes

Surface Wind Speed	Day Time Incoming Solar Radiation			Night time Cloud Cover	
m/s	Strong	Moderate	Slight	>50%	<50%
<2	A	A-B	B	E	F
2-3	A-B	B	C	E	F
3-5	B	B-C	C	D	E
5-6	C	C-D	D	D	D
>6	C	D	D	D	D

[7] Julie Schroeder and Denis Jugloff (2012), Interpretation of 24-hour sampling data: Development of 24-hour ambient air quality criteria and their use in Ontario, Human Toxicology & Air Standards Section, Standards Development Branch, Ontario Ministry of the Environment, Toronto, ON, Canada

Weather data was not recorded during the monitoring period. So, from Bangladesh context, the annual average wind speed in Dhaka area is about <2 m/s. Considering the wind speed, from **Table 4-12** (1st row as the average wind speed in all the area is <2 m/s), the project stability class was calculated as 0.39 (see below):

$$P = \frac{0.5 + 0.5 + 0.167}{3}$$

$$= 0.389 \approx 0.39$$

The value of exponential factor is calculated based on the stability class of study area (**Table 4-11**). According to the wind speed and the stability class of the study area is A, B, E, and F. Hence, the value of P will be the average of the respected P values of these stability classes. This suggests a somewhat unstable air mass, resulting in considerable dilution of an eight-hour sample when spread out over a 24-hour period. To provide 24-hour averages for the five parameters, the following power-law equation as defined in Schroeder and Jugloff 2012 was applied:

$$C_{long} = C_{short}\ (t_{short}/t_{long})^{p}$$

Where,

C_{long} = Expected output in specific period
C_{short} = Outcome during Monitoring Period
t_{short} = Specific period during monitoring (in minutes)
t_{long} = Expected period (in minutes)
p = Exponential factor where the value is 0.39

This generalized approach was applied to all data, and the 24-hour/annual averages generated to be able to compare Project results to the GoB standards. The equation has been used in many approved EIA report and using by the Bangladesh Council of Scientific and Industrial Research (BCSIR) and Military Institute of Science and Technology (MIST) of MRT Line-6 for the Individual Monitoring Group (IMG) testing report.

4.4.1.2 Air Quality during Initial Baseline Study 2017

Ambient air quality was monitored at five different locations of MRT line- 5N during Initial Baseline study in 2017. Air quality monitoring locations is provided in the **Table 4-13** and shown in **Figure 4-21.**

Table 4-13: Air Quality Sampling Location of MRT Line 5N

No.	Location	Geographic Coordinate
AQ5-1	Depot Site of Line 5N	23°48'1.79"N 90°16'44.04"E
AQ5-2	Gabtoli Station	23°47'0.29"N 90°20'36.07"E
AQ5-3	Mirpur 10 Station	23°48'26.44"N 90°22'13.12"E
AQ5-4	Gulshan 2 Station	23°47'40.79"N 90°24'46.65"E
AQ5-5	Vatara Station	23°47'57.44"N 90°26'23.25"E

Source: EIA Report of MRT Line-5N, 2017

Source: EIA Report of MRT Line-5N, 2017

Figure 4-21: Air Quality Monitoring Location of MRT Line 5N (2017)

Total seven parameters (PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO, Pb and O_3) of ambient air quality was analyzed for each location. Out of seven parameters, PM_{10} and $PM_{2.5}$ concentration exceed the National Ambient Air Quality Standards (NAAQS) in Gabtoli, Mirpur 10 and Gulshan 2 stations of MRT line- 5N. At the same time, NO_2 concentration exceeds the NAAQS in Gabtoli and Mirpur 10 stations. Rest of the parameters (NO_2, CO, Pb and O_3) concentrations were well within the NAAQS in the sampling locations of MRT line-5N. The national ambient air quality standard is presented in **Table 4-14**. Results of the Air Quality has been provided in **Table 4-15.**

Table 4-14: National Ambient Air Quality Standards for Bangladesh

Pollutant	Standard	Average Time
CO	10 mg/m^3 (9 ppm)	8 hours
	40 mg/m^3 (35 ppm)	1 hours
Pb	0.5 µg/m^3	Annual
NO_2	100 µg/m^3 (0.053 ppm)	Annual
PM_{10}	50 µg/m^3	Annual
	150 µg/m^3	24 hours
$PM_{2.5}$	15 µg/m^3	Annual
	65 µg/m^3	24 hours
O_3	235 µg/m^3 (0.12 ppm)	1 hours

Pollutant	Standard	Average Time
	157 µg/m^3 (0.08 ppm)	8 hours
SO_2	80 µg/m^3 (0.03 ppm)	Annual
	365 µg/m^3 (0.14 ppm)	24 hours

Source: Environmental Conservation Rules 1997 and subsequent amendment in 2005

Table 4-15: Ambient Air Quality of MRT line- 5N during baseline study in 2017

Location	Present Concentration in µg/m^3						CO (ppm)
	PM_{10}	$PM_{2.5}$	NO_2	SO_2	O_3	Pb	
Depot Site of Line- 5N	68.2	33.8	33.6	5.5	2.4	BDL	0.2
Gabtoli Station	345.5	145.6	120.5	24.6	23.2	0.1	5.1
Mirpur 10 Station	318.4	134.9	101.7	13.7	15	0.07	1.6
Gulshan 2 Station	268.5	88.4	87.9	12.0	12.8	BDL	0.5
Vatara Station	72.4	36.8	46.7	6.4	3.2	BDL	0.1
Standard ECR1997	150	65	100	365	157	0.5	9
Duration	24 hours	24 hours	Annual	24 hours	8 hours	Annual	8 hours

Source: EIA Report of MRT Line 5N, 2017

Note: BDL- Below Detection Limit

Exceeding Standard Level

4.4.1.3 Air Quality during EIA updating Environmental Baseline Survey 2021

Ambient air quality has been monitored at seventeen different locations of MRT line-5N during the EIA updating environmental baseline survey in 2021. The monitoring locations have been selected based on the locations of stations and depot site. Air quality monitoring locations are given in **Table 4-16** and shown in **Figure 4-22**.

Table 4-16: Air Quality Monitoring Location

Sl.	Locations	Location ID	GPS location
1.	Hemayetpur Station	AQ1	23°47'38.40"N 90°16'31.25"E
2.	Depot Area (Western Boundary of Depot)	AQ2	23°47'48.02"N 90°16'35.19"E
3.	Depot Area (Eastern Boundary of Depot)	AQ3	23°48'0.72"N 90°16'39.74"E
4.	Front site of depot area (Beside Dhaka-Aricha Highway)	AQ4	23°47'40.17"N 90°16'40.69"E
5.	Baliarpur Station	AQ5	23°47'43.81"N 90°17'8.79"E
6.	Bilamalia Station	AQ6	23°47'29.79"N 90°18'26.04"E

Sl.	Locations	Location ID	GPS location
7.	Amin Bazar Station	AQ7	23°47'24.85"N 90°19'9.77"E
8.	Gabtoli Station	AQ8	23°46'58.70"N 90°20'33.23"E
9.	Dar-us-Salam Station	AQ9	23°47'19.93"N 90°21'13.74"E
10.	Mirpur-1 Station	AQ10	23°47'59.71"N 90°21'18.89"E
11.	Mirpur-10 Station	AQ11	23°48'23.92"N 90°21'59.52"E
12.	Mirpur-14 Station	AQ12	23°48'15.60"N 90°22'37.67"E
13.	Kochukhet Station	AQ13	23°47'57.87"N 90°23'4.35"E
14.	Banani Station	AQ14	23°47'39.34"N 90°24'7.52"E
15.	Gulshan-2 Station	AQ15	23°47'41.52"N 90°24'50.60"E
16.	Notun Bazar Station	AQ16	23°47'52.81"N 90°25'30.84"E
17.	Vatara Station	AQ17	23°47'58.29"N 90°26'32.74"E

Source: Field Survey, May 2021

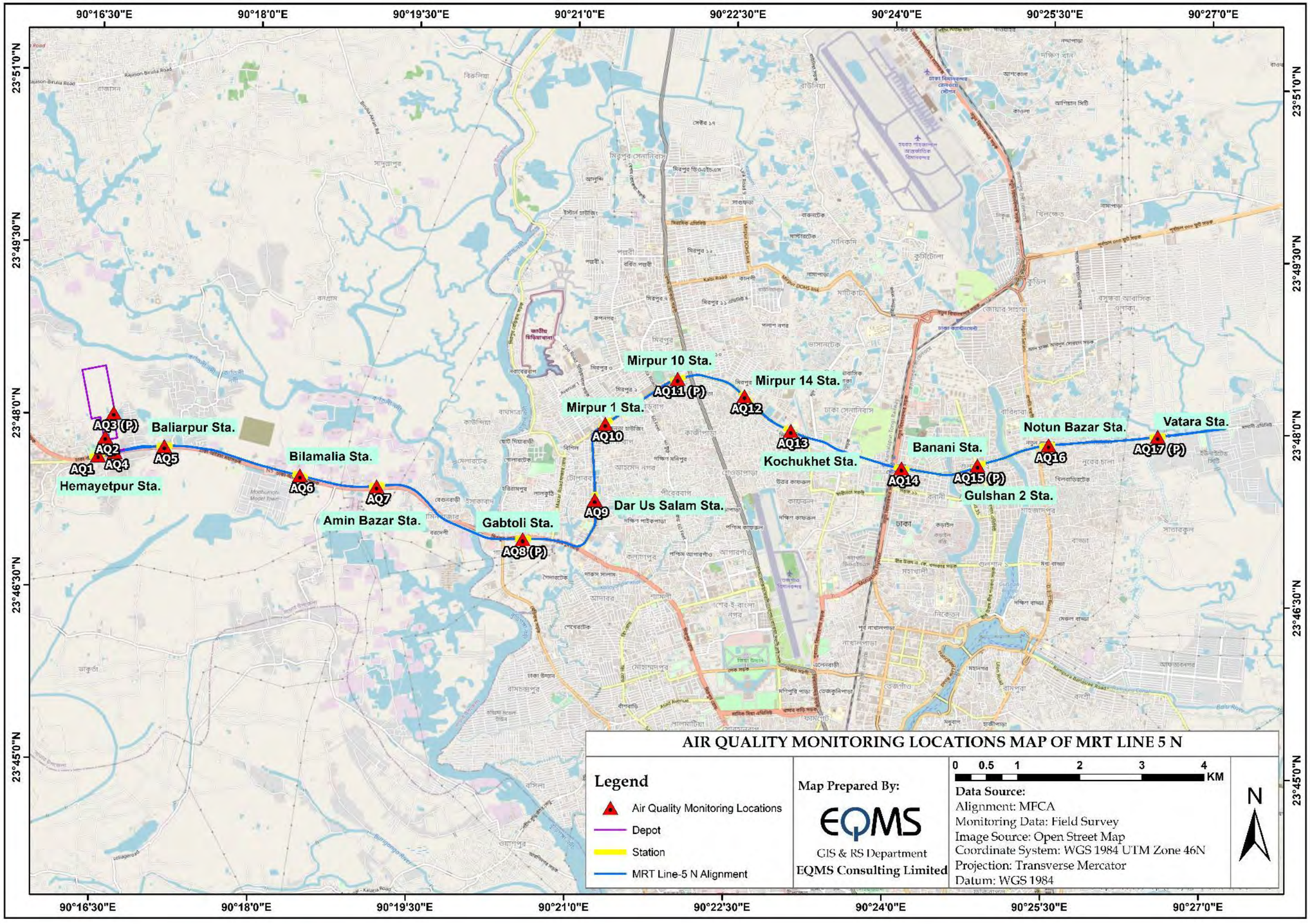


Figure 4-22: Air Quality Monitoring Location of MRT Line 5N (2021)

Total seven parameters (PM_{10}, $PM_{2.5}$, NO_x, SO_2, O_3, Pb and CO) of ambient air quality have been analyzed for each location. The summary results of Air Quality monitoring are given in **Table 4-17**. Overall, the results show that the level of air pollutants in all monitoring locations were found within the national standard, except the concentration of $PM_{2.5}$ and PM_{10} in Mirpur-10 Station area. During the monitoring period, it was observed that, a development work was in progress in front of the nearby fire service adjacent to the Mirpur-10 station area. The concentration of fine particulate matter ($PM_{2.5}$) ranges from about 35.4 in Mirpur-01 to 98.0 µg/m^3 in Mirpur-10 station area. Similarly, the concentration of PM_{10} also varies from about 52.3 in Mirpur-01 to about 171.6 µg/m^3 in Mirpur-10 station area. It is understandable from the measured data that the ambient air quality during the monitoring period was relatively better in case of particulate matter and gaseous substances in all the monitoring stations.

A nationwide lockdown was ongoing during the monitoring period which may have decreased the ambient concentration of air pollutants. The traffic movement was allowed during the monitoring period, but volume of traffic was relatively lower than normal period. The industries were not shutdown during this lockdown. A major industrial source of air pollution in Dhaka is brick kilns, which was at the end of their production season during the EIA updating baseline survey. Many of them were closed due to onset of monsoon season. This overall situation contributed to lower concentration of air pollutants during the baseline monitoring.

Table 4-17: Results of the Ambient Air Quality in MRT Line- 5N during the baseline survey of 2021

Sampling Code	Date	PM_{10} µg/m^3	$PM_{2.5}$ µg/m^3	NO_X µg/m^3	SO_2 µg/m^3	O_3 µg/m^3	Pb µg/m^3	CO ppm
AQ01	06.05.21	85.1	52.3	38.7	40.2	14.9	0.128	0.69
AQ02	06.05.21	68.8	44.7	26.1	32.5	21.3	0.047	0.28
AQ03	06.05.21	56.5	40.1	27.4	25.8	38.8	0.050	0.01
AQ04	07.05.21	66.4	44.2	25.8	31.9	15.9	0.084	0.19
AQ05	07.05.21	73.9	49.1	23.3	28.2	44.5	0.063	0.15
AQ06	07.05.21	96.6	59.8	27.1	31.3	31.8	0.056	0.10
AQ07	08.05.21	89.3	54.5	34.6	21.4	22.1	0.053	2.95
AQ08	08.05.21	76.4	48.9	27.2	25.3	16.8	0.056	0.01
AQ09	08.05.21	58.7	37.6	20.8	18.5	26.4	0.063	0.47
AQ10	09.05.21	52.3	35.4	23.2	15.1	18.7	0.053	0.21
AQ11	09.05.21	171.6	98.0	45.1	29.8	24.4	0.056	0.02
AQ12	09.05.21	81.6	50.6	20.7	13.1	11.9	0.050	0.63
AQ13	10.05.21	65.1	40.5	16.2	9.6	17.3	0.072	0.65
AQ14	10.05.21	90.5	51.7	38.6	14.5	8.5	0.091	0.01
AQ15	10.05.21	63.8	41.9	34.7	18.3	13.6	0.059	0.01
AQ16	11.05.21	74.1	41.4	93.6	16.9	40.7	0.066	0.58
AQ17	11.05.21	83.9	47.9	67.3	8.4	9.9	0.059	0.01
Duration (Hours)		**24**	**24**	**24**	**24**	**8**	**24**	**8**
Bangladesh ECR 1997*		**150**	**65**	**100 (Annual)**	**365**	**157**	**0.5 (Annual)**	**9**

* The Environment Conservation Rules (ECR) 1997 and Subsequent amendment 19th July, 2005; vide S.R.O. No.220-Law/2005
Primary data Source: Air quality analysis conducted by EQMS Consulting Limited, May 2021

Date of Monitoring: 06th – 11th May, 2021, Date of Analysis: 1-3 June, 2021

Exceeding Standard Level

Several studies found that both local, regional, and long-distance trans-boundary sources are responsible for air pollution, especially by particulate matter, in Dhaka city. Begum et al. (2010a) found that the coarse particles in the air of Dhaka are mainly dominated by local source, whereas fine particles are originated

from both local and transboundary sources[8]. Another study by Begum et al. (2013) found that about 22% and 36% PM in the air of Dhaka city are emitted from brick kiln and motor vehicles[9]. The main sources of particulate matter in the air of Dhaka are wood burning, soil dust, brick kilns, fugitive pb, road dust, Zn sources, motor vehicles, and sea salt (Begum and Hopke 2019)[10]. Among the transboundary routes, middle India, Iran and Middle East, Afghanistan, Tajikistan are main sources from where pollutants enter Dhaka through north-west and western wind movement (Rana et al. 2016)[11]. In addition, marine air enters Dhaka from southern direction that carry salt particle. US Embassy Dhaka has a continuous air quality monitoring station and publish daily Air Quality Index (AQI) for Dhaka City based on the concentration of $PM_{2.5}$ (https://bd.usembassy.gov/embassy/air-quality-data/). The $PM_{2.5}$ concentration of the monitoring month during last Six years (2016 to 2021 period) are given in **Table 4-18** based on US Embassy Data. It shows that the average concentration of $PM_{2.5}$ during May (month of the EIA updating baseline survey) was ranging from 43.4 µg/m^3 to 58.0 µg/m^3. It also shows that, the concentration generally increases during the dry season than that of wet season. Monthly average shows that, $PM_{2.5}$ concentration of the supplemental baseline survey is in line with the US embassy data.

Table 4-18: Average concentration of PM2.5 in Dhaka City

Year	Average $PM_{2.5}$ Concentration in µg/m^3			
	May	Wet Season	Dry Season	Annual
2021	49.0	55.1	162.6	97.3
2020	46.9	48.4	154.7	74.9
2019	58.0	54.9	150.8	87.0
2018	43.4	75.8	162.4	99.4
2017	50.4	48.5	157.3	79.9
2016	51.3	51.1	133.9	67.8

Source: US Embassy, Dhaka

Table 4-19 shows a comparison between the air quality of same locations from two baseline studies in 2017 and 2021. The findings show that the concentrations of particulate matters have decreased during the EIA updating baseline survey than that of initial baseline study. The comparison of gaseous pollutants shows a mixed result where the concentration of some pollutants (e.g. NO_x) decreased and the concentration of some pollutants (e.g. SO_2) increased.

The concentration of particulate matter in ambient air depends on several factors, such as surrounding activities (traffic movement, construction activities, and road surface dust), weather conditions (wind speed and direction, relative humidity), etc. In case of $PM_{2.5}$, the concentrations were found lower in all the monitoring locations except Mirpur-10 station. Though in mid-April 2021, it was reported that Dhaka air quality was one of the poorest in the world. However, it can be said that strict lockdown, the weather condition and surrounding activities have low down the particulate concentration level.

[8] Begum BA, Biswas SK, Markwitz A, Hopke PK (2010a) Identification of Sources of Fine and Coarse Particulate Matter in Dhaka, Bangladesh. Aerosol and Air Quality Research 10: 345-353

[9] Begum BA, Hopke PK, Markwitz A (2013) Air pollution by fine particulate matter in Bangladesh. Atmospheric Pollution Research 4(1): 75-86

[10] Begum BA and Hopke PK (2019) Identification of Sources from Chemical Characterization of Fine Particulate Matter and Assessment of Ambient Air Quality in Dhaka, Bangladesh. Aerosol and Air Quality Research 19: 118-128

[11] Rana MM, Mahmud M, Khan MH, Siversten B and Sulaiman N (2016) Investigating Incursion of Transboundary Pollution into the Atmosphere of Dhaka, Bangladesh. Advances in Meteorology. http://dx.doi.org/10.1155/2016/8318453

Table 4-19: Comparison between Ambient Air Quality during Initial Baseline Study (2017) and EIA updating Baseline Survey (2021)

Locations	PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)		NOx (µg/m³)		SO_2 (µg/m³)		O_3 (µg/m³)		Pb (µg/m³)		CO (ppm)	
	2017	2021	2017	2021	2017	2021	2017	2021	2017	2021	2017	2021	2017	2021
Depot Site of Line-5N	68.2	56.5	33.8	40.1	33.6	27.4	5.5	5.5	2.4	2.4	BDL	BDL	0.2	0.69
Gabtoli Station	345.5	76.4	145.6	48.9	120.5	27.2	24.6	25.3	23.2	16.8	0.1	0.056	5.1	0.01
Mirpur 10 Station	318.4	171.6	134.9	98.0	101.7	45.1	13.7	29.8	15	24.4	0.07	0.056	1.6	0.02
Gulshan 2 Station	268.5	63.8	88.4	41.9	87.9	34.7	12.0	18.3	12.8	13.6	BDL	0.059	0.5	0.01
Vatara Station	72.4	83.9	36.8	47.9	46.7	67.3	6.4	8.4	3.2	9.9	BDL	0.059	0.1	0.01
Standard (ECR 1997)	**150**		**65**		**100**		**365**		**157**		**0.5**		**9**	
Standard avg. period	**24 hr**		**24 hr**		**Annual**		**24 hr**		**8 hr**		**Annual**		**8 hr**	

Source: EIA report of MRT Line 5N, 2017 and Air quality analysis in May 2021

Exceeding Standard Level

4.4.2 Noise Level

Noise level has been monitored two times. At first, noise level was monitored during preparatory EIA study in 2017. Later, noise level was monitored again in 2021 during EIA updating environmental baseline survey. The findings from both monitoring are given below.

4.4.2.1 Methods

During the initial baseline study for EIA, 9 locations were considered for ambient noise level monitoring. Considering the sensitive receptors in and around the alignment and depot site, noise levels have been monitored at additional 14 locations during the EIA updating environmental baseline survey of 2021. A total of 23 locations including the initial 9 locations were considered for ambient noise level monitoring, 24 hours duration was monitored in each location during the survey period. The Tekcoplus meter shown in **Figure 4-23** was used for continuous noise level monitoring. The following **Table 4-20** mention the instrument character that was used for noise level monitoring and method of measurement. The device was recorded one reading in every minute throughout the monitoring period. After getting the raw data from the device, appropriate formula was applied to calculate Leq_{day} and Leq_{night} for each location. Baseline noise level has been compared with national standard (Noise pollution control rules, 2006).

Figure 4-23: Ambient Noise Level Monitoring equipment (Tekcoplus)

Table 4-20: Methods of Noise Level Monitoring

Parameter	Device Name	Laboratory	Methods of Measurement
Leq_{day} and Leq_{night}	Tekcoplus sound level meter	In House	Analysis in computer after download all data

4.4.2.2 Noise Level during Initial Baseline Study 2017

Noise levels were recorded at nine locations in the study area during the monitoring period. Noise levels were recorded in the form of sound pressure levels with the help of a digital sound level meter. The details of noise monitoring locations are given in **Table 4-21** and depicted in **Table 4-24**.

Table 4-21: Noise Level Sampling Location of MRT Line 5N

No.	Location	Geographic Coordinate
NL5-1	Depot Site of Line 5N	23°48'0.55"N 90°16'36.97"E
NL 5-2	Modhunmoti Station	23°47'27.93"N 90°18'31.56"E
NL 5-3	Gabtoli Station	23°46'57.69"N 90°20'24.27"E
NL 5-4	Dar-Us-Salam Station	23°47'31.21"N 90°21'14.54"E
NL 5-5	Mirpur 10 Station	23°48'26.35"N 90°22'12.88"E
NL 5-6	Mirpur 14 Station	23°48'15.31"N 90°22'38.85"E
NL 5-7	Banani Station	23°47'38.50"N 90°24'10.17"E
NL 5-8	Gulshan 2 Station	23°47'42.09"N 90°24'46.49"E
NL 5-9	Vatara Station	23°47'57.09"N 90°26'20.62"E

Source: EIA Report of MRT Line-5N, 2017

Source: EIA Report of MRT Line-5, 2017

Figure 4-24: Ambient Noise Level Monitoring location (2017)

Monitoring results of the ambient noise level are given in **Table 4-22**.

Table 4-22: Noise Level Analysis of MRT Line-5N during Initial Baseline Study (2017)

Code	L_{max}	L_{min}	Leq_{day}	Leq_{night}	L90	L50	L10	Area Setting*	Standard**	
									Day	Night
NL1	65.6	43.7	54.3	50.1	47.6	50.4	56.3	Residential	55	45
NL2	84.2	58.8	69.2	63.5	60.1	64.3	70.5	Commercial	70	60
NL3	95.5	56.2	74.8	68.0	62.1	64.9	71.9	Commercial	70	60
NL4	82.7	55.1	69.3	65.7	60.7	63.7	70.1	Mixed	60	50
NL5	87.5	57.8	68.2	63.9	61.3	63.8	66.2	Commercial	70	60
NL6	84.8	53.4	67.3	62.3	59.1	61.9	69.5	Commercial	70	60
NL7	82.2	56.5	71.0	68.1	62.8	64.4	71.5	Commercial	70	60
NL8	90.3	52.7	65.9	59.7	56.1	60.5	67.3	Commercial	70	60
NL9	74.9	46.7	64.5	57.1	55.1	59.6	66.5	Commercial	70	60

Source: EIA Report of MRT Line 5N, 2017

* Area setting (according to the ECR, 1997)

**Standard according to the ECR, 1997 and subsequent amendment in 2006

Note: The time from 0600 hrs to 2100 hrs is counted as daytime and from 2100 hrs to 0600 hrs is counted as night time.

Exceeding Standard Level

Ambient daytime noise level (Leq_{day}) was recorded in the range of 54.3 to 74.8 dB (A). Whereas, ambient night time noise level (Leq_{night}) in the study area were 50.1 to 68.1 dB (A). Maximum noise levels (L_{max}) at the monitoring locations were recorded in the range of 65.5 to 95.5 dB(A) and the minimum noise levels (L_{min}) at the monitoring locations were recorded in the range of 43.7 to 58.8 dB(A). From the analyzed data it has been found that, most of the cases noise level exceeds the ECR, 1997 standard during night time. Noise level exceeds the standard level due to the huge number of traffic movement during day and night time.

4.4.2.3 Noise Level during EIA updating Environmental Baseline Survey 2021

Noise level monitoring was carried out in 23 locations along the alignment and depot area. The study team measured the A-weighted equivalent continuous sound pressure level (Leq) [dB (A)] during day time (6 am–9 pm) and night time (9 pm–6 am). A list of noise level monitoring locations is given in the following **Table 4-23.** Noise level monitoring location map with alignment is shown in **Figure 4-25**.

Table 4-23: Noise Level Monitoring Location

Sl.	Location	Location ID	Geographic Coordinate
1.	Hemayetpur Station	NL1	23°47'38.40"N 90°16'31.25"E
2.	In-front of Al Nasir Laboratory School, Hemayetpur	NL2	23°47'35.81"N 90°16'31.28"E
3.	In-front of Baitul Habib Mosque, Hemayetpur	NL3	23°47'39.16"N 90°16'33.01"E
4.	Depot Area (Western Boundary of Depot)	NL4	23°47'48.02"N 90°16'35.19"E
5.	Depot Area (Eastern boundary of Depot)	NL5	23°48'0.72"N 90°16'39.74"E
6.	Alam Nagar Central Jame Mosque, Sugandha Housing, Hemayetpur	NL6	23°47'45.24"N 90°16'50.61"E
7.	Baliarpur Station (In-front of Institute for Autistic Children and Blind, Old Home and TN Mother Child Hospital)	NL7	23°47'43.81"N 90°17'8.79"E
8.	Jamia Islamia Jame Mosque, Baliarpur	NL8	23°47'44.00"N 90°17'30.15"E
9.	Jamuna Natural Park, Baliarpur	NL9	23°47'34.45"N 90°17'53.95"E
10.	Bilamalia Station	NL10	23°47'29.79"N 90°18'26.04"E
11.	Amin Bazar Station	NL11	23°47'24.85"N 90°19'9.77"E
12.	Gabtoli Station	NL12	23°46'58.70"N 90°20'33.23"E
13.	Dar-us-Salam Station (In-front of Delta Medical College & Hospital)	NL13	23°47'19.93"N 90°21'13.74"E
14.	Mirpur-1 Station	NL14	23°47'59.71"N 90°21'18.89"E
15.	Mirpur-10 Station	NL15	23°48'23.92"N 90°21'59.52"E

Sl.	Location	Location ID	Geographic Coordinate
16.	Mirpur-14 Station	NL16	23°48'15.60"N 90°22'37.67"E
17.	Kochukhet Station (In-front of Shaheed Police Smriti College)	NL17	23°47'57.87"N 90°23'04.35"E
18.	Banani Station	NL18	23°47'39.34"N 90°24'7.52"E
19.	Gulshan 2 Station	NL19	23°47'41.52"N 90°24'50.60"E
20.	Notun Bazar Station	NL20	23°47'52.81"N 90°25'30.84"E
21.	In front of Baitul Mamur Mosque, Madani Avenue, Vatara	NL21	23°47'53.81"N 90°25'37.78"E
22.	In front of Divine Mercy Church, Vatara	NL22	23°47'58.77"N 90°26'16.95"E
23.	Vatara Station	NL23	23°47'58.29"N 90°26'32.74"E

Source: Field Survey, May 2021

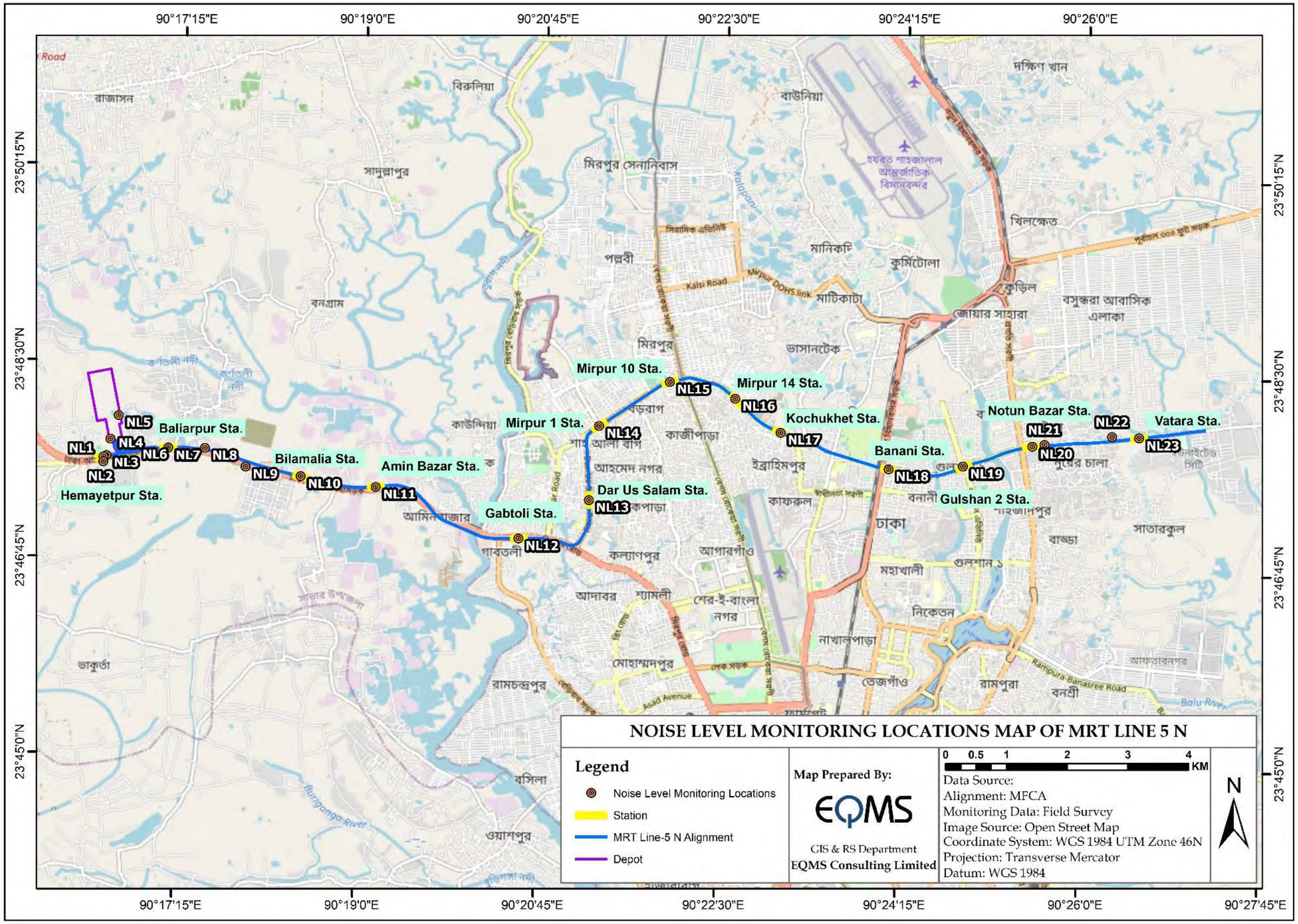


Figure 4-25: Ambient Noise Level Monitoring location (2021)

The noise level was recorded for 24 hours in each sampling point to identify the Leq_{day} and Leq_{night}. As per ECR, 1997: Schedule 2, Daytime is considered from 6 am to 9 pm and Night time is considered from 9 pm to 6 am. The monitoring locations were classified into three zones, namely: silent zone, mixed zone and residential zone as per the guidelines of Noise Pollution Control Rules 2006. Among them, NL2, NL3, NL6, NL 7, NL13, NL17, NL21 and NL22 belong to silent zone, where only NL5 goes to residential zone and rest of the locations fall under mixed zone.

The summary findings of noise level analysis are given in **Table 4-24**. The results show that the noise level in most of the locations exceeded the national standard level. Only in few locations, such as western boundary of the depot area, Bilamalia Station (during nighttime), and Mirpur-10 Station (during night time) noise levels are found within the standard limit. The lowest level of noise during daytime is found in western boundary of the Depot area, whereas the highest level of noise is found in Mirpur-10 station area during daytime since the area was crowded by higher traffic or other factors. On the other hand, during nighttime, the lowest noise level is found in Bilamalia Station and the highest noise level is found in -front of Baitul Habib Mosque, Hemayetpur, as the mosque is adjacent to the Dhaka-Aricha highway road.

Table 4-24: Leqday and Leqnight during the EIA updating Environmental Baseline Survey 2021

Code	Monitoring Date	Leq_{day} (dBA)	Leq_{night}	Standard (dBA)		Category
				Day	Night	
NL1	06-05-2021	76.4	59.4	60	50	Mixed
NL2	06-05-2021	69.1	54.0	50	40	Silent
NL3	06-05-2021	71.3	68.5	50	40	Silent
NL4	06-05-2021	55.4	49.8	60	50	Mixed
NL5	06-05-2021	57.6	51.1	55	45	Residential
NL6	07-05-2021	64.5	58.8	50	40	Silent
NL7	07-05-2021	59.8	47.0	50	40	Silent
NL8	07-05-2021	64.5	63.1	50	40	Silent
NL9	07-05-2021	65.1	59.4	60	50	Mixed
NL10	07-05-2021	65.7	42.1	60	50	Mixed
NL11	08-05-2021	72.3	66.4	60	50	Mixed
NL12	08-05-2021	62.8	54.6	60	50	Mixed
NL13	08-05-2021	70.4	64.8	50	40	Silent
NL14	09-05-2021	71.4	55.1	60	50	Mixed
NL15	09-05-2021	81.2	46.2	60	50	Mixed
NL16	09-05-2021	66.7	59.1	60	50	Mixed
NL17	10-05-2021	72.7	60.9	50	40	Silent
NL18	10-05-2021	75.1	62.8	60	50	Mixed
NL19	10-05-2021	75.5	53.9	60	50	Mixed
NL20	11-05-2021	75.9	65.6	60	50	Mixed

Code	Monitoring Date	Leq_{day} (dBA)	Leq_{night}	Standard (dBA)		Category
				Day	Night	
NL21	11-05-2021	75.8	65.6	50	40	Silent
NL22	11-05-2021	65.4	58.9	50	40	Silent
NL23	11-05-2021	61.5	50.9	60	50	Mixed

Standard: The Environment Conservation Rules (ECR) 1997 and Subsequent amendment in 2006

Primary data Source: Noise level analysis conducted by EQMS Consulting Limited, May 2021

Date of Monitoring: 06th – 11th May, 2021; Date of Analysis: 25 May-1st June, 2021

Exceeding Standard Level

Table 4-25 shows a comparison of the noise level in same locations during the initial baseline study of 2017 and EIA updating baseline survey in 2021. The findings show a mixed comparison between the results of two baseline studies. The noise level has been increased in some locations mostly in daytime, whereas decreased in almost all the locations during nighttime. Due to the lockdown situation during EIA updating baseline survey in 2021, there were limited vehicles movement during nighttime which has a direct influence in the ambient noise level. However, the noise values exceeded the standard values in most of the monitoring locations.

Table 4-25: Comparison of Noise Level in the Same Locations of Initial Baseline of 2017 and EIA updating Baseline Survey of 2021

Locations	Leq_{day}		Leq_{night}		Standard		Zone
	2017	2021	2017	2021	Day	Night	
Depot Site of Line 5N	54.3	57.6	50.1	51.1	55	45	Residential
Bilamalia Station	69.2	65.7	63.5	42.1	70	60	Commercial
Gabtoli Station	74.8	62.8	68.0	54.6	70	60	Commercial
Dar-Us-Salam Station	69.3	70.4	65.7	64.8	60	50	Mixed
Mirpur 10 Station	68.2	81.2	63.9	46.2	70	60	Commercial
Mirpur 14 Station	67.3	66.7	62.3	59.1	70	60	Commercial
Banani Station	71.0	75.1	68.1	62.8	70	60	Commercial
Gulshan 2 Station	65.9	75.5	59.7	53.9	70	60	Commercial
Vatara Station	64.5	61.5	57.1	50.9	70	60	Commercial

Source: EIA report of MRT Line 5N, 2017 and Noise level analysis done by EQMS Environmental Laboratory, May 2021

Exceeding Standard Level

4.4.3 Surface Water Quality

Surface Water Quality has been monitored at two times. At first, surface water quality was monitored during preparatory EIA study in 2017. Later, surface water quality has been monitored again in 2021 during EIA updating environmental baseline survey. The findings from both monitoring are given below.

4.4.3.1 Surface Water Quality Monitoring during Initial Baseline Study 2017

Surface water samples were taken once from 5 different locations for MRT line 5N. Surface water sample were collected on 19th to 22nd March 2017. Detail sampling locations are provided in the following **Table 4-26** and **Figure 4-27**.

Table 4-26 : Surface water Sampling Location of MRT Line 5

No.	Location	Geographic Coordinate
SW5-1	Depot Site of Line 5N	23°48'2.20"N 90°16'33.40"E
SW 5-2	Wetland between Modhunmoti Station and Amin Bazar	23°47'25.00"N90°19'18.40"E
SW 5-3	Turag River	23°47'4.40"N 90°20'10.80"E
SW 5-4	Banani Lake	23°47'35.70"N 90°24'36.20"E
SW 5-5	Gulshan Lake	23°47'46.40"N 90°25'6.00"E

Source: EIA Report of MRT Line-5N, 2017

Source: EIA Report of MRT Line-5N, 2017

Figure 4-26: Surface and Ground Water Sampling Location of MRT Line 5N (2017)

Surface water samples were collected as grab water sample in a pre-washed 5-litre plastic jerry can and 250 ml sterilized clean PET bottle for complete physio-chemical tests respectively.

The samples were analyzed as per standard procedure/method given in Standard Method for Examination of Water and Wastewater Edition 20, published by APHA. Details of the analysis method and protocol are

presented in **Table 4-27.** The samples were analyzed for parameters covering Bacteriological and physico-chemical characteristics which include certain heavy metals and trace elements.

Table 4-27: Methods of Water Parameter Analysis

Sl.	Parameter	Test method
1.	Temperature (˚C)	Digital thermometer
2.	pH	Hanna Combo Meter (Temperature, pH, EC, TDS)
3.	Salinity	Salinity Meter
4.	Dissolved Oxygen (DO)	Lutron 5509 Dissolved Oxygen Meter
5.	Biochemical Oxygen Demand (BOD)	5 Day Incubation
6.	Chemical Oxygen Demand (COD)	CRM
7.	Coliform (Faecal)	MFM
8.	Colour	UVS
9.	Total Suspended Solid (TSS)	Gravity Multimeter
10.	Sodium	AAS
11.	Potassium	AAS
12.	Calcium	AAS
13.	Bicarbonate	Titrimetric
14.	Chloride	Titrimetric
15.	Sulfate	UVS
16.	Nitrate	UVS
17.	Nitrite	UVS
18.	Arsenic	AAS

Note: AAS: Atomic Absorption Spectrophotometer, UVS- UV- Visible Spectrophotometer, MFM- Membrane Filtration Method

The quality of surface water was compared with the standards for Inland Surface Water, Environment Conservation Rules (ECR), 1997-Schedule 3 (a) whereas the groundwater was compared with the Drinking Water Standard ECR-Schedule-3 (b), 1997. The standards have been presented along with the monitoring results of surface and groundwater for comparison.

Surface water quality of the collected samples is poor compared to the Bangladesh inland surface water quality standard. The main causes of the degraded water quality are liquid waste discharge as well as sewage discharge in the surface water body. The Surface water quality of MRT line 5N is shown in the **Table 4-28.**

Table 4-28: Surface Water Quality Analysis Result

Parameter	Unit	SW5-1	SW5-2	SW5-3	SW5-4	SW5-5	Standard for Inland Surface Water*					
							a	b	c	d	e	f
Colour	Hazen	2.1	1.8	2.0	1.3	1.7	-	-	-	-	-	-
Temperature	˚C	23.2	23.1	24.5	24.4	24.0	-	-	-	-	-	-
pH	-	7.22	7.08	7.46	7.00	7.34	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5
DO	mg/l	4.1	3.2	2.7	1.3	2.9	6 or above	5 or more	6 or more	5 or more	5 or more	5 or more
BOD	mg/l	13	08	12	13	10	2 or less	3 or less	6 or less	6 or less	10 or less	10 or less
COD	mg/l	48	32	44	48	36	-	-	-	-	-	-
TSS	mg/l	24	15	42	28	21						
Coliform (Faecal)	N/100ml	475	786	995	840	787	50 or less	200 or less	5000 or less	---	5000 or less	1000 or less
TDS	mg/l	280	290	530	320	300	-	-	-	-	-	-

Source: EQMS laboratory and Department of Public Health and Engineering Lab; Analysis date: 22/03/2017- 30/04/2017 and 30/04/2-17-22/05/2017

*Note: a- Source of drinking water for supply only after disinfecting

b- Water usable for recreational activity

c- Source of drinking water for supply after conventional treatment

d- Water usable by fisheries

e- Water usable by various process and cooling industries

f- Water usable for irrigation

From the **Table 4-28**, pH concentration of the surface water in all samples are within the Bangladesh standard. Dissolved Oxygen (DO) level of all parameters are below the standards whereas BOD and COD concentration of all samples are very high and cross the national standard limit. TSS and Fecal coliform concentrations of all samples are relatively higher than the national standard. Fecal coliform concentrations are very high in all samples.

4.4.3.2 Surface Water Quality Monitoring during EIA updating Baseline Study 2021

Surface water samples have been collected from six locations along the alignment and the depot area. **Table 4-29** shows the locations of surface water sampling points. After collection of the water samples, some parameters (Temperature, pH, DO, TDS and EC) have been tested onsite and other parameters were tested in BCSIR and EQMS laboratories. The parameters include Color, Temperature, pH, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solis (TSS) and Total Coliform (TC). Surface water sampling locations map with alignment are shown in **Figure 4-27**.

Table 4-29: Surface Water Sampling Location

Sl.	Location	Location ID	Geographic Coordinate
1.	Upstream of Karnatali River, Rajarghat	SW1	23°48'36''N 90°16'23''E
2.	Downstream of Karnatali River (In-between Gendura and Nagarkunda)	SW2	23°48'34''N 90°16'39''E
3.	Baliarpur (Northern side of Dhaka-Aricha Highway	SW3	23°47'32''N 90°18'6''E
4.	Amin Bazar (South Side of Dhaka-Aricha highway	SW4	23°47'29''N 90°19'10''E
5.	Amin Bazar (North Side of Dhaka-Aricha highway)	SW5	23°47'17''N 90°19'8''E
6.	Satarkul-Vatara 1st Bridge, Madani Avenue, Vatara	SW6	23°48'1''N 90°26'46''E

Source: Field Survey, April 2021

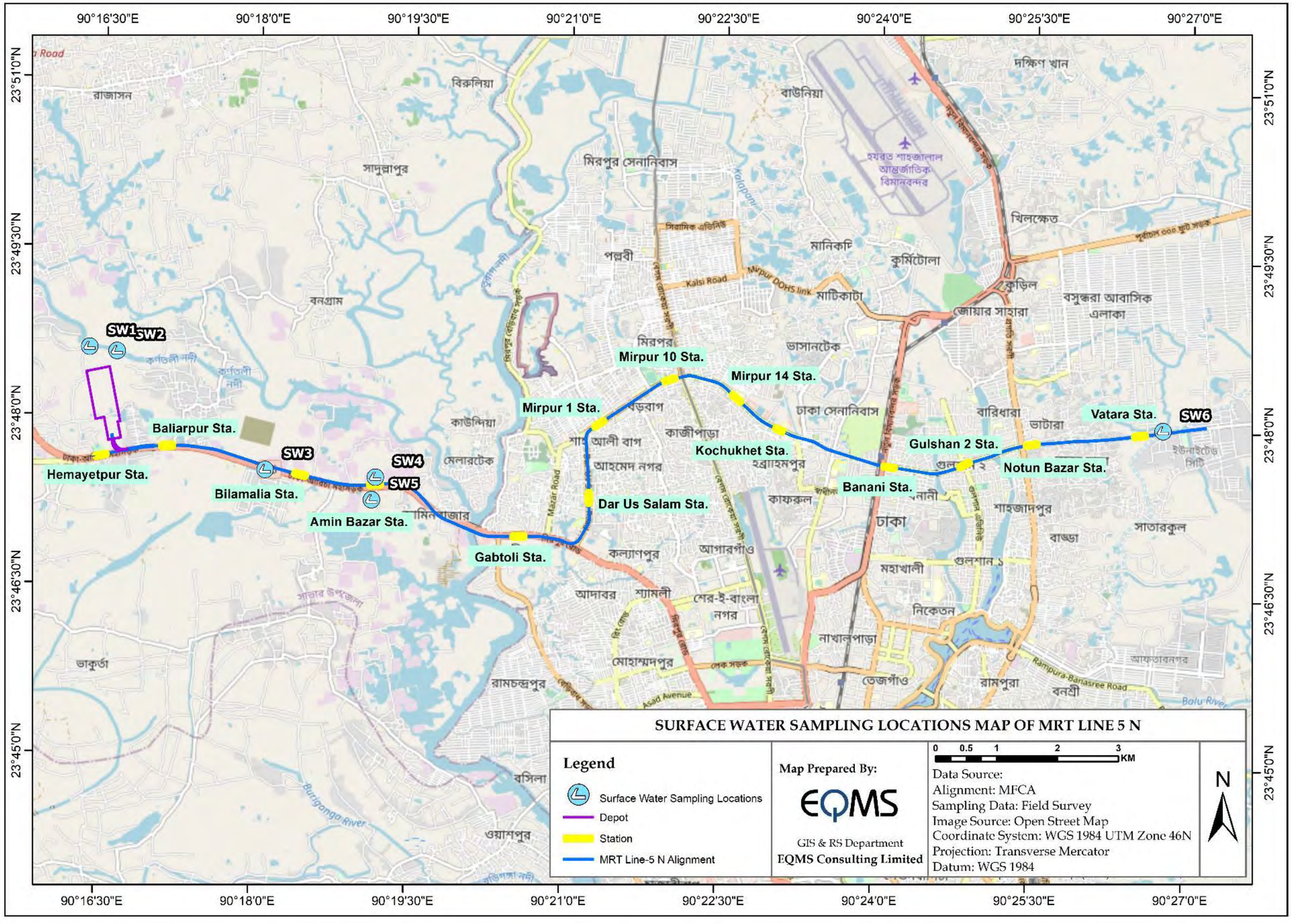


Figure 4-27: Surface Water Sampling Location of MRT Line 5N (2021)

4.4.3.3 Site Selection for Surface Water Sampling

A total of six surface water samples has been collected from the Karnatali river beside depot area and adjacent surface water bodies (canal, pond) of MRT Line -5N alignment. During the sampling site selection, focus has been given to the surface water bodies mostly adjacent to the depot area and the elevated section of the alignment. There is a possibility of surface water pollution during the construction of depot and elevated section. Other surface water bodies that are adjacent to the underground section of the alignment are unlikely to be impacted by the project activity. Hence, those locations weren't considered during the sampling site selection.

4.4.3.4 Special Precautions for Surface Water Sampling

a. A clean pair of new, non-powdered, disposable gloves were worn each time a different location is sampled and the gloves were donned immediately prior to sampling. The gloves had not meet the media being sampled and were changed during sample collection.
b. Sample containers suspected of containing high concentration of contaminants were stored separately.
c. All background or control samples were collected and placed in separate ice chests or shipping containers.
d. A member of the field sampling team has taken all the notes and photographs, fill out tags, etc., while the other members have collected the samples.

4.4.3.5 Details of Surface Water Sampling

There are some surface water bodies besides depot area and along the alignment, especially along the elevated section. Total six surface water samples have been collected from respective locations during dry period (April 2021) Details of sampling locations are presented in **Table 4-30**. Water samples were collected as grab water sample in a pre-washed 5-litre plastic jerry can and 1-liter sterilized clean PET bottle for complete physico-chemical tests respectively. Some parameters (Temperature, pH, DO, TDS and EC) have been tested on-field using the portable water testing meter and rest of the parameters were tested in laboratory. **Figure 4-28** shows the on-site water testing equipment and in-house laboratory testing facilities that have been used for both on-site and in-house testing of surface water.

	
Lutron DO Meter	Hanna Combo Meter (Temperature, pH, EC, TDS)

COD and Multiparameter Photometer

Testing Facilities at EQMS Wet Lab

Figure 4-28: On-site Surface and Ground Water Testing Equipment and In-House Testing Laboratory

Surface water results have been compared with national standard [ECR, 1997-schedule 3 (A)]. The following **Table 4-30** shows the laboratory name and methods of surface water analysis.

Table 4-30: Methods of Surface Water Analysis

Parameter	Laboratory	Methods/Instrument to be used for Analysis
Color	EQMS Laboratory	APHA 22nd Edition-2012, 2120B
Temperature	On Site	Hanna Combo Meter
pH	On Site	Hanna Combo Meter
EC	On Site	Hanna Combo Meter
TDS	On Site	Hanna Combo Meter
DO	On Site	Lutron DO Meter (DO-5509)
BOD	EQMS Laboratory	5 days incubation
COD	EQMS Laboratory	CRM/APHA 22nd Edition-2012, 5220B
TSS	EQMS Laboratory	APHA 22nd Edition-2012, 2540D
Total Coliform	BCSIR Laboratory	9221B-C

4.4.3.6 Sample Handling and Preservation Requirements

a. Surface water samples were collected by directly filling the container from the surface water body being sampled.
b. Samples were placed into appropriate, labeled containers.
c. Samples requiring reduced temperature storage were placed on ice immediately.

4.4.3.7 Surface Water Quality Analysis Result

Surface water samples have been collected from the water bodies in and around the project alignment and depot site. Result of the surface water quality analysis is shown in **Table 4-31**. The results show that, the pH levels at SW3, SW4, and SW5 are higher than the standard of ECR'97. The concentration of DO at SW1, SW2, SW5, and SW6 have been found lower than the standard limit. Apart from these, the concentration of BOD at SW1, SW2, and SW6 have been found higher than the standard. There is no stipulated standard in ECR'97 for Temperature, EC, color, TDS, TSS and Total coliform. The lower

concentration of DO and higher concentration of BOD indicates the presence of organic waste in significant amount that require higher volume of oxygen to decompose. In other words, the water quality in these water body is deteriorated because of some anthropogenic activities. There is a positive correlation between EC and the concentration of TDS. Such type of correlation is also found in this study also as the samples with higher TDS also have higher level of EC.

Table 4-31: Surface Water Quality Test Result

Parameters	Unit	Concentration						ECR'97 Standard*					
		SW1	SW2	SW3	SW4	SW5	SW6	a	b	c	d	e	f
Temperature	(^{0}C)	32.9	33.9	35.6	33.4	35.0	31.1	-	-	-	-	-	-
EC	µS/cm	1420	1410	350	380	300	880	-	-	-	-	-	-
Color	PCU	300	297	160	35	27	414	-	-	-	-	-	-
pH	--	7.95	7.84	9.34	8.95	9.40	6.81	6.5-8.5	6.5-8.5	6.5-8.5	6.5 -8.5	6.5-8.5	6.5-8.5
TDS	ppm	710	690	170	190	150	440	-	-	-	-	-	-
DO	mg/l	1.9	2.0	5.3	6.3	4.5	1.5	6 or above	5 or more	6 or more	5 or more	5 or more	5 or more
BOD_5	mg/l	8.0	7.5	1.6	0.8	0.4	15	2 or less	3 or less	6 or less	6 or less	10 or less	10 or less
COD	mg/l	84	82	40	49	61	131	-	-	-	-	-	-
TSS	mg/l	34	29	29	63	64	56	-	-	-	-	-	-
TC	MPN/100 ml	>1600	>1600	32	47	40	>1600	50 or less	200 or less	5000 or less	-	5000 or less	1000 or less

Highlighted values do not comply with Bangladesh Environment conservation rules 1997

*The Environment Conservation Rules (ECR) 1997, Schedule 3(A);

a. Source of drinking water for supply only after disinfecting

b. Water usable for recreational activity

c. Source of drinking water for supply after conventional treatment

d. Water usable for fisheries

e. Water usable by various process and cooling industries

f. Water usable for irrigation

Primary data Source: Water quality analysis done by BCSIR & EQMS Wet Laboratory, April 2021

Reporting Date: 31st May, 2021

Below/Exceeding Standard Level

4.4.4 Ground Water Quality

Ground Water Quality has been monitored at two times. At first, ground water quality has been monitored during preparatory EIA study in 2017. Later, ground water quality has been monitored again in 2021 during EIA updating environmental baseline survey. The findings from both monitoring are given below.

4.4.4.1 Ground Water Quality Monitoring during Initial Baseline Study 2017

Ground water samples were collected once during the study period from nine different locations for MRT line 5N. The ground water samples were collected on 19th to 22nd March 2017. Detail Sampling Locations are provided in the following **Table 4-32** and **Figure 4-29**.

Table 4-32: Ground water Sampling Location of MRT Line 5N

SL#	Location	Sampling ID	Geographic Coordinate
1.	Abdul Malek house, Guydar Tak, Gabtoli	GW5-1	23°46'44.0"N 90°20'49.7"E
2.	Mirpur Bangla College WASA pump	GW5-2	23°47'03.6"N 90°21'10.5"E
3.	Mirpur 10 WASA Pump	GW5-3	23°48'24.4"N 90°22'24.5"E
4.	Police Staff Collage Mirpur 14	GW5-4	23°48'15.3"N 90°22'47.1"E
5.	Banani DOHS Pump House	GW5-5	23°47'33.59"N 90°23'51.38"E
6.	Vatara WASA Pump house	GW5-6	23°47'44.7"N 90°26'14.6"E

Source: EIA Report of MRT Line-5N, 2017

Ground water qualities of all samples are well within the permissible limit in accordance with the Environmental Conservation Rules, 1997. The Ground water quality of the MRT line 5N is shown in the following **Table 4-33.**

The concentration levels of pH, chloride, sulfate, Na, K, Ca, Mn, As, Fe, Ammonia Nitrate, total hardness, chloride and Faecal coliform for tube well were found within limit of drinking water standard.

Table 4-33: Ground Water Quality of MRT Line 5N

Parameter	Unit	GW5-1	GW5-2	GW5-3	GW5-4	GW5-5	GW5-6	ECR, 1997 Standard
Depth of the Tube well/Pump	m	122	275	275	305	275	275	-
Colour	Hazen	0.9	1.3	1.0	1.7	0.8	1.0	15
Temperature	˚C	25.9	23.8	24.9	29.3	28.3	26.8	20-30
pH	-	6.75	7.14	6.78	6.96	7.06	26.80	6.5-8.5
Sodium	mg/l	28	29	24	28	23	17	200
Potassium	mg/l	04	04	03	03	03	03	12
Calcium	mg/l	10	15	07	07	09	05	75
Bicarbonate	mg/l	170	205	135	160	165	90	-
Chloride	mg/l	12	16	13	15	14	12	150-600
Sulfate	mg/l	02	1.0	02	1.0	1.0	1.0	400
Nitrate	mg/l	0.10	< LOQ	< LOQ	2.38	< LOQ	0.28	10
Nitrite	mg/l	< LOQ	< LOQ	0.017	< LOQ	< LOQ	< LOQ	<1.0
Arsenic	mg/l	0.002	0.001	0.001	0.003	0.002	0.001	0.05
Fecal Coliforms	N/ 100ml	0	0	0	04	0	0	0

Source: EQMS Laboratory and Department of Public Health and Engineering Lab; Analysis date: 22/03/2017- 30/04/2017 and 30/04/2017-22/05/2017

Note: LOQ- Limit of Quantitation

4.4.4.2 Ground Water Quality Monitoring EIA updating Baseline Study 2021

Groundwater samples have been collected from 10 locations along the route alignment and depot area. **Table 4-34** shows the details of ground water sampling locations with their coordinates. After collecting ground water, temperature and pH have been tested onsite, while other parameters were tested in BCSIR and EQMS laboratories. The parameters of ground water quality include Temperature, Color, pH, Arsenic (As), Potassium (K), Calcium (Ca), Chloride (Cl^-), Nitrate (NO_3^-), Nitrite (NO_2^-), Sulfate (SO^{2-}_4), Sodium (Na), Bicarbonate (HCO_3^-) and Fecal Coliform (FC). Ground water sampling locations map with alignment are shown in **Figure 4-29**.

Table 4-34: Ground water Sampling Location

Sl.	Location	Location ID	Geographic Coordinate
1.	Depot Area	GW1	23°47'48''N 90°16'37''E
2.	Markazut tarbiya Madrasha, Sugandha Housing, Alam Nagar, Hemayetpur	GW2	23°48'3''N 90°16'51''E
3.	Abu Saeed's Home, 20/A, Goidartek, Ward: 10, Gabtoli	GW3	23°46'43''N 90°20'49''E
4.	DWASA Mods Zone-4, Darussalam (Near to Mirpur Bangla College)	GW4	23°46'43''N 90°20'49''E
5.	Paikpara Govt. Colony, Mirpur-1	GW5	23°47'28''N 90°21'10''E
6.	Mirpur-10 (bottled water production plant)	GW6	23°48'25''N 90°22'24''E
7.	Police Stuff College, Mirpur	GW7	23°48'10''N 90°22'45''E
8.	Mirpur-14, DWASA Pump House	GW8	23°47'55''N 90°23'14''E
9.	Banani DOHS Club Canteen	GW9	23°47'34''N 90°23'54''E
10.	Vatara DWASA Pump House	GW10	23°47'45''N 90°26'14''E

Source: Field Survey, April 2021

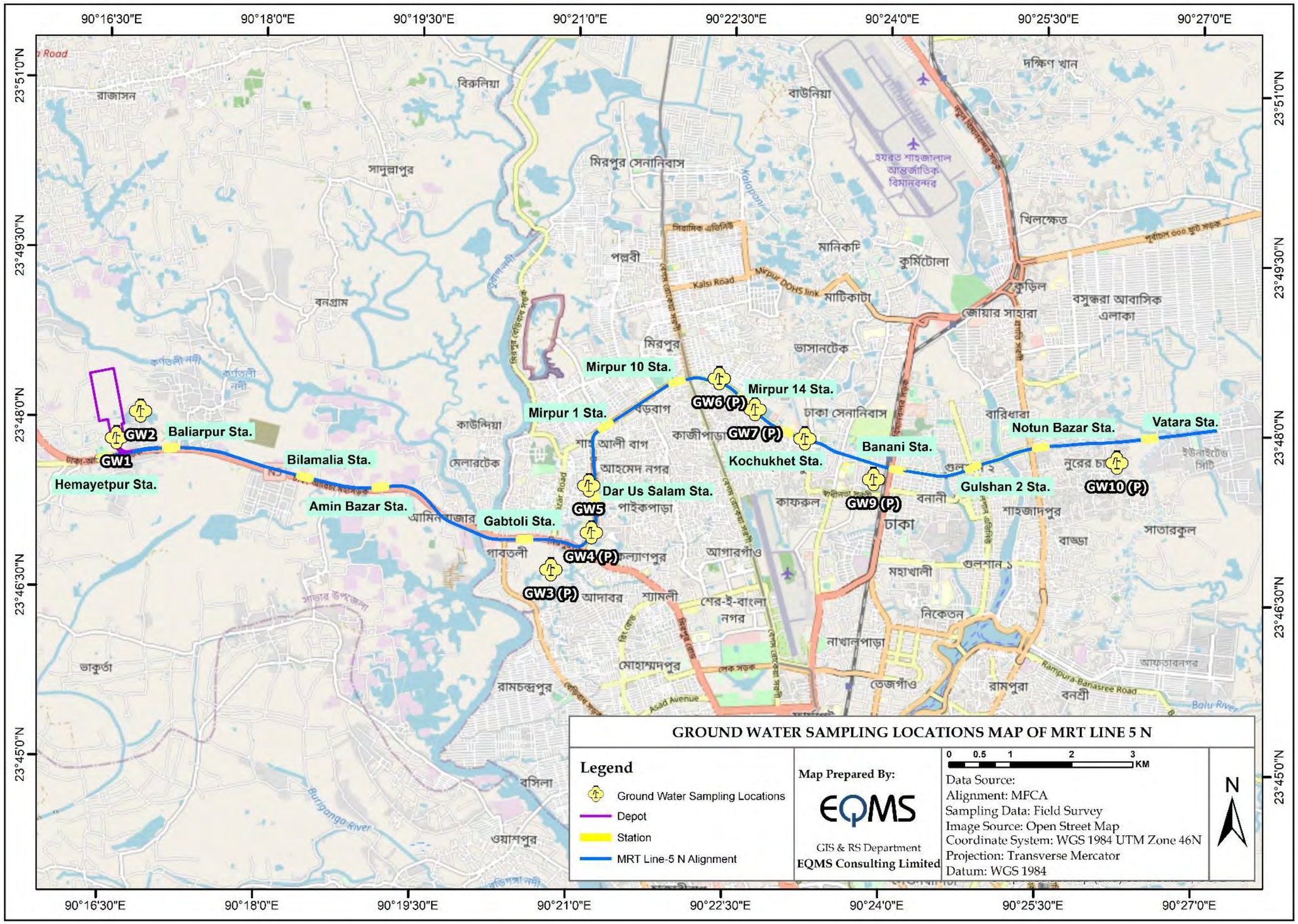


Figure 4-29: Ground Water Sampling Location of MRT Line 5N (2021)

4.4.4.3 Site Selection for the Groundwater Sampling

A total ten ground water samples have been collected from the nearby groundwater sources along the depot and route alignment of the MRT Line- 5N. These are the nearby ground water source of depot and stations area. Hence it is necessary to establish the baseline value because during the construction phase it will help to determine whether these groundwater sources are impacted due to the project activity or not. Therefore, these nearby sources have been considered for ground water sampling source to establish the baseline values.

4.4.4.4 Sampling Procedure of Groundwater

a. Checked the correct sample bottle and label;
b. Sterilized the open area of the tap/source with cotton immerged in alcohol or fire;
c. Turned on cold water tap at maximum flow and started timing;
d. Considering the distance of laboratory and sampling location, temperature and pH value were taken immediately.

4.4.4.5 Details of Groundwater Sampling

The groundwater samples were collected by maintaining standard procedures from the selected locations. Some parameters (Temperature and pH) have been tested onsite, while other parameters were tested in laboratory. Ground water results has been compared with national standard [ECR, 1997-schedule 3 (B)]. **Figure 4-28** shows the on-site water testing equipment and in-house laboratory testing facilities that have been used for both on-site and in-house testing of ground water. The analysis methods of different parameters of ground water are given in the following **Table 4-35**.

Table 4-35: Methods of Ground Water Analysis

Parameter	Laboratory	Methods/Instrument to be used for Analysis
Temperature	On Site	Hanna Combo Meter
Color	EQMS Laboratory	Photometric method
pH	On Site	Hanna Combo Meter
Arsenic	EQMS Laboratory	Modified Gutzeit method
Potassium	EQMS Laboratory	Photometric method
Calcium	EQMS Laboratory	Photometric method
Chloride	EQMS Laboratory	Photometric method
Nitrate	EQMS Laboratory	Photometric method
Nitrite	EQMS Laboratory	Photometric method
Sulfate	EQMS Laboratory	Photometric method
Sodium	BCSIR Laboratory	3500-Na B
Bicarbonate	BCSIR Laboratory	Titrimetric Method
Fecal Coliform	BCSIR Laboratory	9221B-C

4.4.4.6 Ground Water Quality Analysis Result

Groundwater samples were collected from the nearby sources throughout the project alignment and depot area. The analysis results of the ground water quality are shown in **Table 4-36**. The results show that, ground water temperature at GW1, GW2, GW3 and GW9 are slightly higher than the standards of ECR'97. In addition to this, pH level at GW5 has been found slightly lower than the standard. There is no stipulated standard for ground water Bicarbonate in ECR'97. Rest of the parameters have been found within the standards of ECR'97.

Table 4-36: Ground Water Quality Test Result

Parameters	Unit	Concentration Present										ECR'97 Standard*
		GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8	GW9	GW10	
Temperature	(^{0}C)	31.3	31.3	31.3	28.6	28.6	29.7	32.9	29.5	30.8	28.9	20-30
Color	PCU	2.0	2.0	7.0	5.0	2.0	4.0	8.0	5.0	5.0	10.0	15.0
pH	--	6.68	6.44	6.44	7.02	6.45	7.05	7.61	6.97	7.54	6.92	6.5-8.5
Arsenic	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.05
Potassium	mg/l	1.95	2.0	1.95	2.1	2.1	1.85	3.1	1.76	1.93	2.14	12.0
Calcium	mg/l	40.0	45.0	40.0	45.0	30.0	40.0	50.0	45.0	40.0	40.0	75.0
Chloride	mg/l	9.3	10.6	57.0	7.7	52.0	6.5	6.0	3.0	3.3	3.1	150-600
Nitrate	mg/l	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0
Nitrite	mg/l	0.02	0.02	0.02	0.03	0.04	0.02	0.03	0.03	0.04	0.03	<1.0
Sulphate	mg/l	5.0	5.0	15.0	10.0	10.0	0.0	5.0	5.0	0.0	5.0	400
Sodium	mg/l	22.2	20.9	28.7	22.2	25.8	24.2	25.9	24.0	24.3	24.8	200
Bicarbonate	mg/l	206.0	154.0	454.0	160.0	148.0	181.0	193.0	176.0	170.0	175.0	-
FC	MPN/100 ml	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	0

Highlighted values do not comply with Bangladesh Environment conservation rules (ECR) 1997, Schedule 3(B)

Primary data Source: Water quality analysis done by BCSIR & EQMS Wet Laboratory, April 2021,

Reporting Date: 31st May, 2021

Exceeding Standard Level

4.5 Biological Resource

An Ecological Survey was conducted during preparation of the preparatory EIA report in 2017. In that survey a detail investigation was carried out to find out the biodiversity in the project area following proper methodology. The detail findings of that survey, including the list of plant and animal species can be found in the preparatory EIA report of 2017 (see section 4.9 of 2017 preparatory EIA report). During this EIA updating study, no ecological survey is carried out.

4.6 Socioeconomic Characteristics

The present socio-economic conditions of the people of the project or study area will provide sound reference and assess probable socio-economic impact of the proposed interventions. This will enable us to compare the changes and impacts of the project interventions in future.

The socio-economic baseline scenario describes the socio-economic characteristics of the project area based on primary and secondary data. The socio-economic characteristics include administrative area, demographic data, household size, education, occupation, housing, employment opportunity, health, access to water and sanitation status, etc. The data provided in this section are mostly based on the Population and Housing Census 2011. Although these data are very old, but these are the latest available data that may differ from current situation. Therefore, these data are given to show just a crude outline.

4.6.1 Administrative Divisions and Location

The Project site is in Dhaka District. Dhaka is the most populous city in Bangladesh and the political, economic and cultural heart of Bangladesh. It lies between 23º53` and 24º06` north latitudes and between 90º01' and 90º37' east longitudes. Dhaka city consists of 2 City Corporations - Dhaka North City Corporation and Dhaka South City Corporation for ensuring better civic facilities. These two corporations are headed by City Mayor. Area within city corporations divided into several wards which have a ward commissioner each and wards 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 and these unions are headed by Union Parishad Chairman.

These two city corporations have different administrative boundaries with overall 10 zones and 92 wards where Dhaka South City Corporation has 56 wards and Dhaka North City Corporation has 36 wards.

On the other hand, Savar Upazila consists of 12 union parishad. There are also 2 Thana, 1 Pourashava, 377 villages. **Table 4-37** show the list of wards/union adjacent to the alignment in North and South Dhaka.

Table 4-37: Study Area/Wards of the MRT Line-5N Alignment

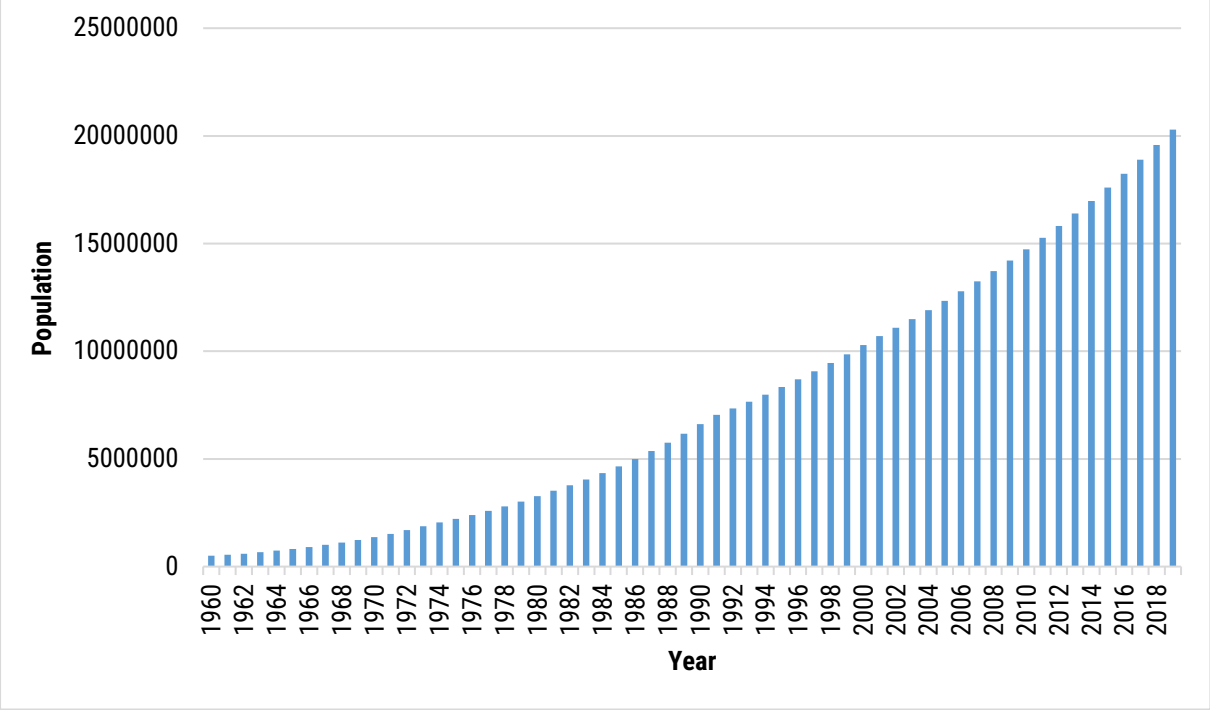
Upazila/Ward	Area/Thana/Union Covered
Dhaka North City Corporation	
Ward-03	Mirpur section-10
Ward-04	Mirpur section-14, Byshteki
Ward-07	Mirpur section-2, Rupnagar, Govt. housing Estate
Ward-08	Mirpur section-1, Box nagar, Zoo and Botanical Garden
Ward-09	Golartek, Bagbari, Gabtoli Bus Terminal
Ward-10	Gabtoli, Mirpur Colony, Darus Salam
Ward-11	Paikpara

Upazila/Ward	Area/Thana/Union Covered
Ward-12	Ahmed Nagar
Ward-14	Kazipara, Sawrapara, Senpara-parbata
Ward-16	Ibrahimpur, Kafrul
Ward-18	Baridhara, Shahjadpur
Ward-19	Gulshan, Banani
Savar Upazila and Tejgaon Unnayon Circle	
Savar Upazila	Banagram, Kaundia, Tetuljhora, Amin Bazar
Tejgaon Unnayon Circle	Bhatara

(http://www.dncc.gov.bd/, 2017)

4.6.2 Population and Demography

Dhaka is the most populated city in Bangladesh, and it is also one of the most populated cities in the world. According to the Population and Housing Census, 2011 the city itself has a population estimated at about 8 million. According to a recent estimate of World Bank, total population of Dhaka City stands more than 20 million in 2019. **Figure 4-30** shows an illustration of population growth in Dhaka City from 1960 to 2018.



Source: World Bank 2020

Figure 4-30: Population Growth of Dhaka City from 1960 to 2018

According to the population and housing census 2011, there are 375541 households (HHs) including squatters with a total population of 1566290 in the study area. The average household size is 4.2. **Table 4-38** shows the ward and union wise Demography of the study area as per the findings of the Population and Housing Census 2011.

Table 4-38: Demography of the Study Area Crossed by the Project

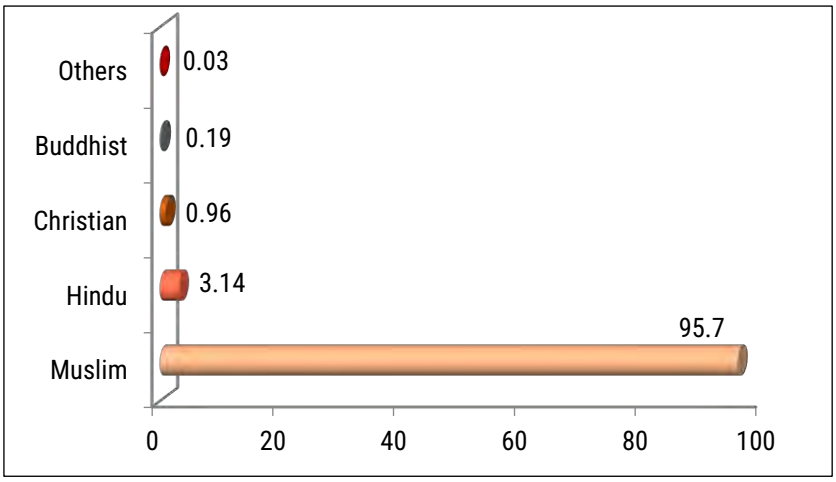
City Corporation/ Upazila	Ward No./ Union	Total Population	Total HHs	Avg. HH size	Sex Ratio	Literacy (%)
North City Corporation	Ward No-03	94664	22275	4.2	108	72.3
	Ward No-04	75246	18058	4.2	124	77.9
	Ward No-07	113750	26844	4.2	112	70.7
	Ward No-08	111251	27116	4.1	115	71.5
	Ward No-09	71260	16936	4.2	126	65.6
	Ward No-10	87879	23128	3.8	116	68.4
	Ward No-11	97033	22905	4.2	120	79.7
	Ward No-12	116544	27286	4.3	117	80.4
	Ward No-14	163797	38571	4.2	116	81.4
	Ward No-16	142413	35008	4.1	112	77.1
	Ward No-18	63616	14365	4.4	136	81.2
	Ward No-19	96291	22646	4.3	119	69.4
Savar Upazila	Banagram	33627	7813	4.3	112	51.7
	Kaundia	27796	6182	4.5	116	54.1
	Tetuljhora	106929	26287	4.1	119	63.9
	Amin Bazar	37500	8907	4.2	119	54
Tejgaon Unnoyon Circle	Bhatara	126694	31214	4.1	134	70.9
Project Study Area		**1566290**	**375541**	**4.2**	**119**	**70.0**

Source: Population and Housing Census, 2011, Bangladesh Bureau of Statistics (BBS)

Literacy rates are available by ward of DNCC as shown in **Figure 4-33** alongside sex ratio. The illiteracy rate in the study area is 70% which is higher than the national average 42.1% and the average sex ratio (number of males per 100 females) is 119.

4.6.3 Religion

As per the 2011 census, the population of the study area dominated by the Muslim community (95.7%) in terms of faith. The second group goes to Hindu who is only 3.14% and other groups (Christian and Buddhist) are very negligible in percentage. The following **Figure 4-31** indicates the various religious profile of the study area.

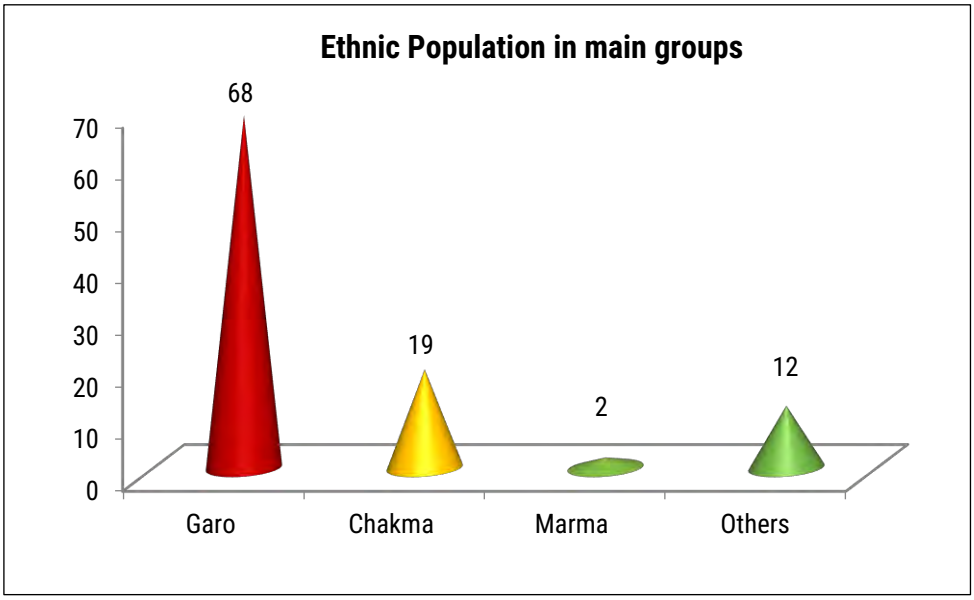


Source: Population and Housing Census, 2011, Bangladesh Bureau of Statistics (BBS)

Figure 4-31: Religious Profile of the Study Area

4.6.4 Ethnic Composition

According to population census (2011), among the selected Unions 5409 ethnic households are found in the study area. Garo, Chakma, Marma and some other ethnic communities are over there. Ethnic composition of the Study area is dominated by the Garo community**. Figure 4-32** shows the distribution of ethnic community of the study area.

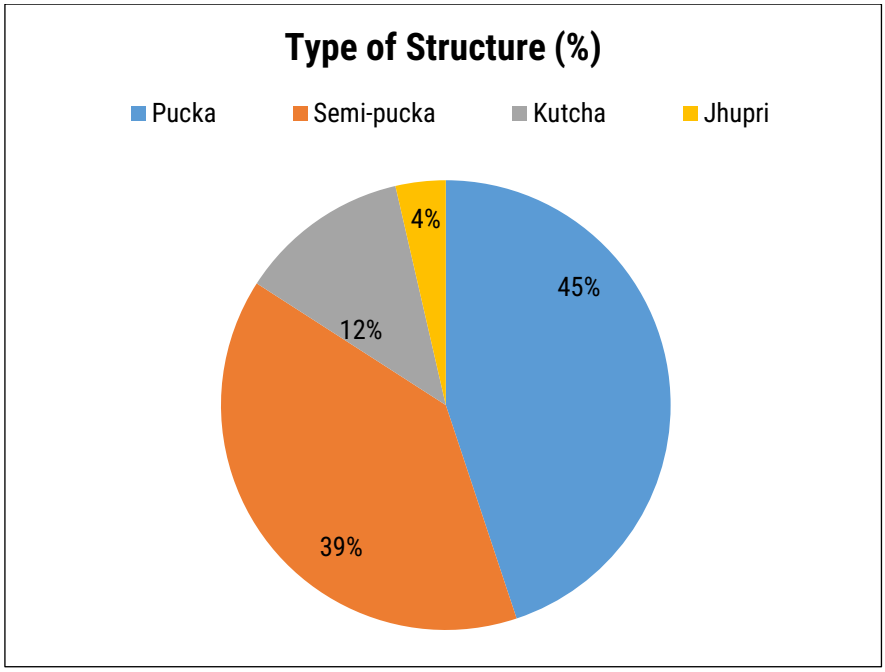


Source: Population and Housing Census, 2011, Bangladesh Bureau of Statistics (BBS)

Figure 4-32: Distribution of Ethnic Community

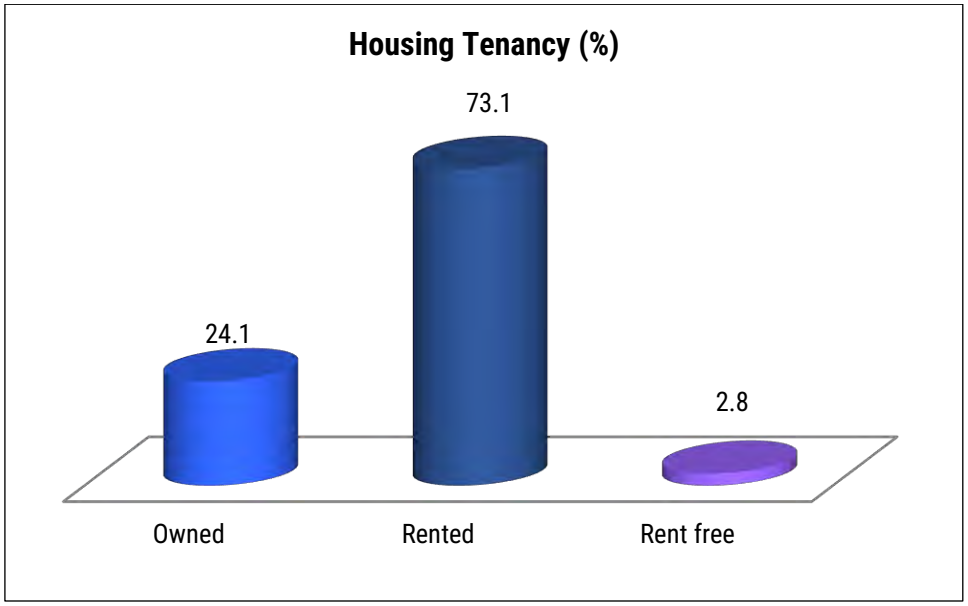
4.6.5 Human Settlement and Housing

According to population census (2011), total household of the study area is 375541. Predominant structure of this study area is Pucka (45%) followed by Semi-pucka (39%), Kutcha (12%) and Jhupri (4%). Housing tenancy of the study area is owned by (24.1%), rented (73.1%) and rent free (2.8%). **Figure 4-33** and **Figure 4-34** show the type of structure and housing tenancy in the project area.



Source: Population and Housing Census, 2011, Bangladesh Bureau of Statistics (BBS)

Figure 4-33: Type of Housing Structure in the Study Area



Source: Population and Housing Census, 2011, Bangladesh Bureau of Statistics (BBS)

Figure 4-34: Housing Tenancy in the Project Area

4.6.6 Economic Activities

In accordance with the Census of Bangladesh (2011), service is the dominant source of employment in the study area. Approximately, 60204 and 30232 male and female involved in service-related activities. Moreover, significant numbers of the population; 24218 male and 20279 female of the study area are involved in industrial activities. According to the census in the study area, agriculture (including livestock and farming) is another source of income. Though 6951 male and 612 female are involved in agricultural activities in the study area. **Table 4-39** shows employment status of the study area.

Table 4-39: Employment Status of the Study Area

City Corporation/Upazila	Ward No./ Union	Population Aged 7+, not attending school but employed			Field of Activity					
					Agriculture		Industry		Service	
		Total	Male	Female	Male	Female	Male	Female	Male	Female
Dhaka North City Corporation	Ward No-03	94664	6421	3402	136	15	3299	1847	2986	1540
	Ward No-04	75246	3202	2718	25	0	926	1774	2251	944
	Ward No-07	113750	4645	3574	331	28	1567	1759	2747	1787
	Ward No-08	111251	7313	4262	467	98	2083	2350	4763	1814
	Ward No-09	71260	6728	2183	104	7	1096	910	5528	1266
	Ward No-10	87879	5972	3065	141	24	1563	1263	4268	1778
	Ward No-11	97033	3860	2699	77	11	621	885	3162	1803
	Ward No-12	116544	3850	2470	63	11	1038	884	2749	1575
	Ward No-14	163797	5284	4085	100	7	1618	1547	3566	2531
	Ward No-16	142413	6716	4274	122	7	1970	1664	4624	2603
	Ward No-18	63616	2564	1669	12	0	180	59	2372	1610
	Ward No-19	96291	6316	6220	221	69	947	826	5148	5325
Savar Upazila	Banagram	33627	3731	476	2140	57	318	128	1273	291
	Kaundia	27796	3592	651	183	10	1431	133	1978	508
	Tetuljhora	106929	8738	4370	2351	197	4017	3261	2370	912
	Amin Bazar	37500	4600	1429	201	36	85	117	4314	1276
Tejgaon Unnayon Circle	Bhatara	126694	7841	3576	277	35	1459	872	6105	2669
Project Study Area		1566290	91373	51123	6951	612	24218	20279	60204	30232

Source: Population and Housing Census, 2011, Bangladesh Bureau of Statistics (BBS)

4.7 Archaeological Monuments and Sites

MFCA has conducted a survey on cultural assets/historical importance/archeological places of interest for MRT Line-5: Northern Route, engaging a sub-consulting firm. During the survey, monuments/structures have been documented within 1 km area on both sides of the 20 km alignment center line, and depot area of MRT Line-5N. A total of one hundred thirty-seven (137) monuments were documented from field survey. After critical scrutiny, twenty (20) monuments [Six (06) from the elevated section and Fourteen (14) from the underground section] including mosque, mazar, house, temple, vihara, memorial, playground, educational institution etc. were primarily selected for further analysis based on their historical significance and relatively closer proximity to the MRT Line-5N area. Among the twenty (20) monuments, there will be no impact on the fourteen (14) monuments/structures as all the underground sections will have noise and vibration proof MSS tracks. Out of the remaining six (6) along the elevated section, three (3) monuments/structures were finally identified for their historical importance and having the likeliness of being impacted by the project activity. These three monuments/structures namely (I) Mazar of Shah Md. Abdus Samad Bangalai Wayeshi, (II) Dewan Bari Mosque and (III) Dewan Bari were identified considering their proximity to the alignment and national/historical importance. Among three monuments, Dewan Bari Mosque and Dewan Bari are listed as heritage monument by RAJUK whereas the Mazar of Shah Md. Abdus Samad Bangalai Wayeshi is not listed as heritage site neither by the DoA nor RAJUK.

Table 4-40 presents the importance of selected monuments/sites from the perspective of their period of establishment, locations and distance from alignment etc.

Table 4-40: Importance of the Selected Monuments along the MRT-5N alignment

SL	Name of identified Monument	Distance (Meter) from MRT-5N	Importance of the Monument	Section Type
1	Mazar of Shah Md. Abdus Samad Bangalai Wayeshi	Centerline: 9.27m Nearest Pier: 10.77m [Pier no. 14] From Sheet Pile: 6m	The Mazar Sharif is said to build in 1983 but the structure is modern. It is located close to the MRT Line-5N and pier location. Gathering happens at this Mazar during the Urash Mubarak festival once in a year.	Elevated
2	Dewan Bari Mosque	36	The Mosque belongs to British Colonial Period. It is enlisted as a heritage site by RAJUK.	
3	Dewan Bari	50	The structure of Dewan Bari belongs to British Colonial Period. It is also enlisted as a heritage site by RAJUK.	

Source: Cultural Asset/Historical Importance/Archaeological Survey, 2022

As there will be probable impact on these three monuments/structures, analysis of impacts and appropriate mitigation measures are needed. Details of the impact analysis and mitigation measures are discussed in section 6.18.

CHAPTER 5

5 SCREENING AND SCOPING

5.1 Screening

Screening is the step to categorize projects/activities based on degree of environmental impacts caused by the project.

According to Environment Conservation Rules, 1997 (ECR, 97) the project (MRT Line-5N) does not make any reference to the category list of DoE. Nevertheless, regarding its activity and infrastructure development, this project is likely similar to the 'RED' category listed project and category "A" according to the JICA Environmental Guidelines, and thus EIA is necessary to be conducted.

5.2 Procedure of Scoping for Environmental Impact Assessment

In order to assess the anticipated significant environmental and social consequences, potential environmental and social impacts of the Project were preliminarily identified based on the project description and overall environmental and social conditions in and around MRT Line-5N project. The impacts of pollution, natural and social environments, health and safety, emergency risk, and others were classified as A to D in accordance with the following criteria, assuming no specific measures toward the impacts are taken:

1) A-/A+: Significant negative/positive impact
2) B-/B+: Some negative/positive impact
3) C-/C+: Impacts are not clear, require more investigation
4) D: Impacts are negligible, no further study required

As the MRT Line-5N will go through the underground from Aminbazar to Notun Bazar (which is already urbanized) and elevated from Hemayetpur to Aminbazar and Notun Bazar to Vatara (semi urbanized), so there might be some significant environmental impacts due to the construction and operation period of the MRT Line-5N project. To find out the significant environmental impacts of the environmental components, four environmental standpoints have been considered. These are:

- Physical Environment
- Biological Environment
- Social Environment and
- Others

5.3 Results of Scoping for Environmental Impact Assessment

Results of the scoping for environmental impact assessment are shown in **Table 5-1**. These impacts were evaluated in each of the three phases namely pre-construction, construction and operation.

Table 5-1: Scoping Matrix of the MRT Line- 5N Project

No.	Items of Impact	Predicted Impact		Description of Rating
		Before/During Construction Stage	Operation Stage	
Physical Environment				
1.	Noise	A-	B-	**During Construction:** Operations of the heavy equipment at the construction sites, movement of heavy machineries and transportation of vehicles may cause noise. **During Operation:** Running of railway may cause noise around viaduct section.
2.	Vibration	A-	B-	**During Construction:** Construction activities and operation of equipment may cause vibration. **During Operation:** Running of railway may cause vibration around viaduct section.
3.	Air pollution	A-	B+	**During Construction:** Transport of construction materials, heavy equipment operation and earthworks will generate dust and exhaust gas, temporarily. **During Operation:** The project will decrease road congestion, air pollution will be reduced.
4.	Surface Water Pollution	B-	B-	**During Construction:** Turbid water by construction work may deteriorate water quality of water bodies. **During Operation:** Untreated water maintenance facilities of depot may deteriorate water bodies.
5.	Ground Water pollution	B-	D	**During Construction:** Excavation and the construction of underground tunnel structure may cause depletion of ground water aquifers level. **During Operation:** Operation of metro rail will not impact on ground water quality

No.	Items of Impact	Predicted Impact		Description of Rating
		Before/During Construction Stage	Operation Stage	
6.	Soil pollution	B-	B-	**During Construction:** The construction will require hazardous material like lubricant for the light and heavy vehicles, maintenance of the equipment etc. and bentonite/polymer slurry for the piling activities. Such use of hazardous material will increase the possibility of soil pollution at the project site if proper steps will not be taken. Also mishandling of the bentonite slurry may pollute the surrounding soil of the construction sites. **During Operation:** Oil leak from maintenance facilities of depot may cause soil pollution.
7.	Waste	A-	B-	**During construction:** The construction work will generate several hundred metric ton surplus spoil as well as fragments of construction materials and garbage. It is assumed that the impact will be significant because the surplus spoil maintenance will be difficult task. **During Operation:** Illegal dumping of trash from stations and depot may affect the environment.
8.	Ground subsidence	C	C	**During Construction:** Construction on soft ground appropriate methods should be selected to avoid ground subsidence. **During Operation:** Ditto
9.	Offensive odor	D	D	**During construction:** Construction work with odor is not estimated. **During Operation:** Railway project will not create odor.
10.	Topography and geology	D	D	**During Construction:** Elevated and Underground structure construction may not change the current topography significantly. **During Operation:** Elevated and Underground structure will not bring any major change in the topography.

No.	Items of Impact	Predicted Impact		Description of Rating
		Before/During Construction Stage	Operation Stage	
11.	Landscape	B-	B-	**During Construction:** Some extents of impacts are assumed; however, the magnitude might be not significant and affected duration will be short. **During Operation:** Impacts are assumed when the height of viaduct is so high to over other structures.
12.	Urban Drainage	B-	D	**During construction/Operation**: Flood risk by the project should be confirmed. The drainage system could be hampered due to construction activities like infilling, construction of the depot, construction yards and haul routes. **During Operation:** No impact during metro rail operation.
Natural Environment				
13.	Protected area	D	D	**During Construction:** There is no projected area in/around the project site. **During Operation:** Ditto
14.	Biota and ecosystem	B-	D	**During Construction:** Construction work may impact on aquatic organism and clear/felling trees. **During Operation:** Operation of the depot may affect ecosystem around the depot.
Social Environment				
15.	Involuntary resettlement	A-	D	**During Construction:** PAPs will be displaced for MRT Line-5N, therefore, significant impact is assumed. **During Operation:** All PAPs will be resettled prior to start the construction activity, therefore, impact will be almost nil.
16.	Local economies such as employment, livelihood, etc.	B-/B+	A+	**During Construction:** Livelihood are assumed to be affected due to their displacement, however, the job opportunity will be increased at the same time. **During Operation:** local economics and employment will be increased.

No.	Items of Impact	Predicted Impact		Description of Rating
		Before/During Construction Stage	Operation Stage	
17.	Social service facilities	C	C	**Before/During Construction:** Magnitude of impact is not clear at this stage. **During Operation:** Ditto
18.	Cultural Heritages	C	C	**During Construction:** Cultural heritages concerned are not clear at this moment. **During Operation:** Ditto
19.	Local conflicts of interest	D-	C	**During Construction:** The gaps between those who shall be displaced and non-displaced are assumed. **During Operation:** Impacts are not clear at this stage.
20.	Infectious disease such as HIV/AIDS	B-	D	**During Construction:** Influx of workers may increase the risk of infectious diseases. **During Operation:** No impact expected.
21.	Working conditions	B-	C	**During Construction:** Insufficient management by the contractor may worsen the workers' working condition. **During Operation:** No impact expected.
22.	Gender	B-	B+	**During Construction:** Magnitude of impact will be clear after completion of the RAP study. **Operation:** Employment opportunity for women will be created.
23.	Children's rights	C	C	**During Construction:** Impacts including school roads are not clear at this stage. **Operation:** Ditto
24.	Misdistribution of benefits and damages	D	D	**During Construction:** It is assumed that the physical impact along the alignment might be almost same at this moment. The number of damages due to the project activities might be negligible. Therefore, the people will not be deprived from their benefit. **During Operation:** No impact expected.
25.	Indigenous or ethnic minority people	D	D	**During Construction:** Magnitude of impact will be clear after completion of the RAP study. **During Operation:** Ditto.

No.	Items of Impact	Predicted Impact		Description of Rating
		Before/During Construction Stage	Operation Stage	
26.	Land use and utilization of local resources	B-/ B+	B+	**During Construction:** It is assumed that impact due to the acquisition of land for depot will change the present aspect from negative and positive points of view. **During Operation:** Vacant suburbs will be improved properly by providing new structures related to MRT.
Others				
27.	Global warming/Climate change	B-	B+	**During construction:** The operation of construction machine and vehicle will produce greenhouse gas (CO_2). **During Operation:** Power consumption increases greenhouse gas; however, fuel efficiency of railway is much higher than vehicle. Therefore, modal shift from vehicles to railway will decrease the emission of greenhouse gas.
28.	Accident	B-	B-	**During Construction:** Since many heavy machineries and vehicles will be used for construction purpose, accidents may happen if employees ignore the safety rules. Inappropriate traffic control or increase of traffic may induce the accident. **During Operation:** Minor collision with viaduct and accident at depot are assumed.

Evaluation: A-/A+: Significant negative/positive impact
B-/B+: Some negative/positive impact
C-/C+: Impacts are not clear, require more investigation
D: Impacts are negligible, no further study required

CHAPTER 6

6 ANTICIPATED ENVIRONMENTAL IMPACTS AND THEIR MITIGATION MEASURES

This chapter describes the potential impacts of project implementation works on different variables of natural and human environment. The following sections incorporated the probable impacts due to construction and operation of the MRT line-5N. In most of the case, environmental impacts will remain same as identified in preparatory EIA of 2017.

6.1 Noise

Noise impact due to the MRT Line-5N project construction and operation which will be more or less same to the receptor level as the existing ambient noise level. The major activities under the MRT Line-5N project during the construction phase are construction of foundations and piers, erection of precast viaduct section, construction of station and depot, tunnel boring etc. For depot land development, noise source will be Sand Compaction Piles (SCP), Dynamic Compaction (DC), etc. In the city area there are residential and commercial buildings beside the MRT Line-5N alignment. But as the line will go through underground so the impact of noise level will be minimum. Only impact will be for the construction of the underground station which will be open cut method. Rest of the source of the noise level at both construction and operation stage is the elevated section (mainly from Hemayetpur to the Aminbazar area and Notunbazar to Vatara area). In addition to these, noise from VRF will be another source during the operation period. In Bangladesh (as per Noise Pollution Control Rules 2006), there is no applicable standard for the train operation. So, this project will voluntarily abide by the 2006 standards for the operation stage. Though the standard has been set up after the output from the noise modeling and comparing with different international laws.

6.1.1 Construction Noise Analysis

This section addresses noise levels expected from various combinations of equipment required to perform construction tasks. The main sources of noise level during the construction phase are:

- Different types of equipment used for the sand compaction piles (both static and vibratory) and Dynamic Compaction used to stabilize the soil of Depot area.
- Operation of the heavy equipment during infilling and construction.
- Foundation, pier and viaduct construction and station construction at the elevated section (Aminbazar to Hemayetpur and Notun Bazar to Vatara).
- Station construction at the underground stations.

For the underground section from Aminbazar to Notun Bazar, less impact is anticipated except in the station area compared to the viaduct section. Underground station area will experience some source of noise as open cut system will be practiced. This section addresses noise levels expected due to construction of MRT Line-5N.

6.1.1.1 Approach

The prediction of construction noise on receptor points has been calculated based on sound power levels of equipment required to perform the work. Point of impact on the receptors are taken to be 7.5 – 94.5m based on the receptor distance. The nearest receptor from the track center of the viaduct is situated at

the Hemayetpur area which is around 10.8m. In the city area, the distance from the receptor level to the station construction area is even closer (ranging from 6.5m to 30m). Predicted values are compared with ambient noise levels. Ambient and predicted noise levels are superimposed; comparisons are made with the applicable noise standards.

6.1.1.2 Applicable Standards

The ambient noise levels along the alignment have already exceeded the national noise level standard at 21 out of 23 locations as shown in the earlier chapter. There is no standard for construction noise in Bangladesh; target noise limits for construction depend on ambient noise conditions and standards used in other countries, which are reviewed and stipulated in **Table 6-1**. Based on the other countries standard, following table has been summarized the standards proposed for construction noise control for the project.

Table 6-1: Noise Criteria and Standards Considered in Setting Limits for Metro Line-5: Northern Route

Countries	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 – 6pm)	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
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-7pm, 12 hrs)	50 dB (7 pm-7am, 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, 55dB)
	Other Buildings	75 dB (7 am-7 pm, 12 hrs)	
UK	In rural, suburban and urban areas away from main road traffic and industrial noise	70 dB (8.00-18:00)	

Countries	Standard or Criteria	Day Time Leq	Night Time Leq
	Urban Areas near main roads	72 dB (8.00-18:00)	
USA America	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

U.S Department of Transport (2018), Transit Noise and Vibration Impact Assessment Manual, Federal Transit Administration

From the **Table 6-1**, it is observed that USA criteria allowed maximum of ambient + 10 db in urban areas with existing high ambient noise levels. Also, their target noise level in the commercial area at both day and nighttime is 85 dBA. Japan also set 85 dBA as a standard for the construction area where piling or excavation activity is normally going on by heavy equipment.

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 as 85 dB. Japanese criteria also refer to the value of 85 dB. But as per ECR, 1997, there is no standard for the construction activity except schedule 5 where there is a standard for the mechanized vehicles and which is 85 dBA at 7.5m distance from the construction site. Since there is no standard for construction noise in Bangladesh, Considering the current ambient noise level, US Standards and practices from MRT Line 6 and MRT Line 1, the project standard noise for MRT Line 5N has been set as following conditions,

- Target of standard noise level "existing ambient level + 10 db" or 85 db, whichever is higher has been adopted.

6.1.1.3 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. 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)

Source: EIA report of MRT Line 6 project

6.1.1.4 Impact Prediction

The following formula is used to predict noise levels from construction activities by the Institute of Noise Control Engineering in Japan. 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) +ΔL, where

ΔL=

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

Where,

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

δ: Difference in sound propagation routes [m]

Table 6-2 shows heavy equipment sound power levels for various types of construction work along the alignment using 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 different distance from the activity (7.5-94.5 m) and further combined with ambient noise levels that were measured at the locations.

Table 6-3 shows the daytime noise analysis results for depot development and construction work along the elevated section from Aminbazar to Hemayetpur and Notun Bazar to Vatara. During daytime, the average combined noise level at monitoring locations of elevated section varies from 64.4 – 85.8 dB whereas the peak ambient noise levels are 64.9-88.3 dB. The average combined noise levels at all station are lower than the established standard (standard is ambient Noise Peak Level +10 dB or 85 dB, whichever is higher). The average combined noise level at elevated section is 78.4 dB, the standard is typically 85 dB. Combined noise levels are on average 6 dB lower than the project standard.

Table 6-4 shows the nighttime noise analysis results for depot development and construction work along the elevated section from Aminbazar to Hemayetpur and Notun Bazar to Vatara. During nighttime, the combined noise level at monitoring locations of elevated section varies from 61.2 – 84.2 dB whereas the peak ambient noise levels are 48.0 – 83.5 dB. The combined noise levels are lower than the established standard (standard is ambient Noise Peak Level +10 dB or 85 dB, whichever is higher). The average combined noise level at elevated section is 72.4 dB, the standard is typically 85 dB. Combined noise levels are on average 12 dB lower than the ambient standard.

Table 6-5 shows the daytime noise analysis results for the construction work along the underground section from Gabtoli to Notun Bazar. During daytime, the combined noise level at monitoring locations of underground section varies from 79.3– 93.4 dB whereas the peak ambient noise levels are 74.7-97.3 dB. The combined noise levels are lower than the established standard (standard is ambient Noise Peak Level +10 dB or 85 dB, whichever is higher). The average combined noise level at underground section is 84.8

dB, the standard is typically 85 dB. Combined noise levels are on average 0.2 dB lower than the ambient standard.

Table 6-6 shows the nighttime noise analysis results for the construction work along the underground section from Gabtoli to Notun Bazar. During nighttime, the combined noise level at monitoring locations of underground section varies from 78.7– 82.7 dB whereas the peak ambient noise levels are 55.5 – 75.1 dB. The combined noise levels are lower than the established standard (standard is ambient Noise Peak Level +10 dB or 85 dB, whichever is higher). The average combined noise level at underground section is 81.3 dB, the standard is typically 85 dB. Combined noise levels are on average 3.7 dB lower than the ambient standard.

Table 6-2: Heavy Equipment Noise Power Level and Combined Leq

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

Table 6-3: Expected Day time Noise Levels at Receptor Points during Construction Period in the Elevated Portion

Section	Types of Construction		Hemayetpur Station	Al Nasir School, Hemayetpur	Mosque at Hemayetpur	Western Boundary of Depot)	Sugandha Housing, Hemayetpur	Baliarpur Station	Jamia Islamia Mosque, Baliarpur	Jamuna Natural Park, Aminbazar	Bilamalia Station	Amin Bazar Station	Baitul Mamur Mosque, Vatara	Divine Mercy Church, Vatara	Vatara Station	
	Ambient noise Peak Day (Leq_{10})		87.3	88.3	87.6	64.9	79.7	72.3	77.6	80.8	77.5	83.5	88.2	74.7	77.3	
	Distance from Source		7.5	80.7	10.8	50.6	94.5	60	32.2	86.5	7.5	7.5	13.7	74.8	7.5	
	Target Noise Level (Leq)	Day	97.3	98.3	97.6	85.0	89.7	85.0	87.6	90.8	87.5	93.5	98.2	85.0	87.3	
Depot Area	Compacting ground	Leq10				69.4										
	Groundwork	Leq10				66.7										
Depot & Track Prep.	Groundwork	Leq10	85.6	84.1	84.7	66.7	75.6	69.5	74.8	76.7	82.6	83.9	84.7	71.0	82.6	
	Framework Construction & track pre.	Leq10	84.9	84.1	84.3	65.6	75.5	69.1	74.4	76.6	81.2	82.9	84.5	70.9	81.2	
Elevated track	Girder installation & track preparation	Leq10	84.4	84.1	84.0	64.4	75.5	68.8	74.1	76.6	79.8	82.0	84.3	70.7	79.7	
Elev. Track & Station	Preparation	Leq10	85.8	84.1	84.8	67.0	75.6	69.6	74.9	76.7	82.9	84.2	84.8	71.1	82.9	
	Groundwork	Leq10	85.6	84.1	84.7	66.7	75.6	69.5	74.8	76.7	82.6	83.9	84.7	71.0	82.6	
	Girder Inst.& Framework construction	Leq10	85.2	84.1	84.4	66.0	75.5	69.2	74.5	76.6	81.7	83.3	84.6	70.9	81.7	
Avg. of combined Noise			85.2	84.1	84.5	66.6	75.5	69.3	74.6	76.6	81.8	83.3	84.6	70.9	81.8	78.4
Excess			-12.1	-14.2	-13.1	-18.4	-14.2	-15.7	-13.0	-14.2	-5.7	-10.2	-13.6	-14.1	-5.5	-13
%±			-12%	-14%	-13%	-22%	-16%	-19%	-15%	-16%	-7%	-11%	-14%	-17%	-6%	-13.9%

Table 6-4: Expected Night time Noise Levels at Receptor Points during Construction Period in the Elevated Portion

Section	Types of Construction		Hemayetpur Station	Al Nasir School, Hemayetpur	Mosque at Hemayetpur	Western Boundary of Depot)	Sugandha Housing, Hemayetpur	Baliarpur Station	Jamia Islamia Mosque, Baliarpur	Jamuna Natural Park, Aminbazar	Bilamalia Station	Amin Bazar Station	Baitul Mamur Mosque, Vatara	Divine Mercy Church, Vatara	Vatara Station	
	Ambient noise Peak Night (Leq_{10})		75.0	63.3	81.7	59.9	67.1	56.5	70.9	65.7	48.0	83.5	74.0	67.8	66.5	
	Distance from Source		7.5	80.7	10.8	50.6	94.5	60	32.2	86.5	7.5	7.5	13.7	74.8	7.5	
	Target Noise Level (Leq)	Night	85.0	85.0	91.7	85.0	85.0	85.0	85.0	85.0	85.0	93.5	85.0	85.0	85.0	
Depot Area	Compacting ground	Leq10				69.0										
	Groundwork	Leq10				65.9										
Depot & Track Prep.	Groundwork	Leq10	82.4	63.4	81.2	65.9	64.7	64.3	71.2	64.2	82.1	83.9	77.6	65.9	82.1	
	Framework Construction & track pre.	Leq10	80.9	62.5	80.4	64.5	64.2	62.8	70.3	63.5	80.5	82.9	76.3	65.3	80.5	
Elevated track	Girder installation & track preparation	Leq10	79.3	61.6	79.6	63.0	63.8	61.2	69.3	62.9	78.7	82.0	75.0	64.8	78.8	
	Preparation	Leq10	82.7	63.7	81.5	66.3	64.8	64.7	71.5	64.3	82.5	84.2	77.9	66.1	82.5	

Section	Types of Construction		Hemayetpur Station	Al Nasir School, Hemayetpur	Mosque at Hemayetpur	Western Boundary of Depot)	Sugandha Housing, Hemayetpur	Baliarpur Station	Jamia Islamia Mosque, Baliarpur	Jamuna Natural Park, Aminbazar	Bilamalia Station	Amin Bazar Station	Baitul Mamur Mosque, Vatara	Divine Mercy Church, Vatara	Vatara Station	
Elev. Track & Station	Groundwork	Leq10	82.4	63.4	81.2	65.9	64.7	64.3	71.2	64.2	82.1	83.9	77.6	65.9	82.1	
	Girder Inst.& Framework construction	Leq10	81.4	62.8	80.7	65.0	64.4	63.3	70.6	63.7	81.1	83.3	76.8	65.5	81.1	
Avg. of combined Noise			81.5	62.9	80.8	65.7	64.4	63.4	70.7	63.8	81.1	83.3	76.9	65.6	81.2	72.4
Excess			-3.5	-22.1	-10.9	-19.3	-20.6	-21.6	-14.3	-21.2	-3.9	-10.2	-8.1	-19.4	-3.8	-14
%±			-4%	-26%	-12%	-23%	-24%	-25%	-17%	-25%	-5%	-11%	-10%	-23%	-4%	-16.0%

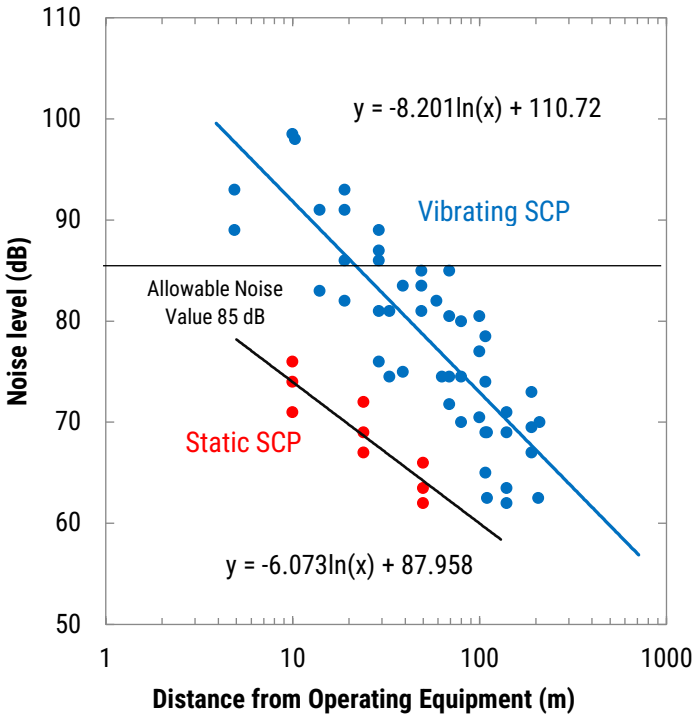
Table 6-5: Expected Day time Noise Levels at Receptor Points during Construction Period in the Underground Station

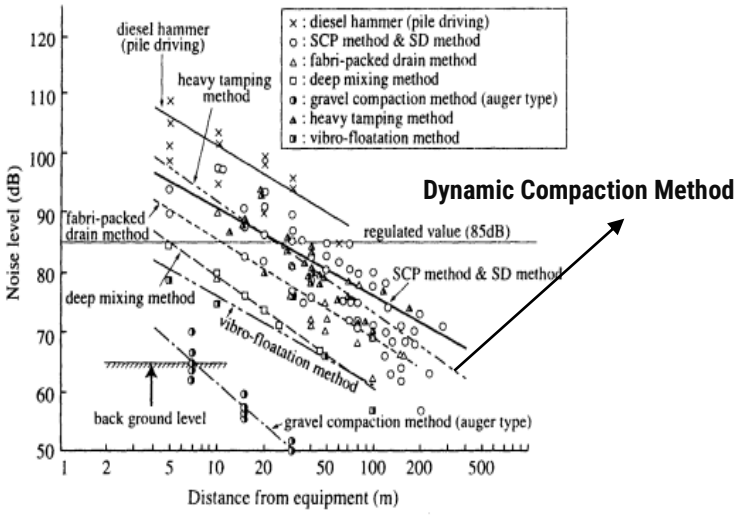
Section	Types of Construction		Gabtoli Sta.	Dar-us-Salam Sta.	Mirpur-1 Sta.	Mirpur 10 Sta.	Mirpur 14 Sta.	Kochukhet Sta.	Banani Sta.	Gulshan-2 Sta.	Notun Bazar Sta.	
	Ambient noise Peak Day (Leq_{10})		74.7	78.8	82.7	97.3	77.6	82.7	91.8	86.5	87.6	
	Distance from Source		7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	
	Target Noise Level (Leq)	Day	85.0	88.8	92.7	107.3	87.6	92.7	101.8	96.5	97.6	
UG Stations	Preparation	Leq_{10}	82.7	83.1	83.9	93.4	83.0	83.9	88.7	85.4	85.9	
	Groundwork	Leq_{10}	82.3	82.8	83.6	93.4	82.6	83.6	88.6	85.2	85.8	
	Girder Inst.& Framework construction	Leq_{10}	81.4	81.9	83.0	93.3	81.7	83.0	88.4	84.7	85.4	
Avg. of combined Noise			81.5	82.0	83.0	93.3	81.8	83.0	88.5	84.8	85.4	84.8
Excess			-3.5	-6.8	-9.7	-14.0	-5.8	-9.7	-13.3	-11.7	-12.2	-9.6
%±			-4.1%	-7.6%	-10.4%	-13.0%	-6.6%	-10.4%	-13.1%	-12.2%	-12.5%	-9.99%

Table 6-6: Expected Nighttime Noise Levels at Receptor Points during Construction Period in the Underground Station

Section	Types of Construction		Gabtoli Sta.	Dar-us-Salam Sta.	Mirpur-1 Sta.	Mirpur 10 Sta.	Mirpur 14 Sta.	Kochukhet Sta.	Banani Sta.	Gulshan-2 Sta.	Notun Bazar Sta.	
	Ambient noise Peak Night (Leq_{10})		60.3	72.8	63.9	55.5	69.2	72.6	70.5	60.7	75.1	
	Distance from Source		7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	
	Target Noise Level (Leq)	Night	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.1	
UG Station	Preparation	Leq_{10}	82.5	82.6	82.5	82.5	82.5	82.6	82.6	82.5	82.7	
	Groundwork	Leq_{10}	82.1	82.2	82.1	82.1	82.1	82.2	82.2	82.1	82.4	
	Girder Inst.& Framework construction	Leq_{10}	81.1	81.3	81.1	81.1	81.2	81.3	81.2	81.1	81.5	
Avg. of combined Noise			81.1	81.4	81.2	81.1	81.2	81.4	81.3	81.1	81.5	81.3
Excess			-3.9	-3.6	-3.8	-3.9	-3.8	-3.6	-3.7	-3.9	-3.6	-3.8
%±			-4.5%	-4.3%	-4.5%	-4.6%	-4.4%	-4.3%	-4.4%	-4.5%	-4.2%	-4.42%

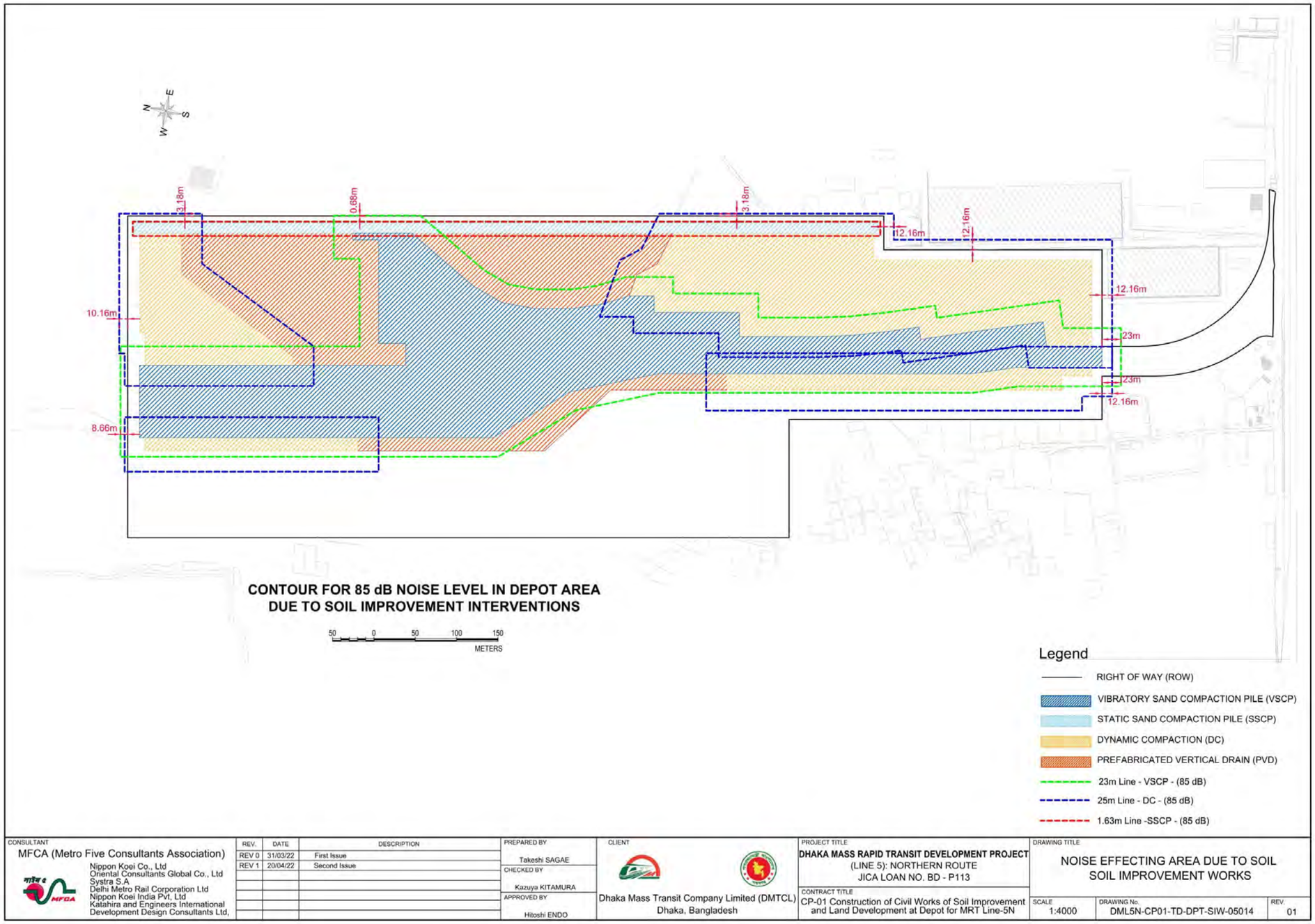
For the Depot area, separate noise level analysis has been done based on soil improvement interventions (**Figure 6-1**) and a contour map has been prepared (presented in **Figure 6-2**). From the noise level analysis, it has been found that for the static SCP machine for the compaction work in Depot area, the noise level is about 85 dB at 1.63 m distance. At the same time, for vibrating SCP and dynamic compaction, the noise level of 85dB will occur at 23 m and 25 m distance accordingly. So, for avoiding the impact on the nearest receptor during the compaction activity of the depot area, the static SCP will be used at the boundary. But for inside depot area, the vibrating SCP, dynamic compaction and prefabricated vertical drain (PVD) will be used as it will not affect the existing receptors. From the contour figure, it is clear that there will be no noise impact outside the depot boundary for the soil improvement interventions.





Source: Kitazume, M. (2005). The sand compaction pile method. CRC Press.

Figure 6-1: Noise Level Analysis for the Depot Area



Source: MFCA

Figure 6-2: Noise Contour Map for the Depot Area

6.1.1.5 Mitigation Measures

All mitigation measures stated in the preparatory EIA report, 2017 will be applicable for the MRT Line-5N project. The mitigation measures are proposed to reduce noise impacts from construction:

- Use low noise generating equipment as much as possible;
- 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. If the construction equipment cannot be placed far away from sensitive receptors, Contractor should take appropriate mitigation measures
- 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 night time activities where there is sensitivity to noise, such as hospitals
- Avoid noisy works during prayer time
- In case of significant noise generation, Contractor should carry out prior consultations with potential affected persons.
- Provide noise-dampened equipment, such as quieted and enclosed air compressors and properly working mufflers on all engines
- In the Depot area, the boundary fence should be high, and should have some sound absorption material where necessary.

Residual Impacts

The proposed mitigation measures will be able to mitigate noise pollution in a significant extent. Despite these measures, the occurrence of over standard noise can happen during construction stage, especially during rigging, rebar cutting, etc. However, these noises will not be occurred frequently and the public nuisance creates from this occurrence will not be significant.

6.1.1.6 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 target noise level. 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, Noise Control Ordinance 2006 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 work 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 Noise Control Ordinance 2006.

6.1.2 Train Operation

Noise due to train operation of MRT Line-5N Route has been predicted in this report which was absent in the preparatory EIA report of 2017. The method is similar, as used for the calculation of MRT Line 6.

6.1.2.1 Procedure

The noise level due to the train operation has been predicted considering the speed of train, curvature of the rail and structural configuration of the viaduct (height, parapet walls and other features). Procedure of noise impact analysis during operation has followed some process which includes:

- Selection of target level
- Set condition for noise impact levels
- Prediction of noise level
- Combine with ambient noise monitoring results
- Combine with target noise level and
- Taking mitigation action

6.1.2.2 Target Level

As per the Noise Pollution Control Rules 2006, train operation is exempted from the rules. Even then the MRT line-5N project will follow the current standard in Bangladesh. The standard noise level for specific zone under the Noise Pollution Control Rules 2006 is given in **Table 6-7**.

Table 6-7: Noise level standard in different categories

Category	Day	Night
Silent zone	50	40
Residential zone	55	45
Mixed area	60	50
Commercial area	70	60
Industrial area	75	70

The standards specified in the Noise Pollution Control Rules 2006 are only for specific areas and applicable for the ambient noise level. But 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 provided the following guidance:

a) Sound receiving point shall be 12.5m distance from center of track and the height shall be 1.2m above ground.
b) Leq will be less than 60dB during daytime (7:00-22:00) and less than 55dB during night time (22:00-7:00)

Japanese guideline 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 (nighttime), with attention to sensitive receptors along the alignment that could be affected by excessive noise. For the MRT Line-5N, Aminbazar to Notun bazar route will be undergrounded where many the schools,

colleges, medical centers, mosques, temples are located. The elevated part is located Hemayetpur to Aminbazar and Notun Bazar to Vatara. There are some sensitive receptors as well as household along the elevated section. So, considering that Japanese standard and also considering the prediction noise level, the target could be fixed.

6.1.2.3 Condition

The general input conditions for the analysis of noise impacts during operations are shown in **Table 6-8**. These vary in special cases as described in the following sections.

Table 6-8: Conditions for Predicting Operation Noise Levels

Item	Condition
Rail Type	Different radius of curvature, or curve radius
Track Structure	Ballast-less track with or without MSS bearing
Height of Bridge Railing	1.5m
Prediction Point	12.5m (Japanese standard) and at sensitive receptors
Operating Speed	Per CBTC system
Train length	160m

6.1.2.4 Method for Predicting Transit Noise

The approach follows generally that prescribed in "Draft Proposal of the Prediction of Noise from Elevated Railway" written by Ishii et al.[12], and has been used on numerous elevated metro rail projects. Three types of noise are categorized for moving train e.g. rolling noise, structural noise and vehicle device noise. This method calculates Leq-10 (equivalent 10-minute A- weighted sound pressure level, in busy hour) using a conversion formula and predicts ambient peak noise level. Combined noise levels and ambient noise measurements are calculated for the receptors.

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

[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.

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

L_{W1} = 13.7 log10V+72.7+4.6

Lw1 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 6-3.

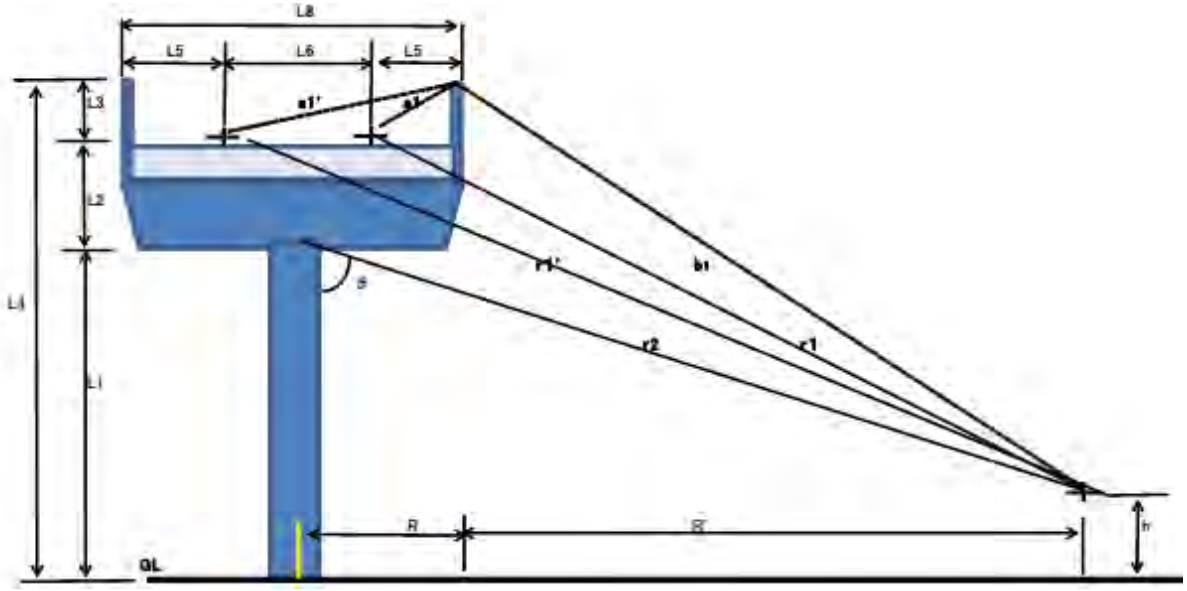


Figure 6-3: Sound Pathways

The longer path for deflected sound introduces a differential that reduces the overall sound level according to the graph in **Figure 6-4**.

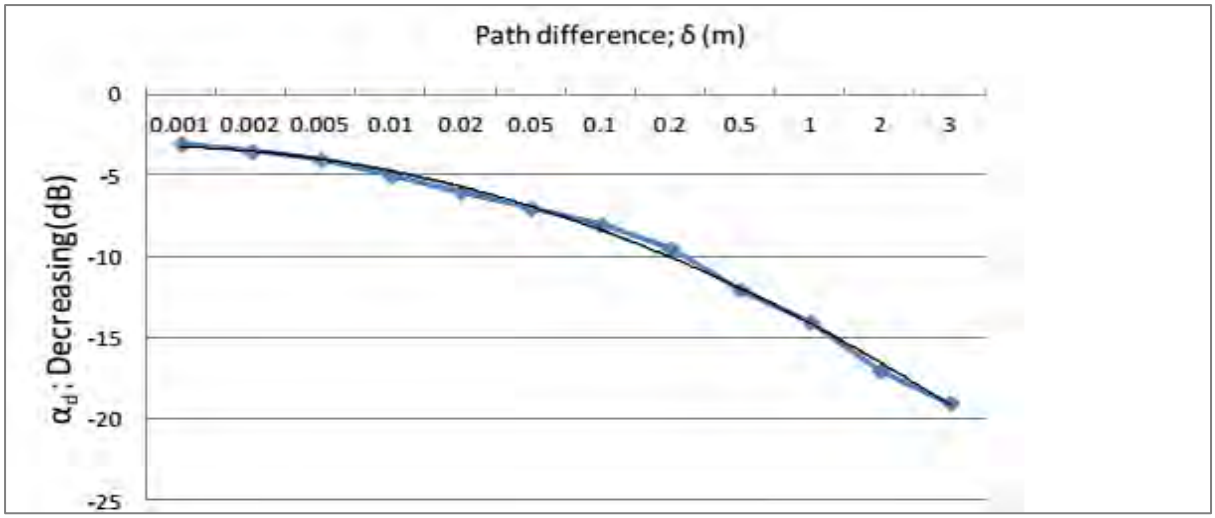


Figure 6-4: Path Difference and Sound Reduction

Structural dimensions of the viaduct configuration (e.g. dimensions in **Figure 6-4**) are shown in **Table 6-9**. 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 6-9: Input Factors Related to Structural Dimensions of the Viaduct

Receptor Height, m		R'								
h	R'	r1	r2	L3	a1	b1	δ=a1+b1-r1	α1	l/2r1	l/2r2
1.2	0.5	22.38	20.16	1.00	3.21	23.1	3.93	-20.6	3.57	3.96
1.2	0.5	22.38	20.16	1.50	3.39	23.6	4.62	-21.27	3.57	3.96
1.2	0.5	22.38	20.16	2.00	3.64	24.1	5.36	-21.90	3.57	3.96

Structure Noise Power Level (LW2)

Structure Noise Power Level (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 (LA2) 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)

ɵ: The angle of center of floor slab to ground and center of floor slab to sound receiving point (^{0})

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 ration = 6.06

V: Train speed (km/s)

L: Train length (m)

Lm: Length of motor car (m)

L_{W3} is covered 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

6.1.2.5 Evaluation of Noise Impact

The evaluation of noise impact has been determined based on the equation presented in the previous part, different primary and secondary input variables in accordance with the curvature (greater or lesser than 400 m) and anticipated travel velocity based on the CBTA operation schedule. A spreadsheet was setup to place all equations and data for getting output. Predicted noise levels are shown in **Table 6-10**.

Table 6-10: Predicted Noise Levels

Prediction/Assumption	Radius of curvature,R<400m,Lw1=13.7log V +80.3					R>=400m, Lw1=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	85	85
Vehicle Device Power L. noise[4], (L_{w3})	80.1	82.9	87.6	91.6	95.1	96.7	99.6	100.9

Prediction/Assumption	Radius of curvature,R<400m,Lw1=13.7log V +80.3					R>=400m, Lw1=13.7 log V+75.7		
BLT Rolling noise[5], $L_{A1}=L_{w1}$- 40.2 (Parapet ht 1 m)	62.8	63.4	64.5	65.4	66.2	62.0	62.6	62.9
VP BLT Rolling noise, $L_{A1'}=L_{w1'}$ -40.2 (Para Ht 1 m)	59.8	60.4	61.5	62.4	63.2	59.0	59.6	59.9
BLT Structure noise[6] , $L_{A2}=L_{w2}$-19.4	75.2	75.2	75.2	75.2	75.2	73.1	73.1	73.1
VP BLT Structure noise, $L_{A2'}=L_{w2}'$ -19.4	67.0	67.0	67.0	67.0	67.0	65.6	65.6	65.6
Vehicle Device noise[7], $L_{A3}=L_{w3}$-37.2 (Para ht 1 m)	43.0	45.7	50.4	54.5	57.9	59.5	62.4	63.8
Peak Level noise, L_{Amax}=10 log $[\sum^{n}_{i=1}10^{LAi/10}]$	75.5	75.5	75.6	75.7	75.8	73.6	73.8	73.9
Sound Exposure[8] Level, $L_{AE}=L_{Amax}$+10 log(576/V)	86.5	86.1	85.4	84.8	84.4	81.9	81.6	81.5
Predicted value[9], Leq= 10 log$[0.0074*10^{(LAE/10)}]$	65.2	64.8	64.1	63.5	63.1	60.6	60.3	60.2
Peak Lev VPT noise,L'_{Amax}=10 log $[\sum^{n}_{i=1}10L^{Ai/10}]$	67.8	67.9	68.2	68.5	68.9	67.3	68.0	68.4
Sound Ex.of VPT Level, $L_{AE}=L'_{Amax}$ + log (576/V)	78.8	78.5	78.0	77.6	77.5	75.6	75.8	76.1
VPT Predicted value[9], Leq= 10 log$[0.0074*10^{(LAE/10)}]$	57.5	57.2	56.7	56.3	56.1	54.3	54.5	54.7
BLT Rolling noise[5], $L_{A1}=L_{w1}$- 40.8 (Parapet ht 1.5 m)	62.1	62.7	63.8	64.7	65.5	61.3	61.9	62.3
Vehicle Device noise[7], $L_{A3}=L_{w3}$-37.8 (Para ht 1.5 m)	42.3	45.0	49.8	53.8	57.3	58.9	61.8	63.1
Peak Level noise,L_{Amax}=10 log $[\sum^{n}_{i=1}10^{LAi/10}]$	75.4	75.5	75.5	75.6	75.7	73.5	73.7	73.8
Sound Exposure[8] Level, $L_{AE}=L_{Amax}$+10 log(576/V)	86.5	86.1	85.3	84.8	84.3	81.8	81.5	81.4
Predicted value[9], L_{eq}= 10 log$[0.0074*10^{(LAE/10)}]$	65.2	64.8	64.0	63.5	63.0	60.5	60.2	60.1
BLT Rolling noise[5], $L_{A1}=L_{w1}$- 41.5 (Parapet ht 2 m)	61.5	62.1	63.2	64.1	64.9	60.7	61.3	61.6
Vehicle Device noise[7], $L_{A3}=L_{w3}$-38.5 (Para ht 2 m)	41.6	44.4	49.1	53.2	56.6	58.2	61.1	62.5
Peak Level noise,L_{Amax}=10 log $[\sum^{n}_{i=1}10L^{Ai/10}]$	75.4	75.4	75.5	75.6	75.6	73.5	73.6	73.7
Sound Exposure 8 Level, $L_{AE}=L_{Amax}$+10 log(576/V)	86.5	86.0	85.3	84.7	84.2	81.8	81.5	81.3
Predicted value[9], L_{eq}= 10 log$[0.0074*10^{(LAE/10)}]$	65.2	64.7	64.0	63.4	62.9	60.5	60.2	60.0
VP BLT Rolling noise, $L_{A1'}=L_{w1'}$ -40.8 (Para Ht 1.5 m)	59.1	59.7	60.8	61.7	62.5	58.3	58.9	59.3
Vehicle Device noise[7], $L_{A3}=L_{w3}$-42.3 (Para ht 1.5 m)	42.3	45.0	49.8	53.8	57.3	58.9	61.8	63.1
Peak Lev VPT noise,L'_{Amax}=10 log $[\sum^{n}_{i=1}10L^{Ai/10}]$	67.7	67.8	68.0	68.3	68.7	67.1	67.7	68.1

Prediction/Assumption	Radius of curvature,R<400m,Lw1=13.7log V +80.3					R>=400m, Lw1=13.7 log V+75.7		
Sound Ex.of VPT Level, L_{AE} =L_{Amax} + log (576/V)	78.7	78.4	77.8	77.4	77.2	75.4	75.6	75.7
VPT Predicted value[9], L'_{eq}= 10 log[0.0074*$10^{(LAE/10)}$]	57.4	57.1	56.5	56.1	55.9	54.1	54.2	54.4
VP BLT Rolling noise, $L_{A1'}$ =$L_{w1'}$ -41.5 (Para Ht 2 m)	58.5	59.1	60.2	61.1	61.9	57.7	58.3	58.6
Vehicle Device noise[7], L_{A3}=L_{w3}-38.5 (Para ht 2 m)	41.6	44.4	49.1	53.2	56.6	58.2	61.1	62.5
Peak Lev VPT noise,L'_{amax}=10 log [$\sum^{n}_{i=1}10L^{Ai/10}$]	67.6	67.7	67.9	68.1	68.5	66.9	67.5	67.9
Sound Ex.of VPT Level, L_{AE} =L_{Amax} + log (576/V)	78.7	78.3	77.7	77.3	77.0	75.2	75.3	75.5
VPT Predicted value[9], L'_{eq}= 10 log[0.0074*$10^{(LAE/10)}$]	57.4	57.0	56.4	56.0	55.7	53.9	54.0	54.2

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 radius 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 Ballast less track

(5) Rolling noise LA1= Lw1-8-10 log r1 + 10 log [(l/2r1)/(1+(l/2r1) 2 + tan -1(l/2r1)] + α d = Lwi1-19.17, with values of train length l=160, Dumping number αd = (-)17,7714, Distance between track center and sound receiving point, r1=17.1898 with horizontal 7.5m

(6) Structure Noise LA2 = Lw2 -8 - 10 log r1 + 10 log [(cos θ)(tan -1(l/2r2))] = Lw2 - 20.301 , with value r2=16.19 with horizontal 7.5 m

(7) Vehicle Device Noise LA3 = Lw3 -5 -10 log r1 + 10 log [(l/2r1)/(1+l/2r1) 2+tan -1(l/2r1)] + αd = Lw3 - 16.17, with the values as in (5)

(8) Sound Exposure Level LAE= LAmax + 10 log t = LAmax + 10 log (576/V), with t = train passing time (sec)=2.15 sec, V= velocity km/hr,

(9) Predicted Value (as per DOE) Leq.10=10 log (nx 10LAE/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)

Total 23 locations were selected for noise level monitoring along the MRT line 5-Northern Route alignment and predictive analysis is applied to thirteen locations (**Table 6-11**).

Table 6-11: Noise Receptor Locations

Code	Location
NL1	Hemayetpur Station
NL2	In-front of Al Nasir Laboratory School, Hemayetpur
NL3	In-front of Baitul Habib Mosque, Hemayetpur
NL4	Depot Area (Western Boundary of Depot)
NL6	Alam Nagar Central Jame Mosque, Sugandha Housing, Hemayetpur

Code	Location
NL7	Baliarpur Station (In-front of Institute for Autistic Children and Blind, Old Home and TN Mother Child Hospital)
NL8	Jamia Islamia Jame Mosque, Baliarpur
NL9	Jamuna Natural Park, Baliarpur
NL10	Bilamalia Station
NL11	Amin Bazar Station
NL21	In front of Baitul Mamur Mosque, Madani Avenue, Vatara
NL22	In front of Divine Mercy Church, Vatara
NL23	Vatara Station

Ambient noise results (**Table 4-24**) and predicted result (**Table 6-10**) are combined to get the combined noise impact level at receptor points. Ballast Less Tract (BLT) and Vibration Proof Track (VPT) including 1.5-meter parapet wall have been considered for evaluating noise impact at the receptor points to determine a feasible option. The combined sound level predictions are shown in **Table 6-12**. Conclusion reached from the data include the following:

a) Ballast less Track (BLT) –

- The predicted noise levels from transit operations on ballast less track is generally lower than the ambient noise levels at different receptor points. At the receptor level, the noise is even lower than the day standard level of the mixed area. Transit noise is on average 0.09 dB greater than peak ambient noise levels and 11.91 dB greater than observed LD/N levels. Median values are 0.04 and 12.31 dB respectively.
- Transit noise, when added to ambient noise levels, provides a combined noise level that is, on average, 0.13% greater than observed ambient peak noise levels and 17.81% greater than observed day/night noise levels. Most increases also are about 0.05% and 17.17%, respectively (median values).

b) **Vibration Proof Track (VPT)**

- Transit noise is on average 0.02 dB greater than peak ambient noise levels, and 12.01 dB greater than observed LD/N levels. Median values are 0.01 and 12.30 dB respectively.
- Transit noise, when added to ambient noise levels, provides a combined noise level that is, on average, 0.03% greater than observed ambient peak noise levels and 17.69% greater than observed day/night noise levels. Most increases are about 0.02% and 17.10%, respectively (median values).

It has been observed that the average transit noise is same as the ambient peak. Also, the combined noise for both ballast less and vibration proof track varied slightly from each other. So, considering the predicted noise, ballast less track with 1.5m parapet wall is recommended for the elevated section part. As the predicted noise level is same as the ambient noise level. So, the impact due to the train operation will be very insignificant. In the city area, the line will go under the ground. So, no impact from the noise is anticipated.

Table 6-12: Noise Levels at Elevated Sections with respect to receptor distance

Name of Receptor	NL1	NL2	NL3	NL4	NL6	NL7	NL8	NL9	NL10	NL11	NL21	NL22	NL23		
Distance from Track Centre (m)	7.5	80.7	10.8	50.6	94.5	60	32.2	86.5	7.5	7.5	13.7	74.8	7.5		
Ambient Peak(7am-7pm), L_{eq}	84.6	88.3	99.0	64.9	79.7	72.3	77.6	80.8	77	80.9	88.2	74.7	77.3		
Ambient Noise Level, L_{dn}	74.9	67.8	81.0	57.6	66.6	58.9	69.7	67.2	63.7	74.3	75.7	67.1	61.3		
Train Speed (Km/h) at R>500m	45	45	45	45	95	45	95	95	45	45	95	95	45		
BLT Transit Noise at R>500, L_{eq}	61.9	51.8	61.3	57.0	52.7	56.0	56.7	53.2	61.9	61.9	58.8	53.8	61.9		
Train Speed (Km/h) at R>500m	45.0	45.0	45.0	45.0	95.0	45.0	95.0	95.0	45.0	45.0	95.0	95.0	45.0		
VPT Transit Noise at R>500, L_{eq}	54.8	46.4	54.2	48.7	50.3	48.0	54.0	53.0	54.8	54.8	54.7	52.1	54.8		
Combined Noise Impact Levels acting on Receptors (BLT)	84.6	88.3	99.0	65.5	79.7	72.4	77.6	80.8	77.1	81.0	88.2	74.7	77.4		
Combined Noise Impact Levels acting on Receptors (VPT)	84.6	88.3	99.0	65.0	79.7	72.3	77.6	80.8	77.0	80.9	88.2	74.7	77.3		
														Avg.	Median
Pct Increase over Peak Ambient considering ballast less track	0.03%	0.00%	0.00%	1.00%	0.01%	0.14%	0.05%	0.01%	0.17%	0.07%	0.01%	0.05%	0.16%	0.13%	0.05%
Pct Increase over D/Nt Ambient considering ballast less track	13.0%	30.2%	22.2%	13.8%	19.7%	22.9%	11.4%	20.2%	21.1%	9.0%	16.5%	11.4%	26.3%	17.81%	17.17%
Pct Increase over Peak Ambient considering VPT	0.01%	0.00%	0.00%	0.16%	0.01%	0.02%	0.02%	0.01%	0.03%	0.01%	0.00%	0.03%	0.03%	0.03%	0.02%
Pct Increase over D/Nt Ambient considering VPT	13.0%	30.2%	22.2%	12.9%	19.7%	22.8%	11.4%	20.2%	20.9%	8.9%	16.5%	11.4%	26.1%	17.69%	17.10%
Diff between combined and peak (BLT)	0.02	0.00	0.00	0.65	0.01	0.10	0.04	0.01	0.13	0.05	0.01	0.04	0.12	0.09	0.04
Diff between combined and D/N (BLT)	9.72	20.50	18.00	7.95	13.11	13.50	7.94	13.61	13.47	6.65	12.51	7.64	16.12	11.91	12.31
Diff between combined and peak (VPT)	0.00	0.00	0.00	0.10	0.00	0.02	0.02	0.01	0.03	0.01	0.00	0.02	0.02	0.02	0.01
Diff between combined and D/N (VPT)	9.70	20.50	18.00	7.40	13.10	13.42	7.92	13.61	13.33	6.61	12.50	7.62	16.02	12.01	12.30

6.1.2.6 Mitigation Measures

Since the operation of MRT line 5N with noise abatement measures will not create additional noise than ambient noise level. Hence, no mitigation measures are required.

6.1.3 Non-Transit Operation Noise

There are some non-transit operation noise sources during MRT line-5N operation e.g. standby generator, Variable Refrigerant Flow (VRF) air conditioning units and the Ventilation Shaft. The standby generator would be acoustically treated to reduce the noise level 65 – 55 dBA at generator loading 80 - 70 % in the absence of any substantial external interference, measured at 1m from the external wall. VRF outdoor unit will be placed at entrance roof and pedestal ground level with perforated screen cladding panels to reduce noise level. Noise prediction from VRF shows that resultant sound power level of VRF at 10 m and 30m distances will be 32 dB(A) and 23 dB(A) which are much lower than the mixed area noise level standard (60 dB at day and 50 dB at night). Background noise for "noisy urban street" is found in the range of 95 dB which is bit higher as compared to noise level (60-70 dB (A) of VRF outdoor units. Hence VRF outdoor unit noise level will not be susceptible to human ear at street level. Also, the ventilation fans that are connected to the respective ventilation shaft would be provided with atmospheric side sound attenuator to meet the accepted noise criteria i.e. 55 dBA from 2 m of shaft opening. As a result, the impact of noise from the ventilation shaft of the underground section needs not to be calculated as the target noise level also will be within the standard range.

6.1.3.1 Mitigation Measures

Non-transit equipment operation will not create any nuisance to the receptors or pedestrian. Therefore, no additional mitigation measures are required.

6.2 Vibration

Vibration is measured in Vibration decibels (VdB) and in Peak Particle Velocity (PPV, mm/sec). The vibration during transit operations at 12.5 distance from pier-head, and also vibration during construction of the viaduct is found insignificant. But vibration during compaction work in the Depot area is significant.

6.2.1 Vibration Impact during Construction

6.2.1.1 Depot Area Construction

Vibration induced by the construction activities in the main alignment is insignificant. But the Vibration induced by installation of sand compaction piles and dynamic compaction at the depot site during soil improvement and also during the construction activities in the station area is significant.

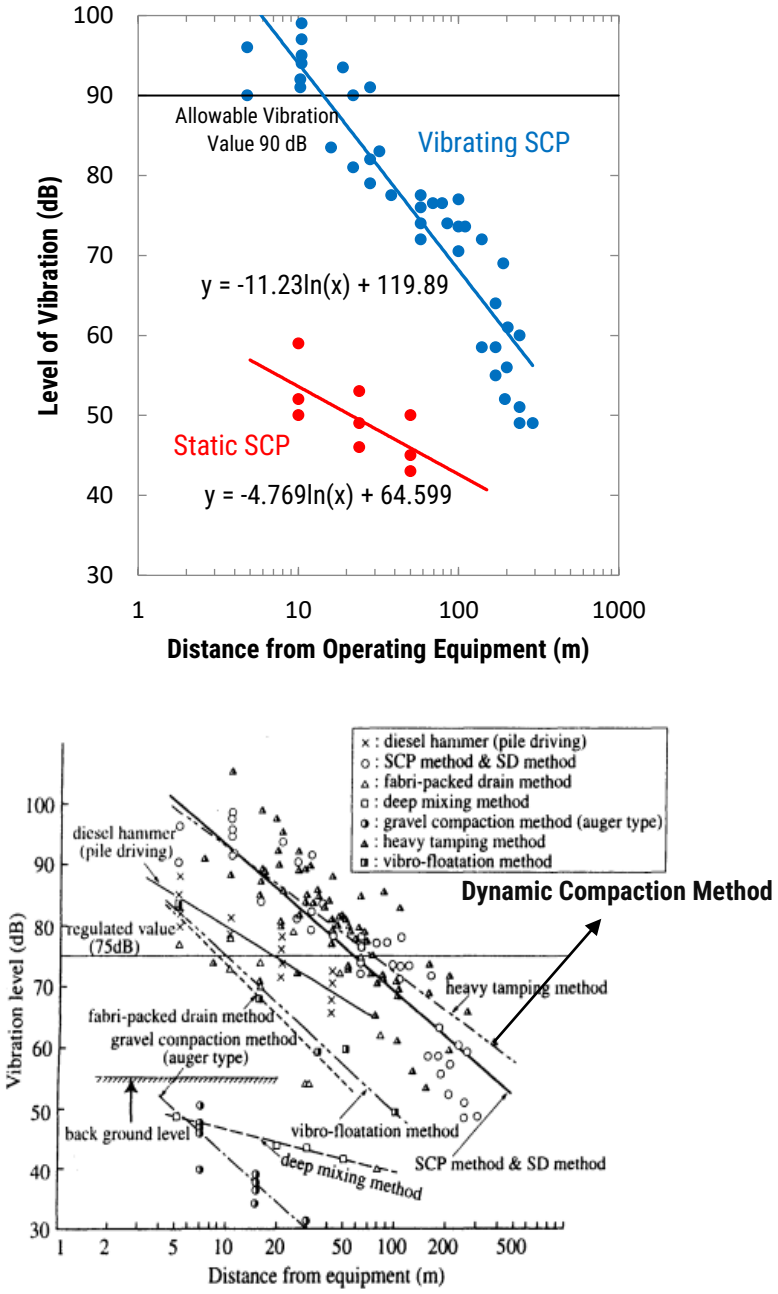
There is no vibration standard in Bangladesh. There are different international vibration standards. But, like the existing MRT Line 6 and MRT Line 1 project practices, US FTA standard for "extremely susceptible to vibration" is recommended in this project as 90 VdB, approximately corresponding to 3 mm/s PPV, which is proposed as the project standard.

Construction activity can result in various degrees of ground vibration, depending on the equipment and methods employed. Buildings founded on the soil near the construction site respond to these vibrations with varying results, ranging from no perceptible effects at the lowest levels, low rumbling sounds and perceptible vibrations at moderate levels, and slight damage at the highest levels.

During the construction period, major sources of vibration are sand compaction pile, dynamic compaction, operation of Hoe Ram, Caisson drilling. Normally Sand Compaction Pile (SCP) is used for soil improvement. For the Depot area, separate vibration level analysis has been done based on soil

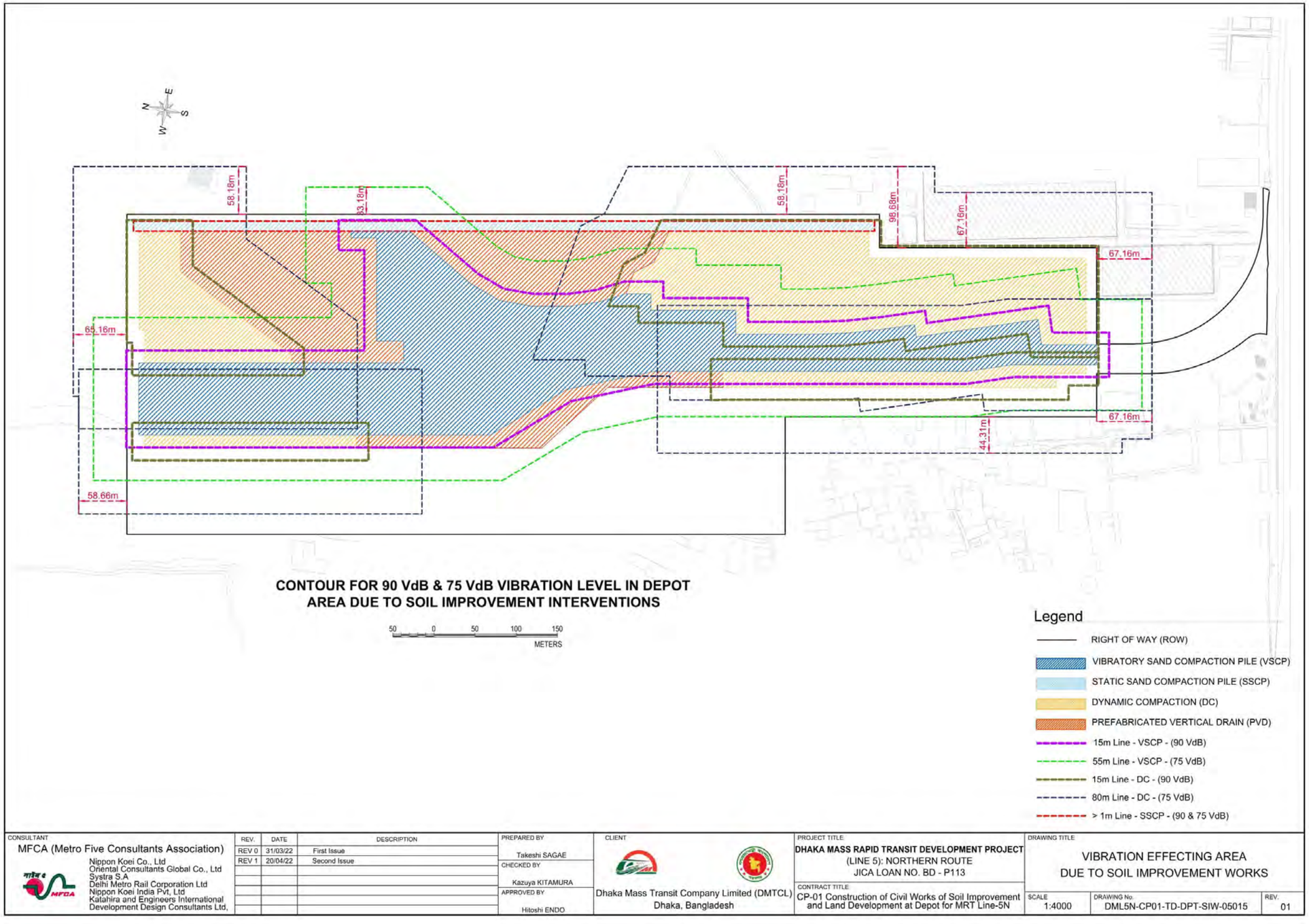
improvement interventions and a contour map has been prepared (presented in **Figure 6-6**). Vibrating SCP, static SCP, dynamic compaction and Prefabricated Vertical Drain (PVD) will be used during MRT line-5N depot land development. Comparison of vibration level of vibrating SCP & static SCP and vibration level of dynamic compaction is presented in **Figure 6-5**.

For vibrating SCP and dynamic compaction, 90 VdB will reach at almost 15m distance whereas for static SCP, 90 VdB vibration will reach only at 0.005m distance. Therefore, static SCP would be used near boundary areas of Depot.



Source: Kitazume, M. (2005). The sand compaction pile method. CRC Press.

Figure 6-5: Vibration Level Analysis for the Depot Area



Source: MFCA

Figure 6-6: Vibration Contour Map for the Depot Area

6.2.1.2 Alignment and Station Area

Construction activity can result in various degrees of ground vibration, depending on the equipment and methods employed. During the underground station construction period, major sources of vibration are steel sheet pile driving, operation of Hoe Ram, Caisson drilling. Vibration source levels for construction equipment is presented in **Table 6-13**.

Table 6-13: Vibration Source Levels for Construction Equipment

Equipment		PPV at 25 ft, in/sec	Approximate Lv* at 25 ft
Pile Driver (sonic)	Typical	0.17	93
Hoe Ram		0.089	87
Caisson drilling		0.089	87

* RMS velocity in decibels, VdB re 1 micro-in/sec

Source: transit noise and vibration impact assessment manual, U.S Department of Transportation, Federal Transit Administration, September 2018

The following equitation is used to apply the propagation adjustment to the source reference level to account for the distance from the equipment to the receiver.

$$PPV_{equip} = PPV_{ref} X (25/D)^{1.5}$$

Total 14 stations will be constructed under the project of which 9 stations are underground and 5 are elevated. The underground station will be constructed in the city area following the open cut method where commercial and residential buildings are present along the road. On the other hand, elevated stations will be constructed from Hemayetpur to Aminbazar area and Notun Bazar to Vatara area where industrial and residential buildings are present within 15 meters from the alignment. The residential and commercial buildings are located 20-50 meters from the proposed underground stations area. Different construction equipment will be used during the underground station construction which will generate vibration. There is no vibration standard in Bangladesh. Vibration standards for different countries are shown in **Table 6-14**. The Japanese standard is the strictest (as it gives more importance to human perception). Like existing MRT line 6 project, 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 for the extremely susceptible structures. For non-engineered mason structured, it is 94 VdB, approximately corresponding to 5 mm/s PPV. Vibration level generated from different equipment and level at the receiver points due to the construction activity is shown in **Table 6-15**.

Table 6-14: Vibration Standards for Construction in Different Countries

Country	Standard
India (CMRI)	
Historical buildings	2 mm/sec PPV
Domestic site development	5 mm/sec PPV
Industrial site development	12.5 mm/sec PPV
Australia	
Historical buildings	2 mm/sec PPV
Residential development	10 mm/sec PPV
Commercial development	25 mm/sec PPV

Country	Standard
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

Table 6-15: Vibration Level at the Receiver Point during Construction Period

Equipment		PPV at 25 ft, in/sec	Vibration level at Receiver Point					Standard (VdB)
			10.0 m (32.8 ft)	20.0 m (65.6 ft)	30 m (98.4 ft)	50 m (164 ft)	100 m (328 ft)	
Pile Driver (Sonic)	Typical	0.04 in/sec PPV (80 VdB)	0.113 in/sec PPV (89 VdB)	0.04 in/sec PPV (80 VdB)	0.022 in/sec PPV (75 VdB)	0.022 in/sec PPV (55 VdB)	0.0005 in/sec PPV (41 VdB)	90
Hoe Ram		0.089 (87 VdB)	0.059 in/sec PPV (83 VdB)	0.021 in/sec PPV (74 VdB)	0.011 in/sec PPV (69 VdB)	0.011 in/sec PPV (50 VdB)	0.0002 in/sec PPV (36 VdB)	
Caisson drilling		0.089 (87 VdB)	0.059 in/sec PPV (83 VdB)	0.021 in/sec PPV (74 VdB)	0.011 in/sec PPV (69 VdB)	0.011 in/sec PPV (50 VdB)	0.0002 in/sec PPV (36 VdB)	

The **Table 6-15** shows that the vibration generated during the construction of underground stations and elevated section will not affect the structure located at a distance of 10 meters and more. So, no major vibration impact is expected during the underground station and elevated section construction.

According to the cultural assets/historical importance/archeological place survey, three (3) monuments/structures were finally identified, namely (I) Mazar of Shah Md. Abdus Samad Bangalai Wayeshi, (II) Dewan Bari Mosque and (III) Dewan Bari for their historical importance and proximity to the alignment. Among them, Dewan Bari Mosque and Dewan Bari are listed as heritage monument by RAJUK which are located at 36 and 50 meter distances from the MRT line 5N alignment respectively. Mazar of Shah Md. Abdus Samad Bangalai Wayeshi is not listed as heritage site neither by DoA nor by RAJUK, which is located at 10.77 m distance from pile location. The impact on historical building during construction phase has been described in section 6.18.1.

6.2.1.3 Conclusion

There is no settlement along the depot area which are susceptible to 90VdB vibration level. The 75 VdB vibration during the construction activity may create annoyance to the occupants, even though there will be no damage. However, some measures or compensation are required for the residents residing within the 75 VdB impact zone around the Depot Boundary and underground station area to mitigate vibration impact during construction.

6.2.1.4 Mitigation Measures

- Compensation will be provided to the vibration susceptible households located near to the depot boundary. The level of compensation will be set out in the Resettlement Action Plan (RAP). If necessary, the affected people will be relocated for temporary period from the area of influence.
- Contractors will be required to use low-vibration generating equipment and machineries whenever it is necessary.
- To identify impact on the surrounding buildings, the vibration level and condition of the buildings should be monitored.
- The explanation and consultation to the affected persons prior to the construction should be conducted to obtain the understanding about the potential impacts including information of the positive impacts such as promotion of the local socio-economic activity. If the local people complain about noise and vibration, the consultant of the supervision and the contractors should reconsider the construction technique.
- Considering the extent of the work, routine vibration monitoring is required and necessary precautions should be taken to reduce the potential for vibration impacts. Monitoring will also be conducted if any grievance comes from the adjacent residents/receptors.
- Concurrent workload should be reduced if high vibration readings are found in monitoring. Instead, frequency of vibration generating works will be reorganized to reduce the impacts.

Residual Impacts

After implementing the mitigation measures, no significant impact related to vibration will remain. Therefore, no additional measures are required.

6.2.2 Train Operations

6.2.2.1 Method

The Japanese method established by Toei and used for analyzing the Tsukuba Express Line is used to calculate expected vibration levels along the alignment. The formula for vibration at-source (Lv) is based on ballast-less track: Lv = 10logV + 47 + 7.5.

If R<=400m, the following equation should be used: Lv = 10logV + 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:

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

a. LP; Vibration level at target point (VdB)
b. Lv; Vibration level at reference point (VdB)
c. r; Distance from center of structure to target point (m)

d. r0; Distance from center of structure to reference point(m)

α; Correction factor for internal dampening assumed α=0.04）

6.2.2.2 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 are 0.20 in (5 mm)/sec (approx. 100 VdB) for fragile buildings or 0.12 in (3 mm)/sec (approx. 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 5N of 60 VdB (1.4 mm/sec PPV) is stricter than many international standards. The vibration level has been calculated at 12.5 m from the piers along the alignment.

6.2.2.3 Analysis

The formulas were applied for three curves radii and related train speeds. **Table 6-16** shows results for ballast-less 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 6-16: Expected Vibration Levels for Track Radii (VdB) considering Ballast-less Track

Track	R=200m	R=400	Straight(R>=500m)
At Pier Face			
Ballast-less track	64.9	68.2	66.8
At 12.5 m from Pier			
Ballast-less track	59.7	62.9	61.5

Table 6-17: Expected Vibration Levels for Track Radii (VdB) considering Vibration Proof Track

Track	R=200m	R=400	Straight(R>=500m)
At Pier Face			
Vibration proof track	57.4	60.7	59.3
At 25m from Pier			
Vibration proof track	52.2	55.4	54.0

The curvatures of proposed MRT Line-5N elevated portion alignment varies from 590 - 6000 meter. There are only two sharp curvatures at the depot entering point as 160 m (east bound) and 164m (west bound). Due to the sharp curvature, locations in the proximity of piers near <=200 m radius curves at depot entering point of proposed alignment will exceed the standard when ballast-less track is used. But the vibration level will be well within the standard for the ballast-less track at 12.5 m from pier. The vibration frequency

will be below the normal level for all the curvature at the minimum distance for the receptor level (25m from the track center). Therefore, vibration proof track is not required at all in the elevated section. So, for the elevated section, ballast less track with 1.5 m parapet wall is recommended throughout the alignment.

For the underground section, even if the vibration is minimal, but to eliminate the risk of natural resonance, Mass Spring System (MSS) type Floating Slab Track (FST) will be placed for the entire UG section, which will also reduce the vibration. Low speed will be maintained in curved sections during train operation.

6.3 Air Pollution

6.3.1 Before/During Construction Stage

Effects on the air quality by the MRT line-5N project is one of the major concerns especially during the construction phase. Dhaka air is inherently bad in winter season, due to northern wind with dust, high pressure at sea, and suspension of particle in land. So, without any construction, it will be very bad. Scientific explanations of such phenomenon are explained in section 4.4.1. The project target is to prevent construction activities not to add any further pollution. In the operation phase, there will be no direct impact of MRT line-5N. As it is already described in the project area that there will be underground and elevated section. The train will operate based on the electricity. So, there will be no use of fossil fuel which is normally a big source of the gaseous pollutants. So, the total set up for the MRT line-5N will be environment friendly. However, there will be some indirect impact also. The major sources of the pollution during the construction works are:

- Dust from earth works during site preparation, excavation, utility relocation and tunnel boring activities,
- Emissions from the operation of construction equipment and machines,
- Fugitive emissions from vehicles plying on the road,
- Fugitive emissions during the transport of construction materials
- Loading and unloading of construction materials, and
- Localized increased traffic congestion in construction areas,
- Construction site generates dust from construction materials, waste, loose earth, and moving excavated material and transporting wastes on vehicles,
- Emission of gases from the heavy equipment will also be a good source of air pollution,
- All the stationary heavy equipment or machineries like batching plant, crusher, quarry site, generator etc. will be a good source for the air pollution,
- Stockpiling of soil in the construction area will be another source of dust in the construction site if not disposed in time.

6.3.1.1 Mitigation Measures

Following mitigation measures should be taken to reduce air pollution during construction work:

- Fit machinery with appropriate exhaust systems and emission control devices. Maintain these devices in good working condition in accordance with the specifications defined by their manufacturers to maximize combustion efficiency and minimize the contaminant emissions. Proof or maintenance register shall be required by the equipment suppliers and contractors / subcontractors.
- Equipped all machineries with the exhaust system to control the black smoke.
- Operate the vehicles in a fuel-efficient manner.

- Cover haul vehicles carrying dusty materials moving outside the construction site (if the materials are dry).
- Impose speed limits on all vehicle movement at worksite to reduce dust emissions.
- Removal of mud from the wheel at entry and exit point
- Install signage at the construction area roadside for speed limit control
- Control the movement of construction traffic.
- Service all vehicles regularly to minimize emissions.
- Machinery causing excess pollution (e.g. visible smoke) will be temporarily banned from the construction sites.
- Service all the equipment regularly to minimize emissions.
- Provide filtering systems, dust collectors or humidification or other techniques (as applicable) to the concrete batching and mixing plant to control the particle emissions in all its stages, including unloading, collection, aggregate handling, cement dumping, circulation of trucks and machinery inside the installations
- Water the material stockpiles, access roads and bare soils on an as required basis to minimize the potential for environmental nuisance due to dust. Increase the watering frequency during periods of high risk (e.g. high winds). Stored materials such as gravel and sand shall be covered and confined to avoid their being wind-drifted.
- Minimize the extent and period of exposure of bare surfaces.
- Reschedule earthwork activities or vegetation clearing activities, where practical, if necessary, to avoid during periods of high wind and if visible dust is blowing off-site.
- Restore disturbed areas as soon as practicable by vegetation/grass-turfing.
- Store the cement in silos and minimize the emissions from silos by equipping them with filters.
- Establish adequate locations for storage, mixing and loading of construction materials, in a way that dust dispersion is prevented because of such operations
- Air pollution monitoring shall be carried out as per monitoring plan and corrective action shall be taken in case of any deviation.

Residual Impact

With the implementation of air pollution mitigation measures stipulated in this EIA report during construction stage, no significant residual impact on air quality is expected.

6.3.2 Operation Stage

Vehicle exhaust emissions and entrained dust could increase in the vicinity of stations due to increased movements of people.

However, the MRT line-5N will be electrical operation and not use diesel fuel. Moreover, the operation will improve congestion of roads along the MRT Line 5N and efficiency of vehicle mobility. Consequently, increase in air pollution in Dhaka city may be mitigated as a positive impact.

6.3.2.1 Mitigation Measures

The trains will be operated by electricity. Although the production of electricity required for operation of metro rail will cause emission of air pollutants, but it will be insignificant than the amount of reduced emission due to decreasing of other vehicles. No additional measures are required.

Residual Impacts

No residual impact on ambient air quality is anticipated during operation stage.

6.4 Surface Water Pollution

6.4.1 Before/During Construction Stage

The potential sources of impact to surface water resource are:

- At the project site due to excavation activities may increase erosion during rainfall, that may increase the suspended sediment concentration in the adjacent water body (especially in the Karnatali river, Turag River, Gulshan-Baridhara Lake and Satarkul-Vatara Canal);
- The mismanagement of wastes that may cause surface water pollution in the project area although the waste would be very small amount except the spoil materials;
- Washing of construction materials will generate liquid effluents which causes surface water pollution in the project area;
- All kind of blackish and grey water from the accommodation area and office area will pollute the surrounding environment.
- Washing of the batching plant and ready mixture truck will increase the sedimentation in the storm water drainage line if not properly cleaned and high pH level may pollute the adjacent water body of the construction yard and depot area.

6.4.1.1 Mitigation Measures

Following mitigation measures should be taken to control surface water pollution during construction work:

- Install temporary drainage line (drains and bunds) around the storage areas for construction materials.
- Install temporary sediment basins, where appropriate, to capture sediment-laden run-off from site.
- Divert runoff from undisturbed areas around the construction site.
- Stockpile materials away from drainage lines.
- Prevent all solid and liquid wastes entering waterways by collecting solid waste, oils, chemicals, and wastewaters from brick, concrete and asphalt cutting where possible and transport to an approved waste disposal site or recycling depot.
- Wash out ready-mix concrete agitators and concrete handling equipment at washing facilities off site or into approved bounded areas on site. Ensure that tires of construction vehicles are cleaned in the washing bay (constructed at the entrance of the construction site) to remove the mud from the wheels. This should be done in every exit of each construction vehicle to ensure the local roads are kept clean.
- Stabilize the cleared areas which will not be used for construction activities with vegetation or appropriate surface water treatments as soon as practicable following earthwork to minimize erosion.
- Ensure that roads used by construction vehicles are swept regularly to remove sediment.
- Water material stockpiles, access roads and bare soils on an as required basis to minimize dust. Increase the watering frequency during periods of high risk (e.g. high winds).
- Monitor water quality in the runoff from the site or areas affected by dredge plumes, and improve work practices as necessary.
- Protect water bodies from sediment loads by silt screen or bubble curtains or other barriers.

- Minimize the generation of sediment, oil and grease, excess nutrients, organic matter, litter, debris, and any form of waste (particularly petroleum and chemical wastes). These substances must not enter waterways, storm water systems or underground water tables.
- Use environment friendly and nontoxic slurry during construction of piles.
- Strong pollution control measures will be taken to protect surface water quality of ECA sites (Turag River and Gulshan-Baridhara Lake) due to construction activities.
- Reduce infiltration of contaminated drainage through storm water management design.
- Do not discharge cement and water curing used for cement concrete directly into water courses and drainage inlets.
- Pumping of groundwater should be from aquifers free from arsenic and other contaminants. Safe and sustainable discharge option must be confirmed prior to selection of pumps.
- Tube wells will be installed with due regard for the surface environment, protection of groundwater from surface contaminants, and protection of aquifer cross contamination.
- Protect groundwater supplies to adjacent lands.
- Take legal permission as per applicable local law.

Residual Impacts

With the implementation of proposed mitigation measures for surface water pollution, most of the anticipated pollution will be prevented. However, a little number of residual impacts, such as sedimentation of surface water, especially the river nearby depot can be occurred. This impact is not significant and will occur for short period (during construction phase). No additional measures are required.

6.4.2 Operation Stage

The surface water pollution due to the operation of metro rail is negligible as there is no significant source of pollution to water. In depot area, there will be Wastewater/Effluent Treatment Plant. The wastewater will go through an oil-water separator before coming to the treatment plant. In stations, the sewage will be discharged to the existing sewage line of DWASA wherever it is available. Otherwise, aerobic or septic tank will be installed in the stations if any sewage line is not available. All discharges from depot area Effluent Treatment Plant (ETP) and from stations Sewerage Treatment Plants (STP) must ensure the effluent quality standard of DOE. Thus, there will be no residual impact during the operation period.

6.5 Ground Water

6.5.1 Construction Stage

Potential impacts on groundwater due to construction activities of the MRT line-5N are insignificant. In Dhaka City, Ground Water extraction started from a depth of 100m and in some extreme condition the well goes up to 300 meters to reach the main aquifer and is unlikely to be affected by surface and tunnel activity related to construction of the Metro. Only impact will be the extraction of groundwater for the construction purpose. So, this will create a little bit pressure on the groundwater table. But the impact is not so significant as the borehole will be in the specific area only. However, the piles driven into the ground with multi layers and construction of underground/tunnel structure would penetrate the aquiclude/aquitard and then cause the risk to pollute the water quality of the aquifer. Therefore, the mitigation measures for hazardous waste, mentioned in this report, should be implemented to prevent any contamination of ground water by hazardous waste, which is very unlikely.

Residual Impacts

Residual impacts on ground water are very rare. No additional measures are required.

6.5.1.1 Mitigation Measures

Following mitigation measures should be taken to control ground water depletion during construction work:

- Tube wells will be installed with due regard for the surface environment, protection of groundwater from surface contaminants, and protection of aquifer cross contamination.
- Water quality and water levels of all installed wells near construction yards and construction camps will be monitored regularly.

6.5.2 Operation Stage

As the tunnel construction will be on the alignment (under the existing road) so there will be no possibility of interruption of ground water percolation.

In depot area, oil and lubricants can be released during train maintenance and repairing. Since there will be oil/water separator in the wastewater treatment, so, there will be practically no chance that these wastes would reach aquifer.

6.5.2.1 Mitigation Measures

(SOP) Standard Operating procedure related to the handling of hazardous chemicals and drainage from contaminated areas should be prepared to highlight safety and environmental aspects. Also, for avoiding contamination from oil spillage, treatment plant will be installed at the depot area to avoid groundwater contamination.

Residual Impacts

No residual impact is expected.

6.6 Soil Pollution

6.6.1 Before/During Construction Stage

The project may not have significant impact on soil pollution because most of the alignment of the project will be in the underground. Also, there is no activity in or near the agricultural field. The alignment will go through the urban area from Hemayetpur to Vatara. There is minor chance to soil pollution due to construct the project include soil stabilization, installation of pilling, construct of viaduct sections, construction of station, utility relocation, construction yard etc. Some minor problems could arise from dumping of debris i.e. construction soils (concrete, bricks), waste materials (from contractors' camp) etc. Improper management of these sources may contaminate the adjacent soil quality. Oil leakage from the unfitted machine and vehicle may also cause minor soil pollution. Waste from construction yard and camp may also contribute to the soil pollution. In addition, during refueling of any vehicle and from the stationary sources, oil leakage could happen which may cause minor soil pollution.

6.6.1.1 Mitigation Measures

Following mitigation measures should be taken to control soil pollution during construction work:

- Before site works commence, a Spill Management Plan need to be prepared by the contractor and shall be approved by project supervision consultant (PSC). The plan shall provide details of procedures, responsibilities, resources, documentation and reporting requirements, training

provisions for relevant staff, etc. to avoid spills of hazardous substances and to effectively respond to such incidents, in case these occur.

- Store fuel and hazardous substances in paved areas with embankment. If spills or leaks do occur, undertake immediate clean up.
- Ensure availability of spill clean-up materials (e.g., absorbent pads, foam etc.) specifically designed for petroleum products and other hazardous substances where such materials are being stored.
- Ensure all storage containers are in good condition with proper labeling.
- Regularly check containers for leakage and undertake necessary repair or replacement.
- Store hazardous materials above flood level.
- Equipment maintenance areas shall be provided with drainage leading to an oil-water separator that will be regularly skimmed of oil and maintained to ensure.
- The disposal of soil waste shall be made in approved/designated locations.

Residual Impacts

It is expected that the possibilities of soil contamination can be mitigated by implementing the recommended measures in this report. It is very unlikely that any residual impact on soil will occur during construction phase. However, if such impacts happen, that will be very minor and insignificant, any agricultural land will not be affected. No additional measures are required.

6.6.2 Operation Stage

Oil leakage from the maintenance work at depot site may slightly contaminate soil quality of the surrounding.

6.6.2.1 Mitigation Measures

Following mitigation measures should be taken to control soil pollution during operation period:

- In the vehicle washing, maintenance area and wheel washing pits, drains shall be linked to the water treatment plant.
- Drainage from the depot workshops will be equipped with oil interceptors.
- Office buildings shall be provided with toilets and septic tanks to handle domestic sewage.
- The sewer system will be designed to prevent leakage or overflow of wastewater that could contaminate the surrounding areas.
- All hazardous and potentially contaminating materials (chemicals, fuels, oils, etc.) shall be stored in facilities with weatherproof flooring and roofing, security fencing and access control and drainage/wastewater collection systems.

Residual Impacts

No residual impact during operation period is expected.

6.7 Waste and Spoil Soil

6.7.1 Before/During Construction Stage

During the construction stage several metric tons of waste soil will be generated from tunnel boring as well as station construction by cut and covers method. The management of waste/spoil soil is the major challenge during the construction period. It is estimated that approximately 2.5 million cubic meter of spoil will be generated during construction and this need to be disposed in a suitable location. Several

disposal locations have already been identified and will be finalized before construction. Different types of construction materials and garbage will also generate during the construction period from construction site, construction yard and construction camp. Construction wastes will be disposed of at designated locations after obtaining clearance from the Engineer/DMTCL. Solid waste generated from different area during construction site may impact on the surrounding soil as well as water quality. Garbage should also be disposed of designated municipal disposal area. Improper management of waste during the construction stage might cause soil as well as water pollution so the impact of waste has been assessed as significant.

6.7.1.1 Mitigation Measures

Following mitigation measures should be taken to manage waste during construction period:

- Need to ensure proper segregation of solid wastes and put it in specified areas.
- Organize disposal of all solid wastes generated during construction in an environmentally acceptable manner.
- Minimize the production of solid waste materials by 3R (Reduce, Recycle and Reuse) approach.
- Segregate and reuse or recycle all the solid wastes, wherever practical.
- Prohibit burning of solid waste.
- Collect and transport non-hazardous solid wastes to all the approved disposal sites. Vehicles transporting solid waste need to be covered with tarps or nets to prevent spilling waste along the route.
- Clinical wastes need to be bagged separately and then disposed of with the wastes by marking.
- Provide refuse containers at each worksite.
- Maintain all construction sites in a cleaner, tidy and safe condition and provide and maintain appropriate facilities as temporary storage of all the solid wastes before transportation and final disposal.
- Protective clothing, safety boots, helmets, masks, gloves, goggles, should be provided to the construction personnel, appropriate to materials in use.
- For collection and disposal of solid wastes in an environmentally acceptable manner, the contractor needs to appoint a third party who is experienced in this issue and will be responsible for taking care of it.
- Need to make sure all containers, drums, and tanks that are used for storage are in good condition and are labeled with expiry date. Any container, drum, or tank that is dented, cracked, or rusted might eventually leak. Need to check for leakage regularly to identify potential problems before they occur.
- Separate spoil soil management plan needs to be prepared before construction stage and those spoil materials will be disposed of at an approved land.
- Construction waste should also be disposed of at pre-approved designated locations.

Residual Impacts

There is very little scope of occurring any residual impact after implementing the mitigation measures, especially in the case of hazardous waste. There would also be a chance of sedimentation of water bodies nearby spoil disposal site due to runoff induced erosion. However, these impacts are insignificant and very unlikely to happen. No additional measures are required.

6.7.2 Operation Stage

At the operation phase, no hazardous waste, spoil soil and construction waste are expected to be generated except maintaining works, depot and operations of stations. Miscellaneous garbage, and municipal wastes, will be generated at depot and stations. The putrefaction of the organic component of the uncollected wastes will give rise to foul smells. Uncollected waste also will act as breeding grounds for the disease producing vectors and will affect the aesthetics of the project area.

6.7.2.1 Mitigation Measures

Following mitigation measures should be taken to manage waste during operation period:

- Offices, workshops, other areas within the depot and station areas shall be provided with waste collection bins or receptacles;
- Solid wastes shall be segregated into hazardous, non-hazardous and reusable waste streams and stored temporarily on site in secure facilities with weatherproof flooring and roofing, security fencing and access control and drainage/wastewater collection systems;
- Garbage shall be regularly collected and shall be disposed of consistent with local regulations;
- Wastes shall only be disposed to approved sites by local authorities.

Residual Impacts

No residual impacts are expected during operation period.

6.8 Ground Subsidence

6.8.1 Before/During Construction Stage

There will be no ground subsidence due to tunnel boring activities if there is no accident during the construction process of the metro rail. Minor possibilities will be during the open cut method of the station work. But to avoid such accident, diaphragm wall method will be used. Therefore, if there is no disaster, there would be no possibility of land subsidence after taking the appropriate technology.

Buildings would be less likely to collapse due to ground subsidence because the planned metro rail alignment will be constructed under the existing road network.

6.8.1.1 Mitigation Measures

Following mitigation measures should be taken to control ground subsidence during construction period:

- Diaphragm wall method will be used to avoid any land slide during the construction of the underground station in open cut method;
- Detail methodology need to be prepared and submitted to the supervision engineer for their approval before starting any activities related to ground subsidence.

Residual Impacts

No residual impact is expected.

6.8.2 Operation Stage

During the operation phase of the metro rail, the possibility of the ground subsidence is less as the tunnel will be shielded. Also, from the subsoil investigation, it has been assured that there will be no ground subsidence during the operation phase. Moreover, the design of MRT LINE-5N is prepared based on the

guidelines of Bangladesh National Building Codes (BNBC) to protect the underground structures from the impacts of earthquake.

6.9 Offensive Odors

6.9.1 Before/During Construction Stage

Exhaust emission from heavy equipment causes odor problem. Though the construction camp site not yet finalized but there is a possibility of odor problem due to the open burning of construction waste, improper treatment of human liquid waste.

6.9.1.1 Mitigation Measures

Following mitigation measures should be taken to control offensive odors during construction period:

- Prohibit burning of solid wastes in the construction yard
- Need to install sewage treatment plant in the construction yard and in the depot area
- Need to seal the food wastes and dispose in a designated ground within a shortest period
- Storm water drainage line need to be cleaned at regular interval to avoid any bad odor from the stagnant water.

Residual Impacts

No residual impact is expected.

6.9.2 Operation Stage

Improper solid waste management in the station area might cause offensive odor but the possibility of this impact is negligible as regularly the solid waste will be collected from the station and depot area.

6.9.2.1 Mitigation Measures

Following mitigation measures should be taken to control offensive odors during operation period:

- Need to install sewage treatment plant in the depot area
- All kind of biodegradable wastes need to be separated, sealed in a plastic bag and then disposed in a designated place.

Residual Impacts

There will be no residual impact.

6.10 Topography and Geology

6.10.1 Before/ During Construction Stage

The MRT line-5N will be constructed mostly underground and some part is elevated portion. It is located on the plain topography. The construction activities during the construction phase will not modify or alter the geologic formation and topography. So, no mitigation measures are required.

6.10.2 Operation Stage

In the operation stage, only the elevated section with station will be visible which will not change topography significantly. So additional mitigation measures are not required.

6.11 Landscape

6.11.1 Before/ During Construction Stage

Primarily land will be acquired for the depot construction in the Hemayetpur, which is currently privately owned. Most of the land is fallow land, and most of the land is vacant and unused agricultural land. During construction, the present landscape will be changed. MRT line-5N will follow the city's current road alignment. The attractive station structure would enhance the scenery in the depot area and on the elevated section.

The station, ventilation shafts, and sections of the metro line will be designed by using cut and cover method are the key components of the MRT line-5N that could influence the surrounding landscape and aesthetics. Construction sites may have a detrimental effect on visual facilities and the appearance of the local area if they are not well maintained.

6.11.1.1 Mitigation Measures

Following mitigation measures should be taken during construction period:

- For the construction of the station at the underground route line area and in the elevated section area, barricade at minimum height needs to be provided to cover the construction activities from the city dwellers and
- Implementation of the mitigation measures stated in the air pollution part to avoid any spoil or mud outside of the construction sites or not to keep open while transporting from the generating sources to the disposal sites.
- Construction camps should be constructed at suitable place to minimize this probable impact.

Residual Impact

After taking the mitigation measures, still there will be chances of negative landscaping at the entry and exit point. Also Spoil or mud may come on the road due to the washout from heavy rain. So, at the entry and exit point, security guard or signal men need to be posted to avoid entry or standing of the general people during the construction activities. Also, the barricade needs to be sealed to avoid washout of water on the road.

6.11.2 Operation Stage

In the operation phase, present landscape of the project area will be changed with the architectural and structural beauty from Hemayetpur to Aminbazar and Notunbazar to Vatara area. In the city area (from Aminbazar to Notunbazar route line), ventilation shaft will be constructed in a nice way so that they merge with the surrounding landscape. The construction of new structures such as viaduct, station as well as new improved structures with plantation will improve the aesthetics view of the project area.

6.12 Flood and Urban Drainage

6.12.1 Construction Stage

The drainage system could be hampered due to construction activities like infilling, construction of the depot, construction yards and haul routes. A major impact during construction stage is due to entrain of suspended solids into the internal drainage line that can clog drainage system. The depot area is low lying area and the area act as water retention as well as drainage of the surrounding area. According to the flood inundation report, the impact on flood level of surrounding area will be negligible.

6.12.1.1 Mitigation Measures

Following mitigation measures should be taken to maintain urban drainage during construction period:

- Construction materials, excavated spoils, equipment placement shall not block flow of rainwater into canals/drainage structures.
- Prohibit disposal of waste materials to drainage channels.
- Proper drainage facility should be ensured around the depot area;
- Regularly inspect and maintain all drainage channels in the vicinity of construction sites to keep these free from obstructions.

Residual Impacts

There will be change in surface runoff characteristics in depot and alignment area. However, these changes will not make any adverse impacts as proper drainage facilities will be developed for drainage. No additional measures are required.

6.12.2 Operation Stage

Dhaka city is flood prone area. Flooding may impact the operation of the metro rail especially underground tunnel. A hydrological study and modelling have been conducted analyzing the historic flooding data during the detail design stage. The 100-years flood level was varied from 7.03 mSoB at Gabtoli station to 13.68 mSoB at Mirpur-1 station without considering the effect of climate change. Based on the flood depth simulation it has been found that, the surrounding areas of depot under inundation may remain almost the same. The maximum flood level may rise by 2 cm in the northeastern side of the Depot Area, 2 cm in the southeastern side, 0 cm in the middle-eastern side and 2 cm in the middle-western side. The maximum flood depth may increase by 2 cm. But there would be some significant effect on the flow velocity. The velocities in the northeast and southeast areas surrounding the Depot Area would increase much, and the velocities in the middle-west and middle-east areas would decrease to some extent. Overall, the impact of flood on depot and the impact of depot construction on flood are negligible. Already the study has been considered in the design phase. So, there will be no impact and no additional mitigation measures will be required.

Flood levels at each station are known and given in Section 4.3.5.7, design of entry/exit considered the values and raised accordingly. This will prevent water entering into UG stations during operation stage. For elevated stations, base of equipment, lift and escalators are designed considering maximum flood level, so that there will be no impact during operation stage.

6.13 Protected Area

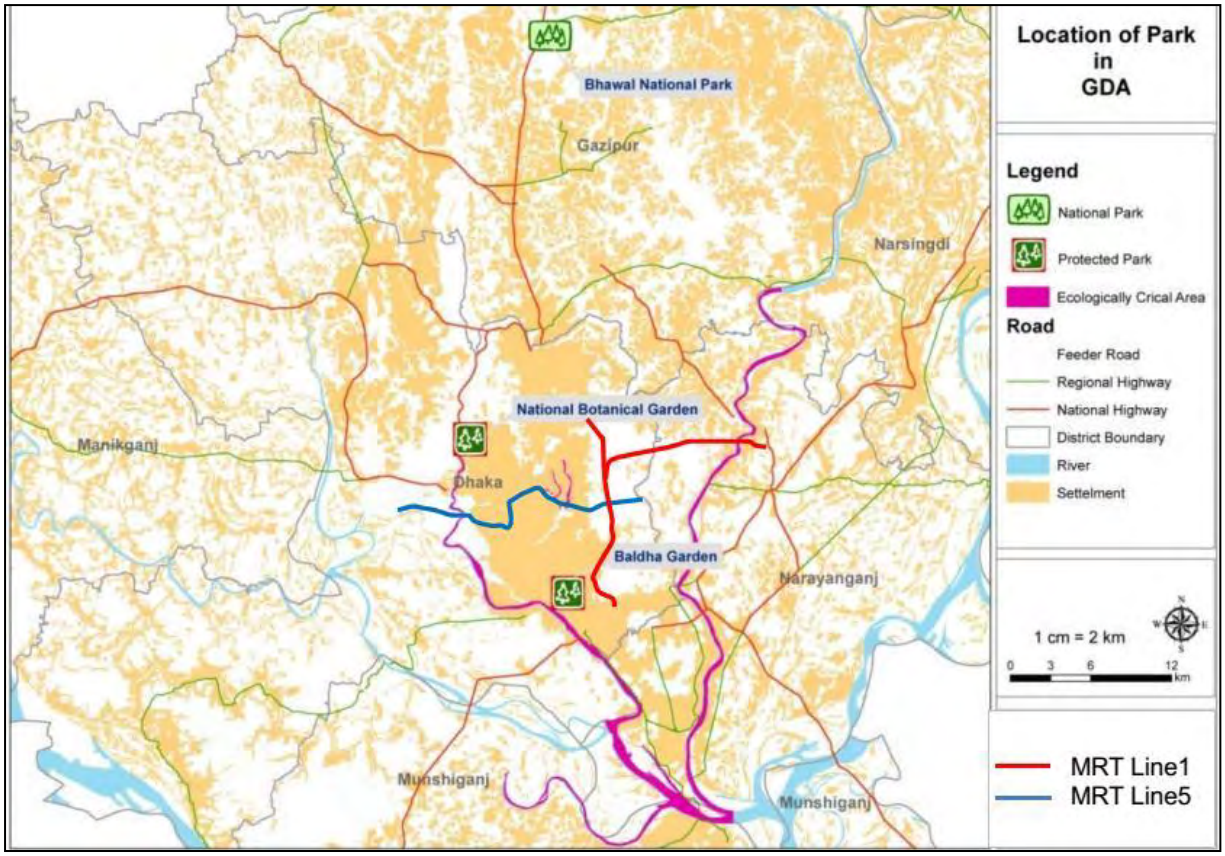
6.13.1 Construction Stage

Based on Wildlife (Conservation and Security) Act, 2012, Protected Areas (PAs) is classified into national parks, wildlife sanctuaries, game reserves and private game reserves. The protected areas in and around the project site are shown on **Figure 6-7**.

There is no protected area such as natural park, sanctuary, and conservation site in the project alignment. National Botanical Garden and Baldha Garden are located on over 5km from the project site. So, no impact is assumed.

There are five Ecologically Critical Area (ECA) including one lake (Gulshan -Baridhara Lake) and four rivers (Buriganga, Turag, Balu and Shitalakshya) (Figure 6-3) in the project area. Considering the ecological

value of ECA, the underground structure of MRT line-5N will cross Turag River and Gulshan- Baridhara lake which are designated in ECA, 2009. So, no impact is assumed.



Source: JICA Study Team, 2017

Figure 6-7: Protected Area in and Around the Project Site

6.13.2 Operation Stage

As there is no protected area near MRT Line therefore no impact is expected.

6.14 Biota and Ecosystem

6.14.1 Construction Stage

There is less impact on ecology as most of the section is underground. In the elevated section from Hemayetpur to Aminbazar alignment and Notun Bazar to Vatara, there are some tree species that need to be cut down. A study is going on to update the RAP, which will provide the exact number. Proper compensation will be provided for the loss of trees under RAP and a tree plantation program will be carried out in the depot and under the viaducts once the construction is completed.

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 *6-18***.

Apart from these trees, median should also have grass cover. 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. The tree species has been recommended based on Line 6 EIA Report. Depot landscape planner will determine the tree plantation provision for the depot area.

Table 6-18: 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

Few birds, reptile, mammals were found during the field survey in the depot area. Bengal Monitor is only near threatened according to the IUCN Red list 2015 whereas all species are least concern. As there are lots of homestead plantations near to the depot area, they can migrate to the nearby area during the construction period of depot.

Residual Impacts

No residual impact is expected after implementing the mitigation measures, such as compensation and tree plantation.

6.14.2 Operation Phase

No impact has been predicted on ecosystem due to the rail operation in the underground tunnel. In the elevated section (from Hemayetpur to Aminbazar and Notunbazar to Vatara), there are no big trees. So, there will be no significant impact anticipated on the ecosystem due to the operational activities of the MRT line-5N.

6.15 Involuntary Resettlement

6.15.1 Before/During Construction

In the design phase, Updating of RAP is under preparation. The information related to number of project affected person and loss of property will be known once the RAP study is completed. Details information

can be found in that report. As stipulated in the Updated RAP report, proper compensation will be paid to all the project affected people.

6.15.2 Operation Phase

There will be no impact expected during the operation stage.

6.16 Local Economics

6.16.1 Before/During Construction Stage

During construction stage of the MRT line-5N, businessmen will be affected in the elevated station area (from Hemayetpur to Aminbazar). Final number will be confirmed after the completion of the detailed RAP study. There will be proper compensation for the affected businessmen as per the final RAP study. So, the impact will be very minimal after taking the compensation package. There will be no residual impact after compensation and other mitigation measures will be implemented as per the recommendation of the RAP report.

6.16.2 Operation Stage

It is expected that the new employment opportunity will be increased all along the route at every station. New manpower will be required to operate the metro rail as well as many new businesses will be created around the station areas. So, during the operation phase, the impact will be positive.

6.17 Social Service Facilities

6.17.1 Before/During Construction Stage

No social service facilities exist in the viaduct section from Notun Bazar to Vatara section. There may be some social service facilities in the Hemayetpur to Aminbazar section but not yet confirmed as the detail RAP study is underway. It would be known once the RAP study is completed. Proper compensation will be provided for the impacted social service facilities as per the national law and JICA guideline. Major route of the MRT Line 5N will pass through underground as a result the impact on social service facilities is negligible.

6.17.2 Operation Stage

MRT Line-5N is a major social service facility that will reduce the travel time and enhance the economic growth of the people.

6.18 Cultural Heritages

6.18.1 Before/ During Construction Stage

According to the survey on cultural assets/historical importance/archeological places of interest, a total of one hundred thirty-seven (137) monuments were documented. After critical scrutiny, twenty (20) monuments [Six (06) from the elevated section and Fourteen (14) from the underground section] were primarily selected for further analysis based on their historical significance and relatively closer proximity. Among the twenty (20) monuments, there will be no impact on the fourteen (14) monuments/structures as all the underground sections will have noise and vibration proof MSS tracks. Out of the remaining six (6) along the elevated section, three (3) monuments/structures namely (I) Mazar of Shah Md. Abdus Samad Bangalai Wayeshi, (II) Dewan Bari Mosque and (III) Dewan Bari were finally identified for their historical importance and proximity to the alignment. Of these, Dewan Bari Mosque and Dewan Bari are listed as heritage monument by RAJUK whereas the Mazar of Shah Md. Abdus Samad Bangalai Wayeshi

is not listed as heritage site neither by the DoA nor RAJUK. Details of the cultural heritage sites and associated impact due to the Line-5N construction is presented in **Table 6-19**.

Table 6-19: Construction Phase Impacts on the Cultural Heritage Sites

SL	Name of identified Monument	Distance (Meter) from MRT-5N	Probable Impacts during Construction Phase
1	Mazar of Shah Md. Abdus Samad Bangalai Wayeshi	Centerline: 9.27m Nearest Pier: 10.77m [Pier no. 14] From Sheet Pile: 6m	Followers may face minor impact of vibration during ritual activities.
2	Dewan Bari Mosque	36	No impact is suspected as the structure is considerably far away from the project corridor. However, any unplanned construction activities may create impact (such as dust pollution, waste generation, noise pollution, etc.) during the construction phase.
3	Dewan Bari	50	No impact is suspected as the structure is considerably far away from the project corridor. However, any unplanned construction activities may create impact (such as dust pollution, waste generation, noise pollution, etc.) during the construction phase.

Source: Cultural Asset/Historical Importance/Archaeological Survey, 2022

There are several guidelines (such as US FTA, Indian CMRI) for vibration impact assessment. As per the guidelines of United States Federal Transit Administration (USFTA), standard for "extremely susceptible to vibration" is 90 VdB which reflects that any such structure within12.5m distance from the pier [typical pile driver (Sonic)] will have impact. It means, vibration generated during construction will not affect any extremely susceptible monuments/historical structures located at 12.5 meters or more from the pier. None of the 03 identified/listed monuments finally considered is within the 12.5 m/less distance from Line-5N corridor except Mazar of Shah Md. Abdus Samad Bangalai Wayeshi [which is 10.44 m from the nearest pier (pier No 14) according to the pier position plan]. The mazar is said to have been built in 1983, and the structure is modern with non-architectural design. As per same US FTA, for non-engineered masonry building, the limit of allowable vibration is 94 VdB (0.2 in/sec PPV [Peak Particle Velocity])

Considering the structure type and construction materials used, US FTA standards for non-engineered masonry building is more relevant to the Mazar of Shah Md. Abdus Samad Bangalai Wayeshi. As shown in Table 6-15, the vibration generated from sonic pile construction is 89 VdB at 10m distance. Therefore, it can be stated that the said monument has only minor susceptibility for vibrational impact [as it is made of modern and masonry structure] which can be further reduced by taking appropriate mitigation measures.

Mitigation Measures

- Environmental Contract Specifications (ECS) will recommend appropriate protection measures to avoid any harm to the structures of Mazar that the contractor must follow;

- Proper care should be taken during the construction work not to cause any damaging impact;
- High-level civil engineering technique(s) and modern construction methodology should be ensured during the construction stage to prevent any damage to the structures.

6.18.2 Operation Stage

There will be negative impact during the operation period as well if proper mitigation measures will not be taken. The mitigation measures indicated under the subsections 6.1, 6.2 and 6.3 are enough to avoid such negative impact during the operation phase. Due to the operation of MRT Line-5N, the connectivity will be improved for all these cultural heritages. So, there will be positive impact as well.

6.19 Local Conflict of Interest

6.19.1 Before/ During Construction Stage

In the construction phase, near the construction yard, accommodation camp, and depot area, there will be good opportunity of employment and business for local people. Also, many people will come from different district of Bangladesh for construction work. There will be migrant workers also from different countries. As a result, establishment of new business will take place at the construction sites. A positive impact on local economy will be occurred. But there might be chaos and conflict between the local residents and migrant workers. Separate security plan needs to be prepared and assured before starting of the construction phase.

Residual Impacts

There will be no residual impact after taking the mitigation measures.

6.19.2 Operation Stage

MRT Line-5N operation will enhance the development of the concerned area. The underground section will go through a developed area, while the elevated section will be in developing area. Although it is expected that the benefits of this MRT will be enjoyed by the people in catchment area without any discrimination.

6.20 Infection Disease

6.20.1 Before/ During Construction Stage

During the construction period, there will be accommodation camp for both the local staffs, workers and the migrant staffs and workers. So, there is a risk of increasing and spreading of infectious diseases in the accommodation camp and other sites also. An HIV prevention program has been prepared and included in the contractor's bid document. Also, a detail implementation guideline is now under preparation for contractor's use. Therefore, this risk is not significant.

6.20.1.1 Mitigation Measures

- The accommodation camp needs to be separated for the local and migrant workers;
- Security needs to be posted at the entry gate to avoid direct entry of the workers in other camp;
- Infectious disease related banner needs to be posted at the accommodation sites to create awareness among the workers;
- Training needs to be provided at regular interval to create awareness among the workers;
- All the staffs need to go for the medical test and infectious disease related test to prove them fit before joining to the sites;
- Checkup of the workers and staff at the regular interval.

Residual Impacts

After implementation of mitigation measures, the chance of spreading infectious disease will be rare. If such spread-out occur, then proper treatment and other benefits will be provided to the victims.

6.20.2 Operation Stage

In the operation period, official staffs will be limited and located at the station area and main depot area. So, there will be no possibility of spreading infectious disease as like as it is in the construction stage.

6.21 Working Condition

6.21.1 Before/ During Construction Stage

During the construction phase, there will be risk related to occupational health and safety in work sites due to the movement of heavy vehicles, work at height, depth and underground, handing of construction material etc. So, the impact will be significant if no mitigation measures are taken.

6.21.1.1 Mitigation Measures

To keep the work site safe, the following mitigation measures need to be provided

- All the staffs and members need to enter the site after taking induction training containing basic safety requirement, safety policy of the contractor and related environmental issue. The record of the induction training needs to be stored at site for further checking by the supervision consultant.
- Safety related mitigation measures need to be taken at sites. Detail safety management plan needs to be approved by the supervision consultant prior to start the construction work.
- Daily toolbox meeting needs to be conducted at sites to discuss about the safety issue of that day working activities.
- Regular workforce training needs to be provided at site.
- Safety related signboard needs to be posted at the required place to avoid any accidents.
- All the equipment should take permit to work before starting construction activities. The Safety department of both the Supervision Consultant and the Contractor will fix the items to be considered for the permit to work process.
- Daily inspection checklists need to be followed for the specific safety items (like first aid, fitness of the heavy equipment, fire extinguisher etc.).
- Maintenance record of the heavy equipment needs to be kept at site.

Residual Impacts

After implementation of mitigation measures, the chance of accidents will be minimized. If such accidents happen, proper treatment and compensation will be provided to the victims.

6.21.2 Operation Stage

During the operation phase, there will be possibility of accidents in the station area and office premises. Therefore, the impact is not significant. For avoiding such accidents, health safety plan will be adopted to ensure safety at work sites.

6.22 Gender

6.22.1 Before/ During Construction Stage

An updated RAP study is being carried out for depot area. There might be some women headed households among the affected households. The number will be known once the report is completed.

This project will contribute to women empowerment by creating employment opportunity for women. The project implementation agency will not do any discrimination between male and female employees. A Gender Action Plan (GAP) has been prepared. Some part is related to construction stage, some part is for design inclusion and some part will be implemented during operation.

6.22.2 Operation Stage

This project will contribute to women empowerment by creating employment opportunity for women in the operation phase also. A Gender Action Plan (GAP) has been prepared. Some part is related to construction stage, some part is for design inclusion and some part will be implemented during operation.

6.23 Children Rights

6.23.1 Before/ During Construction Stage

During the construction phase of the MRT Line-5N project, no under aged labor will be employed as per the condition of the local law. If the contractor and sub-contractor hire any under aged labor, compensation will be given to stop his/her work or compensates his family for starting a local business. Due to resettle for elevated section construction, children may be displaced along with their families. The vulnerable family will be taken care during RAP implementation. So, the project will not violate children rights. No additional mitigation measures are required in this part.

6.23.2 Operation Stage

During the operation phase, the children will be benefitted as they can move easily from one place to another for their education. So, the project will bring positive impact to the children.

6.24 Misdistribution of Benefits and Damages

6.24.1 Before/ During Construction Stage

The number of damages due to the project activities is negligible. Therefore, the people will not be deprived from their benefit. The RAP study is under preparation. The affected people will get benefit as per Land Acquisition and Requisition act 2017 and JICA guideline.

6.24.2 Operation Stage

During operation phase, there will be no damages. No impact has been expected. So, no mitigation measures are required.

6.25 Indigenous and Ethnic Minority People

6.25.1 Before/ During Construction Stage

From the previous RAP study, there were no existence of the indigenous people or the ethnic minority people along the MRT alignment and the Depot area. So, no impact is assumed in the construction stage.

6.25.2 Operation Stage

There are no indigenous people in or around the project site. So, there will be no impact during operation phase. Therefore, no mitigation measures are required.

6.26 Land Use and Utilization of Land Resources

6.26.1 Before/ During Construction Stage

For depot development, land use pattern will change from existing fallow land and low lying area to developed area. As the depot will be within the confined area and additional land will not be required

therefore, impact on land use and land resources will be minimum. However, for avoiding such impact, proper compensation needs to provide to the affected people who are directly or indirectly depend on that land resources.

6.26.2 Operation Stage

New transportation system will enhance the development of Hemayetpur area which will enable them to get more benefit.

6.27 Global Warming

6.27.1 Before/ During Construction Stage

GHG will be released from vehicles and machineries during construction phase. But the impact is not so significant considering the overall traffic numbers in the city area. Regular maintenance of heavy vehicles, implementation of the mitigation measures under the Air pollution part will reduce the GHG emission as much as possible during the construction phase.

6.27.2 Operation Stage

The operation of metro rail will decrease the emission of greenhouse gas by reducing the numbers of conventional vehicles, e.g., bus, car, CNG rickshaw, etc.

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 baseline emission has been calculated considering the number of passengers of the project activity year, average trip distance, CO_2 emission factor of different vehicles, and share of passenger by transport mode. CO_2 emission factors and other considerations taken from the Traffic Demand Estimate (TDE) report and published sources from the web, including Automotive Research Association of India (ARAI), Department for Environment, Food and Rural Affairs (DEFRA), Government of United Kingdom and United States Environmental Protection Agency (US EPA). Power generation emission factors are taken from the Department of Environment. Energy is used for traction power, lighting, air conditioning and station equipment. Other simplifying assumptions were used in the analysis are as follows:

- 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 6-20 summarizes results of GHG emission reduction due to MRT line 5N operation in 2028, 2038, 2048 and 2058. Total CO_2 emission reduction has been calculated as 91,857 tCO_2/year in 2028 whereas project CO_2 emission/generation due to power consumption for MRT line-5N operation in 2028 is 88,283 tCO_2/year. Hence, net CO_2 reduction due to MRT line-5N operation will be 3,574 tCO2/year in 2028.

Similarly, the net reductions will be 47,237 tCO_2/year in 2038, 102,641 tCO2/year in 2048, and 130,149 tCO_2/year in 2058.

Table 6-20: Potential GHG Emission Reductions from Metro Line 5N

Component	Horizon Year			
	2028	2038	2048	2058
Average Trip Distance	7.11	7.95	7.97	7.99
Number of Passengers of the project activity years	313,749,009	474,226,173	609,768,173	745,559,772
Share of Passengers by Transport Mode (%)				
Motorcycle	4.21	4.58	6.06	8.13
Human Hauler	3.50	2.39	2.33	2.53
CNG	6.83	6.76	8.28	10.72
Car	6.21	7.69	8.37	9.60
Bus	79.25	78.58	74.96	69.02
Emission factor (gm/veh/km)	Motorcycle- 111, Human Hauler- 190, CNG- 190, Car- 242, Bus- 1200			
Emission factor (t-CO2/person.km)	Motorcycle- 0.000069, Human Hauler- 0.000033, CNG- 0.000083, Car- 0.000110, Bus- 0.000031			
Baseline CO_2 Emission (ton)	90,016	150,627	201,224	261,547
Power Requirement for MRT operation				
Traction power (MW)	132	164	164	239
Auxiliary Power (MW)	229	297	297	382
Total	361	461	461	621
Project CO_2 Emission due to Power Consumption				
Combined power emission factor (tCO_2/MW-hr)	0.67	0.67	0.67	0.67
CO_2 generated (MT/day)	242	308.9	308.9	416.1
CO_2 generated (T/annum)	88,283	112,738	112,738	151,866
Green House Gas (GHG) Emission Reduction Potential for Metro Line 5-Northern Route				
Baseline Emissions (t/day)	91,857	150,627	215,379	282,015
Project Emissions (t/annum)	88,283	159,975	112,738	151,866
Emissions Reduction (tons CO_2 eq per annum)	3,574	47,237	102,641	130,149

The summary is illustrated in the following **Figure 6-8**. Further information is given in **Appendix G**.

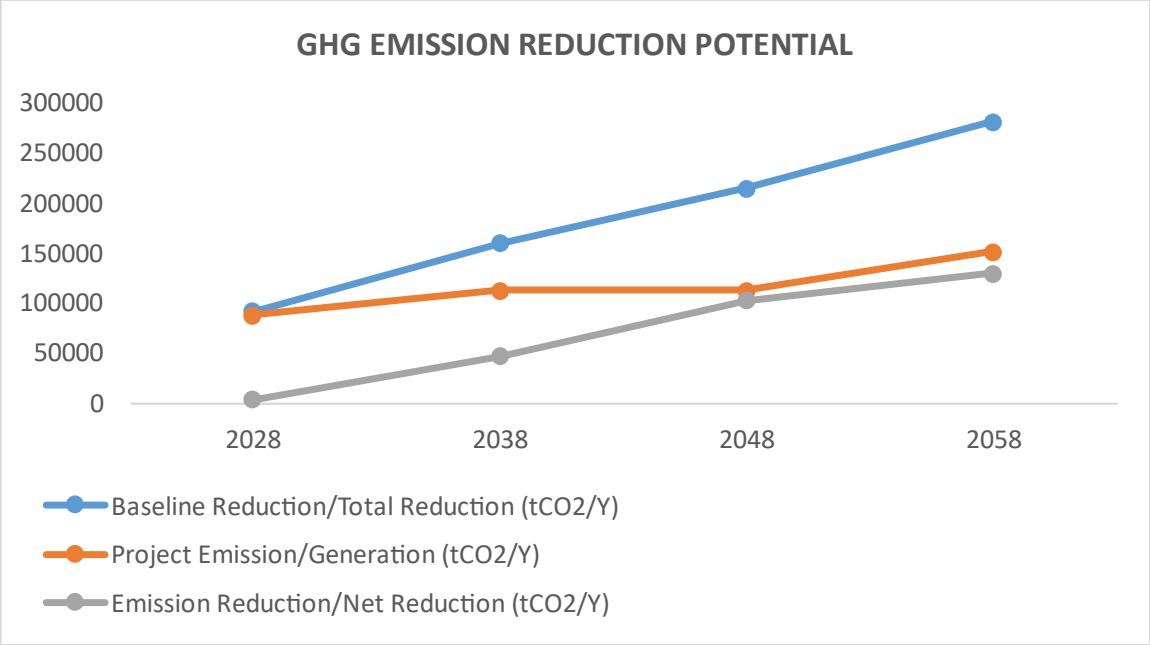


Figure 6-8: GHG Emission Reduction Potential

6.28 Traffic Congestion

6.28.1 Before/ During Construction Stage

The construction of MRT line 5N will interrupts the business as usual in terms of traffic congestion trough the alignment. Some probable impacts are listed below:

- construction works through the median of the road are likely to create traffic congestion
- temporary bottleneck may create during the construction of underground station
- movement of construction vehicles will increase the regular road traffic

6.28.2 Mitigation Measures

The following mitigation measures should be taken to avoid traffic congestion during construction period

- Traffic diversion throughout the alignment where possible
- Movement of heavy construction b=vehicles during the night time
- Preparation and implementation of the traffic management plan

Residual Impacts

After effective implementation of the mitigation measures, most of the impacts in terms of traffic congestion is expected to be minimized.

6.28.3 Operation Stage

It is expected that the implementation of MRT line 5N will decrease the existing traffic congestion at a large-scale during operation period.

6.28.4 Mitigation Measures

No additional mitigation measure is required.

6.29 Accident

6.29.1 Before/ During Construction Stage

There can be some sorts of accidents during construction as below:

- MRT construction requires works in elevated place such as work on the top of pier, girders and other height works;
- Traffic accident during the carrying construction material using the existing road;
- Heavy equipment's can bring on various significant accidents.

6.29.2 Mitigation Measures

The following mitigation measures should be taken to avoid accident during construction period

- Detail safety procedure needs to be prepared and followed for avoiding any kind of accidents during the construction stage;
- Proper safety training needs to be provided to the contractor and the sub-contractor;
- Continuous inspection needs to be ensured by the Employer and the Supervision Consultant to avoid any accidents;
- Before site works commence, a Traffic Management Plan for the construction phase needs to be prepared by the contractor and needs to be approved by the Supervision Consultant. The plan shall be designed to ensure that traffic congestion due to construction activities and movement of construction vehicles, haul trucks, and equipment is minimized. The plan needs to be prepared in consultation with local traffic officials and people's committees at the administrative and community levels. The plan shall identify traffic diversion and management, traffic schedules, traffic arrangements showing all detours, necessary barricades, warning/advisory signs, road signs, lighting, and other provisions to ensure that adequate and safe access is provided to motorists in the affected areas;
- Post traffic advisory signs (to minimize traffic build-up) in coordination with local authorities;
- As much as possible, schedule delivery of construction materials and equipment during non-peak hours;
- Regularly monitor traffic conditions along access roads to ensure that project vehicles are not causing congestion.

Residual Impacts

After implementation of mitigation measures, the chance of accidents will be minimum. If such accidents happen, proper treatment and compensation will be provided to the victims.

6.29.3 Operation Stage

The metro rail accident is rare in worldwide but it might happen. Fire is one of the risks, especially in stations. There will be automated sprinkler system to extinguish the fire in stations. On the other hand, all materials in the trains will be fireproof. Traffic accident will decrease because of the modal shift which will enhance the change from automobile to MRT.

CHAPTER 7

7 EVALUATION OF IMPACT

All positive and negative impacts on environmental and social components due to the MRT line-5N construction and operation have been discussed in section 6. Also, the proposed mitigation measures and residual impacts have been discussed elaborately. The evaluation of impact has been made in this chapter considering without mitigation measures and with mitigation measures. As like as the scoping matrix, each impact was evaluated based on a rating instead of numeric scale. Impacts are rated in A, B, C and D. The definition of the rating is same as depicted in section 5.2.

Some impact ratings of construction and operation period during the scoping stage have been changed after detail assessment in the EIA study. The evaluation of environmental impacts is expressed in the context of physical, natural and social environment and other points of view as assessed during the scoping stage. The evaluation matrix after detail assessment considering without mitigation and with mitigation along with scoping rating is presented in **Table 7-1.**

Table 7-1: Evaluation Matrix of Environmental Impact under MRT Line-5N

	Items of Impact		Impact Rating during Scoping Stage		Impact Rating after detail Study			
			Before/During Construction Stage	Operation Stage	Before/During Construction Stage		Operation Stage	
					Without Mitigation	With Mitigation	Without Mitigation	With Mitigation
Physical Environment	1.	Noise	A-	B-	A-	D	A-	D
	2.	Vibration	A-	B-	A-	D	B-	D
	3.	Air Pollution	A-	B+	A-	D	A+	-
	4.	Surface Water Pollution	B-	B-	A-	D	A-	D
	5.	Ground Water	B-	D	B-	D	B-	D
	6.	Soil Pollution	A-	B-	B-	D	B-	D
	7.	Waste	A-	B-	A-	D	A-	D
	8.	Ground Subsidence	C	C	B-	D	D	-
	9.	Offensive Odors	D	D	B-	D	D	-
	10.	Topography and Geology	D	D	B-	D	D	-
	11.	Landscape	B-	B-	B-	D	A+	-
	12.	Urban Drainage	B-	D	B-	D	D	-
Biological Environment	13.	Protected Area	D	D	D	-	D	-
	14.	Biota and Ecosystem	B-	B-	B-	D	D	-

	Items of Impact		Impact Rating during Scoping Stage		Impact Rating after detail Study			
			Before/During Construction Stage	Operation Stage	Before/During Construction Stage		Operation Stage	
					Without Mitigation	With Mitigation	Without Mitigation	With Mitigation
Social Environment	15.	Involuntary Resettlement	A-	D	A-	D	D	-
	16.	Local Economics	B-/B+	A+	B-	D	A+	-
	17.	Social Service facilities	C	C	D	D	A+	-
	18.	Cultural Heritage	C	C	B-	D	B-/B+	D/B+
	19.	Local Conflicts of Interest	B-	C	B-	D	B-	D
	20.	Infectious Diseases such as HIV/AIDS	B-	D	B-	D	D	-
	21.	Working Conditions	B-	D	A-	D	B-	D
	22.	Gender	C	C	B-	D	B+	-
	23.	Children Rights	C	C	B-	D	B+	-
	24.	Misdistribution of Benefits and Damages	D	B-	B-	D	D	-
	25.	Indigenous and Ethnic Minority People	D	D	D	-	D	-
	26.	Land use and utilization of local resources	B-/ B+	B+	B-	D	A+	-
Others	27.	Global Warming	B-	B+	B-	D	B+	-
	28.	Accidents	B-	B-	A-	D	B+	-

Note:

- A = Significant impact is assumed, B = Impact is assumed but less than A, C = Impact is not clear because the design is not finished and further survey is needed to confirm, D = No impact is little
- The scoping items are referred from JICA guidelines
  '+' and '-'signs indicate positive and negative impacts, respectively

An extensive mitigation measures will be taken during construction and operation stage for the MRT line 5N project as stipulated in section 6 of this report. As a result, during construction stage 8 significant environmental and social impacts will be reduced as no impact whereas 20 moderate impacts or less than significant impact will come as no impact. During operation stage, all significant or moderate impacts will not have any impact due to adoption of proper mitigation measures.

7.1 Evaluation of Positive Impacts

7.1.1 Impacts on Local Economies

New employment will be generated due to construction and operation of the project as the project will create substantial direct employment; more people would be indirectly employed in allied activities and trades.

Introduction of the metro rail project at Dhaka city will result in the reduction in number of buses and private vehicles. This, in turn will result in significant social and economic benefits due to reduction of fuel consumption, vehicle operating cost and travel time of passengers. With the development of the metro rail, it is likely that more people will be involved in trade, commerce and allied services.

7.1.2 Increase Business Opportunities

New business opportunity will be developed near the depot site that has positive impact to the life and livelihoods of the local community. In addition to this, it is expected that business opportunities will be created adjacent to the station area as a result of transit-oriented development.

7.1.3 Land use and Utilization of Local Resources

Most of the alignment of the project will be constructed at underground so there will be very few losses of the public land and other natural resources. So, the land will be used for other development activities.

7.1.4 Urban Area Decentralization

Implementation of the MRT line 5N will reduce the traffic congestion in and around the Dhaka city and will create easier transport facilities towards Dhaka outskirts. This will facilitate more people to live in the adjacent areas and thereby decentralize the urban area over time.

7.1.5 Technological Development

Technological Advancement like introducing cash-less transaction, exchange of technical knowledge, increase skill to handle such mega projects etc will be ensured through the implementation of MRT system.

7.1.6 Global Warming and Climate Change

Due to the operation of MRT Line-5N, it is expected that the modal shift and increase of travel speed will reduce the greenhouse gas emission. An estimation for GHG emission reduction potential for MRT Line 5N has been conducted considering the baseline emission and project emission. Section 6.27.2 shows that total in 2028 total 91,857 tCO_2/year CO_2 emission will be reduced whereas project CO_2 emission/generation due to power consumption for MRT line-5N operation in 2028 is 88,283 tCO_2/year. Hence, net CO_2 reduction due to MRT line-5N operation will be 3,574 tCO2/year in 2028.

Similarly, the net reductions will be 47,237 tCO_2/year in 2038, 102,641 tCO2/year in 2048, and 130,149 tCO_2/year in 2058.

7.1.7 Air pollution

The maximum alignment of the proposed Metro Rail Line 5N project will be underground and train will be operated by electricity. No diesel or other fuel will be used. On the other hand, a large number of passengers will use the metro rail instead of other vehicle for movement. So, another vehicle will be reduced from the road that is run by diesel engine. So, the air pollution will be mitigated after construction of the MRT Line-5N.

7.1.8 Traffic Congestion Reduction

There will be reduction in road traffic due to the operation of metro rail project. The numbers of vehicles are increasing day by day in Dhaka city. Traffic jam also increases with the increase of vehicles. People have great interest in the metro rail project. After completion of the project, a large number of people shift from road vehicle to proposed metro rail project. So, traffic congestion will be reduced at the operation phase of the project.

7.1.9 Mobility and Safety

The development project will reduce the journey time of the passenger. The project will also provide improved safety and lower number of accidental deaths and injuries of the passenger.

7.1.10 Gender

This project will contribute to women empowerment by creating opportunity of employment for women in the operation phase also. The project implementation agency will not do any discrimination between male and female employees. It is expected that some seats will be reserved for women passengers which is still under the planning stage.

7.1.11 Tourism

There will be some positive impact on local tourism due to introduce Metro Rail. MRT Line 5N will provide a safe, smooth and reliable transport to the tourist as well as reduce the travel time.

CHAPTER 8

8 ENVIRONMENTAL MANAGEMENT PLAN

8.1 Introduction

The Environmental Management Plan (EMP) is prepared for all the identified environmental impacts as specified in Chapter 6 during pre-construction, construction and operation stages. The EMP outlines mitigation and monitoring requirements that will ensure compliance with the GOB environmental laws and regulations and comply with the JICA Guidelines for Environmental and Social Considerations. This section documents the EMP for the project and contains the overall institutional framework, project level institutional framework, environmental mitigation plan, environmental monitoring and management plan, compliance and grievances and EMP reporting.

8.2 Overall Institutional Framework

As per the MRT Line-5N project organogram, there is a position of Additional Project Director (E&HS, LA and Resettlement). Under him, there are positions of Deputy Project Director (E&HS), Deputy Project Director (LA and Resettlement), Assistant Project Director (E&HS)., and Assistant Project Director (LA and Resettlement). This section of DMTCL will monitor and coordinate all environmental related activities.

8.3 Environmental Management Plan

Environmental management is essential to ensure that impacts identified are prevented and mitigated by the Environmental Management Plan (EMP). The EMP includes measures to address the potential impacts listed above that will be implemented during the construction stage of the project. The implementation of the EMP shall be monitored to ensure overall potential environmental and safety impacts that are readily avoidable and can be easily mitigated by adopting good engineering practices.

DMTCL and other relevant authorities will be involved in auditing project performance and will receive copies of monitoring reports. The Department of Environment will also be involved in monitoring activities. These agencies/institutions may also request an increase in frequency of monitoring as they deem necessary. **Table 8-1** summarizes the proposed mitigation measures and budget and responsible agencies of management.

Table 8-1: Environmental Management Plan

Project Activities	Environmental Impacts	Proposed Mitigation Measures	Budget	Institutional Responsibilities	
				Implementation	Supervision
PRE-CONSTRUCTION STAGE					
A. Environmental Management Plan for tunnel/elevated track/depot					
1. Project information	Disclosure of project information	• Prior to start site works, local residents and establishments, local authorities and other stakeholders who are likely to be affected by the project shall be informed about the construction schedule and activities, potential environmental impacts and mitigation measures through public consultation.	Included in consultant's scope	DMTCL, General Consultant	DMTCL
2. Land acquisition and resettlement	Loss of land and homestead	• Provide proper compensation in accordance with Resettlement Action Plan (RAP) • Engage NGOs for implementation of RAP • Establish Monitoring Unit	Estimated by RAP	DC, DMTCL	DMTCL
3. Cutting trees at depot site, elevated section and station area	Loss of vegetation	• Creating green ground cover by planting of ornamental shrubs below the elevated track/viaduct. A list of recommended tree species for planting in the median strip beneath the viaduct can be found in • Table ***6-18*** under section 6.14.1. • Tree plantation should be conducted in the Project Corridor.	Estimated by RAP	Compensation by the RAP implementation agency and Plantation by the Contractor	General Consultant, DMTCL
4. Specific management plan shall be	Hazard at work places and ambient	Prior to start of site works, Construction Environment Management Plan (CEMP) in the form of the following specific management plans shall be prepared by the	Included in contractor's scope	Contractors	General Consultant, DMTCL

Project Activities	Environmental Impacts	Proposed Mitigation Measures	Budget	Institutional Responsibilities	
				Implementation	Supervision
prepared by the Contractor and shall be submitted to the Supervision Consultant prior to stat works		contractor and shall be submitted to the project Supervision Consultant for approval: **Dust Control Plan:** The plan will include details information of mitigation measures about specific location, mitigation measures to minimize the adverse impacts of sensitive receptors (residential areas, Mosque, Graveyards, Educational Institutions, Hospitals etc.) due to construction works, sourcing and transport of construction materials and other project related activities; **Noise Control Plan:** The plan will include detail information about specific location, mitigation measures to minimize the adverse impacts of sensitive receptors (residential areas, Mosque, Graveyards, Educational Institutions, Hospitals etc.) due to construction works, sourcing and transport of construction materials and other project related activities; **Waste Management Plan:** The plan shall include details on responsibilities, resources, documentation and reporting requirements, training of relevant staff, etc. to avoid contamination from various specific wastes (recyclable waste, construction debris, combustible waste, hazardous substances, food waste, etc.), and shall also include how to respond effectively when such incidents occur. **Spoil Management Plan**: The plan shall include details of procedures, responsibilities, resources, documentation and reporting requirement, training provision for relevant staff etc. to manage spoil.			

Project Activities	Environmental Impacts	Proposed Mitigation Measures	Budget	Institutional Responsibilities	
				Implementation	Supervision
		Traffic Management Plan: The plan shall be designed to ensure that traffic congestion due to construction activities and movement of construction vehicles, haul trucks and equipment is minimized. The plan will be developed after completion of consultation with the local community in the project area. **Occupational Health and Safety Plan**: The occupational health and safety plan will include all construction activities (e.g. excavations, working at heights etc.), establishment and operation of construction/workers camps, use of heavy equipment, transport of materials and other hazards associated with various construction activities. **Emergency Response Plan:** An emergency response plan will be developed to prevent, mitigate, respond and recover from emergency situation that could occur due to project activities such as accidents, spills of hazardous substances, fire, extreme weather events and other crisis			

Project Activities	Environmental Impacts	Proposed Mitigation Measures	Budget	Institutional Responsibilities	
				Implementation	Supervision
5. Start of site works	Lack of mechanism to resolve environmental complaints due to project implementation	Prior to start site works, DMTCL shall undertake the following: • Establish a Grievance Redress Mechanism (GRM); ➢ Establish a 24-hour hotline and publicized for complaints; ➢ Establish several Complaints/Suggestions box in the construction sites. • Place the contractor and DMTCL representative's name and contact numbers on the notice board outside of the construction sites.	During pre-construction period, it will be included in contractor's scope.	Contractor (construction stage)	General Consultant, DMTCL
CONSTRUCTION STAGE					
A. **Environmental Management Plan for underground Tunnel/Elevated Track/Viaduct/Depot**					
1. Tunnel Construction	Spoil disposal, material stockpiles, and dust	• Strictly implement approved Spoils Disposal plan; • The disposal sites will be cleaned and then treated so that leached water does not contaminate the ground water; • Material will be stabilized each day by watering or other accepted dust suppression techniques; • The height from which soil will be dropped shall be minimum practical height to limit the dust generation; • The stockpiling of earth in the designated locations with suitable slopes; • During dry weather, dust control methods such as water sprinkling will be used daily especially on windy, dry day to prevent any dust from blowing;	Included in contractor's scope	Contractor	General Consultant, DMTCL

Project Activities	Environmental Impacts	Proposed Mitigation Measures	Budget	Institutional Responsibilities	
				Implementation	Supervision
		• Sufficient equipment, water and personnel shall be available on dumping sites at all times for dust suppression; • Dust control activities shall continue even during work stoppages; • The spoil shall be filled in the dumping site in layers and compacted mechanically. Dumping sites on sloping ground shall be protected adequately against any possible slide/slope failure through engineering measures; • If possible, use the spoil soil for development work surrounding the Dhaka city as well as brick kiln as there are lots of brick field near to the Dhaka city.			
2. Pier excavation works	Spoils generation from pier excavation works	• Strictly implement approved Spoil Disposal plan; • Spoil disposal only at the approved areas; • Trucks transporting spoils shall be tightly covered with suitable materials to minimize dust emission and spills; • Wheel washing shall be undertaken to remove mud to ensure that access road is kept clean; • Road surfaces shall be regularly cleaned of spilled spoils.	Included in contractor's scope	Contractor	General Consultant, DMTCL
3. Air quality at the time of construction	Air quality impacts due to gaseous and dust emissions	• Strictly implement approved dust control plan; • Wherever possible, use electrically-powered equipment; • Construction equipment and vehicles shall be well-	Included in contractor's scope	Contractor	General Consultant, DMTCL

Project Activities	Environmental Impacts	Proposed Mitigation Measures	Budget	Institutional Responsibilities	
				Implementation	Supervision
		maintained and shall meet national DOE emission standards; • Store excavated materials outside road reserve, but where there is no area, spoils shall be loaded and transported immediately; • All vehicles shall have their engine turned off while parked on the site. Batching plant sites and their ancillary areas shall be frequently cleaned and watered to minimize any dust emissions. • Clean up debris/spoils falling from construction equipment and vehicles on the road; Undertake daily cleaning of paved routes around the pier construction sites; • Impose speed limits on construction vehicles to minimize road dust in areas where sensitive receptors are located; • Provide prior notification to the community regarding schedule of construction activities; • Suppress of dust by spraying water at required interval.			
4. Noise and vibration at the time of construction	Noise and vibration impact due to operation of construction equipment and other activities	• Strictly implement approved Noise Control Plan; • Erection of temporary walls/ noise barrier around the underground and elevated station construction sites and other construction sites; • All construction equipment and vehicles shall be well	Included in contractor's scope	Contractor	General Consultant, DMTCL

Project Activities	Environmental Impacts	Proposed Mitigation Measures	Budget	Institutional Responsibilities	
				Implementation	Supervision
		maintained; • No noisy construction –related activities will be carried out during night and prayer time; • As much as possible, use quiet equipment and working method; • Provide prior notification to the community regarding schedule of construction activities, and if needed, carry out prior consultations; • Noise and vibration level monitoring shall be conducted periodically; • For workers who work with excessive noisy machines such as piling, explosion, mixing, etc., ear plagues should be provided for noise control and workers' protection. • The surveillance and monitor of local residents shall be carried out periodically. When a complaint arises from them, additional conservation measures shall be taken; • All equipment, engines and motors shall be equipped with proper silencers or mufflers during construction. •			
5. Surface water pollution at the time of construction	Surface water pollution due to the construction activities	• Adequate sanitary and drainage facilities in the temporary colonies of the construction workers; • Maximum rainwater harvesting and minimum use of existing water sources for construction will be ensured;	Included in contractor's scope	Contractors	General Consultant, DMTCL

Project Activities	Environmental Impacts	Proposed Mitigation Measures	Budget	Institutional Responsibilities	
				Implementation	Supervision
		• Provide sediment trap to reduce sediment load in construction wastewater; • Water quality parameters will be monitored during construction period on regular basis. • Avoid activities that may cause pollution to surface water of ECA sites (Turag river and Gulshan-Baridhara lake). If unavoidable, take necessary permission prior to start work from the competent authority. • The fuel storage and equipment maintenance yard should have weather/rain protection and should be on concrete pads to prevent dripping and leaking oils from entering the water bodies via surface runoff. • If possible, please prepare a site-Specific Management Plan before starting the work at Turag river and Gulshan-Baridhara lake since they are ecologically critical area.			
6. Placement of materials	Drainage obstruction	• Placement of construction materials, excavated spoils, equipment shall not block flow of rain water into drainage structures • Regular inspect and maintain all drainage channels • Prohibit disposal of waste materials to drainage channels; • In case existing drainage ditch is filled up as required for the construction works, provide alternative drainage for rainwater; • Protect natural slopes of drainage channels to ensure adequate stormwater drains.	Included in contractor's scope	Contractors	General Consultant, DMTCL

Project Activities	Environmental Impacts	Proposed Mitigation Measures	Budget	Institutional Responsibilities	
				Implementation	Supervision
		• Regularly inspect and maintain all drainage channels to alleviate any drainage congestion problem.			
7. Solid waste	Generation of solid wastes	• Separate solid waste into hazardous, non-hazardous and reusable waste streams and store temporarily on site • Undertake regular collection and disposal of wastes to sites approved by authority • Disposal site and method of treatment must be inspected and confirmed to prevent the secondary environmental pollution	Included in contractor's scope	Contractors	General Consultant, DMTCL
8. Closure of median lanes for traffic	Traffic congestion and access problems	• Prepare a traffic management plan and strictly implement the approved Plan; • Provide signs advising road users that construction is in progress and that the road narrows to one lane using cones; • Employ flag persons to control traffic; • As much as possible, lifting and placing of the pre-cast pier and viaduct sections will be done at night to minimize traffic congestion; • Use traffic cones to direct traffic to move to the open lane.	Included in contractor's scope	Contractors	General Consultant, DMTCL
9. Working Environment	Hazards to health and safety of workers and the public due to operation of viaduct and tunnel facilities	• Implementation of Occupational health and safety plan; • Implantation of emergency response plan; • Appointment of Environment, Health and Safety	Included in contractor's scope	Contractors	General Consultant, DMTCL

Project Activities	Environmental Impacts	Proposed Mitigation Measures	Budget	Institutional Responsibilities	
				Implementation	Supervision
		Manager; • Conduct orientation of construction workers on safety; Keep camps in good order and proper safety on construction sites • Provide firefighting equipment at working site; • Provide fencing of all areas of excavation and construction sites			
10. Land Subsidence/ Landslides	Tunnel construction as well as underground station construction work may lead to landslides or ground subsidence if any accident happens.	• According to the feasibility study, RC segment will be used in the underground section. The D-wall method will be used for construction of the underground station. Closed type machines like Earth Pressure Balanced (EPB) shield machine and Slurry Shield machine are to be considered during construction of tunnel section to reduce the risk of landslides.	Included in contractor's scope	Contractor	General Consultant, DMTCL
11. Hazardous waste		• Make available Material Safety Data Sheet (MSDS) for chemicals and dangerous goods on-site. • Manage solid waste according to 3R policy, Reduce Reuse, and Recycling, • Provide a garbage disposal service such that no garbage and food waste is dumped in the contractor's yard or work camp at any time. There should be no litter or food scraps dumped anywhere but in appropriate bins that are collected and cleaned at least weekly.	Included in contractor's scope	Contractor	General Consultant, DMTCL
OPERATION STAGE					

Project Activities	Environmental Impacts	Proposed Mitigation Measures	Budget	Institutional Responsibilities	
				Implementation	Supervision
A. Environmental Management Plan for Train Operation					
1. Train operation and maintenance of rolling stock	Noise emission and vibration from rolling stock and operation of elevated and underground station	• Noise barrier will be placed in the curve section; • Parapet wall will be installed along the track to reduce the noise level at the receptor point; • Vibration proof track will be installed throughout the underground section; • Optimal maintenance of rolling stocks; • At the station platform, paging and bell signaling volume shall be adjusted to the lowest level where it will not detract from their function; • Noise and vibration level monitoring shall be conducted periodically as long as the operation continues • The surveillance and monitor of local residents shall be carried out periodically. When a complaint raises from them, additional mitigation measures shall be taken • Grinding and other maintenance activities that will generate high noise level will be undertaken inside the maintenance sheds	Included in contractor's scope during construction period and DMTCL's budget during operation period	DMTCL	DMTCL
2. Cleaning of stations and depot activities	Solid waste and Wastewater generation	• Waste collection bins shall be provided • Garbage shall be collected regularly and disposed in designated places • Stations shall be provided toilet and other facilities • Wastewater shall be treated at the depot's industrial	Included in DMTCL's budget	DMTCL	DMTCL

Project Activities	Environmental Impacts	Proposed Mitigation Measures	Budget	Institutional Responsibilities	
				Implementation	Supervision
		treatment plant. The treatment facility shall be properly maintained • Drainage emanating from the depot workshops will be equipped with oil interceptors • Office building shall be provided with toilets and septic tanks to handle domestic sewage			
3. Working condition	Hazards to health and safety of workers and the public due to operation of viaduct facilities	• Implementation of Occupational Health and Safety Plan • Implementation of Emergency Response Plan • New buildings should be prohibited within 50 m of the edge of carriageway. No new schools and hospitals should be allowed within 200 m of carriageway	Included in DMTCL's budget	DMTCL	DMTCL
4. Emergency Situation	Health and safety of the passenger	• Occupational Health and Safety Plan for viaduct and tunnel operation and train staffs in the implementation of such plan; • Emergency response plan (e.g. in case of fire, extreme weather events, power outage, equipment breakdown, accidents etc.) covering operation of viaduct of above-ground stations and underground stations; • Ventilation system will be provided in the underground system; • Air compressors with fans will be used to cool air, before injecting it into the stations; • Air will be filtered prior to exhaust to the external environment; • Pumps will be installed into the tunnel and	DMTCL's budget	DMTCL	DMTCL

Project Activities	Environmental Impacts	Proposed Mitigation Measures	Budget	Institutional Responsibilities	
				Implementation	Supervision
		underground stations to pump storm water and waste water. Waste water treatment system will be installed at stations to treat sewage prior to discharge to the city system; • There will be provisions for sufficient emergency exits; • Backup electricity and ventilation systems will be installed in the tunnel sections; • Safety and evacuation measures in case of fire and other accidents (e.g., derailment, collision etc.) shall be developed prior to operation. • Provision of First-Aid facility in every stations.			
5. Water Supply	Water supply liability	• Train wash water and rain water shall be collected in underground storage tanks for recycling • Considering installation of back-up well in addition to the existing well	Included in DMTCL's budget	DMTCL	DMTCL

8.4 Environmental Monitoring Plan

Table 8-2 shows Environmental Monitoring Plan (EMoP) for construction and operation stages. During construction stage, in-house monitoring will be conducted by the contractors and supervised by DMTCL and General Consultant. The location of in-house monitoring will be selected based on ongoing construction works and consultant's requirements. The suggested parameters and locations can also be changed as per the requirements of the consultant. In addition to the in-house monitoring, contractor will also employ an Independent Monitoring Group (IMG) for monitoring on a quarterly basis. The number of monitoring locations and parameters for IMG monitoring will be in the line of EIA baseline study. During operation period, the number of monitoring locations are suggested based on the locations of EIA baseline study. The frequency of operation period monitoring will be once in a quarter.

Table 8-2: Environmental Monitoring Plan

Parameters	Locations	Means of Monitoring	Frequency	Budget BTD	Responsible Agency	
					Implemented by	Supervised by
DURING CONSTRUCTION						
A. Environmental Monitoring Plan for Tunnel/Elevated Track/Viaduct/Depot						
Air quality (PM_{10}, $PM_{2.5}$, SO_x, NO_x, CO, O_3)	As per construction activity and consultant's requirement	• Sample collection and laboratory analysis	Monthly or as per consultant's requirements	Included in contractor's scope	Contractor	DMTCL, General Consultant
Noise Level	As per construction activity and consultant's requirement	• Noise level collection and analysis	Monthly or as per consultant's requirements	Included in contractor's scope	Contractor	DMTCL, General Consultant
Vibration Level	As per construction activity and consultant's requirement	• Vibration level collection and analysis	Every day at CP-01 while working close to the boundary line, As and when required at other CPs.	Included in contractor's scope	Contractor	DMTCL, General Consultant
Water quality (DO, BOD_5, COD, pH, TDS, TSS, EC, oil and grease for surface water	As per construction activity and consultant's requirement.	• Sample collection and laboratory analysis	Monthly or as per consultant's requirements	Included in contractor's scope	Contractor	DMTCL, General Consultant

Parameters	Locations	Means of Monitoring	Frequency	Budget BTD	Responsible Agency	
					Implemented by	Supervised by
Waste	Depot, Construction Yard, Station Area, Pier construction area and Labour Camp	• Visual inspection at the depot area, throughout the alignment and station construction area • Transportation of waste • Check waste bin and storage area • Proper disposal practice of waste	Daily	Included in contractor's scope	Contractor	DMTCL, General Consultant
DURING OPERATION						
A. Environmental Monitoring Plan during Operation of Train						
Air quality (PM_{10}, $PM_{2.5}$, SO_x, NO_x, CO, O_3)	17 locations/as per EIA baseline locations	• Sample collection and laboratory analysis	Quarterly	Included in DMTCL's budget	DMTCL	DOE
Noise Level	23 locations/as per EIA baseline locations	• Noise level collection and analysis	Quarterly	Included in DMTCL's budget	DMTCL	DOE
Water quality (DO, BOD_5, COD, pH, TDS, TSS, EC, oil and grease for surface water	6 locations (near depot and mainline)	• Sample collection and laboratory analysis	Quarterly	Included in DMTCL's budget	DMTCL	DOE
	Treated water of ETP at Depot Area	• Sample collection and laboratory analysis	Quarterly	Included in DMTCL's budget	DMTCL	DOE
Waste	Depot and station area	• Auditing for waste bin, transportation arrangement and proper disposal practice	Monthly	Included in DMTCL's budget	DMTCL	DOE

8.5 Reporting

The Environmental Construction Specifications (ECS) will be prepared based on this EIA and EMP, which will have necessary instructions and provisions to implement environmental compliance measures by the contractors and it will be incorporated into contract document. Supervision Consultant will check the work of the contractor based on ECS. A system of monitoring compliance based with environmental mitigation measures will be set out prior to mobilization of construction which will conform to the general arrangement shown in **Figure 8-1.** The system provides periodic inspection, data compilation, and reporting of results. Consultant will prepare a quarterly monitoring report for DMTCL, JICA and DOE.

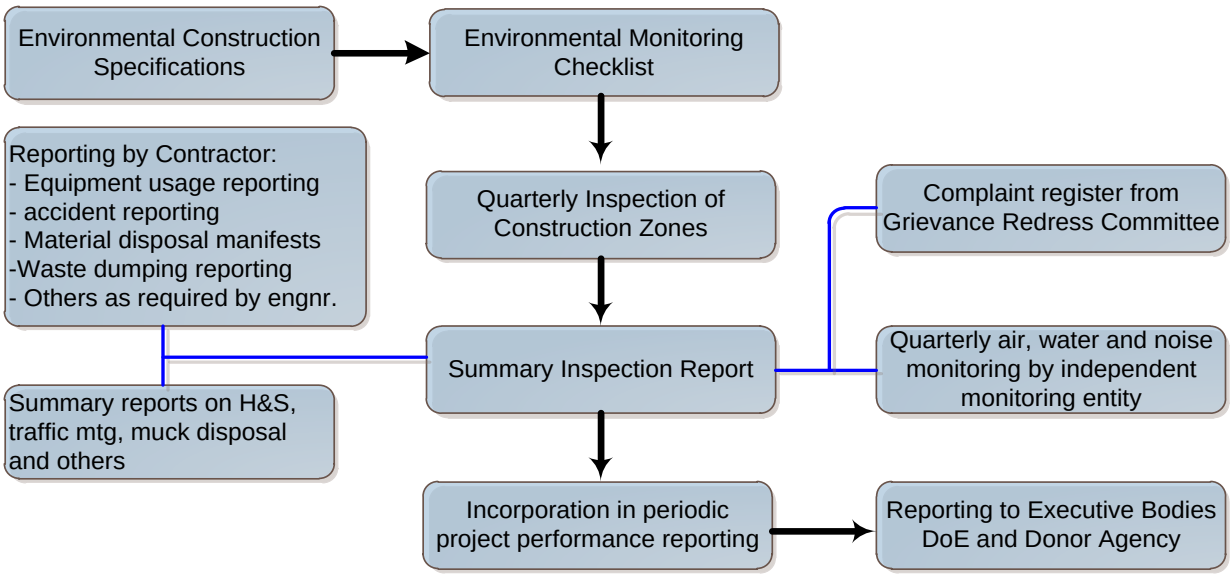


Figure 8-1: Flowchart for Environmental Monitoring and Reporting during Construction

Appropriate checklists will be used in inspecting compliance with mitigation measures. The main purpose of using checklists is to draw attention to requirements for pre-start up and the Contractor's Construction Environmental Management Plan (CEMP), the contract period, and completion stages. The checklists serve primarily as guides for reviewing performance to determine general compliance with broad indicators. The officials from ENV section of DMTCL, Consultant's Environment staff, and the Contractor's Environmental Management Officer (EMO) will review performance against selected indicators. Indicators may 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) Spoil disposal
i) Use of land for Construction Purposes
j) Protection of Community Values and other indicators selected for the work at hand.

CHAPTER 9

9 STAKEHOLDER CONSULTATION

The Guidelines for Environmental and Social Considerations of JICA require public consultation prior to starting the work in participation of project implementation authorities, beneficiaries, and project affected people. The main purpose of this consultation meeting is to inform people about the project and their potential environmental and social impacts and mitigation measures. Another purpose is to obtain their opinions regarding the implementation of the project.

9.1 Public Consultation Meeting

Two Public Consultation Meetings were held for MRT Line-5N project. **Table 9-1** shows the detail information of the meetings.

Table 9-1: Details of Public Consultation Meetings

PCM No.	Date and Time	Location	Catchment Area	Type of Participants
01	20.09.2021 10:30 AM	Pranto Party Center, Hemayetpur, Dhaka	Depot, Elevated section from Aminbazar to Hemayetpur and Underground section from Kochukhet station to Aminbazar	Project Implementation Authority, Consultants, Chairman of respective unions, Beneficiaries and Project Affected People, including teacher, businessman, shop owner, religious leader, representative from market association and hospital, senior citizen, service holder and local resident, etc.
02	26.09.2021 10:30 AM	Rosemary Restaurant, Madani Avenue, Vatara, Dhaka	Underground section from Banani to Notun Bazar, Elevated section from Notun Bazar to Vatara	Project Implementation Authority, Consultants, Beneficiaries and Project Affected People, including teacher, businessman, shop owner, representative from market association, religious leader, representative from hospital, senior citizen, local resident, service holder etc.

9.1.1 Public Consultation Meeting-1

First public consultation meeting held on 20 September 2021 at Pranto Party Center, Hemayetpur, Dhaka. A total of 144 person presented in the meeting from different groups. Detail of the meeting is as follows.

A. Overview of the Meeting

The objective of the meeting was to inform and obtain opinions of the public regarding the proposed MRT Line-5N, its potential environmental impacts and mitigation measures. The stakeholders and public were invited through invitation letters hand to hand. A list of stakeholders and the representatives of project implementation authority who were present at the meeting are given at **Appendix E**. Health safety measures considering the COVID19 pandemic have been taken for the PCM including body temperature measurement, hand sanitizing and mask distribution upon arrival of participants at the venue. A total of

144 person (male 130, female 14) participated in the meeting, including local residents (16), businessmen (70), teacher (2), religious leader (2), community leader (8), service holder (24) and sector specialist (22). The Project Director of DMRTDP (Line-5N) Mr. Md. Aftab Hossain Khan, was present in the meeting as chief guest. Mr. Mohammad Abdur Rouf (Joint Secretary), Additional Project Director (Environment, Health Safety, Land Acquisition and Resettlement) DMRTDP (Line-5N) presided the meeting.

Mr. Mohammad Abul Khayer, Deputy Project Director (Land Acquisition & Resettlement), DMRTDP (Line-5N), Mr. Syed Abdul Hafiz, Deputy Project Director (Civil, Depot) DMRTDP (Line-5N), Mr. Md. Badruddoza Shuvo, Assistant Project Director (Land Acquisition and Resettlement) DMRTDP (Line-5N), Mr. Kazuya KITAMURA, Acting Team Leader (MFCA), Ms. Anjuman Ara Rahman, Natural Environment Specialist (MFCA), Mr. Tonmoy Pandit, Junior Engineer, Natural Environment-1 (MFCA) were also present in the meeting.

B. Opening of the Meeting

The meeting was opened by reciting from the Holy Quran by a local Qari. Then Mr. Mohammad Abul Khayer, Deputy Project Director (Land Acquisition & Resettlement), DMRTDP (Line-5N) welcomed all participants and briefly explained the objectives and agenda of the meeting. After that, Mr. Mohammad Abdur Rouf (Joint Secretary), Additional Project Director (Environment, Health Safety, Land Acquisition and Resettlement) DMRTDP (Line-5N) delivered the welcome speech.

C. Presentation

Firstly, an animated documentary film was showed in the meeting which displayed the route alignment of MRT Line-5N, viaduct and tunnel design, elevated and underground station design, train design, entrance and exit design, etc. to give a clear idea about the project. Secondly, Mr. Kazi Farhed Iqubal from EQMS Consulting Ltd. presented the findings of the EIA updating study of MRT Line-5N. The presentation was divided into three parts. In first part, some key information about the project were presented. The second part was about the findings of EIA updating study, including the summary results of ambient air quality, water quality, and noise level monitoring. Finally, the potential environmental impacts and their mitigation measures were discussed.

D. Question and Answer Session

After the presentation, a question-and-answer session were held, which is summarized in **Table 9-2**. While many questions and opinions were raised by the participants, once their concerns were answered, nobody expressed any objection towards the Project. Mr. Md. Aftab Hossain Khan, Project Director of DMRTDP (Line-5N) answered all the questions.

He started answer giving session after getting all the questions from the participants. At start, he gave some overall summary and objectives of the project then answered the questions one by one Mr. Khan said that the present design of MRT line-5N will be more developed in coming days. He mentioned that, train will be available at every three and half minute and the traffic jam of Amin bazar will be easily avoided. He also mentioned that the surrounding environment will be examined first. Later, during construction stage environment degradation will be prevented by considering all the environmental parameters. These two will be main objective to improve the transportation facilities and to develop the environment by implementing metro rail, he added. Then he started to answer the question one by one.

Table 9-2: Summary of Question-and-Answer Session of PCM-1

No	Name	Question/Opinion	Answer
1.	Mr. Abdus Sobhan, Director, National Heart Foundation, Mirpur	He requested to change the location of Dar Us Salam Station of the MRT Line-5N. As the hospital is located at this place and maximum patients of the hospital are suffering from heart related diseases, he expects that changing the location of the station is necessary.	The Project director replied, as if the metro rail station locates near to the hospital, it will take short time for the ambulance movement as well as for the patients will find it easier to get the transportation. In addition, metro rail won't create any kind of environmental degradation to its surroundings since the station will be underground. So, he expects that station near the hospital would be more beneficial for the patients.
2.	Khandokar Mohidul Islam, Director, Dhaka Eye Hospital, Mirpur	One of the stations will be located at Mirpur 1 adjacent to the hospital. So, he requested to change the location of the station.	Mr. Khan replied that the station of this area wont damage the road since it will be underground. The station could be used by the hospital people and zoo going people, he added.
3.	Shilpi Sarker Assistant Head Teacher, Mirpur government Primary School, Amin bazar	If the school building damages, it will be difficult for them to shift the school location. She requested to change the alignment of the metro rail to avoid school building.	As per the design, MRT Line-5N will go underground before the school location. In construction period, there would be some minor problem but after that the school authority and the students won't fell any disturb due to the movement of Metrorail. Mr. khan added, still, we are looking for the pile foundation of school and will take all necessary measures so that the building will not get affected.
4.	Md. Al amin, Member, Bangaon Union Parishad	He wanted to know about the exact location of the MRT Line-5N.	Mr. Khan briefly discussed the alignment and replied that, the track will be on the left-hand side while going from Hemayetpur to Vatara.
5.	Md. Lutfur Rahman, Local Businessman	He welcomes the project taken by the Bangladesh government to improve the communication facilities. He also expressed his concern about the locals who earning their livelihoods from the business in that area for a longer period of time. He requested to consider the well and woe of the locals.	Mr. Khan replied that, owner or land user, all will be considered at the time of land acquisition. Under Resettlement Action Plan everyone will get the compensation as per the rules and regulations of Bangladesh. Mr. Khan also requested him to send a written statement to the DMTCL regarding this issue.

No	Name	Question/Opinion	Answer
6.	Mughal E Azam, Businessman, Mirpur 1 Market Association	Mirpur circle road has increased the beauty of the area. So, he requested to change the station location so that the area remain as beautiful as it is.	Mr. Khan replied, During the construction there will be some disturbance for short period, but once the underground construction completed, the environmental quality will be improved and the beauty will increase eventually.
7.	Md. Ismail Mollah, Councillor, Ward No13, DNCC	He said that, it's a very good news that we are going to enter the era of new technology. He wanted to know about the drainage system of the project area since a lot of people will be assembled in that area. If there is no proper drainage system, it will lead to an unhealthy environment. He exampled the case of Rokeya Sarani mentioning the construction of MRT-Line 6. In addition, he suggested to construct a station in front of the 60 feet road as the people of the ward 11, 13 and 14 have pass through this road and the medical, hospital, post office are situated in this location. He also requested to construct the hub spaciously so that traffic jam won't create. Finally, he requested to all to all to be more responsible.	Mr. khan replied that, multiple projects are ongoing in Rokeya Sarani area. Due to the lack of coordination, drainage problem has created. But this time, most of the work will be under the ground which will not create the same problem. Drainage system will be taken into considerations, he added. Three drains will be constructed so that the stagnant water can easily move through that and fall into the river. Also, if any problem arises the necessary action will be taken.
8.	Saiful Islam, Chairman, Bangaon Union Parishad	Due to the MRT Line-5N depot construction, east, west and north side of the depot will be blocked. So, he wanted a peripheral road so that the transportation facilities of this industrial area remain same. Also, he expressed his concern about the drainage system of the depot area.	Mr. Khan replied that a peripheral road with adequate space for vehicles would be constructed and there would be no obstruction during the construction phase so that people could move easily.

No	Name	Question/Opinion	Answer
9.	Mr. Mahbubur Rahman Murad, Hotel Businessman	He wanted to know about the businessman who have shops at that area. He asked whether they will get compensation for their business or not.	People those will be affected by the project will receive compensation as per the government rules.
10.	Mr. Abul Hosen Bullet, Local Businessman, Gabtoli	He wanted to know the depth of underground construction. He also asked regarding the possible effect on businessman of Gabtoli bus stand area.	Mr. Khan replied that, Metro rail are designed in a way that nothing will be damaged which is structured above the surface. He mentioned that, modern technology will be used to construct the MRT Line-5N. The maximum depth of underground construction will be near about 150 feet beyond the surface, he added.
11.	Mr. Topu Raihan, Shopkeeper, Hemayetpur	Since the businessman have to shut down their business at the construction period. He asked how they will pay the rent to the owner.	PD replied that if they fall under the project area, they will be compensated.
12.	Mr. Md. Abdullah, Imam, Masjid e Baitul Habib	He asked that, if the mosque need to demolish during the project construction, where it will be reconstructed and what will happen for Imam and Muezzin.	Mr. Khan example a similar incident of Amin Bazar Mosque and replied that, Mosque committee will get proper compensation to reconstruct a new and developed mosque.

E. Speech by the guest and Closing of the Meeting

The Project Director of DMRTDP (Line-5N) Mr. Md. Aftab Hossain Khan made a short speech after question-and-answer session. Then, Mr. Md. Saiful Islam, Chairman, Bangaon Union Parishad, Mr. Md. Ismail Mollah, Councillor, Ward 13, DNCC and Professor Khaleda Khnaom, former MP and Secretary of Jatiya Ondho Kallyan Samity delivered speech as a special guest. After that, Mr. Mohammad Abdur Rouf (Joint Secretary), Additional Project Director (Environment, Health Safety, Land Acquisition and Resettlement) DMRTDP (Line-5N) made the conclusive speech and declared the closing of the meeting. At the end, the participants were entertained with refreshment snacks.

9.1.2 Public Consultation Meeting-2

Second public consultation meeting held on 26 September 2021 at Rosemary Restaurant, Madani Avenue, Vatara, Dhaka. A total of 70 person from different groups was presented in the meeting. Detail of the meeting is as follows.

A. Overview of the Meeting

The objective of the meeting was to inform and obtain opinions of the public regarding the proposed MRT Line-5N, its potential environmental impacts and mitigation measures. The stakeholders and public were invited through invitation letters hand to hand. A list of stakeholders and the representatives of project implementation authority who were present at the meeting is given at **Appendix-E**. Health safety measures considering the COVID19 pandemic have been taken for the PCM including body temperature measurement, hand sanitizing and mask distribution upon arrival of participants at the venue. A total of 70 person (male 60, female 10) participated in the meeting, including Businessmen (10), Landowner (5), Teacher (2), Religious leader (2), community leader (2), service holder (31) and sector specialist (18). The Project Director of DMRTDP (Line-5N) Mr. Md. Aftab Hossain Khan, was present in the meeting as chief guest. Mr. Mohammad Abdur Rouf, Additional Project Director (Environment, Health Safety, Land Acquisition and Resettlement) DMRTDP (Line-5N) presided the meeting. Mr. Mohammad Abul Khayer, Deputy Project Director (Land Acquisition & Resettlement), DMRTDP (Line-5N) presented the meeting.

In addition, Mr. Md. Badruddoza Shuvo, Assistant Project Director (Land Acquisition & Resettlement), DMRTDP (Line-5N), Mr. Md. Nazmul Hasan, Assistant Manager, DMRTDP (Line-5N), Mr. Kazuya KITAMURA, Acting Team Leader (MFCA), Ms. Anjuman Ara Rahman, Natural Environment Specialist (MFCA), Mr. Tonmoy Pandit, Junior Engineer, Natural Environment-1 (MFCA) were also present in the meeting.

B. Opening of the Meeting

The meeting started with a brief introduction of the participants. It was opened by reciting from the Holy Quran by a local Qari. Then Mr. Mohammad Abul Khayer, Deputy Project Director (Land Acquisition & Resettlement), DMRTDP (Line-5N) welcomed all participants and briefly explained the objectives and agenda of the meeting. After that, Mr. Mohammad Abdur Rouf, Additional Project Director (Environment, Health Safety, Land Acquisition and Resettlement) DMRTDP (Line-5N) delivered the welcome speech.

C. Presentation

Firstly, an animated documentary on MRT Line 5: Northern Route was showed in the meeting which displayed the route alignment, viaduct and tunnel design, elevated and underground station design, train design, entrance and exit design, etc. to give a clear idea about the project. The second part of the presentation was regarding the EIA of the project and how the project impacts are planned to be mitigated. Mr. Kazi Farhed Iqubal from EQMS Consulting Ltd. presented the findings of the EIA updating study of MRT Line-5N like the previous PCM.

D. Speech from Special guest

Mr. Shafiqul Islam- councilor, ward no 39, DNCC and Ms. Nilufar Yeasmin Eti (female ward councilor, reserved) ward no 38, 39, and 40, DNCC gave their valuable speech. Both of them praised the project and hoped that it will create a sustainable transport system by reducing traffic congestion and environmental pollution. They see this as a symbol of development of the country.

Question and Answer Session

After the presentation, a question-and-answer session was held, which is summarized in **Table 9-3**. While many questions and opinions were raised by the participants, once their concerns were answered, nobody expressed any objection towards the Project. Mr. Md. Aftab Hossain Khan, Project Director of DMRTDP (Line-5N) answered all the questions.

Table 9-3: Summary of Question-and-Answer Session of PCM-2

No	Name	Question/Opinion	Answer
1.	Xavier Pererra, St. Vincent Church, Vatara	He asked, what will be the impact of the project during construction and how far will this affect from the road. He also asked, if anyone is affected due to the construction, will the government compensate for that or not.	Mr. Khan replied, in the Vatara section of the MRT line 5N, there is no activity that will create any vibration as it doesn't require land compaction. Any structure just beside the road will not be affected by the project.
2.	Afroza Haque, Barik brothers, Vatara	She wanted to know the duration of the project implementation (construction phase) in the Vatara section.	Mr. Khan replied, during the open cut of underground station, one side of the road might be closed for a while and normal car movements will be diverted to another way. Hence, it is unlikely to take more than six months to complete the procedure. In case of underground work, 01 year or more will be required but no effect will be there above the ground as thick steel sheet will be placed and traffic can be mobilized normally.
3.	Mr. Shahadat Hossain, PS to councilor, Ward 40, DNCC	He asked, whether there will be any land acquisition in Notun Bazar to Vatara elevated section or not?	Mr. Khan responded that, there is no need for land acquisition for building the track in Vatara section.
4.	Md. Zakir Hossain, Farazee Diagnostic Center, Vatara	He asked whether the MRT line 5N will affect their diagnostic center building or not. He also asked about the compensation package and relocation time if their building gets affected.	As previous, Mr. Khan said that no land acquisition is required for the Vatara section of MRT Line 5N. No structure near the road side is likely to be affected by the project construction work, he added.
5.	Shahadat Hossain Khandokar, Head Teacher, Solmaid High School, Vatara	He mentioned that the school is located 50 meters north from the 100 ft road. He wanted to know that, whether the construction activities of the project will impact the school or not?	During the construction of stations, downwards cut and drill will be required, which will create inconvenience for the people as one side of the road might be closed and vehicle movement might be diverted. He also said that, necessary mitigation measures will be taken during the construction phase.

No	Name	Question/Opinion	Answer
6.	Md. Imtiaz Chowdhury, UAE Moitri complex, Banani	Since the Banani station will be constructed in front of the market, he asked whether they have to shut down the market during the construction period.	Mr. Khan replied that, the underground stations will be constructed in open cut method where downwards drill will be required and after reaching certain depth, this will be covered up with heavy steel sheet so that the road can be used. However, during the of cut temporary diversion of road might be needed. No need to shut down the market, he added.
7.	Md. Faruk Ahmed, Landowner, Vatara	He wanted to know the location of Vatara Station.	Mr. Khan replied, the Vatara station will be located up to the gate of Bashundhara residential area. After the station a 200m track will be there but won't be used for carrying passenger, it will be used for parking train or moving the train.
8.	Mizanur Rahman Bacchu, Owner, City timber and Sawmill	He asked whether the elevated section of MRT Line 5N goes through the median or not. He opines that, if it goes through the median line, it will be better for the school, college, shops, hospital etc.	The authority will try their best to go through the median line of the road. Two sides of the track will be allowed for normal vehicle movement. However, some space will be required for the entry and exit of the trains, which will require some land acquisition. However, those land won't be any business entity or shop, he added.

E. Closing of the Meeting

The Project Director of DMRTDP (Line-5N) Mr. Md. Aftab Hossain Khan made a short speech after question-and-answer session. After that, Mr. Mohammad Abdur Rouf, Additional Project Director (Environment, Health Safety, Land Acquisition and Resettlement) DMRTDP (Line-5N) made the conclusive speech and declared the closing of the meeting. At the end, the participants were entertained with lunch.

9.2 Key Informant Interview (KII)

Series of consultation meeting has been conducted with school/college teacher, councilors of respective wards along the alignment. Besides, consultations are carried out with sectoral experts like environmental expert, transport expert, urban planner, archeologist, historian, disaster management expert. Details of the key informant interview with major stakeholders is given in **Table 9-4**.

9.3 Information Disclosure

As per JICA guidelines, information disclosure is required. JICA guidelines stated it could be disclosure meeting, public display of EIA document, web posting, etc. After finalization of EIA report, disclosure will be done in some form, and feedbacks will be incorporated in the final report.

Table 9-4: Details of Key Informant Interview

Date	Stakeholder Details	Issues Discussed	Stakeholder Observations	Response
18/08/2021	Thomas Mintu Bairagi Sr. Teacher Abinta Kabir Foundation School	Perception and viewpoint of the people about the project	The initiative by the government is obviously great considering the current transport system. This will have a positive impact in the overall development of the country There will be good impact of the project on the local community. People can easily move from Vatara to the western part of the Dhaka within a shortest period. This will save time, ensure more working scope, and contribute to local economy.	The observations were noted with thanks
		Perception regarding the environmental pollution in the current system	The vehicles on road today emits more polluting gases.	The observation was noted with thanks
		Please mention if the construction activities of the project are likely to contribute any pollution.	During the construction period, there will be dust, noise, road traffic, water congestion arising from project activities.	There will be mitigation measures taken to minimize these impacts as much as possible
		Do you think implementation of MRT system will reduce the environmental pollution?	This will reduce emission of pollution because vehicles will run less on the road.	The observation was noted with thanks
		Do you have any suggestions or comments or opinion that needs to be considered during the implementation of this project?	During the construction phase, there will be noise and the schooling will be hampered. So, the timing (8AM to 2.30 PM) of the school should be taken into consideration while working. Secondly, small children will move through the roads which requires a safe traffic management system during construction.	The construction work will minimize the impact to the highest possible level. During the school time noise will be reduced for construction work.

Date	Stakeholder Details	Issues Discussed	Stakeholder Observations	Response
				The authority will take the responsibility of traffic management in front of the school access point.
18/08/2021	Kazi Kawser Hossain General Manager Mohaimid Medical center	Perception and viewpoint about the project	The perception is very positive regarding the project as this will play a vital role in developing the overall transport system. No development can be done without some compensation but for the bigger cause it is needed. This is a good project as there is no need for land acquisition and resettlement in the area.	The observations were noted with thanks
		Current status of traffic jam in your area.	Like other places in Dhaka city	The observation was noted with thanks
		Please mention if the construction activities of the project are likely to contribute any pollution.	The progress the country is going to make through this project has more impact than the impacts of dust and noise generation for a short period of time.	Proper mitigation measures will be taken to reduce negative impact during the construction phase.
		Perception regarding the environmental pollution reduction with the project	The environment will be less polluted with metro rail.	The observation was noted with thanks
		Expectations from the project	It will add a new dimension to the country's development. Any kind of help will be provided for the project. As it is a JICA funded project, the implementation will be perfect.	The observation was noted with thanks
18/08/2021	Md. Abdur Rahim Assistant Head Teacher	Perception and viewpoint of the people	Good initiative by the government. The next generation will be benefited from the project.	The observations were noted with thanks

Date	Stakeholder Details	Issues Discussed	Stakeholder Observations	Response
	Solmaid High School	about the project	It is a good solution for the traffic jam in the city. It will be easier for the students to come to school easily. The teachers can commute within a short time. It will increase the overall mobility.	
		Current status of traffic jam in your area.	The current situation of the traffic is very bad. Most importantly the transport system itself throws a challenge for both teachers and students.	The observation was noted with thanks
		Please mention if the construction activities of the project are likely to contribute any pollution.	There will be generation of dust, noise, water congestion, road traffic. The authority should take the responsibility to mitigate these impacts	Dust and noise will be minimized by taking proper mitigation measure.
		Do you have any suggestions or comments or opinion that needs to be considered during the implementation of this project?	Proper implementation of the project on time.	The covid situation has impacted the timeline a little bit but the project aims to be finished within the given time considering the interruption.
18/08/2021	A.Z.M Rabbiul Hassan Rana Manager Standard Medical Center	Perception and viewpoint about the project	Overall perception about the project is good. More people will be able to travel in a short time.	The observation was noted with thanks
		Please mention if the construction activities of the project are likely to contribute any pollution.	The medical center is basically a medical test center for the people going abroad so the impact is relatively less than a hospital. Dust and noise will be an issue.	Proper mitigation measure will be taken.
		Expectations from the project	Reduction of traffic jam and travel time.	The observation was noted with thanks

Date	Stakeholder Details	Issues Discussed	Stakeholder Observations	Response
		Comments or opinion that needs to be considered during the implementation of this project	The entrance of the medical center should not be blocked during the construction. Noise should be reduced.	The access road to the medical center will be kept open during the construction. Noise reducing barriers will be given.
25/08/2021	Md. Nazrul Islam Ward Councilor Ward 40 DNCC	Perception and viewpoint of the people about the project	Good initiative by the government to go for underground MRT Line-5. This will make the development of the country one step ahead. It takes 1 hour to go to Gulshan from Vatara, the time will be reduced so it is a good initiate without any doubt.	The observation was noted with thanks
		Current status of traffic jam in your area.	Traffic jam is a common issue throughout the route including Pragati sharani and Gulshan.	The observation was noted with thanks
		How would the activities of the project affect the local community?	The local people will have positive impact by a smooth transport system. It will be good for the mass people.	The observation was noted with thanks
		Expectations from the project	Proper implementation of the project Maintaining the timeline. Reduce the problems during the construction phase as much as possible.	The Covid situation will affect the timeline a little bit but otherwise the project is expected to follow the timeline. As most of the construction is underground, public sufferings is expected to be less.

Date	Stakeholder Details	Issues Discussed	Stakeholder Observations	Response
		Any concern of the local Community that need to be communicated to DMTCL?	For underground track construction, a huge amount of spoil soil will be generated. How this will be managed is a concern.	As per the plan, the TBM method cuts into the ground and takes out the soils backwards simultaneously. Trucks will be used to carry those soils and the soil will be used for different development work.
25/08/2021	Jakir Hosen Ward Councilor, Ward No. 18, DNCC	Perception and viewpoint about the project	It's a great initiative by the government to construct a the MRT Line from Hemayetpur to Vatara. Already aligned in the MRT line-1, this project will enhance the transport system of this area to a new horizon.	The observation was noted with thanks
		Current status of traffic jam in your area.	Traffic jam will be reduced and people will enjoy less travel time to go from one end to another end of the city.	The observation was noted with thanks
		Please mention if the construction activities of the project are likely to contribute any pollution.	Generation of dust and noise during the construction of stations in the elevated section. This will also generate road traffic.	Proper mitigation measure will be taken during the constriction
		MRT system and reduction of environmental pollution	This is obvious that along with the reduction of traffic jam this project will also reduce the environmental pollution of the surrounding areas.	The observations were noted with thanks
		Do you have any suggestions or comments or opinion that needs to be considered during the	Any government project is well thought out and as this project is funded by JICA it will be well organized.	

Date	Stakeholder Details	Issues Discussed	Stakeholder Observations	Response
		implementation of this project?		
08/26/2021	Mofizur Rahman Ward Councilor, Ward No. 19, DNCC	Perception and viewpoint about the project	Having a knowledge about the MRT Line-1, the ward councilors are already aware of the project. It needs to be informed to the public about the project. The commuting time for a long-distance travel will be reduced with metro rail. Hopefully there will be good positive impact due to this MRT Line-5.	To inform the people in details there will be a public consultation meeting in Vatara. In that meeting brief information will be given by the DMTCL authority.
		Current status of traffic jam in your area.	Traffic jam is a common problem in Dhaka city. Hopefully projects like this will be able to mitigate that to a great extent.	The observation was noted with thanks
		Please mention if the construction activities of the project are likely to contribute any pollution.	Dust and noise will be generated from the construction phase.	Proper mitigation measures will be taken to minimize the impact
		Environmental pollution reduction by the MRT Line 5	It is obvious that the number of vehicles will be reduced if people use the metro rail. Eventually this will have an impact on the overall environmental situation. The noise will be reduced and reducing the number of cars will reduce the black smoke to be emitted into the environment	The observations were noted with thanks
		Suggestions or comments or opinion that needs to be considered during the implementation of this project	People always expect less suffer from any project. The timely completion of the project is of main concern. However, as this project will be underground in most of the route hopefully the problems will be less compared to the MRT line-6.	This project will be mostly underground construction with TBM method that will reduce the sufferings of the people. For this the budget of the project has

Date	Stakeholder Details	Issues Discussed	Stakeholder Observations	Response
				also increased but priority is given to the lessen the sufferings of the people.
		Any concern of the local Community that need to be communicated to DMTCL?	The timely management of the project is very important as this will facilitate the transport system and thereby ensure overall development.	The observation was noted with thanks
08/26/2021	Shafiqul Islam Councilor Ward 39, DNCC	Perception and viewpoint about the project	Good initiative by the current government to go for the underground MRT Line.	The observation was noted with thanks
		Do you think implementation of this project will reduce road traffic?	Traffic jam is severe issue in the Notunbazar Gulshan area. It takes around an hour or more to move through the Pragati Sharani. Implementation of this project will definitely contribute to the reduction of road traffic in this area.	The observations were noted with thanks
		What is your perception regarding the environmental pollution from the existing transportation system?	The current transport system of the city is polluting the environment with black smoke from the cars, buses. Also, the roads during the winter months generate dust.	The observations were noted with thanks
		Please mention if the construction activities of the project are likely to contribute any pollution.	During the construction activities in the elevated section there will be road dust, the construction site barrier will create traffic jam, the construction related vehicles and generators used in the site will emit polluting gases, noise will be generated from the activities.	The observations were noted with thanks
		Do you have any suggestions or comments or opinion that needs to be	During the construction phase there will be road traffic. The traffic management system has to be considered.	The observations were noted with thanks

Date	Stakeholder Details	Issues Discussed	Stakeholder Observations	Response
		considered during the implementation of this project?		
08/26/2021	Md. Ismail Mollah Ward Councilor Ward no 13, DNCC	What is your perception and view point about this project?	The experience of MRT line-6 is very bad as it hampered the life of the people living in this area badly for last 5 years. Skeptical about the project as how well it will be organized and implemented. However, as the line is going to be underground hopefully the sufferings will be reduced.	The MRT Line-6 was a new experience for Bangladesh. Learning from that project this time Line 5N is planned in a combination track of both underground and elevated to reduce the sufferings.
		Do you think implementation of this project will reduce road traffic?	This line will help reduce the traffic jam in the area.	The observation was noted with thanks
		Please mention if the construction activities of the project are likely to contribute any pollution.	As the amount of waste generated by the project will be huge in amount the proper management of the waste is a big concern.	Regarding the soil that will be out of the ground will be carried by trucks and low-lying lands around the city will be filled. So, the amount of waste should be minimized.
		Do you think implementation of MRT system will reduce the environmental pollution?	Reduction of cars will reduce the amount of pollutants in the environment when the train will be operating.	The observation was noted with thanks
		Any suggestion from your side	The stations should be spacious There should be provision in the stations for disabled people to move	MRT line-6 was the first ever experience for Bangladesh to enter into the elevated rail track, the

Date	Stakeholder Details	Issues Discussed	Stakeholder Observations	Response
			As people from Hemayetpur can take a stop in Mirpur 10 and take another route in the MRT line-6, a transport hub in the MRT system will help people commute in multiple directions. Restrooms, food and shops could be provided for people. The major focus should be the drainage management system. During the construction of MRT line-6, the whole drainage system of the area collapsed and people had to suffer a lot. This should be given top priority this time. The authority should be more accountable while implementing projects like this.	learnings from that project will be implemented in the coming projects. The suggestions will be definitely considered during the construction.
08/26/2021	Kazi Jahirul Islam Manik Councilor Ward no 3, DNCC	Perception and viewpoint about the project	This is a great initiative of Bangladesh government to construct another MRT Line which will be both elevated and underground. The underground construction will minimize the hassles of the people.	The observations were noted with thanks
		Perception regarding the environmental pollution from the existing transportation system?	The existing transport system generates huge amount of black smoke, noise, dust from the vehicles.	The observation was noted with thanks
		Please mention if the construction activities of the project are likely to contribute any pollution.	During the construction of the project there will be road dust, water congestion, traffic, noise, emissions from vehicles and generators. Concern is also there regarding soil that will be generated from the construction.	Proper mitigation plan is taken to reduce dust and noise pollution as well as traffic congestion. The soils will be carried by the trucks and fill the low-

Date	Stakeholder Details	Issues Discussed	Stakeholder Observations	Response
				lying areas adjacent to the city.
		Expectations from the project	The timely completion of the project is the main concern as numbers of lines is ongoing simultaneously. This should not create interruption in the daily life of people	The process will follow open cut method for the stations and for the underground trails TBM will be used.
		Suggestions or comments or opinion that needs to be considered during the implementation of this project?	The underground trail will be built close to the utility connections these especially the sewage line should be taken into consideration to avoid any unexpected spillage. There should be provision for further utility connections to be built underground e.g internet or electricity. Risk management plan for emergency.	The suggestion is very relevant and will be communicated to the responsible authority. Regarding the emergency situation such as fire hazard the system is designed to prevent any such disaster from taking place. Even after that there are hydrants and sprinklers to automatically function from the control tower during any hazard. There is also provision for pump out the water from the tunnel simultaneously.
08/29/2021	Murad Hossain Councilor Ward no 12, DNCC	What is your perception and view point about this project?	Heard about the project but not informed in detail. This is obviously going to be a good project that will help the people to travel from one side of the city to another within a very short time. People will use less car and the traffic situation will improve. This route is going to be more effective than the	MRT Line-5N is in detailed design phase and in the upcoming PCM, detail information will be provided.

Date	Stakeholder Details	Issues Discussed	Stakeholder Observations	Response
			other two lines and hopefully more passengers will commute through this route.	
		Opinion on implementation of this project and reduction of road traffic	Hopefully the project will improve the existing traffic system of the Dhaka City and also contribute to the country's economy.	The observation was noted with thanks
		Please mention if the construction activities of the project are likely to contribute any pollution.	There will be waste generation such as soil, how that will be managed is of a concern. Dust will be generated. There will be traffic congestion during the construction phase.	Proper mitigation plan is taken to reduce dust and noise pollution as well as traffic congestion.
		Implementation of MRT system and the reduction of the environmental pollution	MRT system will carry a large number of people so the need for the public transportation on the road will reduce. This can help phase out the outdated unfit vehicles from the road. Moreover, less vehicles will emit less pollutants to the environment.	The observations were noted with thanks
		Any concern of the local Community that need to be communicated to DMTCL?	The possibility of flood and ground subsidence need to be taken into consideration.	The project has already surveyed the areas and the utility survey is undergoing. A detail hydrological survey is ongoing.
09/07/2021	Akhter Mahmud Urban Planner Professor, JU Email: aktermahmud@juniv.edu	As an Urban Planner, what is your perception and view point about this project?	It would be more appreciated if the public transport system could be developed with less expensive alternatives. As experts, we didn't oppose during the construction of MRT Line 6 regarding the change in alignment because we wanted people to see something visible.	This project should lessen the problems and sufferings of people as most of the part will be underground.

Date	Stakeholder Details	Issues Discussed	Stakeholder Observations	Response
			As a densely populated country this kind of rapid transport system should have been introduced much earlier. The problem with the mega projects is that the project starts but the timely implementation is not seen in most cases. Though the ToR and the feasibility study done by the consultants had given proper guideline. The sufferings of people have to be taken very seriously. To minimize the sufferings the ToR needs to be implemented properly. For example, in Rokeya sharani people has suffered a lot due to water congestion and also dust and air pollution. For this particular project, good thing is that the construction will be underground. Overall, as a citizen of the country I am positive about the project	
		Do you agree that implementation of this project will facilitate the sustainable public transport system in Dhaka?	Agreed but two crucial points were mentioned 1.More priority should be given to bus route rationalization; transport hub should be disciplined with engineering solution. 2. Footpath should be given utmost priority considering that it is the way to connect people with different transport system.	The observations were noted with thanks
		DMTCL is planning to turn every multi-storey station and adjacent areas into income-generating	This is the only possible solution in the market economy. The investment might not be covered with the metro operation.	The observations were noted with thanks

Date	Stakeholder Details	Issues Discussed	Stakeholder Observations	Response
		commercial hubs under a transit-oriented development (TOD) system. Please comment.	If we want to people centric transport system, we need to give subsidy in ticket price, still this would be a viable solution. The commercial hub can be sold or rented to generate income.	
		For successful TOD Planning, what factors need to be considered?	To consider the radius of the TOD, it might not be possible to implement the TOD at once. It will be developed gradually. The transformation will be dictated by the market. However, if there is a plan or guideline on how to use both the plot and the land, it will give good results. Mixed land use sometimes gives birth to contradictory interest – it has to be very well thought. The land cannot be used for any purpose that might pose a risk afterwards. Because it will discourage small plots and encourage big plots – its profitable. Walking friendly TOD: road and footpath, plaza everything should create walking friendly environment for people. Only then people will be encouraged to use the metro, in such a way that people don't have to use car.	The shape of the TOD – might be square but not finalized yet
		Please mention if you have any concern/suggestion regarding the location of the station and depot area?	Station: It is such a route wherever station is built it will have people for travelling. Depot: The depot location is acting as water retaining area. When the land development will be started it will have an impact, in that case how to resolve the issue is a big concern.	The observations were noted with thanks

Date	Stakeholder Details	Issues Discussed	Stakeholder Observations	Response
		Please mention if you have any more concern or suggestion other than these?	• Open cut method station construction will create suffering. How to manage that is one of the concerns. • Soil management – concerned that the soil that will come from TBM even if the soil is sold to private land developers, they will have to carry it by trucks. Huge transport will be needed to complete the task. If it is not managed properly, it will be responsible for traffic congestion and dust pollution. • It has to be well designed beforehand • The implementation of the project should not be delayed • Reduce the suffering as much as possible • The contractor should obey the ToR properly. They follow them in other countries but reluctant in BD. • The clogging of the drainage system delinked of the drainage- why this has not been taken care of.	ECS will be in the bid document. This defines the supervision responsibility of various impacts during construction. Drainage: There was a problem in MRT line 6 regarding the drainage cleaning system due to the lack of coordination between the city corporation and DMTCL regarding cleaning of the drainage. Learning from MRT Line 6 will be implemented in MRT Line 5N.
09/08/2021	Ahsanul Kabir Transport Expert Professor, URP Discipline Khulna University	What is your perception and viewpoint about this project?	Positive	The observation was noted with thanks
		Do you think implementation of this project will reduce road traffic of Dhaka city?	Yes	The observation was noted with thanks
		Do you agree that MRT Line 5N project will facilitate the sustainable	Strongly Agreed	The observation was noted with thanks

Date	Stakeholder Details	Issues Discussed	Stakeholder Observations	Response
		public transport system in Dhaka?		
		The recent development of metro lines in Dhaka brings a prospect to integrate transport & land use through promoting transit-oriented development (TOD). What is your opinion.	Like anywhere in the world, MRT will introduce TOD in Bangladesh. We can observe that land price hike around the proposed stations along all possible routes of MRT in Dhaka. The problem I see for Dhaka is that people are not clear about TOD. RAJUK DAP has recommended height restrictions and allowed higher buildings around MRT. How is it going to happen? Are our connecting roads ready to support the TOD? Are we re-organizing the lower order of public transport to ensure integration?	It will be considered in the detail design
		Please mention if the construction activities of the project are likely to contribute any traffic issue.	Hugely. Highway between Gabtoli and Hemayetpur is very busy connecting Dhaka with south and northern district. If the construction cause disruption in traffic flow it will have severe impact on inter district transport. Only the other hand, it is likely to cause congestion and suffering at Mirpur, Banani, Gulshan and other nodes where MRT-5N is travelling through.	Since the elevated section of Aminbazar to Hemayetpur will be constructed at the northern side of the and will not use the median therefore, traffic congestion will not be a significant issue
		Please mention if you have any concern/suggestion regarding the traffic management during the	Providing signalized/manual traffic management is a must. Having construction on any road requires traffic management on the area not only that road. So, there should be a traffic management plan for each of the major node	A traffic management plan will be developed and followed accordingly

Date	Stakeholder Details	Issues Discussed	Stakeholder Observations	Response
		construction phase of the project.	(station/intersection). Traffic management will consider for one way, turn restriction, vehicle type control, parking, public transport re-routing, pedestrian safety, NMT management and safe public transport stoppage for waiting passenger.	
		Please mention if you have any more concern or suggestion other than transport issue.	• Integration with bus route and lower order public transport • Provision of parking. • Options for pedestrian accessibility (as people from 500-700m can come to MRT station by foot) • Avoid creating any dark spot around station or under elevated path • Ensure to use the place below elevated part. Cannot use for any use that brings traffic. But can be a garden, sculpture, display, weekend-library, enclosed play space etc.	These suggestions will be considered
09/08/2021	Prof. Dr. Ahmad Kamruzzaman Majumder Environmental Expert Professor, Stamford University Email: kamrul_sub@hotmail.com	What is your perception and viewpoint about this project?	Positive project, it's a dream project for people of Bangladesh. The most pressing problem of Dhaka city is traffic congestion, air and noise pollution that makes people want to leave the city. A survey on 800 people has resulted into this conclusion. The successful introduction of the Metro line 1,5, and 6, we can reduce traffic, noise, and air pollution. It is constructed for easy communication but in return we will get other benefits as well.	The observations were noted with thanks

Date	Stakeholder Details	Issues Discussed	Stakeholder Observations	Response
		Do you agree that MRT Line 5N project will facilitate the sustainable public transport system in Dhaka?	Agreed. It will make travelling from the north Bengal to Dhaka easy. It has been seen that people come to Hemayetpur /Gabtoli from the North in 4-5 hours and then from Gabtoli to Gulshan it takes more than 2 hours to reach. With metro it will be reduced to 30 minutes, so obviously it's a sustainable transport system.	The observations were noted with thanks
		What is your perception regarding the environmental pollution from the existing transportation system?	The existing vehicles and road related pollution contribute to 30% of the total air pollution. The utilities and service providing authorities do their work on road it adds up to the pollution by dust and noise generation. According to a study data, 560000 unfit cars are running on road and they are one of the emitters of pollutants. The existing system gives us many sources of air pollution which will be reduced with the implementation of MRT.	This is already under plan and will be considered during the implementation.
		Do you think implementation of MRT system will reduce the environmental pollution?	Soil management is a big issue, when it is not removed properly it generates dust and adversely affect the environment.	The observation was noted with thanks
		Do you have any suggestions or comments or opinion that need to be considered during the implementation of this project to safeguard the environment?	During the construction phase, noise will be there in the elevated section and in the stations. The noise barrier must be sufficient to avoid pollution. How earthquake resistant will the project be? If the rail is displaced what is the rescue planning. It should be communicated with the people.	As the project is in detailed design phase, the authority is taking necessary measure for earthquake plan very strictly It is not yet finalized

Date	Stakeholder Details	Issues Discussed	Stakeholder Observations	Response
		Please mention if you have any more concern or suggestion other than environment?	Waterlogging should be taken into consideration. Wherever the construction is going the roads are being narrowed. It is important to maintain the timeline for project completion. This will reduce human suffering. In the developed countries, the time of road occupancy of a project is written in signboards. If it can be practices in our country people will own the project. Delhi metro is enlisted as a CDM project, if this can also be done in the MRT line it will add value to the whole project.	This will be considered during the project implementation MRT Line 5N
09/09/2021	Dr. Md. Emran Jahan Historian Professor, JU Email: emran@juniv.edu	What is your perception and viewpoint about this project?	Positive	The observation was noted with thanks
		Is there any archeological or historical place in the vicinity of the project alignment?	There is no such as place as per respondent's knowledge	The observation was noted with thanks
		Do you think the construction activities of the project are likely to affect any archeological or historical place during the construction phase of the project?	In my knowledge, any kind of heritage site will not be affected by this construction project	The observation was noted with thanks
		If yes, what should be considered to safeguard the archeological or historical	N/A	The observation was noted with thanks

Date	Stakeholder Details	Issues Discussed	Stakeholder Observations	Response
		place?		
		Please mention if you have any more concern or suggestion other than archeological or historical issue.	There are no ancient and medieval structural sites in this project area, but modern structures especially Masjid and Temple can be there. So from my opinion, if it is possible, the project authority can arrange a visit from Hemayetpur to Vatara with an expert to explore if any modern structure is affected or not.	A cultural survey is ongoing to explore if any monument/ structure will be affected.
09/11/2021	Sikder Md Zulkernine Archaeologist Associate Professor, JU Email: zulkernines@juniv.edu	What is your perception and viewpoint about this project?	Positive	The observation was noted with thanks
		Is there any archeological or historical place in the vicinity of the project alignment?	There is no existence of a reported archaeological there. However, in Amin bazar there is a historical mosque. In Mirpur 10,11 there is Jalladkhana Bhoddhobhumi (Mass execution site) and also there is provision of building a liberation war museum. There is reserve location near Mirpur 10. Hemayetpur depot, there is plan for mosque. Cultural survey will enrich the knowledge. In general, Baliarpur, Amin bazar has some historical settlement.	There is a cultural survey ongoing which will cover this part.
		Do you think the construction activities of the project are likely to affect any archeological or historical place during the construction phase of the project?	There is possibility. Due to lack of seismic survey, we don't know what is in underground. This creates difficulty in rescue operation if there is any emergency. To make the country's historical places visible, it's important to demarcate the places. Mark them with	The project is doing a cultural survey to find out if there is any heritage site or monument along the alignment.

Date	Stakeholder Details	Issues Discussed	Stakeholder Observations	Response
			proper sign so that people are interested to know about the sites.	
		If yes, what should be considered to safeguard the archeological or historical place?	Seismic survey before any development work.	The observation was noted with thanks
		Please mention if you have any more concern or suggestion other than archeological or historical issue.	The archaeology is related to human being. The development work is also for the human beings. For a sustainable development, we need both cultural survey and environmental survey. It's important to keep the continuity to an inclusive project. Level of communication needs to be higher with local public.	A cultural survey is ongoing to identify if there is any heritage site or cultural monument along the alignment
13/09/2021	Syed Hafizur Rahman, PhD Disaster Management Expert Professor, Department of Environmental Sciences JU Email: hafizsr@gmail.com	Perception and viewpoint about this project	Positive. This kind of project will enrich the ongoing development of the country. However, the involvement of the city corporation from an early stage will help incorporate the urban planning in a better way.	There will be an involvement of city corporation
		Do you think that the Project mitigates climate change by bringing about a reduction in greenhouse gas emissions?	Yes. This project will surely mitigate GHG emission as the trains will run by electricity. As a result, the GHG emitted by the current transport system will be reduced significantly.	The observation was noted with thanks
		Is there any risk of natural or man-made disaster for the project?	There is always risk in these types of projects. The natural risks are flood, earthquake. There is a fault zone in Gabtoli. It is important to know how much consideration is given to this fact. Especially the consideration given to the extent of	The earthquake consideration for the project is magnitude 5 onwards

Date	Stakeholder Details	Issues Discussed	Stakeholder Observations	Response
			magnitude of earthquake is important such as for magnitude 5 onwards. In terms of manmade risk, the major one is fire.	
		As an expert, please mention what measures should be considered by DMTCL during detailed design to address natural disaster?	Forecasting the operational phase, car parking will be an issue that needs to be considered in the design phase. This will be determined, based on the population projection and direct how much area to be allocated for car parking in the station areas. The consortium will consider the environmental considerations. As the project lies in the urban areas, the demographic forecast of the areas needs to be considered. Along with this how much development will take place by the completion of the project that also needs to be considered. Flood and earthquake have been considered in the EIA. Soil excavation- the project will need large amount of soil excavation, how this will be managed is a matter of consideration. Along with this, greening in the design must be considered. How much plantation is kept in the design must be determined. Due to climate change water retention areas are lost. Since Hemayetpur is one of the water retentions zones and this will be filled for the project, an alternative way could be thought.	There will be plantation under the viaduct of small trees and grasses.

Date	Stakeholder Details	Issues Discussed	Stakeholder Observations	Response
			If there is a possibility of rainwater harvesting it will add value to the project, as this area is the recharge are for Dhaka city Any design must consider the projection of change in 10 years when the operation will start.	

CHAPTER 10

10 EMERGENCY RESPONSE PLAN AND DISASTER IMPACT ASSESSMENT

An outline of Emergency Response Plan (ERP) is given here in the EIA. During the implementation, Contractor and Consultant will also prepare a more detail version. A general plan is follows.

10.1 Disaster Management

Disaster is an unexpected event due to sudden failure of the system, external threats, internal disturbances, earthquakes, fire, and accidents. The first step is to identify the causes which develop/ pose unexpected danger to the structural integrity of Metro tunnel or overhead rail. The potential causes are excessive load, cracks, failure and malfunctioning of sensing instruments, accident, etc. These need to be investigated with care. A hydrological study is underway by BUET under the consultancy service to assess the flood impacts on the project. Necessary measures will be adopted as per the study. In station entrance and exit points, there will be elevated staircase (sample picture is added in **Figure 10-1** and **Figure 10-2**) to prevent rain or flood water entering into the underground stations. Moreover, there will be provisions of water pump at underground stations to withdraw water from tunnel.

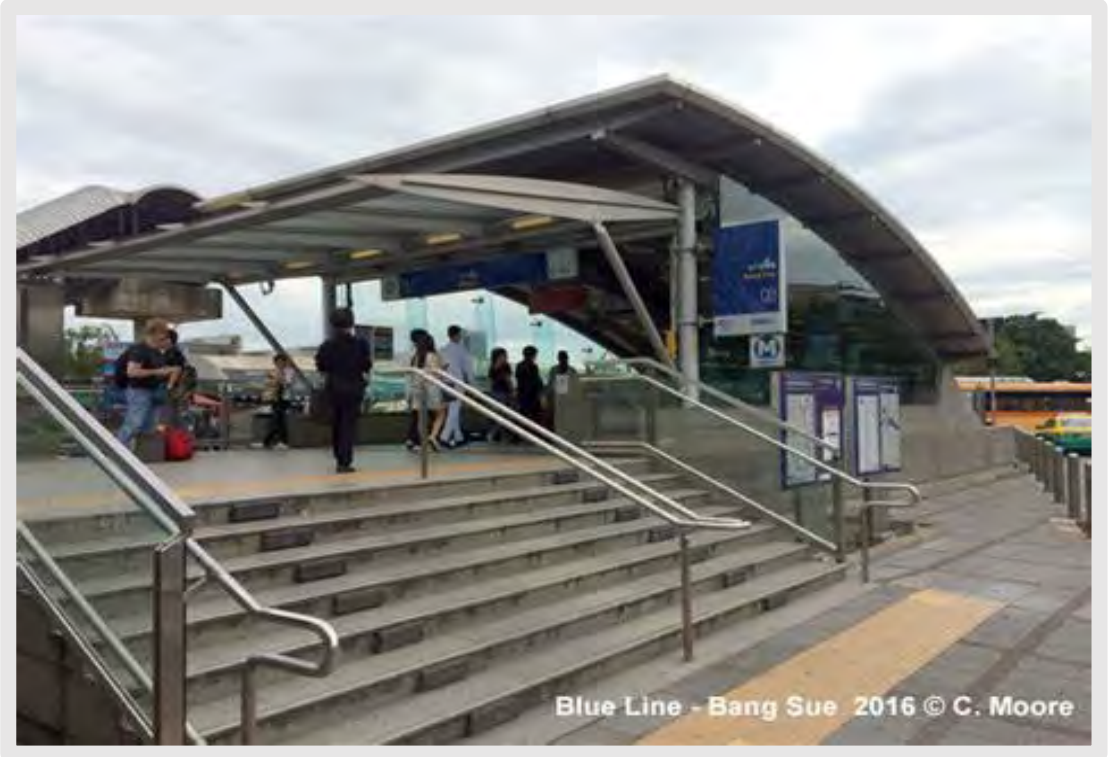


Figure 10-1: Elevated Start Point at Underground Station Entrance to Prevent Flood Water Entrance.

Figure 10-2: Flood Gate at the Entrance of Station

10.1.1 Preventive Action

Once the likelihood of a disaster is suspected, action must be initiated to prevent a failure. For preventive action, the Engineers should identify sources of repair equipment's, materials, labor, and expertise for use during emergency.

Reporting Procedures

The level at which a situation will be termed a disaster shall be specified. This shall include the stage at which the surveillance requirements should be increased both in frequency and details.

The Engineer-in-Chief should notify the officer for the following information:

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

10.1.2 Communication System

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

10.1.3 Emergency Action Committee

Mainline and Station

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

- Station Master concerned,
- Police Officer of the area,

- Dhaka Transport Coordination Authority Representative
- Dhaka Mass Transit Company Limited Representative
- Home Guard representative,
- Fire Brigade representative,
- Health Department representative,
- Department of Information and Publicity, and
- Non-Governmental Organization of the area.

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

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

Depot

An Emergency Action Committee will also be constituted in depot having the similar members mentioned for mainline and stations. This committee will also be assigned with similar works. Since the nature of works is different in depot than mainline and stations, a separate evacuation plan will be prepared considering the possible hazards that can occur in depot.

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

Success of an emergency plan depends on public participation, their response to warning notifications and timely action. It is essential to communicate by whom and how a declared emergency will be terminated. There should be proper notification to the public on de-alert signals regarding termination of the emergency. The notification should be clear so that the evacuees know precisely what to do when re-entering or approaching the affected areas.

10.2 Emergency Measures

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

10.2.1 Emergency Lighting

The emergency lights operated on battery power should be provided at each station. The battery system should supply power to at least 25% of the lights at the station, platforms, and tunnels/viaducts for a period of 2 hours. The underground station should have transformer at each end of the platform. Both the transformers need to be kept energized and should feed independently alternate rows of lights so that in

case of failure of one transformer, there will not be complete darkness. The tunnels need to be provided with fluorescent incandescent lamps at a spacing of 20 m.

10.2.2 Fire Protection

Fire protection is required both construction and operation stages. A fire management plan is being prepared by General Consultant (GC), which will be vetted by the Fire Service before construction starts. The building materials should comply with appropriate fire resistance standard. For underground structures the fire resistance period should be at least 4 hours, and 2 hours for surface or overhead structures. Wood shall not be used for any purpose, excluding artificial wood products, which are flame resistant. The materials which have zero surface burning characteristics need to be used. The electrical systems shall be provided with automatic circuit breakers activated by the rise of current as well as activated by over current. The design of a station will include provision for the following:

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

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

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

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

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

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

Fire of electrical origin, water cannot be used until the electric system has been made dead and earthened. For electrical fires, non-aqueous agents like ABC Power Chloro Bromo Methane or CO_2 gas are utilized for firefighting. Fire extinguishers with these agents shall be liberally provided at static installations and on the rolling stock.

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

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

A. Fire Prevention and Safety Measures

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

I. Fire Prevention

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

II. Safety

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

- Automatic sprinkler/detection system to be provided if floor area exceeds 750 sq.m.
- One wet riser-cum-down comer per 1000 sq. m floor area with static underground storage tank, overhead tanks and pumps of suitable capacity with hydrants, first-aid reel, etc.
- Portable fire non-aqueous extinguishers of Carbon di Oxide, chemical dry powder etc. at suitable places.
- Automatic smokes venting facilities.
- Two separate means of exit shall be provided, if more than 10 persons are working and the area exceeds 1400 sq. m
- Fire resisting doors shall be provided at appropriate places along the escape routes to prevent spread of fire and smoke.
- The travel distance for fire escape shall not exceed 20 m where escape is available in more than one direction; the distance could be up to 40 m.

B. Fire Alarm and Detection System

A complete fire detection system with equipment complying with the requirements of Bangladesh Fire service and Civil Defense shall be provided through out each station and ancillary buildings including entrance passageways, subways and exits etc. to give visual and audible indication of alarm conditions actuated by the operation of break glass contact or fire sensors e.g. detector heads, linear heat detecting cables etc. The system shall be operated from 24 V DC Power sources. Manually operated call points shall be provided at every hydrant and nose reel points, station head wall, tail wall and other locations. Alarm bells shall be installed in each plant room complex at both platform and concourse level and shall be clearly audible at all points in the room/area.

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

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

C. Fire Control Measures

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

D. Access for Fireman

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

10.2.3 Ventilation Shafts

The Environmental Control system for underground stations requires ventilation openings. Ventilation shafts are required for exhaust air, fresh air intake and to remove stale air. Proper design will be prepared for ventilation shafts.

10.2.4 Emergency Door

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

CHAPTER 11

11 CONCLUSION AND RECOMMENDATIONS

This main objective of the present study is to update the EIA report prepared in 2017 for MRT Line-5N following the JICA's Environmental and Social Consideration Guidelines and the guidelines of Department of Environment. Different data collection techniques have been used to conduct the baseline study which include literature review, observation, and environmental baseline survey. The EIA is prepared through identifying the potential impacts, assessing them and recommending possible mitigation measure for adverse impacts. The potential adverse environmental impacts of the Projects include air pollution, land acquisition, involuntary resettlement, loss of livelihood, noise and vibration pollution, loss of vegetation, water pollution, etc. On the other hand, there would be some positive impacts of the project that include enhancement of land and utilization of local resources, social infrastructure and services, development of local economy, reduction of GHG emission, etc. The project also has a positive impact in terms of employment opportunities during both construction and operational phases. In addition, there will be enhancement of economic activities around the stations of the MRT Line-5N.

Proper mitigation measures have been suggested to reduce the impacts during construction and operation phases. Moreover, the residual impacts after implementation of mitigation measures have also been discussed. In case of social impacts like land acquisition, resettlement, loss of trees and property, loss of business and livelihood, proper compensation package will be suggested in the updated RAP report, which is now in under preparation.

Besides, a monitoring plan, including both in-house monitoring and IMG monitoring has been prepared mentioning the monitoring parameters, frequency, implementing and supervision agency, and budget information.

Appendix A: Latest Environmental Clearance Certificate-2021

গণপ্রজাতন্ত্রী বাংলাদেশ সরকার
পরিবেশ অধিদপ্তর
ঢাকা মহানগর কার্যালয়
পরিবেশ ভবন, ই/১৬, আগারগাঁও, ঢাকা ১২০৭
www.doe.gov.bd

পরিবেশগত ছাড়পত্র নবায়ন

ছাড়পত্র নং: ২১-৬৫৫৫৩

পরিবেশগত ব্যবস্থাপনা নিশ্চিতকরণ সাপেক্ষে সংযুক্ত শর্তে নিম্নবর্ণিত প্রতিষ্ঠান/প্রকল্পের অনুকূলে পরিবেশগত ছাড়পত্র নবায়ন প্রদান করা হলো :

প্রতিষ্ঠান/প্রকল্পের নাম	:	Dhaka Mass Rapid Transit Development Project Line 5 Northern Route
উদ্যোক্তার নাম	:	Dhaka Mass Transit Company Limited
সনাক্তকরণ নং	:	১২৬৬৬৪
প্রতিষ্ঠান/প্রকল্পের কার্যক্রম	:	Metro Rail line-5 North route
প্রতিষ্ঠান/প্রকল্পের শ্রেণী	:	Red
প্রতিষ্ঠান/প্রকল্পের ঠিকানা	:	Probashi Kallayan Bhaban, Level 4, 71-72, Old Elephant Road, Eskaton Garden, Dhaka-1000
প্রদানের তারিখ	:	26.10.2021
মেয়াদ উত্তীর্ণের তারিখ	:	04.11.2022

এ ছাড়পত্র সনদের সাথে পৃথকভাবে সংযুক্ত প্রদত্ত শর্তাবলী যথাযথভাবে প্রতিপালন করতে হবে,
অন্যথায় ছাড়পত্র বাতিল/ক্ষতিপূরণ আদায়সহ যে কোন আইনানুগ ব্যবস্থা গ্রহণ করা হবে।

বিঃদ্রঃ এটি একটি সিস্টেম জেনারেটেড ছাড়পত্র এবং এতে কোনোরূপ স্বাক্ষরের প্রয়োজন নেই।

ছাড়পত্রটি যাচাই করতে ভিজিট করুন: https://ecc.doe.gov.bd/certificate_verification
Page 1 of 2

সনাক্তকরণ নং: ১২৬৬৬৪ Dhaka Mass Rapid Transit Development Project Line 5 Northern Route
ছাড়পত্র নং: ২১-৬৫৫৫৩

পরিবেশগত ছাড়পত্র নবায়ন এর জন্য প্রযোজ্য শর্তাবলী:

১ . এ ছাড়পত্র শুধুমাত্র ঢাকা ম্যাস রেপিড ট্রানজিট ডেভেলপমেন্ট প্রজেক্ট (লাইন-৫ নর্থ রুট), ঢাকা নামক প্রকল্প নির্মাণের ক্ষেত্রে প্রযোজ্য হবে।
২ . বর্ণিত প্রকল্পের অনুকূলে পরিবেশ অধিদপ্তরের বিগত ০৫.১১.২০১৭ তারিখ নং-পঅ/ছাড়পত্র/৫৭২৫/২০১৭/৫৫৬ সংখ্যক স্মারকে প্রদত্ত পরিবেশগত ছাড়পত্রের সকল শর্ত অপরিবর্তীত থাকবে।
৩ . প্রকল্পের কার্যক্রম দ্বারা কোন অবস্থায় রাস্তায় যানজট সৃষ্টি করা যাবেনা। এ বিষয়ে বিকল্প ব্যবস্থাপনা সার্বক্ষণিক কার্যকর রাখতে হবে।
৪ . প্রকল্পের এলাইনমেন্টে যানজট নিয়ন্ত্রণের জন্য নিজস্ব জনবল দ্বারা সার্বক্ষণিক যানজট নিয়ন্ত্রণের জন্য কার্যকর উদ্যোগ গ্রহণ করতে হবে।
৫ . কোন অবস্থায় প্রকল্পের কার্যক্রম দ্বারা কোন জলাজয়, ডোবা, নালা, বিল, খাল, পুকুর, বন্যা প্রবাহ এলাকা, ওয়াটার রিটেনশন এরিয়া ভরাট করা যাবেনা।
৬ . প্রকল্পে ব্যবহৃতব্য বৈদ্যুতিক সাব-স্টেশনের ট্রান্সফরমার পিসিবি মুক্ত হতে হবে। পিসিবি যুক্ত কোন ট্রান্সফরমার ব্যবহার করা যাবেনা।
৭ . প্রকল্পের পাশের রাস্তায় কোন ধরনের নির্মাণ সামগ্রী রেখে ফুটপাত/রাস্তার প্রতিবন্ধকতা সৃষ্টি করা যাবেনা।
৮ . প্রকল্পের কার্যক্রম দ্বারা পরিবেশ ও প্রতিবেশের ক্ষতিসাধন করা হলে Polluters Pay Principle অনুসারে ক্ষতিপূরণ ধার্য করে নির্ধারিত সময়ের মধ্যে ধার্যকৃত ক্ষতিপুরণ আদায় করা হবে।
৯ . মহামান্য হাইকোর্ট বিভাগের রিট পিটিশন নম্বর ৯১৬/২০১৯ এর বিগত ২৯/০১/২০১৯ তারিখের আদেশ অনুযায়ী প্রকল্প নির্মাণকালে বায়ু/ডাষ্ট দূষণ নিয়ন্ত্রণকল্পে দৈনিক অন্ততঃ দুইবার পানি ছিটিয়ে বায়ু দূষণ নিয়ন্ত্রণ করতে হবে।
১০ . নির্মাণ কার্যক্রমের মাধ্যমে কোন প্রকার বায়ু দূষণ সৃষ্টি করা যাবেনা। নির্মাণ কাজ চলাকালিন নির্মাণাধীন অবকাঠামো যথাযথভাবে ঢেকে রাখতে হবে যাতে ধূলাবালি আশেপাশে ছড়িয়ে না পড়ে।
১১ . বায়ুদূষণ নিয়ন্ত্রণের জন্য নির্মাণ সামগ্রী ঢেকে রাখতে হবে এবং নির্মাণ সামগ্রী পরিবহনের সময়ও ঢেকে পরিবহণ করতে হবে।
১২ . নির্মাণাধীন অবকাঠামো/প্রকল্পের এলাইনম্যান্ট এলাকায় নিয়মিত পানি ছিটিয়ে বায়ু দূষণ নিয়ন্ত্রণ করতে হবে।
১৩ . প্রকল্পের নির্মাণ কার্যক্রম চলাকালে শব্দ নিঃসরণ/নির্গমন মাত্রা শব্দ দূষণ (নিয়ন্ত্রণ) বিধিমালা, ২০০৬ এবং পরিবেশ সংরক্ষণ বিধিমালা, ১৯৯৭-এ বর্ণিত মানমাত্রার মধ্যে রাখতে হবে।
১৪ . সব ধরণের বর্জ্যরে ক্ষেত্রে বিশেষতঃ কঠিন বর্জ্য ব্যবস্থাপনায়, উৎসে বর্জ্য পৃথকীকরণ করতে হবে এবং বর্জ্য হ্রাস, পুনঃব্যবহার ও পুনঃচক্রায়ন নীতিমালা তথা 3R(Reduce, Reuse, Recycle) Principles অনুসরণ করতে হবে। এছাড়া পৃথকীকৃত বর্জ্য আবৃত অবস্থায় উপযুক্ত সময় নিকটস্থ সিটি কর্পোরেশনের ট্রান্সফার স্টেশন/ডাম্পিং গ্রাউন্ডে স্থানান্তর/পরিবহনের বিষয়টি উদ্যোক্তা নিজস্ব উদ্যোগ/সিটি কর্পোরেশনের সহায়তায় নিশ্চিত করবেন।
১৫ . নির্মাণকাজ চলাকালে শ্রমিকদের পেশাগত স্বাস্থ্য সুরক্ষা সামগ্রী (পিপিই যেমন ইয়ার প্লাগ, নোজ মাস্ক ইত্যাদি) সার্বক্ষণিকভাবে ব্যবহার করতে হবে।
১৬ . প্রকল্পের ইধাইএ প্রতিবেদনে সুপারিশকৃত সকল মিটিগেশন মেজার্স যথাযথভাবে বাস্তাবয়ন করতে হবে।
১৭ . প্রকল্পের ফিজিক্যাল কন্সস্ট্রাকশন কাজ শুরুর পূর্বে এ কার্যালয়কে লিখিতভাবে অবহিত করতে হবে।
১৮ . Polychlorinated Bi-phynile(PCBs) যুক্ত তেল/যন্ত্রাংশ ব্যবহৃত হয় এমন জেনারেটর/সাব-স্টেশন স্থাপন/ব্যবহার করা যাবেনা।
১৯ . বায়ুদূষণ নিয়ন্ত্রণের জন্য প্রকল্পের কাচামাল ও প্রোডাক্ট ঢেকে রাখতে হবে এবং নির্মাণ সামগ্রী পরিবহনের সময়ও ঢেকে পরিবহণ করতে হবে।
২০ . প্রকল্পের কার্যক্রম চলাকালে শব্দের মাত্রা শব্দ দূষণ (নিয়ন্ত্রণ) বিধিমালা, ২০০৬ এ বর্ণিত মানমাত্রার মধ্যে রাখতে হবে এবং বায়ু দূষণ ও তরল বর্জ্য দূষণ নিয়ন্ত্রণের ক্ষেত্রে পরিবেশ সংরক্ষণ বিধিমালা, ১৯৯৭ যথাযথভাবে অনুসরণ করতে হবে।
২১ . পরিবেশগত ছাড়পত্র ও সর্বশেষ নবায়নের কপি প্রকল্প সাইট অফিসে সংরক্ষণ করতে হবে।
২২ . ছাড়পত্র নবায়নের মেয়াদ শেষ হবার অন্ততঃ ত্রিশ দিন পূর্বে প্রাসঙ্গিক কাগজপত্রসহ অন-লাইনে নবায়নের জন্য আবেদন করতে হবে।
২৩ . উপর্যুক্ত শর্ত এবং অবস্থান বিষয়ক পরিবেশগত ছাড়পত্রের প্রদত্ত অন্যান্য শর্তাবলী প্রতিপালনে ব্যর্থ হলে ছাড়পত্র বাতিল বলে গণ্য হবে এবং বাংলাদেশ পরিবেশ সংরক্ষণ আইন, ১৯৯৫ (সংশোধিত-২০১০) এবং পরিবেশ সংরক্ষণ বিধিমালা, ১৯৯৭ অনুযায়ী আইনগত ব্যবস্থা গ্রহণ করা হবে।

Appendix B: Laboratory Result of Environmental Quality Test

Report of EQMS Laboratory

Sl No: **5369**

EQMS

Ref: EQMS/Ambient Air Quality / 2021042897

EQMS ENVIRONMENTAL LABORATORY
Monitoring Results of Ambient Air Quality

Project Name : Updating of the Environmental Impact Assessment (EIA) Report (Including Environmental Baseline Survey) for the MRT Line 5: Northern Route

Description of the Activity : Ambient Air Quality Monitoring

Monitored By : EQMS Environmental Monitoring Team

Monitoring Location : AQ1 - Hemayetpur Station
AQ2 - Depot Area (Western Boundary of Depot)
AQ3 – Depot Area (Eastern Boundary of Depot)
AQ4 - Front site of depot area (Beside Dhaka-Aricha Highway)
AQ5 - Baliarpur Station
AQ6 - Bilamalia Station

Monitoring Date : 06th - 07th May, 2021

Date of Analysis : 1st – 3rd June, 2021

Description of Analysis:

Sampling Code	Date	PM_{10} µg/m³	$PM_{2.5}$ µg/m³	NO_X µg/m³	SO_2 µg/m³	O_3 µg/m³	Pb µg/m³	CO ppm
AQ01	06.05.21	85.1	52.3	38.7	40.2	14.9	0.128	0.69
AQ02	06.05.21	68.8	44.7	26.1	32.5	21.3	0.047	0.28
AQ03	06.05.21	56.5	40.1	27.4	25.8	38.8	0.050	0.01
AQ04	07.05.21	66.4	44.2	25.8	31.9	15.9	0.084	0.19
AQ05	07.05.21	73.9	49.1	23.3	28.2	44.5	0.063	0.15
AQ06	07.05.21	96.6	59.8	27.1	31.3	31.8	0.056	0.10
Duration (Hours)		**24**	**24**	**24**	**24**	**8**	**24**	**8**
Bangladesh ECR 1997*		**150**	**65**	**100 (Annual)**	**365**	**157**	**0.5 (Annual)**	**9**
WHO Standard		**50**	**25**	**-**	**20**	**100**	**-**	**-**

** According to ECR 1997 and Subsequent amendment on 19th August, 2005; vide S.R.O. No.220-Law/2005*

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EQMS Consulting

Environmental and Engineering Analytical laboratory is Accredited by AB-CAB International Accreditation Board

SL No: **5370**

EQMS

Ref: EQMS/Ambient Air Quality / 2021042898

EQMS ENVIRONMENTAL LABORATORY
Monitoring Results of Ambient Air Quality

Project Name	:	Updating of the Environmental Impact Assessment (EIA) Report (Including Environmental Baseline Survey) for the MRT Line 5: Northern Route
Description of the Activity	:	Ambient Air Quality Monitoring
Monitored By	:	EQMS Environmental Monitoring Team
Monitoring Location	:	AQ7 - Amin Bazar Station AQ8 - Gabtoli Station AQ9 - Dar-us-Salam Station AQ10 - Mirpur-1 Station AQ11 - Mirpur-10 Station AQ12 - Mirpur-14 Station
Monitoring Date	:	08th – 09th May, 2021
Date of Analysis	:	1st – 3rd June, 2021

Description of Analysis:

Sampling Code	Date	PM_{10} µg/m³	$PM_{2.5}$ µg/m³	NO_X µg/m³	SO_2 µg/m³	O_3 µg/m³	Pb µg/m³	CO ppm
AQ07	08.05.21	89.3	54.5	34.6	21.4	22.1	0.053	2.95
AQ08	08.05.21	76.4	48.9	27.2	25.3	16.8	0.056	0.01
AQ09	08.05.21	58.7	37.6	20.8	18.5	26.4	0.063	0.47
AQ10	09.05.21	52.3	35.4	23.2	15.1	18.7	0.053	0.21
AQ11	09.05.21	171.6	98.0	45.1	29.8	24.4	0.056	0.02
AQ12	09.05.21	81.6	50.6	20.7	13.1	11.9	0.050	0.63
Duration (Hours)		**24**	**24**	**24**	**24**	**8**	**24**	**8**
Bangladesh ECR 1997*		**150**	**65**	**100 (Annual)**	**365**	**157**	**0.5 (Annual)**	**9**
WHO Standard		**50**	**25**	**-**	**20**	**100**	**-**	**-**

**According to ECR 1997 and Subsequent amendment on 19th August, 2005; vide S.R.O. No.220-Law/2005*

Received by:
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Analyzed by:
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Checked by:
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SL No. 5371

EQMS

Ref: EQMS/Ambient Air Quality / 2021042899

EQMS ENVIRONMENTAL LABORATORY
Monitoring Results of Ambient Air Quality

Project Name	:	Updating of the Environmental Impact Assessment (EIA) Report (Including Environmental Baseline Survey) for the MRT Line 5: Northern Route
Description of the Activity	:	Ambient Air Quality Monitoring
Monitored By	:	EQMS Environmental Monitoring Team
Monitoring Location	:	AQ13 - Kochukhet Station AQ14 - Banani Station AQ15 - Gulshan-2 Station AQ16 - Notun Bazar Station AQ17 - Vatara Station
Monitoring Date	:	10th – 11th May, 2021
Date of Analysis	:	1st – 3rd June, 2021

Description of Analysis:

Sampling Code	Date	PM_{10} µg/m³	$PM_{2.5}$ µg/m³	NO_2 µg/m³	SO_2 µg/m³	O_3 µg/m³	Pb µg/m³	CO ppm
AQ13	10.05.21	65.1	40.5	16.2	9.6	17.3	0.072	0.65
AQ14	10.05.21	90.5	51.7	38.6	14.5	8.5	0.091	0.01
AQ15	10.05.21	63.8	41.9	34.7	18.3	13.6	0.059	0.01
AQ16	11.05.21	74.1	41.4	93.6	16.9	40.7	0.066	0.58
AQ17	11.05.21	83.9	47.9	67.3	8.4	9.9	0.059	0.01
Duration (Hours)		**24**	**24**	**24**	**24**	**8**	**24**	**8**
Bangladesh ECR 1997*		**150**	**65**	**100 (Annual)**	**365**	**157**	**0.5 (Annual)**	**9**
WHO Standard		**50**	**25**	**-**	**20**	**100**	**-**	**-**

** According to ECR 1997 and Subsequent amendment on 19th August, 2005; vide S.R.O. No.220-Law/2005*

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SL No: 5372

EQMS

Ref: EQMS/Noise Level / 2021042900

EQMS ENVIRONMENTAL LABORATORY

Monitoring Results of Noise Level

Project Name	:	Updating of the Environmental Impact Assessment (EIA) Report (Including Environmental Baseline Survey) for the MRT Line 5: Northern Route
Description of the Activity	:	Noise Level Monitoring
Monitored By	:	EQMS Environmental Monitoring Team
Monitoring Location	:	NL1 – Hemayetpur Station NL2 - In-front of Al Nasir Laboratory School, Hemayetpur NL3 – In-front of Baitul Habib Mosque, Hemayetpur NL4 - Depot Area (Western Boundary of Depot) NL5 – Depot Area (Eastern boundary of Depot) NL6 – Alam Nagar Central Jame Mosque, Sugandha Housing, Hemayetpur NL7 – Baliarpur Station (In-front of Institute for Autistic Children and Blind, Old Home and TN Mother Child Hospital)
Monitoring Date	:	06th – 07th May, 2021
Date of Analysis	:	25th May – 1st June, 2021

Description of Analysis:

Code	Monitoring Date	Leq_{day} (dBA)	Leq_{night}	Standard (dBA)		Category
				Day	Night	
NL1	06-05-2021	76.4	59.4	60	50	Mixed
NL2	06-05-2021	69.1	54.0	55	45	Silent
NL3	06-05-2021	80.6	71.4	55	45	Silent
NL4	06-05-2021	55.4	49.8	60	50	Mixed
NL5	06-05-2021	57.6	51.1	50	40	Residential
NL6	07-05-2021	64.5	58.8	55	45	Silent
NL7	07-05-2021	59.8	47.0	55	45	Silent

** The Environment Conservation Rules (ECR) 1997 and Subsequent amendment in 2006*

Received by:
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OHSAS 18001:2007

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SL No: **5373**

EQMS

Ref: EQMS/Noise Level / 2021042901

EQMS ENVIRONMENTAL LABORATORY

Monitoring Results of Noise Level

Project Name	:	Updating of the Environmental Impact Assessment (EIA) Report (Including Environmental Baseline Survey) for the MRT Line 5: Northern Route
Description of the Activity	:	Noise Level Monitoring
Monitored By	:	EQMS Environmental Monitoring Team
Monitoring Location	:	NL8 – Jamia Islamia Jame Mosque, Baliarpur NL9 – Jamuna Natural Park, Aminbazar NL10 – Bilamalia Station NL11 – Aminbazar Station NL12 – Gabtoli Station NL13 – Dar-us-Salam Station (In-front of Delta Medical College & Hospital) NL14 – Mirpur-1 Station NL15 – Mirpur-10 Station
Monitoring Date	:	06th – 11th May, 2021
Date of Analysis	:	25th May – 1st June, 2021

Description of Analysis:

Code	Monitoring Date	Leq_{day} (dBA)	Leq_{night}	Standard (dBA)		Category
				Day	Night	
NL8	07-05-2021	64.5	63.1	60	50	Mixed
NL9	07-05-2021	65.1	59.4	60	50	Mixed
NL10	07-05-2021	65.7	42.1	60	50	Mixed
NL11	08-05-2021	72.3	66.4	75	70	Mixed
NL12	08-05-2021	62.8	54.6	60	50	Mixed
NL13	08-05-2021	70.4	64.8	55	45	Silent
NL14	09-05-2021	71.4	55.1	60	50	Mixed
NL15	09-05-2021	81.2	46.2	60	50	Mixed

** The Environment Conservation Rules (ECR) 1997 and Subsequent amendment in 2006*

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SL No: 5374

Ref: EQMS/Noise Level / 2021042902

EQMS ENVIRONMENTAL LABORATORY

Monitoring Results of Noise Level

Project Name	:	Updating of the Environmental Impact Assessment (EIA) Report (Including Environmental Baseline Survey) for the MRT Line 5: Northern Route
Description of the Activity	:	Noise Level Monitoring
Monitored By	:	EQMS Environmental Monitoring Team
Monitoring Location	:	NL16 – Mirpur-14 Station NL17 – Kochukhet Station (In-front of Shaheed Police Smriti College) NL18 – Banani Station NL19 – Gulshan 2 Station NL20 – Notun Bazar Station NL21 – In front of Baitul Mamur Mosque, Madani Avenue, Vata NL22 – In front of Divine Mercy Church, Vatara NL23 – Vatara Station
Monitoring Date	:	06th – 11th May, 2021
Date of Analysis	:	25th May – 1st June, 2021

Description of Analysis:

Code	Monitoring Date	Leq_{day} (dBA)	Leq_{night}	Standard (dBA)		Category
				Day	Night	
NL16	09-05-2021	66.7	59.1	60	50	Mixed
NL17	10-05-2021	72.7	60.9	55	45	Silent
NL18	10-05-2021	75.1	62.8	60	50	Mixed
NL19	10-05-2021	75.5	53.9	60	50	Mixed
NL20	11-05-2021	75.9	65.6	60	50	Mixed
NL21	11-05-2021	75.8	65.6	55	45	Silent
NL22	11-05-2021	65.4	58.9	55	45	Silent
NL23	11-05-2021	61.5	50.9	60	50	Mixed

** The Environment Conservation Rules (ECR) 1997 and Subsequent amendment in 2006*

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SL No: 5375

Ref: EQMS/Ground Water Quality / 2021042903

EQMS WET LABORATORY
Results of Ground Water Quality

Project Name : Updating of the Environmental Impact Assessment (EIA) Report (Including Environmental Baseline Survey) for the MRT Line 5: Northern Route

Description of Sample : Ground Water Quality

Sample Collector : EQMS Environmental Monitoring Team

Sampling Location : GW1 - Depot Area
GW2 - Markazuttarbiya Madrasha, Sugandha Housing, Alam Nagar, Hemayetpur
GW3 - Abu Saeed's Home, 20/A, Goidartek, Ward: 10, Gabtoli
GW4 - DWASA Mods Zone-4, Darussalam (Near to Mirpur Bangla College)
GW5 - Paikpara Govt. Colony, Mirpur-1

Sampling Date : April, 2021

Date of Reporting : 31st May, 2021

Description of Analysis:

Parameters	Unit	Concentration Present					ECR'97 Standard*
		GW1	GW2	GW3	GW4	GW5	
Temperature	(°C)	31.3	31.3	31.3	28.6	28.6	20-30
Colour	PCU	2.0	2.0	7.0	5.0	2.0	15.0
pH	–	6.68	6.44	6.44	7.02	6.45	6.5-8.5
Arsenic	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	0.05
Potassium	mg/l	1.95	2.0	1.95	2.1	2.1	12.0
Calcium	mg/l	40.0	45.0	40.0	45.0	30.0	75.0
Chloride	mg/l	9.3	10.6	57.0	7.7	52.0	150-600
Nitrate	mg/l	0.0	0.0	0.0	0.0	0.0	10.0
Nitrite	mg/l	0.02	0.02	0.02	0.03	0.04	<1.0
Sulphate	mg/l	5.0	5.0	15.0	10.0	10.0	400
Sodium	mg/l	22.2	20.9	28.7	22.2	25.8	200
Bicarbonate	mg/l	206.0	154.0	454.0	160.0	148.0	-
FC	MPN/100 ml	<1.8	<1.8	<1.8	<1.8	<1.8	0

*The Environment Conservation Rules, 1997 [Schedule 3 (B)]

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SL No: **5376**

EQMS

Ref: EQMS/Ground Water Quality / 2021042904

EQMS WET LABORATORY
Results of Ground Water Quality

Project Name : Updating of the Environmental Impact Assessment (EIA) Report (Including Environmental Baseline Survey) for the MRT Line 5: Northern Route

Description of Sample : Ground Water Quality

Sample Collector : EQMS Environmental Monitoring Team

Sampling Location : GW6 - Mirpur-10 (Bottle water production plant)
GW7 - Police Stuff College, Mirpur
GW8 - Mirpur-14, DWASA Pump House
GW9 - Banani DOHS Club Canteen
GW10 - Vatara DWASA Pump House

Sampling Date : April, 2021

Date of Reporting : 31st May, 2021

Description of Analysis:

Parameters	Unit	Concentration Present					ECR'97 Standard*
		GW6	GW7	GW8	GW9	GW10	
Temperature	(°C)	29.7	32.9	29.5	30.8	28.9	20-30
Colour	PCU	4.0	8.0	5.0	5.0	10.0	15.0
pH	--	7.05	7.61	6.97	7.54	6.92	6.5-8.5
Arsenic	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	0.05
Potassium	mg/l	1.85	3.1	1.76	1.93	2.14	12.0
Calcium	mg/l	40.0	50.0	45.0	40.0	40.0	75.0
Chloride	mg/l	6.5	6.0	3.0	3.3	3.1	150-600
Nitrate	mg/l	0.0	0.0	0.0	0.0	0.0	10.0
Nitrite	mg/l	0.02	0.03	0.03	0.04	0.03	<1.0
Sulphate	mg/l	0.0	5.0	5.0	0.0	5.0	400
Sodium	mg/l	24.2	25.9	24.0	24.3	24.8	200
Bicarbonate	mg/l	181.0	193.0	176.0	170.0	175.0	-
FC	MPN/100 ml	<1.8	<1.8	<1.8	<1.8	<1.8	0

**The Environment Conservation Rules, 1997* [Schedule 3 (B)]

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ISO 9001:2015
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Sl. No: **5377**

EQMS

Ref: EQMS/Ground Water Quality / 2021042905

EQMS WET LABORATORY
Results of Surface Water Quality

Project Name : Updating of the Environmental Impact Assessment (EIA) Report (Including Environmental Baseline Survey) for the MRT Line 5: Northern Route
Description of Sample : Surface Water Quality
Sample Collector : EQMS Environmental Monitoring Team
Sampling Location : SW1 - Upstream of Karnatali River, Rajarghat
SW2 - Downstream of Karnatali River (In-between Gendura and Nagarkunda)
SW3 - Boliarpur (Northern side of Dhaka-Aricha Highway
SW4 - Amin Bazar (South Side of Dhaka-Aricha highway
SW5 - Amin Bazar (North Side of Dhaka-Aricha highway)
SW6 - Satarkul-Vatara 1st Bridge, Madani Avenue, Vatara
Sampling Date : April, 2021
Date of Analysis : 31st May, 2021

Description of Analysis

Parameters	Unit	Concentration						ECR'97 Standard*
		SW1	SW2	SW3	SW4	SW5	SW6	
Temperature	(°C)	32.9	33.9	35.6	33.4	35.0	31.1	-
EC	µS/cm	1420	1410	350	380	300	880	-
Color	PCU	300	297	160	35	27	414	-
pH	--	7.95	7.84	9.34	8.95	9.40	6.81	6.5-8.5
TDS	ppm	710	690	170	190	150	440	-
DO	mg/l	1.9	2.0	5.3	6.3	4.5	1.5	5 or More
BOD_5	mg/l	8.0	7.5	1.6	0.8	0.4	15	6 or less
COD	mg/l	84	82	40	49	61	131	-
TSS	mg/l	34	29	29	63	64	56	-
TC	MPN/100 ml	>1600	>1600	32	47	40	>1600	-

** According to ECR 1997, Schedule 3(A): Best Practice based classification (Water Usable for Fisheries)*

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EQMS Consulting Limited

TNV United Kingdom ISO 9001:2015 ISO 14001:2015 OHSAS 18001:2007

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Report of DPHE Laboratory

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Department of Public Health Engineering
Central Lab, 38-39, Mohakhali C/A, Dhaka-1212
Phone: 88-02-9881927, Fax: 88-02-9882003 , Email: wqmsc_central_lab@yahoo.com

Lab Memo: 944/ CC, DPHE, CL, Dhaka

Date: 03-06-2021

Physical /Chemical/ Bacteriological Analysis of Water Sample

Sample ID: CEN2021060016	Sample Receiving date: 25-05-2021
Ref. Memo No: EQMS/2021/Nill & Dated: 25-05-2021	Sample Source: Ground Water
Sent by:Kazi Farhad Iqbal ,Executive Director , EQMS Consulting Ltd., Banani, Dhaka.	Dist:Dhaka, Ups:
Care Taker: EQMS Consulting Ltd. (Sample ID : AQW-1)	Union:, Vill.:
Sample Collection date: 24-05-2021	Date of Testing: 25/05/2021-01/06/2021

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Lead (Pb)	0.05	0.041	mg/L	AAS	0.001

Comments: Sample was collected & supplied by client.
N.B: AAS- Atomic Absorption Spectrophotometer, LOQ- Limit of Quantitation.

Test Performed by:	Signature	Countersigned/Approved by:	Signature
1.) Name: Md. Saiful Alam Khosru Designation: Sample Analyzer	03.06.2021	1.) Name: Mita Sarker Designation: Senior Chemist	03/06/2021
2.) Name: Taslima Akhter Designation: Sample Analyzer	03.06.2021	2.) Name: Md. Biplab Hossain Designation: Chief Chemist	Mita Sarker Senior Chemist Department of Public Health Engineering Central Laboratory, Mohakhali, Dhaka

Page 1 of 1

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Lab Memo: 944/ CC, DPHE CL Dhaka

Date: 03-06-2021

Physical /Chemical/ Bacteriological Analysis of Water Sample

Sample ID: CEN2021060017	Sample Receiving date: 25-05-2021
Ref. Memo No: EQMS/2021/Nill & Dated: 25-05-2021	Sample Source: Ground Water
Sent by:Kazi Farhad Iqbal ,Executive Director , EQMS Consulting Ltd., Banani, Dhaka.	Dist:Dhaka, Upa:
Care Taker: EQMS Consulting Ltd. (Sample ID : AQW-2)	Union:, Vill :
Sample Collection date: 24-05-2021	Date of Testing: 25/05/2021-01/06/2021

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Lead (Pb)	0.05	0.015	mg/L	AAS	0.001

Comments: Sample was collected & supplied by client.
N.B: AAS- Atomic Absorption Spectrophotometer, LOQ- Limit of Quantitation.

Test Performed by:

1.) Name: Md. Saiful Alam Khosru
Designation: Sample Analyzer
Signature
03.06.2021

2.) Name: Taslima Akhter
Designation: Sample Analyzer
03.06.21

Countersigned/Approved by:

1.) Name: Mita Sarker
Designation: Senior Chemist
Signature
03/06/2021

2.) Name: Md. Biplab Hossain
Designation: Chief Chemist

Mita Sarker
Senior Chemist
Department of Public Health Engineering
Central Laboratory, Mohakhali, Dhaka

Page 1 of 1

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Lab Memo: 944/ CC: DPHE. CL. Dhaka

Date: 03-06-2021

Physical /Chemical/ Bacteriological Analysis of Water Sample

Sample ID: CEN2021060018	Sample Receiving date: 25-05-2021
Ref. Memo No: EQMS/2021/Nill 6 Dated: 25-05-2021	Sample Source: Ground Water
Sent by:Kazi Farhad Iqbal ,Executive Director , EQMS Consulting Ltd., Banani, Dhaka.	Dist:Dhaka, Upa:
Care Taker: EQMS Consulting Ltd. (Sample ID : AQW-3)	Union:, Vill.:
Sample Collection date: 24-05-2021	Date of Testing: 25/05/2021-01/06/2021

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Lead (Pb)	0.05	0.016	mg/L	AAS	0.001

Comments: Sample was collected & supplied by client.
N.B: AAS- Atomic Absorption Spectrophotometer, LOQ- Limit of Quantitation.

Test Performed by:	Signature	Countersigned/Approved by:	Signature
1.) Name: Md. Saiful Alam Khosru Designation: Sample Analyzer	03.06.2021	1.) Name: Mita Sarker Designation: Senior Chemist	03/06/2021 Mita Sarker Senior Chemist Department of Public Health Engineering Central Laboratory, Mohakhali, Dhaka.
2.) Name: Taslima Akhter Designation: Sample Analyzer	03.06.21	2.) Name: Md. Biplab Hossain Designation: Chief Chemist	

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Phone: 88-02-9881927, Fax: 88-02-9882003, Email: wqmsc_central_lab@yahoo.com

Lab Memo: 944/ CC, DPHE, CL, Dhaka

Date: 03-06-2021

Physical /Chemical/ Bacteriological Analysis of Water Sample

Sample ID: CEN2021060019	Sample Receiving date: 25-05-2021
Ref. Memo No: EQMS/2021/Nill & Dated: 25-05-2021	Sample Source: Ground Water
Sent by:Kazi Farhad Iqbal ,Executive Director , EQMS Consulting Ltd., Banani, Dhaka.	Dist:Dhaka, Upa:
Care Taker: EQMS Consulting Ltd. (Sample ID : AQW-4)	Union:, Vill.:
Sample Collection date: 24-05-2021	Date of Testing: 25/05/2021-01/06/2021

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Lead (Pb)	0.05	0.027	mg/L	AAS	0.001

Comments: Sample was collected & supplied by client.
N.B: AAS- Atomic Absorption Spectrophotometer, LOQ- Limit of Quantitation.

Test Performed by

1.) Name: Md. Saiful Alam Khosru
Designation: Sample Analyzer
Signature
03.06.2021

2.) Name: Taslima Akhter
Designation: Sample Analyzer
03.06.21

Countersigned/Approved by:

1.) Name: Mita Sarker
Designation: Senior Chemist
Signature
03/06/2021

2.) Name: Md. Biplab Hossain
Designation: Chief Chemist

Mita Sarker
Senior Chemist
Department of Public Health Engineering
Central Laboratory, Mohakhali, Dhaka.

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Phone: 88-02-9881927, Fax: 88-02-9882003 , Email: wqmsc_central_lab@yahoo.com

Lab Memo: 944/ CC, DPHE, CL, Dhaka Date: 03-06-2021

Physical /Chemical/ Bacteriological Analysis of Water Sample

Sample ID: CEN2021060020	Sample Receiving date: 25-05-2021
Ref. Memo No. EQMS/2021/Nil & Dated: 25-05-2021	Sample Source: Ground Water
Sent by:Kazi Farhad Iqbal ,Executive Director , EQMS Consulting Ltd., Banani, Dhaka	Dist:Dhaka, Upa:
Care Taker: EQMS Consulting Ltd. (Sample ID : AQW-5)	Union:, Vill:
Sample Collection date: 24-05-2021	Date of Testing: 25/05/2021-01/06/2021

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Lead (Pb)	0.05	0.020	mg/L	AAS	0.001

Comments: Sample was collected & supplied by client.
N.B: AAS- Atomic Absorption Spectrophotometer, LOQ- Limit of Quantitation.

Test Performed by:

1.) Name: Md. Saiful Alam Khosru
Designation: Sample Analyzer
Signature
03.06.2021

2.) Name: Tasima Akhter
Designation: Sample Analyzer
03.06.21

Countersigned/Approved by:

1.) Name: Mita Sarker
Designation: Senior Chemist
Signature
03/06/2021
Mita Sarker
Senior Chemist
Department of Public Health Engineering
Central Laboratory, Mohakhali, Dhaka.

2.) Name: Md. Biplab Hossain
Designation: Chief Chemist

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Lab Memo: 944/ CC, DPHE. CL. Dhaka

Date: 03-06-2021

Physical /Chemical/ Bacteriological Analysis of Water Sample

Sample ID: CEN2021060021	Sample Receiving date: 25-05-2021
Ref. Memo No: EQMS/2021/NIl & Dated: 25-05-2021	Sample Source: Ground Water
Sent by:Kazi Farhad Iqbal ,Executive Director , EQMS Consulting Ltd., Banani, Dhaka	Dist:Dhaka, Upa:
Care Taker: EQMS Consulting Ltd. (Sample ID : AQW-6)	Union:, Vill.:
Sample Collection date: 24-05-2021	Date of Testing: 25/05/2021-01/06/2021

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Lead (Pb)	0.05	0.018	mg/L	AAS	0.001

Comments: Sample was collected & supplied by client.
N.B: AAS- Atomic Absorption Spectrophotometer, LOQ- Limit of Quantitation

Test Performed by:

1.) Name: Md. Saiful Alam Khasru
Designation: Sample Analyzer
Signature
03.06.2021

2.) Name: Taslima Akhter
Designation: Sample Analyzer
03.06.21

Countersigned/Approved by:

1.) Name: Mita Sarker
Designation: Senior Chemist
Signature
03/06/2021
Mita Sarker
Senior Chemist
Department of Public Health Engineering
Central Laboratory, Mohakhali, Dhaka

2.) Name: Md. Biplab Hossain
Designation: Chief Chemist

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Lab Memo: 944/ CC, DPHE, CL, Dhaka

Date: 03-06-2021

Physical /Chemical/ Bacteriological Analysis of Water Sample

Sample ID: CEN2021060022	Sample Receiving date: 25-05-2021
Ref. Memo No. EQMS/2021/Nill & Dated: 25-05-2021	Sample Source: Ground Water
Sent by:Kazi Farhad Iqbal ,Executive Director , EQMS Consulting Ltd., Banani, Dhaka.	Dist:Dhaka, Upa:
Care Taker: EQMS Consulting Ltd. (Sample ID : AQW-7)	Union., Vill.:
Sample Collection date: 24-05-2021	Date of Testing: 25/05/2021-01/06/2021

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Lead (Pb)	0.05	0.017	mg/L	AAS	0.001

Comments: Sample was collected & supplied by client.
N.B: AAS- Atomic Absorption Spectrophotometer, LOQ- Limit of Quantitation.

Test Performed by:

1.) Name: Md. Saiful Alam Khosru
Designation: Sample Analyzer
Signature
03.06.2021

2.) Name: Taslima Akhter
Designation: Sample Analyzer
Signature
03.06.21

Countersigned/Approved by:

1.) Name: Mita Sarker
Designation: Senior Chemist
Signature
03/06/2021
Mita Sarker
Senior Chemist
Department of Public Health Engineering
Central Laboratory, Mohakhali, Dhaka

2.) Name: Md. Biplab Hossain
Designation: Chief Chemist

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Phone: 88 02-9881927, Fax: 88-02-9882003 , Email: wqmsc_central_lab@yahoo.com

Lab Memo: 944/ CC, DPHE, CL, Dhaka

Date: 03-06-2021

Physical /Chemical/ Bacteriological Analysis of Water Sample

Sample ID: CEN2021060023	Sample Receiving date: 25-05-2021
Ref. Memo No: EQMS/2021/Nil & Dated: 25-05-2021	Sample Source: Ground Water
Sent by:Kazi Farhad Iqbal Executive Director EQMS Consulting Ltd., Banani, Dhaka.	Dist:Dhaka, Upa:
Care Taker: EQMS Consulting Ltd. (Sample ID : AQW-8)	Union:, Vill.:
Sample Collection date: 24-05-2021	Date of Testing: 25/05/2021-01/06/2021

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Lead (Pb)	0.05	0.018	mg/L	AAS	0.001

Comments: Sample was collected & supplied by client.
N.B. AAS- Atomic Absorption Spectrophotometer, LOQ- Limit of Quantitation.

Test Performed by:

1.) Name: Md. Saiful Alam Khosru
Designation: Sample Analyzer
Signature
03.06.2021

2.) Name: Taslima Akhter
Designation: Sample Analyzer
03.06.21

Countersigned/Approved by:

1.) Name: Mita Sarker
Designation: Senior Chemist
Signature
03/06/2021

2.) Name: Md. Biplab Hossain
Designation: Chief Chemist

Mita Sarker
Senior Chemist
Department of Public Health Engineering
Central Laboratory, Mohakhali, Dhaka

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Lab Memo: 944/ CC, DPHE, CL, Dhaka

Date: 03-06-2021

Physical /Chemical/ Bacteriological Analysis of Water Sample

Sample ID: CEN2021060024	Sample Receiving date: 25-05-2021
Ref. Memo No: EQMS/2021/Nil & Dated: 25-05-2021	Sample Source: Ground Water
Sent by:Kazi Farhad Iqbal ,Executive Director , EQMS Consulting Ltd., Banani, Dhaka	Dist:Dhaka, Upa:
Care Taker: EQMS Consulting Ltd. (Sample ID : AQW-9)	Union:, Vill.:
Sample Collection date: 24-05-2021	Date of Testing: 25/05/2021-01/06/2021

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Lead (Pb)	0.05	0.020	mg/L	AAS	0.001

Comments: Sample was collected & supplied by client.
N.B: AAS- Atomic Absorption Spectrophotometer. LOQ- Limit of Quantitation.

Test Performed by:

1.) Name: Md. Saiful Alam Khosru
Designation: Sample Analyzer
Signature
03.06.2021

2.) Name: Taslima Akhter
Designation: Sample Analyzer
03.06.2021

Countersigned/Approved by:

1.) Name: Mita Sarker
Designation: Senior Chemist
Signature
03/06/2021

Mita Sarker
Senior Chemist
Department of Public Health Engineering
Central Laboratory, Mohakhali, Dhaka

2.) Name: Md. Biplab Hossain
Designation: Chief Chemist

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Phone: 88-02-9881927, Fax: 88-02-9882003 , Email: wqmsc_central_lab@yahoo.com

Lab Memo: 944/ CC, DPHE, CL, Dhaka

Date: 03-06-2021

Physical /Chemical/ Bacteriological Analysis of Water Sample

Sample ID: CEN2021060025	Sample Receiving date: 25-05-2021
Ref. Memo No: EQMS/2021/NIII & Dated: 25-05-2021	Sample Source: Ground Water
Sent by:Kazi Farhad Iqbal Executive Director , EQMS Consulting Ltd., Banani, Dhaka.	Dist:Dhaka, Upa:
Care Taker: EQMS Consulting Ltd. (Sample ID : AQW-10)	Union: Vill.:
Sample Collection date: 24-05-2021	Date of Testing: 25/05/2021-01/06/2021

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Lead (Pb)	0.05	0.017	mg/L	AAS	0.001

Comments: Sample was collected & supplied by client.
N B: AAS- Atomic Absorption Spectrophotometer, LOQ- Limit of Quantitation.

Test Performed by:

1.) Name: Md. Saiful Alam Khasru
Designation: Sample Analyzer
Signature
03.06.2021

2.) Name: Taslima Akhter
Designation: Sample Analyzer
03.06.21

Countersigned/Approved by:

1.) Name: Mita Sarker
Designation: Senior Chemist
Signature
03/06/2021

2.) Name: Md. Biplab Hossain
Designation: Chief Chemist

Mita Sarker
Senior Chemist
Department of Public Health Engineering
Central Laboratory, Mohakhali, Dhaka.

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Lab Memo: 944/ CC, DPHE, CL, Dhaka

Date: 03-06-2021

Physical /Chemical/ Bacteriological Analysis of Water Sample

Sample ID: CEN2021060026	Sample Receiving date: 25-05-2021
Ref. Memo No: EQMS/2021/Nil & Dated: 25-05-2021	Sample Source: Ground Water
Sent by:Kazi Farhad Iqbal Executive Director EQMS Consulting Ltd., Banani, Dhaka	Dist:Dhaka, Upa:
Care Taker: EQMS Consulting Ltd. (Sample ID : AQW-11)	Union:, Vill.:
Sample Collection date: 24-05-2021	Date of Testing: 25/05/2021-01/06/2021

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Lead (Pb)	0.05	0.018	mg/L	AAS	0.001

Comments: Sample was collected & supplied by client.
N.B: AAS- Atomic Absorption Spectrophotometer, LOQ- Limit of Quantitation.

Test Performed by:

1.) Name: Md. Saiful Alam Khosru
Designation: Sample Analyzer
Signature
03.06.2021

2.) Name: Taslima Akhter
Designation: Sample Analyzer
03.06.21

Countersigned/Approved by:

1.) Name: Mita Sarker
Designation: Senior Chemist
Signature
03/06/2021

2.) Name: Md. Biplab Hossain
Designation: Chief Chemist

Mita Sarker
Senior Chemist
Department of Public Health Engineering
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Lab Memo. 944/ CC, DPHE. CL, Dhaka

Date: 03-06-2021

Physical /Chemical/ Bacteriological Analysis of Water Sample

Sample ID: CEN2021060027	Sample Receiving date: 25-05-2021
Ref. Memo No: EQMS/2021/Nill & Dated: 25-05-2021	Sample Source: Ground Water
Sent by:Kazi Farhad Iqbal ,Executive Director , EQMS Consulting Ltd., Banani, Dhaka	Dist:Dhaka, Upa:
Care Taker: EQMS Consulting Ltd. (Sample ID : AQW-12)	Union:, Vill.:
Sample Collection date: 24-05-2021	Date of Testing: 25/05/2021-01/06/2021

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Lead (Pb)	0.05	0.016	mg/L	AAS	0.001

Comments: Sample was collected & supplied by client.
N.B: AAS- Atomic Absorption Spectrophotometer, LOQ- Limit of Quantitation.

Test Performed by:

1.) Name: Md. Saiful Alam Khosru
Designation: Sample Analyzer
Signature
03.06.2021

2.) Name: Taslma Akhter
Designation: Sample Analyzer
03 06 21

Countersigned/Approved by:

1.) Name: Mita Sarker
Designation: Senior Chemist
Signature
03/06/2021

2.) Name: Md. Biplab Hossain
Designation: Chief Chemist

Mita Sarker
Senior Chemist
Department of Public Health Engineering
Central Laboratory, Mohakhali, Dhaka

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Phone: 88-02-9881927, Fax: 88-02-9882003 , Email: wqmsc_central_lab@yahoo.com

Lab Memo: 944/ CC, DPHE, CL, Dhaka

Date: 03-06-2021

Physical /Chemical/ Bacteriological Analysis of Water Sample

Sample ID: CEN2021060028	Sample Receiving date: 25-05-2021
Ref. Memo No: EQMS/2021/Nil & Dated: 25-05-2021	Sample Source: Ground Water
Sent by Kazi Farhad Iqbal ,Executive Director , EQMS Consulting Ltd., Banani, Dhaka.	Dist:Dhaka, Upa:
Care Taker: EQMS Consulting Ltd. (Sample ID : AQW-13)	Union:, Vill.:
Sample Collection date: 24-05-2021	Date of Testing: 25/05/2021-01/06/2021

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Lead (Pb)	0.05	0.023	mg/L	AAS	0.001

Comments: Sample was collected & supplied by client.
N.B. AAS- Atomic Absorption Spectrophotometer, LOQ- Limit of Quantitation.

Test Performed by:	Signature	Countersigned/Approved by:	Signature
1.) Name: Md. Saiful Alam Khosru Designation: Sample Analyzer	03.06.2021	1.) Name: Mita Sarker Designation: Senior Chemist	03/06/2021 Mita Sarker Senior Chemist Department of Public Health Engineering Central Laboratory, Mohakhali, Dhaka.
2.) Name: Taslima Akhter Designation: Sample Analyzer	03 06 21	2.) Name: Md. Biplab Hossain Designation: Chief Chemist	

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Phone: 88-02-9881927, Fax: 88-02-9882003 , Email: wqmsc_central_lab@yahoo.com

Lab Memo: 944/ CC, DPHE, CL. Dhaka — Date: 03-06-2021

Physical /Chemical/ Bacteriological Analysis of Water Sample

Sample ID: CEN2021060029	Sample Receiving date: 25-05-2021
Ref. Memo No: EQMS/2021/Nil & Dated: 25-05-2021	Sample Source: Ground Water
Sent by:Kazi Farhad Iqbal Executive Director , EQMS Consulting Ltd., Banani, Dhaka.	Dist:Dhaka, Upa:
Care Taker: EQMS Consulting Ltd. (Sample ID : AQW-14)	Union:, Vill.:
Sample Collection date: 24-05-2021	Date of Testing: 25/05/2021-01/06/2021

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Lead (Pb)	0.05	0.029	mg/L	AAS	0.001

Comments: Sample was collected & supplied by client.
N B: AAS- Atomic Absorption Spectrophotometer. LOQ- Limit of Quantitation.

Test Performed by:	Signature	Countersigned/Approved by:	Signature
1.) Name: Md. Saiful Alam Khosru Designation: Sample Analyzer	02.06.2021	1.) Name: Mita Sarker Designation: Senior Chemist	03/06/2021 Mita Sarker Senior Chemist Department of Public Health Engineering Central Laboratory, Mohakhali, Dhaka.
2.) Name: Taslima Akhter Designation: Sample Analyzer	03.06.21	2.) Name: Md. Biplab Hossain Designation: Chief Chemist	

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Lab Memo: 944/ CC, DPHE :CL Dhaka

Date: 03-06-2021

Physical /Chemical/ Bacteriological Analysis of Water Sample

Sample ID: CEN2021060030	Sample Receiving date: 25-05-2021
Ref. Memo No: EQMS/2021/Nill & Dated: 25-05-2021	Sample Source: Ground Water
Sent by:Kazi Farhad Iqbal ,Executive Director , EQMS Consulting Ltd., Banani, Dhaka.	Dist:Dhaka, Upa:
Care Taker: EQMS Consulting Ltd. (Sample ID : AQW-15)	Union : , Vill.:
Sample Collection date: 24-05-2021	Date of Testing: 25/05/2021-01/06/2021

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Lead (Pb)	0.05	0.019	mg/L	AAS	0.001

Comments: Sample was collected & supplied by client.
N.B: AAS- Atomic Absorption Spectrophotometer, LOQ- Limit of Quantitation.

Test Performed by:

1.) Name: Md. Saiful Alam Khosru
Designation: Sample Analyzer
Signature
03.06.2021

2.) Name: Taslima Akhter
Designation: Sample Analyzer
03.06.21

Countersigned/Approved by:

1.) Name: Mita Sarker
Designation: Senior Chemist
Signature
03/06/2021
Mita Sarker
Senior Chemist
Department of Public Health Engineering
Central Laboratory, Mohakhali, Dhaka.

2.) Name: Md. Biplab Hossain
Designation: Chief Chemist

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Lab Memo: 944/ CC, DPHE, CL, Dhaka — Date: 03-06-2021

Physical /Chemical/ Bacteriological Analysis of Water Sample

Sample ID: CEN2021060031	Sample Receiving date: 25-05-2021
Ref. Memo No: EQMS/2021/Nill & Dated: 25-05-2021	Sample Source: Ground Water
Sent by:Kazi Farhad Iqbal ,Executive Director , EQMS Consulting Ltd., Banani, Dhaka.	Dist:Dhaka, Upa:
Care Taker: EQMS Consulting Ltd. (Sample ID : AQW-16)	Union:, Vil.:
Sample Collection date: 24-05-2021	Date of Testing: 25/05/2021-01/06/2021

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Lead (Pb)	0.05	0.021	mg/L	AAS	0.001

Comments: Sample was collected & supplied by client.
N.B: AAS- Atomic Absorption Spectrophotometer LOQ- Limit of Quantitation

Test Performed by:

1.) Name: Md. Saiful Alam Khosru
Designation: Sample Analyzer — Signature — 03.06.2021

2.) Name: Taslima Akhter
Designation: Sample Analyzer — 03.06.21

Countersigned/Approved by:

1.) Name: Mita Sarker
Designation: Senior Chemist — Signature — 03/06/2021

Mita Sarker
Senior Chemist
Department of Public Health Engineering
Central Laboratory, Mohakhali, Dhaka.

2.) Name: Md. Biplab Hossain
Designation: Chief Chemist

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Lab Memo: 944/ CC, DPHE CL Dhaka

Date: 03-06-2021

Physical /Chemical/ Bacteriological Analysis of Water Sample

Sample ID: CEN2021060032	Sample Receiving date: 25-05-2021
Ref. Memo No: EQMS/2021/Nill & Dated: 25-05-2021	Sample Source: Ground Water
Sent by:Kazi Farhad Iqbal ,Executive Director , EQMS Consulting Ltd., Banani, Dhaka.	Dist:Dhaka, Upa:
Care Taker: EQMS Consulting Ltd. (Sample ID : AQW-17)	Union:, Vill.:
Sample Collection date: 24-05-2021	Date of Testing: 25/05/2021-01/06/2021

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Lead (Pb)	0.05	0.019	mg/L	AAS	0.001

Comments: Sample was collected & supplied by client.
N.B: AAS- Atomic Absorption Spectrophotometer, LOQ- Limit of Quantitation

Test Performed by:

Signature

1.) Name: Md. Saiful Alam Khosru
Designation: Sample Analyzer
03.06.2021

2.) Name: Taslima Akhter
Designation: Sample Analyzer
03.06.21

Countersigned/Approved by:

Signature

1.) Name: Mita Sarker
Designation: Senior Chemist
03/06/2021
Mita Sarker
Senior Chemist
Department of Public Health Engineering
Central Laboratory, Mohakhali, Dhaka

2.) Name: Md. Biplab Hossain
Designation: Chief Chemist

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Report of BCSIR Laboratory

Form No. QSF-22 Revision No. 12 Revision Date: 04 November, 2020

জীবনের জন্য বিজ্ঞান "শেখ হাসিনার দর্শন, সব মানুষের উন্নয়ন"

বাংলাদেশ বিজ্ঞান ও শিল্প গবেষণা পরিষদ

BANGLADESH COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

Institute of National Analytical Research and Service (INARS)

ANALYSIS REPORT

ASC Ref No. : IN-107 of Analytical Service Cell BCSIR, 22/04/2021

Lab/Sample ID : A-471-476

Client's Details : K. M Shakik Ahmed Walid
MS in GIS for Environment and Development
Jahangirnagar University

Number of Sample : 06 (Six)

Sample Description : Request for testing of Surface and Ground water as part of Academic Research Work. Date: April 22, 2021.

Test Commencement Date : 22/04/2021

Test Completion Date : 30/05/2021

Lab ID	Particulars of supplied sample	Test Parameters	Results	BDS Standard 1240: 1989	Test Method (APHA)
A-471	Surface Water (MRT 05 N SW-01)	Total Coliform (MPN/100 ml)	>1600	nil	9221B-C
A-472	Surface Water (MRT 05 N SW-02)	Total Coliform (MPN/100 ml)	>1600	nil	9221B-C
A-473	Surface Water (MRT 05 N SW-03)	Total Coliform (MPN/100 ml)	32.0	nil	9221B-C
A-474	Surface Water (MRT 05 N SW-04)	Total Coliform (MPN/100 ml)	47.0	nil	9221B-C
A-475	Surface Water (MRT 05 N SW-05)	Total Coliform (MPN/100 ml)	40.0	nil	9221B-C
A-476	Surface Water (MRT 05 N SW-06)	Total Coliform (MPN/100 ml)	>1600	nil	9221B-C

Rokaia Sultana 30.05.21

Analyst
Rokaia Sultana
Scientific Officer
Institute of National Analytical Research & Service (INARS)
BCSIR, Dhaka-1205

30.5.21

Supervisor

30/05/21

Director
Shamim Ahmed
Director (In-Charge)
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Page 1 of 1

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Form No. QSF-22 Revision No. 12 Revision Date: 04 November, 2020

জীবনের জন্য বিজ্ঞান "শেখ হাসিনার দর্শন, সব মানুষের উন্নয়ন"

বাংলাদেশ বিজ্ঞান ও শিল্প গবেষণা পরিষদ

BANGLADESH COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

Institute of National Analytical Research and Service (INARS)

ANALYSIS REPORT

ASC Ref No. : IN-107 of Analytical Service Cell
BCSIR, 22/04/2021

Lab/Sample ID : A-477-486

Client's Details : K. M Shakik Ahmed Walid
MS in GIS for Environment and Development
Jahangirnagar University

Number of Sample : 10 (Ten)

Sample Description : Request for testing of Surface and Ground water as part of Academic Research Work, Date: April 22, 2021.

Test Commencement Date : 22/04/2021

Test Completion Date : 30/05/2021

Lab ID	Particulars of supplied sample	Test Parameters	Results	BDS Standard 1240: 1989	Test Method (APHA)
A-477	Ground Water (MRT 05 N GW-01)	Bicarbonate	206 mg/L	–	TITRIMETRIC
		Fecal Coliform (MPN/100 ml)	<1.8*	nil	9221B-C
A-478	Ground Water (MRT 05 N GW-02)	Bicarbonate	154 mg/L	–	TITRIMETRIC
		Fecal Coliform (MPN/100 ml)	<1.8*	nil	9221B-C
A-479	Ground Water (MRT 05 N GW-03)	Bicarbonate	454 mg/L	–	TITRIMETRIC
		Fecal Coliform (MPN/100 ml)	<1.8*	nil	9221B-C
A-480	Ground Water (MRT 05 N GW-04)	Bicarbonate	160 mg/L	–	TITRIMETRIC
		Fecal Coliform (MPN/100 ml)	<1.8*	nil	9221B-C
A-481	Ground Water (MRT 05 N GW-05)	Bicarbonate	148 mg/L	–	TITRIMETRIC
		Fecal Coliform (MPN/100 ml)	<1.8*	nil	9221B-C

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বাংলাদেশ বিজ্ঞান ও শিল্প গবেষণা পরিষদ

BANGLADESH COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

Lab ID	Particulars of supplied sample	Test Parameters	Results	BDS Standard 1240: 1989	Test Method (APHA)
A-482	Ground Water (MRT 05 N GW-06)	Bicarbonate	181 mg/L	--	TITRIMETRIC
		Fecal Coliform (MPN/100 ml)	<1.8*	nil	9221B-C
A-483	Ground Water (MRT 05 N GW-07)	Bicarbonate	193 mg/L	--	TITRIMETRIC
		Fecal Coliform (MPN/100 ml)	<1.8*	nil	9221B-C
A-484	Ground Water (MRT 05 N GW-08)	Bicarbonate	176 mg/L	--	TITRIMETRIC
		Fecal Coliform (MPN/100 ml)	<1.8*	nil	9221B-C
A-485	Ground Water (MRT 05 N GW-09)	Bicarbonate	170 mg/L	--	TITRIMETRIC
		Fecal Coliform (MPN/100 ml)	<1.8*	nil	9221B-C
A-486	Ground Water (MRT 05 N GW-10)	Bicarbonate	175 mg/L	--	TITRIMETRIC
		Fecal Coliform (MPN/100 ml)	<1.8*	nil	9221B-C

*As per MPN (most probable number) chart (APHA-22nd edition), MPN <1.8 indicates absence of test organism in the supplied sample.

Rokaia sultana 30.05.21

Analyst
Rokaia Sultana
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30.5.21

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ইন্সটিটিউট অব ন্যাশনাল এনালাইটিক্যাল
রিসার্চ এন্ড সার্ভিস (আইএনএআরএস)
বিসিএসআইআর, ঢাকা

30/05/21

Director
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Test Commencement Date : 22/04/2021

Test Completion Date : 30/05/2021

Lab ID	Particulars of supplied sample	Parameters	Concentration	Acceptable limit for drinking water according to BDS 1240:2001	Test Method (APHA)
A-477	Ground Water (MRT 05 N GW-01)	Sodium (Na)	22.2 mg/L	200 mg/L (Max)	3500-Na B
A-478	Ground Water (MRT 05 N GW-02)	Sodium (Na)	20.9 mg/L	200 mg/L (Max)	3500-Na B
A-479	Ground Water (MRT 05 N GW-03)	Sodium (Na)	28.7 mg/L	200 mg/L (Max)	3500-Na B
A-480	Ground Water (MRT 05 N GW-04)	Sodium (Na)	22.2 mg/L	200 mg/L (Max)	3500-Na B
A-481	Ground Water (MRT 05 N GW-05)	Sodium (Na)	25.8 mg/L	200 mg/L (Max)	3500-Na B
A-482	Ground Water (MRT 05 N GW-06)	Sodium (Na)	24.2 mg/L	200 mg/L (Max)	3500-Na B

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Lab ID	Particulars of supplied sample	Parameters	Concentration	Acceptable limit for drinking water according to BDS 1240:2001	Test Method (APHA)
A-483	Ground Water (MRT 05 N GW-07)	Sodium (Na)	25.9 mg/L	200 mg/L (Max)	3500-Na B
A-484	Ground Water (MRT 05 N GW-08)	Sodium (Na)	24.0 mg/L	200 mg/L (Max)	3500-Na B
A-485	Ground Water (MRT 05 N GW-09)	Sodium (Na)	24.3 mg/L	200 mg/L (Max)	3500-Na B
A-486	Ground Water (MRT 05 N GW-10)	Sodium (Na)	24.8 mg/L	200 mg/L (Max)	3500-Na B

30.05.2021

Analyst

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Senior Scientific Officer

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30.5.21

Supervisor

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বিসিএসআইআর, ঢাকা

30/05/21

Director

Shamim Ahmed

Director (In-Charge)

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Appendix C: Photographs of Baseline Monitoring

AQ1: Hemayetpur Station

AQ2: Western Boundary of the Depot Area

AQ3: Eastern Boundary of the Depot Area

AQ4: Front Site of the Depot Area (Beside Dhaka-Aricha Highway)

AQ5: Baliarpur Station

AQ6: Bilamalia Station

AQ7: Amin Bazar Station

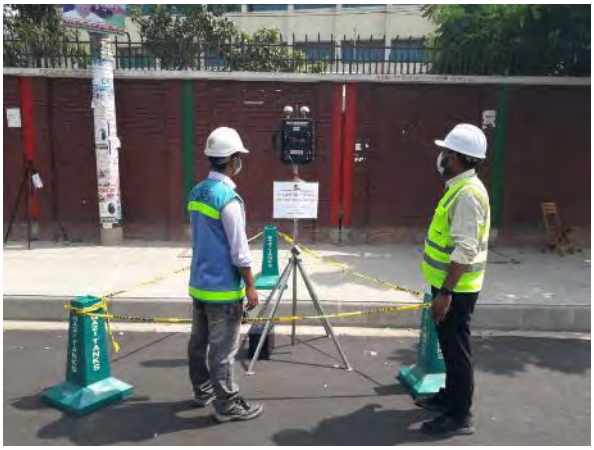
AQ8: Gabtoli Station

AQ9: Dar-us-Salam Station

AQ10: Mirpur-1 Station

AQ11: Mirpur-10 Station

AQ12: Mirpur-14 Station



AQ13: Kochukhet Station

AQ14: Banani Station

AQ15: Gulshan-2 Station

AQ16: Notun Bazar Station

AQ17: Vatara Station

NL1: Hemayetpur Station

NL2: In-front of Al Nasir Laboratory School, Hemayetpur

NL3: In-front of Baitul Habib Mosque, Hemayetpur

NL4: Depot Area (Western Boundary of the Depot)

NL5: Depot Area (Eastern Boundary of the Depot)

NL6: Alam Nagar Central Jame Mosque, Sugandha Housing, Hemayetpur

NL7: Baliarpur Station (In-front of Institute for Autistic Children and Blind, Old Home and TN Mother Child Hospital)

NL8: Jamia Islamia Jame Mosque, Baliarpur

NL9: Jamuna Natural Park, Aminbazar

NL10: Bilamalia Station

NL11: Amin Bazar Station

NL12: Gabtoli Station

NL13: Dar-us-Salam Station (In front of Delta Medical College & Hospital)

NL14: Mirpur-1 Station

NL15: Mirpur-10 Station

NL16: Mirpur-14 Station

NL17: Kochukhet Station (In front of Shaheed Police Smrity College)

NL18: Banani Station

NL19: Gulshan-2 Station

NL20: Notun Bazar Station

NL21: In Front of Baitul Mamur Mosque, Madani Avenue, Vatara

NL 22: In front of Divine Mercy Church, Vatara

NL23: Vatara Station

SW1: Upstream of Karnatali River, Rajarghat

SW2: Downstream of Karnatali River (In-between Gendura and Nagarkunda)

SW3: Baliarpur (Northern side of Dhaka-Aricha Highway)

SW4: Pond at Amin Bazar (South Side of Dhaka-Aricha highway)

SW5: Pond at Amin Bazar (North Side of highway)

SW6: Canal at Satarkul-Vatara 1st Bridge, Madani Avenue, Vatara

GW1: Depot Area

GW2: Markazut tarbiya Madrasha, Sugandha Housing, Alam Nagar, Hemayetpur

GW3: Abu Saeed's Home, 20/A, Goidartek, word: 10, Gabtoli

GW4: DWASA Mods Zone-4, Dar us salam (Near to Mirpur Bangla College)

GW5: Paikpara Govt. Colony, Mirpur-1

GW6: Mirpur-10 (bottled water production plant)

GW7: Police Staff College, Mirpur

GW8: Mirpur-14, DWASA Pump House

GW9: Banani DOHS Club Canteen

GW10: Vatara DWASA Pump House

Appendix D: JICA Environmental Checklist

Category	Items	Check points	Yes: Y No: N	Measures of Environmental and Social Considerations (Reasons for Yes or No, Bases, Mitigation measures)
1. permits and explanation	(1) EIA and Environmental Permits	(a) Have EIA reports been officially completed? (b) Have EIA reports been approved by authorities of the host country's government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? (d In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(a) Y (b) Y (c) N (d) N/A	(a) An F/S stage EIA report was prepared in 2017, which is being updated in 2022 based on information from D/D stage. EIA is prepared in accordance with laws and regulations of Government of Bangladesh, as well as JICA Guidelines. (b) Yes, the F/S stage EIA report was reviewed and approved by DoE on 05/11/2017. This approval (known as Environmental Clearance Certificate, ECC) needs to be renewed annually. The latest ECC was issued on 26/10/2021 and valid till 04/11/2022. (c) There are conditions mentioned in the ECC documents for operating, monitoring, reporting, etc., mostly for construction and operation stage. All conditions will be fulfilled appropriately. (d) The project does not need other environmental permits. However, DMTCL will obtain other permits, for example, ground water abstraction, fire protection, etc. as required.
	(2) Explanation to the Public	(a) Are contents of the project and the potential impacts adequately explained to the public based on appropriate procedures, including information disclosure? Is understanding obtained from the public? (b) Are proper responses made to comments from the public and regulatory authorities?	(a) Y (b) Y	(a) During the F/S stage EIA preparation, stakeholder meetings (2 times x 4 venues) were held. The outlines and expected impacts of the project were shared with the stakeholders. The EIA document is currently available at DMTCL website for public disclosure. For Updated EIA preparation, another 2 public consultations were held and public opinions are recorded. In addition, opinions were obtained through Key Informant Interview (KII) of 17 eminent persons, including local elite, public representatives, religious leaders, school teachers, university professors, transport experts and environmental experts. Further, the D/D stage Updated EIA will also be posted permanently at DMTCL website for public disclosure. (b) Project authority responded to comments made by public, which

Category	Items	Check points	Yes: Y No: N	Measures of Environmental and Social Considerations (Reasons for Yes or No, Bases, Mitigation measures)
				are reported in the Updated EIA. The opinions and comments are reflected to project design, as applicable.
	(3) Alternatives	(a) Are the alternatives of the project examined in terms of the environmental and social matters?	(a) Y	(a) For planning of structure types, alignment and depot locations, alternatives have been examined in terms of environmental and social considerations. There is a separate section (Sec 3.13) in the Updated EIA on alternative analysis.
2. Mitigation Measures	(1) Air Quality	(a) Is there a possibility that air pollutants emitted from various sources, such as construction machinery will affect ambient air quality? Does ambient air quality comply with the country's ambient air quality standards? (b) Where industrial areas already exist near the route, is there a possibility that the project will make air pollution worse?	(a) Y (b) N	(a) Inherent ambient air quality of Dhaka is poor in winter season and exceeds the standards of air quality of Bangladesh. Baseline air quality sampling during EIA and Updated EIA preparations also confirm this. As explained in Sec 4.4.1 of Updated EIA (2022), concentrations of PM and NOx of ambient air quality at some locations currently exceeded the standards of air quality in Bangladesh. There is a possibility of air pollution by construction machinery, so required measures are included in the EMP. (b) Since the trains are electric traction powered, there will be no impacts on air quality directly in the operation stage. Rather it will contribute towards air quality improvement as it will reduce small vehicle operations.
	(2) Water Quality	(a) Is there a possibility that soil runoff from the bare lands resulting from earthmoving activities, such as cutting and filling will cause water quality degradation in downstream water areas? (b)Do effluents from various facilities, such as stations and depot areas/service areas comply with the country's effluent standards and ambient water quality standards? Is there a possibility that the effluents will cause areas that do not comply with the country's ambient water quality standards?	(a) N (b) Y	(a) Entire alignment is either elevated viaduct or underground tunnel within public road ROW, so no scope of cutting and filling except depot area. Depot area land development needs filling activities, which may cause soil runoff. Proper countermeasures are included in the design. (b) Effluent from the stations and depot will be treated to meet the standards of water quality of Bangladesh prior to discharge. Proper measures are proposed to prevent water pollution during construction.

Category	Items	Check points	Yes: Y No: N	Measures of Environmental and Social Considerations (Reasons for Yes or No, Bases, Mitigation measures)
	(3) Waste	(a) Are wastes derived from stations and depot facilities legally disposed?	(a) Y	(a) The wastes derived from the stations and depot facility will be disposed legally, based on Operational Waste Management Plan to be developed by the Contractor as part of Operational Manual. Proper measures are proposed for waste management during construction period in the EMP. Contractors are obelized to make legal dispose, which will be supervised by DMTCL and supervision consultant.
	(4) Noise and Vibration	(a) Do noise and vibrations from railway comply with the country's standards?	(a) Y	(a) The host country does not have noise and vibration standards for railway operation. Measures to meet the guidelines of railway noise of Japan and other countries are adopted.
	(5) Ground Subsidence	(a) Does vast extraction of groundwater cause ground subsidence?	(a) N	(a) There will be limited groundwater extraction at depot area only, so there is a low possibility of ground subsidence.
3. Natural Environment	(1) Protected Areas	(a) Is the project site located in protected areas designated by the country's law or international treaties and conventions? Is there a possibility that the project will affect the protected area?	(a) N	(a) There are water bodies which are designated as ECA along the project. However, there is no direct impacts because the alignment runs through the water bodies with underground structure. As such, DOE, the competent authority for ECA, has already issued ECC for the Project.
	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats? (b)Does the project site encompass the protected habitats of endangered species designated by the country's law or international treaties and conventions? (c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem? (d) Are adequate protection measure taken to prevent impacts, such as disruption of migration routes, habitat fragmentation, and traffic accident of wildlife and	(a)N (b)N (c)N/A (d)N/A (e)N (f)N	(a) There are no primeval forests, tropical rain forests, and ecologically valuable habitats near the Project site. (b) The survey conducted during EIA preparation confirmed that there is no habitat of rare species in the Project site. (c) No significant ecological impacts are anticipated. (d) Because the project is far from forest area and wildlife habitat, there are no impacts like disruption of migration routes, habitat fragmentation, and traffic accident of wildlife and livestock. (e) Because the project is an urban railway, there is no possibility of such negative impacts. (f) Because the project is an urban railway in developed areas, there

Category	Items	Check points	Yes: Y No: N	Measures of Environmental and Social Considerations (Reasons for Yes or No, Bases, Mitigation measures)
		livestock? (e) Is there a possibility that installation of railway will cause impacts, such as destruction of forest, poaching, etc.? (f) In case where the project site is located at undeveloped areas, is there a possibility that the new development will result in extensive loss of nature environments?		are low possibility that the project induced development deteriorates the natural environment.
3. Natural Environment	(3) Hydrology	(a) Is there a possibility that alteration of topographic features and installation of structures, such as tunnels will adversely affect surface water and groundwater flows?(b) Does structures affect the flows of surface and underground water?	(a)N(b) N	(a) Because the project will not have any structures on surface water, so there are no direct impacts on surface water. Also, as the groundwater level is lower than the underground structures of the project, there is a very low possibility of negative impacts on groundwater flow.(b) As explained above, no such possibility is anticipated.
	(4) Topography and Geology	(a) Is there a soft ground on the route that may cause slope failures or landslides? Are adequate measure considered to prevent slope failures or landslides, where needed? (b) Is there a possibility that civil works, such as cutting and filing will cause slope failure or landslides? Are adequate measure considered to prevent slope failure or landslides? (c) Is there a possibility that soil runoff will result from cut and fill areas, waste soil disposal sites, and borrow sites? Are adequate measure taken to prevent soil runoff?	(a) N/A (b) Y (c) Y	(a) Because the project is located on a plainland, there is low possibility of slope failures or landslides. To prevent slope failures at the depot, proper design measures are taken for slope protection. (b) Because the excavation work may cause slope failures, appropriate measures for construction are included in the design. (c) Regarding the soil runoff, appropriate measures are included in the design.
4. Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the	(a)Y (b)Y (c)Y	(a) Implementation of the project will cause the involuntary resettlement. Alternatives have been examined to minimize negative impacts of resettlement. RAP has been prepared, and updating of

Category	Items	Check points	Yes: Y No: N	Measures of Environmental and Social Considerations (Reasons for Yes or No, Bases, Mitigation measures)
		resettlement? (b) Is adequate explanation on relocation and compensation given to affected persons prior to resettlement? (c) Is the resettlement plan, including proper compensation, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? (d) Are compensations paid prior to the resettlement? (e) Are compensation policies issued written instructions? (f) Does the resettlement plan pay particular attention to vulnerable groups or persons, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? (g) Are agreements with the affected persons obtained prior to resettlement? (h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Are monitoring on the resettlement planned? (j) Is a plan developed to monitor the impacts of resettlement?	(d)Y (e)Y (f)Y (g)Y (h)Y (i)Y (j)Y	which is ongoing. Implementation of RAP will minimize the negative impacts of resettlement. (b) During preparation of RAP, compensation policy was shared with PAPs through stakeholder meetings. The policy will be again shared during updating of RAP. (c) Yes, the Entitlement Matrix, and Livelihood and Income Restoration Program, are based on the socioeconomic survey conducted during F/S stage. For upgrading of RAP, another round of socioeconomic survey will be conducted. (d) Compensations will be paid prior to resettlement. (e) During RAP implementation, written compensation policies will be distributed. (f) Yes, entitlement matrix of F/S stage RAP includes particular attention to vulnerable groups or persons. (g) During consultations, no concrete objections from affected persons were identified during F/S stage RAP preparation. (h) DMTCL already established a safeguard unit headed by an additional project director. DMTCL also assures to establish other organizational framework like JVC, PVAC, GRC during the implementation of RAP. Budget has been secured in Project's DPP. (i) Yes, LAP/ RAP monitoring is conducted as part of GC consulting service. Quarterly monitoring reports are issued and shared with JICA. (j) Yes. An External Monitoring Agency (EMA) will be appointed during RAP implementation to monitor impacts of resettlement.
	(2) Living and Livelihood	(a) Where railway is newly installed, is there a possibility that the project will affect the existing means of transportation and associated workers? Is there a possibility that the project will cause significant impacts,	(a)N (b)N (c)N	(a) Existing traffic such as CNG and Rickshaw will convert into feeder traffic. Since the project location is a developed urban, the project will not cause significant conversion of land use and livelihood and unemployment. On the contrary, the project will open

Category	Items	Check points	Yes: Y No: N	Measures of Environmental and Social Considerations (Reasons for Yes or No, Bases, Mitigation measures)
		such as extensive alteration of existing land uses, changes in sources of livelihood, or unemployment? Is adequate measure considered for preventing these impacts? (b) Is there a possibility that the project will adversely affect the living condition of inhabitants other than the affected inhabitants? Are adequate measures considered to reduce the impacts, if necessary? (c) Is there a possibility that diseases, including communicable diseases, such as HIV will be introduced due to immigration of workers associated with the project? Are adequate considerations given to public health, if necessary? (d) Is there a possibility that railway will cause impede the movement of inhabitants? (e) Is there a possibility that structures associated with railway such as bridges will cause a sun shading and radio interference?	(d)N (e)N	up scope of extensive economic activities. (b) There are low possibility of negative impacts on other residents. Rather, the project will improve the living conditions of the city dwellers. (c) Since the project is urban railway, it is not expected that vast population will flow from other areas. Regarding construction phase, appropriate education and enlightenment on public health will be conducted for construction workers. An HIV/AIDS awareness policy has been developed and such provisions are included in the Contractor's bid documents. (d) Since the project takes underground and viaduct structure, the railway will not obstruct movement of residents. (e) Tunnel and underground stations will be located underground, so no issue of sun shade and radio interference. Since the elevated structures of the project will be installed in wide road, sun shading and radio interference will not be a major issue.
	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage sites? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a)N	(a) There are no archeological, historical, cultural, and religious heritage sites around the project site. Nonetheless, a dedicated study is now ongoing for Historical and Archeological site under the GC consulting service. Adequate measures will be proposed through that specialized study, if required.
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a)N	(a) There is no possibility of landscape change due to the project.
	(5) Ethnic Minorities and	(a) Where ethnic minorities and indigenous peoples are living in the rights-of-way, are considerations given to reduce the impacts on culture and lifestyle of ethnic	(a)N/A (b)N/A	(a) The project site is located in an area, which is not natural habitat of ethnic minorities and indigenous peoples.

Category	Items	Check points	Yes: Y No: N	Measures of Environmental and Social Considerations (Reasons for Yes or No, Bases, Mitigation measures)
	Indigenous Peoples	minorities and indigenous peoples? (b) Does the project comply with the country's laws for rights of ethnic minorities and indigenous peoples?		(b) Not applicable as there is no ethnic minorities and indigenous peoples.
4. Social Environment	(6) Working conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project?(b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials?(c)Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public sanitation) for workers etc.?(d)Are appropriate measures being taken to ensure that security guards involved in the project do not violate safety of other individuals involved, or local residents?	(a)Y(b)Y (c)Y(d)Y	(a) The project is implemented based on the host country's laws. The Project will abide by relevant laws and regulations on working conditions, labor and occupational health of GoB.(b)(c)(d) Health and safety requirements are included in the Contractor's bid documents. DMTCL and supervision consultant will strictly inspect the safety compliance.
5. Others	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? (b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts? (c) If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts?	(a)Y (b)Y (c)Y	(a) (b) Yes. Environmental Contract Specifications (ECS) has been prepared to mitigate adverse impacts during construction. ECS has been included in the Contractor's bid documents. DMTCL and supervision consultant will strictly inspect the environmental compliance. ECS also requires continuous monitoring. Supervision consultant will prepare quarterly monitoring reports, which will be shared with DOE and JICA. (c) The construction activities of the project will have limited impact on social environment directly. Nonetheless, measures are included in the ECS.

Category	Items	Check points	Yes: Y No: N	Measures of Environmental and Social Considerations (Reasons for Yes or No, Bases, Mitigation measures)
	(2) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? (b) Are the items, methods and frequencies included in the monitoring program judged to be appropriate? (c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a)Y (b)Y (c)Y (d)Y	(a) According to the monitoring plan stated in the EIA report and the ECS, the monitoring will be conducted by contractor as well as supervision consultant. (b) Yes, the items, methods and frequencies included in the monitoring program provided in the EIA and ECS are judged as appropriate. Further review will be made during preparation of Contractor's Environmental Management Program (CEMP). (c) DMTCL already established a dedicated safeguard section. DMTCL will ensure proper budget for sustain monitoring framework. (d) DOE and JICA requires quarterly environmental monitoring reporting. DMTCL assures that such reports will be prepared by the supervision consultant and will be shared with JICA and DOE.
6. Note	Other Environmental Checklist	(a) If necessary, the impact factors on forestry shall be added. (b) If necessary, the impact factors on power transmission shall be added.	(a)N/A (b)Y	(a) The project is far from any primary forest. (b) Power transmission facilities are currently studied in detail design phase. In case any negative impacts are expected, appropriate mitigation measures will be examined.
	Note on Using Environmental Checklist	(a) If necessary, the impacts to transboundary or global issues should be confirmed, if necessary (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	(a)N	(a) No negative impact on transboundary or global environmental issues. Rather, the Project will decrease carbon emission and NOX/SOX by decreasing vehicles on the roads.

Appendix E : Participants List of Public Consultation Meetings

Participant List of PCM-1

গণপ্রজাতন্ত্রী বাংলাদেশ সরকার
সড়ক পরিবহন ও মহাসড়ক বিভাগ
ঢাকা ম্যাস ট্রানজিট কোম্পানি লিমিটেড
ঢাকা ম্যাস র‍্যাপিড ট্রানজিট ডেভেলপমেন্ট প্রজেক্ট (লাইন-৫) ঃ নর্দার্ণ রুট
প্রবাসী কল্যাণ ভবন, লেভেল-০৪
৭১-৭২ পুরাতন এ্যালিফ্যান্ট রোড, ইস্কাটন গার্ডেন, ঢাকা-১০০০
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তারিখ : ২০ সেপ্টেম্বর ২০২১
সময় : সকাল ১০:৩০ মিনিট
স্থান : প্রান্ত পার্টি সেন্টার, হেমায়েতপুর

ক্রঃ নং	নাম	পদবী	প্রতিষ্ঠান	মোবাইল নম্বর	স্বাক্ষর
১	[illegible]	[illegible] MRT Line-5	DMTCL	01712112553	
2.	Kazuya KITAMURA	ATL	UFCA	01779688070	
৩.	[illegible]	Team Leader	KMC	01712714165	
৪	[illegible]	[illegible] BNSB	BNSB	01728288733	
৫.	[illegible]	APD (E&S and LA&RS)	MRTL-5: N.R.	01720403937	
৬	[illegible]	[illegible]	[illegible]	01735558460	
৭	[illegible]	[illegible]	[illegible]	01711346034	
৮	[illegible]	[illegible]	[illegible]		
৯	[illegible]	Asst. Consultant EQMS	EQMS Consulting Ltd.	01822456177	
১০.	NAYMA AKTHER JAHAN	Asst. Consultant EQMS	EQMS	01312564706	

বিতরনকারীর নাম ও স্বাক্ষর
Maisha Tahsin Hossain

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স্থান : প্রান্ত পার্টি সেন্টার, হেমায়েতপুর

ক্র: নং	নাম	পদবী	প্রতিষ্ঠান	মোবাইল নম্বর	স্বাক্ষর
১১	md. Zahidul Islam	senior consultant	EQMS consulting ltd	01911569270	Zahid
১২	Tawhidul Hasan	Principal Consultant	EQMS consulting Ltd.	01721346853	
১৩	ferdows-Alam Quaraishi	Consultant	EQMS Consulting Ltd.	01717730050	FAQuaraishi
১৪	Maisha Tahrin Hossain	Assistant Consultant	EQMS Consulting Ltd	01912873136	
১৫	Tahmina Nazmin Surovi	Assistant Consultant	EQMS Consulting Ltd.	01759506867	
১৬	Tapos Koremoker	Assistant consultant	EQMS consulting Ltd.	01759368602	
১৭	Rabiul Karim	Senior Consultant	EQMS Consulting Ltd.	01711383496	
১৮	Al-Amin Mia	Junior Ex.	EQMS Consulting Ltd	01766-025729	
১৯	Anjuman Ara Rahman	Natural Env. Spe.	MFCA	01911034040	A.Rahman
২০	Tonmoy Pandit	Jnr. Eng. Natural Env-1	MFCA	01794629289	

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ক্র: নং	নাম	পদবী	প্রতিষ্ঠান	মোবাইল নম্বর	স্বাক্ষর
২১	সৈয়দ আব্দুল হামিদ	ডিপিডি	DMTCL	01912-239425	[signature]
২২	মো: সাইদুল ইসলাম	চেয়ারম্যান	বনগাঁও ইউনিয়ন পরিষদ	01713180 2580	[signature]
২৩	রাহেলা মেম্বার	গৃহিনী	—	01994277346	রাহেলা
২৪	জমিলা খাতুন	মেম্বার	নগরকুন্ডা	01409051987	জমিলা
২৫	মো. মজিবুর	ব্যবসায়ী	মিজান ডেকোরেটর	01712263221	মজিবুর
২৬	মো: সেলিম হোসেন	ব্যবসায়ী	ওয়েলকাম টেইলার্স	01881964677	মো: সেলিম
২৭	মামুন রশীদ	ব্যবসায়ী	ওয়ালটন ডিলারশিপ	0174440792	[signature]
২৮	দীন ইসলাম	ব্যবসায়ী	সাদিক স্টোর	01614610009	[signature]
২৯	মো. মাহবুবর রহমান	ব্যবসায়ী	আল্লাহর দান হোটেল	01911741382	[signature]
৩০	মো: ইয়াছিন আরাফাত	ব্যবসায়ী	ইয়াসিন স্টোর	01717826850	ইয়াসিন

বিতরনকারীর নাম ও স্বাক্ষর [signature] Haisha Tahrein Hossain
Assistant Consultant
20-9-2021.

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স্থান : প্রান্ত পার্টি সেন্টার, হেমায়েতপুর

ক্রঃ নং	নাম	পদবী	প্রতিষ্ঠান	মোবাইল নম্বর	স্বাক্ষর
০১	আব্দুস সাত্তার	ব্যবসায়ী	ইয়াসিন স্টোর	01717826850	
০২	[illegible]	ব্যবসায়ী	SMART Choice	01777642333	
০৩	[illegible]	চাকুরী	KMC Ltd.	01712225455	
০৪	[illegible]	চাকুরী	KMC Ltd.	01715-651532	
০৫	Md. Mahidul Islam	Service	DTL- LAP/RAP, KMC	01206311480	
০৬	[illegible]	প্রবীন শিক্ষক	[illegible]	01712831181	
০৭	Abdus Sobhan	Director	National Heart Foundation	01552410501	
০৮	মো. আবু তাহের	ব্যবসায়ী	[illegible]	01912816921	
০৯	মো. ইব্রাহীম	ব্যবসায়ী	[illegible]	01910076687	
১০	মো. মিঠু	ব্যবসায়ী	[illegible]	01935006088	

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Maiska Tahrin Hossain

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ক্রঃ নং	নাম	পদবী	প্রতিষ্ঠান	মোবাইল নম্বর	স্বাক্ষর
৪১	হান্নান চাঁদদার	ব্যবসায়ী	হান্নান ফিলিং স্টেশন	01712706914	
৪২	মো. হাসান	ব্যবসায়ী	হাসান ফিলিং স্টেশন	01911428084	
৪৩	মো. আনোয়ার	ইমাম	গাবতলী মসজিদ	01716046547	
৪৪	মো. সাইফুল্লাহ	ব্যবসায়ী	গাবতলী বাস টার্মিনাল	01675796288	
৪৫	হাজী মোহাম্মদ আলী	ঠিকাদার	গাবতলী আমে মসজিদ	01712589306	
৪৬	মো. আবুদুল্লা আওয়াল	ব্যবসায়ী	মোস্তফা মটর্স	01855883364	
৪৭	মো. বাবু	ব্যবসায়ী	মীম বলকানাইজিং ওয়ার্কস	01624781811	
৪৮	গৌতম ঘোষ	চাকুরী	N.R. CNG Filling Station	01831415115	
৪৯	মো: সাহাব	ব্যবসায়ী	চাকুরী	01861523554	
৫০	দিলিপ মন্ডল	চাকুরী	NR CNG Filling Stn	01710411096	

বিতরনকারীর নাম ও স্বাক্ষর
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তারিখ : ২০ সেপ্টেম্বর ২০২১
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স্থান : প্রান্ত পার্টি সেন্টার, হেমায়েতপুর

ক্র: নং	নাম	পদবী	প্রতিষ্ঠান	মোবাইল নম্বর	স্বাক্ষর
৫১	মোঃ মোস্তাক হোসেন	ব্যবসায়ী	মক্কা হোটেল	০১৮৫৫৮৮৬৬৭২	[illegible]
৫২	মো: জাহাঙ্গীর আলম	ব্যবসায়ী	কারমিন প্লাস্টিক এন্ড হার্ডওয়্যার	01720387556	[illegible]
৫৩	ফেরদৌস	ব্যবসায়ী (খাবার)	আলমনগর কাঁচাবাজার	01917270989	ফেরদৌস
৫৪	মো: ইসমাইল	হোটেল ব্যবসায়ী	[illegible] হোটেল	01793322720	মোঃ ইসমাইল
৫৫	মো. মজিবুর রহমান ভূইয়া	ব্যবসায়ী	মেসার্স ভূঁইয়া ট্রেডার্স	01711674910	Mojibur
৫৬	খোকন মিয়া	ব্যবসায়ী পান	সামছুল স্টোর	01	খোকন মিয়া
৫৭	মাহেদী হাসান	ব্যবসায়ী	আমেনা ফার্মেসী	01851167024	Mahedi
৫৮	মো: বুলবুল	ব্যবসা	মুসকান টেলিকম	01789185697	[illegible]
৫৯	মো: [illegible]	ব্যবসা	ফুড প্রিন্স	01616179444	[illegible]
৬০	সাহিনা	গৃহিনী	দেওয়ানবাড়ি	—	সাহিনা

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স্থান : প্রান্ত পার্টি সেন্টার, হেমায়েতপুর

ক্র: নং	নাম	পদবী	প্রতিষ্ঠান	মোবাইল নম্বর	স্বাক্ষর
৬১	আনোয়ার	গৃহিনী	দেওয়ান বাড়ি	[illegible]	আনোয়ার
৬২	[illegible] আলম	Engineer	Delta Hospital	01712537241	[signature]
৬৩	ডা. [illegible]	M.D	S N [illegible] LPG	0171759322[illegible]	[signature]
৬৪	Shahadat Hos-	G.M.	,,	01717593226	[signature]
৬৫	মো: [illegible] রহমান	ব্যবসা	[illegible]	01922[illegible]	[signature]
৬৬	সাইফুল	ব্যবসা	[illegible]	01853746666	সাইফুল
৬৭	লাবনী	গৃহিনী	দেওয়ান বাড়ি	01706585197	লাবনী
৬৮	[illegible] ইসলাম	দোকান মালিক	[illegible] স্টোর	01819117190	[signature]
৬৯	আবুল হোসেন	ব্যবসায়ী	বিসমিল্লাহ স্টোর	01	আবুল হোসেন
৭০	মো. ইমরান	চাকুরীজীবী	[illegible]	01839960625	[signature]

বিতরনকারীর নাম ও স্বাক্ষর

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ক্র: নং	নাম	পদবী	প্রতিষ্ঠান	মোবাইল নম্বর	স্বাক্ষর
৭১	Md Shariful islam	Manager	Shetu pesticides Ltd.	01713274243	[illegible]
৭২	Md Abu Zafar	Asstt. Manager	Shetu pesticides Ltd	01755679345	[illegible]
৭৩	Mahmudul Hasan	Shift in charge	Shaheed P.O. Smriti College	01718700732	[illegible]
৭৪	মনির	ব্যবসায়ী	আমিনবাজার	01734956876	মনির
৭৫	[illegible]	ব্যবসায়ী	হেমায়েতপুর	01941350689	[illegible]
৭৬	[illegible]	দোকানদার	[illegible]	01917610049	[illegible]
৭৭	Md Monjurul Haque	Proprietor	Unique Fire Ind	—	[illegible]
৭৮	Sujit Chandra Das		Onike Enterprise	01712134574	
৭৯	Sujit chandra Das	Proprietor	Maa Medical Hall	01712107215	Sujit
৮০	[illegible]	ব্যবসায়ী	আমিনবাজার	01721680647	[illegible]

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স্থান : প্রান্ত পার্টি সেন্টার, হেমায়েতপুর

ক্র: নং	নাম	পদবী	প্রতিষ্ঠান	মোবাইল নম্বর	স্বাক্ষর
৫১	[illegible]	[illegible]	BNSB Dhaka Eye Hospital	01712828783	[illegible]
৫২	খন্দকার নাসিরুল ইসলাম	পরিচালক	বি.এন.এস.বি ঢাকা চক্ষু হাসপাতাল	01713255567	[illegible]
৫৩	[illegible]	[illegible]	KME	01712714165	[illegible]
৫৪	[illegible]	[illegible]	Dorji Dari	01708469691	[illegible]
৫৫	মো: আব্দুল্লাহ	সুপারভাইজার	বায়তুল মোকাররম মার্কেট	01762362391	[illegible]
৫৬	Md. Zibadul Islam	Area Manager	KME	01319-219921	[illegible]
৫৭	[illegible]	[illegible]	Saloon	01920502437	[illegible]
৫৮	[illegible]	[illegible]	[illegible]	01855901030	[illegible]
৫৯	[illegible]	[illegible]	[illegible]	01712755993	[illegible]
৬০	[illegible]	[illegible]	[illegible]	01771615400	[illegible]

বিতরনকারীর নাম ও স্বাক্ষর Tahmina Nazmin Surovi

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ক্রঃ নং	নাম	পদবী	প্রতিষ্ঠান	মোবাইল নম্বর	স্বাক্ষর
০১	[illegible]	[illegible]	[illegible]	01712631548	
০২	[illegible]	[illegible]	[illegible]	01922024990	
০৩	[illegible]	[illegible]	[illegible]	01818495288	
০৪	[illegible]	[illegible]	[illegible]	01731260535	
০৫	[illegible]	[illegible]	TNMCH	021-074387	
০৬	[illegible]	[illegible]	[illegible]	01819631282	
০৭	[illegible]	[illegible]	[illegible]	01718154096	
০৮	[illegible]	[illegible]	[illegible]	01856770 3409	
০৯	[illegible]	[illegible]	[illegible]	01922753086	
১০	[illegible]	[illegible]	[illegible]	01969653499	

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সময় : সকাল ১০:৩০ মিনিট
স্থান : প্রান্ত পার্টি সেন্টার, হেমায়েতপুর

ক্র: নং	নাম	পদবী	প্রতিষ্ঠান	মোবাইল নম্বর	স্বাক্ষর
১০১	Md. Zeek Rahm	Steper	Inefnnas	01713.128963	[illegible]
১০২	Aliakbar	Student		01927599181	[illegible]
১০৩	মো: মনজুর রহমান	ব্যবসা	নারিকেল ইন্ডাস্ট্রি	01710-878812	Rahman.
১০৪	Shimul	Manager	Raj Filling Station	01913438929	[illegible]
১০৫	[illegible]	অধ্যক্ষ	[illegible] স্কুল	01712024597	[illegible]
১০৬	মো: আব্দুল মান্নান	ম্যানেজার	[illegible]	01713049379	[illegible]
১০৭	মো: বেলাল হোসেন	ব্যবসা	[illegible]	01923662220	[illegible]
১০৮	মো: লুৎফর রহমান	[illegible]	[illegible]	01974020818	[illegible]
১০৯	সিদ্দিকুর রহমান	শিক্ষক	[illegible] সম্প্রীতি	01822134492	[illegible]
১১০	মো: মনির	ব্যবসা	[illegible]	01768222737	Monir

বিতরনকারীর নাম ও স্বাক্ষর Tahomina Naznin Suravi

গণপ্রজাতন্ত্রী বাংলাদেশ সরকার
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সময় : সকাল ১০:৩০ মিনিট
স্থান : প্রান্ত পার্টি সেন্টার, হেমায়েতপুর

ক্র: নং	নাম	পদবী	প্রতিষ্ঠান	মোবাইল নম্বর	স্বাক্ষর
১১১	জাকির হোসেন	ব্যবসা	চায়ের দোকান	01722717314	জাকির
১১২	হযরত আলী	ব্যবসা	ব্যবসা	01851323291	হযরত আলী
১১৩	হারুন	ব্যবসা	ব্যবসা	01793527[illegible]	হারুন
১১৪	হাফিজুল রহমান কামরুজ্জামান	ব্যবসা	বস্ত্র	01712701645	কামরুজ্জামান
১১৫	মো: বাবুল	ব্যবসা	বাড়ি মালিক	01680600 [illegible]	মো: বাবুল
১১৬	আমির হোসেন	ব্যবসায়ী, বাড়ির মালিক	বাড়ি	01747745457	আমির
১১৭	মো: মামুন	বাড়ি	বাড়ি	01785031855	মো: মামুন
১১৮	Md. Wahiullah	Lawyer	[illegible]	01719-030695	[signature]
১১৯	Md. Akhtaruzzaman	Business	Sunbeam Trade Inter.	01710099477	[signature]
১২০	Mohd Nooruddin Sheikh	Engineer	Ibrahimgen - HBSP	01913983424	[signature]

বিতরনকারীর নাম ও স্বাক্ষর [signature] Tahmina Nazmin Suravi

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স্থান : প্রান্ত পার্টি সেন্টার, হেমায়েতপুর

ক্র: নং	নাম	পদবী	প্রতিষ্ঠান	মোবাইল নম্বর	স্বাক্ষর
১১১	আনোয়ার হোসেন	ব্যবসায়ী ছিল	মুদির দোকান, [illegible]	01799433784	[illegible]
১১২	ইসমাইল হোসেন	চাকুরী	A S D	01673479120	[illegible]
১১৩	আল আমিন	জনপ্রতিনিধি	[illegible]	01727755837	[illegible]
১১৪	সাবিনা ইয়াসমিন	গৃহিনী	[illegible]	01751340291	[illegible]
১১৫	মো. মহসিন	ড্রাইভার	প্রাইভেট কার	01743356638	[illegible]
১১৬	মো: রুহুল আমিন	ব্যবসায়ী	[illegible] দোকান	01748-910496	মো: রুহুল আমিন
১১৭	[illegible]	বিক্রয় কর্মী	[illegible]	01845-903185	[illegible]
১১৮	মোঃ মো: [illegible]	ব্যবসায়ী	[illegible] কারখানা	01711-612090	[illegible]
১১৯	মো. শাহাদাত হোসেন	ব্যবসায়ী	আমিন বাজার ([illegible])	01794 82224	[illegible]
১২০	মো. [illegible]	ব্যবসায়ী	আমিন বাজার ([illegible])	0199970024	[illegible]

বিতরনকারীর নাম ও স্বাক্ষর Tahmina Nazmin Suravi

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ক্র: নং	নাম	পদবী	প্রতিষ্ঠান	মোবাইল নম্বর	স্বাক্ষর
১৬১	আকতারী [illegible]	ব্যবসা	[illegible] (মুদি)	01716304303	[illegible]
১৬২	[illegible] ইসলাম [illegible]	ব্যবসা	[illegible] (মুদি)	01936937335	[illegible]
১৬৩	[illegible] আলম	ব্যবসা	হেমায়েতপুর	—	আলম
১৬৪	[illegible]	ব্যবসা	[illegible]	01820503704	[illegible]
১৬৫	মাইদুল ইসলাম	ব্যবসা	মায়ের দোয়া চায়ের দোকান	01920154715	মাইদুল
১৬৬	আবেদ আলী	ড্রাইভার	ট্রাক	01826616644	আবেদ আলী
১৬৭	কাজী [illegible]	ব্যবসা	[illegible] এন্টারপ্রাইজ	01819113114	[illegible]
১৬৮	কাজী [illegible]	ব্যবসা	[illegible]	01670167790	[illegible]
১৬৯	[illegible]	ব্যবসা	ইব্রাহিম এন্টারপ্রাইজ	"	[illegible]
১৭০	Tapan Kumar Saho,	Hospital	Ibrahim General Hospital	01716597862	[illegible]

বিতরনকারীর নাম ও স্বাক্ষর Tahmina Naznin Swavi

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ক্রঃ নং	নাম	পদবী	প্রতিষ্ঠান	মোবাইল নম্বর	স্বাক্ষর
১৪১	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 20.09.21
১৪২	[illegible]	[illegible]	[illegible]	01857087888	[illegible]
১৪৩	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
১৪৪	[illegible]	[illegible]	EQMS	01911702074	[illegible]

বিতরনকারীর নাম ও স্বাক্ষর
Maisha Tahsin Hossain

Participant List of PCM-2

গণপ্রজাতন্ত্রী বাংলাদেশ সরকার
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স্থান : রোজমারী রেস্টুরেন্ট, ভাটারা

ক্রঃ নং	নাম	পদবী	প্রতিষ্ঠান	মোবাইল নম্বর	স্বাক্ষর
1.	[illegible]	PD, MRT-5N	DMTCL	01712112553	
2.	KAZUYA KYAMURA	ATL	MFCA	01779688070	
3.	Mohammad Abdur Rouf	APD.	DMTCL	01704403937	
4.	Mohammad Abul Khayer	DPD(LA&R	DMTCL	01715081252	
5.	Md. Badruddoza Shuvo	Asst PD (LA&R)	DMTCL	01781545181	
06.	Md. Nazmul Hasan	Asst Manager	DMTCL	01722607417	
07.	Anjuman Ara Pahuman	Natural Envt. Specialist	MFeA	01911034040	A. Pahuman.
08	Tonmoy Pandit	Jnr. Envt. Engineer	MFeA	01299629289	
09	Kazi F [illegible]	ED	EQMS.	01911702174	
10	Tauhidul Hasan	Principal Consultant	EQMS	01721346853	

তানভির হিরো
বিতরনকারীর নাম ও স্বাক্ষর তানভীর হিরো

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সময় : সকাল ১০:৩০ মিনিট
স্থান : রোজমারী রেস্টুরেন্ট, ভাটারা

ক্রঃ নং	নাম	পদবী	প্রতিষ্ঠান	মোবাইল নম্বর	স্বাক্ষর
২২	K. A. Khan	D&M	Elite S.3	01841242300	
২২	Md. Monir Hossain	Inspector, LP	Doreen Hotel & Resorts	01966662186	
২৬	[illegible]	[illegible]	[illegible]	01611180462	
২৪	[illegible]	[illegible]	[illegible]	01939377439	
২৫	[illegible]	[illegible]	[illegible]	01915141375	
২৬	[illegible]	[illegible]	[illegible]	01782426665	
২৭	Abrar Yazdan	Admin	[illegible]	01782262938	
২৮	Md. Al Mursabbir Hasan	Environmental Engineer	Samsung Cond T	01719580382	
২৯	Md: Abubakar Siddik	Ansar	P.S	01727960200	
২০	Mizanur Rahman Bachchu	Proprietor	City Timber & Sawmill	01719 817181	26.09.21

তারাটুল বিশ্বাস
বিতরনকারীর নাম ও স্বাক্ষর তারাটুল বিশ্বাস

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৭১-৭২ পুরাতন এ্যালিফ্যান্ট রোড, ইস্কাটন গার্ডেন, ঢাকা-১০০০
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ক্রঃ নং	নাম	পদবী	প্রতিষ্ঠান	মোবাইল নম্বর	স্বাক্ষর
২১	Md. Zibedul Islam	Area Manager	KME	01319-219921	[illegible]
২২	মোঃ [illegible]	ব্যবসায়ী	D.S Eng. Automobile	01711-733438	মোঃ [illegible]
২৩	Shah Alam	House Holder	Rte.	01712026694	[illegible]
২৪	Md. Shahadat Hossain Khandaker	Headmaster	Solmaid High School.	018175415 33	[illegible] 26.09.21
২৫	Md. Abu Jafore	Founder	Dhaka Imprium School	01684177007	[illegible] 26.09.21
২৬	Md. Rittal hassan	Banaw	Banaw UAE Market	01713011941	[illegible]
২৭	Md. Alhaz Ali	police	SB.	01823904521	[illegible]
২৮	Xavier Peren	Prayer Leader	church.	01715788780	[illegible]
২৯	Nilufar yasmin	Counsilor	ওয়ার্ড নং -38,39	01993820160	[illegible]
৩০	মোঃ আতিকুর রহমান	ব্যবসায়ী	আশকোনা [illegible]	01929585716	[illegible]

আরিফ আহমেদ খান
[illegible]
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৩১.	[illegible]	[illegible]	A. on. Mokal	01884372171	
৩২.	M. Humayun Kabir	G.M	Elite Sy Svedda	01841842255	
৩৩.	[illegible]	[illegible]	[illegible]	01924766494	
৩৪.	[illegible]	[illegible]	[illegible]	01716329134	
৩৫.	[illegible]	[illegible]	[illegible]	01966667744	
৩৬.	[illegible]	[illegible]	[illegible] U.A.E [illegible]	01861222227	
৩৭.	Rabiqul Haq	Inspector	Vatara Police Station	01715256627	
৩৮	MD. Abu Jabor Howla.	Sub inspector	Vatara P.S.	01712521600	
৩৯	MD. Azazul Haque	Sub-inspector	Vatara P.S	01712484077	
৪০	JHANTU RAJ	A.S.I	Vatara P.S	01721-086580	

[illegible]
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৪১.	[illegible]	[illegible]	[illegible]	01829[illegible]	[illegible]
৪২.	[illegible]	[illegible]	[illegible]	01642344999	[illegible]
৪৩.	Md. Salahuddin	Law enforce	—	01843184874	[illegible]
৪৪.	Md. Zakir Hossain	Executive Director	Fouazy Diagnostic & Hospital	01726100777	[illegible]
৪৫.	Md. Moaz Sharif	Customer Care Manger		01712-790366	[illegible]
৪৬.	Thomas Mintu Baroi	Admin	Abilita kabir foundation school	01717-983209	[illegible]
৪৭.	FAYSAL ABIR.	ADMIN	—	01957996946.	[illegible]
৪৮.	Sakib Chowdhury	ADMIN	—	01721161933	Sakib
৪৯.	[illegible]	Manager	S.M. Khan Elec. World.	01719155044	[illegible]
৫০.	[illegible]	Business	Khandaker IT	01711616210	[illegible]

আবির আহমেদ খান
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৫১	নিজামুল হক	সুপারভাইজার	ইউ.এ.ই মৈত্রী কমপ্লেক্স [illegible]	01912594599	[illegible]
৫২	ফারুক আহমেদ	বাড়ীর মালিক	[illegible] প্রাইভেট লিমিটেড	01715862901	[illegible]
৫৩	মোঃ সাখাওয়াত হোসেন	৪০ নং ওয়ার্ড সচিব	৪০ নং ওয়ার্ড ডিএনসিসি	01911383505	[illegible]
৫৪	মোঃ বেলাল হোসাইন	মুয়াজ্জিন	বাইতুল মামুর জামে মসজিদ [illegible]	01856616050	[illegible]
৫৫	Afroza Haque	Representer	M/S. BARIK BROTHERS	01680492835	[illegible] 26/09
৫৬	Al-Mamun	Manager	Elite force	01841242298	[illegible]
৫৭	Saiful Islam	Manager	Shathi Money EX	01718692472	[illegible]
৫৮	মো! [illegible]	[illegible]	[illegible]	01912460344	[illegible]
৫৯	Md. Shofikul Islam	BSM	Shwapno	01813524361	[illegible]
৬০	Rantidev Goswami	LAE	KMC Ltd.	01712225455	[illegible]

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৬১	Jannatul Ferdaus	Assistant Consultant	EQMS Consulting LTD.	01762759205	
৬২	Sakil Ahmed Khan	Assistant Consultant	EQMS Consulting LTD.	01781254007	
৬৩	Al-Amin Mia	Junior Ex.	EQMS Consulting Ltd	01766-025720	
৬৪	Md. Shahparan	Asst. Consultant	EQMS Consulting Ltd.	01822 456177	
৬৫	Sk Abid Md Sand	Asst. Consultant	EQMS Consulting Ltd.	01675269970	
৬৬	TAPOS KOTAMOKER	Assistant consultant	EQMS consulting Ltd	01759368602	
৬৭	NAYMA AKTHER JAHAN	Assistant consultant	EQMS Consulting Ltd.	01312564706	
৬৮	Ferdous Alam Quaraishi	Consultant	EQMS Consulting Limited	01717730050	
৬৯	Robiul Karim	Consultant	4	01711383496	
৭০	Hriday	M.L.S.S	11	01798581231	Hriday

(MD. SHAHPARAN)
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Appendix F : Photographs of Public Consultation Meetings and Key Informant Interview (KII)

Photographs of PCM-1

	
Participant Registration is ongoing	A local Qari is recitating from the Holy Quran
	
Explanation of objectives of the Stakeholder consultation meeting from Mr. Mohammad Abul Khayer, Deputy Project Director (Land Acquisition & Resettlement), DMRTDP (Line-5N)	Opening Speech from Mr. Mohammad Abdur Rouf, Additional Project Director (Environment, Health Safety, Land Acquisition and Resettlement) DMRTDP (Line-5N)
	
Mr. Kazi Farhed Iqubal, ED, EQMS explaining the possible environmental impacts and subsequent mitigation measures	Participants at PCM asking Questions and sharing opinions

	
Mr. Md. Saiful Islam, Chairman, Bangaon Union Parishad deliversing his speech as a special guest	Mr. Md. Ismail Mollah, Councilor, Ward 13, DNCC delivering his speech as a special guest
	
Particpants at the Meeting listening speech from the guest	Particpants at the Meeting listening speech from the guest
	
The Project Director of DMRTDP (Line-5N) Mr. Md. Aftab Hossain Khan responding to the participant's questions and delivering speech as a special guest	Mr. Mohammad Abdur Rouf, Additional Project Director (Environment, Health Safety, Land Acquisition and Resettlement) DMRTDP (Line-5N) delivering his closing remarks

Photographs of PCM-2

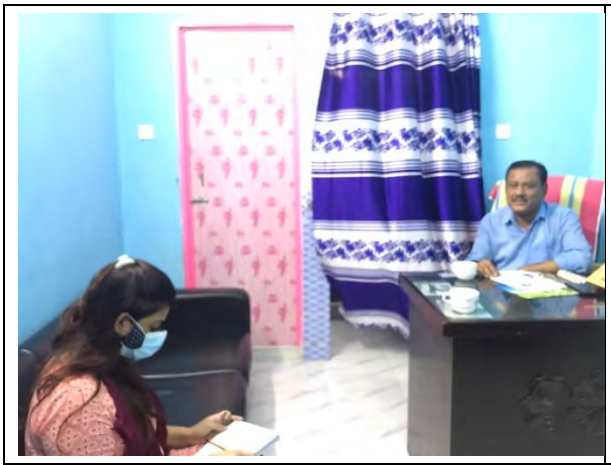
<table>
<tr><td>  </td><td>  </td></tr>
<tr><td colspan="2">Participants are Registering</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>A local Qari is reciting from the Holy Quran</td><td>Mr. Mohammad Abdur Rouf, Additional Project Director (Environment, Health Safety, Land Acquisition and Resettlement) DMRTDP (Line-5N) delivering opening speech</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Mr. Kazi Farhed Iqubal, ED, EQMS explaining the possible environmental impacts and subsequent mitigation measures</td><td>Mr. Shafiqul Islam- councilor, ward no 39, DNCC, delivering his speech as a special guest</td></tr>
</table>

	
Ms. Nilufar Yeasmin Eti (female ward councilor, reserved) ward no 38, 39, and 40, DNCC, delivering her speech as a special guest	Participants at PCM asking Questions and sharing opinions
	
Participants at PCM asking Questions and sharing opinions	Participants at PCM asking Questions and sharing opinions
	
Participants at PCM asking Questions and sharing opinions	Participants at PCM asking Questions and sharing opinions

	
Particpants at the Meeting listening speech from the guest	Particpants at the Meeting listening speech from the guest
	
The Project Director of DMRTDP (Line-5N) Mr. Md. Aftab Hossain Khan responding to the participant's questions and delivering speech as a special guest	Mr. Mohammad Abdur Rouf, Additional Project Director (Environment, Health Safety, Land Acquisition and Resettlement) DMRTDP (Line-5N) delivering his closing remarks

Photographs of Key Informant Interview (KII)

	
KII with Zahirul Islam Manik, Councilor, Ward no 03, DNCC	KII with Md. Ismail Mollah, Councilor, Ward no 13, DNCC
	
KII with Md. Jakir Hossain, Councilor, Ward no 18, DNCC	KII with, Md. Mofizur Rahman Councilor, Ward no 19, DNCC
	
KII with Md. Safiqul Islam, Councilor, Ward no 39, DNCC	KII with Md. Nazrul Islam Dali, Councilor, Ward no 40, DNCC



KII with Murad Hossain, Councilor, Ward no 12, DNCC

KII with Md. Saiful Islam, Chairman, Bangaon Union Parishad

KII with Md. Anwar Hossain, Chairman, Aminbazar Union Parishad

KII with Md. Abdur Rahim, Assistant Head Teacher, Solmaid High School

KII Thomas Mintu Bairagi, Sr. Admin Officer, Abinta Kabir Foundation School

Appendix G: Greenhouse Gas Reduction Potential for Metro Line-5: Northern Route

1. Introduction

During the feasibility study of the MRT Line-5N (JICA, 2018), the net reduction of Green House Gas (GHG) emission was calculated, and net reduction was reported as 39,491 tCO2/year for the year 2028. It was obtained by subtracting the project emission/generation from the total potential reduction compared to no-project condition. Now, during the detail stage, as many of the Project parameters are confirmed/ updated, net carbon reduction potential is re-calculated. The net reduction is estimated for 2028, 2038, 2048 and 2058 horizon with the updated demand forecast and energy consumption values.

2. Methodology

There are various methods/ models to estimate the net carbon reduction potential. The general framework/model for calculating GHG emission reduction is kept the same as that used in the feasibility stage for easier comparation. The method was formulated by Japan Weather Association. In this framework/ model, net reduction is calculated by subtracting the project emission/generation from the total potential reduction compared to no-project condition.

In this method, total potential reduction is calculated by multiplying the number of passengers of the project horizon year, the average trip distance, the unit CO_2 emission and modal share of passengers. The traffic related data was obtained from the updated traffic model prepared during the detail design stage and given in **Annex-1.** Traffic model shows that MRT line-5N will carry 313.74 million people in 2028 followed by 474.22 million in 2038, 609.76 million in 2048 and 745.55 million in 2058. As per the model, the estimated average trip distance is 7.11 km in 2028, 7.95 km in 2038, 7.97 km in 2048 and 7.99 km in 2058 horizon. The traffic model considered modal shift from five vehicle types namely, CNG, Car, Bus, Human hauler and motorcycle. Shares of modal shift in different horizon year are also given in the Annex-1. According to traffic model, the average load factor for different vehicles are Bus- 38.6, Car- 2.2, CNG- 2.3, Human Hauler- 5.8 and Motorcycle- 1.6.

The unit CO_2 emission (gm/veh/km) for different vehicles have been calculated as tCO_2/passenger km using the following formula.

$$CO_2 \text{ emission in } tCO_2/\text{Passenger km} = \frac{CO_2 \text{ emission factor for vehicle type in g/vehicle-km}}{\text{Avg. Load factor (Pax/vehicle)}}$$

CO_2 Emission Factors in t-CO_2/ passenger.km for different transport modes are given in **Annex-2**. Source of the data can also be found in the same Annex.

Project emission/generation has been calculated based on annual electricity consumption for the operation of the project and CO_2 emission factor of the grid electricity. The data was obtained from power system design and is given in **Annex-3**. Total 361 MW-hr power will be required in 2028 for MRT operation which will stand 461 MW-hr in 2038 & 2048 and 621 MW-hr in 2058 horizon. Annually, the electricity consumption will be 131765 MW/year in 2028, 168265 MW/year in 2038 & 2048 and 226665 MW/year in 2058. According to the Department of Environment (DoE), CO_2 emission factor of the grid electricity is 0.67tCO2/ per MW-hr (DoE Reference No. DoE/International Convention/2012/21/07; dated on 19.08.2013). DoE Reference document is given in **Annex-4**.

3. Calculation Result

Total CO_2 emission reduction has been calculated as 91,857 tCO_2/year in 2028 whereas project CO_2 emission/generation due to power consumption for MRT line-5N operation in 2028 is 88,283 tCO_2/year. Hence, net CO_2 reduction due to MRT line-5N operation will be 3,574 tCO2/year in 2028.

Similarly, the net reductions will be 47,237 tCO_2/year in 2038, 102,641 tCO2/year in 2048, and 130,149 tCO_2/year in 2058.

The details calculation sheet of each horizontal year is given in **Annex-5.** The summary is illustrated in the following figure 1.

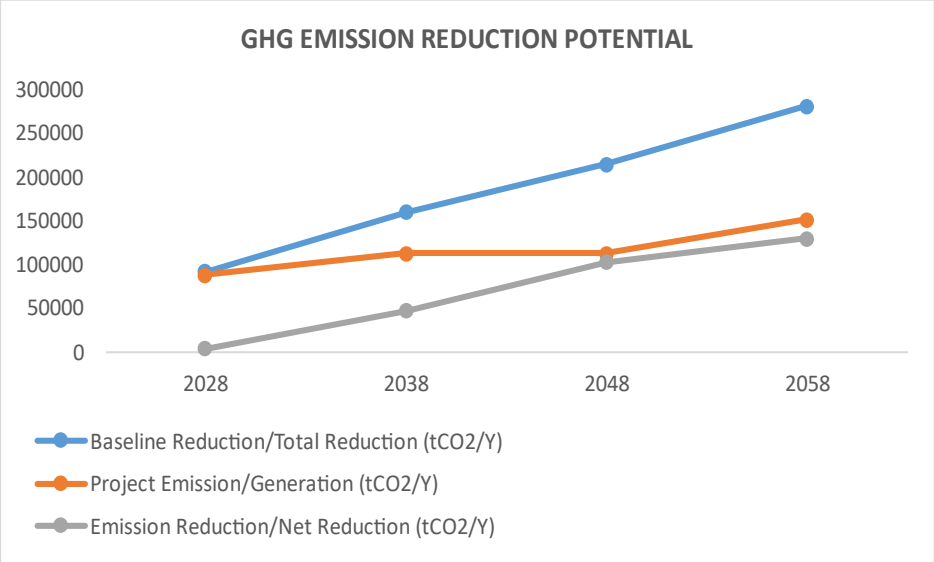


Figure 1: GHG Emission Reduction Potential

4. Comparison Between Values obtained in Feasibility Study and Detail Design

During feasibility study, net reduction was calculated only for year 2028. The net reduction reported was 39,491 tCO_2/year. It was obtained by deducting project emission/generation 99,890 tCO_2/year from total reduction 139,381 tCO_2/year (F/S Report, JICA, 2018). The details calculation of the feasibility study is given in **Annex-6.**

On the contrary, the net reduction calculated in detail design stage shows the net reduction in 2028 as only 3,574 tCO_2/annum, which is obtained by subtracting project emission/generation 88,283 tCO_2/annum from total reduction 91,857 tCO_2/annum.

As mentioned above, the total reduction is depends on traffic demand conditions, like total ridership and average trip distance. The ridership per year was 448,950,000 during the feasibility study, while it is 313,749,009 in the detail design, which is significantly less. The average trip length is 7.11 km in the detail design phase but in the feasibility phase, it was 7.9 km. During detail design phase, total five transportation mode was used for modal shift, namely CNG, Car, Bus, Human hauler and motorcycle whereas in the feasibility phase only three vehicle types were used, such as auto tempo, microbus and standard bus.

Though the electricity consumption value from Detail Design (132 GWh) is less than the value adopted in F/ S (219 GWh) meaning better quality equipment are proposed in DD, the project emissions are not much

different (99,890 tCO_2/year in F/S and 88,283 tCO_2/year in DD). This is because different grid electricity emission factors were used in the calculation of DD stage and F/S stage (0.67 tCO2/MWh in DD and 0.456 tCO_2/MWh in F/S). The value used in DD stage is the recommended value by DOE for Bangladesh condition (**Annex-4**).

So, the main factor attributed for lower net reduction value in DD model is the lower passenger demand in 2028 (449m in F/S and 314 m in DD). The trip length is also lower as per Updated demand forecast (7.11 km in DD and 7.9 km in F/S).

In the 2038 horizon, the passenger demand is 474m as per Updated demand forecast, which is closer to F/S stage demand of 2028 (449m). The net carbon reduction in 2038 as per DD stage is 47,237 tCO_2/year, which is in the similar range to the value of the feasibility phase in 2028 (39,491 tCO_2/year).

Thus, it can be inferred the carbon reduction calculation in the detail design stage is comparable to the F/S stage calculation. However, due to lower passenger demand in 2028 in the Updated traffic model, the net carbon reduction in 2028 is lower than F/S value. The carbon reduction will increase significantly in later years of the Project, as demand is expected to pick up.

Annexure

Annex-1: Data from Updated Traffic Model

1. Avr. Load Factor (Pax/vehicle)

Motorcycle	1.6
Human Hauler	5.8
CNG	2.3
Car	2.2
Bus [Minibus=31.2 Large Bus=46.0]	38.6

2. Average trip distance of the passenger in the project horizon year [km]

2028	2038	2048	2058
7.11	7.95	7.97	7.99

3. Total Number of Passengers of the project (MRT Line-5 North) in horizon years [survey base year 2019]

Ridership	2028	2038	2048	2058
Yearly Ridership	313,749,009	474,226,173	609,768,173	745,559,772
Daily Ridership	859,586	1,299,250	1,670,598	2,042,630

4. Share of passengers by transport mode (%)

Vehicle Type	2028	2038	2048	2058
Motorcycle	4.21	4.58	6.06	8.13
Human Hauler	3.50	2.39	2.33	2.53
CNG	6.83	6.76	8.28	10.72
Car	6.21	7.69	8.37	9.60
Bus	79.25	78.58	74.96	69.02

Annex-2: CO_2 Emission Factors in t-CO2/person.km for Different Transport Modes

Type	Value	Unit
Bike	0.000069	tCO_2/passenger km
Passenger Car	0.000110	tCO_2/passenger km
Bus	0.000031	tCO_2/passenger km
Other 1 (CNG)	0.000083	tCO_2/passenger km
Other 2 (Human Hauler)	0.000033	tCO_2/passenger km

Sources for Vehicle Emission Factors and Values used in Calculations

Source	gm/veh/km	Remarks
DEFRA emissions factor calculator[13]	134	average petrol car
DEFRA emissions factor calculator[13]	1196	Bus (10.8 passengers * 110.7 g/passenger-km)
Automotive Research Association of India (ARAI)[14]	668	HCV diesel bus> 6000 CC
DEFRA emissions factor calculator (2021)[15]	173	average petrol car
DEFRA emissions factor calculator (2013) [13]	194	average petrol car
DEFRA from "Carbon Offset Factors" (2012)[16]	242	average petrol car
DEFRA from "Carbon Offset Factors" (2012)[16]	190	average CNG car
DEFRA emissions factor calculator (2012) [16]	116	average petrol motorbike
DEFRA emissions factor calculator (2021)[15]	111	average petrol motorbike
Value Used in Calculation		
Motorcycle	111	
Human Hauler	190	Since all human haulers are driven on natural gas, hence EF is used as CNG/autorickshaw
CNG	190	
Car	242	
Bus & Minibus	1200	

[13] DEFRA (2013), Government GHG Conversion Factors for Company Reporting: Methodology Paper for Emission Factors, Department for Environment, Food and Rural Affairs, Government of United Kingdom

[14] The Automotive Research Association of India (2007), Emission Factor development for Indian Vehicles "as a part of Ambient Air Quality Monitoring and Emission Source Apportionment Studies

[15] DEFRA (2021). Greenhouse gas reporting: conversion factors, Department for Environment, Food and Rural Affairs, Government of United Kingdom

[16] DEFRA (2012). Government GHG Conversion Factors for Company Reporting: Methodology Paper for Emission Factors, Department for Environment, Food and Rural Affairs, Government of United Kingdom

Annex-3: Carbon Generation from Electricity Consumption of the Project

Traction Power

Energy Use		**MW-hr/workday**				**MW-hr/weekend-day (60%)**			
Traction		2028	2038	2048	2058	2028	2038	2048	2058
Peak Power (MW)		10.2	13.8	13.8	21	6	8	8	13
Day time		8	10.4	10.4	15	5	6	6	9
Nighttime		8	8	8	10.4	5	5	5	6
	hrs	MW-hr/workday				MW-hr/weekend-day			
Peak Time	5.5	56.1	75.9	75.9	115.5	33	44	44	71.5
Daytime	7.5	60	78	78	112.5	37.5	45	45	67.5
Morn/nht	4	32	32	32	41.6	20	20	20	24
Sum	17	148.1	185.9	185.9	269.6	90.5	109.0	109.0	163.0
Daily average MW-hr/day		**132**	**164**	**164**	**239**				

Auxiliary Power

Auxiliary		**MW**			
Horizon Year		2028	2038	2048	2058
Operation Hour	17	11	15	15	20
Non-Operation Hour	7	6	6	6	6
MWHr/day auxiliary power use (constant over the years)					
Operation Hour		187	255	255	340
Non-Operation Hour		42	42	42	42
MWHr/day auxiliary power use (constant over the years)		**229**	**297**	**297**	**382**

Total Power

Energy Use	2028	2038	2048	2058
Traction Power	132	164	164	239
Auxiliary Power	229	297	297	382
Total Power (Traction Power+ Auxiliary Power)	**361**	**461**	**461**	**621**

Annex-4: DoE Reference Document for CO_2 Emission Factor

Government of the People's Republic of Bangladesh
Department of Environment
Paribesh Bhaban, E/16, Agargaon
Sher-e-Bangla Nagar, Dhaka-1207
www.doe-bd.org

Reference No. DOE/International Convention/2012/21/07 Dated. 19.08.2013

Subject: Grid Emission Factor (GEF) of Bangladesh

With reference to above captioned subject, I am directed to notify that National CDM Committee has officially endorsed the recommendation of the Technical Committee for determining the Grid Emission Factor (GEF) of Bangladesh, and the latest GEF of Bangladesh is **0.67 ton CO_2/MWh**. The GEF is calculated as per tool to calculate the emission factor for an electricity system (Version 3.0.0, EB 70, Annex 22).

This is being circulated for further necessary actions by the authorities concerned. Please note that this letter replaces the previous letter having same reference number and date.

(A. M. Monsurul Alam)
Director (Climate Change and Int. Conv.)
and
Member Secretary
National CDM Committee

Copy for information and necessary action:

1. Chairman, Power Development Board, Bidyut Bhaban, Abdul Gani Road, Dhaka-1000.
2. Mr. Chris Warner, Senior Technical Specialist, Climate Policy and Finance Department, World Bank, Sher-e-Bangla Nagar, Agargaon, Dhaka-1207.
3. Dr. Muhammad Eusuf, BCAS, House-10, Road-16/A, Gulshan-1, Dhaka-1212.
4. Dr. Ijaz Hossain, Professor, Department of Chemical Engineering, Bangladesh University of Engineering and Technology (BUET), Dhaka -1000.
5. Mr. Utpal Bhattacharjee, Manager, Carbon Project Development Services, Rahimafrooz Renewable Energy Ltd, 260/B, 5th floor, Tejgaon I/A, Dhaka-1208.
6. Mr. Iftekhar Enayetullah, Executive Director, Waste Concern, House-21(Side B), Road-7, Block-G, Banani Model Town, Dhaka-1213.

7. Dr. Wolfram Engel, President and CEO, Green Project W.S.T, Plot-13 (KC Tower), 7th Floor, Sector-13, Sonargaon Janapath Road, Uttara, Dhaka-1230.
8. Mr. Raden Siddiquee, Future Carbon (BD), Suit 2001, Sena Kallyan Bhaban, Motijheel, Dhaka-1000.
9. Mr. Nabil Haque, Research Officer & CDM Project Associate, Clean Energy Alternative, House-61, Road-1/A, Block-J, Baridhara, Dhaka.
10. Mr. Javed Bin Karim, Managing Director & CEO, BRAC Impact Ventures Ltd, BRAC Centre (14th floor), 75 Mohakhali C/A, Dhaka-1212.
11. Mr. Mahmood Malik, ED & CEO, Infrastructure Development Company Limited, UTC Building, 16th Floor, 8 Panthapath, Kawran Bazar, Dhaka-1215.
12. Mr. Abser Kamal, Managing Director, Grameen Shakti, Grameen Bank Bhaban, Mirpur-2, Dhaka-1216.

Copy for kind information:

1. Secretary, Ministry of Environment and Forests, Bangladesh Secretariat, Dhaka.
2. Secretary, Power Division, Bangladesh Secretariat, Dhaka.
3. Secretary, Energy and Mineral Resources Division, Bangladesh Secretariat, Dhaka.

Annex-5: GHG Reduction Calculation During Detail Design Stage

For 2028

		Value	Unit
Emission reduction/Net Reduction		3574	tCO_2/year
Baseline emission/Total Reduction		91857	tCO_2/year
Number of passenger of the project activity in year y		313,749,009	passenger/year
Average trip distance of the passenger of the project activity in year y		7.1	km
CO_2 emission factor per passenger kilometer for transport mode i	Bike	0.000069375	tCO_2/passenger-km
	Passenger car	0.00011	tCO_2/passenger-km
	Bus	3.10881E-05	tCO_2/passenger-km
	Other1	8.26087E-05	tCO_2/passenger-km
	Other2	3.27586E-05	tCO_2/passenger-km
	Other1	0	tCO_2/passenger-km
Share of passengers by transport mode i in the baseline scenario in year y	Bike	4.21	%
	Passenger car	6.21	%
	Bus	79.25	%
	Other1	6.83	%
	Other2	3.50	%
	Other1	0	%
Project emission/Generation		88283	tCO_2/y
Annual electricity consumption associated with the operation of the project activity in year y		131765	MWh/year
CO_2 emission factor of the grid electricity		0.67	tCO_2/MWh
Annual consumption of fuel i associated with the operation of the project activity in year y		0	t/year
CO_2 emission factor of fuel i		0	tCO_2/TJ
Net calorific value of fuel i		0	TJ/t

For 2038

			Value	Unit
Emission reduction/Net Reduction			47237	tCO_2/year
Baseline emission/Total Reduction			159975	tCO_2/year
	Number of passenger of the project activity in year y		474,226,173	passenger/year
	Average trip distance of the passenger of the project activity in year y		7.95	km
	CO_2 emission factor per passenger kilometer for transport mode i	Bike	0.000069375	tCO_2/passenger-km
		Passenger ca	0.00011	tCO_2/passenger-km
		Bus	3.10881E-05	tCO_2/passenger-km
		Other1	8.26087E-05	tCO_2/passenger-km
		Other2	3.27586E-05	tCO_2/passenger-km
		Other1	0	tCO_2/passenger-km
	Share of passengers by transport mode i in the baseline scenario in year y	Bike	4.58	%
		Passenger ca	7.69	%
		Bus	78.58	%
		Other1	6.76	%
		Other2	2.39	%
		Other1	0	%
Project emission/Generation			112738	tCO_2/y
	Annual electricity consumption associated with the operation of the project activity in year y		168265	MWh/year
	CO_2 emission factor of the grid electricity		0.67	tCO_2/MWh
	Annual consumption of fuel i associated with the operation of the project activity in year y		0	t/year
	CO_2 emission factor of fuel i		0	tCO_2/TJ
	Net calorific value of fuel i		0	TJ/t

For 2048

			Value	Unit
Emission reduction/Net Reduction			102641	tCO_2/year
Baseline emission/Total Reduction			215379	tCO_2/year
	Number of passenger of the project activity in year y		609,768,173	passenger/year
	Average trip distance of the passenger of the project activity in year y		7.97	km
	CO_2 emission factor per passenger kilometer for transport mode i	Bike	0.000069375	tCO_2/passenger-km
		Passenger ca	0.00011	tCO_2/passenger-km
		Bus	3.10881E-05	tCO_2/passenger-km
		Other1	8.26087E-05	tCO_2/passenger-km
		Other2	3.27586E-05	tCO_2/passenger-km
		Other1	0	tCO_2/passenger-km
	Share of passengers by transport mode i in the baseline scenario in year y	Bike	6.06	%
		Passenger ca	8.37	%
		Bus	74.96	%
		Other1	8.28	%
		Other2	2.33	%
		Other1	0	%
Project emission/Generation			112738	tCO_2/y
	Annual electricity consumption associated with the operation of the project activity in year y		168265	MWh/year
	CO_2 emission factor of the grid electricity		0.67	tCO_2/MWh
	Annual consumption of fuel i associated with the operation of the project activity in year y		0	t/year
	CO_2 emission factor of fuel i		0	tCO_2/TJ
	Net calorific value of fuel i		0	TJ/t

For 2058

			Value	Unit
Emission reduction/Net Reduction			130149	tCO_2/year
Baseline emission/Total Reduction			282015	tCO_2/year
	Number of passenger of the project activity in year y		745,559,772	passenger/year
	Average trip distance of the passenger of the project activity in year y		7.99	km
	CO_2 emission factor per passenger kilometer for transport mode i	Bike	0.000069375	tCO_2/passenger-km
		Passenger ca	0.00011	tCO_2/passenger-km
		Bus	3.10881E-05	tCO_2/passenger-km
		Other1	8.26087E-05	tCO_2/passenger-km
		Other2	3.27586E-05	tCO_2/passenger-km
		Other1	0	tCO_2/passenger-km
	Share of passengers by transport mode i in the baseline scenario in year y	Bike	8.13	%
		Passenger ca	9.6	%
		Bus	69.02	%
		Other1	10.72	%
		Other2	2.53	%
		Other1	0	%
Project emission/Generation			151866	tCO_2/y
	Annual electricity consumption associated with the operation of the project activity in year y		226665	MWh/year
	CO_2 emission factor of the grid electricity		0.67	tCO_2/MWh
	Annual consumption of fuel i associated with the operation of the project activity in year y		0	t/year
	CO_2 emission factor of fuel i		0	tCO_2/TJ
	Net calorific value of fuel i		0	TJ/t

Annex-6: GHG Reduction Calculation During Feasibility Study (JICA, 2018)

		Value	Unit
Emission reduction/Net Reduction		39491	tCO_2/year
Baseline emission/Total Reduction		139381	tCO_2/year
Number of passenger of the project activity in year y		448,950,000	passenger/year
Average trip distance of the passenger of the project activity in year y		7.9	km
CO_2 emission factor per passenger kilometer for transport mode i	Auto Tempo	3.41945E-05	tCO_2/passenger-km
	Microbus	0.000117188	tCO_2/passenger-km
	Standard Bus	2.35647E-05	tCO_2/passenger-km
Share of passengers by transport mode i in the baseline scenario in year y	Auto Tempo	7.289	%
	Microbus	15.729	%
	Standard Bus	76.982	%
	Other1	0	%
	Other1	0	%
	Other1	0	%
Project emission/Generation		99890	tCO_2/y
Annual electricity consumption associated with the operation of the project activity in year y		219058	MWh/year
CO_2 emission factor of the grid electricity		0.456	tCO_2/MWh
Annual consumption of fuel i associated with the operation of the project activity in year y		0	t/year
CO_2 emission factor of fuel i		0	tCO_2/TJ
Net calorific value of fuel i		0	TJ/t