ENVIRONMENTAL IMPACT STATEMENT (EIS) FOR METRO MANILA SUBWAY PROJECT (MMSP) (Phase 1)

VOLUME I

MAIN REPORT

SEPTEMBER 2017

DEPARTMENT OF TRANSPORTATION (DOTr)

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LIST OF ABBREVIATIONS

BCDA	Bases and Conversion Development Authority
BGC	Bonifacio Global City
CBDs	Central Business District
CLUP	Comprehensive Land Use Plan
DAO	DENR Administrative Order
DED	Detailed Engineering Design
DENR	Department of Environment and Natural Resources
DIA	Direct Impact Area
DOST	Department of Science and Technology
DOTr	Department of Transportation
DPWH	Department of Public Works and Highways
ECC	Environmental Compliance Certificate
EDSA	Epifanio delos Santos Avenue
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EGF	Environmental Guarantee Fund
EMB	Environmental Management Bureau
EMP	Environmental Management Plan
EMF	Environmental Monitoring Fund
EMoP	Environmental Monitoring Plan
GHG	Greenhouse Gas
IEC	Information, Education and Communication
IIA	Indirect Impact Area
JICA	Japan International Cooperation Agency
JST	JICA Study Team
LWUA	Local Water Utilities Administration
LGU	Local Government Unit
MGB	Mines and Geosciences Bureau
MMDA	Metro Manila Development Authority
MMT	Multi-partite Monitoring Team
MMSP	Metro Manila Subway Project
MRT	Metro Rail Transit
mSL	Mean Sea Level
MWSS	Metropolitan Waterworks and Sewerage System
NATM	New Austrian Tunneling Method
NCR	National Capital Region
NOAH	Nationwide Operational Assessment of Hazards
NSO	National Statistics Office
NWRB	National Water and Resource Board
OCC	Operations Control Center
OCG	Oriental Consultants Global Co., Ltd.
PAGASA	Philippine Atmospheric, Geophysical and Astronomical Services

PAPs	Project Affected Persons
PAR	Philippine Area of Responsibility
PCO	Pollution Control Officer
PDRRMC	Provincial Disaster Risk Reduction Management Council
PFZ	Philippine Fault Zone
PHIVOLCS	Philippine Institute of Volcanology and Seismology
PM	Particulate Matter
PNR	Philippine National Railways
PPE	Personal Protective Equipment
PRA	Philippine Reclamation Authority
PSD	Platform Screen Door
RAP	Resettlement Action Plan
ROW	Right of Way
RCS	Replacement Cost Study
SCADA	Supervisory Control And Data Acquisition
SMEWW	Standard Methods for the Examination of Water and Wastewater
TBM	Tunnel Boring Machine
TMG	Tokyo Metropolitan Government
TSD	Transport, Storage And Disposal
TSP	Total Suspended Particulates
WVF	West Valley Fault

EXECUTIVE SUMMARY

PROJECT FACT SHEET

Name of Project: Metro Manila Subway Project (MMSP) (Phase1)

Project Cost: PhP 218,307 Million (Feasibility Study Stage)

Location:

The MMSP alignment will pass through the following cities:

- Quezon City
- Pasig City
- Makati City
- Taguig City
- Paranaque City
- Valenzuela City for depot

Nature of Project: Subway Construction Project

Basic Design:

Length: 28.3kilometer (km)
Tunnel Structure: Double Tube Single Track (Standard diameter: 6.8 m)
Travel Time (Quirino Highway – FTI): 31 min 5 sec (Express), 42 min 20 sec (Local)
Scheduled Speed: 48.5 km/h (Express), 35.6 km/h (Local)
Gauge: 1,435 mm (Standard gauge)
Number of Stations: 13 (Underground)
Station Platform Length: 210 m
Depot for Trains: 1 site (31.7 hectares, aboveground)
No. of Passengers:

YEAR	2025	2030	2035
(thousand passengers/day)	365	669	973

Proponent: DEPARTMENT OF TRANSPORTATION (DOTr)

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Brief Profile of Proponent: The Department of Transportation (DOTr) is the primary government agency that provides the policy, planning, implementation, promotion, development and regulation of the country's network of transportation, which covers the road, rail, air, and water, and communications systems, as well as in the fast, safe, efficient and reliable transportation and communications services.

EXECUTIVE SUMMARY

The Executive Summary provides a synopsis of the Environmental Impact Statement for the proposed Metro Manila Subway Project, highlighting the brief project description, process documentation of the conduct of Environmental Impact Assessment (EIA), summary of alternatives considered, and the integrated summary of the key environmental impacts and management Plan.

Project Description

The Metro Mania Subway Project (MMSP) (Phase 1) is a railway system that will connect North Caloocan or Meycauayan in Bulacan and Dasmariñas in Cavite through the National Capital Region. The feasibility study of the MMSP for the Central Zone of the National Capital Region (NCR), i.e., between Valenzuela and Taguig is the initial phase of the entire project and is the subject of study in this EIA.

The proposed route of the Central Zone starts at Quirino Highway in Quezon City and ends in FTI, Taguig City, with a proposed depot in Brgy. Ugong, Valenzuela City. The route has a total of 28.3 km of subway and a tunnel diameter of 6.8 m x 2. There will be 13 underground stations traversing five (5) cities in NCR namely: Quezon City, Pasig City, Makati City, Taguig City and Parañaque City. The proposed depot located in Valenzuela City covers about 31.7 hectares of land area above ground.

Environmental Impact Assessment Process

The EIA Process, discussed in details in Appendix A, was carried out following Terms of Reference agreed with the JICA. It was also guided by the DENR Administrative Order No. 30 of 2003 or the Implementing Rules and Regulations of Presidential Decree No. 1586, Establishing the Philippine Environmental Impact Statement System.

The secondary data and information on the baseline environmental conditions for land, water, air, and people of the cities along the MMSP alignment and proposed depot location from Valenzuela City to Paranaque City are collected from various sources, mainly from relevant government organizations and academic institutions. Primary data were obtained through site inspection along the MMSP alignment to validate the secondary data and evaluate the existing environmental conditions. Field surveys and sampling/measurements at the depot and stations were also conducted using the approved standard methodologies for sampling and analysis.

Apart from the primary and secondary data collection, the views of the stakeholders were considered in the EIA study. Stakeholders' consultation meetings and public scoping were conducted for the six (6) cities along the MMSP alignment last March 9 to April 27, 2017. Three (3) Public Hearings were conducted on September 5 to 7, 2017 to present the result of the EIA Study. Presented in Appendix B are the documentations for the IEC meetings, stakeholder's consultation meetings and public hearings. The public consultation has allowed the proponent to

give the community a better understanding of the planning of the Project and site-specific factors and constraints that have to be taken into account in selecting the preferred alignment and design of the Project.

Summary of Alternatives

Three route alternatives for MMSP were studied in the planning stage, namely Option 1: EDSA Route, Option 2: Greenhills Route and Option 3: Katipunan Route. After discussions among relevant organizations including DOTr, DPWH, MMDA, BCDA and the JICA Team, Option 3 was evaluated to achieve most of the objectives and was selected.

Two candidate sites of the depot location, one in Mindanao Avenue in Valenzuela City, and one in General Luis in Caloocan City, were studied in the planning stage. After discussions among the relevant organizations in the same manner as the route alternatives, Mindanao Avenue was adopted.

Options for elevated or underground structure of Quirino Highway Station were studied in the planning stage. After comparing the advantages and disadvantages of these candidate sites, the underground structure was adopted.

Two methods for construction of underground structure were compared: (1) cut & cover method, in which excavation starts on the ground level and forms spaces from there down, and (2) the non-cut & cover methods, including the shielded tunneling method and NATM, in which an excavation machine goes through the earth to form spaces. For excavations at station sections, the cut and cover method was selected. For the excavation method between stations or along the project line, the non-cut & cover tunneling method, specifically the shielded tunneling method, is recommended.

For the tunnel structures, Double Tube Single Track (DTST) and Single Tube Double Track (STDT) were compared in the tunnel structure plan. DTST shall be adopted to a shielded tunnel in the line.

Environmental Impact Assessment and Mitigating Measures

A summary of the potential impacts of the project per project phase and the corresponding mitigation measures and enhancement, are presented in the succeeding table.

Environmental Aspect	Potential Impact	Assessment of Impact	Options for Prevention or Mitigation or Enhancement
I. **PRE-CONSTRUCTION AND CONSTRUCTION PHASES**			
The Land			
Land use	Intensification of future developments at the subway station areas	High adverse	Proper land use planning and strict implementation of land use zoning ordinances to protect the environment should be undertaken for subway operation impacts to remain beneficial.
	Potential conflict with other government infrastructure projects (e.g. DPWH's C6 Project)	Moderate adverse	Close coordination with DPWH and other relevant government agencies to avoid issues on conflict of land use
Land tenure issues	Acquisition of land from land title holders in the Valenzuela depot and other affected lots in the station locations	High adverse	Land acquisition by the government based on current market values of the property following both JICA Guidelines and applicable laws and regulations
Generation of demolition wastes	Soil contamination and aesthetic impacts	Low adverse	• Recycling of demolition wastes • Use of leftover concrete and metals for suitable alternative projects • Uncontaminated residual wastes will be used as backfilling materials in quarry sites and land reclamation projects. • Disposal of contaminated solid wastes through an accredited TSD facility.
Earthwork activities (tunneling, excavation, backfilling and stockpiling)	• Slope failures, landslides and subsidence due to cutting and filling • Soft ground • Soil erosion and siltation	Moderate adverse	• Proper reinforcement of excavations and tunneling sections • Proper planning and scheduling of construction works to ensure that excavated soil is immediately transported to recipient sites • Construction of a good drainage system

Environmental Aspect	Potential Impact	Assessment of Impact	Options for Prevention or Mitigation or Enhancement
	along the rivers and creeks • Soil runoff • Alteration in topography due to excavations of earth and stockpiling		
Clearing and removal of trees	Potential removal of 767 trees, of which 298 are threatened species, present in the proposed depot and stations	Moderate adverse	• Preparation of a detailed management plan for the removal of trees shall be required from the contractors. • Preparation and implementation of a detailed plan for the transfer/earthballing of matured trees. A system to periodically monitor and maintain survival of these species should be set in place to assure high survival rate. • Replacement and planting of corresponding number of tree seedlings by the proponent • Coordination with concerned agencies or groups for relocation sites of earth-balled trees. A system to periodically monitor and maintain survival of these species should be set in place to assure high survival rate.
Clearing and removal of trees	Removal or reduction of ecosystem services such as microclimate regulation, flooding, provision of habitat to faunal species and carbon sequestration	Moderate adverse	• Integration of landscaped green areas (e.g. parks, green roofs and vertical gardens) in the design layout of the proposed depot and stations. • Selection of tree species for green spaces should be biased towards native species to ensure habitat connectivity of local fauna. • Felled trees during the construction phase should not be allowed to degrade under the elements to ensure that the CO_2 trapped in the wood biomass is not released back as GHG.

Environmental Aspect	Potential Impact	Assessment of Impact	Options for Prevention or Mitigation or Enhancement
			• Leaves and clippings from the felled trees should be shredded and mulched to ensure that the nutrients stored and captured in the biomass is returned and cycled back to the soil.
Construction site activities	Impairment of visual aesthetics	Moderate adverse	Use of "green" walls, in the form of green-painted fences, green facades or living walls as construction barriers/fences
Leaks and accidental spills on soil	Soil contamination	Low adverse	Require contractors to: • Implement proper handling and management of chemicals • Practice good housekeeping at construction sites • Establish and implement an emergency and contingency plan in case of spills as well as health and safety management plan • Store bulk chemicals, such as fuel, lubricants and other chemicals, in an impermeable area and with appropriate secondary containment and, • Comply with environmental permitting requirements for the storage, transport, treatment and handling of hazardous substances and wastes.
Damage of subsurface structures during drilling and excavation activities	Soil contamination	Low adverse	Cautious drilling along other artificial subsurface structures; Design adjustments or modification of already present structures
Generation of excavated soil (approximately 4.4 M m^3) from excavation/ tunneling	• Increased siltation of water bodies • Aesthetic impacts • Traffic impact along the route to disposal site	High adverse	• Used of surplus soil as backfilling in: (1) quarry sites in the province of Rizal; (2) projects of PDRRMC in Regions III and IV; and (3) projects of Department of Public Works and Highway (DPWH). • Proper scheduling of excavation works, and coordination with surplus soil recipients to ensure immediate hauling of surplus soil

Environmental Aspect	Potential Impact	Assessment of Impact	Options for Prevention or Mitigation or Enhancement
			• Develop and implement Traffic Management Plan • Road maintenance by the contractors
Generation of solid wastes from the construction workforce	• Land and water contamination • Aesthetic impacts • Spread of diseases	Moderate adverse	• Submission and implementation of Solid Waste Management Plan as part of contractors' engagement • Placement of waste bins to avoid dispersal of litter and regular site maintenance duties • Regular collection, transportation and disposal of wastes to minimize the attraction of vermin, insects and pests
Transport of construction materials	Traffic congestion and damage of roadways along the route to disposal site	High adverse	• Proper scheduling of the delivery of construction supplies and materials • Develop and implement Traffic Management Plan • Road maintenance by the contractors
Liquefaction	• Damage to underground structures and overlying structures (in depot and stations) in the event of an earthquake • Loss of soil strength, settlement of soil, lateral spreading, bearing failures, floatation of embedded structures	Moderate adverse	• Constructing subways structures at deep underground • Chemical liquid injection for soil strength improvement • Observe 20 meters buffer zone from body of water (surface and subsurface) • Conduct a borehole log of Pasig riverbed to identify how thick is the soft sediments and other sedimentary beds
Ground shaking	Damage to components of the construction work	High adverse	• Construction of shield tunnels as a protective and support structure during tunnel excavation • Reinforcement of the surface structures to be constructed for the station to ensure safety and continued use • Adopt a seismic design during the detailed engineering phase of the subway project

Environmental Aspect	Potential Impact	Assessment of Impact	Options for Prevention or Mitigation or Enhancement
			• Earthquake drills and early warning system • Emergency exits on and in between stations for eventuality of an earthquake event
Ground rupture	Damage to components of the construction work	High adverse	• Conduct inclined drilling survey of the subsurface condition of the area surrounding not only the Cayetano Boulevard Station but also the sections of the proposed alignment located nearby the fault traces, in consultation with PHIVOLCS • Strongly consider realignment of the subway in Cayetano Blvd. Station, away from the fault
The Water			
Clearing and excavation activities	Increase in suspended sediments in the receiving water	Moderate adverse	• Conduct demolition and excavation activities during the summer, as much as possible. • Protect demolition and excavated materials from the rain by roofing it and redirecting rainwater to a catchment basin or the nearest drainage system • Proper waste water treatment plans by the contractor prior to construction works. • Debris/soil and other excavated materials shall be hauled out from the site immediately and disposed by accredited waste handlers. • Treatment of turbid water caused by excavation works before discharge • Chemical injection method shall be implemented in appropriate ways under sufficient groundwater monitoring systems. • Monitor and control waste water in construction sites.
Clearing of trees and	Erosion and siltation in	Moderate adverse	Use permeable pavements after construction works while

Environmental Aspect	Potential Impact	Assessment of Impact	Options for Prevention or Mitigation or Enhancement
conversion into construction yards	surface water bodies		converting construction yards into walkways or bike lanes or open spaces.
Clearing and excavation activities	Flooding and inundation due to clogged waterways	Moderate adverse	• Proper disposal of demolition debris and construction spoils by the contractor • Implementation of erosion control measures before major earthmoving works begin
Excavation works	Lowering of groundwater level due to inflow of groundwater into underground tunnel	Low adverse	• Conduct more detailed geological and groundwater level surveys in detailed design stage • Consider proper construction plans on the basis of the survey results. • Adoption of the shield tunneling method will reduce possibility of groundwater inflow into the tunnel structures
The Air			
Generation of dusts and PM from earthmoving, demolition and stockpiling	Temporary increase of air pollutant emissions, specifically TSP and PM	Low adverse	• Regular wetting of ground soil in the construction site • Construction sites must be fenced for safety and security reasons • Hauling trucks for excavated soil must be covered during travel
Emission from vehicles and gensets	Temporary increase of air pollutant emissions (NOx, SOx, CO and HC)	Low adverse	• Regular preventive maintenance of heavy equipment and service vehicle
Movement and operation of construction machinery	Increase noise level and ground vibration during construction	Low adverse	• Select equipment with lower sound power levels • Installation of mufflers on engine exhausts and compressor components • Installation of noise suppressors and vibration isolation to construction/mechanical equipment. • Regular maintenance of heavy equipment, machineries and

Environmental Aspect	Potential Impact	Assessment of Impact	Options for Prevention or Mitigation or Enhancement
			support vehicles • Installation of temporary noise barriers such as galvanized iron shields • Use of Personal Protection Equipment (PPE) • Relocating noise sources to less sensitive areas • Fencing of the construction site • Scheduling of the high noise generating activities during daytime. • Use of shield tunneling method construction technique • Conduct massive IEC campaign to local health units of affected LGUs to implement interventions to mitigate risk to noise exposure of vulnerable groups along the DIAs and IIAs
The People			
Involuntary Resettlement	Displacement of residents, commercial and industrial establishments along the proposed alignment	Moderate adverse	• Alignment was traced under existing public roads and public properties, as much as possible, to minimize ROW acquisition • RAP was prepared to ensure that affected households and establishments are justly compensated and will have a quality of life equal or better than their current condition.
Informal settlers	In-migration of informal settlers in ROW lands	Moderate adverse	• Shorten time between the pre-construction phase and the construction phase as much as possible. • Project areas will be fenced for safety and security reasons.
Displacement of Institutional Facilities	Disruption in the provision of institutional services	High adverse	• Strongly consider diversion of initially proposed construction yard away from Pacific Global Medical Center and United Hills Church of the Nazarene. • Proper resettlement of identified small religious institution in Valenzuela shall be detailed in the final RAP.

Environmental Aspect	Potential Impact	Assessment of Impact	Options for Prevention or Mitigation or Enhancement
Service utilities	Service utilities interruption	Moderate adverse	• Subway will be designed to utilize deep underground space • Coordinate with concerned public utilities such as MERALCO, Maynilad, MWCI and PLDT during the planning and construction phases • Develop a Utility Management Plan
Employment/ Livelihood	• Temporary disturbance of commercial establishments and small vendors • Decline or eventual loss of business in affected areas.	Moderate adverse	• Construction activities shall be undertaken at the shortest possible time to restore normal business operations immediately. • For business establishments that will be permanently removed, the RAP details a replacement cost for the loss. • Alternative livelihood programs in coordination with the LGUs and other government agencies will be taken in to consideration.
	Generation of temporary employment	Beneficial	Priority for employment will be given to the local residents to help boost economic activity of affected LGUs.
Traffic condition	Increase in traffic congestion due to mobilization of workers, heavy equipment and construction materials, transport of demolition debris and excavated soil Threat to availability of health services	Moderate adverse	• A TMP that details the activities to adequately manage traffic flow will be strictly implemented. • Proper coordination and approval of TMP by MMDA and LGUs concerned. • Implementation of a moving construction yard during different phases of the excavation process to minimize traffic congestion. • Proper scheduling of transport of heavy structures during periods when there are less vehicles on the road
Health and safety	Increased risk of accidents due to improper work ethics which may threaten health	Low adverse	• Provision of appropriate PPEs to all construction workers • The contractor shall be duly trained for the subway construction works

Environmental Aspect	Potential Impact	Assessment of Impact	Options for Prevention or Mitigation or Enhancement
	and safety of workers and local residents.		• Contractors shall submit an Occupational Health and Safety Management Plan prior to commencement of work. • A medical station within the complex will be provided to safeguard the health of the workers • The project site will be fully fenced and access points will be not be available for the public. • Include safety measures in the design of subway
Communicable and infectious diseases	Spread of communicable and infectious diseases	Low adverse	• Stringent observance of high standards of cleanliness and sanitation at the construction site • Medical certificates will also be requested to ensure workers are fit to work. • Appropriate sanitary facilities shall be provided at all construction sites such as portable toilets and litter bins. • Implementation of an Occupational Health and Safety Management Plan by the contractor
II. OPERATIONAL PHASE			
The Land			
Leaks and accidental spills of chemicals, especially at the depot area	Soil contamination	Moderate adverse	Emergency and contingency plan in case of spills and health and safety management plan must be in place
Solid waste generation	• Land and water contamination • Aesthetic impacts Spread of diseases	Moderate adverse	Policies on solid waste minimization and solid waste management should be implemented in stations and depot.
Geological hazards (liquefaction, ground shaking/ground rupture)	Damage to underground structures and overlying structures (in depot and stations)	High adverse	Regular maintenance checks of structures and tests of safety measures; Earthquake drills and early warning system

Environmental Aspect	Potential Impact	Assessment of Impact	Options for Prevention or Mitigation or Enhancement
The Water			
Domestic wastewater generation	Pollution of receiving water bodies	Moderate adverse	• Installation of wastewater treatment facility • Administrators of station and other facilities shall maintain water treatment systems in proper conditions
Maintenance and repair activities in the depot	Pollution of receiving water body, specifically Tullahan River	Moderate adverse	• Installation of interceptor tank to remove oil and fuel grease from surface water before discharge. • Installation of controlled perimeter drainage system to ensure catchment of all maintenance runoffs. • Operation of a wastewater treatment facility with oil removal. • Equipment and machinery shall be regularly checked for fuel and oil leaks. • During repair of equipment and machinery, containers/drip trays shall be used to collect leakage. • Any spilled or spent oil will be collected, stored properly and disposed by accredited waste haulers.
Heavy rainfall	Flooding and inundation of subway facilities	Moderate adverse	• Installation of water-shut panels at station entrances • Installation of drainage pumping station to pump up inflow water from outside ground level (rain water, etc.) and water from inside the tunnel and send them to the sewer.
Changes in groundwater flow	Ground subsidence due to lowering of groundwater level	Low adverse	• Installation of monitoring wells for observation along the subway tunnel and monitor change of the surrounding groundwater levels. • If abnormal changes are identified, the administrator shall investigate the causes and implement the proper countermeasures immediately.

Environmental Aspect	Potential Impact	Assessment of Impact	Options for Prevention or Mitigation or Enhancement
The Air			
Operation of service vehicles and standby generator set	Air Pollution	Low adverse	• Proper preventive maintenance of service vehicles and equipment • Use of cleaner fuel for the generator sets
Increase in air pollutants from increased vehicles along stations	Air Pollution	Low adverse	• Management of traffic along stations • Use of blowers to dissipate pollutants along terminal
Generation of low frequency noise from structure-borne noise and ground vibration	May cause mental stress to residence	Low adverse	• Installation of noise barrier • Long welded rail and expansion joint, damped wheel and resilient tie will be adopted • Installation of floating slab trackbed • Regular conditioning and maintenance of the trains will be implemented on a regular basis • Speed of train will be limited to minimize noise and ground vibration
Climate change	Accelerated structural fatigue and materials failure	Low adverse	• Proper design in making infrastructure robust or resilient to the effects of climate change should be taken into consideration
	Greater demands on the construction, operation and maintenance of flood control and drainage structures.	Moderate adverse	Improvement of current drainages along the alignment to be resilient to climate change.
	Increase GHG emissions due to increased demand for cooling system of passenger cars, building offices and ticket booths	Moderate adverse	Install reliable and heavy duty air-conditioning (AC) system of railcars that will be purchased and use of centralized AC system for the stations
	Indirect impact -Increased	Low adverse	• Formulate and implement health and safety protocols for

Environmental Aspect	Potential Impact	Assessment of Impact	Options for Prevention or Mitigation or Enhancement
	vulnerability of passengers to spread of communicable disease via a mass transportation system.		all stations and trains • Information, Education and Communication (IEC) materials on proper hygiene in all stations • Provisions for use of HEPA (High Efficiency Particulate Air) Filter for the AC/ventilation system.
The People			
Employment and livelihood	• Enhanced commuters mobility • Better physical and psychological state of commuters resulting from shorter and more comfortable travel time • Employment of skilled personnel to operate and maintain the railway system	Beneficial	Regular preventive maintenance of the subway system to maintain efficient, reliable and safe subway operation and maintain its economic and social benefits
Traffic Condition	Easement of traffic congestion	Beneficial	• Regular preventive maintenance of the subway system • Consider linkages with LRT, MRT lines, bus and jeepney stations for efficient passenger flow transferring to other modes of transportation
	Increased vehicular flow in areas adjacent to stations	Moderate adverse	• Conversion of construction yards into sidewalks, taxi bays, unloading and loading stations or central stations for public utility vehicles • Coordination with MMDA and the LGUs to assign traffic enforcers in critical areas.
Health and safety	Risk of accidents due to improper work ethics	Low adverse	• Implementation of an Occupational Health and Safety Management Plan, which includes an Emergency Response

Environmental Aspect	Potential Impact	Assessment of Impact	Options for Prevention or Mitigation or Enhancement
			Plan, during the operations stage • Provision of sanitary facilities or utilities to maintain sanitary and healthy conditions in all stations and in the depot • Implement safety measures through engineering design and administrative controls during train operation

CHAPTER 1

Project Description

1. PROJECT DESCRIPTION

1.1. PROJECT LOCATION AND AREA

1.1.1. Alignment

The proposed Metro Manila Subway Project (Phase 1) is approximately 28.3 kilometers (km) in length. The alignment maps are shown in Figure 1 and Figure 2.

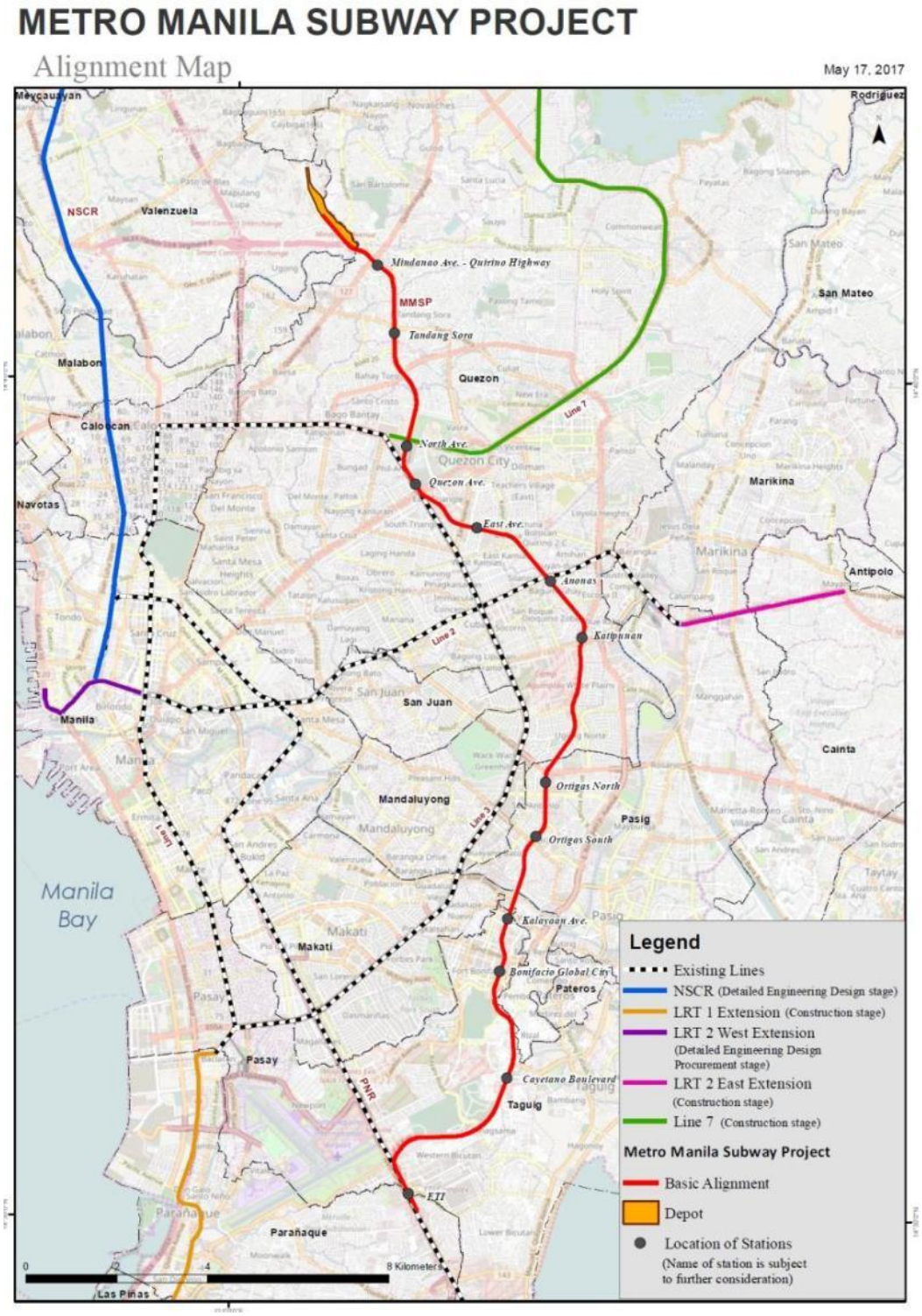
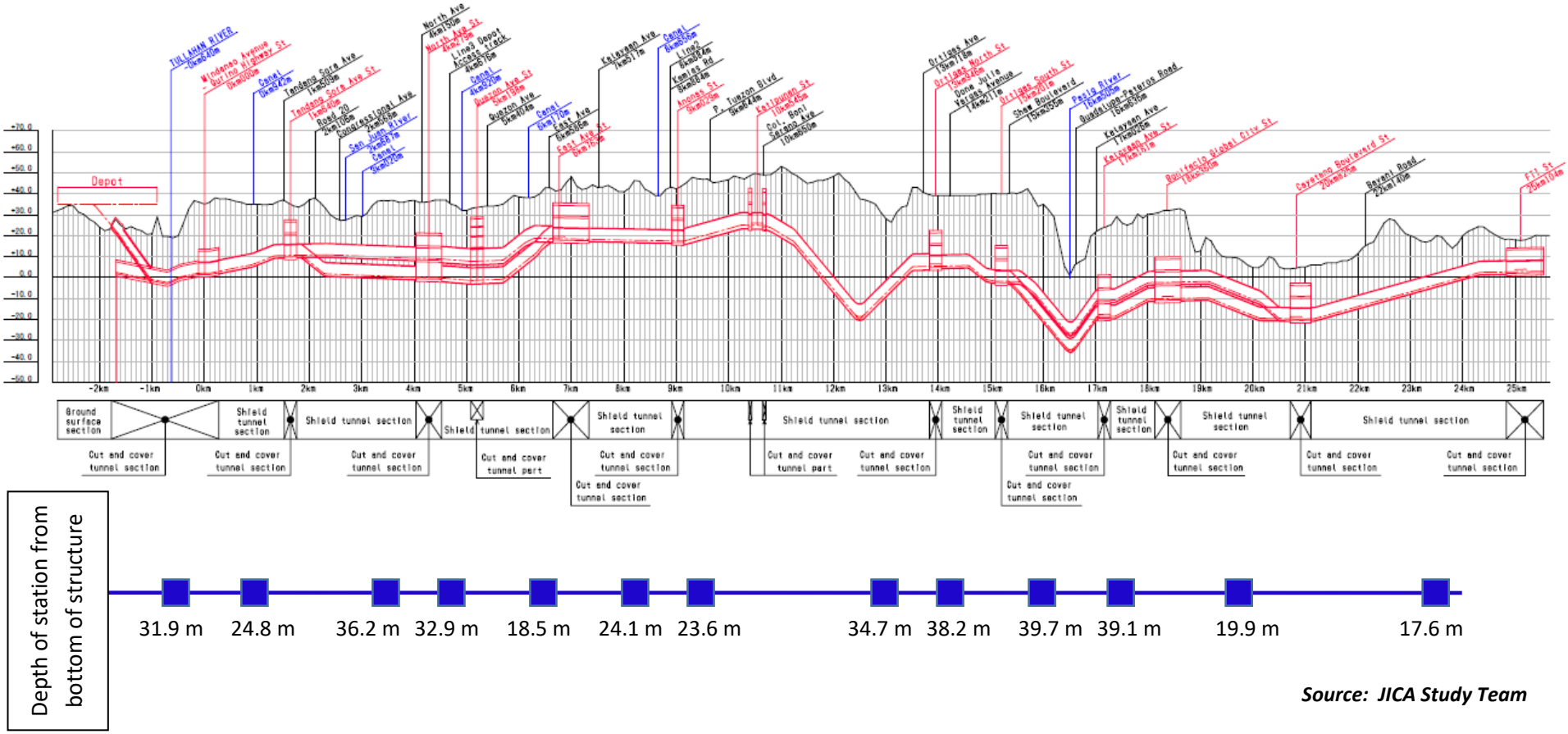


Figure 1.Horizontal Alignment of the Metro Manila Subway Project



Source: JICA Study Team

Figure 2. Vertical alignment of the Metro Manila Subway Project

The actual vertical alignment will be modified on the basis of the more detailed geological surveys which will be conducted during the Detailed Engineering Design stage.

1.1.2. Description of Impact Areas

The proposed railway for the MMSP Central Zone will be mostly underground, with structures above ground for the station entrances and exits. The MMSP alignment will pass through the center of Metro Manila. The route is mostly occupied by the Central Business Districts (CBDs), particularly in Quezon City, Ortigas Center, Bonifacio Global City and will traverse underground portion of Makati City. As such, most areas that the railway will traverse are highly developed as urban commercial and residential areas. The proposed depot location is in Brgy. Ugong in Valenzuela City. The site is long and narrow as they are intended for the maintenance and servicing of trains.

Direct impact areas (DIA) of the MMSP include the depot location in Brgy. Ugong in Valenzuela City and areas where the thirteen (13) stations will be constructed, the construction yard for stations and railway structures, the shield machine base for the excavation of underground tunnels, and the subterranean area between stations. The maps presented in Section 1.5.1 show the proposed location of the stations, the construction yards and shield bases, which are identified as the direct impact areas of the subway project.

It should be noted that the construction plan for the subway project will be finalized during the Detailed Engineering Design (DED) phase, thus exact locations of construction yards and shield base are still subject to modification as the project is still in the feasibility study phase.

Based on the result of the assessment of the project's impact on land, water, air and people, the following are the DIA according to key impacts:

- DIA for impacts on Land

  The depot facilities will be constructed above ground at the proposed depot location in Brgy. Ugong, Valenzuela City. At the station locations, the proposed construction yards are intended to provide for temporary roads during construction and temporary sites for the construction equipment and materials. The shield machine base is the area where the tunneling machine will be assembled and will also serve as staging area for the tunnel boring machine (TBM) utilities.

  As shown on the attached maps in Section 1.5.1 as Figure 8, the depot location and all 13 stations are DIAs because of the presence of trees and other vegetation, which may be affected by the project. The DIA area in the depot is indicated by the red lines. The DIAs in the 13 stations and segments between stations are inside the red line (proposed structure), green line (proposed construction yard) and blue lines (proposed shield machine base).

  Since the project will be excavating large volume of soil, the disposal sites and truck routes going to the reuse and disposal sites will be considered as DIA. At present, exact locations of reclamation and other projects where the surplus soil will be used have not been identified and will be finalized during the DED phase. Preliminary coordination is being conducted with relevant government agencies for the identification of reclamation and other projects that

will be recipients of the surplus soil.

- DIA for Water Quality Impacts

  The proposed depot location in Brgy. Ugong, Valenzuela City is bounded by Tullahan River on the east. The Quirino Highway Station and the proposed construction yard in this station will cross a small creek.

  Due to clearing and excavation activities near these 2 water bodies, there may be a short-term impact on the water quality in terms of increase in sediments and turbidity of the Tullahan River at the boundary of the proposed depot site and at the creek near the Quirino Highway station. Hence, these areas are considered DIAs.

  During operation of the depot, accidental discharge of fuels, lubricants, detergents and other oil-contaminated materials from maintenance operations, if not handled properly, may likely affect water quality of the Tullahan River. However, results of analysis of water sample from the Tullahan River showed that the DENR standard on the following parameters was not met: BOD, surfactants, oil & grease, DO, phosphate and fecal coliform. Nevertheless, the point of wastewater discharge at the depot site will be considered as a DIA.

- DIA for Impacts on Air Quality, Noise and Vibration Level

  Pre-construction and construction activities may temporarily increase the level of total suspended particulates (TSP) and particulate matters (PM). In addition, exhaust gas emission from vehicles coming in and out of the project site as well as generator sets may increase the current level of nitrogen oxides (NOx), sulfur oxides (SOx), carbon monoxide (CO) and hydrocarbons (HC). These impacts are predicted to have short term low adverse effects. Thus, DIA for air quality will be limited to the depot site, station locations, construction yards and shield machine bases.

  Predicted noise and vibration levels caused by construction works may exceed the maximum allowable levels at the borderline of construction work areas. At 5 meters (m) from the borderline, predicted noise and vibration levels during construction works may already satisfy the maximum allowable noise levels. Thus, the DIA for noise and vibration during construction works is at a 5 m radius from the borderline of construction works.

  During the operation of the subway, impact of noise and vibration will be minimal or have low adverse impact since the railway is situated underground. The predicted vibration level at 10 m above the rail track is below night time control level standard in both residential and commercial areas, using Tokyo Metropolitan Government's standard. DIA for noise and vibration during operation of subway is limited at the underground stations and tunnels.

- DIA for Impacts on People

Based on the results of the socio-economic survey, a total of 1,074 structures will be affected by the project. These are all at the location of the proposed Right of Way (ROW) of the subway, the area allotment for construction yard and shield machine base, as well as construction of entrances and exits to the underground stations, and the depot in Valenzuela. The DIA for People is shown on the maps provided in Section 1.5.1, as the red line (proposed structure), green line (proposed construction yard) and blue lines (proposed shield machine base).

The surface above the subway alignment, aside from the station locations, is included as indirect impact areas (IIA). The road network within a 1 kilometer (km) radius from the vicinity of the stations will also be considered as IIAs for traffic congestion during construction works.

Table 1 shows the list of barangays that are in the DIA and IAA of the subway project, while Figure **3** presents the map of the alignment showing the barangays that it will traverse.

Table 1. Barangays in the Direct and Indirect Impact Areas of MMSP

Depot, Stations, Alignment	Structure Location	Barangay	*DIA*	*IIA*
Valenzuela Depot	Surface	Brgy. Ugong, Valenzuela City	✓	
Alignment from Depot to Quirino Highway Station	Underground	Brgy. Talipapa, Quezon City		✓
Quirino Highway Station	Underground	Brgy. Talipapa, Quezon City	✓	
Alignment from Quirino Highway Station to Tandang Sora Station	Underground	Brgy. Tandang Sora, Quezon City		✓
Tandang Sora Station	Underground	Brgy. Tandang Sora, Quezon City	✓	
Alignment from Tandang Sora Station to North Ave. Station	Underground	Brgy. Bahay Toro, Quezon City Brgy. Santo Cristo, Quezon City Brgy. Bagong Pagasa, Quezon City		✓
North Ave. Station	Underground	Brgy. Bagong Pagasa, Quezon City	✓	
Alignment from North Ave. Station to Quezon Ave. Station	Underground	Brgy. Bagong Pagasa, Quezon City		✓
Quezon Ave. Station	Underground	Brgy. Bagong Pagasa, Quezon City	✓	
Alignment from Quezon Ave. Station to East Ave. Station	Underground	Brgy. Pinyahan, Quezon City		✓
East Ave. Station	Underground	Brgy. Pinyahan, Quezon City	✓	

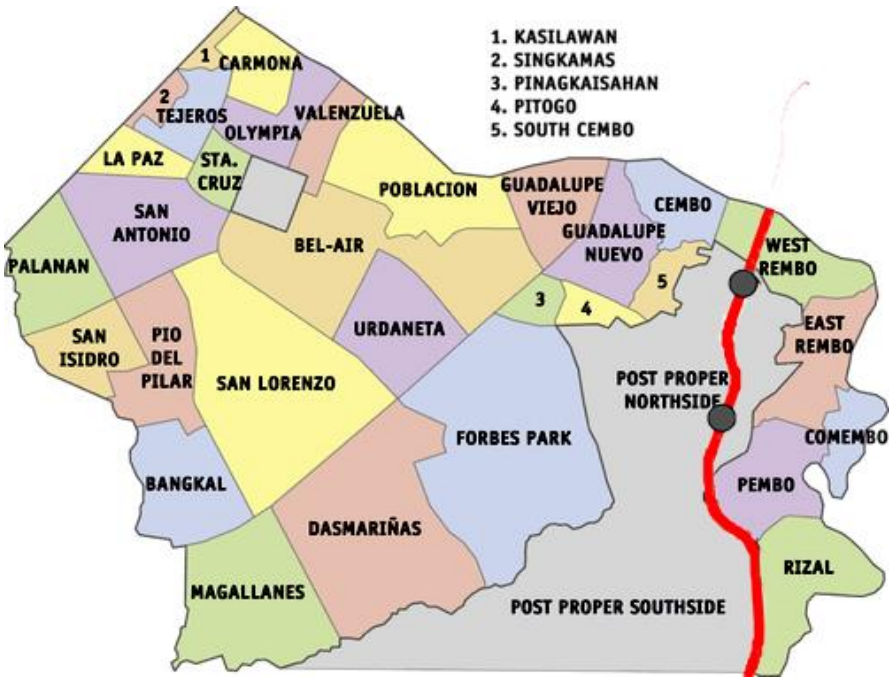
Depot, Stations, Alignment	Structure Location	Barangay	*DIA*	*IIA*
Alignment from East Ave. Station to Anonas Station	Underground	Bgry. Malaya, Quezon City Brgy. Sikatuna Village, Quezon City Brgy. East Kamias, Quezon City Brgy. Quirino 2A, Quezon City Brgy. Quirino 3A, Quezon City		✓
Anonas Station	Underground	Brgy. Bagumbuhay, Quezon City	✓	
Alignment from Anonas Station to Katipunan Station	Underground	Brgy. Bagumbuhay, Quezon City Brgy. Milagrosa, Quezon City		✓
Katipunan Station	Underground	Brgy. Blueridge A, Quezon City Brgy. St. Ignatius, Quezon City Brgy. Bayanihan, Quezon City	✓	
Alignment from Katipunan Station to Ortigas North Station	Underground	Brgy. White Plains, Quezon City Brgy. Ugong Norte, Quezon City		✓
Ortigas North Station	Underground	Brgy. Ugong, Pasig City	✓	
Alignment from Ortigas North Station to Ortigas South Station	Underground	Brgy. Ugong, Pasig City Brgy. Oranbo, Pasig City Brgy. San Antonio, Pasig City		✓
Ortigas South Station	Underground	Brgy. San Antonio, Pasig City Brgy. Oranbo, Pasig City Brgy. Kapitolyo, Pasig City	✓	
Alignment from Ortigas South Station to Kalayaan Ave. Station	Underground	Brgy. Kapitolyo, Pasig City Brgy. Pineda, Pasig City Brgy. West Rembo, Makati City		✓
Kalayaan Ave. Station	Underground	Brgy. Fort Bonifacio, Taguig City	✓	
Alignment from Kalayaan Ave. Station to Bonifacio Global City Station	Underground	Brgy. Fort Bonifacio, Taguig City		✓
Bonifacio Global City Station	Underground	Brgy. Fort Bonifacio, Taguig City	✓	
Alignment from Bonifacio Global City Station to Cayetano Boulevard Station	Underground	Brgy. Fort Bonifacio, Taguig City Brgy. Pembo, Makati City Brgy. Rizal, Makati City Brgy. Pinagsama, Taguig City Brgy. Ususan, Taguig City		✓
Cayetano Boulevard Station	Underground	Brgy. Ususan, Taguig City Brgy. Pinagsama, Taguig City	✓	
Alignment from Cayetano Boulevard Station to FTI Station	Underground	Brgy. Pinagsama, Taguig City Brgy. Western Bicutan, Taguig City		✓

Depot, Stations, Alignment	Structure Location	Barangay	*DIA*	*IIA*
FTI Station	Underground	Brgy. Western Bicutan, Taguig City	✓	
	Service Track	Brgy. San Martin de Porres, Paranaque City Brgy. Merville, Paranaque City	✓	

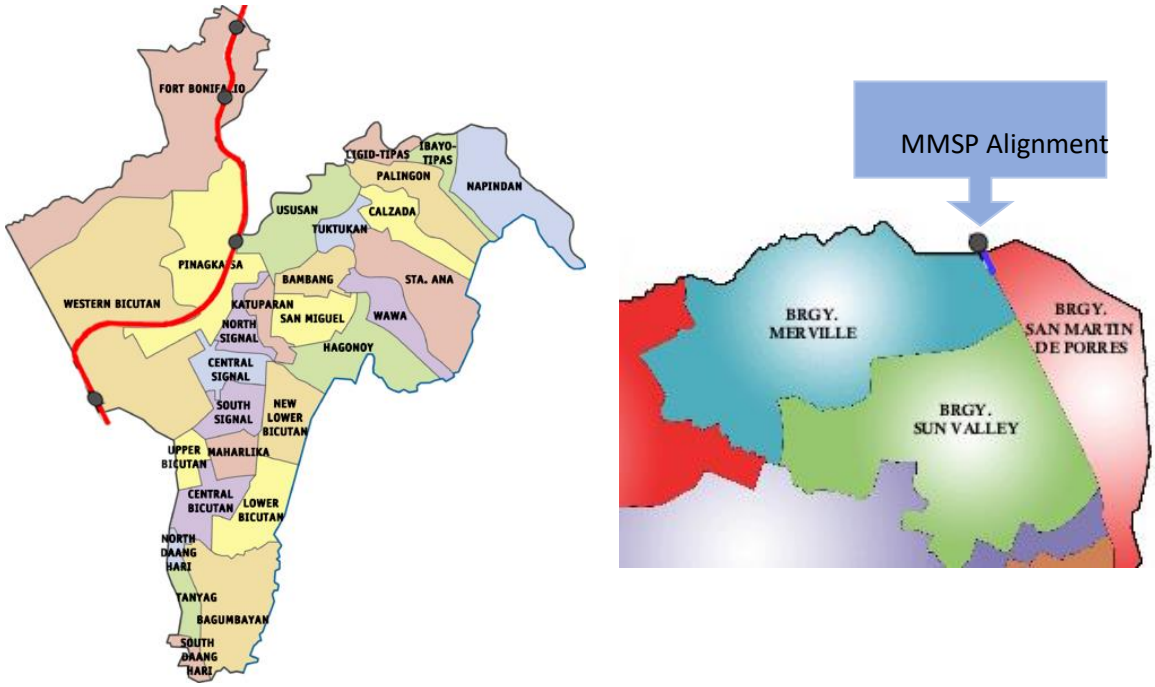
(a) Valenzuela City

(b) Quezon City

(c) Pasig City



(d) Makati City



(e) Taguig City (f) Parañaque City

Figure 3. MMSP Alignment Showing Barangays in Impact Areas

1.2. PROJECT RATIONALE / BACKGROUND OF THE PROJECT

"Roadmap for Transport Infrastructure Development for Metro Manila and its Surrounding Areas" (hereinafter called as "Roadmap Study") was implemented in 2013, envisioned to develop two railway lines to form the public transport backbone in connecting the flourishing areas of National Capital Region, Region III and Region IV-A. This is in view of the driving vision for sustainable development means in the Greater Capital Region (GCR) from the crippling effects of transport-related issues on economic growth. One of which is the proposed Metro Manila Subway Project that will connect San Jose Del Monte in the North and Dasmariñas at the South passing through Metro Manila, as the main objective for realization of the ideal transport network by the year 2030.

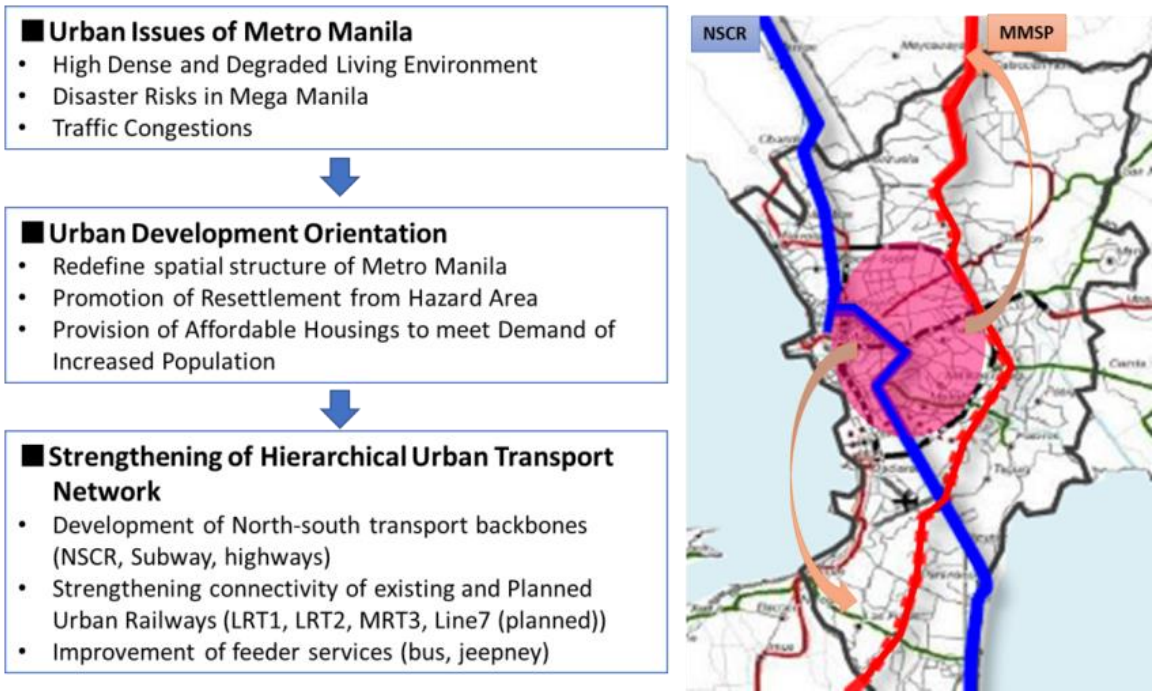
Philippines, as one of the dynamic developing countries in Asia was facing significant challenges due to rapid urbanization and deteriorating public transport systems. Based on the census figures, the population of Manila, as the capital city of the Philippines increased from 7.92 million in 1990 to 12.88 million in 2015. The population density reached to 20,000 per km^2 which is three times that of Tokyo. Manila, therefore, is the concentrated area with people approximately 13% of the national population and with the economic activity of approximately 38% of the country's GDP.

An inadequate public transport system in a highly urbanize city like Manila can cause numerous problem to its citizens on their day-to-day life. Having minimal railway services, people are

forced to commute by buses or jeepney that would take long hours due to heavy traffic congestion in Metro Manila.

To tackle the issues on urban problems such as high dense and degraded environment, disaster risks and traffic congestions, redevelopment/rehabilitation in the city center, provision of affordable housing, and improvement of disaster risk area were only few of the key solutions to resolving the issues. For this, the cluster development in suburban areas such as Bulacan in the North and Laguna at the South, connected by a north-south transport corridor of highways and urban railways should be proposed to reduce the density of Metro Manila and for sustainable urban growth.

To be able to promote inclusive growth and improve transport systems within and beyond Metro Manila, strengthening of hierarchical urban transport network which the Philippine Government will build is the North South Commuter Railway Project (Malolos to Tutuban) and the Metro Manila Subway Project (Phase 1) from Quirino Highway to FTI that aims on providing a safe, fast, and reliable railway system.



Source: JICA Team

Figure 4. Rationale of MMSP for Regional and Urban Development

1.3. PROJECT ALTERNATIVES

1.3.1. Without Project Option

Mass transit services in Metro Manila have been insufficient, which causes the worsening traffic congestion and becomes a bottleneck in the development of Metro Manila. Therefore, if MMSP project, the mass transit system to connect the northern area to the southern area in Metro Manila is not implemented, sustainable development will be hindered. Furthermore, the

environment might be further degraded due to the air pollution and noise issues caused by the increasing vehicle traffic. Thus, the Zero Option (Without Project) case was not selected.

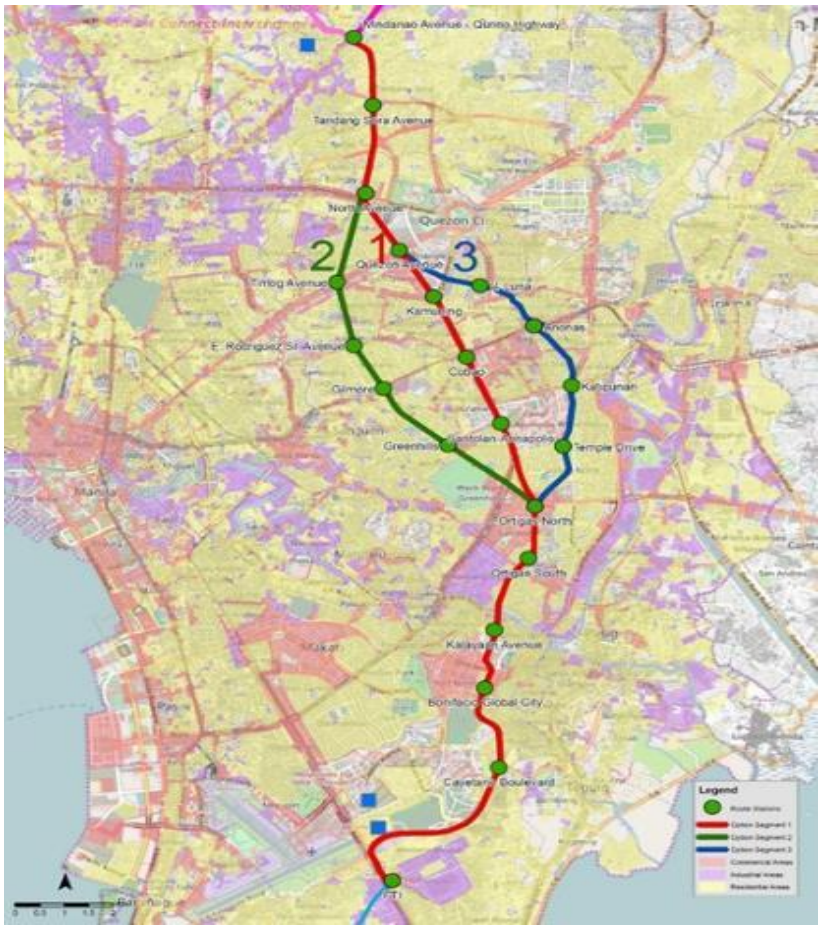
1.3.2. Route Alternative Options, Depot Location and Station Structure

Route Alternative Options

For MMSP, three alternatives were studied in the planning stage, as shown in Figure 5. Table 2 compares the advantages and disadvantages of these alternative routes. The following Evaluation Ranking was used in the comparison and evaluation of alternatives:

- Very good or desirable — Suitable or proper
- Good or desirable — Recommendable or acceptable
- Middle — Recommendable or acceptable in case of no any other options
- Bad or improper — Not recommendable or not acceptable

After discussions among relevant organizations including the Department of Transportation (DOTr), Department of Public Works and Highways (DPWH), Metropolitan Manila Development Authority (MMDA), Bases Conversion and Development Authority (BCDA) and the JICA Study Team, Option 3 was evaluated to most achieve the objectives and was adopted.



Source: JICA Study Team

Figure 5. Route Alignment Options

Table 2.Comparison of Alternatives for MMSP

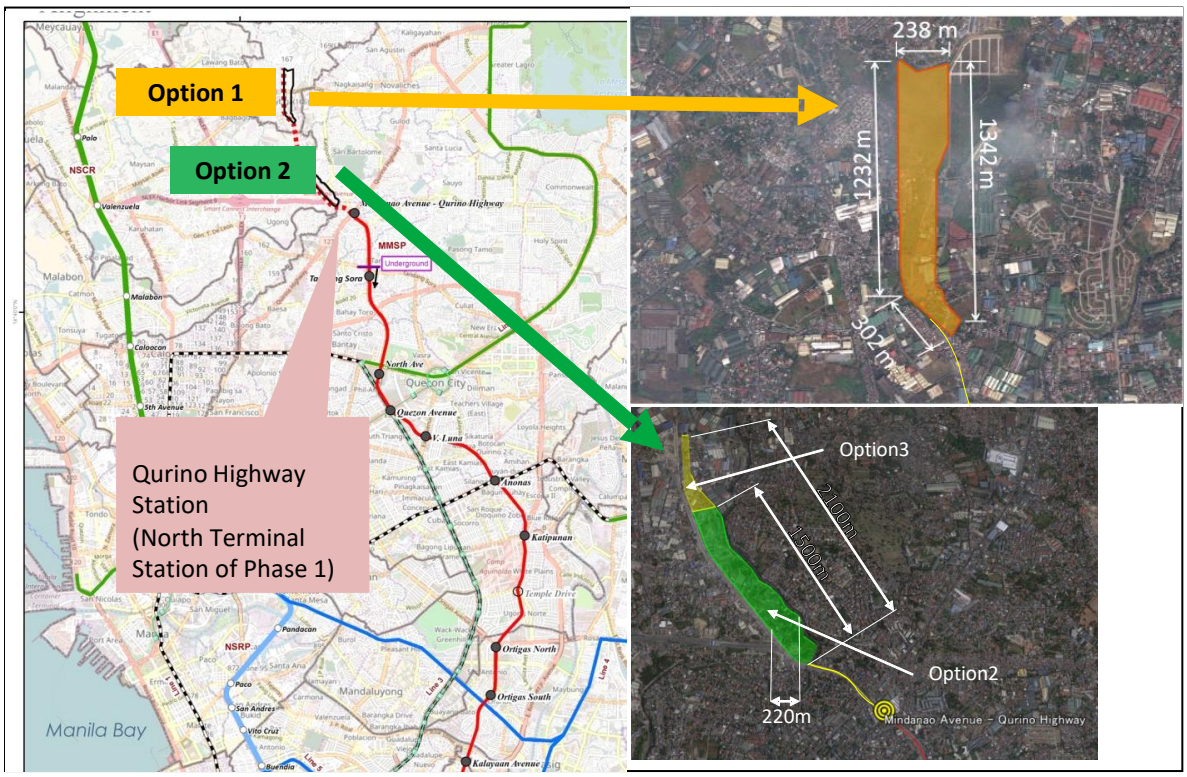
Alternative	Option-1 (EDSA Route)	Option-2 (Greenhills Route)	Option-3 (Katipunan Route)
Characteristics of Route	Route along existing MRT 3 and EDSA as main road	Route passing through many commercial and academic areas and having high development potential	Route passing through many commercial and residential areas and having high development potential
Route length (km)	22.7	23.7	23.6
Estimated project cost (million Peso) (as of route selection)	208,753 (1.00)	210,639 (1.01)	218,307 (1.05)
Demand (in 2025) : No. of Pax (Pax/day)	532 ◎	405 ○	428 ○
Fare Revenue (in 2025) (million Peso/km/day)	0.70 ◎	0.54 ○	0.67 ◎
Economic loss due to traffic jams (million Peso/day) (Without Project: 3,512 million Peso/day	3,490 ○	3,470 ○	3,466 ◎
No. of Stations connected to the Central Business District (CBD)	6 ◎	3 ○	5 ◎
Total CBD Area along MMSP (ha)	810 ◎	660 ○	680 ○
Large-scale Intermodal (which connects to 2 or more railways)	3 ◎	1 ○	2 ○
Intermodal (which Connects to another railway)	2 ◎	2 ◎	1 ○
No. of Stations with flood risk	0 ◎	2 ○	0 ◎
No. of Stations with earthquake risk (liquefaction)	0 ◎	0 ◎	0 ◎
Estimated required area (m^2)	19,000 ○	46,000 △	54,000 △
Estimated Project Affected Persons (PAPs) (Nos.)	20 ○	170 △	320 △
Estimated deemed PAPs (Nos.)	120 ○	320 △	1,490 △
Residential sections along MMSP (m)	990	2,541	2,168

Alternative	Option-1 (EDSA Route)	Option-2 (Greenhills Route)	Option-3 (Katipunan Route)
Noise and Vibration	Because the present noise and vibration levels along the proposed alignment are high, the impacts are likely to be minimal. ○	Because the proposed alignment will pass through many residential areas, the impacts on local people will be more serious than Option-1 △	Because the proposed alignment will pass through many residential areas, the impacts on local people will be more serious than Option-1 △

Evaluation Rank - Very good or desirable: ◎Good or desirable: ○Middle: △ Bad or improper
Source: JICA Study Team

Depot Location

Two candidate sites of the depot location, one in Mindanao Avenue in Valenzuela City, and one in General Luis in Caloocan City, were studied in the planning stage, as shown in Figure 6. Table 3 compares the advantages and disadvantages of these candidate sites. After discussions among the relevant organizations in the same manner as the route alternatives, Option 2 (Mindanao Avenue) was adopted.



Source: JICA Study Team

Figure 6. Candidate Sites for Depot

Table 3. Comparison of Candidate Sites of Depot

Item	Option 1 (General Luis)	Option 2 (Mindanao Avenue)
Existing Land Use	Mixed-use of industrial and residential areas	Mixed-use of industrial, commercial and residential areas
Construction Cost (Depot, Access line) (million Peso)	13,724 ○	10,153 ◎
Land Acquisition Area (m^2)	336, 774 △	255,200 ○
Land Acquisition Cost(million Peso)	6,735 △	5,104 ○
Number of Affected Buildings	409 (Residential land development is on-going.) △	576 ○
Flood Risk	Risk of 0.5 m flood height expected at southern part ○	Risk of maximum 0.5 – 1.5 m flood height expected. △
Others	- Road widening project for arterial road going north-south - -Arterial road is crossing the area, which requires rearrangement of road. - Additional Station Required △	Smart connect segment 8.2 (Expressway Project) ○

Evaluation Rank - Very good or desirable: ◎Good or desirable: ○ Middle: △Bad or improper
Source: JICA Study Team

Structure of Quirino Highway Station

Options for elevated or underground structure of Quirino Highway Station were studied in the planning stage. Table 4 compares advantages and disadvantages of these candidate sites. After discussions among the relevant organizations, underground structure was adopted.

Table 4.Comparison of Structure of Quirino Highway Station

Item	Option 1 (Elevated)	Option 2 (Underground)
Construction cost for 1) Quirino Highway Station 2) Structures between Quirino Highway Station–Tandang Sora Station (million Peso)	4,143 ◎	7,943 ○

Item	Option 1 (Elevated)	Option 2 (Underground)
Land Acquisition Area (m^2)	33,620 △	25,510 ○
No. of affected structures	148 △	54 ○
Others	- Big challenge for land acquisition along Mindanao Ave. where concentration of livelihood is observed. △	- Less risk in land acquisition and traffic disruption along Mindanao Ave. - Ensure speedy construction. ◎

Evaluation Rank: Very good or desirable: ◎Good or desirable: ○ Middle: △ Bad or improper
Source: JICA Study Team

Methodology of Tunneling

There are two methods for construction of underground structure: cut and cover methods, in which excavation starts on the ground level and forms spaces from there down, and the non-cut and cover methods, including the shielded tunneling method and the New Austrian Tunneling Method (NATM), in which an excavation machine goes through the earth to form spaces. The tunnel structure at and between stations, shall be selected after comparison of the different construction methods.

Table 5.Comparison of Excavation Methods at Station Sections

	Cut and Cover Method	Non-Cut and Cover Method (Shielded Tunneling and NATM)
General Description	- Excavate the ground with utilization of retaining walls (diaphragm walls). - It's generally applied for construction of station structures and has been accepted in actual works. - Spaces inside stations and for facilities can be easily ensured since excavated spaces are used efficiently. **Very good**	- Excavate inside the earth using an excavation machine (shielded tunnel), afterward, enlargement works are conducted to ensure a particular space. - It's applied when the ground cannot be excavated. There should be shafts in front and back of a station to move passengers. - Spaces may be smaller than cut & Cover method, so it's difficult to arrange facilities. **Middle**
Cost	- Comparatively cheap **Good**	- More expensive than cut & cover method **Middle**

	Cut and Cover Method	Non-Cut and Cover Method (Shielded Tunneling and NATM)
Construction Period	- Overall period is shorter than non-cut and cover because it's possible to conduct construction of civil works at the same time as the shielded tunnel construction between stations. **Very good**	- Overall period is longer than cut and cover because enlargement works are conducted after completion of the shielded tunnel construction. **Middle**
Social Environment Friendliness	- Temporary roads must be ensured in order to prevent negative impacts from the works on road traffic, which requires land acquisition of about 12 m. —	- There are a few influences on road traffic at the station sections and there are shafts, so they could influence road traffic and cause residence relocation as well. —
Comprehensive evaluation	**Good (Selected)**	**Middle**

Source: JICA Study Team

Table 6. Comparison of Excavation Methods between Station Sections

	Cut and Cover Method	Non-Cut and Cover Method (Shielded Tunneling and NATM)
General Description	- Generally utilized at shallow depth locations (15 m) because of the financial aspect, but is rarely utilized for between-stations tunneling construction because of the traffic congestion due to works. **Middle**	- Possible to excavate inside the earth by a shielded tunneling machine regardless of condition on the ground - Since traffic congestion due to works is the most objectionable factor for the Philippines, this method is desirable. **Very good**
Cost	- High cost because it's required to do a lot of land acquisition. - When considering horizontal alignment of the project line, civil structure cost is also expensive. **Middle**	- Land acquisition is not required. - Civil structure cost is less than cut & cover method. **Very good**
Construction Period	- Total time required will be longer due to the time required for land acquisition and excavation. **Middle**	- The period should be considerably shorter than cut & cover method. **Very good**

	Cut and Cover Method	Non-Cut and Cover Method (Shielded Tunneling and NATM)
Social Environment Friendliness	- Temporary roads must be ensured in order to prevent negative impacts due to the works on road traffic, which requires land acquisition of about 12 m. **Middle**	- Land acquisition is not required. **Good**
Comprehensive evaluation	**Middle**	**Very good (Selected)**

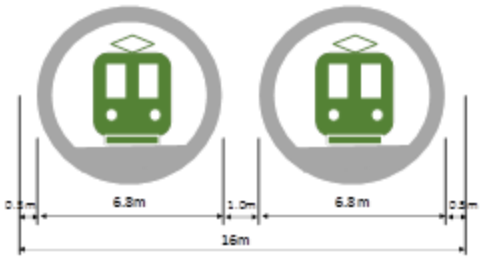
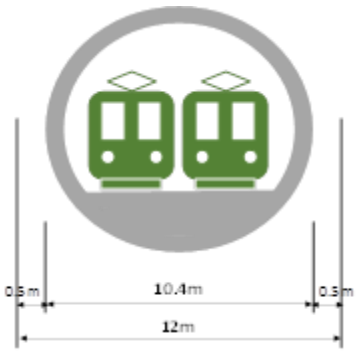
Source: JICA Study Team

As for which non-cut and cover tunneling method should be used in the project line, the shielded tunneling method is recommended. However, if NATM is comprehensively judged to be more favorable based on the more detailed geological survey that will be conducted in the DED phase, then the construction method shall be changed.

Tunnel Structure Options

Double Tube Single Track (DTST) and Single Tube Double Track (STDT) were compared in the tunnel structure plan. DTST shall be adopted to a shielded tunnel in the Line.

Table 7. Selection of Structure of Shield Tunnel

	Double Tube Single Track (DTST)	Single Tube Double Track (STDT)
Overview image		
Construction Cost	Cheaper - A = πr^2 = 36m^2×2 tunnels = 72m^2 - At connection part between island platform and stations, excavation volume of stations can be reduced. **Good**	Expensive - A=πr^2 = 85m^2 - About 1.2 times as expensive as DTST. - The track must be separated at an island platform; excavation length must be over 50 m longer than island platform which results in higher cost. **Middle**
Construction Period	- The period can be shortened by using two shield machines that are 6.8 m outer-diameter to excavate in each different	- Comparatively longer period than DTST because only one shield machine that is 10.4 m outer-diameter conducts

	Double Tube Single Track (DTST)	Single Tube Double Track (STDT)
	period.	excavation.
	Good	**Middle**
Occupying width of platform	- Occupying width of platform is 16 m - When positioning two tunnels vertically, Occupying width of platform is 8 m. **Good**	- Occupying width of platform is 12 m **Good**
Ventilation facilities	- Scale of ventilation equipment can be small proportional to section area, but the other equipment should be larger than that of single tube double track. —	- Scale of ventilation equipment needs to be larger than that of island platform, but the other equipment can be a half of it. —
Comprehensive evaluation	**Good (Selected)**	**Middle**

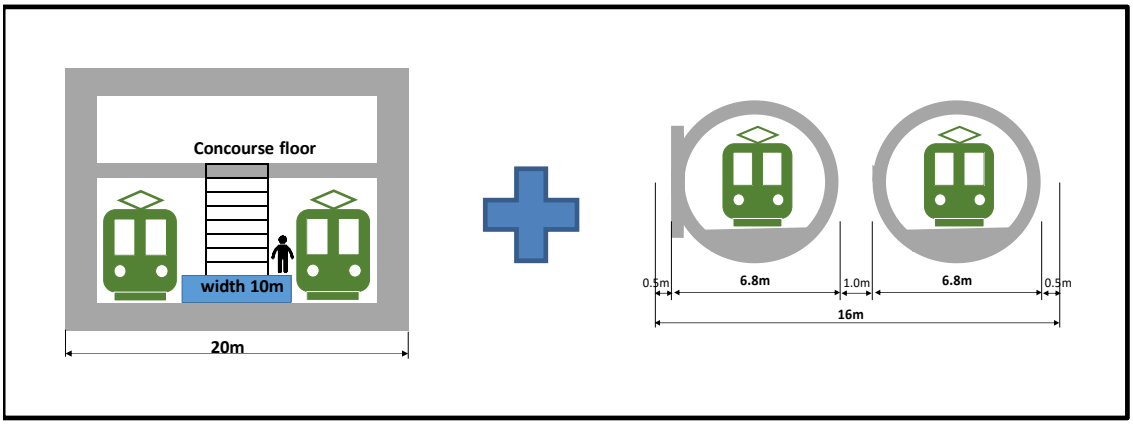
Source: JICA Study Team

External diameter of shielded tunnel is defined as follows.

- Standard shielded tunnel: ϕ6.8 m
- Enlarged shielded tunnel：φ8.1 m

Standard shielded tunnel is defined based on clearance limit, and expansion volume and cant at curve sections. Enlarged shielded tunnel is defined based on an example of underground stations with shielded tunnels in Japan.

The typical configuration of structure for the project shall be the combination below.



Source: JICA Study Team

Figure 7. Configuration of Structure to Apply to MMSP Line

1.4. PROJECT COMPONENTS

The project components, scales of facilities and specifications of equipment are summarized in the following table.

Table 8. Project Components, Scales of Facilities and Specifications of Equipment

Item	Technical Parameter	Specification		
Train Operation Plan	Maximum Speed	80km/h(Underground section)		
	Gauge	1,435 mm (Standard gauge)		
	Length	Embankment	Elevated	Underground
		1.0 km	0.3 km	26.7 km
	No. of Stations	At Grade	Elevated	Underground
		-	-	13
	Traction Power Supply	Overhead Rigid Conductor System (Main Line) Simple Catenary System (Depot)		
	Standard Passenger Capacity	Seated	Standing (7 Passengers /m^2)	Total
	Lead Car	45	221	266
	Intermediate Car	54	231	285
	Capacity of a Train (8 car train)	Capacity per car	No. of cars	Capacity per train
	Lead Car	266	2	532
	Intermediate Car	285	6	1,710
	Total Passengers	-	8	2,242
	System Operational Specifications	Year		
		2020		2030
	Traffic Demand (Passengers Per Hour Per Direction: PPHPD)	12,800		19,900
	Train Composition (cars)	8		8
	No. of Operated trains	9		12
	System Capacity (PPHPD)	20,178		26,904
	Travel Time	Travel Time		Scheduled Speed
	Express (Quirino Highway – FTI)	31 min 5 sec		48.5 km/h
	Local (Quirino Highway– FTI)	42 min 20 sec		35.6 km/h
	Required No. of Trains	Year		
		2020		2030
	Train in Operation	15		20
	Reserved Train	4		4
	Total No. of Train	19		24
	Train Consist	8 cars		8 cars
	Rolling Stock Procurement Plan	Year		
		2020		2030
	No. of Trains to Procure	152 cars (19 x 8-car Train-Sets)		40 cars (5 x 8-car Train-Sets)

Item	Technical Parameter	Specification
Railway Alignment and Structure Plan	Horizontal Curve Radius	
	For Main Line	More than 160 m
	For Stations	More than 400 m
	For Turnout	More than 160 m (Main Line) More than 100 m (Depot)
	Transition Curve Length	Maximum out of L1, L2, L3
		L1=600C
		L2=7.4CV
		$L3=6.7C_dV$
	Length between Transition Curves	More than 20m
	Maximum Gradient	
	For Main Line	35/1,000
	For Stations	Level (0), 5/1,000 (absolute maximum) The underground section installs the gradient for a drainage.
	For Stabling track	Level (0), 5/1,000 (absolute maximum) The underground section installs the gradient for a drainage.
	For Turnout	Level (0), 25/1,000 (absolute maximum) The underground section installs the gradient for a drainage.
	Vertical Curve	Radius 3,000 m (4,000 m where curve radius is less than 800m) Vertical curve is required for more than 10/1,000 of gradient change
	Width of Formation	
	Cut and cover tunnel and U-shaped retaining wall section	More than 2.8 m
	Shield tunnel section	The width which can arrange the evacuation passage width of 1 m or more.
	Depot	More than 3.0 m
	Other section	More than 3.15 m
	Distance between Track Centers	More than 4.0m (Main Line), More than 4.0m (Station), More than 4.0m (Stabling track)
	Width of Structural Gauge	3.4 m (Underground), 3.8 m (others)
	Station Platform	
	Platform Length	210 m (For 10 cars train for future)
	Platform Width	10 m (Standard, Island platform)
		7.5 m (Standard, Separate platform)
System Plan	Train Formation	
	*Tc: Trailer car with driver's cab	4M4T (Tc+M+M+T+T+M+M+Tc)
	*M: Motor car	
	*T: Trailer car	
	Major Dimension	
	Leading Car Length	20,470 mm
	Intermediate Car Length	19,500 mm
	Body Width	2,950 mm
	Passenger Capacity per Train	

Item	Technical Parameter	Specification
	No. of Cars/Train-Sets	8 cars
	Seat	414 passengers
	Standard (4 pax/m^2)	1,466 passengers
	Standing (7 pax/m^2) + Seat	2,242 passengers
	Weight per Train (Tare)	254t
	Body Materials	Aluminum Alloy
	Saloon Design	
	Door Ways	4 doorways each side of a car
	Door Type	Double sliding doors, Pocket Type, 1,300 mm width
	Seat Type	Longitudinal seat
	Special Facilities	
	Wheel Chair Space	Equipped
	Baggage Space	Not equipped
	Cab Front End Door	Equipped
	Traffic Performance	
	Acceleration	0.92 m/s^2 (3.3km/h/s)
	Deceleration (Service/Emergency)	Service: 1.17 m/s^2 (4.2km/h/s) Emergency:1.31 m/s^2 (4.7km/h/s)
	Propulsion System	
	Power Collection System	DC 1,500 V Single-arm pantograph (1 unit per motor car) High Voltage Bus Line
	Control System	VVVF inverter with IGBT elements (Option: SiC) 1 set per motor car
	Traction Motor	High Performance Totally Enclosed Induction Motor Gear Ratio : 6.53 (98/15)
	Brake Control System	Electric command electro-pneumatic regenerative brake Anti-Skid Device : Equipped
	Bogies	Bogie with Bolster
	Air Conditioning Equipment	Roof top type (2 units per car)
	Auxiliary Power Supply Equipment	Static Inverter (SIV)
	Passenger Information System	Public address system via loudspeaker Emergency Intercom Visual information system via 17 inches LCD screens
	Electrification System	DC 1500V feeding system
	Transmission Line System of Auxiliary Power for Stations	AC 34.5kV Loop Parallel Power Distribution system
	Signaling System	CBTC (Automatic Train Protection, Automatic Train Operation, Automatic Train Supervision),Depot signaling (Shunting signal, Track circuit, Computer Based interlocking)
	Telecommunication System	Multi-Service-Network, Telephone, Digital Radio, Closed-Circuit Television, Passenger information display, Public Address system, Clock, Disaster Prevention System, Facility-SCADA
	Fare Collection System	Automatic Fare Correction system

Item	Technical Parameter	Specification		
	Track Work			
	Track type	Main line: Ballastless track, Solid track with resilient sleeper (Main line: underground section) Ballast track (Embankment section and depot)		
	Running Rail	Japanese standard 60 kg/m rail or its equivalent		
	Depot (Mindanao Avenue)	Year		
		2025	2045	
	Inspection Track for Daily and Monthly Inspection	3 trains	5 trains	
	Inspection Track after Overhaul and Semi Overhaul	1 train	1 train	
	Track for Occasional Repair	1 train	1 train	
	Assembling and Disassembling Track	2 train	2 train	
	Stabling Track	22	22	
	Washing Track (rolling stock washing plant)	1	1	
	Washing Track (manual washing)	1	2	
	Wheel Re-Profiling Track	1	1	
Operation Plan	No. of Passengers	Year		
		2025	2030	2035
	(thousand passengers/day)	365	669	973
	Estimated PPHPD	Year		
		2025	2030	2035
	(passenger/hour/direction)	12,556	19,569	26,582

Source: JICA Study Team

1.4.1. Depot components and facilities

The depot will serve as an area for stabling, maintenance, inspection and train repair. Aside from these, the depot will function mainly as a central command office which conducts the operation control of the main line and the integrated management of electricity, facilities for the crew, and the maintenance base for track, power supply system, signaling, communication systems, and civil and architectural facilities.

Typical depot facilities and its functions are summarized in Table 9. The specific design for the depot will be finalized during the DED.

Table 9. Facilities and Functions of Depot

Facilities		Function
Tracks	Stabling track	Stabling cars
	Daily Inspection Track	Daily inspection
	Monthly inspection track	Periodic inspection
	Critical/general inspection track	Inspection with car disassembling

Facilities		Function
	Departure/arrival inspection track	Inspection at departure and arrival
	Car washing track	Machine washing and hand washing of cars
	Lead track	Shunting trains
	Test track	Test run
	Stabling track for maintenance vehicle	Stabling of maintenance and repair vehicle
Building/ Facilities	Central Management Building	Central command office, depot command room, equipment room, office room, welfare facility
	Inspection and Repair Shed	For inspection with disassembling, repair facilities, workshop, warehouse, electric room
	Monthly Inspection Shed	Periodic inspection
	Daily Inspection Shed	Daily inspection
	Store Shed for Maintenance Vehicle	Stabling of maintenance and repair vehicle
	Power Receiving and Substation	Power supply for mainline and depot
	Other Buildings	Oil warehouse, emergency power generation room, storehouse, cleaning stand, footboard
Other Facilities	Road Inside Depot	Access road to facilities and each track in depot
	Gate	Gate at the access entrance of depot
	Fence	Fence to prevent intrusion for safety
	Green Belt, Car Park	-
Facilities/ Equipment	Inspection and Repair Facilities	Facilities for inspection and repair of cars
	Automatic Car Wash Machine	Automatic washing for exterior car body panel
	Drainage Treatment Facilities	Treatment facilities that meet the effluent standards of drainage from workshop and car washing
	Outside Lighting Facilities	Lighting for stabling track, washing track and road inside the depot etc.
	Maintenance Vehicle	Maintenance vehicle for maintenance and inspection of main line facilities during nighttime

Source: JICA Study Team

1.4.2. Station structure

1.4.2.1. Underground Station

The estimated required space and major dimensions for an underground station are shown below. Final specifications will be determined in the DED phase:

- Total required width for station: 27-32 meters

- Width of underground station: 17–22 meters
- Escalator/Staircase: 5 meters for parallel installation of escalator and staircase with wall structure
- Sidewalk: 3 meters for wheelchairs passing at the narrowest spot
- Typical width of underpass: 5-10 meters, depending on the number of passengers
- Length of escalator/staircase: 13-18 meters for 5-7.5 meters gap
- Platform length: 41-210 meters, defined by passenger volume and train length

1.4.2.2. Elevator/ Escalator

Elevators and escalators will be provided for the vertical movement of passengers from the stations to the exits and to reduce travel distance of passengers. Such facilities are also effective means of aiding movement for elderly, disabled and mobility impaired passengers.

Installation of two-way door opening elevators will be considered in stations with limited space. Such two-way door opening elevators are also friendly to passengers on wheelchairs as they do not change the direction when getting out from the elevator. Where provision of an elevator is not possible due to space restriction, equipment to assist passengers on wheelchairs going up stairs will be considered in some existing stations.

1.4.2.3. Universal Design and Special Considerations

The following design which enables easier access to any type of passengers such as children, elders, mobility impaired persons, pregnant women, blind persons, etc., will be incorporated in the structure design. Specifically, the following will be considered:

- Flat access for passengers on wheel chairs by providing slopes and/or elevators, balustrades along stairs with 2 levels for persons with different heights, etc.
- Women only cars which are exclusive use for women and small children, either entire day or during peak hours
- Cars with priority seats for elderly passengers, disabled passengers and expectant mothers, as well as those equipped with wheelchair spaces
- Braille signage at the Ticket Vending Machine

1.4.2.4. Platform Screen Door (PSD)

PSD will be installed for the purpose of improving safety on the platform by preventing accidental contact with trains, passengers falling on tracks, etc.

1.4.3. Trackwork

Tracks secure a train running path and direct the movement of trains, as well absorb the vibration and support load of trains. Tracks will be designed to distribute the force to roadbed and structures at the bottom of the tracks. However, at the embankment section and in the

depot, where the train running speed is slow, ballast track at cheaper construction cost will be used.

1.4.4. Power Supply Facilities

For traction power supply, a 1,500V DC traction power supply system has records of application in middle distance congested urban lines. Moreover, the train car is less expensive, and is thus recommended for the MMSP.

For overhead catenary system, overhead rigid conductor rail system for the underground section is the most suitable for the MMSP, if high speed operation is not required in underground section. At the depot, a simple catenary system is considered due to its low cost advantage and simple appearance.

1.4.5. Signaling and Telecommunications System

The Communications Based Train Control (CBTC) system according to the IEEE1474 standard was developed aiming to increase operation efficiency and reduce installation cost. This system not only has standard Automatic Train Protection (ATP) function, but also has the following functions:

- Automatic Train Supervision (ATS)
- Automatic Train Operation (ATO)
- Automatic Train Protection (ATP)

This train control system is expected to achieve the short headway operation with moving block and increase the total management efficiency by applying ATS and ATO functions.

Facility Supervisory Control and Data Acquisition (SCADA) system that monitors the steady-state situation of electronic and electric devices such as signals and telecommunication equipment, and alarms and switches systems if the malfunction of components will occur, will be introduced using the state-state-of–the-art equipment to providing suitable preventive maintenance. In this way, the incidence of railway system malfunction will be reduced as much as possible.

During DED, a study will be conducted to determine the best way to obtain and make use of information concerning, among other things, civil and track structures like rails and weather conditions along the tracks, and earthquake and other disaster prevention information, with a view to achieving a more stable train operation.

1.4.6. Ventilation and Air Conditioning System

1.4.6.1. Station Ventilation

For the ventilation of the underground station, platform, concourse, staff rooms, equipment rooms will all be ventilated by fresh air by forced ventilation. In addition, smoke exhaust system and station air conditioning system which correspond to the disaster prevention measures for the underground station shall be considered. Design for the ventilation system (e.g. ventilation

fan, air duct, etc.) shall be considered separately for the platform, concourse, staff rooms and equipment rooms respectively and customized for each function.

1.4.6.2. Station Ventilation

For the station air cooling, capacity of the chilling machine is determined with consideration of air conditioning area of each station. Energy efficiency and conservation measures shall be considered in the system design.

1.4.6.3. Tunnel Ventilation System

Forced ventilation system which has function of tunnel air ventilation and emergency smoke exhausting shall be provided for the tunnels. Longitudinal ventilation is the method that will facilitate the ventilation machine room at end of the stations. From one station, fresh air is directly supplied to the tunnel and is vacuumed and exhausted at adjacent station to outside. On the other hand, transverse ventilation shall be used for the ventilation machine room and ventilation shaft at the middle of the tunnel section between the stations.

1.4.7. Drainage Pump Facilities

This is the facility to pump up inflow water from outside ground level (rain water, etc.) and water from inside the tunnel by pre-set pump facilitated at the lowest position of each drainage section, and send them to the sewer. For the pump operation, drainage operation is automatically performed by detecting high water level by pre-set ultrasonic waves water gauge. Pump operation is monitored and controlled from the OCC.

1.4.8. Other Facilities

Other facilities of the subway are:

- Automatic Fare Control systems consisting of Ticket Vending Machines, Automatic Gates, Automatic Fare Adjustment Machines, Data Collecting Machines and office booking machines.
- Signage and various types of Information Displays to help passengers obtain necessary information.
- Restrooms/ toilets
- Emergency exits in all stations

1.5. PROCESS / TECHNOLOGY

1.5.1. General Layout

The general layout of the proposed depot and stations (Ver26) is presented in the succeeding maps as Figure 8. Description of the legend is provided as follows:

- Proposed structure – represented as red lines; location of underground stations, tunnels and other underground facilities.
- Construction yard – represented as green rectangular box; the area to be used for batching, stockpiling and other construction works. It will be a moving construction yard, part of which will be used as a temporary road during construction. Lanes will be switched depending on the phase of construction, as further illustrated in Appendix D.
- Shield machine base –represented as blue box with broken lines; assembly area for tunnel boring machine (TBM), staging of TBM utilities
- Station entrance/exit – represented as green box with 24 m x 15 m dimension
- Ventilation system – represented as small green box with 8 m x 10 m dimension beside the station entrance/ exit

1.5.2. General Description of Pollution Control Devices and Waste Management System

Wastewater Management

During the construction phase, the contractors shall be required to submit a wastewater management plan as requirement for contract bidding and prior to construction works to ensure that proper wastewater management will be considered. The contractors shall provide temporary sanitation facilities such as portable toilets for the construction workers. During the operation phase, stations and the depot facilities shall install sufficient wastewater treatment systems.

Solid Waste Management

During the pre-construction and construction phases, the contractor shall be required to prepare and strictly implement a proper construction solid waste management plan including waste due to demolition works. The contractors shall provide garbage bins and implement segregation of wastes. A supervision consultant shall monitor waste management and disposal. The supervision consultant and contractor should review and evaluate the effectivity of the solid waste management plan regularly to ensure compliance.

During the operation phase, administrators of station and other facilities shall prepare and strictly implement a proper solid waste management plan

Spoils/Surplus Soil Management

At this stage, potential uses of surplus soil near the MMSP location were identified, such as earth filling works at the depot and stations, backfilling of quarry sites in Rizal Province, reclamation projects and elevation of low-lying areas in Regions III and IV, and other infrastructure projects of DPWH, DOTr and LGUs within Metro Manila. The following government agencies were also identified as relevant organizations that are potential recipients of surplus soil for their respective projects: Philippine Reclamation Authority (PRA), Mines and Geosciences Bureau, Provincial Disaster Risk Reduction Management Council (PDRRMC) of Regions III and IV, DPWH and LGUs within the MMSP alignment.

During the detailed engineering design phase, the detailed design consultant shall prepare a plan for the proper reuse of excavated soil. The supervision consultant shall actively coordinate with abovementioned organizations and other agencies which may be identified during DED stage.

1.6. PROJECT SIZE

The estimated surface area for the depot, station facilities, construction yard and shield machine base is shown in the table below. It should be noted that there are some duplications in the reported areas for the stations, construction yard and shield machine base due to overlapping of these areas, like in Quirino Highway, Anonas, Katipunan, Ortigas South, Kalayaan and BGC Stations.

Table 10. Estimated Project Area

Depot /Station	Depot /Station Area (m^2)	Station Facility (Entrance/Exit) (m^2)	Construction Yard Area (m^2)	Shield Machine Base Area (m^2)
Valenzuela Depot	317,300.00	-	-	-
Quirino Highway	9,245.43	2,400.00	16,924.66	3,305.02
Tandang Sora	5,119.23	1,600.00	4,452.69	3,568.67
North Avenue	8,137.63	1,960.00	7,392.33	3,621.95
Quezon Avenue	4,103.27	1,600.00	10,396.20	3,508.96
East Avenue	14,478.1	1,600.00	10,075.21	2,954.34
Anonas	5,119.04	1,240.00	8,122.60	3,984.65
Katipunan	5,119.01	1,960.00	12,764.27	-
Ortigas North	5,119.03	1,240.00	5,436.64	3,640.83
Ortigas South	5,119.06	1,600.00	4,511.24	3,466.08
Kalayaan Avenue	4,622.55	1,240.00	12,439.89	3,474.20
Bonifacio Global City	8,137.46	3,040.00	19,954.33	-
Cayetano Blvd.	8,155.18	1,600.00	6,499.15	3,784.85
FTI	12,027.4	1,960.00	10,403.11	3,656.18

Source: JICA Study Team

The proposed shield base were labeled “in case needed” in Figure 8 because the necessity for acquisition of the proposed shield machine bases will be determined during the DED phase when the excavation plan will be finalized.

1.7. DESCRIPTION OF THE PROJECT PHASES

This section describes the various activities to be undertaken during the Pre-Construction, Construction, Operational and Abandonment Phases of the Subway Project.

1.7.1. Pre-Construction Phase

During this phase, acquisition of ROW at the proposed depot, stations and subterranean land covered by 50 meter distance from the surface to the proposed structures will be conducted.

Site preparation activities include clearing of existing vegetation, and removal and demolition of existing structures on the proposed depot and stations.

1.7.2. Construction Phase

1.7.2.1. Construction Methodology

Construction at Stations

For the construction of stations, large-scale construction machines are set up on the ground for construction of the Reinforced Concrete (RC) diaphragm wall, installation of road decking, excavation, and construction of the structure frame. In order to prevent blockage of traffic flow, the following countermeasures are considered:

- A temporary road is prepared to ensure the space for a construction yard by acquiring private land along the road, as much as possible. In that way, the present number of lanes is ensured and traffic congestion is controlled.
- There must be a shield machine base around a station for the construction of the shielded tunnel. This shield machine base shall be placed in acquired private land instead of placing on a road.
- As to land that is difficult to acquire for a temporary road because of tall buildings in private land, lane closures have to be conducted to ensure work space.

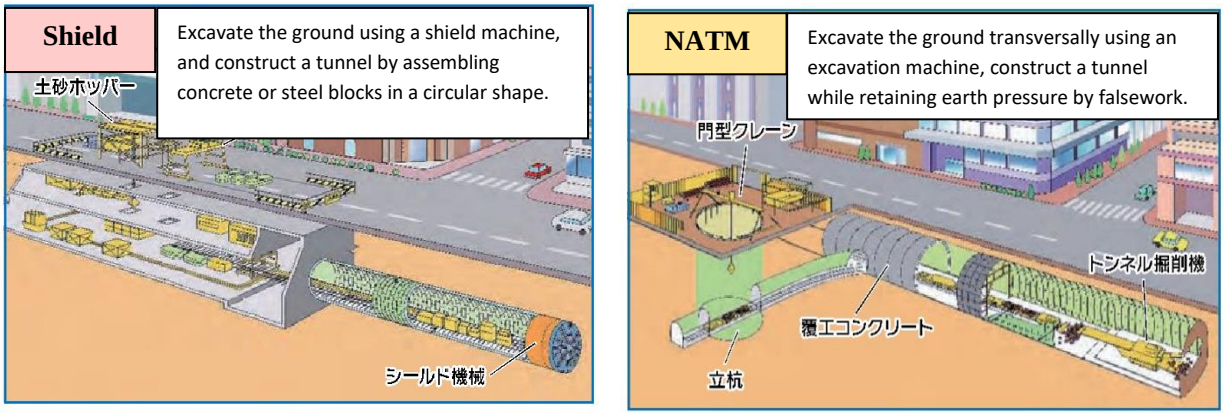
Cut and cover method will be used to build box tunnel at the station section. Based on the common conditions of the 13 stations, the use of diaphragm wall as retaining wall is recommended. Construction of the diaphragm wall involves excavating the ground with bentonite slurry or polymer slurry which is effective for ground stabilization. Rebar cages are placed at the excavated holes then concrete is poured to form the diaphragm wall.

Top-down method of excavation will be applied. In this method, base slabs of the structure are constructed from top down in parallel with excavation. The structure works as a strut supporting retaining walls.

Tunnel Construction

As discussed in Sec. 1.3.2, the shielded tunneling method is selected as the construction method for the sections in between stations. However, if NATM is comprehensively judged as the more favorable method through the detailed geological survey in the DED phase, the construction method shall be changed.

Images of the shielded tunneling method and NATM are shown below.



Source: Brochure of Fukuoka City

Figure 9. Non Cut and Cover Construction Method (Shield tunneling and NATM)

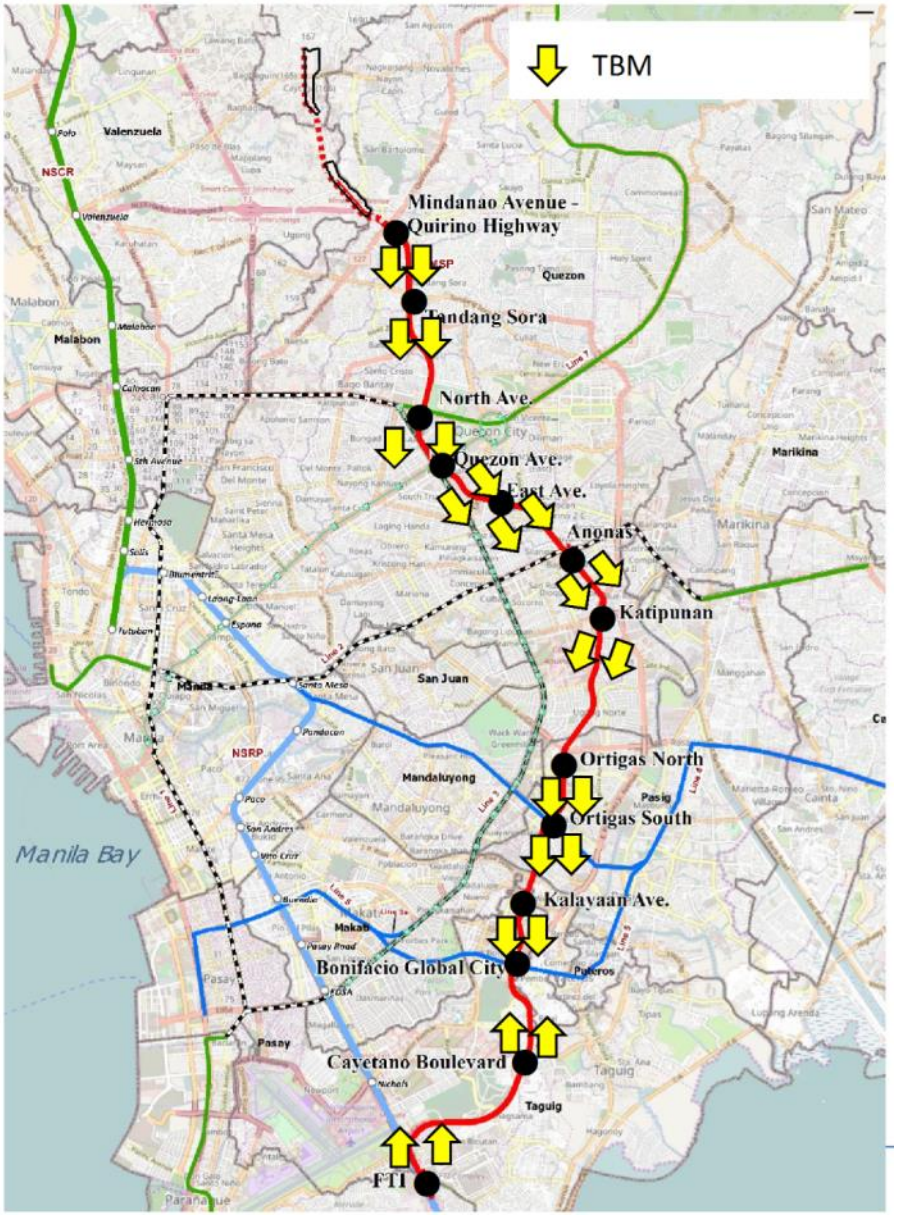
The specific shielded tunneling method to be used is the tunnel boring machine (TBM), which consists of a shield (a large metal cylinder) and trailing support mechanisms. A rotating cutting wheel is located at the front end of the shield. Behind the cutting wheel is a chamber where the excavated soil is either mixed with slurry or left as-is (earth pressure balance or EPB shield). Which type of TBM is suitable for MMSP will depend on the results of the detailed soil survey to be conducted during DED stage.

Systems are also present for removal of the soil (or the soil mixed with slurry).Behind the chamber there is a set of hydraulic jacks supported by the finished part of the tunnel which are used to push the TBM forward. Once a certain distance has been excavated (roughly 1.5–2 meters), a new tunnel ring is built using the erector. The erector is a rotating system which picks up precast concrete segments and places them in the desired position.

Entry point for the TBM will be at the cut and cover sections of the stations. From this point, the shielded tunneling machine will excavate underground to form a tunnel. Excavated soil will exit at the cut and cover section where it entered. Behind the shield, inside the finished part of the tunnel, systems for excavated soil removal, slurry pipelines if applicable, control rooms, rails for transport of the precast segments, etc., can be found.

Tunnel construction requires a large space for a shielded tunneling machine, for instance material stock such as segments, various equipment and tanks, disposal soil pits, machinery (back hoe, trucks) space and the slurry plant. The shield machine base shall have an area of about 3,500m^2 for two TBMs per site.

A shield excavation plan is shown in Figure 10. Detailed plan on how many TBMs will operate simultaneously will depend on the factors such as construction cost and target time of completion of construction. This will be established during the DED phase. Some of the issues that still need to be considered during detailed design are the plan for shortening construction period, cost reduction and possible application of NATM alternative.



Source: JICA Study Team

Figure 10. Typical TBM Operation Scheme Shielded Tunnel Excavation Planning

Depot Construction

Depot for the project line is to be located at a higher position than the current ground by embankment. Though a closer study will be made regarding the embankment structure in the Detailed Design stage, it is necessary to prepare any retaining structures around the embankment in order to ensure a large depot as possible within the limited site.

Though a closer study will be made regarding the embankment structure in the DED stage, the reinforced retaining wall (RRR) is initially selected as the most appropriate type of retaining structure for the depot embankment. This is in view of cost and workability, the height of retaining structures and conditions of the foundation ground.

Reinforced retaining wall is the wall with reinforced materials (steel plates, cloth, plastics, etc.) in backfill, and its wall is constructed to stand at right or almost right angle to the ground. It is applicable to height of less than 10 m, low cost, and has high structural capacity.

During depot construction, most of the construction period would be covered by embankment works for vast area. Retaining-wall works would be conducted at the time between embankment works.

1.7.2.2. Source of Power Supply

Power or electricity will be sourced either by tapping at the nearest electricity source or through a generator set. Contractors will be required to submit an environmental and safety management plan for the use of generator sets.

1.7.2.3. Water for Construction

Water supply for the construction of the project will be coordinated with the water utility service provider. Water tankers will be provided by the contractor.

1.7.3. Operational Phase

1.7.3.1. Subway Operation Plan

Basic concepts of the train operation plan were correspondingly decided referring to the current cases with other countries' subways and commuter trains.

1) Train Operation Service hours
Train service is provided for 18 hours per day (4:30 a.m. to 10:30 p.m.). After finishing service, a concentrated track/facilities maintenance period will be held.

2) Concentrated Rate of Passengers during Peak Hours
Demands from commuters and students is expected in the morning and evening on the planned MMSP route. It is assumed that the peak hour of the passenger concentration is from 6 to 8 a.m., and it is expected that there will be 12.5% more passengers than during normal hours.

3) Allowable congestion rate
The acceptable congestion rate based on "7 passengers/m^2" or Added Weight 3 (crush loaded weight) train capacity concept is 100% or less.

4) Train type
Two train types will operate; express and local trains.

Local trains will stop at all 13 stations with a total travel time of 42 min 20 sec from Quirino Highway to FTI. Express trains will only stop on 7 stations, namely, Quirino Highway, North Ave., Quezon Ave., East Ave., Anonas, Ortigas North, BGC and FTI, making its travel time lesser at 31 min 5 sec from Quirino Highway to FTI.

1.7.3.2. Daily Train Operation

Number of operated trains during peak hour is decided for meeting the passenger demand, while number of operated trains during off peak hour is decided for considering the passenger convenience though it may be slightly larger than the passenger demand. Most railway operators set the number of operated trains during off peak as 50-60% of that during peak hour. Referring to this concept, number of operated trains for MMSP during off peak hour is considered. The table below shows an estimated daily number of operated trains in 2025 and 2030.

Table 11.Estimated Daily Number of Operated Trains

Time	Hourly rate	2025		2030	
		No. of operated trains		No. of operated trains	
		Express	Local	Express	Local
4:30-4:59	0.9%		1		1
5:00-5:59	5.3%	2	3	2	4
Peak hour:6:00-6:59	12.5%	3	6	4	8
Peak hour:7:00-7:59	10.8%	3	6	4	8
8:00-8:59	7.2%	2	4	3	6
9:00-9:59	4.4%	1	3	2	4
10:00-10:59	4.2%	2	3	2	4
11:00-11:59	3.0%	1	3	2	4
12:00-12:59	2.8%	2	3	2	4
13:00-13:59	4.1%	1	3	2	4
14:00-14:59	3.6%	2	3	2	4
15:00-15:59	4.2%	1	3	2	4
16:00-16:59	5.5%	2	3	2	4
Peak hour:17:00-17:59	10.6%	3	6	4	8
18:00-18:59	6.5%	2	4	3	6
19:00-19:59	5.8%	2	3	2	4
20:00-20:59	4.3%	1	3	2	4
21:00-21:59	2.2%	1	2	1	2
22:00-22:30	0.9%		1		1
	sum	31	63	41	84
	total		94		125

Source: JICA Study Team

1.7.3.3. Train Travel Time

Train travel time of express trains and local trains is calculated through a computer assisted simulation. The rolling stock specifications and the alignment data which are decided in this

study are used for this simulation. Travel time is defined based on calculated time adding some recovery time. The results are shown in the table below.

Table 12. Train travel time (2025)

	Section	No. of stopped stations	Train travel time	Scheduled speed
Express train	Quirino Highway- FTI	7	31 m 5 sec	48.5 km/h
Local train	Quirino Highway - FTI	13	42 m 20 sec (without passing; 39 min 20 sec)	35.6 km/h

Source: JICA Study Team

1.7.3.4. Source of Power Supply

To ensure high reliability of power supply during the operation, adequate redundancies in the transmission and distribution will be incorporated in the detailed design stage.

1.7.3.5. Water Supply and Demand

Water supply during operational phase will be sourced from the local water utility provider. Water usage during operations shall be limited to domestic use only, i.e., for usage in, and maintenance of comfort rooms and cleaning of other facilities.

1.7.4. Abandonment Phase

The subway is estimated to operate for about 50 years, semi-permanently. During abandonment, there will be no major changes that will be done on the structures and land. Decommissioning/ demobilization activities after construction and an abandonment framework are described in Section 7. A Detailed Abandonment Plan will be submitted ninety (90) days prior to abandonment phase.

1.8. MANPOWER REQUIREMENTS

During the pre-construction and construction phases of the Project, there will be approximately 5,000 laborers – both skilled and non-skilled. The actual number of laborers significantly changes depending on the construction period and number of construction machines such as shielding machine. During the operation phase, it is estimated that the subway operation will provide employment to more or less 1,400 employees for the manning of the stations, operations and maintenance of the subway and trains at the depot. The number of manpower requirement will be finalized in the detailed design stage.

Table 13. Manpower Requirements for MMSP

Phase	Manpower Requirement	Nature of job
Pre-construction	5,000 laborers – both skilled and non-skilled	Foreman, construction workers, operation of machines and equipment
Construction		
Operation	~ 1,400	Manning of the stations, operations and maintenance of the subway and trains at the depot.

A percentage of the technical personnel will be provided by Japanese consultants, since Japanese technology will most likely be employed for the subway project. Most of the technical personnel will be hired by the Japanese consulting company, while for the construction works, manpower will be hired through the local construction company.

DOTr is committed to provide equal opportunities for employment of everyone, in compliance with the Labor Codes of the Philippines, Republic Act No. 10911 known as the Anti-Age Discrimination in Employment Act, and RA 7277 known as the Magna Carta for Disabled Person. The MMSP will provide equal opportunities for employment of men and women, on the basis of their abilities, knowledge, skills and qualifications rather than on age or disability. Manpower will be sourced as much as possible from Metro Manila, while priority will be given to hiring employees from the areas where the MMSP alignment will be located. The policy on hiring will be stipulated in the TORs and contracts with the local contractors to ensure compliance.

1.9. PROJECT COST

Indicative Project Cost: PhP218,307 Million (Feasibility Study Stage)

CHAPTER 2

Baseline Environmental Conditions, Impact Assessment and Mitigation

2. BASELINE ENVIRONMENTAL CONDITIONS, IMPACT ASSESSMENT AND MITIGATION

This chapter discusses the state of the existing environment before the onset of the proposed project. The baseline data presented in this section are based on primary and secondary data collection. Primary data were obtained through field surveys, consultation meeting and interviews with key stakeholders, and sampling and analyses of environmental parameters. Secondary data were collected from the Comprehensive Land Use Plan (CLUP) of the affected LGUs and from relevant government authorities such as the DENR and DOST. Specific information sources are referenced accordingly.

2.1. THE LAND

2.1.1. Baseline Environmental Conditions

2.1.1.1. Land Use and Classification

Land Use Compatibility

The proposed subway will traverse an existing urban area, which are currently used and classified as mostly commercial and urban zones. Estimated project area coverage at each station is indicated in Table 10. Detailed discussion of current land uses along the project area for each LGU is discussed in the following sections. The number of affected structures reported in the succeeding discussions is based on the structure tagging conducted under the Resettlement Action Plan (RAP) Study and basic design layout version 26, shown in Figure 8.

Depot Site in Valenzuela City

The proposed depot site in Brgy. Ugong, Valenzuela City is a 31.7-hectare lot with mixed use of residential, commercial and industrial sites. There are 267 residential structures, 50 commercial establishments, 28 industrial structures and a religious institution structure that will be affected.

Industrial and commercial establishments that area located within the depot include industrial gas facility, sand and construction suppliers, warehouses, heavy equipment dealer, and car service center, vulcanizing shops, junk shop, gasoline station, a slaughterhouse, mini mart/store and cafeterias. A report and events place facility with an area of approximately 15 hectares is also located at the south east portion the proposed depot, bounded by the Tullahan River.

As shown in Figure 11, the area of the proposed depot is classified as General Industrial and Commercial Zones. General Industrial Zone is defined as a mixed used area intended for industrial developments. The area shall be characterized by low rise buildings or structures for low intensity manufacturing activities. Secondary use as medium density residential development is also permitted. Commercial zone on the other hand is defined as intended for quasi-trade, business activities and service industries that complements activities of a central

business district. This area is characterized mainly by medium rise buildings or structures for medium to high intensity commercial activities.

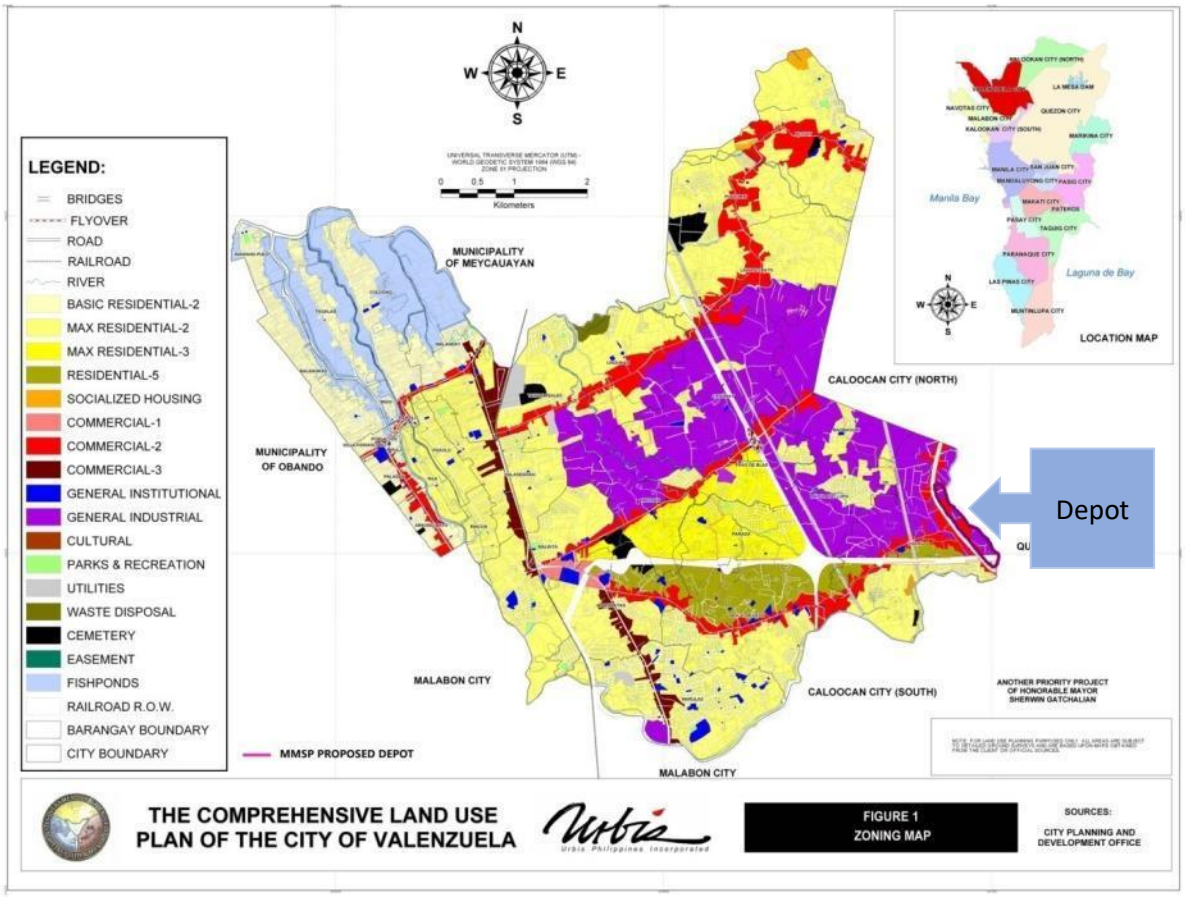


Figure 11.Land Use Plan of Valenzuela City: Depot site

Quezon City

Figure 12 presents the 2013 Zoning Map of Quezon City.

Quirino Highway Station

The Quirino Highway Station going to Tandang Sora Avenue Station will be passing underground following Mindanao Avenue path. Directly affected structures along this station include thirty (30) residential structures, covered courts, a tricycle terminal, ten (10) commercial buildings and Pacific Global Medical Center, a private hospital. Pacific Global Medical Center is categorized as a Level 2 hospital with 100- bed-capacity.

A shallow creek will be intersected by the proposed construction yard in Quirino Highway station.

Quezon City's CLUP indicates that the area around Quirino Highway Station shall be classified as a Medium Density and High Density Residential Zone while the immediate vicinity along Quirino Highway is considered as a Major Commercial Zone. The future existence of a subway station in this area will complement the lack of primary roads for direct access to residential and commercial communities thereat.

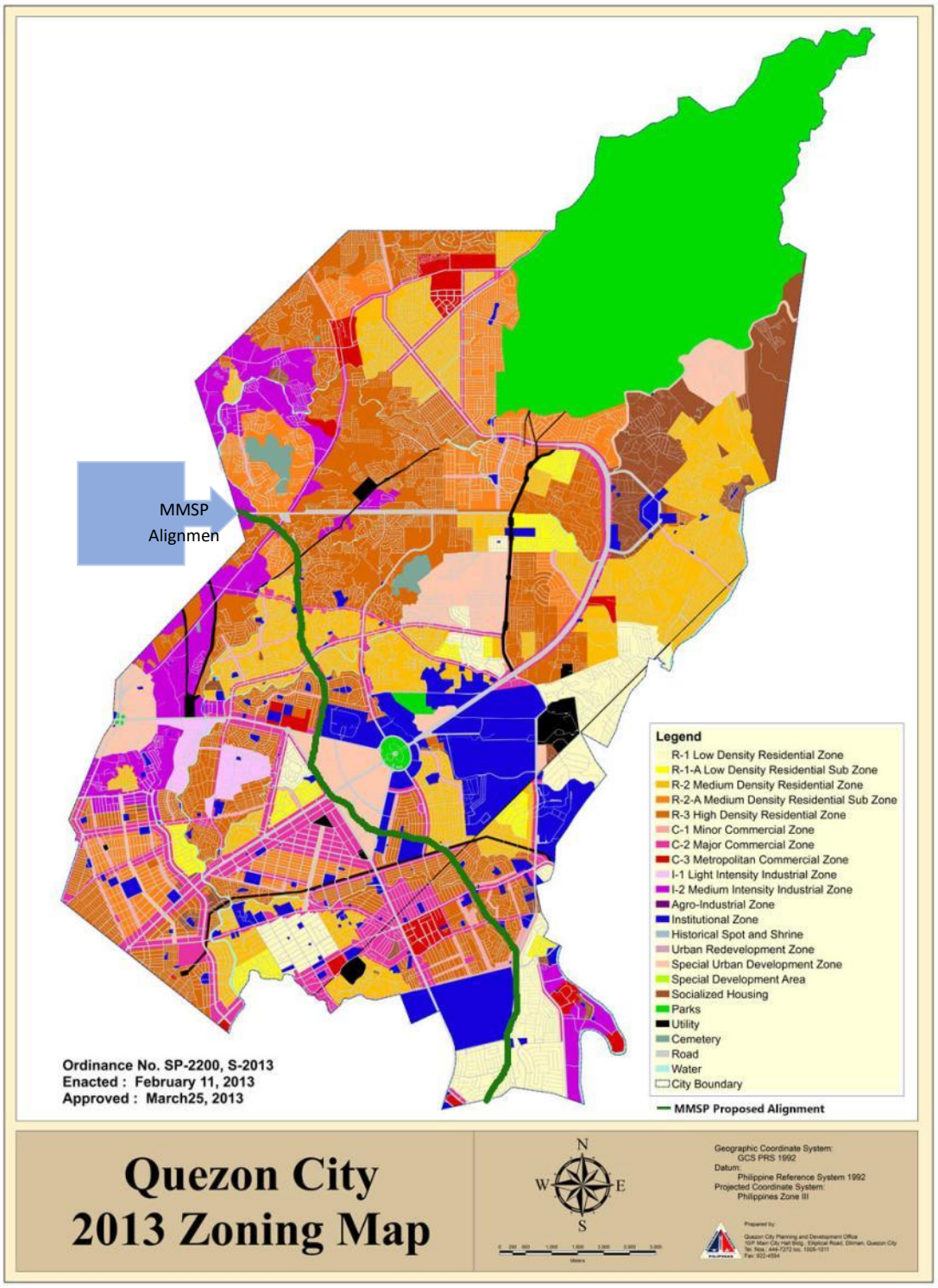


Figure 12. Land Use Map: Quezon City

Tandang Sora Station

The proposed construction yard and shield machine base in Tandang Sora Station will affect 6 residential structures and 17 commercial establishments. Affected structures include a restaurant, construction and hardware shop, commercial buildings, and gasoline station. St. James College of Quezon City, an academic institution, is adjacent to the proposed location of the entrance/exit to Tandang Sora Station.

The area around Tandang Sora Station is classified as Medium Density Residential Zone as well. The section along the Tandang Sora Avenue is classified as a Major Commercial Zone. The future existence of a subway station in this area will facilitate direct access to nearby residential and commercial communities.

The shallow San Juan River and another creek derived from the San Juan River fork is intersected as the alignment passes underground through Mindanao Avenue, between Tandang Sora Station and North Avenue Station. The subway from Tandang Sora Station to North Avenue Station will traverse Mindanao Avenue.

North Avenue Station

The proposed shield machine base at the North Avenue Station will affect portions of Trinoma Mall's open parking space along Mindanao Avenue and a portion of the ground below the elevated rail tracks leading to the MRT 3 depot located underground of Trinoma Mall. The construction yard extends from a portion of Trinoma Mall's open parking space to about 1,920 m^2 strip of the golf course at Veterans Memorial Medical Center. The area of a fast food restaurant will be the location of one of the proposed entrance/exit of North Ave. station.

The North Avenue Station is within Quezon City's North Triangle Business District. The mixed-use development that is intended for this area started with the establishment of the MRT Line 3 Project depot and station. The MMSP's proposed North Avenue station will be connected to the planned central station that will connect MRT 3, MRT 7, LRT 1, and the North Integrated Transport Terminal (ITS) for bus and jeepneys. Therefore, the existing and planned land use in this area is compatible with the projected development along North Avenue Station.

Quezon Avenue Station

The subway will pass through the Epifanio delos Santos Avenue (EDSA) from Trinoma – Mindanao Avenue section up to EDSA – MRT 3 Quezon Avenue station. The proposed construction yard, entrances and other structures at the Quezon Avenue Station, located along EDSA, near Quezon Avenue will affect a portion of three (3) high-rise corporate and residential condominiums and a parcel of vacant lot formerly occupied by Manila Seedling Bank.

Quezon City's CLUP classifies the area around Quezon Avenue Station as Major Commercial Zone along the EDSA side and Minor Commercial Zone at the other side of the road. With inclusion of

a planned connection between MRT 3 and MMSP stations in Quezon Avenue, the intensification of commercialization around this area is anticipated.

East Avenue Station

The underground alignment will pass mostly on settlement and commercial areas from Quezon Avenue station up to East Avenue Station. East Avenue Station, located near East Avenue corner V. Luna Avenue, will directly affect eighteen (18)commercial establishments, four (4) residential structures and portion of the AFP Medical Center parallel to V. Luna Avenue. Most of these sections are part of green space/park inside the AFP Medical Center. The shield machine base, in case needed, is proposed to be located at the entrance to the AFP Medical Center along V. Luna Avenue.

The location of the proposed East Avenue Station is currently classified as Institutional Zone, particularly where VMMC is located, while the rest of the surrounding vicinity is classified as Medium Density Residential Zone. In the Medium Residential Zone, support commercial establishments shall be allowed. The existence of East Avenue Station in close proximity with the existing and planned Medium Density Residential land use form is compatible with the proposed station location, in anticipation of a more intensified spread of neighborhood commercial establishments around the station.

Anonas Station

Six commercial establishments and forty six (46) residential structures comprise the project affected areas in Anonas Station. World Citi Medical Center and the existing LRT 2 Anonas Station are located near the proposed station in Anonas. A small creek can also be found along Anonas Avenue, before reaching Aurora Boulevard, which will be intersected by the alignment.

The area along the Anonas Station is classified as Medium Density Residential Sub-Zone. The close proximity of the proposed Anonas Station to the residential zone, and the provision of better accessibility and connectivity of residents to LRT 2is desirable.

Katipunan Station

The proposed Katipunan station will directly affect nine (9) residential structures and sixteen (16) commercial establishments. The commercial establishments include restaurants, gasoline station, warehouse, and commercial bank. The area around Katipunan Station area is classified as Minor Commercial Zone and Medium Density Residential Zone. Presence of subway will provide better accessibility and connectivity to this part of Quezon City.

Pasig City

Figure 13 shows the Comprehensive Land Use Plan of Pasig City.

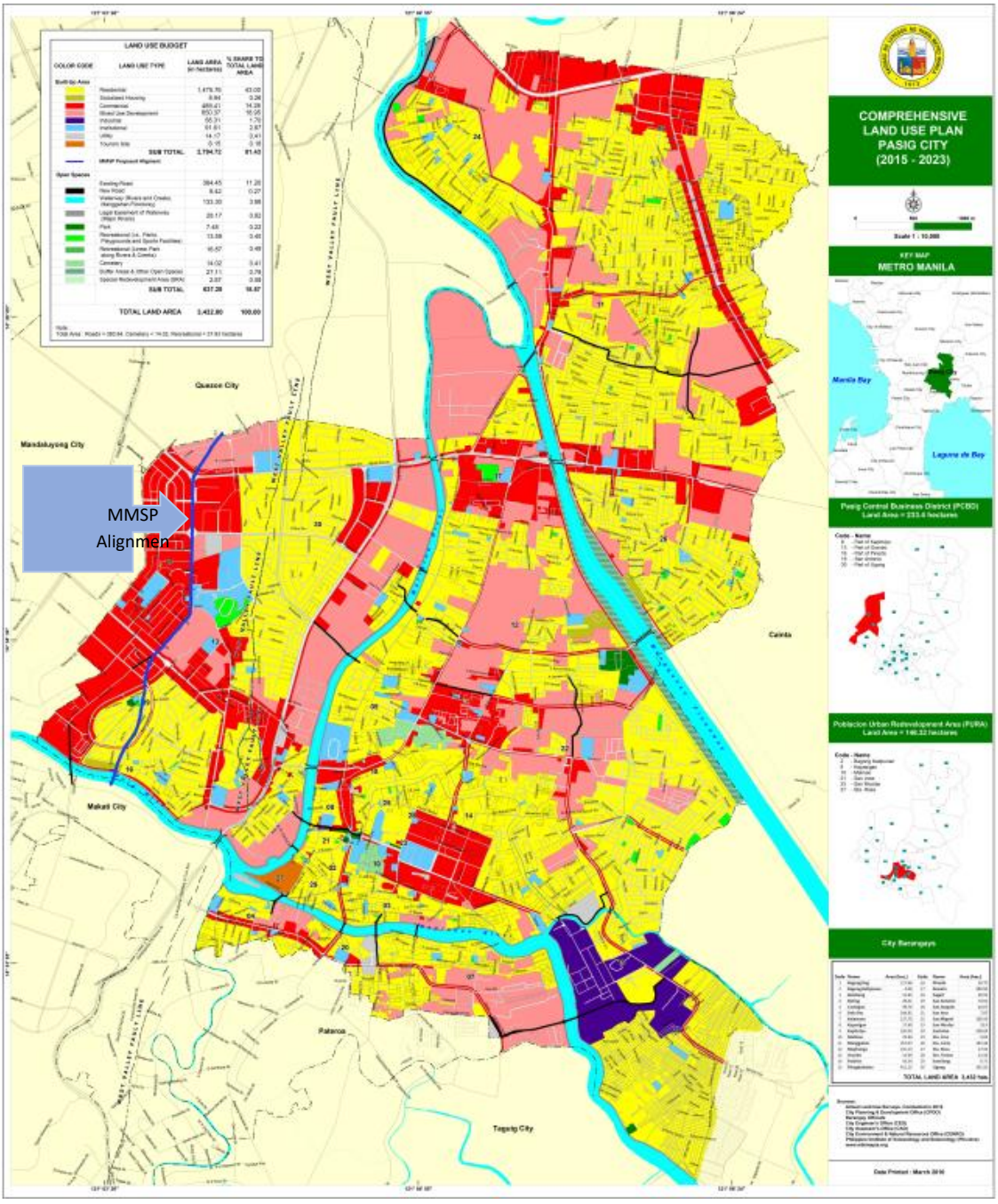


Figure 13. Land Use Map: Pasig City

Ortigas North and Ortigas South Stations

The section between Ortigas North Station and Ortigas South Station is a central business district. Mid to high-rise buildings are situated along Meralco Avenue. These buildings include shopping malls, government offices, hotels, commercial and business establishments.

In particular, 6 commercial establishments will be affected along Ortigas North Station, while 7 commercial establishments will be directly affected at the Ortigas South construction yard. The proposed shield machine base is currently occupied by medium-rise buildings which are used as offices for both private companies and government agencies.

The stretch between Ortigas South Station and Pasig River is mainly occupied by dense low-rise houses. The alignment passes under Pasig River, which is also the boundary between Pasig and Makati City.

Under the Comprehensive Land Use Plan of Pasig City (2015-2023), the area of the North Ortigas and South Ortigas Stations are classified as Commercial and Mixed Used Development Zones. After Shaw Blvd., covering the area of Brgy. Kapitolyo, where the subway tunnel alignment will pass, land use classification aboveground is Residential.

Makati City

The route passing through Makati City will compose entirely of underground structure. Above the MMSP route is primarily occupied by dense low-rise houses. The land use classification of the area above the proposed subway alignment, as shown in Figure 14, is classified as Institutional and High Density Residential/Mixed Use.

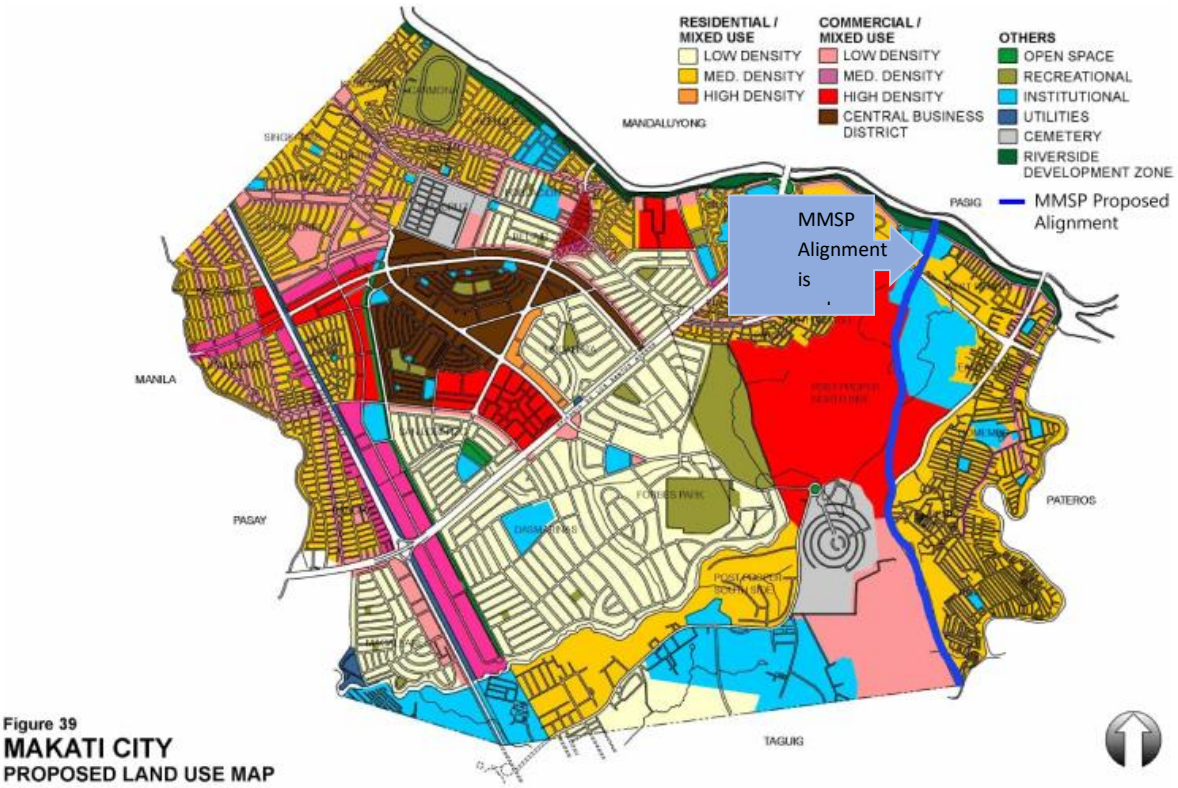


Figure 14. Land Use Map: Makati City

Taguig City

Figure 15 presents the Zoning Map of Taguig City.

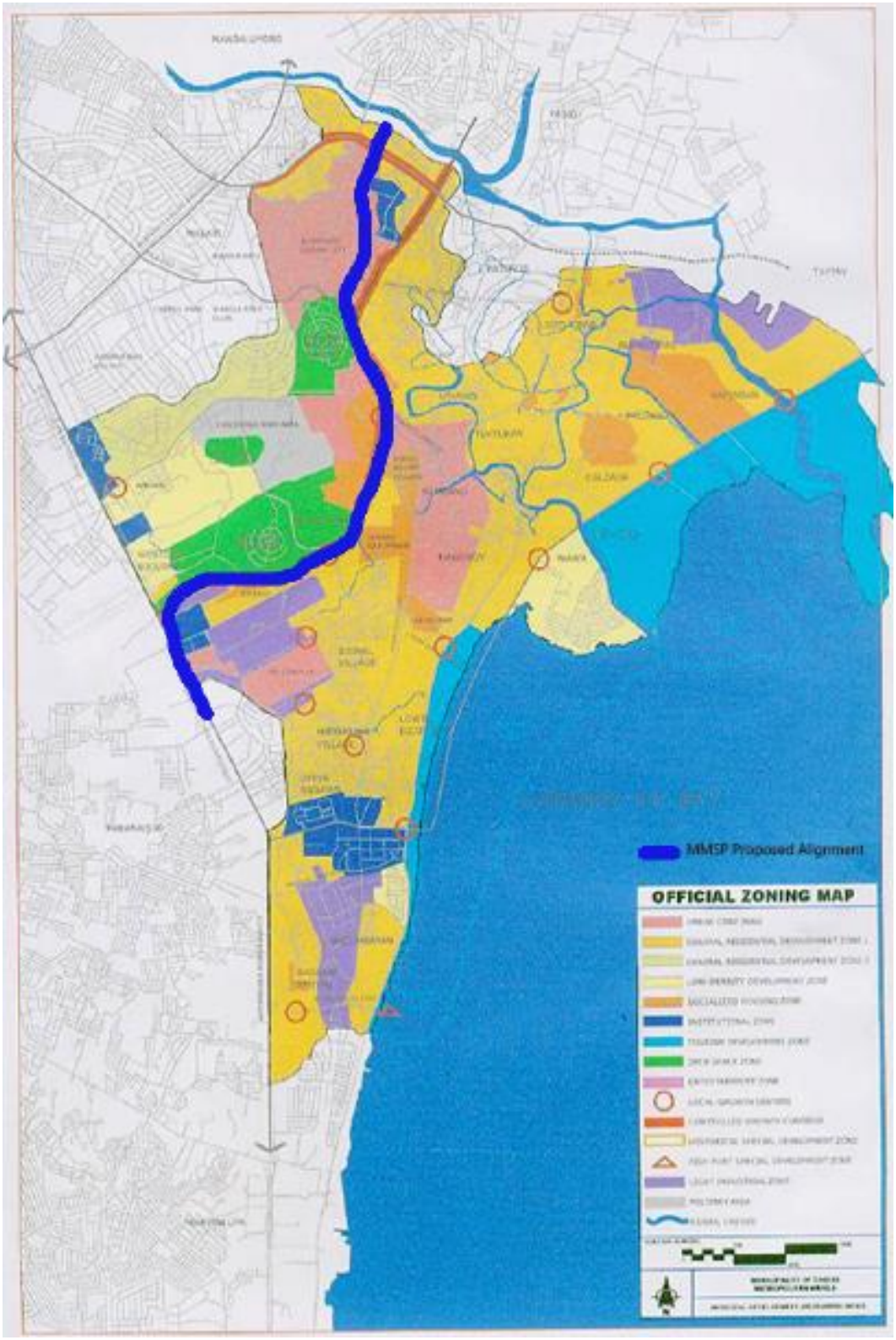


Figure 15. Land Use Map: Taguig City

Kalayaan Avenue and BGC Stations

The segment between Kalayaan Avenue Station and Bonifacio Global City (BGC) Station is a developing business district. The proposed Kalayaan Avenue Station is located inside BGC, along 11th Avenue. The tentative locations of construction yard and shield machine base are occupied by green space/park, empty lots, commercial buildings, a fast food restaurant and a parking space. One of the proposed entrances along Kalayaan Avenue will be affecting about 360 m^2 of the entrance to a residential village.

The proposed station construction yard in BGC Station is along McKinley Parkway, between Market Market, a commercial shopping area and Serendra, a high end condominium complex. The section between Bonifacio Global City Station and Cayetano Boulevard Station goes partly under C-5 road and partly under residential area with low-rise and crowded houses.

Based on the Taguig CLUP approved by the Taguig Sangguniang Bayan on May 19, 2003, Kalayaan Ave. (at 11th St., BGC) and BGC stations located inside the Bonifacio Global City are classified as Urban Core Areas. Station areas in Kalayaan Avenue and BGC Stations are both considered as developing CBDs.

Cayetano Blvd. and FTI Stations

The proposed shield machine base in Cayetano Boulevard station is an open parking area of a commercial establishment and is a BCDA property, while the station will be located underground of C-5 road. One of the three proposed entrances to the station is classified as a socialized housing area, under BCDA property. The other two entrances are currently used as commercial area and residential area. The immediate vicinity of the project area is composed of some commercial establishments and residential houses along C-5.

The proposed MMSP FTI Station will run in parallel with the existing Philippine National Railways (PNR) Station in FTI, but the subway station will be underground. The construction yard and shield base for FTI Station will affect commercial establishment such as Caltex Station, green spaces, which used to be a seedling nursery, at the entrance to the FTI, and portion of the entrance to Bagong Lipunan Condominium (Tenement) at the side of the East Service Road.

The area of Cayetano Blvd. station is along the C5 road and near Pamayanang Diego Silang, which is a Socialized Housing Area. The area covered by the FTI station is classified as Urban Core Zone and Light Industrial Zone.

Urban Core Areas are intended for compact and planned unit developments that provide for the convenient proximity between workplace, home and amenities. Publicly accessible and functional open spaces among individual developments shall be required in these areas. Light Industrial Areas (LIA), including portions of FTI, is planned for light industrial establishments and information technology-based facilities.

The LGU of Taguig has identified 13 Local Growth Centers, which includes the C5 corner Cayetano Blvd. area. The Local Growth Centers are identified to ensure the easy access of community services for residents throughout Taguig. In order to cater to the requirements of the immediate community, small retailing and service facilities are being encouraged in these areas. The entire C5 road is also designated as controlled growth corridor in Taguig City.

Given these existing and planned land classifications in Taguig City where the stations will be located, the proximity of residential area, planned urban development, such as Arca South in FTI Station, and light industrial zones will all benefit from having subway stations within its vicinity.

Parañaque City

About 300meters of the subway lead track extends through Parañaque City, starting at the Cucumber Road intersection southward, along East Service Road. Proposed two entrances located along West Service Road will be affecting residential use area and a cigarette factory lot.

As raised during the public scoping, there is a 117-kilometer gas pipeline from Batangas to Manila, run by the First Philippine Industrial Corporation (FPIC). The pipeline extends into West Service Road, which may be affected by the construction of tunnel walkway connecting the station entrance to the FTI Station.

The area along the East Service Road of Brgy. San Martin de Porres is classified as Low Intensity Commercial Zone characterized by commercial and trade activities on a neighborhood scale including retail outlets, professional offices, personal and home service shops and eateries on small scale. United Hills Subdivision, where its frontage will possibly be affected by the subway project, is classified as a Low Density Residential Zone, characterized mainly by single family, single detached dwellings with the usual community ancillary uses on the neighborhood scale and relatively exclusive subdivisions as well as compatible support and institutional facilities.

An overview of the compatibility of MMSP vis-à-vis the actual land use and the approved comprehensive land use plan/ zoning classification by the respective LGUs is shown in Table 14. Categories of compatibility scale given below were used to determine the compatibility of MMSP with the existing and planned land uses by the LGUs:

- Compatible
- Questionable (Compatible only if impacts are properly mitigated)
- Incompatible

Where MMSP and the current and planned land use are mutually beneficial and complement each other, they have been classified “compatible”. Where neither of the two land uses is in a beneficial relationship, it has been classified as “incompatible”. In instances where only one form of land use benefits from its proximity with another land use, the interrelationship has been considered “questionable”, since it is only a one-way beneficial relationship.

Table 14.Land Use Compatibility Matrix

MMSP Stations	Existing Land Use / Planned Land Use	General Industrial	Commercial	Low-density residential	Medium-density residential	High-density residential	Institutional	Mixed Use Development	Urban Core Zone	Socialized housing
Valenzuela Depot	Existing	/	/		/					
	Planned	/	/							
Quirino Highway	Existing		/		/	/				
	Planned			/	/					
Tandang Sora	Existing		/		/	/				
	Planned		/		/	/				
North Avenue	Existing		/				/			
	Planned		/				/			
Quezon Avenue	Existing		/							
	Planned		/							
East Avenue	Existing		/			/	/			
	Planned		/			/	/			
Anonas	Existing		/			/				
	Planned		/			/				
Katipunan	Existing		/			/				
	Planned		/			/				
Ortigas North	Existing		/							
	Planned		/					/		
Ortigas South	Existing		/					/		
	Planned		/					/		
Kalayaan Avenue	Existing								/	
	Planned								/	
BGC	Existing								/	
	Planned								/	
Cayetano Blvd.	Existing									/
	Planned									/
FTI	Existing	/	/						/	
	Planned	/							/	

Legend:

/ Compatible

? Questionable (Compatible only if impacts are properly mitigated)

x Incompatible

Overall, the proposed railway project is compatible with local government plans on land use development. Current land uses that will be traversed by the subway and its stations are commercial and urban areas, CBDs and residential houses. Hence, the presence of a subway in close proximity to their primary users is desirable.

Compatibility with Classification as an Environmentally Critical Area

Project areas falling under any of the twelve (12) main categories of Environmentally Critical Areas (ECAs) as declared in Proclamation No. 2146, series of 1981 and the Revised Guidelines for Coverage Screening and Standardized Requirements under the Philippine EIS System – EMB Memorandum Circular 005 were identified. Table 15 presents the summary of the identification of ECAs.

Table 15. Checklist of ECAs for MMSP

ECA Categories	MMSP Project Area
1. Areas declared by law as national parks, watershed reserves, wildlife preserves and sanctuaries	x
2. Areas set aside as aesthetic, potential tourist spots	x
3. Areas which constitute the habitat for any endangered or threatened species of indigenous Philippine Wildlife (flora and fauna)	x
4. Areas of unique historic, archaeological, geological or scientific interests	x
5. Areas which are traditionally occupied by cultural communities or tribes	x
6. Areas frequently visited or hard-hit by natural calamities	
6.1 Geologic hazard areas (prone to landslide and land subsidence)	x
6.2 Flood-prone areas	✓ (Anonas station)
6.3 Areas frequently visited or hard-hit by typhoons	✓ (entire Metro Manila)
6.4 Areas prone to volcanic activities/ earthquakes	✓ (all stations rated with Medium to High Ground shaking and ground/ subsurface rupture risks)*
7. Areas with critical slope	x
8. Areas classified as prime agricultural lands	x
9. Recharge areas of aquifers	x
10. Water bodies	x
11. Mangrove areas	x
12. Coral reefs	x

X – None

* - Based on Geohazard Assessment Report from PHIVOLCS

Existing Land Tenure

The project area is neither covered under the Comprehensive Agrarian Reform Program (CARP), nor under any Ancestral Domain territory. The proposed depot in Valenzuela City and in the 13 stations has tenured occupants holding land titles. Table 16 below shows the estimated area of titled land to be acquired for MMSP, both surface and subterranean.

Table 16. Summary of Estimated Area for Land Acquisition for MMSP

Affected Asset	Estimated Land Area (m^2)
LAND (SURFACE)	
Valenzuela City	
Valenzuela Depot	317,300.00
Quezon City	
Mindanao-Quirino Station	16,990.00
Tandang Sora Station	5,910.00
North Avenue Station	9,440.00
Quezon Avenue Station	9,670.00
East Avenue Station	11,620.00
Anonas Station	8,050.00
Katipunan Station	13,880.00
Pasig City	
Ortigas North Station	6,560.00
Ortigas South Station	5,320.00
Taguig City	
Kalayaan Avenue Station	13,240.00
Bonifacio Global Station	22,670.00
Cayetano Avenue Station	8,090.00
Parañaque City	
FTI Station – Taguig-Parañaque	11,520.00
TOTAL	**460,260.00**
Segment	**Estimated Land Area (m^2)**
LAND (SUB-TERRANEAN)	
Kalayaan to Aurora Blvd.	26,360.00
Aurora Blvd. to Katipunan	21,740.00
Temple Drive to Meralco	23,800.00
Shaw Blvd to Pasig River	22,080.00
Pasig River to Kalayaan	8,900.00
TOTAL	**102,880.00**

Source: JICA Study Team

Visually significant landforms, landscapes, structures

The MMSP alignment will traverse urban areas mostly occupied by commercial establishments. Based on the field survey conducted along the alignment, there are no visually significant landforms, landscapes and structures that will be potentially affected by the project.

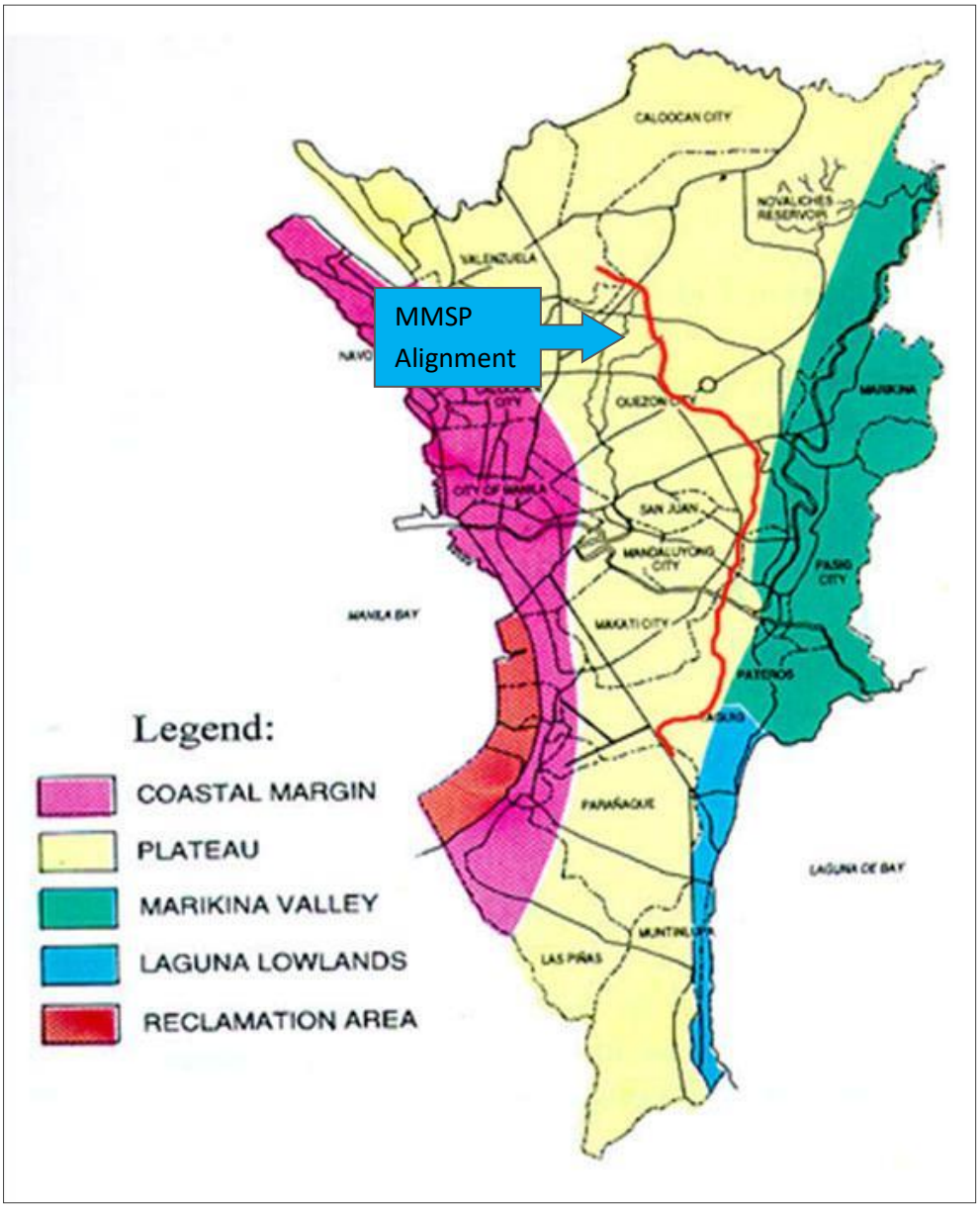
2.1.1.2. Geology and Geomorphology

Topography

The Quezon City area, except the northeastern part of the city, is characterized by generally gentle rolling hills and flat terrain. The MMSP alignment from the Valenzuela Depot will pass through the Tullahan River that is located north of the city. This river and along with its tributaries, provide natural drainage. To the southern part of the city is the San Juan River that leads to the Pasig River. The northeastern part of the city that borders along San Jose Del Monte, Bulacan is characterized by mostly hilly to mountainous terrains though the MMSP alignment will only be located to the center of Quezon City going from the North (coming from the Valenzuela Depot) to the South (Katipunan Avenue area going to Pasig City). The MMSP alignment from the Valenzuela Depot up to Katipunan Avenue station are elevated from approximately 22 to 55 meters mean sea level (mSL) on the surface with the observed highest elevation being the Katipunan Avenue station itself while the lowest is located along the Tullahan River.

As shown in Source: *DENR*

Figure 16, the proposed MMSP alignment will be located on the plateau. Pasig, Makati and Taguig cities are characterized mainly by flat terrain. Through this generally flat terrain will be the proposed MMSP alignment will be constructed. Pasig City, located as part of the identified Marikina valley, is located mainly along the primarily east to west trending Pasig River. Makati City is part of the Guadalupe plateau, a mostly flat area located at a higher elevation. Taguig is part of the Laguna lowlands that is found in the northwest of Laguna de Bay. Taguig and Napindan Rivers, found in the northern area of the Taguig, are tributaries of Pasig River. The MMSP alignment from Katipunan Avenue to FTI station is elevated from approximately 6 mSL to 55 mSL. The lowest elevation is located along the Pasig River intersection of the alignment. Even with the almost 50 meters difference, there is no observed sudden elevation change with the changes being gradual and the natural slopes are estimated to be 10 to 15 degrees at most.



Source: DENR

Figure 16. The four zones of Metro Manila

Regional/ General Geology

The Philippines was formed due to the current regional geodynamic setting of two subducting plates bounding the Philippine Mobile Belt. The country is divided into three major island groups, with the island of Luzon being bounded to the east by the subducting Philippine Sea plate and the subducting Eurasian plate to the west. This two opposing subducting plates are two of the major forces that caused the formation and the movement of the Philippine Fault or also known as Philippine Fault Zone (PFZ). Part of the identified PFZ is the West Valley Fault (WVF) and the East Valley Fault (EVF) that are located around the Metro Manila. There are also two nearby active volcanoes located in the southern part of Luzon Island that is near (less than 110 km) Metro Manila. Taal Volcano is around 66 km to the south and the Mount Banahaw Complex is around 80 km to the southwest.

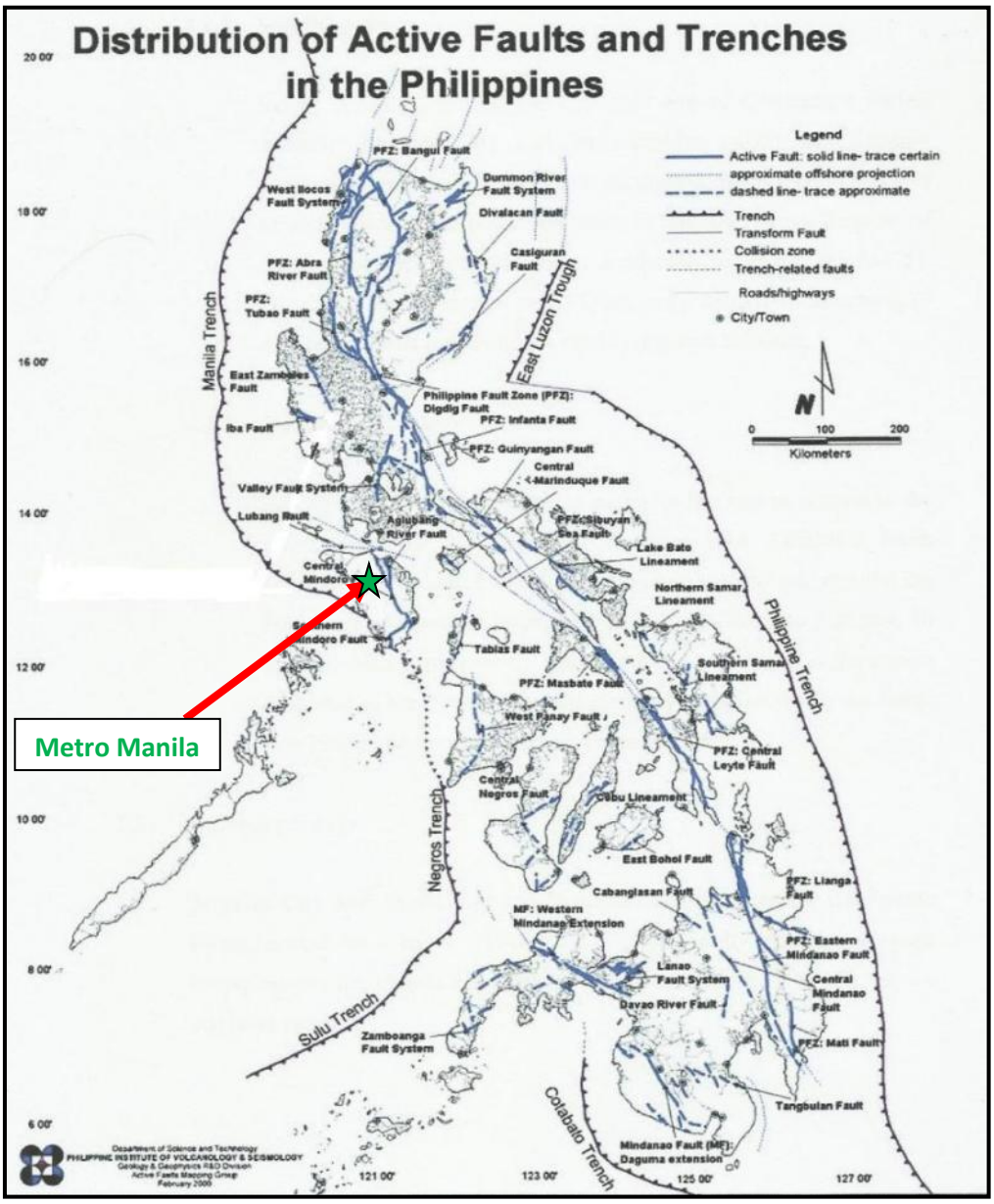


Figure 17. An overview of the major faults and trenches around the Philippines

The MMSP proposed line will most probably drill through the Guadalupe Formation. Composed of the Alat conglomerates and the Diliman Tuff, the Guadalupe Formation was dated to be formed during the Pleistocene Epoch (2.6 million years to 11,700 years ago). As observed during the ocular inspection, the proposed line of MMSP will go through the Diliman Tuff member of the formation. The Diliman Tuff is made up of ejected volcanics with subordinate amounts of tuffaceous fine to medium grained sandstone. Based on previous studies, the Diliman Tuff's thickness is from 1.3 to 2 km.

The Manila Formation may also be encountered along the Pasig area of the proposed line. Manila Formation is described as being formed during the Holocene Epoch (11,700 years ago to recent) and is composed of unconsolidated clay, silt, gravelly sand and tuffaceous silt.

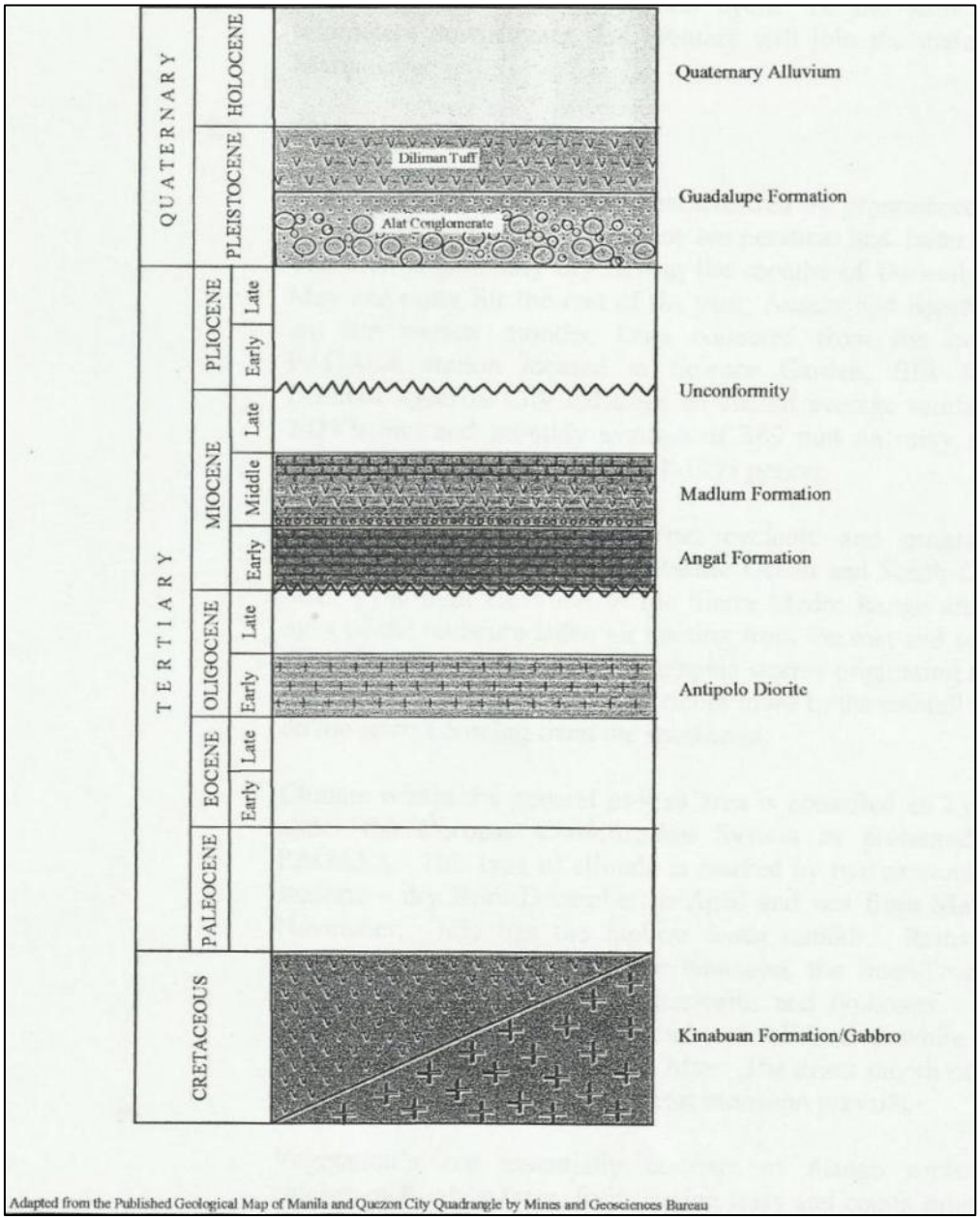


Figure 18.Stratigraphic column of Metro Manila showing the Diliman Tuff and Alat Conglomerate

Geological surveys were conducted by Soil Philippines Indes Testing, Inc. to collect the data for the alignment plan and the civil structures. Results of the survey are summarized below:

- The underground section of the northern area (Quirino Highway to Anonas section) was investigated from 2.0 m to 24.3m below ground level. The ground water table at this section is a little high, averaging 8.6 m, resulting from the deposition of Gray Clayey Silt and Gray Silt Sands in this area.

- The underground section for the middle area (Temple Drive to Bonifacio Global City Station section) was investigated from 3 m to 25 m below ground level. The ground water table depth is about 16.85 on the average, resulting from deposition of Gray Clayey Silt and Sand and Brown Siltstone along this section.

- The southern area (Cayetano Boulevard station to FTI station section) was investigated from 15.5 m to 21.0 m below ground level. The ground water table depth is about 18.3 m in average, resulting from deposition of Gray Clayey Sands and Gravel and Grayish Brown Sandstone.

Figure 19 and Figure 20 show the typical types of soil and rocks from the surface to about 40 m below the ground at Tandang Sora and Anonas Stations. A more detailed geotechnical investigation will be conducted during the DED stage to establish the soil profile along the alignment.

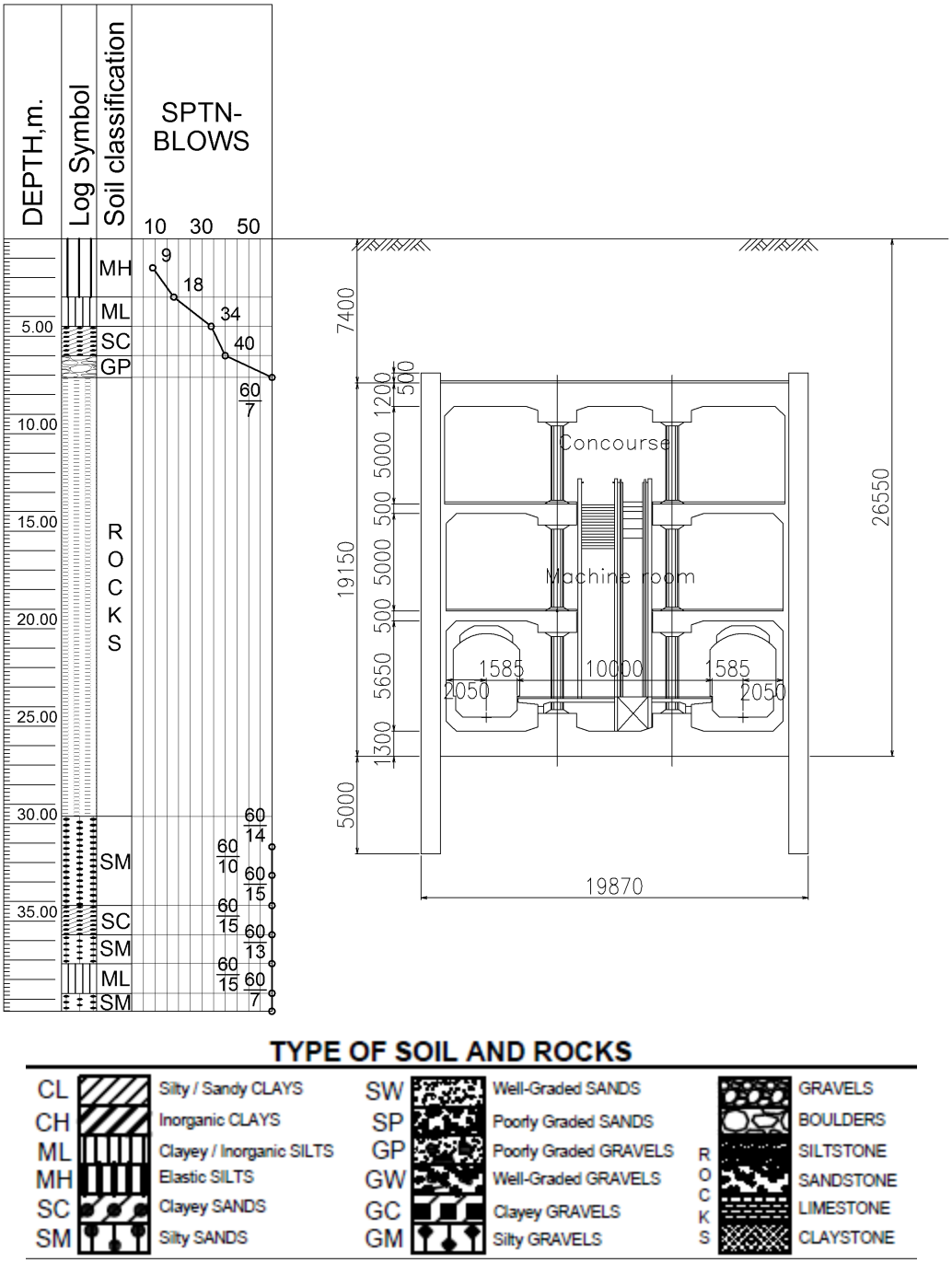


Figure 19. Soil Profile at Tandang Sora Station area

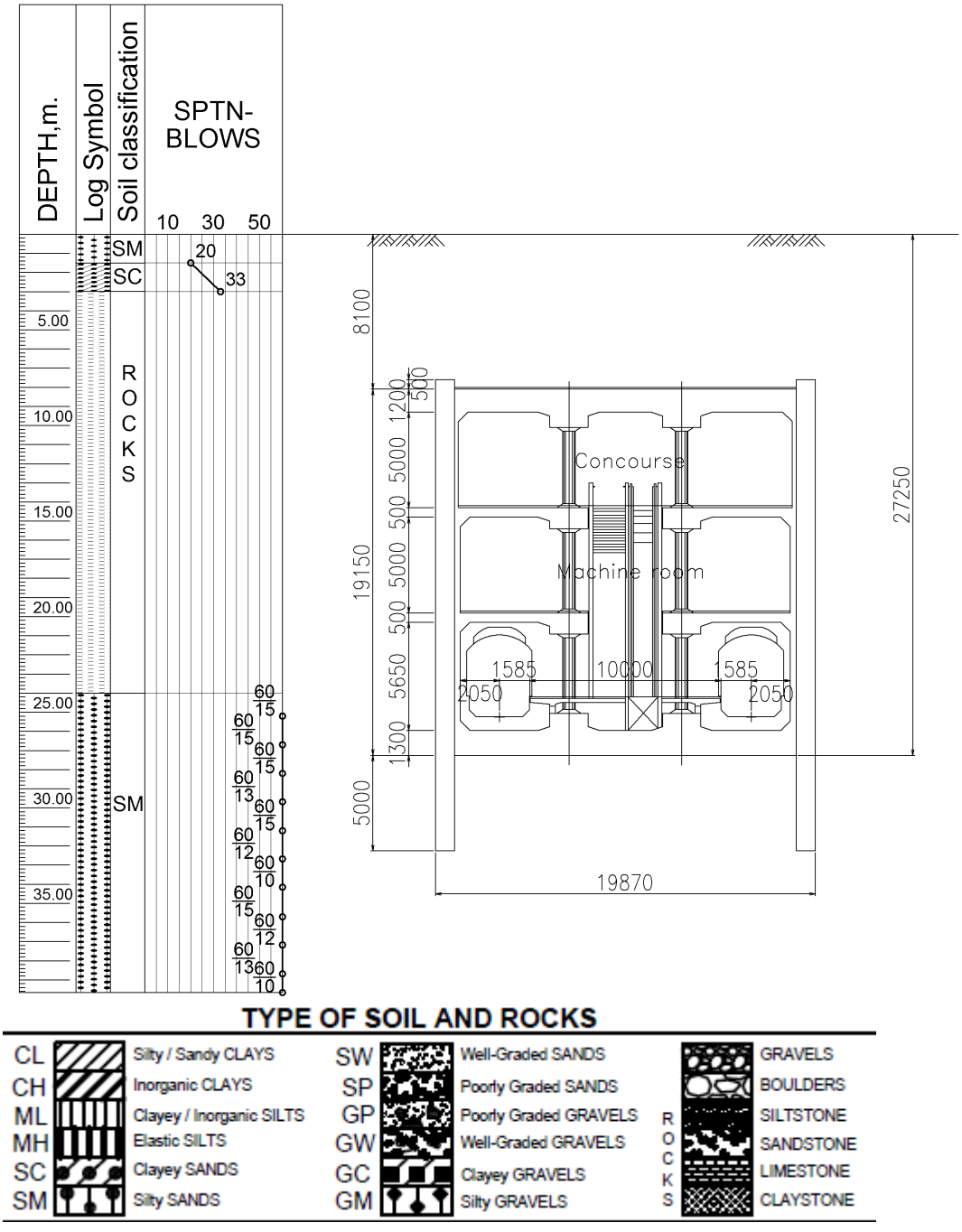


Figure 20. Soil Profile at Anonas Station area

Geologic and Other Natural Hazards

Landslide Hazard

As the MMSP will be done below the surface, and given that the topography of Metro Manila is generally gently rolling to almost flat terrain, there is a low risk of a landslide hazard affecting the subway project.

According to PHIVOLCS earthquake-induced landslide hazard map, as shown in Figure 21, the projected at risk areas of the MMSP line are located starting from the south of the Pasig River. A low to moderate landslide risk is also observed to the east of the MMSP line from Katipunan Avenue station to the Temple Drive area (approximately 2 km). The projected station for the Bonifacio Global City is also near an area (to the south of the station) that has a moderate landslide rating from the PHIVOLCS, but all the other surface structures for the MMSP line are located in the no rating/risk to landslide.

Landslides caused by earthquakes are brought about by stronger factors for slope failure to occur compared with rain-induced landslides. Climate change that is expected to happen will increase the probability of rain-induced landslides to occur but with the generally low gradient of most of the project area, the earthquake-induced landslide hazard map may still be used to interpolate the landslide risk.

Liquefaction Hazard

Liquefaction is defined as the process where intense ground shaking during earthquakes can cause water-saturated surface materials to lose their strength and behave as fluid-like masses that flow. As the country is known to be tectonically active, earthquakes are common events. Also, since the country is a tropical archipelago, water saturation of the soil and/or loose sediments is frequent. Thus, liquefaction is a real hazard risk.

The MMSP will be cutting across or will be adjacent to two major rivers, Tullahan and Pasig, and a couple of small streams/creeks. The proposed depot in Mindanao Avenue, and the Quezon Avenue, Anonas and Cayetano Boulevard stations, as well as part of the subway system that will be crossing Pasig River, are located in areas with moderate potential for liquefaction. Moreover, the subway segment from BGC Station to Cayetano Blvd. Station, particularly those traversing Brgy. Rizal in Makati City and Brgys. Pinagsama and Ususan in Taguig City have high liquefaction potential.

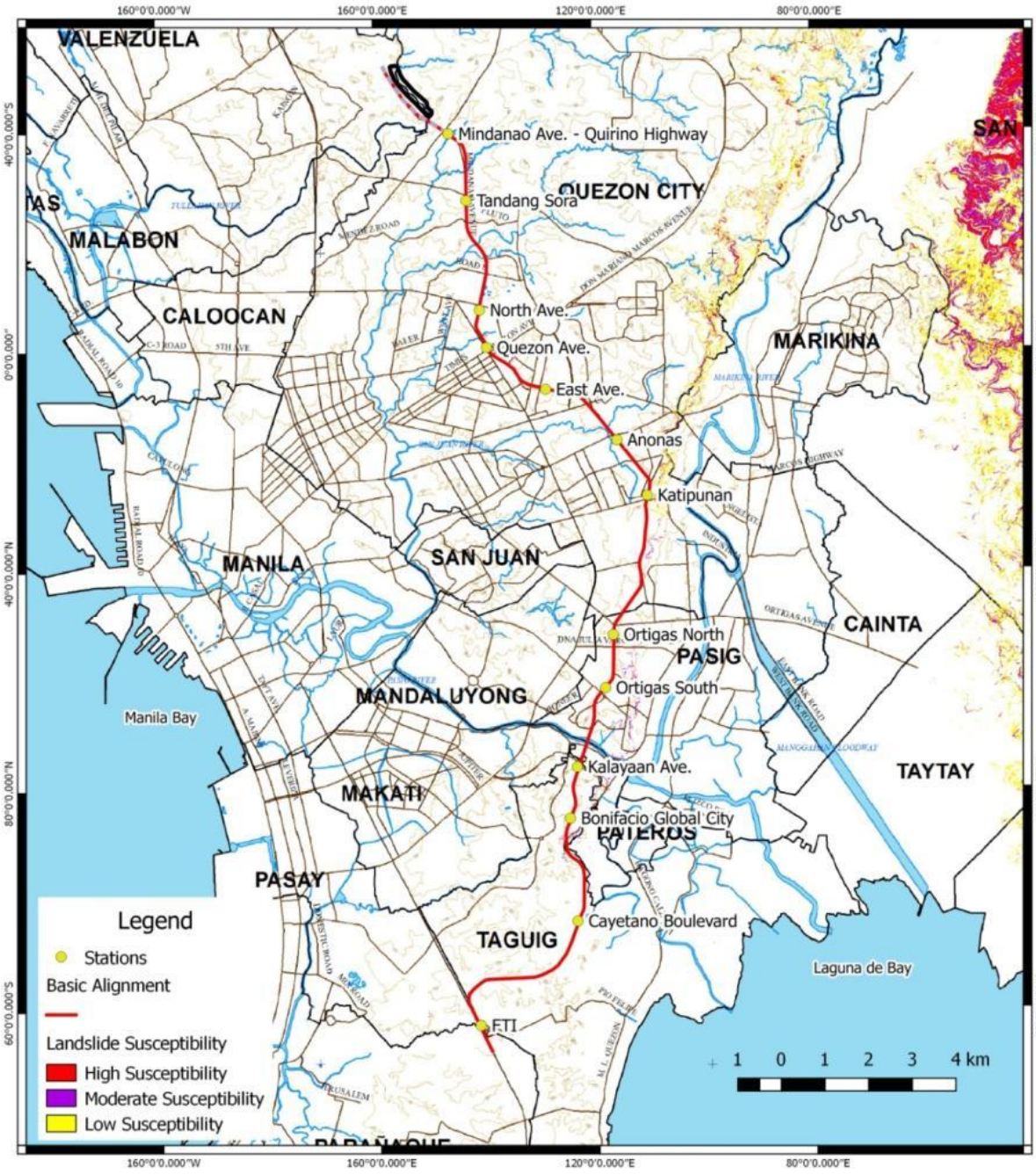


Figure 21. Landslide Hazard map from PHIVOLCS (2013) showing the MMSP alignment

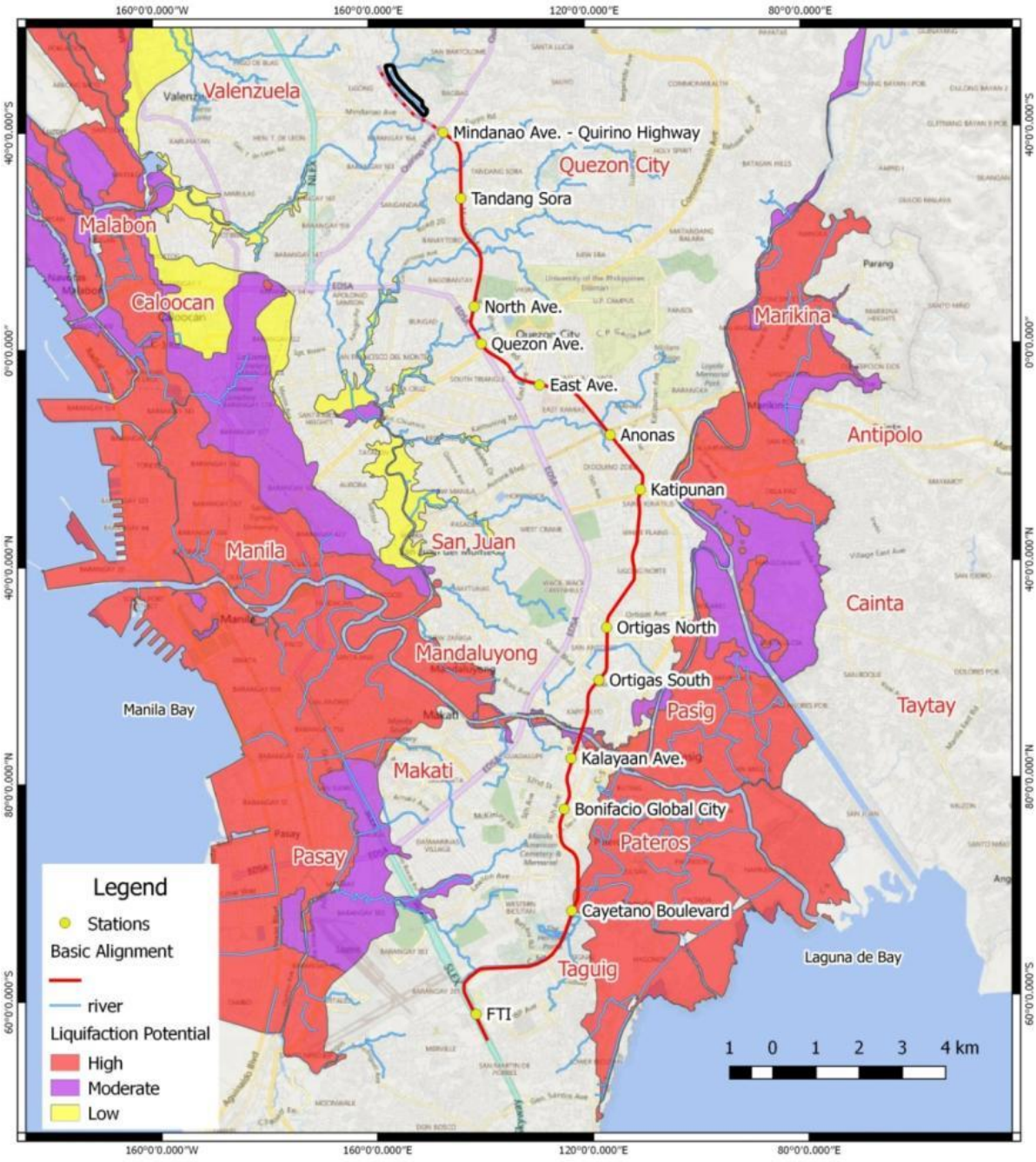


Figure 22. Liquefaction Hazard map from PHIVOLCS (2013) showing the MMSP alignment

Earthquake and Seismic Shaking

The four (4) most recent strong activities along the WVF was within the last 1,400 years and the last recorded was during the 17th century, and with an approximated 500 years cycle, another strong activity is expected to occur in the near future. The MMSP will be highly susceptible to an earthquake in case another seismic activity would occur along the WVF.

The close proximity of the MMSP to the WVF and being the Manila Trench and EVF are also located less than 200 km from Metro Manila, provides at least 3 earthquake generators that threaten the metropolitan area. Based from the modeling of PHIVOLCS to ground shaking

susceptibility of Metro Manila, almost the whole MMSP line is rated to be possibly affected by Intensity Low VIII, as shown in Figure 23. The part of the MMSP going to and from Cayetano Boulevard station actually is rated as part of the Intensity High VIII. This means that the line will be very much affected by ground shaking especially by a strong earthquake that could occur any time.

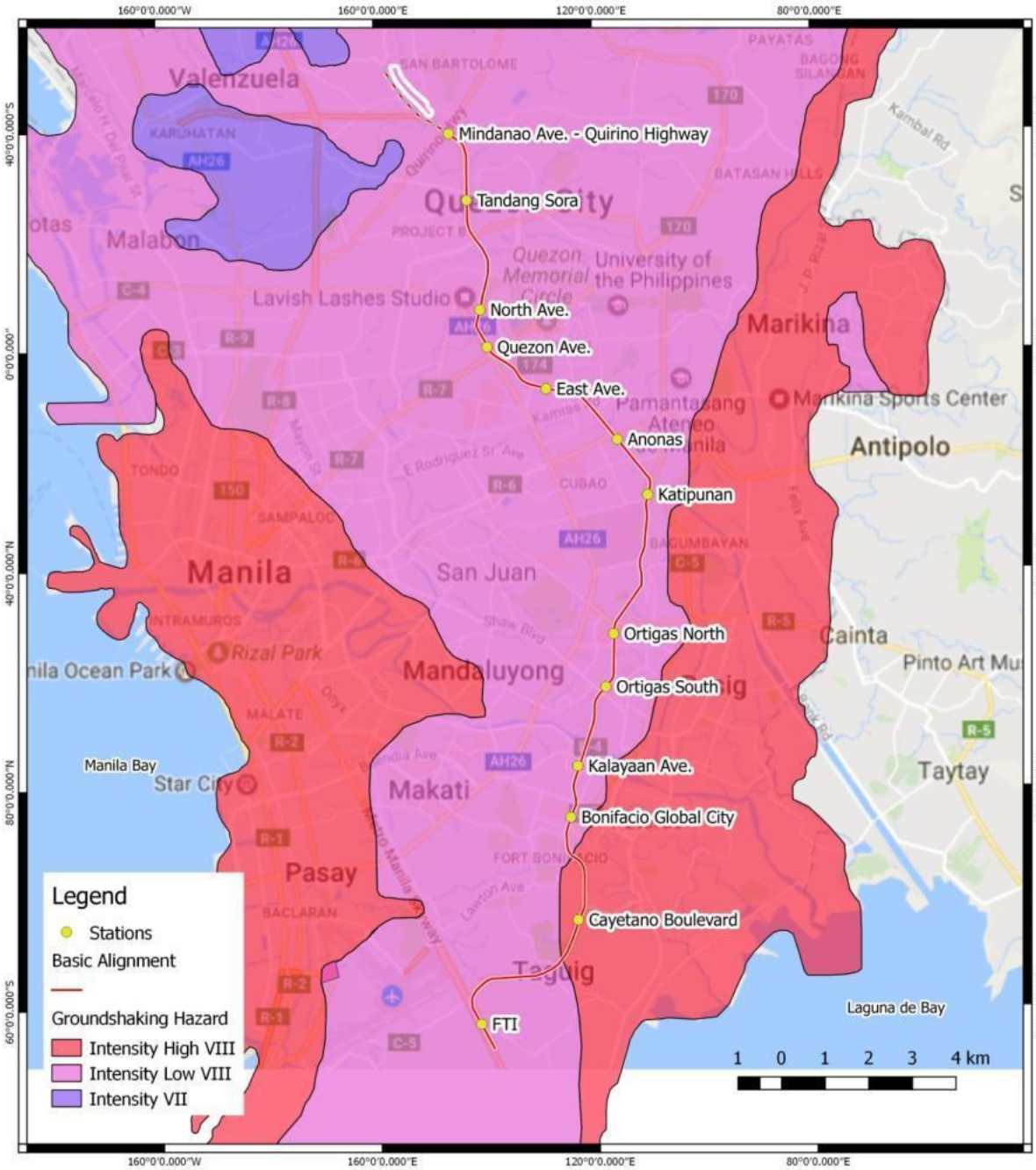


Figure 23. Ground shaking Hazard map from PHIVOLCS GMMA project showing the MMSP alignment

Ground Rupture

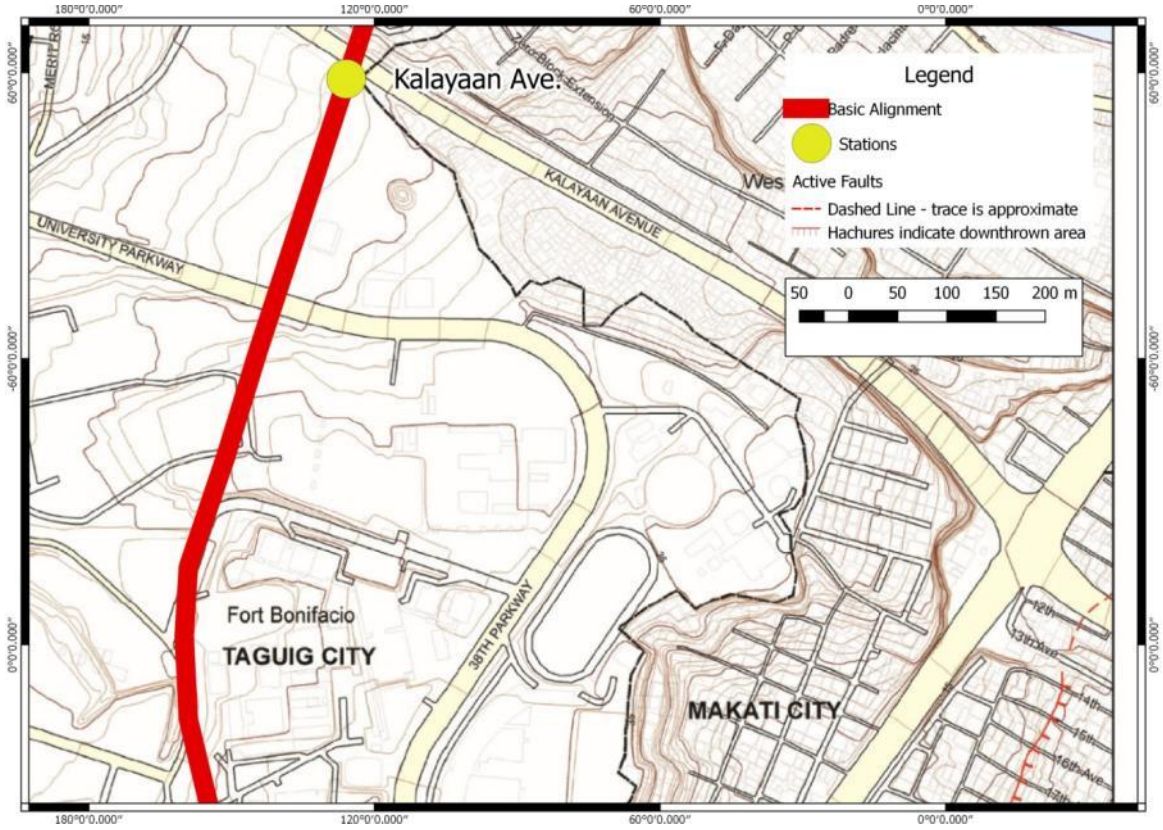
The MMSP alignment is shown on the PHIVOLCS fault map in Figure 24. Based on PHIVOLCS's Hazard Assessment Report for MMSP alignment, the proposed alignment is nearest to the WVF in the vicinity of Brgys. Ususan and Pinagsama in Taguig City. The MMSP segment referred here is that between BGC Station and Cayetano Blvd. Station, as shown in Figure 25. The proposed alignment is within the fault zone, approximately 23 m west and 41 meters east of different segments of the WVF.

As noted in the PHIVOLCS Hazard Assessment Report, the active fault at Brgys. Ususan and Pinagsama is represented as dashed line in the fault map, signifying that the location of the fault is approximate. Hence, there is uncertainty on the position of actual rupture created by past movement of the fault.

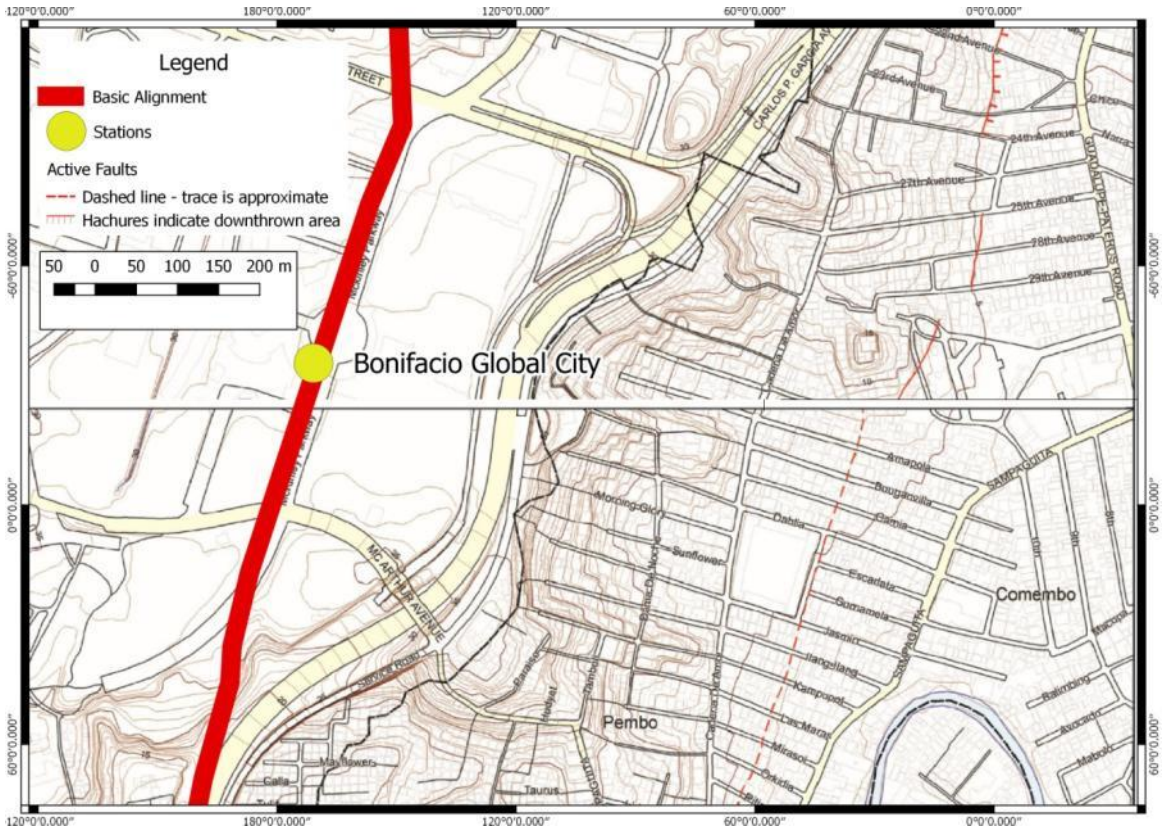
The higher danger and greater problem to the MMSP is the subsurface condition wherein the approximate fault trace dips to the southeast to the direction of the MMSP tunnel and other subsurface structures.

Source: PHIVOLCS (2013)

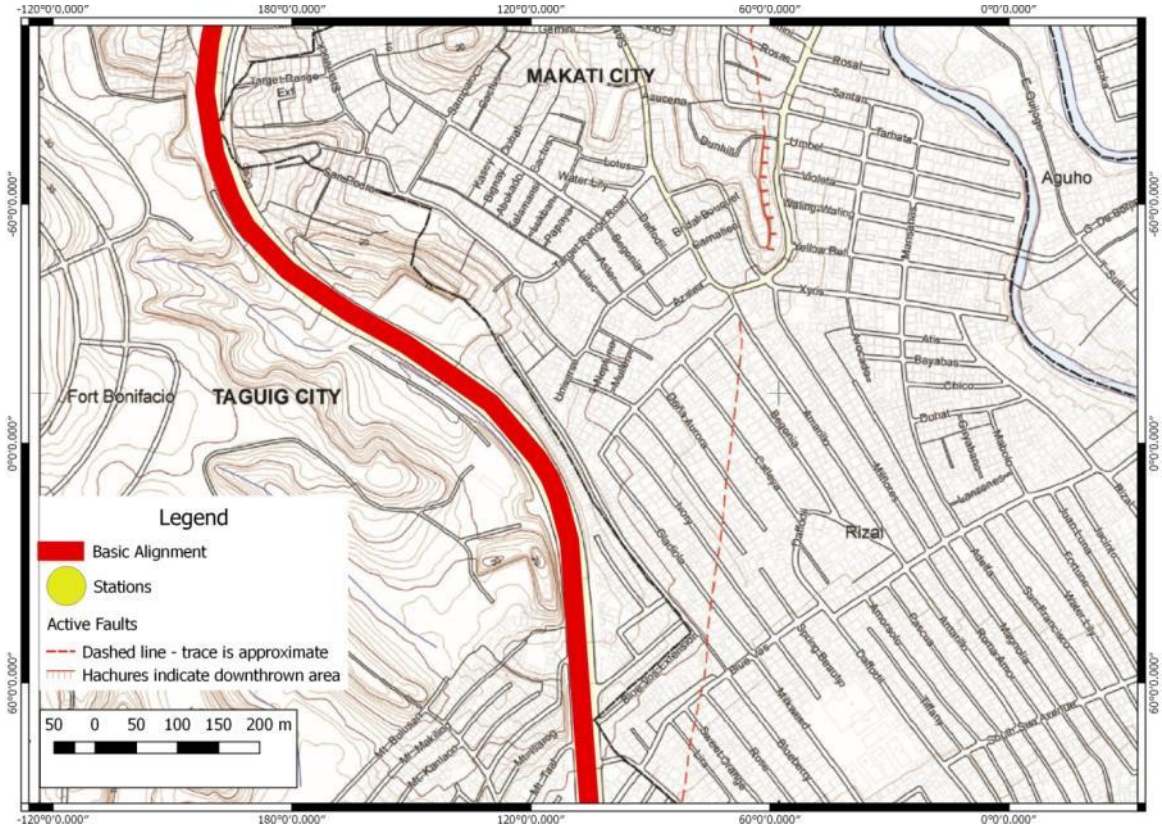
Figure 24. Fault map from showing the MMSP alignment



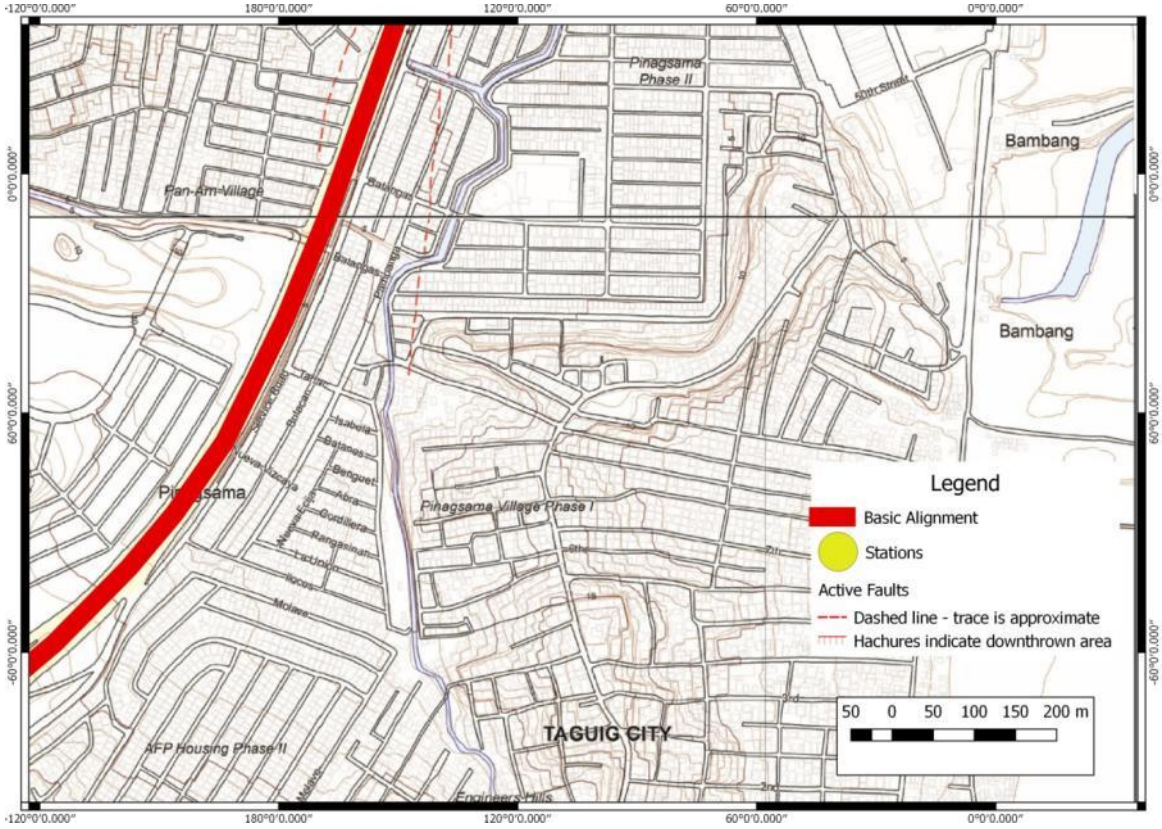
(a) Kalayaan Avenue Station to BGC, Taguig



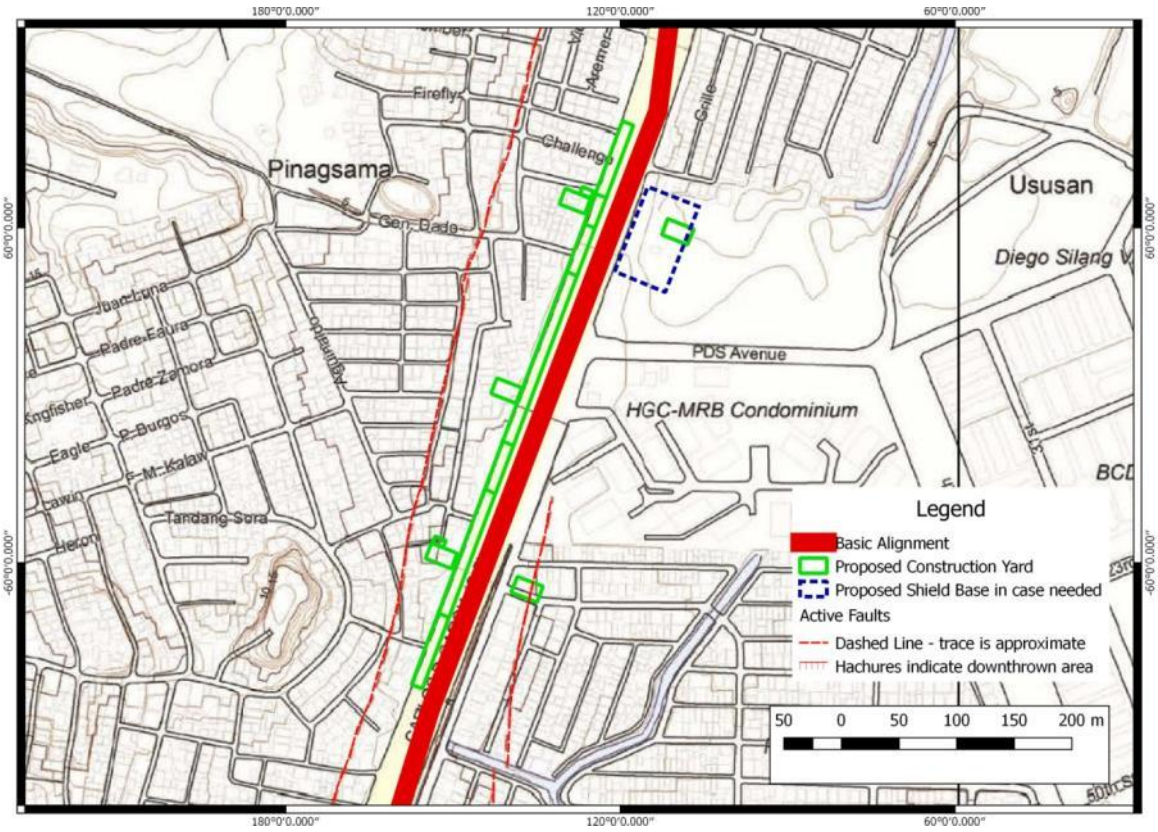
(b) BGC Station



(c) Segment between BGC and Cayetano Blvd. Stations in Brgy. Rizal, Makati



(d) Segment between BGC and Cayetano Blvd. Stations in Brgy. Pinagsama, Taguig



(e) Cayetano Blvd. Station Segment

Source: PHIVOLCS (2013)

Figure 25. Close up views of the fault map near BGC and Cayetano Boulevard Stations

2.1.1.3. Pedology

Valenzuela Depot

The Valenzuela Depot is observed to be underlain by sandy to silty clay soil. This soil is most probably from the decomposition, disintegration and erosion of the underlying Guadalupe Formation most notably the Diliman Tuff. The proximity of the site to Tullahan River also indicates the possibility of the soil having components from the alluvial and fluvial deposits of the said river.

MMSP Stations and Alignment

The MMSP will be constructed on land area that is mostly occupied for commercial or residential use. Most of the identified stations are on paved areas decreasing the exposure of the soil to the surrounding environment. In some areas where soil cover was observed, the soil could also be described to be silty clay soil. As the project is expected to be mainly underlain by the Guadalupe Formation, it is expected that most of the composition of the underlying soil comes from the said Formation. With the same expected underlying Diliman Tuff noted and seen to be extensive along the MMSP line, and the presence of small creeks and the Pasig River, leads to the assumption that most of the soil cover will be similar to the soil cover observed in the Valenzuela Depot.

2.1.1.4. Terrestrial Ecology

2.1.1.4.1. Flora

A baseline assessment of the vegetation occurring along the proposed alignment of the Metro Manila Subway Project was undertaken on April 28, 2017, July 5-6, 2017 and July 11-13, 2017. The survey sites covered the proposed Valenzuela depot, and the proposed location of the 13 stations.

All the pre-identified sites were traversed thru walking and by boarding a slow moving vehicle. All vascular plants which include trees, shrubs, vines, grasses, herbs and epiphytes were enumerated and free listed. Coordinates of species included in the IUCN, DAO 2007-1, Cites I, II and III redlists were taken using a Garmin GPS e-trex 20 receiver with the datum set at WGS 84. Family delimitation follows APG IV (2016).A census was undertaken to document all trees falling within the subway alignment with measurements recorded for each tree using tree diameter tape. Appendix E-1 presents the complete census data for 767 counts of trees and other arborescent taxa within the proposed stations of the MMSP.

Description of Survey Site

Valenzuela Depot

The vegetation occurring in the proposed Valenzuela depot area is a patch mosaic composed primarily of fruit trees and ornamental plants deliberately introduced by settlers. The land use is a mix of residential houses, trucking depots, storage warehouses, batching plants, motor oil factories, slaughterhouses and garden resorts. It is in the latter, the garden resorts (e. g. Villa Gracia, Rolling Hills Resorts) where the greatest concentration of trees and ornamental plants are to be found. These serve as green spaces that diverge from the otherwise heavily built up areas which comprise the proposed Valenzuela depot. A checklist of species occurring in the vicinity of the proposed Valenzuela depot can be found in Appendix E-3.

Figure 26. **A Section of the Proposed Valenzuela Depot**

Tandang Sora Station

The proposed station is situated along Mindanao Avenue between Tandang Sora Avenue and Congressional Avenue. The center island along Mindanao Ave. is planted mostly with narra (*Pterocarpus indicus*) and occasionally with akasya (*Albizia saman)*. These trees are planted at ca. 5 meters apart from each other. The understory is composed of bougainvillea (*Bougainvillea spectabilis*), rhoeo (*Tradescantia spathacea*), spider lily (*Crinum amabile*) and short creeping grasses such as paragis (*Eleusine indica*).

Figure 27. Center Island of Mindanao Avenue

East Avenue Station

The East Avenue Station is located along V. Luna Avenue and will cover the frontage of the AFP Medical Center, which is densely planted with large diameter mahogany *(Swietenia macrophylla)*, narra *(Pterocarpus indicus*), occasionally with mabolo *(Diospyros blancoi)*, kalantas *(Toona calantas)* and coconuts *(Cocos nucifera).* At the back of the perimeter fence at the AFP Medical Center frontage, large diameter molave (*Vitex parviflora*) and narra (*Pterocarpus indicus*) can be found.

Figure 28. AFP Medical Center frontage (left photo); Back of frontage perimeter fence at AFP Medical Center (right photo)

Kalayaan Station

The proposed Kalayaan station, located along 11th St. of the Bonifacio Global City in Taguig City, is occupied by evenly spaced plantings of narra *(Pterocarpus indicus)* with heights ranging from 8-10 meters tall. The base of tree covered with hedge trimmed *Phyllanthus myrtifolius.* Just beyond the intersection are plantings of champaka *(Michelia champaka).*

Figure 29. Narra trees along the proposed Kalayaan Station at 11th St. in BGC

Bonifacio Global City Station

The proposed Bonifacio Global City Station, located in front of Market Market, is populated on both sides of the sidewalk of evenly spaced bitaog trees *(Calophyllum inophyllum)* that are 7-8

meters tall. The base of each tree is covered by hedge trimmed tsaang gubat *(Ehretia microphylla)* and *Phyllanthus myrtifolius.*

Figure 30. Bonifacio Global City Station

Cayetano Blvd. Station

The plants currently established in the proposed Cayetano Blvd. Station, which is near Pamayanang Diego Silang C-5 Service Road are assortment of trees and shrubbery most associated with landscaping and urban greening projects such as tsaang gubat (*Ehretia microphylla*), yellow duranta (*Durantarepens*), luhang dalaga (*Pedilanthus tithymaloides*) and Benjamin's fig (*Ficus benjamina*). There are wind dispersed native species that had spontaneously established themselves such as laniti (*Wrightia pubescens ssp. laniti*), bird dispersed species such as is-is (*Ficus ulmifolia*), and bat dispersed species such as hauili *(Ficus septica*). Occasionally, there are individuals of molave (*Vitex parviflora*) deliberately planted in the area.

Figure 31. C-5 Service Road at the Pamayanang Diego Silang

FTI Station

The proposed FTI station located at East Service Road has a narra (*Pterocarpus indicus*) planted near the Caltex gasoline station at the East Service Road and Manila palm (*Adonidia merrillii*) on the adjacent property. Most of the ornamental plants such as bougainvillea (*Bougainvillea spectabilis*), butterfly palm (*Dypsis lutescens*) and lady palm (*Rhapis excelsa*) are raised in pots and containers. A center island, which used to be a nursery, is heavily planted with narra (*Pterocarpus indicus*), duhat (*Syzygium cuminii*) mahogany (*Swietenia macrophylla*) and molave (*Vitex parviflora*) can also be found along the subway alignment.

Figure 32. Narra and Manila Palm planted near the Caltex gasoline station

Taxa Counts

Two hundred and seventeen (217) species belonging to sixty nine (69) families and eighty eight (88) genera of vascular plants were enumerated from the project sites in the proposed 13 stations and depot. From this tally, eighty six (86) species are trees, thirty nine (39) species are shrubs, forty three (43) species are herbs, sixteen (16) species are climbers, twelve (12) species are fodder grasses, two (2) species are erect bamboos, thirteen (13) species are palms, three (3) species are ferns, one (1) species is an orchid, one (1) species is a pandan and one (1) species is a sedge . The most speciose family is Fabaceae/Leguminosae with eighteen (18) species followed by Poaceae with fourteen (14) species, Euphorbiaceae with thirteen (13) species, and Moraceae with thirteen (13) species. The checklist of species is presented in Appendix E-2 and Appendix E-3.

Endemicity

Out of the 217 species recorded from the project site, 70% or 151 species are exotic and introduced from other countries. Only sixty three (63) species or 29% can be considered indigenous to the Philippines but have natural distributions that extend beyond the country. The endemicity status of the surveyed plants is shown in Figure 33. Only three (3) species are

endemic to the Philippines and these are is-is (*Ficus ulmifolia*), antipolo (*Artocarpus blancoi*) and pugahang suui (*Caryota mitis*) with coordinates of its locations are listed in Appendix E-4.

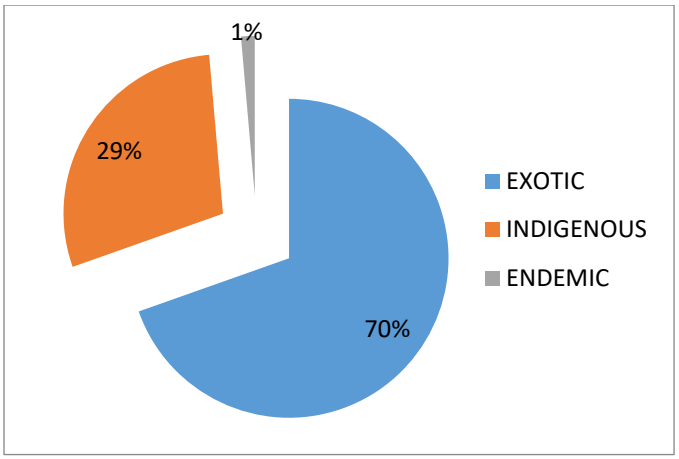


Figure 33. Endemicity Status of Vascular Plants Surveyed

Threatened Plants

Table 17 shows the list of threatened species with corresponding IUCN and DAO 2007, while Appendix E-5 presents in situ photos of the plants.

Table 17. List of Threatened Species under DAO 2007-1 and IUCN 2017

Family	Species	Common name	English name	DAO 2007-1	# 2017
Apocynaceae	*Alstonia macrophylla Wall. ex G Don*	Batino		Not assessed	LR/lc ver 2.3
Apocynaceae	*Wrightia pubescens R Br. ssp. laniti (Blanco) Ngan*	Laniti		Not assessed	LR/lc ver 2.3
Arecaceae	*Adonidia merrillii (Becc.) Becc.*	Bunga de Jolo	Manila palm	EN A1c, B1+2cd	LR/nt ver 2.3
Calophyllaceae	*Calophyllum inophyllum L.*	Bitaog	Alexandrian laurel, beach calophyllum, Borneo mahogany	Not assessed	LR/lc ver 2.3
Ebenaceae	*Diospyros blancoi A DC*	Kamagong, Mabolo	Philippine ebony	CR A1cd	VUA1cd ver 2.3
Fabaceae	*Pterocarpus indicus Willd. forma indicus*	Smooth narra	Amboina wood; Burmese rosewood; Red sandalwood	CR A1cd	VUA1d ver 2.3
Lamiaceae	*Vitex parviflora Juss.*	Molawin	Molave	EN A1cd, B2bc	VUA1cd ver 2.3
Meliaceae	*Toona calantas Merr. & Rolfe*	Kalantas		CR A1cd	DD ver 2.3
Moraceae	*Artocarpus blancoi*	Antipolo		Not	VU

Family	Species	Common name	English name	DAO 2007-1	# 2017
				assessed	A1d ver 2.3
Moraceae	*Ficus ulmifolia Lam.*	Is-is		Not assessed	VUA1cd ver 2.3
Polypodiaceae	*Drynari aquercifolia (L.) J Sm.*	Kabkab		VU A1c	Not assessed

Legend:
LR=Low risk EN=Endangered DD=Data Deficient VU=Vulnerable CR=Critically Endangered

A total of eleven (11) species are currently redlisted under the DAO 2007-1 and IUCN 2017 Lists. These are Manila palm (*Adonidia merrillii*) located at FTI station (16 individuals), Ortigas South station(13 individuals), Katipunan Ave. station (11 individuals), Quirino Highway station (8 individuals), Valenzuela depot (2 individuals) and Cayetano Blvd. station(1 individual); narra (*Pterocarpus indicus*) occurring at FTI station (41 individuals), Kalayaan Ave. station (41 individuals), Tandang Sora Ave. station(16 individuals), East Ave. station (16 individuals), Ortigas South station (9 individuals), Cayetano Blvd. station (6 individuals), Quezon Ave. station(4 individuals), North Ave. station (1 individual) and Valenzuela depot (1 individual); molave (*Vitex parviflora*) located at FTI station (17 individuals), East Ave. station (2 individuals), Cayetano Blvd. station (1 individual) and Valenzuela depot (1 individual) ; is-is (*Ficus ulmifolia*) located at Cayetano Blvd. station (1 individual) and Quirino Highway station (1 individual) ; laniti (*Wrightia pubescens ssp. laniti*) in the Valenzuela depot (1 individual); kabkab (*Drynari aquercifolia*) found at the Valenzuela depot (1 individual) and East Ave. station (1 individual); kalantas (*Toona calantas*) located at East Ave. station(1 individual) , bitaog (*Calophyllum inophyllum*) found at BGC station (82 individuals) and East Ave. station (1 individual); mabolo (*Dipterocarpus blancoi*) located at East. Ave. station and batino (*Alstonia macrophylla*) located at FTI station. There are no species encountered which falls under the CITES I, II and III redlists.

2.1.1.4.2. Fauna

A preliminary inventory undertaken conducted by Ong et al. (1999) at the University of the Philippines (UP) Diliman and Ateneo de Manila campuses, two adjacent Universities north east of Metro Manila with a combined area of 576 hectares, revealed that there are 76 vertebrate species consisting of 6 species of amphibians, 13 species of reptiles, 47 species of birds and 10 species of mammals in the area. These two Universities are 13 kilometers away from the proposed Valenzuela depot.

Results based from a two year survey by Vallejo et al. (2009) on the distribution and diversity of birds in the green spaces of UP Diliman, Quezon Memorial Circle, Ninoy Aquino Parks and Wildlife Center, American War Cemetery, Fort Bonifacio and Libingan ng mga Bayani in Taguig City show that a total of 70 species of birds were recorded in all sites with 24 species of birds encountered in the Libingan ng mga Bayani, 30 species in the American War Cemetery and 28 species in the UP Academic Oval. The Libingan ng mga Bayani is 1 km away from the proposed Cayetano Boulevard station and 5km away from the proposed FTI station, while the American

War Cemetery is 4 km away from the Cayetano Boulevard station and 8.2 km away from the proposed FTI station.

A parallel ecological study on the spatial patterns on bird diversity vis à vis habitat types specific to the UP Diliman area is conducted by Vallejo et al. (2008). The study noted 5 endemic bird species, namely Lowland White Eye *(Zosterops meyeni)*, Pink Bellied Imperial Pigeon *(Ducula poliocephala)*, Philippine Hanging Parrot *(Loriculus philippensis)*, Philippine Coucal *(Centropus viridis)* and Philippine Pygmy Woodpecker *(Dendrocopus maculatus)*. The results illustrate the role of green spaces in Metro Manila as habitat for remnant populations of endemic species.

A cross comparative study along temporal time scales on the avifauna of UP Diliman for the years 2004-2010 coinciding with the infrastructure development of the National Science Complex showed changes in the abundances of birds, specifically *Passer montanus, Pycnonotus goiavier* and *Rhipidura javanica* as a response to habitat changes. There was a marked population decline of *Passer montanus* and *Pycnonotus goiavier* but an increase in the abundance of *Gerygone* and *Geopelia*. Population reduction is attributed to the increasing high density urbanization of Metro Manila, the reduction of insect prey and high nestling mortality. The increase in *Geopelia* and *Gerygone* could be viewed as either a result of immigration or a direct response of these species exploiting the new niche offered by the change of habitat. The area covered by this study is the same area covered by Ong et al. (1999) and is 13 kilometers away from the proposed Valenzuela depot.

The heavily built up nature of the proposed sites in the subway alignment, proximity to the study sites and the high noise and disturbance levels observed in the area support the assumption that the same species pool cited in the above published accounts provided would be in many ways similar to the sites in the subway alignment and depot.

As one could reasonably expect from these sites, the animals would have a difficult time breeding and establishing stable populations as they would be subjected to a great degree of stressors (e.g. high levels of noise and pollution) and predation from domestic and feral cats. Much of the terrain features are paved with only small patches of green areas remaining.

2.1.2. Impact Identification, Prediction and Assessment, and Mitigation

This section presents the potential impacts of the proposed subway project to the natural environment and the surrounding community. Potential and suggested mitigation measures are discussed following an assessment of the significance of effects on the receiving environment and communities.

2.1.2.1. Pre-Construction Phase

Site preparation activities during the pre-construction phase will generate waste such as concrete debris, rebars, and rubbles from the demolition, soil and other land clearing debris, such as stumps, rocks and dirt.

Recycling and re-use is highly prioritized as a management option for wastes generation from the pre-construction phase. Contractors/sub-contractors will be required to submit a recycling and disposal plan for the utilization and disposal of wastes from demolition and land clearing operations.

Pre-construction activities, such as clearing of vegetation, buildings and structures, and movement of various equipment and vehicles will be the major causes of contamination and the change in the current environmental setting along the planned stations and depot.

Change in land use

As already discussed in Section 2.1.1.1, the MMSP route passes through Metro Manila CBDs. As such, the general land use types along the MMSP corridor mainly consist of mixed residential, commercial and industrial and some institutional areas.

The subway project, specifically the presence of the subway stations at the proposed locations along the alignment will generally influence commercial development along the station areas. Major impact of the project on the land use is the potential high intensity of development around the area in the future. The subway station areas may become a hub or central stations that will connect people from North Luzon to South Luzon, passing through the central zone, which is Metro Manila. The subway will serve as the backbone that provides infrastructure support connectivity from North to South and ease out traffic congestion inside Metro Manila.

The increase mobility from various sources and modality that will eventually be provided by the subway operation will help distribute the development outside of Metro Manila into the nearby provinces with comparatively less developed areas.

In terms of land use compatibility, the proposed subway project, in general, is compatible with respective LGUs' plans that support rail systems and transit-oriented development. Existing land use policies and zoning ordinances in affected cities also support the development of the proposed railway. The construction and operation of the project presents opportunities for better integration into the local infrastructure and overall land use and development plans by

the LGUs. In the long term, land development is expected to increase along and near the subway corridor. If not controlled, development may become unsustainable. Hence, local development control mechanism by the LGUs and environmental regulatory agencies, such as proper land use zoning, building code and ensuring environmental and social considerations in land development are imperative.

The DPWH was also consulted by the proponent regarding DPWH projects that are in the pipeline which could conflict or affect the MMSP alignment. The Metro Manila Expressway C-6 Project of the DPWH was identified as having potential impact to the planned MMSP alignment. The C-6 Project is a toll road project that is intended to run from Skyway/ FTI in Taguig to Batasan Complex in Quezon City. The segment of specific concern to MMSP is the C-6 segment intersecting the Bayani Road and the FTI/ Skyway section. The proponent shall continuously coordinate with DPWH to avoid issues on conflict of land use.

Impacts to existing land tenure issues

Land title holders of the affected Valenzuela depot and other affected lots in the stations will be compensated during the land acquisition stage based on the current market values for lands, structures (such as houses, fences, posts, etc.), improvements, crops and trees and other physical properties or non-land-based incomes that will be affected by the Project. Compensation and assistance to all PAPs will be based on the JICA Guidelines (2010) and World Bank OP4.12 and other established and applicable Philippine Laws and similar policies and guidelines, such as the R.A. No. 10752, and R.A. No. 7279 (Urban Development and Housing Act of 1992 or UDHA).

Soil erosion

Due to the uncovering of land during pre-construction, soil erosion is expected to increase with higher soil exposure to rainfall and air. This is especially true with the residential and commercial areas that will be affected during this phase of the project. Constructing a temporary or even a permanent drainage will decrease the effects of added soil exposure to rainfall. Shortening the time between the pre-construction phase and the construction phase may also decrease the added erosion expected to occur.

Soil contamination

The clearing activities will generate solid wastes in the demolition areas. Recycling of wastes will be implemented, as much as possible, through sorting, stockpiling and containing recyclable wastes. Where appropriate, leftover concrete and metals will be used for suitable alternative projects. Contaminated solid wastes will be disposed through an accredited transport, storage and disposal (TSD) facility.

Flora and fauna

A complete census of flora along the alignment showed a total of 767 counts of trees and other arborecent taxa will potentially be affected during pre-construction and construction activities. Of these, 298 counts are threatened species as shown in the table below.

Table 18. No. of Threatened Species that will potentially be affected

Depot / Station	No. of Threatened Species
Valenzuela	7
Quirino Highway	9
Tandang Sora	16
North Ave.	1
Quezon Ave.	4
East Ave.	21
Anonas	none
Katipunan Ave.	11
North Ortigas	none
South Ortigas	22
Kalayaan Ave.	41
BGC	82
Cayetano Blvd.	9
FTI	75

During the DED stage, a detailed plan for the management of affected flora will be required from the contractor. Proper assessment of the matured trees shall be conducted to determine appropriate method of removal, if it will be transferred/earthballed or cut.

Matured trees shall be transferred carefully to designated receiving areas. A detailed plan for transfer/earthballing of matured trees will be prepared prior to removal. The detailed plan should include proper handling of the uprooted tree and preparation of the recipient site to ensure high survival rate of the trees. A system to periodically monitor and maintain survival of these species should be set in place to assure high survival rate. DOTr will coordinate with the LGUs for the identification of relocation area for the potential trees that will be relocated. Potential relocation area for the endangered trees is a farm in Mabalacat, Pampanga owned by Mr. Bobby Wong, Jr.

Tree planting activities will also be conducted to replace trees and vegetation that will be removed and affected by site clearing. For every tree removed, an equivalent of 100 tree seedlings will be planted at the protected area in Norzagaray, Bulacan or other areas identified by DENR. These activities will be coordinated with Forest Management Bureau of DENR or in partnership with private companies, such as MWCI who has reforestation projects in Umiray in Dingalan, Aurora; Ipo in Norzagaray, Bulacan; La Mesa in Quezon City and Upper Marikina Watersheds.

The removal of vegetation would also result to removal or reduction of the ecosystem services that these vegetation provides, such as microclimate regulation, flooding, provision of habitat to faunal species and carbon sequestration.

The estimated carbon stock or amount of carbon dioxide (CO_2) content of the above-ground biomass material is around 218 tons. The estimated annual carbon sequestration is around 5.5 tons per year, which is significantly lower than the estimated GHG reduction resulting from the operation of the MMSP, as discussed in Section 2.3.2.2. The amount of carbon stocks and carbon sequestration of the flora in the area were estimated using the 2006 IPCC Guidelines for National Greenhouse Gas Inventories for Settlements (Chapter 8) under the Land Use, Land Use Change and Forestry (LULUCF), with the discussion of methodology presented in Appendix F.

The following measures are recommended to alleviate the abovementioned impacts:

- Landscaped areas set aside as green areas should be integrated in the design layout of the proposed depot areas and stations. Where feasible, green roofs and vertical gardens should be added to achieve maximum habitat heterogeneity conducive for the re-establishment of local fauna displaced by construction and the re-continuance of ecosystem services such as microclimate regulation, carbon sequestration and flooding. Selection of tree species should be biased towards native species to ensure habitat connectivity of local fauna.
- Felled trees during the construction phase should not be allowed to degrade under the elements to ensure that the CO_2 trapped in the wood biomass is not released back into the atmosphere as greenhouse gas.
- Leaves and clippings from the felled trees should be shredded and mulched to ensure that the nutrients stored and captured in the biomass is returned and cycled back to the soil.

Impairment of visual aesthetics

Construction sites can be eyesores if no proper barriers between the construction site and the rest of the surroundings are in place. Hence, construction sites at the depot and stations will be fenced, not just for safety and security reasons but also to prevent impairment of visual aesthetics.

Instead of ordinary construction fences, “green” walls, in the form of green-painted fences, green facades or living walls are recommended. Green facades and living walls have the advantage of offsetting greenhouse gas emissions during construction, in addition to its visual aesthetic benefits.

Topography impacts and soil erosion

During tunneling and excavations, backfilling, and temporary stockpiling of excavated earth materials will have a low adverse effect on the terrain. The effects can be minimized by proper housekeeping to prevent soil erosion and siltation for areas of the project near rivers and creeks. Excavations at the stations will be reinforced with RC diaphragm wall to prevent slope failure.

Tunneling in between stations using a TBM will be reinforced using precast concrete or steel blocks in a circular shape, which is part of the TBM operation. The tunnel lining wall serves as a temporary support structure that will prevent subsidence of nearby areas.

Proper planning and scheduling of construction works should be done to ensure that excavated soil is immediately transported to recipient sites (to be discussed further in the following sections). This measure will prevent stockpiling of spoils along the project area, which could otherwise cause changes in the topography of the area. To prevent further erosion, a good drainage system can also be installed along the project area. This will prevent possible flooding in the area as well.

Soil contamination

Soil may become contaminated during construction works due to leaks and accidental spills of cleaning materials for equipment, fuels and lubricants from construction vehicles and machineries. Use of inadequate chemical injection method can also pose potential soil contamination. Releases due to leaks may result in relatively insignificant amount of contaminants in the soil. Potential large spills from fuel and lubricants for the machineries, and other chemicals could cause a more serious effect.

To prevent negative adverse impact to the quality of soil during construction, contractors must be required to:

- Implement proper handling and management of chemicals
- Practice good housekeeping at construction sites
- Establish and implement an emergency and contingency plan in case of spills as well as health and safety management plan
- Store bulk chemicals, such as fuel, lubricants and other chemicals, in an impermeable area and with appropriate secondary containment and,
- Comply with environmental permitting requirements for the storage, transport, treatment and handling of hazardous substances and wastes.

During tunneling and excavation through cut and cover method, the presence of artificial subsurface structures should be considered in the design phase to prevent damage and subsequent soil contamination. Aside from the presence of sewers along the alignment, the FPIC gas pipeline is one example of a subsurface structure that could be encountered during construction of underground walkway, specifically from West Service Road going to the proposed FTI Station. Presence of these subsurface structures is currently being studied through a Utility Survey conducted by another JICA consultant, as part of the MMSP feasibility study. Based on results of the Utility Survey, adjustments in depth or slight realignment of the subway structure during the design phase, if necessary, will minimize the risk of soil contamination due to damage of potential gas pipelines or other structures which can release toxic substances when damaged.

Impacts of generation of excavated soil

An estimated volume of 4.4 million cubic meters (m^3) of surplus soil will be generated over the entire construction period, estimated at 5 years. Excavation through cut and cover at the stations is estimated to generate 130 m^3 of excavated soil per day per construction party, while excavation through TBM will approximately generate 200 m^3 of excavated soil per day for each TBM. Given this scenario, the estimated number of dump trucks needed to haul the surplus soil at a rate of 10 m^3/truckload is as follows:

	Volume of excavated soil	*No. of dump truck needed for hauling*
Cut and cover	130 m^3/day/ construction party	13trrucks/ party
Tunnel Boring Machine	200 m^3/day/ TBM	20trucks/ day/TBM

As already mentioned in the discussion of construction methodology, a more detailed shield excavation plan specifying how many TBMs and construction parties will operate simultaneously will be established during the DED phase.

Nevertheless, in order to gain a rough picture of the potential impact of surplus soil generation, the operation of 15 TBMs per day at 20 working hours/ day will be used as an example. Considering this scenario, a total of 3,000 m^3 of spoils will be generated per day, which translates to 300 trucks required to haul the spoils per day, or about 30 trucks that will be running the road per hour from the construction site en route to the recipient site.

Hence, if not managed properly, the generation of spoils will cause severe traffic congestion. Likewise, the number and frequency of heavy trucks plying the road from the construction site to the disposal/ re-use site will easily cause damage of roadways.

Other impacts of surplus soil if not properly mitigated are increased sedimentation in nearby bodies of water if it is discharged to water bodies through run-off; and devaluation of land value.

As one of the mitigating measures, the surplus soil can be used as (1) backfilling of quarry sites in the province of Rizal; (2) projects involving elevation of low-lying areas by the PDRRMC in Regions III and IV; (3) projects of DPWH and DOTr, and (4) reclamation projects to be coordinated with the PRA and LGUs within Metro Manila. The least prioritized option should be the disposal of soil in a landfill. It is of utmost importance that recipients of surplus soil be identified and well-coordinated prior to the construction phase to prevent delay in the tunneling works and most importantly to avoid the adverse environmental impacts of surplus soil generation.

The management of surplus soil should also be integrated in the detailed construction plan to consider the timing of generation of excavated soil and backfilling in other stations, the ingress and egress of excavated soil, and the immediate hauling of excavated soil to recipient sites where these are needed. The detailed construction plan shall also be the basis for establishing a Traffic Management Plan, which should be coordinated with the Metro Manila Development Authority (MMDA) and relevant LGUs.

In order to mitigate damage of roads due to passage of heavy equipment and vehicles, road maintenance shall be incorporated in the construction plan and duly implemented by the contractor.

The MMSP is bound to comply with the JICA Environmental and Social Guidelines, thus, to ensure that the excavated soil does not contain traces heavy metals that area beyond the acceptable standards, periodic analysis of heavy metal levels in surplus soil shall be conducted. If considerable high level of heavy metal is identified, proper management and disposal to an accredited TSD facility shall be implemented.

Impacts of transport of construction materials

The construction of the subway stations and underground tunnels will entail the use and consumption of high volume of construction materials as shown in the table below.

	Estimated Volume/Weight	*Equivalent No. of dump truck for transport*
Total concrete materials	930,000 m^3	93,000 trucks
Total reinforcing bar	139,500 tons	9,300 trucks
Total soil for filling works	2,650,000 m^3	265,000 trucks
	TOTAL	367,300 trucks

The total estimated number of trucks needed to transport materials to the construction sites over the entire duration of the construction phase is approximately 367,000 trucks. The high volume of trucks plying along the road is expected to worsen traffic condition in Metro Manila and will also cause damage of roadways.

Scheduling of the delivery of construction supplies and materials should be incorporated in the detailed construction plan that will be required from the contractors. A Traffic Management Plan, which should be coordinated with the Metro Manila Development Authority (MMDA) and relevant LGUs, shall also be developed.

In order to mitigate damage of roads due to passage of heavy equipment and vehicles, road maintenance shall be incorporated in the construction plan and duly implemented by the contractors.

Impacts of solid wastes from construction materials and workforce

The construction workforce, will likewise, generate solid wastes such as industrial waste packaging materials from construction materials and general wastes from workers such as food scraps, putrescible wastes, recyclable and non-recyclable packaging materials. If such wastes will not be handled properly, these would cause land and potential surface water contamination and negative impacts to aesthetics. Mitigation measures to address solid waste impacts include:

- Submission and implementation of Solid Waste Management Plan as part of contractors' engagement
- Placement of waste bins to avoid dispersal of litter and regular site maintenance duties
- Regular collection, transportation and disposal of wastes to minimize the attraction of vermin, insects and pests

Geohazard impacts

According to PHIVOLCS, Metro Manila should be ready anytime for a possible strong earthquake to occur. During the construction phase, liquefaction, ground shaking and rupture are all risks that can damage the components of construction work.

Liquefaction

The proposed depot along Mindanao Avenue in Valenzuela City, Quezon Avenue station, Anonas stations, part of the subway system that will cross Pasig River, and the segment between the proposed BGC and Cayetano Blvd. stations are within potential areas of liquefaction. In general, at least 20 meters buffer zone from the bottom of the body of water (surface and subsurface) should be observed for construction of subway structures. Moreover, the conduct of borehole logs along the riverbed of Pasig River and other sections with high liquefaction risk is recommended during DED to identify the thickness of soft sediments and other sedimentary beds. Proper observance of the buffer zone based on results of the soil survey shall be considered in the finalization of the vertical alignment.

Ground shaking

As for ground shaking, reinforcement of underground structures is recommended to prevent collapse. The following measures can be undertaken to increase resistance of the structures:

- Construction of shield tunnels as a protective and support structure during tunnel excavation
- Reinforcement of the surface structures to be constructed for the station to ensure safety and continued use
- Adopt a seismic design during the detailed engineering phase of the subway project

Earthquake drills are also encouraged for workers to be prepared and well informed of what are the proper things to do during an earthquake.

Ground rupture

A detailed survey of the subsurface condition of the area surrounding not only the Cayetano Boulevard Station but also the sections of the proposed alignment located nearby the fault traces (identified, inferred and even the concealed) to the north and south of the said station is recommended during the DED Stage of the project. An inclined drilling program should be designed to study the fault along the proposed alignment. The proponent should consider inclined drilling using the triple tube wireline technique to attain 90 to 95% core recovery. The

design of the drilling program and interpretation of results shall be done in consultation with PHIVOLCS.

Nevertheless, it would be most prudent and cautious to strongly consider realignment of the subway in this section away from the fault to reduce or eliminate risk of rupture to the MMSP line and most especially to prevent injury or loss of life in the event of a strong earthquake during construction and subway operation.

2.1.2.2. Operation Phase

Once the MMSP is fully constructed and operational, all mitigating and safety measures applied and constructed during the construction phase are to be continued and maintained. Structural integrity of the subway tunnel and entrance as well as the surrounding soil and bedrock stability are to be maintained. Maintenance checks and tests are advised to guarantee safety.

Geohazard impacts

Earthquake resistance of the MMSP will rely on the constructed protective measures and its maintenance. Proper and prompt maintenance checks are very important to every single installed structure and facility. Upgrades or installation of new technological advances when available are also encouraged for the continued operation of MMSP. Earthquake drills and early warning systems are also advised to be put in place to prevent loss of life and possibly the trains themselves. Emergency escape route in the form of small footpath beside the subway rail shall be incorporated in the design of the tunnel structure. Emergency power supplies for the MMSP are also advised to be installed to ensure continued operation of vital services during emergencies.

Soil contamination

Leaks and accidental spills of hazardous chemicals such as fuels, lubricants, cleaning agents, used oil and other chemicals will be of more concern in the proposed Valenzuela Depot, where train maintenance activities will take place. To prevent such releases, emergency and contingency plan in case of spills and health and safety management plan must be in place. Storage, transport, treatment and disposal of all hazardous wastes must be in compliance with environmental regulations. After mitigation and management, all hazardous and regulated wastes are expected to result in a negligible impact.

Impacts of solid waste generation

The project will require onsite personnel during operation and consequently generate general domestic solid wastes. Likewise, subway patrons are also expected to generate general refuse. Improper management of solid wastes may result to land contamination as well as aesthetic impacts. Policies on solid waste minimization and solid waste management should be implemented in stations and depot.

Impairment of visual aesthetics

In terms of landscape impacts, only the station entrances/exits and the depot will be the structures at the ground. Structures in the station entrances will occupy minimal space as this will comprise only of a small roofed or railed structure. Impact on the aesthetic value of the cityscape will be low. Likewise, the station entrances/exits will be low rise structures that will unlikely block significant amount of sunlight to the surrounding areas. At the depot, almost two-thirds of the depot facility will be bordered by Mindanao Avenue and Tullahan River. Hence, shadows of elevated structures will not be a major problem.

A summary of the potential impacts, assessment of impacts and mitigating measures to address the identified impacts is provided in Table 19.

Table 19.Impact Identification, Assessment and Mitigating Measures for Land

Environmental aspect	Potential impact	Assessment of impacts	Mitigating measure
PRE-CONSTRUCTION PHASE			
Land use	Intensification of future developments in the subway station areas	High adverse	Proper land use planning and strict implementation of land use zoning ordinances to protect the environment should be undertaken for subway operation impacts to remain beneficial.
	Potential conflict with other government infrastructure projects (e.g. DPWH's C6 Project)	Moderate adverse	Close coordination with DPWH and other relevant government agencies to avoid issues on conflict of land use
Land tenure	Acquisition of land from land title holders in the Valenzuela depot and other affected lots in the station locations.	High adverse	Land acquisition by the government based on current market values of the property following both JICA Guidelines and applicable laws and regulations
Clearing and demolition activities	• Soft ground • Soil erosion during clearing of land • Soil runoff	Low adverse	• Construction of temporary or permanent drainage • Limit time between pre-construction and construction; • Set activities during dry season, as much as possible
Generation of demolition wastes	Soil contamination and aesthetic impacts	Low adverse	• Recycling of wastes, as much as possible • Use of leftover concrete and metals for suitable alternative projects • Uncontaminated residual wastes will be used as backfilling materials in quarry sites and land reclamation projects.

Environmental aspect	Potential impact	Assessment of impacts	Mitigating measure
			• Disposal of contaminated solid wastes through an accredited TSD facility.
Clearing and removal of trees	Potential removal of 767 trees, of which 298 are threatened species, present in the proposed depot and stations	Moderate adverse	• Preparation of a detailed management plan for the removal of trees shall be required from the contractors. • Preparation and implementation of a detailed plan for the transfer/earthballing of matured trees. A system to periodically monitor and maintain survival of these species should be set in place to assure high survival rate. • Replacement and planting of corresponding number of tree seedlings by the proponent • Coordination with concerned agencies or groups for relocation sites of earth-balled trees. A system to periodically monitor and maintain survival of these species should be set in place to assure high survival rate.
Clearing and removal of trees	Removal or reduction of ecosystem services such as microclimate regulation, flooding, provision of habitat to faunal species and carbon sequestration	Moderate adverse	• Integration of landscaped green areas (e.g. parks, green roofs and vertical gardens)in the design layout of the proposed depot and stations. • Selection of tree species for green spaces should be biased towards native species

Environmental aspect	Potential impact	Assessment of impacts	Mitigating measure
			to ensure habitat connectivity of local fauna. • Felled trees during the construction phase should not be allowed to degrade under the elements to ensure that the CO_2 trapped in the wood biomass is not released back as GHG. • Leaves and clippings from the felled trees should be shredded and mulched to ensure that the nutrients stored and captured in the biomass is returned and cycled back to the soil.
Construction site activities	Impairment of visual aesthetics	Moderate adverse	Use of "green" walls, in the form of green-painted fences, green facades or living walls as construction barriers/fences
CONSTRUCTION PHASE			
Earthwork activities (tunneling, excavation, backfilling and stockpiling)	• Slope failures, landslides and subsidence due to cutting and filling • Soft ground • Soil erosion and siltation along the rivers and creeks • Soil runoff • Alteration in topography due to excavations of earth and stockpiling	Moderate adverse	• Proper reinforcement of excavations and tunneling sections • Proper planning and scheduling of construction works to ensure that excavated soil is immediately transported to recipient sites • Construction of a good drainage system

Environmental aspect	Potential impact	Assessment of impacts	Mitigating measure
Leaks and accidental spills on soil	• Soil contamination	Low adverse	Require contractors to: • Implement proper handling and management of chemicals • Practice good housekeeping at construction sites • Establish and implement an emergency and contingency plan in case of spills as well as health and safety management plan • Store bulk chemicals, such as fuel, lubricants and other chemicals, in an impermeable area and with appropriate secondary containment and, • Comply with environmental permitting requirements for the storage, transport, treatment and handling of hazardous substances and wastes.
Damage of subsurface structures during drilling and excavation activities	Soil contamination	Low adverse	Cautious drilling along other artificial subsurface structures; Design adjustments or modification of already present structures
Generation of surplus soil (approximately 4.4M m^3) from excavation/tunneling	• Traffic congestion and damage of roadways along the route to disposal site • Increased sedimentation of nearby water bodies	High adverse	• Use of surplus soil as backfilling materials in quarry sites, land reclamation projects, and elevation of low-lying areas; • Proper scheduling of excavation works,

Environmental aspect	Potential impact	Assessment of impacts	Mitigating measure
	• Aesthetic impacts		and coordination with surplus soil recipients to ensure immediate hauling of surplus soil • Develop and implement Traffic Management Plan • Road maintenance by the contractors
Transport of construction materials	Traffic congestion and damage of roadways along the route to disposal site	High adverse	• Proper scheduling of the delivery of construction supplies and materials • Develop and implement Traffic Management Plan • Road maintenance by the contractors
Generation of solid wastes from the construction workforce	• Land and water contamination • Aesthetic impacts • Spread of diseases	Moderate adverse	• Submission and implementation of Solid Waste Management Plan as part of contractors' engagement • Placement of waste bins to avoid dispersal of litter and regular site maintenance duties • Regular collection, transportation and disposal of wastes to minimize the attraction of vermin, insects and pests
Liquefaction	• Damage to underground structures and overlying structures (in depot and stations) in the event of an earthquake • Loss of soil strength, settlement of soil, lateral spreading, bearing	Moderate adverse	• Constructing subways structures at deep underground • Chemical liquid injection for soil strength improvement • Observe 20 meters buffer zone from body of water (surface and subsurface)

Environmental aspect	Potential impact	Assessment of impacts	Mitigating measure
	failures, floatation of embedded structures		• Conduct a borehole log of Pasig riverbed to identify how thick is the soft sediments and other sedimentary beds
Ground shaking	Damage to components of the construction work	High adverse	• Reinforcement of the surface structures to be constructed for the station to ensure safety and continued use • Adopt a seismic design during the detailed engineering phase of the subway project • Earthquake drills and early warning system • Emergency exits on and in between stations for eventuality of an earthquake event
Ground rupture	Damage to components of the construction work	High adverse	• Conduct inclined drilling survey of the subsurface condition of the area surrounding not only the Cayetano Boulevard Station but also the sections of the proposed alignment located nearby the fault traces, in consultation with PHIVOLCS • Strongly consider realignment of the subway in Cayetano Blvd. Station, away from the fault

Environmental aspect	Potential impact	Assessment of impacts	Mitigating measure
OPERATIONAL PHASE			
Landscape	• Aesthetic impacts on landscape resources • Shadows of elevated structures	Low adverse	Structures in the station entrances will be designed to occupy minimal space and will be low rise structures to prevent blockage of significant amount of sunlight to the surrounding areas.
Leaks and accidental spills of chemicals, especially at the depot area	Soil contamination	Moderate adverse	Emergency and contingency plan in case of spills and health and safety management plan must be in place
Solid waste generation	• Land and water contamination • Aesthetic impacts • Spread of diseases • Devaluation of land value	Moderate adverse	Policies on solid waste minimization and solid waste management should be implemented in stations and depot.
Geological hazards (liquefaction, Ground shaking/ground rupture)	Damage to underground structures and overlying structures (in depot and stations)	High adverse	• Regular maintenance checks of structures and tests of safety measures • Earthquake drills and early warning system • Emergency escape route
Leaks and accidental spills of chemicals, especially at the depot area	Soil contamination	Moderate adverse	Emergency and contingency plan in case of spills and health and safety management plan must be in place

2.2. THE WATER

2.2.1. Baseline Environmental Conditions

2.2.1.1. Hydrology

Metro Manila is composed of 17 cities and is surrounded by rivers and creeks, which define the city boundaries and other water channels passing through it. Referring to Figure 34below, the lower right side of Metro Manila is the largest fresh water in the Philippines, the Laguna de Bay, while to the left side is the Manila Bay. Metro Manila is also bounded by several rivers, the San Juan River in Quezon City, the Marikina River, the Pasig River and the Manggahan Floodway. The surface runoffs are drained by rivers such as Meycauayan, San Juan, and Tullahan, and by the Manila Bay.

Figure 34. Water bodies surrounding Metro Manila

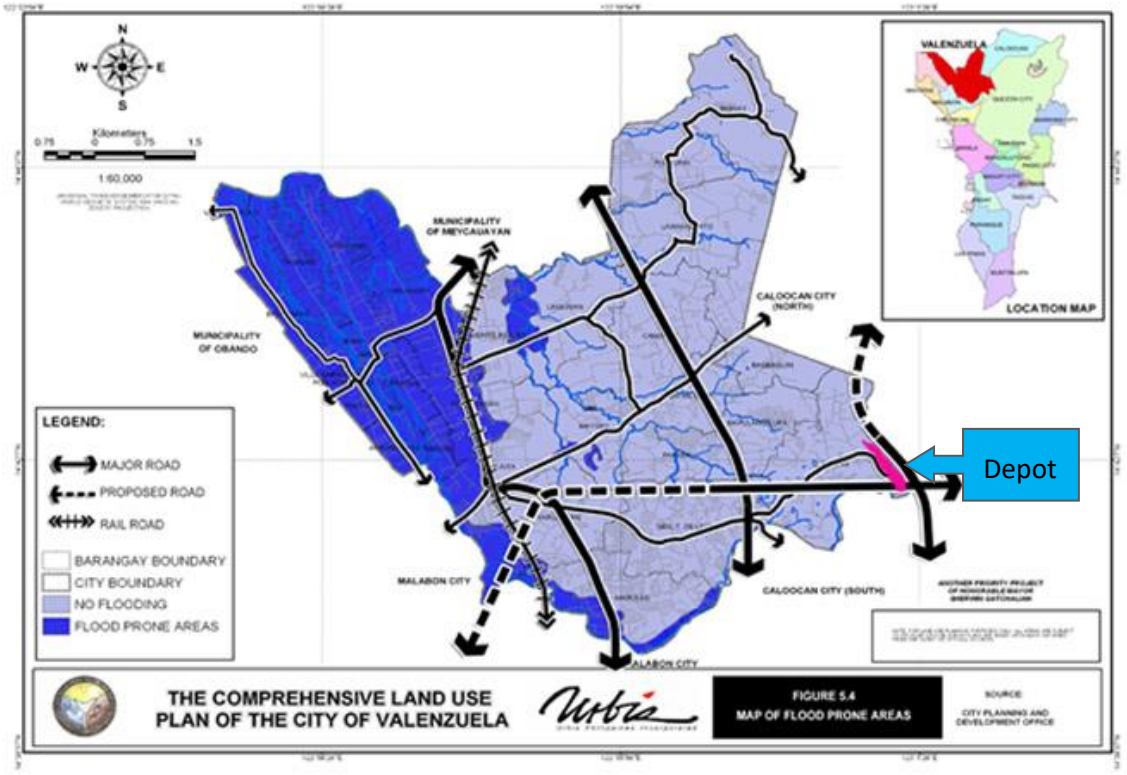
The MMSP alignment, including the depot, will traverse three rivers, namely Tullahan River, San Juan River and Pasig River, and creeks, which is presented in Appendix G. Hydrology of each city along the MMSP alignment will be discussed in the succeeding sections.

Valenzuela

Valenzuela City has several rivers and creeks. The four major rivers in the city are Meycauayan River, Polo River, Calooing River and Tullahan River. Majority of the city's surface runoff drains towards Meycauayan River, as well as to Tullahan River and Manila Bay.

Nearly one third of the city is swampy and fishpond areas with an elevation of only one to five meters above sea level. In addition to this topographic characteristic, the city is within an area that has a 16% frequency of tropical cyclones. These make the western portion of the city susceptible to flooding.

The eastern section, where the proposed depot is located, in turn, generally have more stable soils and are less prone to flooding, as shown in Figure 35.



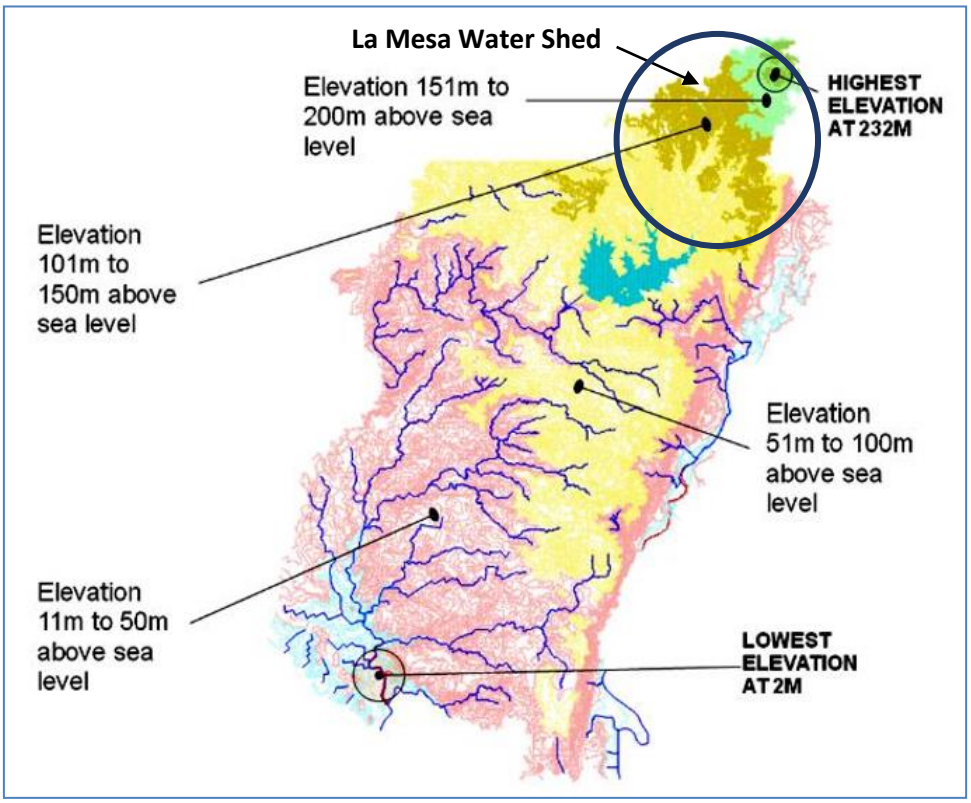
Source: Valenzuela City CLUP for 2009 - 2018

Figure 35. Map of Flood Prone Areas in Valenzuela City

Quezon City

Quezon City is generally unaffected by tidal flooding, as shown in Figure 36, having an elevation ranging from 2 meters above sea level (masl) on the south near Manila, up to 232 masl on the northernmost tip of La Mesa Reservoir. At its lowest elevation, the low lying areas along the banks of San Juan River in Barangay Doña Imelda-Damayang Lagi and Talayan Roxas-Kalusugan, are prone to overflow flooding should San Juan River start to back flow at its junction with Pasig River. The proposed seven stations within Quezon City (Quirino Highway, Tandang Sora, North

Ave., Quezon Ave., East Ave., Anonas and Katipunan) are located 50 meters above sea level which is low to moderately prone to overflow flooding.



Source: Quezon City CLUP for 2011-2030

Figure 36. Tidal Mapping of Quezon City

Although Quezon City has a high elevation, it was heavily flooded during the Typhoon Ondoy in September 2009, wherein 455.00 mm of rainfall fell in Quezon City within 24 hours. This amount of rainfall reached levels that are expected once per century or once every 150 years.

Pasig City

There are two natural bodies of water traversing the city, the Pasig River and the Marikina River. There are also 17 creeks or *esteros* that run through the city's territory and its periphery. The Manggahan Floodway cuts across Pasig, from Marikina River bend in Barangay Rosario towards Laguna de Bay.

Drainage systems in Pasig are determined by the Pasig-Marikina River System and the West Manggahan drainage area. The Pasig-Marikina River System, with a catchment area of 651 km^2, is prone to overbanking which includes excess flood runoff overflowing from Pasig and Marikina riverbanks and storm water inundation from drainage and creek networks. Manggahan Floodway, on the other hand is a typical interior flood-prone area, 39 km^2 along Laguna de Bay. Storm rainfall and high water levels in the lake cause flooding in the area. This endangers communities along the lakeshore.

Apart from the Laguna Bay spillage, Pasig may relatively be free from floods, particularly, the city proper, but floods from storm run-off occur in most areas due to intense rainfall and excessive flows of the two rivers.

Drainage lines within Pasig City have a total aggregate length of 104 kilometers consisting of open canal, covered canal and underground reinforced pipes. These underground reinforced concrete pipes are mostly installed in private subdivisions.

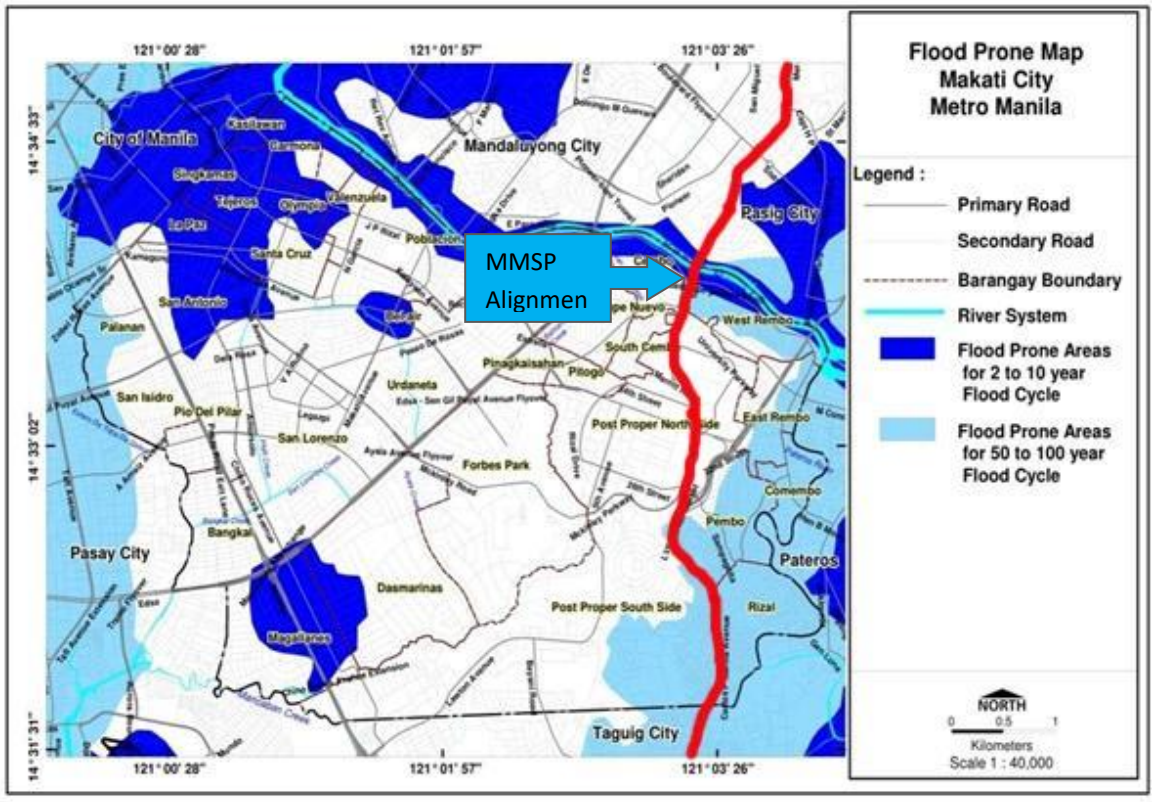
Almost all thoroughfares and residential areas have underground drainage facilities, while those of high density residential areas are provided with open or closed canal to relieved the city of storm flooding.

In recent years, the city has experience severe flooding conditions in many of its low-lying or flood-prone areas. The damaging impacts of Typhoon Ondoy in 2009, and the torrential monsoon rains (Habagat) of 2011 included severe flooding of many areas especially where rivers and creeks crossed.

Makati City

Makati City has areas that are prone to flood hazards. Flood occurrence is generally restricted to creeks and rivers except in the western part of the city wherein sheet floods cover a large area due to the very low and flat topography.

As presented in Figure 37, areas that are prone to 2 to 10-year and 50 to 100-year flood cycles are distributed along creeks, Pasig River and low lying areas. Parts of the City that are prone to 50 and 100-year flood cycle are restricted along the Pateros River and its junction with Pasig River. Even so, the MMSP alignment traversing Makati City will be located underground. Hence, the subway will not have any influence in the flooding conditions in Makati City.



Source: Makati City CLUP for 2013-2023

Figure 37. Flood Hazard Map of Makati City

Taguig City

Taguig has two major rivers that feed Laguna de Bay, namely, the Taguig River and the Napindan Channel, which is linked to the eastern portion of the Pasig River. The Napindan River normally flows from Laguna de Bay to the Pasig River, but can also flow in the opposite direction, depending on the river itself, the water table in the lake, the tidal stage in Manila Bay, and the annual evaporation from the lake.

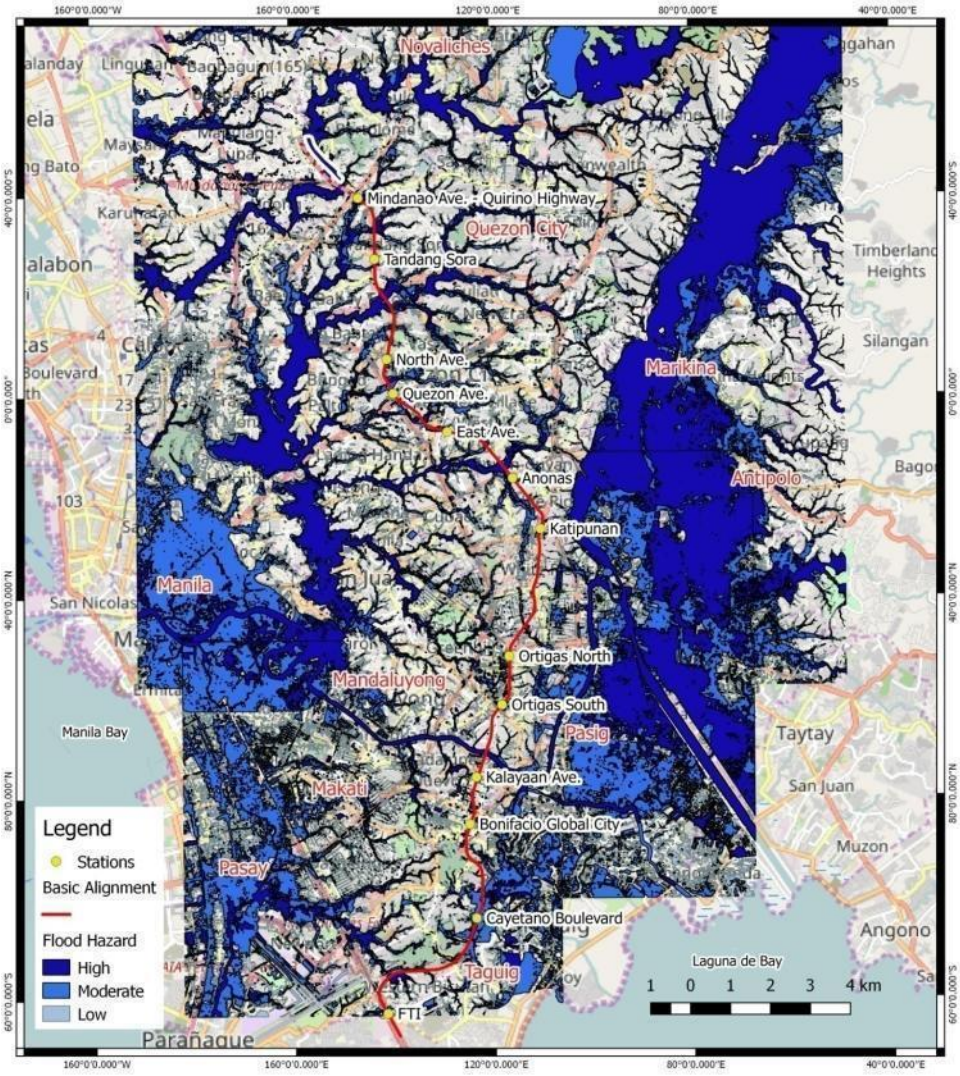
Over half of the municipality of Taguig is within the flood zone, which could be attributed to low elevation, poor soil permeability, altered natural drainage (via the Napindan hydraulic control gate), and water runoff from a large geographical area, which has been further aggravated by recent developments.

Flood Hazard along the MMSP Alignment

The proposed MMSP line appears to be generally safe from flood hazard, aside from possible failure of artificial drainage. According to flood hazard map in Figure 38, the proposed stations will have no risk of flooding except for the proposed Anonas and Quezon Avenue stations.

The Anonas station surrounding area was rated as prone to low and moderate flooding hazard. The nearby creek/stream induces and worsens the risk when it overflows. Proper mitigating

measures are necessary to lessen the risk for the station. The area to the south of Quezon Avenue (Centris area and Panay Avenue near EDSA) acts as a mini catch basin of the surrounding higher elevated areas, generating a moderate to high risk to flooding. The risk of the creek/stream to the north of Quezon Avenue overflowing increases the risk to flooding, hence the rating of moderate to high flood hazard. The surrounding area of Cayetano Blvd. Station in Taguig is also rated with low flooding hazard.



Source: Project NOAH

Figure 38. Composite map of the 100 year Flood hazard maps of Quezon, Pasig, and Makati Cities from Project NOAH.

2.2.1.2. Water Quality

Philippine water quality is assessed based on the set beneficial use as defined in the newly revised DAO 2016-08 or the Water Quality Guidelines (WQG) and General Effluent Standard (GES) of 2016. The WQG applies to all water bodies in the country, of which should meet the parameters that define the desired water quality 100 percent of the time to maintain its designated water body classification. The GES, on the other hand, applies to all point sources of pollution regardless of volume that discharge to the receiving body of water.

In the case of Metro Manila, massive population growth, infrastructure development and increased economic activities led to the deterioration of its water bodies. In 1990, the Pasig River was pronounced as dead and incapable of sustaining marine life. As of 2003, the DENR formally declared four more rivers as biologically dead; the Navotas-Malabon-Tenejeros-Tullahan (NMTT) River, Paranaque River, Marikina River and San Juan River.

To validate existing water quality data from secondary sources, actual surface water sampling was conducted on rivers along the MMSP alignment. Surface water samples were taken from Tullahan River, San Juan River and Pasig River as shown in Figure 39.

Table 20 presents the surface water sampling stations, coordinates, date and time of sampling and weather conditions during sampling. The sampling was undertaken last March 1, 2017. Standard water sample preparation and sampling procedures were followed. Field measurements of pH and temperature were also undertaken. The samples were then analyzed for physico-chemical and bacteriological parameters.

Table 20.Surface Water Sampling Stations, Coordinates, Date and Time of Sampling and Weather Conditions during sampling

Sampling Stations	Coordinates	Date of Sampling	Time of Sampling	Weather Conditions
Tullahan River	14° 41’ 32” N 121° 1’ 26” E	March 1, 2017	10:10 am	Sunny
San Juan River	14° 40’ 1” N 121° 2’ 4” E		10:50 am	Sunny
Pasig River	14° 34’ 4” N 121° 2’ 54” E		12:25 pm	Sunny

Presented in Table 21 is the summary of test results of surface water and the corresponding DENR standards set in DAO 2016-08. Certificates of analysis are presented in Appendix H.

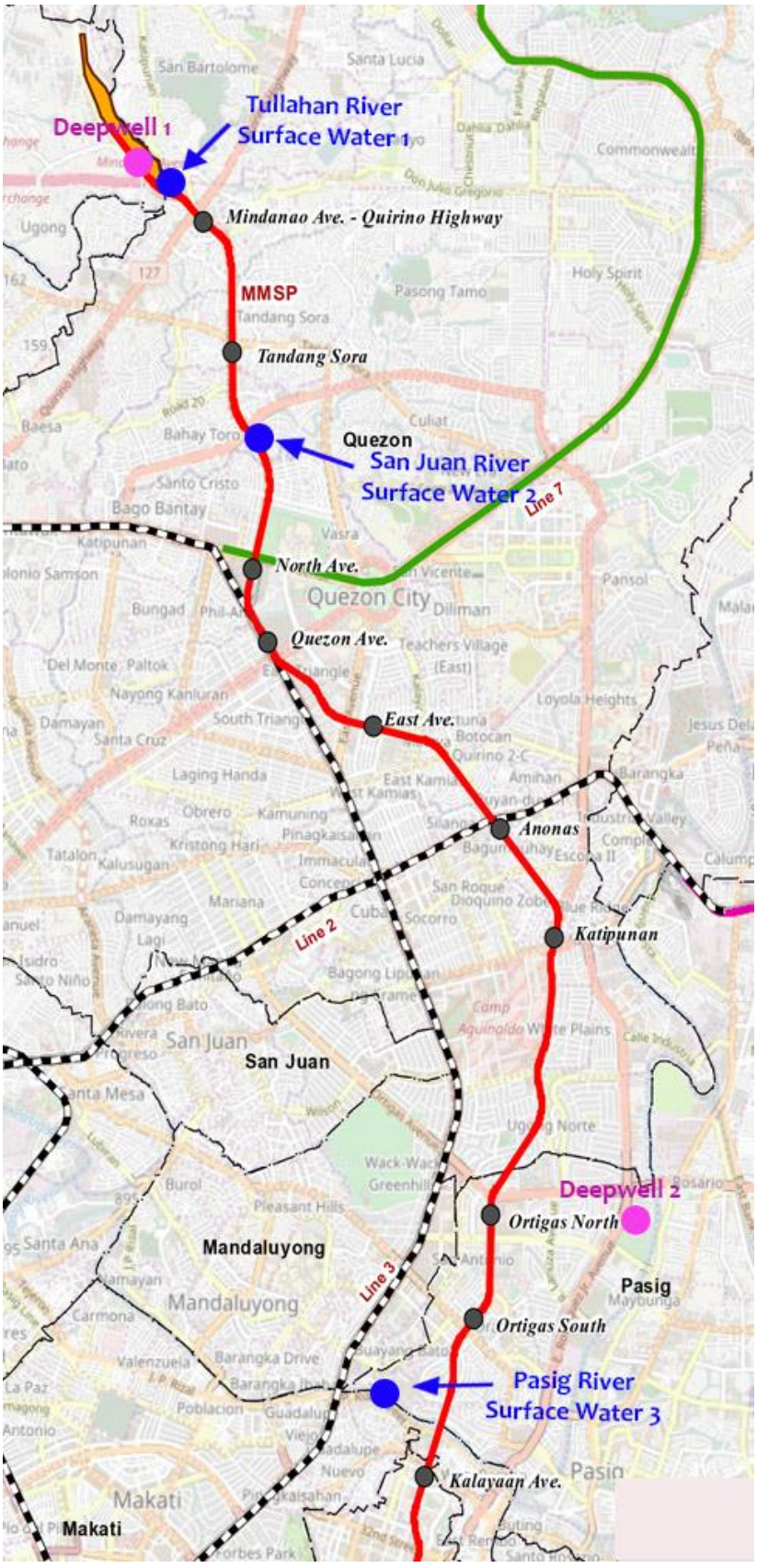


Figure 39.Sampling Locations for Surface Water and Deep Well Survey

Table 21. Summary of Test Results for Surface Water Samples

Parameters	Tullahan River	San Juan River	Pasig River	DENR (Class C) Standards
Metals				
Arsenic (mg/L)	<0.01	<0.01	<0.01	0.02
Cadmium (mg/L)	<0.003	<0.003	<0.003	0.005
Lead (mg/L)	<0.05	<0.05	<0.05	0.05
Mercury (mg/L)	<0.0002	<0.0002	<0.0002	0.002
Dissolved Copper (mg/L)	<0.01	<0.01	<0.01	0.02
Microbiology				
Fecal Coliform (MPN/100ml)	**5,400,000**	**24,000,000**	**54,000**	200
Wet Chemistry				
pH (on-site)	6.8	7.3	7.1	6.5 - 9.0
Temperature (on-site) ^{o}C	27.5	28.9	29	25 - 31
Color (TCU)	40	60	15	75
Biological Oxygen Demand (BOD), (mg/L)	**63**	**50**	4	7
Surfactants (MBAS as LAS, MW=348.48 g/mole) (mg/L)	**2.9**	**5.3**	0.3	1.5
Total Suspend Solids (mg/L)	78	66	**86**	80
Oil & Grease (mg/L)	**3.6**	**3.9**	**3.7**	2
Chloride (mg/L)	44	37	141	350
Hexavalent Chromium (mg/L)	<0.003	<0.003	<0.003	0.01
Free Cyanide (mg/L)	<0.02	<0.02	<0.02	0.1
Dissolved Oxygen (on-site, mg/L)	**<2.0**	**<2.0**	5.1	5 (min)
Nitrate - N	0.3	0.2	1.2	7
Phosphate - P	**0.7**	**1.9**	0.1	0.5
Organic Phenols (mg/L)				
2,3,4,5-Tetrachlorophenol	ND	ND	ND	0.05
2,3,4,6-Tetrachlorophenol	ND	ND	ND	0.05
2,3,4-Trichlorophenol	ND	ND	ND	0.05
2,3,5,6-Tetrachlorophenol	ND	ND	ND	0.05
2,3,5-Trichlorophenol	ND	ND	ND	0.05
2,3,6-Trichlorophenol	ND	ND	ND	0.05
2,4,5-Trichlorophenol	ND	ND	ND	0.05
2,4,6-Trichlorophenol	ND	ND	ND	0.05
2,4-Dichlorophenol	ND	ND	ND	0.05
2,4-Dimethylphenol	ND	ND	ND	0.05
2,4-Dinitrophenol	**0.06**	0.03	0.05	0.05
2,6-Dichlorophenol	ND	ND	ND	0.05
2-Chlorophenol	ND	ND	ND	0.05

Parameters	Tullahan River	San Juan River	Pasig River	DENR (Class C) Standards
2-Methyl-4,6-Dichlorophenol	ND	ND	ND	0.05
2-Methylphenol	ND	ND	ND	0.05
2-Nitrophenol	ND	ND	ND	0.05
3,4,5-Trichlorophenol	ND	ND	0.009	0.05
4-Chloro-3-Methylphenol	ND	0.01	0.004	0.05
4-Methylphenol & 3-Methylphenol	ND	ND	ND	0.05
4-Nitrophenol	0.003	0.05	**0.08**	0.05
Dinoseb	ND	ND	ND	0.05
Pentachlorophenol	0.008	0.007	ND	0.05
Phenol	ND	ND	ND	0.05

Notes:
ND - not detected (below detection limits)
Fonts in red did not meet the DENR standards

Tullahan River

The Tullahan River is located to the north of Metro Manila and has an approximate length of 15 kilometers. It starts at the La Mesa Reservoir in Quezon City and flows through Malabon and Valenzuela and empties into the Manila Bay. Tullahan River is hailed as the dirtiest river in Metro Manila since many industrial wastes have been dumped into the river, including solid wastes.

Water sample was collected across the Tullahan River at the bridge beside Toyota Motors Balintawak, as shown in Figure 40.At the time of sampling, the river's color is blackish and has a rotten odor.

Analysis of the sample shows that Tullahan River has a high level of fecal coliform (5.4 million MNP/100 ml), which exceeded the DENR standard limit of 200 MNP/100 ml. Pollution levels in BOD (63 mg/L), surfactants (MBAs) (2.9 mg/L), oil and grease (3.6 mg/L), phosphates (0.7 mg/L) and 2,4dinitrophenol (0.06 mg/L) have also exceeded the DENR standards. Furthermore, dissolved oxygen at <2 mg/L, is less than the minimum DENR standard of 5 mg/L.

Figure 40. Sampling point at Tullahan River

San Juan River

The San Juan River is one of the main river systems in Metro Manila and is a major tributary of the Pasig River. Like the Tullahan River, it begins near the La Mesa Dam as the San Francisco del Monte River, which officially takes the name of San Juan River when it meets with Mariablo Creek in Quezon City. San Juan River passes through Quezon City, San Juan, the Manila district of Sta. Mesa and Mandaluyong.

Figure 41 shows the sampling point in San Juan River. Sample was taken from a bridge near the intersection of Mindanao Avenue and Congressional Avenue, where commercial establishments and residential areas are nearby.

Figure 41. Sampling Point at San Juan River near Congressional Avenue – Mindanao Avenue

Among the three rivers sampled (Tullahan, San Juan and Pasig), San Juan River has the highest concentration of fecal coliform with 24 million MPN/100ml count. The river also failed to meet the DENR standards for BOD (50 mg/L), DO (<2 mg/L), surfactants (MBAs) (5.3 mg/L), oil and grease (3.9 mg/L) and phosphates (1.9 mg/L).

Pasig River

The Pasig River is an important river system since it connects two large water bodies in Metro Manila: Laguna de Bay, the largest fresh water lake in the country, and Manila Bay, the country's main port of maritime trade and travel. The flow of the Pasig River through the urban areas comes from its upstream portion located in Laguna de Bay, then moves through the Napindan Channel and joins the Marikina River at the boundary of Pasig and Taguig. It links further with San Juan River and finally flows out into Manila Bay. It is approximately 27 km long, with an average width of 91 m, and depths ranging from 0.5-5.5 m. A stretch of the Pasig River has an average depth of 1.3 m. The deepest portions (4.5 m) are located between Guadalupe Bridge and C6 Bridge, while the shallowest portion is at the mouth of Manila Bay.

Before the mass urbanization of Manila, the Pasig River served as an important means of transport. With the influx of population brought about by industrialization and urbanization of Metro Manila, Pasig River became a sewage and industrial effluents depot. Domestic waste accounts for about 60% of the total pollution in the Pasig River, with the rest originating from industrial wastes (33%), such as tanneries, textile mills, food processing plants, distilleries, chemical and metal plants, as well as from solid waste (7%) dumped into the rivers. This has resulted to high organic loads and contamination of the river with heavy metals, pesticides, nitrates, and phosphates.

Due to the continuous dumping of wastes into the river, the river bed has become more and more silted with organic matter and non-biodegradable garbage. This has resulted in serious flooding along the river, affecting nearby communities and carrying polluted water to the households close to the river. Associated with water pollution is the presence of shanties along the river without sufficient sewage facilities and garbage disposal systems.

Collection of water sample, shown in Figure 42, was done in Pasig River at the Guadalupe Ferry Station in Makati City last March 1, 2017. Weather condition during the time of collection was sunny. Color of the river during the water was light brown.

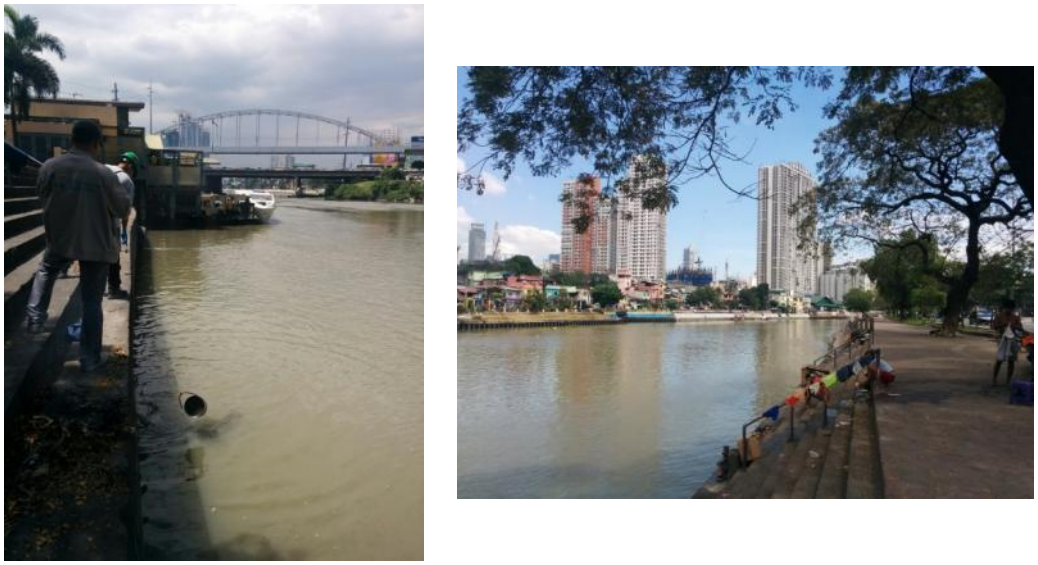


Figure 42. Sampling Point in Pasig River at the Guadalupe Ferry Station in Makati City

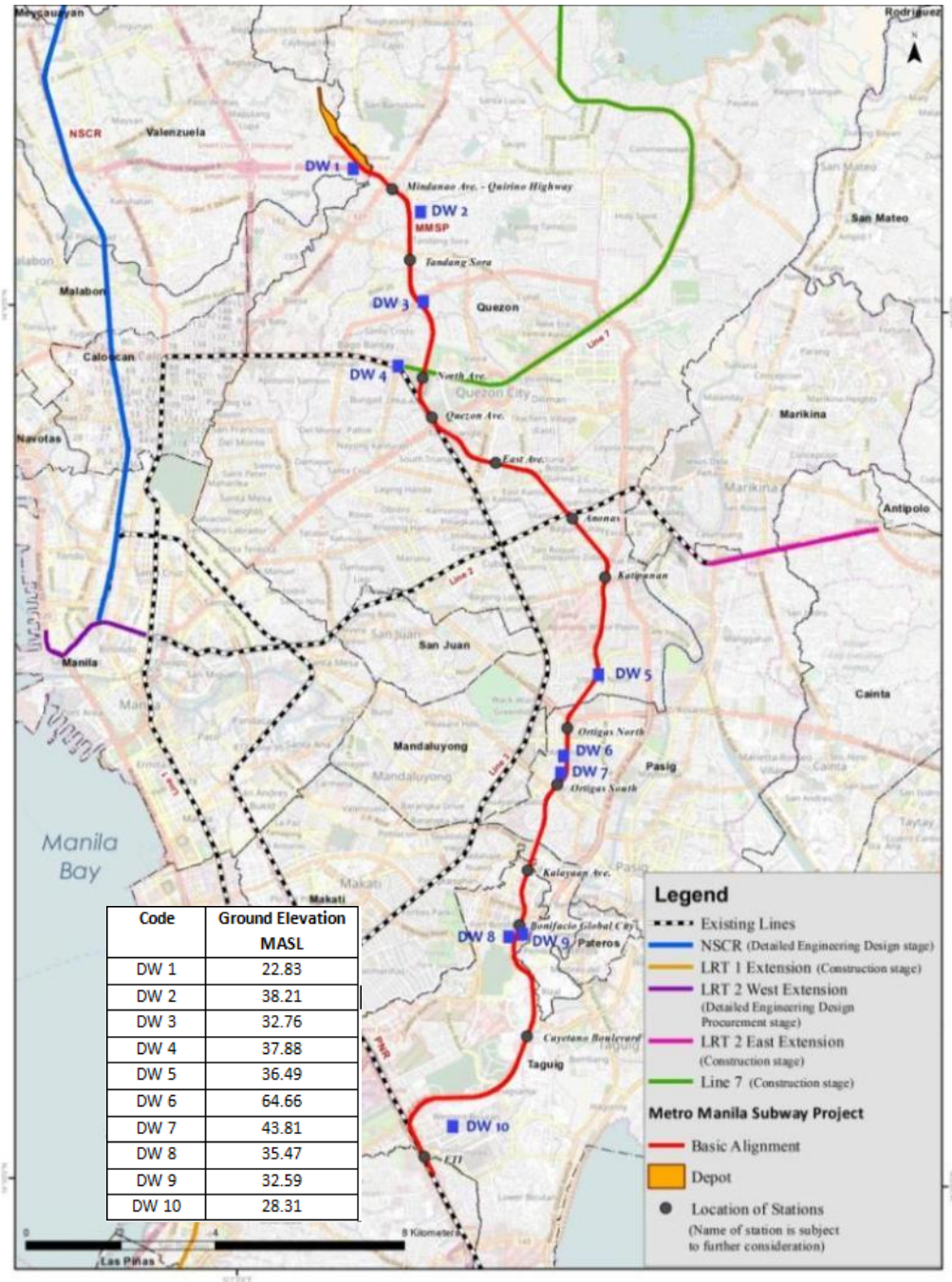
Results of analysis of the water samples showed that BOD is within the DENR standard at 4 mg/L, while results for fecal coliform (54,000 MPN/100 ml), TSS (86 mg/L), oil and grease (3.7 mg/L) and 4-nitrophenol (0.08 mg/L) failed to meet the water quality standards for Class C water.

2.2.1.3. Groundwater

Based on an inventory of groundwater resources in Metro Manila in 2004 under the "Water Resources Assessment for Prioritized Critical Areas (Phase I)" of the National Water Resources Board (NWRB), the groundwater flow pattern in Metro Manila was significantly altered due to excessive withdrawal of groundwater in the aquifer, creating cones of depression within groundwater abstraction areas. Depressions were prominently seen within areas in Parañaque, Pasig and Valenzuela.

At the time of the study, the groundwater abstraction of Metropolitan Waterworks and Sewerage Systems (MWSS) wells accounts 3% of the total water consumption supplied by MWSS for Metro Manila. Groundwater withdrawal legally registered with the NWRB totals 12,823.53 liters/second. The amount of groundwater abstracted by illegal wells plus the amount drawn by permitees exceeding their granted amount is believed to be more than 60% of the total groundwater extraction of registered wells.

This situation has led NWRB to issue Resolution No. 001-0904 in September 22, 2004, which revokes and suspends all water permits or reduces the authorized volume of extraction of existing deep wells in areas adequately served by MWSS. In this provision, groundwater extraction may be allowed only for use in vital services as hospitals or firefighting, only as back-up to commercial supply. By 2009, all remaining deep wells have been decommissioned, padlocked and sealed by the NWRB.



Code	Ground Elevation MASL
DW 1	22.83
DW 2	38.21
DW 3	32.76
DW 4	37.88
DW 5	36.49
DW 6	64.66
DW 7	43.81
DW 8	35.47
DW 9	32.59
DW 10	28.31

Figure 43. Deep wells (DW) along the MMSP Alignment

From the database of registered deep wells with the NWRB, the average depth of identified deep wells located near the MMSP alignment ranges from 90 m to 300m below the ground, as presented in Figure 43.Since the MMSP alignment is mostly in the business districts of Metro Manila where adequate supply of water from either Manila Water Company, Inc. (MWCI) or Maynilad Water is available, unauthorized groundwater extraction is not allowed in these areas.

According to the results of drilling surveys conducted by Soil Philippines Indes Testing, Inc., most of the geological layers to be penetrated by the subway tunnel are solid rock with low moisture rate. Fracture zone where groundwater can potentially flow were not present. A more detailed

geotechnical investigation will be conducted during the DED stage to determine the groundwater level along the MMSP alignment.

For sampling purposes, groundwater samples were sourced from public deepwells near the vicinity of the MMSP alignment, as summarized in Table 22. Sampling locations are plotted in Figure 39. Since NWRB has prohibited the extraction of groundwater, these deep wells are rarely used by the community and served only as back up source of water. Appendix H and I present the Certificates of Analysis and photos during the actual deepwell sampling, respectively.

Table 22. Summary of Ground Water Sampling Conditions

Sampling Stations	Coordinates	Date of Sampling	Time of Sampling	Weather Conditions
Barangay Ugong, Valenzuela City	14° 41' 42"N, 121° 1'15.42" E	May 22, 2017	11:35 am	Sunny
Barangay Ugong, Pasig City	14° 34'49"N, 121° 4'45"E		1:00 pm	Cloudy

Results of analysis shows that deepwell in Valenzuela City has high Total Coliform (9.2 MPN/100 ml), which exceeds the PNS for Drinking Water. This may be attributed to the proximity of the deep well pump to the house septic tank. All other parameters for groundwater quality in both sampling points are within the standards.

Results of analysis shows that deepwell in Valenzuela City has high Total Coliform (9.2 MPN/100 ml), which exceeds the PNS for Drinking Water. This may be attributed to the proximity of the deepwell pump to the house septic tank. All other parameters for groundwater quality in both sampling points are within the standards.

Table 23 shows the summary of results of the analysis of the groundwater samples.

Table 23.Summary of Test Results for Groundwater Samples

Parameters	Pasig Deepwell	Valenzuela Deepwell	PNS Standard*
Metals			
Arsenic, mg/L	<0.01	<0.01	0.01
Cadmium, mg/L	<0.003	<0.003	0.003
Calcium, mg/L	59	16	-
Lead, mg/L	0.004	<0.003	0.01
Magnesium, mg/L	21	2.1	-
Potassium, mg/L	6.2	7.2	-
Sodium, mg/L	37	44	200
Microbiology			
Total Coliform, MPN/100 ml	<1.1	**9.2**	<1.1

Parameters	Pasig Deepwell	Valenzuela Deepwell	PNS Standard*
Fecal Coliform, MPN/100 ml	<1.1	<1.1	<1.1
Wet Chemistry			
pH, onsite	6.5	8.2	6.5 – 8.5
Temperature, ^{o}C, on-site	28.7	28.4	-
Color, Apparent CU	5	8	10
Conductivity @ 25.0^{o}C, µS/cm	676	417	-
Nitrate, mg/L	0.5	0.7	50
Bicarbonate as $CaC0^{3}$ @ pH = 4.4, mg/L	251	168	-
Chloride, mg/L	55	14	250
Sulfate, mg/L	43	17	250
Hexavalent Chromium, mg/L	<0.003	<0.003	-
Cyanide, Total, mg/L	-	<0.002	0.07

* Philippine National Standards for Drinking Water 2007

2.2.2. Impact Identification, Assessment and Mitigation

This section presents an assessment of potential environmental impacts of the subway project at different phases of the project on the water environment. How these potential impacts will be mitigated in order to reduce, if not eliminate, the adverse effects is also discussed.

2.2.2.1. Pre-Construction Phase and Construction Phase

Water pollution

There may be short-term adverse impact on water quality due to clearing and excavation activities involving open cut and shield methods. There may be slight increase in sediments and turbidity of rivers, creeks and other water courses along the proposed alignment. This is a result of erosion of excavated soils and other unconsolidated materials particularly during rainy periods. Piling work for installation of bridge piers will disturb bottom sediments.

The following mitigating measures to prevent surface water and groundwater pollution are recommended:

- To limit the surface water deterioration due to rainfall runoffs, the activity should be done, as much as possible, during the summer or dry season.

- Protect demolition and excavated materials from the rain by roofing it with downspout and redirecting and capturing the rainwater to a catchment basin or directly to the nearest drainage system
- The contractor shall consider proper waste water treatment plans prior to construction works.
- Debris/soil and other excavated materials shall be hauled out from the site immediately and disposed by accredited waste handlers.
- Turbid water caused by excavation works shall be treated in treatment facilities before discharge.
- The supervision consultant and contractor should monitor and control waste water in construction sites. If the results exceed the allowable limits, the supervision consultant and contractor should reconsider the construction technique and water treatment method.

Clearing of trees and converting into construction yards the areas previously occupied by trees and vegetation will result in increased stormwater runoff from paved surfaces. Runoff will cause erosion, siltation in surface water bodies and therefore water pollution.

As a mitigating measure, the use of permeable pavements is recommended after construction works while converting construction yards into walkways or bike lanes or open spaces. Permeable pavements can be made of pervious concrete, plastic grids, porous asphalts, or permeable interlocking concrete pavements under grass. The use of solidified/ encapsulated waste materials as brick pavements is also encouraged.

Permeable paving not only reduces soil erosion and water pollution but also allows stormwater to percolate, infiltrate the surface areas and reach the underlying soil, consequently retaining the absorptive capacity of the soil. Instead of placing traditionally impervious materials, permeable pavements can reduce downstream flooding, and allow water seepage to recharge groundwater.

Flooding and Inundation

The proposed MMSP route generally passes through areas with low flood hazards, except for the proposed Anonas and Quezon Avenue stations. Pre-construction and construction activities may temporarily cause flooding problems if not implemented properly. Improper handling, storage, and hauling of demolition debris/excavated materials, particularly along station locations may clog existing drainage systems and block creeks, canals and other waterways.

The proponent shall execute a Contractor's Program indicating the contractor's commitment to proper disposal of demolition debris and construction spoils. These materials shall not be put anywhere near watercourses and areas where it could be carried away into low-lying areas of the project or into the drainage system. Upon the completion of the project, the contractor will take care of the disposal of all debris and waste materials into an appropriate designated area. The contractor shall initiate erosion control measures before major earthmoving works begin.

Ground subsidence

During excavation works in the construction phase, lowering of groundwater level due to falling of shield top and inflow of groundwater into underground tunnel may bring about ground subsidence and caving of surface ground.

Adoption of the shield tunneling method will reduce possibility of groundwater inflow into the tunnel structures. Still, a more detailed geological survey shall be conducted during the detailed design stage. The detailed design consultant shall consider proper construction plans on the basis of the survey results.

If water leakage is identified in the tunnel during construction works, the contractor and supervision consultant shall implement the proper countermeasures. The supervision consultant shall also monitor change of the surrounding ground. If abnormal changes are identified, the contractor and supervision consultant shall implement the proper countermeasures immediately.

2.2.2.2. Operation Phase

Water Pollution

Subway commuters, depot and station personnel will generate domestic wastes during the operational phase. To prevent water pollution, wastewater treatment facility will be installed. Collection and regular disposal of domestic wastes will be done. Administrators of station and other facilities shall maintain water treatment systems in proper conditions.

During operation of the depot, increased water pollution of Tullahan River from the discharge of fuels, lubricants, detergents and other oil-contaminated materials from maintenance operations, is likely if these chemicals are not handled properly.

The proposed depot in Valenzuela should therefore be equipped with an interceptor tank to remove oil and fuel grease from surface water before discharge. Controlled perimeter drainage system should be installed to ensure catchment of all maintenance runoffs. A wastewater treatment facility with oil removal will be constructed at the Depot.

Other measures to prevent discharge of hazardous substances in receiving water bodies during maintenance and repair activities are as follows:

- Equipment and machinery shall be regularly checked for fuel and oil leaks.
- During repair of equipment and machinery, containers/drip trays shall be used to collect leakage.
- Any spilled or spent oil will be collected, stored properly and disposed by accredited waste haulers.

Flooding and inundation

Although there is low risk of inundation by flooding in most sections of the MMSP alignment, proper measures against inundation to railway facilities shall be taken in the design for station entrances and any opening connected to railway facilities, e.g. ventilation shafts, at all underground stations.

In order to protect the station from flooding, water-shut panels at station entrances will be installed. The use of a tempered glass and waterproof iron doors can be recommended. Drainage pumping station needs to be installed to pump up inflow water from outside ground level (rain water, etc.) and water from inside the tunnel and send them to the sewer.

Ground subsidence

As already mentioned, most of the geological layers to be penetrated by the subway tunnel are solid rock with low moisture rate. Likewise, no fracture zones where the groundwater can flow were identified. The subway operation and existence of the tunnel are unlikely to have impact on groundwater and the ground. As a result, ground subsidence due to lowering of the groundwater level is unlikely to occur.

Though ground subsidence is predicted as unlikely to occur, installation of monitoring wells for observation along the subway tunnel is recommended since this is the first subway project in the country. Change of the surrounding groundwater levels should be monitored. If abnormal changes are identified, the administrator shall investigate the causes and implement the proper countermeasures immediately.

A summary of the potential impacts, assessment of impacts and mitigating measures to address the identified impacts is provided in Table 24.

Table 24. Impact Identification, Assessment and Mitigating Measures for Water

Environmental Aspect	Potential Impacts	Assessment of Impacts	Mitigating/Enhancement Measures
PRE-CONSTRUCTION AND CONSTRUCTION PHASES			
Clearing and excavation activities	Increase in suspended sediments in the receiving water	Moderate adverse	• Conduct demolition and excavation activities during the summer, as much as possible. • Protect demolition and excavated materials from the rain by roofing it and redirecting rainwater to a catchment basin or the nearest drainage system • Proper waste water treatment plans by the contractor prior to construction works. • Debris/soil and other excavated materials shall be hauled out from the site immediately and disposed by accredited waste handlers. • Treatment of turbid water caused by excavation works before discharge • Monitor and control waste water in construction sites.
Clearing of trees and conversion into construction yards	Erosion and siltation in surface water bodies	Moderate adverse	Use permeable pavements after construction works while converting construction yards into walkways or bike lanes or open spaces.
Clearing and excavation activities	Flooding and inundation due to clogged waterways	Moderate adverse	• Proper disposal of demolition debris and construction spoils by the contractor • Implementation of erosion control measures before major earthmoving works begin

Environmental Aspect	Potential Impacts	Assessment of Impacts	Mitigating/Enhancement Measures
OPERATIONAL PHASE			
Domestic wastewater generation	Pollution of receiving water bodies	Moderate adverse	• Installation of wastewater treatment facility • Administrators of station and other facilities shall maintain water treatment systems in proper conditions
Maintenance and repair activities in the depot	Pollution of receiving water body, specifically Tullahan River	Moderate adverse	• Installation of interceptor tank to remove oil and fuel grease from surface water before discharge. • Installation of controlled perimeter drainage system to ensure catchment of all maintenance runoffs. • Operation of a wastewater treatment facility with oil removal. • Equipment and machinery shall be regularly checked for fuel and oil leaks. • During repair of equipment and machinery, containers/drip trays shall be used to collect leakage. • Any spilled or spent oil will be collected, stored properly and disposed by accredited waste haulers.
Heavy rainfall	Flooding and inundation of subway facilities	Moderate adverse	• Installation of water-shut panels at station entrances • Installation of drainage pumping station to pump up inflow water from outside ground level (rain water, etc.) and water from inside the tunnel and send them to the sewer.

Environmental Aspect	Potential Impacts	Assessment of Impacts	Mitigating/Enhancement Measures
Changes in groundwater flow	Ground subsidence due to lowering of groundwater level	Low adverse	• Installation of monitoring wells for observation along the subway tunnel and monitor change of the surrounding groundwater levels. • If abnormal changes are identified, the administrator shall investigate the causes and implement the proper countermeasures immediately.

2.3. THE AIR

2.3.1. Baseline Environmental Conditions

2.3.1.1. Meteorology

Metro Manila has a Type I climate under the Coronas Classification of Climate in the Philippines based on Philippine Atmospheric Geophysical Astronomical Services Administration (PAGASA), as shown in Figure 44. Type I climate is characterized by two pronounced seasons namely the dry season from November to April and wet season for the rest of the year. The period of maximum rain occurs during the peak of the southwest monsoon from July to September.

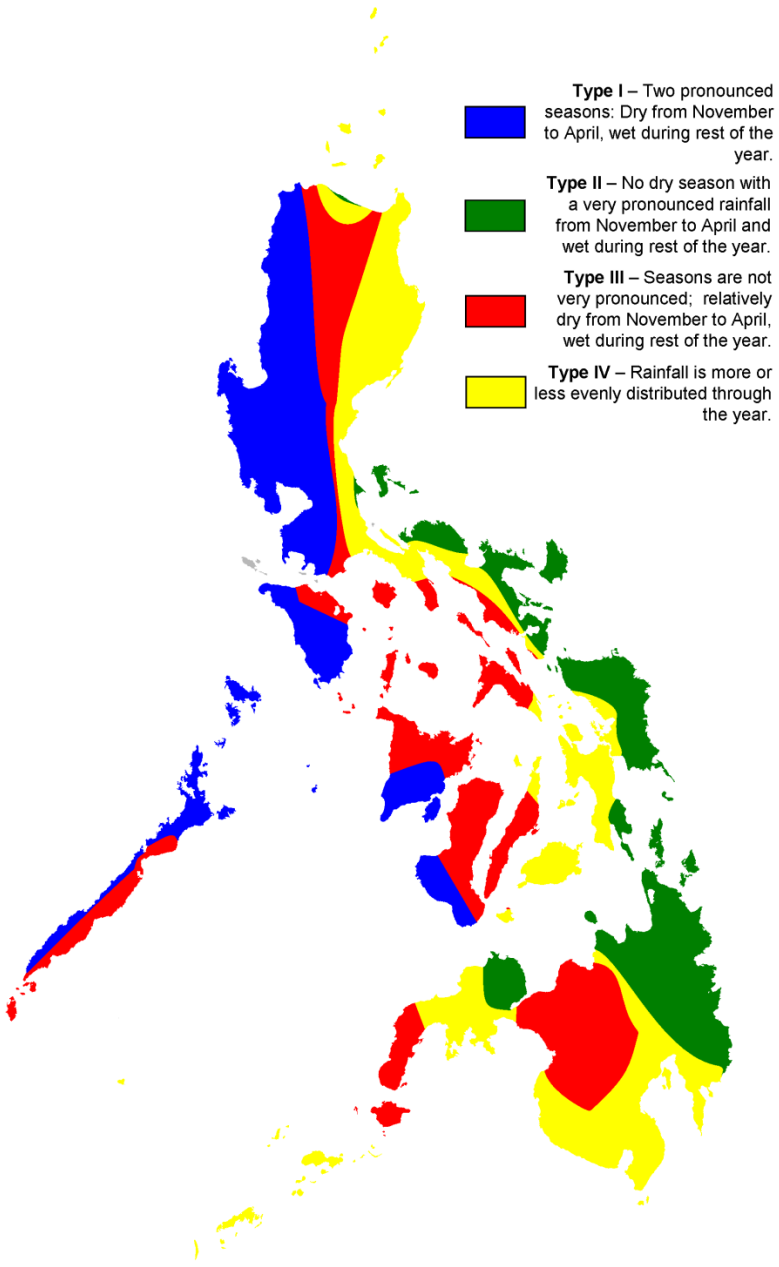


Figure 44. Coronas Classification of Climate in the Philippines

Climate Change

Climate Change Policies in the Philippines

The Government of the Philippines has enacted the Climate Change Act (Republic Act 9729) in response to the future projection of climate change. It provides the policy framework to systematically address the growing threats on community life and its impact on the environment. It establishes the Climate Change Commission (CCC) which is the lead policy making government body. The National Framework Strategy on Climate Change (NFSCC) and the Philippine Strategy on Climate Change Adaptation (both in 2010) and the National Climate Change Action Plan (2011-2028) were formulated as the bases of policies on climate change.

One of the priorities of the NFSCC is the reduction of greenhouse gas (GHG) emissions in the transport sector. Strategies include environmentally sustainable transportation, promotion of models to improve the transport sector's efficiency (e.g. e-jeep), model shift to cleaner fuel such as compressed natural gas and liquefied petroleum gas (LPG) and support to more efficient mass transport systems such as the metro rail transit, light rail transit, and rapid bus transit.

Climate Change Vulnerability

The Philippines is located in the southeastern portion of the Asiatic continent and is considered one of the countries of the world most prone to extreme climatic events. In the report by the United Nations University's Institute for Environment and Human Security and the German Alliance Development Works, the Philippines ranked third in the list of countries most vulnerable to climate change. The risk index used includes exposure to natural disasters like storms, floods, earthquakes, droughts and sea level rise where typhoons are more prominent.

According to PAGASA, the country is visited by an average of 19 to 20 Tropical Cyclones (TC) per year, about nine of which make landfalls in the Philippines annually. The frequency peaks during the month of July, with an average of 3.3 and less during the months of February and March, with an average of 0.3 for the period of 1948-2013 (Cinco et al., 2016). The recorded annual occurrences of tropical cyclones from 1948-2015 is presented in Figure 45. The frequency does not show a clear trend but shows inter annual variability. Typhoon season peaks from July through October, when nearly 70% of all typhoons develop (Cinco et al. 2006).

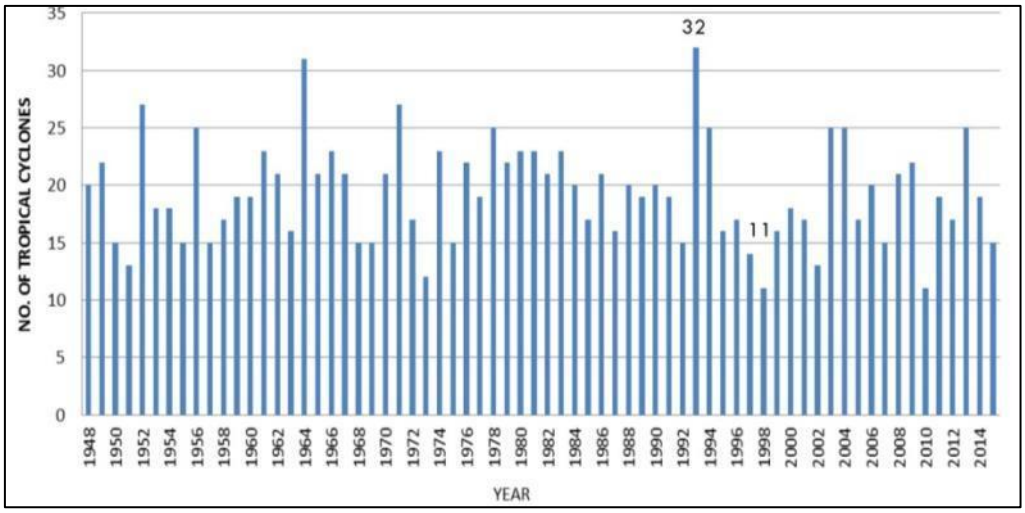


Figure 45. Annual Tropical Cyclone Occurrences (1948-2015)

Wu and Zhao (2012) indicated a slight increase in the number of intense TC with maximum sustained winds greater than 150 kilometer per hour (kph) after 1987 using Joint Typhoon Warning Center (JTWC) data. In addition, data showed that the Philippine Area of Responsibility (PAR) received an average of 5.8 extreme TCs per year. Table 25 presents a list some of the recent tropical cyclones (from 2015-2016) with maximum sustained winds above 150 kph.

Table 25. Some of the Extreme Typhoons in 2015 and 2016

Local Name of Tropical Cyclone	Period	Maximum Sustained Winds (kph)*
Butchoy (Nepartak)	July 2016	205 km/hr
Dindo (Lionrock)	August 2016	165 km/hr
Ferdie (Meranti)	September 2016	220 km/hr
Gener (Malakas)	September 2016	175 km/hr
Igme (Chaba)	October 2016	215 km/hr
Karen (Sarika)	October 2016	175 km/hr
Lawin (Haima)	October 2016	215 km/hr
Nina (Nockten)	December 2016	195 km/hr
Chedeng (Maysak)	April 2015	195 km/hr
Dodong (Noul)	May 2015	205 km/hr
Falcon (Chan-hom)	July 2015	165 km/hr
Goring (Halola)	July 2015	150 km/hr
Hanna (Soudelor)	August 2015	215 km/hr
Ineng (Goni)	August 2015	185 km/hr
Jenny (Dujuan)	September 2015	205 km/hr
Lando (Koppu)	October 2015	185 km/hr
Marilyn (In-fa)	November 2015	175 km/hr
Nona (Melor)	December 2015	175 km/hr

* 10 minute sustained wind. International Name () Source: Wikipedia

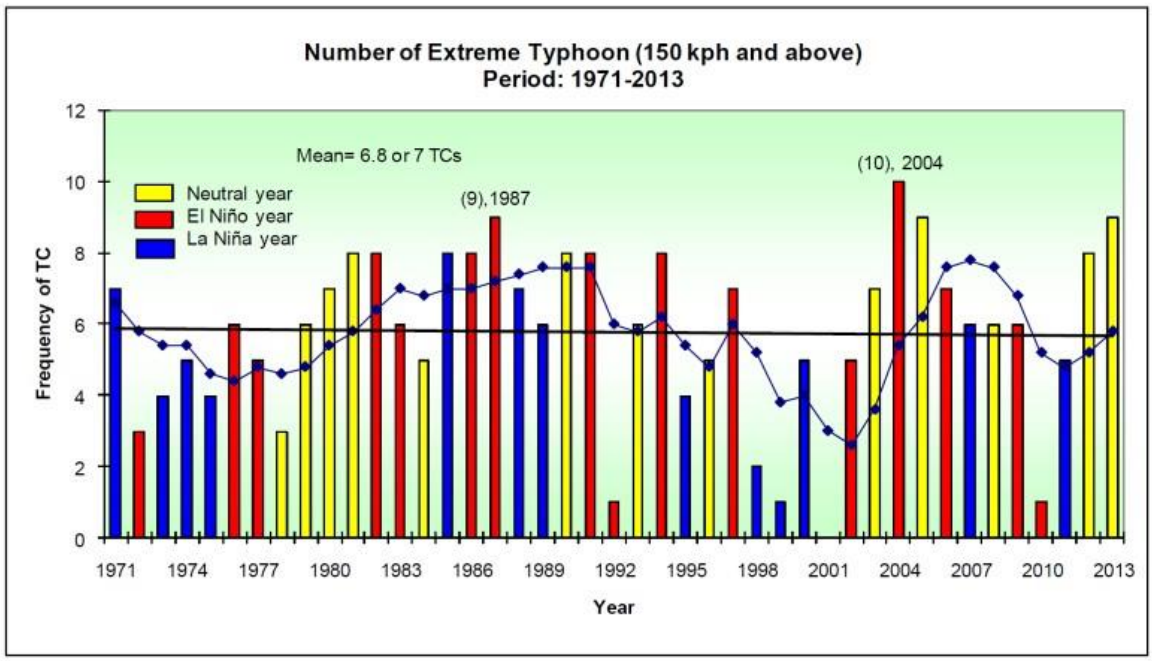


Figure 46. Number of Extreme Typhoons

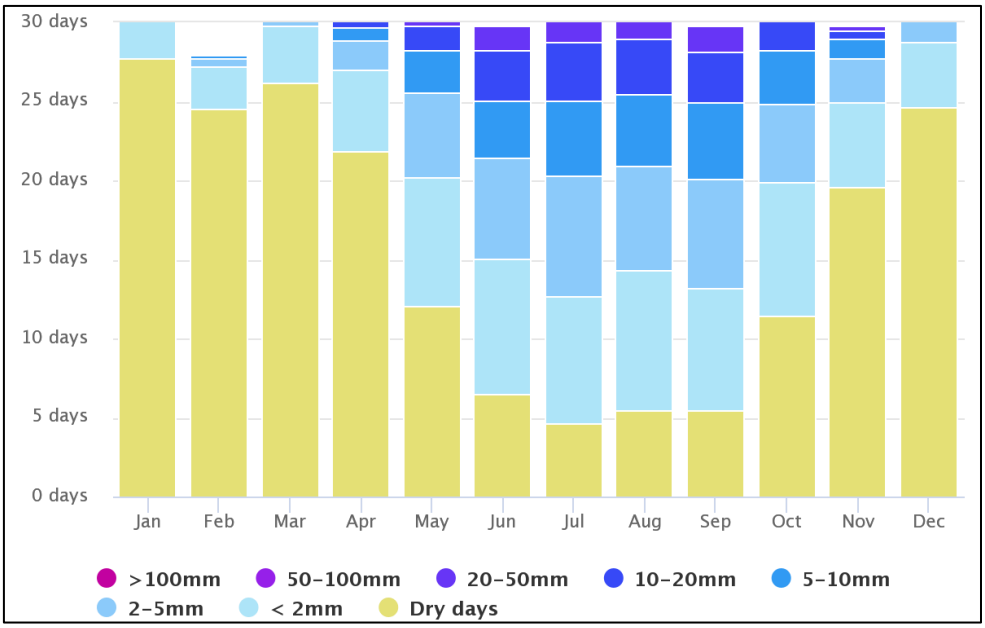
Figure 46 shows the trend on the number of extreme typhoons having a maximum sustained winds of 150 kph and above that entered PAR. From the figure, TC were more active for years 1986, 1997 and 2004 which coincides with the El Niño Southern Oscillation (ENSO) activity as shown by the red lines. Lyon and Camargo (2009) showed that TC activity is enhanced during ENSO events and was attributed to the increase of mid-level atmospheric moisture (as relative humidity), which also affected seasonal precipitation.

As stated in the study conducted by PAGASA, the analysis of the 30-year running means of tropical cyclone passage over the three main islands (Luzon, Visayas and Mindanao) show that there has been a slight increase in their passage in the Visayas during the period from 1971 to 2000 as compared with the 1951 to 1980 and the 1960-2990 periods.

Rainfall

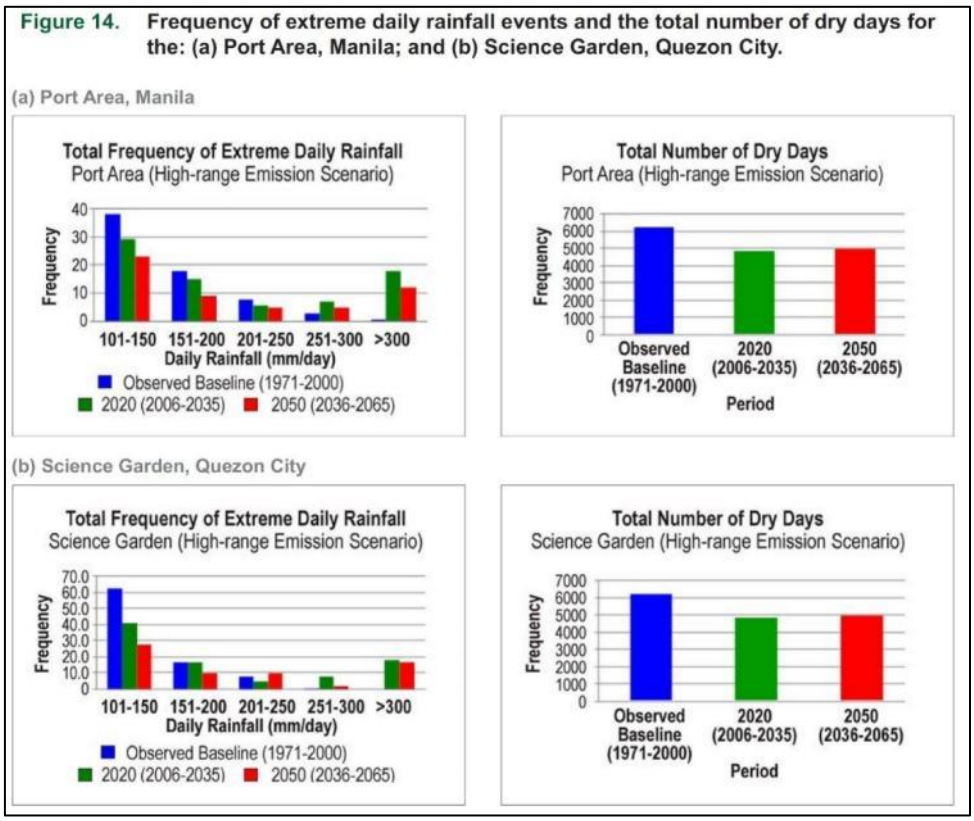
The recorded annual rainfall of the monitoring stations of PAGASA in NAIA (MIA) Pasay City, Port Area Manila and Science Garden Quezon City were 1,767.8 millimeter (mm), 2,103.6 mm and 2,574.4 mm respectively with a total of 101, 139 and 153 rainy days respectively during the period of 1981-2010. The monthly rainfall level for Manila is shown in Figure 47.

The onset of rainy season starts around mid-May. The projected frequency of extreme rainfall events for PAGASA stations in Port Area, Manila and Science Garden in Quezon City is shown in Figure 48. Based on the figure there is an increase in frequency of extreme rainfall on the range of 251 mm/day to greater than 300 mm/day as compared with the observed baseline. On the contrary there is a slight decrease in the projected total number of dry days for both PAGASA stations.



Source: https://www.meteoblue.com/en/weather/forecast/modelclimate/manila_philippines_1701668

Figure 47. Monthly Rainfall for Manila



Source: Integrating Climate Change and Disaster Risk Scenarios into Coastal Land and Sea Using Planning in Manila Bay

Figure 48. Projected Frequency of Extreme Daily Rainfall events and the total number of dry days for the: (a) Port Area Manila; and (b) Science Garden Quezon City

Table 26 shows the extreme rainfall events that cause severe flooding in Metro Manila.

Table 26. List of Extreme Rainfall Events that cause Severe Flooding

Event	Period	Highest Measured Accumulated Rainfall
Ondoy ("Ketsana")	Sept. 24-27, 2009	556.1 mm of rain (4-day period)
Habagat 2012 (enhanced by Typhoon Haiku)	August 6-8, 2012	1,007.4 mm of rain (3-day period)
Habagat 2013 (enhanced by Tropical Storm Maring)	August 17-21, 2013	1,120.2 mm of rain (5-day period)

Source: www.rappler.com/newsbreak/39948-by-the-numbers-ondoy-hbagat-2012-2013

Temperature

The recorded average normal annual temperature for PAGASA stations in Port Area Manila, Science Garden in Quezon City and NAIA (MIA) Pasay City are 28.4 °C, 27.74 °C and 27.8 4 °C respectively. Analysis by PAGASA of the trend during the last 60 years (1951-2010) showed that the observed mean temperature has increased by 0.64°C. Maximum temperature has increased by 0.36°C while the observed minimum temperature has increased by 1°C for the same period. Based on the observed trends in mean, maximum and minimum temperatures over the Philippines compared with the 1971-2000 normal values, the frequency of hot days and warm nights are significantly increasing for most parts of the country.

The projected seasonal temperature increase in 2020 and 2050 under the medium-range emission scenario for Metro Manila is shown in Table 27. The introduction of more efficient technologies, such as the subway system, can contribute to the reduction in the mean temperature increase.

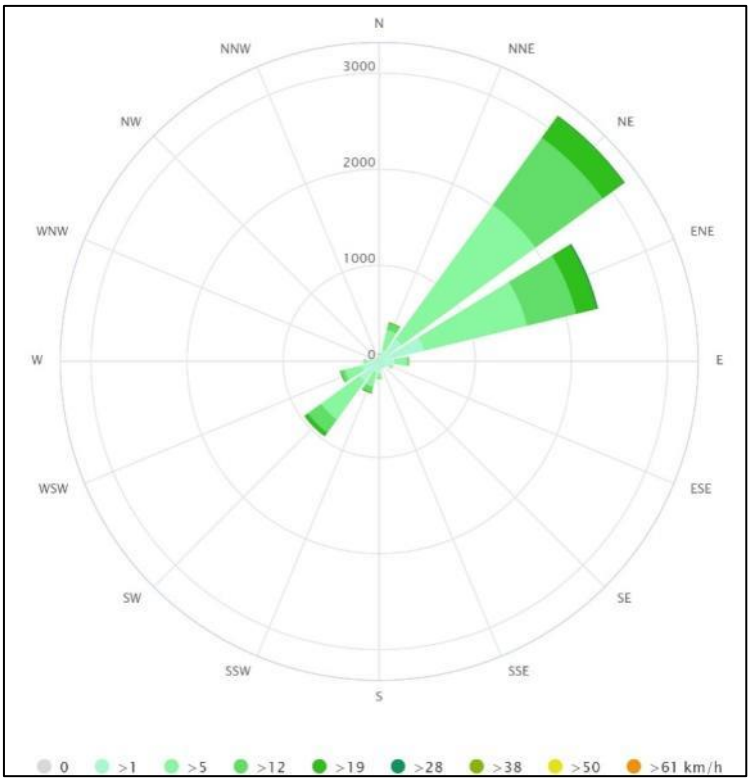
Table 27. Seasonal Temperature increases (in °C) in 2020 and 2050 under medium-range emission scenario in Metro Manila

Region	Observed Baseline (1971-2000)				Change in 2020 (2006-2035)				Change in 2050 (2036-2065)			
	DJF	MAM	JJA	SON	DJF	MAM	JJA	SON	DJF	MAM	JJA	SON
Metro Manila	**26.1**	**28.8**	**28..0**	**27.4**	**1.0**	**1.1**	**0.9**	**1.0**	**2.0**	**2.1**	**1.8**	**1.9**

The introduction of the subway project in the Philippines is expected to alleviate GHG emission, with substantial contribution in the reduction of GHG emission from the transport sector.

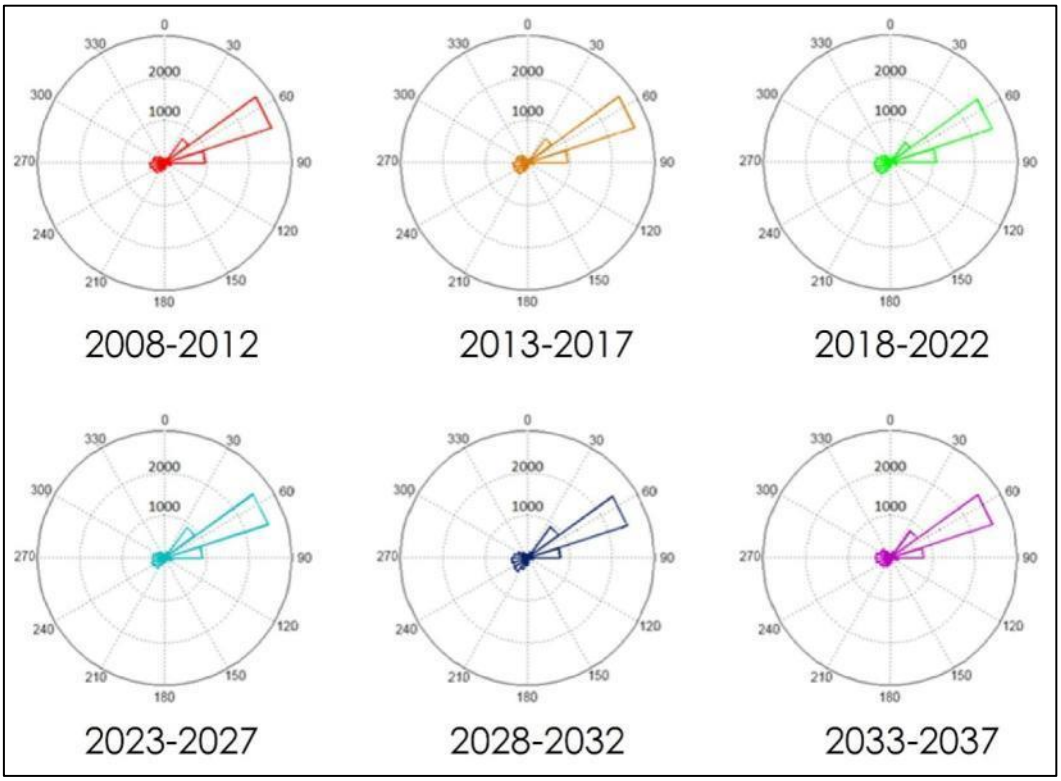
Wind Speed and Direction

The annual wind profile in the area of Metro Manila without typhoon is shown in Figure 49 while the project wind direction and intensity in the nearby location in Pillilia, Rizal is shown in Figure 50. The wind direction is predominantly coming from North East followed by East North East direction. No significant change can be observed for the projected wind direction and intensity compared with the baseline scenario.



Source: https://www.meteoblue.com/en/weather/forecast/modelclimate/manila_philippines_1701668

Figure 49. Windrose for Manila



Source: Silang et al., 2013

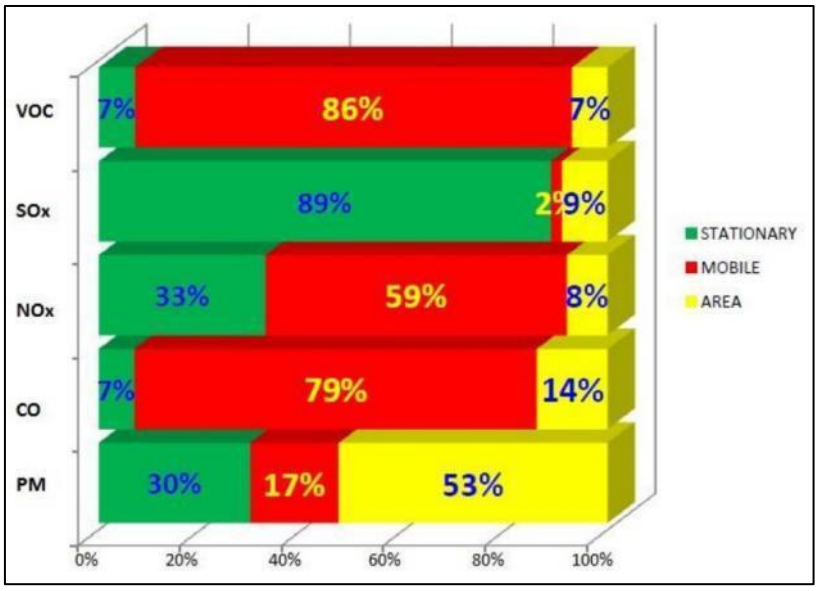
Figure 50. Projected Wind Direction and Intensity

2.3.1.2. Ambient Air Quality

The National Statistics Office (NSO) ranking of top 10 densely populated cities in the Philippines consisted of cities in Metro Manila with shares of 36% of Gross Domestic Product (GDP) based on a JICA study. Concentration of commercial, residential and private establishments in Metro Manila has resulted to slow vehicular traffic, numerous construction activities and congestion of people, which significantly affect the ambient air quality.

In the 2007 report of Land Transportation Office (LTO), NCR has the highest motorization index (the number of vehicle per 1000 people) amounting to 137.3. Furthermore, presence of inefficient vehicles such as jeepneys and two-stroke motorcycle worsen the air quality due to poor maintenance and inherent emission of the two stroke technology respectively. Programs and plans to eliminate old vehicles and two stroke motorcycles/tricycles have been met by resistance from the stakeholders.

The transport sector however only contributes to a significant percentage of ambient air pollutants such as VOC, NOx and CO as shown in Figure 51. Based on the figure, sulfur oxides (SOx) emission are mostly attributed to stationary sources, with the food manufacturer and the chemical and allied products sector contributing significant amounts. Dust sources mostly come from area sources such as unpaved areas, construction activities and burning of waste.



Note: Coverage of emission sources is not 100%
Source: DENR Annual Air Quality Status Report (2010-2011)

Figure 51. National Emission Inventory by Sources and Criteria Pollutants

Ambient air quality was monitored on various sites along the MMSP alignment during dry and wet season, using DENR standard methods of sampling and analysis as specified in the Implementing Rules and Regulation of RA 8749 or the Department Administrative Order (DAO) 2000-81. A total of six (6) sites were surveyed for ambient air quality during the dry season for a 24 hour period from March 27to May 2-3, 2017. On the other hand, a total of 14 sites were

surveyed during the wet season, from July 10 to 27, 2017. Sampling locations are indicated in Figure 52, while photos of the sampling activities are shown in Appendix I. The sampling/monitoring was conducted by a DENR-accredited laboratory at an elevation of at least 2 meters from the ground.

The prevailing wind condition during dry and wet season air sampling is shown in Table 28. Wind direction generally showed a reversal in trend from dry season to wet season. Similarly, the wind speed showed a low speed during wet season compared with dry season except for the sampling station in BGC Market Market Parking Area.

Table 28. Wind Speed and Direction during Air Quality Sampling

Station	Dry Season		Wet Season	
	Prevailing Wind Direction	Average Wind Velocity, m/s	Prevailing Wind Direction	Average Wind Velocity, m/s
Depot (Brgy. Ugong, Valenzuela)	E-W	0-4.2 m/s	NE-SW	0-2.1
Quirino Highway (Pacific Global Medical Center)	-	-	N-S[1]	0-2.7
Tandang Sora (Landcom Village II)	-	-	SE-NW	0-2.9 m/s
North Ave. (Trinoma Mindanao Ave., Open Parking Area)	NE-SW	0-2.28	S-N (mostly calm)	0-2.2
Quezon Ave. (Avida Tower I, EDSA)	-	-	N-S (mostly calm)	0-1.7
East Ave. (AFP Medical Center, V. Luna Ave.)	-	-	SE-NW	0-1.9
Anonas (World Citi Medical Center)	NE-SW	0.1-2.9	SE-NW	0-1.8
Katipunan Ave, (Brgy. Blue Ridge A Multipurpose Hall)	-	-	N-S	0.4-1.3
Ortigas North (MMDA Impounding Ultra 2 Pasig)	NE-SW	0-2.9	N-S (mostly calm)	0-1.9
Ortigas South (Estancia Mall Parking Lot)	-	-	S-N	0-2.5
Kalayaan Ave (11th St.	-	-	N-S	0.4-1.0

Station	Dry Season		Wet Season	
	Prevailing Wind Direction	**Average Wind Velocity, m/s**	**Prevailing Wind Direction**	**Average Wind Velocity, m/s**
corner 38th Avenue				
BGC (Market Market Parking Area)	NE-SW	0-1.8	SW-NE	0.7-3.1
Cayetano Blvd. (BCDA Field Office, Pamayanang Diego Silang)			SW-NE	0-2.4
PNR FTI Station	SE-NW	0.2-2.4	NE-SW	0.4-1.6

Notes: [1] – Direction varies from N-S, NE-SW and S-N

Results of ambient air quality monitoring were compared with the National Ambient Air Quality Standards (NAAQS) of the Philippine Clean Air Act of 1999, as tabulated in Table 29. All parameters for ambient air quality in all monitoring stations sampled during the dry season are within the DENR Guideline Values.

However, some observed air quality parameters exceeds the guideline values in some stations during the wet season sampling, as highlighted in red figures in Table 29. High TSP and PM10 concentration in the Valenzuela and Quirino Highway sampling stations can be attributed to the close proximity of the sampling sites to Mindanao Avenue, which is a major road with lots of traffic. Relatively higher values were observed for the Valenzuela and BGC monitoring station during the wet season compared with the dry season. It should be noted that the sampling station in Valenzuela for the proposed depot during the dry season is within a resort compound located 200 meters from Mindanao Avenue, while for the wet season it was relocated along the Mindanao Avenue due to security reasons.

On the other hand, the increased in observed concentration of PM10 at BGC Market Market parking area sampling site can be attributed to relatively higher wind speed during wet season sampling (0.7 – 3.1 m/s) compared with dry season (0-1.8 m/s). A high wind velocity results to turbulence which scours dust and other particles from the ground resulting to their suspension in air particularly those with smaller sizes/diameter and effectively transport these particles to longer distances. TSP was also slightly exceeded in Katipunan Ave. station, wherein during the time of sampling, there were construction works along the Katipunan Ave. adjacent to the sampling site.

The baseline ambient air quality data will be used as reference values in determining changes in pollutant levels with subsequent monitoring during the pre-construction, construction and operational phases of the project.

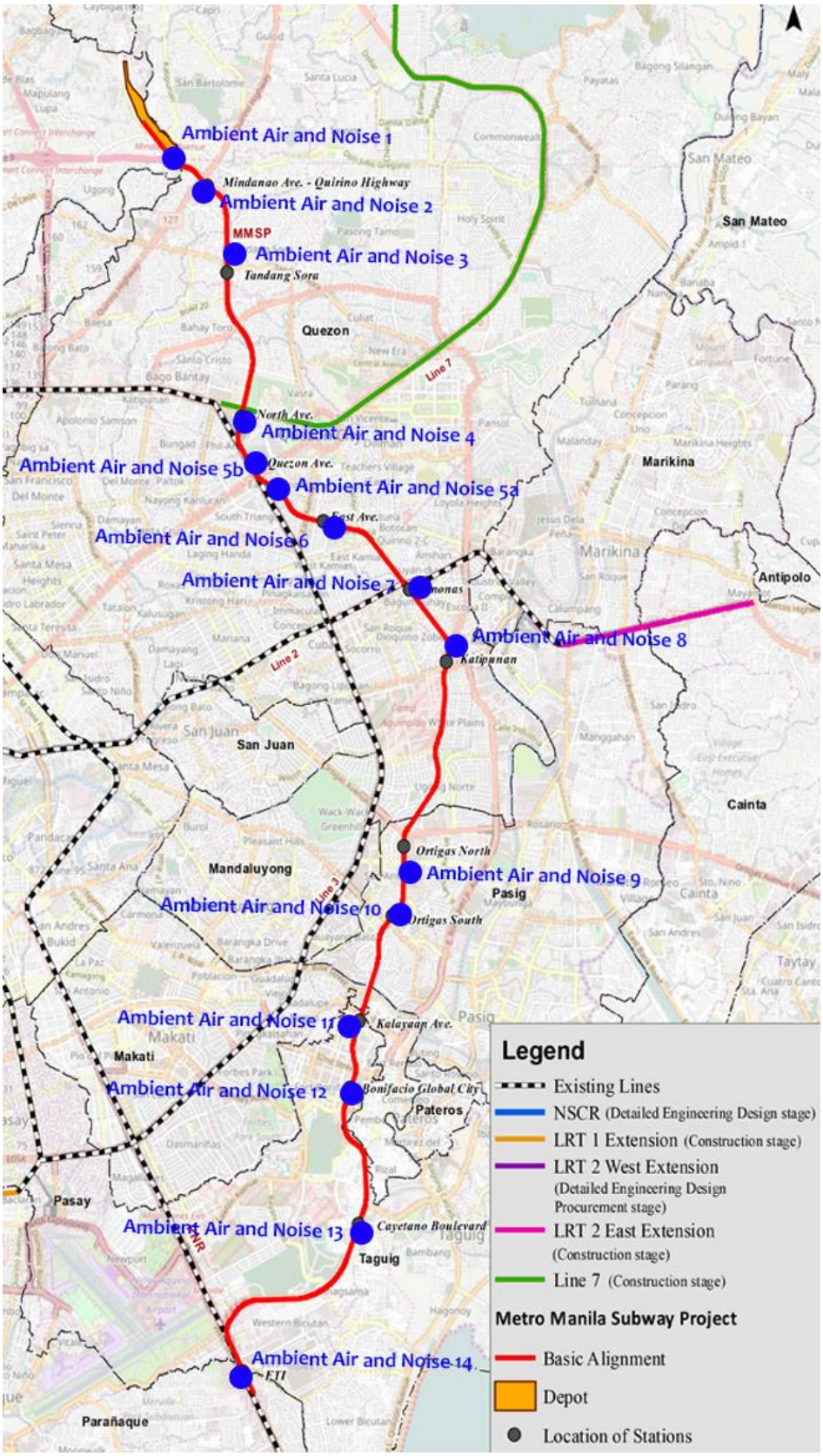


Figure 52. Survey Sites for Ambient Air Quality and Noise Level Monitoring

Table 29. Observed Ambient Air Concentrations

Station/ Sampling Site	Coordinates	Dry Season, µg/Ncm						Wet Season, µg/Ncm			
		TSP	PM_{10}	Pb	NO_2	SO_2	O_3	TSP	PM_{10}	NO_2	SO_2
Depot (Brgy. Ugong, Valenzuela)	14°43'10.82" N 121°0'46.83" E	57.5	44.2	ND	15.7	5.3	ND	**521**	**209**	26.8	17.1
Quirino Highway (Pacific Global Medical Center)	14° 41'16.33" N 121° 1'47.42" E	-	-	-	-	-	-	**248**	**191**	20.8	ND
Tandang Sora (Landcom Village II)	14° 40' 44.85" N 121° 1'56.11" E	-	-	-	-	-	-	85.9	41.3	4.5	ND
North Ave. (Trinoma Mindanao Ave., Open Parking Area)	14°39'0.95" N 121°2'3.04" E	103.1	37.2	ND	31.9	3.5	ND	66.0	47.2	6.7	1.8
Quezon Ave. (Avida Tower I, EDSA)	14° 38' 47.63" N 121° 2' 10.96" E	-	-	-	-	-	-	94.9	78.7	8.2	ND
East Ave. (AFP Medical Center, V. Luna Ave.)	14° 38' 10.02" N 121° 3' 14.42" E	-	-	-	-	-	-	67.4	40.2	5.0	0.9
Anonas (World Citi Medical Center)	14°37'39.33" N 121°3'47.83" E	93.6	57.1	ND	28.3	2.0	ND	72.7	29.1	17.9	ND
Katipunan Ave, (Brgy. Blue Ridge A Multipurpose Hall)	14° 37' 22.40" N 121° 4' 30.45" E	-	-	-	-	-	-	**265**	86.3	8.6	1.4

Station/ Sampling Site	Coordinates	Dry Season, µg/Ncm						Wet Season, µg/Ncm			
		TSP	PM_{10}	Pb	NO_2	SO_2	O_3	TSP	PM_{10}	NO_2	SO_2
Ortigas North (MMDA Impounding Ultra 2 Pasig)	14°34'59.25" N 121°3'51.58" E	159.7	77.4	ND	28.3	ND	ND	31.9	19.6	15.7	ND
Ortigas South (Estancia Mall Parking Lot)	14° 34' 33.29" N 121° 3' 49.19"E	-	-	-	-	-	-	60.0	34.0	10.3	ND
Kalayaan Ave (11th St. corner 38th Avenue		-	-	-	-	-	-	51.0	25.2	9.8	1.4
BGC (Market Market Parking Area)	14°32'51.21" N 121°3' 16.04" E	112.5	54.7	ND	37.3	1.6	ND	110.4	193	21	ND
CayetanoBlvd. (BCDA Field Office, Pamayanang Diego Silang)	14°31'40.8" N 121°3' 28.36" E	-	-	-	-	-	-	74.6	71.5	14.6	1.7
PNR FTI Station Taguig City	14°30'24.84" N 121°2' 7.21" E	204.3	81.4	ND	37.2	ND	ND	209.7	34.8	27.3	2.0
NAAQGV[1]		**230**	**150**	**1.5***	**150**	**180**	**140****	**230**	**150**	**150**	**180**
WHO Guidelines		**-**	**50**	**-**	**20**			**-**	**50**	**20**	

[1] National Ambient Air Quality Guideline Values

* Evaluation of this guideline is carried out for 24-hour averaging time

** Evaluation of this guideline is carried out for 1-hour averaging time

ND-Not Detected

2.3.1.3. Noise Level

The ambient noise level measurements were conducted at the proposed depot site and at the 13 stations of the MMSP, as indicated in Figure 52. The hourly noise level measurement was carried out for 24 hours and the results were compared to the National Pollution Control Commission (NPCC) Memorandum Circular No. 002 Series of 1980, Section 78 – Ambient Noise Quality and Emission Standards for Noise. Noise level standard used at the sampling stations also varies depending on the category of each location, as presented in Table 30.

Table 30. Noise level standard

No.	Station (Survey Site) Location	Description	Class Category	Daytime (9:00 AM to 6:00 PM	Morning/Evening (5:00 AM to 9:00 AM/6:00 PM to 10:00 PM)	Nighttime (10:00 PM to 5:00 AM)
1	Valenzuela Depot	The area is a combination of residential and industrial.	B	65	60	55
2	Quirino Highway (Pacific Global Medical Center)	Mostly commercial establishments with presence of Pacific Global Medical Center	AA	50	45	40
3	Tandang Sora (Landcom II Village)	Station is near St. James College of Quezon City. The area is mostly commercial and a few residential.	A	55	50	45
4	North Avenue (Trinoma Parking Lot)	Presence of religious institution and the Veterans Memorial Medical Center in the area.	B	65	60	55
5	Quezon Avenue (Eton Centris Parking Lot)	Presence of high-rise residential condominium in the area	B	65	60	55
6	East Avenue (AFP Medical Center, V. Luna Ave.)	Combination of commercial establishments, residential and government institutions with presence of AFP Medical Center	AA	50	45	40

No.	Station (Survey Site) Location	Description	Class Category	Daytime (9:00 AM to 6:00 PM	Morning/Evening (5:00 AM to 9:00 AM/6:00 PM to 10:00 PM)	Nighttime (10:00 PM to 5:00 AM)
7	Anonas	Station location has close proximity to the World Citi Medical Center.	AA	50	45	40
8	Katipunan (Brgy. Blue Ridge A Multipurpose Hall)	Presence of residential areas and commercial establishments.	A	55	50	45
9	Ortigas North (MMDA Impounding Area)	Central business district with combination of government office, shopping malls, commercial and business establishments	B	65	60	55
10	Ortigas South (Estancia Mall Parking Lot)	Presence of dense low-rise houses and commercial establishments	B	65	60	55
11	Kalayaan Avenue (Uptown Mall parking lot along 11th St. cor. 38th St.)	Central business district, combination of commercial shopping area and business establishments	B	65	60	55
12	Bonifacio Global City (Market Market)	Presence of high-rise condominium and commercial/ business establishments	B	65	60	55
13	Cayetano Blvd. (BCDA Office, Pamayanang Diego Silang)	Proximity to low-rise residential areas.	A	55	50	45
14	FTI	Mostly commercial areas	B	65	60	55

Based on the measurement carried out, the noise levels recorded were attributed to the intermittent peaks of passing trucks, buses, motorcycles/tricycles and all sorts of vehicles near the site. Since the MMSP project alignment passes near schools, hospitals, churches, residential, commercial and industrial areas, and also along major roads and highways, noise level is expected to be high during the day and less in the evening.

The summary of results of noise level measurement is shown in Table 31. The level of noise at almost all of the survey sites were above the DENR maximum limit at all times when compared with the assigned category as indicated in Table 30. The noise levels at Katipunan slightly exceeded the limits of DENR at all times except during morning. Lastly, the noise level at Ortigas North is within the DENR limits during morning and daytime but exceeds the noise level limit in the evening and at night.

Table 31. Observed 24-hour Noise Level, dB (A)

Station / Survey Site		Morning (5:00 AM to 9:00 AM)	Daytime (9:00 AM to 6:00 PM)	Evening (6:00 PM to 10:00 PM)	Nighttime (10:00 PM to 5:00 AM)
Valenzuela Depot		67	66	67	66
Quirino Highway		73	73	71	69
Tandang Sora		73	74	74	70
North Avenue		59	61	61	58
Quezon Avenue		72	72	73	71
East Avenue		64	64	67	65
Anonas		72	70	70	66
Katipunan		51	53	53	51
Ortigas North		56	59	70	56
Ortigas South		67	67	63	62
Kalayaan Avenue		63	61	62	60
Bonifacio Global City		65	70	69	65
Cayetano Blvd.		65	66	67	62
FTI		80	77	74	76
Noise Level Standard	**Class AA**	**45**	**50**	**45**	**40**
	Class A	**50**	**55**	**50**	**45**
	Class B	**60**	**65**	**60**	**55**
	Class C	**65**	**70**	**65**	**60**

2.3.1.4. Ground Vibration Level

Ground vibration measurement was conducted at several locations along the alignment as indicated in Figure 53 to monitor the ground movement.

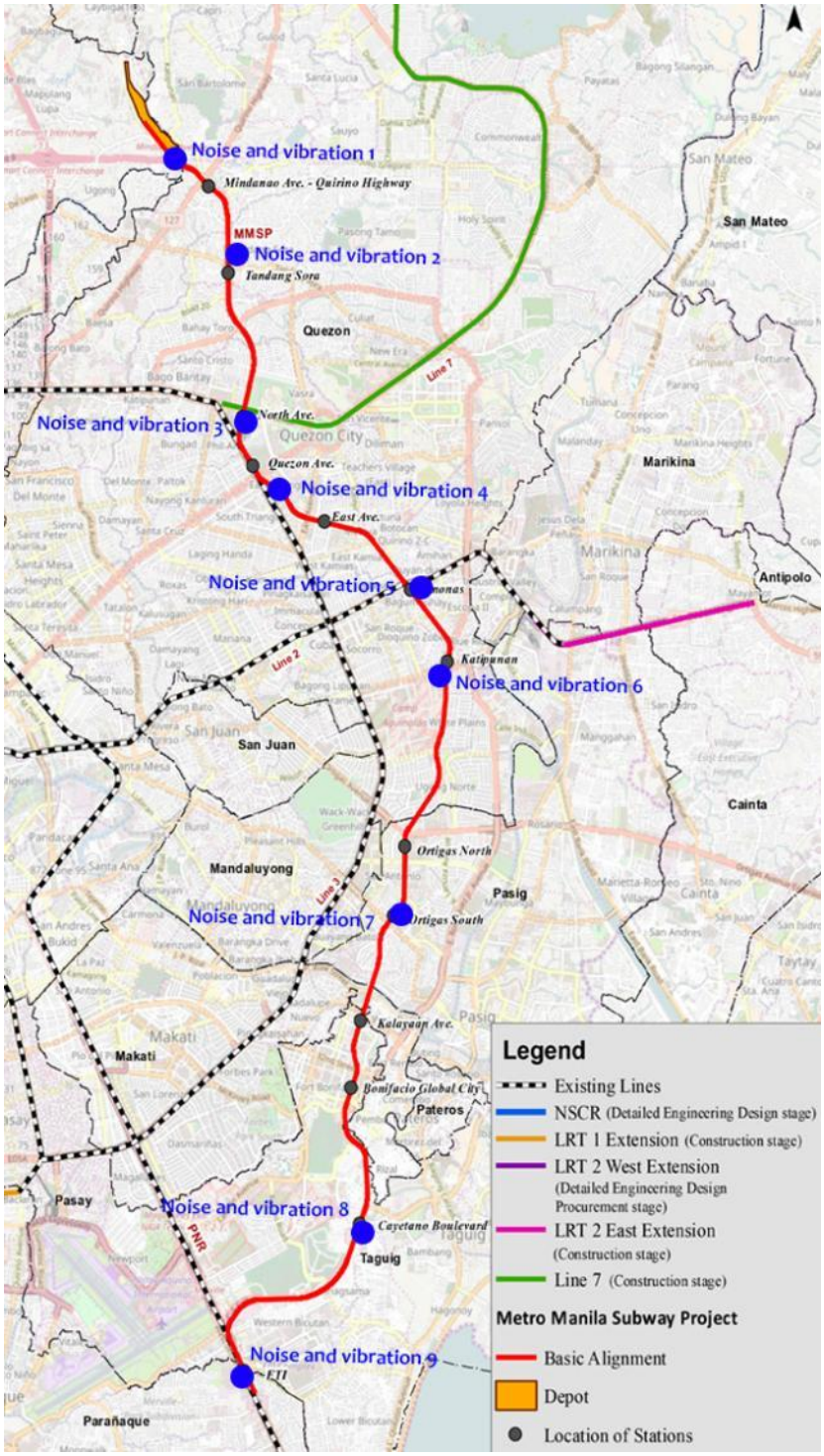


Figure 53. Sites for Vibration Survey

Ground vibration readings were recorded in each site's natural state for 24-hour period. The sampling sites for ground vibration numbered as 1, 3, 4, 5, 8, 9, 11, 13 and 14 comprise the 9 sites for ground vibration measurements, as described in Table 30. Three records were taken per site using three tri-axial accelerometers positioned at 10 meters distance interval.

Tables 32 and 33 show the summary of monitored average vibration levels (in dB) and average acceleration (m/s^2), respectively per station for the morning, daytime, evening and night. The vibration levels measured in Tandang Sora, Blue Ridge in Katipunan and Rolling Hills in Valenzuela showed almost consistent average vibration levels throughout the day. For other locations, majority showed higher vibration levels in the evening and in the night compared with vibration levels in the morning and day for the sites in PNR-FTI, Anonas, Trinoma in North Avenue and Centris in Quezon Avenue. This could be attributed to light traffic in the area in the evening and night where vehicles could travel much faster causing significant ground movement.

Meanwhile, the average acceleration showed similar trend with average vibration levels wherein higher overall values were observed at the PNR-FTI and Tandang Sora Sites compared with other stations. However, unlike vibration, higher levels of acceleration were observed during the morning and day in sites such as Trinoma in North Avenue, Capitol Commons in Ortigas, Trinoma in North Avenue and Anonas Station. Other sites showed higher observed acceleration in the evening such as in BCDA in Cayetano Blvd., PNRT-FTI and Blue Ridge in Katipunan.

Table 32.Observed Vibration Level (dB)

Station / Survey Site	Morning (5:00 AM to 9:00 AM)	Daytime (9:00 AM to 6:00 PM)	Evening (6:00 PM to 10:00 PM)	Nighttime (10:00 PM to 5:00 AM)
Valenzuela Depot	54	53	53	54
Tandang Sora	70	70	70	70
North Avenue	59	59	63	62
Quezon Avenue	56	56	58	58
Anonas	60	59	62	61
Katipunan	56	56	56	56
Ortigas North	64	63	58	59
CayetanoBlvd.	64	65	66	65
FTI	73	73	74	74

Table 33. Observed Ground Acceleration Level (m/s^2)

Station / Survey Site	Morning (5:00 AM to 9:00 AM)	Daytime (9:00 AM to 6:00 PM)	Evening (6:00 PM to 10:00 PM)	Nighttime (10:00 PM to 5:00 AM)
Valenzuela Depot	1.20E-03	9.12E-04	8.30E-04	1.08E-03
Tandang Sora	1.56E-02	1.49E-02	1.54E-02	1.50E-02
North Avenue	4.62E-03	4.90E-03	1.74E-03	4.56E-03

Station / Survey Site	Morning (5:00 AM to 9:00 AM)	Daytime (9:00 AM to 6:00 PM)	Evening (6:00 PM to 10:00 PM)	Nighttime (10:00 PM to 5:00 AM)
Quezon Avenue	2.19E-03	1.68E-03	1.24E-03	1.77E-03
Anonas	6.36E-03	5.86E-03	4.94E-03	5.64E-03
Katipunan	1.30E-03	1.39E-03	1.85E-03	1.61E-03
Ortigas North	9.61E-03	5.98E-03	1.72E-03	4.81E-03
CayetanoBlvd.	2.93E-03	3.43E-03	3.62E-03	3.54E-03
FTI	1.19E-02	1.35E-02	1.60E-02	1.37E-02

2.3.2. Impact Identification, Assessment and Mitigation

This section presents the potential impacts of the subway project to the air quality, noise and vibration level in the surrounding community. Potential and suggested mitigation measures are discussed following an assessment of the significance of effects on the receiving environment and communities.

2.3.2.1. Pre-Construction and Construction Phase

Pre-construction and construction activities, such as clearing of vegetation, earthmoving activities and movement of various equipment and vehicles will be the major causes of increase in level of air and noise pollution, and increase in vibration measurement around the project site.

Air pollution

Pre-construction and construction activities such as demolition of existing structures, excavation and backfilling and construction of tunnel would result to generation of dusts. These activities temporarily increase the level of total suspended particulates (TSP) and particulate matters (PM). Movement of heavy equipment, dump trucks and service vehicles during these activities would also contribute to increase in concentration of TSP and PM at the site as well as the route of these vehicles between the site and dumping area for the excavated earth. In addition, exhaust gas emission coming from these vehicles coming in and out of the project site as well as generator sets may increase current level of NOx, SOx, carbon monoxide (CO) and hydrocarbons (HC).

These identified impacts at ground level have low adverse effect and short term, limited only during the preconstruction and construction phase. To control and minimize the generation of dusts and exhaust gas emission which would have drastic effects to workers and the environment, the following measures need to be implemented:

- Regular wetting of ground soil at the construction site will minimize generation of TSP and dust
- The contractors/subcontractors must conduct regular preventive maintenance of heavy equipment and service vehicle.

- Construction sites must be fenced for safety and security reasons.
- Trucks that haul excavated soil must be covered and the soil partly wetted to minimize generation of dust during travel.
- Wheels of all vehicles (e.g. hauling trucks and service vehicle) leaving the site should be washed to prevent emission.
- Contractor shall provide prior notification to the local community on the schedule of construction activities

Greenhouse Gas Emission

Carbon dioxide emission volume from the subway construction was estimated using the method used in "The study on reduction effect of CO_2 due to urban railway development project, 2008 by Japan Railway Technical Service". The estimated emission volume is 655,000 tons, which is equivalent to about 0.7% (2.5%) of the total CO_2 emission from fuel combustion in 2014 in the Philippines or 2.5% of the total CO_2 emissions from the country's transport sector.

Table 34. CO_2 Emission from Subway Construction

Item	Basic Unit	Unit	Quantity	Emission volume (t-CO_2)
1. Construction Works				
1.1 Route (Station sections, 210x13=2,730m, are included in station construction)				
Digging tunnel	16,400	t-CO_2/km	1.98	32,472
Shield tunnel	8,840	t-CO_2/km	21.99	194,392
1.2 Slab track	322	t-CO_2/km	26.7	8,597
1.3 Underground station	31,100	t-CO_2/station	13	404,300
1.4 Depot	6,130	t-CO_2/depot	1	6,130
2. Production of rolling stock	62	t-CO_2/car	152	9,363
			Total	655,254

Source: JICA Study Team

The estimation in Table 34 already includes CO_2 emissions from the use of generator sets during the construction works.

To reduce CO_2 emission, the contractors should maintain their construction equipment in adequate working conditions and actively use electrically-powered equipment, as much as possible. The contractor and supervision consultant should actively adopt construction methods and materials that have CO_2 reduction effects.

Noise pollution and ground vibration

During the pre-construction phase, increase level of noise will be generated during destruction and demolition of structures from machines and equipment that will be used, and from trucks coming in and out of the site hauling the debris.

Likewise, generation of noise and ground vibration is inevitable from the construction activities of the MMSP. Noise will be generated from the movement and operation of heavy machineries, generator sets, service and hauling vehicles coming to and from the construction site. Operation of construction machinery, such as pile driver and rock drilling, causes ground vibrations. Because ground vibrations from construction activities spread through the ground and diminish in strength with distance, these do not often reach the levels that can damage structures, but can achieve the audible and sensing ranges for human very near the construction site.

Vulnerable groups of people, including those with long-term illnesses, those sensitive to noise, people with mental health problems, unborn and newly born babies, and children are often more susceptible to the adverse health effects of noise. As a result, these vulnerable groups of people may be more at risk from exposure to environmental noise than healthy adults. Based on a study by Van Kamp, I. and Davies, H. (2013), the most common effects of noise on the vulnerable group include raised blood pressure, sleep disturbance, heart and circulation problems, headaches.

Areas along the MMSP alignment, particularly near the stations, will be affected by the noise level generated during the pre-construction and construction phases of the project. The method of prediction and assessment of noise levels and ground vibration during the construction phase is presented in Appendix J. The predicted noise levels caused by construction works is shown in Table 35.

Table 35. Predicted Noise Level Caused by Construction Works

Construction Site	Predicted Noise Level	Predicted Noise Level (With temporary noise reduction sheet)	Maximum Allowable Noise Level[1]
Construction works of station	87 dB	78 dB	90 dB (Class 1)
Vertical shaft construction works of tunnel	88 dB	79 dB	85 dB (Class 2)

[1]NPCC Memorandum Circular No. 002, May 12, 1980

Class 1: Work which requires pile drivers (excluding manual type), file extractors, riveting hammers or combination thereof.

Class 2: Work which requires rock drills or similar equipment like jack hammers or pavement breakers

Source: JICA Study Team

Installation of temporary noise reduction sheets on the edge of the construction limit is generally expected to reduce noise levels by approximately 9 dB. The noise level in a station construction site is likely to be slightly less than the maximum allowable noise level (90 dB) without the temporary noise reduction sheets. To satisfy the maximum allowable noise level (85 dB), the temporary noise reduction sheets will be required for vertical shaft construction works of tunnel.

In addition to these noise reduction measures, a massive information dissemination campaign to prepare local health units from the affected LGUs, is recommended to address adverse health impacts of noise to vulnerable groups of people, especially within the DIAs.

The predicted vibration levels caused by construction works is shown in Table 36.

Table 36. Predicted Vibration Level Caused by Construction Works

Construction Site	Predicted Vibration Level (on borderline)	Predicted Vibration Level (at 5 m from borderline)	**Day time control level in Tokyo[1]**	
			Residential Area	Commercial Area
Construction works of station	66 dB	61 dB	60 dB	65 dB
Vertical shaft construction works of tunnel	63 dB	58 dB		

[1] Tokyo Metropolitan Government

Source: JICA Study Team

In lieu of absence of Philippine standard for vibration level, the Tokyo Metropolitan Government (TMG) standard was used in order to illustrate the impact of vibration level caused by construction works. The vibration level caused by construction works of station at 5 m point from the borderline is likely to exceed TMG's day time control level in residential area and satisfy the level in commercial area. The vibration level caused by construction works of tunnel at 5 m point from borderline will satisfy the level in residential area.

Countermeasures can be implemented to reduce the noise disturbance which will affect the workers and nearby community, as follows:

- Selecting equipment with lower sound power levels
- Installation of mufflers on engine exhausts and compressor components
- Installation of noise suppressors such as acoustic enclosures and vibration isolation to all construction/mechanical equipment to help minimize noise generated. It is also recommended to conduct regular maintenance of heavy equipment, construction machinery, and other support vehicles.

- Installation of temporary noise barriers such as galvanized iron shields, particularly in noise-sensitive areas such as churches, schools, and hospitals in the immediate vicinity of the construction area.
- Construction workers must be provided with personal protective equipment (PPE), such as earmuffs.
- Re-locating noise sources to less sensitive areas
- Fencing of the construction sites for safety and security reasons.
- Scheduling of high noise generating activities during daytime
- Use of shield tunneling method construction technique as illustrated in Figure 54.

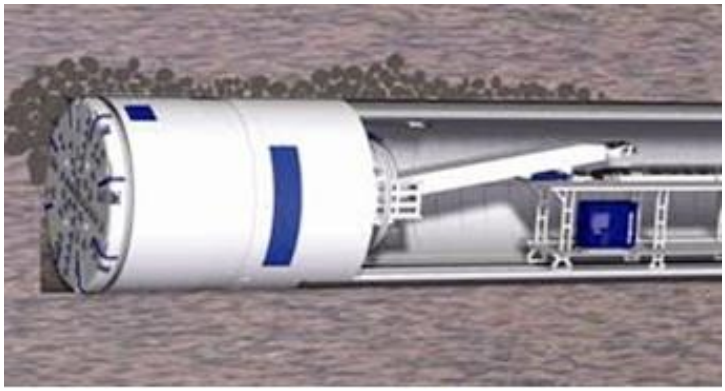


Figure 54. Shield Tunneling Method

2.3.2.2. Operation Phase

During the operational phase of the subway project, air pollution is expected to lessen because the railway will be operated using electricity.

Air Pollution

At the station's ground level entrance and depots, air emission sources will be limited to service vehicles of the proponent (DOTr) and from the standby generators that will be operated in case of power outage in stations and in the depot. However, vehicular traffic may concentrate near the stations due to loading and unloading of passengers resulting to intermittent increase in emissions of CO, PM, NOx, SO_x and HC. Mitigating measures that need to be implemented to reduce the air emission impacts are:

- Proper preventive maintenance of service vehicles and equipment
- Use of cleaner fuel for the generator sets.
- Management of traffic and terminals near the stations
- Integration of stations with transport terminals, commercial establishments and other Mass Transit System
- Painting of stations with photocatalytic paint which reduces NOx pollutants

Overall, the impact of a mass railway commuter system is beneficial mainly due to reduction in vehicle air emissions resulting from decline in number of vehicles plying along the major road near the MMSP alignment. This translates to light traffic on these roads and reduction of total amount of pollutants from vehicles. Ambient Air Pollutants that will be significantly reduced in particular includes VOCs, NOx, CO and PM wherein a significant percentage is contributed by mobile sources. Pavement of the stations and depots and the surrounding area in particular will reduce the TSP concentration in the area.

Since the railway will be operated using electricity, emissions of air pollutant from underground operation is minimal. However, without proper ventilation systems there will be accumulation of CO_2 from respiration of passengers which could affect the commuters. To minimize CO_2 and heat accumulation in the railway system the following ventilation system must be installed:

- Station ventilation system for the underground station, platform, concourse, staff rooms, equipment rooms by force ventilation
- Station Air Conditioning Facilities using chilling machine
- Tunnel ventilation system by forced ventilation to introduce fresh air and remove heat from the tunnel

Impacts of the Project to Climate Change

Shifting of passengers from road to a rail-based mass transportation system will result to potential significant reduction of GHG emission. These public mass transport systems promote reduction of both public and private vehicle trip with low passenger occupancy. As a result vehicle traffic will be lesser and much faster. Furthermore, since the MMSP is operated electrically and can accommodate more passengers, the corresponding GHG emission is much less. The MMSP will satisfy transport demand and efficiency and at the same time contribute to the emission reduction objectives of NFSCC.

With the reduction of vehicle usage, the Greenhouse Gas (GHG) emission will also decrease. The estimated GHG emission reduction by introduction of the subway project is presented in Table 37.

Table 37. Estimated Reduction of GHG Emission with Subway Operation

Year	2025	2035	2045
GHG ton/year	49,040	184,154	242,415

Source: JICA Study Team

Negative impacts of the project would include reduction of carbon sink due to clearing of trees and vegetation and additional GHG emission from the operation of standby generation sets. However, these impacts are minimal and could be offset by the total GHG emission reduction from the subway operation.

Impact of Climate Change on the Project

Climate change is characterized by sea level rise, increase in temperature, extreme weather conditions which include increase in rain intensity, temperature, weather disturbances and drought in some areas. Once the MMSP is in operation, it will be oftentimes directly exposed to prolonged and frequent rainfall, strong winds, higher waves (in coastal areas) and temperature variations. The underground component of the railway and stations are less vulnerable to strong winds cause by extreme weather disturbances. However, it is more vulnerable to flooding and could lead to accelerated structural fatigue and materials failure. This places greater demands on construction, operation and maintenance of flood control and drainage structures. On the other end, heat waves may result to increased demand of the cooling system for building offices, ticket booths and passenger cars. These factors must be consider in the design to make the infrastructure robust or resilient to the effects of climate change and may result to higher project cost.

Climate change may also impact human health with increase morbidity and mortality rates especially due to vector-borne and increase in spread of other communicable diseases. In mass transport system, passengers are more exposed and consequently more vulnerable to contracting diseases. Therefore, measures to prevent spread of disease such as control of vector, information and education, formulation and implementation of policies (e.g. food restrictions), use of materials with antibacterial properties (e.g. copper and silver) for hand railings and door knobs and installation of high efficiency particulate filters in the ventilation and air-conditioning system should be implemented.

Noise and Vibration

The noise of MMSP operation will be minimal or have low adverse impact since it is situated underground. However, underground vibration caused by train passage causes noise in buildings and houses as shown in Figure 55. Subway operation may cause structure-borne noise and has the impact on people living above the rail track.

The structure-borne noise is a type of noise that transmits through solid such as ground or structures from subway tunnel with vibration. There is no established prediction method for vibration attributed to train operation. The estimated vibration level at 10 m from the subway tunnel will likely to be less than the level at which a person starts feeling the vibration, which is at 55 dB. However, actual measured vibration levels are often different from the theoretical or predicted levels due to complexity of ground and structure basement conditions. It is difficult to predict vibration and low-frequency noise level due to the complex generation mechanism precisely.

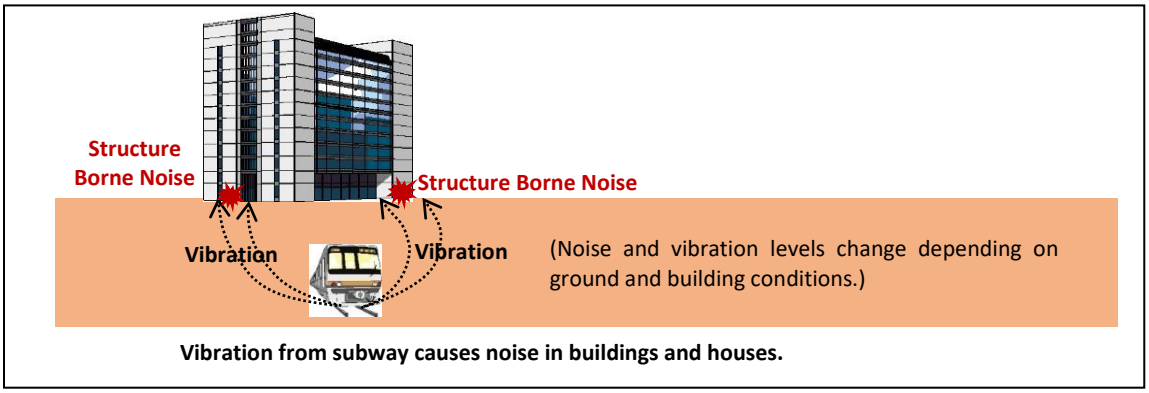


Figure 55. Vibration from subway causes noise in buildings and houses

Most of structure-borne noises are low-frequency noises (1~100 Hz). Even if low-frequency noise levels are less than environmental standards, the noise may cause mental stress to residence. Most of complaints against noise and vibration caused by subway operation are related to the low-frequency noise issues.

The subway operation also causes ground vibrations, which spread through the ground and diminishes in strength with distance. The ground vibrations do not often reach the levels that can damage structures, but can achieve the audible and sensing ranges for humans who are very near the subway tunnel.

A prediction model developed in "Teito Rapid Transit Authority, Japan" was applied to predict the vibrations levels caused by subway operation and presented in detail in Appendix K. The prediction result of noise levels caused by subway operation is shown in Table 38.

Table 38. Predicted Vibration Level Caused by Subway Operation

Prediction Point	Predicted Vibration Level on Ground	Night time control level in Tokyo [1]	
		Residential Area	Commercial Area
10 m Point from Tunnel	52 dB	55 dB	60 dB
20 m Point from Tunnel	46 dB		
30 m Point from Tunnel	42 dB		

[1] Tokyo Metropolitan Government *(TMG)*

Source: JICA Study Team

The predicted vibration level caused by subway operation at 10 m above the rail track is below TMG's night time control level standard in both residential and commercial areas.

During train operation, the speed of the train will be limited to minimize vibration and noise. In addition some structural design measures will be incorporated. Structural design measures that will be incorporated to minimize noise and vibration during the operation of the MMSP include designs

of the railway and wheel systems and installation of additional noise barrier coupled with regular maintenance. The following designs will be incorporated to minimize noise and ground vibration.

Figure 56. Noise Barrier (noise reduction ~5dB)

Figure 57. Long Welded Rail and Expansion Joint

Figure 58. Damped Wheel

Damped wheels reduce noise and vibration generated by train operation.

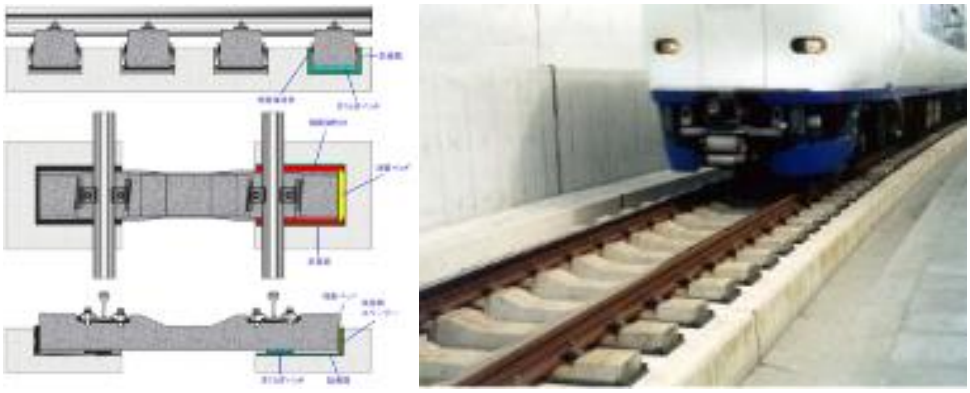


Figure 59. Resilient tie (Vibration Reduction: ~7-12 dB)

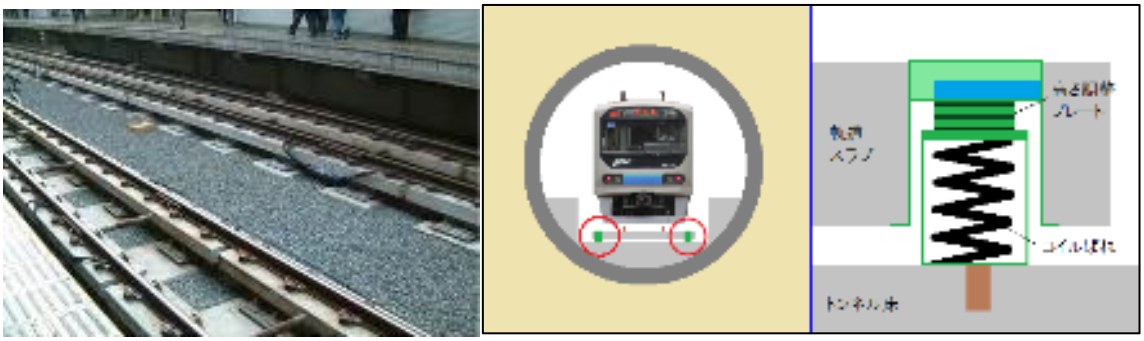


Figure 60. Floating slab trackbed (Noise Reduction: ~7dB)

In addition, regular conditioning of train and its components which includes brakes, suspension systems, and wheel and slip-slide detectors should be conducted. Proper maintenance of trains and trucks such as rail grinding must also be implemented on a periodic basis.

A summary of the potential impacts, assessment of impacts and mitigating measures to address the identified impacts is provided in Table 39.

Table 39. Impact Identification, Assessment and Mitigating Measures for Air Quality, Noise and Vibration

Environmental Aspect	Potential Impacts	Assessment of Impacts	Mitigating/Enhancement Measures
PRE-CONSTRUCTION AND CONSTRUCTION PHASE			
Generation of dusts and PM from earthmoving, demolition and stockpiling	Temporary increase of air pollutant emissions, specifically TSP and PM	Low adverse	• Regular Wetting of ground soil in the construction site • Construction sites must be fenced for safety and security reasons • Hauling trucks for excavated soil must be covered during travel • Washing of wheels of all vehicles leaving the site
Emission from vehicles and gensets	Temporary increase of air pollutant emissions (NOx, SOx, CO and HC)	Low adverse	• Regular preventive maintenance of heavy equipment and service vehicle
Movement and operation of construction machinery	Increase noise level and ground vibration during construction	Low adverse	• Select equipment with lower sound power levels • Installation of mufflers on engine exhausts and compressor components • Installation of noise suppressors and vibration isolation to construction/mechanical equipment. • Regular maintenance of heavy equipment, machineries and support vehicles • Installation of temporary noise barriers such as galvanized iron shields • Use of Personal Protection Equipment (PPE) • Relocating noise sources to less sensitive areas • Fencing of the construction site • Scheduling of the high noise generating activities during daytime.

Environmental Aspect	Potential Impacts	Assessment of Impacts	Mitigating/Enhancement Measures
			• Use of shield tunneling method construction technique • Conduct massive IEC campaign to local health units of affected LGUs to implement interventions to mitigate risk to noise exposure of vulnerable groups along the DIAs and IIAs.
OPERATION PHASE			
Operation of trains as mass transport system	Reduction of pollutants from vehicles; Reduction in GHG emission	Beneficial	No mitigating measure needed.
Operation of service vehicles standby generator set	Air Pollution	Low adverse	• Proper preventive maintenance of service vehicles and equipment • Use of cleaner fuel for the generator sets
Increase in air pollutants from increased vehicles along stations	Air Pollution	Low adverse	• Management of traffic along stations • Use of blowers to dissipate pollutants along terminal
Generation of low frequency noise from structure-borne noise and ground vibration	May cause mental stress to residence	Low adverse	• Installation of noise barrier • Long welded rail and expansion joint, damped wheel and resilient tie will be adopted • Installation of floating slab trackbed • Regular conditioning and maintenance of the trains will be implemented on a regular basis • Speed of train will be limited to minimize noise and ground vibration
Climate change	Accelerated structural fatigue and materials failure	Moderate adverse	Proper design in making infrastructure robust or resilient to the effects of climate change should be taken into consideration

Environmental Aspect	Potential Impacts	Assessment of Impacts	Mitigating/Enhancement Measures
Operation of trains as mass transport system	Greater demands on the construction, operation and maintenance of flood control and drainage structures.	Moderate adverse	Improvement of current drainages along the alignment to be resilient to climate change.
	Increase GHG emissions due to increased demand for cooling system of passenger cars, building offices and ticket booths	Moderate adverse	Install reliable and heavy duty air-conditioning (AC) system of railcars that will be purchased and use of centralized AC system for the stations
	Indirect impact - Increased vulnerability of passengers to spread of communicable disease via a mass transportation system.	Low adverse	• Formulate and implement health and safety protocols for all stations and trains • Information, Education and Communication (IEC) materials on proper hygiene in all stations • Provisions for use of HEPA (High Efficiency Particulate Air Filter) for the AC/ventilation system.
	Reduction of pollutants from vehicles; Reduction in GHG emission	Beneficial	No mitigating measure needed.

2.4. THE PEOPLE

2.4.1. Socio-economic profile

Metro Manila or the National Capital Region (NCR) is the center of culture, economy, education and government of the Philippines. The total population of NCR at 12,877,253 accounted for about 12.8% of the Philippine population based on the latest 2015 Census of Population by the Philippine Statistics Authority (PSA). The population of NCR grew faster than the rest of the country, with an average increase of 1.58% annually, during the period 2010 to 2015.

NCR is the most densely populated region in the country at 20,785 persons per square kilometer. The increasing population growth rate in NCR is indicative of in-migration due to the educational and economic opportunities associated with urban life. Employment rate in NCR based on the January 2017 Labor Force Survey of the PSA is 91.5%.

NCR is composed of sixteen (16) cities and one municipality. The MMSP alignment will traverse six (6) of these cities, namely, Valenzuela, Quezon City, Pasig, Makati, Taguig and Parañaque. It will pass through the Central Business Districts of Quezon City, Ortigas Center in Pasig, Makati and Bonifacio Global City in Taguig, characterized as highly developed urban commercial and residential areas. Predominant land uses along the alignment is discussed in more detail in Section 4.1.1.1.

Road networks in NCR include radial roads (R1 – R10) and circumferential roads (C1 – C5). However, there are still missing road links due to right-of-way constraints and porous zoning controls. NCR is connected to the CALABARZON area through the South Luzon Expressway (SLEX) and linked to Central Luzon on the north through the North Luzon Expressway (NLEX). Southwest of Manila is the Manila-Cavite Expressway (CAVITEX) running along the coast of Bacoor Bay after south of Roxas Boulevard.

Four railway systems currently operate within Metro Manila, LRT 1 along R-2 in the southern section and R-9 in the northern segment, LRT 2 along R-6 and MRT 3 on C-4, and the PNR South Commuter Line from Tutuban, Manila to Alabang in Muntinlupa. LRT 1, LRT 2 and MRT 3 are elevated structures, while the PNR line is an at grade railway system.

Road transport include private vehicles, public vehicles such as buses, jeepneys, taxis, UV or GT express, tricycles and pedicabs. On the other hand, international and domestic air transportation to and from Metro Manila is being served by the Ninoy Aquino International Airport (NAIA) in Pasay, consisting of four terminals.

Discussion of specific socio-economic environment for the affected cities of the project is provided in the succeeding sections.

2.4.1.1. Demography

Demographic data for the six affected cities of MMSP Phase I based on 2015 Census is summarized in Table 40. Quezon City has the highest population and population density among the cities of Metro Manila.

Table 40.Demographic Data for the Affected Cities

City	Population	Population density (persons/ km^2)
Quezon City	2,936,116	71,263
City of Manila	1,780,148	17,099
Caloocan City	1,583,978	28,387
Taguig City	804,915	29,815
City of Pasig	755,300	18,014
City of Parañaque	665,822	27,010
City of Valenzuela	620,422	23,267
City of Las Piñas	588,894	41,580
City of Makati	582,602	20,945

2.4.1.2. Local economy

The proposed depot in Brgy. Ugong in Valenzuela City is currently a mixed land use area consisting of low to medium rise residential buildings, commercial establishments and industries. Examples of industries located within the depot, mostly along Mindanao Avenue side are sand and construction suppliers. Commercial establishments include eateries, vulcanizing shops and a resort.

Quezon City, covering about 50% of the MMSP alignment in the Central Zone, is a major contributor of service-oriented establishments in Metro Manila. It is the site of main broadcast stations in the Philippines, information technology companies and a hub of commercial centers, including large shopping malls like SM North EDSA, Araneta Cubao Center and Trinoma.

Economic activities in Pasig City are dominated by business establishments engaged in personal and community services. However, top income generators are headquarters of Jollibee Foods Corporation, First Gas Power Corporation, San Miguel Corporation and Suzuki Philippines, among others. The MMSP alignment passes through the Ortigas Business District Center, particularly along shopping malls, offices, condominiums, bars and restaurants.

The MMSP corridor passes through Bonifacio Global City (BGC) in Taguig, currently composed of residential condominiums, corporate buildings and commercial establishments. The local economy in BGC is expected to rise as many Filipinos and multinational corporations have started acquiring properties in this business district.

2.4.1.3. Service Utilities

Water supply

Maynilad Water Services Inc. is the biggest concessionaire providing water supply in Valenzuela City. The rest of the households are served by private water systems within their subdivisions.

Water supply in cities along the Central Zone alignment is dominantly within the concession area of Manila Water Company, Inc., except for Brgy. Talipapa, Brgy. Tandang Sora at the western portion of Mindanao Avenue, and Brgy. Bahay Toro in Quezon City. The said areas are supplied by Maynilad Water Services, Inc. Both utility companies adequately supply the water requirements of the households, business, commercial and industrial establishments.

Power supply

Electric power in all cities traversed by MMSP alignment is being distributed by the Manila Electric Company (MERALCO). MERALCO caters to all types of power supply connections and to all barangays. Residents, commercial establishments and industries have access to power supply 24 hours a day.

Environmental health and sanitation facilities

The Barangay Hall in Barangay Ugong, Valenzuela has a public health center for barangay residents. Bigger hospitals within Valenzuela City outside of the barangay are available to provide the city's public health services.

Quezon City has a large number of hospitals and wellness centers. Among these are government hospitals such as Lung Center of the Philippines, National Kidney and Transplant Institute, Philippine Heart Center for Asia, East Avenue Medical Center and the AFP Medical Center, all located near the proposed East Avenue Station. Pacific Global Medical Center and World Citi Medical Center are private hospital located in the vicinity of the proposed Quirino Highway and Anonas Stations, respectively. Like Quezon City, Pasig and Taguig Cities have a number of public and private hospitals and barangay health centers. In Taguig City, city-owned hospitals offer discounted fees to Taguig residents.

Sewage disposal in Metro Manila is most commonly through individual septic tanks. Effluents from septic tanks are either seeped through the ground or discharged to street drains together with storm water. Unfortunately in Metro Manila, only 11% of the total population is directly/indirectly connected to a sewerage system, 85% are served by over 2 million ill-maintained septic tanks.

Solid waste management

In Metro Manila, in general, domestic wastes are collected by the LGUs through contractors and disposed in landfills. Based on Ecological Solid Waste Management Act of 2003 by the DENR, the wastes should be segregated and collected in the barangay level in designated Materials Recovery

Facilities (MRFs). The city is only supposed to collect the residual wastes for landfill disposal. However, not all cities have segregation schemes and have MRFs that are supposed to divert solid wastes from landfills.

At present, Valenzuela City is collecting garbage from households, markets and along the major thoroughfares of the city. Parts of the garbage collected in the city are diverted for recovery and recycling at the Valenzuela Eco Center and MRF in Barangay Marulas before final disposal into the 5-hectare controlled dumpsite in Brgy. Lingunan.

Quezon City generates large amount of solid wastes because of its high population and high concentration of social and economic activities. The LGU contracts private haulers to collect wastes from the barangays. Some barangays have their own garbage collection using their own dump trucks. Commercial establishments, on the other hand, are held responsible for collecting and disposing their own wastes. Wastes are finally disposed at the Payatas Controlled Dump Facility. This facility is equipped with a Biogas emission capture technology.

Pasig City implements a "no segregation, no collection" policy in solid waste management. The city disposes their wastes in Montalban Sanitary Landfill. In Makati City, the volume of actual garbage collected showed a declining trend from 2006 to 2011 at an average rate of 2%. This is due to the implementation of ordinances and programs towards the diversion of solid wastes from landfills.

In Barangay Fort Bonifacio in Taguig City, it is notable that they were able to divert 80% of its waste by building an MRF and hiring waste collectors to visit every household, separate organic waste and bring it to the facility.

Telecommunications

Telecommunication lines in Metro Manila are serviced by private telecommunication companies. Fixed line telephone services are supplemented by mobile phone and other wireless services.

2.4.1.4. Transport networks

Road network

There are currently 10 radial roads (R-1 to R-10) and 5 circumferential roads (C-1 to C-5), which conveys traffic in and out of Metro Manila to the surrounding cities and to the provinces. The sixth circumferential road, C-6, which will connect the north provinces to the south without the need to pass Metro Manila, is currently under construction.

Metro Manila is linked by expressways to CALABARZON on the south by the SLEX and the Skyway, to Central Luzon on the north by the NLEX which T-connects to Subic-Clark-Tarlac Expressway. On the southwest is the Manila-Cavite Expressway (or CAVITEX), which is a 14-km toll road that forms part of R-1 running along the coastline of Manila Bay to Cavite.

Railway Network

Three elevated railway systems currently operate in Metro Manila: the 20-km Light Rail Transit (LRT) 1 along R-2 in the southern section and R-9 in the northern section, the 13-km LRT-2 along the R-6 corridor, and the 17-km Metro Rail Transit (MRT)-3 on C-4. A fourth28-km railway line is operated by the PNR South Commuter Line from Tutuban in Manila to Alabang in Muntinlupa. The PNR North Commuter Line (about 32 km to Malolos) was closed in 1984 and is lined up for rebuilding with the expected opening of the Malolos to Tutuban segment in the latter part of 2021.

Road Traffic

Road transport in Metro Manila includes private vehicles and public transport vehicles such as buses, jeepneys, UV express service, taxis, tricycles and pedicabs. As reported by the JICA Study Team in the "Information Collection Survey for the MMSP, September 2015", the Transport Roadmap Study has shown that the estimated 2012 travel demand within and to/from Metro Manila has decreased by 7% for public transport and increased 15% by car. The study revealed that car traffic has increased because of the growth in car ownership and decline of car occupancy rate.

2.4.1.5. Cultural/ historical sites

Based on the field survey, the database of historical sites and structures of the National Historical Commission of the Philippines (NHCP) and the register of World Heritage Sites from the National Commission for Culture and the Arts (NCCA), there will be no historical and culturally important structures that will be directly affected by the MMSP Central Zone alignment. Likewise, no Indigenous People (IPs) and ancestral domain lands will be affected by the project.

Table 41 shows a list of historic sites, structures, and monuments installed with historical markers that are within a two-kilometer radius from the proposed MMSP alignment. As can be discerned from the said table, the MMSP alignment will not entail any displacement/removal of such historic sites.

Table 41.List of Historic Sites, Structures, and Monuments Installed with Historical Markers
(within the 2 km Radius of the MMSP Alignment)

Title of Marker	Category	Type	Location	Date of Installation of Marker	Approximate Distance
Eugenio López	Marker	Personage	Benpres Building, Exchange Road corner Meralco Ave., San Antonio	1989	150 meters from proposed Ortigas North Station
Julia Vargas Vda. de Ortigas	Marker	Personage	Emerald Ave., Ortigas Center	April 27, 1982	290 meters from proposed Ortigas North Station

Title of Marker	Category	Type	Location	Date of Installation of Marker	Approximate Distance
Melchora Aquino (Tandang Sora) Shrine	National Shrine	Monument	Banlat Rd., Tandang Sora	March 3, 2012	1.6 km from proposed Tandang Sora Station
Philippine Medical Association	Association/ Institution/ Organization	Office	North Avenue, Santo Cristo	May 6, 1992	450 meters from proposed North Avenue Station
Philippine Expeditionary Forces to Korea	Monument	Personage	PEFTOK Memorial Hall, Taguig	June 28, 2015	1.3 km from proposed Cayetano Blvd. Station

Though not officially declared as a historic site by the NHCP, based on the public scoping conducted at Makati and Taguig City, the presence of an underground tunnel known as the Fort Bonifacio War Tunnel, was raised. The tunnel passes underneath BGC in Taguig and Barangays Pembo and East Rembo in Makati City.

Based on the research done by the NHCP, the tunnel was built by the US Military Government in 1902. The site is of historical importance as it served as a depository for military supplies for the US and Philippine Armies. It was later used as barracks by the Japanese Army when they captured the base. The tunnel, constructed with the help of the Igorots, stretches to about 2.24 kilometers, at an average depth of 21 meters.

Figure 61 shows the location of the tunnel relative to the MMSP alignment. BGC used to be a military base in the Philippines. Now, its development is under the authority of the Philippine Bases Conversion and Development Authority (BCDA).

Figure 61. Location of MMSP Alignment and Fort Bonifacio Tunnel

BCDA plans to rehabilitate the war tunnel. They conducted a feasibility study to assess the stability of the tunnel. The assessment showed that the tunnel is structurally sound, but recommended reinforcements at the ceiling of the explorable portion of the tunnel to improve its condition. The next phase of the rehabilitation plan is to build a museum to preserve the historical value of the tunnel and develop it into a tourist attraction.

Figure 62. Tunnel entrance near the Market Market Parking Building

Figure 63. Inside the Fort Bonifacio War Tunnel

2.4.2. Impact Identification, Assessment and Mitigation

2.4.2.1. Pre-Construction and Construction Phase

Displacement of Settlers and Properties

During the planning stage of the project, one of the main factors considered in deciding the subway route is the avoidance of residential and commercial areas that needs to be acquired for the ROW. As much as possible, the alignment was traced under existing public roads and public properties.

Despite efforts to minimize ROW acquisition, the allotment of construction yard and shield base, as well as construction of entrances and exits to the underground stations can inevitably displace households, business and commercial establishments along the ROW and the depot in Valenzuela.

Table 42 shows estimated number of structures and PAPs based on Census Tagging and Socio-Economic Survey.

Table 42. Estimated Number of Structures and PAPs based on Census Tagging and Socio-Economic Survey

	Station	No. of Structures	No. of Respondents	Informal Settler Families (ISFs)	Total No. of Respondents
	Depot	352	708	62	770
1	Quirino Highway	49	34	0	34
2	Tandang Sora	23	16	0	16
3	North Avenue	1	-	0	0
4	Quezon Avenue	6	2	0	2
5	East Avenue	23	30	0	30
6	Anonas	48	84	0	84
7	Katipunan	33	16	0	16
8	Ortigas North	9	7	0	7
9	Ortigas South	10	20	0	20
10	Kalayaan Avenue	n.d.	n.d.	n.d.	n.d.
11	Bonifacio Global City	n.d.	n.d.	n.d.	n.d.
12	Cayetano Boulevard	n.d.	n.d.	n.d.	n.d.
13	FTI:Station	n.d.	n.d.	n.d.	n.d.
	Parañaque	15	5	0	5
	Total	**569**	**922**	**62**	**984**

Notes:

1. Number of structures is based on census tagging activity after conduct of stakeholder consultation meetings;
2. Number of structures and respondents do not match because:
   - There are structures with more than one occupant/household (e.g., renters of residential units, as well as lessees of commercial establishments);
   - There are respondents who own more than one (1) affected structure
3. n.d. – No data; no stakeholder meeting with PAPs and corresponding field activities has been held pending approval of Taguig City

Considering that the MMSP will traverse a highly urbanized portion of Metro Manila, it is expected to impact a wide-ranging group of affected persons, which may be categorized as shown in Table 43, based on type of land use.

Table 43. Expected Type of PAPs

Type	Sub-type	Description
Type A: Residential	Sub-type A1	Residents who own land, structure, and business
	Sub-type A2	Residents who own land and structures
	Sub-type A3	Residents who own land only
	Sub-type A4	Residents who own structures only (informal settlers)
	Sub-type A5	Residents who own structures only with business
Type B: Commercial	Sub-type B1	Owners of business establishments who also own land and structure
	Sub-type B2	Business enterprise that own land only
	Sub-type B3	Owners of business establishments who lease space
	Sub-type B4	Ambulant vendors with permit from LGU
	Sub-type B5	Ambulant vendors without permit from LGU
Type C: Industrial	Sub-type C1	Owners of industries who also own land and structure
	Sub-type C2	Owners of industries who lease space
Type D: Institutional	Sub-type D1	Government (owned by government)
	Sub-type D2	Non-government (e.g., church, cemetery

Source: JICA Study Team

A Resettlement Action Plan (RAP) and Land Acquisition Plan (LAP) will be prepared to ensure that affected households and establishments are justly compensated and will have a quality of life equal or better than their current condition.

Section 5.2 Social Development Plan of this Report further discusses the social impact assessment and the benefits and compensation of affected persons by the project, which describes different types of losses and the types of Livelihood Rehabilitation Assistance and Training to be extended to affected individuals if their source of income and livelihood will not anymore be applicable to their relocation site.

In-migration

Once the right of way has been acquired by the government and the areas had been cleared during the pre-construction stage, informal settlers can potentially occupy or resettle in the area. In order to avoid this, the time between the pre-construction phase and the construction phase should be shortened as much as possible. Project areas will also be fenced and guarded with security personnel to limit access or entry at the right of way.

Impact to Historical Cultural/Heritage

Based on the basic design and route of the subway and the location of the depot in Brgy. Ugong, Valenzuela City, the MMSP alignment will not entail any displacement or removal of historic sites and structures.

The nearest site with historical importance, which is located approximately 250 meters east of the proposed underground BGC Station, is the Fort Bonifacio War Tunnel. A potential impact of the project to the historical tunnel during the construction of the subway is the inducement of ground borne noise and vibration particularly during tunnel boring. The noise and vibration can propagate from the tunnel under construction to the existing historical tunnel.

The extent of vibration that will be felt at the Fort Bonifacio War Tunnel will depend on the distance of the MMSP subway to the existing tunnel, the method used for boring and underground structure. The distance of the MMSP alignment from the existing tunnel cannot be determined yet at this stage. However, considering same depth lateral distance of approximately 210 meters between the existing and the proposed tunnel, this distance is too large to induce noise and vibration that can be felt at the war tunnel.

Displacement of Institutional Facilities

Based on the proposed general layout of the depot and stations shown in Figure 8, the following institutional facilities are within the area for acquisition:

- Jesus Haligi ng Buhay Gospel Ministry (Religious Institution) at the proposed Valenzuela depot
- Pacific Global Medical Center (Hospital) at the proposed Quirino Highway station
- United Hills Church of the Nazarene(Religious Institution) at the proposed FTI station

The displacement of Pacific Global Medical Center will disrupt the provision of medical services to approximately 100,000 patients per year, mostly from Northern Metro Manila. The disruption of services by the hospital is especially critical to patients requiring continuous treatment.
In the same way, the displacement of religious institutions will also disrupt the functions and services that the institution provides to its community.

Following JICA Guidelines, World Bank OP4.12 and other established and applicable Philippine Laws and similar policies and guidelines, the most practicable measures possible to divert the initially proposed construction yard away from Pacific Global Medical Center and United Hills Church of the Nazarene shall be strongly considered. The religious institution in the proposed Valenzuela depot is relatively a small facility. Proper resettlement of this facility shall be detailed in the final RAP.

Service utilities interruption

A Utility Survey was undertaken by RRGSON Engineering to assess the impacts of the project to the existing utility structures and facilities such as flyovers, underpass roads, elevated and at grade railways, water pipes, sewage pipes, electric power distribution lines, telecommunication cables, etc. along the alignment.

Results of the Utility Survey are summarized below:

(1) Utility lines

- The survey along the proposed MMSP Alignment shows that there are three (3) main utilities that exist: Electrical Utilities, Water & Sewerage Utilities and the Electronics and Communication Utilities.
- These utilities are along the existing road networks that the proposed alignment will traverse. With exemptions along the residential and building areas, the informal settler's area and the waterways area, the rest of the proposed alignment have existing utilities. They may be overhead or under the pavement.
- Some of these three (3) utilities are located underground within the private compounds of Trinoma Mall along Mindanao Avenue/EDSA, Eton-Centris along Quezon Avenue/EDSA, Corinthian Hills and Corinthian Garden Subdivisions, MERALCO compound in Quezon City and within the Bonifacio Global City in Taguig.

(2) Electrical Utilities

Electrical Posts are placed along the sidewalks of all road networks that will be passed or crossed by the proposed alignment, starting from the proposed Depot location up to the end of the proposed alignment (approximately 28.35 km).

The majority of these posts that supply electricity in Metro Manila are from MERALCO and some are from Manila Grid Corporation. These posts were made of wood, concrete or steel.

(3) Water & Sewerage Utilities

Water lines and sewerage lines are placed along and under the sidewalks and are placed under the road carriage way in some areas. These utilities exist in all road networks where the proposed alignment will traverse.

These utilities are under the Metropolitan Waterworks and Sewerage System (MWSS). MWSS has divided its function into two concessionaires namely MAYNILAD Water Service, Inc. and Manila Water Company, Inc. They serve all the residential houses and building establishments that are facing the roads along the alignment.

(4) Electronic & Communication Utilities

The electronic & communication utility lines exist both overhead and underground in majority of the road networks that the proposed alignment will pass through. These utilities belong to the Philippine Long Distance Telephone Company (PLDT), Smart Telecom, Global Telecom and Cable Network Companies.

As for interruption of groundwater usage in Metro Manila, NWRB has already prohibited the extraction of groundwater through deep wells. Hence, impact to groundwater access is unlikely to occur.

Given these current conditions, the subway will be designed to utilize deep underground space where there would be no disruption of utility services or conflict with existing structures. All stations are designed to be located underground, and will only surface gradually from Quirino Highway Station as it approaches the Valenzuela depot.

In order to avoid or at least minimize disruptions in the delivery of basic services, coordination with concerned public utilities such as MERALCO, Maynilad, MWCI and PLDT will be done during the planning and construction phases. Moreover, relocation of major utilities, if needed, along and crossing the subway corridor and the construction sites shall be completed before the commencement of the construction.

A Utility Management Plan will be developed in consultation with, and agreed by concerned utility authorities along the alignment during the Design Phase. The plan will be developed using the following principles:

- Everything possible will be done to avoid conflict with major utility services and adopt construction methodology to support and protect major services in place;
- For unavoidable conflicts, utilities will be relocated or diverted in advance of construction activities;
- The timing and execution of utility relocations and diversions will be selected to minimize impact to those served by the utility.

Impact to public health and safety

Construction-related accidents can occur due to improper work ethics, which may be a threat to the health and safety of workers and local residents.

The following measures are recommended to reduce risks of threats to human health and safety:

- Appropriate personal protective equipment (PPE) must be provided to all construction workers, especially those who are working on heights, heavy and electrical equipment, and underground construction activities.
- The contractor shall be duly trained for the subway construction works
- The contractor should submit an Occupational Health and Safety Management Plan prior to commencement of work.
- A medical station within the complex will be provided to safeguard the health of the workers.
- The project site will also be fully fenced and access points will be not be available for the public.

The workers and the local community also run the risk of exposure and spread of contagious/ infectious diseases due to unsanitary condition at the project site. The following mitigation measures are recommended:

- Stringent observance of high standards of cleanliness and sanitation will minimize the risk of disease transmission.
- Medical certificates will also be requested to ensure workers are fit to work.

- Appropriate sanitary facilities shall be provided at all construction sites such as portable toilets and litter bins.
- A health education campaign and training should be conducted for the construction workers in safety and health protection measures as part of their Occupational Health and Safety Management Plan.

Notable health facilities that are located along or near the MMSP alignment are Pacific Global Medical Center in Quirino Highway Station, Veterans Memorial Medical Center near North Avenue Station, AFP Medical Center at East Avenue Station and the World Citi Medical Center near Anonas Station. In order to ensure that availability of health services will still be accessible during construction, the proposed excavation method described in the section "Changes in Traffic Condition" below, will be employed. As for the Pacific Global Medical Center which will be directly affected and may need to be acquired by the government, the proponent shall strongly look into considering during the DED phase the possible diversion of the construction yard away from the hospital. The proponent shall closely coordinate with the facility regarding this matter.

Impact to Employment/Livelihood

The construction of the subway will require both skilled and unskilled laborers, thus, will provide temporary employment opportunities. Approximately 5,000 workers and operators will be employed, the exact number depends on the construction duration and number of construction machines that will be used. To boost economic activity of the local community and affected LGUs, the project proponent will mandate contractor to give priority to the local residents.

However, commercial establishments and small vendors may experience temporary disturbance during pre-construction, especially in the proposed Valenzuela depot. The project may also lead to a decline or eventual loss of business in affected areas. In consideration of affected groups, construction activities shall be undertaken at the shortest possible time to restore normal business operations immediately.

Alternative livelihood programs in coordination with the LGUs and other government agencies will also be taken in to consideration. For business establishments that will be permanently removed, the RAP details a replacement cost for the loss.

Changes in Traffic Condition

Because of the mobilization of heavy vehicles and equipment, construction activities and staging of works, restriction of some roadways and sidewalks will be unavoidable. This will lead to increased traffic congestion and changes in traffic patterns. Motorists, cyclists and pedestrians might alter their trip routes to their inconvenience in order to avoid heavy traffic in the construction areas.

To address this, a Traffic Management Plan (TMP) that details the activities to adequately manage traffic flow will be strictly implemented. The TMP will be properly coordinated and approved by the MMDA and LGUs concerned. Some measures that may be included in the plan are rerouting of

traffic and proper scheduling of transport of heavy structures during periods when there are less vehicles on the road.

To keep the existing road lines during construction works, road side lands shall be acquired for the temporary construction yards. A proposed excavation method to ensure traffic flow during construction is illustrated in Appendix D. The basic method involves a moving construction yard, depending on the phase of construction. When half of the road is opened for excavation, the flow of traffic will be transferred to the side of the road. After the first half of the road is excavated, it will be covered with pre-cast panels to make it passable. The next half of the road will then be excavated. Hence, the traffic will be diverted to the construction yard and the covered portion of the road.

Employing this proposed excavation method will also ensure that people will have continued access to facilities near the project area.

2.4.2.2. Operation Phase

Service Utilities Interruption

Service utilities will not be disrupted once the subway is in operation. The power, water and other utilities requirements of the subway will be integrated into the service areas of the existing public utilities and would not deprive the public access to such utilities.

Impact to public health and safety

There may be risk of accidents due to improper work ethics, which may threaten health and safety of workers and passengers at the stations and depot. An Occupational Health and Safety Management Plan will be implemented by the proponent during the operations stage. This will be aligned with the policy of the DOTr mandating the strict implementation of precautionary, safety and security measures to ensure safe, fast, efficient and reliable transportation services.

Appropriate personal protective equipment (PPE) must be provided to all personnel undertaking maintenance work. Security guards will be deployed in all stations to direct passengers on the safe zone. An Emergency Response Plan shall also be established by the proponent in order to define actions in preventing the occurrence of accidents and response procedure in case of accidents, fire and natural hazards. The health of employees working at the stations and depot may be affected from exposure to unsanitary conditions. Sanitary facilities or utilities to maintain sanitary and healthy conditions will be made available in all stations and depot.

The following safety measures will also be considered in the design of the subway so that safe operation of the railway will be ensured:

- Rolling stock for the MMSP will run on sections where there are many curves and poor and limited view. The rolling stock should be equipped with the train protection system that assures high safety, such as Automatic Train Control (ATC), Automatic Train Operation (ATO) in order to avoid collision of trains.

- Incombustibility of construction materials shall be thoroughly incorporated in the selection of materials used in the rolling stock to reduce damages in case of fire of the train. The base of the rolling stock to be selected shall be proven in terms of safety, without serious accidents in the past, since the evacuation in case of emergency, such as fire, is difficult for a subway.
- Rolling Stock for the MMSP should have a low failure rate as well as redundancy that ensures uninterrupted operation of trains even in case of failure of propulsion units as evacuating from trains in the subway corridor is difficult and dangerous, thus should be avoided as much as possible.
- Emergency escape door will be provided at the front of the driver's cabin.
- The rolling stock will apply impact buffer structure to the body and strengthened body.
- Underground station, platform, concourse, staff rooms, equipment rooms will be ventilated by fresh air. In addition, smoke exhaust system and station air conditioning system which correspond to the disaster prevention measures for the underground station should be considered.
- Forced ventilation system and emergency smoke exhausting shall be provided for proper tunnel air ventilation.
- Drainage pump facilities will be installed to pump up inflow water from outside ground level (rain water, etc.) and water from inside the tunnel. Drainage operation is automatically performed by detecting high water level by pre-set ultrasonic waves water gauge. Pump operation is able to be monitored and controlled.
- Platform Screen Door will be installed to improve safety on the platform.

Increase employment and enhanced productivity

The project is expected to enhance workforce mobility between the CBDs of Metro Manila through the provision of an efficient mass transit system. Students and the general public will also have enhanced mobility in going to educational and other institutions. This fast and continuous means of transportation gives the labor force in NCR more chances of getting available jobs without having to consider the distance between their home and their place of work. Shorter and more comfortable travel time will also bring workers better physical and psychological state resulting to work productivity.

Employment for skilled personnel to operate and maintain the railway system will also be available. It is estimated that the subway operation will provide employment to more or less 1,400 employees for manning the stations, operations and maintenance of the subway and trains at the depot. Creation of new business opportunities is estimated to create jobs for a total of 220,000 people. This number is a preliminary estimation based on an analysis report of Tsukuba Express case in Japan.

Improved Traffic Mobility

The subway project will generally improve the traffic situation within the project area due to expected shift of commuters from road-based to rail-based transport system. The project will also

result to a shorter travel time and convenience for commuters, especially at the eastern and southern parts of Metro Manila.

At present, travel time from Quirino Highway to FTI by public bus through EDSA will take approximately 2.5 hours. Using the subway, travel time from Quirino Highway to FTI will only take 43 minutes. Hence, travel time will be shortened by approximately 107 mins/passenger. Considering that the subway can accommodate 365,000 passengers per day, the total travel time reduction translates into increase in employee productivity estimated at Php 39 M per day.

The project benefit will be enhanced by expanding ridership between various parts of Metro Manila. Thus, the operator should ensure the efficient, reliable and safe operation of the system with zero down time through regular maintenance. Linkages with LRT, MRT lines, bus and jeepney stations will also be considered for efficient passenger flow transferring to other modes of transportation. Fares must be affordable to the riding public. Discounts should be extended to students, person with disabilities and senior citizens.

On the contrary, there may also be increased vehicular flow in areas adjacent to stations, where commuters are likely to load and unload to and from other modes of road transport. Conversion of construction yards into sidewalks, taxi bays, unloading and loading stations or central stations for public utility vehicles (Figure 64) can help address this potential increase in traffic. Coordination with MMDA and the LGUs could also be done to assign traffic enforcers in critical areas.

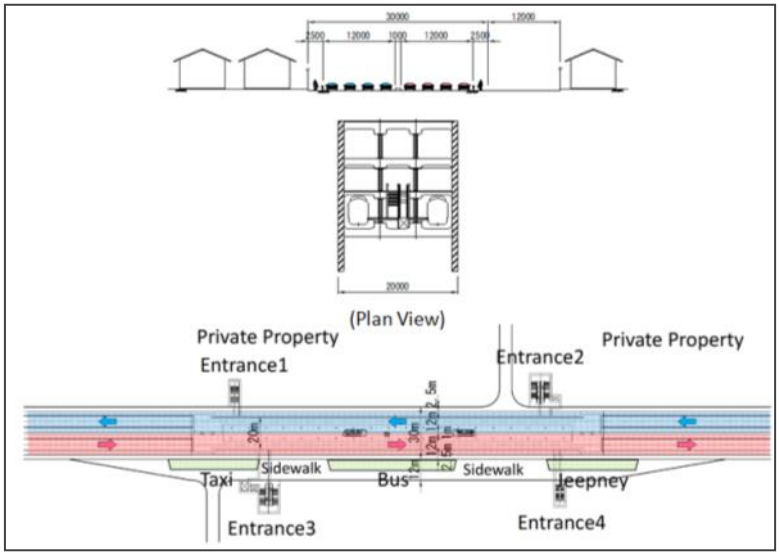


Figure 64. Illustration of plan for conversion of construction yard

After the construction works, the acquired lands will be utilized for Transit Oriented Development (TOD). TOD will ensure mobility of people and accessibility to services and activities, and promote compact and energy efficient urban spatial structure at and around the stations. The following TOD concepts will be considered:

- Stations will be designed to provide a safe, convenient and comfortable pedestrian access within a walkable area from the station. Sidewalks and station plazas can be designed into parks with green spaces to encourage walking and improve urban environment.

- Integrate in the subway design the universal access for all passengers including elderly people and persons with disabilities or special needs.
- Some of the preliminary TOD concepts for MMSP include:
  - Connection of neighboring business/ commercial facilities with stations
  - Integrate in the design feeder public transportation services such as buses and jeepneys to improve the passenger convenience and expand the transit supportive area. To implement access improvement, coordination with the relevant public sector such as DPWH and LGUs as well as local community is imperative.
  - Conversion of construction yards into sidewalks, taxi bays, unloading and loading stations or central stations for public utility vehicles
  - Direct transfer with stations of other railway systems such as LRT1, MRT3, MRT7 and North Integrated Transport Terminal (ITS) for bus and jeepneys at the North Avenue Station
  - Direct transfer with MRT3 Quezon Avenue Station to MMSP Quezon Avenue Station
  - Direct transfer with North-South Commuter Railway (NSCR) and South ITS (bus, jeepney), access to ARCA South in FTI Station
  - Transit terminal connecting BGC Station with the Makati-Pasay-Taguig Mass Transit System Loop (MTSL) Project

A summary of the potential impacts, assessment of impacts and mitigating measures to address the identified impacts is provided in Table 44.

Table 44. Impact Identification, Assessment and Mitigating Measures for People

Social Aspect	Potential Impacts	Assessment of Impacts	Mitigating/Enhancement Measures
PRE-CONSTRUCTION AND CONSTRUCTION			
Involuntary Resettlement	Displacement of residents, commercial and industrial establishments along the proposed alignment	Moderate adverse	• Alignment was traced under existing public roads and public properties, as much as possible, to minimize ROW acquisition • RAP was prepared to ensure that affected households and establishments are justly compensated and will have a quality of life equal or better than their current condition.
Informal settlers	In-migration of informal settlers in ROW lands	Moderate adverse	• Shorten time between the pre-construction phase and the construction phase as much as possible. • Project areas will be fenced for safety and security reasons.
Historical/cultural heritage	Potential displacement or removal of historical structures	Negligible	No mitigating measures are needed.
	Potential disturbance of Fort Bonifacio War Tunnel due to ground-borne noise and vibration from subway	Negligible	No mitigating measures are needed.
Displacement of Institutional Facilities	Disruption in the provision of institutional services	High adverse	• Strongly consider diversion of initially proposed construction yard away from Pacific Global Medical Center and United Hills Church of the Nazarene. • Proper resettlement of identified small religious institution in Valenzuela shall be detailed in the final RAP.
Service utilities	Service utilities interruption	Moderate adverse	• Subway will be designed to utilize deep underground space • Coordinate with concerned public utilities such as MERALCO, Maynilad, MWCI and PLDT during the planning and construction phases

Social Aspect	Potential Impacts	Assessment of Impacts	Mitigating/Enhancement Measures
			• Develop a Utility Management Plan
Employment/ Livelihood	• Temporary disturbance of commercial establishments and small vendors • Decline or eventual loss of business in affected areas.	Moderate adverse	• Construction activities shall be undertaken at the shortest possible time to restore normal business operations immediately. • For business establishments that will be permanently removed, the RAP details a replacement cost for the loss. • Alternative livelihood programs in coordination with the LGUs and other government agencies will be taken in to consideration.
	Generation of temporary employment	Beneficial	Priority for employment will be given to the local residents to help boost economic activity of affected LGUs.
Traffic condition	Increase in traffic congestion due to mobilization of workers, heavy equipment and construction materials, transport of demolition debris and excavated soil	Moderate adverse	• A TMP that details the activities to adequately manage traffic flow will be strictly implemented. • Proper coordination and approval of TMP by MMDA and LGUs concerned. • Implementation of a moving construction yard during different phases of the excavation process to minimize traffic congestion. • Proper scheduling of transport of heavy structures during periods when there are less vehicles on the road
Health and safety	Increased risk of accidents due to improper work ethics which may threaten health and safety of workers and local residents.	Low adverse	• Provision of appropriate PPEs to all construction workers • The contractor shall be duly trained for the subway construction works • Contractors shall submit an Occupational Health and Safety Management Plan prior to commencement of work. • A medical station within the complex will be provided to safeguard the health of the workers • The project site will be fully fenced and access points will be not be available for the public.

Social Aspect	Potential Impacts	Assessment of Impacts	Mitigating/Enhancement Measures
			• Include safety measures in the design of subway
	Threat to availability of health services	Moderate adverse	• A TMP that details the activities to adequately manage traffic flow will be strictly implemented. • Proper coordination and approval of TMP by MMDA and LGUs concerned. • Implementation of a moving construction yard during different phases of the excavation process to minimize traffic congestion. • Proper scheduling of transport of heavy structures during periods when there are less vehicles on the road
Communicable and infectious diseases	Spread of communicable and infectious diseases	Low adverse	• Stringent observance of high standards of cleanliness and sanitation at the construction site • Medical certificates will also be requested to ensure workers are fit to work. • Appropriate sanitary facilities shall be provided at all construction sites such as portable toilets and litter bins. • Implementation of an Occupational Health and Safety Management Plan by the contractor.
OPERATION PHASE			
Service Utilities	Service utilities interruption	Negligible	The power, water and other utilities requirements of the subway will be integrated into the service areas of the existing public utilities
Employment and livelihood	• Enhanced commuters mobility • Better physical and psychological state of commuters resulting from shorter and more comfortable travel time	Beneficial	Regular preventive maintenance of the subway system to maintain efficient, reliable and safe subway operation and maintain its economic and social benefits

Social Aspect	Potential Impacts	Assessment of Impacts	Mitigating/Enhancement Measures
	• Employment of skilled personnel to operate and maintain the railway system		
Traffic Condition	Easement of traffic congestion	Beneficial	• Regular preventive maintenance of the subway system to maintain efficient, reliable and safe subway operation and maintain its economic and social benefits • Consider linkages with LRT, MRT lines, bus and jeepney stations for efficient passenger flow transferring to other modes of transportation
	Increased vehicular flow in areas adjacent to stations	Moderate adverse	• Conversion of construction yards into sidewalks, taxi bays, unloading and loading stations or central stations for public utility vehicles • Coordination with MMDA and the LGUs to assign traffic enforcers in critical areas. • Utilization of acquired lands for TOD
Health and safety	Risk of accidents due to improper work ethics	Moderate adverse	• Implementation of an Occupational Health and Safety Management Plan, which includes an Emergency Response Plan, during the operations stage • Provision of sanitary facilities or utilities to maintain sanitary and healthy conditions in all stations and in the depot • Implement safety measures through engineering design and administrative controls during train operation

CHAPTER 3

Environmental Management Plan

3. ENVIRONMENTAL MANAGEMENT PLAN

This chapter details the Impact and Monitoring Plans required under the DENR Administrative Order (DAO) 03-30 to ensure that the proposed project will not cause undue adverse impacts on the environment and also contribute to social and economic development of the affected area. This will include the proposed work programs, budget estimates, schedule, lead persons and other necessary support services to implement the mitigating measures.

3.1. Impacts Management Plan

Table 45 shows the summary of the Impacts Management Plan enumerating activities aimed at eliminating, reducing or controlling the adverse environmental impacts of the proposed project.

Table 45. Impacts Management Plan

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
I. **PRE-CONSTRUCTION AND CONSTRUCTION PHASES**					
The Land					
Clearing and demolition activities	• Soft ground • Soil erosion during clearing of land • Soil runoff	Limit time between pre-construction and construction; Set activities during dry season	• Contractors • Proponent	Included in the construction cost	Bid Documents / Contract Agreement
Generation of demolition wastes	Soil contamination and aesthetic impacts	• Recycling of demolition wastes • Use of leftover concrete and metals for suitable alternative projects • Uncontaminated residual wastes will be used as backfilling materials in quarry sites and land reclamation projects. • Disposal of contaminated solid wastes through an accredited TSD facility.	Contractors, with monitoring and supervision by DOTr PMO	Disposal of contaminated soils & wastes is Php 32,000 per 15 m^3 truckload to Clark Landfill	Bid Documents / Contract Agreement
Clearing and removal of trees	• Potential removal of 767 trees, of which 298 are threatened species, present in the proposed depot and stations • Removal or reduction of ecosystem services such as microclimate regulation, flooding, provision of habitat to faunal species and carbon sequestration	• Preparation of a detailed management plan for the removal of trees shall be required from the contractors. • Preparation and implementation of a detailed plan for the transfer/earthballing of matured trees. A system to periodically monitor and maintain survival of these species should be set in place to assure high survival rate. • Replacement and planting of corresponding number of tree seedlings	Contractors, with monitoring and supervision by DOTr Environment Unit	Earth-balling ~ Php 30,000 per tree Tree planting cost to be determined based on current prices of seedlings during	Bid Documents / Contract Agreement

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
		by the proponent • Coordination with concerned agencies or groups for relocation sites of earth-balled trees. A system to periodically monitor and maintain survival of these species should be set in place to assure high survival rate. • Integration of landscaped green areas (e,g, parks, green roofs and vertical gardens)in the design layout of the proposed depot and stations. • Selection of tree species for green spaces should be biased towards native species to ensure habitat connectivity of local fauna. • Felled trees during the construction phase should not be allowed to degrade under the elements to ensure that the CO_2 trapped in the wood biomass is not released back as GHG. • Leaves and clippings from the felled trees should be shredded and mulched to ensure that the nutrients stored and captured in the biomass is returned and cycled back to the soil.		implementation Other costs: Included in construction cost	
Construction site activities	Impairment of visual aesthetics	Use of “green” walls, in the form of green-painted fences, green facades or living walls	• Contractors • Proponent	Included in the construction	Bid Documents / Contract

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
		as construction barriers/fences		cost	Agreement
Earthwork activities (tunneling, excavation, backfilling and stockpiling)	• Slope failures, landslides and subsidence due to cutting and filling • Soft ground • Soil erosion and siltation along the rivers and creeks • Soil runoff • Alteration in topography due to excavations of earth and stockpiling	• Reinforced or proper cut slope techniques are to be used • Good housekeeping • Proper waste and drilled earth materials disposal • Construction of a good drainage system	• Contractors • Proponent	Included in the construction cost	Bid Documents / Contract Agreement
Leaks and accidental spills on soil	Soil contamination	Require contractors to: • Implement proper handling and management of chemicals • Practice good housekeeping at construction sites • Establish and implement an emergency and contingency plan in case of spills as well as health and safety management plan • Store bulk chemicals, such as fuel, lubricants and other chemicals, in an impermeable area and with appropriate secondary containment and, • Comply with environmental permitting	• Contractors • Proponent	Included in the construction cost	Bid Documents / Contract Agreement

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
		requirements for the storage, transport, treatment and handling of hazardous substances and wastes.			
Damage of subsurface structures during drilling and excavation activities	Soil contamination	Cautious drilling along other artificial subsurface structures; Design adjustments or modification of already present structures	• Contractors • Proponent	Included in the construction cost	Bid Documents / Contract Agreement
Generation of excavated soil (approximately 4.4M m^3) from excavation/ tunneling	• Traffic congestion and damage of roadways along the route to disposal site • Increased siltation of water bodies • Aesthetic impacts • Soil contamination	• Used of surplus soil as backfilling in: (1) quarry sites in the province of Rizal; (2) projects of Provincial Risk Reduction Management Council (PDRRMC) in Regions III and IV; and (3) projects of Department of Public Works and Highway (DPWH). Permits for transporting of excavated soil will be obtained from the LGUs. • Proper scheduling of excavation works, and coordination with surplus soil recipients to ensure immediate hauling of surplus soil • Develop and implement Traffic Management Plan • Road maintenance by the contractors • Periodic analysis of heavy metal levels shall be conducted. If considerable high level of heavy metal is identified, proper management and disposal to an	Contractors/ subcontractors, with monitoring and supervision by DOTr Environment Unit	Approximately Php 3.5 billion pesos for the 4.4M m^3 excavated soil Disposal/transport to recipient sites of surplus soil is Php 32,000 per 15 m^3 truckload	Bid Documents / Contract Agreement

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
		accredited TSD facility shall be implemented.			
Transport of construction materials	Traffic congestion and damage of roadways along the route to disposal site	• Proper scheduling of the delivery of construction supplies and materials • Develop and implement Traffic Management Plan • Road maintenance by the contractors	• Contractors • Proponent	Included in the construction cost	Bid Documents / Contract Agreement
Generation of solid wastes from the construction workforce	• Land and water contamination • Aesthetic impacts • Spread of diseases	• Submission and implementation of Solid Waste Management Plan as part of contractors' engagement • Placement of waste bins to avoid dispersal of litter and regular site maintenance duties • Regular collection, transportation and disposal of wastes to minimize the attraction of vermin, insects and pests	• Contractors • Proponent	Included in the construction cost	Bid Documents / Contract Agreement
Liquefaction	• Damage to underground structures and overlying structures (in depot and stations) in the event of an earthquake • Loss of soil strength, settlement of soil, lateral spreading, bearing failures, floatation of embedded structures	• Constructing subways structures at deep underground • Chemical liquid injection for soil strength improvement • Observe 20 meters buffer zone from body of water (surface and subsurface) • Conduct a borehole log of Pasig riverbed to identify how thick is the soft sediments and other sedimentary beds	• Contractors • Proponent	Included in the construction cost Included in cost of DED	Bid Documents / Contract Agreement

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
Ground shaking	Damage to components of the construction work	• Construction of shield tunnels as a protective and support structure during tunnel excavation • Reinforcement of the surface structures to be constructed for the station to ensure safety and continued use • Adopt a seismic design during the detailed engineering phase of the subway project • Conduct earthquake drills	• Contractors • Proponent	Included in the construction cost	Bid Documents / Contract Agreement
Ground rupture	Damage to components of the construction work	• Conduct inclined drilling survey of the subsurface condition of the area surrounding not only the Cayetano Boulevard Station but also the sections of the proposed alignment located nearby the fault traces, in consultation with PHIVOLCS • Strongly consider realignment of the subway in Cayetano Blvd. Station, away from the fault	• Proponent/ JICA Study Team	Included in cost of DED	Bid Documents / Contract Agreement
The Water					
Clearing and excavation activities	Increase in suspended sediments in the receiving water	• Conduct demolition and excavation activities during the summer, as much as possible. • Protect demolition and excavated materials from the rain by roofing it and	• Contractors • Proponent	Potable water quality meter: Php 200,500 Others: Included in	Bid Documents / Contract Agreement

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
		redirecting rainwater to a catchment basin or the nearest drainage system • Proper waste water treatment plans by the contractor prior to construction works. • Debris/soil and other excavated materials shall be hauled out from the site immediately and disposed by accredited waste handlers. • Treatment of turbid water caused by excavation works before discharge • Chemical injection method shall be implemented in appropriate ways under sufficient groundwater monitoring systems. • Monitor and control waste water in construction sites.		construction and maintenance costs	
Clearing of trees and conversion into construction yards	Erosion and siltation in surface water bodies	Use permeable pavements after construction works while converting construction yards into walkways or bike lanes or open spaces.	• Contractors • Proponent	Included in construction cost	Bid Documents / Contract Agreement
Clearing and excavation activities	Flooding and inundation due to clogged waterways	• Proper disposal of demolition debris and construction spoils by the contractor • Implementation of erosion control measures before major earthmoving works begin	• Contractors • Proponent	Included in construction and maintenance costs	Bid Documents / Contract Agreement

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
Excavation works	Lowering of groundwater level due to inflow of groundwater into underground tunnel	• Conduct more detailed geological and groundwater level surveys in detailed design stage • Consider proper construction plans on the basis of the survey results. • Adoption of the shield tunneling method will reduce possibility of groundwater inflow into the tunnel structures	• Contractors • Proponent	Included in construction and maintenance costs	Bid Documents / Contract Agreement
The Air					
Generation of dusts and PM from earthmoving, demolition and stockpiling	Temporary increase of air pollutant emissions, specifically TSP and PM	• Regular wetting of ground soil in the construction site • Construction sites must be fenced for safety and security reasons • Hauling trucks for excavated soil must be covered during travel	• Contractors • Proponent	Included in the construction cost	Bid Documents / Contract Agreement
Emission from vehicles and gensets	Temporary increase of air pollutant emissions (NOx, SOx, CO and HC)	• Regular preventive maintenance of heavy equipment and service vehicle	• Contractors • Proponent	Included in the construction cost	Bid Documents / Contract Agreement
Movement and operation of construction machinery	Increase noise level and ground vibration during construction	• Select equipment with lower sound power levels • Installation of mufflers on engine exhausts and compressor components • Installation of noise suppressors and	• Contractors • Proponent	Included in the construction cost	Bid Documents / Contract Agreement

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
		vibration isolation to construction/mechanical equipment. • Regular maintenance of heavy equipment, machineries and support vehicles • Installation of temporary noise barriers such as galvanized iron shields • Use of Personal Protection Equipment (PPE) • Relocating noise sources to less sensitive areas • Fencing of the construction site • Scheduling of the high noise generating activities during daytime. • Use of shield tunneling method construction technique			
The People					
Involuntary Resettlement	Displacement of residents, commercial and industrial establishments along the proposed alignment	• Alignment was traced under existing public roads and public properties, as much as possible, to minimize ROW acquisition • RAP was prepared to ensure that affected households and establishments are justly compensated and will have a quality of life equal or better than their current condition.	Proponent	Land acquisition cost: Php ~23,018,765,800 Replacement cost: Php ~11,706,958,350.43	RAP Budget can be adjusted to accommodate changes after DED

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
Informal settlers	In-migration of informal settlers in ROW lands	• Shorten time between the pre-construction phase and the construction phase as much as possible. • Project areas will be fenced for safety and security reasons.	• Contractors • Proponent	--	Bid Documents / Contract Agreement
Displacement of Institutional Facilities	Disruption in the provision of institutional services	• Strongly consider diversion of initially proposed construction yard away from Pacific Global Medical Center and United Hills Church of the Nazarene. • Proper resettlement of identified small religious institution in Valenzuela shall be detailed in the final RAP.	Proponent	Included in DED and RAP costs	RAP Budget can be adjusted to accommodate changes after DED
Service utilities	Service utilities interruption	• Subway will be designed to utilize deep underground space • Coordinate with concerned public utilities such as MERALCO, Maynilad, MWCI and PLDT during the planning and construction phases • Develop a Utility Management Plan	• Contractors • Proponent	Included in construction cost	Bid Documents / Contract Agreement
Employment/ Livelihood	• Temporary disturbance of commercial establishments and small vendors • Decline or eventual loss of business in affected areas.	• Construction activities shall be undertaken at the shortest possible time to restore normal business operations immediately. • For business establishments that will be permanently removed, the RAP details a replacement cost for the loss.	• Proponent • Affected LGUs	Included in the RAP Budget Cost-sharing with LGUs, GOs and other NGOs	RAP Budget / Financing by LGUs, GO's and other NGOs

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
		• Alternative livelihood programs in coordination with the LGUs and other government agencies will be taken in to consideration.			
	Generation of temporary employment	Priority for employment will be given to the local residents to help boost economic activity of affected LGUs.	• Contractors • Proponent • LGUs	N/A	N/A
Traffic condition	Increase in traffic congestion due to mobilization of workers, heavy equipment and construction materials, transport of demolition debris and excavated soil Threat to availability of health services	• A TMP that details the activities to adequately manage traffic flow will be strictly implemented. • Proper coordination and approval of TMP by MMDA and LGUs concerned. • Implementation of a moving construction yard during different phases of the excavation process to minimize traffic congestion. • Proper scheduling of transport of heavy structures during periods when there are less vehicles on the road	• Proponent • LGUs • MMDA	Included in construction cost	Bid Documents / Contract Agreement
Health and safety	Increased risk of accidents due to improper work ethics which may threaten health and safety of workers and local residents.	• Provision of appropriate PPEs to all construction workers • The contractor shall be duly trained for the subway construction works • Contractors shall submit an Occupational Health and Safety Management Plan prior to	• Contractors • Proponent	Included in construction cost	Bid Documents / Contract Agreement

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
		commencement of work. • A medical station within the complex will be provided to safeguard the health of the workers • The project site will be fully fenced and access points will be not be available for the public. • Include safety measures in the design of subway			
Communicable and infectious diseases	Spread of communicable and infectious diseases	• Stringent observance of high standards of cleanliness and sanitation at the construction site • Medical certificates will also be requested to ensure workers are fit to work. • Appropriate sanitary facilities shall be provided at all construction sites such as portable toilets and litter bins. • Implementation of an Occupational Health and Safety Management Plan by the contractor.	• Contractors • Proponent	Included in construction cost	Bid Documents / Contract Agreement
II. **OPERATIONAL PHASE**					
The Land					
Leaks and accidental spills of chemicals, especially at the	Soil contamination	Emergency and contingency plan in case of spills and health and safety management plan must be in place	Station administrators and maintenance contractor	Included in the operation and maintenance	EGF

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
depot area				cost	
Solid waste generation	• Land and water contamination • Aesthetic impacts Spread of diseases	Policies on solid waste minimization and solid waste management should be implemented in stations and depot.	Station administrators and maintenance contractor	Included in the operation and maintenance cost	EGF
Geological hazards (liquefaction, Ground shaking/ground rupture)	Damage to underground structures and overlying structures (in depot and stations)	Regular maintenance checks of structures and tests of safety measures; Earthquake drills and early warning system	Station administrators and maintenance contractor	Included in the operation and maintenance cost	EGF
The Water					
Domestic wastewater generation	Pollution of receiving water bodies	• Installation of wastewater treatment facility • Administrators of station and other facilities shall maintain water treatment systems in proper conditions	Station administrators and maintenance contractor	Included in construction and maintenance costs	EGF / Contract Agreement
Maintenance and repair activities in the depot	Pollution of receiving water body, specifically Tullahan River	• Installation of interceptor tank to remove oil and fuel grease from surface water before discharge. • Installation of controlled perimeter drainage system to ensure catchment of all maintenance runoffs. • Operation of a wastewater treatment facility with oil removal. • Equipment and machinery shall be regularly checked for fuel and oil leaks. • During repair of equipment and	Station administrators and maintenance contractor	• Php500,000 (construction cost) • Php30,000 / quarter (overhead cost)	EGF / Contract Agreement

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
		machinery, containers/drip trays shall be used to collect leakage. • Any spilled or spent oil will be collected, stored properly and disposed by accredited waste haulers.			
Heavy rainfall	Flooding and inundation of subway facilities	• Installation of water-shut panels at station entrances • Installation of drainage pumping station to pump up inflow water from outside ground level (rain water, etc.) and water from inside the tunnel and send them to the sewer.	Station administrators and maintenance contractor	Included in construction and maintenance costs	EGF / Contract Agreement
Changes in groundwater flow	Ground subsidence due to lowering of groundwater level	• Installation of monitoring wells for observation along the subway tunnel and monitor change of the surrounding groundwater levels. • If abnormal changes are identified, the administrator shall investigate the causes and implement the proper countermeasures immediately.	Station administrators and maintenance contractor	Included in construction and maintenance costs	EMF / EGF
The Air					
Operation of service vehicles and standby generator set	Air Pollution	• Proper preventive maintenance of service vehicles and equipment • Use of cleaner fuel for the generator sets	Station administrators and maintenance contractor	Included in the operation and maintenance cost	EGF / Contract Agreement
Increase in air	Air Pollution	• Management of traffic along stations	Station administrators	Included in the	EGF / Contract

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
pollutants from increased vehicles along stations		• Use of blowers to dissipate pollutants along terminal	and maintenance contractor	operation and maintenance cost	Agreement
Generation of low frequency noise from structure-borne noise and ground vibration	May cause mental stress to residence	• Installation of noise barrier • Long welded rail and expansion joint, damped wheel and resilient tie will be adopted • Installation of floating slab trackbed • Regular conditioning and maintenance of the trains will be implemented on a regular basis • Speed of train will be limited to minimize noise and ground vibration	Station administrators and maintenance contractor	Included in the construction, operation and maintenance cost	EGF / Contract Agreement
Climate change	Accelerated structural fatigue and materials failure	• Proper design in making infrastructure robust or resilient to the effects of climate change should be taken into consideration	Station administrators and maintenance contractor	Included in the construction, operation and maintenance cost	EGF / Contract Agreement
	Greater demands on the construction, operation and maintenance of flood control and drainage structures.	Improvement of current drainages along the alignment to be resilient to climate change.	Station administrators and maintenance contractor	Included in the construction, operation and maintenance cost	EGF / Contract Agreement
	Increase GHG emissions due to increased demand for cooling system of passenger cars, building offices and	Install reliable and heavy duty air-conditioning (AC) system of railcars that will be purchased and use of centralized AC system for the stations	Station administrators and maintenance contractor	Included in the construction, operation and maintenance	EGF / Contract Agreement

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
	ticket booths			cost	
	Indirect impact -Increased vulnerability of passengers to spread of communicable disease via a mass transportation system.	• Formulate and implement health and safety protocols for all stations and trains • Information, Education and Communication (IEC) materials on proper hygiene in all stations • Provisions for use of HEPA (High Efficiency Particulate Air Filter) for the AC/ventilation system.	Station administrators and maintenance contractor	Included in the construction, operation and maintenance cost	EGF / Contract Agreement
The People					
Employment and livelihood	• Enhanced commuters mobility • Better physical and psychological state of commuters resulting from shorter and more comfortable travel time • Employment of skilled personnel to operate and maintain the railway system	Regular preventive maintenance of the subway system to maintain efficient, reliable and safe subway operation and maintain its economic and social benefits	• Proponent • Station administrators	Included in maintenance cost	N/A
Traffic Condition	Easement of traffic congestion	• Regular preventive maintenance of the subway system to maintain efficient, reliable and safe subway operation and maintain its economic and social	• Proponent • Station administrators	Included in maintenance cost	N/A

Environmental Aspect	Potential Impact	Options for Prevention or Mitigation or Enhancement	Responsible Entity	Cost	Guarantee / Financial Arrangements
		benefits • Consider linkages with LRT, MRT lines, bus and jeepney stations for efficient passenger flow transferring to other modes of transportation			
	Increased vehicular flow in areas adjacent to stations	• Conversion of construction yards into sidewalks, taxi bays, unloading and loading stations or central stations for public utility vehicles • Coordination with MMDA and the LGUs to assign traffic enforcers in critical areas.	• Proponent • Station administrators	Included in construction and maintenance cost	N/A
Health and safety	Risk of accidents due to improper work ethics	• Implementation of an Occupational Health and Safety Management Plan, which includes an Emergency Response Plan, during the operations stage • Provision of sanitary facilities or utilities to maintain sanitary and healthy conditions in all stations and in the depot • Implement safety measures through engineering design and administrative controls during train operation	• Proponent • Station administrators	Included in the health, safety and environmental management plan and budget of the proponent	EGF / Contract Agreement

CHAPTER 4

Environmental Risk Assessment and Emergency Response and Policy Guidelines

4. ENVIRONMENTAL RISK ASSESSMENT AND EMERGENCY RESPONSE AND POLICY GUIDELINES

4.1. Environmental Risk Assessment

4.1.1. Objectives

Environmental Risk Assessment (ERA) is a process that identifies the environmental, health and safety risks associated with the activities to be conducted during MMSP implementation. ERA aims to manage unforeseen events and potential hazards that may have adverse impacts to the environment and the people. It aims to provide information for making reasoned decisions and mechanisms to communicate forecasted risks such that stakeholders and the public are informed of the implications of identified risks.

4.1.2. Methodology

ERA was conducted using these steps:

1) Hazard identification – identification of hazards to the environment and people which can cause an increase in the incidence of adverse health effects, events that could threaten the safety of the people, or cause ecological damage, during the different stages of the project
2) Hazard assessment - assessment of the relationship between the level of exposure and the severity of an effect
3) Exposure assessment – estimation of the magnitude, frequency and duration of human exposure to adverse consequences that may occur, assessment of the size, nature and types of receptors that can be exposed to the hazards, sources and emission routes of the chemicals and consideration of chemical transport and fate in the environment.
4) Risk characterization - estimation of the incidence and severity of the effects likelihood to occur in an environmental compartment due to actual or predicted exposure to a hazard.

4.1.3. Hazard identification

Hazards associated with the project were identified during construction and operation phases and is summarized in the table below. It should be noted that hazards caused by noise and vibration are not included in this section as these are already discussed in the previous sections. Hazards identified below are focused more on the health and safety impacts to the people.

Table 46. Hazards Associated with the Project

Hazards	Description
Construction related accidents	During construction, all personnel assigned at the project site may be subject to accidents if health and safety management plans are not properly carried out. Examples of accidents are as follows: • Collapse of scaffolding • Falling of construction materials while being lifted by a crane boom

Hazards	Description
	• Personnel being run over by heavy equipment • Accidental fall of workers from elevated location or in open pits • Injury from construction debris and materials • Collapse of underground tunnel/ pit
Toxic chemicals	The chemicals to be used and wastes to be generated from maintenance activities at the depot like solvent-based cleaning chemicals, grease and used oil are classified as hazardous. Accidental release or spillage into the environment may soil contamination, air pollution and surface water pollution.
Fire	Fire normally occurs during summer season due to excessive heat. It can also occur due to accidents, equipment failure or faulty electrical systems. Fire may result to damage of property and/or loss of human life.
Rail system failure	This includes failure of rail equipment particularly rail track, signaling/ communication systems and rolling stock. Failure of these devices due to natural hazards (flood, earthquake, volcanic eruption and the like), natural wear and tear of rail parts, or other forms of accidents may result to derailment.
Structural failure	Related to buildings at the Depot, stations, underground structures, as well as all infrastructures where the rail tracks are laid. Failure of these structures due to natural or man-made hazards may result to damage of property and/or loss of human life.
Terrorism attacks	Terrorist attacks like bombing or chemical or biological attacks in public transport systems is a threat which needs to be addressed as it could cause serious mass casualty event.
Security and violence incidents	The structural environment of subway systems may present opportunities for security incidents, crime and violence to occur. These include numerous unobserved niches and empty spaces, poorly lit stations, constricted platforms and crowded facilities.
Transmission of infectious diseases	Transmission of infectious diseases through close person-to-person spread, or indirect contact is a potential health hazard related to subways, where spaces could be confined. Rodents may also be a problem in subway systems. Hence, it is important to consider diseases that maybe spread by these rodents.

4.1.4. Effects assessment

The identified hazards will be assessed in terms of the relationship between the level of exposure and the severity of effect of losses to the people, financial, public and environment. The table below shows the relationship of exposure and severity of effects.

Table 47. Loss Severity

Rating	People	Financial	Public	Environment
1	First aid injury or exposure	Slight damage and downtime <1 day	No effect	Contained. NO impact on site, groundwater, noise or air quality
2	Medical aid injury or exposure	Damage and downtime 1-5 days	Precautionary evacuation	<2 m^2 spill on site or any spill off site. < 200 liter
3	Loss time injury or exposure	Damage and downtime 5-10 days	Medical aid injury or exposure	>2 m^2 spill impacting air, groundwater or waterway. < 200 liter
4	Life threatening injury or exposure	Damage and downtime > 10 days	Serious life threatening injury or exposure	>5 m^2 spill on land, any spill impacting air, groundwater or waterway. >200 m

4.1.5. Exposure assessment

The exposure assessment estimates the magnitude, frequency and duration of human or ecological exposure to the identified hazards. Table 48 presents the probability rating that were used in the exposure assessment.

Table 48. Probability of Event

Rating	Score	Criteria
Almost certain	5	Expected to occur regularly at normal circumstances
Probable	4	Expected to occur at some time
Possible	3	May occur at some time
Unlikely	2	Not unlikely to occur in normal circumstances
Rare	1	Could happen but probably never will

4.1.6. Risk characterization

Risk characterization integrates the effects and exposure assessments into a quantitative and qualitative expression of risks. The degrees of risks were rated by multiplying the probability of event and severity of effects. Risk assessment matrix is presented in Appendix K, while the table below shows the summary of the risk assessment and corresponding risk reduction measures for each identified hazards.

Table 49. Summary of Risk Assessment and Risk Reduction Measures

Possible hazards	Relative Risk	Rating	Risk reduction measure
Construction related accidents	21	Medium	Require contractors to strictly follow construction occupational safety and health regulations.
Toxic chemicals	10	Low	Contractors and Subway Administration must establish and follow emergency and contingency plan for chemical spills.
Fire	28	Medium	Subway Administration must establish fire prevention programs and implement fire and emergency evacuation procedures.
Rail system failure	27	Medium	Design of subway system should conform to standards; Regular predictive and preventive maintenance must be implemented.
Structural failure	33	High	Design of subway system should conform to standards; Regular predictive and preventive maintenance must be implemented.
Terrorism attacks	32	High	Tight security measures, including passenger security inspections, must be implemented.
Security and violence incidents	20	Medium	Tight security measures, including passenger security inspections, must be implemented.
Transmission of infectious diseases	10	Low	Regular maintenance of ventilation system and implement adequate health and safety sanitation programs.

4.2. Emergency Response Policy and Guidelines

4.2.1. Objective

An Emergency Response Plan shall be established by the proponent in order to define actions in preventing the occurrence of accidents and response procedure in case of accidents, fire and natural hazards. This will be aligned with the policy of the DOTr mandating the strict implementation of precautionary, safety and security measures to ensure safe, fast, efficient and reliable transportation services.

During the Detailed Engineering Design Stage, DOTr, through the Subway Administration, will establish an Emergency Response Plan (ERP) in order to define actions in preventing the occurrence of accidents and response procedure in case of accidents, fire and natural hazards. For the construction phase, the contractor is required to prepare the ERP.

During the operational phase, the DOTr and Subway Administration of MMSP should also prepare a specific ERP for its operations. This will be aligned with the policy of DOTr mandating the strict implementation of precautionary, safety and security measures to ensure safe, fast, efficient and reliable transportation services.

4.2.2. Concept

Possible causes of emergency situations due to man-made and natural hazards should be considered in the Detailed Design to reduce the chance of their occurrence. There are a number of design standards and codes that Subway Administration will have to comply with and incorporate in its performance specifications. These standards are part of the requirements of the local agencies concerned in order to grant permits and licenses to DOTr.

Procedures for each of several emergency categories shall be established. The procedures shall specify necessary actions to be performed by appropriate personnel within a time or event sequence. The emergency response plan shall as a minimum address, but not limited to the following categories:

- Construction-related accidents
- Fire
- Bomb Threat
- Total Power Failure
- Structural Failure
- Train Derailment or Collision
- Transport of Dangerous Goods
- Suicide/Railway Injuries or Fatalities
- Criminal Acts
- Natural disasters (High Winds, Flood, Earthquake, etc.)

The plan shall establish what constitutes an emergency and procedure should be developed for:

- Emergency Reporting
- Notification of Emergency Response Personnel
- Dispatching of Emergency Response Personnel and Equipment to the Site
- Coordination of all Emergency Response activities
- Protection of passengers/personnel, and equipment at the emergency site
- Evacuation of passengers/personnel
- Communication to all passengers, employees, emergency response personnel,
- Restoration of normal operations

Training of contractors, employees and emergency response team shall also be undertaken. Education of the riding public with regard to emergency procedures and equipment as well as required passenger emergency response will also be included. Facilities and equipment, vehicles needed to cope effectively with emergency situations shall also be required.

4.2.3. Emergency Response Program

The proponent through its vision shall adopt an active program of pursuing a healthy, safe and environment-friendly operation. Company guidelines on health and safety will be made clear to contractors and all employees during construction and operations. An orientation briefing for contractors and training for employees shall be implemented.

Construction Stage

Emergency situations that could occur during construction are construction-related accidents and fire. The Contractor will set up safety measures required for the construction works. The Contractor shall comply with the following:

- Provide and enforce wearing of efficient helmets, and where necessary, eye goggles, ear protection, safety harnesses, and other personal protection equipment for all the personnel.
- Submit for the approval of DOTr detailed proposals for safety regulations and emergency procedures.
- Approved copies of such safety regulations and emergency procedures shall be produced by the Contractor and distributed and displayed at each place of work, together with any other documents, posters, notices boards, or the like which are required by law. The Contractor shall revise, replace, maintain, or remove the notices, regulations and the like as required by legislation.
- Provide adequate warning signs, barricades, and warning lights at all times during construction.
- Ensure that all equipment are in good working condition
- Provide at designated stations within the site emergency telephones, suitable accommodation, and transport and first aid equipment including stretchers.
- Provide adequate service for the protection against fire at the site in accordance with the local fire regulations.

Operation Stage

For the operation stage, emergency situations that could occur and corresponding preventive measures are as follows:

Table 50. Preventive Measures during Emergency Situations

Emergency Situation	Preventive Measures
Derailment	DOTr Subway Administration will procure emergency re-railing and rescue equipment. These should be part of the depot equipment. DOTr Subway Administration shall inspect, maintain adjust and replace defective, excessively worn or broken running rails, cross ties, special track work components, ballast, direct fixation fasteners, and other track materials, related hardware and support equipment. DOTr Subway Administration shall also inspect and adjust the smoothness of the alignment and levels of the track geometry. There will be inspections for: • Track geometry and ride quality

Emergency Situation	Preventive Measures
	• Turnouts (which may be combined with regular lubrication and cleaning) • Ultra-sonic testing of rail joints and turnout components. These tests will be based on an annual test in each of the first two years and then scheduled as necessary according to the initial results.
Fire	The Fire Safety Enforcement Manual of the Bureau of Fire Protection will be principally used as the design criteria and firefighting/ protection requirements.
Earthquake, Ground Setting and Liquefaction	DOTr Subway Administration shall perform regular inspections by routine patrol of all subway and depot structures and perform maintenance and repairs. A detailed structure inspection shall be performed at least once per year. All structures will be catalogued and numbered in a register of structures that records the conditions, inspection requirements, results and any corrective actions. Main structures shall be the subject to periodic structural inspections. These inspections will be designed and performed according to general practice according to the structure types, materials (steel or concrete), foundations and any specific examination of components such as bearing and expansion joints. Stations and Depot buildings will also be inspected using route patrolling and general route inspections. The inspections will be supplemented with fault reports made by the operational staff. Should periodic inspection detect signs of ground movement, services shall be suspended or be run at reduced speed. If services are allowed to continue, detailed monitoring of the site would be instigated. If services shall be suspended, passengers would be de-trained at the next available station stop. Detailed investigation into the improvements required would be undertaken before services are recommenced or speed restrictions be lifted and such works would be put in hand as soon as reasonably.
Flood	Drainage pump facilities will be included to pump up inflow water from outside ground level (rain water, etc.) and potential water from inside the tunnel and send pumped water to the sewer. Automatic drainage operation will be designed once high water level is detected. Pump operation shall be monitored and controlled from Operation Control Center.
Failure of Structure	DOTr Subway Administration will comply with international and

Emergency Situation	Preventive Measures
	national standards to ensure that the structures are designed and built in accordance with these safety standards.
Transport of Dangerous Goods	DOTr Subway Administration has no immediate plans for the transport of dangerous goods. However, DOTr PMO train crew and emergency re-rail and rescue crews would receive specific training on emergency procedures associated with the specific types of goods carried.
Medical attention required by passengers	For every station, security guards will be equipped with first aid kits. During extreme emergency cases, medical services including ambulance would be summoned to the nearest station by the central supervising station.
Criminal Acts	DOTr Subway Administration will provide security services and passenger security inspections to ensure the safety of passengers, crew and office workers.
Poor underground air quality	For the ventilation of the underground station, platform, concourse, staff rooms, equipment rooms shall be ventilated with fresh air by forced ventilation. In addition, smoke exhaust system and station air conditioning system which correspond to the disaster prevention measures for the underground station should be considered. For the tunnel ventilation, forced ventilation system which has function of tunnel air ventilation and emergency smoke exhausting shall be provided.

DOTr Subway Administration will produce an emergency procedural plan, which shall include, but not limited to, the following:

- Policy, purpose, scope and definitions
- List of participating agencies and signatures of executives signing for each agency
- Safety procedures during emergency situations
- Purpose and operation of Centralized Train Control (CTC) System and alternate CTC
- Purpose and operation of command post and auxiliary command post
- Communication facilities available for use during emergency cases
- Operating manuals of all specialized rescue equipment
- Maps and plans of complex areas of the system
- Any additional information and data that the particular agencies require to have in the plan.

LGUs and other participating agencies within the locality shall be coordinated with by DOTr PMO to cooperate and assist depending on the nature of an emergency which would include:

- Medical services
- Building department
- Fire department

- Police department
- Utility companies
- Other transportation agencies

Training for emergency response crew for the operation stage will be programmed. This would include training programs:

- Sponsored by equipment suppliers for the rescue equipment, firefighting equipment and the like
- Courses being offered by some government agencies such as DSWD, Bureau of Fire Protection, Occupational Health and Safety Center, etc.
- Evacuation of passengers from train, to a point of safety along the guideway
- Evacuation of passengers from stations (surface and underground)
- Emergency procedures to be controlled from the CTC within the Depot control center, including co-ordination of participating agencies such as fire service, police, ambulance, public works and utility companies, etc.

CHAPTER 5

Social Development Plan and IEC Framework

5. SOCIAL DEVELOPMENT PLAN AND IC FRAMEWORK

5.1. Social Development Plan

5.1.1. Introduction

The Social Development Plan (SDP) Framework is intended for formulation in coordination with the City Planning and Development Officers of the cities where the MMSP will pass through, in order to derive from the respective local SDPs of the LGUs, their programs and projects for people's livelihood, health and environment. The MMSP SDP should be aligned with the local SDP, incorporate those programs and projects that prevent, mitigate or enhance the project's negative and positive impacts, especially those relating to the livelihoods, health and environment of the communities affected by the project.

The formulation of the SDP will involve government agencies with mandates to deliver services in social development such as Department of Health (DOH), DENR, Department of Education (DepEd), Department of Trade and Industry (DTI), Department of Labor and Employment (DOLE), Technical Education and Skills Development Authority (TESDA), Philippine National Police, Presidential Commission for the Urban Poor and etc. It should also include civil society such as NGOs and People Organizations. The cost estimates shall be prepared once the specific projects have been identified and processed in consultation with the LGUs and sectors concerned. DOTr shall share in the cost of the selected projects. The Social Development Framework is shown in Table 51.The components of the SDP will be formulated in the detailed engineering design stage.

The SDP will be in the form of a Resettlement Action Plan (RAP) and will also include a Land Acquisition Plan where the list of Project-affected families and corresponding compensation and entitlements for qualified beneficiaries, including timeline, will be found.

Table 51.Social Development Framework for the MMSP

Concern	Responsible Community Member/ Beneficiary	Government Agency/ Non-Government Agency and Services	Proponent	Indicative Timeline	Source of Fund
Preparation of Resettlement Action Plan (RAP)	・Barangay Chairman ・Presidents of Homeowners Association ・Property Owners / Business Owners representative	・DOTr ・LGU	DOTr Project Management Office (PMO)	Feasibility Study and Detailed Engineering Design Stage	Part of Consultancy Budget
Relocation of informal settlers	・Barangay Chairman ・Presidents of Homeowners Association	・DOTr ・LGU Housing office	DOTr PMO	Pre-Construction Stage	DOTr

Concern	Responsible Community Member/ Beneficiary	Government Agency/ Non-Government Agency and Services	Proponent	Indicative Timeline	Source of Fund
Gender Responsive Livelihood Training Program ・Skills training for construction work ・Skills training for handicraft making ・Skills training for food preparation, etc.	・Barangay Chairman ・Barangay Kagawad for Livelihood ・Presidents of Homeowners Association ・Officers of Women's organizations	・LGU Livelihood Office	DOTr PMO	After ECC Issuance	LGU Livelihood Office
Formation of/Support to Vendors Organizations	・Barangay Chairman; and ・Leaders of Vendors Organizations	・DOTr ・DTI	DOTr PMO	Prior to RAP Implementation	LGU Livelihood Office
Health and Safety	・Barangay Chairman; and ・Barangay Kagawad for Health and Safety	・City Health Office; ・Barangay Health Centers	DOTr PMO	Pre-Construction, Construction, Operation Stage	LGU Health Office
Environment and Sanitation	・Barangay Chairman ・Barangay Kagawad for Environment and Sanitation	・LGU ・DENR	DOTr PMO	Pre-Construction, Construction, Operation Stage	LGU
Peace and Order	・Barangay Chairman ・Barangay Kagawad for Peace and Order ・Homeowners Association Sergeant at Arms	・LGU	DOTr PMO	Pre-Construction, Construction, Operation Stage	LGU
Spiritual	・Barangay Chairman ・Parish Pastoral Council ・President Homeowners Association ・Leaders of other religious groups	・Parish Priests ・LGU	DOTr PMO	Pre-Construction, Construction, Operation Stage	LGU

5.1.2. Social Impact Assessment

To understand scope of the resettlement impact of the Project, socio-economic survey has been undertaken for the affected LGUs since April 2017, which consists of, (i) Census Survey, (iii) Asset and Land Survey, and (iii) Livelihood and Living Survey. Census will be done on all PAPs, and their assets (land, structures, improvements, crops and trees) will be inventoried and tagging will be done. Livelihood and Living Survey shall be conducted on 20% of PAPs using the questionnaires, and through focus group discussions.

The cut-off date for the informal settlers has been disclosed to each affected barangays by the relevant LGUs and the barangays have disclosed to their populations. Presidents of Home Owners Association in respective barangays have been contacted to disseminate the information to member ISFs.

The scope of the socio-economic survey under the RAP study is based on the basic design titled as Version 17 and 22. Thus scope of resettlement impacts shall be reviewed during the DED stage which is scheduled to be started in 2018. Therefore, outcomes of the census survey should be verified based on the final Detailed Design accordingly. In case there is no resettlement activities conducted after two years from the said cut-off dates, the census data shall be updated. This is in accordance with the World Bank Operational Policy (OP) 4.12.

At present, the RAP study for the feasibiity stage of the subway project is under review and for finalization by DOTr and JICA Study Team.

5.1.3. MMSP's Project Resettlement Policy

The Government of the Philippines will adopt the Project Resettlement Policy (the Project Policy) for the Mega Manila Subway Project (MMSP) specifically because existing national laws and regulations have some gaps with the international practice, including JICA's policy. The Project Policy is aimed at filling in any gaps in order to help ensure that PAPs are able to rehabilitate themselves to at least their pre-project condition. This section discusses the principles of the Project Policy and the entitlements of the PAPs based on the type and degree of their losses. Where there are gaps between the Philippines' legal framework for resettlement and JICA's policy on involuntary resettlement, practicable mutually agreeable approaches will be designed consistent with the Philippine Government practices and JICA's policy.

I. Land acquisition and involuntary resettlement will be avoided where feasible, or minimized, by identifying possible alternative project designs that have the least adverse impact on the communities in the project area.
II. Where displacement of households is unavoidable, all PAPs (including communities) losing assets, livelihoods or resources will be fully compensated and assisted so that they can improve, or at least restore, their former economic and social conditions.
III. Compensation and rehabilitation support will be provided to any PAPs, that is any person or household or business which on account project implementation would have his, her their;
    - Standard of living adversely affected;

- Right, title or interest in any house, interest in, right to use, any land (including premises, agricultural and grazing land, commercial properties, tenancy, or right in annual or perennial crops and trees or any other fixed or moveable assets, acquired or possessed, temporarily or permanently;
- Income earning opportunities, business, occupation, work or place of residence or habitat adversely affected temporarily or permanently;
- Social and cultural activities and relationships affected or any other losses that may be identified during the process of resettlement planning.

IV. All affected people will be eligible for compensation and rehabilitation assistance, irrespective of tenure status, social or economic standing and any such factors that may discriminate against achievement of the objectives outlined above. Lack of legal rights to the assets lost or adversely affected tenure status and social or economic status will not bar the PAPs from entitlements to such compensation and rehabilitation measures or resettlement objectives. All PAPs residing, working, doing business and/or cultivating land within the project impacted areas as of the date of the latest census and inventory of lost assets (IOL), are entitled to compensation for their lost assets (land and/or non-land assets), at replacement cost, if available, and restoration of incomes and businesses, and will be provided with rehabilitation measures sufficient to assist them to improve or at least maintain their pre-project living standards, income-earning capacity and production levels.

V. PAPs that lose only part of their physical assets will not be left with a portion that will be inadequate to sustain their current standard of living. The minimum size of remaining land structures will be agreed during the resettlement planning process.

VI. People temporarily affected are to be considered PAPs and resettlement plans address issues of temporary acquisition.

VII. Where a host community is affected by the development of a resettlement site in that community, the host community shall be involved in any resettlement planning and decision-making. All attempts shall be made to minimize the adverse impacts of resettlement upon host communities.

VIII. The resettlement plans will be designed in accordance with Philippines' National Involuntary Resettlement Policy and JICA's policy on involuntary Resettlement.

IX. The Resettlement Plan will be translated into local languages and disclosed for the reference of PAPs as well as other interested groups.

X. Payment for land and/or non-land assets will be based on the principle of replacement cost.

XI. Compensation for PAPs dependent on agricultural activities will be land-based wherever possible. Land-based strategies may include provision of replacement land, ensuring greater security of tenure, and upgrading livelihoods of people without legal titles. If replacement land is not available, other strategies may be built around opportunities for re-training, skill development, wage employment, or self-employment, including access to credit. Solely cash compensation will be avoided as an option if possible, as this may not address losses that are not easily quantified, such as access to services and traditional rights, and may eventually lead to those populations being worse off than without the project.

XII. Replacement lands, if the preferred option of PAPs, should be within the immediate vicinity

of the affected lands wherever possible and be of comparable productive capacity and potential. As a second option, sites should be identified that minimize the social disruption of those affected; such lands should also have access to services and facilities similar to those available in the lands affected.

XIII. Resettlement assistance will be provided not only for immediate loss, but also for a transition period needed to restore livelihood and standards of living of PAPs. Such support could take form of short-term jobs, subsistence support, salary maintenance, or similar to those available in the lands affected.

XIV. The resettlement plan must consider the needs of those most vulnerable to the adverse impacts of resettlement (including the poor, those without legal title to land, ethnic minorities, women, children, elderly and disabled) and ensure they are considered in resettlement planning and mitigation measures are identified. Assistance should be provided to help them improve their socio-economic status.

XV. PAPs will be involved in the process of developing and implementing resettlement plans.

XVI. PAPs and their communities will be consulted about the project, the rights and options available to them, and proposed mitigation measures for adverse effects, and to the extent possible be involved in the decisions that are made concerning their resettlement.

XVII. Adequate budgetary support will be fully committed and made available to cover the costs of land acquisition (including compensation and income restoration measures) within the agreed implementation period. The funds for all resettlement activities will come from the government.

XVIII. Displacement does not occur before provision of compensation and other assistance required for relocation. Sufficient civic infrastructure must be provided in the resettlement site prior to relocation. Acquisition of assets, payment of compensation, and the resettlement and start of the livelihood rehabilitation activities of PAPs will be completed prior to any construction activities, except when a court of law orders so in expropriation cases. (Livelihood restoration measures must also be in place but not necessarily completed prior to construction activities, as these may be on-going activities.)

XIX. Organization and administrative arrangements for the effective preparation and implementation of the resettlement plan will be identified and in place prior to the commencement of the process; this will include the provision of adequate human resources for supervision, consultation, and monitoring of land acquisition and rehabilitation activities.

XX. An appropriate reporting (including auditing and redress functions,) monitoring and evaluation mechanism, will be identified and set in place as part of the resettlement management system. An external monitoring group will be hired by the project and will evaluate the resettlement process and final outcome. Such groups may include qualified NGOs, research institutions or universities.

Source: JICA Study Team

5.1.4. Grievance Redress Mechanism

Grievance refers to any controversy, issue or conflict resulting from the interpretation and implementation of the Subway Project ranging from issues on compensation (lot and structure owners) and eligibility criteria to issues on relocation sites and the quality of services extended by proper authorities and agencies on those sites. Thus, a systematic grievance redress mechanism must be established to address grievances from PAPs. Procedures for grievance redress shall be examined in their simplicity, affordability, and reliability to justify an application of existing procedures or a new procedure for settlement of disputes arising from the resettlement of the Project. If there will be grievances arising from any aspect of the Project, these will be handled through negotiations following the succeeding procedures.

A Grievance Handling Task Force (GHTF) shall be formed within the PMO - Resettlement Implementation Management Team (RIMT) in each traversed City, Makati maybe an exceptional, which is mostly indirectly affected, to facilitate the resolution of the PAPs' grievances. The GHTF's Chairperson shall head this Committee. Each representative from concerned Barangay government shall be his Co-Chairperson(s). The formation of the GHTF shall be towards the end of the Detailed Engineering Design (DED) Stage. The GHTF shall consist of the following members:

Table 52.Expected Composition of the A Grievance Handling Task Force

Title	Original Organizations
Chairperson	Chairperson of PMO-RIMT
Co-Chairpersons	Barangay Captains of traversed barangays
Members	DOTr ROW Engineer DENR-NCR Land Management Section (LMS) Chief or Representative City Assessor City Environment and Natural Resources Officer (CENRO) City Urban Poor Affairs Office (UPAO) RAP Consultant (Construction Supervision Stage) Representatives of NGOs operating in the area

Grievances from the PAPs related to the resettlement implementation or any related issues to the project will be handled, free of monetary charge, through negotiations and are aimed to have consensus decision to the following procedures:

1. Any aggrieved PAP will lodge their grievances by writing to their respective LIAC for immediate resolution. When received verbally, the grievances may be written by the staff of LIAC, LGU, or RIMT, or staff assigned by RIMT, for official submission. The same grievance will be forwarded by the receiving entity to the Resettlement Arbitration Committee, composed of concern agencies created by LIAC and DOTr-PMO/RIMT, for immediate resolution.
2. The receiving entity, however, upon receipt of the complaint, may determine and decide whether the nature of the complaint will fall under the definition of a grievance or not related to the project. Or, the receiving entity will forward immediately to the Resettlement

Arbitration Committee for immediate resolution. However, if his/her complaint is rejected by the receiving entity, the complainant may elevate his/her complaint to the DOTr-PMO.

3. If the complaint is not satisfactorily resolved by Resettlement Arbitration Committee or the PAP does not receive any response from the LIAC within 15 days upon receipt, the PAP can forward the complaint or file an appeal to the DOTr-PMO.
4. If the complaint is not satisfactorily resolved by the DOTC-PMO National Office or the PAF does not receive any response from the DOTr-PMO in 15 days of registry of the complaints, the PAP can file a legal complaint in any appropriate Court of Law.

5.2. Information, Education and Communication (IEC) Plan

The Information, Education and Communication (IEC) Plan will be undertaken to encourage the participation and cooperation not only of the affected households but a broader sector of stakeholders and facilitate the establishment of support linkages in the implementation of the subway project, from the Pre-Construction Stage through the Completion Stage. The IEC will also inform the stakeholders about the progress of the project and provide feedback to the proponent regarding the concerns and issues raised by the stakeholders during the project progress. The IEC methods shall include individual methods (key informant interviews), group methods (focus group discussions), and multi-media (print and social media). The IEC should also inculcate value formation by making members of the community aware of their responsibilities as stakeholders.

A summary of the IEC Plan for the next phases of the project is summarized in Table 53. The details and specifics of the IEC Plan will be finalized at the start of the detailed engineering design stage.

Table 53. Information, Education and Communication Plan

Target Sector	Objective / Major Topics	IEC Scheme / Methods	Information Medium	Indicative Timelines and Frequency	Indicative Cost
(1) General Public	Information dissemination about the MMSP Project	Multimedia	TV, Radio, Social Media (FB, Twitter), Print Ads or audio-visual at the stations on MRT, LRT	Starting from Detailed Design Stage up to Operational phase	Cost of public relations (PR) materials (for estimation)
(2) LGUs along the subway alignment	Regular updating of the Progress of the MMSP Project	Meetings and memorandum	Slide Presentation , Minutes of meetings. and print materials	All phases of the project, from Detailed Design Stage up to Operational phase	Included in the Consultant's contract
(3) PAPs at Barangay-level (DIA and IIA)	Regular updating of the Progress of the MMSP Project	Meetings or Assembly; Regular memorandum circulars; Leaflets/Brochures	Multi-sectoral Cluster meetings Print materials	All phases of the project, from Detailed Design Stage up to Operational phase	Included in the Consultant's contract
(4) Affected Sectors (PAPs)					
Land and Structure owners	Consultation on the Resettlement Action Plan; Presentation of valuation methodology and next steps for R-O-W Acquisition	Focus Group Discussion	Slide Presentation , Minutes of meetings. and print materials	Starting from Detailed Design Stage up to Pre-construction phase	Included in the Consultant's contract
Business Owners	Consultation on the Resettlement Action Plan; Presentation of valuation methodology and next	Focus Group Discussion	Slide Presentation , Minutes of meetings. and print materials	Starting from Detailed Design Stage up to Pre-construction phase	Included in the Consultant's contract

Target Sector	Objective / Major Topics	IEC Scheme / Methods	Information Medium	Indicative Timelines and Frequency	Indicative Cost
	steps for R-O-W Acquisition				
Residents	Consultation on the Resettlement Action Plan; Presentation of valuation methodology and next steps for R-O-W Acquisition	Focus Group Discussion	Slide Presentation , Minutes of meetings. and print materials	Starting from Detailed Design Stage up to Pre-construction phase	Included in the Consultant's contract
Informal Settlers	Consultation on the Resettlement Action Plan; Presentation of valuation methodology and next steps for R-O-W Acquisition	Focus Group Discussion	Slide Presentation , Minutes of meetings. and print materials	Starting from Detailed Design Stage up to Pre-construction phase	Included in the Consultant's contract
Local Interagency Committees (LIACs) including local POs, NGOs, women's groups, disadvantage groups	Consultation on the Resettlement Action Plan; Presentation of valuation methodology and next steps for R-O-W Acquisition	Focus Group Discussion	Slide Presentation , Minutes of meetings. and print materials	Starting from Detailed Design Stage up to Pre-construction phase	Included in the Consultant's contract
(5) Barangay-level (at the station areas), in coordination with Barangay Health Centers and LGU Health Units	Information dissemination and preparation for mitigating measures against impact of project on health and safety, e.g noise pollution and increase in vibration level	Meetings or Assembly; Regular memorandum circulars; Leaflets/Brochure	Multi-sectoral Cluster meetings Print materials	Prior to start of Pre-construction and Construction Phase	Included in the Consultant's contract
(6) General Public	Traffic Management Plan,	Multimedia	TV, Radio,	During the pre-	Cost of PR materials

Target Sector	Objective / Major Topics	IEC Scheme / Methods	Information Medium	Indicative Timelines and Frequency	Indicative Cost
	Alternative Routes around the station areas		Newspaper, Social Media (FB, Twitter)	construction, construction phase of the project	(for estimation)
(7) General Public	Proper hygiene in all stations; Emergency response plans (e.g. fire, earthquake)	Multimedia	Posters, leaflets, audio-visual presentation at the stations	Operation phase	Cost of PR materials (for estimation)

CHAPTER 6

Environmental Compliance Monitoring

6. ENVIRONMENTAL COMPLIANCE MONITORING

6.1. Self-Monitoring Plan

DENR Administrative Order (DAO) 03-30 states that the primary purpose of monitoring is to ensure the judicious implementation of environmentally sound management within a company/corporation and its areas of operation. Specifically, it aims to:

- Monitor Project compliance with the conditions stipulated in the ECC;
- Monitor compliance with the EMP and with applicable laws, rules and regulations; and
- Provide a basis for timely decision-making and effective planning and management of environmental measures through the monitoring of actual Project impacts vis-a-vis the predicted impacts in this EIA.

Table 54 presents the proposed Self-Monitoring Plan/Environmental Monitoring Plan (EMoP) for the Project during the pre-construction, construction and operational phases.

Table 54.Environmental Monitoring Plan (EMoP) for Metro Manila Subway Project

Environmental Aspect	Potential Impacts	Parameters to be Monitored	Sampling & Measurement Plan			Lead Person	Annual Estimated Cost, Php	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
I. **PRE-CONSTRUCTION and CONSTRUCTION PHASE**													
The Land													
Solid /domestic wastes generation	Soil pollution and aesthetic impacts	Solid waste management and disposal method	Visual observation, reporting and meeting with contractor	Reporting and Meeting: Monthly or as needed Visual observation: Daily	Construction site and disposal site	Supervising Consultant, Contractor	To be included in engineering cost	N/A			N/A		
Generation of hazardous (oils and lubricants) waste	Soil pollution and aesthetic impacts	Waste management and disposal method	Visual observation, reporting and meeting with contractor	Reporting and Meeting: Monthly or as needed Visual observation: Daily	Construction site and disposal site	Supervising Consultant, Contractor	To be included in engineering cost	N/A			N/A		
		Condition of construction equipment, oil and fuel storage, and chemical injection method			Construction site	Supervising Consultant, Contractor	To be included in engineering cost	N/A			N/A		
Generation of surplus soil	Soil pollution and aesthetic	Proper management	Visual observation,	Reporting and	Construction site and	Supervising Consultant,	To be included in engineering	N/A			N/A		

Environmental Aspect	Potential Impacts	Parameters to be Monitored	Sampling & Measurement Plan			Lead Person	Annual Estimated Cost, Php	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
	impacts	and disposal of surplus soil	reporting and meeting with contractor	Meeting: Monthly or as needed Visual observation: Daily	disposal site	Contractor	cost						
		Heavy metal levels in surplus soil: Cd, Cr (VI), Hg, Se, Pb, As, F and B	Toxicity Characteristic Leaching Procedure (TCLP)	5 samples /1km tunnel excavation	Construction site and disposal site	Supervising Consultant, Contractor	~ Php 50,000/ 5 samples	To be established POST-ECC		Cd, Pb, Cr (VI), As: 5 mg/L; Hg: 0.2 mg/L; Se: 1 mg/L; , F and B – no standard	To be established POST-ECC		
Earthwork activities (tunneling, excavation, backfilling and stockpiling)	Slope failures, landslides and subsidence	Change of ground level	Level survey, Visual observation	Level survey: Monthly or as needed Visual observation: Daily	In and around construction site	Supervising Consultant, Contractor	To be included in engineering cost	N/A			N/A		
Clearing operation	Potential removal of 767 trees, of which 298 are	• Number of trees transferred or cut • Number of	Ocular inspection	During clearing operations, monthly during	Construction sites with affected tree species	Supervising Consultant, Contractor	To be determined and finalized implementation of the	To be established POST-ECC		85-90% survival rate of the trees planted as prescribed by	To be established POST-ECC		

Environmental Aspect	Potential Impacts	Parameters to be Monitored	Sampling & Measurement Plan			Lead Person	Annual Estimated Cost, Php	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
	threatened species, within the project site	trees replaced • Survival rate of the species transferred • Provision of correspon-ding number of tree seedlings		construction			project based on current prices of seedlings			the DENR-EMB Region III and NCR			
The Water													
Clearing and excavation activities;	Increase in suspended sediments in receiving water	DO, TSS and pH of surface water, water turbidity	Analysis using potable water quality meter, Visual observation of turbid water	Water quality analysis: Weekly or as needed Visual observation: Daily	Tullahan river, San Juan river, creek near Tandang Sora Avenue	Supervising Consultant, Contractor	Php200,000 (cost of portable equipment)	To be established POST-ECC		DO: 5ppm; TSS:30ppm; pH: 6.5 and/ or 8.5	To be established POST-ECC		
Generation of wastewater	Water pollution	BOD, COD, color, TSS, Oil& Grease, Fecal/Total Coliform, pH	Water sampling in accordance with DAO 2016-08 and	Quarterly	Discharge point	Supervising Consultant, Contractor	Php 20,000/ qtr	To be established POST-ECC		BOD: 50ppm COD: 100ppm TSS: 100ppm Oil & Grease:	To be established POST-ECC		

Environmental Aspect	Potential Impacts	Parameters to be Monitored	Sampling & Measurement Plan			Lead Person	Annual Estimated Cost, Php	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
			EMB-DENR Manual for Ambient Water Quality Monitoring							5ppm Fecal Coliform: 400 MPN/100mL Total Coliform: 10,000MPN/ 100mL pH – 6.5 to 9.5 Color: 150 TCU			
Hydrology	Flooding and inundation	Water leakage	Visual observation		In and around construction site	Supervising Consultant, Contractor	To be included in engineering cost	N/A			N/A		
	Lowering of groundwater level	Groundwater level	Water level survey	Visual observation: Daily Water level survey: Monthly or as needed	In and around construction site	Supervising Consultant, Contractor	To be included in engineering cost	N/A			N/A		

Environmental Aspect	Potential Impacts	Parameters to be Monitored	Sampling & Measurement Plan			Lead Person	Annual Estimated Cost, Php	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
The Air													
Generation of dusts and PM from earthmoving and construction activities; Emission from vehicles, equipment and gensets	Air pollution	Dust level (qualitative)	Visual observation and interview of pedestrians	Visual observation: Daily Interview: Monthly or as needed	In and around construction site	Supervising Consultant, Contractor	To be included in operation and maintenance cost	N/A			N/A		
		TSP, PM2.5, PM10, NO2, SO2,	Air Quality sampling using the following: 1. TSP – High Volume Gravimetric Method; 2. PM2.5 – High Volume w/2.5 micron particle size, Gravimetric 3. PM10 – High Volume w/ 10 micron particle-size inlet, Gravimetric	Quarterly during construction	At the depot and 13 stations	Supervising Consultant, Contractor	Php30,000/ sampling station	To be established POST-ECC		TSP 24 hr – 230 µ/Ncm PM2.5 24hr – 75 µ/Ncm PM10 24 hr – 150 µ/Ncm SO2 24hr – 180 µ/Ncm NO2 24 hr – 150 µ/Ncm	To be established POST-ECC		

Environmental Aspect	Potential Impacts	Parameters to be Monitored	Sampling & Measurement Plan			Lead Person	Annual Estimated Cost, Php	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
			4. SO_2 – Pararosaniline Method; 5. NO_2 – Griess Saltzman Reaction										
Movement and operation of construction machinery	Nuisance from increase in Noise and vibration level	Noise level (decibel)	Interview of local residents and pedestrians, Noise Meter	Interview: Monthly or as needed Noise meter measurement: Weekly or as needed	At critical areas affected by the construction noise	Supervising Consultant, Contractor	~Php 50,000 (cost of noise meter); personnel cost included in maintenance and operation cost	To be established POST-ECC		Noise level standard in Table 30; Vibration level at daytime: Residential:60dB Commercial: 65dB	To be established POST-ECC		
The People													
Resettlement/ Land Acquisition	Involuntary resettlement	Progress of resettlement action plan	Site survey and meeting with PAPs	Monthly or as needed	Construction and relocation sites	DOTr, in coordination with LGUs	To be determined and finalized during the RAP updating in the Detailed Engineering Design Phase	N/A			N/A		

Environmental Aspect	Potential Impacts	Parameters to be Monitored	Sampling & Measurement Plan			Lead Person	Annual Estimated Cost, Php	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
OPERATION PHASE													
The Land													
Solid /domestic wastes and hazardous (oils and lubricants) waste generation	Soil pollution and aesthetic impacts	Proper waste management and disposal of surplus soil, construction wastes and general garbage	Visual observation and reporting	Weekly or as needed	Station and other facilities	Subway Administrator, Pollution Control Officer	To be included in operation and maintenance cost	N/A			N/A		
The Water													
Wastewater effluent	Water pollution of receiving water bodies	BOD_5, COD, pH, TSS, Color, Oil & Grease and coliform	Water sampling in accordance with DAO 2016-08 and EMB-DENR Manual for Ambient Water Quality Monitoring	Quarterly	Discharge point	Supervising Consultant, Contractor	Php 20,000 /qtr	To be established POST-ECC		BOD: 50ppm COD: 100ppm TSS: 100ppm Oil & Grease: 5ppm Fecal Coliform: 400 MPN/100mL Total Coliform: 10,000MPN/ 100mL pH – 6.5 to 9.5 Color: 150	To be established POST-ECC		

Environmental Aspect	Potential Impacts	Parameters to be Monitored	Sampling & Measurement Plan			Lead Person	Annual Estimated Cost, Php	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
										TCU			
Hydrology	Lowering of groundwater level	Groundwater level	Water level survey	2 time per year for 2years at 5 locations after completion Total 20 times	Around subway tunnel	Subway Administrator, Pollution Control Officer	To be included in operation and maintenance cost	N/A			N/A		
The Air													
Generator Set Operation	Air pollution	TSP, PM_{10},SO_x, NO_x, CO	Hi-Volume Sampler PM_{10} Sampler Gas Sampler CO Analyzer	Annually	Stations and depot	Subway Administrator, Pollution Control Officer	Php 30,000/ station	To be established POST-ECC		TSP 24 hr – 230 µ/Ncm PM10 24 hr – 150 µ/Ncm SO2 24hr – 180 µ/Ncm NO2 24 hr – 150 µ/Ncm	To be established POST-ECC		
Subway operation	Increase in noise and vibration level	Noise level (decibel)	Noise meter	Annually	Ground above subway tunnel in selected stations	Subway Administrator, Pollution Control Officer	Php 50,000 (cost of noise meter)	To be established POST-ECC		Vibration level at nighttime: Residential:55 dB Commercial:	To be established POST-ECC		

Environmental Aspect	Potential Impacts	Parameters to be Monitored	Sampling & Measurement Plan			Lead Person	Annual Estimated Cost, Php	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
										60 dB			
		Perception of residents and pedestrians	Interview of local residents and pedestrians	Semi-annual for 5 years			Included in maintenance and operation cost	N/A			N/A		

6.2. Multi-partite Monitoring Team

Pursuant to DAO 2003-30, the law mandates that after issuance of the ECC, a Multi-Partite Monitoring Team (MMT) shall be formed. The MMT is tasked to monitor the compliance of the project as stated in the ECC conditions, Environmental Management Plan and other related policy. Furthermore, the MMT shall gather information and data relating to complaints and impacts of the project to environment and society. Other tasks of the members of the MMT are the following:

- Prepares and submit quarterly report
- Assimilate all monitoring reports
- Disseminate information to the affected individual
- Submit recommendations to EMB-DENR

The EMB-DENR shall provide oversight guidance to the MMT and consider its reports and recommendations in its impact and compliance evaluation.

The composition of the MMT shall be representative of relevant stakeholders groups. The following are recommended members of the MMT:

- Representative from the LGUs along the MMSP alignment
  - ✓ Valenzuela
  - ✓ Quezon City
  - ✓ Pasig City
  - ✓ Makati City
  - ✓ Taguig City
  - ✓ Paranaque City
- Representative from the LGU-accredited local NGOs with mission/s specifically related to environmental management. Representative from an academic institution may be included in absence of a local NGO
- Representative from locally recognized community leaders who can represent vulnerable sectors such as women and senior citizen
- Concerned Government Agencies
  - ✓ Department of Public Works and Highways
  - ✓ Metro Manila Development Authority

Members of MMT will elect among themselves the Chairman and Vice Chairman.

6.3. Environmental Monitoring and Guarantee Fund Commitment

The Proponent is amenable to create an Environmental Monitoring and Guarantee Fund if EMB-DENR will determine the need for such. The Environmental Monitoring Fund (EMF) is a fund that the Proponent will commit to establish in support of the activities of the MMT for the compliance monitoring. The Environmental Guarantee Fund (EGF) shall be established and used for the following risk-management related purposes:

1) the immediate rehabilitation of areas affected by damage to the environment and the resulting deterioration of environmental quality as a direct consequence of project construction, operation, and abandonment;
2) the just compensation of parties and communities affected by the negative impacts of the project;
3) the conduct of scientific or research studies that will aid in the prevention or rehabilitation of accidents and/or risk-related environmental damages; or
4) for contingency clean-up activities, environmental enhancement measures, damage prevention program including the necessary IEC and capability building activities to significantly minimize or buffer environmental risk- related impacts.

The initial determination of the EMF and EGF is included as part of the Environmental Management and Monitoring Plan. The actual amount to be allocated for the EMF/EGF shall be determined on the basis of the Annual Work and Financial Plan that will be decided upon the creation of the MMT, which will also be derived from the stated Impact Management Plan (IMP) and Environmental Monitoring Plan (EMoP).

To show the commitment of DOTr to establish the EMF and EGF, the amount of Php 250,000.00 for EMF and Php 350,000.00 for EGF will be initially allocated annually. However, the actual amount that will be allocated for EMF and EGF will be finalized during the DED phase and with the consultation of the MMT upon its creation.

CHAPTER 7

Decommissioning/ Abandonment/ Rehabilitation Policy

7. DECOMMISIONING/ABANDONMENT/REHABILITATION POLICY

Prior to abandonment of the construction areas, the Contractors must undertake and comply with the following decommissioning/demobilization activities:

- Complete restoration of affected social service utilities (i.e. power and water supply, and telecommunication lines) to their normal functions;
- Complete closure and dismantling of the workers' camps, field offices, and temporary construction facilities;
- Complete dismantling of the temporary sanitation facilities, particularly the portable toilets;
- Clean-up and sterilization of the worker's camps and field offices to ensure that no wastes are abandoned in the sites;
- Remaining muck soils, construction spoils and debris are hauled and disposed to sites duly-approved by the Cities of Valenzuela, Quezon City, Pasig, Makati, Taguig and Parañaque.
- Complete restoration/reconstruction of affected public and cultural and historical structures, if any.

Upon completion of the project, all parties concerned, such as the DOTr, DENR, and the LGUs must inspect the area for compliance to the above activities. The proponent must continuously implement maintenance activities to preserve and restore the existing infrastructures in good operating conditions.

Project abandonment is not envisioned in the near future since there is a pressing need for an efficient public transport system in Metro Manila. Nevertheless, an abandonment framework is provided below.

After the expected service life of the Project, parts that are determined to be serviceable will be salvaged for use in other railway infrastructures or other public facilities. The structures may be retrofitted, if adaptable, for use with newer technology. Otherwise, the major structures will be demolished/ dismantled. The area may be re-developed according to alternative land uses for the site as the government may see appropriate.

The major activities will include removal of all buildings, structures, equipment and any other works. DOTr shall ensure minimal damage that may be caused by the removal of the facilities. An audit of hazardous wastes, particularly at the Valenzuela depot, and environmental site assessment (ESA) will be conducted to account for proper disposal and site treatment, if deemed necessary. DOTr shall leave the site in a secure, clean and tidy condition and will ensure that the site is securely enclosed.

A detailed decommissioning or abandonment plan will be developed, as required by the DENR through DAO 2003-30, ninety days prior to the end of operating life of the MMSP.

CHAPTER 8

Institutional Plan For EMP Implementation

8. INSTITUTIONAL PLAN FOR EMP IMPLEMENTATION

The main purpose of this Institutional Plan is to define the roles and responsibilities through collaborative efforts of the project proponent and the inter-agency stakeholders in order to implement the Environmental Management Plan.

It is practical to assemble an organizational structure and multi-partite monitoring team in order to have an improved and efficient roles and responsibilities among the stakeholders or inter-agency members through their respective plans and actions.

1. Department of Transportation (DOTr)

The DOTr as the proponent for the MMSP is the primary policy, planning, programming, coordinating, implementing and administrative entity of the executive branch of the government on the promotion, development and regulation of a dependable and coordinated network of transportation and communications systems, as well as in the fast, safe, efficient and reliable transportation and communications services. For the MMSP, the DOTr will create a new office or designate one of the railway attached agencies to serve as Project Management Office.

2. Project Management Office (PMO):

The PMO designated by the DOTr shall be responsible for complying with the conditions stipulated in the Environmental Compliance Certificate (ECC), including the Environmental Management Plan (EMP) and Environmental Monitoring Plan (EMoP). The PMO will be responsible for the implementation, coordination, supervision, and monitoring activities that will be undertaken by the Contractor as part of the agreement. The specific responsibilities of the PMO shall include:

i. Prior to bidding process, prepare the "Environmental Protection Clauses" of the Bid Documents to apply to the project based on the EMP and the ECC for the project;
ii. Discuss contract environmental clauses with bidders to allow the latter to include realistic costs of complying with contract provisions in their bids;
iii. Ensure that compliance to all conditions stipulated in the ECC are included as provisions in the Bid Documents to be issued to prospective Contractors;
iv. Ensure that all engineering interventions in the approved EMP, Resettlement Action Plan (RAP), and ECC issued are included in the Terms of Reference (TOR) of the Detailed Engineering Design

The PMO and the Contractor's implementation of the EMP shall be in coordination with the following entities:

1) DENR EMB Central Office
2) DENR Forest Management Bureau and Biodiversity Management Bureau (for flora and fauna)
3) Department of Public Works and Highways
4) Third Party Monitoring Firm

5) LGUs of Valenzuela City, Quezon City, Makati City, Taguig City, Pasig City and Paranaque City

3. Subway Administrator:

The Subway Administrator designated by the DOTr shall be responsible for the subway operation including the EMoP in operation phase.

This Plan shall be updated upon finalization of the Detailed Engineering Design (DED) for the Project. The proposed organization for the environmental monitoring plan is shown in Figure 65.

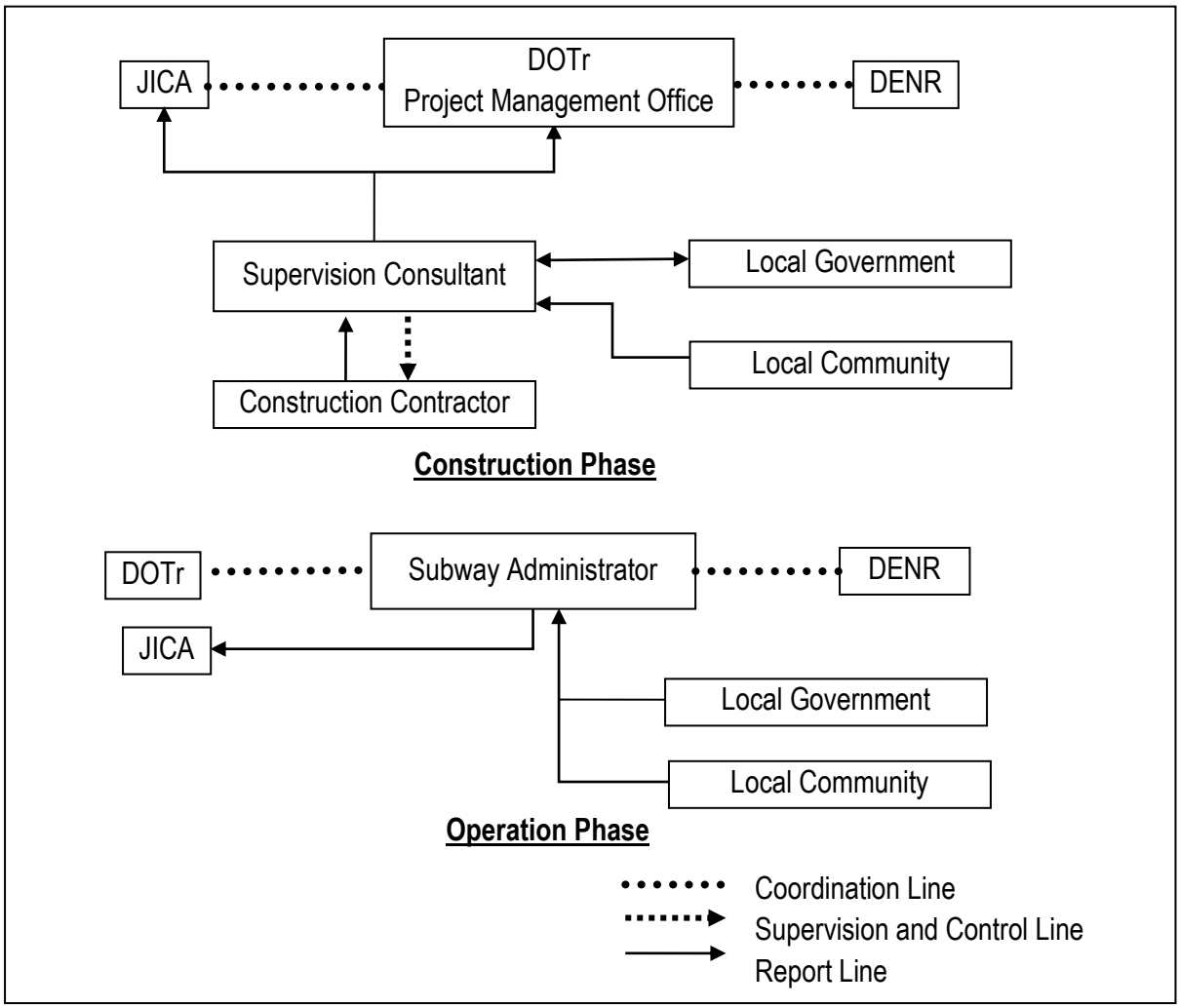


Figure 65. Proposed Organizational Structure for Environmental Monitoring Plan during Construction and Operation Phases

CHAPTER 9

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