DEPARTMENT OF TRANSPORTATION (DOTr)
THE REPUBLIC OF THE PHILIPPINES

FEASIBILITY STUDY
ON
THE MALOLOS-CLARK RAILWAY PROJECT (NORTH-SOUTH COMMUTER RAILWAY EXTENSION PROJECT)
IN
THE REPUBLIC OF THE PHILIPPINES

DRAFT FINAL REPORT (MALOLOS-CLARK-CIA SECTION)

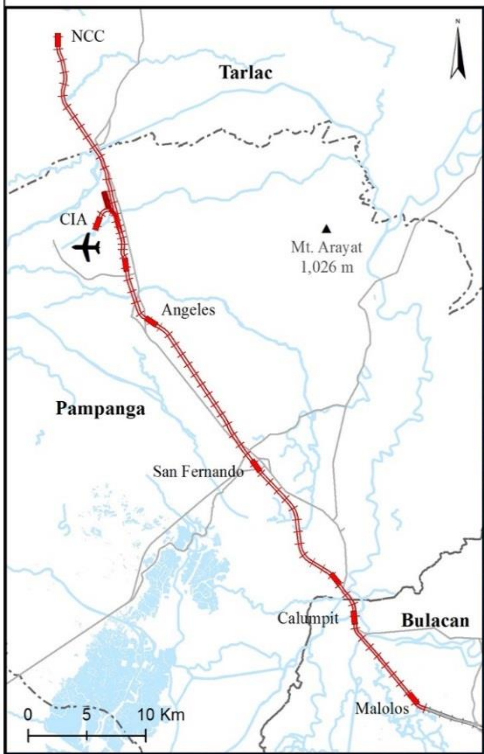
OCTOBER 2018

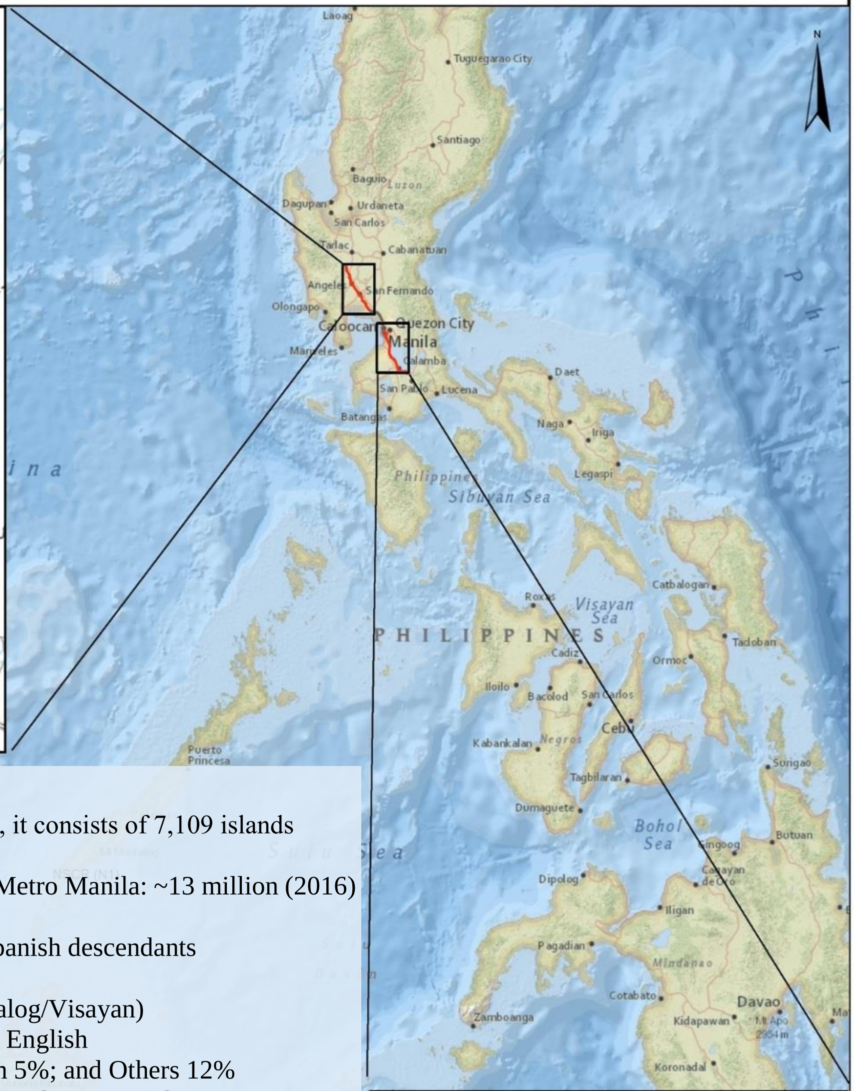
JAPAN INTERNATIONAL COOPERATION AGENCY

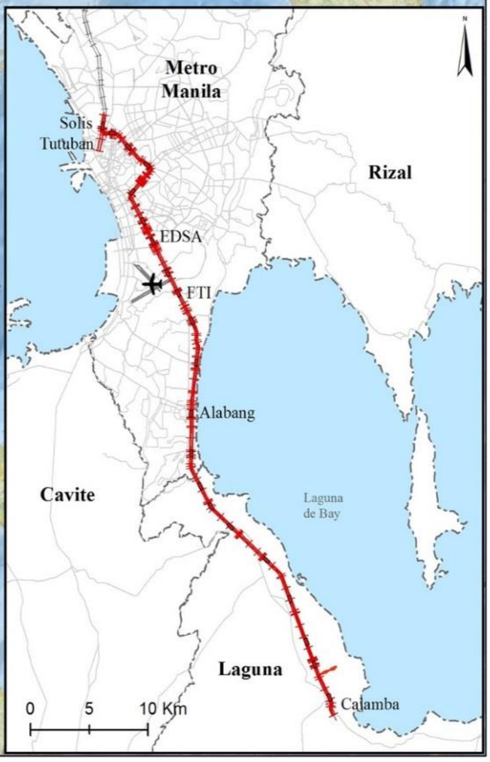
ORIENTAL CONSULTANTS GLOBAL CO., LTD.
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO., LTD
TONICHI ENGINEERING CONSULTANTS, INC.
KATAHIRA & ENGINEERS INTERNATIONAL
PACIFIC CONSULTANTS CO., LTD.
TOKYO METRO CO., LTD

Republic of the Philippines

Fact sheet





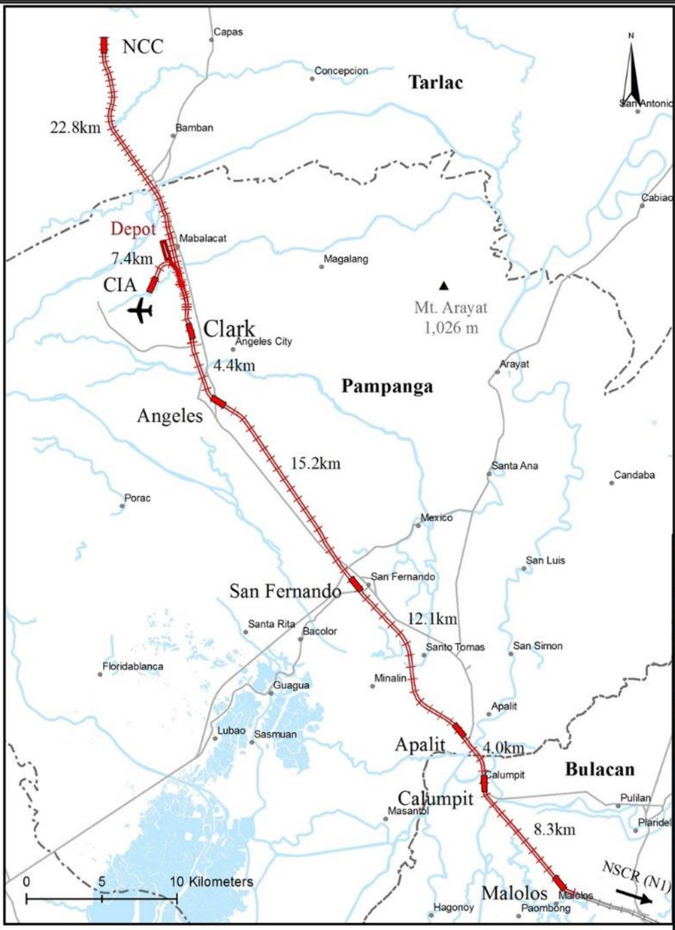


- Land area[1/]: ~299 thousand km^2
  (0.8 times of Japan's land mass), it consists of 7,109 islands
- Population: ~103 million (2016)[3/]
- Population of Greater Capital Region/Metro Manila: ~13 million (2016)
- Capital City: Manila
- Ethnic groups: Malay, Chinese, and Spanish descendants
- Languages:
  - National Language: Filipino (Tagalog/Visayan)
  - Official Languages: Filipino and English
- Religions: Roman Catholic 83%; Islam 5%; and Others 12%
- Major industries: Agriculture, forestry, and service industry
- GDP per capita: $ 3,100（IMF-2016）
- Current economic growth rate[2/]: 6.8% p.a.
- Inflation rate[2/]: 1.8% p.a.
- Total trade - FOB value (2016)[2/]:
  - Exports: US$57 billion
  - Imports: US$84 billion
- Major trade items[2/]:
  - Exports: Electronics/Electrical equipment, and transport equipment
  - Imports: Material, intermediate product, capital equipment, oil, and consumable goods.
- Currency: Philippine Peso
  - PHP1＝¥2.27 (Jan.2018) [5/]
  - US$1＝PHP50.51 (Jan.2018) [4/]
- Aid from Japan (cumulative, up to 2015) [1/]:
  - Loan: ¥2.47 trillion (E/N) [6/]
  - Grant: ¥2.81 trillion (E/N) [6/]
  - Technical cooperation: ¥2.26 trillion

Sources:
[1/]Ministry of Foreign Affairs of Japan, Countries and Regions
[2/]Philippine Statistics Authority (PSA)
[3/]Asian Development Bank (ADB)
[4/]Bangko Sentral ng Pilipinas (BSP)
[5/]Japan International Cooperation Agency (JICA)
[6/]E/N - Exchange of Notes

Malolos Clark Railway and North South Railway-South Line (Commuter)
(North-South Commuter Railway Extension Project)

Projects Factsheet

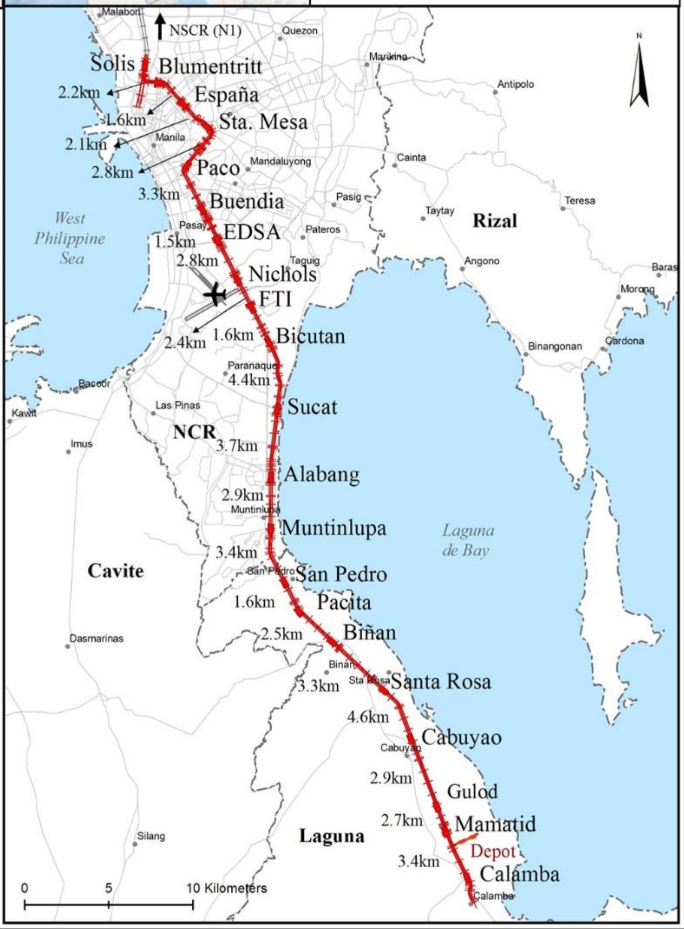


Malolos-Clark-NCC MCRP Railway (N2)

- Line length: 74km; + Depot Spur 3.5km Viaduct
- No. of stations: 7; (Elevated: 5; U/G: 2); 1 Depot.
- Connects with NSCR (N1) line in the south at Malolos station
- Passes through the cities/municipalities of: Malolos, Calumpit, Apalit, Minalin, Santo Tomas, San Fernando, Angeles, Mabalacat, Bamban, and Capas.
- Design speed: 160km/h
- Opening year: May 2022
- Proposed fare: PHP20 + PHP2/km
- Alignment Configuration- Standard gauge double track.
- At-grade: 2km; Viaduct: 63km; U/G: 9km; Total 74km.

Connecting GCR by Railways

- A facility for millions of residents of GCR
- A backbone of transportation system connecting North and South through Metro Manila
- A high speed railway system
- Would extend the currently under construction, Tutuban-Malolos line, to the north and to the south



North South Railway-South Line (Commuter) Solis to Calamba

- Line length: 55.6km
- No. of stations: 21; at-Grade: 2; Elevated: 18; U/G: 1.
- Connects with NSCR (N1) line in the north at Solis station and MMSP line in the middle at FTI and Bicutan station.
- Passes through the cities/municipalities of: Manila, Makati, Taguig, Parañaque, Muntinlupa, San Pedro, Biñan, Santa Rosa, Cabuyao, and Calamba
- Design speed: 120km/h
- Opening Year: November 2023
- Proposed fare: PHP20 + PHP2/km (Commuter)
- PNR Current fare:
  Tutuban - Alabang: PHP30 A/C; PHP24 Non-A/C
- Alignment configuration:
  - Standard gauge; Double track
  - At-Grade: 12.6km;
  - Viaduct: 42km;
  - U/G: 1km.

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List of Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
AAQ	Ambient Air Quality
ACEL	The Association of Carriers & Equipment Lessors Inc.
AD	Ancestral Domain
ADB	Asian Development Bank
ADC	Analog to Digital Converter
ADM	Add Drop Multiplexer
A&D	Alienable and Disposable
AFCS	Automatic Fare Collection System
AFP	Armed Forces of the Philippines
AIDS	Acquired Immunodeficiency Syndrome
AISC	American Institute of Steel Construction
AP	Access Point
APG	Angiosperm Phylogeny Group
APS	Auxiliary Power Supply
APSI	Air Pollution Source Installation
AR5	IPPC's Fifth Assessment Report
ARP	Address Resolution Protocol
As	Arsenic
ASTM	American Society of Testing and Materials
AT	Auto Transformer
ATO	Automatic Train Operation
ATP	Automatic Train Protection
ATS	Automatic Train Stop
AUV	Asian Utility Vehicles
AWARE	Airport Weather Advanced Readiness Toolkit
AWS	American Welding Society
BAFs	Bureau of Agriculture and Fisheries Standards
BCDA	Bases Conversion Development Authority
BCR	Benefit and Cost Ratio
BD	Basic Design
BEM	Bangkok Expressway and Metro Public Company Limited

BFP-SRU	Bureau of Fire Protection – Special Rescue Unit
BGC	Bonifacio Global City
BIR	Bureau of Internal Revenue
BLT	Build-Lease-and-Transfer
BMA	Bangkok Metropolitan Administration
BMB	Biodiversity Management Bureau
BMCL	Bangkok Metro Company Limited
BMTA	Bangkok Mass Transit Authority
BMS	Building Management System
BOD	Biochemical Oxygen Demand
BOI	Board of Investments
BOO	Build-Own-and-Operate
BOT	Build-Operate-and-Transfer
BP	Beginning Point
BPF	Band-pass filter
BPO	Business Process Outsourcing
BRGY	Barangay
BRT	Bus Rapid Transit
BS	British Standard
BSWM	Bureau of Soils and Water Management
BT	Battery
BT	Booster Transformer
BT	Build-and-Transfer
BTO	Build-Transfer-and-Operate
BTS	Base Transceiver Station
BTSC	Bangkok Mass Transit System Public Co., Ltd.
Ca	Calcium
CADC	Certificate of Ancestral Domain Claim
CADT	Certificate of Ancestral Domain Title
CALA	Cavite Laguna
CALABARZON	Cavite, Laguna, Bantangas, Rizal, and Quezon
CALC	Certificate of Land Claims
CALT	Certificate of Ancestral Land Title
CAPEX	Capital Expenditures

CAO	Contract-Add-and-Operate
CARI	Contractor's All Risk Insurance
CARP	Comprehensive Agrarian Reform Program
CAVITEX	Manila-Cavite Expressway
CBD	Central Business District
CBI	Computer Based Interlocking
CBTC	Communication Based Train Control
CCA	Climate Change Adaptation
CCC	Climate Change Commission
CCTV	Closed-circuit Television
Cd	Cadmium
CCU	Communication Control Unit
CDC	Clark Development Corporation
CDM	Clean Development Mechanism
CE	Critically Endangered Species
CER	Communication Equipment Room
CEZ	Clark Economic Zone
CEMMAP	Contractor's Environmental Management Plan
CENRO	City Environment and Natural Resources Office
CFZ	Clark Freeport Zone
CGC	Clark Green City
CHSRA	California High-Speed Rail Authority
CIA	Clark International Airport
CIAC	Clark International Airport Corporation
Cl	Chloride
CIF	Common Intermediate Frame
CLLEx	Central Luzon Link Expressway
CLUP	Comprehensive Land Use Plan
CLUDP	Comprehensive Land Use and Development Plan
CMR	Compliance Monitoring Report
CMVR	Compliance Monitoring and Validation Report
CN	Curve Number
CMWPI	Construction Materials Wholesale Price Index

Cn	Cyanide
CNC	Certificate of Non-Coverage
CNO	Certificate of No Overlap
CNR	Carrier to Noise Ratio
CO	Carbon Monoxide
COAG	Council of Australian Government
CP	Compressor
CPCS	Canadian Pacific Consulting Services
CPDO	City Planning and Development Office
CPL	Central Plain of Luzon
Cr	Chromium
Cr+6	Chromium Hexavalent
CR	Critically Endangered
CS	Conservation Status
CSELR	CBT and South East Light Rail
CSEZ	Clark Special Economic Zone
CSZ	Clark Sub-Zone
CT	Current Transformer for Measuring
CTC	Centralized Train Control
CTF	Cable Termination Frame
CWD	Civil Works Division
CWDM	
DA	Department of Agriculture
DAIP	Duterte Administration’s Infrastructure Plan
DAO	DENR Administrative Order
DAP	Development Academy of the Philippines
DAR	Department of Agrarian Reform
dB	Decibel
dBA	A-weighted decibels
DC	Direct Current
DCT	Current Transformer for DC measuring
DD / DED	Detailed Design Stage / Detailed Engineering Design Stage
dbh	Diameter at Breast-Height

DENR	Department of Environment and Natural Resources
DepEd	Department of Education
DGCS	DPWH Design Guidelines, Criteria and Specifications
DIA	Direct Impact Area
DILG	Department of Interior and Local Government
DMU	Diesel Multiple Unit
DO	Dissolved Oxygen
DOF	Department of Finance
DOH	Department of Health
DOST	Department of Science and Technology
DOT	Develop-Operate-and-Transfer
DOTC	Department of Transportation and Communications
DOTr	Department of Transportation
DPWH	Department of Public Works and Highways
DRR	Disaster Risk Reduction
DSPEWPC	Department of Sustainability, Environment, Water and Population Communities
DSR	Digital Space Radio
DSWD	Department of Social Welfare and Development
DTI	Department of Trade and Industry
DTM	Digital Elevation Model
DTS	Distributed Temperature Sensor
DUPA	Detailed Unit Price Analysis
DVAS	Digital Voice Announcement System
DVR	Digital Video Recorder
DVT	Voltage Transformer for DC Measuring
EBR	Error Bit Rate
ECA	Environmentally Critical Area
ECC	Environmental Compliance Certificate
ECP	Environmentally Critical Project
EDSA	Epifanio delos Santos Avenue
EF	Emission Factor
EGF	Environmental Guarantee Fund
EHS	Environmental Health and Safety

EIA	Environmental Impact Assessment
EIAMD	Environmental Impact Assessment and Management Division
EIARC	Environmental Impact Assessment Review Committee
EIRR	Economic Internal Rate of Return
EIS	Environmental Impact Statement
EISR	Environmental Impact Statement Report
E&M	Electrical and Mechanical Systems
EMB	Environmental Management Bureau
EMC	Electro Magnetic Compatibility
EMF	Environmental Monitoring Fund
EMI	Electro Magnetic Interference
EMoP	Environmental Monitoring Plan
EMP	Environmental Management Plan
EMU	Electric Multiple Unit
EN	Endangered Species
ENPV	Economic Net Present Value
ENRO	Environment and Natural Resources Officer
EO	Executive Order
EOCC	End of Circular Curve
EP	End Point
EPC	Engineering Procurement Construction
EPRMP	Environmental Performance Report and Management Plan
ERA	Environmental Risk Assessment
ERP	Emergency Response Plan
ESD	Engineering Support Division
ESRD	Environment, Social and ROW Division
ETC	End of Transition Curve
EQPL	Environmental Quality Performance Level
EQS	Environmental Quality Standard
FACP	Fire Alarm Control Panel
FBI	Field Based Investigation
FBDC	Fort Bonifacio Development Corporation

FC	Foreign Currency
FDIs	Foreign Direct Investments
FFU	Fiber reinforce Foamed Urethane
FGD	Focus Group Discussion
FIRR	Financial Internal Rate of Return
FMEA	Failure Modes and Effects Analysis
FMB	Forest Management Bureau
FNPV	Financial Net Present Value
FOC	Fiber Optical Cable
FPIC	Free, Prior and Informed Consent
FS,F/S	Feasibility Studies
FTI	Food Terminal Incorporated
FV	Field Validation
GAA	General Appropriation Act
GAF	Grievance Action Form
GCEs	Government Corporate Entities
GCR	Greater Capital Region
GDP	Gross Domestic Product
GE	Ground Elevation
GFIs	Government Financial Institutions
GICPs	Government Instrumentalities with Corporate Powers
GNI	Gross National Income
GOCCs	Government-Owned and/or Controlled Corporations
GPRAM	Generic Preferred Risk Allocation Matrix
GPS	Global Positioning System
GRDA	General Residential Development Area
GRM	Grievance Redress Mechanism
GRDP	Gross Regional Domestic Product
GTI	Geosphere Technologies Inc.
GUI	Graphical User Interface
GVA	Gross Value Added
GW	Ground Water

HCM	High Capacity Manual
HCS	Hundred Call Second
HDD	Hard Disk Drive
HCO3	Bicarbonate
HEC-RAS	The Hydrologic Engineering Center's River Analysis System
HIV	Human Immunodeficiency Virus
HG	Total Mercury
HSH	High Standard Highway
HSHs MP	High Standard Highways Master Plan
HSEC	Health, Safety and Environment Committee
HUDGC	Housing and Urban Development Coordinating Council
Hz	Hertz
IA	Implementing Agency
IBA	Important Bird Area
IC	Industrial, Commercial
ICC	Indigenous Cultural Communities
ICT	Information Communication Technology
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IEA	International Energy Agency
IEC	Information Education and Communication
IEE	Initial Environmental Examination
IESAM	Institute of Environmental Science and Management
IFC	International Finance Corporation
IGBT	Insulated Gate Bipolar Transistor
IIA	Indirect Impact Area
IOS	International Organization for Standardization
IP	Internet Protocol
IP	Indigenous Peoples
IPC	Indigenous Peoples Communities
IPCC	Intergovernmental Panel on Climate Change
IPP	Indigenous People Plan
IP-PBX	Internet Protocol Private Branch eXchange

IPRA	Indigenous Peoples Rights Act
IRR	Internal Rate of Return
IRR(Chapter 9)	Implementing Rules and Regulations
IRRI	International Rice Research Institute
ISF	Informal Settler Families
ISO	International Organization for Standardization
ISP	Internet Service Provider
IUCN	International Union for Conservation of Nature
IV	Importance Value
JBIC	Japan bank for International Cooperation
JDT	JICA Design Team
JICA	Japan International Cooperation Agency
JIS	Japanese Industrial Standards
JOIN	Japan Overseas Infrastructure Investment Corporation for Transport and Urban Development
JPY	Japanese Yen
JRIS	Japanese Railway Industrial Standards
JV	Joint Venture
K	Potassium
KBAs	Key Biodiversity Areas
Km	Kilometer
KPI	Key Performance Indicator
KW/H	Kilowatt per hour
Kv	Kilovolts
L2SW	Layer 2 Switch
L3SW	Layer 3 Switch
LA	Link Aggregation
LAN	Local Area Network
LAeq	Equivalent continuous sound pressure level
LC	Least Concern
LCC	Low Cost Carrier
LCD	Liquid Crystal Display
LCX	Leaky Coaxial Cable

LED	Light Emitting Diode
LEED	Laguna Lakeshore Dyke Expressway
LGU	Local Government Unit
LIAC	Local Inter-Agency Committee
LLDA	Laguna Lake Development Authority
LLDP	Link Layer Display Protocol
LMA	Limit of Movement Authority
LOS	Line Of Sight
LPA	Low Pressure Area
LPF	Low-Press Filter
LRBG	Last Relevant Balise Group
LRC	Luzon Railway Corporation
LRFD	Load Resistance Factor Design
LRMC	The Light Rail Manila Corporation
LRS	Land Readjustment Scheme
LRT	Light Rail Transit
LRT-1,2	Light Rail Transit Line 1 & Line 2 in Metro Manila
LRTA	Light Rail Transit Authority
LRV	Light Rail Vehicles
LTFRB	Land Transportation Franchising and Regulatory Board
LVC	Land Value Capture
M&E	Materials & Equipment
MA	Movement Authority
MAC	Media Access Control
MBAS	Methylene Blue Active Substances
MCA	Metro Clark Area
MCLUPZO	Manila City Comprehensive Land Use Plan and Zoning Ordinance
MCR	Malolos-Clark Railway
MCRP	Malolos Clark Railway Project
MDBF	Mean Distance Between Failure
MDF	Main Distribution Frame
MENRO	Municipal Environment and Natural Resources Office

MERALCO	Manila Electric Railroad and Light Company
METI	Ministry of Economy, Trade and Industry
Mg	Magnesium
MIGA	Multilateral Investment Guarantee Agency
MGB	Mines and Geosciences Bureau
MH	Merchantable Height
MIB	Management Information Frame
MICT	Manila International Container Terminal
MLIT	Ministry of Land, Infrastructure, Transport and Tourism
MLUP	Municipal Land Use Plan
MMDA	Metro Manila Development Authority
MMFR	Mount Makiling Forest Reserve
MMSP	Metro Manila Subway Project
MMT	Multi-partite Monitoring Team
MMTC	Metro Manila Transit Corporation
MMSS 3	Metro Manila Skyway Stage 3
MMUTIS	Metro Manila Urban Transportation Integrated Study
MNTC	Manila North Tollways Corporation
MOA	Memorandum of Agreement
MOA	Mall of Asia
MOU	Minutes of Understanding
MPEG	Moving Picture Experts Group
MPDO	Municipal Planning and Development Office
MPLS	Multi-Protocol Label Switching
MPN	Most Probable Number
MRF	Materials Recovery Facility
MRT	Metro Rail Transit
MRTC	Metro Rail Transit Corporation Limited
MSMEs	Micro, Small and Medium Enterprises
MSWMB	Municipal Solid Waste Management Board
MT	Metric Ton
MUCEP	The Project for Capacity Development on Transportation Planning and Database Management in the Republic of the Philippines

Na	Sodium
NAAQGV	National Ambient Air Quality Guideline Values
NAIA	Ninoy Aquino International Airport
NAMRIA	National Mapping and Resource Information Authority
NBCP	National Building Code of the Philippines
NBSAO	National Biodiversity Strategy and Action Plan
NCC	New Clark City
NCCA	National Commission for Culture and the Arts
NCCAP	National Climate Change Action Plan
NCIP	National Commission of Indigenous Peoples
NCR	National Capital Region
NECP	Non-Environmentally Critical Project
NEDA	National Economic Development Authority
NEX	Narita Express
NEXI	Nippon Export and Investment Insurance
NFSCC	National Framework Strategy on Climate Change
NGA	National Government Agency
NGCP	National Grid Corporation of the Philippines
NGO	Non-Government Organization
NHA	National Housing Authority
NHCP	National Historical Commission of the Philippines
NIED	Japan National Research Institute for Earth Science and Disaster Prevention
NIPAS	National Integrated Protected Areas System
NLEX	North Luzon Expressway
NLRC	North Luzon Railways Corporation
NM	National Museum
NMS	Network Management System
NMTT	Navotas-Malabon-Tenejeros-Tullahan River
NO2	Nitrogen Dioxide
NO3	Nitrate
NPCC	National Pollution Control Commission
NPV	Net Present Value

NSCR	North South Commuter Railway Project
NSCP	National Structure Codes of the Philippines
NSRP South	North South Railway Project – South Line (Commuter)
NTC	National Telecommunications Commission
NTP	Notice to Proceed
NVMS	Network Video Management System
O3	Ozone
OCC	Operation Control Center
OCD	Office of Civil Defense
ODA	Overseas Development Assistance
O&G	Oil and Grease
O&M	Operation & Maintenance
OPEX	Operating Expenditures
OSH	Occupational Safety and Health
OTS	Other Threatened Species
OWS	Other Wildlife Species
P2P	Point to (2) Point
PA	Public Address
PA	Philippine Army
PAF	Project Affected Families
PAGASA	Philippine Atmospheric Geophysical and Astronomical Services Administration
PAP	Project Affected Persons
PAR	Philippine Area of Responsibility
PAST	Paleontological Statistical Software
PAWB	Protected Areas and Wildlife Bureau
Pb	Lead
PBX	Private Branch eXchanger
PC	Pre-cast
PCE	Passenger Car Equivalent
PCSD	Project Control Support Division
PCU	Passenger Car Unit
PCUP	Presidential Committee for the Urban Poor

PD	Presidential Decree
PDCA	Plan-Do-Check-Action
PDP	Philippines Development Plan
PDR	Project Description Report
PEC	Philippine Electrical Code
PEISS	Philippine Environmental Impact Statement System
PEMAPS	Project Environmental Monitoring and Audit Prioritization Scheme
PENRO	Provincial Environment and Natural Resources Office
PEPRMP	Programmatic Environmental Performance Report and Management Plan
PET	Polyethylene Terephthalate
PF	Power Fuse
PGM	Philippine Geoid Model
PH	Public Hearing
pH	Potential of Hydrogen
PIDS	Passenger Information System
PHIVOLCS	Philippine Institute of Volcanology and Seismology
PHP, PhP, Pesos	Philippine Peso
PLDT	Philippine Long Distance Telephone Company
PM	Particulate Matter (in microns)
PMO	Project Management Office
PNP	Philippine National Police
PNR	Philippine National Railways
PNS	Philippine National Standard
PNSC	Philippine National Structural Code
PNSDW	Philippine National Standard for Drinking Water
PO4	Phosphate
PO	People Organizations
PoE	Power over Ethernet
POP	Persistent Organic Pollutant
POS	Point of Sale System
PPCC	Philippine Plant Conservation Committee
PPE	Personal Protective Equipment

PPHPD	Passengers Per Hour Per Direction
PPP	Public Private Partnership
PPP Center	Public-Private-Partnership Center of the Philippines
PPP-LCC	PPP life cycle costs
PRA	Public Railway Authority
PRC	Programmed Route Control
PRI	Philippine Railway Institute
PRS	Philippine Reference System
PSA	Philippine Statistical Authority
PSC	Public Sector Comparator
P-SCAN	Projection-scan
PSCCA	Philippine Strategy in Climate Change Adaption
PSD	Platform Screen Door
PT	Pantograph
PTAC	Pilotage Trading and Construction
PTSMP	Philippine Transportation System Master Plan
PTZ	Pan Tilt Zoom
PUD	Planned Unit Development
PUJ	Public Utility Jeepney
PUV	Public Utility Vehicle
PUVMP	Public Utility Vehicle Modernization Program
PVC	Polyvinyl Chloride
PWU	Philippines Women's University
Qh	Recent deposits
QoL	Quolity of Life
QoS	Quality of Service
QPSK	Quadrature Phase Shift Keying
QVP	Quaternary Volcanic Pyroclastic
R	Radius of Curve
RA	Republic Act
RAMS	Reliability, Availability & Maintainability Studies
RAP	Resettlement Action Plan

RBC	Radio Block Centre
R/C	Revenue and Cost Ratio Analysis
R&D	Research and Development
RDP	Regional Development Plan
REG	Region
RF	Rainfall
RHU	Rural Health Unit
RIC	RAP Implementation Committee
RIDF	Rainfall-Intensity-Duration-Frequency
RIE	Residential, Institutional, Educational
ROSCO	Rolling Stock Company
ROO	Rehabilitate-Own-and-Operate
ROT	Rehabilitate-Operate-and-Transfer
ROW	Right-of-Way
RPM	Revised Procedural Manual
RPT	Real Property Tax
RRR	Reinforced Railroad with Rigid Facing-Method
RS	Residency Status
RSD	Rolling Stock Division
RTK	Realtime Kinematic
RTP	Real-time Transport Protocol
RTU	Remote Terminal Unit
SAFDZ	Strategic Agriculture and Fisheries Development Zone
SB	Sangguniang Bayan
SBD	Secondary Business District
SCADA	Supervisory Control and Data Acquisition
SCF	Standard Conversion Factor
SCM	Stakeholder Consultation Meeting
SCPW	Society for the Conservation of Philippine Wetlands Inc.
SCS	Soil Conservation Service
SCTEX	Subic-Clark-Tarlac Expressway
SDN	Software Defined Network

SDP	Social Development Plan
SDR	Software Defined Radio
SEMS	Social and Environmental Management Systems
SEZ	Special Economic Zone
SHFC	Social Housing Finance Corporation
SIC	Semi-conductor
SiC	Silicon Carbide
SIL	Safety Integrity Level
SIP	Session Initiation Protocol
SLEX	South Luzon Expressway
SM	Single Mode
SMR	Self-Monitoring Report
SNC	Philippines Second National Communication on Climate Change
SNMP	Simple Network Management Protocol
SO2	Sulfur Dioxide
SO4	Sulfate
SPC	Special Purpose Company
SPD	Surge Protection Device
SPL	Sound Pressure Level
SPS	Safeguard Policy Statement
SPT	Standard Penetration Test
SRTM	Shuttle Radar Topography Mission
STEP	Special Terms for Economic Partnership
STOA	Supplemental Toll Operating Agreement
STP	Spanning Tree Protocol
STP	Sewage Treatment Plant
STPP	Sucat Thermal Power Plant
SUCs	State Universities and Colleges
SW	Surface Water
SWMP	Solid Waste Management Plan
TBM	Tunnel Boring Machine
TC	Trailer Car

TCLP	Toxicity Leaching Procedure
TCU	Total Color Unit
TD	Tropical Depression
TDD	Tagum-Davao-Digos
TDS	Total Dissolved Solids
TESDA	Technical Education and Skills Development Authority
TH	Total Height
TIA	Traffic Impact Assessment
TIF	Tax Increment Finance
TIS	Train Information System
TMP	Traffic Management Plan
TMS	Train Management System
TMV	Ticket Vending machine
TOC	Train Operating Company
TOD	Transit Oriented Development
TOR	Terms of Reference
TRIP	Three-Year Rolling Infrastructure Program
TS	Tropical Storm
TSI	Technical Specification for Interoperability
TSMCS	Time Server and Master Clock System
TSP	Total Suspended Particulates
TSS	Total Suspended Solids
TTC	Travel Time Cost
TY	Typhoon
TX	Tsukuba Express
UH	Unit Hydrograph
ULC	Universal LRT Corporation
UNDP	United Nations Development Program
UNESCO	United Nations Educational, Scientific and Cultural Organization
UP	University of the Philippines
UPS	Uninterruptible Power-supply System
UR	Urban Renaissance Agency

URS	Urban Redevelopment Scheme
USD	United States Dollar
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UTC	Coordinated Universal Time
UTP	Unshielded Twisted Pair
VAT	Value Added tax
VCR	Volume Capacity Ratio
VCT	Voltage Current Transformer for Measuring
VFM	Value For Money
VGF	Viability Gap Fund
VL	Vibration Level
VLAN	Virtual Local Area Network
VOCs	Vehicle Operation Costs
VoIP	Voice over Internet Protocol
VT	Voltage Transformer for Measuring
VU	Vulnerable Species
VVVF	Variable Voltage and Variable Frequency
WACS	Waste Analysis Characterization Study
WB	World Bank
WBCP	Wild Bird Club of the Philippines
WBCSD	World Business Council for Sustainable Development
WFP	Work and Financial Plan
WHO	World Health Organization
WQG	Water Quality Guidelines
WRI	World Resources Institute
WSS	Water Sampling Site

Note: The Project name "The Malolos-Clark Railway Project" shall be replaced with "The Malolos-Clark Railway Project (North-South Commuter Railway Extension Project)"in this report.

CHAPTER 1 INTRODUCTION

1.1 Project Background and Development

1.1.1 Philippines Railways History

The Philippine Rail Road Company operated some 800km or railways at the beginning of the 1900's up and down Luzon Island and with many spur lines. In 1917 it was nationalized to be Philippine National Railway and it expanded its network to ~1,140km by 1941. During the second world war much of the network was destroyed and at the end of the war only ~450km network was operational. Post war repairs rehabilitated much of the network, and by 1951 about 85% of the pre-war network was operational. In late 1950's much of the steam network was replaced with diesel locomotives from USA. The 1964 Republic Act 4156 established Philippine National Railway (PNR).

However, due to natural calamities and other issues the services went in to steep decline and only a handful of services remained operational by the end of the last century. As a result, the current operational services are limited to Tutuban-Alabang and limited service onward from Alabang to Calamba. The services to the north were halted in June 1991 with mount Pinatubo exploding and burying much of the system under ash.

However, in late 1990's GOP decided to revive the northern part of the rail system and Northrail project was started. The project involved upgrading of the existing single track to a dual-track system, converting the rail gauge from narrow to standard gauge. Linking Metro Manila (MM) to Malolos City in Bulacan and further on to Angeles City, Clark Special Economic Zone (CSEZ) and the Clark International Airport (CIA).

Preparatory construction began in early November 2006. Due to delays in the construction work, the project was cancelled in March 2011. Later in 2011, President Aquino administration scrapped the project due to lingering legal and administrative issues. The Philippine Supreme Court in March 2012 handed down a decision for the annulment of the allegedly overpriced Northrail project contract.

The Department of Transportation and Communications (DOTC) has examined reviving the project by commissioning feasibility studies for Manila Clark Railways with the help of JICA in 2012/13. Tutuban-Calamba-Los Banos commuter line study under its own program to rehabilitate the Philippine's Luzon railways.

1.1.2 Background – Clark Airport Link and Other Studies

To improve the situation mentioned above, JICA supported formulation and GOP approved of a roadmap namely "Roadmap for Transport Infrastructure Development for Metro Manila and its Surrounding Areas" (Roadmap 1). In this project, it was recommended that the necessity to lead the further development of Metro Manila to be in the direction of north and south in order to disperse the socioeconomic activities. In addition, there are proposals of new urban cities and further strengthening of the North-South rail and road corridors Through Metro Manila. Based on the results of the Roadmap 1, and Manila-Clark Airport Express/ commuter rail feasibility studies. The "North-South Commuter Railway Project (Tutuban – Malolos) Detailed Design Study" (NSCR) was implemented through a JICA grant which was completed in December 2017. At present, general consulting services of this project including bidding process assistance are underway through the ODA of Japanese Yen loan provision.

The current Philippine government, which started its tenure on June 30, 2016, announced the economic policy with infrastructure development as its main pillar. In that policy, it showed that the infrastructure investment of the Philippine government had stayed at only 2.4% of GDP on average over the past 50 years. In response to this shortage in infrastructure investment, the economic policy aims to increase the infrastructure investment to 5.4% of the GDP from 2017 onwards. It had presented fourteen priority infrastructure projects. One of these priority projects is the Malolos-Clark Railway Project (MCRP), which connects Clark International Airport (CIA) with Metro Manila area. The other project is North-South Railway Project-South Line (Commuter): NSRP that connects Metro Manila with its southern suburbs.

1.1.3 Malolos Clark Railway Project (MCRP) – Study Background

In October 2016, the Minister of Land, Infrastructure, Transport and Tourism of Japan proposed to the Philippine Transport Minister that a feasibility study by Japan Overseas Infrastructure Investment Corporation needs to be conducted for the Transport and Urban Development (JOIN) project. Based on the MOU signed at that time, the JOIN feasibility study is to be conducted (JOIN F/S) to help Philippine Government to decide whether or not to implement the project. The JOIN F/S was completed by July 2017. Table 1.1.1 presents the events chronologically leading up to the start of this study.

Table 1.1.1 Chronologial Table of Events to the Start of this Study

Year/Month	Events
2014	Implementation of Roadmap 1
2016/June	New Administration launched economic plan with Investment in Infrastructure
2016/October	Proposal and commencement of JOIN F/S
2017/July	Completion of JOIN F/S (Clark Manila Railway Project)
2017/June	The project (MCRP & NSRP) was approved

Source: JICA Design Team

In July 2017, the Japanese government reported the result of JOIN F/S to Philippine Department of Transportation (DOTr). The conclusion of JOIN F/S satisfied the following two requests of DOTr:

(1) Open the MCRP railway within the current administration (Partial operation by May 2022); and
(2) Connect CIA to Metro Manila area, with a railway within 1 hour of travel time on an express train from CIA to Makati CBD.

However, with regard to (1), the Philippine government suggested that the Japanese Government and JICA should speed up their procedures for the project implementation. The scope of JOIN F/S has been limited to information gathering/ surveys to satisfy the desire of the Government of the Philippine to open the railway within the term of the current administration, and it did not include the examination of environmental and social considerations.

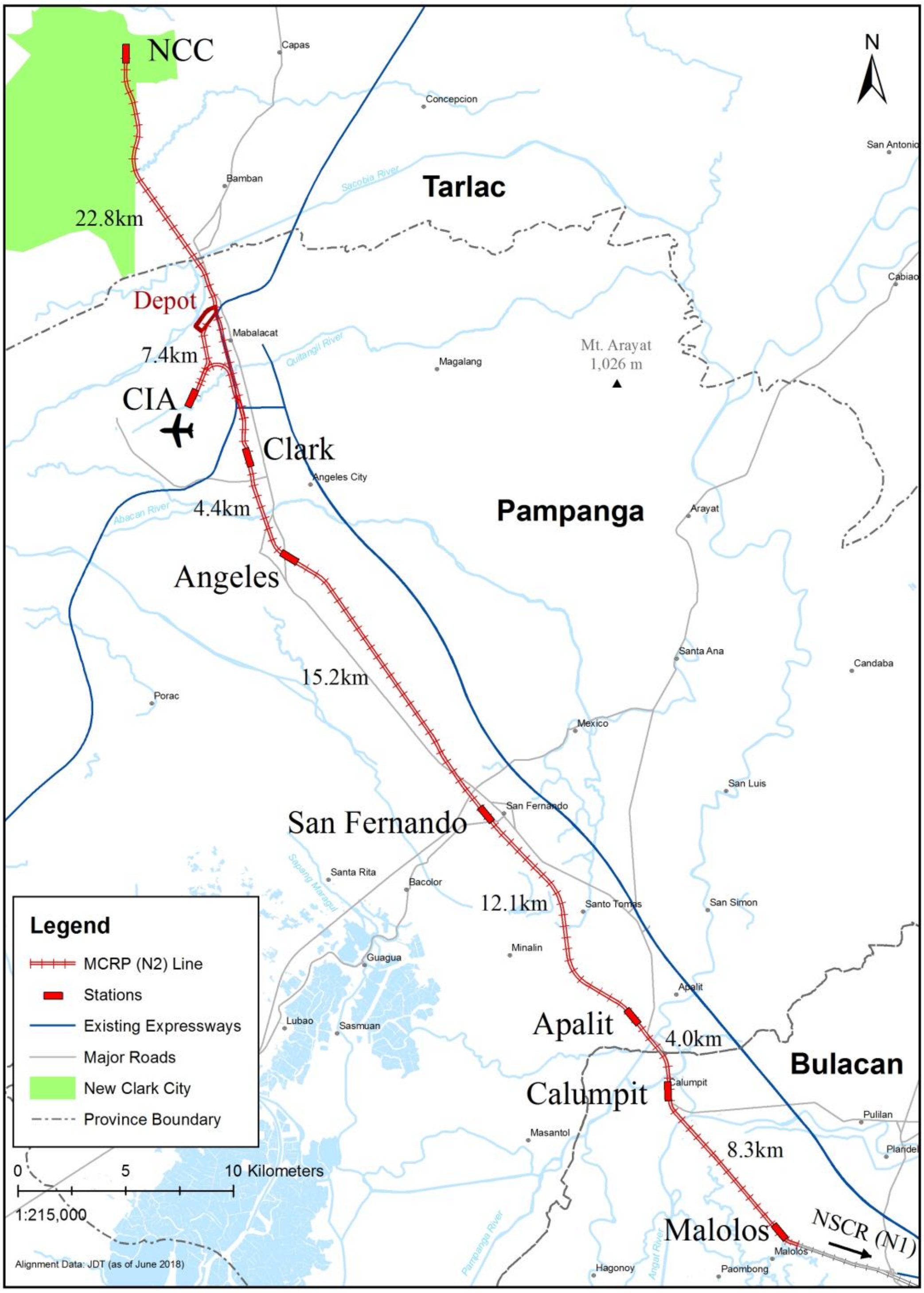
1.2 Objectives of the MCRP Study

The key objectives of the Project are to conduct a complementary study to the JOIN F/S and ADB F/S to cover the technical and other aspects not covered by these two studies, and to confirm the 'full' feasibility of the MCRP and NSRP. Subsequently, this project aims to conduct a detailed examination of the civil structures and E&M systems of the two railway projects by setting the design standards. The project would propose construction plans in compliance with the technical standards, considering the optimum construction contract forms, contract packages, and prepare draft bid documents for the grant of ODA loans for the two projects. MCRP Project Study Area

1.2.1 Malolos – Clark Railway Project (MCRP)

The MCRP study area covers from Malolos to Clark via cities of Calumpit, Apalit, San Fernando, Angles. From Clark onwards the proposed railway will connect to the Clark International Airport (CIA), and also extend further north from Clark to the New Clark City (NCC). The distance from Malolos to Clark is 44km and about 67km to the New Clark City, with a total line length of 74km including the 7.4km spur line to CIA. It is proposed that there will be seven stations and one depot (with additional spur of 3.5km from CIA) on this section of the railway to be designed with 1160kph design speed, fully electrified with dual standard gauge tracks.

The alignment will be at-grade, viaduct. The current estimate from Malolos to CIA and NCC is 63km is on viaduct, 9km would be underground and the remainder at-grade or on transition from elevated to underground, mostly around CIA and NCC stations. The section from Clark to New Clark City (NCC) is under further studies and the Project Study area is illustrated in Figure 1.2.1 next.



Source: JICA Design Team

Figure 1.2.1 MCRP Study Area

1.3 MCRP Study Phasing and Scope of Work

1.3.1 MCRP Study Phase I – Feasibility Study (December 2017 – August 2018)

The MCRP as studied in the JOIN F/S in 2017 did not cover the necessary tasks required for the project appraisal for an ODA loan. The tasks to be covered in this study will be conceptual/ preliminary/ detail design of the project and revised cost estimates,‘ Environmental and social considerations (environmental assessment or environmental impact assessment, EIA), and resettlement Action plan (RAP) will be prepared. This initial assessment is to include inspection of all affected parties. The results of Phase I is to be reported in this Feasibility Study report.

1.3.2 MCRP Phase-I Study Scope of Work

The scope of the studies for Phase-I are summarized in Table 1.3.1 below.

Table 1.3.1 Scope of Studies for Phase-I

(1) Supplementary FS and Development of Basic/ Concept Railway system	
1	Necessity and Background of the Project
2	Topographic and Geologic Survey
3	Route Alignment Plan
4	Developing Project Plan
5	Developing Project Implementation Plan
6	Developing Project Implementation Structure
7	Social and Environmental Impacts
8	Assessment of Project Effectiveness
(2) Basic Design	
1	Design Criteria
2	Design Specification
3	Documentation for Procurement of Contractor

Source: JICA Design Team

1.4 JICA JDT Coordination Meetings with DOTr-PMO

The Coordination Meetings for the project that has been held to-date are listed in Table 1.4.1 below.

Table 1.4.1 List of Coordination Meetings

No.	Date	Venue	Reference
1	December 14, 2017	DOTr Clark Office	Attachment 1
2	January 15, 2018	DOTr Clark Office	Attachment 2
3	January 31, 2018	ADB Office	Attachment 3
4	February 21, 2018	LRTA Office	Attachment 4
5	April 18, 2018	LRTA Office	Attachment 5
6	August 3, 2018	BCDA Office BGC	Attachment 6

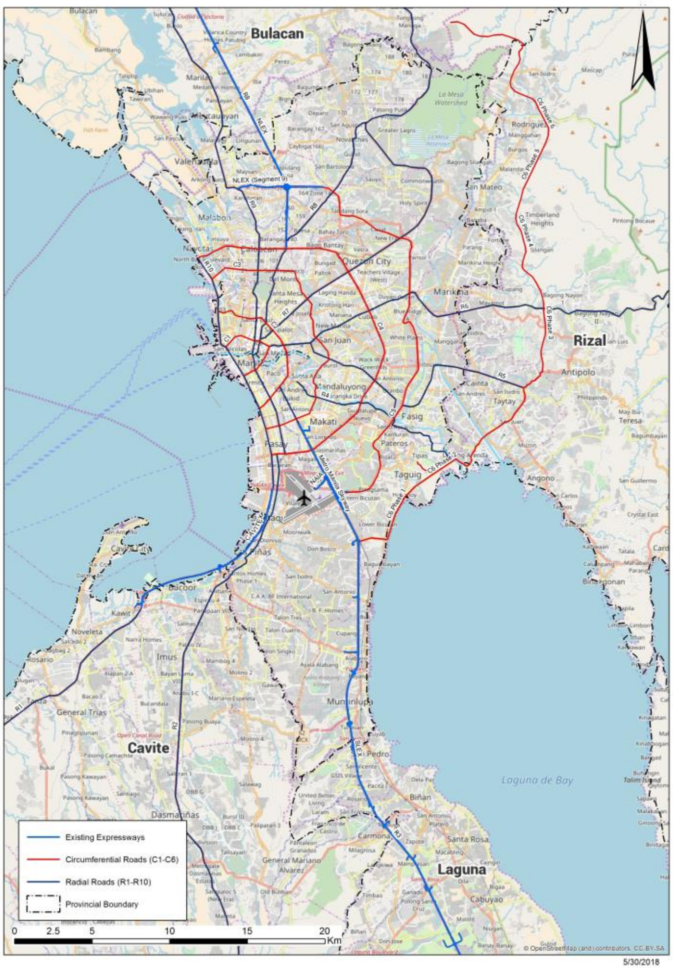
Source: JICA Design Team

CHAPTER 2 NECESSITY OF THE PROJECT

2.1 Overview and Issues of Transport Sector in GCR

2.1.1 Road and Expressway Network

Metro Manila has ten radial roads and five circumferential roads. Outside Metro Manila, MacArthur Highway is the only highway which connects Metro Manila with Bulacan and Pampanga Provinces, in the north. In wider area, Metro Manila is linked by expressways to Laguna on the south by the South Luzon Expressway (SLEx ~51km) and Skyway (16km); to Bulacan and Pampanga on the north by the North Luzon Expressway (NLEx ~84km), which T-connects to Subic-Clark-Tarlac Expressway (SCTEx ~94km). In the southwest MM is linked to Cavite province by Manila-Cavite Expressway (CAVITEx ~14km). Complete existing highway and expressway network is depicted in Figure 2.1.1.



Source: JICA Design Team

Figure 2.1.1 Existing Roads, Highways and Expressways Network in Greater Metro Manila

2.1.2 GCR Railway Network

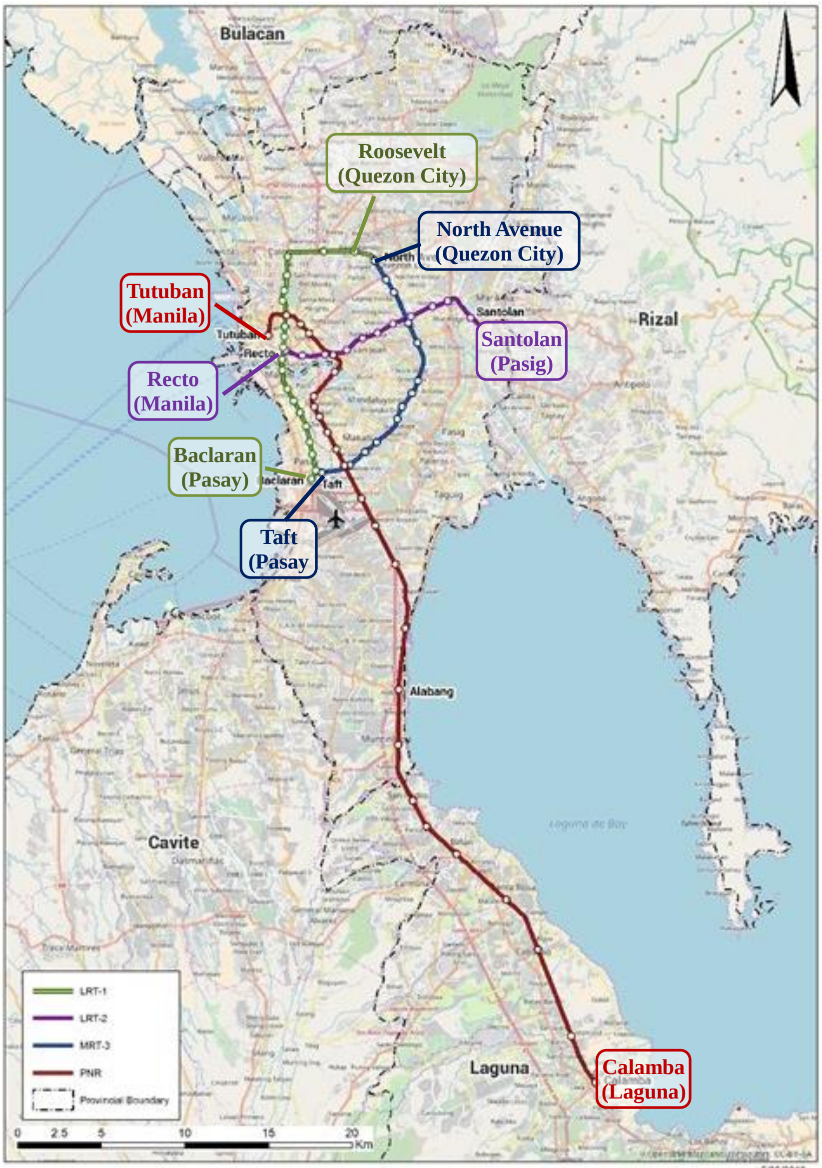
(1) Rail Network Characteristics and Operation

The railway system in Greater Capital Region of Manila consists of the Philippine National Railway (PNR) for inter-urban or suburban service, and three LRTs for inner-city urban travel. PNR currently provides limited frequency service. The PNR service albeit unreliable provides a services to the south - from Tutuban in Manila, heart of the old city to Calamba in Laguna province. Revival of the operation to the north via a commuter service from Tutuban in Manila City to Malolos in Bulacan province had been stalled since the last decade due to the collapse of the Northrail project. The current performance of the 4 railway lines are summarized in Table 2.1.1. The rail network is illustrated in Figure 2.1.2.

Table 2.1.1 Summary of Railway Systems in GCR

Characteristics	PNR	LRT Line 1	LRT Line 2	MRT Line 3
Guideway & Railway Type	At-grade (HRT, narrow-gauge)	Elevated (LRT, std gauge)	Elevated w/UG (LRT, std gauge)	Elevated, w/UG (LRT, std gauge)
Route	Tutuban (Manila)-Calamba (Laguna)	Roosevelt (Quezon City) - Baclaran (Pasay)	Santolan (Pasig) - Recto (Manila)	North Avenue (Quezon City) – Taft (Pasay)
Route Length	~56 km	18.1 km	13.5 km	16.9 km
No. of Stations	25	20	11	13
Capacity	-	1,358 pax/train	1,628 pax/train	1,182 pax/train
Maximum Speed	-	60 kph	80 kph	65 kph
Operating Speed	-	38 kph	33 kph	30 kph
Fare (distance-based)	PhP15 - (AC PhP60	PhP11 + 1/km[2/]	PhP11 + 1/km[2/]	PhP11 + 1/km[2/]
Travel Time	~2.5 hours	~28 minutes	30 minutes	30 minutes
Headway	30 minutes (variable)	2 minutes	4~5 minutes	3 minutes

Source: Follow-up Survey on Roadmap for Transport Infrastructure Development for Greater Capital Region (GCR)

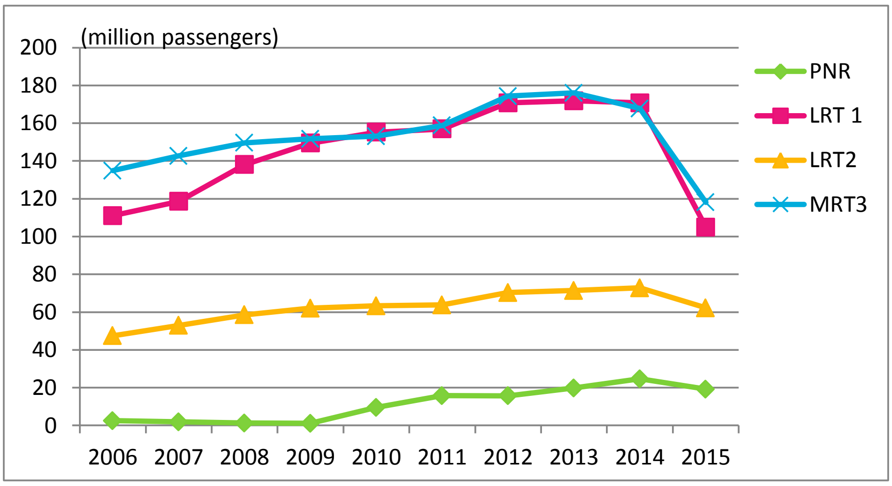


Source: JICA Design Team

Figure 2.1.2 Existing Railway Network in Greater Metro Manila

(2) Ridership

The aggregate number of railway passengers in 2015 was more than 304 million passengers - of which, MRT3 accounted for 39%, followed by LRT-1 (34%). Passenger volumes for the four lines has shown healthy growth from 2006 to 2014. The trend in patronage has been illustrated below in Figure 2.1.3. The precipitous decline after 2014 was primarily caused by 45% reduction in train availability on MRT-3, about 20% on LRT-1, and ~16% on PNR. The frequency of incidents / disruptions on MRT3 alone have been observed to be more than 10 times a week since 2017.



Source: Statistics from DOTr.

Figure 2.1.3 Railway Passengers in GCR 2006-2014

2.1.3 Road Based Public Transport System

Buses, jeepneys and Asian Utility Vehicle (AUV) basically comprise the road-based public transport services in the Study Area In many local communities other paratransit like trishaws, Pedi-cab provide service mainly for short distances and as feeder service to access main roads served by Jeepneys or buses. Almost all public transport vehicles are owned and operated by the private sector, but are regulated by the Land Transportation Franchising Regulatory Board (LTFRB). Besides, DOTr (formally DOTc) launched the point to point (P2P) premium bus services in December 2015, this to cover the shortfall in PT supply caused by lack of trains for MRT-3. Aside from a fixed departure and arrival schedule, the P2P service uses premium buses with free WiFi and GPS to provide comfortable and convenient ride for commuters. As of December 2016, P2P is operated along 11 routes. Other than the P2P, no new bus services have been added or issued any new franchises within MM/ GCR.

2.1.4 Airports

There are two international airports in the Study Area. Ninoy Aquino International (NAIA) located in Pasay City, Metro Manila. It is the gateway airport for the Philippines mainly due to its close proximity to business centers of Metro Manila. Currently, NAIA is handling approximately 34 million passengers per annum including both international and domestic the majority of NAIA passengers are domestic from/to Metro Manila and southern Luzon and other Islands. On the other hand, Clark International Airport (CIA) located in Mabalacat City, Pampanga Province is currently utilized by mainly low-cost carrier (LCC) airlines. CIA is handling less than one million passengers per annum. CIA does not attract many airlines/ passengers due to its poor accessibility to/from Metro Manila. The capacity of NAIA is assumed approximately 35 million passengers per annum and 250,000 aircraft movements.[1] In 2016, the passenger traffic at NAIA was 39.5 million in 2016 (excluding general aviation) and the number of

[1] JICA, "Information Collection Survey for New Manila International Airport in the Philippines", Jan 2016

aircraft movements was more than 258,000. Thus, NAIA has already reached its capacity. For CIA, although the existing passenger terminal building had expanded to accommodate 5 million international and domestic passengers per year, the annual passenger counts as of 2014 was only 878,000 passengers. However, in the future, CIAC has planned for extension capacity, it will be extended to 46 million / year on 3rd phase[2].

In road map II Study, a strategy has been proposed for the airport which is the gateway of GCR as below, CIA is written that future expansion plans will be made, and it will absorb NAIA's excess demand.

Table 2.1.2 GCR Gateway Airport by Roadmap II

Airport	Phase 1 (2018-2022)	Phase 2 (2023-2029)	Phase 3 (2030 upward)
CIA	Complete the new CRK International Passenger Terminal in tandem with private O&M	Expand capacity and upgrade systems to absorb spill over from & provide relief to existing NAIA	Build the 2nd and 3rd runway, as well as expand Pax Terminal building & Cargo Terminal
NAIA	Complete the transfer of General aviation from NAIA to Sangley Terminal space expansion & management improvements (T1 to T4) via PPP	Build a new NAIA in another site south of NCR (if not Sangley 1, then Laguna Lake or Lipa-Batangas)	Shutter existing NAIA and convert to “green lungs of NCR” plus socialized housing community
Regional airports outside GCR	Complete the night landing facilities in other airports feeding into NAIA	Complete full development of regional airports, as well as tourism-based airports (Bohol, Palawan, etc.)	Aviation policies to steer traffic growths from GCR to regional airports (Cebu, Davao, Iloilo, Laoag)

Source: Follow-up Survey on Roadmap for Transport Infrastructure Development for Greater Capital Region (GCR)

2.1.5 Current Key Transport Issues

(1) Overview of Traffic Congestion

The significant increase in traffic volume resulted in congestion level much worse than that in the late 1960’s, in some cases leading to total grid-locks on key arterial and circumferential roads. Traffic congestions occur not only on road traffic but also on railways, especially on LRT1 and MRT3, where passenger queues for considerable time even to access the station entrance. The cheap fare on LRTs compared to other public transport modes, faster travel times and the lack of railway network attracts passengers to LRT1 an MRT3 beyond their current operating capacities. This results in overcrowding on the platforms (sometime reaching dangerous levels) with queues of passengers in concourses waiting to go to the already overcrowded platforms. The passengers suffer unnecessary delays and discomfort due to delayed/ cancelled trains.

The overloaded railway infrastructure has been facing technical problems, causing accidents and operation suspensions. In addition, the problems of the railway system in Metro Manila are caused by lack of physical and service integration among the three railway lines as well as institutional integration to manage the railway systems.

2 http://madaboutsolutions.space/staging/amchamwp/wp-content/uploads/2017/06/feb23.pdf

Similarly, the airport has been facing the congestion, specially at NAIA the busiest airport in the Philippines which has reached its capacity. The air passenger movement in NAIA has been increasing inline with economic growth of the Philippines. The penetration of the LCC airlines in the Philippines has pushed NAIA runways to their capacity limits. However, it is extremely difficult to expand NAIA capacity due to its location and congested surrounding areas. The Philippine Government declared in 1994 to utilize CIA as a premier international gateway airport for the Philippines so that air traffic demand of Metro Manila could be handled by NAIA and CIA togather. However, CIA is underutilized because of unpredictable travel time to/from Metro Manila in the absence of high speed rail link.

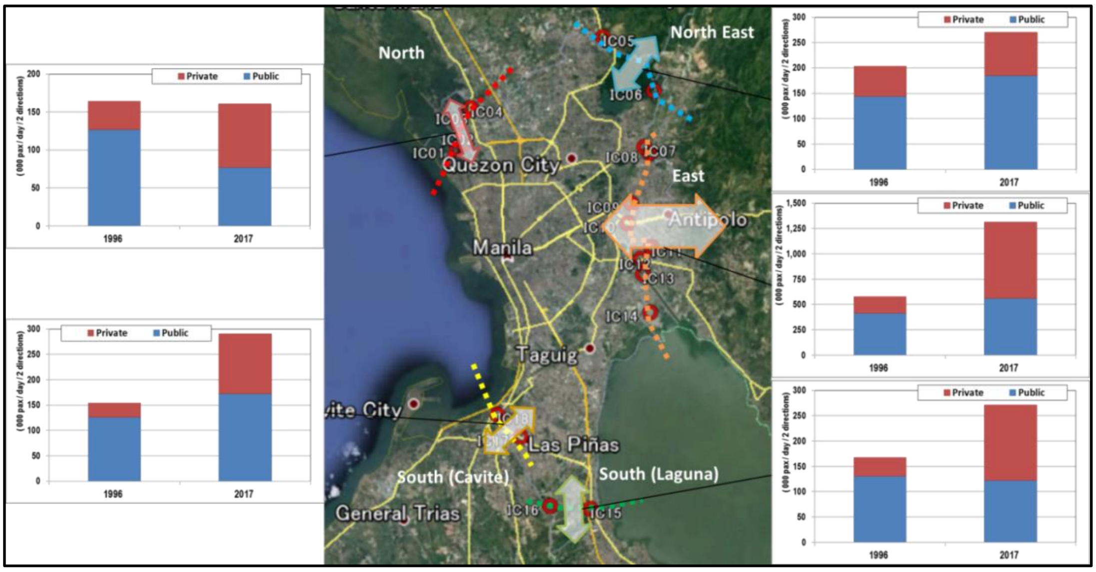
The population of Metro Manila, the capital city of the Philippines increased by 1.5 times from 8.0 million in 1990 to over 12.0 million in 2010. With a population density of 20,000 per km^2, Manila is home to about 13% of the population of the Philippines and the main economic center accounting for 38% of the country's GDP.

Severe traffic congestion and environmental degradation characterize Metro Manila particularly at city centers, where high density development continues unabated. Urban sprawl has spilled over onto surrounding northern and southern provinces which are within daily commuting distance from Metro Manila. With increasing vehicle ownership, congestion is expected to worsen, further increasing travel times of commuters to unacceptable levels.

Figure 2.1.4 Current Traffic Congestion on EDSA

(2) Road Traffic Demand

Comparing the traffic count results along the boundary of Metro Manila of 1996, 2012, and 2017, the daily traffic has been increasing in the period 1996–2017 as illustrated in Figure 2.1.5. In particular, the traffic to and from east and south increased about three-fold. This implies the rapid expansion of urban areas of Rizal, Laguna, and Cavite provinces. Comparing the growth of the number of passengers with the number of PCU, the number of passengers increases 1.8 times on average, while the number of PCU increases 2.7 times in during the same period. This implies that more people use private vehicles rather than public transport such as bus and jeepney, i,e, increase has been mostly in the number and use of private vehicles, whereas share of public transport has either declined or remained roughly the same over the same period.



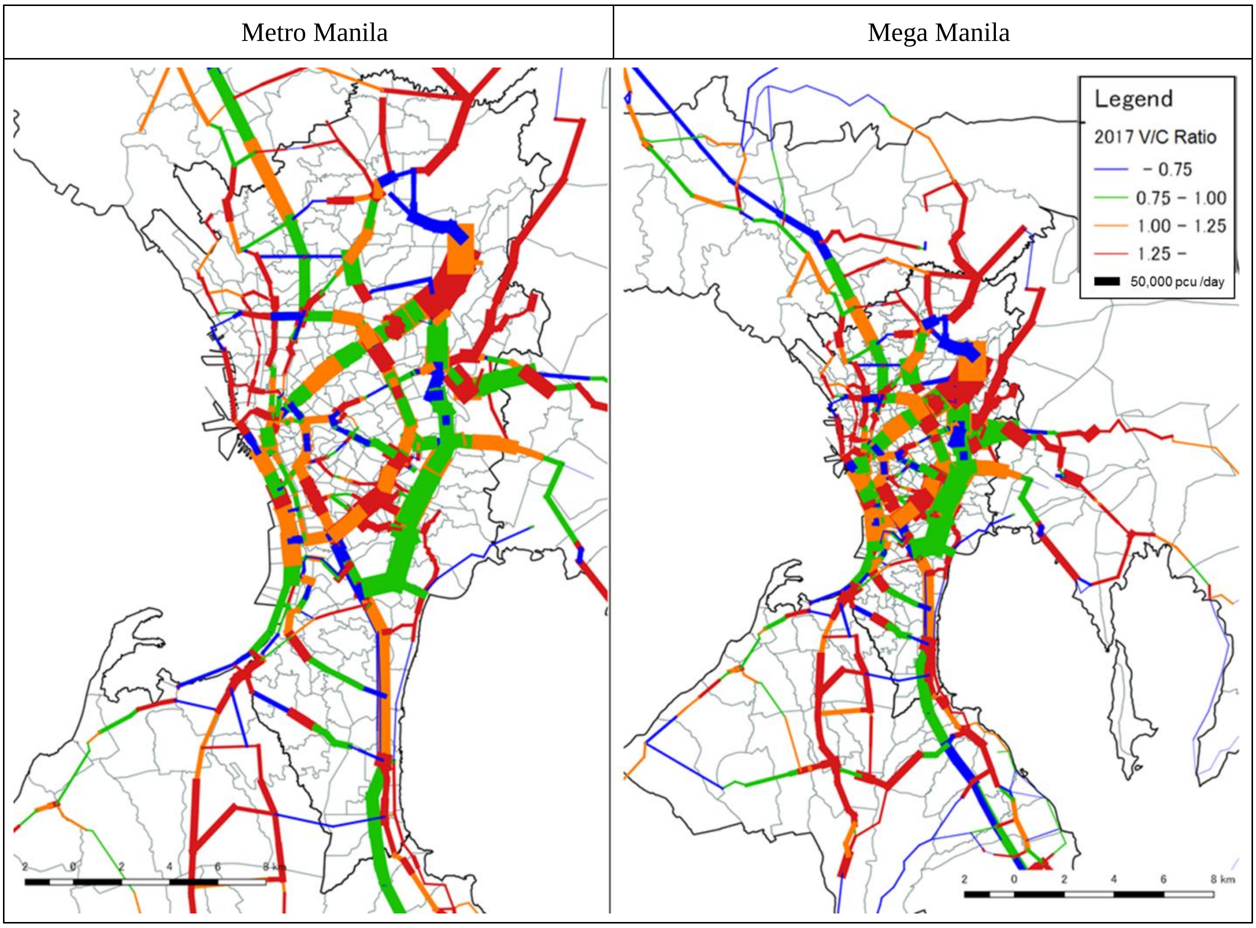
Source: Follow-up Survey on Roadmap for Transport Infrastructure Development for Greater Capital Region (GCR)

Figure 2.1.5 Changes in Daily Traffic Crossing Metro Manila Boundary

(3) Existing Road Network Performance

In Mega Manila, the daily traffic volume on most of the roads are nearly or exceed their capacity. When the traffic volume of a road exceeds 50% of its capacity, the travel speed starts to decrease dramatically and such road condition may be referred to as heavy traffic.

The traffic volume/capacity ratio of road sections in Mega Manila and Metro Manila are shown in Figure 2.1.6. Orange and red colors in the figures indicate road sections with volume/capacity ratio >=1.0. Or could be defined having reached capacity and require additional capacity to meet demand.



Source: Follow-up Survey on Roadmap for Transport Infrastructure Development for Greater Capital Region (GCR)

Figure 2.1.6 Traffic Volume and V/C Ratio on Existing Road Network—Based on Traffic Model

(4) Impact of Traffic Congestions

The estimated congestion costs[3] in Metro Manila and the adjoining provinces are estimated to be PhP 3 and 2 billion/day, respectively. Besides congestion cost, environmental emission can also be converted to monetary value. Based on the market value of CO_2 in November 2017,[4] CO_2 emission in Metro Manila and the adjoining areas cost about PhP75,000 and PhP68,000 per day, respectively.

(5) Summary of Issues

The traffic congestions in Metro Manila and adjoining provinces have been getting worse by the day. The congestion is not only in the morning and evening peak rush hours, but also, prevails throughout the day. The congestion is spreading to the outer areas and adjoining provinces. It is estimated that the cost of congestions exceeds PhP3.0 billion/day in Metro Manila and PhP2.0 billion daily in the adjoining

[3] Congestion cost is the difference between the actual transport cost and the transport cost with free-flow traffic. The free-flow traffic in this Study was assumed that the travel speed of expressways, primary roads and secondary roads are 60 kph, 35 kph and 20 kph, respectively. The transport cost consists of (i) Vehicle Operating Cost and (ii) Travel Time Cost of all road users. The unit costs by vehicle type were estimated in MUCEP Study and updated to the price in 2017. Value of Time by the vehicle types are as follows: Public (86.2 php/hr), Motorcycle (81.1 php/hr)、Car (131.5 php/hr).

[4] 1 ton of CO_2 = EUR7.26 (CO_2 EUROPEAN EMISSION ALLOWANCES) on 16 November 2017.
EUR7.26 =PhP435 (JICA Conversion Rate in November 2017)

provinces comprising of Bulacan, Rizal, Cavite, and Laguna. This huge economic loss is due to increase in vehicle operating cost and travel time also affect the peoples' life significantly.

Causes of the traffic congestions are complex. Primarily, traffic demand exceeds capacities of infrastructure. This does not mean that more construction of roads and rail infrastructures is the solution. Before expansion of roads, negative factors attributed to the existing facilities may be identified in a long list such as, but not limited to:

(i) Inadequate road intersection management:

Capacities of roads as a network are constrained due to non-signalized intersection, signalized intersection with adequate traffic flow control, including cycle time of traffic signals, channelization of intersections, and enforcement of traffic rules at and around intersections.

(ii) Lack of corridor management:

This includes loading and unloading of bus/jeepney passengers, which is particularly obvious in the CBD area and at LRT/MRT stations, illegal road side parking and vendors, driving behavior, inadequate pedestrian crossing facilities and jaywalking, etc.

(iii) Lack of enforcement capacity:

Impact of traffic congestion on land use is also notable. In 1970 and 1980, the most significant CBD was in the City of Manila, therefore, traffic distribution was planned radially which justified the radial road development and LRT Line-1. Thereafter, CBD center of gravity gradually shifted to Makati and Ortigas areas. Today, urban spatial structure in Metro Manila is more complex and a number of activities centers have emerged.

Traffic congestion does not only cause travel cost and time losses, but also deteriorates air quality and the living environment. The main vehicle emissions consist of CO_2, NOx, and PMx. These will affect not only climate change, but also human health.

2.2 Review of Current Development Policies and Plans

2.2.1 National Transport Policy (NTP)

The NTP envisions the establishment of "a safe, secure, reliable, efficient, integrated, intermodal, affordable, cost-effective, environmentally sustainable, and people-oriented national transport system that ensures improved quality of life of the people" as the Transport Vision.

The Philippine Government will adopt the NTP to achieve the Transport Vision, which all elements of the transport system and all sub-sectors of transportation, including passengers, shippers, service providers, investors, agencies and instrumentalities of government and those involved in the movement of people and goods and in the provision of transport infrastructure, facilities and services, shall abide by and use as guidance in transport development, management, operations, and use.

The NTP was approved and adopted by NEDA Board in June 2017 meeting and is expected to unify all transport-related projects in the country.

2.2.2 Philippines Development Plan (2017-2022)

The Philippine Development Plan (PDP) 2017–2022 was officially approved by the National Economic Development Authority (NEDA) Board in February 2017. The development plan aims to lay a stronger foundation for inclusive growth, a high-trust society, and a globally-competitive economy towards realizing the vision by 2040. The target of PDP 2017–2022 is to reduce poverty incidence from 21.6 percent in 2015 to 14.0 percent by 2022.

To support a higher growth trajectory and improve the quality of life in both urban and rural communities, and infrastructure development will remain among the top priorities. Moreover, initial steps were taken towards developing new railway and other mass transit systems in and outside Metro Manila. For more efficient use of road infrastructure, the movement of people and goods will be prioritized over private vehicles. The desired shift from private to public transport with emphasis on mass transport will be encouraged by ensuring the accessibility, availability, affordability, adequacy, convenience, and reliability of rail transport and bus priority systems.

2.2.3 Philippine Transportation System Master Plan (PTSMP)

The formulation of a comprehensive transport master plan on a nationwide scale is one of the strategies espoused in the NTP, particularly to ensure the holistic and evidence-based program/project selection process.

The study aims to come up with a master plan, formulated based on a detailed assessment of the existing national transport network and the results of a comprehensive analysis of the gaps therein. The PTSMP aims to guide the rational development of an intermodal transport network in the country through coordinated planning and operation of projects and programs as an integrated network of intermodal sub-systems. It also aims to promote sub-regional economic cooperation/agglomeration and utilization of multimodal transport system for more efficient connectivity between industrial/production areas, major cities, and rural areas in line with the Government's direction to decentralize development away from highly urbanized cities and metropolis.

2.2.4 Public Utility Vehicle Modernization Program (PUVMP)

The PUVMP is a road-based transport reform program that envisions a restructured, modern, well-managed, and environmentally sustainable transport sector. Where drivers and operators have stable, sufficient, and dignified livelihoods while commuters get to their destinations quickly, safely, and comfortably. It was declared that with the program, "By 2022, Filipinos will have a pleasant commuting experience."

It is envisaged that the benefits of the PUVMP are (i) congestion reduction especially in highly urbanized area; (ii) improvement of public transport level of service; (iii) passenger and commuter welfare; (iv) Improvement of welfare for the transport sector; (v) creation of more jobs/employment by engaging the local manufacturing industry; (vi) reduction of both environmental and social costs (health) through less production of carbon dioxide and particulate matter emissions; and (vii) improvement of take-home pay for the drivers. The major components of the PUVMP are shown in Figure 2.2.1.

The Department of Transportation (DOTr) is in the process of seeking the support of all stakeholders for the government initiative to upgrade public utility jeepneys as part of the PUVMP.

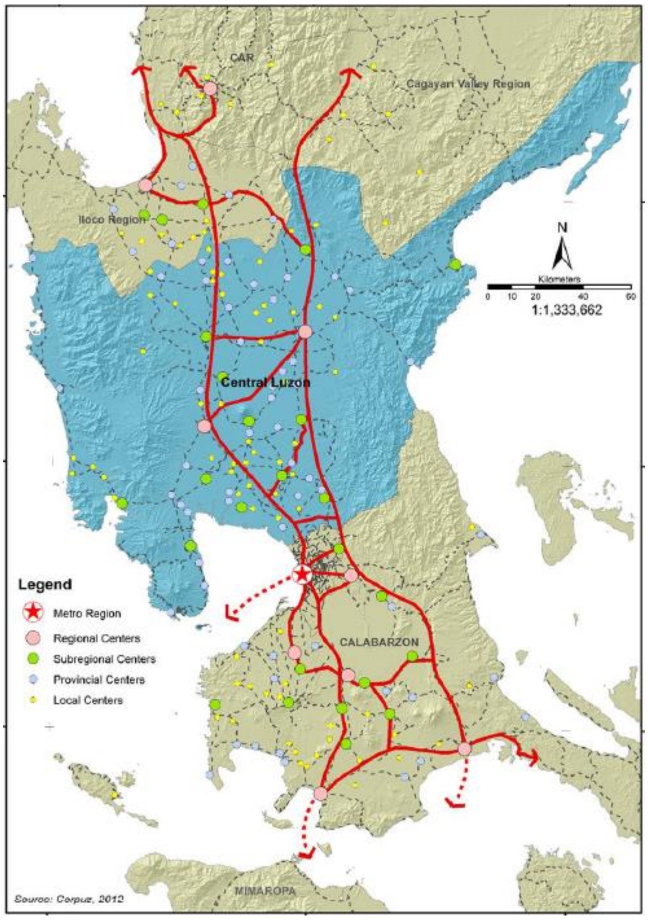
Source: DOTr

Figure 2.2.1 Major Components of the PUV Modernization Program

2.2.5 Central Luzon Regional Development Plan 2017–2022

Central Luzon Regional Development Plan (RDP) 2017–2022 states that the vision of the region is: "to have globally competitive human resources, a highly productive and profitable agricultural sector, seamless and integrated physical access, and a transshipment and logistics hub in the Asia-Pacific Region."

Access and circulation between and among the different sub-regional, provincial, and town centers will be facilitated through the development of backbone, lateral, and strategic all-access roads. The critical sections of the existing MacArthur and Pan- Philippine Highways (north–south arterial backbone roads) will be rehabilitated or widened to improve capacity (Figure 2.2.2).



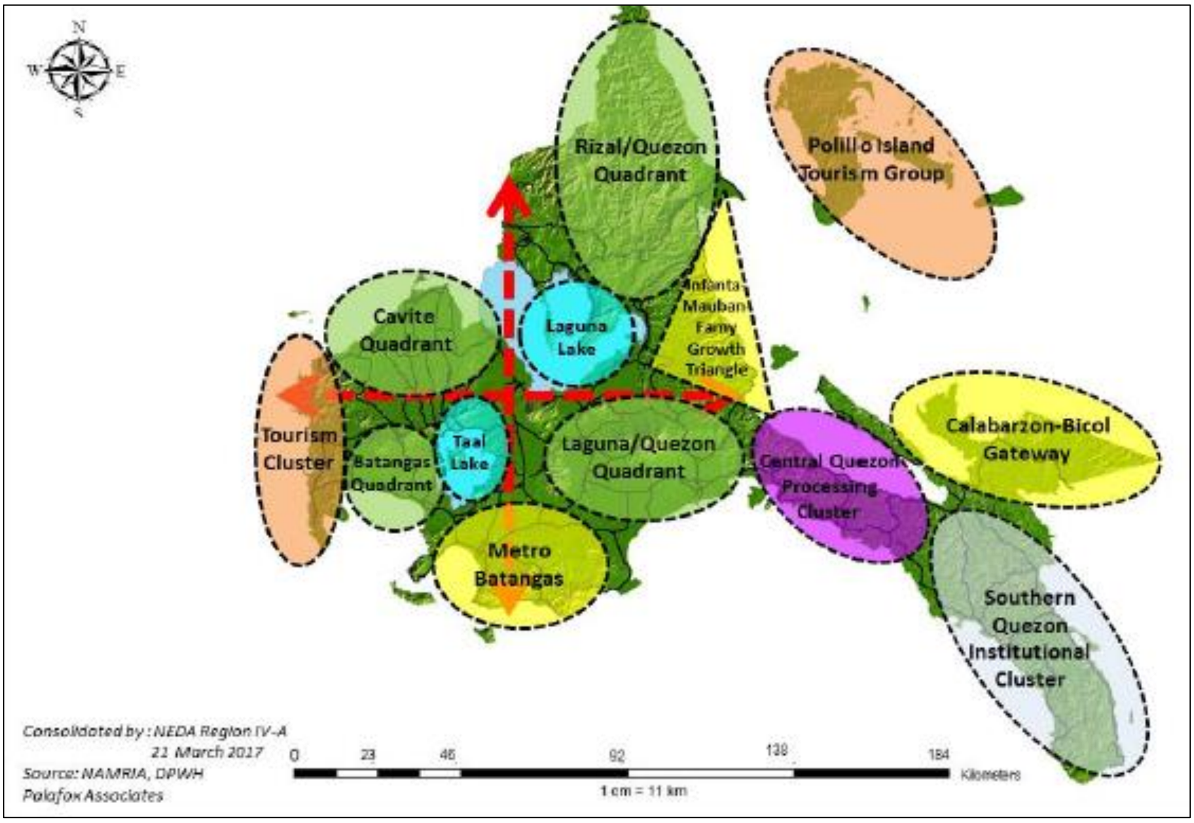
Source: Central Luzon Regional Development Plan 2017 - 2022

Figure 2.2.2 Twin-spine Connectivity Framework Showing Linkages between Urban Centers

2.2.6 Regional Development Plan for CALABARZON 2017–2022

The CALABARZON Regional Development Plan (RDP) 2017–2022 states that the vision of Region 4-A is "a region of vibrant economic diversity and vitality with progressive, well-planned town clusters inhabited by God-loving people enjoying globally competitive, balanced, and resilient ecosystems."

To realize the region's vision, in 2011, the plan proposed a spatial development strategy called Center/Cluster-Corridor-Wedge (CCW) to enhance development along the west–east and north–south axes. However, this was refined in CALABARZON RDP 2017–2022 and a five-tier network or hierarchy of settlements was proposed, which became consistent with the population and economic trends. Consistent with the spatial development strategy of the country (concentration, connectivity, and vulnerability reduction), settlements were grouped based on their commonalities in terms of physical configuration, roles, and socio-economic potentials and constraints to improve their viability and competitiveness in the role they are expected to perform (Figure 2.2.3).



Source: CALABARZON Regional Development Plan 2017–2022

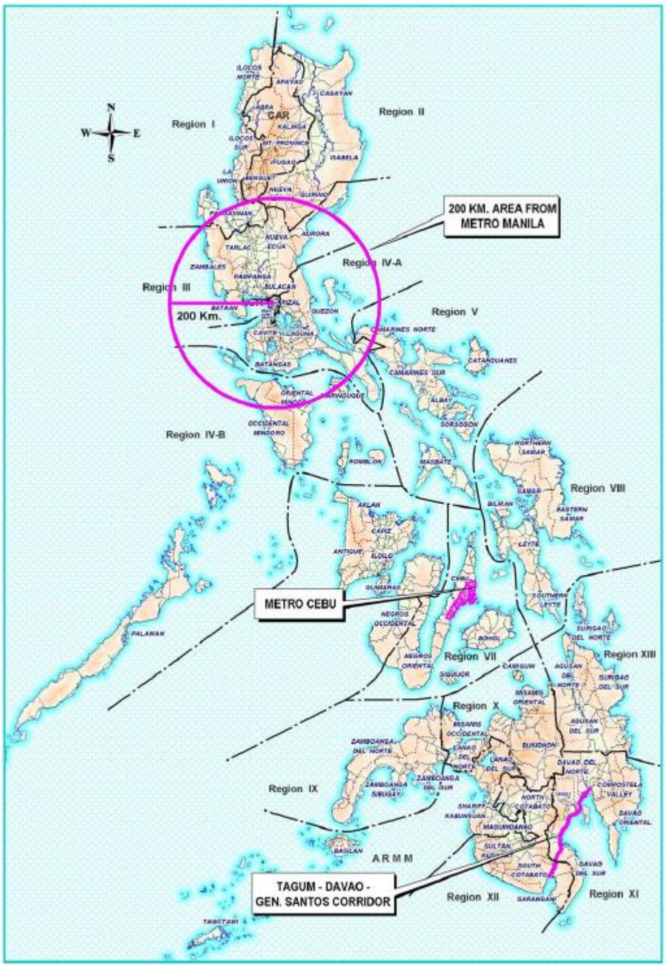
Figure 2.2.3 CLALBARZON Quadrant and Cluster Framework Concept

2.2.7 High-Standard Highway Master Plan

In response to the request of the Government of the Philippines, the Government of Japan decided to conduct the "Study of Master Plan on High Standard Highway Network Development in the Republic of the Philippines" and entrusted the study to the Japan International Cooperation Agency (JICA), which was conducted from April 2009 to May 2010.

The objectives of the High-Standard Highway Master Plan were the formulation of a Development Strategy for the High-Standard Highway (HSH) Network and the formulation of the High-Standard Highway Master Plan with the goal of eventually providing transport facilities that assure high mobility and higher transport capacity.

The study areas covered by the HSH Master Plan were the 200-km radius around Metro Manila, Metro Cebu, and the Tagum–Davao–General Santos Corridors. The location map of the study area is shown in Figure 2.2.4.



Source: The Study of Masterplan on High Standard Highway Network Development in the Republic of the Philippines

Figure 2.2.4 Location Map and Study Areas of the High-Standard Highway Network Masterplan

2.2.8 Metro Manila Greenprint 2030

The Metropolitan Manila Development Authority (MMDA) embarked on creating a green development plan for the metropolis to replace the outdated Metro Manila Development Plan. The vision of this plan is “Metro Manila for all; Green, connected, resilient; Offering talent and opportunity; Processing knowledge and delivering services at home and abroad.” This plan also recommends relocation of the majority of commercial airport functions of NAIA to a site that has road and rail access to major urban nodes as well as realization of the full potential of Clark International Airport.

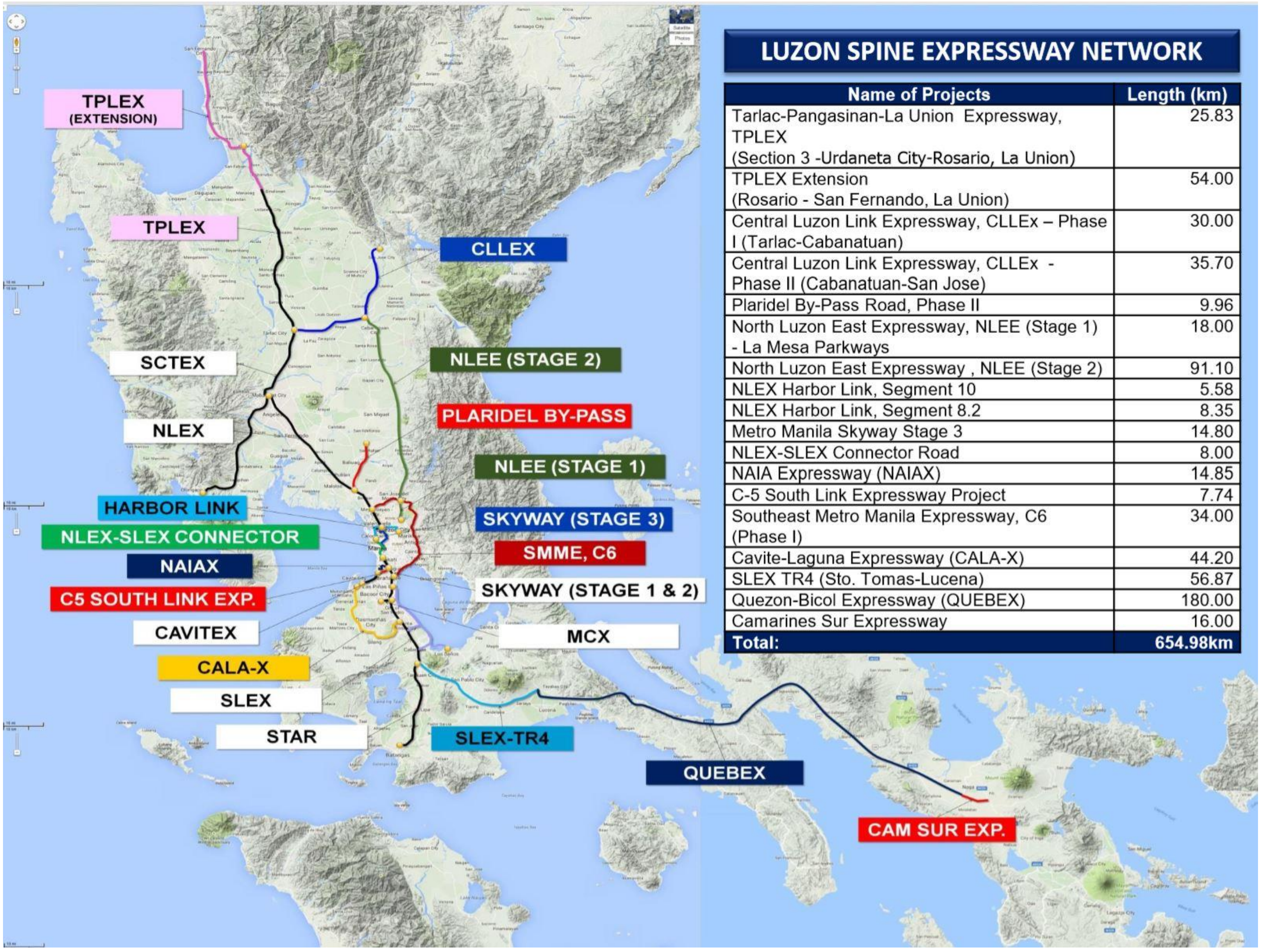
The spatial strategies for Metro Manila Greenprint 2030 was planned to be developed in two Phases. However, as of August 2017, no Phase 2 has been implemented.

2.2.9 Major Transport Projects in Greater Capital Region

(1) Urban Highways and Expressways

DPWH announced plans for 13 new bridges across Pasig and Marikina Rivers. This was followed by an announcement of a grant from China to build two bridges across Pasig River. There are also several urban road projects in the Three Year Rolling Plan (TRIP) of DPWH, but more projects are focused on Metro Manila.

The DPWH has unveiled a long-term Luzon expressway network development plan which they dubbed as the "Luzon Spine Expressway Network" (Figure 2.2.5). Although the implementation timetable is not clear, the implicit target is to complete 655 km of expressways by 2022. Approximately, 50% of this network is in GCR. A review of the records in the last three decades, as well as recent improvements in funding and ROW issues, suggests a more realistic target should be a 20-year horizon.



Name of Projects	Length (km)
Tarlac-Pangasinan-La Union Expressway, TPLEX (Section 3 -Urdaneta City-Rosario, La Union)	25.83
TPLEX Extension (Rosario - San Fernando, La Union)	54.00
Central Luzon Link Expressway, CLLEx – Phase I (Tarlac-Cabanatuan)	30.00
Central Luzon Link Expressway, CLLEx - Phase II (Cabanatuan-San Jose)	35.70
Plaridel By-Pass Road, Phase II	9.96
North Luzon East Expressway, NLEE (Stage 1) - La Mesa Parkways	18.00
North Luzon East Expressway , NLEE (Stage 2)	91.10
NLEX Harbor Link, Segment 10	5.58
NLEX Harbor Link, Segment 8.2	8.35
Metro Manila Skyway Stage 3	14.80
NLEX-SLEX Connector Road	8.00
NAIA Expressway (NAIAX)	14.85
C-5 South Link Expressway Project	7.74
Southeast Metro Manila Expressway, C6 (Phase I)	34.00
Cavite-Laguna Expressway (CALA-X)	44.20
SLEX TR4 (Sto. Tomas-Lucena)	56.87
Quezon-Bicol Expressway (QUEBEX)	180.00
Camarines Sur Expressway	16.00
Total:	**654.98km**

Source: DPWH

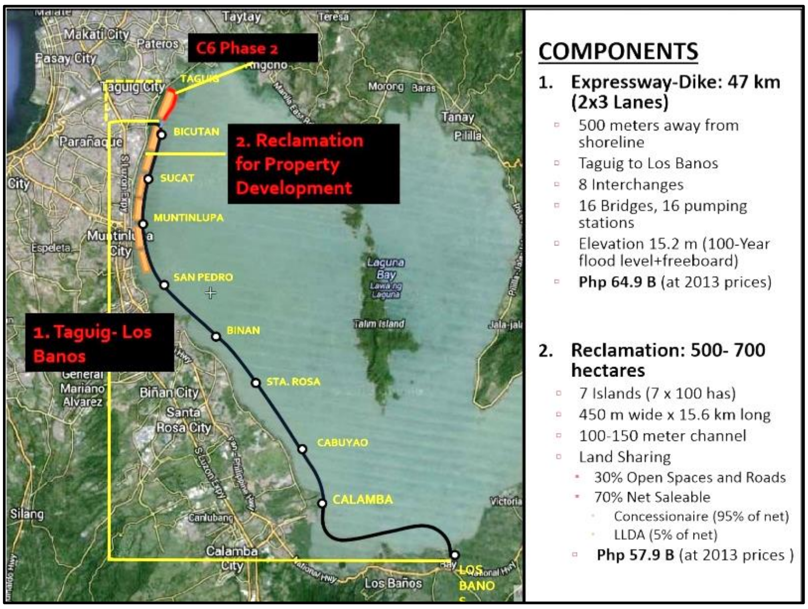
Figure 2.2.5 The DPWH Expressway Program for Luzon

The conspicuous omissions in the above network are: The Lakeshore Expressway (43-km), the Calamba-Los Baños Expressway (14.7 km), and the C-5 Expressway (46-km from Cavitex to San Jose del Monte in Bulacan). Presumably, the C-6 (proposed in the 2010 DPWH High Standard Highway program) will be in lieu of C-5. There are cogent reasons why the three projects should be included in this master plan:

(i) Extensive studies and project preparation works have already been undertaken for the three projects. Their early realization is more likely and lessons the infrastructure backlog.

(ii) The Lakeshore and Calamba projects complement the flood control projects for Laguna Lake. Traffic congestions are already severe in these areas to be served. The Lakeshore project will provide relief to SLEX, which is almost a monopoly route to the south of Makati. The PPP tender in 2015 failed due to the stiff investment hurdles. It could and should be revived – by increasing the Viability Funding Gap and putting the costs upfront. (Figure 2.2.6)

(iii) An unsolicited proposal for C-5 has been submitted in early 2017 to DPWH (Figure 2.2.7). The spatial plan for GCR favors C-5 over C-6, aside from the higher natural hazard risks and do-ability/ constructability for the later.



Source: DPWH

Figure 2.2.6 Alignment of Laguna Lakeshore Expressway

Source: DPWH

Figure 2.2.7 Alignment of C-5 Expressway

There are two other expressways that have been put forwards recently by the private sector. These are:

(i) The NLEX-Cavitex Port Expressway Link Project, in two phases. Phase 1 is 6.4km from R10 to MICT. Phase 2 is 8.6km from MICT to Cavitex along R-1. This was proposed by MNTC/MPIC.

(ii) The C-3 Expressway, 8.6km from Sta Mesa to the Mall of Asia complex, submitted by AC Infrastructure to DPWH in March 2017. Variations of this project have been considered by DPWH for the last 10 years. (Figure 2.2.8)

Source: DPWH

Figure 2.2.8 C3 Expressway to MoA

(2) Railway Projects

It is nearly impossible to sustain a megalopolis the size of GCR without an extensive network of mass rail transit system. There is a limit to road expansion; whilst motor vehicles continue to grow unabated. Construction of much-needed railway lines, however, has been very slow, compounded by failure to complete committed investments. Construction of the 35-km Northrail project commenced in 2005, but it was aborted in 2012 without completing a single kilometer. The 4-km extension of LRT-2 could have been completed in 2014, but the schedule has skidded to 2019.

The plans for the rail network of GCR have always been grand and ambitious but have not materialized for various reasons. Lethargic implementation could be ascribed to lack of financing – from 1990 to 2010. The 15-year MMUTIS Plan that was completed in 1999 contained a scaled-back rail network plan that took into account a projected budget envelope as well as corollary improvements in the road network to year 2015. Very little of this plan has been implemented, as demonstrated in Table 2.2.1.

The urban railway PPP projects have been also proposed but most of them failed. The main problems and issues are outlined as follows:

(i) In general, railway projects especially green-field projects have uncertainty of the passenger demand and their profitability is unclear for the private sector involvement.

(ii) The tendering processes of PPP are more complicated and more-costly than those of conventional procurement.

(iii) The project proposal tends to be not consistent with other related projects

Table 2.2.1 Railway Project in Last Decade

Name of Project	Plan Realization vis-à-vis MMUTIS		Remarks
	Plan for 2000–2012	Actual	
LRT-1 South Extension	Construction start in 2001 and completion by 2004. JV between LRTA and SNC Lavallin got signed & later terminated.	Deal with SNC Lavallin got scuttled. A new PPP tender was conducted; Concession awarded to LRMC in 2015. New completion date is 2022.	18 years behind original schedule. Faulty structure of JV and delays in the PPP tendering
LRT-2 East Extension	Construction from 2002–2004.	The viaduct was completed in 2016, but without tracks, station, power and signaling. New completion target is 2019.	Repetitive feasibility studies: 4 done from 2006–2012. Project components were unnecessarily unbundled and the implementation has been delayed.
LRT-2 West Extension	For implementation after 2004 and completion of East Extension.	None. No on-going effort to re-start.	Feasibility study updated in 2010.
LRT-3 Phase 2	Completion by 2004 of the 4-km extension from North Avenue to Monumento.	Converted into an extension of Line 1 (North Loop); completed in 2010.	Connection to MRT-3 at Trinoma was deleted from North Loop project. Issue on Common Station with MRT-7 stretched for 7 years
PNR South Commuter	Packaged into MCX as an unsolicited proposal	DOTr disregarded MCX. Rehabilitation of a 30-km line from Tutuban to Alabang completed as Phase 1 of N–S Linkage Project.	Track rehabilitation was deemed insufficient since double-tracking to Alabang fell short. Phase 2 improvements cancelled
LRT-4	Phase 1 (Recto-to-Batasan) to be completed by 2004	Abandoned. It was proposed as unsolicited proposal, but it has been not approved by the NEDA board. New proposal was published in 2017.	Competing claimants on original proponent status. BRT Line also adopted on same corridor.
MRT-7	Busway to be built on Commonwealth after completion of Line 4.	Concession awarded in 2009 to private proponent of unsolicited proposal. New completion is 2021.	Project ownership changed hands 3 times, before start of construction in 2016.
Northrail (Manila–Clark)	Suburban commuter service between Malolos and Caloocan was to be completed by 2008.	Contract with Chinese contractors signed in 2004. Implementation problems led to contract termination in 2012.	New plans as part of North-South Commuter Railway. Change in railway gauge reset timetable. Loan agreement signed with JICA in 2017.

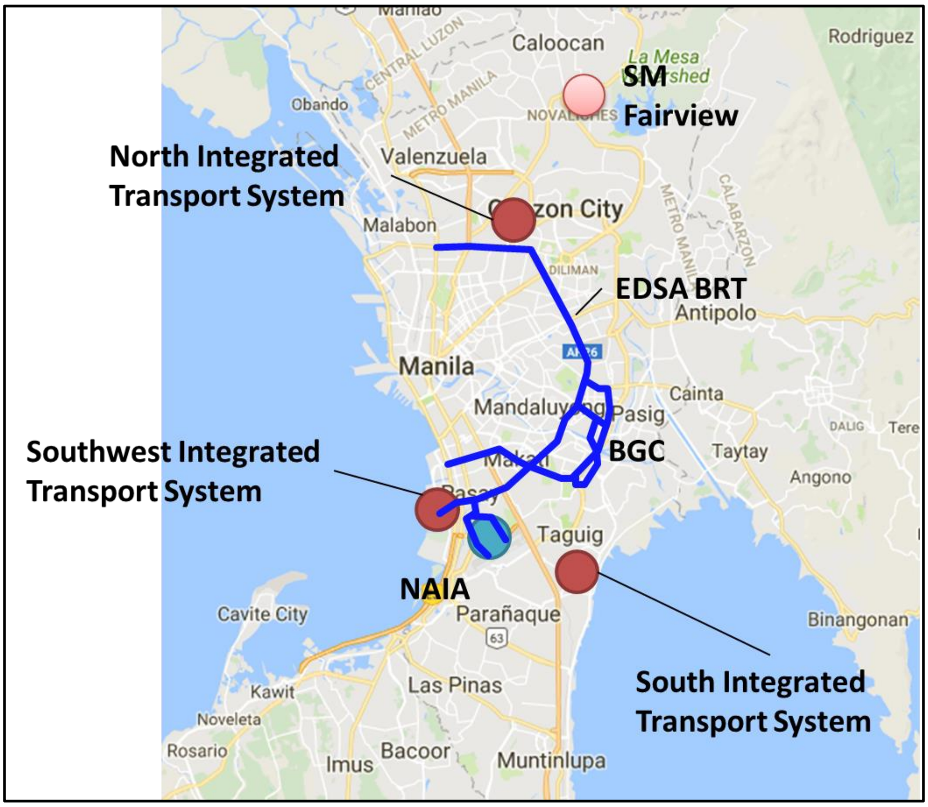
Source: Follow-up Survey on Roadmap for Transport Infrastructure Development for Greater Capital Region (GCR)

(3) Road Based Public Transport System

(a) Transport Terminal Projects (Integrated Transport System): The project involves the establishment of transportation terminals at the suburbs of Metro Manila to connect passengers to/from outer areas to various transport modes. Currently, the following 3 facilities are planned to be developed; (i) North terminal planned in the north of EDSA is to serve passengers to/from Region III, planned to be completed in 2020, (ii) South Terminal (Taguig Terminal Exchange: ITX) is to serve passengers to/from Laguna and Batangas Provinces, and (iii) Southwest terminal is to serve passengers to/from Cavite Province. Ayala Land Inc. has bagged the right to build and operate 35year concession agreement for the South terminal at Php4 billion, of its 5.6 ha area. MWM Terminals awarded construction of the Southwest terminal at Php3 billion. The concessionaire can also undertake commercial development and would collect generated revenues.

(b) BRT System: The 48.6-kilometer Metro Manila Bus Rapid Transit (BRT) – EDSA was approved by NEDA in September 2016. This BRT is expected to be operational by 2020. The project route covers Monumento up to Diosdado Macapagal Avenue/Roxas Boulevard, with integrated routes between the Ortigas Business District, BGC, and the Makati Business District. It is also planned to link with the NAIA terminals and include off-corridors to the target Integrated Transport System terminals in the North, South and Southwest of Metro Manila, and near SM Fairview. The project is now shelved due to its poor FS and issues of constructability and financial viability. (Figure 2.2.9).

The location of road public transport system projects is shown in Figure 2.2.9.



Source: Worked out by JICA Design Team based on various sources

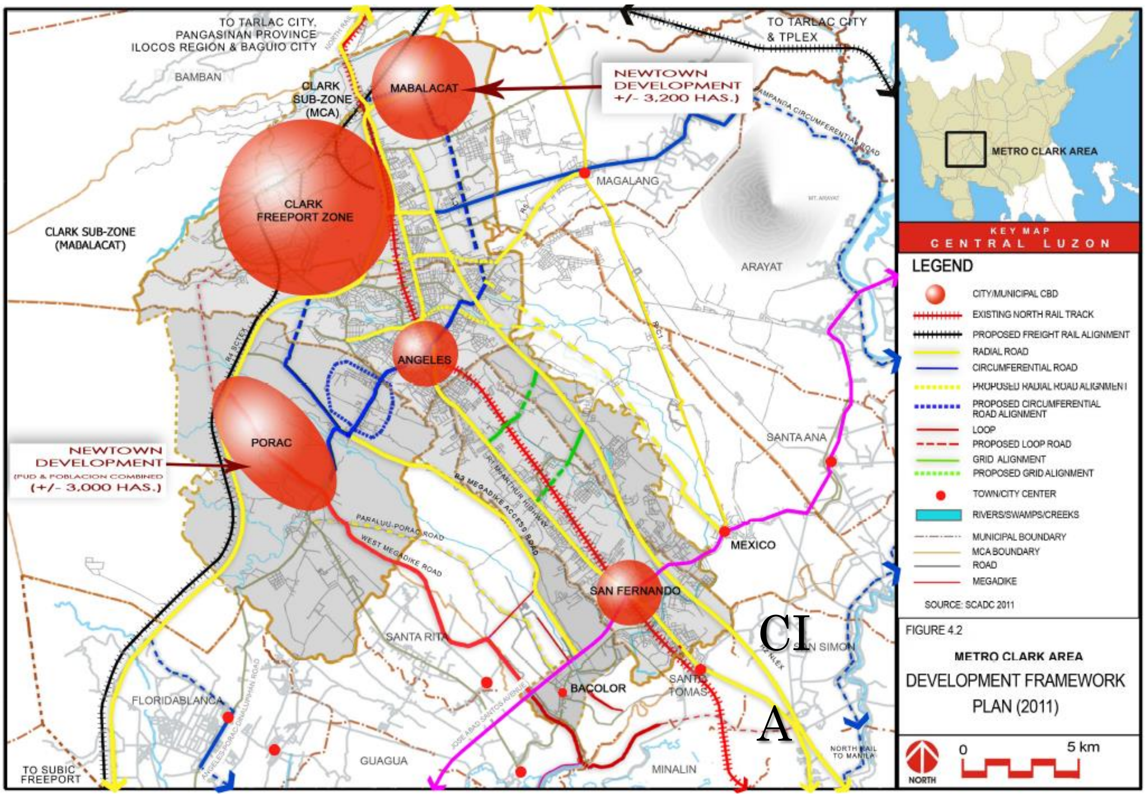
Figure 2.2.9 Location of Road Public Transport System Projects

2.2.10 MCA Preliminary Master Development Plan

The Metro Clark Manila (MCA) spans over seven local government units (LGU) including Mabalacat, Angeles City, Porac, San Fernando, Mexico, and Bacolor. Mabalacat, Angeles City, San Fernando, and the Clark Freeport Zone (CFZ) comprise the inner core while parts of Mexico, Porac, and Bacolor make up the outer core.

CFZ will be the main economic driver of MCA and considered the central business district (CBD) of the metropolis. This primary business district will be supported by the secondary growth centers of: Mabalacat CBD, an old city center of Angeles; Porac secondary business district (SBD); and, San

Fernando SBD. In order to promote the connectivity and accessibility to CBDs and SBDs, the various transportation projects are expected to be implemented: (Figure 2.2.10):



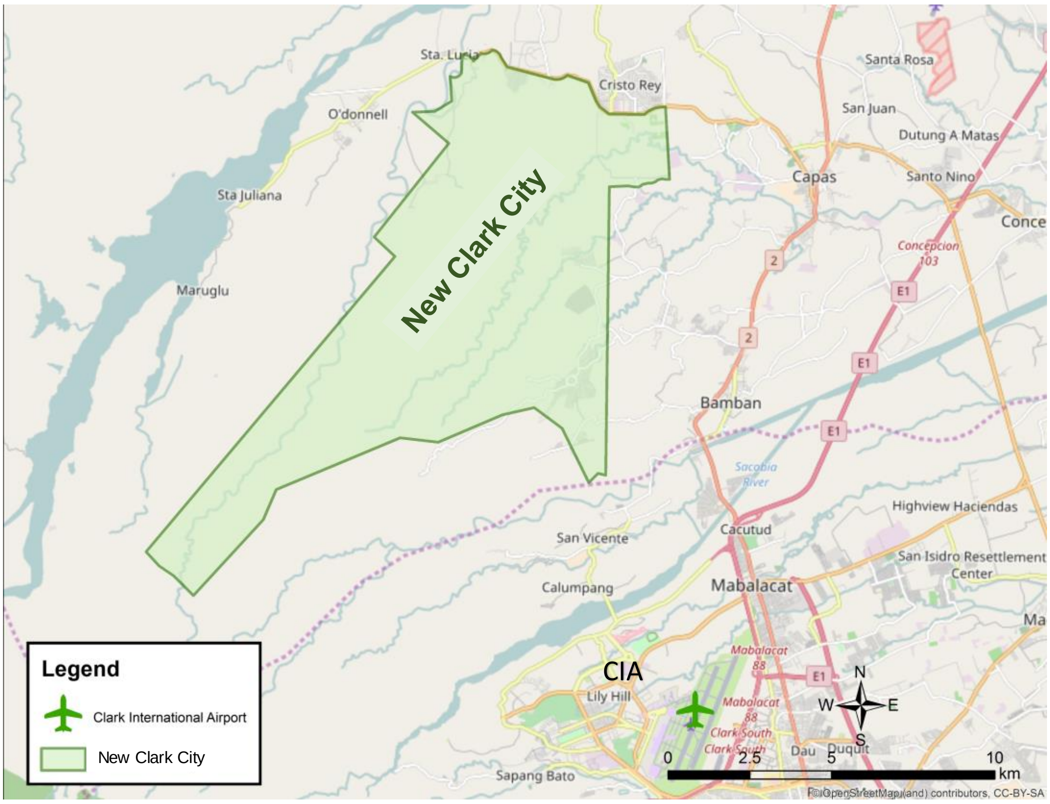
Source: Metropolitan Clark Area Preliminary Master Development Plan

Figure 2.2.10 Development Framework of Metropolitan Clark Area

2.2.11 New Clark City (NCC)

The recent NEDA approved New Clark City (NCC) Project formally known as Clark Green City (CGC) is envisioned to become the Philippines' most modern and first technologically-integrated city with a mix of residential, commercial, agro-industrial, institutional, and information technology developments. NCC will be a green, sustainable, and intelligent community for its residents, workers, and business establishments. The project is located in Tarlac province some 15~20km north of Clark International airport. The NCC will have direct access to TPLEX expressway and McArthur highway providing connectivity to the north and south of Luzon. The NCC location is depicted in Figure 2.2.11. The Location of NCC planned development projects is illustrated in Figure 2.2.12. These developments have been initiated as per Phasing of NCC vision as illustrated in Figure 2.2.13. The Figure shows the three distinct development phases of the NCC.

The impact of Phasing on the growth of population and employment from 2022 to 2065 have been explained in detail in Chapter 3, section 3.4.3 of this report. This section also illustrates a comparison of the NCC envisioned growth with similar cities developed/ developing in the world.



Source: JICA Design Team

Figure 2.2.11 Clark New City and Current Surrounding Road Network

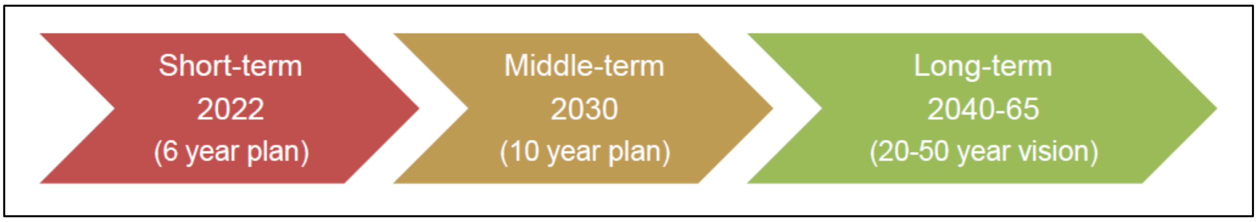
The NCC is a flagship project of BCDA and is an integral part of Presidents' 'Build Build Build' (BBB) program. Figure 2.2.14 shows the components and funds allocated to the various projects within NCC under the BBB program. The level of commitment accorded to the NCC is reflected in that some US$4.4billion (69%) has been allocated for the key NCC projects out of the total BCDAs' BBB budget of US$6.3billion. The key four project allocation distribution is illustrated in Figure 2.2.14 below. Construction work has been stated on various NCC infrastructure projects. The Sports complex is due to open for the 2019 ASEAN Games, scheduled to start end November 2019.

Construction work on the basic infrastructure: main roads, access roads, drainage, and other civil amenities have already started. The housing project and the athlete's village construction is also underway to be ready by November 2019. The development phasing of other projects is somewhat unclear, however, the current phase of development of NCC is rapid to say the least,

The 9,450ha area of NCC is located within CSEZ. The development is generally mixed-use and structured under six different major projects as defined by their main functions, namely Housing sector, Government District; Sports City; Academic District (mixed land use) ; Agri-Forestry Research and Development District; and, food processing terminal. The design competition for New Clark City's conceptual master development plan is currently under formulation by a private firm. The first phase of the development of NCC would cover 1,300ha. At full development, by 2065 the future population projection is expected to be about one million residents and over half million jobs located within the NCC development.

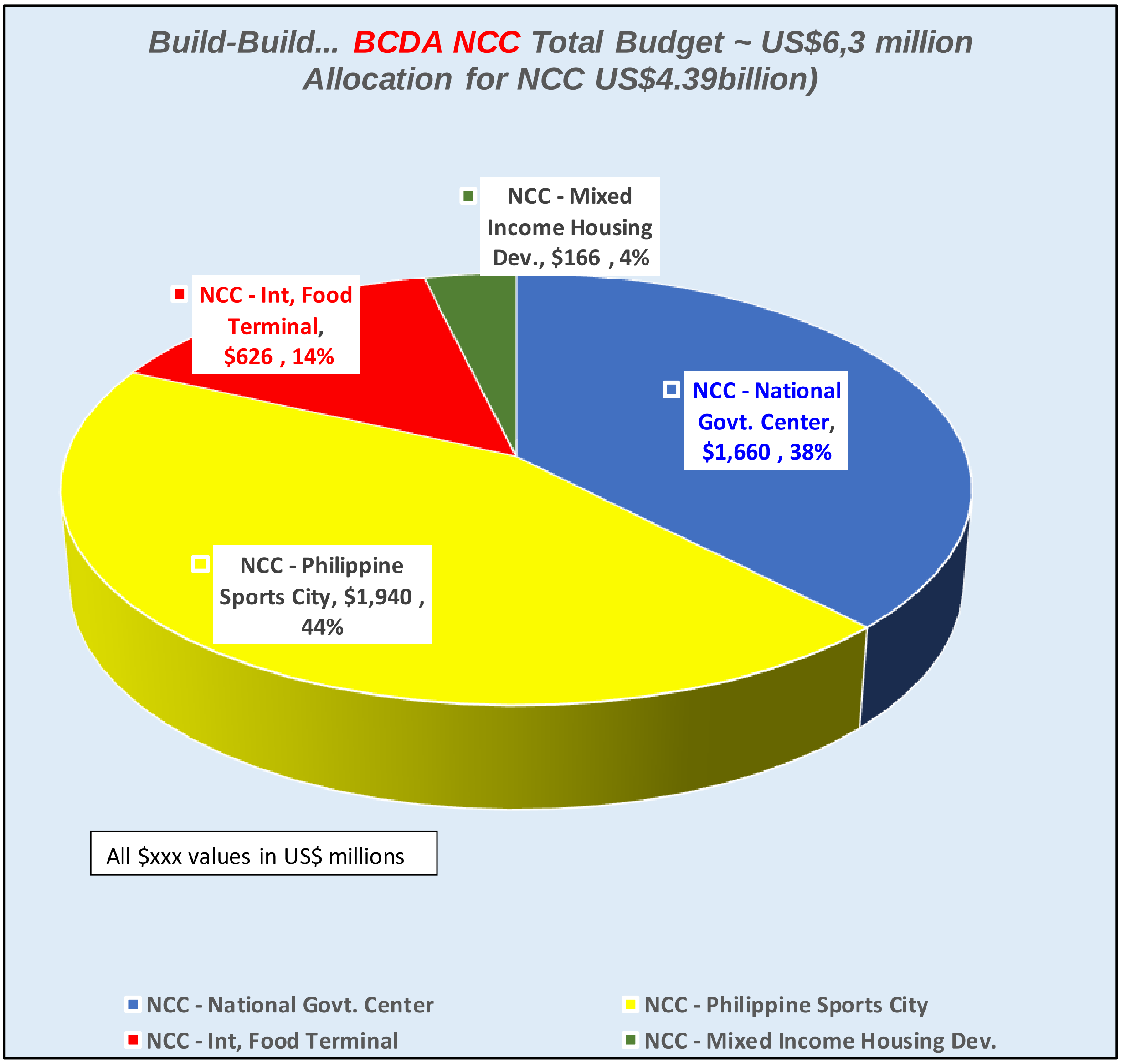
Source: BCDA

Figure 2.2.12　Masterplan of New Clark (Green) City



Source: BCDA Master Plan Chapter 2.

Figure 2.2.13　Phased Implementation of NCC Masterplan 2022 to 2065



Source: BBB Database

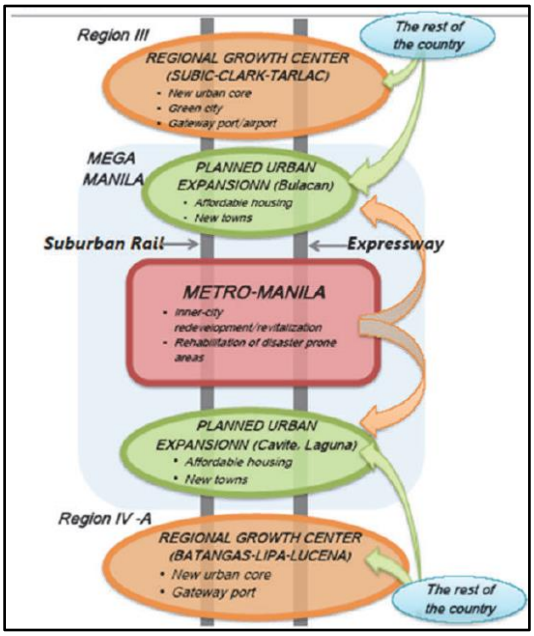
Figure 2.2.14 BCDA Budget Allocation for NCC under BBB Program

2.3 Confirmation of Project Necessity

2.3.1 Necessity of Integration with Regional Development Strategy

Integrated development as Mega Manila contributes to decentralize and complement the functions of each urban center. To promote sustainable growth in the region, it is necessary to develop north-south transport backbones consist of expressway and suburban rail network. And it contributes to meet necessity of resettlement of informal settlers from high hazard risk areas, and to formulate affordable housing plan in new urban areas with good accessibility and living environment in adjoining provinces. (Figure 2.3.1)

It is also necessary to be integrated with retrofit, regeneration and new plans of urban transportation development in port areas, new NAIA (international airport), water front and others within Metro Manila area to meet requirement of strengthening of economic competitiveness.



Source: Roadmap Study for Transport Infrastructure Development for Metro Manila and Its Surrounding Areas (Region III and Region IV-A)

Figure 2.3.1 Regional Development Strategy along North- South Corridor

2.3.2 Necessity of Solving Traffic Problem

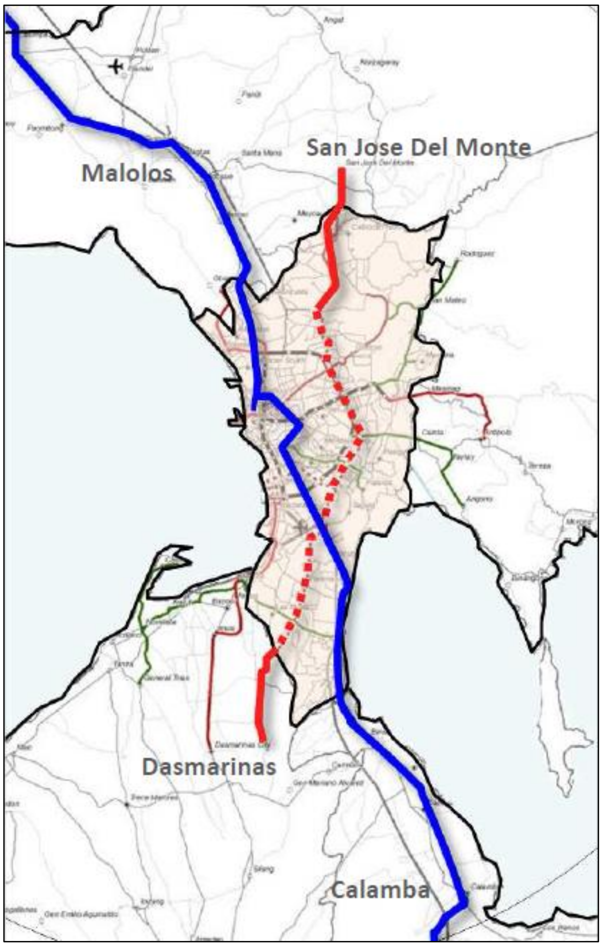
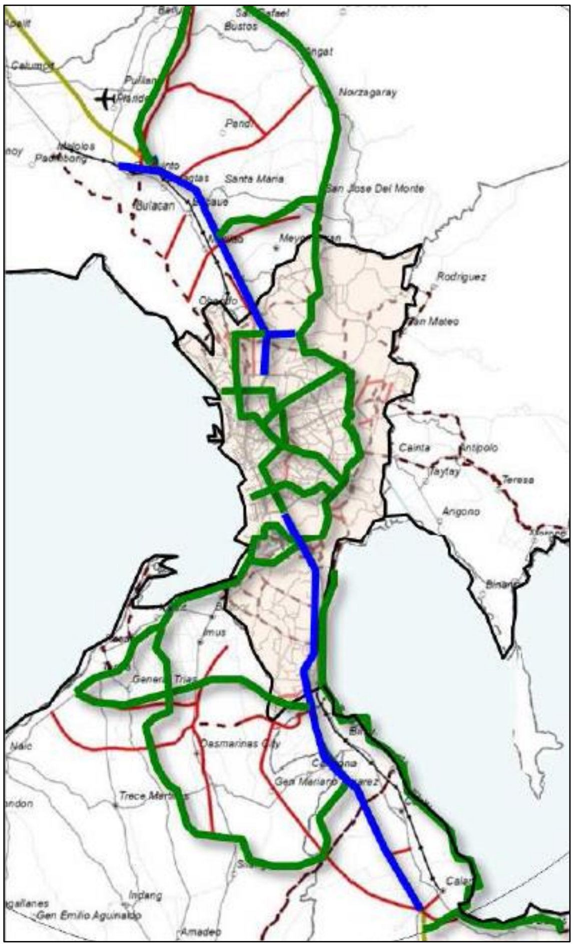
The traffic congestion causes huge economic losses. This would include lost opportunities of business, inefficiency in economy, pollution, waste of energy and resources, impact on health, decline of quality of life, increased risk of accidents, etc.

The traffic congestion in Metro Manila needs integrated approach based on urban mass transit, since improvement of road network alone cannot solve the issue. In particular, for the urban poor, a lack of transport choices significantly restricts their mobility and then reduces job opportunities, because of high transport cost.

2.3.3 Roles of Railways and Expressways

The 2 transit backbones, MMSP and NSCR and future expressway network are shown in Figure 2.3.2. To utilize both of the railway and expressway networks, the fare policy is a Key and transport network in Bangkok gives a lesson. The fare of urban railway in Bangkok is twice of the bus. The service level is also higher, and it attracts the middle-income group. As the result, the role of sharing among urban expressway (mainly for logistics and business trip), urban railway (mainly for commuting and school trips) and road transport (feeder) are established.

Unlike Bangkok, the fare of existing urban railway in Metro Manila is the same as other road-based public transport modes. Together with the serious congestion in road-based transport, urban railway service attracts more passengers than the capacity, causing machine troubles and accidents. And the low fare setting has affected profitability of the urban railway and the operating expenses are much more than the revenues. The Philippine Statistics Authority (PSA) showed the railway transportation sector receiving P8.4 billion in subsidies from the government in 2012.[5] Fare setting match with the high level of service is important for financial viability and to achieve role sharing with expressway network. The fare setting policy is mentioned in the later chapter.

MMSP / NSCR Network	Main Roads/ Network Expressways Network
	

Source: Follow-up Survey on Roadmap for Transport Infrastructure Development for Greater Capital Region (GCR)

Figure 2.3.2 Proposed Railway & Expressway Network

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5 http://www.gmanetwork.com/news/money/economy/397806/psa-data-shows-subsidy-to-metro-rail-systems-reach-p8-billion-in-2012/story/

2.4 GOP BUILD! BUILD! BUILD! Program

2.4.1 An Overview

President Duterte's administration released a 10-point Socio-economic Agenda as follows.

(i) Continue and maintain current macroeconomic policies, including fiscal, monetary, and trade policies.
(ii) Institute progressive tax reform and more effective tax collection indexing taxes to inflation.
(iii) Increase competitiveness and ease of doing business. This effort will draw upon successful models used to attract business to local cities (e.g., Davao) and pursue the relaxation of the constitutional restrictions on foreign ownership, except in regard to land ownership, in order to attract foreign direct investment.
(iv) Accelerate annual infrastructure spending to account for 5% of the GDP, with PPPs playing a key role.
(v) Promote rural and value chain development toward increasing agricultural and rural enterprise productivity and rural tourism.
(vi) Ensure security of land tenure to encourage investments and address bottlenecks in land management and titling agencies.
(vii) Invest in human capital development, including health and education systems, and match skills and trainings to meet the demand of businesses and the private sector.
(viii) Promote science, technology, and creative arts to enhance innovation and creative capacity towards self-sustaining, inclusive development.
(ix) Improve social protection programs, including the government's Conditional Cash Transfer program, to protect the poor against instability and economic shocks.
(x) Strengthen implementation of the Responsible Parenthood and Reproductive Health Law to enable especially poor couples to make informed choices on financial and family planning.

Among the reforms that will drive this agenda is the acceleration of infrastructure and the development of industries that will yield robust growth across the archipelago, create jobs, and uplift the lives of Filipinos. Infrastructure is among the top priorities of this administration. Public spending on infrastructure projects could reach PhP8-9 trillion from 2017–2022.

2.4.2 Transport Projects in Build!Build!Build! Program

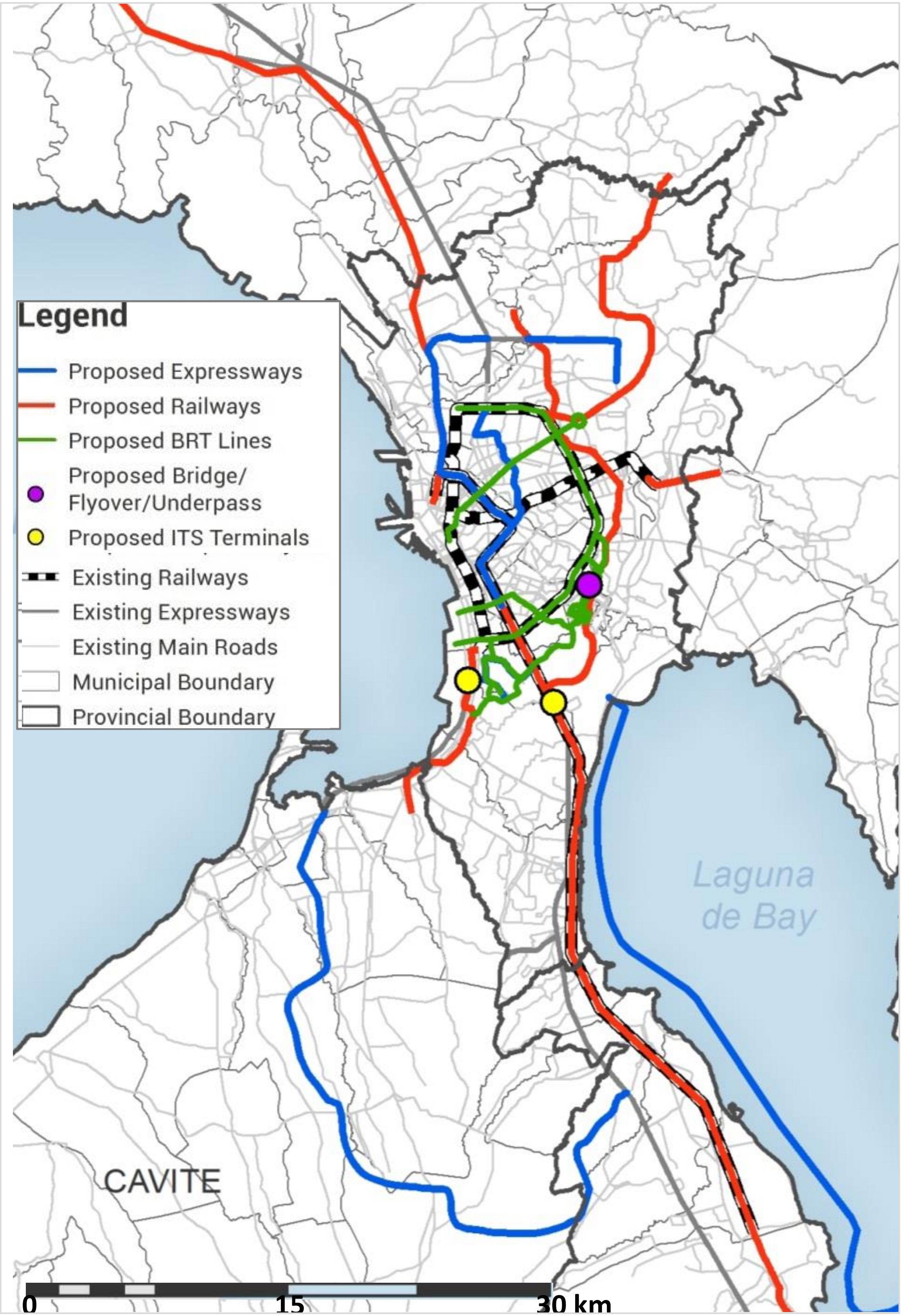
The Build!Build!Build! Program is the administration's comprehensive infrastructure development program launched in April 2017. The program identified 70 infrastructure flagship projects or high impact projects. Among the 70, 19 projects are located in Mega Manila. Besides the flagship projects, four projects were also listed as key projects. See Table 2.4.1 for full list of projects in the Build!Build!Build! Program.

The projects for Mega Manila are composed of expressway, urban road, railway, road-based public transport, and traffic management. Completion of most of the projects is within or by end of current administration, i.e. by 2022. However, seven projects are still under project development stage. In terms of location, most of the projects are in Metro Manila rather than adjoining provinces (Figure 2.4.1).

Table 2.4.1 Main Projects in Build!Build!Build! Program

Category		Project Name	Cost (PhP Bil.)	Schedule	Implementing Agency	Status
Flagship Projects	Expressway	NLEX-SLEX Connector Road	23.2	2014–2021	DPWH	Implementation
Flagship Projects	Expressway	NAIA Expressway Phase II	17.9	2013–2017	DPWH	Implementation
Flagship Projects	Expressway	NLEX Harbor Link, Segment 10	9.0		DPWH	Project Development
Flagship Projects	Expressway	Cavite - Laguna Expressway	35.4	2013–2020	DPWH	Implementation
Flagship Projects	Expressway	Laguna Lake Highway	123	2020–2025	DPWH	Procurement
Flagship Projects	Urban Road	BGC to Origas Road Link Project	5.6	2017–2020	DPWH	Procurement
Flagship Projects	Railway	Mega Manila Subway	355	2017–2024	DOTr	Project Development
Flagship Projects	Railway	PNR North 1 (Malolos – Tutuban)	105	2016–2021	DOTr	Implementation
Flagship Projects	Railway	PNR North 2 (Clark – Malolos)	139	2018–2024	DOTr	Project Development
Flagship Projects	Railway	PNR South Commuter (Tutuban – Calamba)	134	2018–2021	DOTr	Project Development
Flagship Projects	Railway	LRT 1 South (Cavite) Extension Project	65.9	2017–2021	DOTr	Implementation
Flagship Projects	Railway	LRT Line 2 East (Masinag) Extension Project	0.9	2015–2019	DOTr	Implementation
Flagship Projects	Railway	Line 7 (MRT 7)	62.7	2016–2019	DOTr	Implementation
Flagship Projects	Railway	Unified Common Station	2.8	2016–2019	DOTr	Procurement
Flagship Projects	BRT	Metro Manila BRT- Line 1 (Quezon Avenue BRT)	4.8	2017–2020	DOTr	Project Development
Flagship Projects	BRT	Metro Manila BRT- Line 2 (Central Corridor)	37.8	2017–2020	DOTr	Procurement
Flagship Projects	BRT	BGC to NAIA BRT System	24.0	2016–2021	BCDA	Project Development
Flagship Projects	Road-based Public Transport	South Integrated Transport System (bus terminal)	4.0	2016–2019	DOTr	Implementation
Flagship Projects	Road-based Public Transport	Southwest Integrated Transport System (bus terminal)	4.0	2015–2018	DOTr	Implementation
Other Key Projects	Expressway	Skyway Stage 3	26.7		DPWH	Implementation
Other Key Projects	Expressway	C5 Expressway	13.6		DPWH	Project Development
Other Key Projects	Railway	LRT1/MRT3 Capacity Expansion	10.7		DOTr	Implementation
Other Key Projects	Traffic Management	Intelligent Transport System (traffic signal)	4.7	2012–2022	MMDA	Implementation
		Total	**1,210**			

Source: Build!Build!Build! Program website, NEDA



Source: Follow-up Survey on Roadmap for Transport Infrastructure Development for Greater Capital Region (GCR)

Figure 2.4.1 Location of Main Projects in Build!Build!Build! Program

2.4.3 Roadmap for Transport Infrastructure Development for Greater Capital Region

To achieve these goals stated in PDP 2011–2016, infrastructure development in terms of revitalization of economic activities is focused. The new administration, which was established in June 2016, stated an increase in annual infrastructure expenses of up to 5% of gross domestic product (GDP) as a policy objective. Thus, the promotion of infrastructure development is still a priority agenda.

The "Roadmap for Transport Infrastructure Development for Metro Manila and Its Surrounding Areas (Region III & Region IV-A)" (Transport Roadmap), which was conducted from March 2013 to March 2014, identified the priority transport projects to realize the ideal transport network by 2030. The Transport Roadmap was approved by National Economic and Development Authority (NEDA) Board in June 2014 and was considered a long-term plan of the Philippine government. JICA has agreed to implement "Follow-up Survey on Roadmap for Transport Infrastructure Development for Greater Capital Region" to update the roadmap and provide additional information.

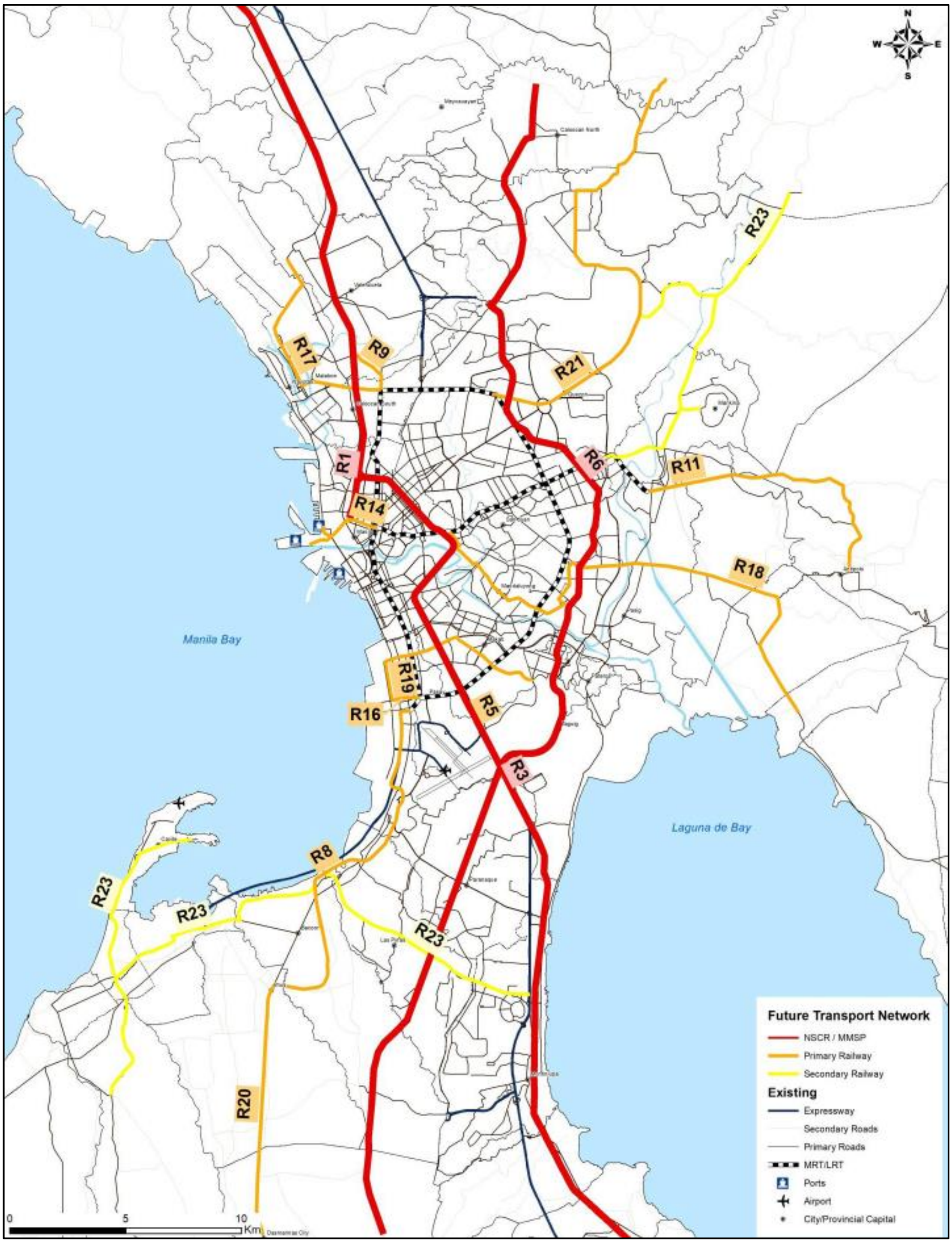
The general objectives of this study are the following:

(i) Clarify the transport development policy for Metro Manila by the new administration through the Transport Roadmap update;
(ii) Identify the changes in the transport sector since the first Transport Roadmap of Metro Manila was approved. Planned, committed, ongoing, and completed transport projects after the Transport Roadmap will be reviewed;
(iii) Identify the past and present Japanese government-assisted projects, and determine the expected Metro Manila traffic decongestion due to the planned projects;
(iv) Re-estimate economic losses, environmental pollution, and disaster risks as a result of traffic congestion in Metro Manila, which were indicated in the Transport Roadmap; and,
(v) Update priority projects based on the review of the Transport Roadmap by the Philippine government.

The specific objectives of the follow-up study are: (i) to revise the transport development strategies and policies of the 2014 Transport Roadmap based on the updated transport demand forecast; and (ii) to update the Transport Roadmap with target years 2022, 2035, and 2040 and examine the validity of the priority projects. The roadmap review covers roads, expressways and highways; urban and suburban rails; ports and airports; and traffic management.

The location of proposed railway projects is shown in Figure 2.4.2. It is proposed that NSCR and MMSP are proposed will be developed as north-south transit backbones. North-South Commuter Railway provides rapid access from adjoining provinces to the Centre of Metro Manila and provides opportunities of further development along the line.

The transport demand forecast model was updated to evaluate the proposed transport projects. The transport demand forecast used in this detailed design study is based on the models updated in the follow-up study on Roadmap.



Source: Follow-up Survey on Roadmap for Transport Infrastructure Development for Greater Capital Region (GCR)

Figure 2.4.2 Location of Railway Projects Proposed in Follow-up Survey on Roadmap for Transport Infrastructure Development for Greater Capital Region (GCR)

CHAPTER 3 MCRP CORRIDOR ANALYSIS AND TRAVEL DEMAND FORECAST

3.1 Review of pre-FS Route Alignment

3.1.1 Summary of Route Alignment in Pre-F/S

There are two options as the route from Malolos to Clark proposed in JOIN F/S, "PNR Route" and "NLEX Route". PNR Route is to use the existing PNR ROW, and NLEX Route is to run parallel to the NLEX highway located to the east of PNR RoW.

The past study only covered the route alignment planning, and the depot site was not finalized.

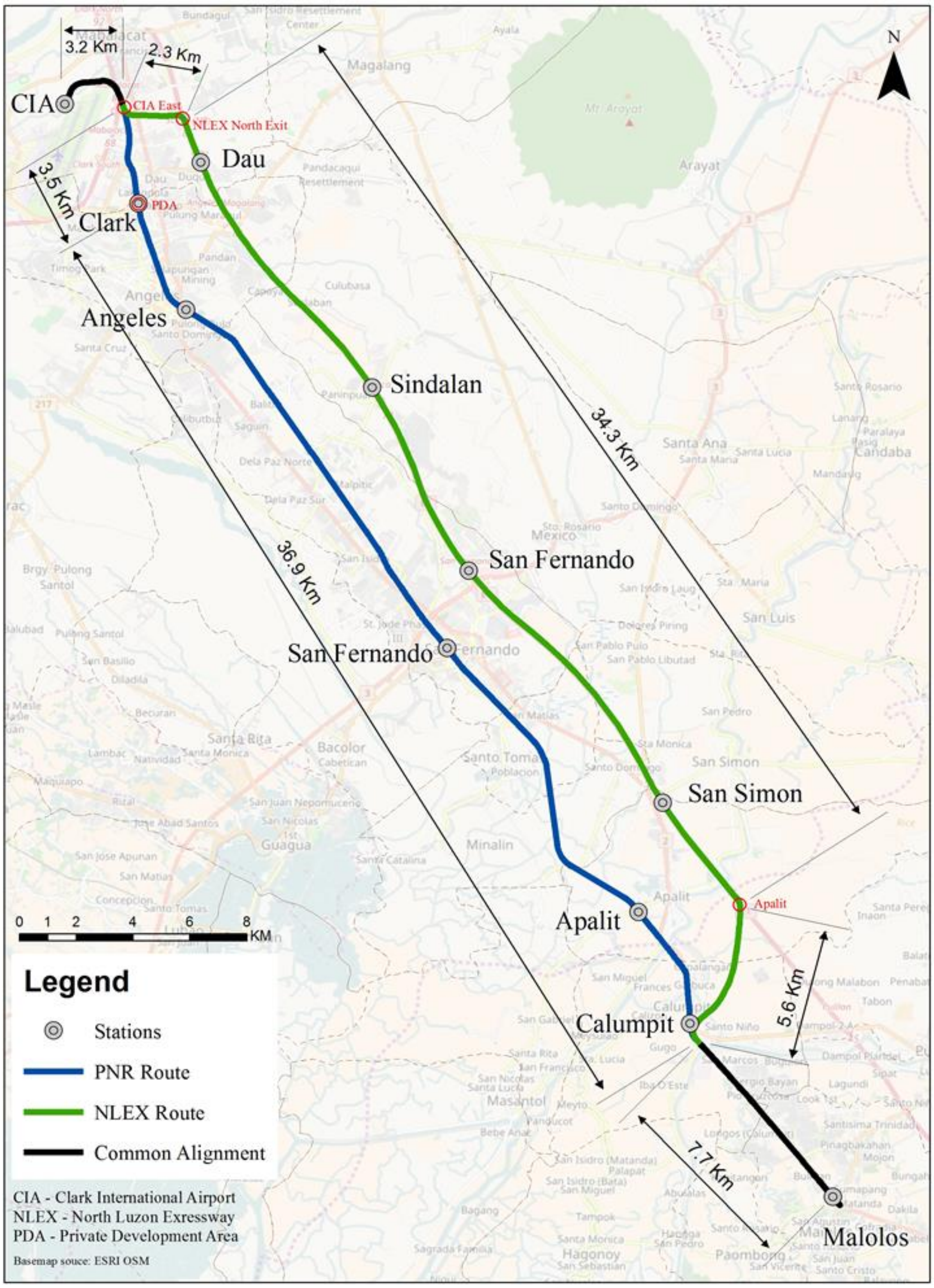
1) PNR Route Option

This route would minimize the land acquisition by utilizing the PNR ROW. The ROW of PNR has around 50.5km of length between Malolos and Clark, and it is surrounded by the agricultural land and the developed land along its length. While there are the vacant areas around the former, the latter is occupied by informal settler or encroached by adjacent landowner along ROW.

2) NLEX Route Option

NLEX Route separates from the existing ROW of PNR at Calumpit, Bulacan City, and heads to the north along NLEX, with starting at around 5.8km south of San Simon Interchange. The proposed route runs on the east side of NLEX and crosses with each interchange at Apalit, San Fernando and Sindalan. North of the interchange at Dau, it turns to the west to Clark Special Economic Zone. Then it passes the goes through the PNR route and parallel with the CIA airport runway. The length of this route is around 52.2km.

A schematic overview of the two routes is shown in Figure 3.1.1.



Source: JICA Design Team

Figure 3.1.1 Map of Route Options between Malolos and Clark

3.1.2 Review of MCRP pre-FS Alignment Option

This study reconfirmed the alternative evaluation criteria as used by the JOIN F/S. There is no significant change to the criteria. The impact of the review of the criteria was such that it had no limited impact on the project cost, the line patronage, the constructability and on the social/ environmental issues, as the JOIN F/S was conducted only recently (late 2017). However, the followings impacts must still be considered.

The project cost would be reviewed as it would reflect the results of further studies on facility planning in current study. In JOIN F/S, the location of the depot was not finalized. The distance between the depot and the main line has an impact on the project cost, as the cost of the access tracks would be added.

The viaduct structure for the main line as proposed in JOIN F/S is to arrange single-track beam in parallel. It could become feasible by the gradual increase of the operational frequency. Nevertheless, the double-track beam generally applies to reduce the cost. Thus, the optimum structure type shall only be studied/ designed once the train operation planned finalized.

The study about the selection of the structure, the single-track beam or the double-track beam, is described later.

3.2 Evaluation Criteria of Route Planning

The alignment is planned with considering the following criteria.

- To consider the workability, economic efficiency and quick transportation.
- To minimize the additional land acquisition by utilizing PNR-owned property.

3.3 Selection of Optimal MCRP Route Alignments

3.3.1 Comparison of Route Options

(1) Between Malolos and Clark

There is no comparison of route options since the route basically passes on PNR-owned property in viaduct or at-grade structure.

(2) Between Clark and CIA

DOTr showed their reluctance to use the extension section to NCC as the branch line. The reason why they expressed the negative view is that the direct operation between CIA Station and NCC Station becomes not feasible. In other words, a train must turnback or passengers need to transfer at Clark Station, which deteriorates the access to CIA while the high demand is expected at NCC in the future.

Thus, JICA Design Team studied the feasibility of alternative routes from Clark to CIA passing through the airport.

1) Option A

Option A is proposed by the masterplan of the airport. It runs to the east of the airport, crosses around to the north of the airport runway, and then approaches the airport terminal. From Clark Station to the airport runway, it passes along with the periphery of the development area and the airport land.

The horizontal alignment has some sharp curves. While the viaduct structure is utilized to the section around Clark Station, some sections must be with speed restrictions. The vertical alignment has the height limitation at the end of the airport runway, to avoid the obstruction to the flight path. Thus, to pass the airport the structures need to be at ground or at depressed levels The CIA Station is built at-grade. The extension to NCC is planned to be a branch line diverging around Clark Station.

2) Option B

Option B would make the main line detour to the west, and on the south side of Clark Station. The detoured line passes to the south of the airport runway, and onwards to the airport terminal. The main line can run direct/ through to NCC.

Since this is outside of the PBR ROW, it would require massive land acquisition and will be longer in length due to detour to avoid the airport runway. This significant change of route also requires moving the location of Clark Station as an at ground station to the green belt between the existing roads.

The section from Clark to CIA is generally be underground structure to satisfy the height restrictions at the end of the airport runway and to pass the certain areas of the airport to be restricted in the future.

The tunnel can be placed at a shallow depth and the cut and cover structure could be used.

CIA Station needs to be underground since this route crosses the taxiway to be constructed behind the station. Then, this line becomes at ground to the north of CIA Station, and it would extend to NCC by way of a viaduct structure.

3) Option C

Option B passes outside of PNR ROW and changes the location of Clark Station to be located at the south of the airport runway. Thus, it would require substantial land acquisition. To resolve this issue, Option C proposed underground structure to pass under the airport runway to the terminal building to minimize the land acquisition. The location of Clark Station is same as in Option A.

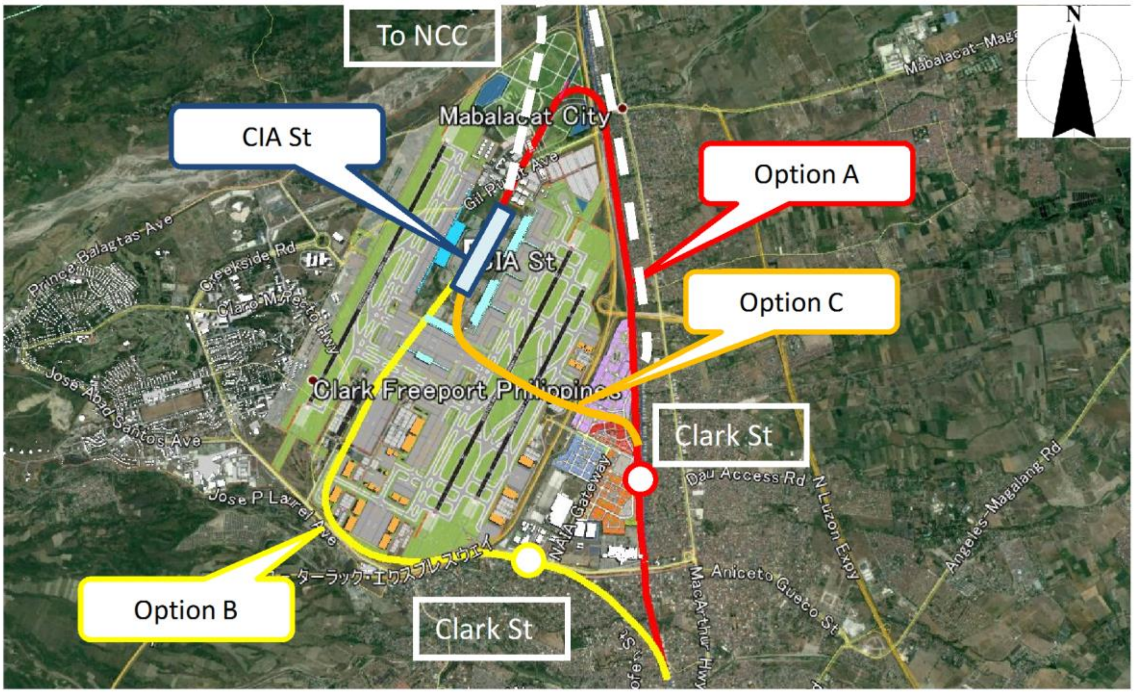
To pass under the airport runway, this route becomes the underground from the north of the viaduct at Clark Station. To get to CIA Station, the shield tunnel method need to be applied to cross this section, so as not to obstruct the airport operation.

The tunnel shall be deep to pass under the runway. Thus, the CIA Station is planned as an underground station. Then, this line becomes at-grade to the north of CIA Station, and it extends to NCC by on a viaduct structure. A schematic overview of three route options is shown in Table 3.3.1 and Figure 3.3.1.

Table 3.3.1 Comparison of Route Options around CIA

Item	Option A	Option B	Option C
Length of section	10.9km (From the branch point of Option B)	9.6km (From the branch point of Option A)	6.7km (From the branch point of Option B)
Environment around the route	Land for development (Vacant area) Airport area	Residential area Commercial area Airport area	Land for development (Vacant area) Airport area
Overview of route option	Option A is mentioned in the master plan of area around the airport and proposed in Pre-F/S. While the existing railway land cannot be used as is, the land acquisition is relatively less difficult.	Option B can straight extend the line from CIA Station towards NCC by connecting to CIA Station at the south. The route detours at the south of the airport to prevent the railway construction from obstructing to the airport.	In contrast to Option B needs to detour greatly and acquire larger area, Option C takes a shortcut by passing under the airport runway to shorten the length of route.
Expected structure	While the viaduct is expected basically, the at-grade is necessary near the airport runway due to the height limit. A runway end to the CIA Station side is the underground section.	The viaduct at the east of Clark Station and the cut-and-cover tunnel at the west of it are expected.	The viaduct at the south of Clark Station is expected, and the route goes to underground at the north of it. The cut-and-cover tunnel and the shield tunnel are expected for the underground section.
Structure of CIA Station	Underground station (two basement floors)	Underground station (two basement floors)	Underground station (two basement floors)
Issues	The extension towards NCC is to be switched back at CIA Station or diverged at Clark Station as the branch line.	The larger land acquisition is necessary due to passing non-railway land.	The longer construction period and the higher project cost are expected since the structure under the airport runway is the shield tunnel as non-open cut method.

Source: JICA Design Team



Source: Prepared by JICA Design Team with referring Google Earth and the material provided by DOTr

Figure 3.3.1 Location Map of Route Options around CIA

(3) Extension to NCC

While the JOIN F/S studied the extension from Clark to NCC, the route was not elaborated. Thus, this study examines following three route options based on an assumed location of NCC Station.

1) Option A

Option A runs along with a road which is planned to be constructed from CIA to NCC. This area is mountainous, so the long length of tunnel section/s would be necessary to minimize horizontal sharp curves.

This route is proposed based on the order from DOTr, with the objective to reduce the land acquisition by using BCDA's land and it would improve construction accessibility by running along with a road under planning.

However, the further study found an issue that a part of the route is recognized as the area with ancestral domain title. The areas of ancestral domain title are heritage site and complex to acquire.

2) Option B

Option B heads to the north from CIA and passes outside of BCDA's land. The short tunnel section is necessary since the area is hilly, nevertheless other sections could basically be on viaduct structure.

This option proposed by JICA Design Team has less issue for the railway construction, and it is shorter than other options.

This route passes outside the PNR's and BCDA's land, thus the most part needs the land acquisition except around NCC Station.

3) Option C

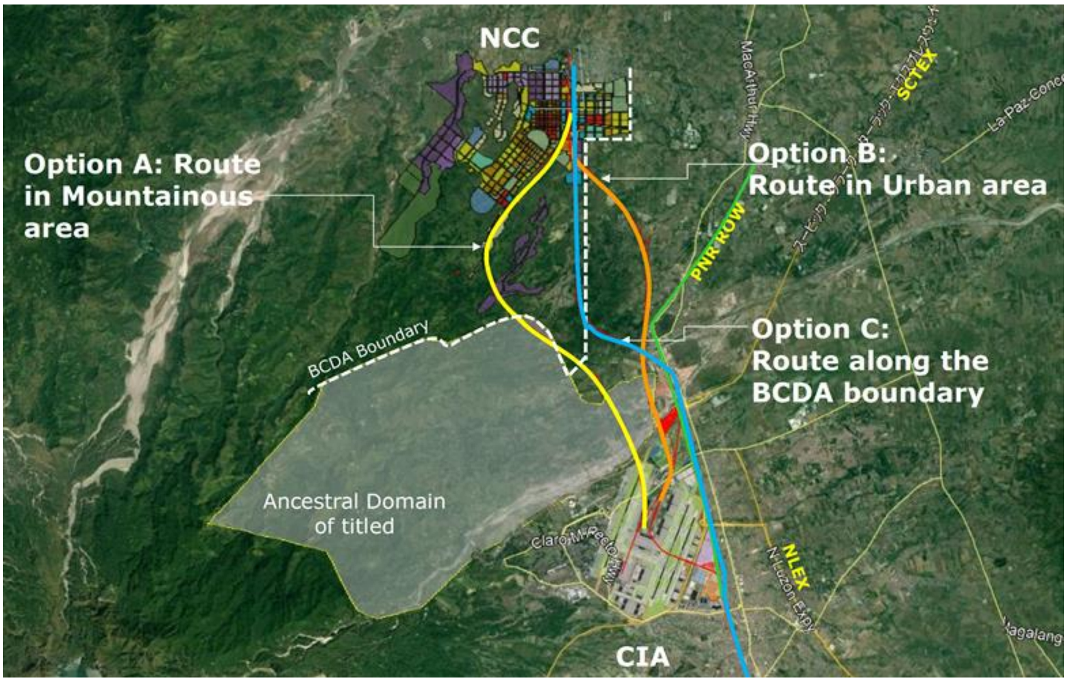
Option C diverges at the north of Clark Station extends to NCC. This route utilizes the area returned by U.S. Army, and it minimizes the land acquisition. While the south of the route is comparatively flat, a long tunnel section is necessary in the mountainous area.

This route avoids the land with ancestral domain title, and it would accelerate the land acquisition process. Overview of each of the three options is shown in Figure 3.3.1 and Table 3.3.1

Table 3.3.2 Comparison of Alignment Options

Item	Option A	Option B	Option C
Inter-station distance (Approximate)	21.4km	20.0km	20.4km
Topographical features	Mountainous	Flat	Mountainous
Aim of route option	Option A is proposed based on the order from DOTr. The purpose is to minimize the land acquisition by passing BCDA land. In addition, for the improvement of construction accessibility, this route runs along with the road under planning.	The purpose is to shorten the construction schedule by passing through the flat area without the obstructions to construction.	The purpose is to avoid the area with certificate of ancestral domain title by passing BCDA's property as much as possible.
Likely structures	A lot of tunnels would be required.	Most part is the viaduct while limited sections in tunnel.	A number of tunnels are predicted.
Issues	To pass the area with certificate of ancestral domain title is difficult.	The land acquisition area is much larger.	Further studies to be conducted to shorten construction schedule is needed since the tunnel sections are necessary.

Source: JICA Design Team



Source: Prepared by JICA Design Team with referring Google Earth and the material provided by DOTr

Figure 3.3.2 Location Map of Extension to NCC

3.3.2 Determination of Optimal Route

(1) Between Malolos and Clark

Reviewing the comparison between PNR Route and NLEX Route proposed in JOIN F/S, JICA Design Team concluded PNR Route is more favorable since it minimizes the land acquisition, shorten the route length and passes through the population concentrated area to attract higher patronage.

The selected route, PNR Route, is shown in Figure 3.3.3.

Source: JICA Design Team

Figure 3.3.3 Map of PNR Route

(2) Between Clark and CIA

JICA Design Team proposed Option A as the optimum route since it minimizes the land acquisition around CIA and has the advantages of ease of construction. The structure passes on the periphery on the east side of the airport.

Option B and C have the underground sections that would lead to higher construction cost and longer time. Thus, these options are concluded as inferior to Option A. Option C must use the shield tunnel method. The manufacturing time for a shield machine and the tunnel construction time would be critical.

The selected route option, Option A, is shown in Figure 3.3.4.

Source: Prepared by JICA Design Team with referring Google Earth and the material provided by DOTr

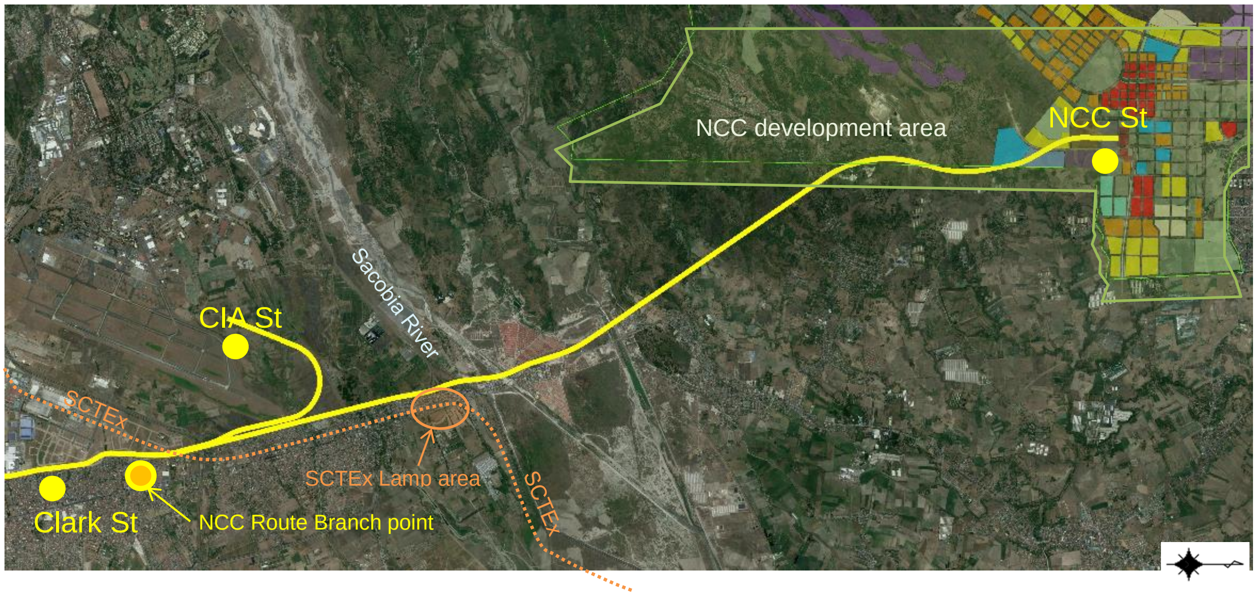
Figure 3.3.4 Map of Adapted Route around CIA

(3) Extension to NCC

JDT adopted OptionB.

The reason for adoption has a short route and is because the boundary of BCDA can be used.

The selected route option, Option B, is shown in Figure 3.3.5.



Source: Prepared by JICA Design Team with referring Google Earth and the material provided by BCDA.

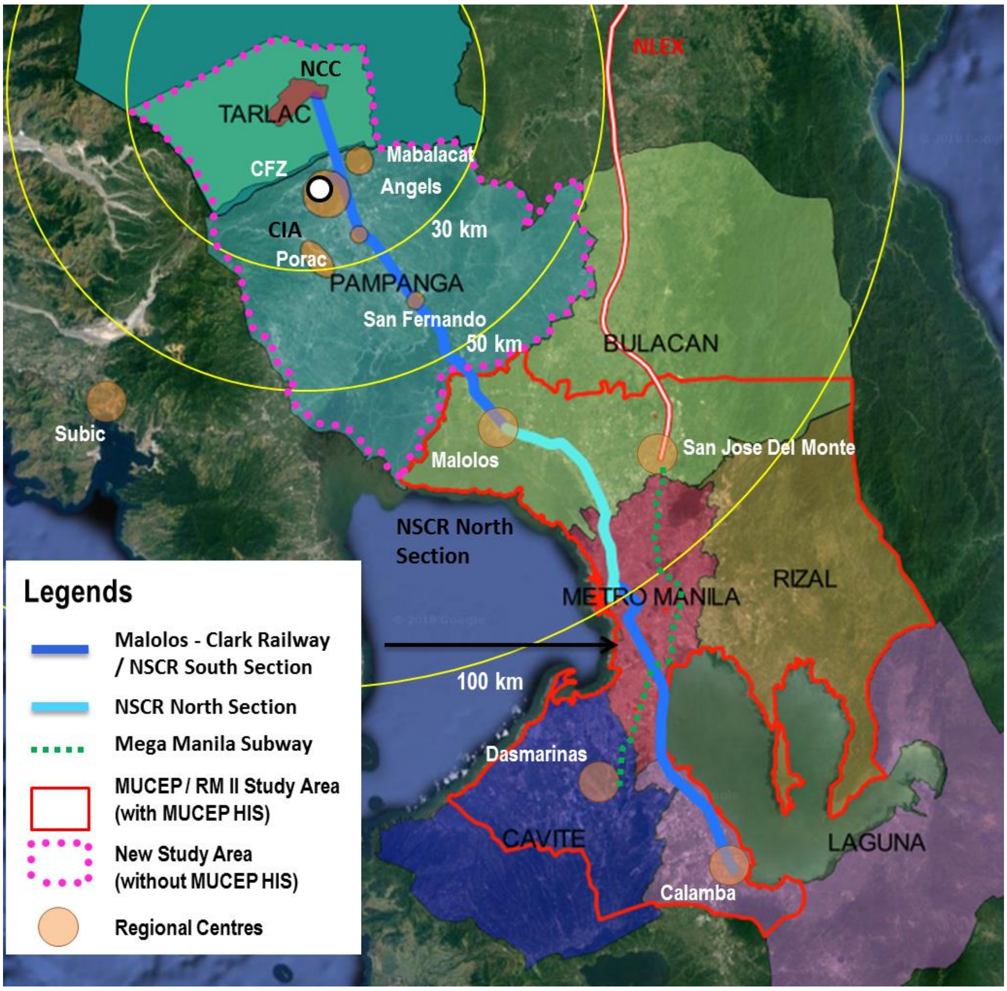
Figure 3.3.5 Map of Adapted Route Clark to NCC.

3.4 Travel Demand Forecast

3.4.1 Study Area

The Study Area for the demand forecast is defined as the area, which covers "The Project for Capacity Development on Transportation Planning and Database Management in the Republic of the Philippines" (referred to as MUCEP Study) Area (including Metro Manila, Rizal, and a part of Bulacan, Laguna and Cavite Provinces), Pampanga Province and several municipalities of Tarlac Province. As the special traffic zones, CIA and NCC are also included.

The location of the Study Area with distribution of major cities is shown in Figure 3.4.1. As the transit backbones, both the commuter rail and Mega Manila Subway are planned to connect Metro Manila and Sub-urban centres in adjoining areas.



Source: JICA Design Team

Figure 3.4.1 The Study Area for Demand Forecast

3.4.2 Socio-economic Framework of the Study Area

The socio-economic framework of the Study Area is based on the "Follow-up Survey on Roadmap for transportation infrastructure development for Greater Capital Region (GCR)" (referred to as Roadmap II). And that of Tarlac and Pampanga Provinces were developed from the statistical information and the local development plans.

The population projection by LGU is shown in Table 3.4.1. The main points are as follows:

Currently, some LGUs are densely populated and the population is expected to be decreased in the future.

However, total population in Metro Manila is estimated to increase until 2040.

The future population growth in adjoining provinces including Pampanga, Tarlac is estimated to be much higher than of Metro Manila.

Table 3.4.1 Projection of the Night-time Population of the Study Area

Province	LGU	2015			Population Projection (000)			Population Net Density (person/ha)			Annual Growth Rate (%/year)		
		Population (000)	AGR 10-'15 (%/yr)	Net Density (/ha)	2022	2035	2040	2022	2035	2040	15-'22	22-'35	35-40
Metro Manila	Caloocan City	1,584	1.2	303.1	1,666	1,665	1,622	318.7	318.6	310.4	0.7	-0.0	-0.5
	Las Pinas City	589	1.3	186.9	621	624	609	197.1	198.0	193.2	0.8	0.0	-0.5
	Makati City	583	1.9	277.8	643	704	709	306.7	335.5	338.3	1.4	0.7	0.2
	Malabon City	366	0.7	296.8	370	344	326	300.1	279.1	264.3	0.2	-0.6	-1.1
	Mandaluyong City	386	3.3	357.4	467	605	651	432.1	559.7	602.2	2.7	2.0	1.5
	Manila	1,780	1.5	504.5	1,906	1,970	1,943	540.1	558.1	550.6	1.0	0.3	-0.3
	Marikina City	451	1.2	205.8	473	472	459	216.1	215.5	209.7	0.7	-0.0	-0.5
	Muntinlupa City	505	1.9	132.9	554	600	602	145.9	158.0	158.7	1.3	0.6	0.1
	Navotas City	249	0.0	424.8	241	206	189	410.5	350.6	321.5	-0.5	-1.2	-1.7
	Paranaque City	666	2.5	139.6	763	896	928	160.1	187.9	194.7	2.0	1.2	0.7
	Pasay City	417	1.2	219.7	436	432	419	229.9	227.7	221.0	0.7	-0.1	-0.6
	Pasig	755	3.8	232.9	946	1,309	1,445	291.8	403.7	445.6	3.3	2.5	2.0
	Pateros	64	-0.1	388.7	61	51	47	372.4	313.1	285.3	-0.6	-1.3	-1.8
	Quezon City	2,936	1.2	177.0	2,981	2,790	2,650	179.7	168.3	159.8	0.2	-0.5	-1.0
	San Juan	122	0.9	214.8	125	120	115	220.4	210.5	201.5	0.4	-0.4	-0.9
	Taguig City	805	4.5	235.5	1,060	1,608	1,839	310.1	470.5	538.1	4.0	3.3	2.7
	Valenzuela City	620	1.5	160.5	665	689	680	172.0	178.2	175.9	1.0	0.3	-0.3
	Subtotal	12,877	1.7	224.4	13,978	15,084	15,233	243.5	262.8	265.4	1.2	0.6	0.2
Bulacan		2,640	2.7	28.9	2,871	3,424	3,546	31.4	37.5	38.8	1.2	1.4	0.7
Cavite		3,315	3.7	49.1	3,622	4,545	4,795	53.7	67.4	71.1	1.3	1.8	1.1
Laguna		1,888	3.3	54.9	2,032	2,475	2,590	59.0	71.9	75.3	1.1	1.5	0.9
Rizal		2,884	3.0	23.1	3,054	3,765	3,948	24.5	30.2	31.7	0.8	1.6	1.0
Pampanga		2,198	1.8	11.0	2,435	2,861	3,025	12.2	14.3	15.1	1.5	1.2	1.1
Tarlac		1,366	1.4	4.5	1,537	1,807	1,910	5.0	5.9	6.3	1.7	1.2	1.1
Study Area Total		56,541	2.4	37.6	61,193	70,782	73,053	40.6	47.0	48.5	1.1	1.1	0.6

1) Net Land: Without Cemetery, Airport, and Port Area

Source: JICA Design Team

The projection of the employment at workplace by LGU is shown in Table 3.4.2. Unlike the population projection, LGUs in Metro Manila will be increased. The workers in Adjoining Provinces are expected to commute to Metro Manila.

Table 3.4.2 Projection of Employment (at workplace) in the Study Area (000)

Province	LGU	2015				2022				2035			
		Primary	Secondary	Tertiary	Total	Primary	Secondary	Tertiary	Total	Primary	Secondary	Tertiary	Total
Metro Manila	Caloocan City	34	73	466	574	35	75	479	590	36	74	491	600
	Las Pinas City	18	47	200	265	19	48	206	273	19	47	212	279
	Makati City	35	81	544	660	38	87	587	712	43	94	657	793
	Malabon City	11	22	112	144	11	21	110	143	10	19	105	135
	Mandaluyong City	21	47	294	362	25	55	347	428	33	70	461	564
	Manila	42	122	1,212	1,376	44	126	1,269	1,440	46	129	1,343	1,518
	Marikina City	8.8	35	194	238	9	36	200	245	9	35	204	248
	Muntinlupa City	20	49	246	315	22	52	264	337	24	56	292	372
	Navotas City	14	11	56	82	13	11	53	77	12	9	47	67
	Paranaque City	22	53	335	411	25	59	376	460	30	69	451	550
	Pasay City	18	30	235	283	18	30	241	289	18	29	244	292
	Pasig	31	83	360	473	38	101	440	579	53	137	624	814
	Pateros	2.0	0.9	14	17	1.9	0.8	13	16	1.6	0.7	11	14
	Quezon City	142	254	1,587	1,983	141	250	1,575	1,966	134	231	1,510	1,875
	San Juan	2.1	6.7	57	66	2.1	6.6	58	66	2.0	6.2	56	65
	Taguig City	26	73	314	413	34	93	404	530	52	139	627	818
	Valenzuela City	23	61	212	296	24	63	222	309	26	64	236	325
	Subtotal	471	1,048	6,439	7,958	501	1,114	6,844	8,460	548	1,210	7,572	9,329
Bulacan		107	208	888	1,202	116	224	958	1,298	144	275	1,201	1,620
Cavite		127	466	1,479	2,072	136	496	1,582	2,214	170	618	2,019	2,808
Laguna		92	213	775	1,081	98	225	819	1,142	121	276	1,027	1,425
Rizal		115	225	835	1,175	119	230	849	1,197	139	263	967	1,369
Pampanga		60	107	473	639	65	116	513	693	77	137	617	831
Tarlac		37	66	294	397	41	73	324	438	49	86	390	525
Study Area Total		1,010	2,332	11,182	14,524	1,075	2,478	11,888	15,441	1,248	2,866	13,793	17,907

Source: JICA Design Team

3.4.3 Socio-economic Framework for New Clark City (NCC)

The socio-economic framework of New Clark City is assumed as given in Table 3.4.3. Assumption of Population conflicts with 2 patterns, 1) Socio economic framework of Original Clark Green City (CGC) M/P (as of JOIN F/S), 2) Socio-economic framework proposed in the report of Consultancy Services of a Comprehensive Master Development Plan for the Clark Green City (CGC). The DOTr Provided the latest socio-economic framework of CGC now called as New Clark City (NCC). The original CGC master plan was very ambitious in that it expected to develop a new city of 1.1million inhabitants by 2045 with over 800,000 jobs. Where as the revised plan of over a million inhabitants and 540,000 jobs by 2065 is still has some uncertainties and was assumed to be conservative and was adopted by the JDT.

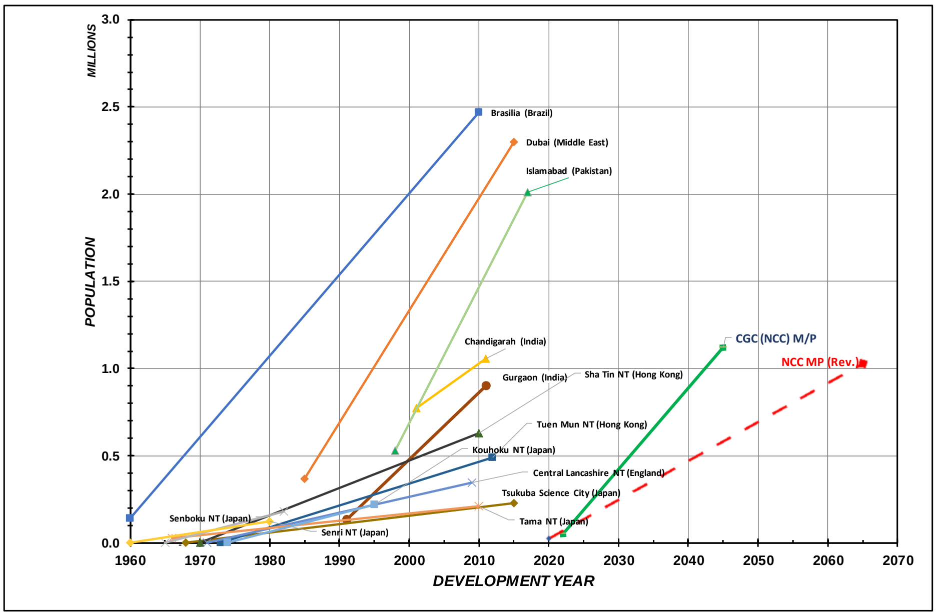
Figure 3.4.2 shows a comparison of NCC (and Original CGC) master plan population data with cities around the world which have developed over the last six decades either as new urban centers to relieve population pressure on the current metropolis or as new Capitals or Government Centers. It can be seen that the original CGC plan was rather too ambitious whereas growth rate of NCC is more in line with a group of cities developed since 1960's.

Alternatively, Figure 3.4.3 illustrates the growth of cities (population) over periods of forty to fifty years. The figure illustrates that the CGC MP growth rate was much higher than achieved by any other city, where is NCC growth and ultimate population of just over one million inhabitants is very much in line with cities such as Denentoshi, Brasilia etc.

Table 3.4.3 The assumption of the Socio-economic Framework of New Clark City

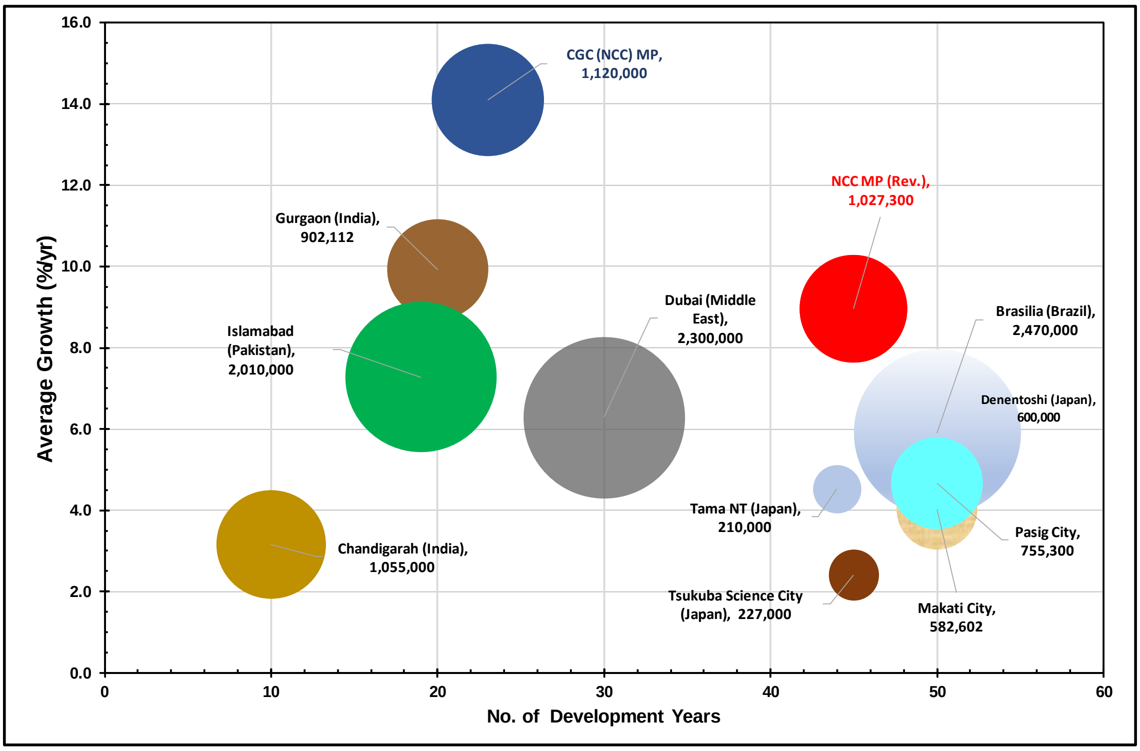
Characteristics		1) CGC (NCC) Original M/P (As of JOIN F/S)	2) Consultancy Services of a Comprehensive Master Development Plan for the Clark Green City (NCC)
Socio-economic Framework	Population	672,000	344,700
	Employment	480,000 (around 70 % of night time population)	176,800 (around 50% of night time population)
Trip Rate (Trip / person)		1.76	1.41
Intra trip rate (Share of the trips within NCC)		45.1 % for all transport modes (Intra trip ratio of Bulacan Area is applied)	
Trip Distribution		Trip distribution patterns are estimated from the generalized cost from / to each area. The trip patterns are based on the transport database developed in MUCEP / Road Map II Study	
Modal Share (%)	Motorcycle	13.5	
	Car	25.5	
	Public	61.0	

Source: JICA Design Team



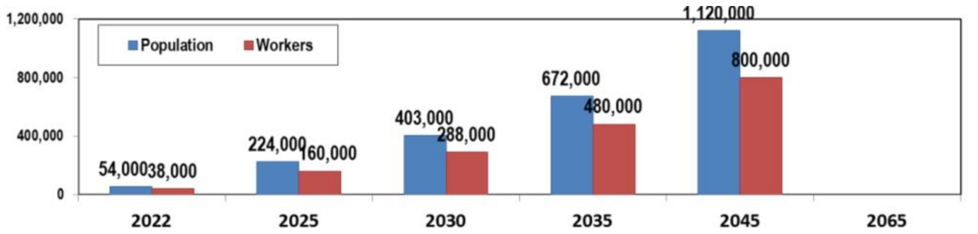
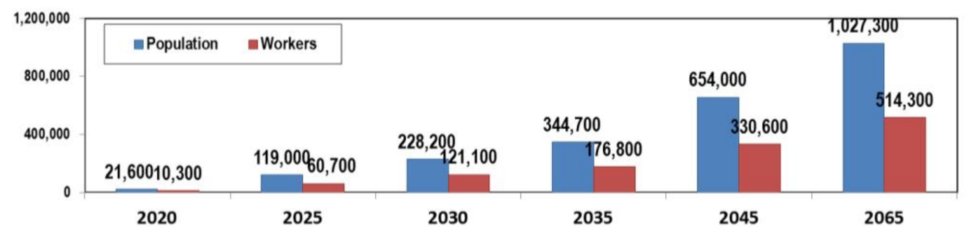
Source: JICA Design Team

Figure 3.4.2 Comparison of Population and Development Year between Other New Cities CGC and NCC Over Last Six Decades



Source: JICA Design Team

Figure 3.4.3 Comparison of Population Growth in Different Cities of the World, and Planned CGC & NCC

1) CGC (NCC) Original M/P (As of JOIN F/S)	
2) Consultancy Services of A Comprehensive Master Development Plan for the Clark Green City (NCC)	

Source: JICA Design Team

Figure 3.4.4 Socio-economic Framework of NCC

The socio-economic framework (population – Plate-1, and Employment Plat-2) of CGC and NCC is further below in Figure 3.4.5. The growth rate of CGC were way to ambitions whereas that of NCC appears to be plausible and given the current (on-going) rapid development program and allocation of substantial funding it could be realized by 2065.

Plate_1 - Population

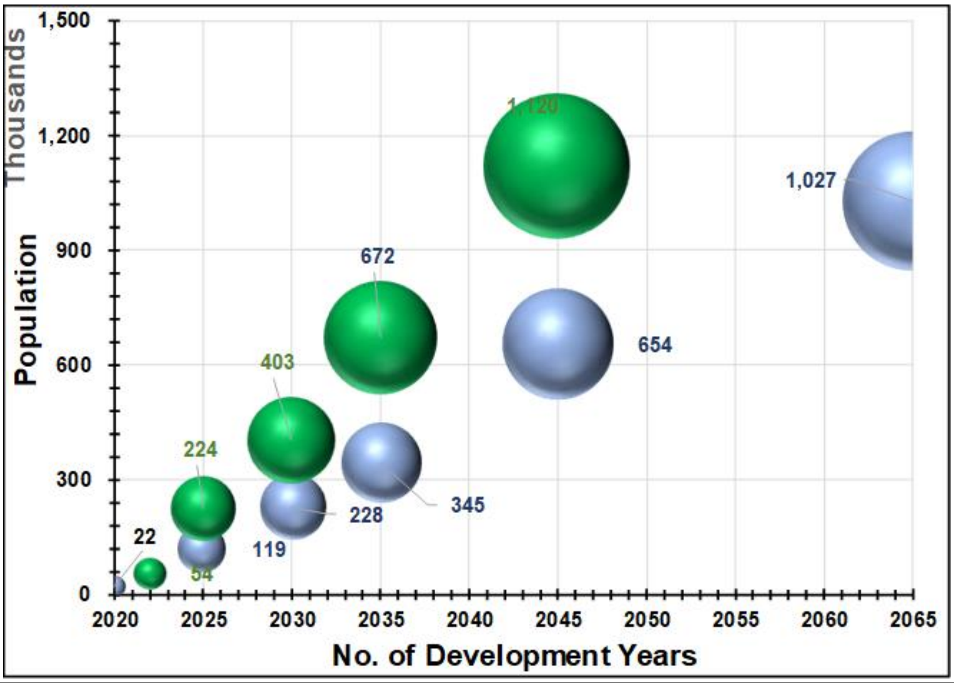
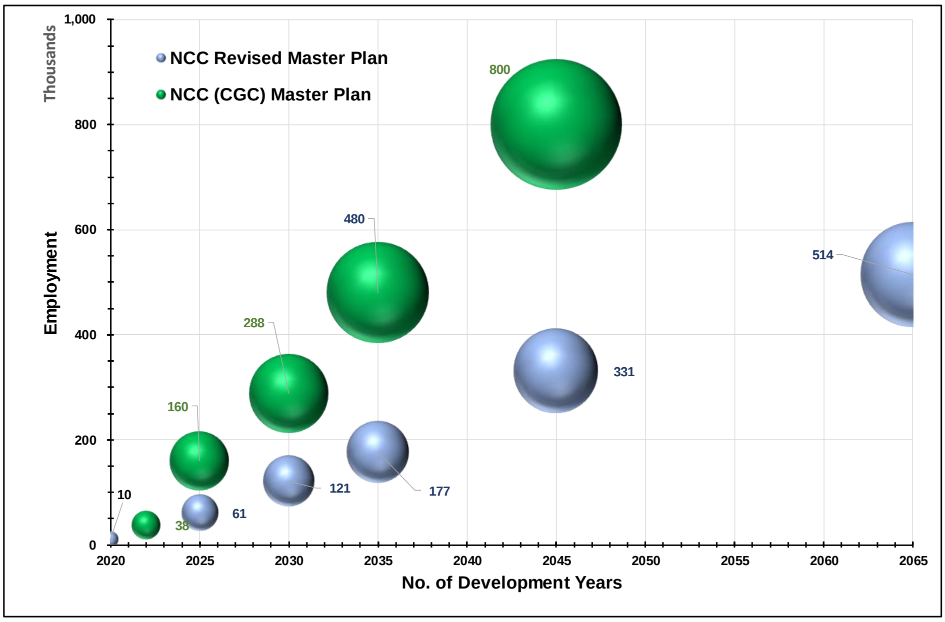


Plate 2 – Employment



Source: JICA Design Team

Figure 3.4.5 Growth of Population and Employment in NCC

Future travel demand of NCC in 2035, is estimated through the assumed socio-economic framework as shown in Table 3.4.4. The result shows that the 45.1% of total trips are within NCC. The modal share was estimated from value of the adjoining area.

Table 3.4.4 Traffic demand of the New Clark City in 2035

000Trip/day			Motor Cycle	Car	Public	Total
1) CGC (NCC) Original M/P (As of JOIN F/S)	Modal Share (%)		13.5	25.5	61	100
	No. of Trips (000 / day)	To / from NCC	88.1	166	394	648
		Within NCC	72.6	137	325	534
		Total	161	303	719	1,182
2) Consultancy Services of A Comprehensive Master Development Plan for the New Clark City (NCC)	Modal Share (%)		13.5	25.5	61	100
	No. of Trips (000 / day)	To / from NCC	36.2	68.1	162	266
		Within NCC	29.8	56.1	133	219
		Total	66.0	124	295	485

Source: Estimated by JICA Design Team

3.5 Passenger Forecast for MCRP

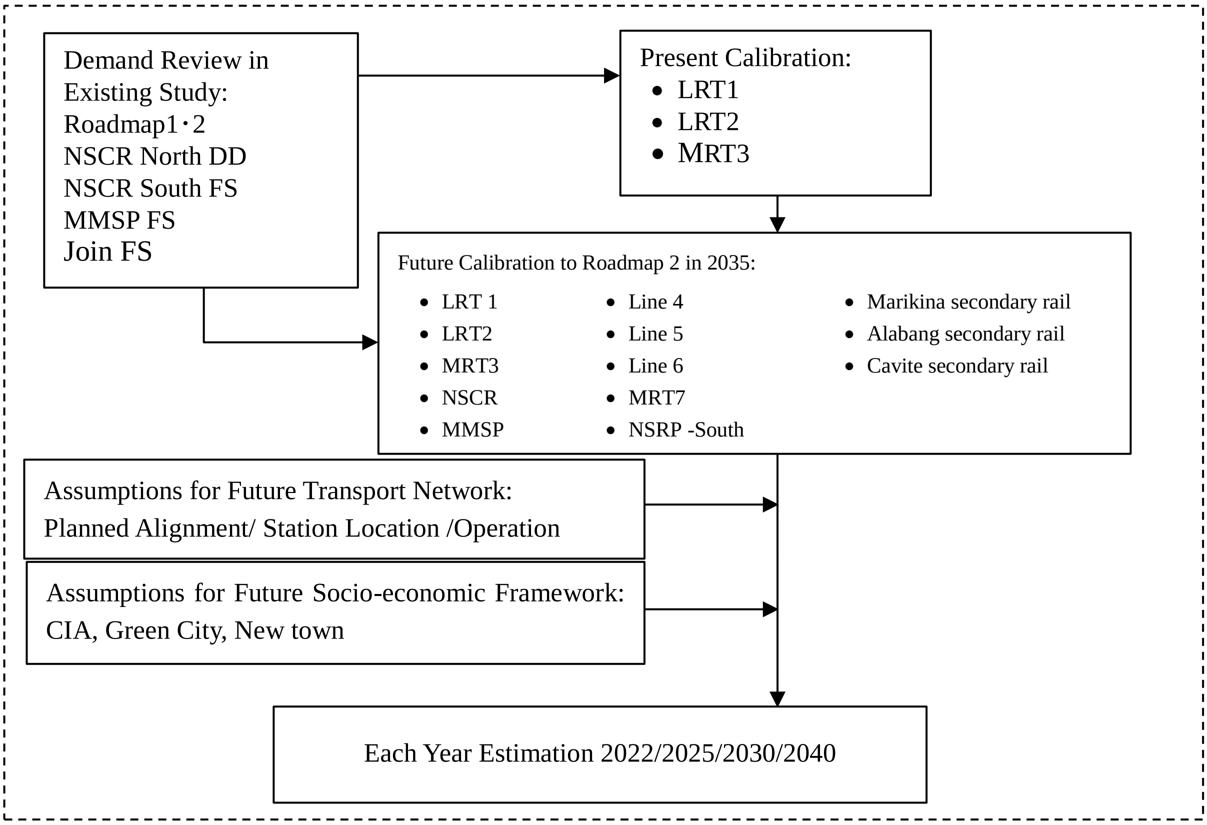
The implementation schedule of road and railway projects was based on Roadmap II (Table 3.5.1). The main findings by category are as follows:

3.5.1 Overview of Model Development

The demand forecast approach is based on the models used in the Feasibility Study on Clark-Manila Railway Project (JOIN, 2017), The Detailed Design Study of the North-South Commuter Railway Project in the Republic of the Philippines (Malolos-Tutuban section) of the JICA survey and Supporting Regional Project Development for Association of Southeast Asian Nations Connectivity Study on NSCR-South Line (PNR South) (ADB, 2016).

The demand forecast model was considered in Road Map II Study, which is an updated version from the MUCEP transport database.

The MUCEP transport database is based on the Person Trip Survey conducted in 2014. The covered area is Mega Manila Area. In this Study, Pampanga province and several municipalities of Tarlac province are additionally included. The trip pattern in this area is estimated from the data obtained by the traffic surveys conducted in Roadmap II Study.



Source: JICA Design Team

Figure 3.5.1 Flow Chart of Demand Forecast Methodology

The demand forecast model is based on a kind of basic 4-step model, which is composed of generation/attraction, distribution, modal split, assignment model. In this study, population data such as NCC and CIA user for future is considered by the model.

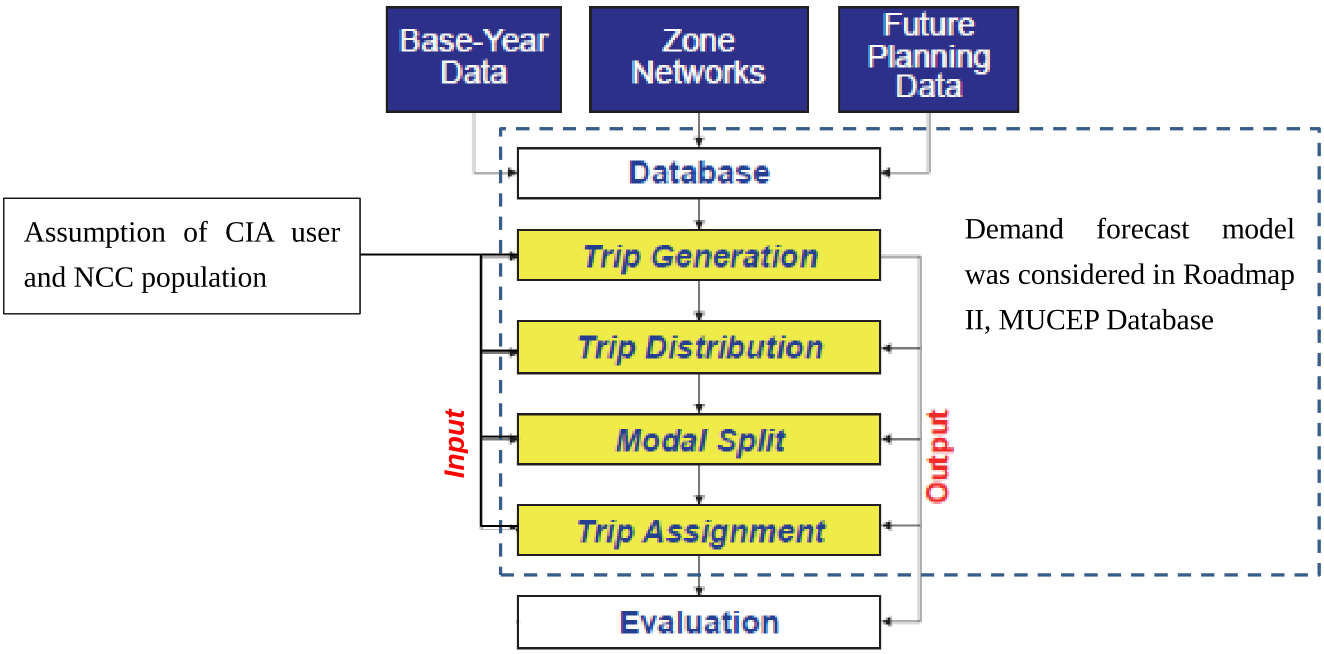


Figure 3.5.2 Demand Forecast Model

3.5.2 Basic Assumptions

In demand forecast, the transport network and station construction schedule by each of the forecast years are assumed. The implementation schedules of other sections are assumed through discussions between DOTr and JDT, and these are modified as necessary.

(1) Station construction schedule

The construction schedule of the stations, which is assumed in the demand forecast, is shown in Table 3.5.1. In 2021, only 10 stations of the NSCR North section will be opened. And after 2025, MMSP is entering to NSCR each other from Bictan to Calamba.

Table 3.5.1 The Assumed Station Construction Schedule of Malolos-Clark section and NSCR

Section	Station	Year of opening				Assumption
		2022	2023 (October)	2025	2030	
Malolos-Clark (MCRP)	NCC			●	●	Assumption of NCC Plan
	CIA	●	●	●	●	Assumption of Air Pax is 46mil.per year
	Clark	●	●	●	●	Branch to NCC and CIA
	Angeles	●	●	●	●	
	San Fernando	●	●	●	●	
	Apalit	●	●	●	●	
	Calumpit	●	●	●	●	
NSCR North	Malolos	●	●	●	●	
	Malolos South				●	
	Guiguinto	●	●	●	●	
	Tuktukan				●	
	Balagtas	●	●	●	●	
	Bocaue	●	●	●	●	
	Tabing Ilog	●	●	●	●	
	Marilao	●	●	●	●	
	Meycauayan	●	●	●	●	
	Valenzuela	●	●	●	●	
	Valenzuela Polo				●	
	Malabon				●	
	Caloocan	●	●	●	●	
	Solis	●	●	●	●	Can transfer to NSRP-South
	Tutuban	●	●	●	●	Can transfer to LRT2 ext.
NSCR South	Blumentrit	●	●	●	●	Can transfer to LRT1
	Espana		●	●	●	
	Santa Mesa		●	●	●	
	Paco		●	●	●	
	Buendia		●	●	●	
	Pasay Road					
	EDSA		●	●	●	
	Nichols		●	●	●	
	FTI		●	●	●	
	Bicutan		●	●	●	Entering to MMSP after 2025
	Sucat		●	●	●	Entering to MMSP after 2025
	Alabang		●	●	●	Entering to MMSP after 2025
	Muntinlupa		●	●	●	Entering to MMSP after 2025
	San Pedro		●	●	●	Entering to MMSP after 2025
	Pacita		●	●	●	Entering to MMSP after 2025
	Binan		●	●	●	Entering to MMSP after 2025
	Santa Rosa		●	●	●	Entering to MMSP after 2025
	Cabuyao		●	●	●	Entering to MMSP after 2025
	Gulod		●	●	●	Entering to MMSP after 2025
	Mamatid		●	●	●	Entering to MMSP after 2025
	Calamba		●	●	●	Entering to MMSP after 2025

Source: JICA Design Team

(2) Stop Stations of Express / Limited Express Services

The train operation schedule as stop stations by service which are assumed in the demand forecast are shown in Table 3.5.2.

Table 3.5.2 The Assumed Stop Stations by Service Operation

Section	Station	Limited Express CIA-Alabang	Commuter Express CIA-Calamba	Commuter CIA-Calamba	Commuter Express NCC-Tutuban	Commuter NCC-Tutuban	Entering to MMSP
Malolos-Clark (MCRP)	NCC				●	●	
	CIA	●	●	●			
	Clark		●	●	●	●	
	Angeles			●		●	
	San Fernando		●	●	●	●	
	Apalit			●		●	
	Calumpit			●		●	
NSCR North	Malolos		●	●	●	●	
	Malolos South			●		●	
	Guiguinto			●		●	
	Tuktukan			●		●	
	Balagtas			●		●	
	Bocaue		●	●	●	●	
	Tabing Ilog			●		●	
	Marilao		●	●	●	●	
	Meycauayan			●		●	
	Valenzuela		●	●	●	●	
	Valenzuela Polo			●		●	
	Malabon			●		●	
	Caloocan		●	●	●	●	
	Solis	●		●		●	
	Tutuban				●	●	
NSCR South	Blumentrit		●	●			
	Espana			●			
	Santa Mesa		●	●			
	Paco			●			
	Buendia	●	●	●			
	Pasay Road						
	EDSA		●	●			
	Nichols			●			
	FTI	●	●	●			
	Bicutan			●			●
	Sucat		●	●			●
	Alabang	●	●	●			●
	Muntinlupa			●			●
	San Pedro			●			●
	Pacita			●			●
	Binan			●			●
	Santa Rosa		●	●			●
	Cabuyao		●	●			●
	Gulod			●			●
	Mamatid			●			●
	Calamba		●	●			●

Source: JICA Design Team

3.5.3 Road Based Public Transport Projects

The expansion of the mass transit network will entail a more massive investment than roads. A total of 268 km of main rail lines (in 6 corridors) and 60 km of secondary transit lines must be provided as an integrated system. Hence, the urgency of clearing the backlog of railway projects by 2018, such as LRT-1 Cavite extension (12 km), LRT-2 east extension (4 km), LRT-2 west extension (3 km), reconstructing PNR North commuter service (38 km), LRT-4 (19 km), MRT-5 (20 km), LRT-6 (19 km), MRT-7 (22 km), and Mega Manila Subway (25 km for Phase 1).

(1) Road Based Public Transport Projects

As the road based public transport systems, the Integrated Transport System and bus priority systems are included into the assumed transport network.

To compensate for the long gestation for railways, developing the bus priority or BRT mass transit ahead of the rail line in specific corridors should be pursued. BRT operation may be terminated and replaced with the rail transit. In Road Map Study II, the development of BRT Line 1 on Quezon Boulevard corridor is proposed, due to lower hurdles to overcome on the corridor and function as pre-METRO, BRT operation is terminated and replaced with the rail transit. However, in discussion with DOTr, the development of BRT Line 1 is excluded from the assumed transit network due to the duplication with MRT Line 7, which is planned to be developed in early stage.

(2) Road & Expressway Projects

The road and expressway network as proposed in Road Map II Study is extensive to connect suburban centres and Metro Manila, and between suburban centres. (Table 3.5.3 & Figure 3.5.3 & 3.5.3)

C5 Expressway connecting proposed Central Luzon Expressway and Laguna Lakeshore Dyke Expressway are expected to strengthen the north–south traffic flow. With the second expressway connecting both north–south expressway corridors can effectively complement each other and strengthen the resilience of road network. With the proposed network, Metro Manila is provided with integrated urban expressway system together with east–west expressways and contribute to dramatically to reduce the at-grade traffic congestion.

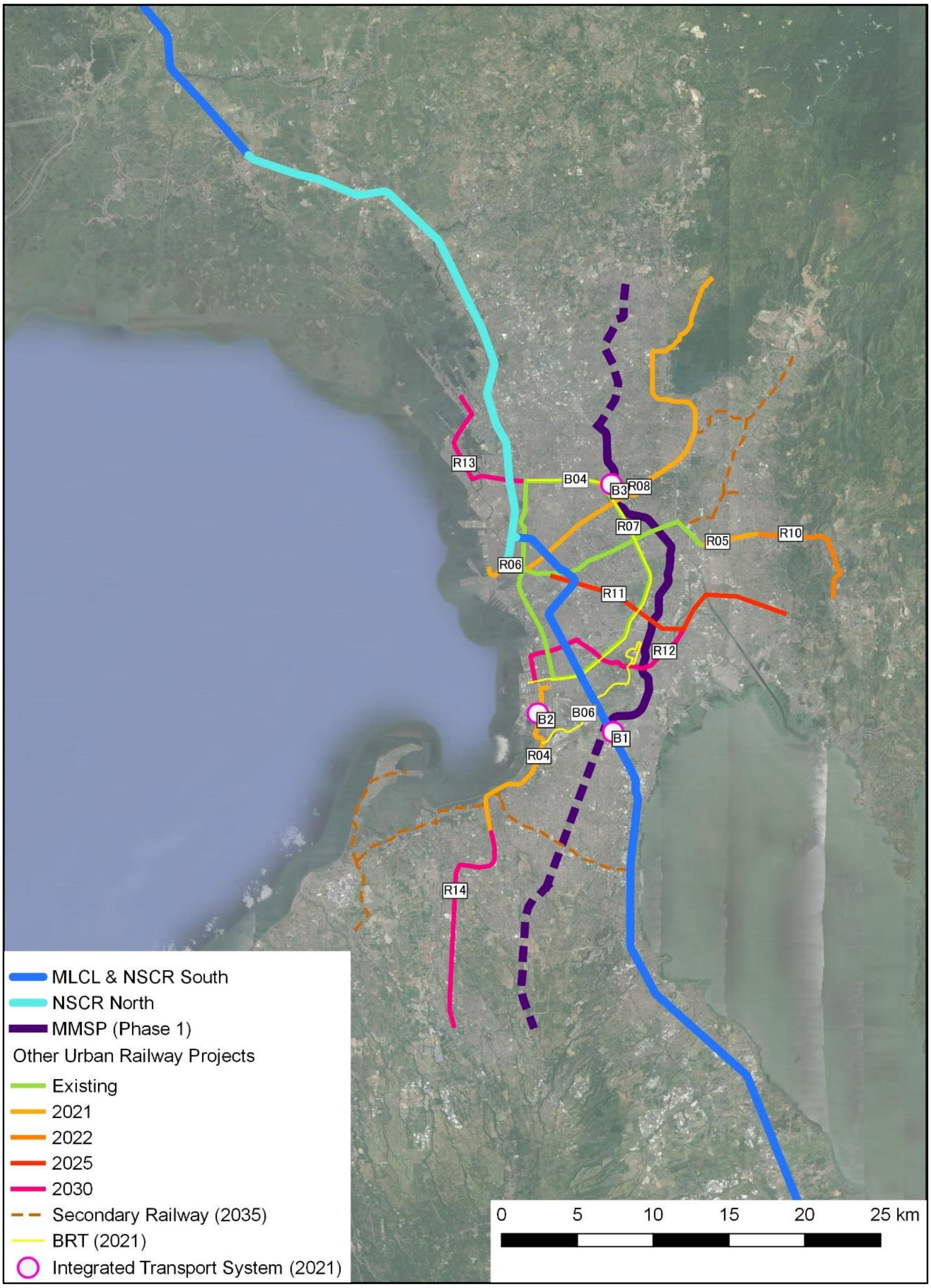
From future road and expressway projects proposed in Road Map II Study, Laguna Lakeshore Expressway is omitted through the discussion with DOTr. This expressway project is selected as the priority project and proposed to be opened in 2025. But the currently the project has been halted indefinitely.

Table 3.5.3 The Implementation Schedule of Road and Railway Projects

Category	No.	Project	2022	2025	2030	2035	2040	Project cost (PHP mil.)
Railway	R01	MCRP	●	●	●	●	●	This study
	R02	North South Commuter Rail	●	●	●	●	●	117,304
	R03	NSRP-South	●	●	●	●	●	This study
	R04	LRT Line 1 Cavite Extension	●	●	●	●	●	64,915
	R05	LRT Line 2 East (Masinag) Extension Project	●	●	●	●	●	9,759
	R06	LRT Line 2 West Extension	●	●	●	●	●	10,118
	R07	MRT 3 Capacity Expansion Project	●	●	●	●	●	8,633
	R08	MRT Line7	●	●	●	●	●	62,700
	R09	Mega Manila Subway		Phase 1	Phase 1	Phase 2	Phase 2	227,000
	R10	LRT-1 North Extension	●	●	●	●	●	15,920
	R11	LRT-2 East Extension (Phase II)	●	●	●	●	●	80,480
	R12	LRT Line 4 Project		●	●	●	●	85,000
	R13	Metro Manila Line 5		●	●	●	●	301,801
	R14	MRT-3 Extension - South and West			●	●	●	68,600
	R15	MRT-3 Extension - North			●	●	●	68,600
	R16	LRT Line 6				●	●	64,710
	R17	Ortigas Secondary Railway (Marikina, Pasig, Alabang, Cavite)				●	●	-
Road Based Public Transport	B01	South Integrated Transport System Project	●	●	●	●	●	4,000
	B02	Southwest Integrated Transport System (ITS) Project	●	●	●	●	●	3,153
	B03	Integrated Transport System-North Terminal Project	●	●	●	●	●	4,000
Road/ Expressway	E01	NLEX Harbor Link, Segment 10	●	●	●	●	●	9,000
	E02	Skyway Stage 3	●	●	●	●	●	26,656
	E03	NLEX–SLEX Connector Road Project	●	●	●	●	●	23,320
	E04	Metro Manila Expressway Project (C-6)	●	●	●	●	●	31,320
	E05	Plaridel Bypass Phase III	●	●	●	●	●	1,184
	E06	Cavite-Laguna Expressway	●	●	●	●	●	35,426
	E07	C6 North Section	●	●	●	●	●	4,330
	E08	Laguna Lakeshore Expressway Dike						122,861
	E09	CAVITEX - C-5 - San Jose Del Monte (Bulacan)			●	●	●	13,640
	E10	Sta. Mesa - Pasig (Shaw Boulevard) R-4 Expressway			●	●	●	23,430
	E11	Manila City - Quezon City (Quezon Av.) R-7 Expressway				●	●	24,480
	E12	North Luzon Expressway (SJ Del Monte-Cabanatuan-San Jose)				●	●	24,850
	E13	CAVITEX Extension West to Rosario				●	●	12,710
	U16	Circumferential Road 3 (C-3), Southern Segment from N. Domingo St. in San Juan City to Buendia Avenue in Makati City	●	●	●	●	●	10,500
	U17	Alabang-Zapote Areas	●	●	●	●	●	9,470
	U18	Marcos Highway	●	●	●	●	●	1,450
	U19	Calamba Local Area Roads Package	●	●	●	●	●	3,090
	U20	Rosario Package	●	●	●	●	●	4,010

Note: JDT Agreed with GOP on 25th April 2018. Project cost is based on the information of web site.

Source: JICA Design Team



Source: JICA Design Team

Figure 3.5.3 Existing / Proposed Railway Projects

Source: JICA Design Team

Figure 3.5.4 Existing and Proposed Expressway / Road Projects

(3) Development of Clark International Airport

In road map II Study, a strategy has been proposed for the airport which is the gateway of GCR as below, CIA is written that future expansion plans will be made, and it will absorb NAIA's excess demand.

Table 3.5.4 GCR Gateway Airport by Roadmap II

Airport	Phase 1 (2018-2022)	Phase 2 (2023-2029)	Phase 3 (2030 upward)
CIA	Complete the new CRK International Passenger Terminal in tandem with private O&M	Expand capacity and upgrade systems to absorb spill over from & provide relief to existing NAIA	Build the 2nd and 3rd runway, as well as expand Pax Terminal building & Cargo Terminal
NAIA	Complete the transfer of General aviation from NAIA to Sangley Terminal space expansion & management improvements (T1 to T4) via PPP	Build a new NAIA in another site south of NCR (if not Sangley 1, then Laguna Lake or Lipa-Batangas)	Shutter existing NAIA and convert to “green lungs of NCR” plus socialized housing community
Regional airports outside GCR	Complete the night landing facilities in other airports feeding into NAIA	Complete full development of regional airports, as well as tourism-based airports (Bohol, Palawan, etc.)	Aviation policies to steer traffic growths from GCR to regional airports (Cebu, Davao, Iloilo, Laoag)

Source: Follow-up Survey on Roadmap for Transport Infrastructure Development for Greater Capital Region (GCR)

Meanwhile, according existing reports, there are several numbers in the CIA's airport demand level following below.

Table 3.5.5 CIA Airport Demand

Case	Assumption of CIA demand
Case A: Domestic passengers are dominant due to a better attraction of passenger from CIA catchment area	Low: 26 million. Based on the forecast in “Information Collection Survey for New Manila International Airport (JICA, 2016)” Planned New Manila International Airport will be dominant
	Middle: 46 million / year Based on the target in “CRK Master Development Plan”
	High: 79 million / year Based on the forecast in “Feasibility Study of the Extension of CIA (DOTr, 2014)“
Case B: All international flights operate to/from CIA: the trip pattern is based on the NAIA.	High: 79 million / year Based on the forecast in “Airport Strategy Study for the GCR (JICA, 2011)”

Source: JICA Design Team

In the result of discussion with DOTr, the assumption of CIA’s passenger will be as of Middle Case A (46 million/ year), considering competition with NAIA, which new airport is planned. The demand of CIA, including working and well-wisher, is estimated using surveyed traffic volume in Roadmap II and above the number of user.

Table 3.5.6 The Demand at CIA

Year	Passenger (pax/year)	Passenger (pax/day)	Total No. of Trips for CIA (000trip/day)
2016	951,007	2,605	-
2017	2,828,048	7,748	14
2040	46,000,000	126,027	238

Source: Estimated by JICA Design Team

3.5.4 MCRP Passenger – Station and Line Volumes

(1) Calibration of Current Demand

In demand forecast, the current traffic demand was calibrated by reviewing input data and verified. The following materials were referred:

- Number of operations
- Connectivity with other transportation methods
- Review of construction projects

The comparison between the statistics of railway ridership in 2016 and present calibration result by model are shown in Table 3.5.7. The estimated value is about 1.0 times against statistics and it proves that the model is predictable.

Table 3.5.7 Validation of Demand Model (daily passenger)

2016		Statistics (A)	Calibrated Estimation (B)	(B)/(A)
LRT1	000pax/day	453	469	1.04
LRT2	000pax/day	126	129	1.02
MRT3	000pax/day	425	455	1.07

Source: JICA Design Team

(2) Consistency with Roadmap

The comparison between estimated demand of roadmap and this study is shown in Table 3.5.8. The forecast result in this study is almost same volume and similar to Roadmap II and the model result in this study has the consistency with Roadmap II result. In this Study, the connectivity by each station was reviewed and reflected on the demand forecast. Through the update the ridership of LRT Line 2 increased by 1.6 times and MRT Line 3 decreased by 0.84.

Table 3.5.8 The Consistency between Roadmap II and the Study (Daily Passenger)

2035		Roadmap II Estimation (A)	This Study Estimation (B)	(B)/(A)
LRT1	000pax/day	642	629	0.98
LRT2	000pax/day	270	430	1.59
MRT3	000pax/day	440	370	0.84
NSCR	000pax/day	785	787	1.00
MMSP	000pax/day	673	677	1.01

Source: JICA Design Team

(3) Overview of the Ridership Demand Forecast

Ridership Demand forecast based on operation plan is shown in Table 3.5.9. The socio-economic framework of NCC was updated from the projection in the Consultancy Services of A Comprehensive Master Development Plan for the Clark Green City, and the demand of Malolos-CIA/NCC section is less than the result of previously reported. The JOIN-F/S report anticipated a high demand because of generating the demand from/to the NCC development area, but the future demand was updated by updated information and the demand became be less than JOIN-F/S demand. Because NCC development largely affects on the Malolos-Clark section, the demand of the Malolos-Clark section is smaller than JOIN-F/S report.

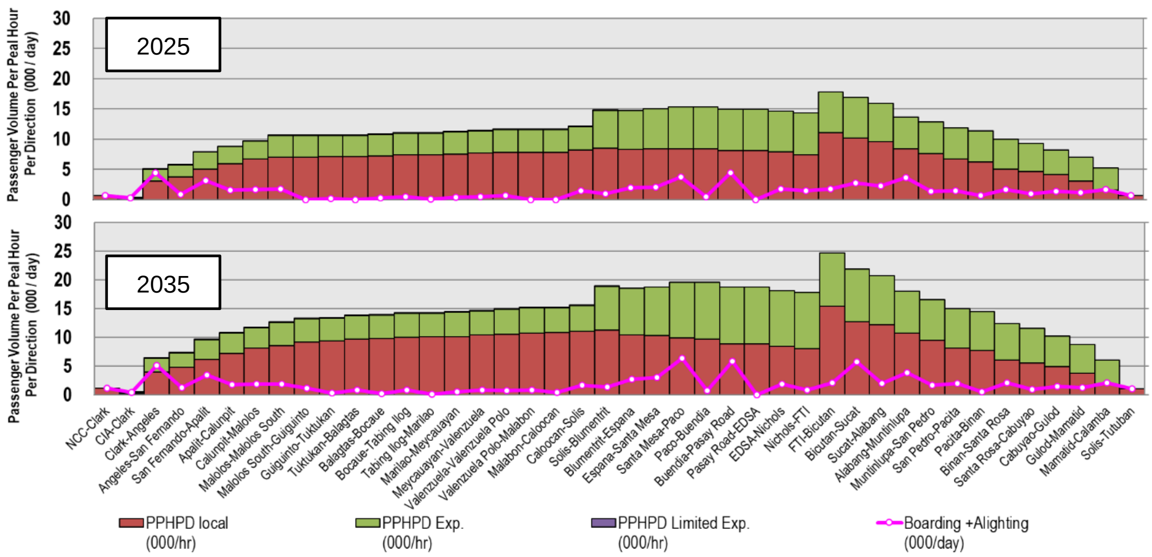
Table 3.5.9 Overview of the Demand Forecast Results

Section		2022	2023 October	2025	2035	2040	JOIN-F/S Report (2035)
Ridership (000/day)	Malolos-CIA/NCC	185	193	184	222	248	427
	Tutuban-Malolos	276	238	262	357	409	375
	Solis-Calamba	76	523	516	706	815	717
	Total	**337**	**555**	**549**	**767**	**883**	**n/a**
PPHPD (000/hr)	Malolos-CIA/NCC	9.3	10.5	9.6	11.6	13.0	11.8
	Tutuban-Malolos	11.1	12.3	12.0	15.5	17.8	19.2
	Solis-Calamba	4.8	16.8	17.5	24.6	27.9	24.9

Source: JICA Design Team

(4) Cross-sectional traffic volume and alighting and boarding passenger

The estimation results of cross-sectional traffic volume and alighting and boarding are shown in the Figure 3.5.5, Table 3.5.10. The maximum cross section is between FTI-Bictan stations.



Source: JICA Design Team

Figure 3.5.5 The Forecast Results of Cross-sectional Passenger Volume and Alighting and Boarding of the Commuter Railway

Table 3.5.10 The Forecast Results of Cross-sectional Passenger Volume and Alighting and Boarding of the Commuter Railway

Station		2022			2023			2025			2035			2040		
		Section Volume (000/day/ 2directions)	PPHPD (000/hr)	Boarding +Alighting (000/day)	Section Volume (000/day/ 2directions)	PPHPD (000/hr)	Boarding +Alighting (000/day)	Section Volume (000/day/ 2directions)	PPHPD (000/hr)	Boarding +Alighting (000/day)	Section Volume (000/day/ 2directions)	PPHPD (000/hr)	Boarding +Alighting (000/day)	Section Volume (000/day/ 2directions)	PPHPD (000/hr)	Boarding +Alighting (000/day)
Malolos-Clark section	Clark to NCC	0	0	0	0	0	0	10	1	10.4	20	1.2	19.6	26	1.6	26.3
	Clark to CIA	11	0.6	10.5	12	0.7	11.5	4	0.2	3.8	7	0.4	7.3	7	0.4	7.5
	Clark	90	5.4	82.9	87	5.2	77.3	84	5.0	73.1	105	6.3	84.8	120	7.2	94.7
	Angeles	102	6.1	16.5	97	5.8	12.6	96	5.7	15.0	121	7.2	19.9	137	8.2	23.5
	San Fernando	135	8.1	57.7	145	8.7	62.2	132	7.9	51.5	160	9.6	56.9	181	10.9	61.5
	Apalit	146	8.8	22.8	161	9.7	24.6	147	8.8	25.5	178	10.7	29.8	200	12.0	32.3
	Calumpit	154	9.3	25.9	175	10.5	22.5	161	9.6	28.2	193	11.6	31.6	217	13.0	34.4
NSCR North section	Malolos	174	10.4	60.4	185	11.1	17.7	174	10.4	27.1	210	12.6	31.4	235	14.1	33.0
	Malolos South	174	10.4	0	185	11.1	0	174	10.4	0	220	13.2	18.6	248	14.9	23.3
	Guiguinto	177	10.6	19.0	186	11.2	1.5	175	10.5	2.9	223	13.4	5.6	251	15.1	6.9
	Tuktukan	177	10.6	0	186	11.2	0	175	10.5	0	229	13.7	14.5	259	15.5	17.1
	Balagtas	181	10.8	14.8	187	11.2	1.6	177	10.6	4.3	230	13.8	3.4	261	15.6	5.2
	Bocaue	185	11.1	34.6	191	11.4	5.6	182	10.9	9.7	236	14.1	13.8	268	16.1	15.8
	Tabing Ilog	184	11.0	8.0	191	11.4	0.2	183	11.0	1.8	236	14.2	1.8	268	16.1	2.0
	Marilao	171	10.3	71.9	193	11.6	5.5	185	11.1	6.9	239	14.3	7.7	273	16.4	10.8
	Meycauayan	169	10.1	22.1	196	11.7	3.7	188	11.3	7.5	243	14.6	13.6	278	16.7	16.0
	Valenzuela	127	7.6	78.0	197	11.8	3.7	191	11.5	8.5	247	14.8	12.7	283	17.0	14.4
	Valenzuela Polo	127	7.6	0	197	11.8	0	191	11.5	0	251	15.1	13.8	287	17.2	15.8
	Malabon	127	7.6	0	197	11.8	0	191	11.5	0	252	15.1	6.1	289	17.4	7.1
	Caloocan	89	5.3	58.0	205	12.3	15.4	199	12.0	23.5	258	15.5	27.7	297	17.8	30.1
	Solis	81	4.8	10.0	213	12.8	15.8	245	14.7	15.2	315	18.9	21.6	361	21.7	25.9
NSCR South section	Blumentrit	0	0.0	61	220	13.2	30.7	245	14.7	34.6	310	18.6	48.0	358	21.5	57.1
	Espana	0	0.0	0	235	14.1	36.4	250	15.0	36.2	315	18.9	57.5	365	21.9	71.0
	Santa Mesa	0	0.0	0	255	15.3	64.1	255	15.3	65.6	328	19.7	127.1	382	22.9	159.8
	Paco	0	0.0	0	258	15.5	10.0	256	15.3	8.5	329	19.7	17.7	382	22.9	21.6
	Buendia	0	0.0	0	266	16.0	63.4	250	15.0	80.1	314	18.9	126.3	362	21.7	153.5
	Pasay Road	0	0.0	0	266	16.0	0.0	250	15.0	0.0	314	18.9	0.0	362	21.7	0.0
	EDSA	0	0.0	0	277	16.6	75.9	243	14.6	34.9	302	18.1	42.6	345	20.7	46.8
	Nichols	0	0.0	0	280	16.8	63.1	238	14.3	30.8	297	17.8	20.1	338	20.3	22.0
	FTI	0	0.0	0	273	16.4	41.8	291	17.5	31.1	411	24.6	44.6	465	27.9	53.4
	Bicutan	0	0.0	0	262	15.7	50.0	280	16.8	53.9	364	21.8	113.8	407	24.4	134.4
	Sucat	0	0.0	0	249	15.0	36.9	264	15.9	41.6	345	20.7	36.9	384	23.1	41.8
	Alabang	0	0.0	0	215	12.9	72.5	227	13.6	70.8	300	18.0	78.5	330	19.8	88.0
	Muntinlupa	0	0.0	0	199	11.9	31.4	212	12.7	28.2	276	16.5	40.9	301	18.1	46.4
	San Pedro	0	0.0	0	183	11.0	27.6	197	11.8	26.9	249	15.0	37.8	273	16.4	39.6
	Pacita	0	0.0	0	175	10.5	12.5	189	11.3	12.5	241	14.5	12.2	265	15.9	11.9
	Binan	0	0.0	0	154	9.2	30.2	166	9.9	33.1	207	12.4	44.3	227	13.6	49.1
	Santa Rosa	0	0.0	0	143	8.6	15.4	154	9.3	16.0	193	11.6	18.8	211	12.7	20.1
	Cabuyao	0	0.0	0	126	7.5	23.4	137	8.2	24.2	171	10.2	28.7	187	11.2	30.7
	Gulod	0	0.0	0	107	6.4	22.7	117	7.0	24.0	146	8.7	29.5	160	9.6	32.1
	Mamatid	0	0.0	0	82	4.9	27.9	87	5.2	32.6	101	6.0	48.4	108	6.5	55.8
	Calamba	0	0.0	0	0	0.0	82.0	0	0.0	86.8	0	0.0	100.7	0	0.0	107.5
Tutuban-Solis	Tutuban	21	1.3	20.9	10	0.6	9.7	11	0.7	10.9	18	1.1	17.9	20	1.2	19.6

1) Peak Hour Ratio of the commuter railway is 12.0 %, from those of NLEX.

Source: JICA Design Team

3.5.5 Fare Sensitivity Analysis

(1) Outline of the Survey

To examine the validity of the fare system of the Commuter Rail service, Willingness to Pay survey was conducted to obtain from potential users of the commuter rail.

There is a total of 9 survey stations as listed in Table 3.5.11 while their locations are indicated in Figure 3.5.6. The target number of samples size was 1,600 interviews.

Source: JICA Design Team

Figure 3.5.6 Survey Location of Willingness to Pay Survey Stations

Table 3.5.11 List of Willingness to Pay Survey Stations

Code	Survey Station	No. of Samples
1	Around CIA Station	400
2	Around Angeles Station	150
3	Around San Fernando Station	150
4	Around Malolos Station	150
5	Around Solis Station	150
6	Around Santa Messa Station	150
7	Around EDSA Station	150
8	Around Alabang Station	150
9	Around Calamba Station	150
Total		**1,600**

Source: JICA Design Team

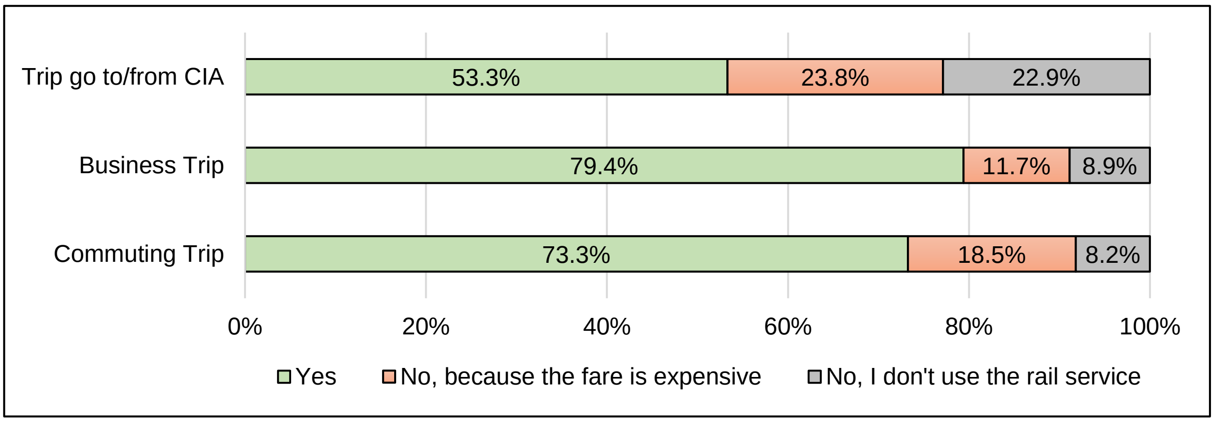
1) Survey Result

In term of willingness-to-pay, respondents were asked about whether or not they use new transport service and their maximum fare that they can pay. There are 3 scenarios as follows:

1) a commuting trip under the introduction of commuter rail,
2) a business trip under the introduction of commuter rail,
3) a trip go to/from CIA under the introduction of commuter rail and limited express train.

Source: JICA Design Team

Figure 3.5.7 shows the result of respondents' choice about new transport service in 3 scenarios. In the context of commuting trip, 73.3% of respondents chose commuter rail and 18.5% did not choose because the fare is expensive. The share of respondents choosing commuter rail increases to 79.4% in the context of business trip (i.e. the second scenario), and only 11.7% did not choose because the fare is expensive. In the context of trip go to/from CIA, 53.3% of respondents want to use limited express train and 23.8% did not use because the fare is expensive. Notably, the fare of commuter rail is in the range of 100 to 170 Peso, while that of limited express train is in the range of 170 to 320 Peso.



Source: JICA Design Team

Figure 3.5.7 Share of choosing new railway service

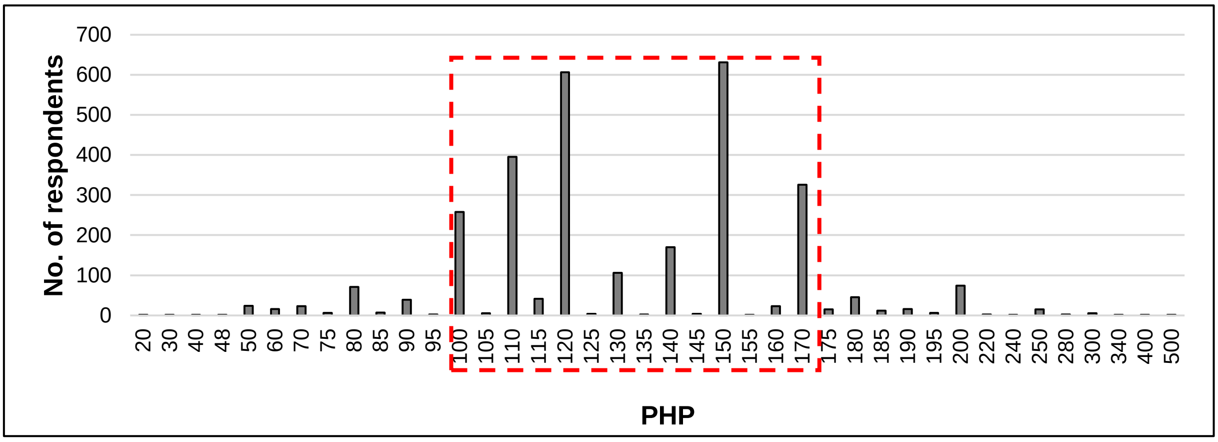
To measure and assess disparities in choosing new railway service between income groups, respondents are grouped into either low income or medium-to-high income. The main reason for dividing sample into two income groups is to simplify the discussion. With regard to the cut-off point, annual per capita GRDP in National Capital Region is 2017 was about 244,453 Peso (posted by the Philippine Statistics Authority), meaning that monthly income per capita was 20,371 Peso. Therefore, respondents with a monthly income below 20,001 Peso are ranked as low-income group and those with a monthly income of 20,001 and more are grouped into medium-to-high-income group. The result indicates a significant different in choosing new railway service by income group. As can be seen from Table 3.5.12, the percentage of medium-to-high-income respondents choosing new railway service in 3 scenarios is significantly larger than that of low-income ones. In term of the second option (i.e. No, because the fare is expensive), the share of medium-to-high-income group is relatively smaller than that of low-income group. For instance, 79% of medium-to-high-income respondents want to commute by commuter rail, and only 12.7% did not choose because the fare is expensive. As for low-income group, the rates are 71.1% and 20.7%, respectively.

Table 3.5.12 Share of choosing new railway service by income

Scenario	Category	Low income	Medium-to-high income
Commuting Trip	Yes	71.1%	79.0%
	No, because the fare is expensive	20.7%	12.7%
	No, I don't use the rail service	8.1%	8.3%
	Total	**100.0%**	**100.0%**
Business Trip	Yes	78.0%	83.2%
	No, because the fare is expensive	13.7%	6.6%
	No, I don't use the rail service	8.4%	10.2%
	Total	**100.0%**	**100.0%**
Trip go to/from CIA	Yes	50.2%	61.6%
	No, because the fare is expensive	26.0%	18.1%
	No, I don't use the rail service	23.8%	20.3%
	Total	**100.0%**	**100.0%**

Source: JICA Design Team
(a) Source: JICA Design Team
Figure 3.5.8, Source: JICA Design Team

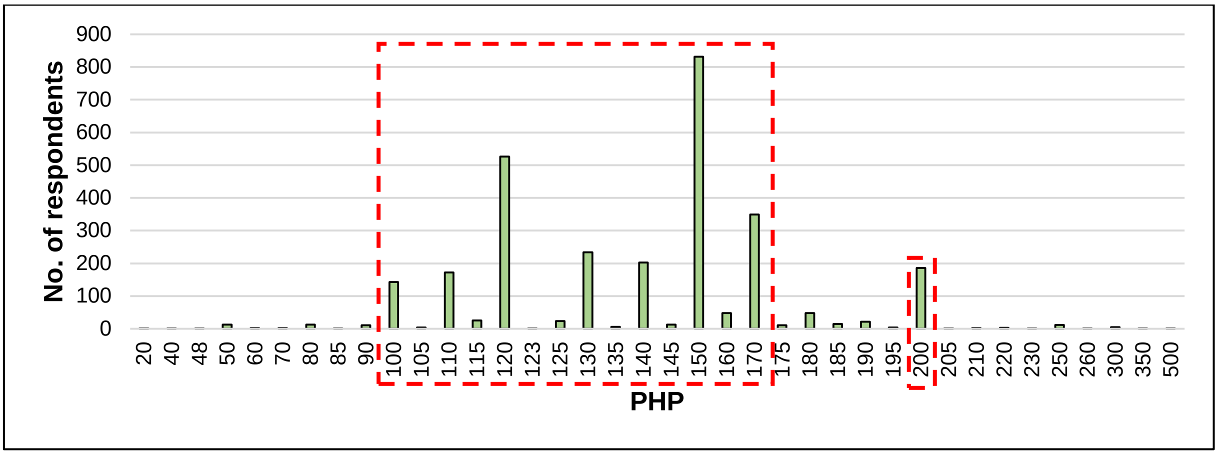
Figure 3.5.9 show the frequency of WTP data in different scenarios. In the context of both commuting and business trips, the most frequency of WTP is in the range of 100 to 170 Peso. However, the most frequency of WTP in the context of trip go to/from CIA is in the range of 150 to 320 Peso.



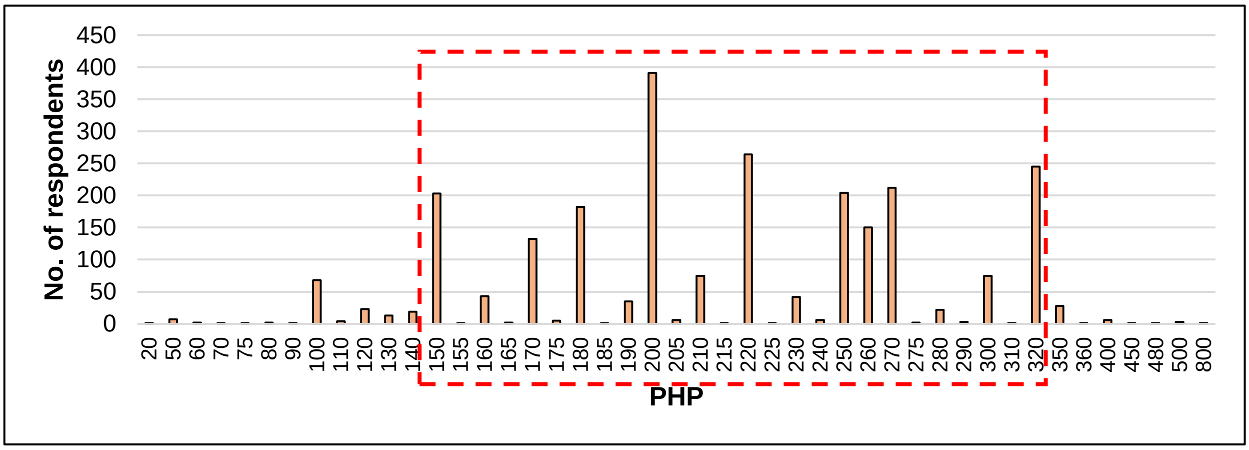
(b) Commuting Trip

(c) Source: JICA Design Team

Figure 3.5.8 Frequency of WTP data in different scenarios (1)



(b) Business Trip



(c) Trip go to/from CIA

Source: JICA Design Team

Figure 3.5.9 Frequency of WTP data in different scenarios (2)

There is a significant difference in maximum fare by income group. In average, low-income group paid the amounts of 131, 142 and 218 Peso in three scenarios, respectively. However, those average value of medium-to-high-income group increased by about 10 Peso in each scenario. In term of maximum value, low-income people's WTP are 340 and 350 Peso in the first and second scenarios, while that of medium-to-high-income group is 500 Peso. In the context of trip going to/from CIA, such value rose to 500 Peso for low-income group, but medium-to-high-income group could pay up to 800 Peso.

Table 3.5.13 Descriptive Analysis of WTP by Income Group

Scenario	Criteria	Low income	Medium-to-high income
Commuting Trip	Average	131	139
	Min	20	50
	Max	340	500
	SD	31.4	35.5
	Sample size	**2153**	**807**
Business Trip	Average	142	149
	Min	20	50
	Max	350	500
	SD	29.2	31.1
	Sample size	**2148**	**786**
Trip go to/from CIA	Average	218	232
	Min	20	75
	Max	500	800
	SD	60.2	61.6
	Sample size	**1786**	**701**

Source: JICA Design Team

2) Sensitivity Analysis on Fare Setting

Table 3.5.14 and Figure 3.5.10 show the result of sensitivity analysis for the fare setting for the commuter railway in 2035. The result shows that the fare setting assumed (PHP 22 + 2.0 / km) is justifiable since the expected revenue is expected to be the highest in the assumed fare setting. If the fare of commuter railway is assumed as PHP 11 + 1.0 / km, the ridership is nearly twice of the base case. On the other hand, the PPHPD reached 47,000 pax. To carry the passengers, the required frequency of the railway will be 21 trains per peak hour per direction. The fare of existing urban railway in Metro Manila is same as other road-based public modes. And as traffic congestion is serious, existing urban railway service is used more than the capacity causing machine troubles and accidents.

It is difficult to change public transport fares once these are decided. “Fare setting beyond populism” is the key to the profitability of transport development projects.

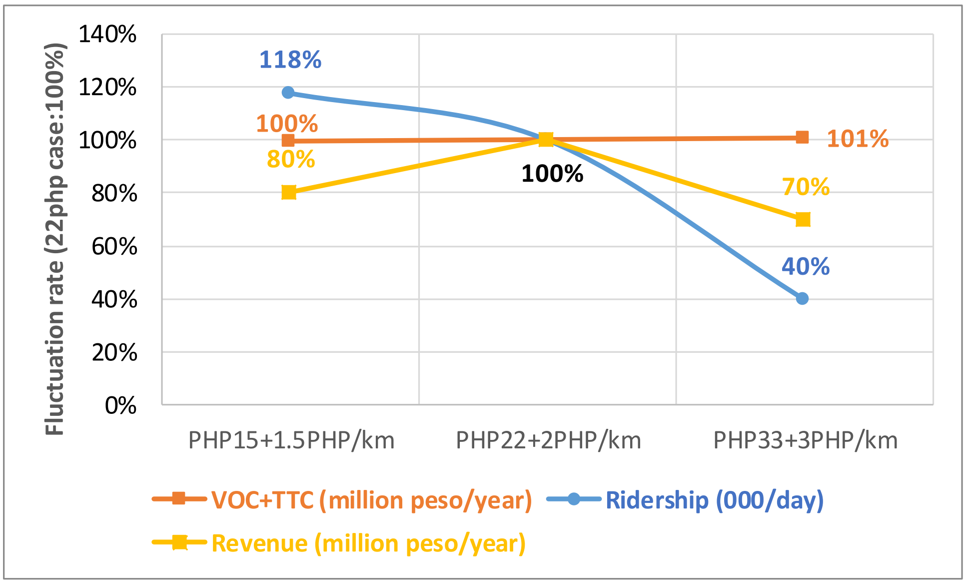
Regarding the fare setting of Limited express is based on the result of existing study[1]. According of it, the fare was analyzed on some perspective of economy, transportation engineering, acceptation for citizen. As the result, the appropriate fare was intercept of fare was same as local fare and twice of slope per km of local fare. Therefore, the fare of limited express on this study is used 22php+4php/km.

[1] Railway Strategy for Clark-Metro Manila for the Greater Capital Region in the Republic of the Philippines

Table 3.5.14 Result of Sensitivity Analysis in 2035

Description	Case 1	Case 2 (Base)	Case 3
	Php 15 + 1.5 / km	Php 22 + 2.0 / km	Php 33 + 3.0 / km
Ridership (000/day)	903	767	305
PPHPD (pax/hour)	32,000	25,000	10,000
Revenue (million peso/year)	26,881	33,521	23,383
VOC+TTC (million peso/year)	3,302,056	3,312,186	3,346,746

Source: JICA Design Team



Source: JICA Design Team

Figure 3.5.10 Result of Sensitivity Analysis in 2035

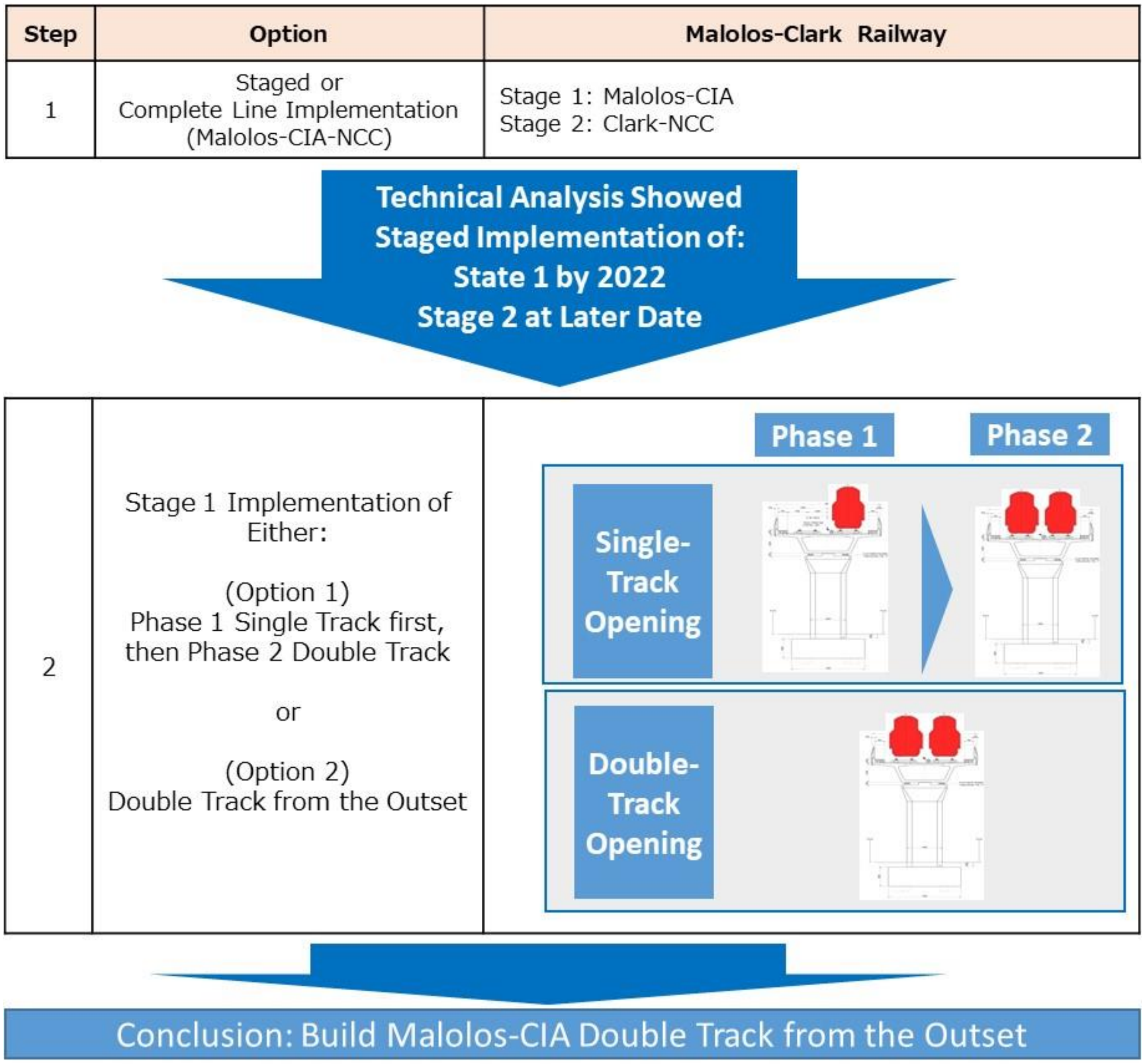
3.6 Analysis of Staged Implementation of MCRP-Malolos-NCC

The JOIN F/S proposed to establish the connection between Malolos and New Clark City (NCC) in two stages. The first stage of implementation would involve the segment from Malolos to Clark International Airport (CIA) to be completed by 2022 as a single-track or double-track system. The second stage of implementation would connect Clark to NCC and connections between Malolos and NCC as a double-track railway.

However, this project began with the assessment of a “complete-line” implementation approach, as DOTr requested to have the simultaneous opening of Malolos-Clark Railway Project – i.e., opening of the complete 70-km track with all seven (7) identified stations by 2022. The optimum development strategy for the Malolos-Clark Railway Project assuming both the starting of rail services in 2022 and the one-hour service between CIA and Manila was desired by the DOTr.

The evaluation process started with the technical analysis as to whether to have the “staged” opening of the “complete-line” - i.e., implementation of the complete Malolos-CIA/Clark-NCC Railway Project, or the complete-line opening without staging. If the staged development approach was deemed to be more technically viable development approach, the two opening options - i) a single-track line opening as proposed in the JOIN F/S or ii) a double-track operation at the outset – would then need to be analyzed for the first stage of development. Therefore, the technical feasibility of a single or double track operation at the outset, that would contribute to higher ridership and better financial returns were examined.

The results of the analyses have been shared and discussed with DOTr and the best implementation strategy has been put together, as elaborated further in this section. The results of the analyses are illustrated in Figure 3.6.1.



Source: JICA Design Team

Figure 3.6.1 Steps in Analyzing the Implementation Viability of the Malolos-CIA/ Clark-NCC Railway Project

3.6.1 Step 1: Malolos-Clark Railway: Stageed/ Full Opening

As to whether to develop Malolos-Clark Railway Project in staged or as a "complete-line", the ancestral domains that fall within or near Clark to New Clark City (NCC) segment of the railway calls for due attention and care in planning the alignment and requirements in line with pertinent laws and policies on 'ancestral domains'. As detailed in Chapter 8, development interventions in the Philippines which overlap with the ancestral domain areas are required by law to obtain a Free and Prior Informed Consent (FPIC) from government agencies such as the National Commission on Indigenous Peoples (NCIP). This process is expected to take considerable time. Therefore, the start of construction work between Clark and NCC will inevitably has to fall behind that of the segment between Malolos and CIA. Therefore, completing the construction work and opening of between Clark and NCC by 2022 will not be technically feasible.

Furthermore, a more comprehensive Resettlement Action Plan (RAP) will be required in case the entire line will be opened in one instance. The progress of RAP execution/ implementation may cause delays in the signing of the loan agreement for the said project. Consequently, this may cause delay in the start of construction works. A staged opening is therefore a more preferred option to contain and minimize the risk of delays in construction.

On the other hand, the assessment of the time required to complete the construction for the segment from Malolos to CIA reveals that the completion date of 2022 is technically feasible. The one-hour connection between CIA and Manila is also technically achievable.

Accordingly, the first stage of the implementation would be for the segment from Malolos to CIA to be operational by 2022. Consequently, the second stage of the implementation would provide the connection between Clark and NCC. This implementation strategy has obtained the consent of DOTr in prior discussions with the said agency held last March 2018.

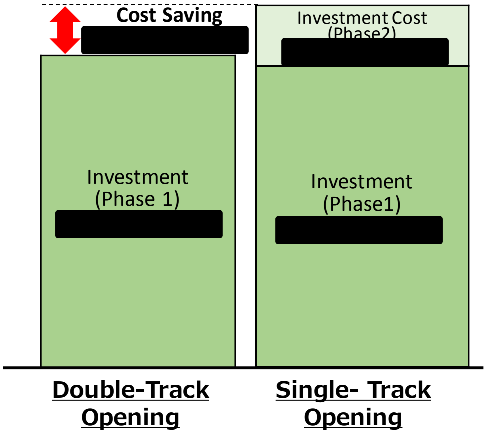
3.6.2 Step 2: Malolos-Clark Railway: Single or Double Track in Stage 1

The assessment of the opening of Malolos to CIA as a double-track or single-track system is conducted. The opening of this section with double-track in 2022 is technically achievable as well.

Moreover, the greater flexibility and frequency of train service of a double-track opening will contribute to higher ridership at the beginning of operation when compared with single-track system.

Furthermore, from a financial standpoint, a double-track opening at the outset can result in investment savings than having a single-track opening. This is because the single-track opening in the initial phase will require subsequent works for laying out double-tracks most likely during nighttime to build electrical systems and catenary etc. with electricity supply for the rail line turned off. This is not to disrupt usual train service operations in its specified operating hours.

This is further illustrated in Figure 3.6.2.



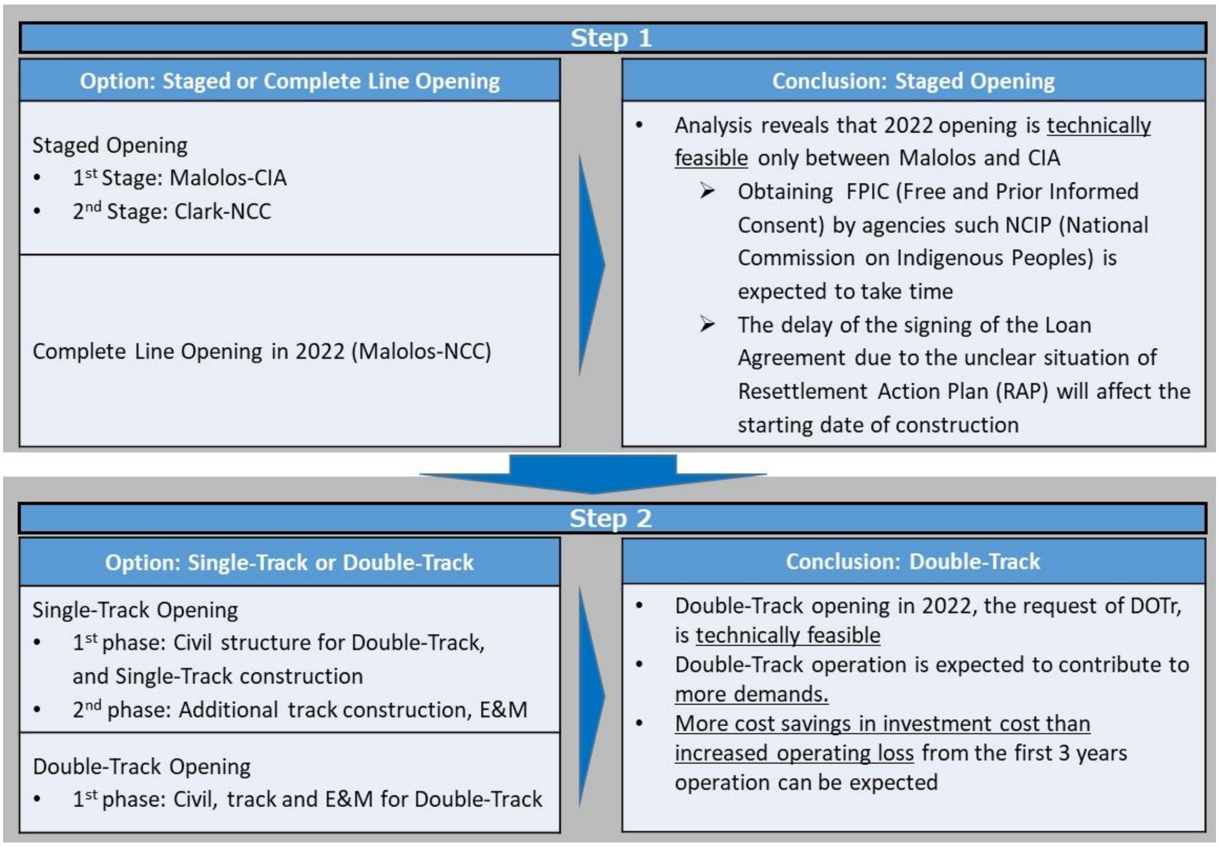
*The figures are for reference purpose only: The figures shown above are only preliminary and rough estimates of the civil works (excluding E&M and other investment costs) as of now. Thus, further in-depth estimation will be needed.

Source: JICA Design Team

Figure 3.6.2 Single-Track vs Double-Track, Investment and Cost Comparison

While the double-track operation incurs higher O&M cost in comparison to the single-track operation due to increased number of trains in operation, the initial financial assessment reveals that the increase in O&M cost is off-set by the increased ridership of the rail line in earlier years or operation and the savings in investment costs.

In conclusion, since the double-track opening for the segment from Malolos to CIA in the first stage of implementation is expected to contribute to maximizing the ridership for the Malolos-Clark Railway and consequently it will generate better financial conditions, this segment will be developed as double-track rail line. The economic and financial analysis of the project will be conducted with the assumption that a double-track opening will be carried out. This development strategy has obtained the 'full' consent of DOTr in prior discussions held last March 2018. Conclusions of the analyses are further illustrated in Figure 3.6.3



Source: JICA Design Team

Figure 3.6.3 Summary Conclusions of the Analyses

3.7 Legal Implications for the Development of MCRP Railways

3.7.1 Introduction

The legal aspects of MCRP project development, issues and concerns of all 'possible' stakeholders were addressed and reviewed in a comprehensive manner by the Philippine legal experts under supervision of JDT team. The full document is attached in Appendix, covering the MCRP Line. The following sections provides a synopsis of the legal review and its salient features applicable to the MCRP.

The review also entailed examples of issues, concerns, rights, constraints and opportunities of developing, implementing and operating similar transport infrastructure projects. It includes examples of rail and road projects. The road projects, which may not appear relevant, but do need to be given due consideration specially in terms ROW provision and land development right of all parties.

3.7.2 Synopsis of Legal Review for MCRP

(1) Examination of other relevant transportation infrastructure projects vis-à-vis the Manila-Clark Railway (MCR);

This section looks into the different concession agreements covering transportation projects executed by government with private entities, which may have some similar station locations in their alignment with that of the MCR.

Upon scrutiny, it appears that while the said concession agreements uniformly give private concessionaires exclusive right-of-way (only) to the alignment of their respective projects, or where the rails or toll roads are actually located and other specifically designated areas like depots, there is no impediment for government to pursue other projects within the vicinity of the stations of existing projects. Simply put, so long as the new projects do not actually sit on the right-of-way of existing projects, government is not restricted from building new infrastructure and from fulfilling its fundamental service or infrastructure delivery obligation.

Further, the mandate of the DOTr authorizes it to implement projects in pursuit of the state's police power.

(2) Updates on the North Luzon Railway Corporation (Northrail);

The DOTr has settled the arbitration case filed by Sinomach against Northrail in November 2017. The settlement is intended to eliminate issues involving Sinomach's structures on the PNR ROW of the original Northrail Project.

3.8 Assessment of Connectivity Potential of Proposed Stations

The MCRP stations can accommodate transport hubs to serve urban mixed-mode commuting. These would include transfer facilities for: (1) rail-to-rail on existing and future lines; (2) PUV-to-rail; and (3) automobile-to-rail, such as "Park-and-Ride", "Kiss-and-Ride" and "Ride-Share" facilities. Bike-and-Ride is another type of intermodal transfer, but it might not be suitable for NSCR station considering Filipino behavior. They are not comfortable to leave their bicycle anywhere even it is locked. Table 3.8.1 is a matrix showing the proposed stations and the possible transfer facilities for each. The possible transfer facilities for each station were determined by the criteria below. Table 3.8.1 provides list of facilities that could be provided at the MCRP Stations.

(i) **Rail-to-Rail:** at stations that are near junctions of regional and/or inter-provincial transport routes where future rail spur lines are possible

(ii) **Rail-to-PUV:** all commuter train stations can be expected to be served by all kinds of PUVs

(iii) **Park-and-Ride/Kiss-and-Ride:** stations that are surrounded by middle- and high-income residential communities whose residents are most likely vehicle owners and, therefore, will be attracted to use the commuter rail if parking and drop-off space for private vehicles are provided near the station[1]

(iv) **Ride-Share:** similar to (iii) above although the stations located in LGUs where per capita income is lower suggests that less people own cars and therefore will have less demand for ride-sharing[2]

Table 3.8.1 Required Transfer Facilities by Station – MCRP Line

Station	Transfer Facility			
	Rail-to-Rail	PUV-to-Rail	Park-and-Ride	Ride-Share
New Clark City		✓		
Clark Int'l. Airport		✓	✓	✓
Clark		✓	✓	✓
Angeles		✓	✓	✓
San Fernando		✓	✓	✓
Apalit		✓	✓	
Calumpit		✓	✓	

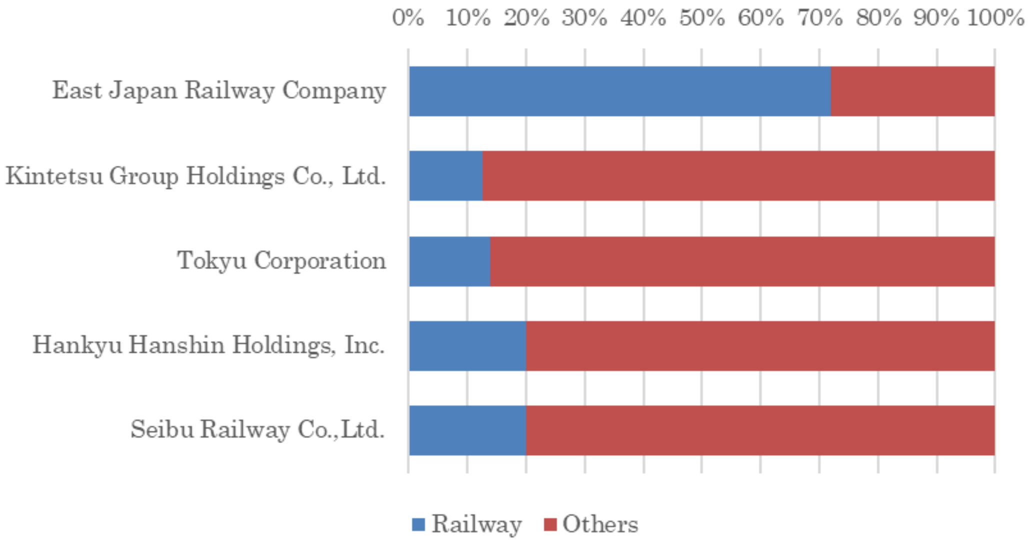
Source: JICA Design Team

1 Since the per capita income data is not available at all the station areas, income level was determined by observing the communities around the stations.
2 ditto

3.9 Estimating the Development Potential of Station Building and "Eki-Naka"

(1) Trend of development of Station Building and "Eki-naka"

For many Japanese railway operators, railway revenue constitutes less than half of their total revenue (as shown on Figure 3.9.1). For this project, having non-railway revenue would help stabilize overall project operation. For instance, operating a station building and managing space for commercial purpose located in the premises of the station building (commonly known as "Eki-naka") have synergies with the railway operations, and would thus be the areas railways operators may find interest in being involved. In this study, the candidate railway stations fit for station building operation and Eki-naka management will be identified.



Source: Compiled by JICA Design Team based on the information from the annual reports of the respective companies

Figure 3.9.1 Segment Sales of Major Railway Operators in Japan (Fiscal Year 2017)

Table 3.9.1 Eki-naka Facilities of East Japan Railway Company

Station	Daily Entry Figure (Fiscal Year 2016)	Shop Area (㎡)	Annual Sales (Fiscal Year 2016) (100,000,000 Yen)
Omiya	252,769	2,300	102
Shinagawa	371,787	1,600	71
Tachikawa	165,645	4,500	49
Nippori	110,529	300	18
Tokyo	439,554	800	55
Ueno	182,693	4,300	98
Shinagawa South (Shinagawa Station)	371,787	1,900	113
Akbane	93,534	1,645	54

Source: Compiled by JICA Design Team based on the information from East Japan Railway Company

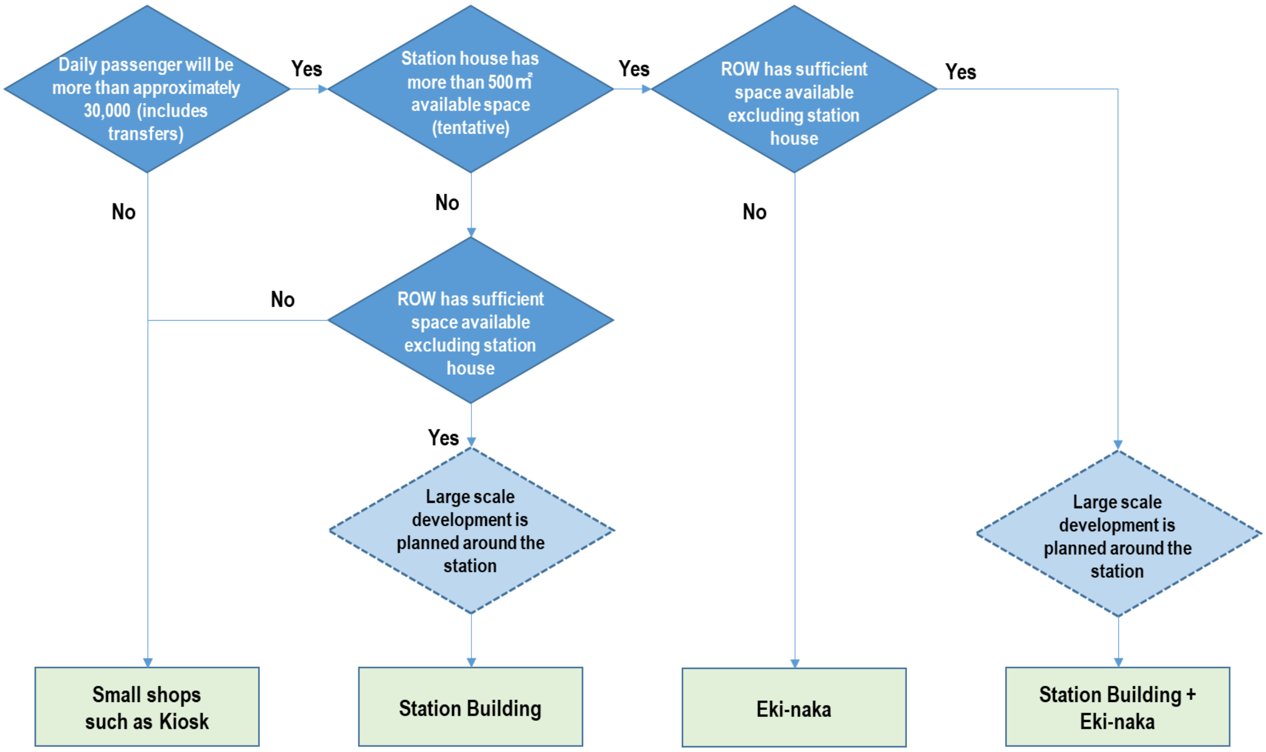
	Station name: Fujimidai Daily Passenger Number: 27,386 (Year 2017) Commercial Facilities: Super market, Book shop, cafe, bakery, convenience store, Flower shop and so on.

Source: Seibu Properties

Figure 3.9.2 Example of Eki-naka facility of a station in sub-urban area (Fujimidai)

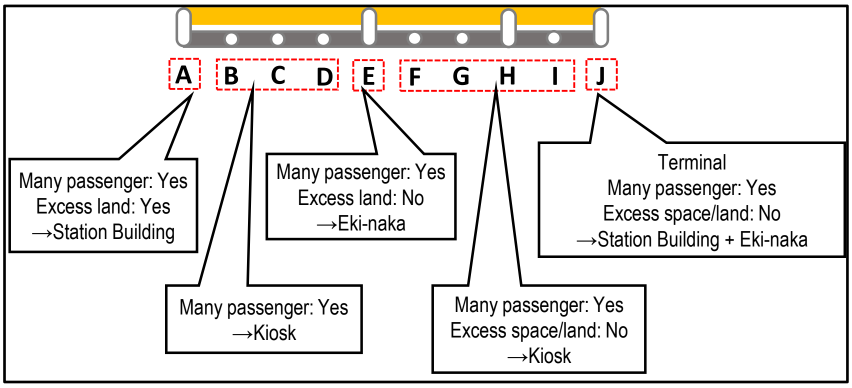
(2) Process for evaluating the potential of development of Station Building and "Eki-naka"

Considering the precedent cases in Japan, the areas fit for station building operation and Eki-naka management will be selected and grouped based on such data as the estimated daily number of passenger, space availability within the station building, ROW in the areas adjacent to station, and the results of the analysis of the potentials for Transit Oriented Development (TOD) in the station area being carried out in Chapter 5.



Source: JICA Design Team

Figure 3.9.3 Station Selection Process for Station Building and Eki-naka Development



Source: JICA Design Team

Figure 3.9.4 Example of the station building and Eki-naka Strategy

First, the utilization type for each station will be determined along with the viable area measurement that can be deployed for the station building and Eki-naka development.

(3) Result of the Analysis

The analysis based on the criteria mentioned in (2) identify NCC, Clark, Angeles, and San Fernando station as the possible station building and Eki-naka locations. However, it should be noted that the function of stations should be updated the structure of stations and station plazas considering ROW.

Further analysis will be implemented in the TOD study considering the land ownership and intention of stakeholders, and interest of potential developers.

Table 3.9.2 Result of Preliminary analysis for selecting potential Station building/Eki-naka study

Station	Type	Notes
NCC	Station Building & Eki-naka	The number of passengers per day are expected to be well over 100,000 in 2035. Therefore, retail business such as a station building and Eki-naka will be able to accommodate consumer demands. Although the availability of the land for a station building is uncertain, it is expected that the BCDA will cooperate for the allocation of the land for a station building.
CIA	Kiosk	The number of passengers will be small. Moreover, due to its location inside the airport, the space available for retail will be limited.
Clark	Kiosk or Eki-naka	The number of passengers per day are expected to be around 100,000 in 2035. On the other hand, the large scale of shopping mall is already in operation and therefore, the development of new station building might result in the oversupply of commercial facilities. Moreover, it is important to confirm the intention of BCDA for possible land use adjacent to the station.
Angeles	Station Building	The number of passengers will be relatively small compared to NCC and Clark. However, the vacant land adjacent to the station might be allocated for station area development and the development of a station building might be one of the development options.
San Fernando	Kiosk or Eki-naka	The number of passengers will be relatively large and the station is considered a regional central hub. On the other hand, there is little available land for the development of a station building.
Apalit	Kiosk	The number of passengers will be relatively small compared to NCC and Clark.
Calumpit	Kiosk	The number of passengers will be relatively small compared to NCC and Clark.

Source: JICA Design Team

CHAPTER 4 RAILWAY FACILITY PLAN

4.1 Route Planning

4.1.1 Basic Conditions

(1) Section Characteristics

In MCRP section, in principle, there exist two types of train operations from Metro Manila to Clark International Airport for local and airport access limited express trains. The proposed maximum speed of the airport access limited express is 160km/h in contrast to 120km/h of local trains. In order to realise the high-speed operation of the airport access limited express, the railway facilities for MCRP need to incorporate design considerations to higher speed compared to NSCR due for bid announcement for the construction soon.

Due to substantial speed difference between the airport access limited express and the local trains, provision of side tracks for the limited express to overtake the local trains is essentially required to attain shorter headway.

The environment of MCRP section can be divided into two areas, namely rural and urban areas. The section from Malolos to CIA is located in rural area, and the northward from San Fernando is in urban areas.

The topographic feature from Malolos to the vicinity of San Fernando is relatively flat, and it gets gradually higher towards Clark. However, there is no steep gradient disabling the train operation and generally viaduct structure is applicable to this section.

On the contrary, from Clark towards New Clark City is the hilly terrain overall which has the large difference of elevation. Thus, this section is to have some tunnels.

(2) Technical Particulars

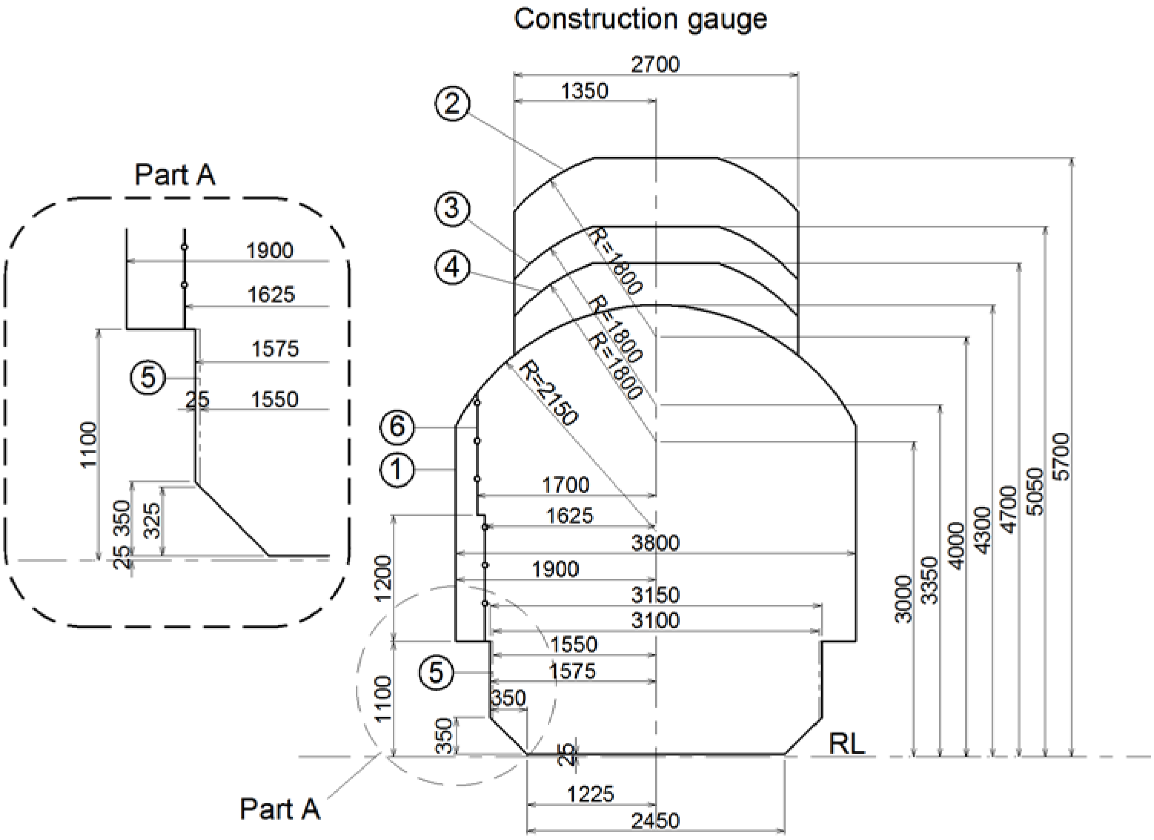
The technical particulars presented herein are still in discussions with DOTr subject to change upon finalization. Basically, they are adapted from NSCR.

In MCRP section from Malolos Station to the northward, the airport access limited express runs at maximum speed of 160km/h. The technical particulars of NSCR have been modified as appropriate in this respect. The major technical particulars for MCRP are shown in Table 4.1.1.

Table 4.1.1 Major Technical Particulars of MCRP

Item		Specifications	
Track Gauge		1,435mm	
		Tutuban – Malolos (NSCR Section)	120km/h
Design Speed		Malolos - Angeles	160km/h (Limited Express) 120km/h (Other train classes)
		Angeles - CIA	120km/h (All train class)
		Clark - NCC	160km/h (For future Limited Express) 120km (Other train classes)
Horizontal Curve Radius	Main Line	More than 300m. (More than 1,800m at the section allowing 160km/h)	
	Station	More than 400m. (More than 1,800m at the section allowing 160km/h)	
	Depot and Storage Track	More than 100m.	
Transition Curve Type		Cubic Parabolic Curve	
Transition Curve Length		Use the maximum value among L_1, L_2 and L_3 with rounded up in 5m. $L_1 = 1000\ C_a$ $L_2 = 7.5 \times C_a \times V_m$ $L_3 = 6.7 \times C_d \times V_m$ Ca: Cd Vm	
Length of Straight Line between Transition Curves		More than 20m	
Maximum Gradient	Main Line	15/1,000 (In the usual case or at the section with the operation speed of more than 120km/h) 25/1,000 (In the emergency or at the section with the operation speed of less than 120km/h)	
	Siding	15/1,000 (In the usual case) 35/1,000 (In the emergency as well as at section not used for the passenger transportation, such as the spur line to the depot.)	
	Station and Depot	0 (for special/provisional case 5/1,000)	
	Storage Track	0 (In the usual case)	
Vertical Curve		Gradient Changing Point Adapted for the section of more than 10/1,000 Radius of 5,000m (Section with the operation speed of more than 120km/h) Radius of 3,000m (4,000m apply to the radius of less than 800m) R/600 shall be considered as the gradient resistance	
Track Spacing		More than 4.0m (Main Line),more than 4.0m (Station) and more than 4.0m(Storage Track)	
Platform		Platform Length 180m (To adapt for 8-car train) In addition, the length of 220m shall be considered for the future expansion. The whole route shall take into account the expandability for 10-car train to avoid the constraint on the railway operation in the future.	
Turnout	Main Line	Turnout number shall be #10 or more in general. No. 12 turnout applies to the section with the operation speed of 160km/h in general. Swing nose turnout applies not to have the notched part of crossing.	
	Depot and Siding	Turnout number shall be #8 or more in general.	

Source: JICA Design Team

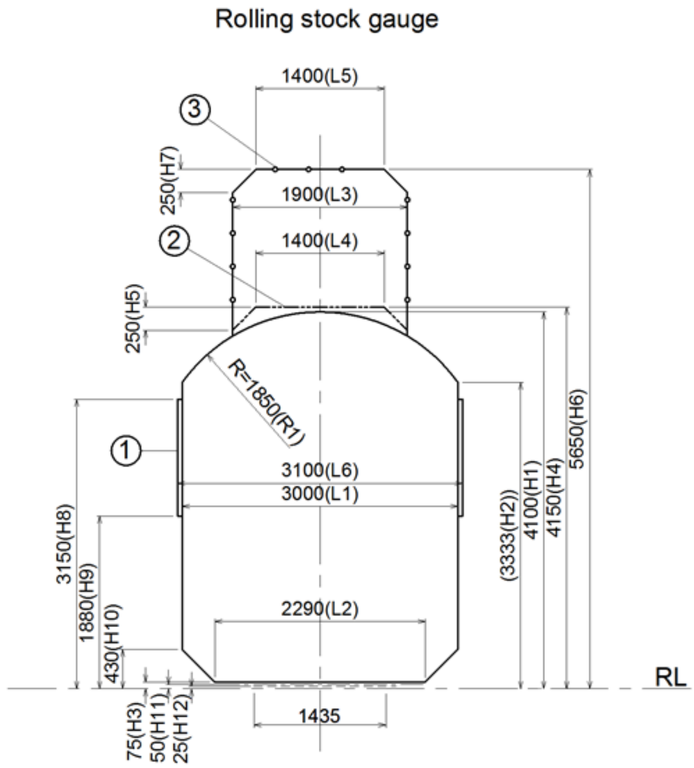


	Gauge
①	Basic Gauge
②	Gauge for track on which trains run receiving supply of direct current.
③	Gauge for tunnels, bridge, overpass, along track on which trains run receiving supply of direct current.
④	Gauge for tunnel section in case of using rigid overhead wire or safe supporting system.
⑤	Gauge only platform edge. — - - — Remark : It can be applied when the passage velocity of a train is 120 km/h or less. The use in the case of 120 km/h or more is forbidden strictly.
⑥	Gauge only Platform screen door. -o——o—— Remark : It can be applied when the passage velocity of a train is 120 km/h or less. The use in the case of 120 km/h or more is forbidden strictly.

Source: JICA Design Team

Figure 4.1.1 The rolling stock gauge and structure gauge

In the application of the gauge for platform edge (⑤), the basic gauge (①) shall be used first for the planning of alignment and design of station structures. The difference between the basic gauge (①) and gauge for platform edge (⑤) shall be adjusted using “platform panel” etc. which can supplementary make fine adjustment on the platform surface to materialize the gap between the panel and rolling stock ≥ 60mm.



		Gauge	
		Basic	H1,H2,H3,H10,L1,L2,R1
②		Gauge when current collector is folded.	H4,H5,L3,L4
③		Gauge in relation to top of roof when current collector is operated.	H6,H7,L3,L5
①		Gauge in relation to signs,marker lamps, car side lamps.	H8,H9,L6
		Gauge in relation to parts that do not move vertically due to action of bogie spring.	H11,L2
		gauge in relation to sanding pipe,obstacle deflector, brake shoe and other parts that do not exceed the wheel rim width.	H12

Source: JICA Design Team

Figure 4.1.2 The rolling stock gauge and structure gauge

(3) Determination of Cant for 160km/h Operation

The airport access limited express can run at up to 160km/h in MCRP section. In contrast, the top speed of local train is 120km/h. Thus, the cant is determined by the following criteria to ensure both trains running on curve safely.

- The value of cant (actual cant) applies the equilibrium cant for 120km/h train. (“Equilibrium cant” means the value of cant which achieves the balance with the centrifugal force of 120km/h train)
- The actual cant for 160km/h train applies the equilibrium cant of 120km/h tain, but it shall be adjusted to be within the value of cant deficiency.

The following table shows the examples of the calculation to determine the value of cant.

Table 4.1.2 Calculation examples for determination of cant

Curve Radius	160km/h Train				120km/h Train				Remarks
	Speed (km/h)	Cm (mm)	Ca (mm)	Cd (mm)	Speed (km/h)	Cm (mm)	Ca (mm)	Cd (mm)	
R=1800m	160	168	**100**	68	120	95	**100**	-5	
R=2000m	160	152	**85**	67	120	86	**85**	1	
R=2500m	160	121	**65**	56	120	69	**65**	4	
Cm : Equilibrium Cant Ca : Actual Cant Cd : Cant Dificiency Cd_{max}=70mm									

Source: JICA Design Team

(4) Proposed Station of MCRP (Malolos – CIA and NCC Section)

Table 4.1.3 shows the list of stations proposed in MCRP.

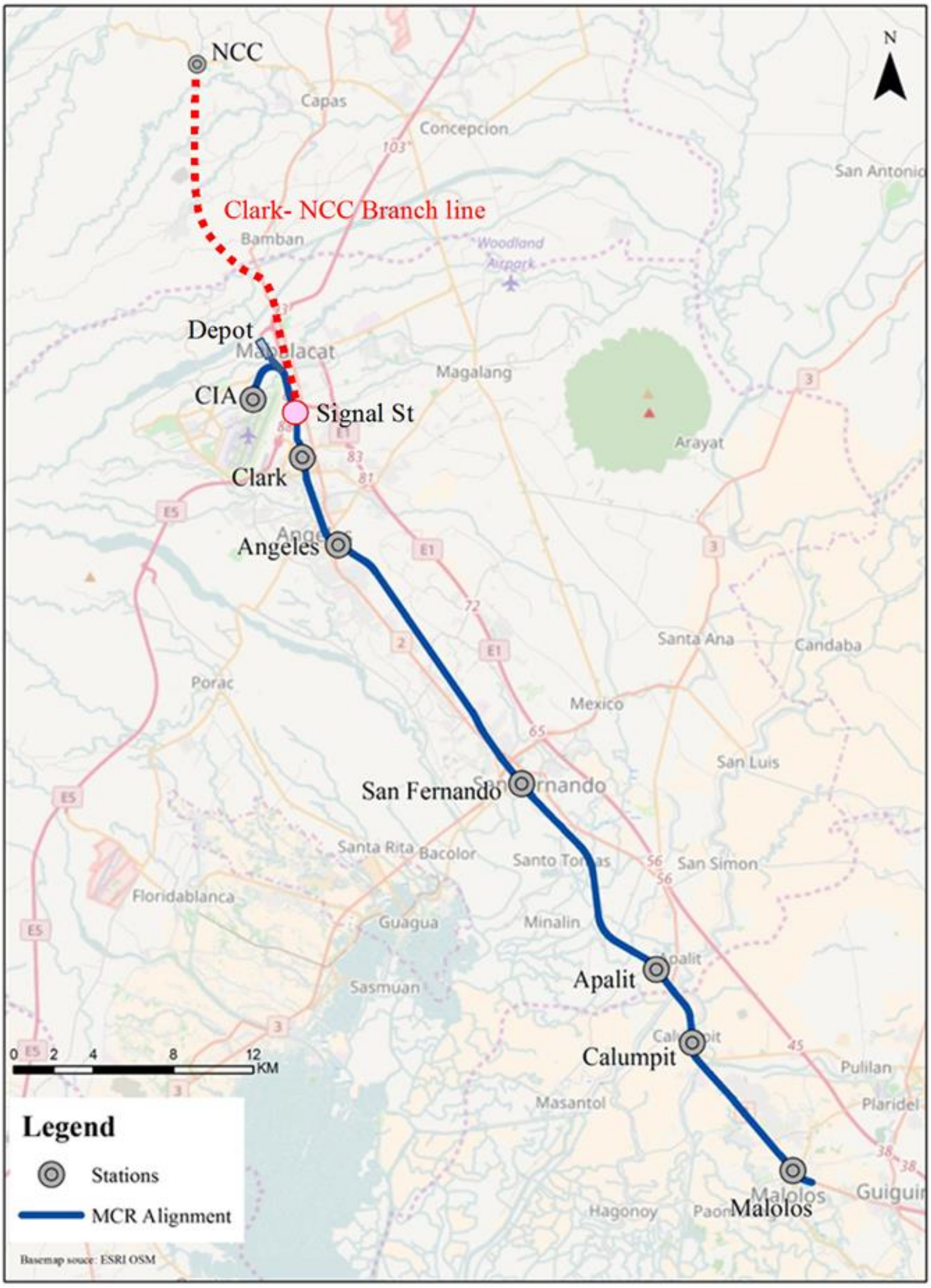
Table 4.1.3 Station list of MCRP

No.	Name of Station	Platform Type	Remarks
1	Malolos	One platform and two tracks	NSCR Section
2	Calumpit	Two platforms and four tracks	
3	Apalit	Two platforms and two tracks	
4	San Fernando	Two platforms and four tracks	
5	Angeles	Two platforms and four tracks	
6	Clark	Two platforms and four tracks	
7	CIA	Two platforms and four tracks	Connected to Clark International Airport
8	NCC	Two platforms and four tracks	

Source: JICA Design Team

4.1.2 Alignment

MCRP section is composed of two lines, the main line between Malolos and CIA and the branch line between Clark and NCC. The route map of MCRP is shown in Figure 4.1.3.

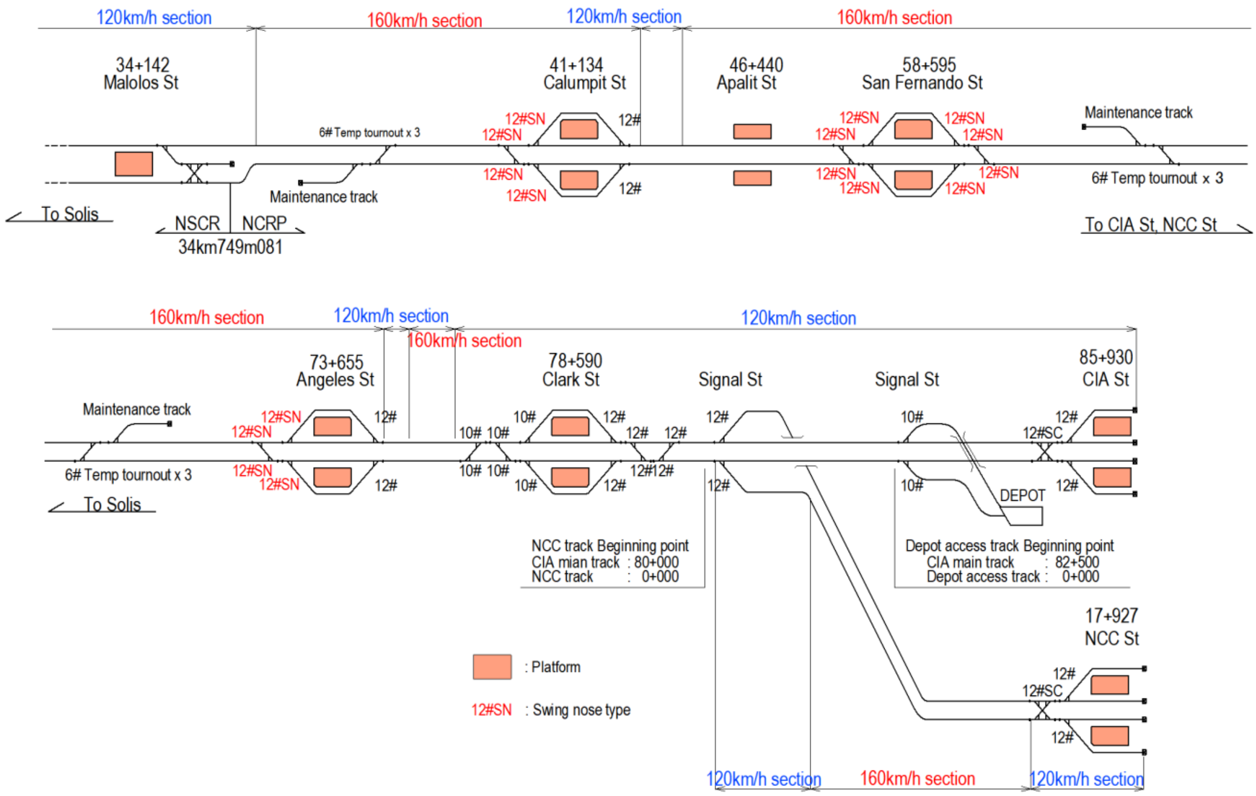


Source: JICA Design Team

Figure 4.1.3 Route Map of MCRP

(1) Schematic Alignment Drawing

Schematic alignment drawing of MCRP section is shown in Figure 4.1.4.



Source: JICA Design Team

Figure 4.1.4 Schematic Alignment of MCRP

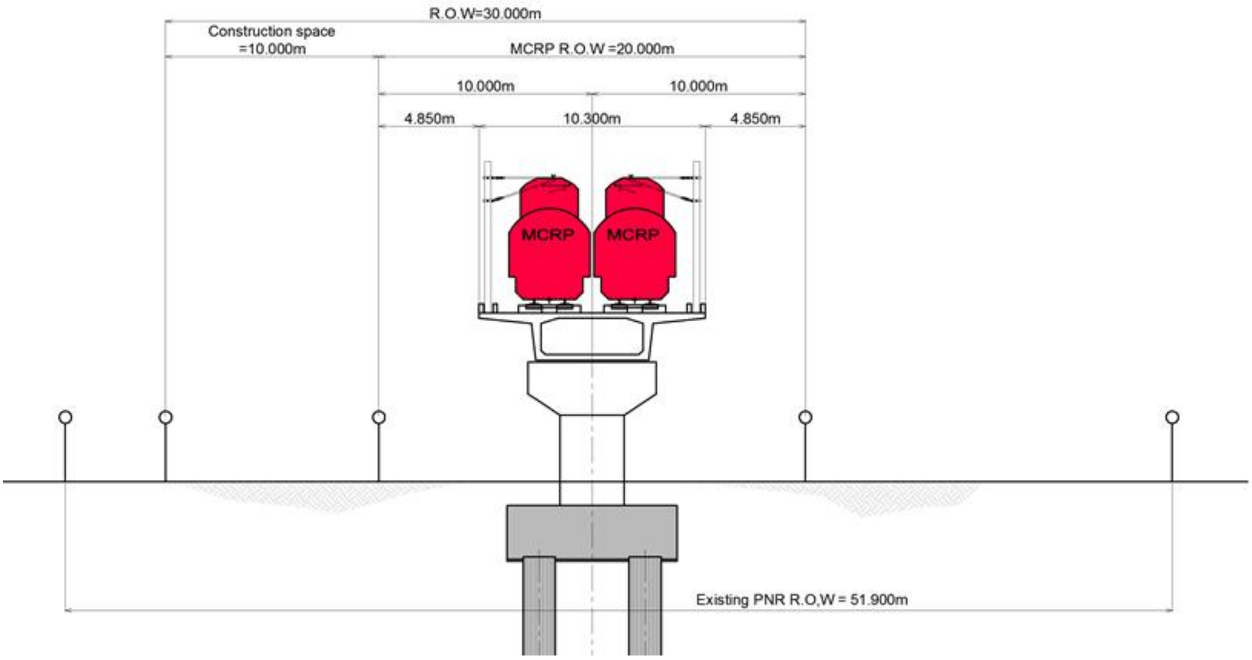
(2) From Malolos to Calumpit

This section starts from the end of the elevated Malolos Station of NSCR. The alignment is almost straight overall and it does not have a curve with the speed restriction until Calumpit Station. Thus, this section can achieve the train operation with 160km/h.

In this section, there are residences between PNR ROW and MacArthur Highway running parallel on the east. There is the pastoral land overall around Malolos Station except for some residential area. and the west of the route also has relatively large vacant area except for scattered residences.

This section is to be the double-track viaduct. In addition to 20m wide land for viaduct, the construction space is to be established at the west for the rapid construction. This space is to be used for the temporary road and the stock yard.

The typical cross section is shown in Figure 4.1.5.



Source: JICA Design Team

Figure 4.1.5 Typical Cross Section between Malolos and San Fernando

The current ground elevation of this section is around 2 to 5m above sea level and the terrain is not ragged. Therefore, the typical viaduct structure is proposed for this section except for the point across the broad Angat River just before Calumpit Station.

(3) From Calumpit and Apalit

This section has curves of 800m and 1,200m radius at the north side of Calumpit Station, where the speed limit earlier explained is applied. Despite no such restriction beyond this curve, the distance to Apalit station is short at 5km.

In general, there is rural area overall along the alignment while some residential complexes are dotted from Calumpit Station to Pampanga River. The critical position is just after passing Pampanga River, where MacArthur Highway on embankment structure gets closer to PNR ROW. To minimize the interference to the embankment, the alignment is shifted westward and passes outside PNR ROW.

This section has the construction space at the west of viaduct.

The alignment in this section is shown in Figure 4.1.6.

Source: JICA Design Team

Figure 4.1.6 Horizontal Alignment of MacArthur Highway Approaching Section

The current ground elevation of this section is around 2 to 3m above sea level and the terrain is not ragged. Therefore, the typical viaduct structure is proposed for this section except for the point across the broad Pampanga River.

(4) From Apalit to San Fernando

In general, this section passes in rural area and no substantial obstructive buildings except for the urban area beyond San Fernando Station.

If the alignment passes inside PNR ROW, curved sections with the speed limit are required. To avoid the speed limit, larger radius is considered in the curved alignment taking a shortcut inward across the existing PNR ROW or running its outside. The whole of this section allows running of trains at maximum 160km/h. In general, the construction space is to be at the west of MCRP, while it moves to the east at the south of San Fernando Station.

The current ground elevation of this section is around 1 to 5m above sea level and the terrain is not ragged.

However, this elevation is about the ground of the embankment of the existing PNR ROW. That of the rural area is 1 to 3m above sea level.

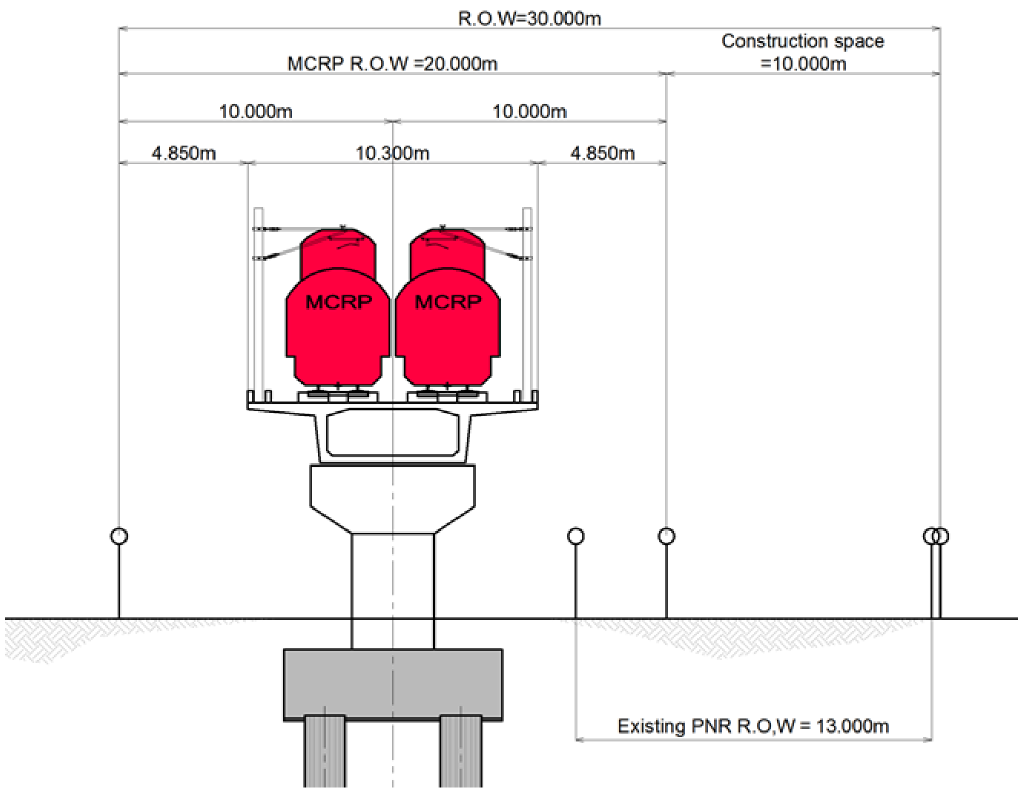
The typical viaduct structure is proposed for this section.

(5) From San Fernando to Angeles

In general, this section is located in residential area and passes some densely populated segments. In addition, the width of PNR ROW in this section is approximately 13m only, which requires additional land acquisition.

Overall, the alignment is straight without curves limiting the maximum speed of 160km/h. Considering surroundings such as residence, the construction space is shifted to the west in the north of this section.

The typical cross section is shown in Figure 4.1.7.



Source: JICA Design Team

Figure 4.1.7 Typical Cross Section between San Fernando and Clark

The critical control point on the alignment in this section is the road bridge overpass (Jose Abad Santos Avenue) crossing the existing PNR at the north of San Fernando Station. The girder of the bridge is in the existing PNR ROW. The construction space is to be provided under the girder, and the alignment is adjusted for construction vehicles to use the temporary road.

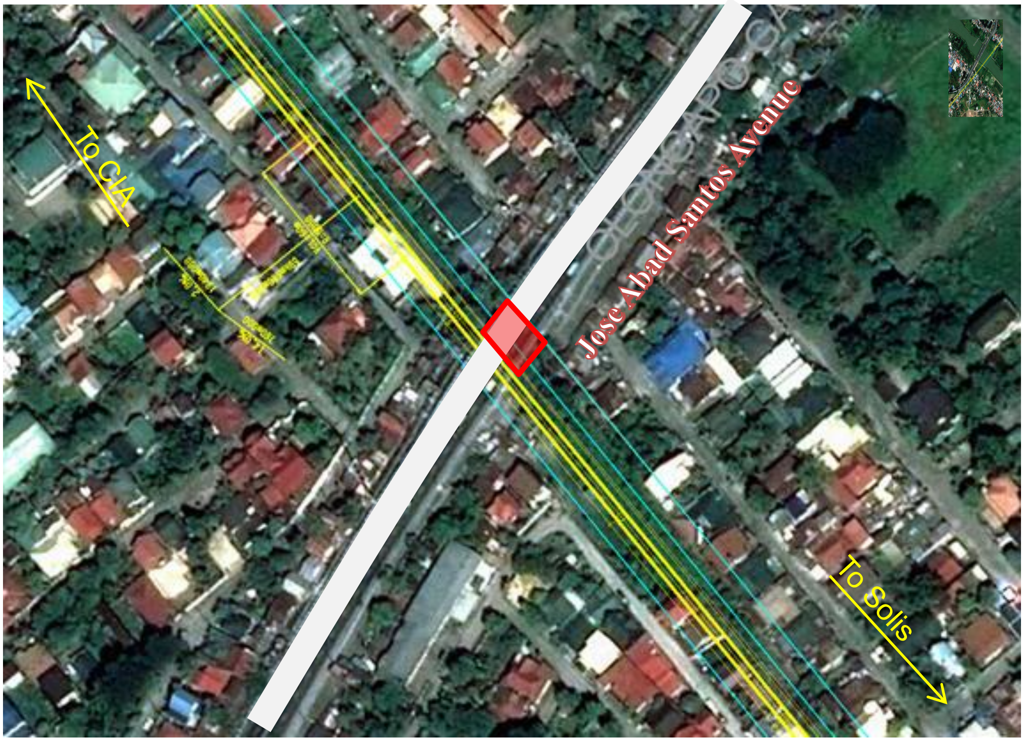
The vertical alignment of the main line also considers sufficient allowance underneath for construction gauge of the road overpass.

The location and the typical cross section of the bridge crossing are shown in Figure 4.1.8 and Figure 4.1.9.

This section gradually ascends from the vicinity of San Fernand Station at altitude of 5m above sea level to Angels Station at that of 81m above sea level. In short, there is the large difference of altitude.

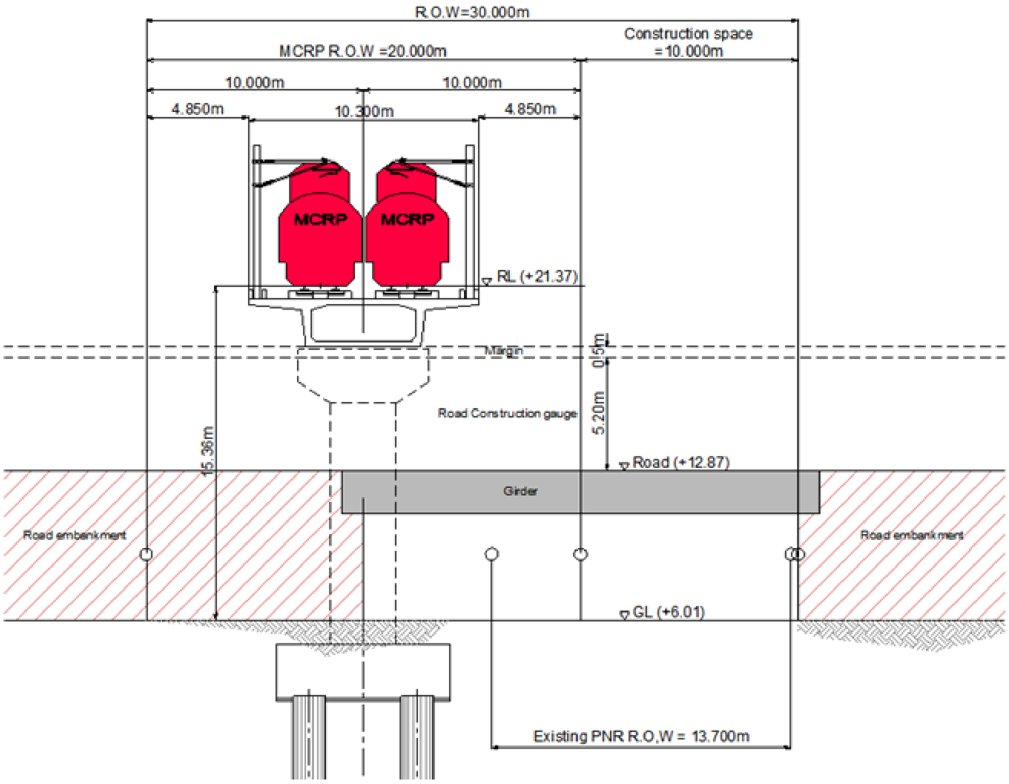
Nevertheless, the distance between these stations is long and it is around 15km. Thus, the average gradient is around 5‰ (5:1000) and no consideration can be required.

The typical viaduct structure is proposed for this section.



Source: JICA Design Team

Figure 4.1.8 Map of Road Bridge Crossing



Source: JICA Design Team

Figure 4.1.9 Typical Section of Road Bridge Crossing

(6) From Angeles to Clark

This section is located in dense residential area, and the width of the existing PNR ROW is not enough. Additional land acquisition in longer strip beside the alignment is inevitable.

From Angeles Station, the alignment needs to make a curve of 1,100m radius towards Clark Station in a short distance. This limits the train speed at maximum 120km/h.

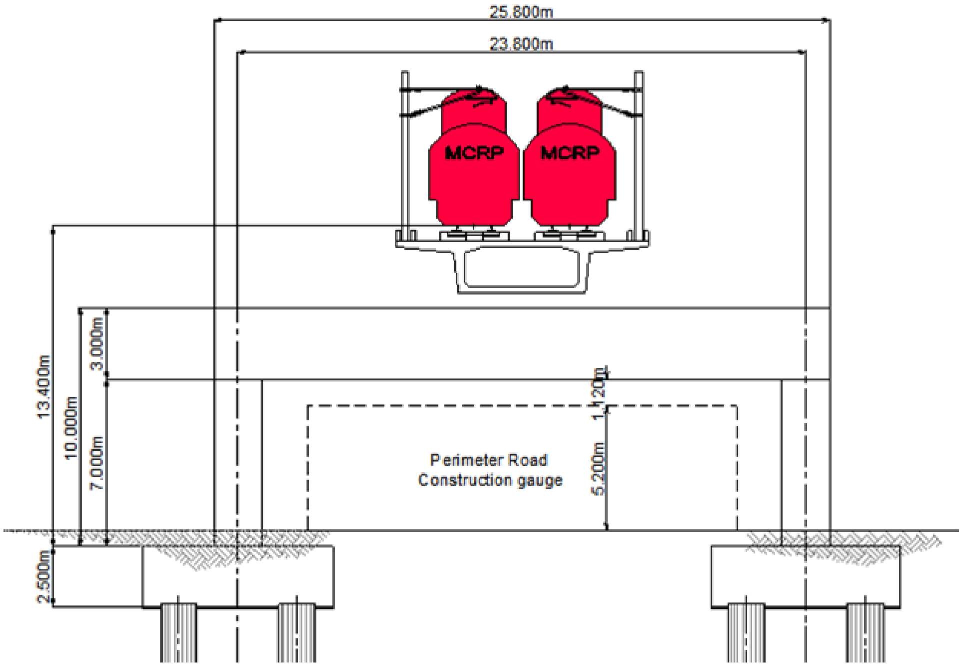
The control point is at the south of Clark Station, where alignment crosses the main road and another road at shallow angle. This requires a bridge structure of portal type overpassing the roads to secure enough margins for the construction gauge below.

The ground elevation of this section is at the ascending slope from San Fernando, and this section also continuously ascends from the vicinity of Angeles Station at altitude of 81m above sea level to Clark Station at that of 108m above sea level.

The average gradient is around 6‰ (6:1000) and no consideration for a gradient can be required.

Basically, the typical viaduct structure is proposed for this section. However, the railway is to overpass a road at a shallow angle. Thus, the viaduct of this point is to be relatively high by the portal frame bridge.

The typical section of this point is shown in Figure 4.1.10



Source: JICA Design Team

Figure 4.1.10 Typical Section of Road Crossing near Clark Station

(7) From Clark to Clark International Airport

This section passes perimeter of the CIA re-development zone within the BCDA area, and leads to the airport terminal through the north of the runway. The sharp curve is necessary to run along the outer edge of the re-development zone and to turn southward at the northern end of the runway.

The schematic track layout is shown in Figure 4.1.11

Source: Google earth, JICA Design Team

Figure 4.1.11 Schematic Track Layout between Clark Station and CIA Station

From Clark Station to the vicinity of crossing with Clark Spur Road which is the connection road for North Luzon Expressway (NLEx) and Subic–Clark–Tarlac Expressway (SCTEx), the alignment is along with the periphery of the development area converted from the former U.S. military base.

The alignment is laid out not to obstruct the perimeter road along with the development area.

The track bound for NCC is to be diverged around 1.4km far from Clark Station toward the terminal (80km000m). After divergence, the main track bound for CIA Station turns to the north through the west of SCTEx, and the NCC line also goes north through the east of it. Then, the main line passes the periphery of the airport and turns to the south at the north of the airport to go to CIA Station.

In order to secure height limitation in consideration of the civil aviation in CIA, the vertical alignment from Clark Station needs to be lowered thru the viaduct structure to at-grade at the edge of the runway.

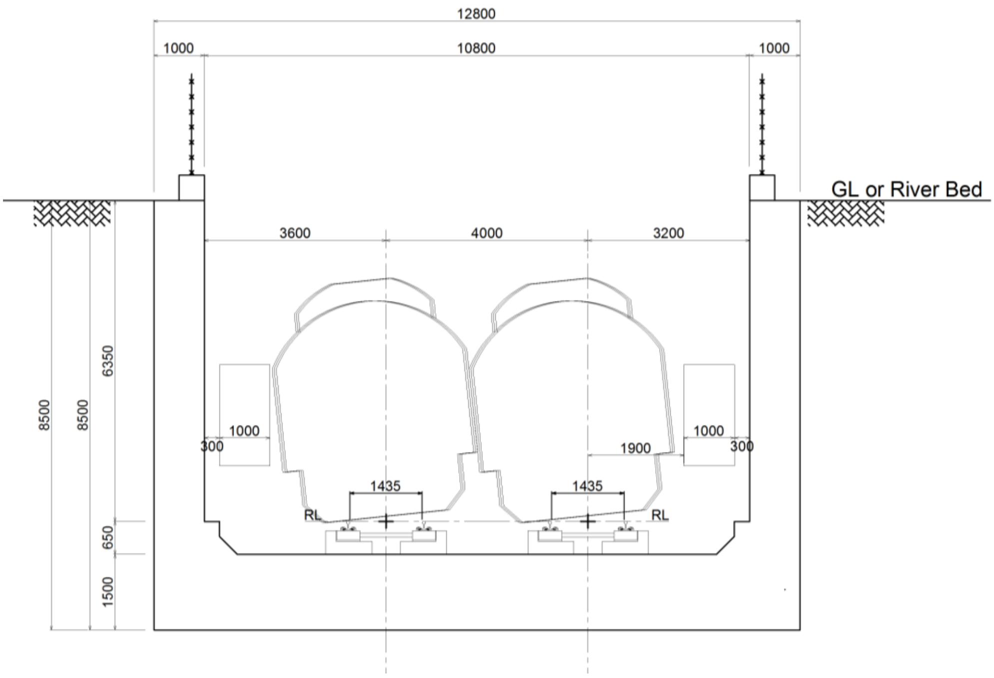
In addition, a part of the alignment passes the extension area of the airport runway with the aeronautical lights. If the railway passes this area at a position higher than the runway approach lights arranged at almost level with the runway, it may cause the problem on the visibility of the lights from the airplane. Therefore, the extension part of the runway shall be passed at lower than the existing runway.

Since there is a river whose name is unknown at this area, the vertical alignment excessively descending may cause the obstruction to the river. Thus, to avoid this influence, the at-grade structure is preferable around the area.

After passing the extension part of the airport runway, the underground structure is desirable to utilize the airport property. The structure is shifted from the U-shaped retaining wall to the cut-and-cover tunnel on the route to CIA Station.

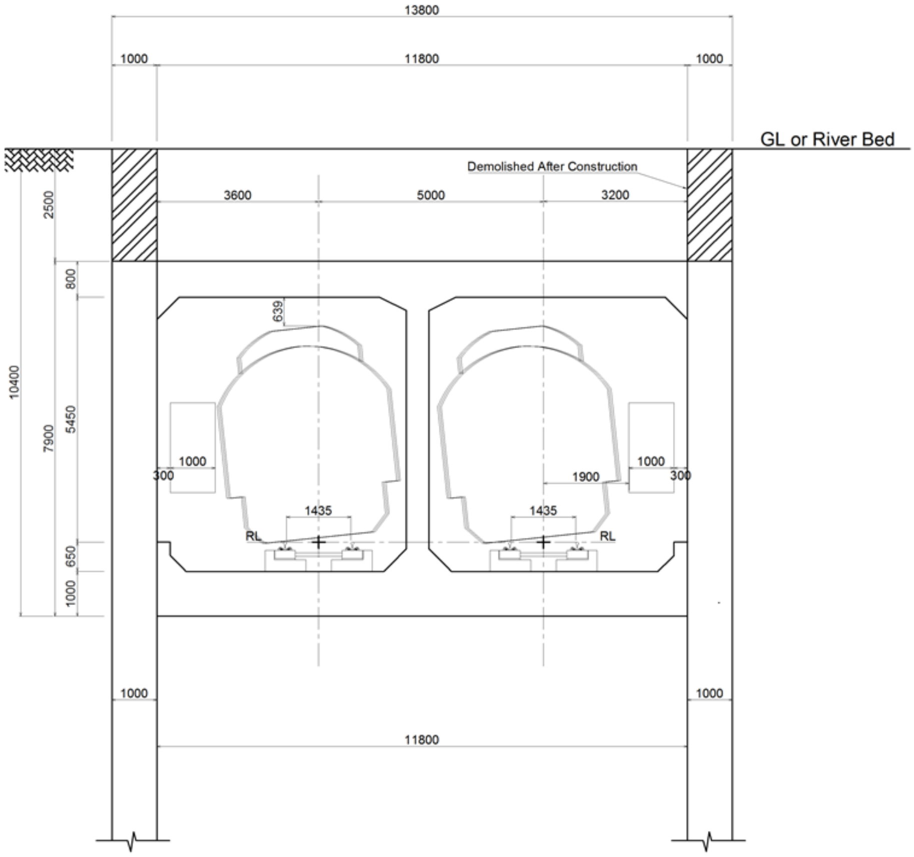
The expected cross section is shown in Figure 4.1.12 and Figure 4.1.13.

Adding to the reason that CIA terminal station has the underground or the semi-underground section, DOTr desires to utilize the upper space. Thus, this station is proposed as the underground station having the platform at the second floor of basement.



Source: JICA Design Team

Figure 4.1.12 Typical section of U-shaped retaining wall section



Source: JICA Design Team

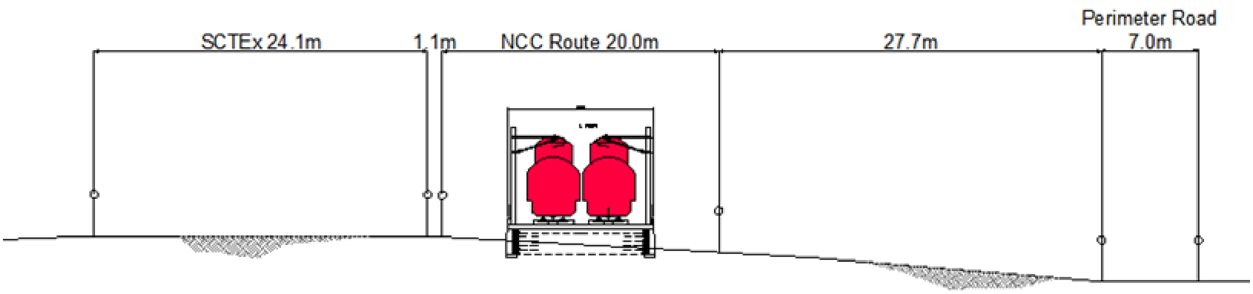
Figure 4.1.13 Typical section of underground box section

(8) From Clark to New Clark City

NCC line is diverged at around 1.4 km north from Clark Station, which is the kilometer point 80km000m of the main line bound for CIA Station.

After this divergence, NCC line turns to the north through a space between SCTEx and the perimeter road along with the development area converted from the former U.S. military base.

The typical section of this area is shown in Figure 4.1.14.



Source: JICA Design Team

Figure 4.1.14 Typical section of running parallel with SCTEx

There is Sacobia River at the north of the airport and the ramp of SCTEx behind, and SCTEx turns to the west. Thus, the route crosses the expressway eastward by the long span bridge.

After crossing, the route also crosses Sacobia River via a bridge and leads to the periphery of NCC development area in the north-northwest, brushing the City of Mabalacat.

The maximum speed in this section is 120km/h since there are more curves until passing the City of Mabalacat and a curve with the large radius cannot be used.

However, it is raised up to 160km/h from the north of the Mabalacat due to becoming less curves.

There are some tunnel sections after passing the tributary of Sacobia River at the north of Mabalacat since the terrain becomes mountainous.

The north of this section passes the periphery inside NCC development area to minimize the land acquisition.

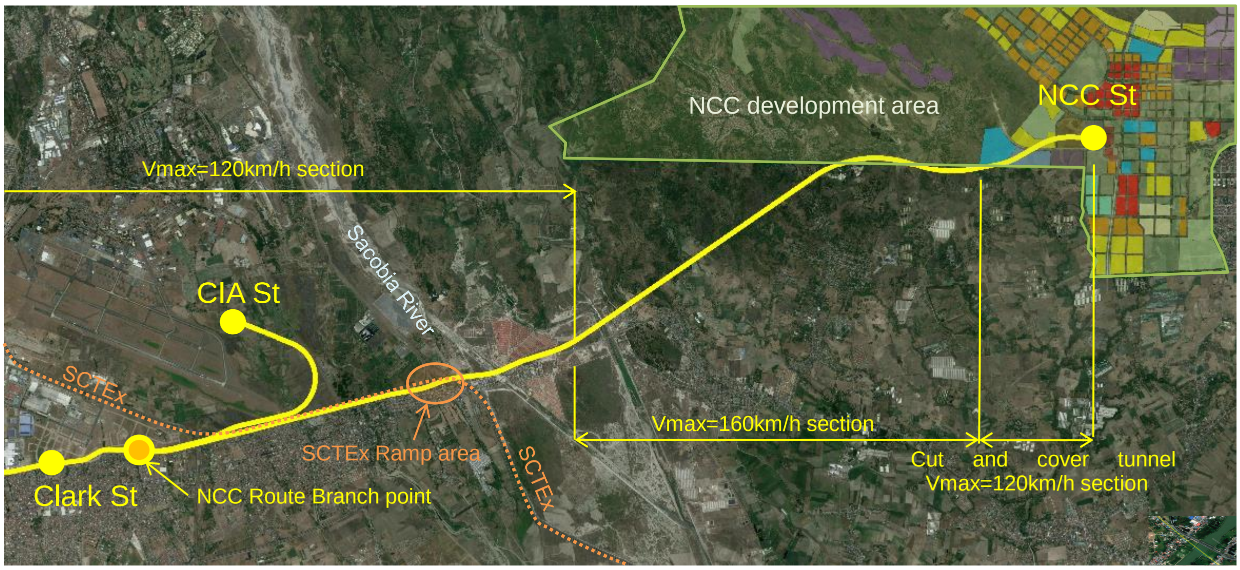
However, a part of the route passes outside of NCC development area since it shall avoid the area acknowledged by Certificate of Ancestral Domain Title which has difficulty in the land acquition.

While the initial study planned to lead the route to the central area, NCC Station is located behind it at the south-east of the urban development area as requested by BCDA.

The station is proposed as the cut-and-cover underground structure with two basement floors since BCDA also requested to design NCC Station as the underground station.

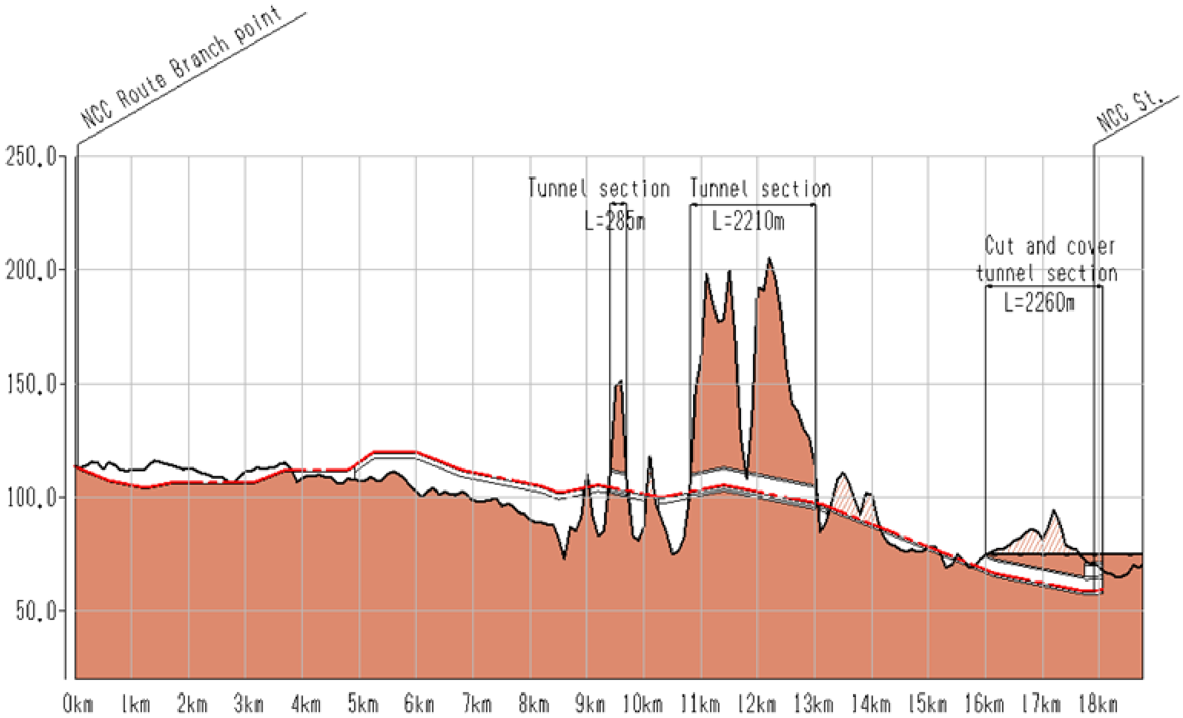
Regarding the cut-and-cover tunnel section to the station, it starts shifted to the underground structure behind the urban development area to avoid cutting off a road by the transition of the railway structure from the viaduct or the at-grade to the underground.

The overview of NCC line is shown in Figure 4.1.15. Also, Figure 4.1.16 shows the tunnel layout and the difference of the elevation around this area.



Source: JICA Design Team

Figure 4.1.15 Overview of NCC route



Source: JICA Design Team

Figure 4.1.16 Schematic vertical alignment of NCC route

(9) Depot access track

The double tracks for entering to and exiting from the depot is branched at the middle section from Clark Station to CIA Station at between Clark Station and CIA Station, and this location is around 4.0km from Clark Station which is kilometer point 82km500m.

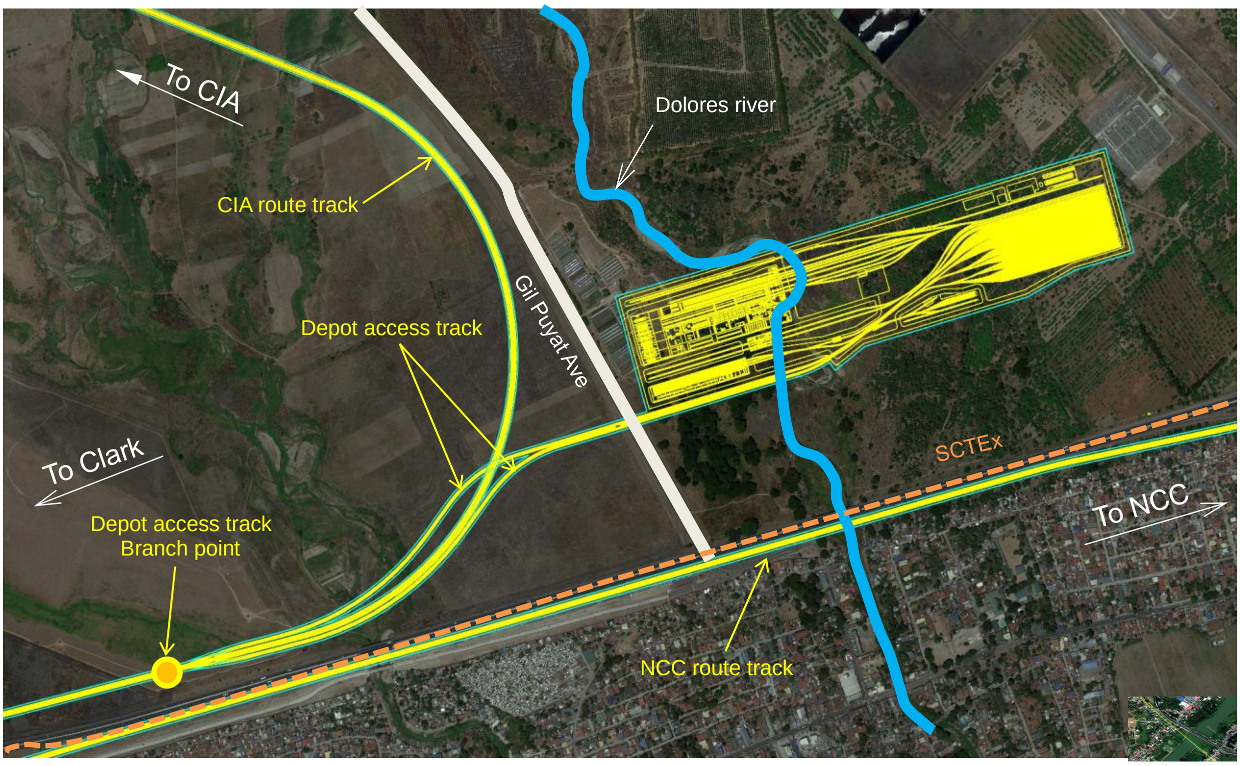
The railway entries from and exits to Clark Station, and a train bound for CIA Station and NCC Station turns back at Clark Station at once.

The depot access tracks are branched from the main line outward, and its southbound track overpass the main line at which starts the structure transition to the underground.

The layout of the depot access tracks, the main line and the depot is shown in Figure 4.1.17. Also, Figure 4.1.18 shows the typical section of the depot access tracks overpassing the main line.

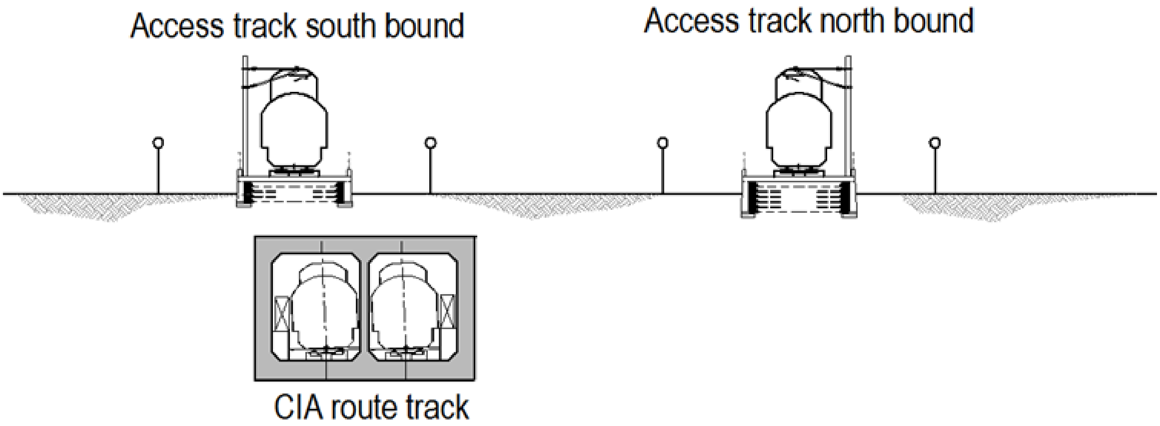
The low-height embankment structure is proposed for the depot access tracks since they pass a point slightly higher than the current ground elevation.

The schematic vertical alignment of the depot access track is shown in Figure 4.1.19.



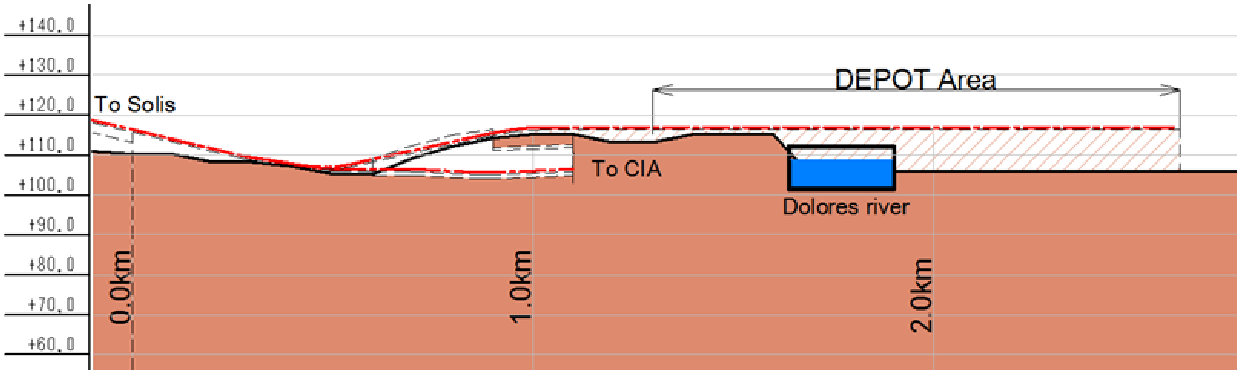
Source: JICA Design Team

Figure 4.1.17 Layout of depot access tracks



Source: JICA Design Team

Figure 4.1.18 Typical section of depot access track crossing the main line



Source: JICA Design Team

Figure 4.1.19 Schematic vertical alignment of depot access track

4.1.3 Station position

The station location of MCRP section from Malolos to CIA and NCC is selected based on the result of JOIN F/S considering the following factors. The chainage and the distance between stations are shown in Table 4.1.4.

- Linkage with the road transportation
- Utilization of the existing PNR ROW
- Location of historical PNR stations
- Avoidance of conflicts with the surrounding buildings

Table 4.1.4 Location of Station and Distance of Inter-station

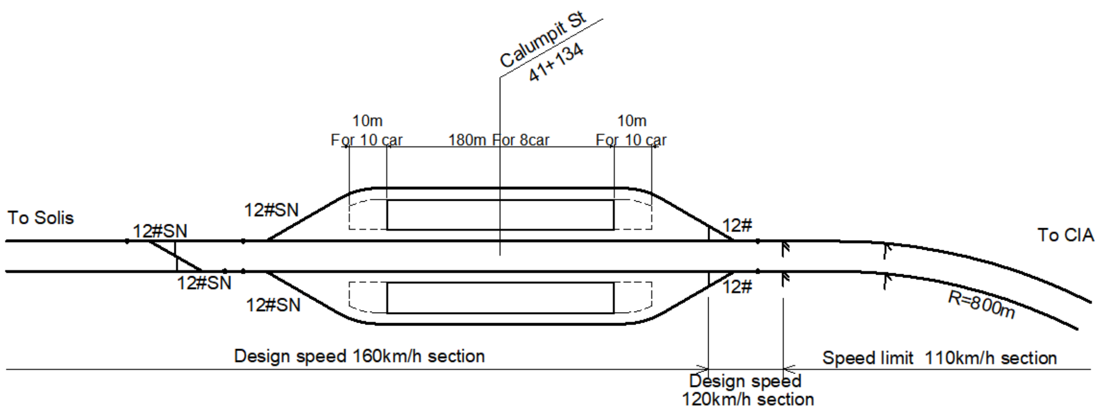
Name of Station	Chainage (Center of Station)	Inter-station Distance (km)	Remarks
Malolos	34km142m (kilometer point)	-	Scope of NSCR
Calumpit	41km134m (kilometer point)	6.99	
Apalit	46km440m (kilometer point)	5.31	
San Fernando	58km595m (kilometer point)	12.16	
Angeles	73km655m (kilometer point)	15.06	
Clark	78km590m (kilometer point)	4.94	
Clark International Airport (CIA)	85km930m (kilometer point)	7.34	
New Clark City (NCC)	17km927m (kilometer point)	19.34	1.41km of branching section from Clark Station to NCC Line is included.

Source: JICA Design Team

(1) Calumpit Station

Calumpit Station is located near the kilometer point 41km134m (from Solis) as the island-type platform with two platforms and four tracks.

The platform layout and the schematic alignment are shown in Figure 4.1.20.



Source: JICA Design Team

Figure 4.1.20 Schematic alignment of Calumpit Station

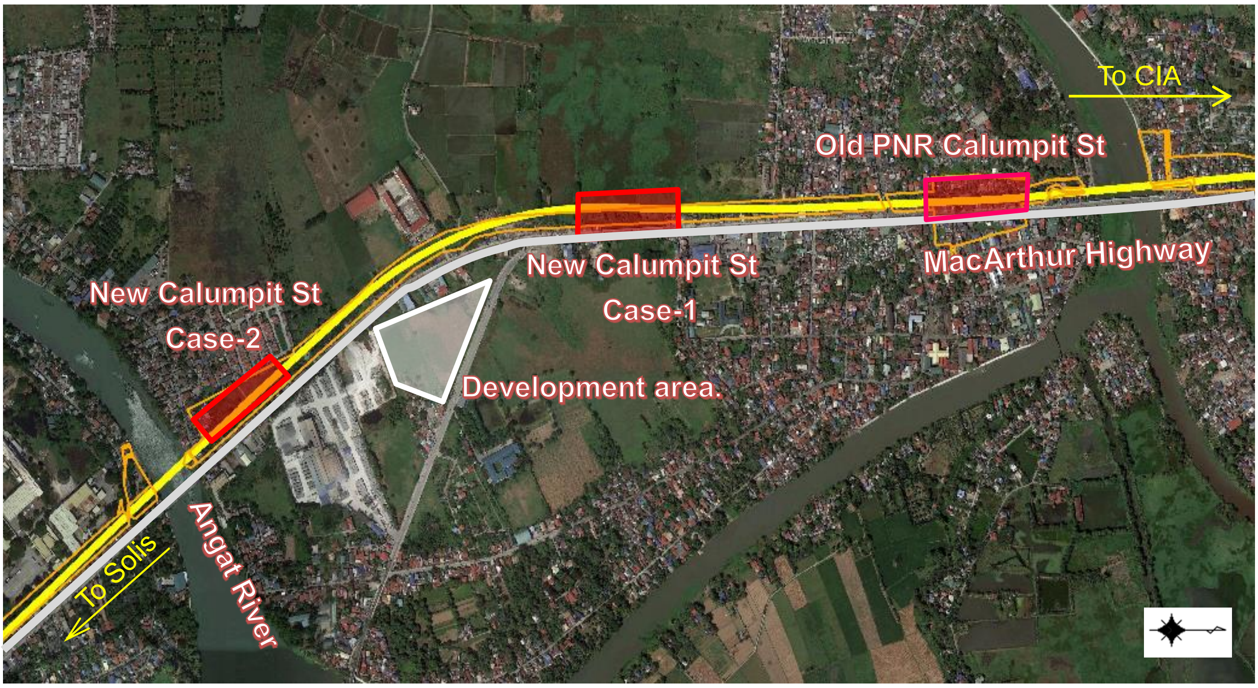
This is the first station to the northward from Malolos Station of NSCR which has fewer passing tracks. Thus, the passing tracks for the airport express to pass the local train are installed at Calumpit Station.

Moreover, an additional turn back track is planned to complement this less capacity for the future extension since only one track at Malolos Station for the turn back operation to Solis Station may not enough.

The location of Calumpit Station was initially at the south of old Calumpit Station due to difficulty in the station plaza construction since the old Calumpit Station is surrounded by dense residential area and is close to MacArthur Highway even located in relatively large space available. (New Calumpit Station Case-1)

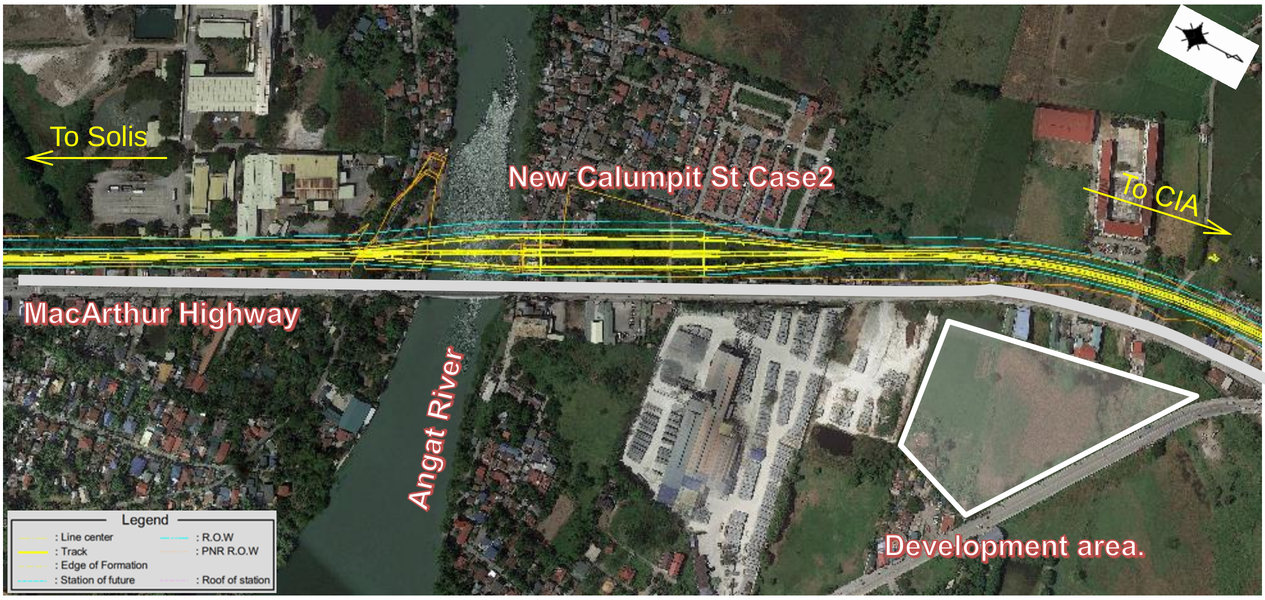
However, this location is moved to south further near Angat River since LGU requested for the development plan. (New Calumpit Station Case-2)

The location map of old and new Calumpit Station is shown in Figure 4.1.21 and the detailed map around final location of station is shown in Figure 4.1.22.



Source: Google earth, JICA Design Team

Figure 4.1.21 Location of old and new Calumpit Station



Source: Google earth, JICA Design Team

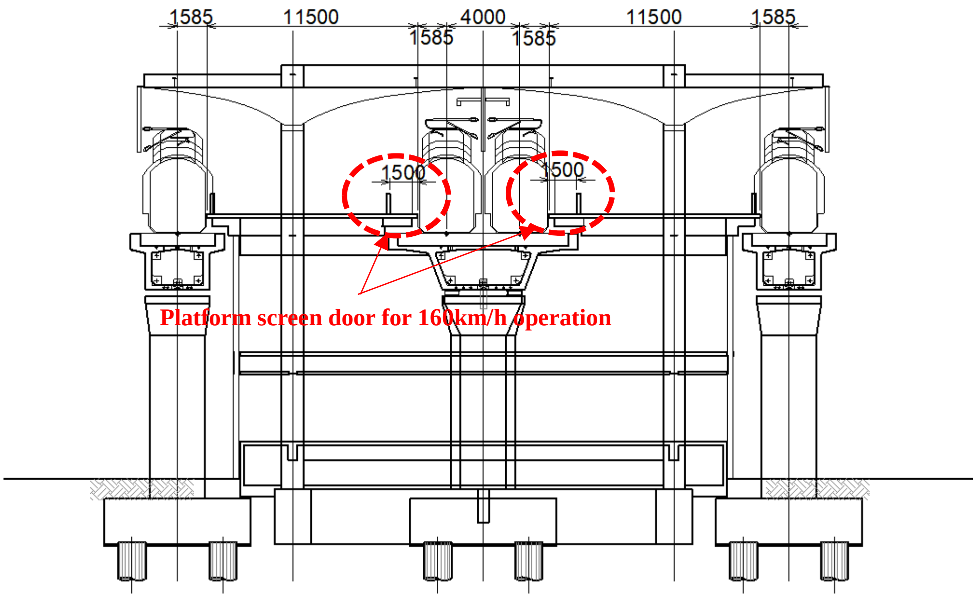
Figure 4.1.22 Layout of Calumpit Station

A train runs along the south of Calumpit Station (Solis side) at 160km/h. In contrast, at the north side (CIA side), the speed is restricted due to the curve of 800m radius.

The airport access limited express passes this station at less than 160km/h due to the abovementioned curve. Even with that, since the passing speed is expected to be more than 120km/h is expected, the platform screen door capable for 160km/h operation shall be applied for the main track.

For the passing track, the regular platform screen door will be usually enough since the passing speed on this track is not fast.

The layout of platform screen door is shown in Figure 4.1.23.



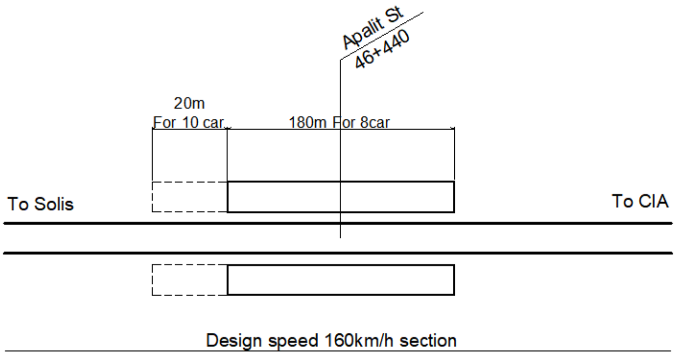
Source: JICA Design Team

Figure 4.1.23 Typical section of Calumpit Station

(2) Apalit Station

Apalit Station is located around the kilometer point 46km440m from Solis Station, and it is facing platform type with two platforms and two tracks.

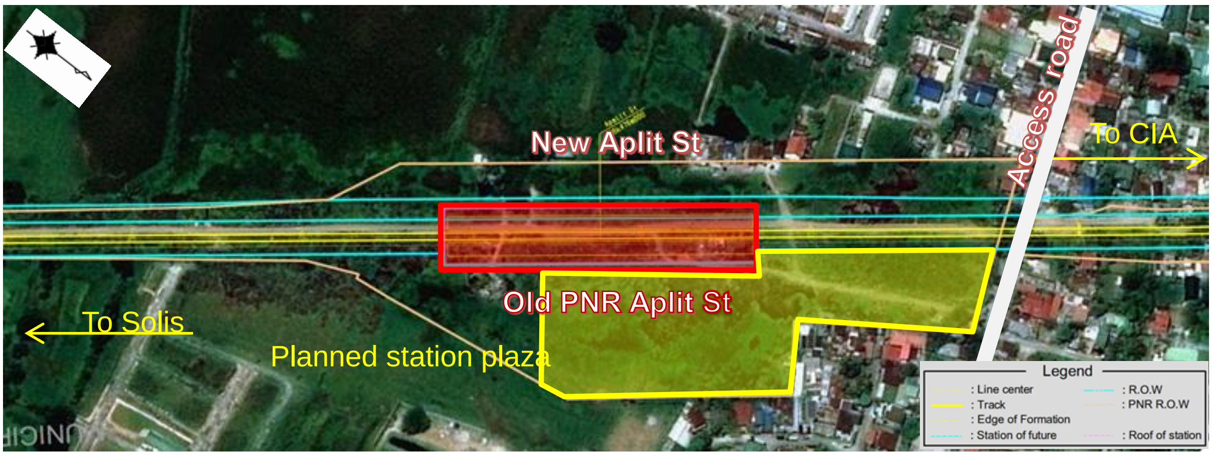
The platform layout and the schematic alignment are shown in Figure 4.1.24.



Source: JICA Design Team

Figure 4.1.24 Platform layout of Apalit Station

The distance from Calumpit Station is only about 5km. This station does not need side tracks. The location is at the same as the old Apalit Station. The existing PNR ROW has sufficient space without requiring additional land acquisition. There is crossing with a wide road at the north of the station. To secure the access from the northern road, the station plaza is proposed at the east. The location map around Apalit Station of MCRP is shown in Figure 4.1.25.



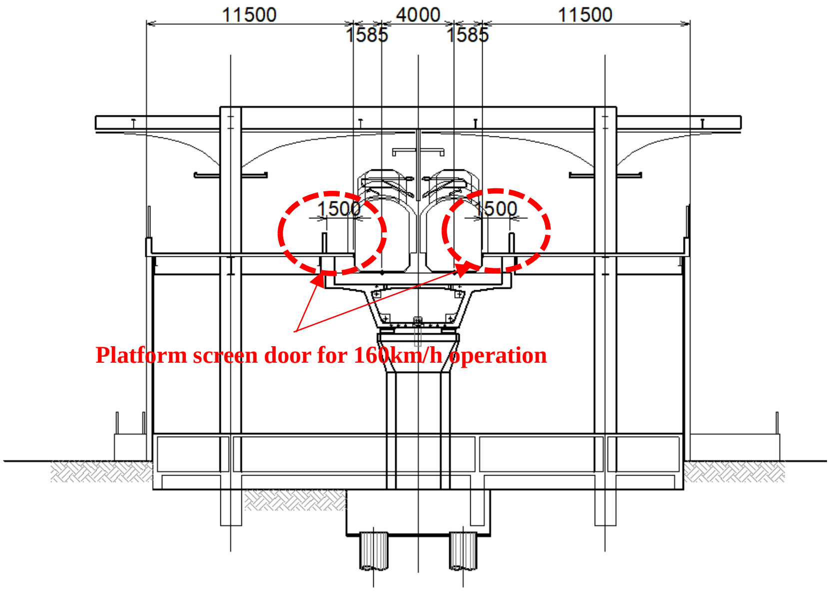
Source: JICA Design Team

Figure 4.1.25 Layout of Apalit Station

Apalit Station is capable for 160km/h operation of the airport access limited express, and there is no speed restriction area around the station.

Since a train passes at high speed, Apalit Station applies the platform screen door applicable for 160km/h.

The layout of platform screen door is shown in Figure 4.1.26.



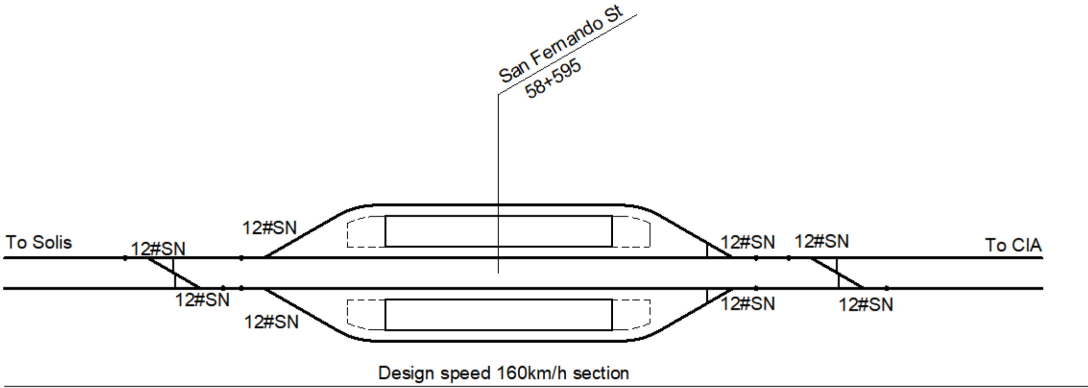
Source: JICA Design Team

Figure 4.1.26 Typical section of Apalit Station

(3) San Fernando Station

San Fernando Station is located near the kilometer point 58km595m from Solis Station, and it is island platform type with two platforms and four tracks.

The platform layout and the schematic alignment are shown in Figure 4.1.27.



Source: JICA Design Team

Figure 4.1.27 Platform layout of San Fernando Station

This station is located almost in the middle between Malolos and CIA. It has side tracks due to long distance from Apalit Station as well as to Angeles Station. While not assuming turn back at this station in usual operation, a crossover in emergency is installed for a train to turn back. Despite its location in urban complex, the additional land acquisition is not necessary with sufficient space owned by PNR. However, the area gets narrow in width towards north, where land acquisition is expected.

In order to secure wider space for the station plaza plan, further study is necessary.

To access the station, the existing road at the east can be utilized. Another existing road at the south of the station does not have enough width and may need consideration for future widening for access from the west.

The location map around San Fernando Station is shown in Figure 4.1.28.

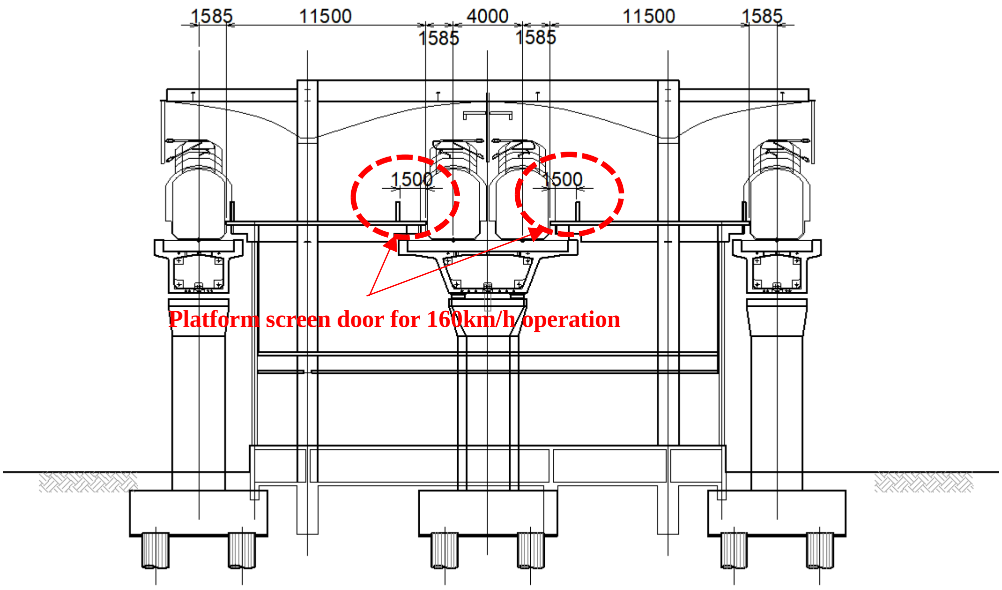
Source: JICA Design Team

Figure 4.1.28 Layout of San Fernando Station

San Fernando Station is capable for 160km/h operation of the airport access limited express, and there is no speed restriction area around the station.

Since a train passes at high speed, San Fernando Station applies the platform screen door applicable for 160km/h.

The layout of platform screen door is shown in Figure 4.1.29.



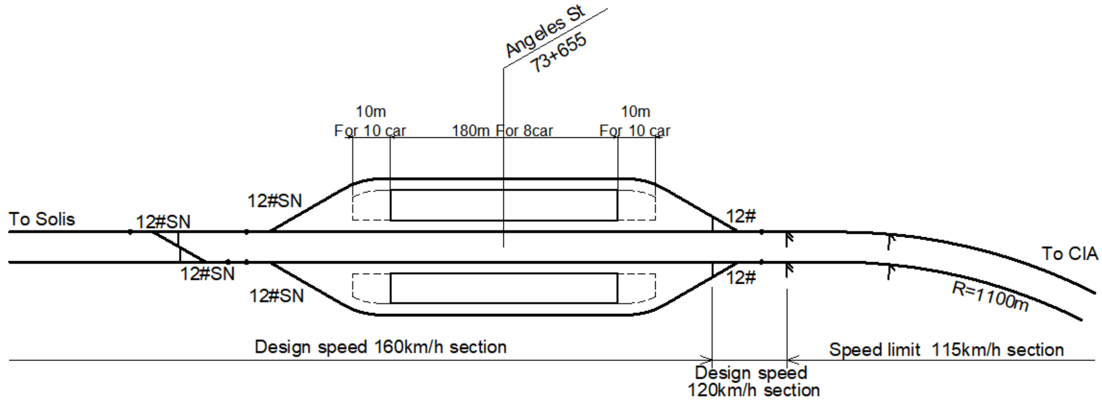
Source: JICA Design Team

Figure 4.1.29 Typical section of San Fernando Station

(4) Angeles Station

Angeles Station is located around the kilometer point 73km655m from Solis Station, and it is island platform type with two platforms and four tracks.

The platform layout and the schematic alignment are shown in Figure 4.1.30.



Source: JICA Design Team

Figure 4.1.30 Schematic alignment of Angeles Station

The old Angeles Station is located at 1.5km north-northwest from the new Angeles Station. It is located in densely populated residential area and the width of the existing PNR ROW is not sufficient. Access to major roads is another issue in this location. From the above difficulties, the location of new Angeles Station is proposed in less populated area with good access to MacArthur Highway.

The location of old and new Angeles Station is shown in Figure 4.1.31. While the north of the proposed location is a cemetery, the south is almost vacant with very small number of residents.

Considering the linkage with MacArthur Highway from the viewpoint of the station planning, the station plaza is at the south to ease the connection of road transport.

The location map around Angeles Station is shown in Figure 4.1.32.

Source: JICA Design Team

Figure 4.1.31 Location Map of New and Old Angeles Station

Source: JICA Design Team

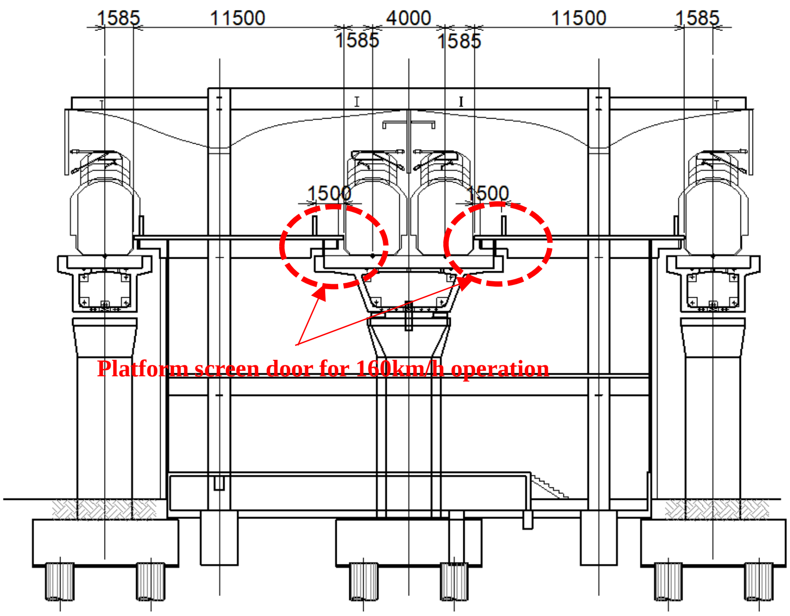
Figure 4.1.32 Layout of Angeles Station

A train runs along the southeast of Angeles Station (Solis side) at 160km/h. In contrast, at the northwest side (CIA side), the speed is restricted due to the curve of 1,100m radius.

The airport access limited express passes this station at less than 160km/h due to the abovementioned curve. Even with that, since the passing speed is expected to be more than 120km/h is expected, the platform screen door capable for 160km/h operation shall be applied for the main track.

For the passing track, the regular platform screen door will be usually enough since the passing speed on this track is not fast.

The layout of platform screen door is shown in Figure 4.1.23.



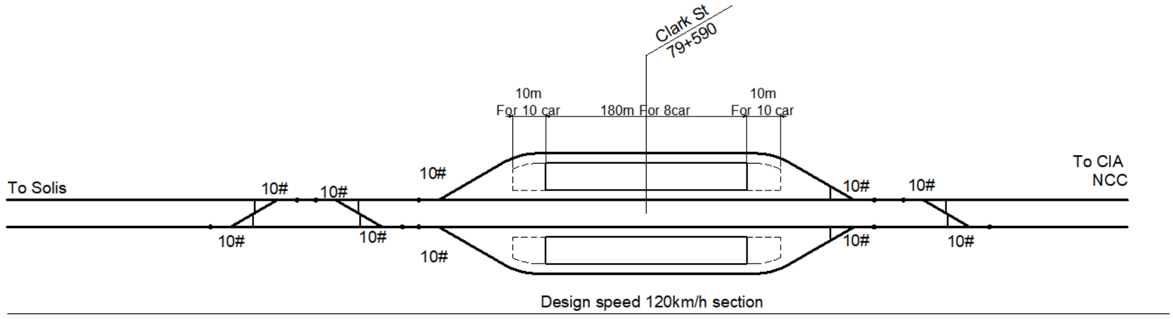
Source: JICA Design Team

Figure 4.1.33 Typical section of Angeles Station

(5) Clark Station

Clark Station is located around the kilometer point 78km590m from Solis Station, and is island platform type with two platforms and four tracks.

The platform layout and the schematic alignment are shown in Figure 4.1.34.



Source: JICA Design Team

Figure 4.1.34 Schematic alignment of Clark Station

This station requires turn back since the north of this station has the diversion bound for CIA and NCC.

The location of the station is along the periphery of the CIA re-development zone in BCDA area.

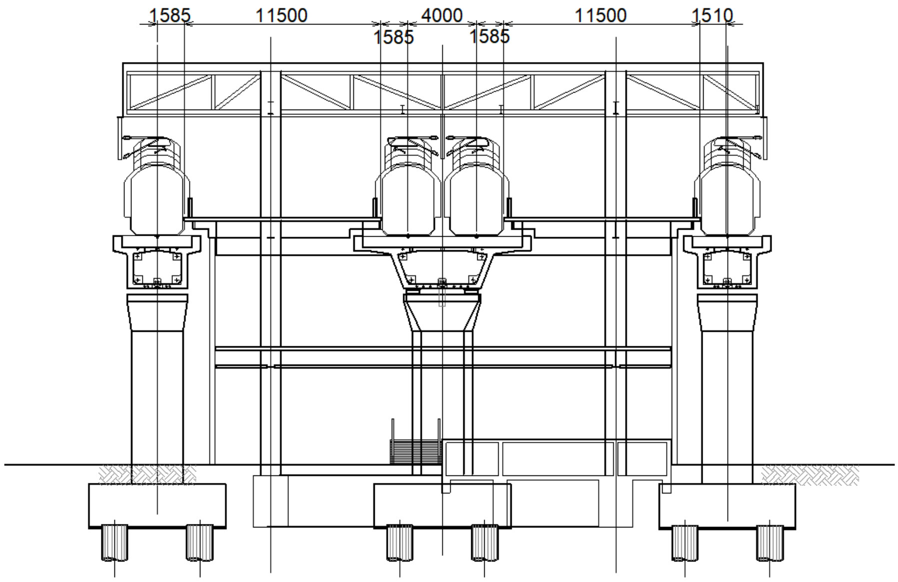
The east of the station is in PNR ROW. However, it is not enough wide and LGU has a strong objection to resettle the residences within ROW. Currently, JDT proposes to locate it in the re-development zone subject to refinement.

The location map around Clark Station is shown in Figure 4.1.35.

Source: JICA Design Team

Figure 4.1.35 Layout of Clark Station

The operation speed around Clark Station is up to 120km/h due to the speed restriction caused by curves before and after the station. Thus, the maximum train speed in this section becomes less than 120km/h even though the airport access limited express passes Clark Station. Therefore, it is usually enough to install the regular platform screen door at both sides. The layout of the platform screen door is shown in Figure 4.1.36.



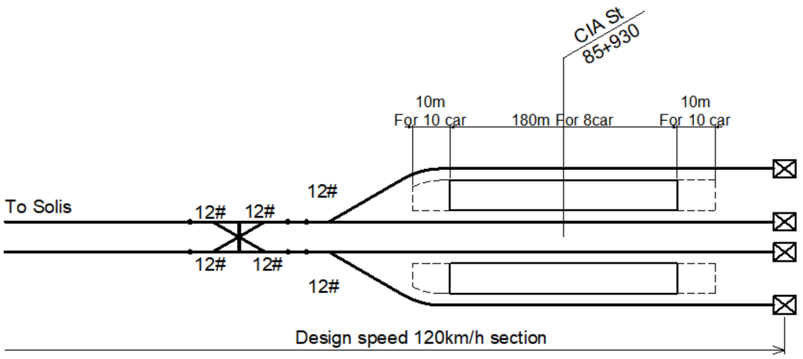
Source: JICA Design Team

Figure 4.1.36 Typical section of Clark Station

(6) Clark International Airport Station

Clark International Airport Station is located around the kilometer point 86km930m far from Solis, and is island platform with two platforms and four tracks as the dead-end on the route.

The platform layout and the schematic alignment are shown in Figure 4.1.37.



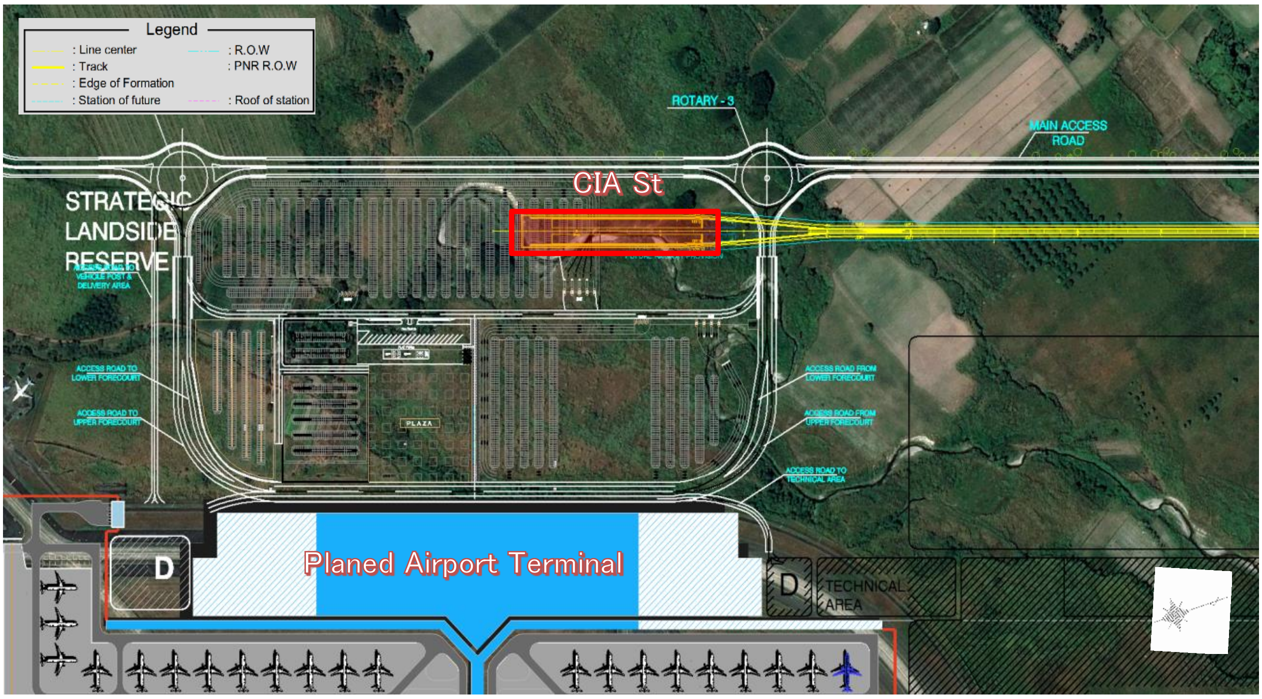
Source: JICA Design Team

Figure 4.1.37 Schematic alignment of CIA Station

Following the master plan of the airport, the location of the station is behind the airport terminal under construction.

CIA Station is proposed as the underground station having two basement floors following the strong request by DOTr.

The location around CIA Station is shown in Figure 4.1.38.

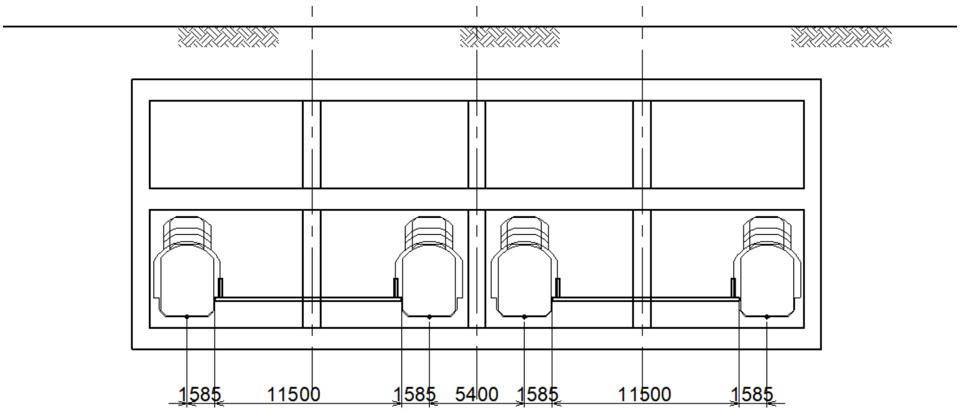


Source: Google earth, JICA Design Team

Figure 4.1.38　Layout of Clark International Airport Station

CIA Station is designed with two stories underground, the concourse and the machinery room are provided on the first basement level and the platform on the second basement level.

The train slows down since CIA Station is terminal. Thus, the regular platform screen door is applied to both side of the station.



Source: JICA Design Team

Figure 4.1.39　Typical section of CIA Station

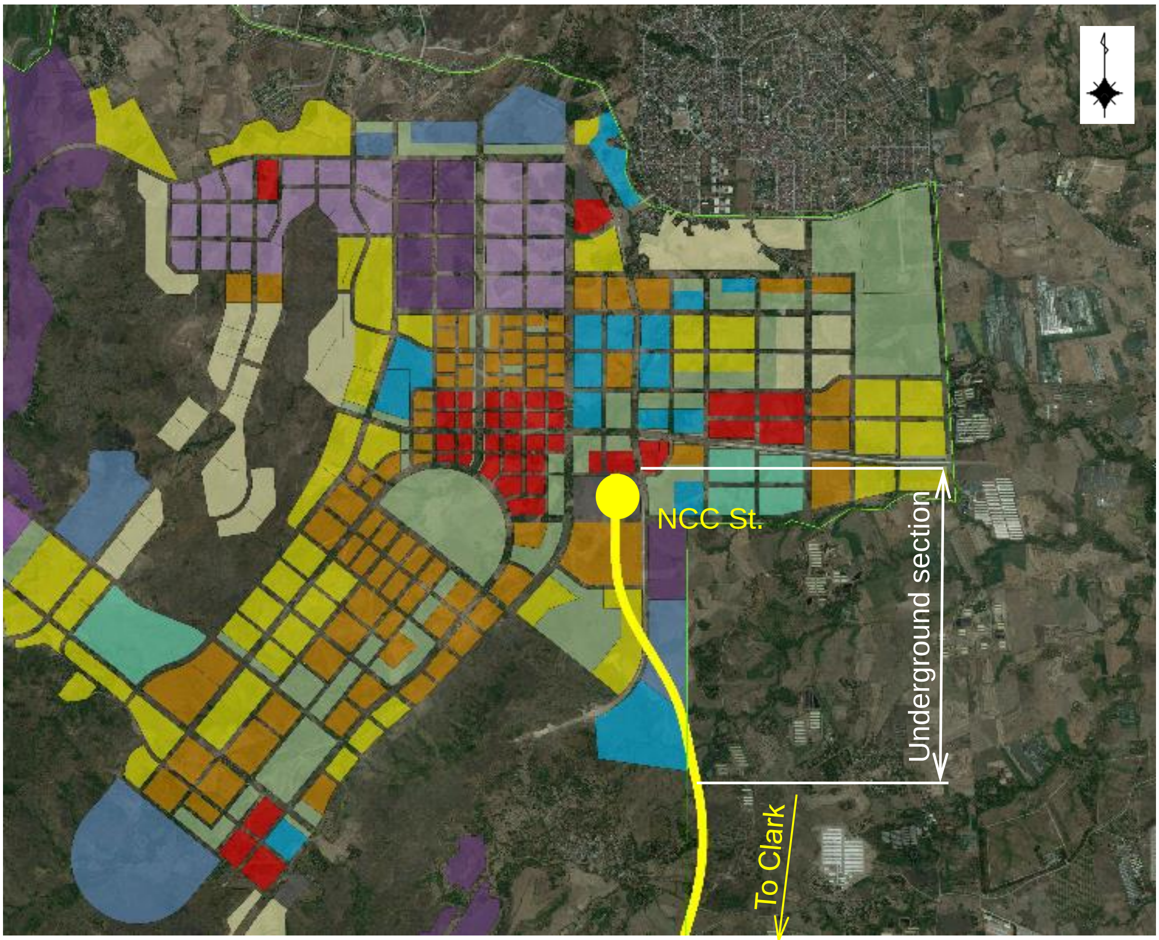
(7)　New Clark City Station

NCC Station is located at the kilometer point 17km927m from the branch point of NCC route which is around 1.4km far from Clark Station.

The station is located at the southeast of the central development area since the development of surround area is progressing.

This location is designated as the available place with no conflict to the development plan through the coordination with the development agency, BCDA.

The location within the development area is shown in Figure 4.1.40.

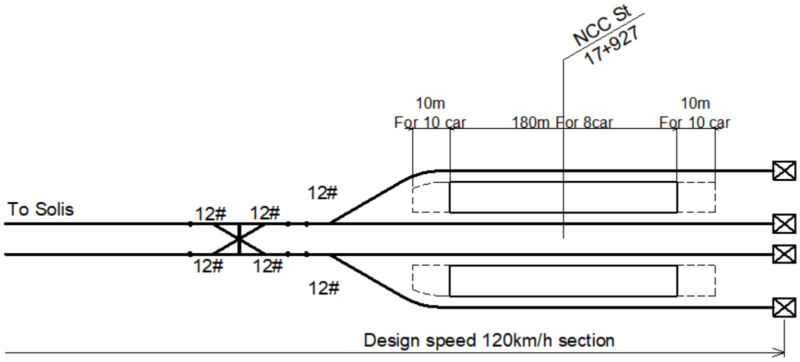


Source: Google earth, BCDA, JICA Design Team

Figure 4.1.40 Location map of NCC development area

Following the request, NCC Station is the underground station with two basement floors which is same as CIA Station.

The platform layout and the schematic alignment are shown in Figure 4.1.41.



Source: JICA Design Team

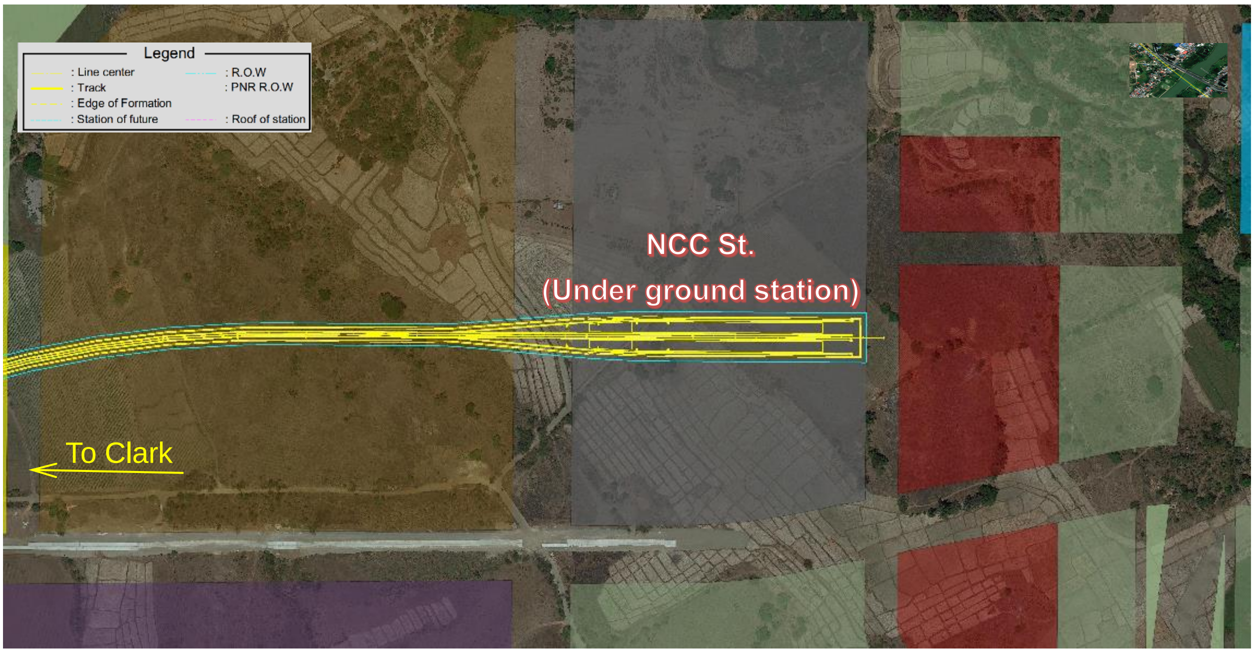
Figure 4.1.41 Schematic alignment of NCC Station

The transition of structure from the viaduct to the underground section starts behind the development area to avoid cutting off a road.

The island-typed platform is proposed with two platforms and four tracks and the scissors crossing is to be arranged at south of the station for the turn back operation.

The reason why two platforms and four tracks are proposed is to enable train parking at night so that deadheading from the depot at early morning and mid night is not required.

The layout of NCC Station is shown in Figure 4.1.42.

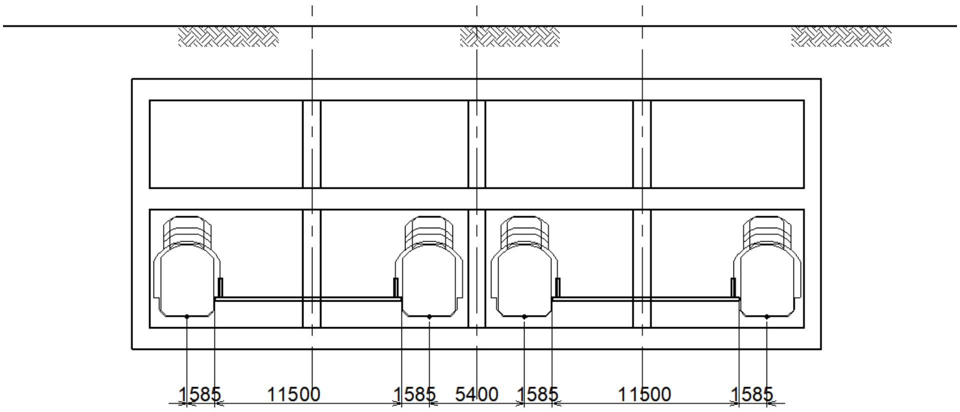


Source: Google earth, BCDA, JICA Design Team

Figure 4.1.42 Layout of NCC Station

NCC Station is designed with two stories underground, the concourse and the machinery room are provided on the first basement level and the platform on the second basement level.

The train slows down since NCC Station is terminal. Thus, the regular platform screen door is applied to both side of the station.



Source: JICA Design Team

Figure 4.1.43 Typical section of NCC Station

4.2 Infrastructure Plan

4.2.1 Structural Type of MCRP

(1) Standard Type Type of Viaducts

The standard type of the viaduct basically follows the standard type of the viaduct of NSCR, which MCRP will go through mutually.

In view pint of a marketability of material used for the viaducts in Manila, an ease of construction of MCRP, an economic efficiency of the structure type and a landscape of viaducts, , the standard structure type of viaduct of MCRP should be applied e PC box girder bridge (segmental construction method) which is same standard type viaduct as NSRP. The comparison table for the selection of optimal standard type of the viaduct is shown below.

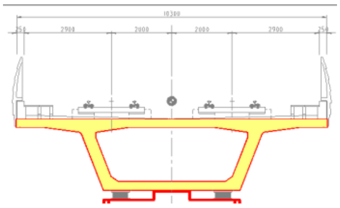
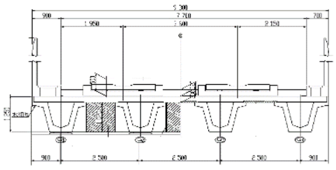
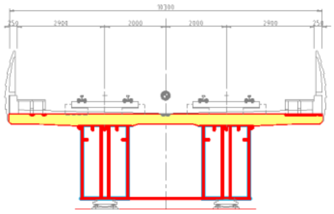
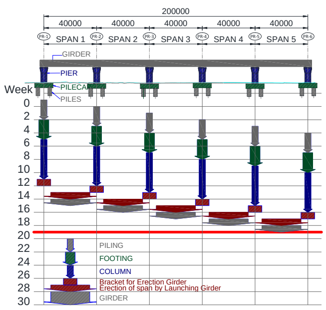
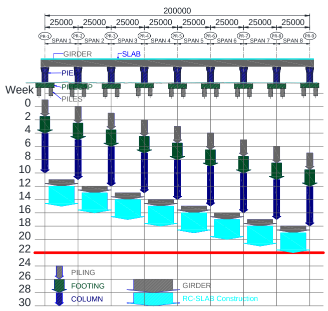
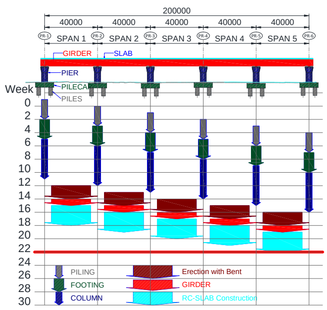
1) Optimal Structure Type of Viaduct

This section compares the structural forms and types of the viaducts, prioritizing on the shortening of the construction period. JDT compared the following three options.

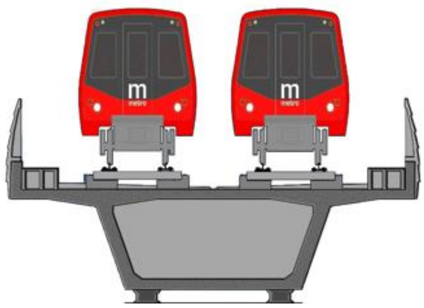
Option-1; Precast PC BOX girder (Segmental method), Span Length L=40m
Option-2; Precast PC-U Composite girder (RC composite slab), Span Length L=25m
Option-3; Steel BOX girder (RC composite slab), Span Length L=40m

The results of the comparative study are shown in the table below.

Table 4.2.1 Comparison of Superstructure Type for Viaduct

Items	Option-1	Option-2	Option-3
Structural forms	Precast PC BOX girder (Segment method)	Precast PC-U Composite girder (RC composite deck)	Steel BOX girder (RC composite deck)
Span Length	L=40m	L=25m	L=40m
Cross section			
Construction	➢ Can be constructed using temporary erection girders. ➢ Can be transported as short length segments. ➢ No need to cast in place concrete. →Save one step of construction period	➢ Crane installation space required on the side of the viaduct. ➢ Transportation weight is light. However, the girder length that can be transported is limited. ➢ It is necessary to cast in situ concrete. → one more step of construction compared with Box Girder	➢ Can be constructed using temporary construction gantries. ➢ Transportation weight is light. However, the girder length that can be transported is limited. ➢ It is necessary to cast in situ concrete. →one more step of construction compared with Box Girder
Required resources	➢ Piling rig ; 2 set ➢ Footing ; 3 team ➢ Column ; 4 set ➢ Crane ; 4 ➢ Erection girder ; 1	➢ Piling rig ; 2 set ➢ Footing ; 3 team ➢ Column ; 4 set ➢ Crane ; 4 ➢ Heavy lifting crane ; 1	➢ Piling rig ; 2 set ➢ Footing ; 3 team ➢ Column ; 4 set ➢ Crane ; 4 ➢ Heavy lifting crane ; 1
Construction process			
Construction Speed	➢ 19 Weeks /200m ➢ 1.5 m /Day	➢ 22 Weeks /200m ➢ 1.3 m /Day	➢ 22 Weeks /200m ➢ 1.3 m /Day
Conclusion	Fastest Construction Method	-----	-----

Source: JICA Design Team



Source: JICA Design Team

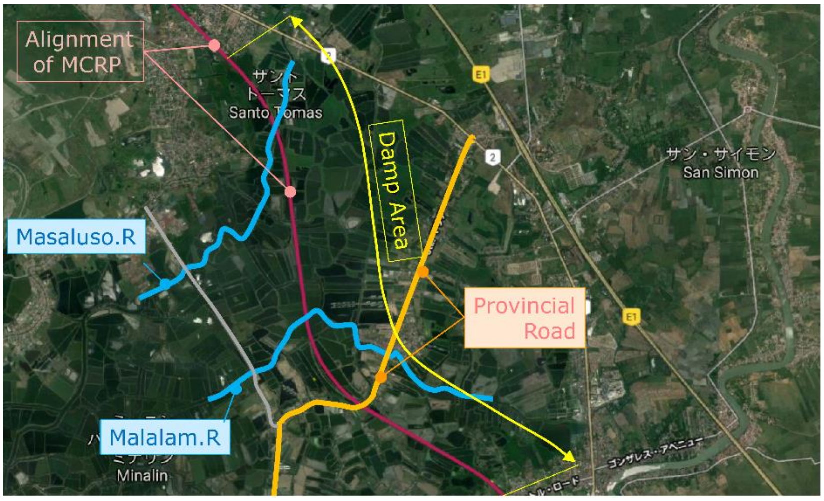
Figure 4.2.1 PC segmental box girder

(2) Study and Selection of Viaduct Structure Type in Special Condition Section in MCRP

1) Wetland Area between Apalit Sta. and SanFernando Sta.

a) Location

The wetland area is located about 8 km north from Apalit station (Source: JICA Design Team: Figure 4.2.2). There are 2 rivers, the Malalam River and the Masaliso River, and Provincial Road.



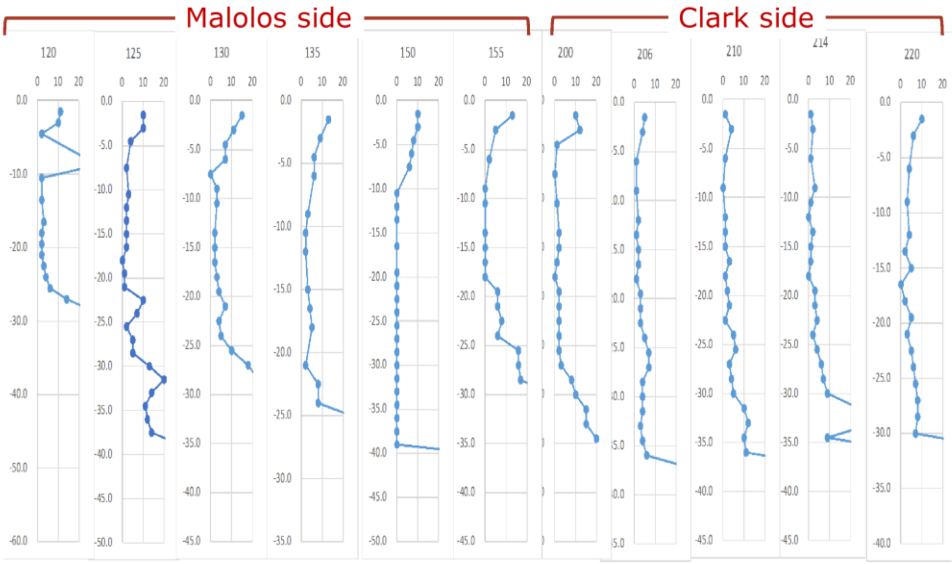
Source: JICA Design Team

Figure 4.2.2 Location of Wetland area

b) Overview of the Wetland area

i) Ground condition

N value of the layer in top few meters is around 10, however the soft chohesive soil layer, which N value is 2 or less, is in below top layer with more than 30m thickness. The top layer is presumed to have been compacted by PNR trains which had been operated long term previously.

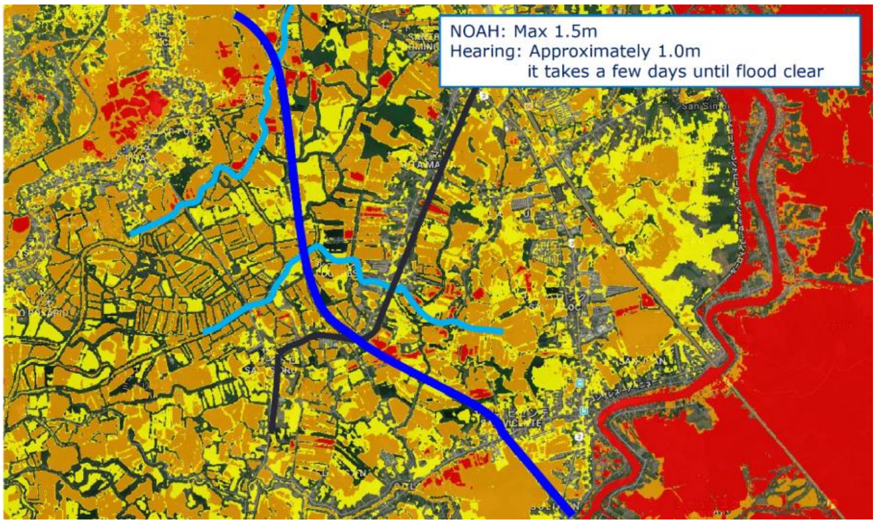


Source: JICA Design Team

Figure 4.2.3 Geological survey results of damp area (excerpts)

ii) Prediction of inundation during flood

The flood risk at this area is studied using a 100-year return period flood hazard map obtained from the Nationwide Operational Assessment Hazards (NOAH) (Figure 4.2.4). From the flood hazard map, it can be determined that the height of flooding is expected approximately 1.5 m.



Source: JICA Design Team

Figure 4.2.4 Flood inundation (damp area)

c) Selection of Viaduct Type

Since very soft and weaken soil accumulated thickly at wetland area, it is required to take into consideration the workability on soft ground for select of structure type. Therefore, three structure options shown below was selected and compared.

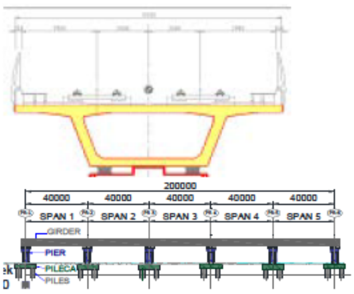
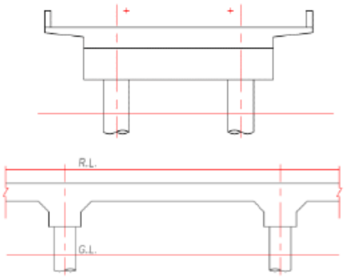
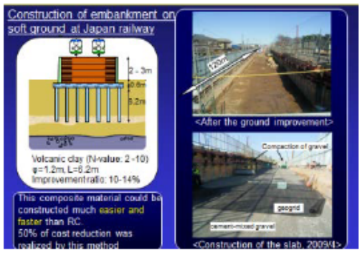
Option-1: Typical viaduct type of PC segment box girder.

Option-2: Concrete slab connected to Reinforced Concrete Column-Pile Foundation.

Option-3: Retaining Wall upon underground slab connected to Reinforced Concrete Pile Foundation.

Based on the comparison, PC segmental box girder has been selected on the view point of flood mitigation and of avoid of separation of township.

Table 4.2.2 Comparison of structural forms

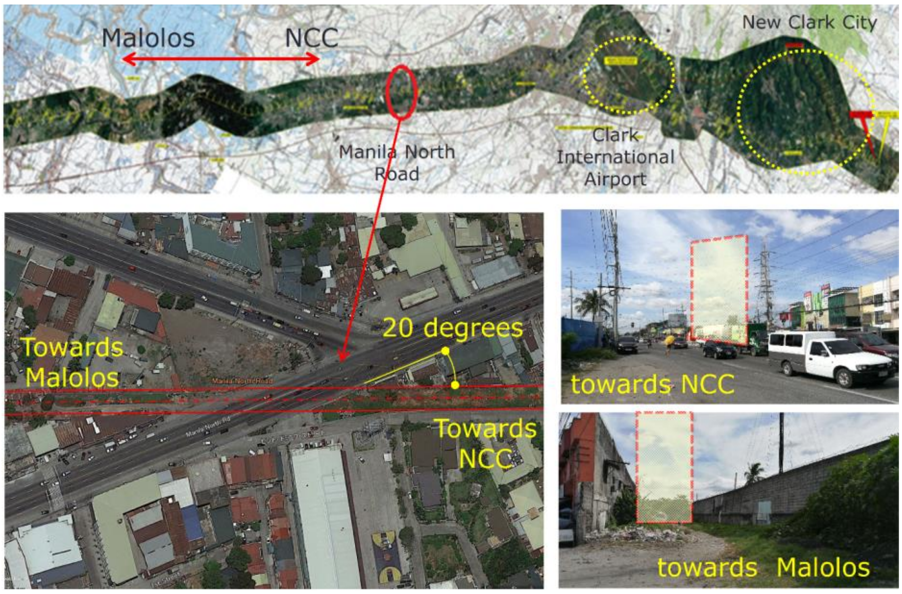
	Option-1	**Option-2**	**Option-3**
Structural forms	Viaduct (PC-Box + Pile foundation)	Low slab viaduct (RC-slab + Pile)	Embankment (Retaining wall + Pile slab)
Cross section / Side view			
Construction cost	[redacted]	[redacted]	[redacted]
Construction period	B	C	B
Construction advantage	➢ Temporary roads and yard is required for working ➢ A large machine is required.	➢ Temporary roads and yard is required for working ➢ Construction period will be longer by reason of the deck slub that cast in situ.	➢ Temporary roads and yard is required ➢ A large machine is not required
Environment al impact	➢ When flooding, stagnant water and dam stops are not a problem ➢ Cross street can be planned	➢ When flooding, stagnant water and dam stops are not a problem ➢ Cross street can be planned, and future development is restricted	➢ When flooding, Dam and water stagnation are concerned.(Install a cross box every 200 meters) ➢ Cross street can be planned, and future development is restricted
Structural performance	➢ Structure is excellent because it is supported by piles ➢ Adopt a slab track ➢ Because it is a statically determinate structure, influence of soft ground is small	➢ Unequal subsidence is concerned. ➢ Adopt a slab track ➢ A statically determinate structure are not suitable due to soft ground	➢ Unequal subsidence is concerned. ➢ Ballast trajectory is desirable and requires maintenance
Evaluation	A	C	B

Source: JICA Design Team

2) Crossing Section MCRP and MacArthur Highway

a) Location

The section MCRP crossing MacArthur Highway is located about 3 km north from New San Fernando station (Figure 4.2.5).



Source: JICA Design Team

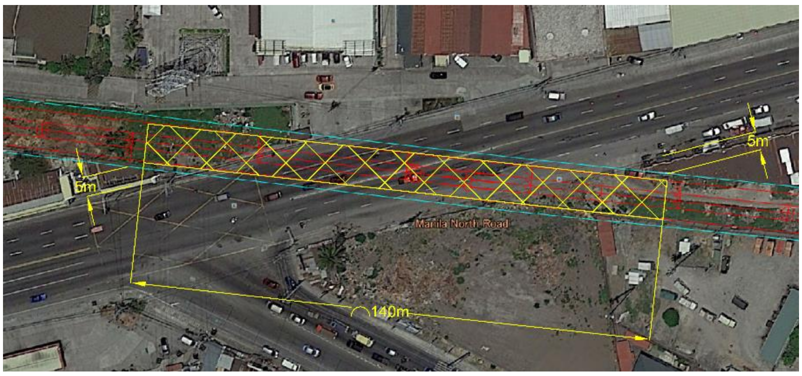
Figure 4.2.5 Location of MacArthur Highway Bridge

b) Preliminary Study of Bridge

i) Location of Pier and Bridge Span Length

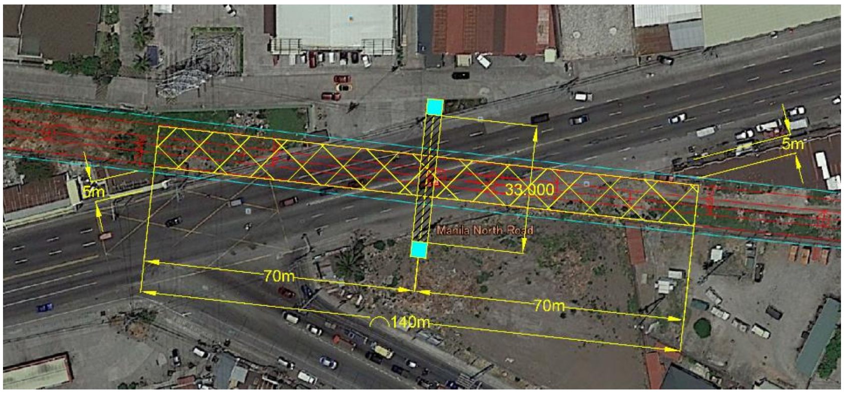
The pier of this bridge is planned to set 5m apart from road edge (Figure 4.2.6) and MCRP intersects the MacArthur Highway at an extremely small angle of about 20 degrees resulting in a span length of about 140m.

To reduce the length of the span, we studied a 2 spans bridge with rigid-frame pier at the middle of the bridge which beam length is more than 30m length (Figure 4.2.7).



Source: JICA Design Team

Figure 4.2.6 Crossing MacArthur Highway by One Span Bridge



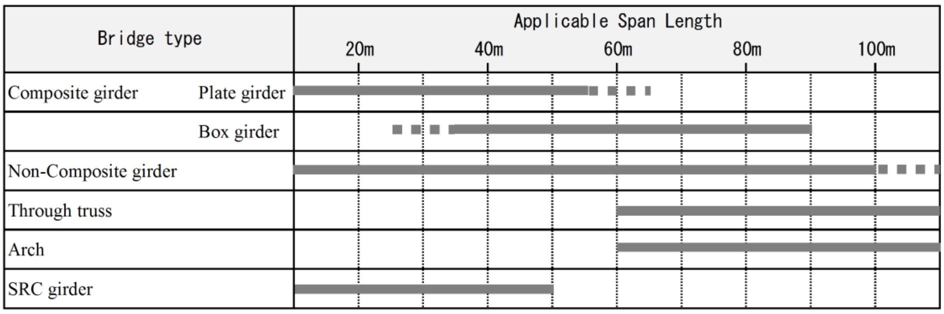
Source: JICA Design Team

Figure 4.2.7 Crossing MacArthur Highway by Two Span Bridge

ii) Preliminary Study of Bridge Type

Table 4.2.3 show the relation between applicable span length and bridge type. From this table, PC Extradosed Bridge (Option-5), Trough Truss Bridge with pier in MacArthur Highway (Option-3), and PC Box-Girder Bridge (Option-4) have been selected as suitable bridge type. Option-1 Extradosed Bridge is recommended plan due to the reasonable plan (Table 4.2.5).

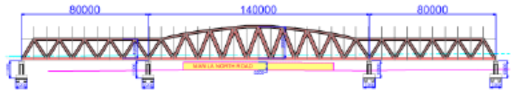
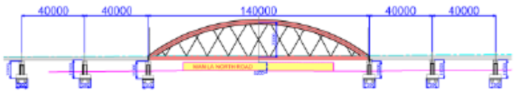
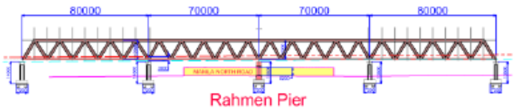
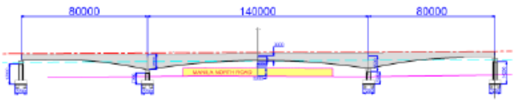
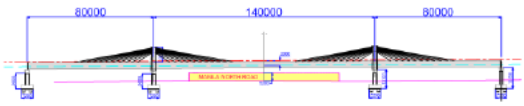
Table 4.2.3 Structure Type and Applicable Span Length



※ This table was modified by the JICA Design Team that published in " Railway Technical Research Institute, 2015, *Introduction to Railway Technologies for Beginner*, Tokyo.".

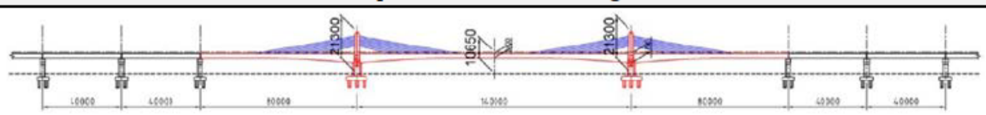
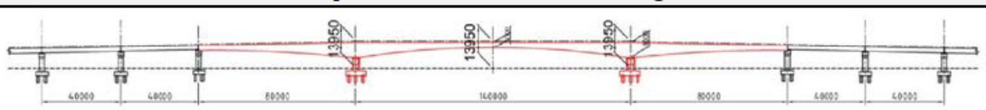
Source: JICA Design Team

Table 4.2.4 Study on Bridge Type with 140m span

	General View	Comment			
Option-1 **Truss Bridge (3-Span)**		➢ Structural height (Negotiation with Power company) ➢ Field construction period ➢ Planning height ➢ Bridge Scale (Landscape) ➢ **Construction cost**	Difficult (20m) Middle No impact Huge Expensive	C B A C C	C (8)
Option-2 **Arch bridge +PC Box-Girder (5-Span)**		➢ Structural height (Negotiation with Power company) ➢ Field construction period ➢ Planning height ➢ Bridge Scale (Landscape) ➢ **Construction cost**	Difficult (23m) Middle No impact Huge. Expensive	C B A C C	C (8)
Option-3 **Truss Bridge (4-Span)**		➢ Structural height (Negotiation with Power company) ➢ Field construction period ➢ Planning height ➢ Bridge Scale (Landscape) ➢ **Construction cost**	Little Difficult (13m) Middle Roughly 3.0mUP Big Expensive	B B B B C	C' (9)
Option-4 **PC-Box Girder (3-Span)**		➢ Structural height (Negotiationwith Power company) ➢ Field construction period ➢ Planning height ➢ Bridge Scale (Landscape) ➢ **Construction cost**	No problem Middle Roughly 5.3mUP Big Fair	A B C B A	B (10)
Option-5 **Extradosed Bridge (3-Span)**		➢ Structural height (Negotiation with Power company) ➢ Field construction period ➢ Planning height ➢ Bridge Scale (Landscape) ➢ **Construction cost**	Little Difficult (13m) Middle Roughly 3.0mUP Becomes a landmark Little Expensive	B B B A B	A (11)

Source: JICA Design Team

Table 4.2.5 Study on Cost of Bridge Crossing MacArthur Highway Bridge

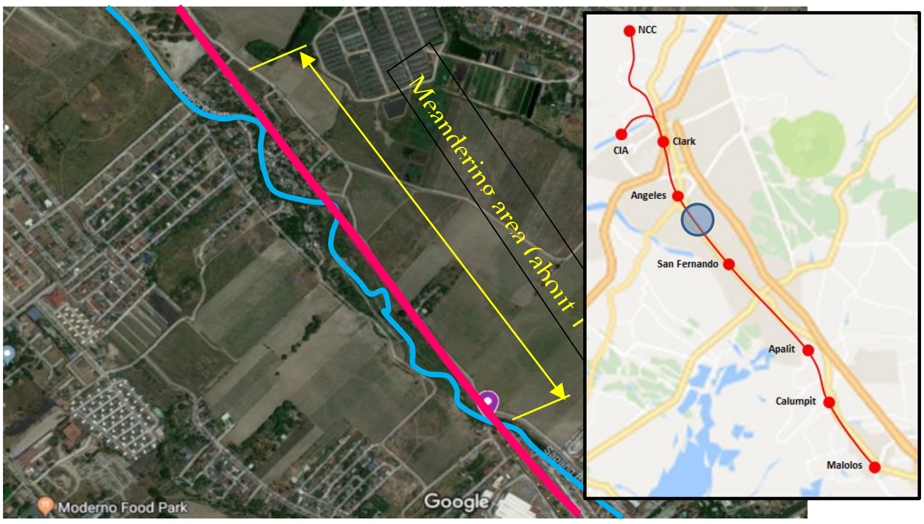
Option-1 Extradosed Bridge	
	
Superstructure ; [redacted] Substructure ; [redacted] Vertical Alignment Impact range ; [redacted]	Construction cost ; [redacted]
Option-2 Balanced Cantilever Bridge	
	
Superstructure ; [redacted] Substructure ; [redacted] Vertical Alignment Impact range ; [redacted]	Construction cost ; [redacted]

Source: JICA Design Team

3) Study of Railway structure along the meandering area

a) Location

Meandering area is located about 2.5 km south from New Angels Station (Source: JICA Design Team Figure 4.2.8).

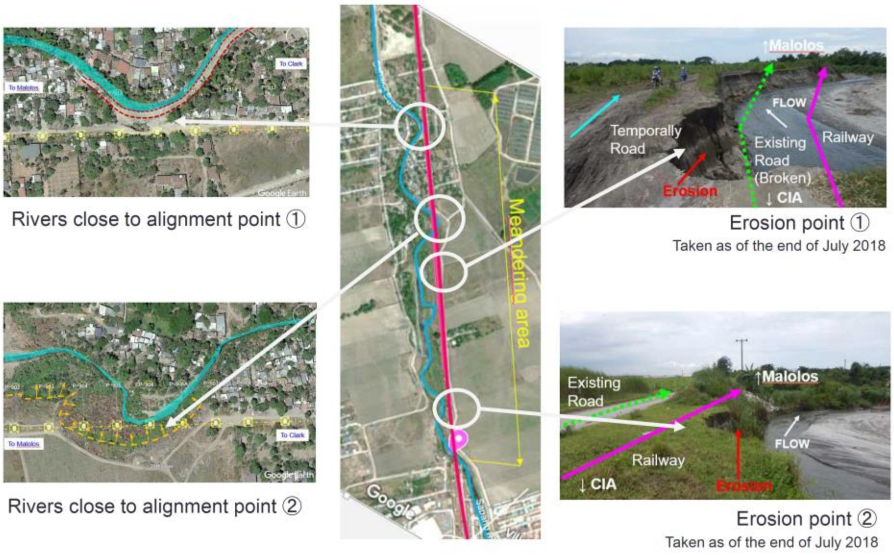


Source: JICA Design Team

Figure 4.2.8 Location of meandering area

b) Overview of meandering area

The river is meandering and it overlaps the MCRP ROW. In this section there is river meandering near the railway alignment. This river may change in shape each time the water is increased and adversely affect the construction of the railway.

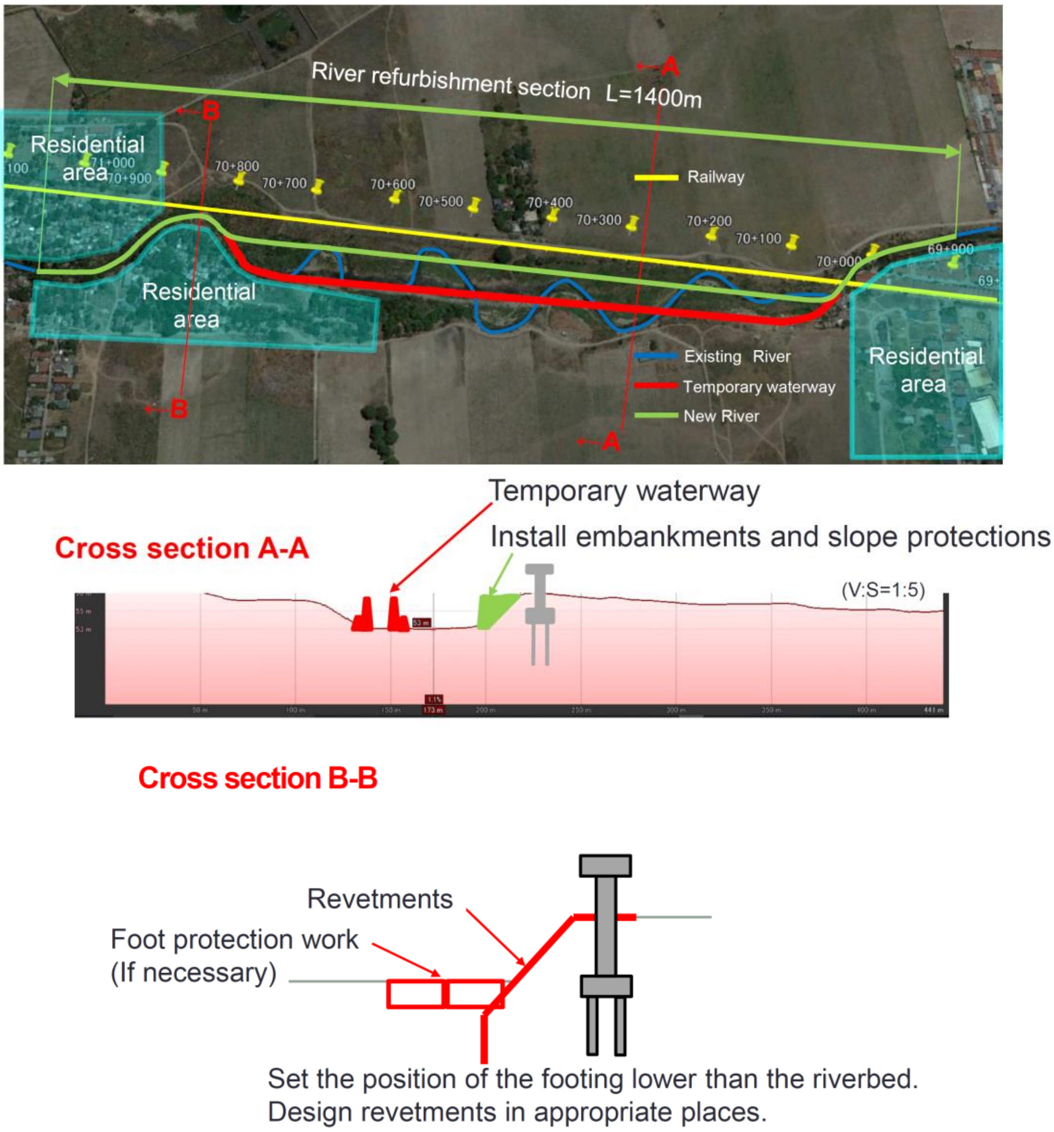


Source: JICA Design Team

Figure 4.2.9 Overview of meandering area

c) Planning policy in meandering area

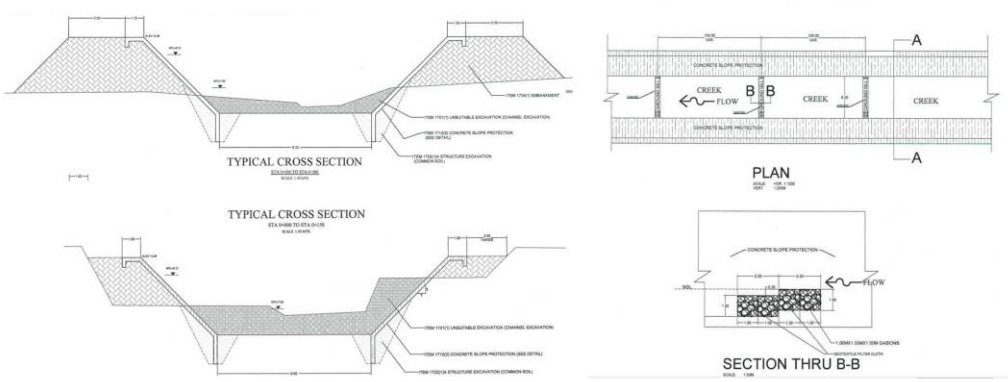
If erosion occurs around the newly constructed structure, ①the structure become unstable and ②if the structure break down, it becomes obstacles to the flow of the river. Therefore, the river should be diverted in order not to occur erosion during construction. Afterward, embankments and slope protections should be installed after setting piers and the position of the river is set to a new position. The new embankments and slope protections should correspond to river refurbishments by DPWH in terms of design principle.



Source: JICA Design Team

Figure 4.2.10 Policy to set piers in meandeirng area

Source: JICA Design Team



Source: DPWH drawings

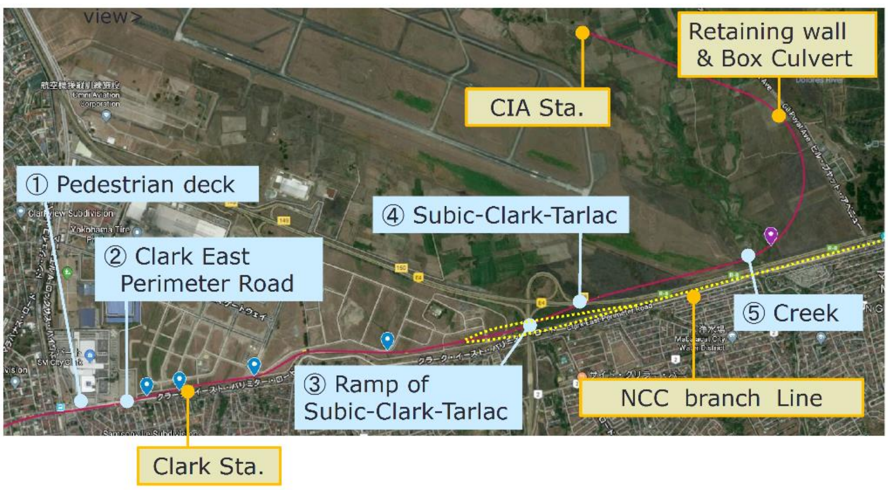
Figure 4.2.11 DPWH river improvement plan

4) Study of CIA area

a) Planning Location

This section is a part from Clark station to CIA station where exist the following obstacle objects:

① Pedestrian bridge connecting a bus terminal from a shopping mall
② Perimeter Road having 4 lanes crossing south of Clark station
③ Subic Clark Tarlac expressway built by embankment
④ Ramp of Subic Clark Tarlac expressway built by embankment
⑤ Creek flowing to the east side



Source: JICA Design Team

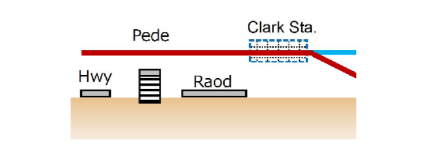
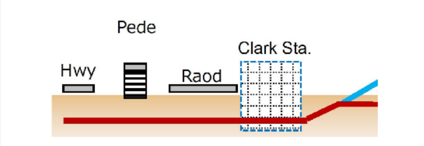
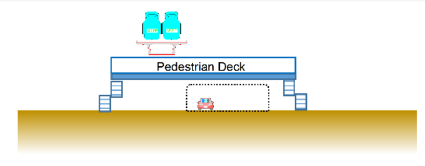
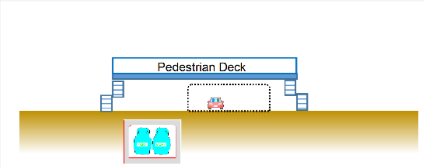
Figure 4.2.12 Planning condition of CIA area

b) Profile plan of CIA area

i) The Section from SM Shopping Mall to Clark station

The section from SM shopping mall to Clark station crosses a pedestrian bridge and perimeter road (4 lane road). Since there is a large intersection in the north and south of the pedestrian deck, at-grate plan has been excluded, viaduct and underground structures are considered for comparison. Based on the comparison, option-1:viaduct is adopted on the view point of the economical efficiency and construction feasibility.

Table 4.2.6 Profile of from SM Shopping Mall to Clark station

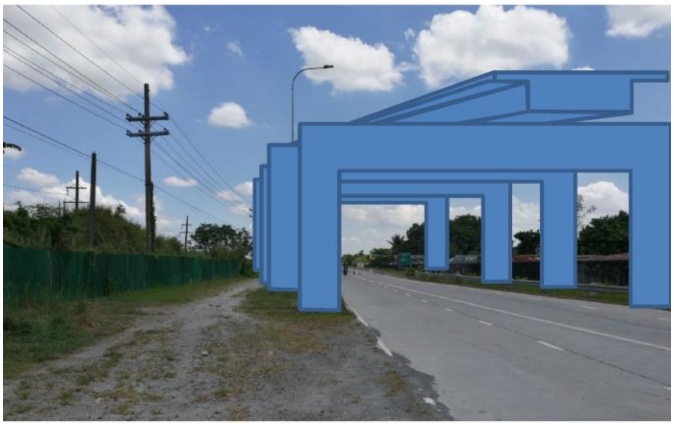
	Option-1	Option-2
Overview		
Cross section		
MCRP	Viaduct	Box Calvert
Clark Sta.	Elevated	Underground
Construction method	Span by span (Standard method of NSCR)	Open Cut
Construction period	Fair	Long
Construction cost	Fair	Expensive
Evaluation	**A**	**B**

Source: JICA Design Team

The line will cross perimeter roads at an extremely shallow angle and the pier cannot be built on the median of the perimeter roads. A bridge of 270 meters is necessary to cross over the road all at once. Therefore, portal type piers crossing the perimeter road continuously supporting the superstructures have been planned.

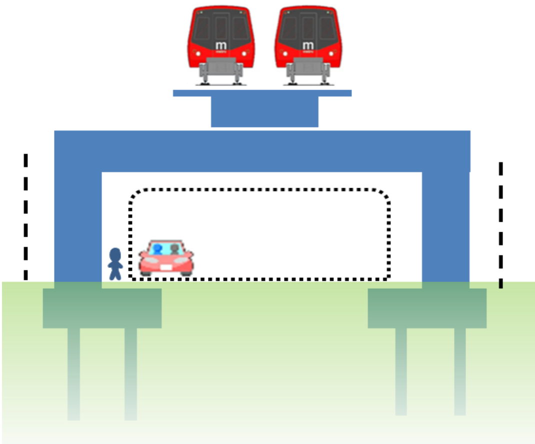
Source: JICA Design Team

Figure 4.2.13 Alignment of the intersection with the perimeter road



Source: JICA Design Team

Figure 4.2.14 Image of crossing over the Perimeter road



Source: JICA Design Team

Figure 4.2.15 Structure image

As a result of trial calculation as standard type (PC box girder bridge (span length 40 m), RC piers), the foundation of the portal piers requires piles of 4 or more on one side. However, the width of the sidewalk on the east side is about 3.5 m. For this reason, it is necessary to reduce the basic reaction force and to reduce the structure in order to plan within the site. So the following two policies are conceivable.

Policy-① By shortening the span length, the reaction force is dispersed

Policy-② Change the super structure and sub structure to steel, and make the whole structure lighter.

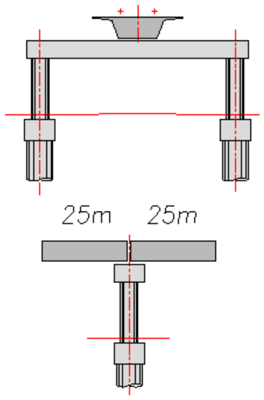
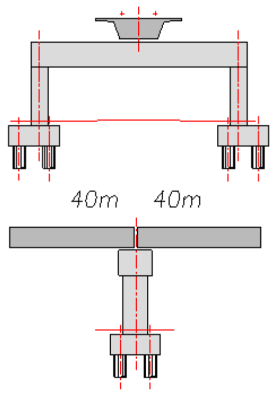
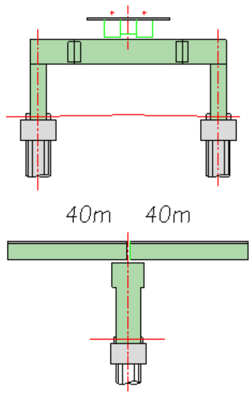
Considering the design direction of this bridge piers, including these, by comparison shown below.

- ✓ Option-1: Standard structure. However, in order to plan the foundation in the site, part of the foundation is planned under the roadway
- ✓ Option-2: In order to plan the foundation in the site, reduce the foundation by reducing the span length. (Policy-①)

- ✓ Option-3: In order to plan the foundation in the site, Change superstructure and sub structure to steel, reduce reactive force.（Policy-②）

The results of the study, Option-1 which is structurally reasonable and highly economical is adopted.

Table 4.2.7 Study of Structure

Option	Opt-1	Opt-2	Opt-3
Cross Section (rigid frame pier)			
Super Structure pan	PC 25m	PC 40m	Steel 40m
Sub Structure	RC	RC	Steel
Foundation	Single	Group	Single
Construction period time	B	B	A
Cost	B	A	C
Evaluation	B	A	C

Source: JICA Design Team

ii) Crossing SCTEx and the Junction Road

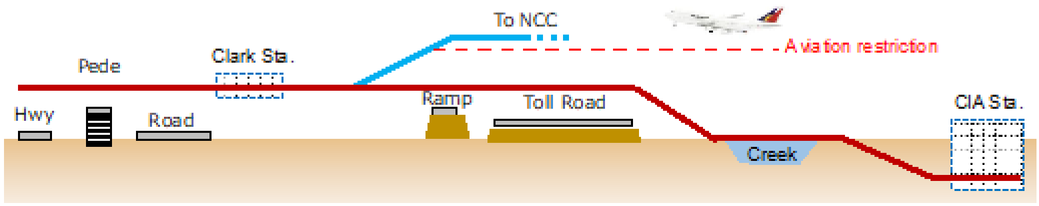
MCRP is diverged into 2 lines, one is main line going to C.I.A Station, and other one is branch line bound for NCC station before the both lines cross the junction road connecting Subic Clark Tarluck Express Way (SCTEx) and the North Luzon Express way (NLEx). The branch line bound for NCC have to pass the mainline going to C.I.A through under or flyover the mainline.

There are 3 options to cross SCTEx and the junction road as shown below. Since the total height of Option-1, however, is higher than the height limitation of takeoff limit, option-1 cannot be applied. Therefore either the mainline or the branch line can cross junction road by bridge and other one must go through under the junction road.

Table 4.2.8 Policy of cross SCTEx and the junction road

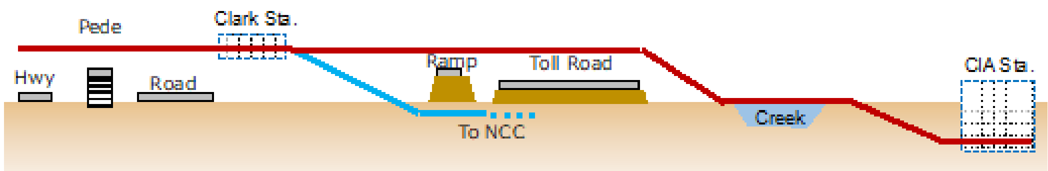
<table>
<tr><td>

✓ **Option-1** : Mainline overpass the Junction road and SCTEx by Bridge, and branch line bound for NCC over pass mainline.



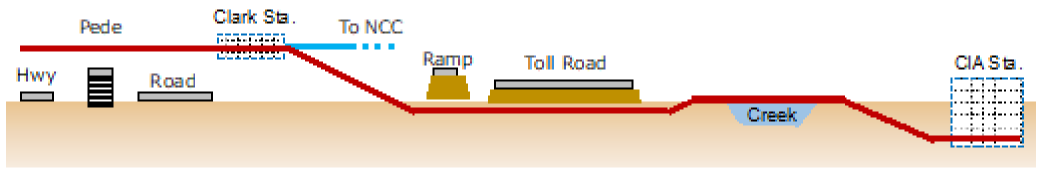
</td><td>×</td></tr>
<tr><td>

✓ **Option-2** : Mainline overpass the Junction road and SCTEx by Bridge, and branch line bound for NCC through under junction road.



</td><td>○</td></tr>
<tr><td>

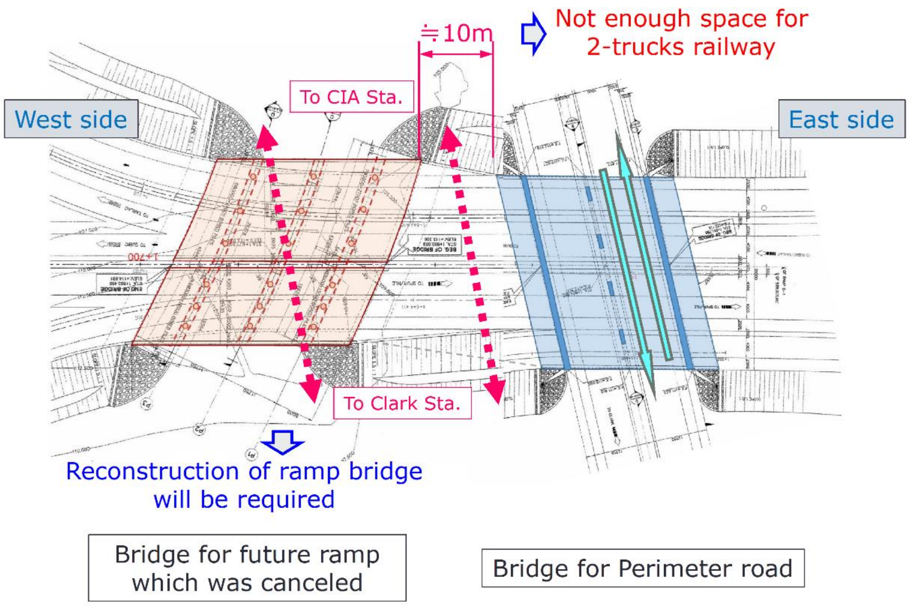
✓ **Option-3** : Mainline through the Junction road by semi-underground structure and SCTEx by tunnel (Box Culvert) and branch line bound for NCC over pass mainline and the Junction road.



</td><td>○</td></tr>
</table>

Source: JICA Design Team

There are 2 bridges where MCRP crosses the junction road, one is for CDC's perimeter road and other one is for new ramp way of SCTEx which was planned to construct in future but it has been canceled now, therefore, the position of crossing the junction road have to be study when MCRP goes through under the junction road. Since the distance between these two bridges is around 10m at smallest, which is in north side of the junction road, it is difficult that the mainline or branch line, which width is more than 11m, go through between both bridges by underpass tunnel of the junction road. And it also difficult that MCRP goes through under the bridge for the canceled future ramp way space because the bridge is carved and MCRP mainline and the ramp way (space under the bridge) meet at an angle.

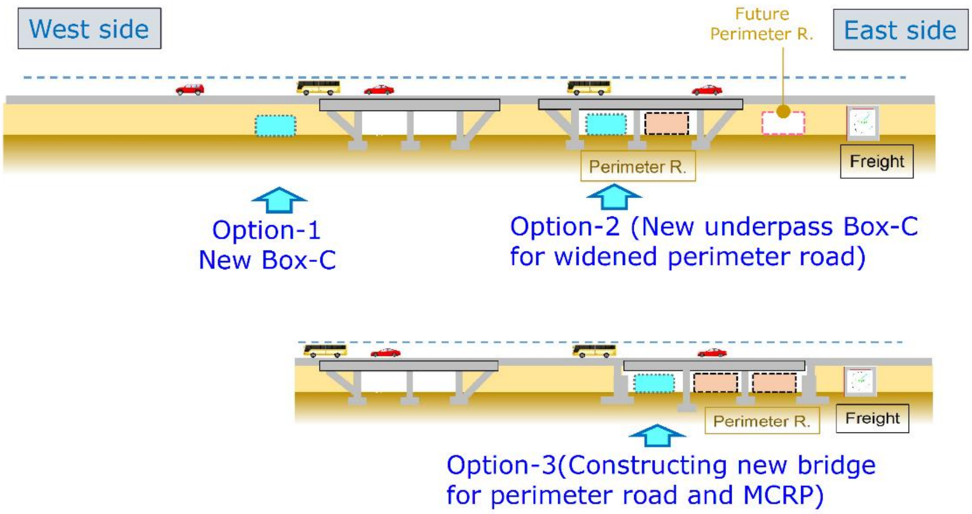


Source: JICA Design Team

Figure 4.2.16 Two bridges of ramp

From mentioned above, the options going through under the junction road by semi-underground tunnel are as follow.

- ✓ Option-1: Construct new cut and cover tunnel west side of the existing bridges
- ✓ Option-2: Use existing the space for future perimeter road and construct new bridge
- ✓ Option-3: Reconstruct new bridge for MCRP and perimeter road including its future



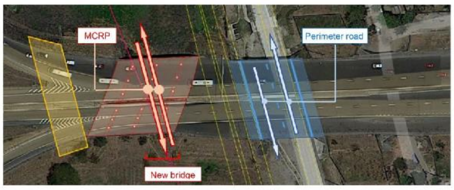
Source: JICA Design Team

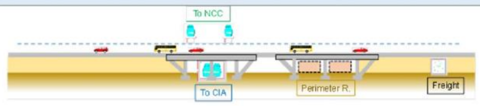
Figure 4.2.17 A study plan near the ramp bridge

The comparison of 3 options mentioned above is shown Table 4.2.9 From this table, Option-2 is selected for the plan which the mainline or branch line go through under Junction road in terms of construction cost and period, and occupied area of urban development, which is under taking by Global Gateway Development Corporation (GGDC), to MCRP.

Table 4.2.9 Comparison of Method for Underpass Junction Road

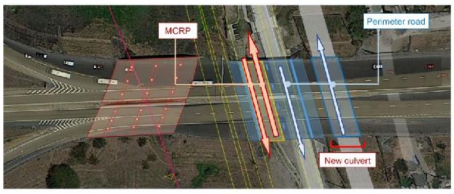
Option-1

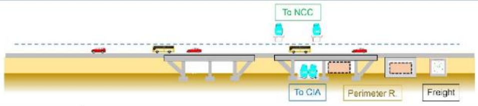




MCRP	Construct a new Bridge at the future IC bridge which was canceled	B
Perimeter road	Under the existing bridge	
Affect to GGDC area	Biggest	
Construction Period	Longer than Option2	
Construction Cost	Expensive	

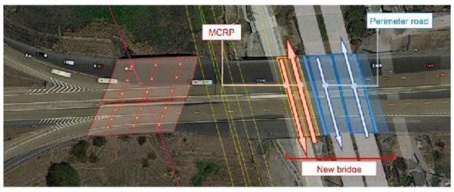
Option-2

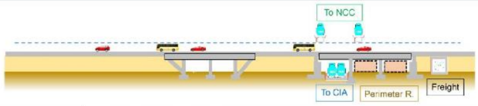




MCRP	Under the existing bridge	A
Perimeter road	Construct a new culvert (2-trucks), and under the existing bridge	
Affect to GGDC area	Less than Option 1 but bigger than Option 3	
Construction Period	Shortest	
Construction Cost	Fair	

Option-3





MCRP	Under the replace bridge	C
Perimeter road	Under the replace bridge	
Affect to GGDC area	Minimum	
Construction Period	Longest	
Construction Cost	Most expensive	

Source: JICA Design Team

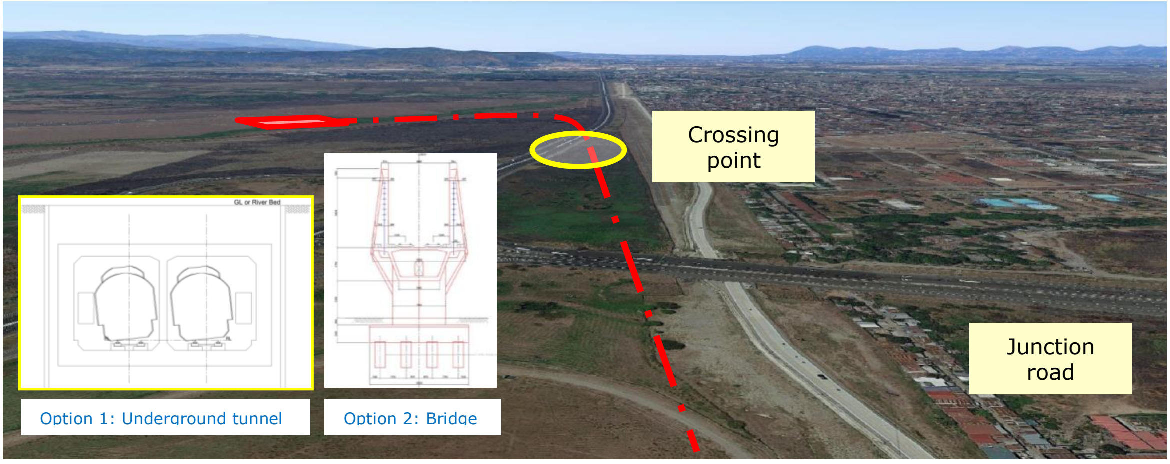
① Investigation of intersection with SCTEx (semi-underground plan)

The mainline going to CIA station is cross SCTEx after crossing the junction road(seeFigure 4.2.18). There are 2 options for crossing SCTEx, one is cross over by a bridge and other one is going through under SCTEx by a cut and cover tunnel.

Option-1: The main line goes through under the junction road and SCTEx, and the brunch line bound for NCC crosses over the junction road and SCTEx.

Option-2: Main line crosses over the junction road and SCTEx, and the brunch line bound for NCC goes through the space under the bridge of the junction road.

Comparison of both options mentioned above is surmalize in Table 4.2.10.



Source: JICA Design Team

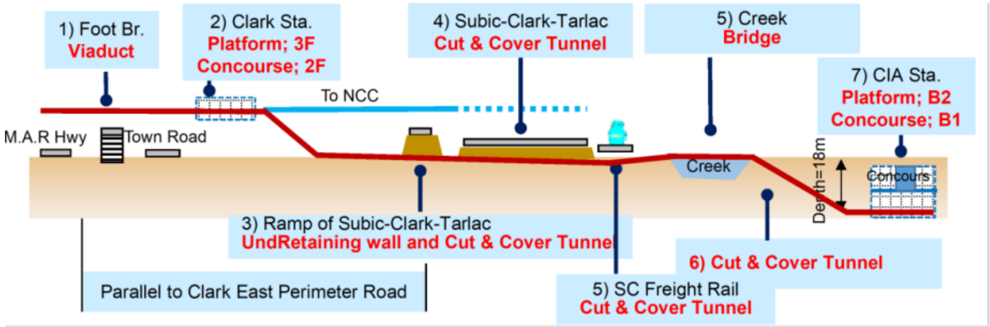
Figure 4.2.18 Location of Crossing SCTEx

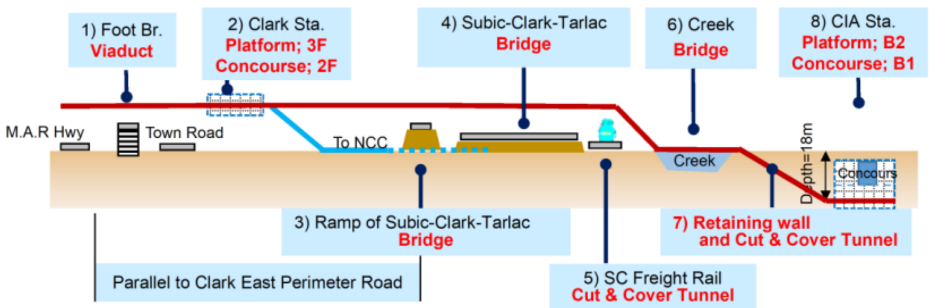
Regarding option-1, it is required the traffic regulation of SCTEx during the construction of cut and cover tunnel. It is necessary to divert SCTEx during the construction and 2 lanes for each direction (4 lanes in total) are secured to avoid traffic congestion (see Table 4.2.10). The construction sequence and schedule of the tunnel construction at crossing SCTEx is shown Figure 4.2.19 and Figure 4.2.20.

From the Table 4.2.10, the timeline Option-2 is selected because the construction period of option-1 is 38month. It is longer than the target construction period, which is 27 month.

Regarding traffic regulation during the construction of bridge crossing over SCTEx, the diversion road is not required, however, the short time traffic regulation or traffic management is sometime required.

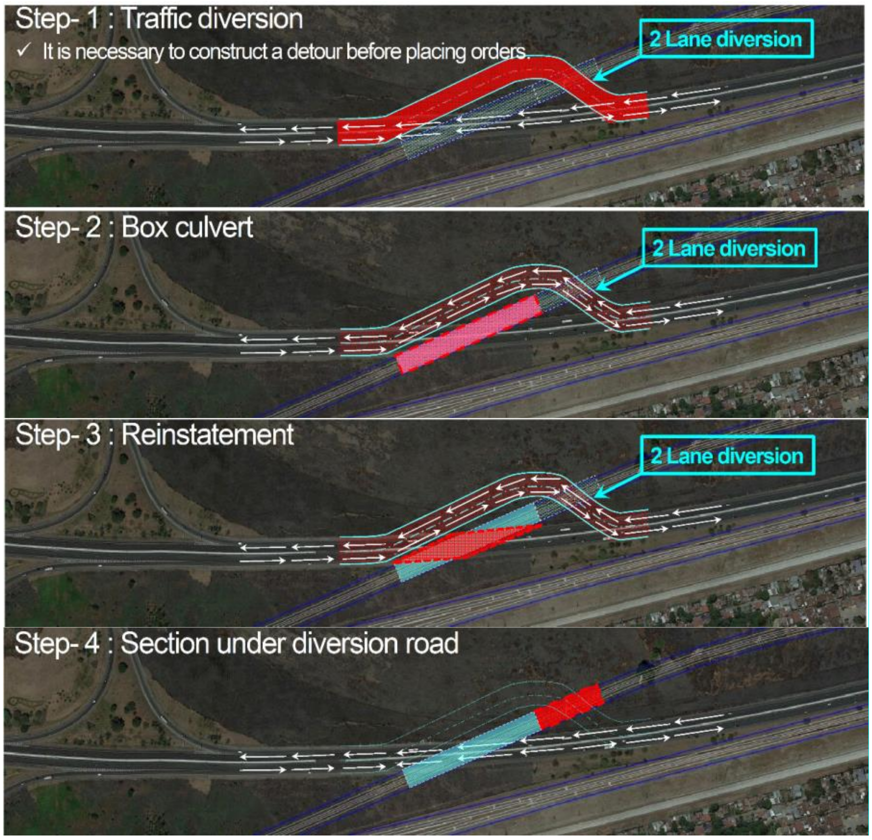
Table 4.2.10 Comparison of the plans to cross Junction Road and SCTEx

<table>
<tr><td colspan="2">Option-1; The mainline crosses SCTEx and JCT road by underground structure</td></tr>
<tr><td colspan="2">


</td></tr>
<tr><td>
➢ <u>Construction period (main line)</u>
• Viaduct & Bridge; within 27 month
• Underground ; 38 month (Critical)
• CIA Sta. (Civil) ; 34 month
• CIA Station is most critical. It need 34 month for only Civil works
• If DOTr can complete diversion road for SCTEx before start construction, it can be complete 27month
</td><td>
➢ <u>Construction cost for main line</u>
• Viaduct & Bridge ; [redacted]
• Underground ; [redacted]
• CIA Sta. (Civil) ; [redacted]
• Total Cost ; [redacted]
<u>Construction cost is lower</u>
</td></tr>
<tr><td colspan="2">Option-2; The main line crosses SCTEx and JCT by bridges.</td></tr>
<tr><td colspan="2">


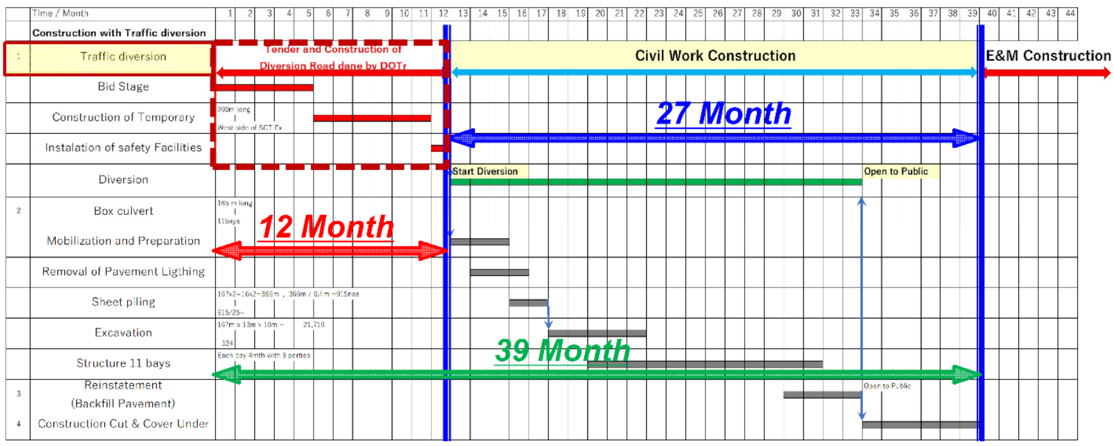
</td></tr>
<tr><td>
➢ <u>Construction period (main line)</u>
• CIA Station is most critical. It need 34 month for only Civil works
• Other works can be complete 27 month
</td><td>
➢ <u>Construction cost for main line</u>
• Viaduct & Bridge ; [redacted]
• Underground ; [redacted]
• CIA Sta. (Civil) ; [redacted]
• Total Cost ; [redacted]
<u>Construction cost is Higher</u>
</td></tr>
</table>

Source: JICA Design Team



Source: JICA Design Team

Figure 4.2.19　Cut and Cover tunnel Construction Sequence



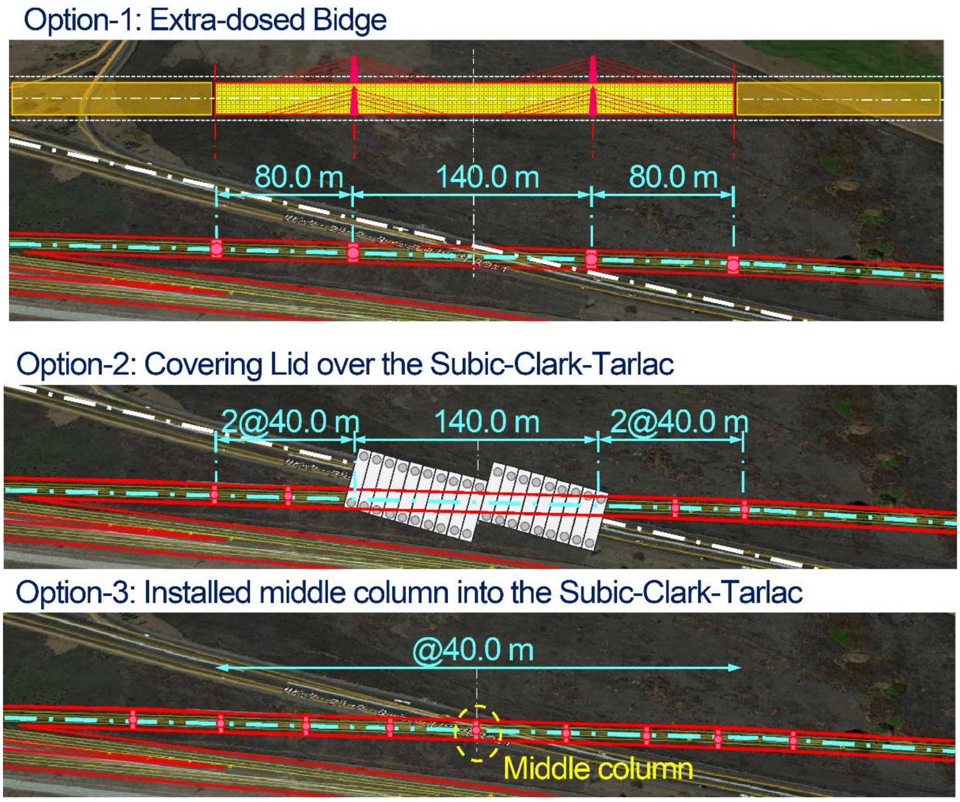
Source: JICA Design Team

Figure 4.2.20　Schedule of Cut and Cover Construction at crossing SCTEx

② Study Bridge Type to Cross Over SCTEx

The brige types to enable the main line to cross over SCTEx can be considered as shown below.

- ✓ Option-1: 1 spaned bridge (L=140m) (No pier in SCTEx)
- ✓ Option-2: Viaduct with short interval portal pier along SCTEx
- ✓ Option-3: 2 spaned bridge (L=40m+40m) (One pier is in SCTEx)



Source: JICA Design Team

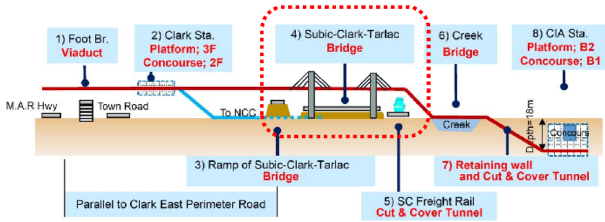
Figure 4.2.21 Option of Bridges that cross with SCTEx

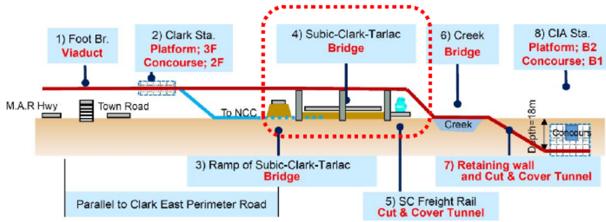
The minimum span length enable to cross the SCTEx when center-pier is in the median of SCTEx is 40m and diameter of center pier is 3.5m. The width of median of SCTEx, however, is 3.0m, therefore SCTEx is required to change alignment permanently. And also temporary diversion is required during construction of the center pier to obtain the space for construction. For that reason, only 1 lane diversion road is secured each direction (total 2 lanes) (see Figure 4.2.21).

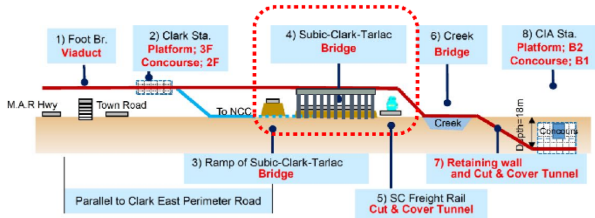
As mentioned above and Table 4.2.10, 2 lanes diversion road should be secured for each direction traffic to avoid the traffic congestion during construction of the center pier.

The comparison of three options is shown Table 4.2.11. From this table, the option-1 is selected in terms of construction period and impact on traffic of SCTEx.

Table 4.2.11 Comparison of Bridge type that cross with SCTEx

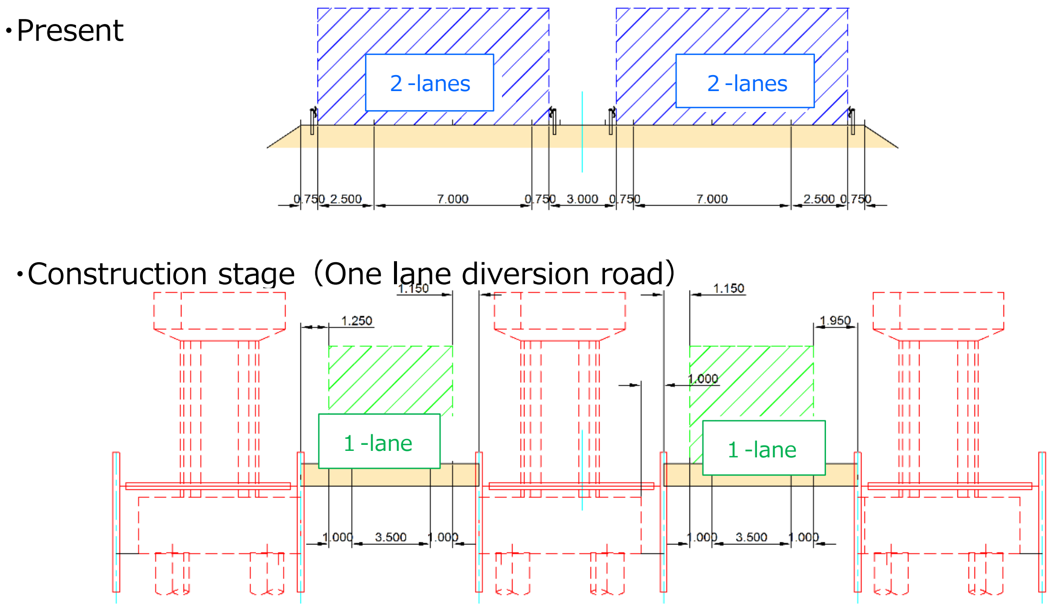
<table>
<tr><td>Option-1: Extra-dosed Bridge</td><td>Adopt</td></tr>
<tr><td>
</td><td>Construction period
CIA Station is most critical. It need 34 month for only Civil works
Other works can be complete 27 month
There will be very short time disruption during the construction (either early morning or midnight time)

Construction cost is Higher
Total Cost ; [redacted]</td></tr>
<tr><td colspan="2">Option-2: Covering Lid over the SCTEX</td></tr>
<tr><td>
</td><td>Construction period
CIA Station is most critical. It need 34 month for only Civil works
Other works can be complete <u>27+α month</u>
<u>Heavy traffic jam occurs due to lane regulation during the construction</u>
(afternoon)

Construction cost is Higher
Total Cost ; [redacted]</td></tr>
<tr><td colspan="2">Option-3: Covering Lid over the SCTEX</td></tr>
<tr><td>
</td><td>Construction period
CIA Station is most critical. It need 34 month for only Civil works
Other works can be complete <u>27+α month</u>
There will be <u>many time disruption</u> during the construction (either early morning or midnight time)

Construction cost is Higher
Total Cost ; [redacted]</td></tr>
</table>

Source: JICA Design Team



Source: JICA Design Team

Figure 4.2.22 Trafic regulation during construction of center pier

Table 4.2.12 Analysis Result of Traffic Condition Study on One Lane Diversion

	Without		With			Without		With	
	NB	SB	NB	SB		SB	NB	SB	NB
06:00-7:00	A	A	B	B	14:00-5:00	B	B	**E**	**E**
07:00-8:00	B	B	D	C	15:00-6:00	B	B	**E**	**E**
08:00-9:00	B	B	C	C	16:00-7:00	C	C	**F**	**F**
09:00-10:00	B	B	C	C	17:00-8:00	C	C	**F**	**F**
10:00-11:00	B	B	D	D	18:00-9:00	B	B	**E**	**E**
11:00-12:00	B	B	C	C	19:00-0:00	B	B	C	C
12:00-13:00	B	B	D	C	20:00-1:00	B	B	C	C
13:00-14:00	B	B	D	D	21:00-2:00	B	B	B	B

Source: JICA Design Team

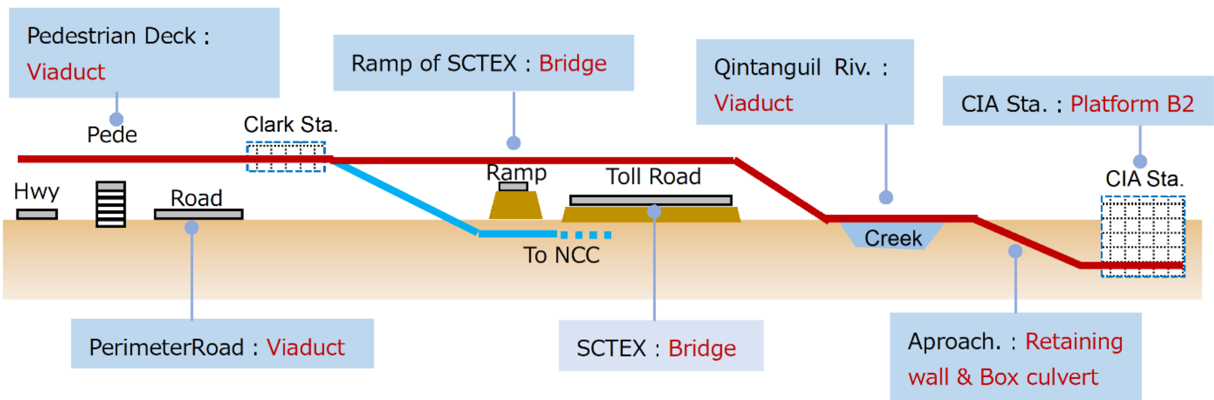
Table 4.2.13 Rough Standard of Traffic Congestion Degree

LOS	Characteristics	VCR
A	Condition of free flow with high speeds and low traffic volume wherein drivers can choose desired speeds without delays.	0.00 – 0.19
B	In stable flow zone wherein drivers have reasonable freedom to select their speed.	0.20 – 0.44
C	In stable flow zone wherein drivers are restricted in selecting their speed.	0.45 – 0.69
D	Approaches unstable flow and nearly all drivers are restricted. Service volume corresponds to tolerable capacity.	0.70 – 0.84
E	Traffic volumes near or at capacity and flow is unstable with momentary stoppages.	0.85 – 1.00
F	Forced or congested flow at low speeds with long queues and delays.	1.00<

Source: JICA Design Team

iii) Study of CIA area

Based on the above, alignment of the CIA area was planned with the following.

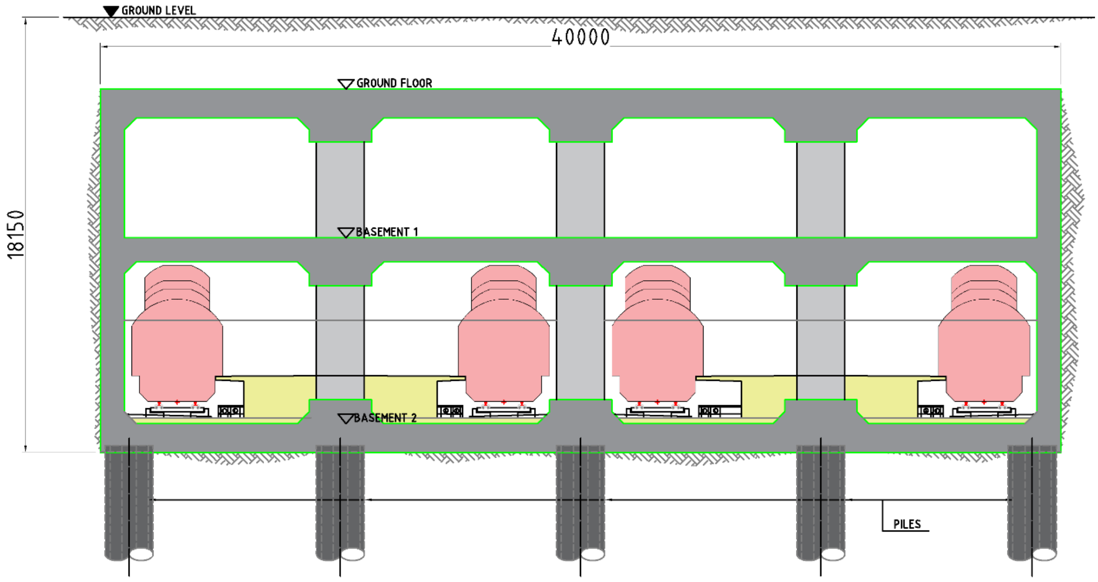


Source: JICA Design Team

Figure 4.2.23 Profile of CIA area

c) Planning policy of CIA station

i) Structure of CIA station



Source: JICA Design Team

Figure 4.2.24 Structure of CIA station

ii) Clark station～DEPOT

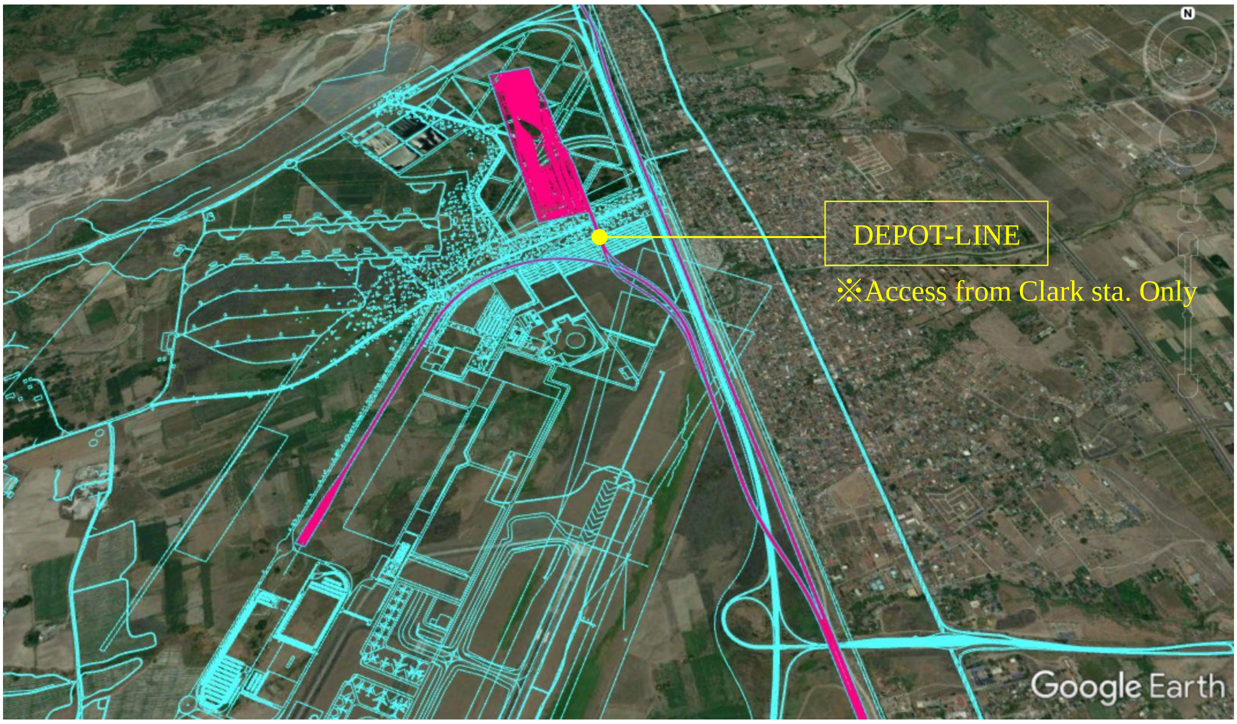


Figure 4.2.25 Branch plan from Clark station to Depot

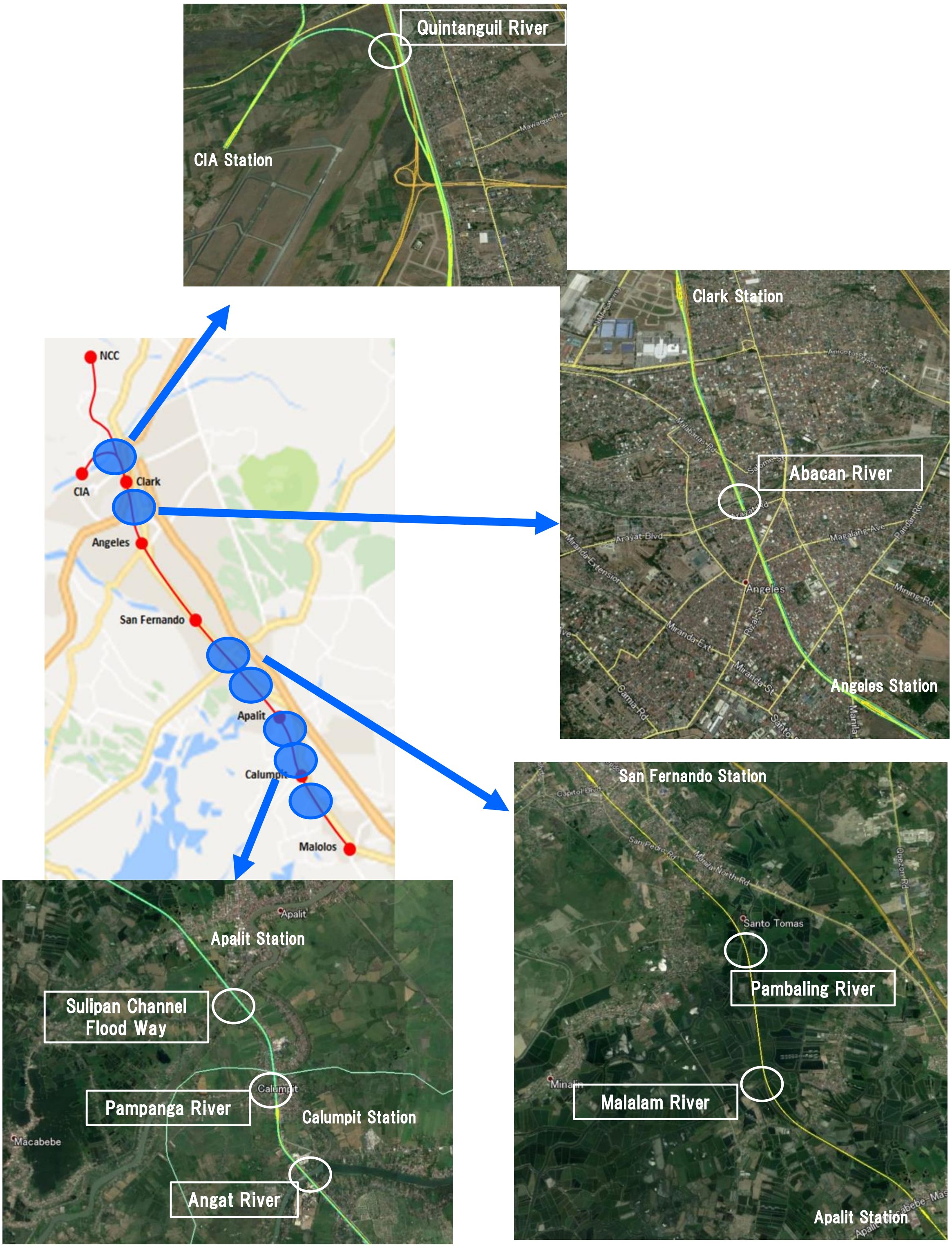
5) Planning policy at river area

a) Target River & Location

Table 4.2.14 Target River List

Name of River	Kilometrage	Width	Comment
Angat River	40k 960	120m	(Buliham Bridge)
Pampanga River	43k 200	150m	(Calumplit Bridge)
Sulipan Channel Flood way	45k 000	320m	
Malalam River	50k 720	35m	
Pambaling River	53k320	50m	
Abacan River	76k200	80m	
Qintanguil River	82k900	150m	

Source: JICA Design Team

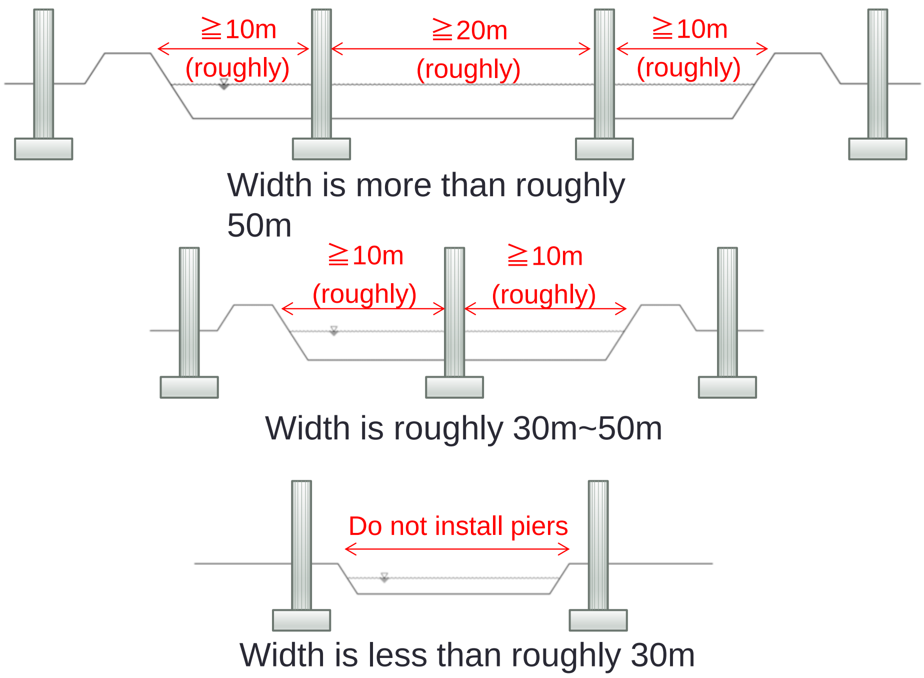


Source: JICA Design Team

Figure 4.2.26 Target River Location

b) Planning policy

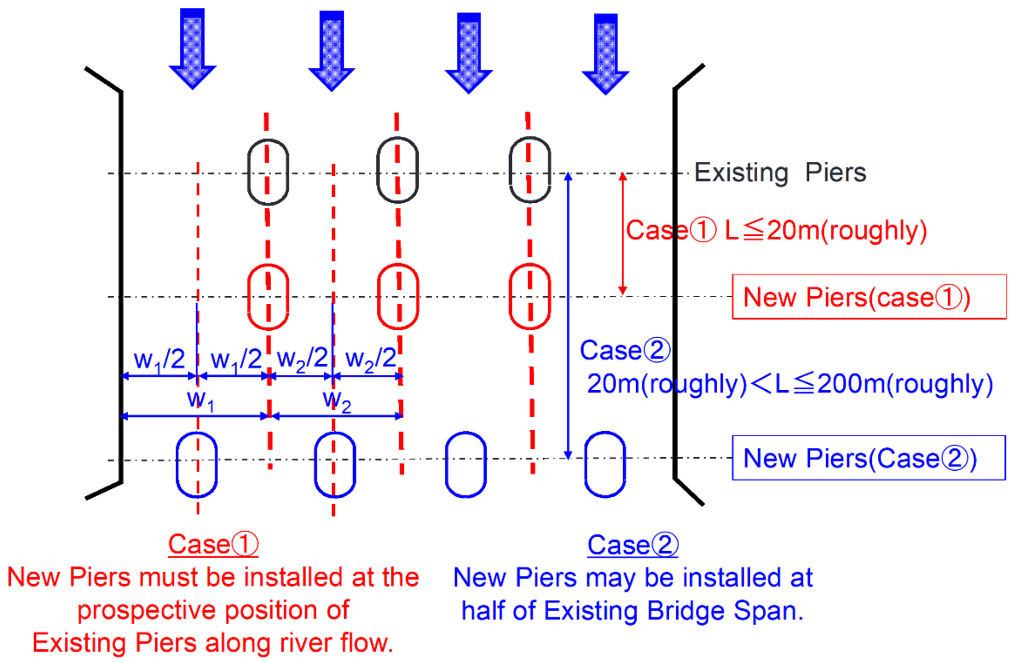
Span layout must comply with the width of the river in the case of.



Source: JICA Design Team

Figure 4.2.27 Planning policy

The span layout must adjust Existing Pier



Source: JICA Design Team

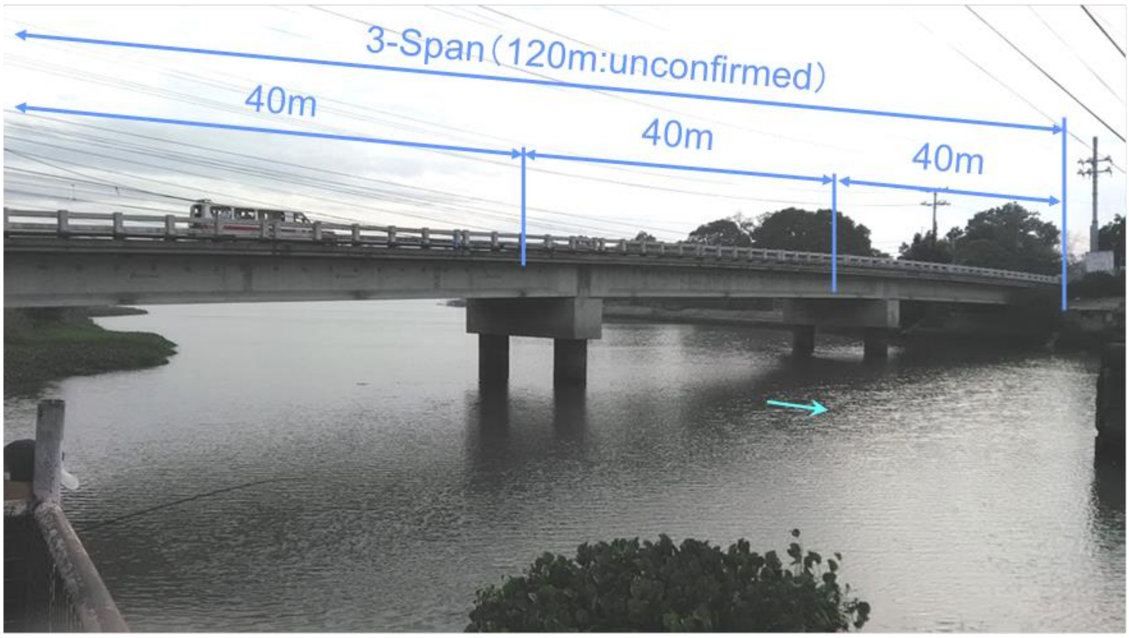
Figure 4.2.28 The span layout must adjust Existing Pier

c) Study of span layout

i) Angat River (41k 000)

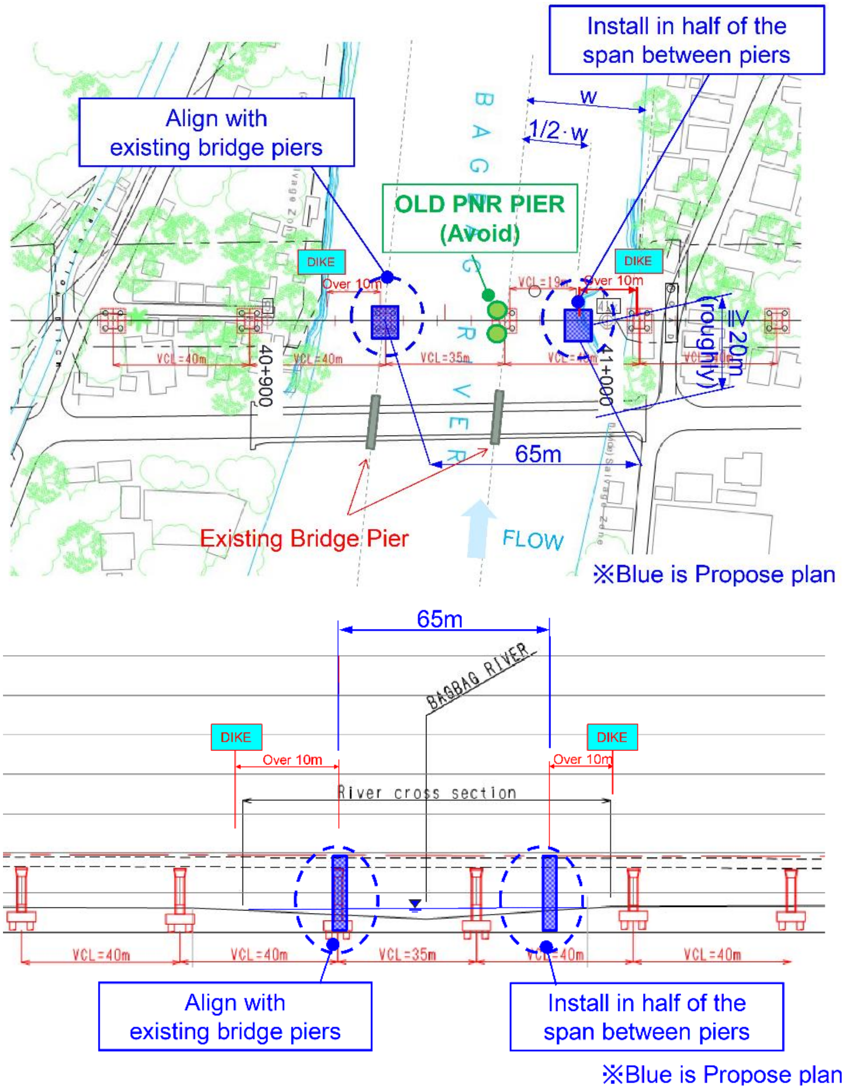
Source: JICA Design Team

Figure 4.2.29 Angat River



Source: JICA Design Team

Figure 4.2.30 Existing bridge



Source: JICA Design Team

Figure 4.2.31 Planning

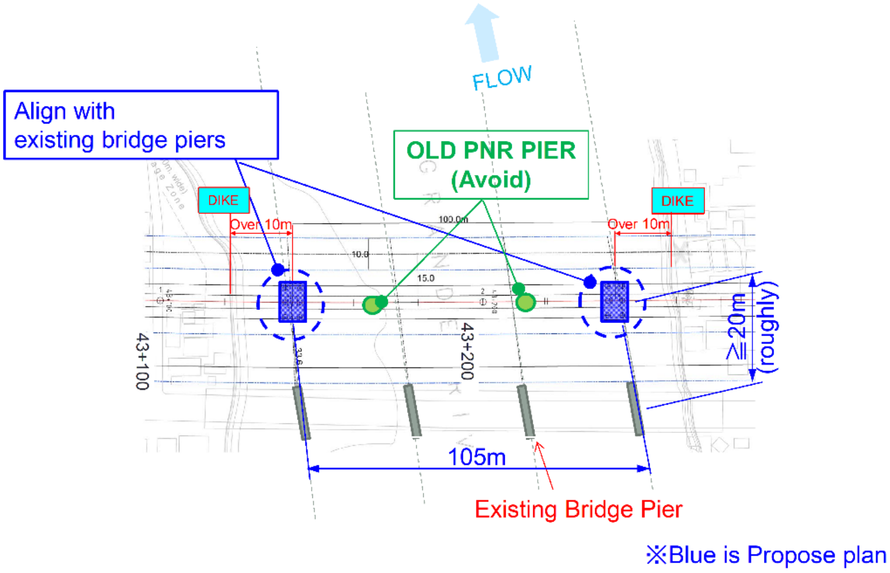
ii) Pampanga River (43k 200)

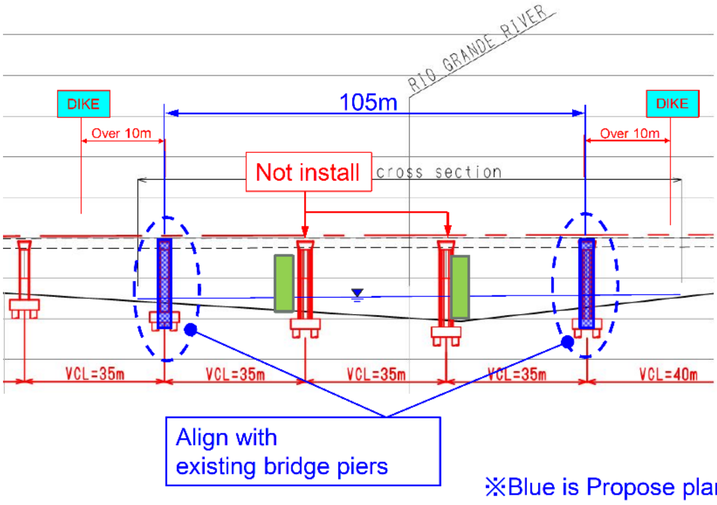
Source: JICA Design Team

Figure 4.2.32 Pampanga River

Source: JICA Design Team

Figure 4.2.33 Existing bridge

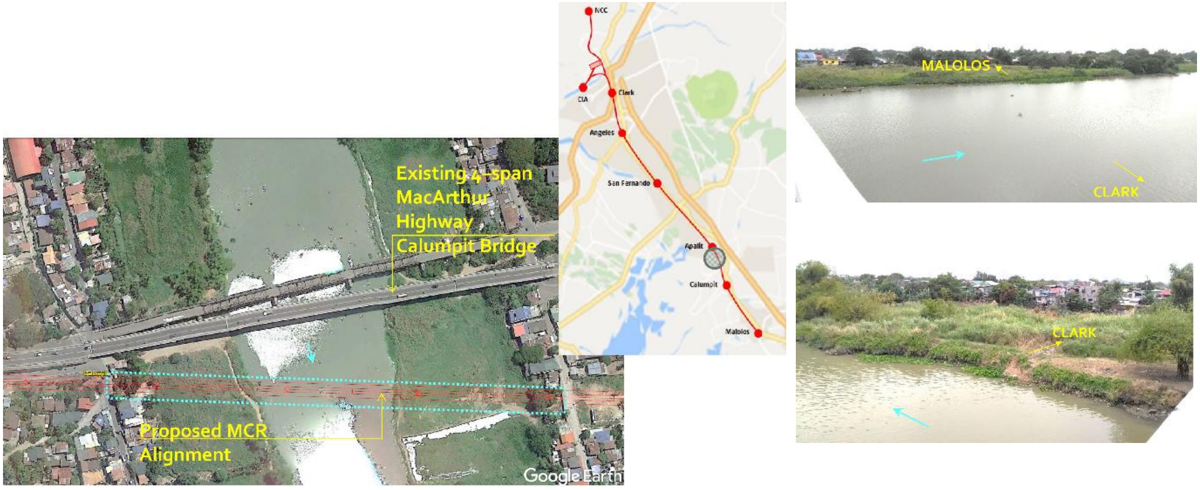




Source: JICA Design Team

Figure 4.2.34 Planning

iii) Sulipan Channel Flood Way (45k 000)

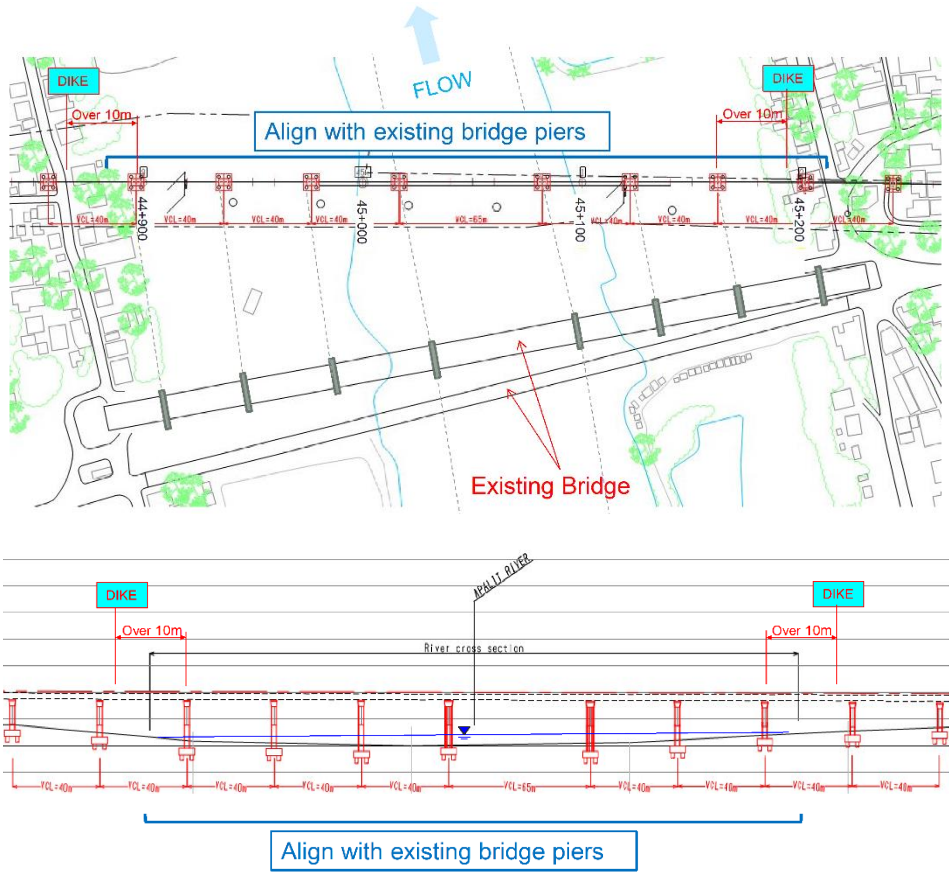


Source: JICA Design Team

Figure 4.2.35 Sulipan Channel Flood Way

Source: JICA Design Team

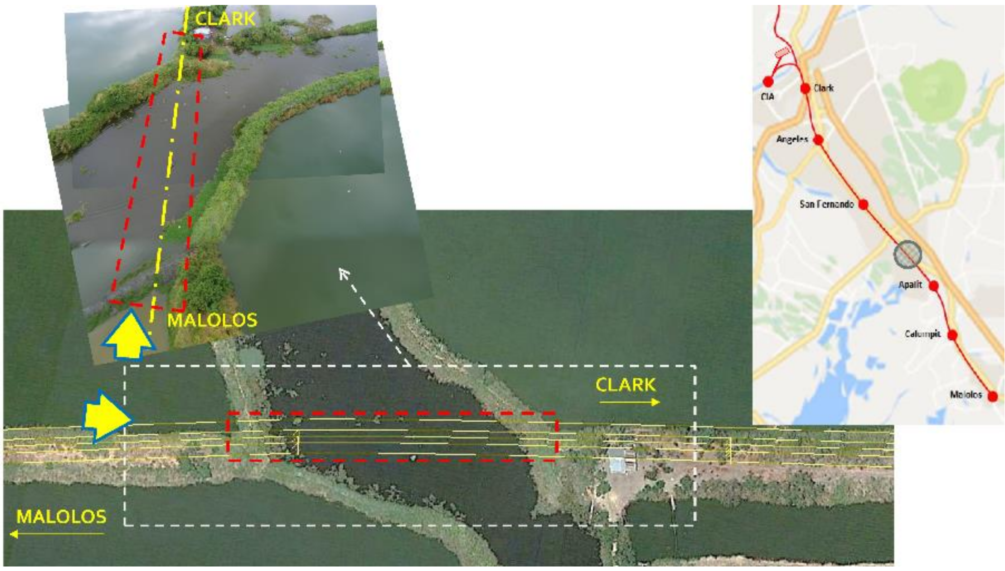
Figure 4.2.36 Existing bridge



Source: JICA Design Team

Figure 4.2.37 Planning

iv) Malalam River (50k 720)

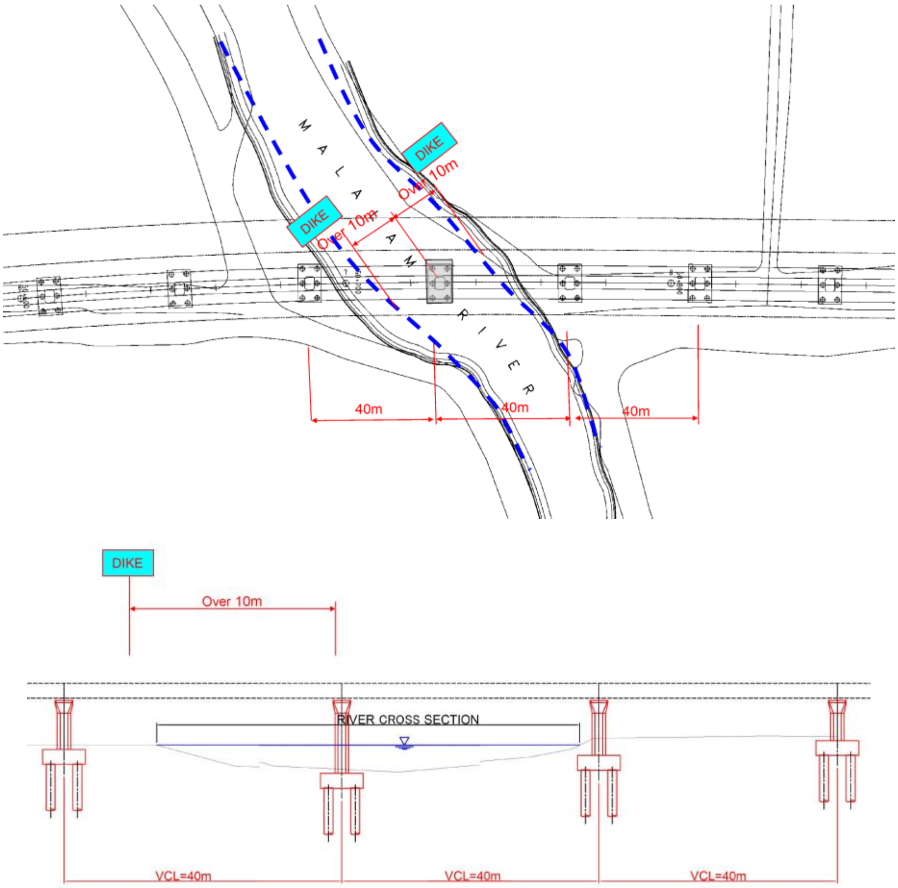


Source: JICA Design Team

Figure 4.2.38 Malalam River

Source: JICA Design Team

Figure 4.2.39 Existing bridge



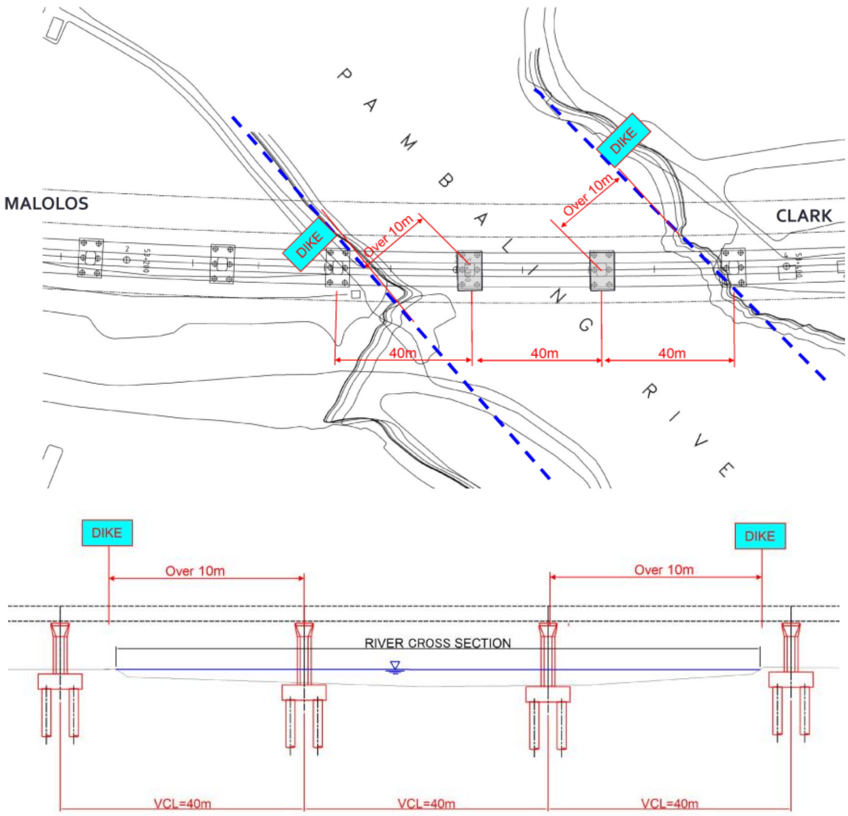
Source: JICA Design Team

Figure 4.2.40 Planning

v) Pambaling River (53k 320)

Source: JICA Design Team

Figure 4.2.41 Pambaling River



Source: JICA Design Team

Figure 4.2.42 Planning

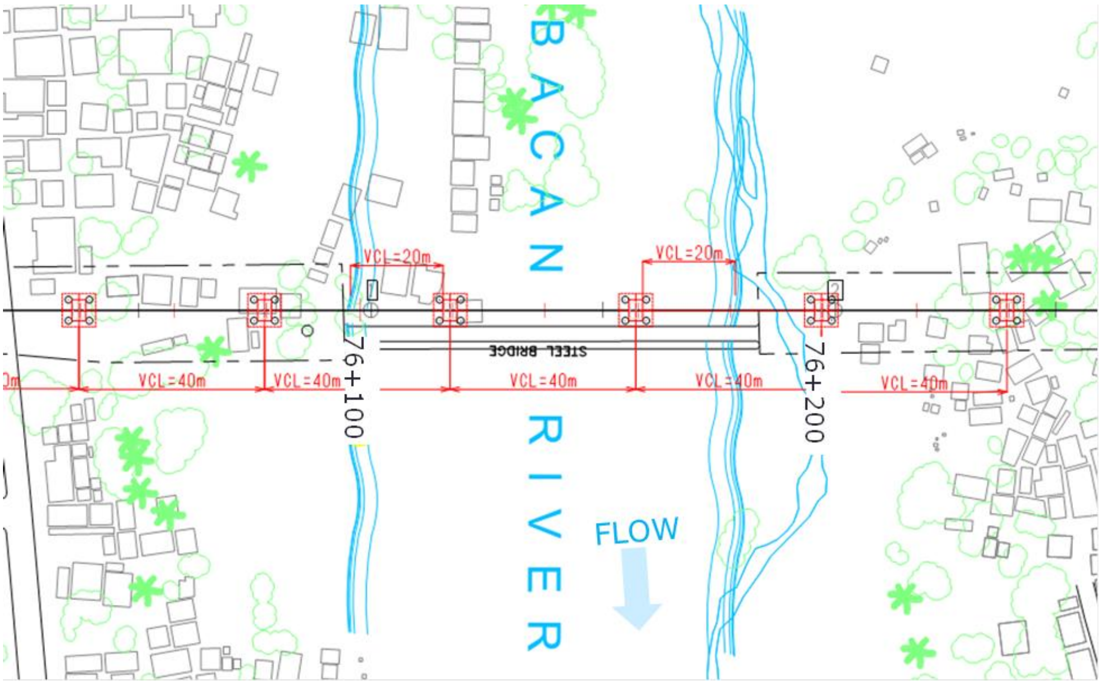
vi) Abacan River (76k 200)

Source: JICA Design Team

Figure 4.2.43 Abacan River

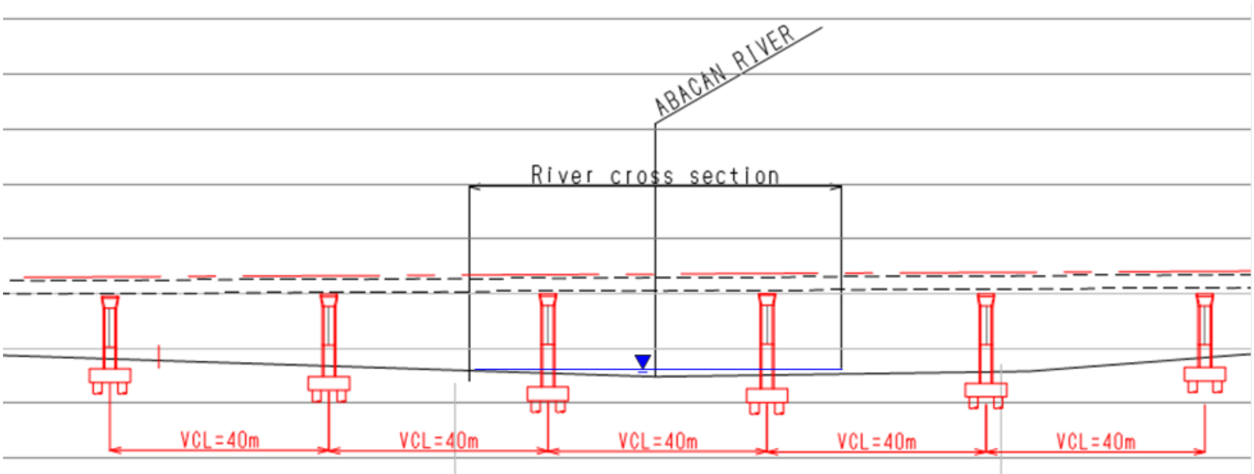
Source: JICA Design Team

Figure 4.2.44 Abacan River



Source: JICA Design Team

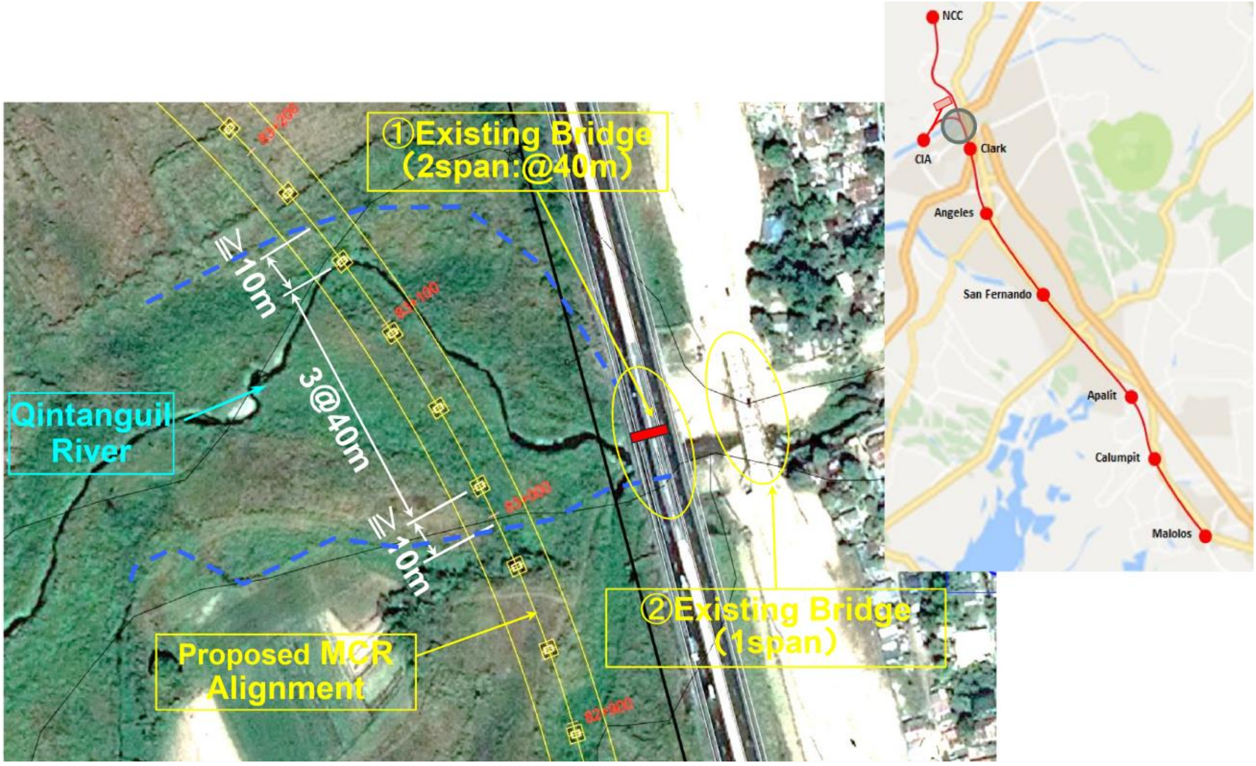
Figure 4.2.45 Planning



Source: JICA Design Team

Figure 4.2.46 Side view

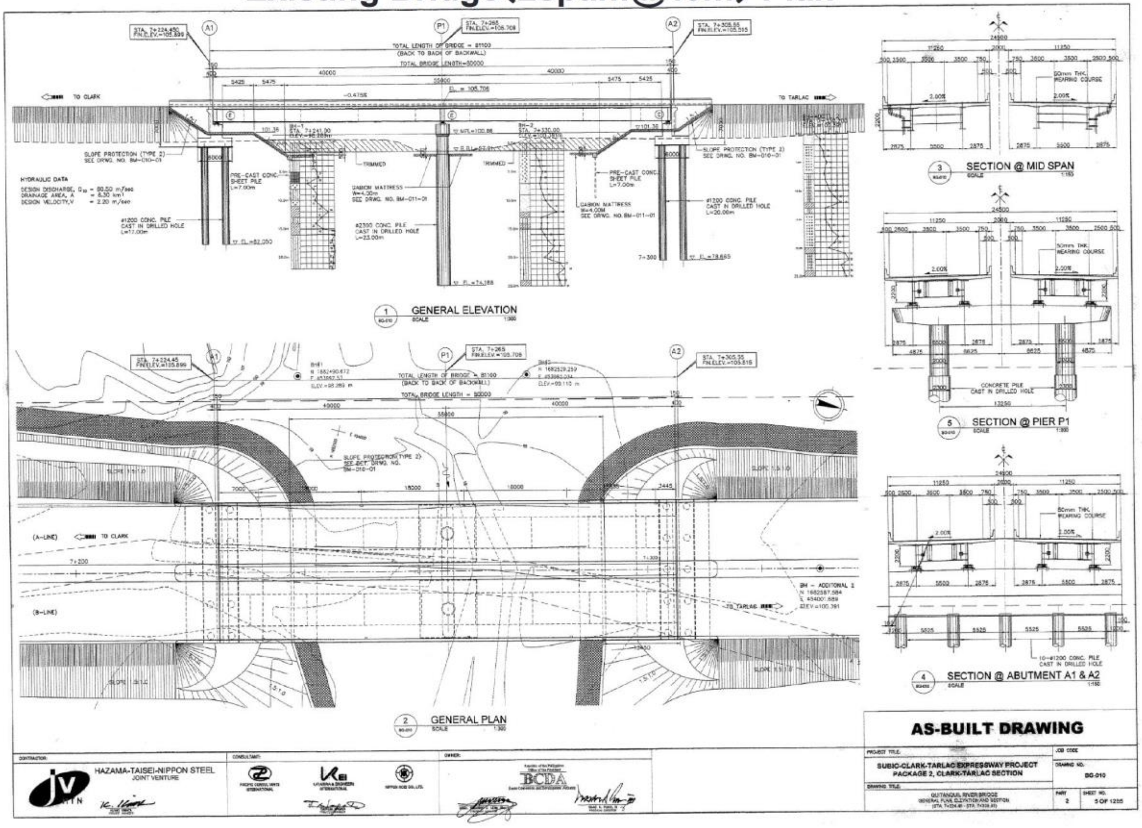
vii) Qintanguil River (82k 900)



Source: JICA Design Team

Figure 4.2.47 Abacan River and Planning

Existing Bridge(2span:@40m) Plan



Source: JICA Design Team

Figure 4.2.48 Existing bridge

4.2.2 Track

(1) Comparison of Ballasted Track and Ballast-less Track

The track structure adopts the same structure type as NSCR track as a basis, but it shall be modified according to the speed, running conditions of the passing train, the alignment and civil structure supporting condition of formation level.

Source: JICA Design Team

Figure 4.2.49 Ballast less Track structure
(Elastic sleeper directly fastened track on concrete bed)

At the beginning of railway development ballasted track was applied. Crushed stone is used for track bed to support sleepers. This is a simple structure, the construction cost is relatively low and it can be easily corrected against roadbed displacement. From this reason ballasted track have been adopted in all over the world railways up to the present age.

The main advantages of ballasted track are, easy replacement of track components, good damping of noise and vibration. As the speed is increasing, high precision laying of track is done using large maintenance machines and it has been adopted in 300 km/h sections.

The general problem with ballasted track is relatively heavy loads on the viaducts or bridges, vertical and lateral irregularities due to repeated train load are likely to occur, and consequent maintenance is required.

On the other hand, many ballast-less tracks(BLT) have been developed in the second half of the 20th century for the purpose of reducing maintenance work. The main advantages of ballast-less track are relatively light, little displacement, higher stability and reliability. The disadvantage is that the initial construction cost is higher than the ballasted track. However long-term life cycle cost is judged to be lower than ballasted track by small maintenance cost. Noise and vibration are slightly higher than ballasted track in the past, but the vibration level approximately becomes equivalent to ballast track by many improvements.

A comparison of characteristic for ballasted track and ballast-less track is provided in Table 4.2.15.

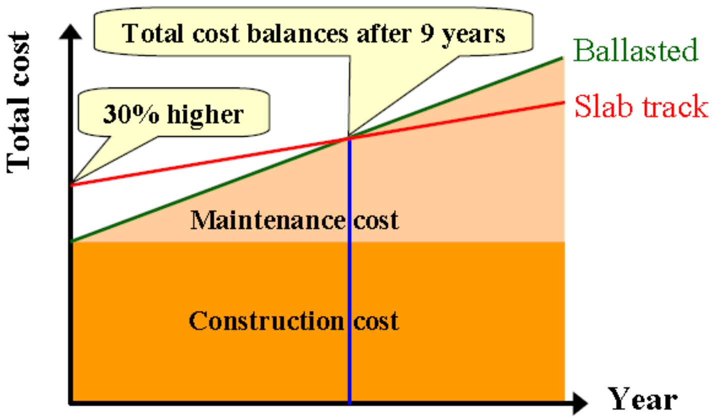
Table 4.2.15 Comparison of Ballasted Track and Ballast-less Track

	Ballasted Track	Ballast-less Track
Components	1. PC Sleeper 2. Crushed stone Ballast	1. RC/PC Sleeper 2. Elastic support
Construction Cost	Relatively low	+20 ~ 30% Higher than Ballasted Track
Noise & Vibration	Relatively small	Within the tolerable limits
Riding Quality	Satisfactory level	Superior level
Life Cycle	15-20 years serviceable or more	30-40 years serviceable or more
Maintenance Requirement	Maintenance (realignment) required but easy. Roadbed Strength and track precise in construction is essential to minimize maintenance works.	Basically, maintenance free. In the case of differential settlement, maintenance work is not easy and require time.

Source: JICA Design Team

(2) Life Cycle Cost of Ballasted and Ballast-less Track

The schematic of the life cycle cost of ballasted and ballast-less track is shown in Figure 4.2.50. According to the past experience the initial construction cost of ballast-less track is about 20-30% higher than that of the ballasted track. But the total cost including construction and maintenance will be balanced at 9th-10th year later to that of the ballasted track. Another merit of ballast-less track is relatively light weight that can reduce the design dead load for viaducts and bridges.



Source: JICA Design Team - RTRI document

Figure 4.2.50 Comparison of Total Cost of Ballasted Track and Ballast-less Track

(3) Track-Form/Structure of Ballast-less Track

There are many kinds of ballast-less track used in the world. The representative features of that are as follows. Common ballast-less track forms include the Japanese-Slab track, the plinth track, Rheda track, and the elastic sleeper directly fastened track. (refer Figure 4.2.51) These tracks should be evaluated for the aplication of viaducts, bridges and embankment from the point of view of workability, functionality, maintainability and the life cycle cost.

1) Plinth Track

Pedestal called plinth is constructed on roadbed concrete and rail is fastened to directly on it. It has simplest structure in ballast less track. Only rail pads provide elasticity for the track. Plinth track has been laid in many countries in Europe, Canada and Southeast Asia, and Manila LRT 2, MRT 3 in Philippines.

[Achievements in Japan] That corresponds to ballast-less track which the fastening device is directly fastened to the concrete road bed. That has been adopted long term in mountain tunnel and subway tunnel.

2) Rheda Track

The name of Rheda is attributed to the place name of Germany and this track has been developed in Germany. Monoblock PC sleepers or Bi-block RC sleepers are held by around concrete layer on roadbed. Only rail pads provide elasticity for the track. Similar type tracks have been laid in Japan, China and many countries.

[Achievements in Japan] That corresponds to the Direct Fastened track on concrete bed with sleepers. This type is common in the subway tunnel and station. Recent trend is using elastic material under the sleeper to reduce noise and vibration

3) Elastic Sleeper Directly Fastened Track

Sleeper attached elastic material on bottom surface is held by a height-adjustable concrete on formation level. As elasticity of the track, rail pad and elastic material for sleeper perform as a serial spring. Similar track using bi-block sleeper have been laid even in France, Switzerland, USA, Manila LRT1 north extension line. Recent years mono-block sleeper supported both ends has been laid in Japan as shown in Figure 4.2.49, which contributes to reduce dead load on the viaduct.

[Achievements in Japan] It has been used for Shinkansen since 1970's. Recently there are many achievements in conventional lines near urban areas. The noise vibration level shows the same measurement value as ballasted track. In Shinkansen and urban area line that track has been laid more than 200 km.

4) J-Slab Track

J-slab track have been developed in Japan that concrete slab of 5 m length is laid on concrete roadbed without sleepers. The slab is held by protruding concrete at both ends. Cement asphalt mortar is injected under the slab, since that spring constant is very hard the elasticity of the track is given by rail pads. Slab track have also been laid in Germany and Italy, Japanese frame type slab with center hollow is laid in Taiwan. Special large machines are required for laying the slab, then construction cost becomes extremely high in case of less than 100 km.

[Achievements in Japan] Since the 1960's testing laying has been done, there have been many achievements in the Shinkansen and middle speed lines. That track has been laid more than 1,200 km in Shinkansen, more than 400 km in middle speed line.

(i) Plinth Track

(ii) Rheda Track

(iii) Elastic Sleeper Directly Fastened Track

(iv) J-Slab Track

Source: JICA Design Team

Figure 4.2.51 Various Types of Ballast Less Track

(4) MCRP(Malolos-Clark) Track

MCRP (Malolos-Clark) has north extending route from NSCR (Tutuban-Malolos) Malolos Station. Maximum speed is planned for 160 km/h where the alignment condition is suitable for high speed.

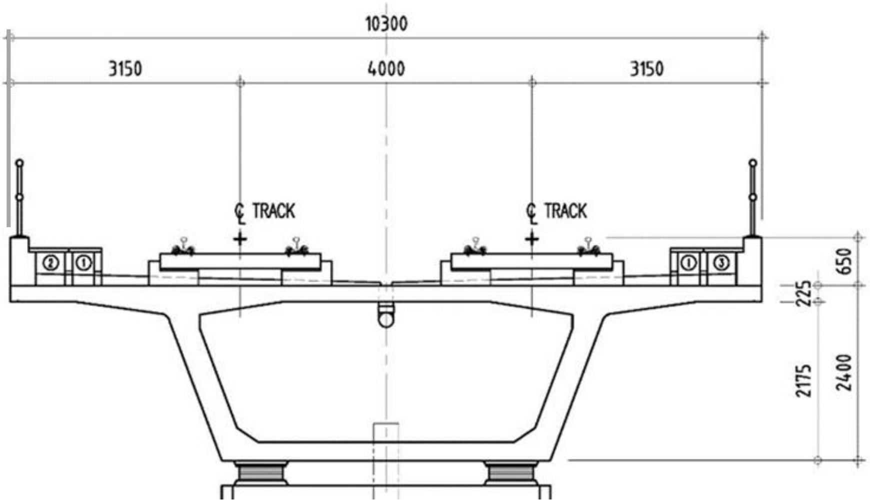
In the design of NSCR the above-mentioned elastic sleeper directly fastened track was adopted in viaduct or bridge section. (refer Figure 4.2.52) Elastic sleeper directly fastened track has achivement of 160 km/h operation in Japan, and it is desirable to adopt same concept track with NSCR main line in consideration of the compatibility of track materials.

As for the turnout, nose movable turnout without broken line portion in crossing is required to lay in 160 km/h section from a standpoint of running stability, reduction of noise and vibration, prevention of destruction of material. Fixed crossing is used for turnout in main line at maximum speed 120 km/h. For the turnout in mainline it was proposed to use Plastic/Fiber-reinforced Foamed Urethane sleepers in ballast-less, direct fixation system.

In the design of NSCR the above-mentioned elastic sleeper directly fastened track was adopted in viaduct or bridge section and RRR method embankment. Therefore in MCRP the direct fastened track shall be possible to adopt in same structure section as NSCR.

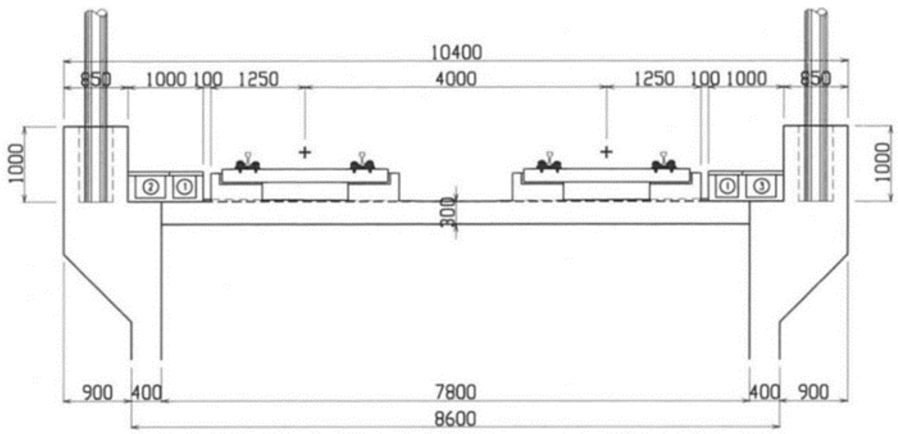
The embankment may be adopted on hard ground where the support capacity satisfies the required value. In that case the RC slab with 300 mm thickness is laid at the top of embankment. The elastic sleeper directly fastened track is laid on this concrete roadbed that has the effect of spread decreasing pressure on soil foundation. (refer Figure 4.2.53)

It is necessary to evaluate previously the strength of roadbed material. In the section where there is a possibility of settlement larger than 20mm in future, ballasted track shall be adopted generally. For ballasted track on soil roadbed, it is considered to adopt asphalt roadbed that is well drainable and good stability. In depot area traveling speed is low, ballasted track with mono-block PC sleeper is suitable which is laid on sub-ballast layer and low construction cost. In inspection and repair shed direct fastened track on concrete roadbed or open pit track supported independent columns shall be adopted.



Source: JICA Design Team

Figure 4.2.52 Elastic Sleeper Directly Fastened Track at Elevated Section



Source: JICA Design Team

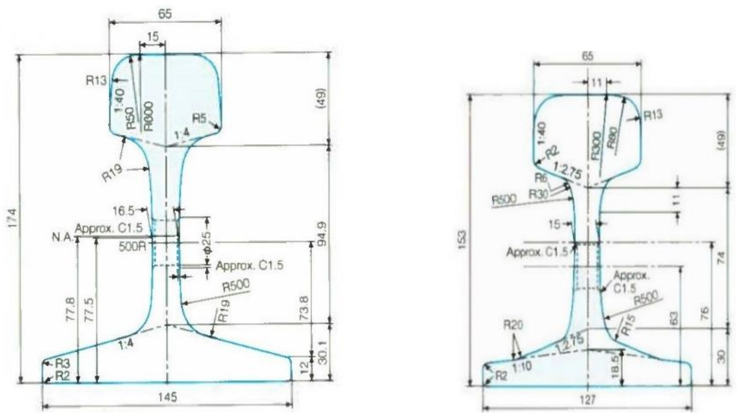
Figure 4.2.53 Elastic Sleeper Directly Fastened Track at Embankment Section

(5) Track Components

Track components options of the MCRP is selected with consideration to below materials.

1) Rails

Rolling stock's dynamic load is supported by rails directly. Larger bending stiffness shall have an advantage against durability of the track, pressure force distribution on sleeper, reduction of noise and vibration. Rail cross-section 60 kg/m is suitable for mainline 160 km/h operation. 50 kg/m rail is suitable for depot lower 35 km/h. (refer Figure 4.2.54) Steel material quality of rail is very important to avoid breakage or wear problems. Rail quality shall conform to stringent Japanese standards or equivalent international standard. Head hardened rail is desired to use at outer rail in curvature less than 800m radius section for controlling extensive wear and tear. The compromise rail connecting two kinds of rail shall be inserted in site where rail cross section changes 60 kg/m to 50 kg/m rail, etc.



(i) 60kg Rail (JIS60) **(ii) 50kg Rail (JIS50N)**

Source: NIPPON STEEL & SUMITOMO METAL

Figure 4.2.54 Rail Profile

2) Rail Joint

Expansion joint is installed in required continuous welding rail section. That has the function to reduce excessive longitudinal axial force between bridge/viaduct and continuous welding rail. Particularly it is necessary to set near the long span bridge and turnouts. Glued insulated joint shall be laid as necessary for track signaling circuit in continuous welding rail section

Normal length rail is laid at side line track, siding track connected to the main line and stabling track in depot area. In that case rails are connected by normal fishplate joint.

3) Rail Welding

Continuous welding rails (CWR) is recommended which contributes to improve riding quality and reduce maintenance works, noise and vibration. Interaction between rail and structure should be studied to reduce rail axial force within allowable limits, and to prevent excessive axial force acting on structures.

As types of rail welding there are Flash butt pressure welding, Gas pressure welding and Alumino-thermit welding, and they are appropriately selected and used at each site.

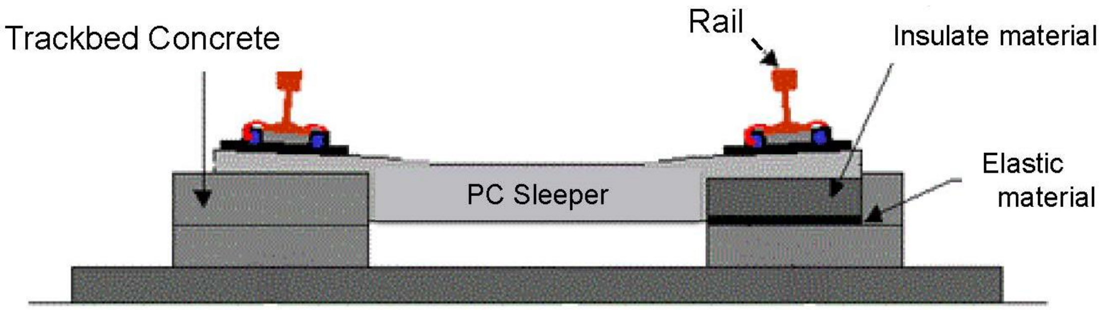
4) Sleeper

There are three type sleepers proposed for MCRP and NSRP-SOUTH track.

The first type sleeper has glued elastic material on bottom face. This is supported to the trackbed concrete on viaduct or bridge. Rail is fastened to the sleeper via rail pad and the sleeper is supported by track bed concrete via elastic material. Its major advantage is absorption of noise and vibrations and better riding quality. This track structure using mono-block sleeper panel has been developed in Japan and used extensively in Japanese railways. (refer Figure 4.2.55)

The second type sleeper is traditional mono-block PC sleeper on ballasted track. That sleepers shall be used for ballasted track section and depot area.

The third type sleeper is Plastic/Fiber-reinforced Foamed Urethane(FFU) sleeper for turnout section. For the turnout in mainline that sleeper is proposed to use as Direct Fixation System.



Source: JICA Design Team

Figure 4.2.55 Elastic Sleeper Directly Fastened Track

5) Rail Fastening System

Rail clips provides resilient supporting force under dynamic loads. Wire clip type widely used in Philippines (PNR, LRT, MRT) is proposed. Those clips by spring steel have elasticity against dynamic loads. That is fastened to anchor of shoulder directly or with baseplate into PC Sleeper.

Elastic sleeper directly fastened system on viaduct is difficult for realignment maintenance because sleepers are fastened in concrete bed. Then at necessarily case rail realignment should be adjusted at base-plate position for lateral or vertical direction by using the adjustable type fastening with base plate.

Mono-block PC sleeper is used for ballasted track at stabling yard in depot. Realignment work for irregularity is relatively easy. Rail fastening system without base-plate type is suitable for ballasted track and relative low cost.

6) Ballast

Crushed stone ballast shall be consented to requirement at rock quarry by the Employer's Representative before being incorporated at construction site. The ballast shall consist of crushed Granite, Basalt, Rhyolite, Quartzite, Andesite or equivalent. Weathered rock shall not be acceptable. The ballast produced from crushing hard rock, clean angular fragments shall be free from deleterious material and without thin or elongated pieces. That shall have a high percentage of fractured faces and be cuboids in shape.

The track ballast shall be laid minimum 150 mm thickness between the bottom of sleeper and the sub-ballast layer at surface compaction in Depot area. Ballast throw and compaction works shall be laid at two stages and be finished to top level of sleeper.

7) Turnout

In main line #12 or #10 simple turnout is laid, scissors crossing is inserted at necessary site. Plastic/ FFU sleepers is used for turnout on viaduct.

In depot area #8 turnout is laid and #6 simple turnout for maintenance vehicle stabling track are laid, scissors crossing is inserted at necessary site. Timber sleepers is used for turnout at ballasted track.

The main figures of each simple turnout are as below Table 4.2.16.

Table 4.2.16 Turnout in MCRP

Simple Turnout	Crossing Angle	Lead Rail Radius
No.12	4°46′	374.060m
No.10	5°43′	259.496m
No.8	7°9′	165.328m
No.6	9°32′	91.913m

Source: JICA Design Team

8) Summary of Track Components

Track components of elastic sleeper directly fastened track in main line are shown in Table 4.2.17.

Table 4.2.17 Track Components of Elastic Sleeper Directly Fastened Track

No.	Component	Proposed
1.	Track Form	Elastic sleeper directly fastened track on concrete bed in main line
2.	Rail Section	Weight 60 kg/m rails for mainline, Standard length 25m
3.	Continuous Welded Rails (CWR)	CWR with expansion joints at necessary locations required, according to Japanese technical standards Rail shall generally be Flash Butt Welded (FB), Gas Pressure (GP) Welded or Alumino-thermic (AT) welded.
	Short Welded Rails (SWR)	SWR and normal fish plated track at other than CWR locations.
4.	Sleepers	Elastic mono-block pre-stressed concrete sleepers are adopted. Normal 666 mm spacing between sleeper centers using 12 numbers per 8m, shortening 625mm. at curvature radius less than 600 m. Plastic/FFU sleepers are adopted turnout section.
5.	Fastening system	Wire spring with base-plate, Anti-theft type is selected for elastic sleepers
6.	Turnouts	#12 or #10 turnouts with 60kg/m rail on FFU sleepers. Movable nose crossings is used along 160km/h speed section.
7.	Expansion Joints	Expansion Joints is used at necessary site of CWR (continuous welded rail) at near long span bridge and near turnouts.
8.	Insulated joints	Glued insulated joints is used in CWR tracks at necessary site depending on signaling system.

Source: JICA Design Team

Track components of ballasted track in depot area are shown in Table 4.2.18.

Table 4.2.18 Track Components of Ballasted Track

No.	Component	Proposed
1.	Track Form	Ballasted track in at-grade of main line and depot.
2.	Rail Section	Weight 50 kg/m rails, Standard length 25m.
3.	Sleepers	Mono-block pre-stressed concrete sleepers are adopted. 37 sleepers per 25m for normal 675 mm spacing between sleeper centers.
4.	Fastening system	Wire spring non tie-plate for PC sleeper, Anti-theft type is selected.
5.	Ballast	Crushed stone ballast of minimum 150 mm thickness under sleeper. Ballasted track is laid on subballast layer surface.
6.	Turnouts	#8 or #6 turnouts with 50kg/m rail on timber sleepers.
7.	Insulated joints	Insulated joints is used near turnout and at necessary site depending on signaling system.

Source: JICA Design Team

(6) Maintenance Practices

Maintenance of track is aimed to maintain initial good condition and to perform the safety function. These activities include both technical and administrative functions.

Preventive maintenance of equipment is intended to prevent breakdown, to prolong the equipment, to repair damaged parts and to maintain good condition. This aim is to delay the deterioration of parts and to maintain running safety and good riding quality. For example rail grinding is concerned with this activity. Condition monitoring is for preventive maintenance and measurement of riding quality is also one of them. Track maintenance include realignment, removal of damaged parts, detailed cleaning, parts adjustment, parts replacement and so on.

Overall repair maintenance is carried out when spot corrective maintenance is less effective or un economical. This involve the replacement of the minor rubber pads, elastic clips, parts of turnout, tongue rail, lead rail, crossing etc. This scheduled shall be considered for safety and savings.

Comprehensive tamping for ballasted track in depot and access line shall be conducted by inspecting track condition after one year train operation. Ballast replacement shall be carried out to maintain durability as necessary at any time. Joint gap maintenance and adjustment of fastening torque shall be done.

Minimum quantities(numbers or volumes) of spare parts, rails in main line and depot, PC sleepers, FFU sleepers, rail fastening systems, expansion joints, glued insulated rail joints, assembly of turnouts, thermit welding kits etc, shall be provided to ensure the future track maintenance works.

(7) Track Maintenance Equipment

Main track maintenance is replacement of materials, rail grinding, tamping, re-alignment etc. Materials to be replaced are rails, rail fastenings, sleepers, ballast etc.

For operation, working schedule table is necessary assuming track works volume per day. Degradation of the track depends on train gross tonnage. Actual track works frequency, maintenance working length per day are planned by the department of track works according to the record of track inspection.

The main equipment required for track maintenance is shown inTable 4.2.19.

Table 4.2.19 Track Maintenance Equipment

Maintenance Equipment	
Motor car with crane	Tie Tampers with Generator Set
Open Wagon with Side Plate	Field Welding Hardware Sets and Welding Kits
Open Rail Carrying Wagon	Rail Heater
Track Geometry Measuring Car	Rail Tensor
Rail Profile Grinding Car	Weld Shear
Ultrasonic Rail Inspection Equipment	Refueling Facility for Maintenance Car
Rail Roughness Inspection Equipment	Tolls and Equipment for Track Maintenance
Surveying Equipment	Track Work Tools, Human Powered

Source: JICA Design Team

4.2.3 Design criteria for Civil work

Design conditions for designing civil engineering structures (bridges, viaducts and earth structures) of MCRP are shown below.

(1) Design standards

Design of structures including viaducts, bridges, embankments are basically follows appropriate latest design codes widely used in the republic of the Philippines, Japan and/or internationally. These referenced design codes are indispensable for the application of this specification and listed in Table 4.2.20 .

Table 4.2.20 List of Track and Structure Design Codes

Items	Name of Design Codes
Track Alignment and Track Structure	• Japanese Technical Regulatory Standards on Japanese Railways (Civil Engineering), and its Approved Model Specifications (2007). • Japanese Industrial Standards (JIS) or equivalent specifications
Bridge, Viaduct and Embankment Structure	For design: • AASHTO LRFD Bridge Design Specifications, 6th ,7th Edition (2012, 2014) • AASHTO Guide Specification for LRFD Seismic Bridge Design, 2nd Edition (2011). • DPWH Guide Specifications - LRFD Bridge Seismic Design Standard, 1st Edition (2013). • AREMA Manual for Railway Engineering (2015) • The National Structural Code of the Philippines (2010) • Japanese Design Standards for Railway Structures [Retaining Structure] (2012) Reference depending on necessity: • CHSRA Technical Memorandum - Structure Design Loads (TM2.3.2) (2011) • ACI 318 Building Code Requirements for Structural Concrete and Commentary For verification: • Japanese Design Standards for Railway Structures [Seismic Design] (2012)
Drainage	• Japanese Design Standards for Railway Structures [Earth structures] • Guideline for Planning & Design of Wastewater Facilities (Japan Sewage Works Association) • Other appropriate standards and guidelines
Materials	In general • American Society for Testing and Materials (ASTM) • American Institute of Steel Construction (AISC) • American Welding Society (AWS) • Japanese Industrial Standards (JIS) • Other appropriate material standards and guidelines. Concrete and Aggregates • ASTM, JIS and equivalent specifications Ballast/Sub-ballast • Japanese Design Standards for Railway Structures [Track Structures] Embankment • Japanese Design standards for Railway Structures [Earth Structures] • ASTM, JIS and equivalent specifications

Source: JICA Design Team

(2) Planning conditions

1) Track Type and Contents

Elastic Sleeper Direct Fasten track is adopted. The composition of track element in total height (RL to SL) of 650mm is as follows:

60kgN(60N)Rail	:	174 mm	Total 650 mm
Rail Pad etc.:	10 mm		
Base Plate :	35 mm		
PC Sleeper :	175 mm		
Elastic pad :	30 mm		
Drain Slope Concrete :		226 mm	

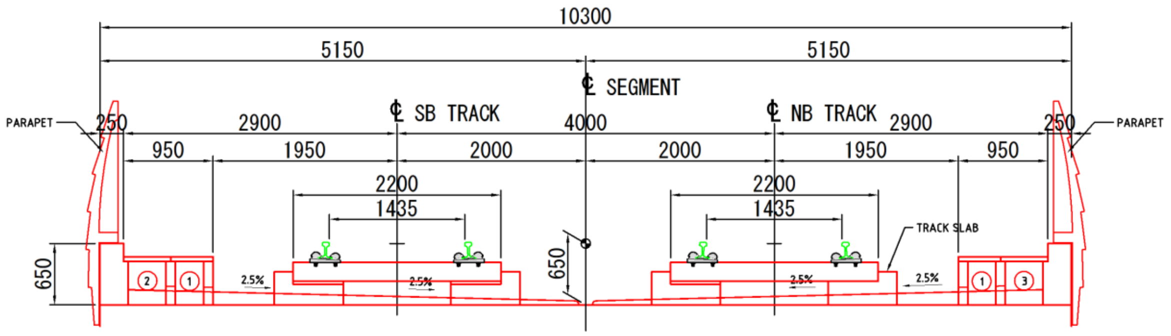
2) Fixtures and Provisions on Viaduct and Bridge

Fixtures and provisions on viaduct and bridge structures which support railway track and equipment are shown in Figure 4.2.56 to Figure 4.2.60 Double track is placed at 4m of distance between each track center for NSCR. The following fixtures and provisions on viaduct and bridge are required:

- Kinematic and structural gauge for the proposed rolling stock,
- Cabling and ducting requirements,
- Drainage for deck surface,
- Location and clearance to overhead catenary systems (OCS),
- Maximum cant at curvature section which considers radius in the horizontal alignment and the allowable passing speed,
- Walkway for maintenance,
- Walkway for emergency access,
- Noise barrier and parapet (noise assessment in progress).

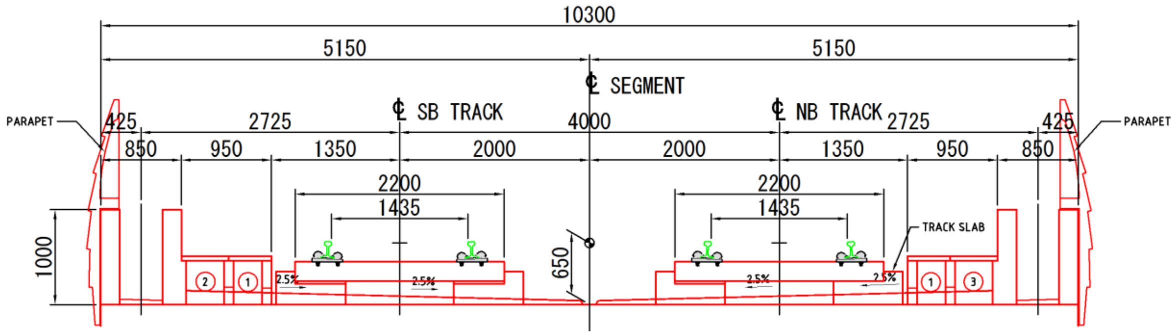
These fixtures and provisions are unified over the alignment regardless of horizontal alignments or installation of OCS poles.

a) Typical cross section of double track



Source: JICA Design Team

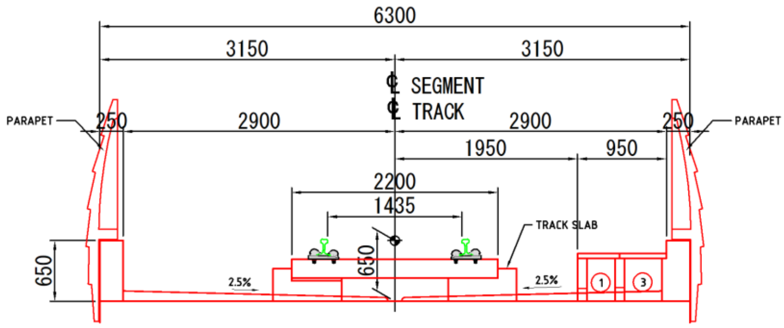
Figure 4.2.56 Fixtures in Typical Cross Section



Source: JICA Design Team

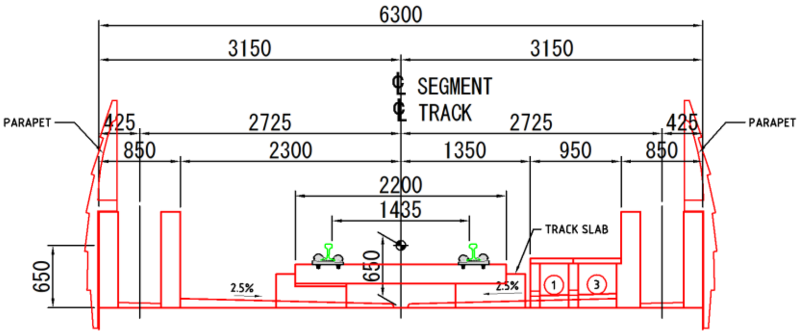
Figure 4.2.57 Fixtures in Typical Cross Section Double Track with OCS Pole

b) Typical cross section of single track



Source: JICA Design Team

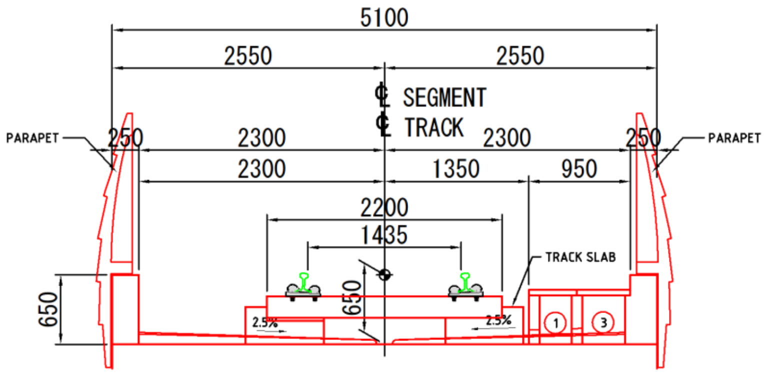
Figure 4.2.58 Fixtures in Typical Cross Section of Single Track



Source: JICA Design Team

Figure 4.2.59 Fixtures in Typical Cross Section of Single Track with OCS Pole

c) **Typical cross section of single track for station (required at Island type Platform Station)**



Source: JICA Design Team

Figure 4.2.60 Fixtures in Typical Cross Section of Single Track for Station

(3) Load Conditions

The following loading conditions for bridge structures (both superstructures and substructures) are considered and to be determined in accordance with AASHTO (AREMA) or referring to the Philippines codes of practice as appropriate:

○ Dead Load
- Unit Weight of Materials
  (Reinforced Concrete, Prestressed Concrete, Plain Concrete, Reinforcing Bar or Steel, Prestressing Strand, Ballast, Backfilling Soil)
- Weight related to Tracks (Weight of Rail & Sleeper & Fastening, Weight of Ballast)
- Weight of Bridge Railing and Power Pole

○ Live Load
- Train Load (Axle Load: 160kN×4 Axle / 1 Vehicle)
- Impact Load
- Braking Load / Starting Load
- Centrifugal Load
- Wind Load
- Pedestrian Load
- Handrail Thrust Force
- Prestress Force
- Shrinkage Effect
- Creep Effect
- Temperature Change Effect
- Earth Pressure
- Earthquake Load

Combination of these design loads is configured by each design limit state. The load combination and load factors are in accordance with AASHTO LRFD and AREMA shown in Table 4.2.21.

Each load combination is defined as follows:

Table 4.2.21 Load Combination and Load Factors Used in the Design of the NSCR

Load Comb. or Limit State	DC DD DW EV EH ES EL	LL IM CE BR PL LS	WA FR	WS	WL	TU	TG	SE	CL	EQ1	EQ2 WA ED
Strength I	1.25	1.75	1.0	-	-	1.0	0.5	1.0	-	-	-
Strength II	1.25	-	1.0	1.4	-	1.0	0.5	1.0	-	-	-
Strength III	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Strength IV	1.25	1.35	1.0	0.4	1.0	1.0	0.5	1.0	N/A	N/A	N/A
Extreme I	1.25	0.5	1.0	-	-	-	-	-	-	1.0	-
Extreme II	1.00	0.5	1.0	-	-	-	-	-	1.0	-	-
Extreme III	1.0	0.5	1.0	-	-	-	-	1.0	-	-	1.0
Service I	1.0	1.0	1.0	0.45	1.0	1.0	0.5	1.0	-	-	-
Service II	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Fatigue	-	1.0	-	-	-	-	-	-	-	-	-

Source: JICA Design Team

"Strength 1" is the basic load combination for normal use.

"Strength 2" is the load combination for the structure exposed to wind.

"Strength 3" is the load combination for very high dead load to live load force effect ratios. This is not required for the viaduct.

"Strength 4" is the load combination for normal use when exposed to wind.

"Extreme 1" is the load combination for normal use when designing columns for Operating Basis (Level 1) seismic events.

"Extreme 2" is the load combination for collision.

"Extreme 3" is the load combination for Extreme seismic events: Maximum Considered Earthquake (Level 2).

"Service 1" is the basic service load combination for normal use with wind.

"Service 2" is the service load combination intended to control yielding of steel structures and slip of slip-critical connections due to train load. Not applicable for the concrete viaduct

Where;

DD = down drag

DC = dead load of structural components and nonstructural attachments

DW = dead load of wearing surfaces and utilities

EH = horizontal earth pressure load

EL = accumulated locked-in force effects resulting from the construction process, including the secondary forces from post-tensioning

ES = earth surcharge load
BR = vehicular braking force
CE = vehicular centrifugal force
CR = creep
CT = vehicular collision force
CV = vessel collision force
EQ = earthquake
FR = friction
IM = vehicular dynamic load allowance
LL = vehicular live load
LS = live load surcharge
PL = pedestrian live load
SE = settlement
SH = shrinkage
TG = temperature gradient
TU = uniform temperature
WA = water load and stream pressure
WL = wind on live load
WS = wind load on structure

The factored force shall be modified by the load modifier specified in AAHSTO 3.4.1.

The total factored force effect shall be taken as :

$Q = \Sigma\eta i \cdot \gamma i \cdot Qi$

Where,

Hi =Load modifier specified in Article 1.3.2
Qi =Force effects from loads specified herein
γi = Load factors specified in Tables 1 and 2

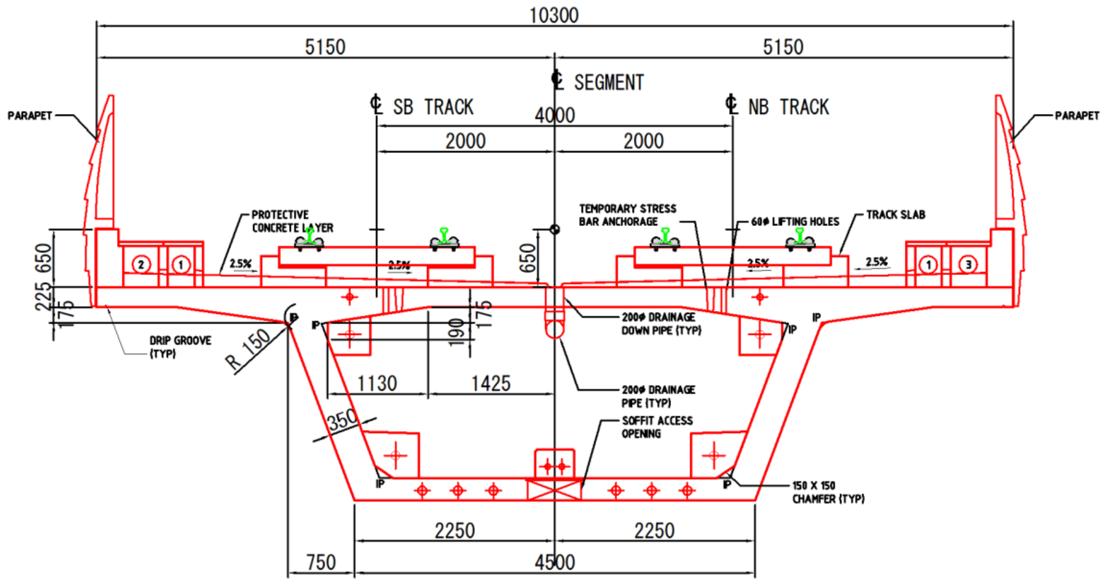
1) Dead Load

The following unit weights shall be considered in the design:

PSC/Reinforced Concrete	25 kN/m^3
Plain Concrete	24 kN/m^3
Structural Steel	78 kN/m^3
Wearing Coat	24 kN/m^3
Soil	19 kN/m^3
Ballast	19 kN/m^3

2) Superimposed Dead Load

The superimposed loads are shown in Figure 4.2.61 and Table 4.2.22.



Source: JICA Design Team

Figure 4.2.61 Locations of Superimposed Loads

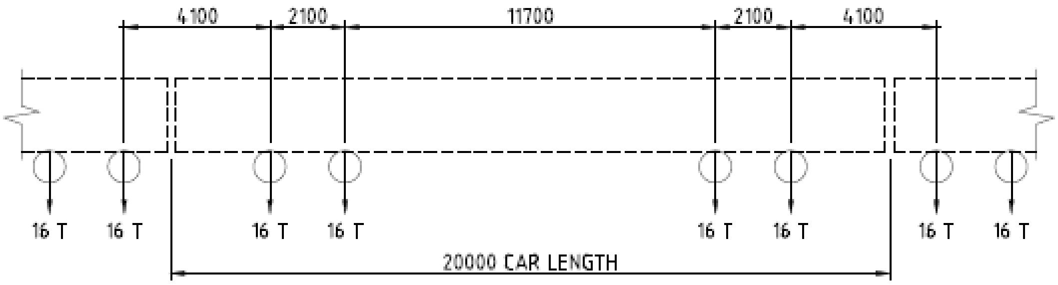
Table 4.2.22 Superimposed Loads (Summary)

Load Case	Description	Loading (kN/m)
Protective Concrete	100mm average thickness except under track slab	20.8 kN/m run
Rail + Fastening + Slab + Mortar layer	13.0 kN/m run per track	26 kN/m run
Bridge Railings inc. heel guard and noise barrier	10.0 kN/m run each side	20 kN/m run
Electrical, signal and communication cables (inc. ducts)	4.5 kN/m run each side	9 kN/m run
Weight of OHS poles	75 kN/pole each side	150 kN per section
	For girder design	150 kN located at mid span of girder;
	For pier design	150 kN located at centre line of pier
OHS Imposed loadings due to tensioning of electrical supply wires	OHW moment about axis transverse to track	±450 kNm at 2 m c/c 4 nos per span
	OHW concentrated load acting longitudinally to track	±70 kN
	OHW concentrated load acting transverse to track	± 30 kN
	OHW moment about axis longitudinal to track	±180 kNm

Source: JICA Design Team

3) Live Load

Axle loads of 16T (160 kN) with axle spacing are as shown in Figure 4.2.62.



Source: JICA Design Team

Figure 4.2.62 Typical Train Loading

Axle load = 16T= 160 kN

Maximum number of successive cars = 10 car units

4) Braking and Traction

The braking and traction forces are given in AREMA 2012 Clause 2.2.3 (j).

For a given rolling stock, braking and traction forces are taken as 30% of the vertical axle load at each axle, acting horizontally at the top of rail parallel to the center-line of track.

5) Centrifugal Force

The centrifugal force shall be taken in accordance with AREMA 2012 Clause 2.2.3 (e) 4. It will be applied acting at height of 1.5m above from the top of rail and acting radially.

$C = 0.00117\ S^2D$ **EQ 2-1**

$C = 0.000452\ S^2D$ **EQ 2-1M**

$E = 0.0007\ S^2D - 3$ **EQ 2-2**

$E = 0.0068\ S^2D - 75$ **EQ 2-2M**

$$S = \sqrt{\frac{E+3}{0.0007D}} \quad \textbf{EQ 2-3}$$

$$S = \sqrt{\frac{E+75}{0.0068D}} \quad \textbf{EQ 2-3M}$$

where:

C = Centrifugal force in percentage of the live load
D = Degree of curve (Degrees based on 100 foot (30 m) chord)

E = Actual superelevation in inches (mm)
S = Permissible speed in miles per hour (km/hr)

6) Impact Load

Impact load is set in accordance with AREMA 2012 – Volume 2 Chapter 8 Part 2 Clause 2.2.3 (d),

- $L \leq 4$ m … $I = 60$ (%)
- 4 m $< L \leq 39$ m … $I = 125 / L^{0.5}$ (%)
- $L > 39$ m … $I = 20$ (%)

  Herein, L: Span Length of Bridge (m)

7) Multiple track factor for railway bridges.

Multiple track factor shall be 1 for both single and double tracks.

8) Wind Loading

Wind loading shall be considered as per the requirements of the DPWH-DGCS Section 10.13.

An wind speed of 160 km/hour has been considered as per the requirements in the DPWH-DGCS

9) Pedestrian Loading

Non-public footpaths are those designated for use by only authorized persons when there are no train operations. Pedestrian, cycle and general maintenance loads should be represented by a uniformly distributed load with a characteristic value $q = 3.5$ kN/m^2 over the width of emergency walkways.

10) Loads on Balustrade for Pedestrian Railing

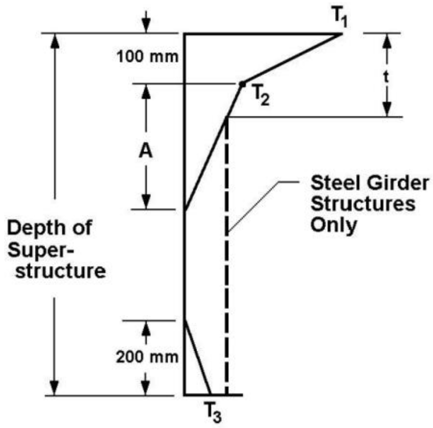
Pedestrian Handrail Load of 0.7 KN/m shall be used

11) Temperature Loading

The temperature range (expansion and contraction) shall be applied as per the requirements of DPWH-DGCS Clause 10.16.1 Procedure A and Table 10.16.1-1. Climate is set as moderate and temperature range of -12 to +27 degrees C variations with base temperature of 28ºC assumed.

12) Differential Temperature (Temperature Gradient)

The temperature profile for the effect of differential temperature is in accordance with AASHTO LRFD 2015 Figure 3.12.3.



Source: JICA Design Team

Figure 4.2.63 Differential Temperature Gradient

13) Time Dependent Effects of Creep and Shrinkage

Concrete shrinkage is considered in accordance with CEB-FIP 2010 Code. (Refer AASHTO LRFD Clause 5.4.3.2.1)

Concrete creep is considered in accordance with CEB-FIP 2010 Code. (Refer AASHTO LRFD Cause 5.4.3.2.1)

14) Bearing Friction

Elastomeric bearings will be used on all simple supported spans of the elevated structure. Such bearings are capable of transferring horizontal loads from deck to supporting members, either via friction, shear deformation or assisted by mechanical devices. The compressive and shear stiffness of the bearing adopted will be input into the analysis model.

15) Seismic Load

For the load of the inertial force at the time of earthquake, refer to the “4.2.3(5) Seismic Design Requirements” described later.

(4) Following Standard of Materials and Concrete Cover

Standard of materials and Concrete cover for viaduct structure are shown in Table 4.2.23.

Table 4.2.23 Quality of Materials to be Use

	Item \ Member	Superstructure (PC) Box Girder Precast	Superstructure (PC) Box Girder Cast-in-Situ	Substructure (RC) Pier (Column & Footing)	Substructure (RC) Cast-in -place Pile
Concrete	Design Standard Strength (MPa) (CYLINDER)	50 (Strength at the Moment of Prestressing Installation 75%= 40) (Cast-in-place: 40)	40 [*2] (Strength at the Moment of Prestressing Installation 75%= 30) (Cast-in-place: 40)	40	40
Reinforcing Bar	Standard (Grade)	ASTM 615M GRADE 60 [*2]		ASTM 615M GRADE 60[*2]	ASTM 615M GRADE 60[*2]
	Design Tensile Yield Strength (N/mm^2)	520		520	520
	Standard Type of Diameter (mm)	Deformed Bar 12, 16, 20, 24,28,32,36,40mm			
Prestressed Concrete Steel	Standard (Grade)	ASTM A722/A 722M, GRADE 275 7-Strand Wires Dia.15.7mm		–	–
	Design Tensile Strength (N/mm^2)	1,860		–	–
	Apparent Relaxation Rate (%)	Low Relaxation Type =2.5%		–	–
	Friction Wobble Coefficient:K	0.003/m		–	–
	Friction Curvature Coefficient:K	0.2		–	–
	Maximum Permissible Slip	6 mm		–	–

*1: Design standard strength of "Lean Concrete" shall be 15 MPa.
*2: Materials are different from NSCR (Cast-in-Situ Concrete 50 MPa, Reinforcing Bar GRADE 75) due to rapid construction, quality control and ease of material procurement..

Source: JICA Design Team

Concrete grade and covering for the viaduct and bridge structures are shown in Table 4.2.24

Table 4.2.24 Concrete Grade and Concrete Cover

Items	Exposure Condition	Concrete Grade	Concrete Cover To Outermost Re-Bar
Piles	Moderate	40 Mpa	75mm
Pile Cap	Moderate	40 Mpa	75mm if cast against soil 50mm elsewhere
Abutment	Moderate	40 Mpa	75mm if cast against soil 50mm elsewhere
Approach Slab	Moderate	40 Mpa	75mm if cast against soil 50mm elsewhere
Pier	Moderate	40 Mpa	75mm if cast against soil 50mm elsewhere
Precast PSC/RCC Beams	Moderate	50 Mpa-PSC 40 Mpa-RCC	40mm
Precast PSC Box-Girder		50 Mpa	35mm
Track Slab		40 Mpa	40mm to upper surface 35mm to soffit where protected by precast girder or permanent formwork

Source: AASHTO LRFD

(5) Seismic Design Requirements

Basically, the design standard of bridge and viaduct applied is AASHTO which is generally used in the Philippine except for seismic load quoted from DPWH-BSDS. In order to consider resilience in seismic events beyond the design conditions prescribed above, verification will be also carried out in accordance with “Design Standards for Railway Structures and Commentary (Seismic Design)” of Japanese Railway Standards.

1) Seismic Type

The seismic types applied to the design are shown in Table 4.2.25.

Table 4.2.25 Example of Expected Seismic Activity and Performance Level

Design Seismic Acceleration	Probability of Occurrence	Seismic Performance Requirement
Level 1	• Has the probability of occurring multiple times during the design life of the structure.	• Maintain sound functionality during and after earthquake. • Limit damage to the minimal.
Level 2	• The largest seismic acceleration that can be conceived for area of construction of the structure • May happen once or never during the design life of the structure. For japan; Hansin-Awaji or the Tohoku earthquake is considered.	• Prevent Collapse • Sustain limited damages that can be recovered within a short time.

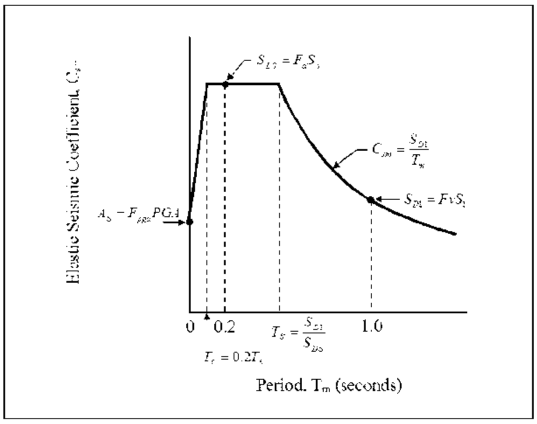
Source: JICA Design Team

It is necessary to study the seismic loads that are located near active faults.

2) AASHTO

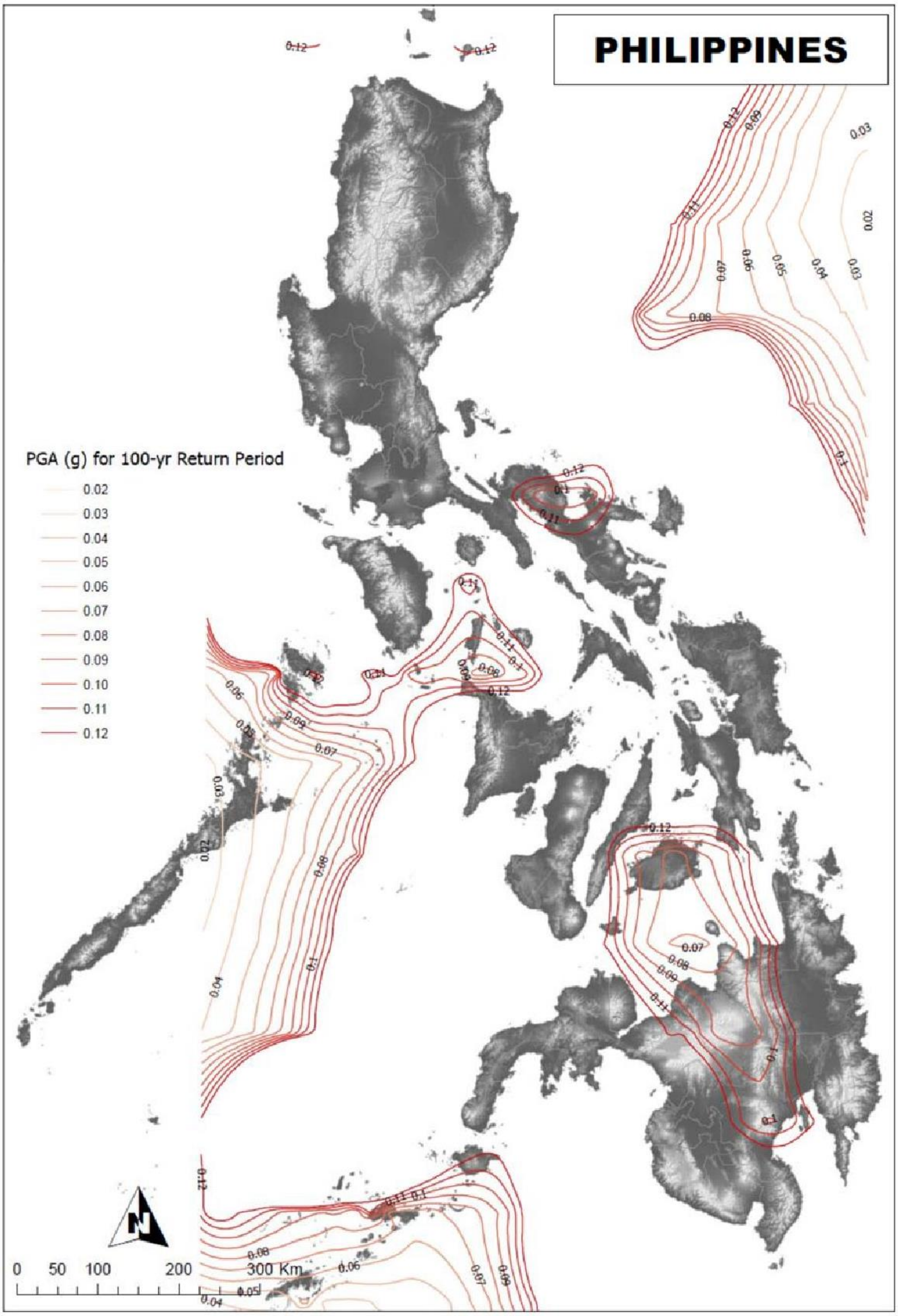
The seismic loads based on「LRFD Bridge Seismic Design Specifications 1st Edition, 2013」(DPWH) are applied when the seismic design is implemented according to AASHTO. The response spectrum of level I and II are shown in Figure 4.2.65 ~ Figure 4.2.70

Design seismic load is obtained from Figure 4.2.64, considering the soil type and condition.



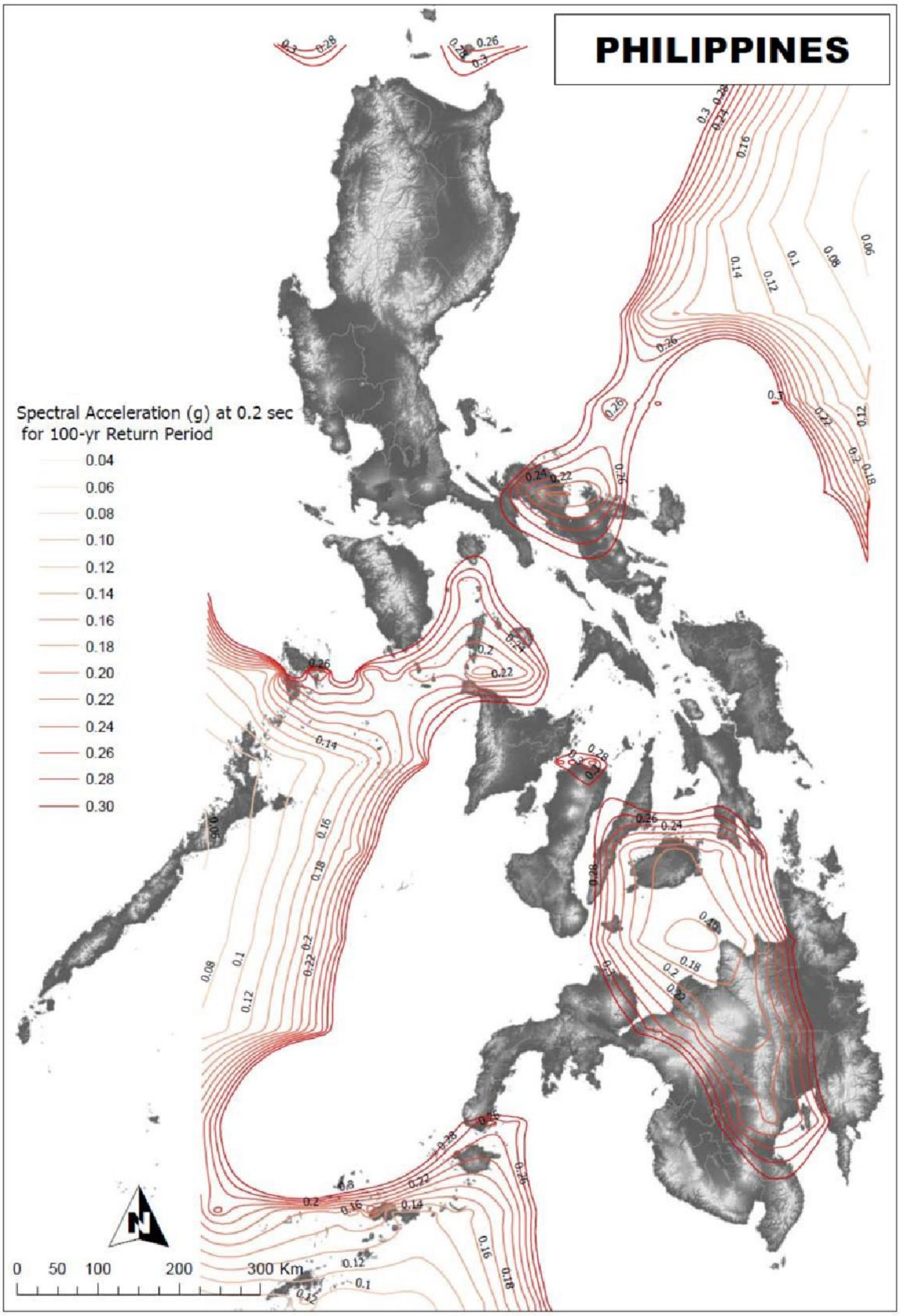
Source:“*LRF*D Bridge Seismic Design Specifications 1st Ediiton,2013” (DPWH)

Figure 4.2.64 Design Response Spectrum



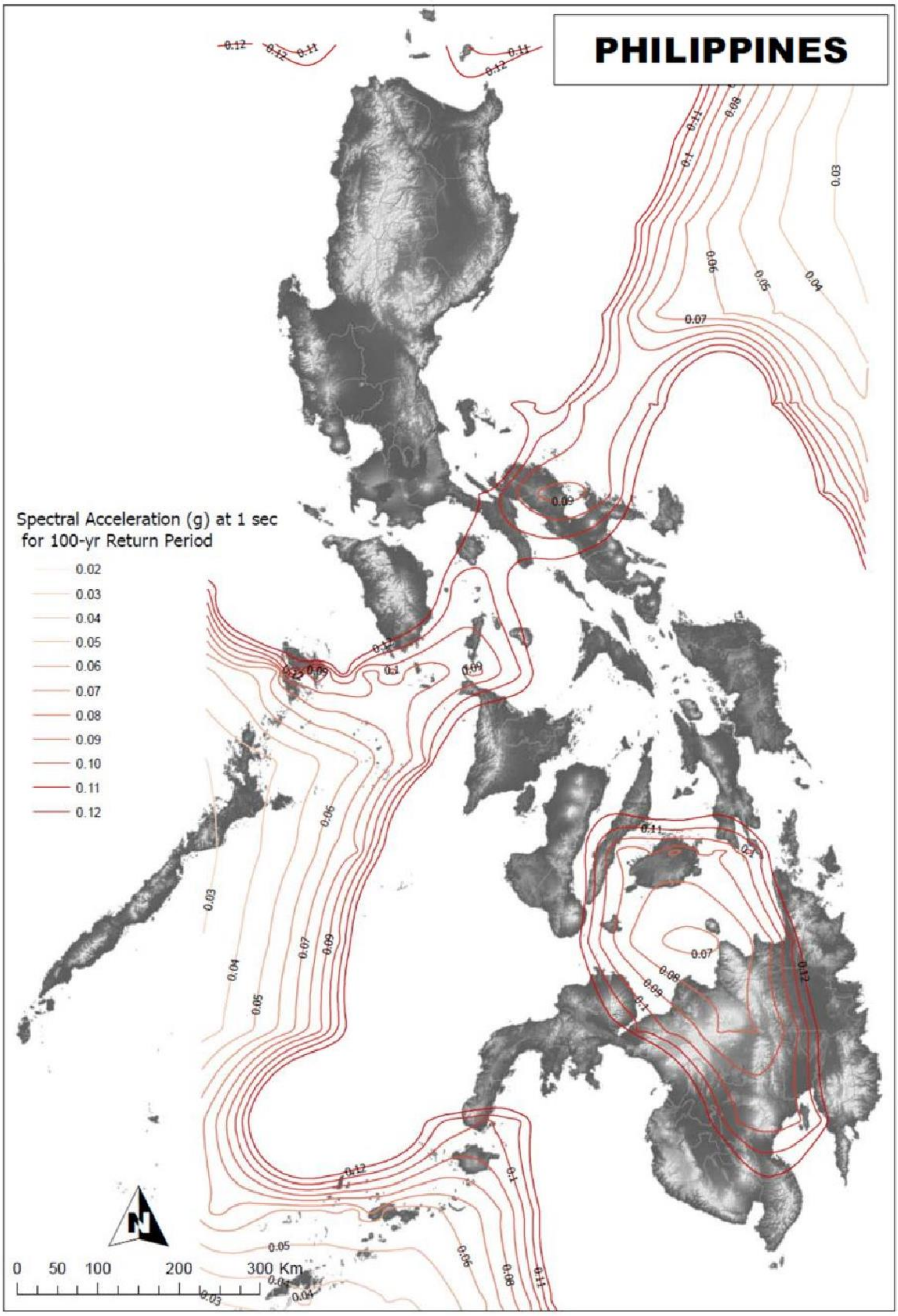
Source: "LRFD Bridge Seismic Design Specifications 1st Ediiton,2013" (DPWH)

Figure 4.2.65 Horizontal Peak Ground Acceleration Coefficient (PGA) with 53% percent Probability of Exceedance in 75 Years (Approximately 100-year Return Period) for Level 1 Earthquake Ground motion



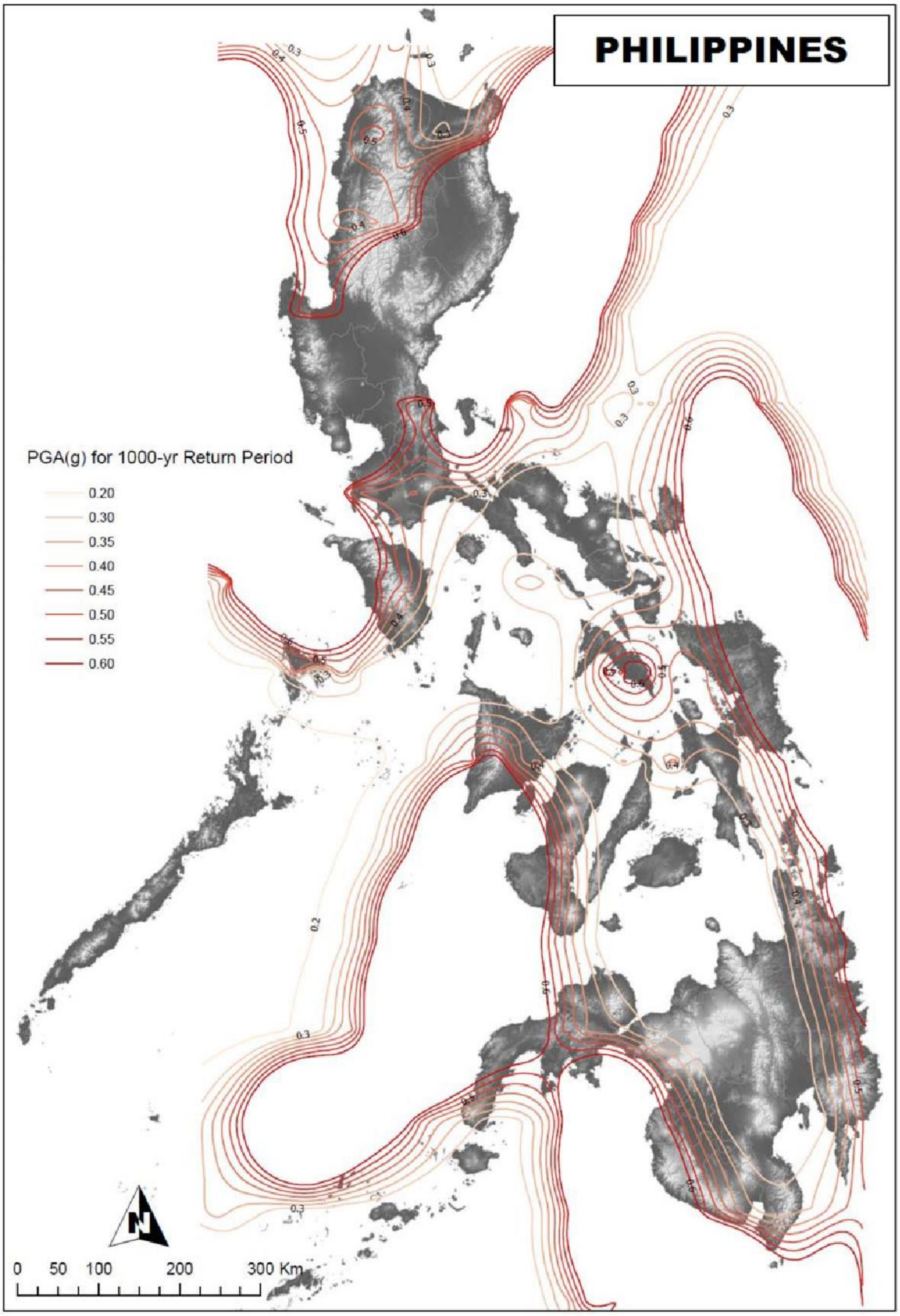
Source: "LRFD Bridge Seismic Design Specifications 1st Ediiton,2013" (DPWH)

Figure 4.2.66 Horizontal Peak Ground Acceleration Coefficient at Period of 0.20-sec (Ss) with 53% percent Probability of Exceedance in 75 Years (Approximately 100-year Return Period) for Level 1 Earthquake Ground motion



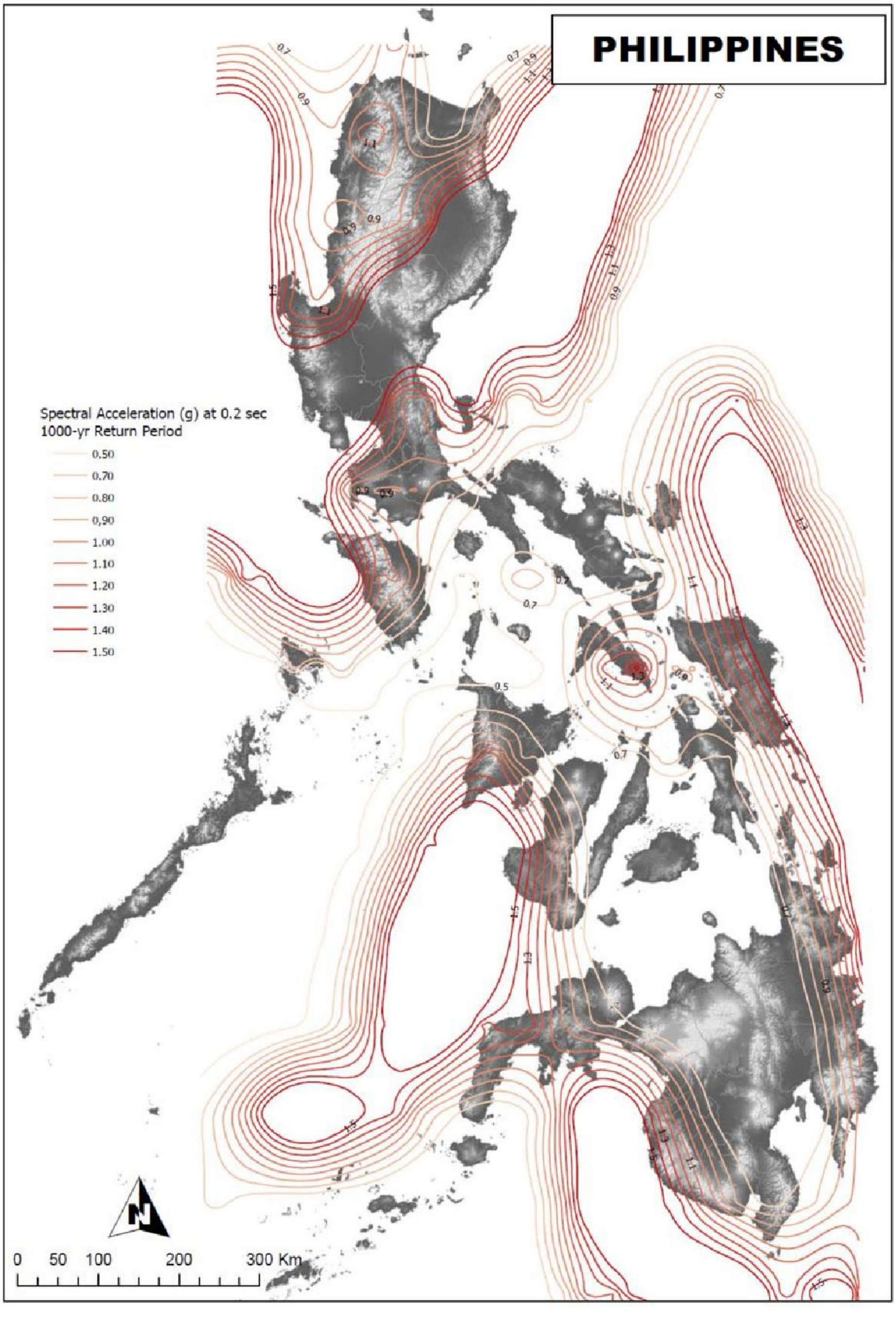
Source: "LRFD Bridge Seismic Design Specifications 1st Ediiton,2013" (DPWH)

Figure 4.2.67 Horizontal Peak Ground Acceleration Coefficient at Period of 1.0-sec (S1) with 53% percent Probability of Exceedance in 75 Years (Approximately 100-year Return Period) for Level 1 Earthquake Ground motion



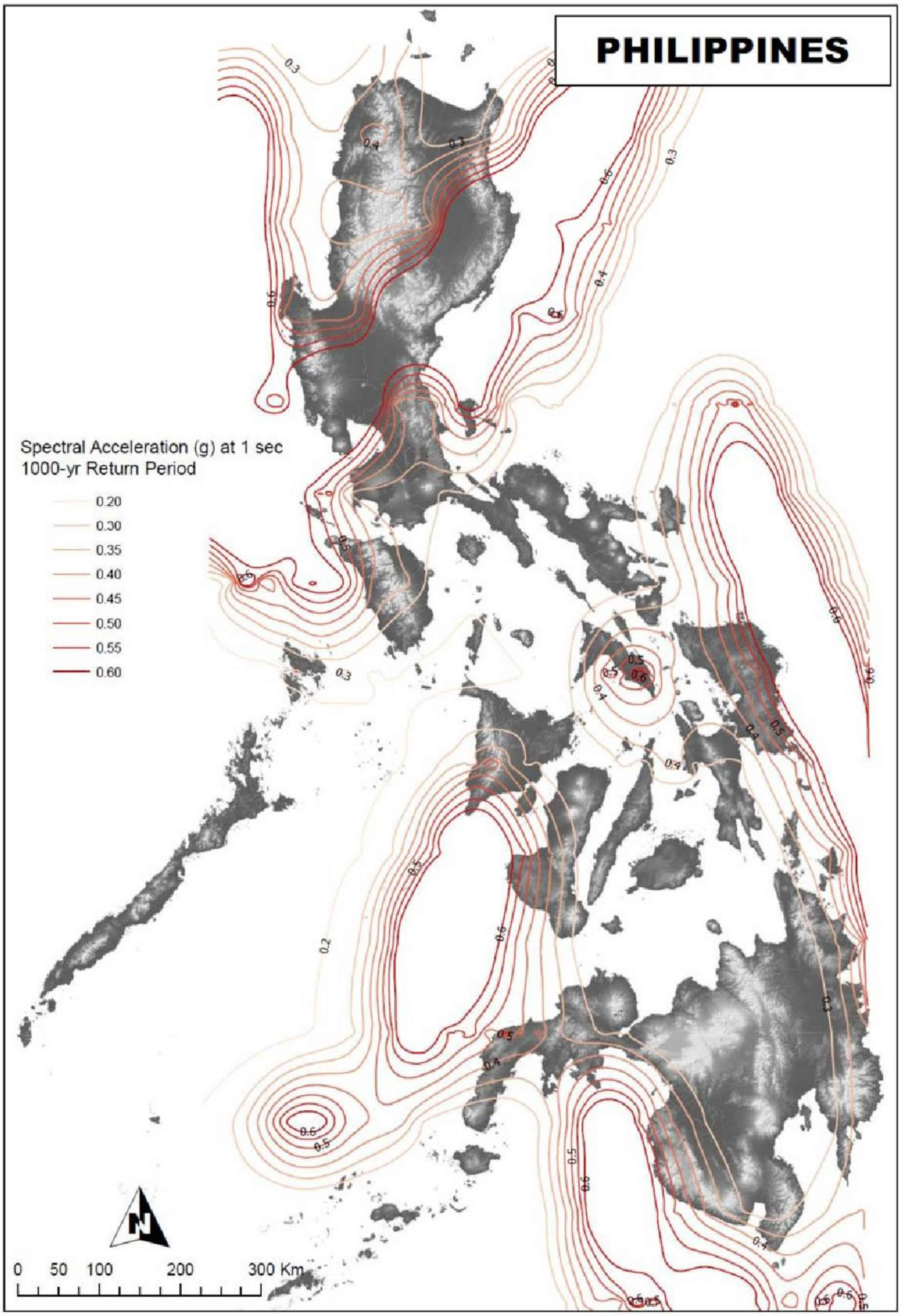
Source: "LRFD Bridge Seismic Design Specifications 1st Ediiton,2013" (DPWH)

Figure 4.2.68 Horizontal Peak Ground Acceleration Coefficient (PGA) with Seven percent Probability of Exceedance in 75 Years (Approximately 1,000-year Return Period) for Level 2 Earthquake Ground motion



Source: "LRFD Bridge Seismic Design Specifications 1st Ediiton,2013" (DPWH)

Figure 4.2.69 Horizontal Peak Ground Acceleration Coefficient at Period of 0.20-sec (Ss) with Seven percent Probability of Exceedance in 75 Years (Approximately 1,000-year Return Period) for Level 2 Earthquake Ground motion



Source: "LRFD Bridge Seismic Design Specifications 1st Ediiton,2013" (DPWH)

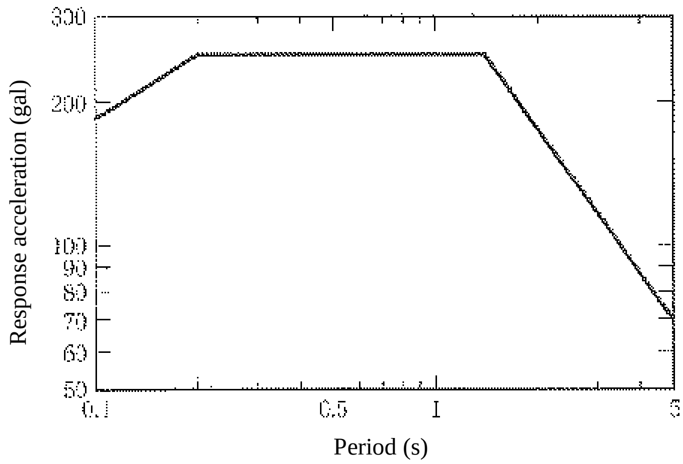
Figure 4.2.70 Horizontal Peak Ground Acceleration Coefficient at Period of 1.0-sec (S1) with Seven percent Probability of Exceedance in 75 Years (Approximately 1,000-year Return Period) for Level 2 Earthquake Ground motion

3) Seismic loads based on Railway Standards

Seismic design loads are determined according to Design Standards for Railway Structures and Commentary (Seismic Design) revised in 2012 (Railway Technical Research Institute） (herein Railway Standards).

a) Level 1

Level 1 seismic motion is decided according to considering the location factor.

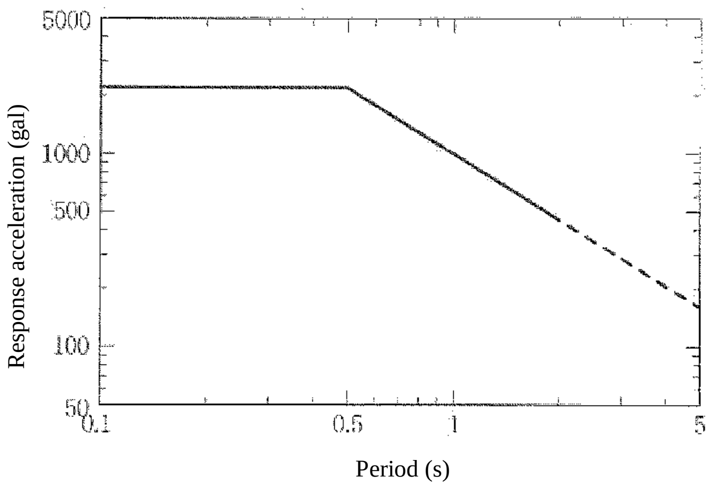


Source: Design Standards for Railway Structures and Commentary (Seismic Design) revised in 2012 (Railway Technical Research Institute)

Figure 4.2.71 Plastic acceleration response spectrum of Level 1 seismic motion

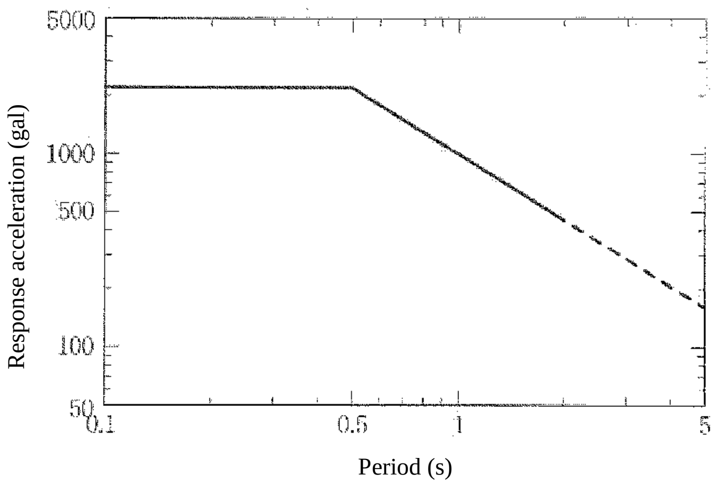
b) Level 2

Level 2 seismic motion should be applied considering the largest one which is expected to occur at the construction location. For large-scale marine earthquake (spectrum I) and earthquake occurred by inland active faults (spectrum II) are used in seismic design. Spectrum I, II are shown in Figure 4.2.72



Source: Design Standards for Railway Structures and Commentary (Seismic Design) revised in 2012 (Railway Technical Research Institute)

Figure 4.2.72 Plastic acceleration response spectrum of Spectrum 1



Source: Design Standards for Railway Structures and Commentary (Seismic Design) revised in 2012 (Railway Technical Research Institute)

Figure 4.2.73 Plastic acceleration response spectrum of Spectrum II

(6) Geotechnical Design Condition

1) Design Policy

For MSRP, boreholes of depths ranging from a few meters to as deep as 40m were drilled at about 600 locations along the approximately 69km length of the project route. Ideally all piers should be design using the geotechnical conditions obtained through field and laboratory test of the nearest borehole to the said pier. However, in large projects such as the MCRP where cost and project time becomes critical, it is general practice to group the boreholes into a manageable set of representative cases that are used in the design of substructures.

The actual length of piles for all the structures shall be determined based on specific borehole nearest to the respective substructures.

2) Geotechnical models used in the design of substructures

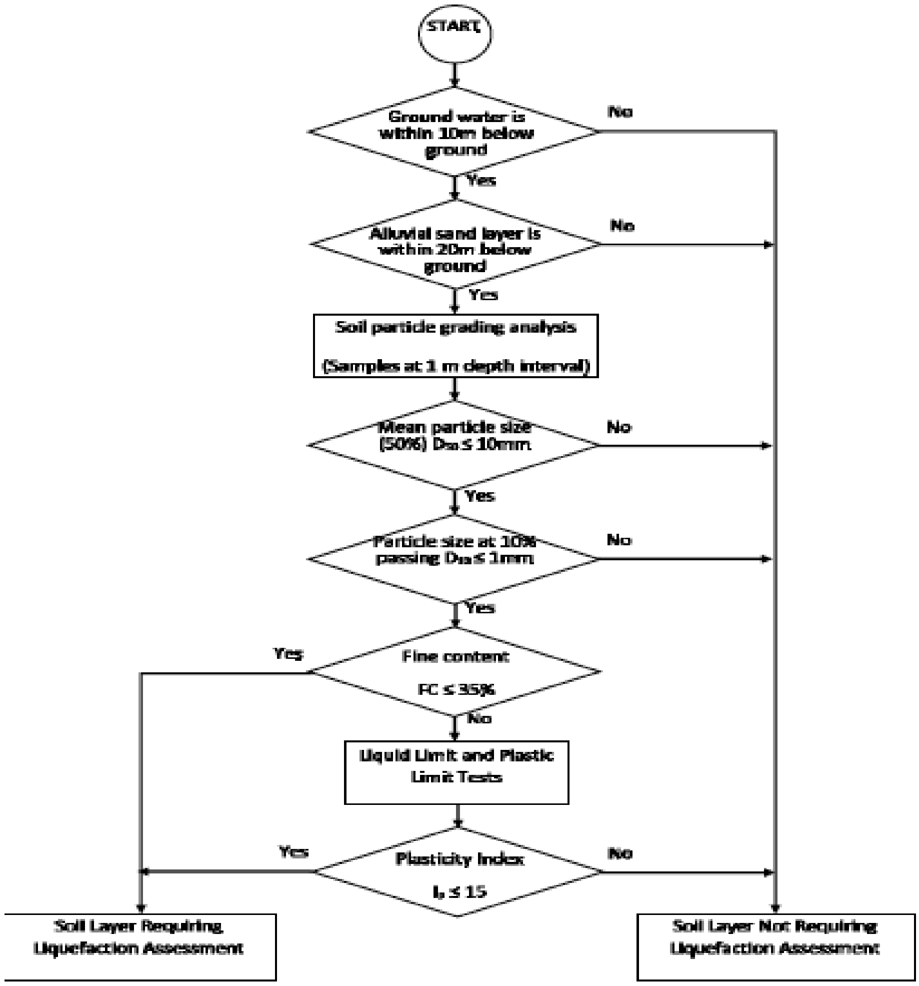
A combination of probabilistic (using statistical parameters such as mean, standard deviations and correlation of borehole data) and deterministic approach (use of professional engineering experience and judgement) were used to develop geotechnical models based on Standard Penetration Test (N values) data.

By analyzing the SPT-N values of all the boreholes from the geotechnical investigation, a) the average SPT-N value up to a certain depth of the soil profile, and b) the depth which SPT-N value becomes greater than 50 were used as parameters to classify all the boreholes into Model cases that were used in design of the substructure. Prior to grouping of the boreholes, liquefaction susceptibility evaluation was carried out in accordance with the flow chart shown in Figure 4.2.74

Liquefaction evaluation was carried out based on the DPWH Guide Specification- LRFD Bridge Seismic Design Specification. Soils that much the following considers are considered as prone to liquefaction, and requiring liquefaction assessment.

- Saturated soil layer with depth less than 20m below the ground surface and having ground water level higher than 10m below the ground surface.
- Soil layer containing a fine content (FC) of 35% or less, or soil layer having plasticity index, IP, less than 15, even if FC is larger than 35%.
- Soil layer having a mean particle size (D50) of less than 10mm and a particle size at 10% passing (D10) (on the grading curve) is less than 1 mm.

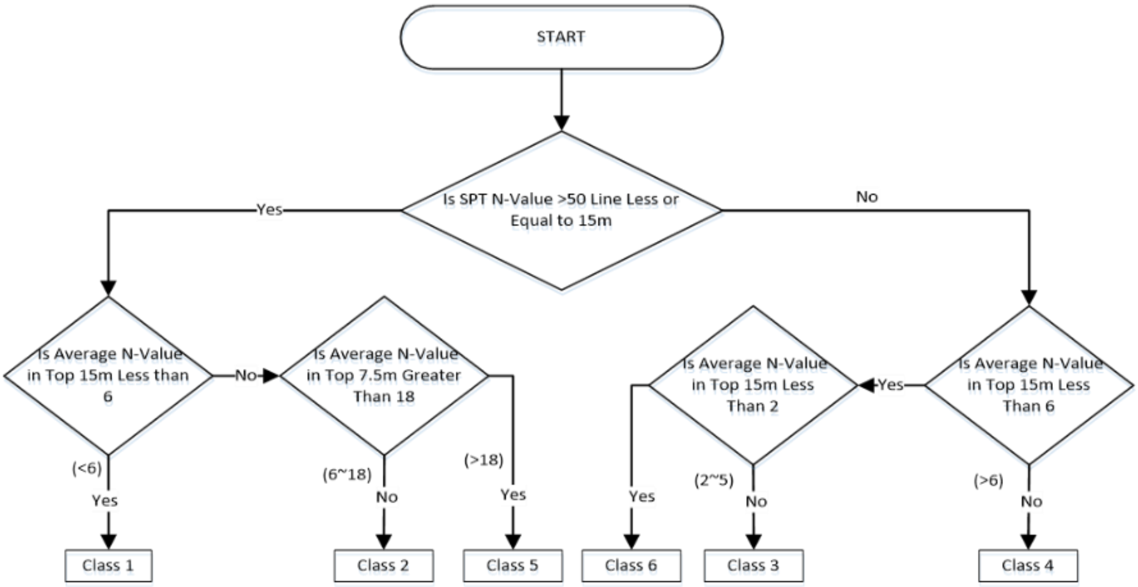
Where a layer or layers in a given borehole is known to be susceptible to liquefaction, the liquefaction reduction factor D_E for that layer is calculated and its SPT-N value modified accordingly.



Source: NSCR Report

Figure 4.2.74 Determination of Liquefaction Assessment Necessity Flow

After the effect of liquefaction for all the boreholes have been considered and applied to each and every borehole, realistic models that will result in economical and safe foundation were developed using the flow chart shown in Figure 4.2.75 , and the actual Models used in the design of typical substructures shown in Table 4.2.26.



Source: JICA Design Team

Figure 4.2.75 Soil Model Selection Flow

Table 4.2.26 Soil Models used in the Design of MCRP Typical Substructure Design

Depth (m)	Model 1	Model 2	Model 5	Model 6	Model 3	Model 4
1.5	2	6	15	0	2	6
3.0	2	6	15	0	2	6
4.5	2	6	20	0	2	6
6.0	2	6	20	0	2	6
7.5	2	6	20	0	2	6
9.0	2	6	50	2	2	6
10.5	2	6	50	2	2	6
12.0	2	6	50	2	2	6
13.5	2	6	50	2	2	6
15.0	2	6	50	2	2	6
16.5	50	50	50	10	10	15
18.0	50	50	50	10	10	15
19.5	50	50	50	10	10	15
21.0	50	50	50	10	10	15
22.5	50	50	50	10	10	15
24.0	50	50	50	50	10	15
25.5	50	50	50	50	10	15
27.0	50	50	50	50	10	15
28.5	50	50	50	50	10	15
30.0	50	50	50	50	10	15
31.5	50	50	50	50	50	50
33.0	50	50	50	50	50	50
34.5	50	50	50	50	50	50
36.0	50	50	50	50	50	50
37.5	50	50	50	50	50	50
39.0	50	50	50	50	50	50
40.5	50	50	50	50	50	50
42.0	50	50	50	50	50	50
43.5	50	50	50	50	50	50
45.0	50	50	50	50	50	50

Legend: N value **0** **2** **6** **10** **15** **20** **50**

Source: JICA Design Team

In Table 4.2.26 above, values represented in the vertical direction is the SPT N value at every depth of the soil profile. The color spectrum is simply to indicate the differences in the SPT N value in the various layers from deep from top to bottom.

In the same way, the color spectrum is simply to indicate the SPT V-value in the various layers from top to bottom. The lighter color highlights show soft conditions, and stronger/darker colors indicates harder conditions.

(7) Other Ancillary Structures

1) Foundation of OCS Pole (Cast-in place concrete)

Set up for t supporting OCS Pole.

2) Cable Trench (with the exception of cap, Cast-in place concrete. Cap; precast concrete)

Set up for power distribution cables, signaling and telecommunication cables.

3) Noise Barrier (Precast concrete)

Set up for cutting the noise.

4) Drainage

Set up for smooth drainage from the upper surface of the super structure.
Drainage set inside the box girder with consideration for aesthetic aspect.

5) Expansion Joint

Set up for preventing water leakage from the joint.

6) Expansion of slab due to setting signal related facilities.

The slab should be expanded due to setting of impedance bond, electric point machine, and, shunting signal.

7) Waterproofing

Waterproofing is not required for the reason that precast segment box girders are applied as the form of superstructures, and tendons are arranged in the top slab, then no water leakage occurs.

8) Track Slab (Cast-in place concrete)

Refer to chapter 6.1.

9) Signal related facilities

Refer to chapter 12.

4.2.4 Geotechnical and Topographic Surveys

(1) Geotechnical Survey

The Detailed Design Study (including the Supplementary Feasibility study) of the Malolos-Clark Railway Project aims to provide a sufficient level of geotechnical information on the underlying soils and rock to facilitate the engineering design of the project. The scope of work comprises to the proposed alignment in the Figure 4.2.76 of field investigation by rotary drilling and laboratory testing in accordance with the American Society for Testing and Materials (ASTM) standards.

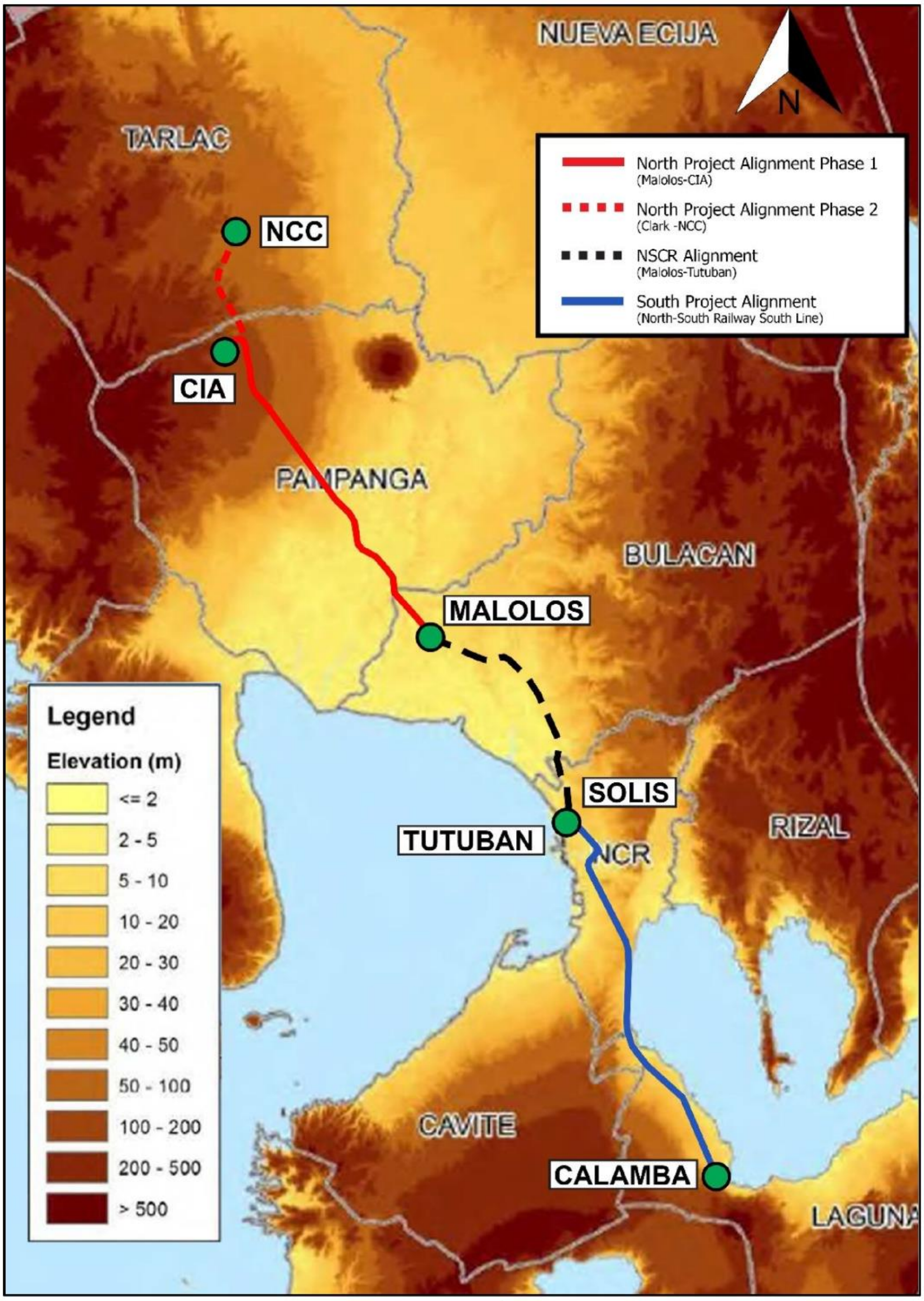
Source: JICA Design Team

Figure 4.2.76 Area Map of Proposed Alignment

1) Summary of Physiography and Geology

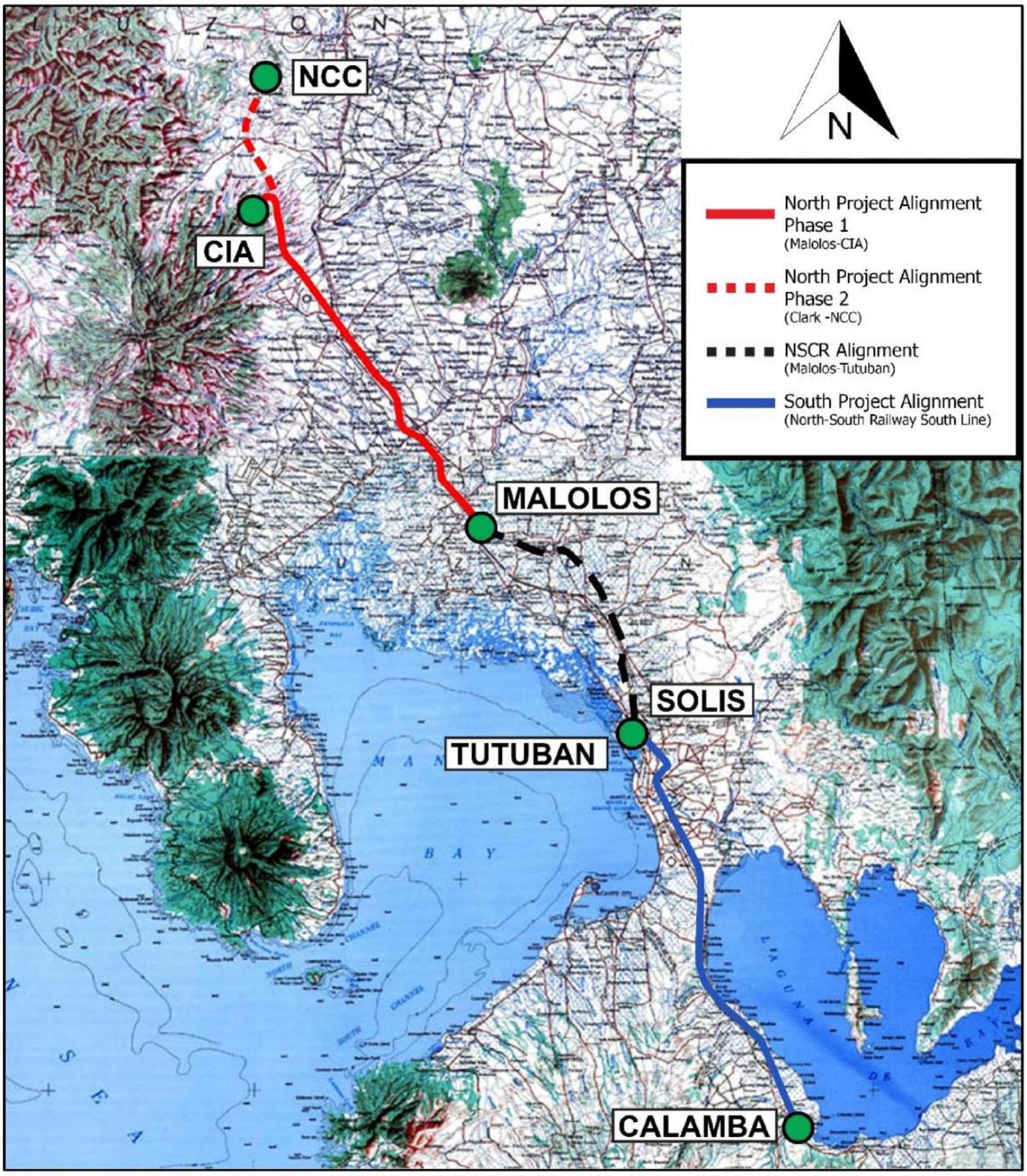
a) Physiography

A relief map of the area traversed by the railway (Figure 4.2.77) shows that the proposed extension in the North line lies in areas with low elevations (yellow shaded region). However, the last four (4) stations are found in relatively higher elevations (brown shaded regions).



Source: Roadmap for Transport Infrastructure Development of Metro Manila and its Surrounding Areas

Figure 4.2.77 Elevation Map of the Project Area



Source: NAMRIA

Figure 4.2.78 Extract from the Topographic Map

b) Regional Geology

Categorized geologically, the Malolos-Clark Railway is part of the Central Luzon Basin, which is filled with Recent, 8,000-m thick sedimentary sequence. Its eastern and western flanks are stratigraphically distinguished from each other. Sediments on the east, which covers the Bulacan area, are characterized by a significant amount of volcanic sources, such as volcanic sandstones and shales, tuffs, and by a shallow marine depositional environment. To the west, which covers Pampanga to Tarlac areas, are Neogene sediments dominated by Middle Miocene turbidites overlie directly the Eocene ophiolites of Zambales. (Source: Geology of the Philippines)

Based on Figure 4.2.79, the alignment is mostly underlain by Recent Deposits mainly of alluvium and fluviatile deposits from Malolos to Angeles. Characterized by volcanic or volcanic piedmont deposits, the Pliocene – Quaternary Deposits underlie the Mabalacat portion of the alignment. This formation is chiefly pyroclastics and volcanic debris at the foot of volcanoes. Upper Miocene – Pliocene Deposits underlie New Clark City in Capas. It is characterized by marine clastics (molasse) overlain by extensive, locally transgressive pyroclastics (chiefly tuff, tuffites) and tuffaceous sedimentary rocks. It is associated with calcarenite in some parts of Luzon. (Source: Mines and Geosciences Bureau)

Stratigraphy

The stratigraphy of Bulacan and Pampanga underlain by the project alignment may be categorized into four (4) major geologic formations: 1) Guadalupe Tuff Formation, 2) Bamban Formation, 3) Tarlac Formation and 4) Malinta Formation. Generally, the areas of Malolos, Calumpit and Apalit are underlain by the Guadalupe Formation; the municipality of Sto. Tomas is underlain by Quaternary Pyroclastics; the San Fernando, Angeles and Mabalacat areas are underlain by the Bamban Formation; and the Capas area is underlain by the Tarlac and Malinta formation.

Quaternary Alluvium Deposits are generally detrital deposits of sand and gravel. These contain lahar deposits in Mabalacat. The Quaternary Pyroclastics, on the other hand, are pyroclastic deposits, agglomerates and volcanic ashes. Based on available geologic information from the Geology of the Philippines (Source: Mines and Geosciences Bureau) the aforementioned formations are described as follows:

Guadalupe Tuff Formation

The Guadalupe Tuff Formation, or GTF, is the regional bedrock in Metro Manila. The thickness of the formation is around 1,500-2,200m and is of Pleistocene age. It is composed of two members: (1) Alat Conglomerate member composed of conglomerate, sandstone and mudstone, and (2) Diliman Tuff member composed of tuffs, pyroclastic breccias and tuffaceous sandstones. It is a horizontally rock referred to as “adobe.” It consists of well laid rock formation of minor fine to medium grained tuffaceous sandstone, tuffaceous siltstone, and shale being the weakest member.

Bamban Formation

The Bamban Formation is made up of tuffaceous sandstone and lapilli tuff with basal conglomerate. It is unconformable over the Tarlac Formation and is aged Pleistocene. The Bamban Formation was named for the tuffaceous clastic and tuff section in Bamban, Tarlac. The basal conglomerate is massive, fairly well-consolidated, and consists of poorly sorted subangular to subrounded pebbles, cobbles and small boulders of diorite, andesite and basalt with minor amounts of scoria cemented by tuffaceous sand and volcanic ash. It is locally cross-bedded and grades laterally and vertically to the sandstone.

The sandstone is bedded, fine to coarse-grained, fairly sorted, soft, porous, tuffaceous and consists mainly of angular to subrounded grains of feldspar, quartz and ferro-magnesian minerals in a fine silt and volcanic ash cement. Interbedded with the sandstone are thin beds of hard, well-cemented and brittle tuffaceous shale. The tuff is medium to thick bedded, hard, brittle and consists of well cemented, fine volcanic ash, dust and lapilli.

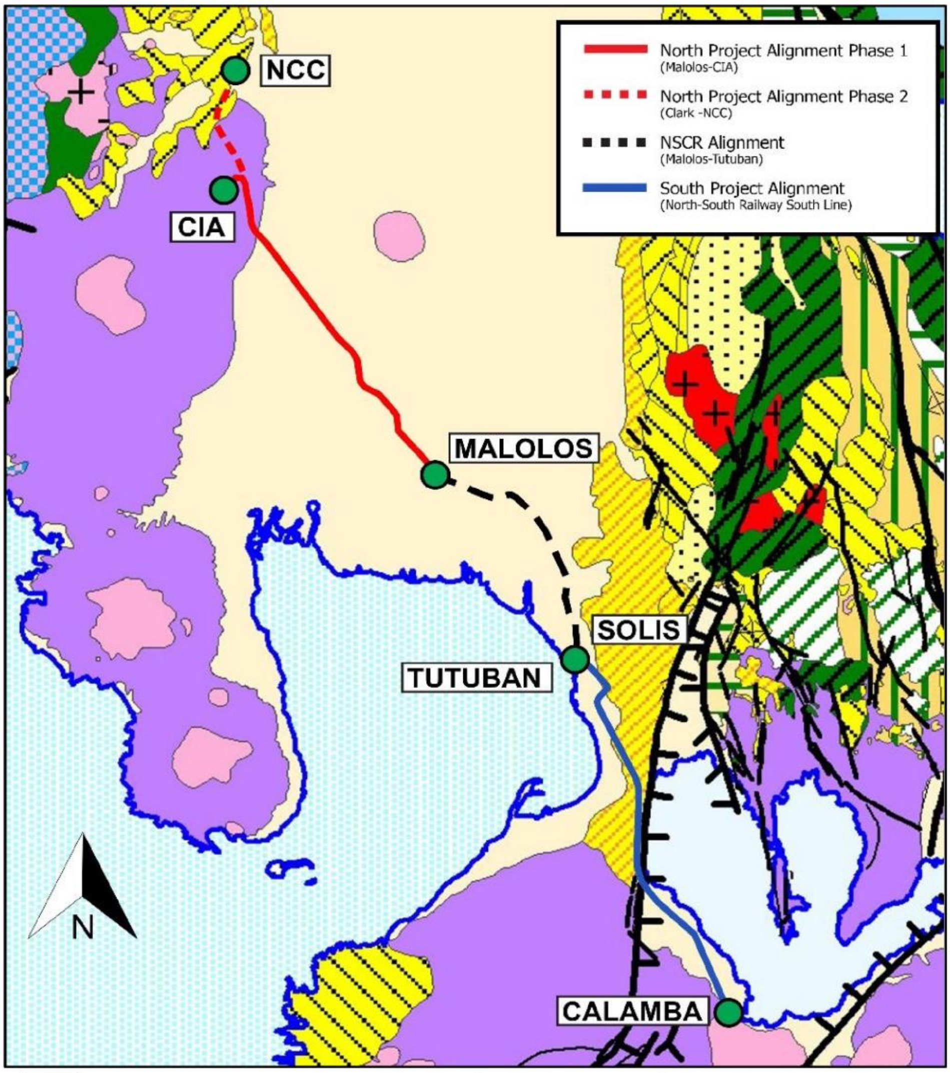
Tarlac Formation

The Tarlac Formation is made up of interbedded sandstone, shale and conglomerate. It has a thickness of 1,200 meters and is conformable over the Malinta Formation and unconformably overlain by the Bamban Formation. It is aged Late Miocene to Early Pliocene. It was named for the interbedded shale, sandstone and conglomerate in the vicinity of Tarlac City. It is a widespread formation forming a Y-shaped outcrop pattern from O'Donnell River in the south to the town of Camiling in the north. The shale is sandy and fossiliferous. The sandstone exhibits spheroidal weathering and has less fossils. The conglomerate is massive to thin-bedded with subangular to subrounded to flat pebbles, cobbles and boulders of igneous rocks, sandstone and limestone in a coarse, tuffaceous sandstone matrix.

Malinta Formation

The Malinta Formation has an upper Aparri Gorge Sandstone and a lower Pau Sandstone. It is conformable over the Moriones Formation and is aged Late Miocene. It has a thickness of 574 meters. It was named for the sandstone-dominated section exposed in the vicinity of Barrio Malinta, Tarlac. It forms a prominent ridge east of the Moriones outcrop belt from O'Donnell River in the south to about 3.5 kilometers southwest of Sta. Ignacia.

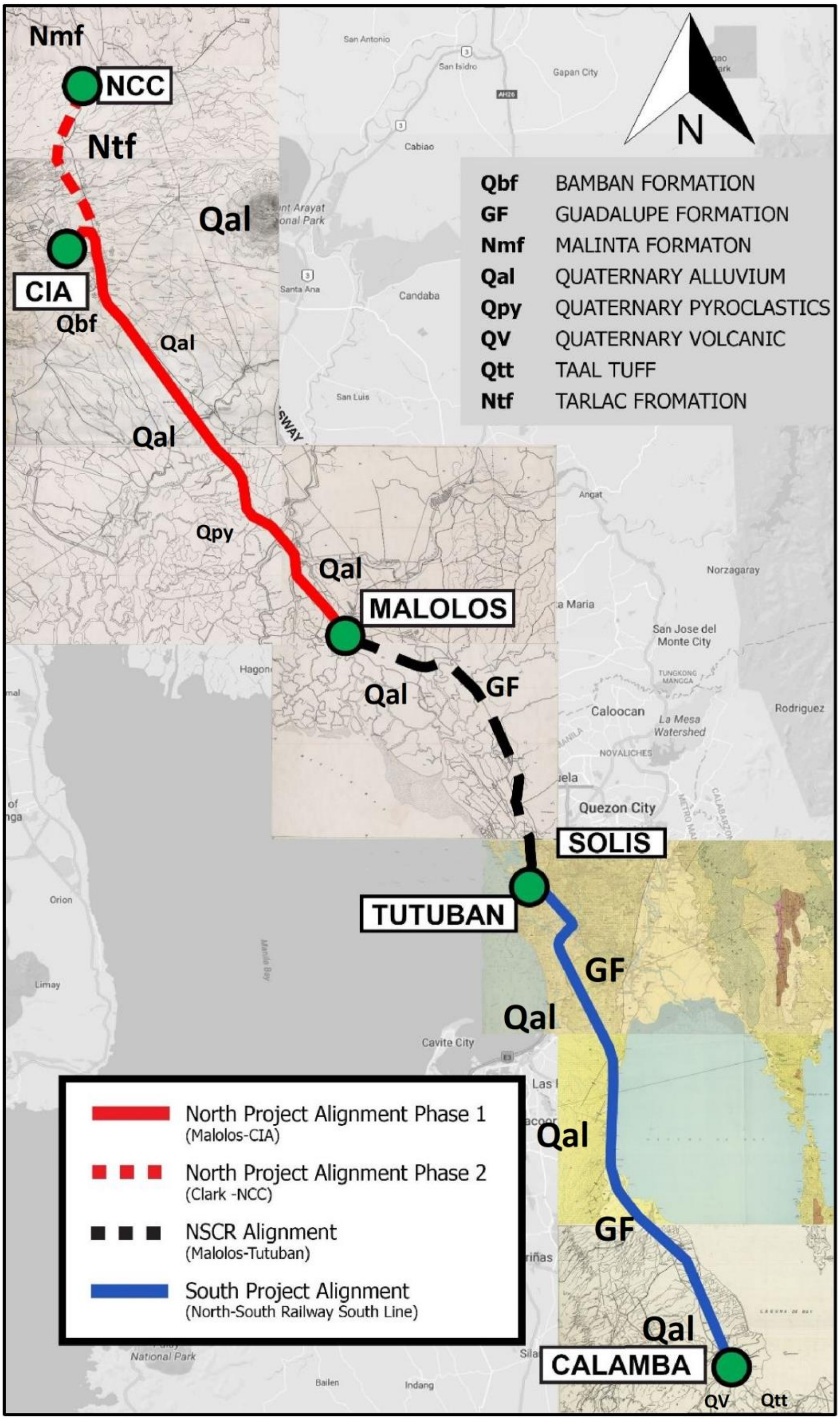
The lower Pau Sandstone member consists of sandy shale grading southward to coarse quartz sandstone to tuffaceous pebbly sandstone overlain by a thick sandstone section with minor amounts of coarse sandy tuffaceous shale and conglomerate. The Aparri Gorge member is a well-cemented quartz sandstone with occasional shale stringers and conglomerate lenses. The Malinta was described as an interbedded sequence of sandstone, shale, conglomerate and lapilli tuff. The sandstone which is predominant in the lower and upper parts of the section is light to gray brown, thin to thick bedded, graded, fine to medium grained, fairly well sorted, well-cemented, tuffaceous and slightly calcareous. The shale is thin to medium bedded, light greenish gray when wet, sandy, tuffaceous and calcareous. The conglomerate at the lower and upper parts of the section is dark gray, massive in places, with rounded to sub-rounded pebbles, cobbles and occasional boulders of igneous rocks held together by fine to medium grained tuffaceous sandstone. The lapilli tuff occur as dirty white to gray, thin to thick beds. The formation was probably deposited in the inner neritic zone. Studies by BEICIP (1976) indicate tidal conditions for the deposition of the conglomerates, as well as the mudstones and sandstones containing fragments of corals and molluscs.



Qh	QUATERNARY (Holocene)	Alluvium, fluviatile, lacustrine, paludal, and beach deposits; raised coral reefs, atolls, and beachrock.
N3 + Q1	PLIOCENE-PLIESTOCENE	Marine and terrestrial sediments. Associated with extensive reef limestone in the western coastal area of Luzon, Bicol region, Visayas, and Mindanao; with pyroclastics in western and southern Central Luzon Basin and in northern Bicol Lowland. Predominantly marl and reworked tuff in places. Sporadic terrace gravel deposits in some coastal and fluvial tracts. Plateau red earths and/or laterites in some elevated flat land surfaces. Deformation limited to gentle warping and vertical dislocation.
N2	UPPER MIOCENE-PLIOCENE	Largely coarse marine clastics overlain by extensive, locally transgressive pyroclastics (chiefly tuff, tuffites) and tuffaceous sedimentary rocks. Associated with calcarenite and/or silty limestone in some parts of Luzon, central Visayas, and Mindanao. Reef limestone lenses intercalated with dacite and andesite flows in Zamboanga (western Mindanao). Chiefly sandstones and limestones in Palawan. Local bog iron; laterite deposits in some elevated near-peneplaned surfaces.
QVP	PLIOCENE-QUATERNARY	Volcanic plain or volcanic piedmont deposits. Chiefly pyroclastics and/or volcanic debris at foot of volcanoes. Plateau basalt in Pagadian and Lanao regions, Mindanao; associated with pyroclastics north and east of Laguna de Bay, Luzon.
QV	PLIOCENE-QUATERNARY	Non-active cones (generally pyroxene andesite); also dacitic and/or andesitic plugs. Basaltic dikes in Binga, Mt. Province, Luzon and in Misamis Oriental, Mindanao.

Source: MINES AND GEOSCIENCES BUREAU

Figure 4.2.79 Geologic Map of the Project Alignment

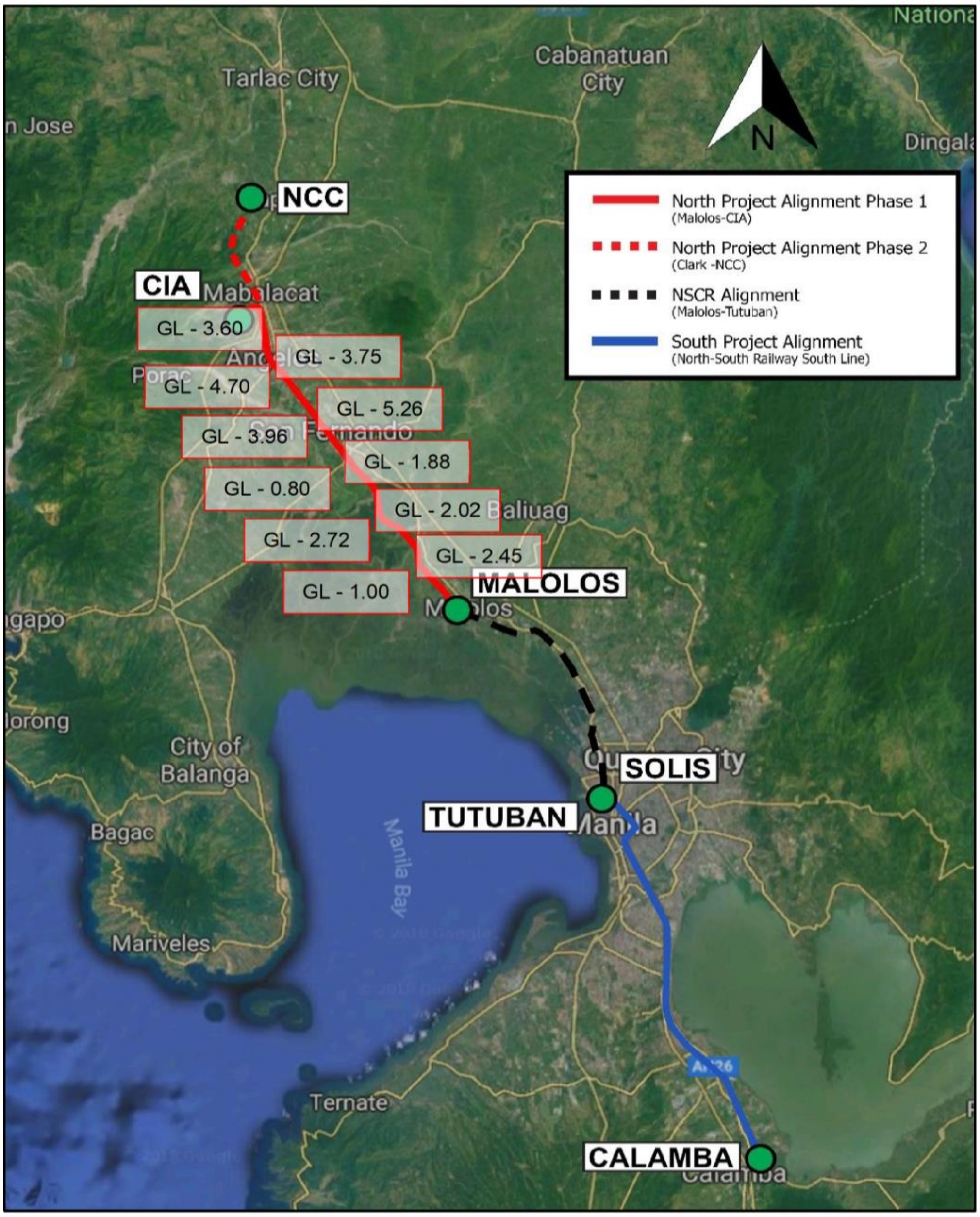


Source: MINES AND GEOSCIENCES BUREAU

Figure 4.2.80 Combined Detailed Geologic Maps of the Project Site

c) Hydrology

The groundwater levels were based on the borehole logs. Under natural conditions, groundwater moves along flow paths from areas of recharge to areas of discharge along streams, lakes and oceans. Figure 4.2.81 presents the estimated average groundwater levels along the project alignment. In general, the groundwater level was encountered at a relatively shallow depth (i.e. less than 3.00 meters below ground level) from Malolos, Bulacan to San Fernando, Pampanga. Further up north to Clark, Pampanga, groundwater level is encountered at lower depths (i.e. average is ranging from 3.60 meters to 5.26 meters).



Source: JICA Design Team

Figure 4.2.81 Average Groundwater Level along the Project Alignment

d) Tectonic Activity

The Philippines accounts for 3.2% of the world's seismicity. It is situated in the Circum-Pacific Belt a.k.a. "Ring of Fire", where 80% of the world's earthquakes occur. Philippine seismicity is mainly related to plate subduction and in part to strike-slip motions along trans-current faults.

The country is a north-south strip of lithosphere built partly on obducted oceanic basement rocks, and by portions of drifted continental crust from southern China. It is pictured as "a wedge caught in between two opposite dipping trenches". The northwestward moving Pacific Plate pushes the Philippine Sea Plate beneath the eastern side of the archipelago at the rate of about 7 centimeters per year (PHIVOLCS, 1991). The oceanic parts of the slower moving Eurasian Plate are being subducted along the western side of Luzon and Mindoro at the rate of 3 centimeters per year.

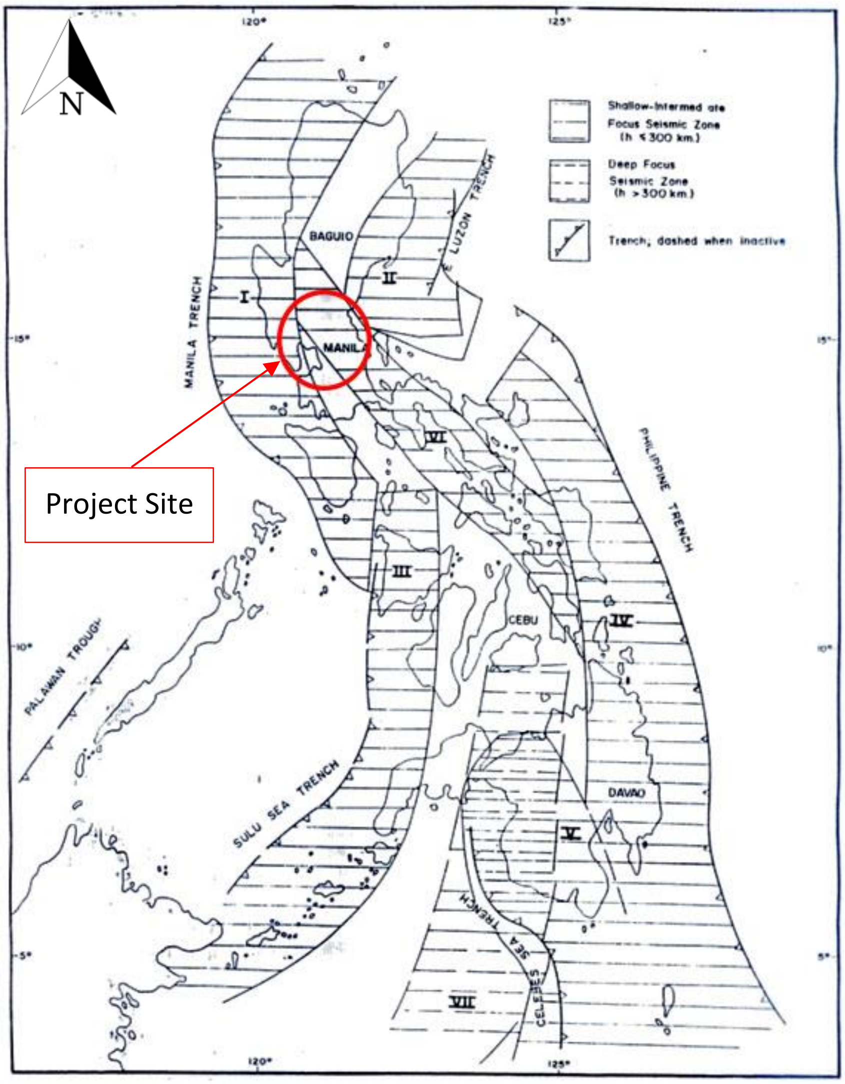
Table 4.2.27 and Figure 4.2.82 ow the seven (7) regional seismic zones in the Philippines. These are delineated and interpreted as follows in the succeeding pages.

Table 4.2.27 Philippine seismic zones and earthquake sources

ZONE-I	Related to the east-dipping Manila Trench
ZONE-II	Related to the west-dipping East Luzon Trench
ZONE-III	Related to the east dipping Sulu Trench and Antique Trough
ZONE-IV	Related to the west-dipping Philippine Trench
ZONE-V	Related to the east-dipping Cotabato Trench
ZONE-VI	Related to the activities along the Philippine Fault and its splays
ZONE-VII	Possibly related to a west dipping subduction zone surfacing at the Agusan-Davao Trough

Source: Geology and Mineral Resources of the Philippines, Vol.1, 1981

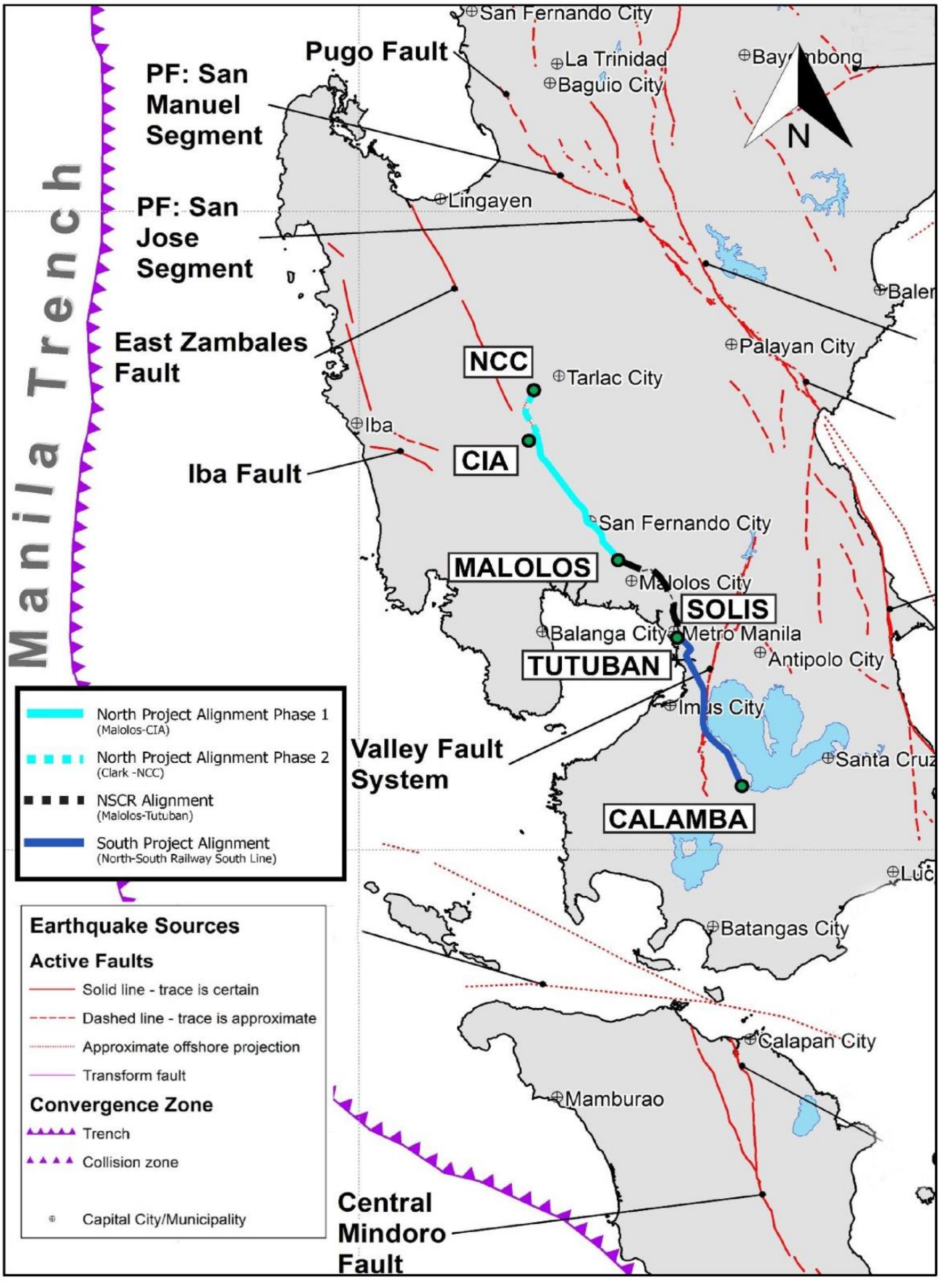
The study thus far indicates the high probability that the regional seismicity of the site would be related to Zone-I and VI, meaning damaging earthquakes are to be brought about by east-dipping Manila Trench and Philippine Fault.



Source: MINES AND GEOSCIENCES BUREAU

Figure 4.2.82 Seismic Zones in the Philippines

Based on the seismic map published by the Philippine Institute of Volcanology and Seismology (PHIVOLCS), the nearest seismic source in the North Line is the East Zambales Fault which is located North West of the proposed last station (NCC Station) (Figure 4.2.83).



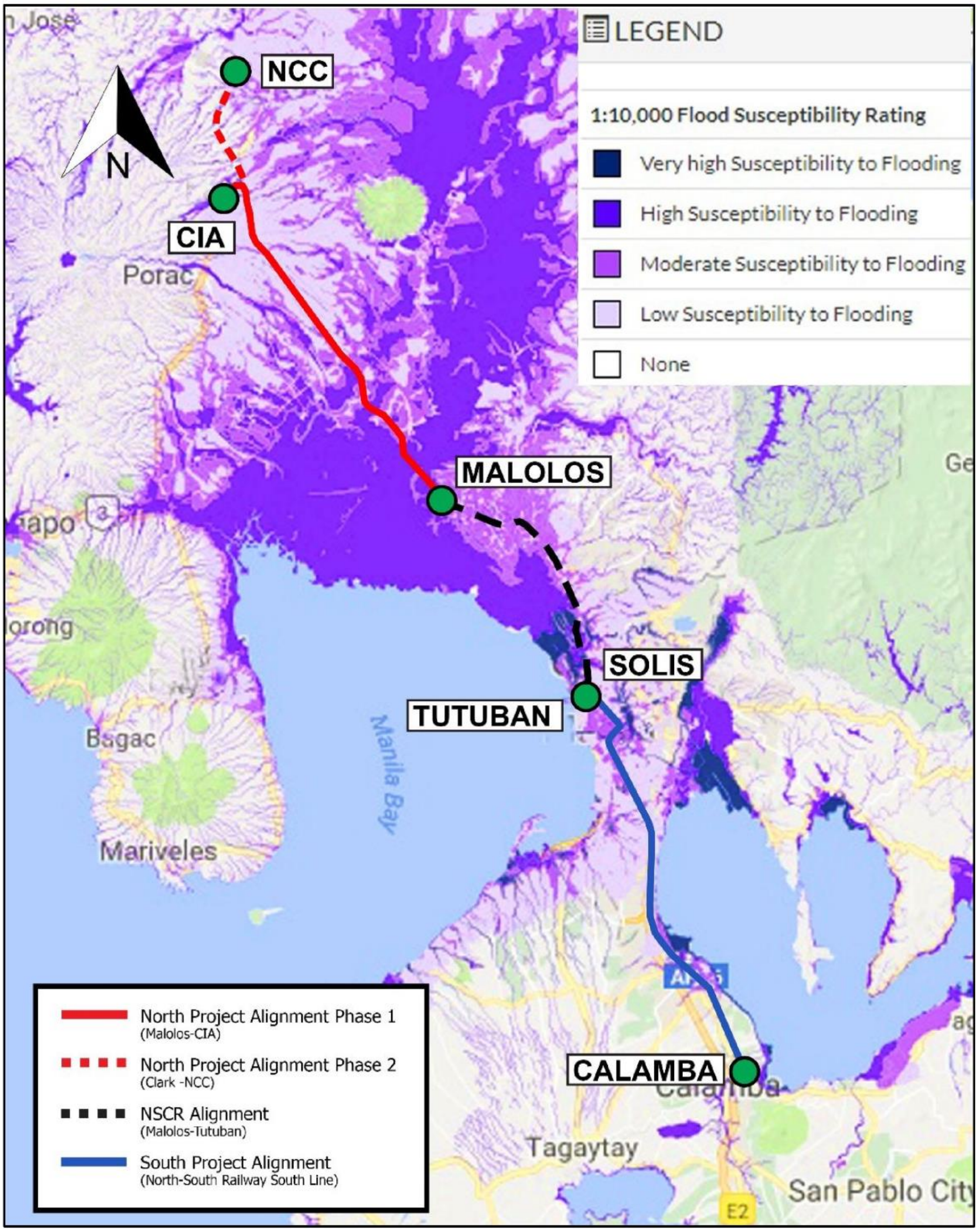
Source: PHIVOLCS

Figure 4.2.83 Extract from the Distribution of Active Faults & Trenches

e) Natural Hazard

Flood and Landslide

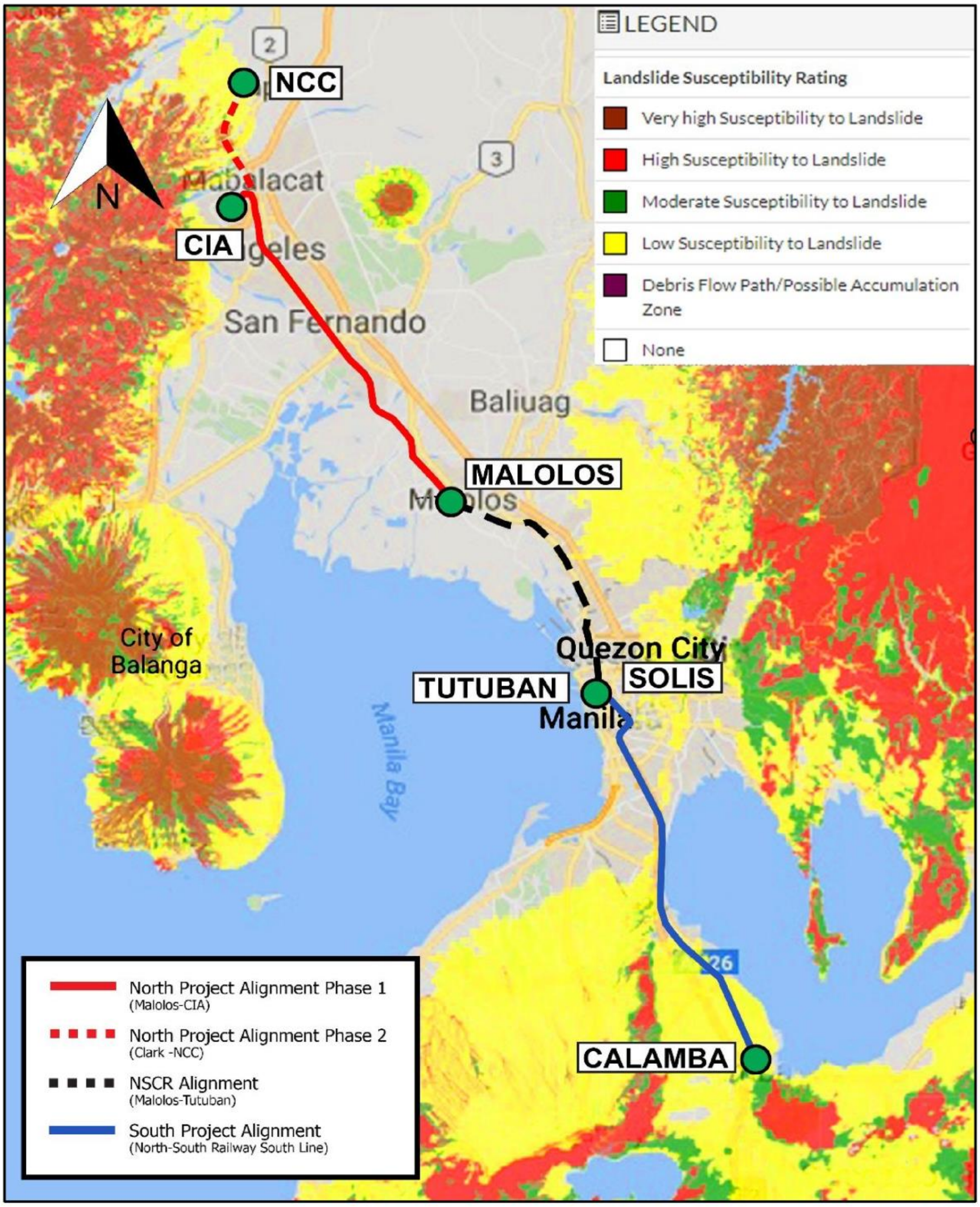
Based from the Mines and Geosciences Bureau (MGB) flood inundation map (Figure 4.2.84), it shows that approximately most parts of Bulacan area in the North Line have high susceptibility to flooding.



Source: Mines and Geosciences Bureau

Figure 4.2.84 Flood Susceptibility Map (Mines and Geosciences Bureau)

On the other hand, the landslide hazard map Figure 4.2.85 shows that the alignment is generally not susceptible to landslides. The alignment between the CIA Station and NCC Station of the North Line in the Laguna area has low susceptibility to landslides.



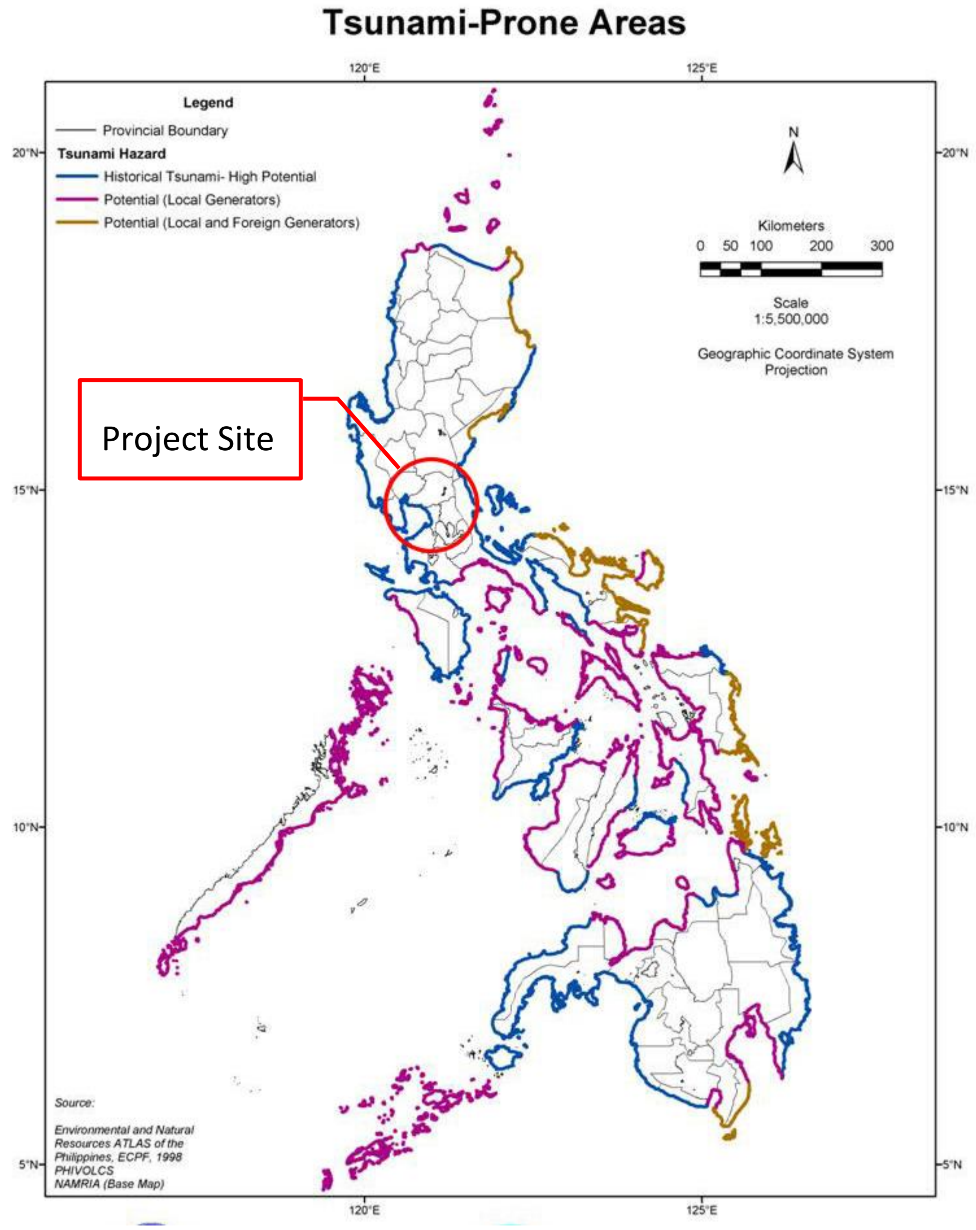
Source: Mines and Geosciences Bureau

Figure 4.2.85 Landslide Susceptibility Map (Mines and Geosciences Bureau)

Tsunami

Tsunami is a sea wave of local or distant origin that results from large-scale seafloor displacements associated with large earthquakes, major submarine slides, or exploding volcanic islands. (Ref: Manila Observatory)

With the proximity of Manila Bay to the project site, the susceptibility to tsunami is potentially high as classified by the following Figure 4.2.86 published by Manila Observatory and DENR.



Source: Manila Observatory & Department of Environmental and Natural Resources

Figure 4.2.86 Tsunami Vulnerability Map of the Philippines

2) The subsurface investigation status

- Malolos-Clark Railway Project (Malolos-NCC) : approximately 780 borings
- Numbers for accomplishment of Boring work : approximately 82％, As of Oct 24 2018
- The Boring work is finished on the Alignment in Malolos to CIA, and the laboratory test is being conducted.

3) Summary of Ground Condition

According to the results of the subsurface investigation until now, stratification for the section is shown below;

- Mololos-Calumpit Section
  Silt and clay layer with a layer thickness of 10 to 20 meters is distributed from in shallow layer.
  Water Level:GL-0.30~6.30m

- Calumpit-San Fernando Section
  Soft silt and clay with N value 0 to 4 is continuously distributed in the layer of 30 to 50 meters thickness.
  Water Level:GL-0.10~23.00m

- North region of San Fernando Section
  The ejecta, which is composed due to the eruption of Mt. Pinatubo Volcano is accumulated of sandy
  soil with volcanic ash and gravel. The sandy soil is firm and N value is approximately over than 20.
  The fine bearing layer with N value over than 50 is distributed at 10 to 20 meters deep. The soft clayee soil layer is distributed limitedly.
  Water Level:GL-Full~16.00m

4) Laboratory test

Laboratory tests, which is carrying out for this project, include the Mechanical Property Test and the Physical Property Test. The Mechanical Property Test includes Triaxial Compression Test (UU), Consolidation Test, and Unconfined Compression Test (UCT). The Physical Property Test includes Specific Gravity, Unit Weight, Natural Moisture Content, Atterberg Limits and Grain Size Analysis (Using Sieve and Hydrometer), including Unified Soil Classification System (USCS).

Physical test is performing at intervals at approximately 200 meters in the horizontal direction and at intervals 3 meters in the vertical direction.

Mechanical test is performing for Undisturbed Sample (UDS) which is taken at the several depth per borehole at intervals at approximately 200 meters in the horizontal direction. In Culumpit-San

Fernando Section, Mechanical test is performing for Max 4 Undisturbed Sample (UDS) per borehole, which depends on the thickness of the soft layer in Culumpit-San Fernando Section.

5) Liquefaction

For the seismic design, the liquefaction resistivity will be analyzed when occurrences of liquefaction is supposed.

6) Summary of Geotechnical Investigation

For this report, the final boring logs were evaluated, 540 boreholes that run along the Malolos – Clark International Airport (CIA) alignment (approximately 50.95 km), The summary of field investigations for all the boreholes is presented in Table 4.2.28.

Table 4.2.28 Philippine seismic zones and earthquake sources

No.	Borehole Name	Final Depth (m)	Ground Elevation (m)	Water Level (m)	Date of Drilling
1	NBH 001	27.00	1.985	GL — 0.71	Mar. 8 – 10, 2018
2	NBH 002	29.50	1.912	GL — 0.70	Mar. 8 – 10, 2018
3	NBH 003	26.50	1.453	GL — 0.90	Mar. 9 – 10, 2018
4	NBH 004	27.50	2.125	GL — 0.42	Mar. 8 – 10, 2018
5	NBH 005	36.50	1.687	GL — 0.70	Feb. 9 – 12, 2018
6	NBH 006	23.00	1.172	GL — 0.70	Mar. 10 – 11, 2018
7	NBH 007	26.00	1.519	GL — 0.80	Mar. 12 – 13, 2018
8	NBH 008	25.00	1.254	GL — 0.80	Mar. 15 – 16, 2018
9	NBH 009	27.50	1.214	GL — 0.69	Mar. 12 – 14, 2018
10	NBH 010	28.63	1.195	GL — 0.90	Feb. 9 – 11, 2018
11	NBH 011	27.50	1.556	GL — 0.92	Mar. 12 – 13, 2018
12	NBH 012	27.50	1.896	GL — 0.92	Mar. 14 – 15, 2018
13	NBH 013	26.50	2.165	GL — 1.10	Mar. 12 – 13, 2018
14	NBH 014	29.50	2.183	GL — 2.30	Mar. 12 – 13, 2018
15	NBH 015	38.00	2.229	GL — 0.96	Feb. 9 – 12, 2018
16	NBH 016	26.50	2.254	GL — 1.50	Mar. 15 – 16, 2018
17	NBH 017	31.00	2.154	GL — 0.60	Mar. 17 – 19, 2018
18	NBH 018	36.50	2.056	GL — 1.10	Mar. 17 – 19, 2018
19	NBH 019	27.50	2.096	GL — 1.30	Mar. 15 – 16, 2018
20	NBH 020	39.00	1.147	GL — 1.42	Feb. 13 – 16, 2018
21	NBH 021	28.00	0.938	GL — 0.53	Mar. 18 – 19, 2018
22	NBH 022	29.50	1.067	GL — 0.83	Mar. 15 – 16, 2018
23	NBH 023	32.00	0.983	GL — 0.57	Mar. 15 – 16, 2018
24	NBH 024	36.50	0.892	GL — 0.52	Mar. 18 – 20, 2018
25	NBH 025	36.00	0.752	GL — 0.92	Feb. 13 – 15, 2018
26	NBH 026	32.00	0.813	GL — 0.51	Mar. 17 – 19, 2018
27	NBH 027	27.50	0.798	GL — 1.15	Mar. 17 – 20, 2018
28	NBH 028	35.00	0.853	GL — 0.40	Mar. 21 – 23, 2018
29	NBH 029	30.50	0.850	GL — 0.35	Mar. 21 – 24, 2018
30	NBH 030	36.50	1.618	GL — 1.90	Feb. 13 – 16, 2018
31	NBH 031	29.78	0.590	GL — 0.30	Mar. 22 – 24, 2018
32	NBH 032	28.00	0.729	GL — 0.80	Mar. 21 – 22, 2018
33	NBH 033	23.50	0.993	GL — 0.51	Mar. 20 – 21, 2018
34	NBH 034	29.00	1.246	GL — 1.10	Mar. 20 – 21, 2018
35	NBH 035	30.50	1.899	GL — 1.42	Feb. 16 – 18, 2018
36	NBH 036	26.00	0.886	GL — 0.80	Mar. 23 – 24, 2018
37	NBH 037	30.50	1.633	GL — 0.92	Mar. 23 – 24, 2018
38	NBH 038	31.40	1.371	GL — 0.30	Mar. 26 – 29, 2018
39	NBH 039	30.50	1.127	GL — 0.40	Mar. 26 – 27, 2018
40	NBH 040	31.50	1.385	GL — 5.60	Feb. 17 – 19, 2018
41	NBH 041	27.50	1.625	GL — 0.52	Mar. 23 – 24, 2018
42	NBH 042	30.50	2.214	GL — 2.20	Mar. 25 – 26, 2018
43	NBH 043	30.50	2.208	GL — 1.80	Mar. 25 – 26, 2018
44	NBH 044	27.50	1.506	GL — 1.30	Mar. 25 – 26, 2018
45	NBH 045	30.00	2.782	GL — 1.30	Feb. 17 – 19, 2018
46	NBH 046	29.00	1.577	GL — 0.80	Mar. 26 – 28, 2018
47	NBH 047	38.00	1.967	GL — 0.60	Mar. 27 – 28, 2018
48	NBH 048	36.50	1.345	GL — 0.50	Mar. 28 – 29, 2018
49	NBH 049	30.50	1.413	GL — 0.40	Mar. 27 – 28, 2018
50	NBH 050	31.50	2.020	GL — 1.50	Feb. 19 – 20, 2018

No.	Borehole Name	Final Depth (m)	Ground Elevation (m)	Water Level (m)	Date of Drilling
51	NBH 051	33.00	2.671	GL — 1.47	Apr. 3 – 6, 2018
52	NBH 052	33.00	2.744	GL — 1.62	Apr. 3 – 5, 2018
53	NBH 053	34.50	2.148	GL — 0.50	Mar. 27 – 29, 2018
54	NBH 054	45.50	1.395	GL — 0.50	Apr. 3 – 6, 2018
55	NBH 055	37.50	1.831	GL — 0.80	Mar. 22 – 24, 2018
56	NBH 056	37.50	1.563	GL — 0.58	Apr. 12 – 15, 2018
57	NBH 057	41.00	1.533	GL — 1.60	Apr. 14 – 17, 2018
58	NBH 058	41.00	1.966	GL — 0.66	Apr. 15 – 17, 2018
59	NBH 059	41.00	2.199	GL — 1.45	Apr. 14 – 17, 2018
60	NBH 060	37.50	2.559	GL — 1.35	Apr. 7 – 9, 2018
61	NBH 061	42.80	2.092	GL — 0.50	Apr. 16 – 19, 2018
62	NBH 062	42.50	3.252	GL — 1.20	Apr. 14 – 17, 2018
63	NBH 063	41.00	3.502	GL — 2.20	Apr. 14 – 16, 2018
64	NBH 064	31.00	-7.555	Offshore	May 24 – 26, 2018
65	NBH 065	33.00	-7.405	Offshore	May 28 – 30, 2018
66	NBH 066	40.50	2.980	GL — 1.40	Feb. 18 – 21, 2018
67	NBH 067	42.54	1.697	GL — 0.60	Apr. 3 – 5, 2018
68	NBH 068	40.57	1.198	GL — 1.05	Apr. 3 – 5, 2018
69	NBH 069	43.90	1.315	GL — 3.00	Apr. 3 – 6, 2018
70	NBH 070	33.00	0.911	GL — 1.30	Feb. 19 – 21, 2018
71	NBH 071	50.00	0.686	GL — 0.50	Apr. 7 – 14, 2018
72	NBH 072	41.00	1.077	GL — 1.40	Apr. 6 – 8, 2018
73	NBH 073	41.00	0.707	GL — 1.10	Apr. 7 – 10, 2018
74	NBH 074	40.50	1.368	GL — 0.95	Mar. 9 – 12, 2018
75	NBH 075	43.50	1.943	GL — 2.91	Feb. 16 – 21, 2018
76	NBH 076	39.00	2.614	GL — 4.60	Jun. 9 – 12, 2018
77	NBH 077	41.00	2.385	GL — 6.30	Jun. 27 – 29, 2018

No.	Borehole Name	Final Depth (m)	Ground Elevation (m)	Water Level (m)	Date of Drilling
78	NBH 078	38.50	2.588	GL — 3.09	Jun. 27 – 29, 2018
79	NBH 079	39.50	2.241	GL — 1.30	Jun. 12 – 16, 2018
80	NBH 080	42.00	2.034	GL — 2.15	Mar.29-Apr. 3, 2018
81	NBH 081	40.50	2.190	GL — 2.50	Mar. 21 – 23, 2018
82	NBH 082	42.00	2.236	GL — 1.90	Mar. 24 – 26, 2018
83	NBH 083	37.50	4.341	GL — 2.30	Mar. 16 – 18, 2018
84	NBH 084	37.50	2.512	GL — 2.15	Mar. 12 – 14, 2018
85	NBH 085	39.00	3.022	GL — 2.30	Feb. 15 – 17, 2018
86	NBH 086	38.00	3.022	GL — 6.10	Mar. 10 – 12, 2018
87	NBH 087	36.00	3.855	GL — 6.15	Mar. 14 – 16, 2018
88	NBH 088	40.50	3.500	GL — 6.23	Mar. 18 – 20, 2018
89	NBH 089	40.50	4.531	GL — 2.15	Feb. 18 – 23, 2018
90	NBH 090	39.00	-2.553	GL — 0.90	Apr. 21 – 26, 2018
91	NBH 091	36.00	-2.560	Offshore	Apr.29–May 4, 2018
92	NBH 092	36.00	-1.160	Offshore	May 6 – 8, 2018
93	NBH 093	46.50	4.298	GL — 7.00	May 22 – 26, 2018
94	NBH 094	39.00	4.019	GL — 6.10	Mar. 23 – 25, 2018
95	NBH 095	42.00	2.727	GL — 5.20	Feb. 13 – 16, 2018
96	NBH 096	42.00	2.737	GL — 3.12	Apr. 5 – 8, 2018
97	NBH 097	45.00	0.752	GL — 2.30	Mar. 27 – 29, 2018
98	NBH 098	43.50	1.623	GL — 1.20	Apr. 12 – 14, 2018
99	NBH 099	40.50	1.388	GL — 1.52	Apr. 16 – 19, 2018
100	NBH 100	43.95	0.714	GL — 7.65	Feb. 13 – 17, 2018
101	NBH 101	42.50	1.498	GL — 1.60	Apr. 10 – 13, 2018
102	NBH 102	44.00	1.040	GL — 1.60	Apr. 7 – 9, 2018
103	NBH 103	48.50	1.313	GL — 0.90	Apr. 10 – 13, 2018
104	NBH 104	47.00	1.282	GL — 0.80	Apr. 7 – 9, 2018

No.	Borehole Name	Final Depth (m)	Ground Elevation (m)	Water Level (m)	Date of Drilling
105	NBH 105	39.00	1.291	GL — 1.00	Mar. 15 – 17, 2018
106	NBH 106	51.50	1.110	GL — 0.65	Apr. 7 – 12, 2018
107	NBH 107	44.00	0.806	GL — 0.92	Apr. 8 – 10, 2018
108	NBH 108	50.00	0.572	GL — 0.40	Apr. 12 – 15, 2018
109	NBH 109	45.50	1.140	GL — 0.80	Apr. 10 – 13, 2018
110	NBH 110	37.50	0.965	GL — 1.20	Feb. 13 – 14, 2018
111	NBH 111	40.50	0.347	GL — 3.50	May30-Jun. 2, 2018
112	NBH 112	42.50	-3.924	Offshore	May 11 – 16, 2018
113	NBH 113	36.00	-6.424	Offshore	May 18 – 21, 2018
114	NBH 114	42.00	1.576	GL — 1.25	May 5 – 10, 2018
115	NBH 115	35.50	1.730	GL — 2.00	Feb. 9 – 11, 2018
116	NBH 116	48.00	1.516	GL — 1.00	Apr. 5 – 7, 2018
117	NBH 117	43.00	4.232	GL —22.10	Mar. 26 – 28, 2018
118	NBH 118	57.50	3.018	GL —23.00	Mar. 19 - 23, 2018
119	NBH 119	42.00	2.575	GL —17.26	Mar. 11 – 15, 2018
120	NBH 120	52.50	2.352	GL — 2.25	Feb. 9 –13, 2018
121	NBH 121	46.50	2.149	GL — 2.10	Mar. 8 – 13, 2018
122	NBH 122	49.50	1.611	GL — 2.25	Mar. 14 – 18, 2018
123	NBH 123	48.00	1.237	GL — 2.19	Mar. 18 – 21, 2018
124	NBH 124	49.50	1.255	GL — 1.25	Mar. 22 – 24, 2018
125	NBH 125	46.50	1.647	GL — 2.05	Feb. 9 – 12, 2018
126	NBH 126	48.00	1.290	GL — 2.15	Mar. 26 – 28, 2018
127	NBH 127	46.50	1.217	GL — 2.10	Apr. 2 – 6, 2018
128	NBH 128	49.50	1.327	GL — 1.48	Mar.27 - Apr.2,2018
129	NBH 129	45.00	1.331	GL — 1.80	Mar. 22 – 25, 2018
130	NBH 130	42.00	1.035	GL — 0.39	Feb. 9 – 12, 2018
131	NBH 131	54.00	1.289	GL — 1.07	Mar. 8 – 11, 2018

No.	Borehole Name	Final Depth (m)	Ground Elevation (m)	Water Level (m)	Date of Drilling
132	NBH 132	42.00	1.274	GL — 1.24	Mar. 13 – 14, 2018
133	NBH 133	43.50	0.899	GL — 0.95	Mar. 15 – 17, 2018
134	NBH 134	46.50	1.379	GL — 1.33	Mar. 19 – 21, 2018
135	NBH 135	36.00	1.464	GL — 1.30	Feb. 13 – 15, 2018
136	NBH 136	49.50	1.655	GL — 1.40	Apr. 7 – 14, 2018
137	NBH 137	46.50	1.348	GL — 1.35	Apr. 19 – 28, 2018
138	NBH 138	42.00	1.055	GL — 1.40	Apr.30-May 3, 2018
139	NBH 139	51.00	1.961	GL — 2.10	May 3 – 8, 2018
140	NBH 140	57.00	1.938	GL — 1.50	Mar. 12 – 23, 2018
141	NBH 141	46.50	1.667	GL — 1.40	Apr.28-May 2, 2018
142	NBH 142	43.50	1.278	GL — 0.96	Apr. 25 – 27, 2018
143	NBH 143	49.50	1.448	GL — 1.25	Apr. 18 – 21, 2018
144	NBH 144	48.00	1.663	GL — 1.50	Apr. 6 – 17, 2018
145	NBH 145	46.50	1.636	GL — 1.35	Mar.26-Apr. 3, 2018
146	NBH 146	48.00	2.254	GL — 2.45	May 4 – 17, 2018
147	NBH 147	36.00	1.864	GL — 2.80	May 22 – 24, 2018
148	NBH 148	46.50	1.459	GL — 2.35	Apr.30-May 2, 2018
149	NBH 149	46.50	1.205	GL — 1.75	Apr. 25 – 27, 2018
150	NBH 150	46.50	0.662	GL — 0.63	Feb. 17 – 20, 2018
151	NBH 151	48.00	1.548	GL — 1.15	Apr. 18 – 23, 2018
152	NBH 152	46.50	1.018	GL — 1.05	Apr. 9 – 16, 2018
153	NBH 153	46.50	0.949	GL — 0.70	Mar.28-Apr. 6, 2018
154	NBH 154	46.50	0.301	GL — 1.00	Mar. 17 – 26, 2018
155	NBH 155	43.50	1.265	GL — 1.40	Feb. 11 – 15, 2018
156	NBH 156	36.00	1.274	GL — 1.62	May 20 – 26, 2018
157	NBH 157	42.00	1.564	GL — 3.82	May 19 – 21, 2018
158	NBH 158	40.50	0.855	GL — 6.17	May 23 – 25, 2018

No.	Borehole Name	Final Depth (m)	Ground Elevation (m)	Water Level (m)	Date of Drilling
159	NBH 159	41.00	1.337	GL — 1.50	May 26 – 29, 2018
160	NBH 160	43.50	1.764	GL — 1.82	Apr. 6 – 9, 2018
161	NBH 161	46.50	1.359	GL — 1.32	May 19 – 21, 2018
162	NBH 162	42.00	1.324	GL — 2.86	May 16 – 17, 2018
163	NBH 163	45.00	1.373	GL — 1.40	Jun. 1 – 4, 2018
164	NBH 164	45.00	0.964	GL — 1.83	May 8 – 10, 2018
165	NBH 165	42.00	1.202	GL — 1.97	Apr. 13 – 15, 2018
166	NBH 166	46.50	1.361	GL — 2.10	May 4 – 6, 2018
167	NBH 167	46.50	1.328	GL — 1.50	Apr.30-May 2, 2018
168	NBH 168	40.50	1.983	GL — 3.69	Apr. 27 – 28, 2018
169	NBH 169	40.50	1.738	GL — 2.51	Apr. 24 – 26, 2018
170	NBH 170	45.00	0.603	GL — 0.80	Apr. 18 – 20, 2018
171	NBH 171	48.00	-0.898	Offshore	Jun. 13 – 14, 2018
172	NBH 172	52.50	1.220	GL — 1.00	Jun. 20 – 22, 2018
173	NBH 173	51.00	1.330	GL — 2.00	Jun. 15 – 16, 2018
174	NBH 174	51.00	0.836	GL — 0.60	Jun. 9 – 14, 2018
175	NBH 175	49.50	-0.618	Offshore	Jun. 8 – 9, 2018
176	NBH 176	51.00	0.397	GL —12.09	May 1 – 8, 2018
177	NBH 177	52.50	1.850	GL — 2.70	May31-Jun. 8, 2018
178	NBH 178	52.50	1.303	GL — 1.35	May 12 – 28, 2018
179	NBH 179	49.50	1.661	GL — 1.50	Jun. 13 – 17, 2018
180	NBH 180	46.50	1.149	GL — 1.50	Apr. 27 – 29, 2018
181	NBH 181	46.50	1.268	GL — 1.20	May 9 – 10, 2018
182	NBH 182	48.00	1.642	GL — 3.00	May 12 – 17, 2018
183	NBH 183	46.50	2.075	GL — 2.90	May 19 – 23, 2018
184	NBH 184	46.50	2.107	GL — 2.00	May 25 – 26, 2018
185	NBH 185	46.50	1.755	GL — 1.35	Apr. 20 – 21, 2018

No.	Borehole Name	Final Depth (m)	Ground Elevation (m)	Water Level (m)	Date of Drilling
186	NBH 186	49.50	2.135	GL — 1.90	May 28 – 30, 2018
187	NBH 187	51.00	2.249	GL — 4.10	Jun. 3 – 6, 2018
188	NBH 188	57.00	1.979	GL — 2.00	May 17 – 30, 2018
189	NBH 189	51.00	0.530	GL — 0.10	Jun. 2 – 6, 2018
190	NBH 190	48.00	1.526	GL — 1.80	Mar.28-Apr. 2, 2018
191	NBH 191	48.00	1.602	GL — 0.75	Apr. 6 – 7, 2018
192	NBH 192	54.00	1.485	GL — 1.05	Apr. 9 – 11, 2018
193	NBH 193	54.00	1.555	GL — 1.00	Apr. 13 – 14, 2018
194	NBH 194	45.00	1.515	GL — 1.56	Apr. 19 – 21, 2018
195	NBH 195	49.50	1.958	GL — 1.45	Mar. 23 – 24, 2018
196	NBH 196	52.50	2.150	GL — 1.92	Apr. 24 – 25, 2018
197	NBH 197	49.50	2.134	GL — 1.61	Apr. 27 – 28, 2018
198	NBH 198	49.50	1.887	GL — 1.52	Apr.30-May 1, 2018
199	NBH 199	48.00	1.568	GL — 2.10	May 8, 2018
200	NBH 200	48.00	1.502	GL — 0.65	Mar. 19 – 20, 2018
201	NBH 201	49.50	1.317	GL — 0.87	May 17 – 18, 2018
202	NBH 202	46.50	1.051	GL — 0.53	Mar. 14 – 16, 2018
203	NBH 203	48.00	-1.992	Offshore	May28-Jun. 1, 2018
204	NBH 204	48.00	-1.404	Offshore	Jun. 4 – 5, 2018
205	NBH 205	45.00	0.596	GL — 0.69	Feb. 23 – 24, 2018
206	NBH 206	45.00	0.952	GL — 1.20	Mar. 27 – 28, 2018
207	NBH 207	43.50	0.932	GL — 1.42	Mar. 27 – 28, 2018
208	NBH 208	45.00	0.966	GL — 1.30	Mar. 23 – 25, 2018
209	NBH 209	43.50	1.120	GL — 1.47	Mar. 20 – 22, 2018
210	NBH 210	43.50	0.977	GL — 0.40	Feb. 16 – 18, 2018
211	NBH 211	42.00	1.001	GL — 1.23	Mar. 18 – 19, 2018
212	NBH 212	43.50	1.011	GL — 0.80	Mar. 15 – 16, 2018

No.	Borehole Name	Final Depth (m)	Ground Elevation (m)	Water Level (m)	Date of Drilling
213	NBH 213	43.50	0.809	GL — 0.85	Mar. 12 – 13, 2018
214	NBH 214	42.00	0.612	GL — 0.80	Mar. 8 – 9, 2018
215	NBH 215	42.00	0.499	GL — 0.47	Feb. 11 – 14, 2018
216	NBH 216	40.50	0.503	GL — 0.42	Mar. 23 – 24, 2018
217	NBH 217	37.50	0.632	GL — 0.41	Mar. 20 – 22, 2018
218	NBH 218	40.50	0.789	GL — 0.45	Mar. 15 – 16, 2018
219	NBH 219	37.50	0.624	GL — 0.45	Mar. 11 – 13, 2018
220	NBH 220	37.50	0.861	GL — 0.31	Feb. 11 – 14, 2018
221	NBH 221	42.00	1.736	GL — 1.40	Apr. 19 – 21, 2018
222	NBH 222	34.50	0.629	GL — 0.52	Apr. 15 – 17, 2018
223	NBH 223	39.00	1.066	GL — 0.80	Apr. 10 – 12, 2018
224	NBH 224	36.00	1.029	GL — 1.50	Apr. 7 – 8, 2018
225	NBH 225	63.00	0.856	GL — 0.50	Mar. 5-Apr. 5, 2018
226	NBH 226	65.50	0.680	GL — 1.00	Mar. 22 – 27, 2018
227	NBH 227	60.00	0.130	GL — 0.56	May31-Jun. 3, 2018
228	NBH 228	43.50	0.730	GL — 0.47	May 24 – 27, 2018
229	NBH 229	39.00	0.918	GL — 0.39	May 21 – 23, 2018
230	NBH 230	36.00	0.714	GL — 0.55	Mar. 7 – 9, 2018
231	NBH 231	40.50	0.963	GL — 0.56	May 17 – 20, 2018
232	NBH 232	37.20	1.479	GL — 1.14	Mar. 21 – 22, 2018
233	NBH 233	36.00	1.189	GL — 1.00	Mar. 17 – 19, 2018
234	NBH 234	37.50	1.627	GL — 1.20	Mar. 15 – 16, 2018
235	NBH 235	37.50	1.144	GL — 0.60	Mar. 11 – 13, 2018
236	NBH 236	39.00	1.223	GL — 0.90	May 19 – 22, 2018
237	NBH 237	37.50	1.594	GL — 1.35	May 13 – 17, 2018
238	NBH 238	40.50	1.188	GL — 0.80	May 7 – 11, 2018
239	NBH 239	37.50	1.362	GL — 1.50	Apr. 24 – 27, 2018

No.	Borehole Name	Final Depth (m)	Ground Elevation (m)	Water Level (m)	Date of Drilling
240	NBH 240	57.00	1.630	GL — 1.02	Mar. 8 – 16, 2018
241	NBH 241	37.50	1.493	GL — 0.89	Apr. 25 – 28, 2018
242	NBH 242	34.50	1.937	GL — 0.60	May 18 – 20, 2018
243	NBH 243	34.50	1.758	GL — 1.00	May 13 – 16, 2018
244	NBH 244	36.00	2.082	GL — 0.60	Mar. 16 – 22, 2018
245	NBH 245	36.00	1.913	GL — 0.50	Mar.26-Apr. 5, 2018
246	NBH 246	28.50	2.080	GL — 0.70	Apr. 9 – 10, 2018
247	NBH 247	28.50	2.026	GL — 0.70	Apr. 13 – 14, 2018
248	NBH 248	31.50	1.921	GL — 0.35	Apr. 16 – 20, 2018
249	NBH 249	31.50	2.316	GL — 0.54	May 7 – 11, 2018
250	NBH 250	31.50	1.995	GL — 0.56	Feb. 15 – 17, 2018
251	NBH 251	31.50	2.397	GL — 0.65	Apr. 14 – 17, 2018
252	NBH 252	33.00	2.272	GL — 0.46	Apr. 11 – 12, 2018
253	NBH 253	31.50	1.946	GL — 0.65	Apr. 6 – 8, 2018
254	NBH 254	71.50	1.748	GL — 0.96	Mar.10-Apr. 6, 2018
255	NBH 255	34.50	1.791	GL — 0.75	Feb. 19 – 22, 2018
256	NBH 256	33.00	2.056	GL — 1.30	Mar. 12 – 15, 2018
257	NBH 257	33.00	2.190	GL — 5.20	Mar. 17 – 20, 2018
258	NBH 258	34.50	2.287	GL — 1.00	Mar. 24 – 28, 2018
259	NBH 259	37.50	2.215	GL — 0.45	Apr. 2 – 4, 2018
260	NBH 260	30.00	2.398	GL — 0.52	Feb. 16 – 17, 2018
261	NBH 261	31.50	2.315	GL — 1.00	Apr. 6 – 7, 2018
262	NBH 262	43.50	2.490	GL — 0.50	Apr. 11 – 14, 2018
263	NBH 263	33.00	2.469	Dry	Apr. 21 – 22, 2018
264	NBH 264	33.00	2.563	Full	Jun. 25 – 28, 2018
265	NBH 265	31.50	2.684	GL — 0.30	Feb. 24 – 27, 2018
266	NBH 266	36.00	2.960	GL — 0.45	Apr. 17 – 18, 2018

No.	Borehole Name	Final Depth (m)	Ground Elevation (m)	Water Level (m)	Date of Drilling
267	NBH 267	33.00	3.484	GL — 0.75	Apr. 25 – 26, 2018
268	NBH 268	31.50	3.949	GL — 0.92	Apr. 28, 2018
269	NBH 269	31.50	4.129	GL — 0.82	May 2 – 3, 2018
270	NBH 270	28.50	5.225	GL — 0.85	Feb.24-Mar.11,2018
271	NBH 271	31.50	5.467	GL — 2.00	Apr. 19 – 20, 2018
272	NBH 272	34.50	5.633	GL — 1.00	Apr. 23 – 26, 2018
273	NBH 273	27.00	5.366	GL — 1.43	Apr. 27 – 28, 2018
274	NBH 274	28.50	5.983	GL — 1.08	May 1 – 3, 2018
275	NBH 275	29.50	6.584	GL — 8.73	Feb. 24 – 26, 2018
276	NBH 276	36.50	6.724	GL — 5.95	May 22 – 25, 2018
277	NBH 277	26.00	7.168	GL — 4.10	May 27 – 29, 2018
278	NBH 278	32.00	7.802	GL — 4.05	May 28 – 29, 2018
279	NBH 279	33.00	8.070	GL — 1.41	Apr. 5 – 7, 2018
280	NBH 280	31.50	8.786	GL — 2.40	Feb. 22 – 24, 2018
281	NBH 281	31.50	8.719	GL — 1.25	Apr. 2 – 5, 2018
282	NBH 282	31.50	9.356	GL — 1.27	Mar. 22 – 25, 2018
283	NBH 283	33.00	9.566	GL — 1.26	Apr. 11 – 12, 2018
284	NBH 284	31.50	10.046	GL — 2.20	Feb. 21 – 22, 2018
285	NBH 285	31.50	10.591	GL — 1.70	Apr.30-May 1, 2018
286	NBH 286	31.50	11.055	GL — 1.74	Apr. 24 – 26, 2018
287	NBH 287	34.50	11.069	GL — 1.74	Apr. 20 – 21, 2018
288	NBH 288	36.00	11.155	GL — 2.10	Apr. 16 – 18, 2018
289	NBH 289	31.50	12.725	GL — 2.46	Apr. 13 – 15, 2018
290	NBH 290	28.50	13.283	GL — 1.50	Feb. 22 – 24, 2018
291	NBH 291	66.00	13.459	GL — 2.15	Mar.26-Apr.10,2018
292	NBH 292	33.00	13.919	GL — 2.20	Apr. 4 – 10, 2018
293	NBH 293	33.00	14.505	GL — 2.15	Apr. 12 – 14, 2018

No.	Borehole Name	Final Depth (m)	Ground Elevation (m)	Water Level (m)	Date of Drilling
294	NBH 294	30.00	14.983	GL — 3.00	Apr. 12 – 13, 2018
295	NBH 295	30.00	15.148	GL — 1.60	Feb. 22 – 24, 2018
296	NBH 296	31.50	15.407	GL — 2.86	Apr. 16 – 17, 2018
297	NBH 297	31.50	15.451	GL — 3.05	Apr. 15 – 17, 2018
298	NBH 298	27.00	15.486	GL — 2.05	Apr. 20 – 21, 2018
299	NBH 299	31.50	17.996	GL — 2.00	Apr. 21 – 24, 2018
300	NBH 300	25.50	15.658	GL — 2.10	Feb. 25 – 27, 2018
301	NBH 301	28.50	16.057	GL — 3.00	Apr. 17 – 20, 2018
302	NBH 302	28.50	16.118	GL — 1.50	Apr. 22 – 24, 2018
303	NBH 303	30.00	15.911	GL — 3.30	Apr. 22 – 27, 2018
304	NBH 304	31.50	17.130	GL — 2.60	Apr. 23 – 25, 2018
305	NBH 305	31.50	18.171	GL — 2.30	Feb. 23 – 25, 2018
306	NBH 306	28.50	18.570	GL — 2.30	Apr. 26 – 28, 2018
307	NBH 307	25.50	18.612	GL — 3.36	Apr. 26 – 28, 2018
308	NBH 308	25.50	18.958	GL — 2.30	Apr. 26 – 27, 2018
309	NBH 309	30.00	19.314	GL — 2.50	Apr.29-May 1, 2018
310	NBH 310	31.50	19.945	GL — 4.10	Feb. 26 – 27, 2018
311	NBH 311	30.00	20.322	GL — 3.20	Apr.29-May 3, 2018
312	NBH 312	31.50	21.119	GL — 2.50	Apr.29-May 3, 2018
313	NBH 313	31.50	21.759	GL — 2.50	Apr.30-May 3, 2018
314	NBH 314	27.00	22.744	GL — 3.40	May 2 – 4, 2018
315	NBH 315	21.00	23.434	GL — 4.20	Feb. 25 – 26, 2018
316	NBH 316	30.00	24.186	GL — 5.59	Apr. 6 – 8, 2018
317	NBH 317	30.00	24.435	GL — 3.15	Apr. 10 – 13, 2018
318	NBH 318	31.50	24.572	GL — 5.18	Apr. 15 – 16, 2018
319	NBH 319	36.00	25.271	GL — 7.50	Apr. 18 – 19, 2018
320	NBH 320	30.00	25.875	GL — 4.30	Feb. 27 – 28, 2018

No.	Borehole Name	Final Depth (m)	Ground Elevation (m)	Water Level (m)	Date of Drilling
321	NBH 321	39.00	26.499	GL — 4.25	Apr. 7 – 9, 2018
322	NBH 322	33.00	26.575	GL — 3.30	Apr. 12 – 13, 2018
323	NBH 323	34.50	26.786	GL — 4.30	Apr. 15 – 16, 2018
324	NBH 324	34.50	26.885	GL — 3.80	Apr. 18 – 19, 2018
325	NBH 325	25.50	27.191	GL — 3.80	Feb.28-Mar.1, 2018
326	NBH 326	31.50	28.275	GL — 1.35	Apr. 12 – 15, 2018
327	NBH 327	33.00	28.690	GL — 1.72	Apr. 17 – 18, 2018
328	NBH 328	22.50	29.033	GL — 2.10	Apr. 20, 2018
329	NBH 329	24.00	28.677	GL — 2.20	Apr. 21 – 22, 2018
330	NBH 330	28.50	29.167	GL — 2.45	Mar. 2 – 4, 2018
331	NBH 331	31.50	29.660	GL — 6.24	Apr. 9 – 12, 2018
332	NBH 332	33.00	30.213	GL — 7.19	Apr. 13 – 15, 2018
333	NBH 333	31.50	31.446	GL — 6.45	Apr. 16 – 17, 2018
334	NBH 334	34.50	32.427	GL — 6.85	Apr. 18, 2018
335	NBH 335	33.00	32.906	GL — 9.00	Mar. 2 – 3, 2018
336	NBH 336	33.00	33.284	GL — 3.10	Apr. 20 – 22, 2018
337	NBH 337	34.50	33.868	GL — 3.50	Apr. 20 – 22, 2018
338	NBH 338	33.00	34.743	GL — 2.90	Apr. 22, 2018
339	NBH 339	31.50	35.319	GL —16.00	Apr. 19 – 21, 2018
340	NBH 340	33.00	35.689	GL — 2.00	Feb.27 Mar. 1, 2018
341	NBH 341	30.00	37.157	GL — 1.20	Apr. 18 – 19, 2018
342	NBH 342	21.00	37.725	GL — 3.30	Apr. 18 – 20, 2018
343	NBH 343	36.00	38.581	GL — 3.80	Apr. 18 – 21, 2018
344	NBH 344	33.00	39.125	GL — 4.00	Apr. 18 – 21, 2018
345	NBH 345	36.00	39.534	GL — 5.86	Feb.27-Mar.1, 2018
346	NBH 346	33.00	39.538	GL — 4.20	Apr. 18 – 21, 2018
347	NBH 347	30.00	39.797	GL — 3.10	Apr. 18 – 21, 2018

No.	Borehole Name	Final Depth (m)	Ground Elevation (m)	Water Level (m)	Date of Drilling
348	NBH 348	27.00	40.298	GL — 3.90	Apr. 20 – 21, 2018
349	NBH 349	30.00	41.463	GL — 3.40	Apr. 20 – 21, 2018
350	NBH 350	33.00	42.001	GL — 4.10	Feb.28-Mar.3, 2018
351	NBH 351	28.50	42.473	GL — 4.50	Apr. 21 – 23, 2018
352	NBH 352	33.00	42.994	GL — 3.90	Apr. 22 – 24, 2018
353	NBH 353	34.50	43.597	GL — 4.00	Apr. 22 – 24, 2018
354	NBH 354	28.50	44.137	GL — 4.10	Apr. 22 – 24, 2018
355	NBH 355	31.50	44.497	GL — 6.30	Feb.28-Mar.8, 2018
356	NBH 356	31.50	45.128	GL — 4.10	Apr. 22 – 25, 2018
357	NBH 357	30.00	45.154	GL — 3.60	Apr. 22 – 24, 2018
358	NBH 358	30.00	46.228	GL — 4.90	Apr. 22 – 24, 2018
359	NBH 359	22.50	46.619	GL — 4.50	Apr. 24 – 25, 2018
360	NBH 360	25.50	48.202	GL —12.23	Mar. 1 – 3, 2018
361	NBH 361	28.50	47.935	GL — 3.60	Apr. 25 – 26, 2018
362	NBH 362	22.50	48.188	GL — 3.40	Apr. 25 – 26, 2018
363	NBH 363	27.00	49.230	GL — 3.80	Apr. 25 – 27, 2018
364	NBH 364	25.50	49.850	GL — 4.20	Apr. 25 – 26, 2018
365	NBH 365	30.00	50.142	GL — 6.20	Mar. 1 – 3, 2018
366	NBH 366	28.50	50.718	GL — 4.30	Apr. 26 – 28, 2018
367	NBH 367	21.00	51.324	GL — 4.40	Apr. 26 – 27, 2018
368	NBH 368	34.50	52.277	GL — 6.20	Apr. 27 – 28, 2018
369	NBH 369	18.00	52.778	GL — 5.60	Apr. 27, 2018
370	NBH 370	32.30	52.698	GL — 6.21	Mar. 2 – 5, 2018
371	NBH 371	32.00	52.685	GL — 7.50	Apr. 24 – 25, 2018
372	NBH 372	25.50	53.702	GL — 6.80	Apr. 24 – 25, 2018
373	NBH 373	25.50	53.705	GL — 4.90	Apr. 23 – 24, 2018
374	NBH 374	30.00	54.349	GL — 5.00	Apr. 22 – 23, 2018

No.	Borehole Name	Final Depth (m)	Ground Elevation (m)	Water Level (m)	Date of Drilling
375	NBH 375	19.50	54.969	GL — 4.57	Mar. 2 – 3, 2018
376	NBH 376	24.00	55.205	GL — 5.20	Apr. 24 – 25, 2018
377	NBH 377	27.00	55.720	GL — 8.27	Apr. 25 – 26, 2018
378	NBH 378	31.50	55.902	GL — 3.50	Apr. 27 – 28, 2018
379	NBH 379	27.00	57.152	GL — 6.25	Apr. 24 – 25, 2018
380	NBH 380	27.00	57.626	GL — 4.90	Mar. 2 – 5, 2018
381	NBH 381	28.50	57.807	GL — 2.69	May 1 – 2, 2018
382	NBH 382	24.00	58.535	GL — 9.00	May 3, 2018
383	NBH 383	24.00	58.992	GL — 6.50	May 5 – 6, 2018
384	NBH 384	24.00	59.723	GL — 3.10	Apr. 27 – 28, 2018
385	NBH 385	25.50	55.991	GL — 1.30	Mar. 6, 2018
386	NBH 386	30.00	61.803	GL — 3.15	Apr.29-May 1, 2018
387	NBH 387	33.00	62.396	GL — 7.15	Apr.30-May 1, 2018
388	NBH 388	33.00	62.713	GL — 6.73	May 3, 2018
389	NBH 389	24.00	63.417	GL — 5.48	May 3, 2018
390	NBH 390	25.50	63.939	GL — 5.88	Mar. 3 – 5, 2018
391	NBH 391	30.00	64.242	GL — 6.15	May 4 – 6, 2018
392	NBH 392	27.00	64.890	GL — 5.50	May 4 – 5, 2018
393	NBH 393	27.00	65.450	GL — 5.70	May 6 – 7, 2018
394	NBH 394	30.00	66.203	GL — 6.20	May 4 – 5, 2018
395	NBH 395	27.00	67.218	GL — 8.60	Mar. 3, 2018
396	NBH 396	34.50	68.201	GL — 2.60	May 21 – 25, 2018
397	NBH 397	34.50	68.829	GL — 3.00	May 22 – 26, 2018
398	NBH 398	40.50	68.720	GL — 5.70	May 24 – 27, 2018
399	NBH 399	31.50	68.823	GL — 5.15	May 27 – 31, 2018
400	NBH 400	24.00	69.563	GL — 6.55	Mar. 3 – 6, 2018
401	NBH 401	31.50	70.365	GL — 3.95	May 27 – 29, 2018
402	NBH 402	28.50	71.563	GL — 4.50	May 20 – 26, 2018
403	NBH 403	27.00	72.236	GL — 5.52	May 14 – 18, 2018
404	NBH 404	27.00	72.919	GL — 7.80	May 14 – 19, 2018
405	NBH 405	24.00	73.522	GL — 5.93	Mar. 5 – 7, 2018
406	NBH 406	30.00	74.245	GL — 5.50	May 7 – 11, 2018
407	NBH 407	25.50	74.643	GL — 7.20	May 7 – 11, 2018
408	NBH 408	27.00	75.262	GL — 3.05	May 9 – 11, 2018
409	NBH 409	25.50	75.520	GL — 3.85	May 13 – 15, 2018
410	NBH 410	24.00	76.342	GL —10.30	Mar. 7, 2018
411	NBH 411	25.50	76.689	GL — 5.20	May 7 – 8, 2018
412	NBH 412	25.50	77.502	GL — 4.50	May 12 – 14, 2018
413	NBH 413	21.00	78.423	GL — 4.50	May 10 – 11, 2018
414	NBH 414	22.50	78.714	GL — 6.67	May 16 – 18, 2018
415	NBH 415	18.00	79.997	GL — 5.50	Mar. 7 – 8, 2018
416	NBH 416	19.50	79.948	GL — 3.70	May 17 – 18, 2018
417	NBH 417	19.50	80.406	GL — 3.97	May 12 – 16, 2018
418	NBH 418	22.50	80.657	GL — 3.85	May 9 – 10, 2018
419	NBH 419	18.00	81.983	GL — 4.10	May 7 – 8, 2018
420	NBH 420	24.00	84.429	GL — 6.95	Mar. 7 – 8, 2018
421	NBH 421	18.00	84.952	GL — 3.40	Apr. 28 – 30, 2018
422	NBH 422	18.00	85.938	GL — 3.10	Apr. 28 – 30, 2018
423	NBH 423	18.00	86.549	GL — 3.40	Apr.30-May 1, 2018
424	NBH 424	18.00	87.546	GL — 3.90	Apr. 28 – 30, 2018
425	NBH 425	21.00	88.579	GL — 6.35	Mar. 5 – 6, 2018
426	NBH 426	18.00	88.799	GL — 3.24	Apr. 30, 2018
427	NBH 427	18.00	89.480	GL — 3.82	Apr.30-May 1, 2018
428	NBH 428	18.00	90.605	GL — 4.42	Apr. 30, 2018

No.	Borehole Name	Final Depth (m)	Ground Elevation (m)	Water Level (m)	Date of Drilling
429	NBH 429	19.50	90.589	GL — 6.60	May 1, 2018
430	NBH 430	21.00	91.394	GL — 6.25	Mar. 5 – 6, 2018
431	NBH 431	21.00	92.233	GL — 3.10	May 1 – 2, 2018
432	NBH 432	19.50	92.642	GL — 3.12	May 2 – 3, 2018
433	NBH 433	28.50	92.542	GL — 3.46	May 1 – 3, 2018
434	NBH 434	18.00	92.744	GL — 5.65	May 1 – 2, 2018
435	NBH 435	33.05	93.616	GL —10.00	Mar. 5 – 7, 2018
436	NBH 436	21.00	94.613	GL — 3.00	May 2 – 3, 2018
437	NBH 437	18.00	95.082	GL — 3.25	May 2 – 3, 2018
438	NBH 438	22.50	95.849	GL — 3.70	May 3 – 4, 2018
439	NBH 439	18.00	96.331	GL — 4.82	May 4 – 7, 2018
440	NBH 440	27.00	96.869	GL —11.20	Mar. 5 – 8, 2018
441	NBH 441	19.50	92.987	GL — 3.40	May 4 – 7, 2018
442	NBH 442	22.50	83.504	GL — 0.10	Jun. 7 – 9, 2018
443	NBH 443	24.00	85.265	GL — 0.90	May30-Jun. 5, 2018
444	NBH 444	22.50	87.396	GL — 5.00	Mar. 9 – 10, 2018
445	NBH 445	16.50	89.072	GL — 2.10	Mar. 12 – 13, 2018
446	NBH 446	21.00	95.537	GL — 3.80	May 8 – 10, 2018
447	NBH 447	22.50	96.755	GL — 3.68	May 8 – 9, 2018
448	NBH 448	21.00	97.265	GL — 3.92	May 8 – 10, 2018
449	NBH 449	19.50	98.312	GL — 3.90	May 9 – 10, 2018
450	NBH 450	25.50	98.354	GL — 6.10	May 3 – 4, 2018
451	NBH 451	24.00	98.633	GL — 6.30	May 9 – 10, 2018
452	NBH 452	24.00	98.727	GL — 5.20	May 9 – 10, 2018
453	NBH 453	24.00	98.848	GL — 6.15	May 11, 2018
454	NBH 454	24.00	99.283	GL — 5.60	May 9 – 10, 2018
455	NBH 455	21.00	99.534	GL — 3.80	May 4 – 5, 2018

No.	Borehole Name	Final Depth (m)	Ground Elevation (m)	Water Level (m)	Date of Drilling
456	NBH 456	21.00	100.420	GL — 3.82	May 11 – 14, 2018
457	NBH 457	22.50	101.647	GL — 3.95	May 14 – 15, 2018
458	NBH 458	21.00	100.843	GL — 6.75	May 15 – 16, 2018
459	NBH 459	27.00	102.556	GL — 6.40	May 11 – 12, 2018
460	NBH 460	27.00	103.607	GL — 4.60	May 4 – 5, 2018
461	NBH 461	30.00	104.028	GL — 4.20	Jun. 20 – 21, 2018
462	NBH 462	30.00	104.676	GL — 3.00	Jun. 16 – 18, 2018
463	NBH 463	28.50	104.286	GL — 3.45	Jun. 19 – 20, 2018
464	NBH 464	22.50	104.865	GL — 4.15	Jun. 15 – 16, 2018
465	NBH 465	30.00	105.004	GL — 5.20	Jun. 14 – 15, 2018
466	NBH 466	30.00	105.704	GL — 6.05	Jun. 9 –12, 2018
467	NBH 467	30.00	106.251	GL — 6.10	Jun. 15 – 16, 2018
468	NBH 468	30.00	106.329	GL — 3.90	Jun. 18 – 19, 2018
469	NBH 469	30.00	106.631	GL — 3.85	Jun. 20 – 21, 2018
470	NBH 470	30.00	106.833	GL — 3.15	Jun. 11 – 14, 2018
471	NBH 471	30.00	106.910	GL — 4.90	Jun. 22 – 23, 2018
472	NBH 472	30.00	106.691	GL — 1.50	Jun. 21 – 22, 2018
473	NBH 473	30.00	106.210	GL — 1.23	Jun. 19 – 20, 2018
474	NBH 474	30.00	105.750	GL — 0.68	Jun. 16 – 18, 2018
475	NBH 475	30.00	105.842	GL — 3.01	Jun. 7 – 8, 2018
476	NBH 476	30.00	106.375	GL — 1.30	Jun. 22 – 23, 2018
477	NBH 477	30.00	107.537	GL — 4.00	Jun. 22 – 23, 2018
478	NBH 478	30.00	108.570	GL — 6.18	Jun. 23 – 24, 2018
479	NBH 479	30.00	110.347	GL — 3.85	Jun. 14 – 15, 2018
480	NBH 480	30.00	109.078	GL — 3.20	Jun. 7 – 9, 2018
481	NBH 481	30.00	108.380	GL — 3.85	Jun. 24 – 26, 2018
482	NBH 482	30.00	108.812	GL — 2.90	Jun. 22 – 23, 2018

No.	Borehole Name	Final Depth (m)	Ground Elevation (m)	Water Level (m)	Date of Drilling
483	NBH 483	31.50	108.899	GL — 2.82	Jun. 20 – 21, 2018
484	NBH 484	30.00	107.039	GL — 3.00	Jun. 18 – 19, 2018
485	NBH 485	30.00	105.779	GL — 4.10	Jun. 14 – 15, 2018
486	NBH 486	30.00	108.074	GL — 1.91	Jun. 22 – 23, 2018
487	NBH 487	30.00	108.674	GL — 3.62	Jun. 18 – 21, 2018
488	NBH 488	30.00	109.318	GL — 3.00	Jun. 15 – 16, 2018
489	NBH 489	33.00	109.547	GL — 3.80	Jun. 9 – 13, 2018
490	NBH 490	30.00	106.597	GL — 3.20	Jun. 5 – 8, 2018
491	NBH 491	30.00	108.574	GL — 2.34	Jun. 21 – 22, 2018
492	NBH 492	30.00	109.829	GL — 2.10	Jun. 21 – 22, 2018
493	NBH 493	30.00	109.540	GL — 1.20	Jun. 21 – 22, 2018
494	NBH 494	30.00	106.530	GL — 2.82	Jun. 18 – 20, 2018
495	NBH 495	30.00	108.879	GL — 2.80	Jun. 5 – 9, 2018
496	NBH 496	30.00	109.201	GL — 3.80	Jun. 15 – 16, 2018
497	NBH 497	30.00	110.506	Full	Jun. 11 – 12, 2018
498	NBH 498	30.00	110.823	GL — 2.60	Jun. 12 – 13, 2018
499	NBH 499	30.00	111.563	GL — 3.62	Jun. 9 – 11, 2018
500	NBH 500	30.05	108.402	GL — 4.60	Jun. 5 – 7, 2018
501	NBH 501	30.00	107.694	GL — 3.40	Jun. 15 – 16, 2018
502	NBH 502	30.00	107.329	GL — 2.10	Jun. 18 – 19, 2018
503	NBH 503	30.00	106.835	GL — 1.52	Jun. 15 – 16, 2018
504	NBH 504	30.00	105.957	GL — 1.90	Jun. 12 – 13, 2018
505	NBH 505	30.00	105.947	GL — 3.80	Jun. 9 – 11, 2018
506	NBH 506	30.00	108.581	GL — 2.45	Jun. 18 – 20, 2018
507	NBH 507	30.00	106.694	GL — 2.00	Jun. 21 – 22, 2018
508	NBH 508	30.00	109.065	GL — 2.65	Jun. 18 – 19, 2018
509	NBH 509	30.00	107.970	GL — 3.64	Jun. 15 – 16, 2018

No.	Borehole Name	Final Depth (m)	Ground Elevation (m)	Water Level (m)	Date of Drilling
510	NBH 510	30.00	106.717	GL — 3.00	Jun. 11 – 13, 2018
511	NBH 511	30.00	100.818	GL — 1.82	Jun. 6 – 7, 2018
512	NBH 512	30.00	103.379	GL — 4.92	Jun. 3, 2018
513	NBH 513	30.00	99.145	GL — 0.90	Jun. 6 – 7, 2018
514	NBH 514	31.50	105.351	GL — 5.70	May 29 – 31, 2018
515	NBH 515	30.00	107.349	GL — 4.50	May 11 – 12, 2018
516	NBH 516	30.00	109.454	GL — 6.05	May 14 – 16, 2018
517	NBH 517	31.50	110.609	GL — 4.60	May 20 – 23, 2018
518	NBH 518	30.00	111.364	GL — 6.50	May 24 – 25, 2018
519	NBH 519	31.50	111.491	GL — 6.15	May 26 – 27, 2018
520	NBH 520	30.00	112.166	GL — 6.20	May 13 – 17, 2018
521	NBH 521	30.00	113.011	GL — 6.30	Jun. 2 – 3, 2018
522	NBH 522	30.00	113.794	GL — 6.72	May 20 – 22, 2018
523	NBH 523	30.00	114.138	GL — 4.30	May 23 – 25, 2018
524	NBH 524	30.00	115.459	GL — 7.43	May 25 – 27, 2018
525	NBH 525	31.50	115.575	GL —10.10	May 4 – 5, 2018
526	NBH 526	34.50	115.683	GL — 3.82	May 11 – 12, 2018
527	NBH 527	31.50	116.990	GL — 4.15	May 13, 2018
528	NBH 528	30.00	115.128	GL — 3.00	May 19 – 20, 2018
529	NBH 529	30.00	118.708	GL — 4.30	May 23 – 24, 2018
530	NBH 530	30.00	118.038	GL — 2.05	May 4 – 5, 2018
531	NBH 531	31.50	119.243	GL — 2.40	May 11 – 12, 2018
532	NBH 532	31.50	120.347	GL — 3.11	May 18 – 19, 2018
533	NBH 533	30.00	119.366	GL — 1.10	May 15 – 16, 2018
534	NBH 534	30.00	121.389	GL — 2.21	May 21 – 22, 2018
535	NBH 535	30.00	122.333	GL — 3.45	Apr.30-May 1, 2018
536	NBH 536	30.00	123.449	GL — 3.08	May 23 – 24, 2018

No.	Borehole Name	Final Depth (m)	Ground Elevation (m)	Water Level (m)	Date of Drilling
537	NBH 537	30.00	124.010	GL — 3.62	May 25 – 26, 2018
538	NBH 538	30.00	124.432	GL — 2.59	May 25 – 26, 2018
539	NBH 539	30.00	125.040	GL — 3.65	May 29 – 30, 2018
540	NBH 540	30.00	125.077	GL — 1.44	Apr.30-May 1, 2018

No.	Borehole Name	Final Depth (m)	Ground Elevation (m)	Water Level (m)	Date of Drilling

7) Soil Condition

The results of the field work and laboratory investigation were used to establish the subsurface profile and showed that the site has varying soil condition.

For most parts of Bulacan, the site subsoil is predominantly thick layers of high plasticity very soft to soft cohesive soils at the upper portion underlain by dense to very dense sand or very stiff to hard clays at depths of around 40.0 meters below ground level.

In the Pampanga area, the subsurface is mainly composed of medium dense sands underlain by dense to very dense sands at depths of around 25.0 meters below ground level.

The following figures present the scattergram of boreholes per city area. (Figure 4.2.87 to Figure 4.2.92)

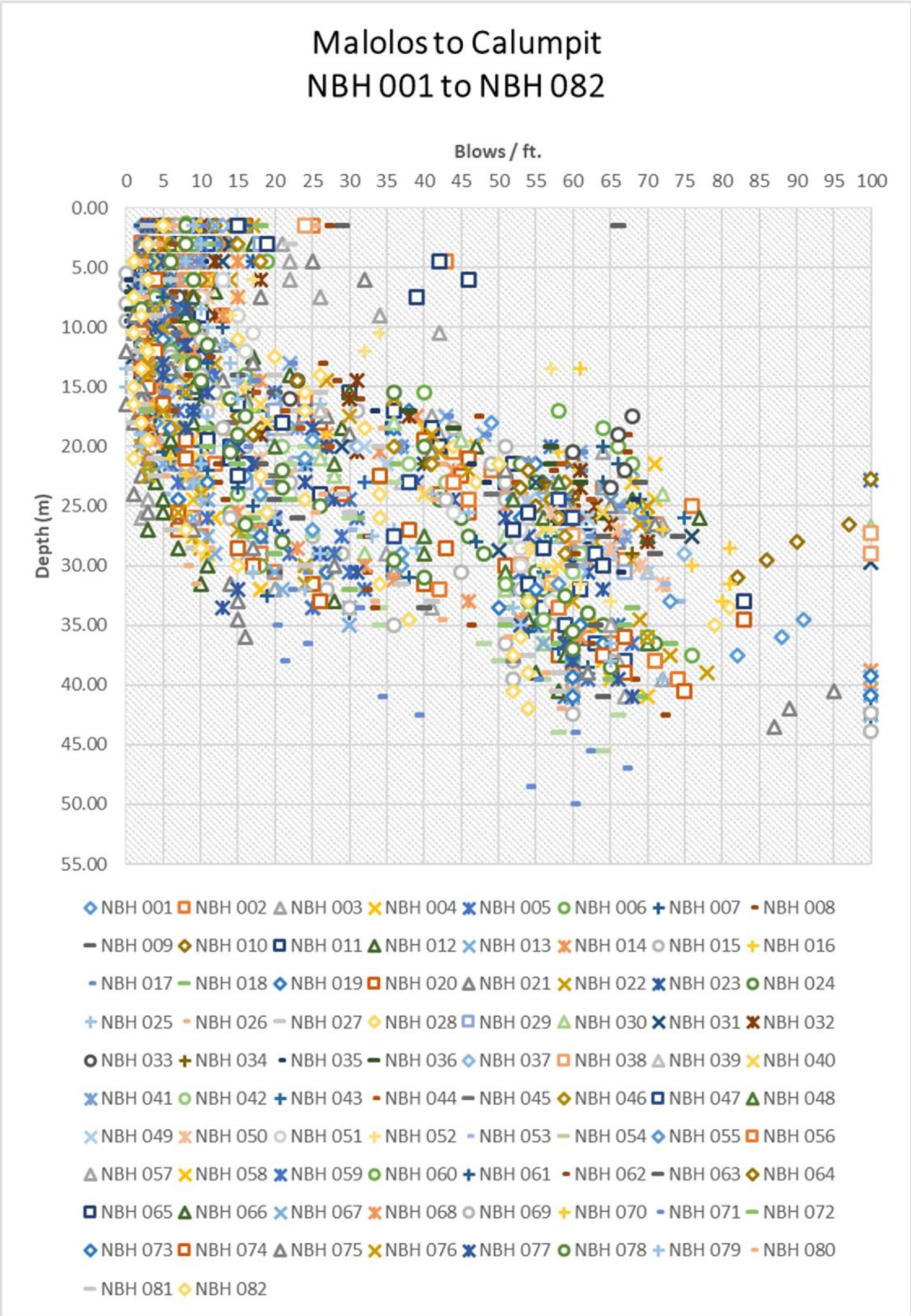


Figure 4.2.87 SPT N-Value vs. Depth for Malolos to Calumpit

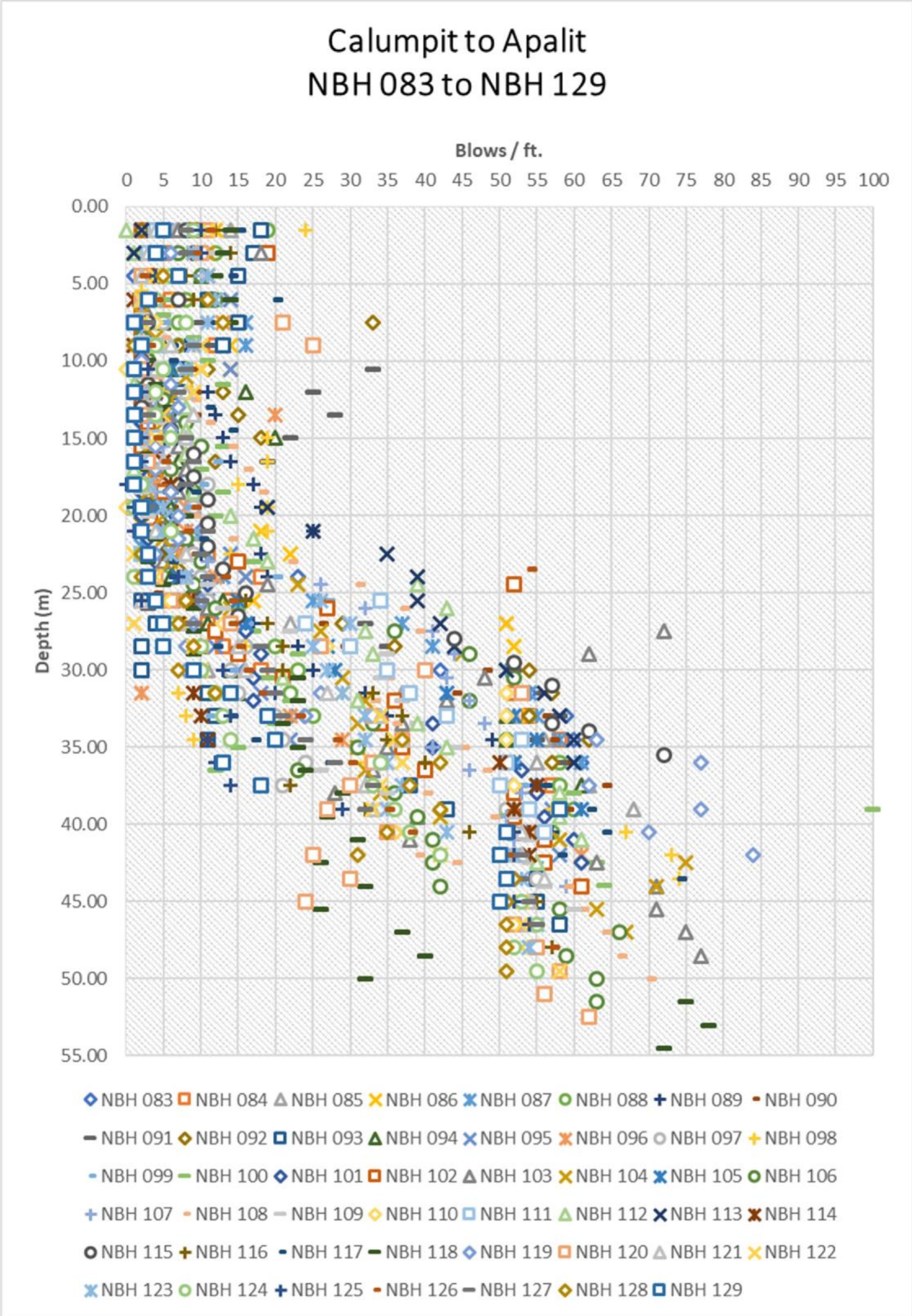


Figure 4.2.88 SPT N-Value vs. Depth for Culmpit to Aparit

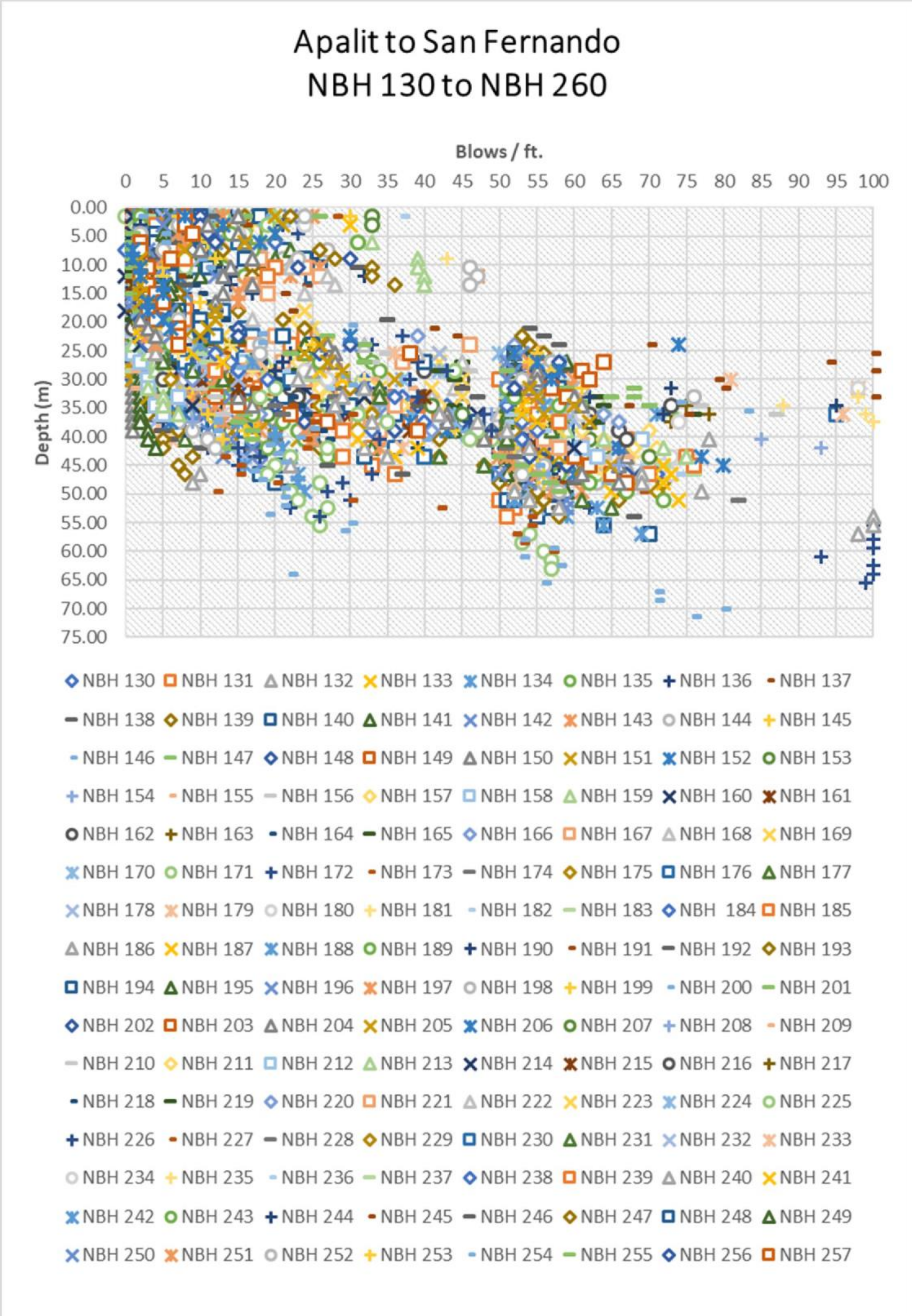


Figure 4.2.89 SPT N-Value vs. Depth for Aparit to SanFernando

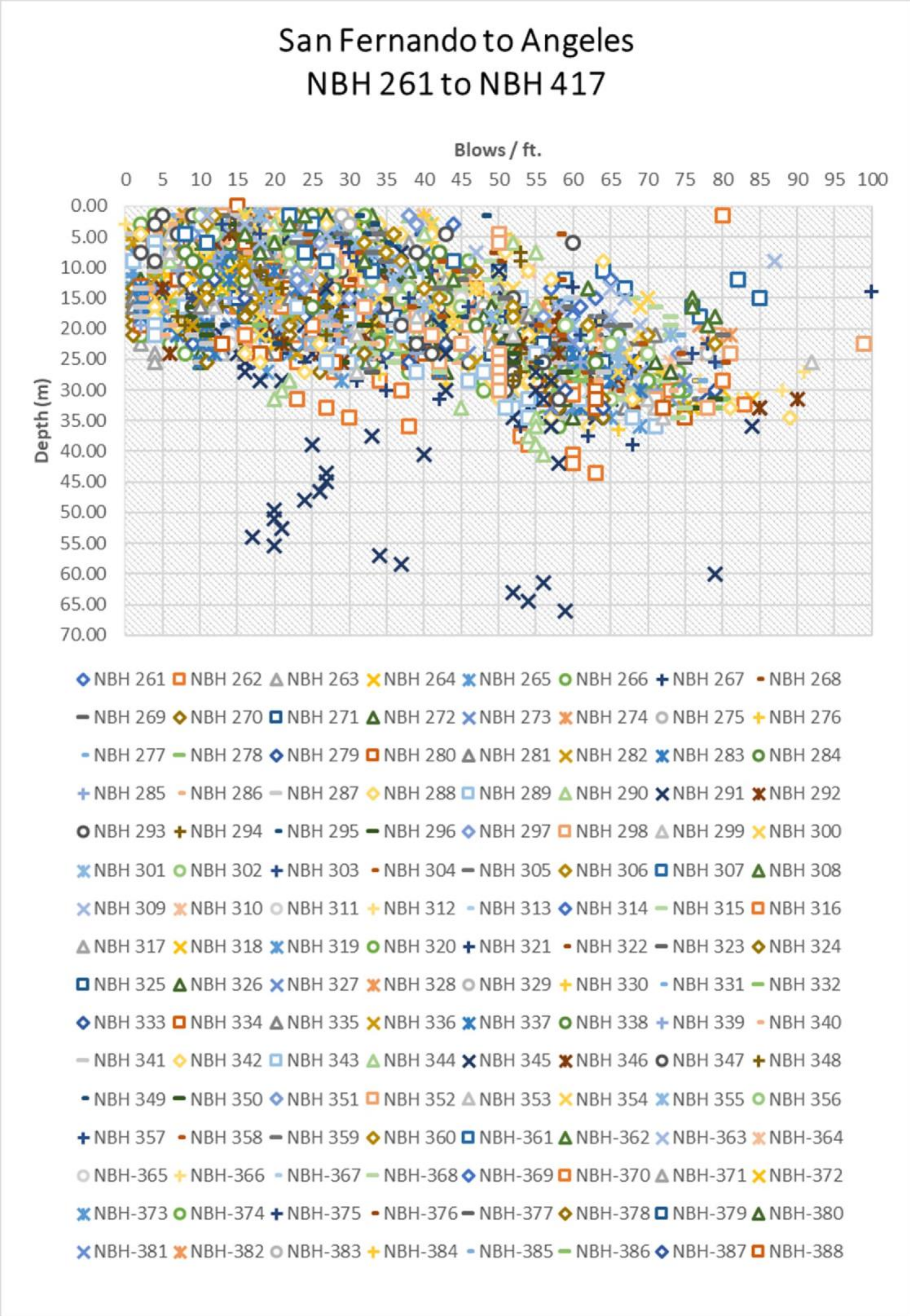


Figure 4.2.90 SPT N-Value vs. Depth for SanFernando to Angeles

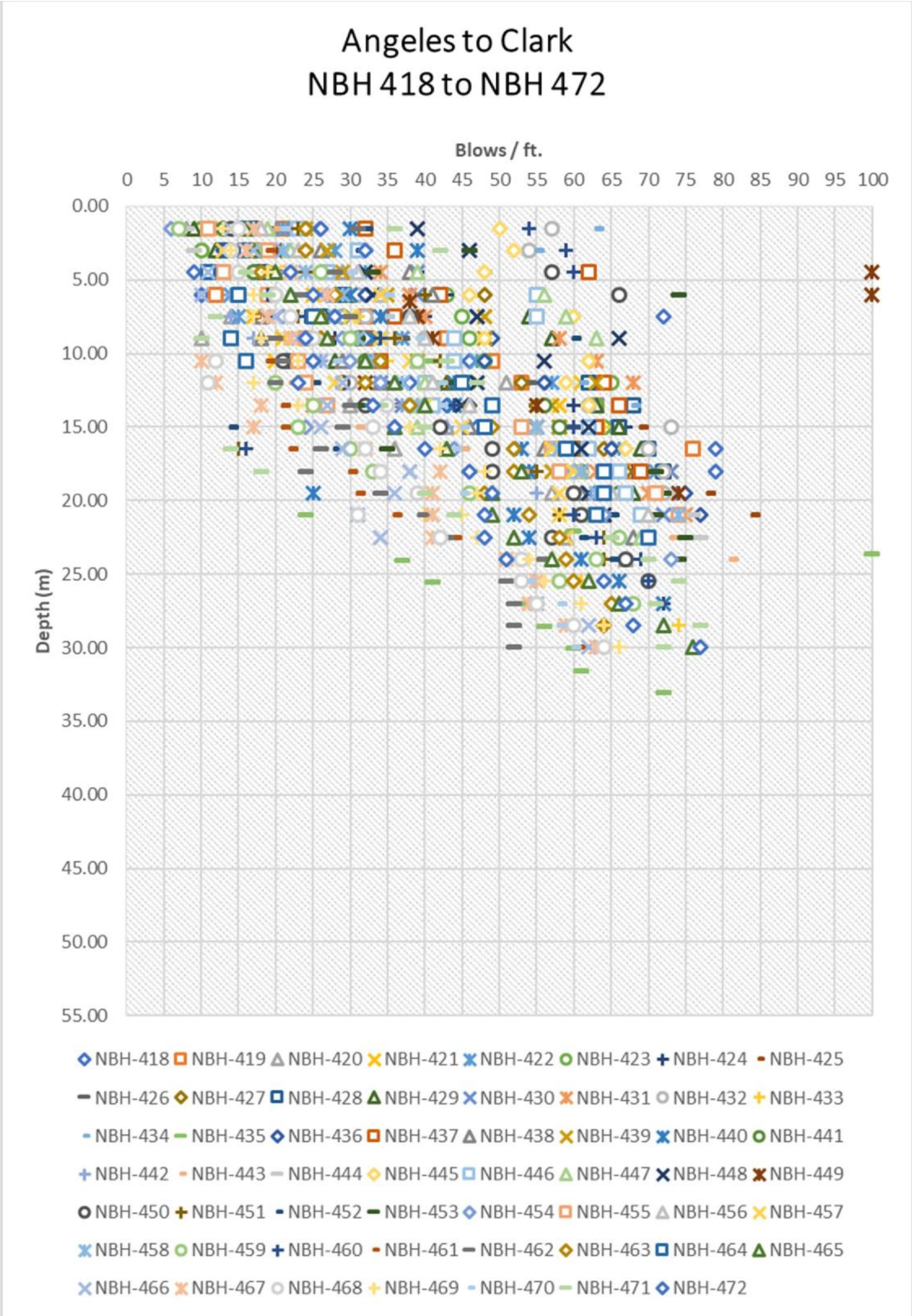


Figure 4.2.91 SPT N-Value vs. Depth for Angeles to Clark

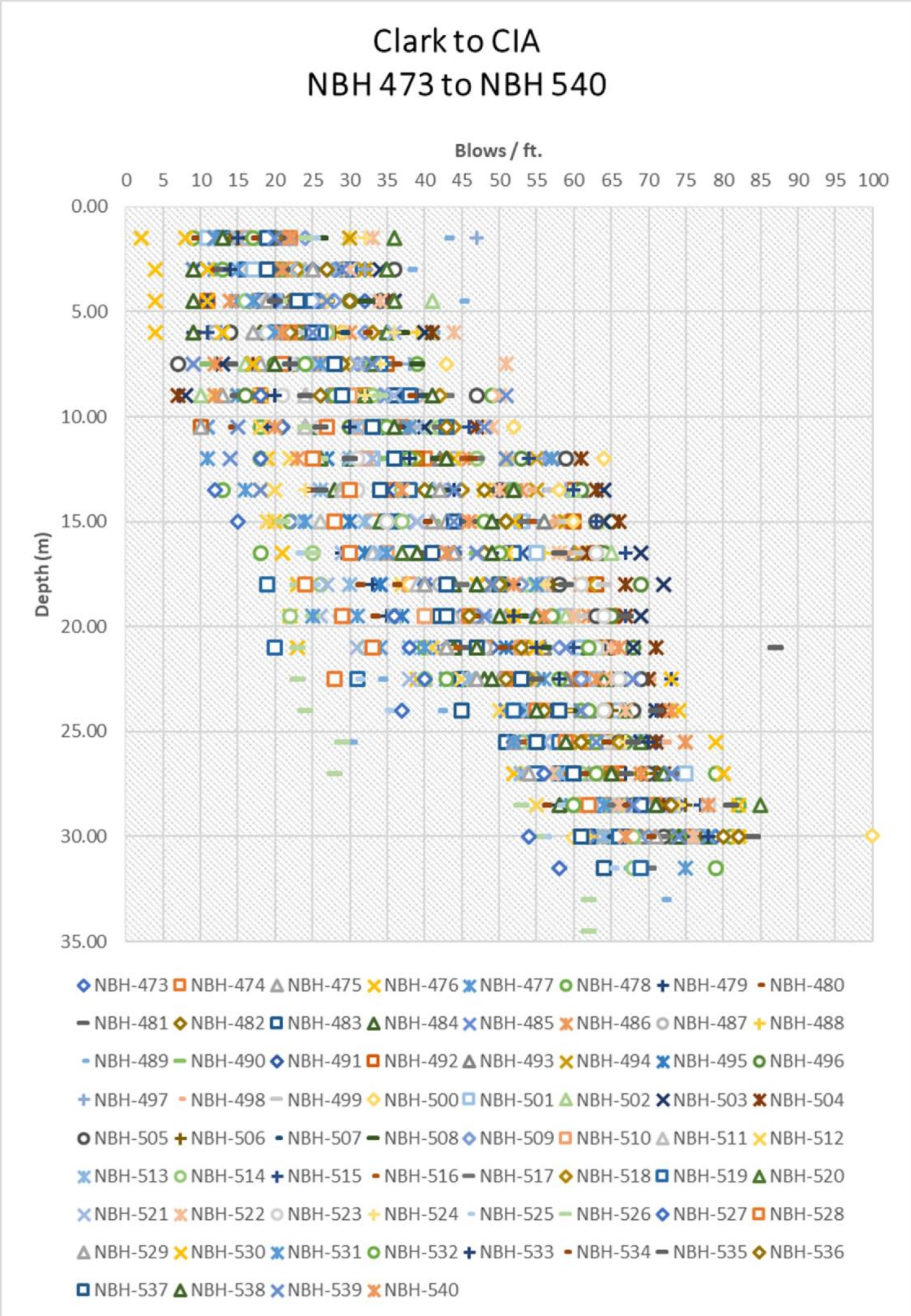


Figure 4.2.92 SPT N-Value vs. Depth for Clark to CIA

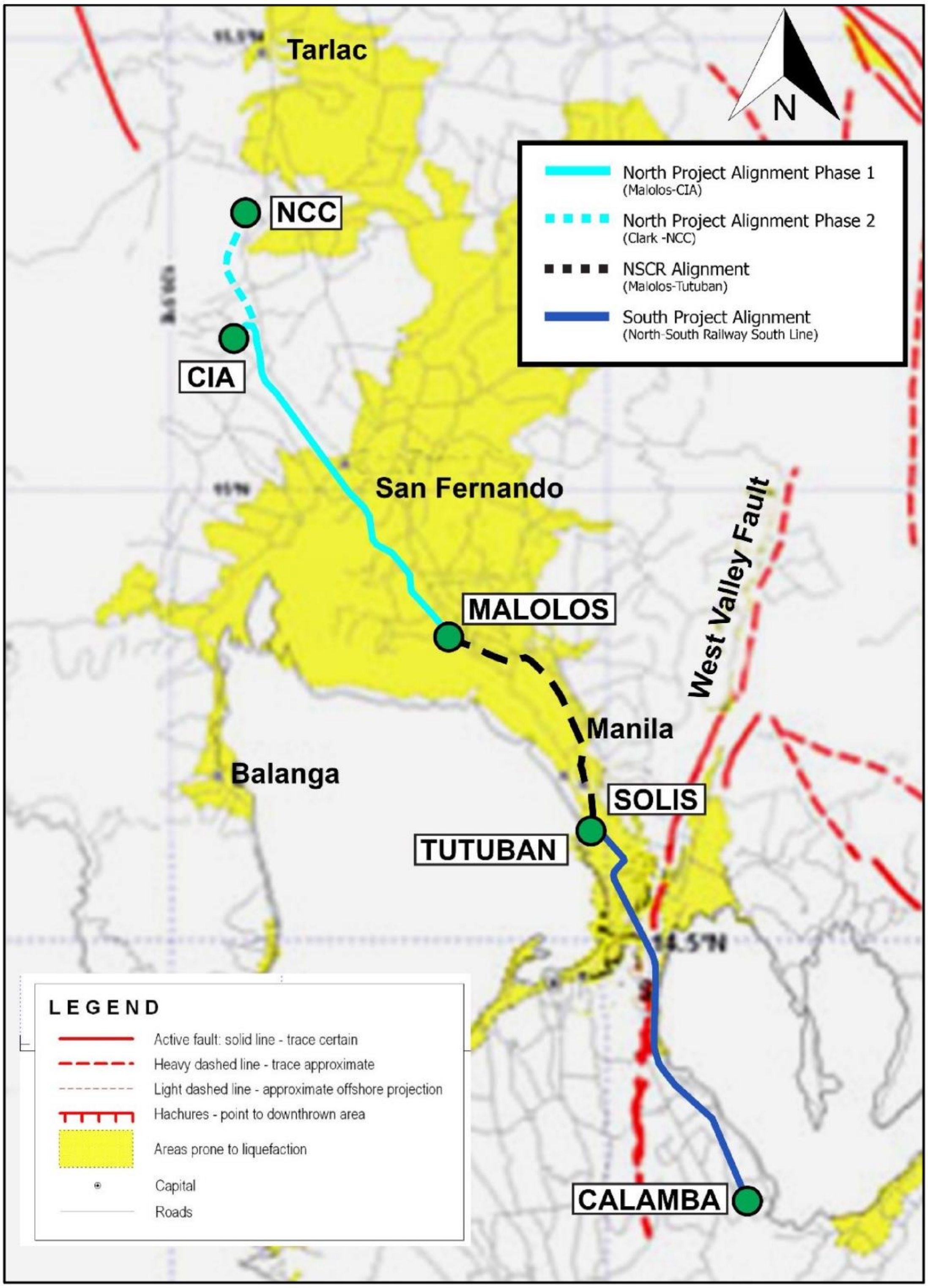
8) Ground Water

From the results of the field investigation, the depth of the groundwater level is relatively shallow (less than 3.0 meters below ground level) for most of the areas in Bulacan and some areas of Pampanga. Groundwater was encountered at relatively lower depths for most of the areas in Pampanga. The depths of ground water table were measured at least twenty-four (24) hours after drilling is completed at each borehole.

9) Liquefaction

Soil liquefaction is a phenomenon that occurs mostly in saturated and loose, medium to fine-grained sands wherein a mass of soil loses a large percentage of its shear resistance when subjected to monotonic, cyclic or shock loading and flows in a manner resembling a liquid. Much of the damage on substructures and foundations during earthquakes is attributed to this phenomenon

Considering the subsoil condition and the relatively shallow groundwater level, some segments along the alignment are deemed susceptible to soil liquefaction. This is consistent with the liquefaction hazard map published by PHIVOLCS as shown in Figure 4.2.93.



Source: PHIVOLCS

Figure 4.2.93 Liquefaction susceptibility map of the project alignment

Liquefaction assessment will be performed conforming to the procedures described in DPWH LRFD Seismic Bridge Design Specifications 2013, based on AASHTO.

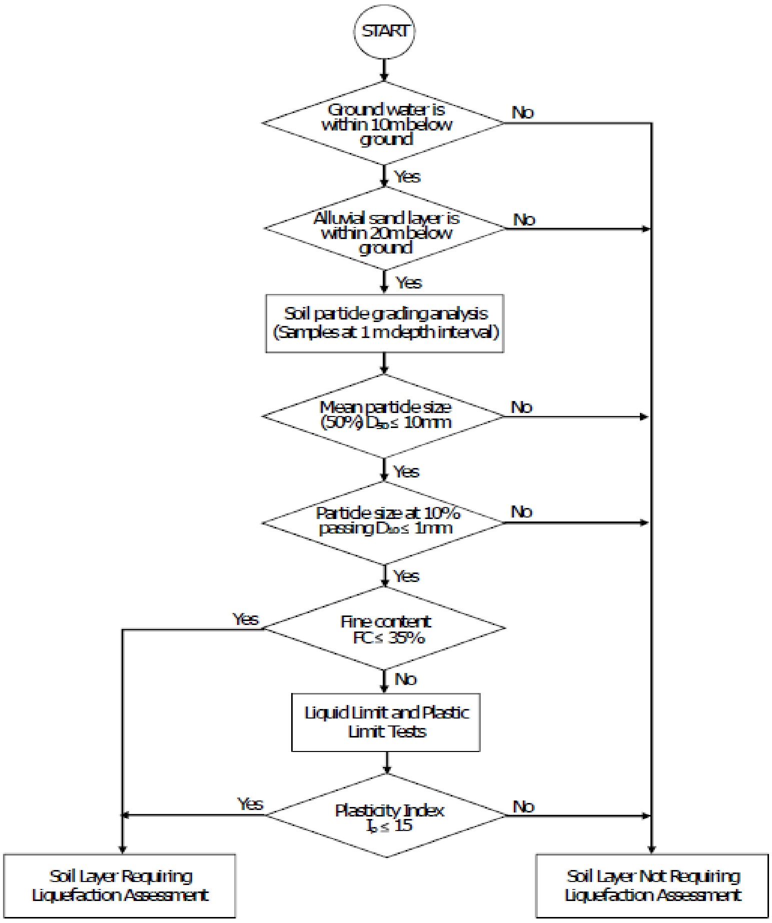
The following flowchart presents the process to determine the soil layers requiring liquefaction assessment. Liquefaction resistance factor, F_L, is calculated using the following equation:

$$F_L = \frac{R}{L}$$

where:

R = $c_w R_L$ = Dynamic shear strength ratio

L = $\dfrac{r_{dk} k_{hg} \sigma_v}{\sigma'_v}$ = Seismic shear stress ratio



Source: DPWH LRFD Bridge Seismic Design Specifications

Figure 4.2.94 Determination of necessity for liquefaction assessment of soil layer

(2) Topographic Survey

The scope of work for the topographic survey was conducted along the proposed 71 km PNR alignment from Malolos - Clark Green City, which is necessary for detailed design work.

Status of current survey work is scheduled to end at the end of October for all terrain survey items except for historic buildings survey. However, due to progress in information design additional instrumentation, continue implementing topographic surveying.

1) Survey Area

North–South Railway Project (North Line)

-1. Malolos Station	---------------- Clark International Airport	: 51km
-2. Clark International Airport	---------------- Clark Green City (CGC)	: 20km

The reconnaissance and inventory survey on the existing railway property in the North and South sections was executed for the preparation of the technical specifications, methodologies and work schedule required during the conduct of topographic survey.

Prior to production of the topo-map in 1/1,000 scale, a satellite imagery was undertaken control with NAMRIA map of 1/50,000 scale for Pre-DD work and accuracy standard deviation 1m horizontally. The satellite Ortho-imagery was produced which imageries obtained from the latest archive not earlier than year 2016 at level 3 with 0.5m resolution. And this imagery was rectified in NAMRA map of 1/50,000 scale. Then work item 5.1 will produce DTM to generate 2m contour interval line.

Table 4.2.29 Topographic Survey Work Schedule

No	Topographic Survey Work Item	2017 Dec	2018 Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	2019 Jan
1	Railway Property Site Reconnaissance														
2	Railway Structures Inventory Survey														
3	Historical Building Survey														
4	Produce satellite ortho-imagery 0.50 m resolution														
5	Topographic Survey for DD study														
5.1	Satellite imagery DTM with 2m contour line 1/10,000														
5.2	Basic Control Point Survey														
	-1 GPS Survey														
	-2 Primary Traverse Survey														
	-3 Control Direct Leveling														
5.3	Photogrammetric Survey														
	-1.Aerial Photography & Airborne LiDAR														
	-2.Topographic Mapping 1/1,000 scale														
	-3. Profile and Cross section by Photo-method														
5.4	Photogrammetric & Ground Survey														
	-1. River Survey by Photogrammetric method (SP)														
	-2. Major cross Road Survey by Ground method (TS)														
5.5	CAD processing work & Survey Report														

Legend : Executed : Scheduled

Source: JICA Design Team

2) Survey Mapping Work Reference

The Survey shall be carried out according to the criteria shown below, with due consideration of the preparation for the Philippines transition to the world geodetic system.

The standards of geodetic reference system and mapping elements to create Geo-spatial are as follows:

- Philippine Reference System (PRS92)
- Reference Ellipsoid: Clark Spheroid of 1866
- Horizontal Datum: Luzon Datum
- Vertical Datum: Mean Sea Level
- Geoid Model: PGM2014

3) Topographic Mapping Survey

The Topo-Mapping Survey is divided into eleven (11) work items as:

- Production of Ortho-rectified Satellite Image (Geometric correction work using GCP data)

- Horizontal Control Point Survey (GPS Static Differential method)
- Preliminary Traverse Points Survey (Total Station (TS) method)
- Control Leveling Survey
- Airborne LiDAR and Digital Photography Acquisition
- Topographic Mapping (1/1,000) Survey (Photographic measurement method)
- Sounding Survey on the fish pond and swamp area
- Photogrammetric Profile and Cross Section Survey
- River (Topo, Profile and Cross Section) Survey
- Major Cross Road Topographic (1/500) Survey (Ground Survey method)
- Auto CAD Mapping Processing Work & Preparation of Final Survey Report

4) Production of Orthorectified Satellite Imagery

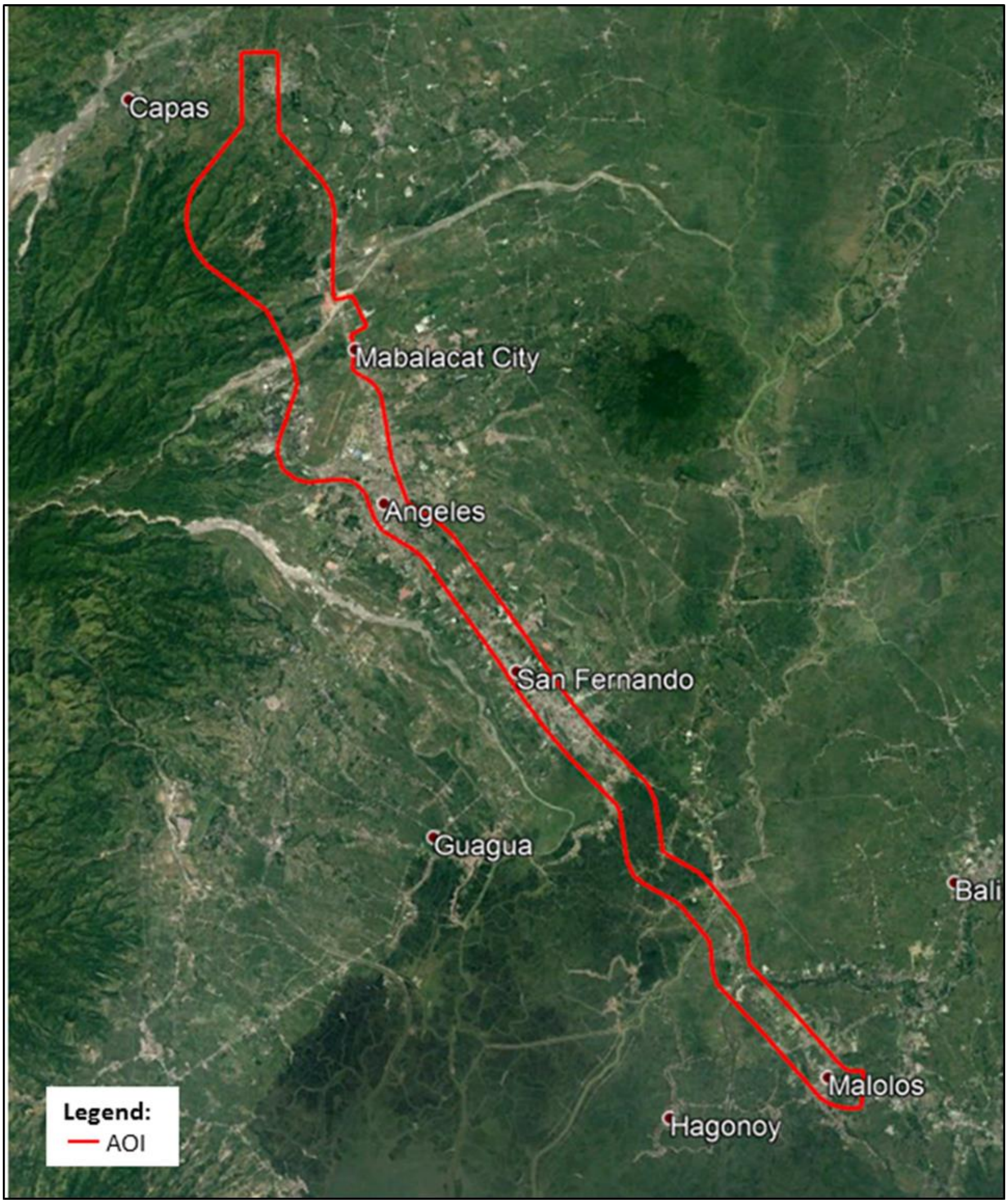
It's should be applied ortho-rectified satellite image of 50cm resolution (GSD) Pleiades. The work conducted geometric correction for the provided images by using Ground Control Points (GCP) established. The product scale to be 1:10,000 together with the 2m interval contour lines generated from DTM data.

The production of Pleiades ortho-imageries is produced to assist the Design Team in used for the preparation of the basic design of the NSCR Project covering portions of Malolos to Clark (North Section) in the Philippines, as indicated in the following table and AOI Map:

Table 4.2.30 Area of Coverage

Section	AREA [Hectares]
South Section (Malolos to Clark Green City)	19,000
TOTAL	19,000

Source: JICA Design Team



Source: JICA Design Team

Figure 4.2.95 AOI Map South Section (Malolos to Clark)

For the Malolos to Clark section, Table 4.3.3 below summarizes the specifications of Pleiades VHR satellite imageries used for the North Section, while, Table 4.3.4 shows the list of Pleiades VHR satellite imageries used for the South Section.

Table 4.2.31 Specifications of the PLEIADES VHR Satellite Imagery

Portion of NSCR North Section (Malolos to Clark)	
Pleiades Product Type:	Archive
Total Area:	190 km²
Product level:	Orthorectified
Date of Imagery:	2016,2017 Pleiades Archive Imageries
Spatial Resolution:	0.50m-resolution
Spectral bands combination:	Natural Color 3-bands
Projection:	PTM Zone 3, PRS92 Datum
Bit depth:	16bits
Product format:	GeoTIFF , ECW , IMG

Source: JICA Design Team

Table 4.2.32 Archive Pleiades VHR Satellite Imageries for the Portion of NSCR North Line

	Scene ID	*Date of Imagery*
1	DS_PHR1B_201612230228324_FR1_PX_E120N15_0811_07168	Dec. 23, 2017
2	DS_PHR1B_201611130235419_FR1_PX_E120N15_1007_05204	Nov. 13, 2016
3	DS_PHR1B_201704130223595_FR1_PX_E120N14_0921_02484	Apr. 13, 2017
4	DS_PHR1B_201612230228120_FR1_PX_E120N15_0609_06396	Dec. 23, 2017

Source: JICA Design Team

5) Horizontal Control Point Survey

There are a total of fifty-four (54) Horizontal Control Points selected for the north part. The horizontal controls points were named as GPSN1 to GPSN54. The locations selected are near the railway alignment where intervisible pairs of GPS points with spacing of more or less 200 meters were installed. The monuments were constructed according to the recommended specifications. The monuments for the horizontal control for the north part are installed in Malolos City, Calumpit in the province of Bulacan, Apalit, Minalin, Sto Tomas, San Fernando City, Angeles City, Clark Freeport Zone, Mabalacat City in the province of Pampanga, Bamban, and Capas in the province of Tarlac.

Existing ground control points by DENR-LMB and NAMRIA were included in the network observations. RINEX data for the NAMRIA PageNET stations (CORS) nearest to the project area (PFLO, PSRF, PTLC) were downloaded and used as fixed reference points for the GNSS processing.

The GNSS observation was done from March 26 until April 11. Additional observations were done from May 11, 12, 13 and 16. Preliminary field processing results were obtained using Trimble Business Center. The final coordinates were computed and adjusted using the PTM Zone 3 projection and Philippine Reference System of 1992(PRS92).

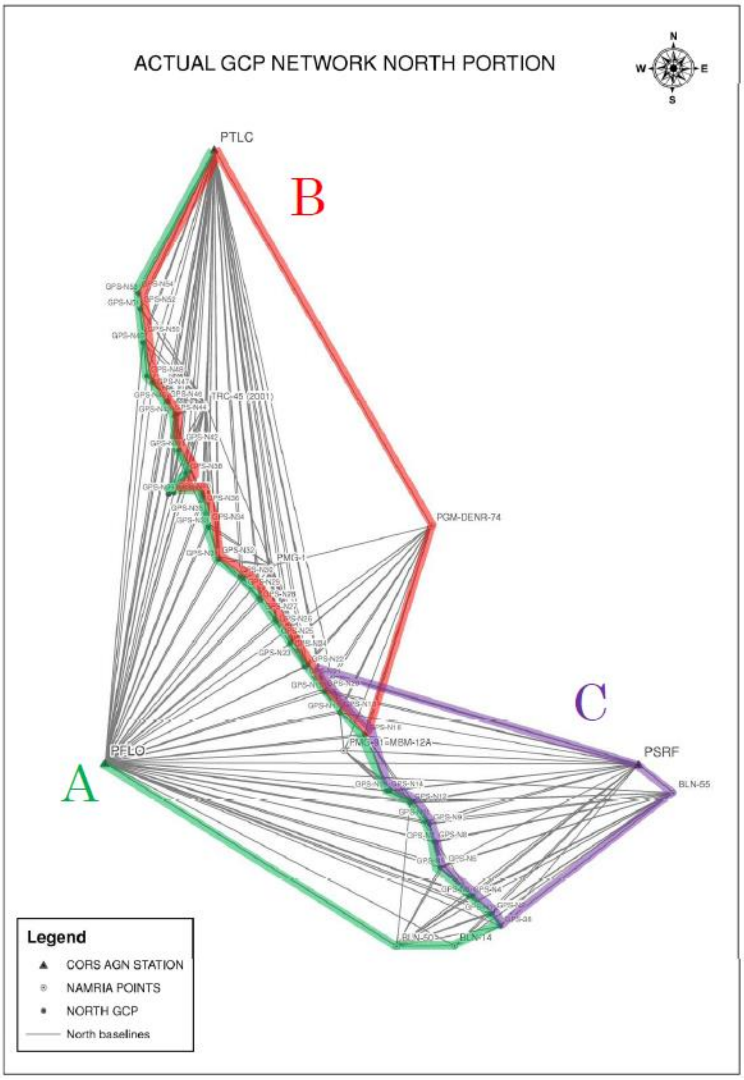
The closure error of Section A (56 edges) is dN = -0.066, dE = 0.049 and dU = 0.010. TOR tolerance is 0.153 for dN and dE, 0.230 for dU.

For Section B, dN = 0.064, dE = -0.032 and dU = -0.038. TOR tolerance is 0.098 for dN and dE, 0.295 for dU.

For Section C, dN = -0.010, dE = 0.011 and dU = -0.015. TOR tolerance is 0.076 for dN and dE, 0.229 for dU.

All of these results are satisfied the TOR tolerances.

Following figure and tables show the course of horizontal control point survey and the results of quality control.



Source: JICA Design Team

Figure 4.2.96 Actual GCP network of south portion

In the following table, the error of closure between the existing control points [Section A]

Table 4.2.33 The error of closure between the existing control points [Section A]

Route： PFLO to PTLC

StartPoint product : PFLO		-3127782.193	5310055.142	1638295.12
Name		dX	dY	dZ
BLN-50		-23798.114	-9257.831	-15777.540
BLN-14		-4312.934	-2575.386	38.305
GPS-38		-3156.050	-2404.277	1685.551
GPS-N1		884.541	209.158	1032.462
GPS-N2		-136.207	-136.472	178.441
GPS-N3		1707.165	603.091	1340.026
GPS-N4		232.340	142.812	-13.497
GPS-N5		2481.282	699.327	2520.619
GPS-N6		-265.046	-214.729	180.590
GPS-N7		858.623	-97.540	1967.368
GPS-N8		135.334	58.667	68.691
GPS-N9		563.028	-118.865	1493.657
GPS-N10		270.880	92.457	222.130
GPS-N11		1190.766	162.766	1719.041
GPS-N12		217.861	167.868	-121.688
GPS-N13		1656.711	660.506	1047.445
GPS-N14		219.730	123.962	21.966
GPS-N15		2190.345	-150.534	4662.611
GPS-N16		130.216	28.450	155.189
GPS-N18		2145.089	635.027	2053.302
GPS-N17		-72.658	9.447	-168.048
GPS-N19		1389.249	271.315	1790.379
GPS-N20		168.614	30.789	226.068
GPS-N21		1623.417	374.842	1920.503
GPS-N22		-217.778	-153.023	75.922
GPS-N23		1344.894	174.394	2031.377
GPS-N24		194.973	164.325	-141.254
GPS-N25		1237.698	172.076	1828.888
GPS-N26		142.372	27.844	183.301
GPS-N27		1295.181	261.822	1654.079
GPS-N28		152.620	33.523	186.569
GPS-N29		1382.714	312.681	1665.824
GPS-N30		225.561	83.951	162.214
GPS-N31		1803.166	627.620	1471.413
GPS-N32		114.318	-11.732	257.586
GPS-N33		1027.123	-178.655	2541.550
GPS-N34		74.559	-44.755	286.368
GPS-N35		613.153	-351.162	2261.087
GPS-N36		147.202	3.073	267.228
GPS-N38		1504.960	317.182	1843.801
GPS-N37		-367.245	-307.158	263.854
GPS-N39		1368.850	1507.504	-2098.044
GPS-N40		-368.984	-261.118	112.085
GPS-N41		168.017	-1078.370	3657.709
GPS-N42		-155.792	-276.680	545.435
GPS-N43		878.887	-250.485	2373.530
GPS-N44		-131.301	-130.197	163.737
GPS-N45		823.640	127.769	1100.625
GPS-N46		200.081	-25.957	537.442
GPS-N47		1075.650	377.780	1135.024
GPS-N48		561.651	57.335	505.085
GPS-N49		682.810	-531.960	2869.330
GPS-N50		52.673	-151.015	542.809
GPS-N51		545.914	-416.518	2326.314
GPS-N52		127.586	-9.063	270.626
GPS-N53		206.704	-212.237	1084.451
GPS-N54		125.655	9.092	229.698
		-4032.139	-6265.258	12060.651
	Σ Δ=	-870.445	-17082.522	52499.885
	Obs result =	-3128652.638	5292972.620	1690795.005
EndPoint product : PTLC		-3128652.592	5292972.638	1690795.071
error of closure	dX,dY,dZ	-0.046	-0.018	-0.066
error of closure	dN,dE,dU	-0.066	0.049	-0.010
Tolerance	Num of edges =59	0.153		0.230

※ TOR Tolerance : ΔN, ΔE=20mm√N , ΔU=30mm√N
0.153 0.230
※Japanese Tolerance : ΔN, ΔE=60mm+20mm√N , ΔU=150mm+30mm√N
0.213 0.380

Source: JICA Design Team

In the following table, the error of closure between the existing control points [Section B]

Table 4.2.34 The error of closure between the existing control points [Section B]

Route: PTLC to PTLC

StartPoint product : PTLC	-3128652.592	5292972.638	1690795.071
Name	dX	dY	dZ
GPS-N54	4032.139	6265.258	-12060.651
GPS-N53	-125.655	-9.092	-229.698
GPS-N52	-206.704	212.237	-1084.451
GPS-N51	-127.586	9.063	-270.626
GPS-N50	-545.914	416.518	-2326.314
GPS-N49	-52.673	151.015	-542.809
GPS-N48	-682.810	531.960	-2869.330
GPS-N47	-561.651	-57.335	-505.085
GPS-N46	-1075.650	-377.780	-1135.024
GPS-N45	-200.081	25.957	-537.442
GPS-N44	-823.640	-127.769	-1100.625
GPS-N43	131.301	130.197	-163.737
GPS-N42	-878.887	250.485	-2373.530
GPS-N41	155.792	276.680	-545.435
GPS-N40	-168.017	1078.370	-3657.709
GPS-N39	368.984	261.118	-112.085
GPS-N37	-1368.850	-1507.504	2098.044
GPS-N38	367.245	307.158	-263.854
GPS-N36	-1504.960	-317.182	-1843.801
GPS-N35	-147.202	-3.073	-267.228
GPS-N34	-613.153	351.162	-2261.087
GPS-N33	-74.559	44.755	-286.368
GPS-N32	-1027.123	178.655	-2541.550
GPS-N31	-114.318	11.732	-257.586
GPS-N30	-1803.166	-627.620	-1471.413
GPS-N29	-225.561	-83.951	-162.214
GPS-N28	-1382.714	-312.681	-1665.824
GPS-N27	-152.620	-33.523	-186.569
GPS-N26	-1295.181	-261.822	-1654.079
GPS-N25	-142.372	-27.844	-183.301
GPS-N24	-1237.698	-172.076	-1828.888
GPS-N23	-194.973	-164.325	141.254
GPS-N22	-1344.894	-174.394	-2031.377
GPS-N21	217.778	153.023	-75.922
GPS-N20	-1623.417	-374.842	-1920.503
GPS-N19	-168.614	-30.789	-226.068
GPS-N17	-1389.249	-271.315	-1790.379
GPS-N18	72.658	-9.447	168.048
GPS-N16	-2145.089	-635.027	-2053.302
GPS-N15	-130.216	-28.450	-155.189
PGM-DENR-74	-2396.249	-7002.674	17988.637
	20585.603	1955.142	32245.121

	Σ Δ=	0.054	-0.030	0.051
	Obs result =	-3128652.538	5292972.608	1690795.122
EndPoint product : PTLC		-3128652.592	5292972.638	1690795.071
error of closure	dX,dY,dZ	0.054	-0.030	0.051
error of closure	dN,dE,dU	0.064	-0.032	-0.038
Tolerance	Num of edges =43	0.098		0.295

※ TOR Tolerance : H=15mm√N , V=45mm√N
0.098 0.295
※Japanese Tolerance : ΔN, ΔE=20mm√N , ΔU30mm√N
0.131 0.196

Source: JICA Design Team

In the following table, the error of closure between the existing control points [Section C]

Table 4.2.35 The error of closure between the existing control points [Section C]

Route : PSRF to PSRF

StartPoint product : PSRF	-3167390.932	5286535.638	1638181.214
Name	dX	dY	dZ
BLN-55	-2907.839	-994.210	-2458.066
GPS-38	11249.456	10276.261	-11481.701
GPS-N1	884.541	209.158	1032.462
GPS-N2	-136.207	-136.472	178.441
GPS-N3	1707.165	603.091	1340.026
GPS-N4	232.340	142.812	-13.497
GPS-N5	2481.282	699.327	2520.619
GPS-N6	-265.046	-214.729	180.590
GPS-N7	858.623	-97.540	1967.368
GPS-N8	135.334	58.667	68.691
GPS-N9	563.028	-118.865	1493.657
GPS-N10	270.880	92.457	222.130
GPS-N11	1190.766	162.766	1719.041
GPS-N12	217.861	167.868	-121.688
GPS-N13	1656.711	660.506	1047.445
GPS-N14	219.730	123.962	21.966
GPS-N15	2190.345	-150.534	4662.611
GPS-N16	130.216	28.450	155.189
GPS-N18	2145.089	635.027	2053.302
GPS-N17	-72.658	9.447	-168.048
GPS-N19	1389.249	271.315	1790.379
GPS-N20	168.614	30.789	226.068
GPS-N21	1623.417	374.842	1920.503
GPS-N22	-217.778	-153.023	75.922
	-25715.122	-12681.387	-8433.423
Σ Δ=	-0.003	-0.015	-0.013
Obs result =	-3167390.935	5286535.623	1638181.201
EndPoint product : PSRF	-3167390.932	5286535.638	1638181.214
error of closure dX,dY,dZ	-0.003	-0.015	-0.013
error of closure dN,dE,dU	-0.010	0.011	-0.015
Tolerance Num of edges =26	0.076		0.229

※ TOR Tolerance : H=15mm√N , V=45mm√N
0.076 0.229
※Japanese Tolerance : ΔN, ΔE=20mm√N , ΔU30mm√N
0.101 0.152

Source: JICA Design Team

6) Preliminary Traverse Survey

Instrument accuracy angle min. gradient 1” & distance measurement: + (5mm + 5mm x 10-6 x D). Where D is distance in km. The traverse points to be established in 200m - 300m range along the railway.

The traverse survey was done to establish the horizontal coordinates of the densified ground controls along the project area. The monuments for the primary traverse controls were based on the TOR specifications. The survey was performed using electronic total station (ETS) equipment using the following method:

- Horizontal angles were measured using two pairs of observation which are direct and reverse with gradient 0° and 90°. The final angles were computed by averaging the two results.
- Vertical Angles were recorded using the direct and reverse constant angle of 30”
- Distance measurements were doubled for the forward and backward tolerance of 30 mm.
- Angle closure tolerance between adjacent GPS controls is set at 10”√n.
- Coordinate closure tolerance was set at 1/20,000

For the north section, there are twenty-five (25) loops surveyed for the primary traverse survey starting from pairs of GPS control points towards the succeeding pairs of GPS control points.

Table 4.2.36 GPSS points of each loop

Loop	From	To	Traverse Points
1	GPS- N1 & GPS N2	GPS- N3 & GPS -N4	N2-1 to N2-9
2	GPS- N4 & GPS N3	GPS- N6 & GPS-N-5	N3-1 to N3-18
3	GPS- N5 & GPS N6	GPS- N8 & GPS-N7	N6-1 to N6-10
4	GPS- N8 & GPS N7	GPS- N9 & GPS-N10	N7-1 to N7-6
5	GPS- N9 & GPS N10	GPS- N12 & GPS-N11	N10-1 to N10-8
6	GPS- N11 & GPS N12	GPS- N13 & GPS-N14	N12-1 to N12-8
7	GPS- N13 & GPS N14	GPS- N15 & GPS-N16	N14-1 to N14-17
8	GPS- N15 & GPS N16	GPS- N18 & GPS-N17	N16-1 to N16-14
9	GPS- N17 & GPS N18	GPS- N19 & GPS-N20	N18-1A to N18-9
10	GPS- N19 & GPS-N20	GPS- N22 & GPS-N21	N20-1A to N20-9
11	GPS- N21 & GPS-N22	GPS- N23 & GPS-N24	N22-1A to N22-10
12	GPS- N23 & GPS-N24	GPS- N26 & GPS-N25	N24-1A to N24-9
13	GPS- N25 & GPS-N26	GPS- N27 & GPS-N28	N26-1A to N26-7
14	GPS- N27 & GPS-N28	GPS- N29 & GPS-N30	N28-1A to N28-8
15	GPS- N29 & GPS-N30	GPS- N31 & GPS-N32	N30-1A to N30-12
16	GPS- N31 & GPS-N32	GPS- N33 & GPS-N34	N32-1A to N32-10
17	GPS- N33 & GPS-N34	GPS- N35 & GPS-N36	N34-1A to N34-8
18	GPS- N35 & GPS-N36	GPS- N37 & GPS-N38	N36-1A to N36-8
19	GPS- N37 & GPS-N38	GPS- N40 & GPS-N39	N38-1A to N38-6
20	GPS- N37 & GPS-N38	GPS- N41 & GPS-N42	N38-7A to N38-11
21	GPS- N41 & GPS-N42	GPS- N44 & GPS-N43	N42-1 to N42-7
22	GPS- N43 & GPS-N44	GPS- N45 & GPS-N46	N44
23	GPS- N45 & GPS-N46	GPS- N47 & GPS-N48	N46-1 to N46-3
24	GPS- N47 & GPS-N48	GPS- N49 & GPS-N50	N48-1 to N48-7
25	GPS- N49 & GPS-N50	GPS- N51 & GPS-N52	N50-1 to N50-4

Source: JICA Design Team

Following table shows the result of quality control of traverse survey. Result of miss closure and closure accuracy are satisfied the TOR tolerance.

Table 4.2.37 Quality control records of Traverse Survey

Loop No.	Total length	Inner angle number	Angle Closure		Number of sides	Check Computation Accuracy	
			Closure	Tolerance		Closure	Tolerance
	km		Sec.	Sec			
1	2.523	11	-25	33	10	1/20,014	1/20,000
2	3.77	20	-16	44	19	1/54,595	〃
3	2.525	12	-14	34	11	1/142,376	〃
4	1.838	8	-8	28	7	1/20,477	〃
5	2.164	10	-15	31	9	1/107,212	〃
6	2.167	10	-19	31	9	1/64,467	〃
7	5.319	19	-6	43	18	1/54,265	〃
8	3.127	16	-40	40	15	1/38,203	〃
9	2.139	12	-11	34	11	1/25,360	〃
10	2.49	11	-30	33	10	1/34,306	〃
11	2.539	12	-2	34	11	1/36,355	〃
12	2.484	11	-31	33	10	1/47,557	〃
13	2.128	9	-20	30	8	1/36,309	〃
14	2.375	10	-30	31	9	1/38,975	〃
15	2.704	14	-8	37	13	1/37,091	〃
16	2.758	12	13	34	11	1/48,961	〃
17	2.429	10	5	31	9	1/58,432	〃
18	2.747	10	22	31	9	1/335,394	〃
19	2.23	8	18	28	7	1/21,255	〃
20	2.376	7	-17	26	6	1/35,396	〃
21	3.229	9	-7	30	8	1/21,196	〃
22	1.499	3	-2	17	2	1/83,181	〃
23	1.766	5	-9	22	4	1/26,097	〃
24	3.179	9	-29	30	8	1/88,729	〃
25	2.483	6	7	24	5	1/21,723	〃
1-Feb	0.493	4	3	4	3	1/20,076	〃

Source: JICA Design Team

7) Control Leveling Survey

The elevations of the previously-established GPS Horizontal Controls and Primary Traverse Control Stations were determined by leveling survey for North sections of the project area. Digital Level instrument was used with a bubble accuracy 10” and / or equivalent.

The Leveling survey was performed using the following method:

- Double-run (forward and backward) differential leveling survey was performed.
- The leveling survey was tied to existing NAMRIA BMs (mean sea level datum)

- The leveling survey was performed along the newly-established GPS Control and Traverse points.
- Tolerance of forward and backward: 10mm √D where D is distance in km
- The distance between level instrument and level staff is maintained at 70m max.
- The level instrument was checked by Two-peg method on a daily basis. Tolerance: 3mm.

Following table shows the result of quality control leveling survey. Result of round trip accuracy meets the TOR tolerance.

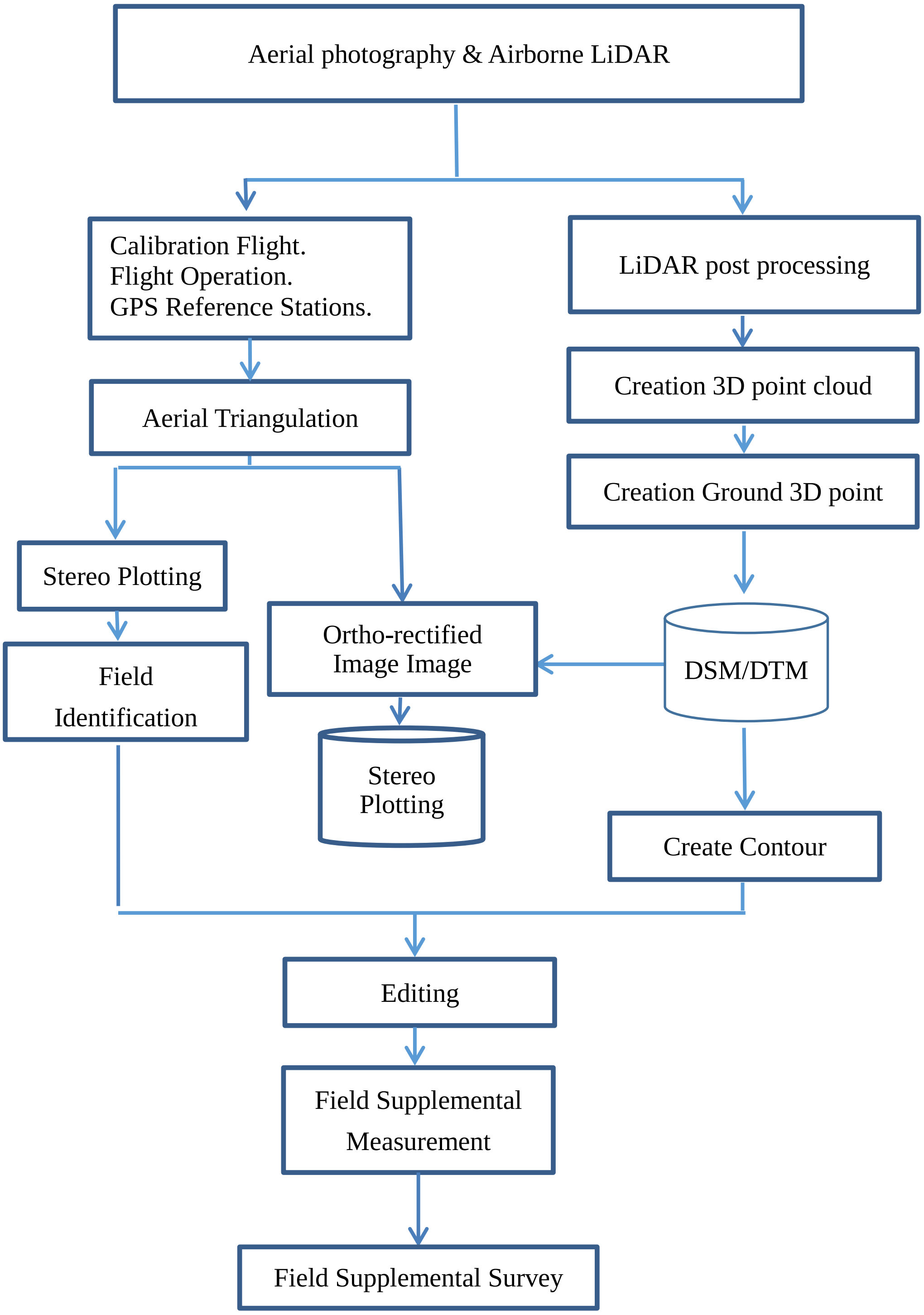
Table 4.2.38 Results of quality control leveling survey

Loop No.	Length (km)	Tolerance	Limit (10mm√km)
		mm	mm
1	4.483	-11	21
2	4.010	-1	20
3	7.650	27	27
4	2.281	12	15
5	3.103	7	17
6	2.649	3	16
7	5.621	15	23
8	3.535	-7	18
9	2.236	4	14
10	2.730	-2	16
11	2.905	2	17
12	2.769	4	16
13	2.447	0	15
14	5.592	23	23
15	2.757	2	16
16	3.235	2	17
17	2.798	-14	16
18	3.539	10	18
19	2.767	-3	16
20	7.195	-14	26
21	4.135	10	20
22	3.645	-2	19
23	5.804	-15	24
24	5.781	-8	24
25	3.894	4	19
2-1	0.583	-3	7

Source: JICA Design Team

8) Aerial photography & Airborne LiDAR Measurement

Aerial photography and airborne LiDAR measurement were planned to proceed with following work flow.

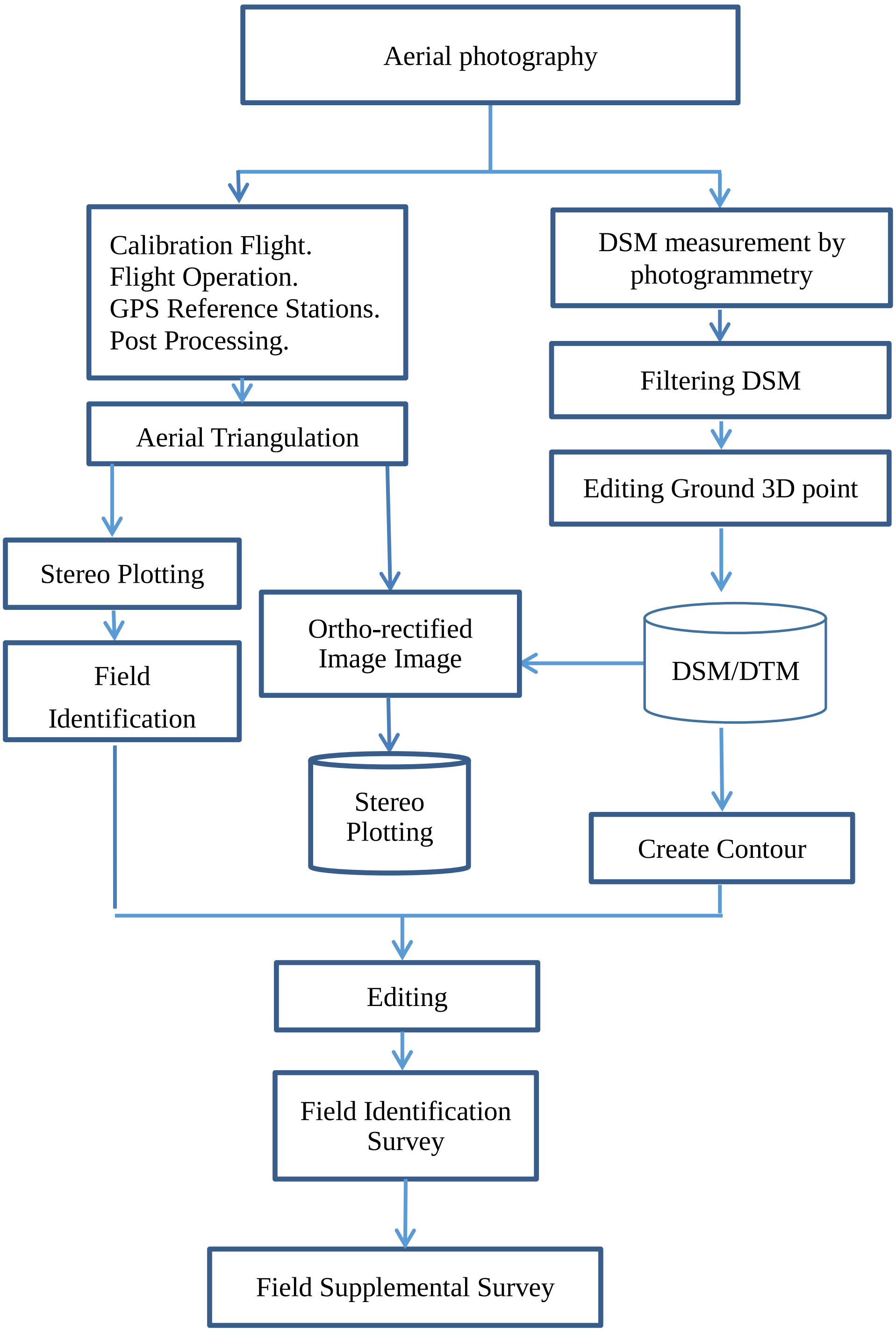


Source: JICA Design Team

Figure 4.2.97 Work flow of aerial photography and aerial LiDAR measurement

However because of the hardware trouble of LiDAR equipment, the workflow was changed to following one. Photogrammetry method was applied for topographic survey (DSM/DTM) instead of using LiDAR.

These changing are agreed with JDT.

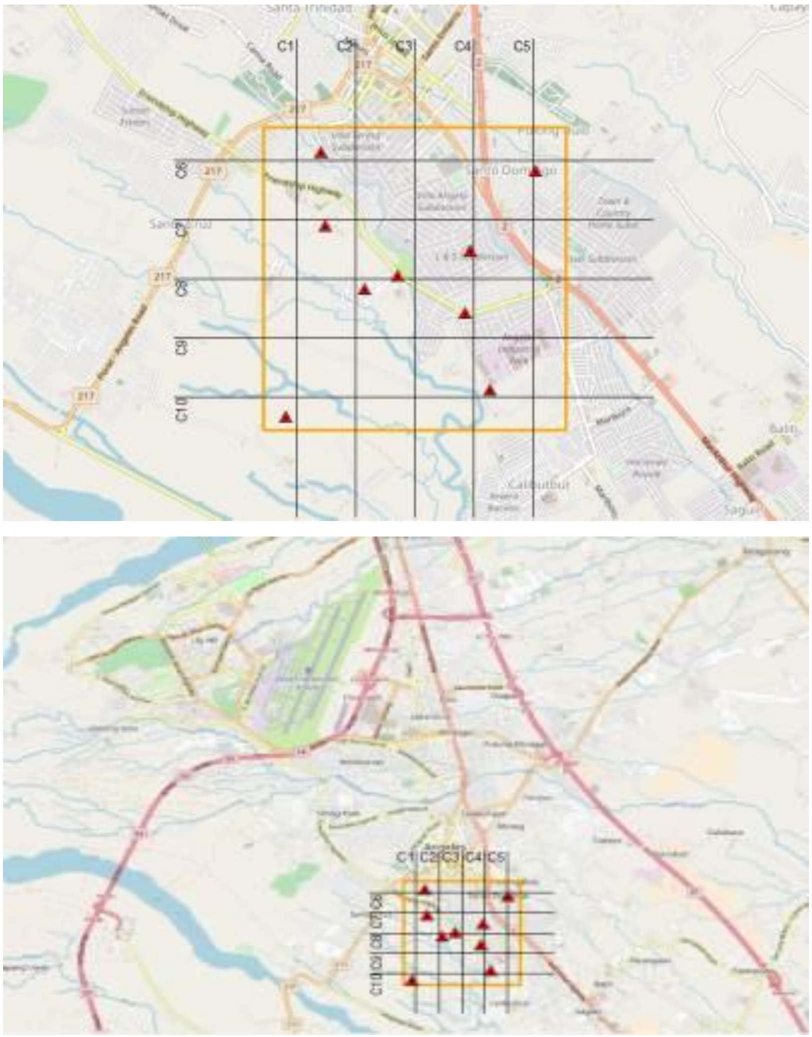


Source: JICA Design Team

Figure 4.2.98 Work flow of aerial photography measurement

a) Calibration Flight

In order to correct the misalignment of the GPS/IMU and the ULTRACAMx sensor near this Clark Airport, a field for boresight calibration is set up. Prior to Aerial Triangulation, calibration photographing of this place is performed, and correction value is obtained beforehand.



Source: JICA Design Team

Figure 4.2.99 Calibration Flight Site

A control point for calibration was set up in order to conduct checking and correction of the 3D measurement data. The number of required control points for correction according to Japanese standards is 9 points. These points shall be set up at an equal distance from each other in each area in the target area. The independent observation by means of RTK method has done used as an observation method.

b) Flight Operation

We shall use UltraCAMx (UCX) as Digital Aerial Camera manufactured by Vexcel Imaging. Since this UCX is a 14,430 x 9,420 pixels of Image Size and 7.2 μm of physical pixel size, it can be used at a 10 cm GSD even at a ground altitude of 1,500 m. Also, when shooting from 1,500 m altitude, the shooting width is about 1.4 km, so you can cover the target area with a single flight. Describe the photographs of UCX used below and their specifications.

Source: JICA Design Team

Figure 4.2.100 ULTRACAMx(Digital Camera)

In this measurement, we plan the measurement with the following specifications.

Table 4.2.39 Aerial Photography parameter

Flight Height	1,500 m
Cruise speed	140kts
Focal length	104mm
Pixel Size	14,430pixels x 9,420pixels
Ground Resolution	10 cm
Photographing range	1,400 m (width) x 940 m (flight direction)
Photographing interval	180 m (overlap 80%)
Number of courses	18 courses

Source: JICA Design Team

The airplane used for aerial photography was Aero Commander 685 owned by Certeza Infosys Corporation (CIC).

Source: JICA Design Team

Figure 4.2.101   Aero Commander 685

Certeza Infosys Corporation (CIC) was in charge of the airplane operation. For this reason, CIC was in charge of flight permission application work.

Aerial Photography was done on May 29th, and it is confirmed that there is no problem after checking the photo data. The flight cruising length, the photograph number and the number of photographs for each course are shown in Table 4.2.40.

Table 4.2.40 Flight course and progress

NORTH RAILWAY

CAMERA	UCX
FRAME SIZE	17,310x11,310
GSD	16cm
PIXEL SIZE	6.0μm
Length of photo center	740m (overlap60%)

Malolos to Clark

Strip ID	Strip Length(km)	Progress
C-1	4.47	100%
C-2	5.24	100%
C-3	6.86	100%
C-4	4.35	100%
C-5	4.33	100%
C-6	2.79	100%
C-7	2.24	100%
C-8	3.70	100%
C-9	4.08	100%
C-10	4.44	100%
C-11	3.69	100%
C-12	14.61	100%
C-13	5.12	100%
C-14	4.85	100%
C-15	3.95	100%
C-16	4.17	100%
C-17	3.03	100%
C-18	9.46	100%
TOTAL	91.38	100%

Source: JICA Design Team

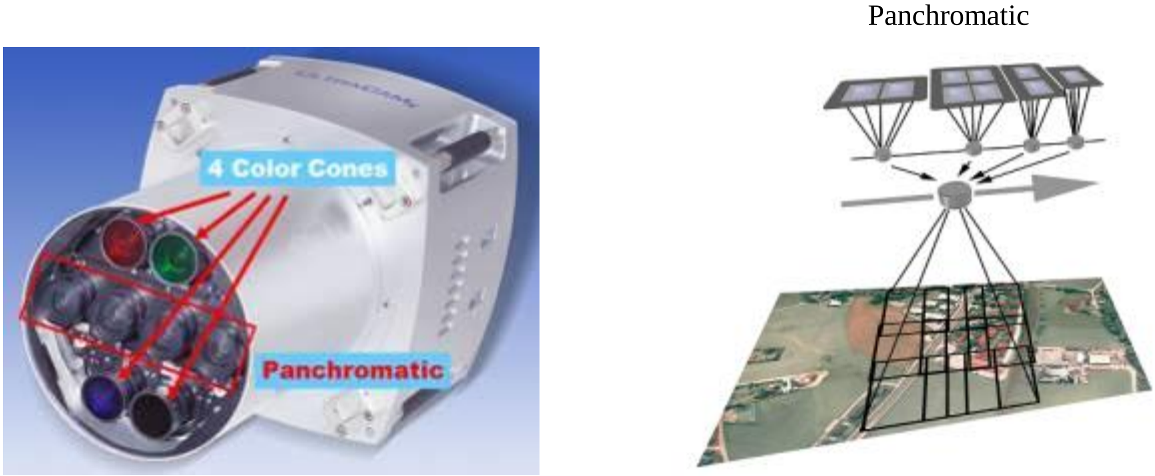
c) GPS Reference Stations

In order to identify the position of the Digital Camera by kinematic GPS surveying, control stations need to be set up on the ground when an aircraft is flying. As a general rule, these stations need to be set up within a range of 50 km of where measuring is performed at each target area(North & South). The final locations of the control stations have determined by taking 5 numbers, such as PTAG, PFLO, PSTC, PTGY, PSRF of NAMRIA Active Geodetic Control.

d) Post Processing

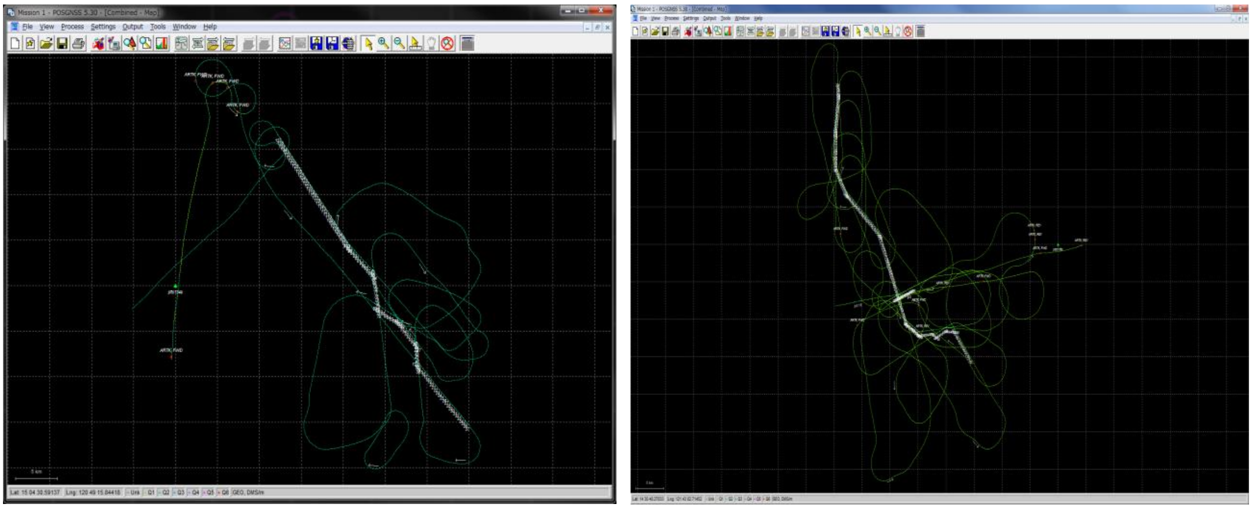
After taking aerial Photography by UCX, there are two types of data acquired, one is image data and another one is GNSS/IMU data. Downloading image raw data from UCX equipped with aircraft, it was performed image compositions using "ULTRAMAP" software attached. On the other hand, for

GNSS / IMU raw data, the processing is performed to calculate the Camera exposure position and attitude (exterior orientation parameter) by using "POSGNSS" software.



Source: JICA Design Team

Figure 4.2.102 Mechanism image compositions by UCX



Source: JICA Design Team

Figure 4.2.103 GNSS/IMU analysis

e) Aerial Triangulation

Aerial triangulation is done based on aerial photo image and GNSS / IMU of the camera at the exposure time and GCP, and calculated the exterior orientation parameter of the camera. The accuracy of aerial triangulation is shown in the following table, and the state of photo observation during aerial triangulation is shown in the following figure.

The accuracy of aerial triangulation was determined to be 4 cm in the horizontal and 1 cm in the vertical direction.

Table 4.2.41 Aerial Triangulation Quality Control

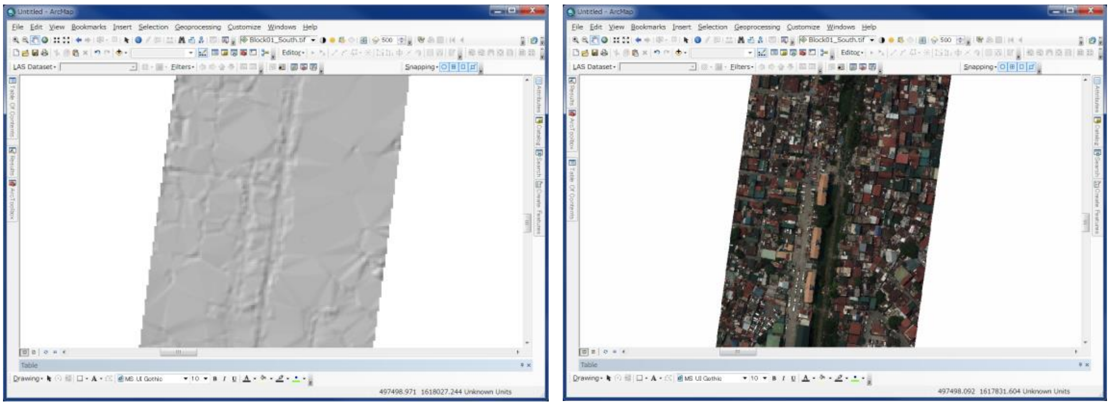
Control point No.	XY residuals(m)	Z residuals(m)
J1	0.08	-0.01
J2	0.10	-0.01
J3	0.11	0.01
J4	0.13	0.01
J5	0.06	0.00
J6	0.11	0.01
J7	0.07	-0.01
J9	0.03	0.01
H06	0.07	0.00
H08	0.04	0.00
H11	0.03	0.00
H12	0.02	0.00
H13	0.03	-0.01
H17	0.02	0.00
H18	0.03	0.00
H19	0.05	0.00
H20	0.07	-0.01
H21	0.01	0.00
H23	0.03	0.00
H25	0.07	-0.01
H26	0.03	0.00
H27	0.01	0.00
H31	0.03	0.00
H85	0.07	0.00
H87	0.11	0.00
H90	0.05	0.00
H91	0.06	-0.01
H93	0.06	0.00
H96	0.07	0.00
H97	0.05	-0.01
H98	0.07	0.00
H99	0.02	0.00
J10	0.01	0.00
J11	0.06	0.01
J12	0.10	0.02
J13	0.02	0.00
J14	0.03	0.00
J15	0.01	0.00
J16	0.04	0.00
J17	0.01	0.00
J18	0.03	0.01
J19	0.05	0.00
H05A	0.04	0.00
H100	0.05	0.01
H101	0.04	0.00

Control point No.	XY residuals(m)	Z residuals(m)
H102	0.02	-0.02
H103	0.04	-0.01
H10A	0.06	0.00
H124	0.07	0.00
H126	0.01	0.00
H15A	0.03	0.00
H19A	0.06	0.00
HH03	0.05	0.00
HH04	0.04	0.01
HH05	0.08	0.00
HH28	0.02	0.00
HH94	0.08	0.01
H101A	0.12	0.00
H125A	0.07	0.00
H127A	0.07	0.00
H21-1	0.01	0.00
H22-1	0.02	0.00
H23-2	0.03	0.00
H24-1	0.04	0.00
H30-1	0.02	0.00
HH06A	0.07	0.00
HH07A	0.14	0.01
HH11A	0.03	0.00
HH128	0.02	0.00
HH129	0.02	0.00
HH131	0.02	0.00
HH94A	0.05	0.00
HH128A	0.05	0.00
HH132A	0.03	0.00
HH132N	0.01	0.00
RMSE	0.06	0.00

Source: JICA Design Team

f) Ortho-rectified Image

Create a DTM based on stereo models using the aerial photo image on which aerial triangulation has been completed. And it was ortho-rectified each aerial photograph using this DTM. The ortho-rectified aerial photographs were mosaiced in the mosaic line, and Ortho-photo was created.

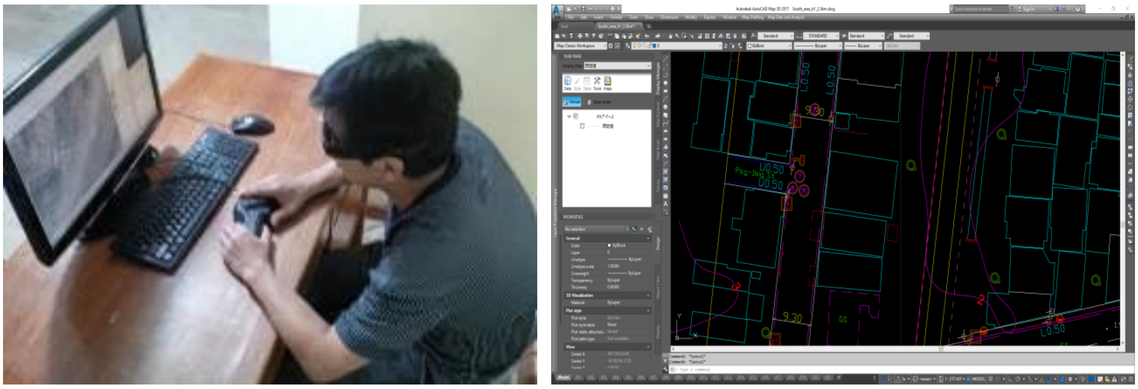


Source: JICA Design Team

Figure 4.2.104 DTM (Left) & Ortho Image(Right)

g) Stereo Plotting

After completing the aerial triangulation, the target area was stereo plotting using a photogrammetric workstation. The topographical map item to be acquired by stereo mapping was based on the acquisition procedure of Japan's 1/1,000 scale. The photogrammetry workstation and stereo plotting data are shown below.



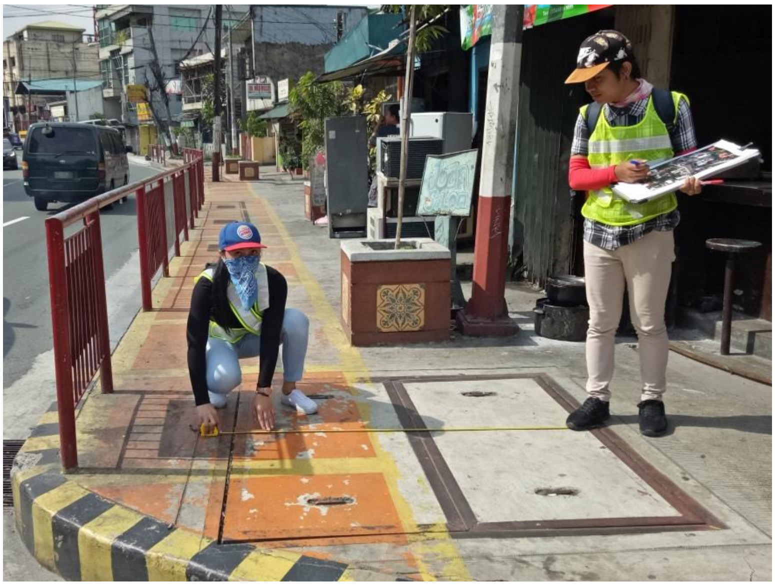
Source: JICA Design Team

Figure 4.2.105 Photogrammetric WorkStation & Stereo Plotting data

h) Field Identification Survey

Field Identification work were conducted to identify the unclear points in the Stereo Plotting and photo interpretation, and to collect additional information available only from the field. In addition, the secular changes in the roads and road facilities were surveyed, as well as visual confirmation of existing above ground utilities, such as manholes and utility posts.

The secular change data on newly constructed roads, electric transmission lines, sub stations, and public facilities were collected from the related agencies that controlled the information and materials on the data. In addition, these secular changes verified and surveyed in the field.



Source: JICA Design Team

Figure 4.2.106 Field Identification Survey Activities

i) Editing

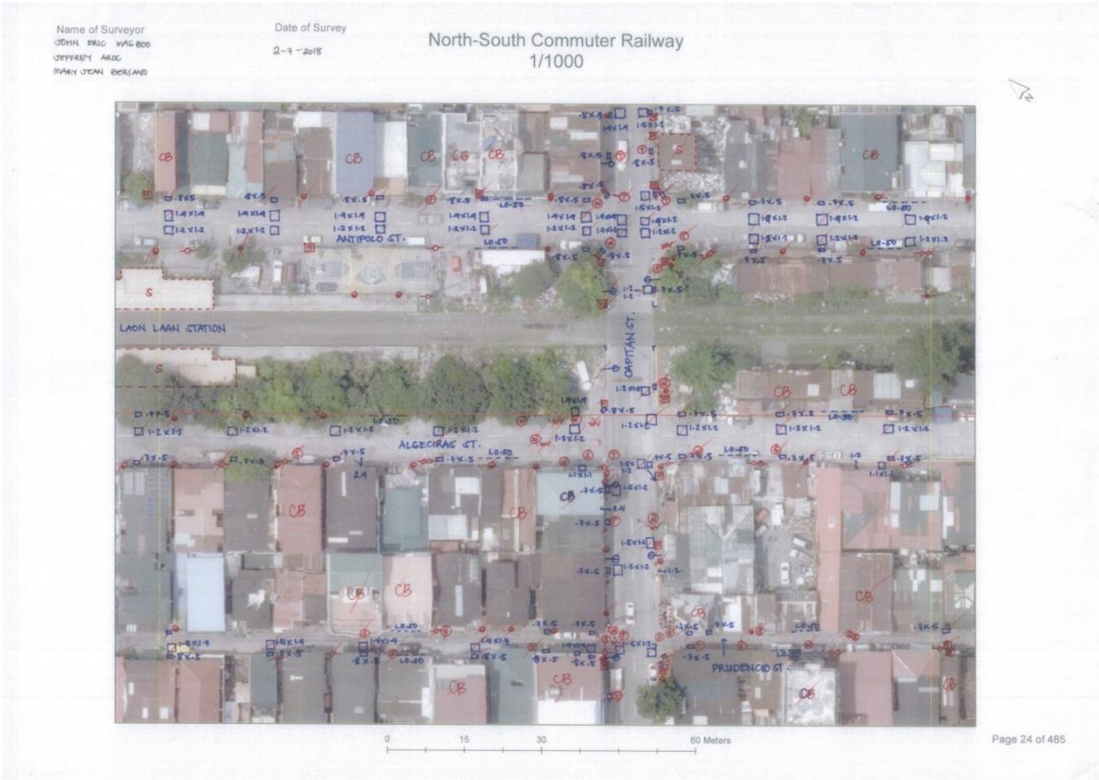
Structural Compilation of the stereo plotting data were done wherein the Stereo Plotting data were inspected, verified and corrected for logical errors (edge mismatching, undershoot, overshoot, area overlap and inconsistency of area classification), and topologically structured (i.e all topographic features were classified into proper geometry of line, polygon, or point) in accordance with the specifications. AutoCAD software, combined with GIS software were used for structural compilation and editing.

Additional features gathered during the field identification survey, as well as data from Utility Survey were added and compiled together with the stereo plotting output, and finally converted to suitable CAD (.dwg) format as final topographic data.

j) Field Supplemental Survey

Doubtful, unclear points and secular changes that were found in digital plotting and compilation were verified through supplemental field survey.

The points that could be interpreted referring to the materials provided by utility companies and agencies were also verified and discussed before inclusion in the final manuscript.



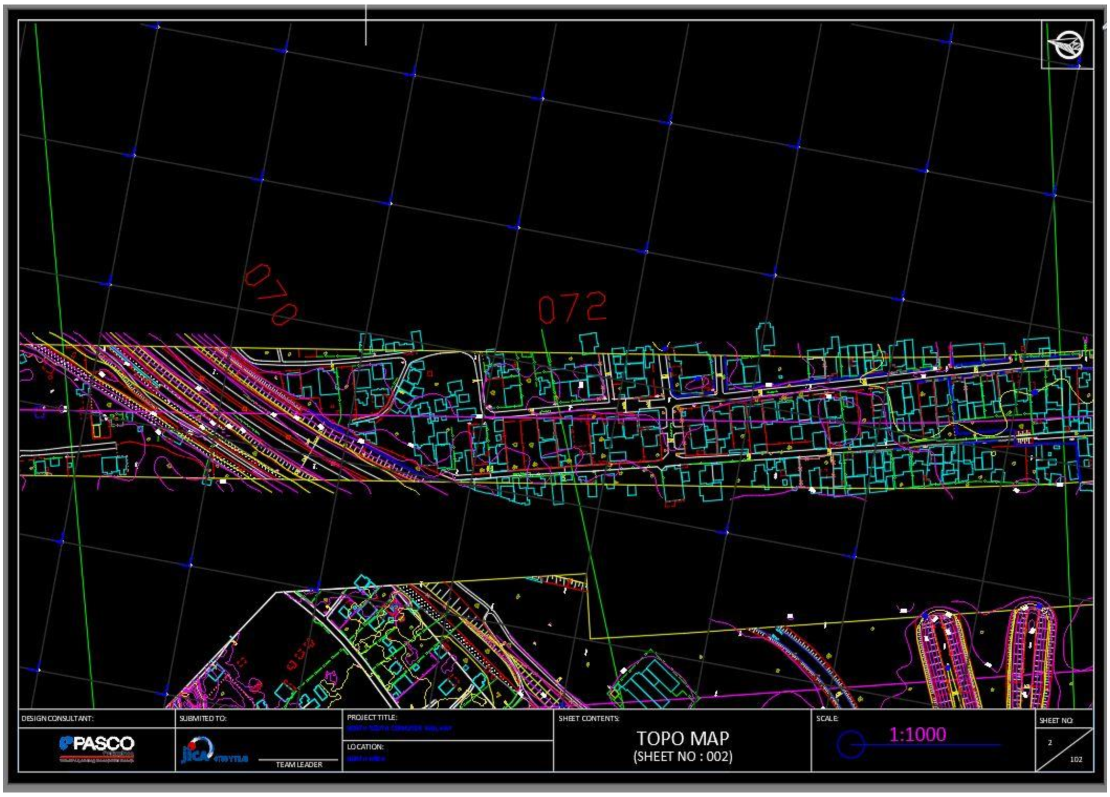
Source: JICA Design Team

Figure 4.2.107 Field ID survey Manuscript

9) Topographic Map Creation

Data gathered from the different survey process, such as, GPS survey, Leveling survey, as well as collected information from Major Cross Roads Mapping, were compiled to create the final Topographic Map data at 1/10,00 scale.

- Contour lines were automatically extracted from filtered data of DTM (Digital Terrain Model)
- Topographic features interpreted from Orthophoto and other survey data were manually digitized using stereo plotting methodology.
- GIS capable and Remotes sensing software, such as ArcGIS and ERDAS imagine were used to verify the correctness and accuracy of the compiled data to produce final Topographic Map suitable for reproduction



Source: JICA Design Team

Figure 4.2.108   Final Topographic Map Layout at 1:1,000 scale

a)   Field Supplementary Survey at Water Area

Water areas such as fishponds and swamp areas surrounding the railway alignment particularly in Pampanga were surveyed. Initial blocks were selected along the alignment. The survey was performed using a Leica Sprinter 250 digital level and barcoded staff rod. Depths and difference in elevation of the ground and the bottom surface of the bodies of water were obtained. For each measurement, a flat ground surface nearest to the body of water is selected and the barcoded leveling staff rod is positioned for the back sight measurement. The other barcoded leveling staff rod is then positioned on the water for the foresight measurement. Photos were taken as shown below.

Source: JICA Design Team

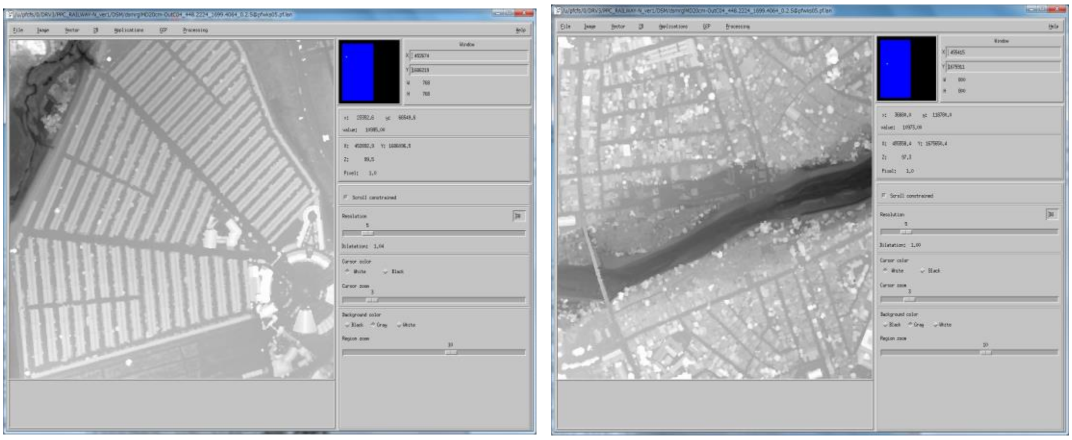
Figure 4.2.109 Ground photo near the fishpond / Measurement at the fishpond

b) Photogrammetric Profile and Cross-Section Survey

The profile data to be generated using the DSM/DTM data created with photogrammetric method. Also, to generate Cross-Section data at 20m intervals with standard 100m width 50 m on both sides from the center.

DSM data was created from stereo model by digital image correlation method. The original GRID size of DSM is 0.2 x 0.2 m.

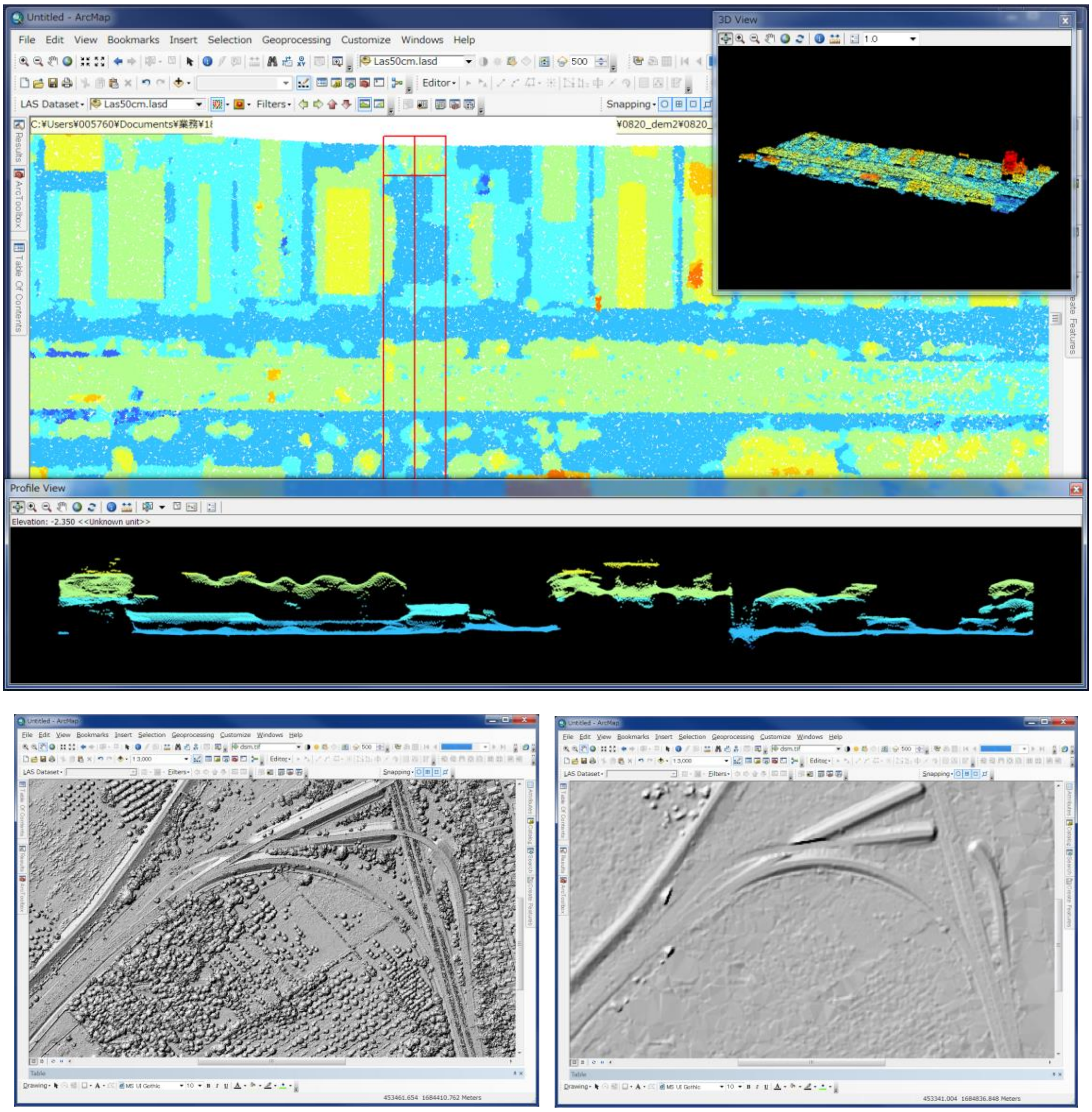
Following images shows the process of DSM processing.



Source: JICA Design Team

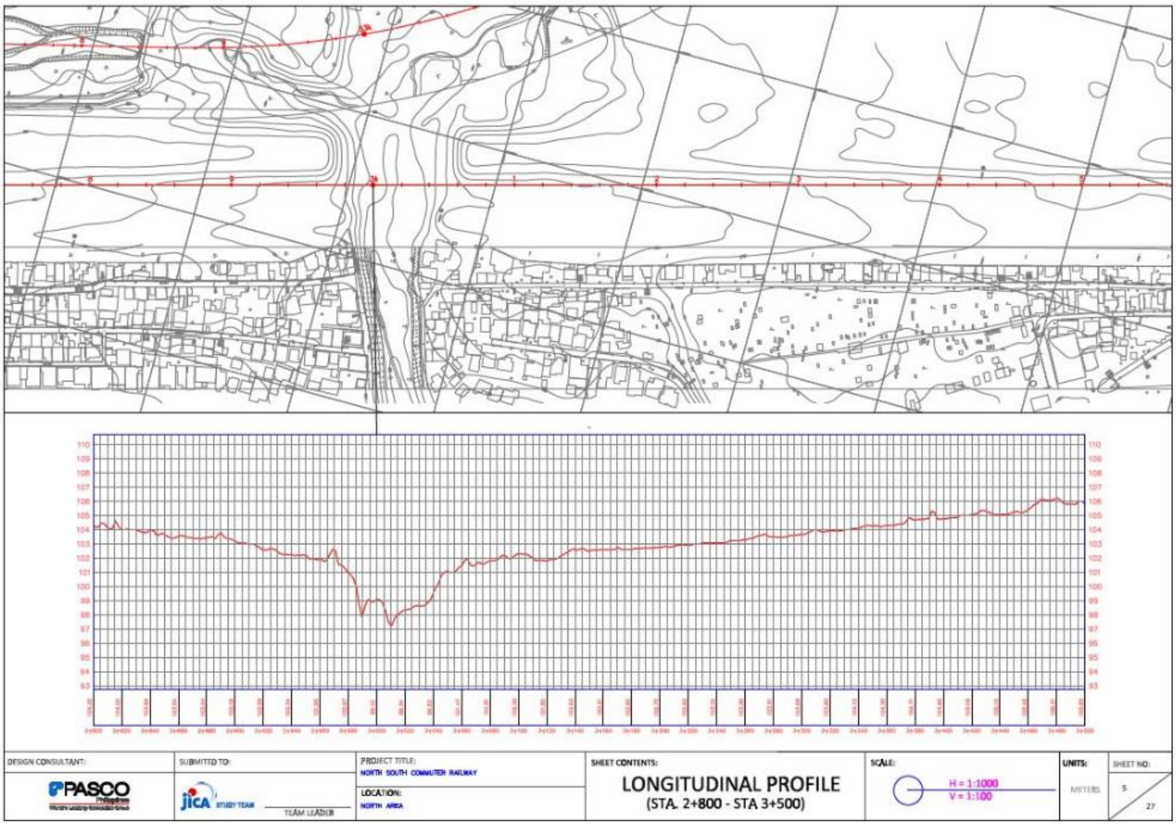
Figure 4.2.110 DSM Processing

DTM data was created from this DSM data with filtering method. The original GRID size of DTM is 0.5 x 0.5m.



Source: JICA Design Team

Figure 4.2.111 DSM Filtering



Source: JICA Design Team

Figure 4.2.112 Longitudinal Profile

Profile and cross section data is created from this DTM. First product of profile and cross section data are used for feasibility study. Based on this study, JDT will consider the probability of current alignment and re-design them. After this process, profile and cross section data will be modified. This modifying task is not started yet.

10) River Surveys

Pre-selected rivers and creeks traversed by or near the railway alignment were surveyed using both total station survey method and sounding measurements.

For the north part, the surveyed covered 11 large rivers/creeks and bridges surveyed. The other sites are either medium-size river and creeks as listed below.

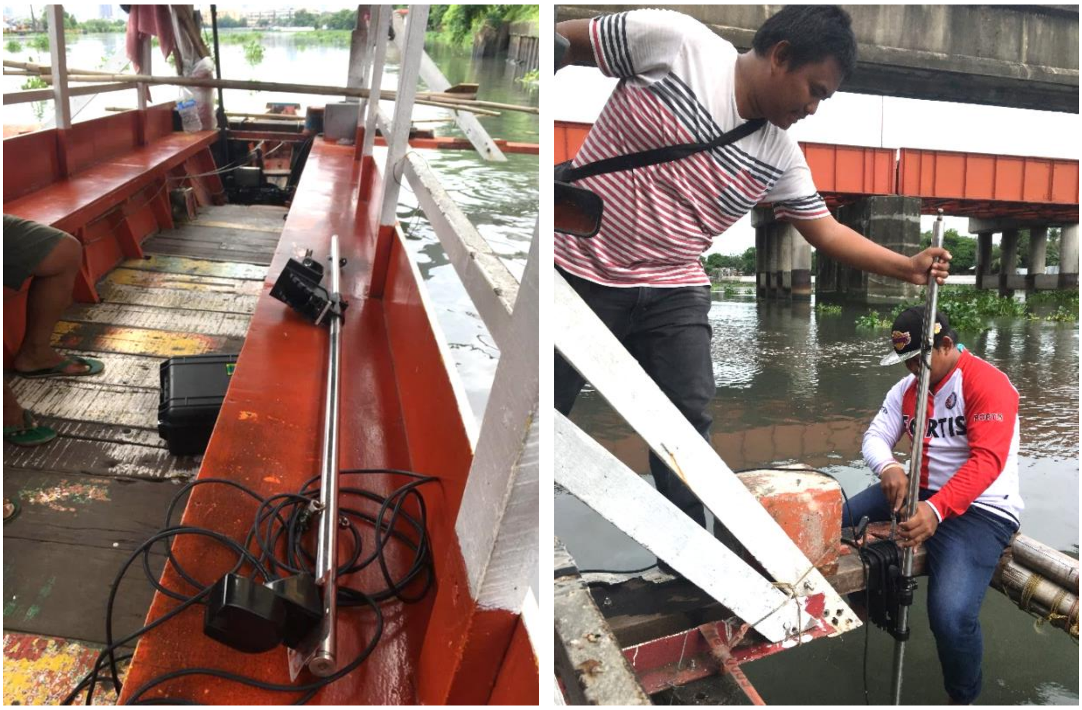
Table 4.2.42 List of Rivers and Creeks Surveyed at the North Part

No.	Name	Sta.	Description
1.	Bulihan River	35 + 764	Large
2.	Angat River	40 + 960	Large
3.	Labangan Creek	42 + 128	Large
4.	Pampanga (Calumpit) River	43 + 197	Large
5.	Sulipan River	45 + 044	Large
6.	Malalam River’	50 + 720	Large
7.	Megildo River	52 + 050	Large
8.	Pambaling River	53 + 320	Large
9.	Abacan River	76 + 171	Large
10.	Sacobia River	6+500	Large
11.	Bamban River	8 + 500	Large

Source: JICA Design Team

For large rivers, the extent includes 510 m upstream and 260 meters downstream for an approximate length of 770 meters. The width of the cross section varies since each cross section include ground points surveyed on both sides at 50 meters inland from the river banks (or less depending on the actual situation on the ground). For small rivers or creeks, the extent is 50 meters with a spacing of 10 meters per section measuring until the top banks only.

For navigable rivers, echo sounder equipment was used for the depth measurements. The logging specification was set at 5 meters interval. The corrected horizontal and vertical positions were recorded along with the depths. The horizontal coordinates were automatically corrected through RTK. The GNSS base is stationed at the nearest ground control while the rover is connected to the echo sounder.



Source: JICA Design Team

Figure 4.2.113 Major equipment installation status (echo sounder)

Source: JICA Design Team

Figure 4.2.114 Major equipment installation status (GNSS)

Source: JICA Design Team

Figure 4.2.115 Observation situation

For non-navigable rivers/creeks, optical/laser measurements were performed using electronic total station equipment. The ETS were set at pre-established pairs of ground control points (GPS and Traverse Points or densified ground control points).

For large/wide non-navigable rivers, the following points along each cross section were measured:

- Top bank at the left (TB)
- Top bank at the right
- Edge of water at the left(EW
- Edge of water at the right(EW
- Center line(CTR)
- Approximate midpoint or point in-between the Centerline and water edge at the left(RB)
- Approximate midpoint or point in-between the Centerline and water edge at the right(RB)

Source: JICA Design Team

Figure 4.2.116 Non-navigable shallow river surveyed

For narrow or smaller creeks, the following points along each cross section were measured:

- Top bank at the left(TB)
- Top bank at the right(TB)
- Water edge at the left(EW)
- Water edge at the right(EW)
- Center line(CTR)

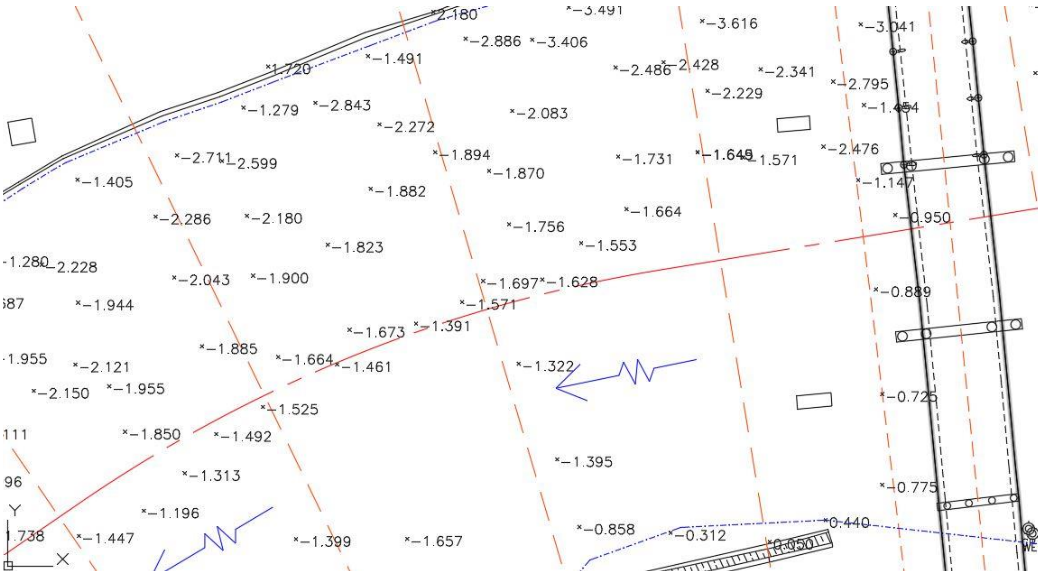
The raw data for the river cross section survey were downloaded in CSV format. The csv files were then loaded to AutoCAD Civil 3D 2016 where the surface contours were generated.

Table 4.2.43 CSV File

Point Nam	Northing	Easting	Elevation	Point Code
S6-7	1614058.259	501166.690	10.751	ST
1	1614076.920	501273.027	-2.051	BATHY
2	1614076.897	501281.568	-0.040	BATHY
3	1614075.992	501290.639	-5.085	BATHY
4	1614067.458	501316.193	-4.500	BATHY
5	1614065.841	501321.181	-4.379	BATHY
6	1614064.477	501326.031	-5.342	BATHY
7	1614062.976	501331.057	-5.503	BATHY
8	1614061.309	501336.000	-5.487	BATHY
9	1614060.044	501340.853	-5.449	BATHY
10	1614058.593	501345.809	-5.581	BATHY
11	1614057.602	501350.748	-4.837	BATHY
12	1614056.769	501355.688	-5.431	BATHY
13	1614056.021	501360.968	-4.517	BATHY
14	1614055.070	501366.057	-4.566	BATHY
15	1614053.895	501371.086	-4.909	BATHY
16	1614052.317	501375.985	-3.867	BATHY
17	1614051.122	501381.007	-3.933	BATHY
18	1614050.239	501386.154	-3.560	BATHY
19	1614049.194	501391.210	-3.166	BATHY
20	1614047.922	501396.330	-3.231	BATHY
21	1614046.511	501401.417	-2.865	BATHY
22	1614044.411	501406.087	-2.523	BATHY

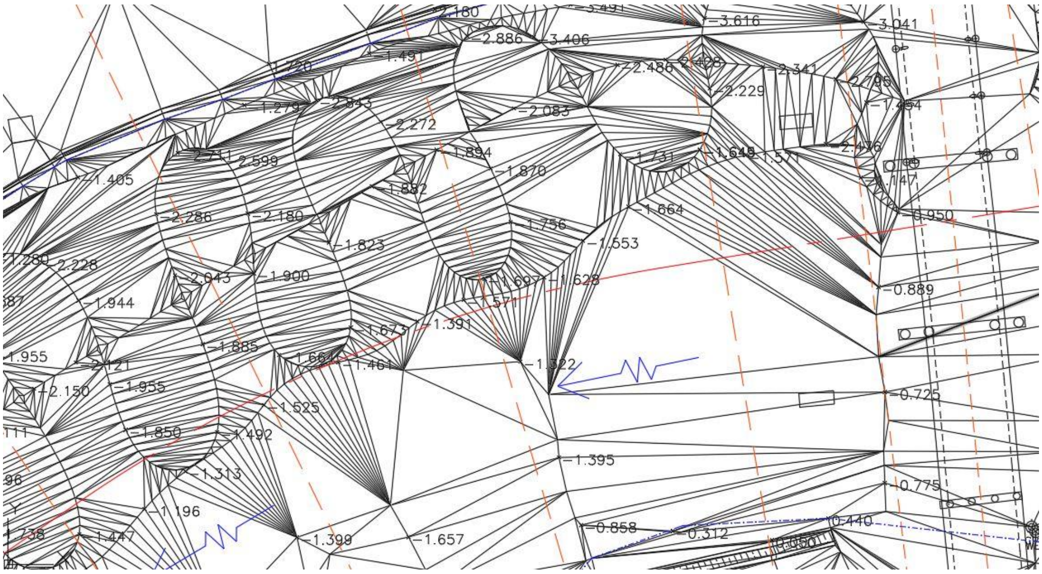
1	1613946.580	501437.423	2.977	0+300
2	1613959.409	501388.231	3.000	0+250
3	1613946.580	501437.423	2.978	0+300
4	1613959.408	501388.235	2.999	0+250
5	1613941.127	501458.352	2.979	SUB 1
6	1613941.127	501458.352	2.979	SUB 1
7	1613946.580	501437.423	2.977	0+300
8	1613941.127	501458.352	2.978	SUB 1
9	1613946.579	501437.428	2.978	0+300
10	1613928.324	501485.522	2.990	0+350
11	1613927.053	501484.900	3.077	PL
12	1613927.510	501485.733	2.985	EDGE SW
13	1613928.375	501486.219	2.993	EDGE SW1
14	1613928.384	501486.271	3.674	TOP R
15	1613928.604	501486.272	3.675	TOP R1
16	1613929.154	501486.020	2.220	TB
17	1613928.787	501486.063	3.047	TB
18	1613928.874	501486.083	3.039	TB1
19	1613928.989	501486.256	2.213	LB
20	1613929.560	501486.390	2.199	LB1
21	1613930.066	501486.568	0.549	EW/WL
22	1613959.409	501388.231	3.000	0+250
23	1613946.580	501437.423	2.977	0+300
24	1613959.409	501388.231	2.999	0+250

Source: JICA Design Team



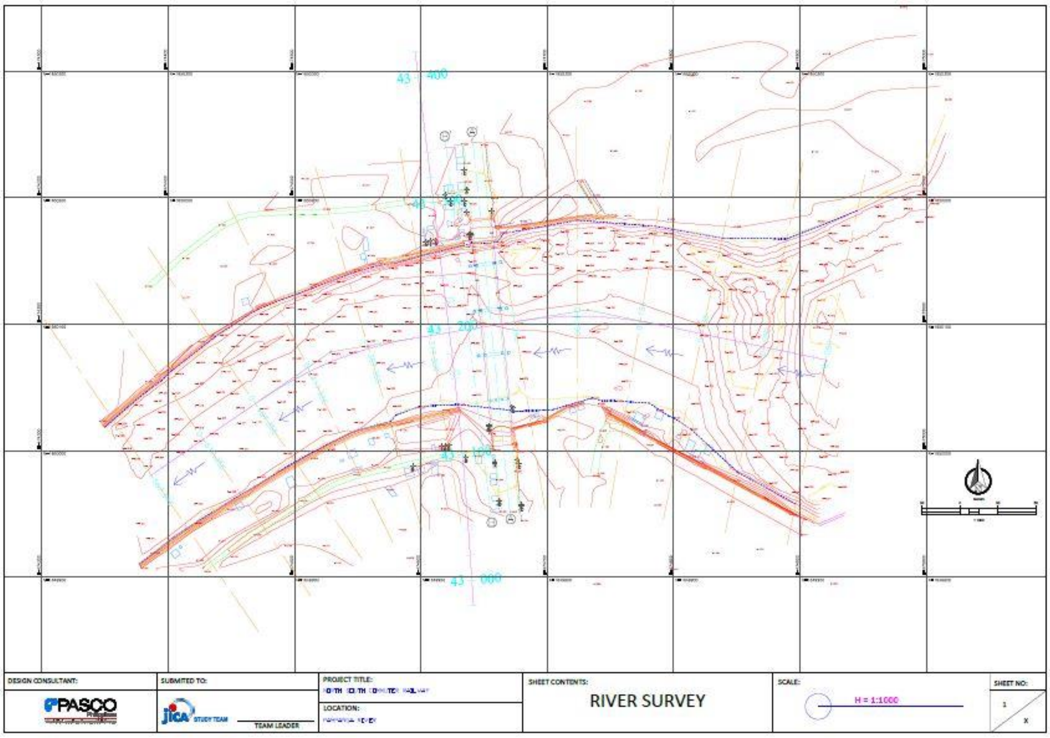
Source: JICA Design Team

Figure 4.2.117 Independent elevation point occurrence situation



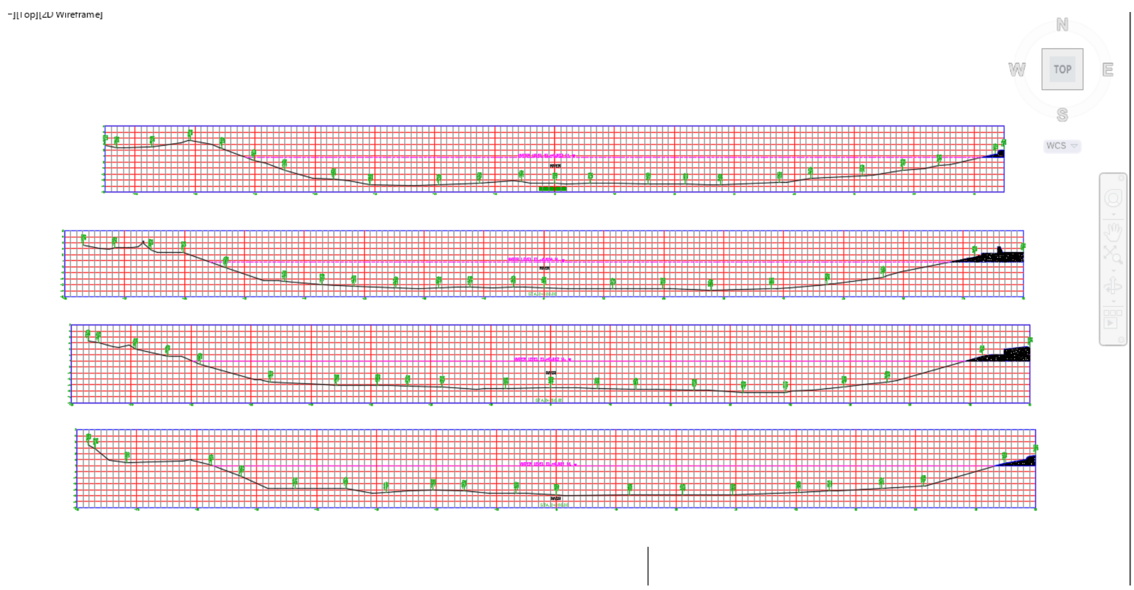
Source: JICA Design Team

Figure 4.2.118 Surface TIN



Source: JICA Design Team

Figure 4.2.119 Surface Plan generated from the TIN



Source: JICA Design Team

Figure 4.2.120 Cross-Section view of a river Survey

a) Major Cross Road Topographic Survey

As per instruction of the Client, spot heights for the center lines of major roads crossing the railway alignment were selected and surveyed using electronic total stations (ETS) equipment, at fifty (50) meters on both sides (left and right). Points along the road center lines were measured at every ten (10) meters interval. The nearest horizontal and vertical control points (GPS and traverse control points) were used as survey reference. The vertical datum used is MSL, and elevations are based on the leveling survey results. There are about eight (8) road cross sections for the north part.

The spot heights of other roads (like a community road) were measured from photogrammetric data.

The cross road data, which are declared in TOR are undergoing.

Table 4.2.44 Road crossing survey site list

NO	STATION	NAME	DESCRIPTION	MUNICIPALITY
1	58 + 400	San Fernando PNR Station	2 Lanes (1 Lane on one side)	San Fernando City
2	59 + 773	Jose Abad Santos Avenue	4 Lanes (2 Lanes on one side)	San Fernando City
3	61 + 000	MNR-Lazatin Boulevard	6 Lanes (3 Lanes on one side)	San Fernando City
4	77 + 900	SM Clark (1st Street)	4 Lanes (2 Lanes on one side)	Angeles City
5	81 + 300	SCTEX Interchange	4 Lanes (2 Lanes on one side)	Mabalacat
6	81 + 800	SCTEX Section	4 Lanes (2 Lanes on one side)	Mabalacat
7	Sta 1 + 013	Gil Puyat Avenue	4 Lanes (2 Lanes on one side)	Mabalacat
8	2 + 800	Clark North Toll Plaza	6 Lanes (3 Lanes on one side)	Mabalacat

Source: JICA Design Team

b) Road Cross Section Survey and As-Built Survey Of Overbridges

There are eleven (11) pre-identified sites for road cross sections with over-bridges. Both ground points/spot heights and modified as-built survey for the over-bridge was performed using total station survey. Using the prism-less electronic total station, side shots were taken to capture the 3D positions the elevated sections of the bridge and the pillars. The lowest elevation of the over-bridge were measured. Spacing used for the cross section is based on the positions of the pillars.

These data are not able to get from aerial photographic data. The measurement targets are covered by objects.

Road cross section survey and as build survey of over bridges are integral part of deciding the configuration of detail design.

11) The Survey Work Progress

Following table shows the planned and implemented quantity list.

Table 4.2.45 Planned and implemented quantity list.

Item	Unit	Qty.	Progress	Rate
Satellite Image data adjusted by GPS H & V				
Image adjusted by GPS data & DTM draw contouring	LS	1	1	100%
Horizontal Control Point Survey (GPS Survey)				
Reconnaissance	km	71	71	100%
New Points Selection Work	Point	54	54	100%
30cmx30cmx100cm Concreting Work	Point	54	54	100%
Observation and Calculation	Point	54	54	100%
Description of GPS station	Point	54	54	95%
Primary Traverse Survey (TS Survey)				
Primary Traverse point selection 200-300m	Point	214	214	100%
Rrimary 20cmx20cmx70cm Concreting Work	Point	214	214	100%
Primary Traverse Observation	Point	214	214	100%
Description of TS point	Point	214	214	95%
Control Leveling Survey (Digital Level)				
Control Leveling Observation (0km – 71km)	km	98	98	100%
Aerial Photography & Airborne LiDAR Measurement				
Process Applications flight clearance PND & Aviation	LS	1	1	100%
Mobilization of Aerial LiDAR and Camera	LS	1	1	100%
Flight Operation_UCX	Course	18	18	100%
Flight Operation_Lidar	Course	18	0	0%
Clibration_UCX	Times	1	1	100%
Clibration_Lidar	Times	1	0	0%
Pre Mark Survey	No	81	81	100%
Aerial Triangulation Survey	Course	18	18	100%
DSM Process Work	km	78.6	78.6	100%
DTM Process Work	km	78.6	78.6	100%
Orth Photo Production North 1/1,000	km	78.6	30	90%
TOPO MAPPING NORTH km 34.7 – 86.0	km	58.9	58.9	100%
Topo-mapping CGC LINE km 0.0 - 20.0 (low priority)	km	19.7	4	90%
Profile Photogrammetric method	km	58.9	58.9	100%
Profile Photogrammetric method	km	19.7	15	100%
Longitudinal section 20m interval km 34.7 – 86.0	km	58.9	58.9	100%
Longitudinal section 20m interval CGC LINE	km	19.7	0	90%
Cross section width 50m both sides km 34.7 – 86.0	Cross	2945	300	90%
Cross section width 50m both sides km CGC LINE	Cross	985	0	90%
Centering, Profile and Cross section by TS	km	7	6	100%
River Survey				
River survey Sounding RTK or TS or Echo sounder	No	11	5	100%
Major Cross Road Topographic Survey				
Major Cross Road Topo-Survey North	No	8	8	100%
Historical Building Survey				
Historical Building Survey	LS	1	1	80%
Topographic Survey for DD study				
Topo Mapping, Longitudinal and Cross Section	LS	1	1	20%

Source: JICA Design Team

(3) Relocation Survey Objectives

- To identify the Philippine National Railway (PNR) right-of-way (ROW) based from existing documents – land titles, cadastral maps, etc.
- To locate and establish boundary monuments on ground for the PNR ROW
- To generate a relocation plan for the PNR ROW

1) Project Area

Malolos-Clark Railway (MCRP)

1. Malolos ~ SM Clark : 45km

Table 4.2.46 MCRP Project Area

Bulacan	Pampanga
Malolos	San Fernando
Calumpit	Angeles*
	Sto. Tomas
	Apalit
	Minalin

Source: JICA Design Team

2) Work Schedule

Table 4.2.47 Relocation Survey Progress Schedule

Activity	Weight	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15	W16	W17	W18	W19	W20	W21	W22	W23	W24	Progress
Research of land titles, maps and plans	20%																									
Accomplishment								100%																		20%
Preparation of base maps	10%																									
Accomplishment													100%													10%
Mobilization of Survey Party																										
Coordination Meetings	10%																									
Accomplishment											100%															10%
Field Surveys																										
MCRP																										
Reconnaissance and referenceing	5%																									
Accomplishment													100%													5%
Relocation Survey	15%																									
Accomplishment															100%											15%
Monumenting	5%																									
Accomplishment																(MCRP - 19/45.5km) 40%										2%

Legend: : Accomplishment : Plan

Source: JICA Design Team

3) Research

- Identification of affected parcels along the existing railway
- Data gathering for parcel information from cadastral maps, tax maps, tax declarations, lot data computations, and so on
- Sources of information:
  - Land Management Bureau (LMB)
  - Land Registration Authority (LRA)
  - Department of Environment and Natural Resources (DENR)

- Registry of Deeds (RD)
- Local Government Units (LGU)

4) Survey Activities

1. Determination of control points for reference using previously established Ground Control Points (GCPs) and other existing reference points
2. Establishment of control points using static GPS
3. Parcellary survey of properties using Real-Time Kinematic (RTK) GPS stationed on determined corners of the parcels
    - For areas with intermittent signal, Total Station will be utilized for boundary determination
4. Monumenting of determined corners for property boundaries
    - Establishment of monuments for every parcel corner
    - For longer boundaries, intermediate monuments are to be established at 100-meter intervals

5) Data Processing/Analysis and Plan Preparation

- Data processing of research-based information
    1. Georeferencing of plans and maps
    2. Digitization/plotting of parcel boundary and corresponding details
        - Property identification
        - Lot number
        - Adjacent boundaries
        - Owner name
        - Available references
- Data processing of field-based information
    1. RTK-GPS data processing and plotting of determined lot corners
    2. Land data matrix
    3. Report generation
- Consolidation of processed data based on existing plans and documents and of field-based data
- Documentation of references
- Quality assessment and quality control – comparison analysis should there be differences between the processed datasets
- Generation of land data matrix and corresponding geodatabase
- Generation of plans and land information system containing all surveyed data

4.2.5 Hydrology

4.2.5.1 Introduction

(1) Objectives of the Hydrologic and Hydraulic Analysis

This report will cover the design of the drainage system and the influence of the piers on the river-water elevation and the riverbed erosion around the piers for the proposed alignment of the Malolos – Clark Railway Project.

The objective of this design is to minimize the adverse impact of the project by safely conveying runoff from the rail to the identified discharge points and introducing applicable improvements to rivers affected by the alignment.

(2) Scope and Limitations

The scope and limitations of the hydrologic and hydraulic analysis will be defined or determined after gathering data and information, maps and reports relevant to the analysis.

The study rage is as follows;

- Hydraulic analysis in rivers
  - The influence of the piers on the river water elevation
  - The erosion analysis of the riverbed around the piers
- Drainage system
  - Design conditions
  - Drainage planning and design of elevated and station sections
  - Drainage planning and design of embankment
  - Drainage planning and design of vehicle base

4.2.5.2 Data Collection

Table 4.2.48 is the list of the data collection and the source about the hydrologic and hydraulic data.

Table 4.2.48 Required Data for Hydrologic and Hydraulic Analysis

No.	Object	Collected data	Purpose
1	General	Design Criteria	JICA Design Team, DPWH etc.
2	Rainfall Intensity	Rainfall Intensity	PAGASA
		Climate change condition	PAGASA
3	Catchment area	Topographic map and satellite photograph	NAMRIA
		Existing drainage facilities ,planned facilities	Local government, DPWH, MMDA
4	Rainfall outflow	Drainage area, land use, rain intensity	NAMRIA
5	Design flood level	Flood hazard map, Flood level record	DPWH, PAGASA
6	Flooding analysis	Topography, hydrological survey	JICA Design Team
7	Drainage design	Destination condition	Local government, JICA Design Team

Source: JICA Design Team

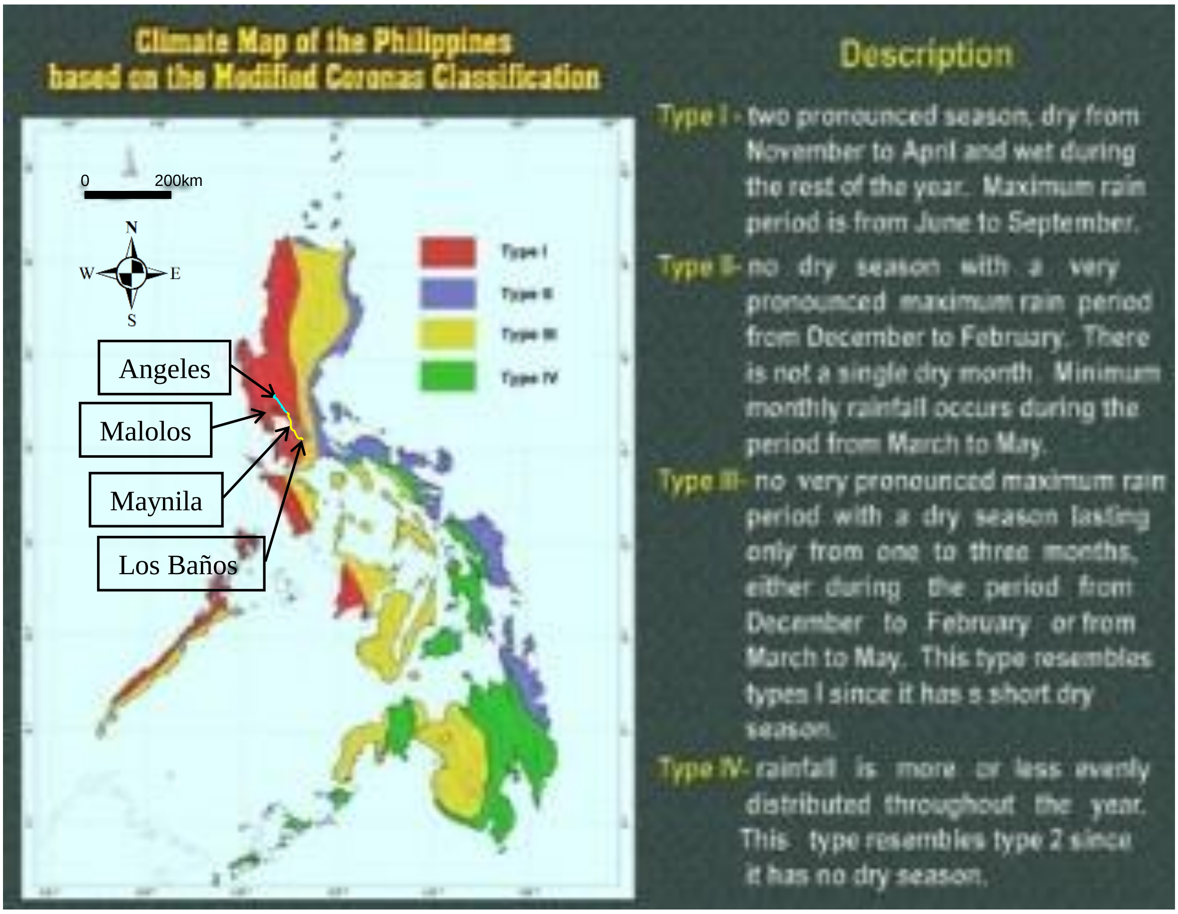
4.2.5.3 Existing Conditions

(1) Climatology

PAGASA characterizes the climate in the Philippines in terms of temperature, humidity and rainfall as shown in Figure 4.2.121.

The project site is located in a Type 1 climate, wherein there are “two pronounced seasons, dry from November to April and wet during the year and maximum rain period is from June to September” as stated in the Climate Map.

Although it is generally rainy season from May to November, rain and storms are also known to occur frequently in December and January. Summer starts in April (extreme heat) and ends in May (extreme heat and humidity). In order to prevent the floods due to the rainy season from affecting stations and users, we should collect data such as hazard maps by NOAH and consider the flood level along the railroad tracks.



Source: PAGASA

Figure 4.2.121 Climate Map of the Philippines

(2) Existing Topography

Initial 1:50,000 (metric) topographic maps were obtained from the National Mapping and Resource

Information Agency (NAMRIA).

The project area and alignment is located on relatively flat slopes. A more accurate description will be available once detailed topographic survey has been completed.

The topographic maps from NAMRIA are used to delineate watershed areas for the streams and rivers traversing the project alignment.

The following topographic maps have been obtained and will be used to support the hydrological analysis:

- 3031-I O'Donnell
- 3031-IIMountPinatubo
- 3130-I Malolos City
- 3130-IVGuagua
- 3131-IIIAngelesCity
- 3131-IV Tarlac City
- 3229 -III CALAMBA
- 3229-IV Muntinlupa City
- 3230-III Quezon City
- 7172 II Manila
- 7271-II San Pablo

(3) Existing Drainage Facilities

Onsite inspections reveal that certain sections of the alignment have earth ditches that run through the northbound and southbound edge of the ROW. Nearby road drainage structures such as RCBCs, covered ditches and RCPC are also accessible as discharge points.

The existing drainage facilities can be comprehensively analyzed as the updated topographic surveys are received.

(4) Location and Tapping points

River crossings are considered as discharge points. Additional discharge points of the drainage system will be identified once the topographic surveys have been completed and received

(5) Existing and Proposed River Improvement Projects

River improvement plans executed by the DPWH on the Malolos – Clark Railway Project alignment were proposed and listed below:

Rehabilitation/Improvement slope protection works along Sapang Balen, Panipuan section, city of San Fernando Pampanga

4.2.5.4 Design Criteria

The reference document for identifying design flood frequencies in the Philippines is the DPWH Design Guidelines Criteria and Standards Volume 4 (DGCS Vol. 4). This document does not specifically outline criteria for railways, however, if the Malolos – Clark Railway Project is considered as equivalent to an "Expressway", then the design flood frequencies as outlined in the following sections for "Expressway" will apply to the culverts, ditches and inlets for the embankments and viaducts of the Malolos – Clark Railway Project.

The drainage system of the stations is considered a minor system while the drainage system of Depot (due to its large area) is considered a major system.

Table 4.4.3 will be applied for the drainage pipes, culverts and drainage channels. This may also include the detention pond or basin.

The design frequency to be used in drainage design are the enumerated below.

The design requirements for drainage structures located on major transport link, shall be as shown in Table 4.2.49.

Table 4.2.49 Design Flood Frequency for Roads (DGCS 2015, Volume 4, pg. 5-8)

Road Classification	Culverts		Roadside Ditches & Inlets		Median Ditches & Inlets		Curb Drop Inlets	
	Design Flood	Check Flood	Design Flood	Check Flood	Design Flood	Check Flood	Design Flood	Check Flood
Expressway	50 yr	100 yr	25 yr	50 yr	25 yr	50 yr	25 yr	50 yr
National Road	25 yr	50 yr	10 yr	25 yr	10 yr	25 yr	10 yr	25 yr
Other Roads	20 yr	50 yr	5 yr	10 yr	5 yr	10 yr	5 yr	10 yr

Source: JICA Design Team

The design requirements for drainage structures not located on major transport link, shall be as shown in Table 4.2.50.

Table 4.2.50 Minimum Capacity of Drainage Infrastructure (DGCS 2015, Volume 3, pg. 6-2)

Land-use (Note 1)	Minor System		Major Drainage System Drainage Capacity (note 2)
	Design Capacity	Check Capacity	
Drainage Pipes	15 year flood	25 year flood	100 year flood
Culverts (Note 1)	25 year flood	50 year flood	
Esteros/creeks/drainage channels	15 year flood	25 year flood	

Note 1: Refer to Volume 4 for highway cross drainage structure capacities

Note 2: Freeboard for buildings are detailed in Volume 6: Public Buildings and Other Related Structures

Source: JICA Design Team

For the bridges of the rivers in which piers are constructed on this projects, Table 4.2.51 shall apply.

Design requirements for drainage structures relating to bridges shall also follow the parameters shown in Table 4.2.51.

Table 4.2.51 Design Flood Frequency for Bridges (DGCS 2015, Volume 5, pg. 3-6)

Road Classification	River				Bridge Drainage	
	Structure		Hydraulic Scour			
	Design Flood	Check Flood	Design Flood	Check Flood	Design Flood	Check Flood
Expressway	100 yr	200 yr	*100 yr	*500 yr	25 yr	50 yr
National Road	50 yr	100 yr	*100 yr	*500 yr	10 yr	25 yr
Other Roads	25 yr	50 yr	50 yr	100 yr	5 yr	10 yr

* or from an overtopping flood of lesser recurrence level, whichever is the more severe based on AASHTOLRFD 2012 Sec 2.6.4.4.2 Bridge Scour

Source: JICA Design Team

4.2.5.5 Design approach

(1) Planned rainwater volume

We collect the latest rainfall data from the rain station from PAGASA. Basically follow the design standards created at NSCR. As shown in the DPWH Design Guidelines In Vol.4, we will verify the falling ability by the calculation of open channel.

(2) Wastewater gradient

For the structure drainage slope, a slope of 2.5% was set in NSCR. In this study, we will verify the flow rate and falling ability in catchment area using latest rainfall data.

1) Drainage planning and design of elevated and station sections

Basically follow the design standards created at NSCR. We plan to consider as soon as the shape of the elevated and embankment area is decided.

2) Drainage planning and design of embankment

Basically follow the design standards created at NSCR.

Collect the rainwater from the orbital side groove and discharge it to a river or the like by a vertical drain pipe via a catchment basin.

3) Drainage planning and design of vehicle base

Basically follow the design standards created at NSCR. It is decided by consultation with stakeholders.

4) Rivers and Stream Crossings

Revetments or river bank protection and river bed protection will be provided at rivers and stream crossings whenever necessary. Bridge abutments and bridge pier foundation may also be provided protection, if warranted. Grouted riprap, gabion wall, gabion mattress or sheet pile will be used for protection, depending on the site conditions (river characteristics, bed and bank material among others), tidal effects and bridge design configuration.

4.2.5.6 Hydrologic analysis

(1) Rainfall Intensity

The rainfall intensity for the entire alignment is obtained from PAGASA Synoptic Stations. The rainfall intensity – duration – frequency (RIDF) applicable to the Malolos – Clark Railway Project are 3 stations (CRUZ, RITA, and APALIT,), as provided in Table 4.2.53. However, since the APALIT station has the highest RIDF of the Malolos – Clark Railway Project, this will be used for the whole Malolos – Clark Railway Project for uniformity of calculations and to provide a greater factor of safety.

The RIDF data of the APALIT station contains 43 years of rainfall data. As for the rain intensity formula, we adopt a Sherman type rainfall intensity formula as shown in the following equation.

$$I = \frac{a}{T_c^b}$$

Where, I = rainfall intensity [mm/hr], Tc= time of concentration [minutes], and the constant a and exponent b are parameters determined from regression analysis. The Sherman equation for the short-duration (less than 150 minutes) and long-duration (greater than 150 minutes) of RIDF is shown in Table 4.2.52.

Table 4.2.52 Sherman Equation for Short Duration and Long Duration of RIDF

Return Period	100yr	50yr	25yr	20yr	15yr	10yr
t < 150 min						
COEFF[a]	903.85	829.02	755.40	731.82	700.75	657.72
EXP[n]	0.441	0.447	0.454	0.456	0.460	0.467
t > 150 min						
COEFF[a]	3714.63	3340.19	2967.78	2845.62	2684.99	2464.46
EXP[n]	0.710	0.712	0.715	0.716	0.717	0.720

Source: JICA Design Team

An applicable return period will be used for the design of the different components of the drainage system.

Table 4.2.53 RIDF APALIT (PAGASA)

Republic of the Philippines
Department of Science and Technology
PHILIPPINE ATMOSPHERIC, GEOPHYSICAL AND ASTRONOMICAL SERVICES ADMINISTRATION (PAGASA)
FLOOD FORECASTING BRANCH
WFFC, BIR Road, Quezon City 1100 Tel. No. 928-27-54/926-50-60 Fax. 929-40-65
Webpage: http://pagasa.dost.gov.ph

RAINFALL INTENSITY - DURATION FREQUENCY ANALYSIS DATA

for

CANSINALA, APALIT , PAMPANGA

Based on 28 years of record

COMPUTED EXTREME (in mm) OF PRECIPITATION

Return Period (yrs)	5 mins	10 mins	15 mins	20 mins	30 mins	45 mins	60 mins	80 mins	100 mins	120 mins	150 mins	3 hrs	6 hrs	12 hrs	24 hrs
2	11.7	17.4	21.7	25.5	32.0	38.2	42.6	48.4	52.8	56.6	61.3	64.8	86.3	109.6	138.6
5	16.1	23.3	28.7	33.8	41.5	49.9	55.7	64.0	71.0	76.8	85.3	92.5	122.7	165.2	207.9
10	19.1	27.2	33.4	39.3	47.8	57.7	64.4	74.3	83.0	90.2	101.2	110.8	146.9	202.0	253.7
15	20.7	29.3	36.0	42.4	51.3	62.0	69.3	80.1	89.8	97.7	110.1	121.1	160.5	222.8	279.6
20	21.9	30.9	37.8	44.6	53.8	65.1	72.7	84.2	94.6	103.0	116.4	128.3	170.1	237.3	297.7
25	22.8	32.1	39.3	46.3	55.7	67.5	75.3	87.3	98.2	107.1	121.2	133.9	177.4	248.5	311.6
50	25.5	35.7	43.6	51.4	61.6	74.7	83.5	97.0	109.5	119.6	136.1	151.1	200.1	283.0	354.6
100	28.2	39.3	48.0	56.5	67.5	81.9	91.6	106.6	120.7	132.1	150.9	168.1	222.5	317.3	397.2

EQUIVALENT AVERAGE INTENSITY (in mm/hr) OF COMPUTED EXTREME VALUES

Return Period (yrs)	5 mins	10 mins	15 mins	20 mins	30 mins	45 mins	60 mins	80 mins	100 mins	120 mins	150 mins	3 hrs	6 hrs	12 hrs	24 hrs
2	140.4	104.4	86.8	76.5	64.0	50.9	42.6	36.3	31.7	28.3	24.5	21.6	14.4	9.1	5.8
5	193.2	139.8	114.8	101.4	83.0	66.5	55.7	48.0	42.6	38.4	34.1	30.8	20.5	13.8	8.7
10	229.2	163.2	133.6	117.9	95.6	76.9	64.4	55.7	49.8	45.1	40.5	36.9	24.5	16.8	10.6
15	248.4	175.8	144.0	127.2	102.6	82.7	69.3	60.1	53.9	48.9	44.0	40.4	26.8	18.6	11.7
20	262.8	185.4	151.2	133.8	107.6	86.8	72.7	63.2	56.8	51.5	46.6	42.8	28.4	19.8	12.4
25	273.6	192.6	157.2	138.9	111.4	90.0	75.3	65.5	58.9	53.6	48.5	44.6	29.6	20.7	13.0
50	306.0	214.2	174.4	154.2	123.2	99.6	83.5	72.8	65.7	59.8	54.4	50.4	33.4	23.6	14.8
100	338.4	235.8	192.0	169.5	135.0	109.2	91.6	80.0	72.4	66.1	60.4	56.0	37.1	26.4	16.6

prepared by:
the HYDROMETEOROLOGICAL DATA APPLICATIONS SECTION (HMDAS)
Hydro-Meteorology Division, PAGASA

requested by: Simon S. Dabu/ JICA Study Team
Date: 26 February 2018

Source: JICA Design Team

(2) Rational Formula

Roadway drainage is calculated using the Rational Method wherein a coefficient of runoff *c* is defined. This coefficient is dependent on the ground cover of the tributary area. The DGCS Vol. 4 provides the following formula to be used.

$$Q = \frac{cIA}{3.6}$$

Where, Q=rate of runoff (m^3/s), c=Coefficient of runoff, I=rainfall intensity (mm/hr), A=catchment area (square kilometers).

The Rational Method is considered applicable for rural catchments less than 20 km^2 and for urban catchments less than 5 km^2 (Section 3.4.1.1, DGCS Vol. 4).

(3) Flood Peak Analysis of Rivers and Streams Using HEC-HMS

The US Army Corps of Engineers' Hydrologic Engineering Center – Hydrologic Modeling System (HEC-HMS) will be applied for peak flood analysis of the rivers in which piers are constructed on this projects. Section 3.5.2 of DCGS Vol.4 provides a brief discussion of HEC-HMS. For this study, it is initially contemplated that the SCS Unit Hydrograph (UH) and the SCS Curve Number (CN) methods will be used in the initial loss computation and the rainfall-runoff transformation, respectively. The Muskingum method will be used in the flood routing along the river channels.

The CN of a basin or sub-basin is obtained from tables published in Technical Report 55 (SCS, 1986) and provided in Section 1.5.2. Depending on the land use, soil type and the antecedent moisture condition, the CN is read from the table. A weighted CN is determined if there is more than one land use and soil type in the basin. CN value ranges from 30 (permeable soils with high infiltration) to 100 (water bodies). The maximum retention, S, is calculated as

$$S = (25400 - 254 * CN) / CN$$

The initial loss or abstraction in the watershed, Ia, is given by the equation

$$Ia = 0.2 * S$$

The % impervious area in the basin will be determined from the updated land use maps, satellite imagery and data from the field reconnaissance and inventory that will be conducted.

The SCS Unit Hydrograph (UH) method uses a dimensionless, single-peaked UH unit hydrograph where the UH peak, UP, and the time to peak, TP, are related by the equation

$$UP = 2.08 * A / TP$$

where, A = watershed area in sq. km. The TP is calculated as

$$TP = \frac{1}{2} \Delta t + t_{lag}$$

where, t is the specified computational time for the model and t_{lag} in hours is determined from the empirical equation

$$t_{lag} = 0.6\ tc$$

The Muskingum method is suitable for channels with small slopes, so the general mass conservation equation is given as

$$S_t = K[XI_t + (1 - X)O_t]$$

where, K = travel time of the flood wave through each reach and X = dimensionless weight (0 < X <0.5).

4.2.5.7 Hydraulic analysis

(1) Flow Capacity of Open Channel, Reinforced Concrete Pipe and RCBC

Manning's Formula is a general equation for uniform flow in open channels and it will be used to size the drainage structures. The formula is empirical and hydraulics. And then, this formula is dependent on slope and the Manning's coefficient of roughness 'n'. The flow capacity of U-Ditch open channels is outlined in Table 4.2.54.

Table 4.2.54 Flow Capacity of U-Ditch Open Channels

Size	Depth	Roughness coefficient	Slope	Velocity	Volume	Froude number
	(m)		%	(m/s)	(m^3/s)	
0.45 x 0.50	0.4	0.013	0.10	0.67	0.12	0.34
	0.4	0.013	0.50	1.49	0.27	0.75
	0.4	0.013	1.00	2.11	0.38	1.07
	0.4	0.013	2.00	2.99	0.54	1.51
0.40 x 0.60	0.5	0.013	0.10	0.66	0.13	0.3
	0.5	0.013	0.50	1.49	0.3	0.67
	0.5	0.013	1.00	2.1	0.42	0.95
	0.5	0.013	2.00	2.97	0.59	1.34
0.60 x 0.60	0.5	0.013	0.10	0.8	0.24	0.36
	0.5	0.013	0.50	1.78	0.53	0.8
	0.5	0.013	1.00	2.52	0.76	1.14
	0.5	0.013	2.00	3.56	1.07	1.61
0.8 x 0.80	0.7	0.013	0.10	0.98	0.55	0.37
	0.7	0.013	0.50	2.18	1.22	0.83
	0.7	0.013	1.00	3.09	1.73	1.18
	0.7	0.013	2.00	4.37	2.45	1.67

Source: JICA Design Team

The falling capacity of a typical box culvert is organized as follows.

Table 4.2.55　Flow Capacity of RCBC

Size	Depth	Roughness coefficient	Slope	Velocity	Volume	Froude number
	(m)		%	(m/s)	(m^3/s)	
1.0x 1.0	0.9	0.013	0.10	1.14	1.03	0.38
	0.9	0.013	0.50	2.55	2.3	0.86
	0.9	0.013	1.00	3.61	3.25	1.21
	0.9	0.013	2.00	5.1	4.59	1.72

Source: JICA Design Team

The falling capacity of a reinforced concrete pipe is organized as follows.

Table 4.2.56　Flow Capacity of Reinforced Concrete Pipe

Size	Depth	Roughness coefficient	Slope	Velocity	Volume	Froude number
	(m)		%	(m/s)	(m^3/s)	
910mmø	0.8	0.013	0.10	1.03	0.62	0.32
	0.8	0.013	0.50	2.29	1.39	0.72
	0.8	0.013	1.00	3.24	1.96	1.02

Source: JICA Design Team

(2)　Flood Analysis Using HEC-RAS

Flood simulation and inundation analysis of the rivers in which piers are constructed on this projects will be undertaken using the Hydrologic Engineering Center – River Analysis System (HEC-RAS) developed by the USACE. The design peak floods calculated for each basin using the HEC-HMS will be the input flood to HEC-RAS.

The one-dimensional (1D) HEC-RAS version 4.1 performs steady (gradually- or rapidly-varied) flow and unsteady flow simulations on river channels and adjacent flood plains. The computation for steady flow condition is done using the standard step method. The computation for unsteady state flow condition is done using an implicit finite difference scheme procedure to solve the continuity and momentum partial differential equations.

The Manning's equation is used in the computation of conveyance in the channel and overbank areas. The main channel conveyance is usually taken as one conveyance element but the left and right overbank can have one or more subdivisions for conveyance computation. The total conveyance at a cross-section is the sum of the main channel conveyance and all conveyances of the overbank subdivisions.

The general Manning's equation is given as:

$$Q = \sum_{i=1}^{n} \left(\frac{1}{n} A R^{2/3} \right)_i S_f^{1/2}$$

Where, n = Manning's roughness coefficient, $R = A/P$ = hydraulic radius in m, A = cross-sectional area in m^2, P = wetted perimeter in m for each subdivision i and S_f is the representative friction slope.

Manning's n values for natural river channels, flood plains and man-made channels and ditches are given in Table 4.2.57 to Table 4.2.59 (Tables 4-2, 4-3 and 4-4, respectively, in Section 4.5.2.1 DCGS Vol. 4).

Table 4.2.57 Range of Values of Manning's 'n' for Natural Channels

Description	Minimum	Maximum
Fairly Regular Section		
1. Some grass & weeds, little or no bush	0.028	0.033
2. Dense growth of weeds, flow depth greater weed height	0.033	0.040
3. Some weeds, light bush on banks	0.035	0.050
4. Some weeds, heavy bush on banks	0.050	0.070
5. Some weeds, dense trees	0.060	0.080
For trees within channel, with branches submerged at high flood increase above values by	0.010	0.020
6. Winding, some pools & shoals, clean (1.)	0.035	0.045
7. Winding, some pools & shoals, clean, lower stages, more ineffective sections	0.045	0.055
8. Winding, some pools & shoals, clean, some weeds & stones (3.)	0.040	0.050
9. Winding, some pools & shoals, clean, lower stages, more ineffective sections, stony sections	0.050	0.060
10. Sluggish river reaches, rather weedy or with deep pools (4.)	0.060	0.080
11. Very weedy reaches (5.)	0.100	0.150
Irregular sections, with pools, slight meander; increase above values by about	0.010	0.020
Mountain streams, no vegetation in channel, bank steep, tree & brushes along banks submerged at high flood		
1. Bottom of gravel, cobbles & few boulders	0.040	0.050
2. Bottom of cobbles, with large boulders	0.050	0.070
Large Stream Channels (top width > 30m) Reduce smaller stream coefficients by 0.10		

Source: JICA Design Team

Table 4.2.58 Range of Values of Manning's 'n' for Floodplains

Description	Minimum	Maximum
1. Pasture, short grass, no brush	0.030	0.035
2. Pasture, tall grass, no brush	0.035	0.050
3. Cultivated land-no crop	0.030	0.040
4. Cultivated land, nature field crops	0.045	0.055
5. Scrub & scattered brush	0.050	0.070
6. Wooded	0.120	0.160

Source: JICA Design Team

Table 4.2.59 Range of Values of Manning's 'n' for Man-made Channels and Ditches

Description	Minimum	Maximum
1. Earth, straight & uniform	0.020	0.025
2. Earth bottom, rubble sides/riprap	0.030	0.035
3. Grass covered	0.035	0.050
4. Dredged	0.028	0.033
5. Stone lined & rock cuts, smooth & uniform	0.030	0.035
6. Stone lined & rock cuts, rough & irregular	0.040	0.045
7. Lined – smooth concrete	0.014	0.018
8. Lined – grouted riprap	0.020	0.030
9. Winding sluggish canals	0.025	0.030
10. Canals with rough stony beds, weeds on earth banks	0.030	0.040

Source: JICA Design Team

(3) Erosion Analysis Using HEC-RAS

The HEC-RAS is also used for erosion (scour) analysis of the river bed and river banks in the vicinity of bridge piers and bridge abutments. The erosion analysis will determine whether river bed and bank scour protection will be necessary.

The equations for the computation of contraction scour (live bed and clear water) and local scour (pier scour and abutment scour) for bridges, scour at bends and other scour conditions on different structures in a river channel are discussed in detail in Annex A Estimating Scour of the DCGS Vol 4.

4.2.5.8 Results and recommendations

As detailed drainage plans are developed, the results of the analysis and related recommendations will be developed ad presented. This section will be updated as detailed drainage plans are prepared.

4.2.5.9 Drainage tables

This section will be updated as detailed drainage plans are prepared.

4.2.5.10 Assessment of Flood Risk

(1) Analysis of Flood Risks – Malolos-CIA-NCC (MCRP) Corridor

The Malolos-Clark-NCC Railway Project – The alignment passes through low lying areas of Bulacan and Pampanga provinces and these areas are known to seasonal flooding area. The area between Malolos, Calumpit and Apalit was given due consideration for the impact of seasonal flooding. Therefore, the vertical alignment is designed in consideration of flood height and future crossing roads rising improvement over the flood height in future as much as possible, because the area roads get hit by floods frequently.

The maximum flood height on the alignment can be applied for results of based on interview survey of local residents and flood height indicated in the Project NOAH (National Operational Assessment of Hazards) flood risk map, respectively.

The flood risk map is made to conduct the numerical simulation with momentum and continuity equations under the simulation conditions as follows;

- Initial conditions: Uses LIDAR DEM acquired in 12-15 February 2013 (1m resolution) and coefficient of roughness based on DPWH guideline volume3.
- Boundary conditions: Inputs rainfall (1/5, 1/25 and 1/100 return period, respectively)

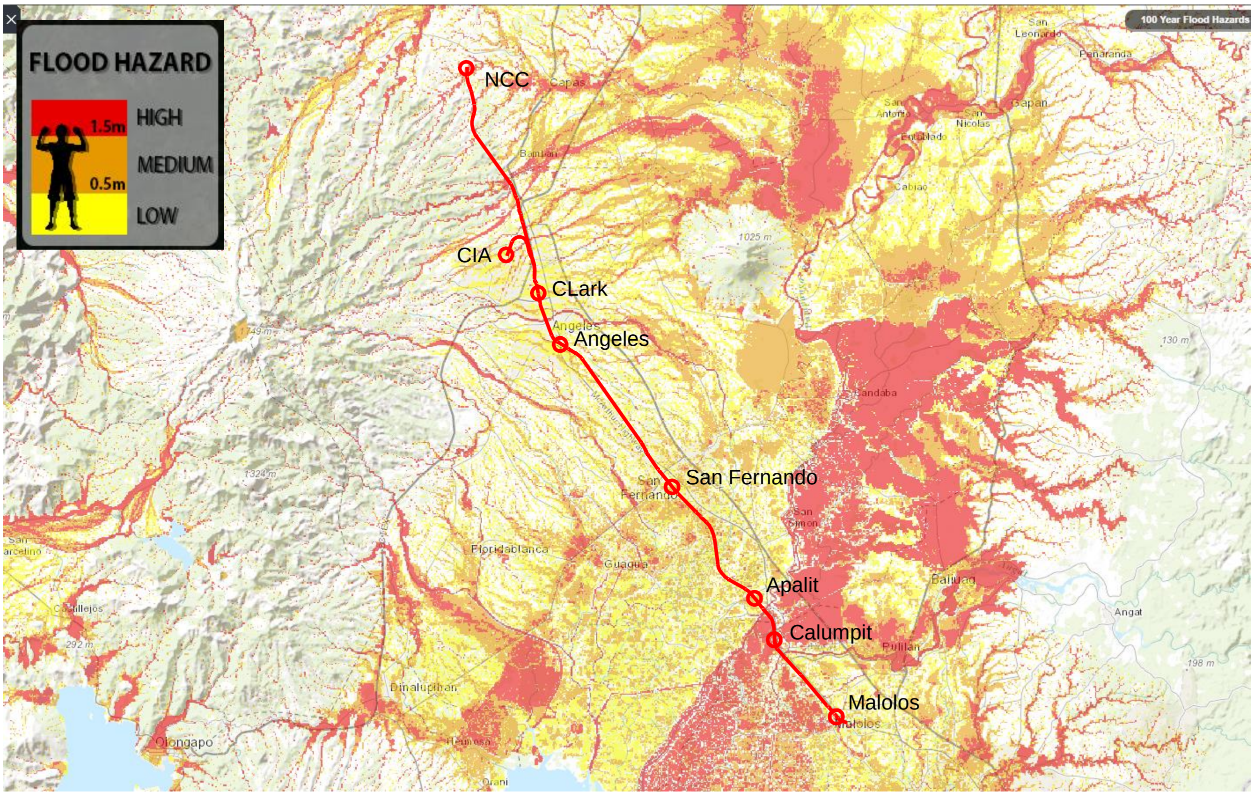


Figure 4.2.122 Flood Risk Map (100-year return period)

The recommended design flood height is adopted higher data by the comparing interview data and NOAH data as shown in Table 4.2.59. The letter "-" in Table 4.2.59 means that any local residents does not live around the point.

Table 4.2.60 Estimated Flood Height

CITY / MUNICIPALITY	STATION	NAME OF ROAD			
			Interview	NOAH (m)	Design Flood Height (m)
MALOLOS CITY	35+130	SAMPAGUITA STREET	0.0	0.0	0.0
	36+118	ROYAL ESTATE ROAD	0.0	0.0	0.0
	36+890	MANALAYSAY BUILDERS STREET	0.0	0.0	0.0
	37+195	LONGOS BARANGAY ROAD	0.0	0.0	0.0
	37+650	MC ARTHUR VILLAGE ROAD	0.0	0.0 - 0.5	0.5
CALUMPIT	38+035	GREEN PLAINS SUBDIVISION ROAD	0.0	0.0 - 0.5	0.5
	38+930	PIO CRUZCOZA STREET (PUROK 5)	0.2	0.0	0.2
	39+206	Road(UNKNOWN)	0.0	0.0	0.0
	39+663	PIO CRUZCOZA (SITIO BORNEO)	0.2	0.0	0.2
	39+840	CALUMPANG-LONGOS ROAD	0.0	0.0	0.0
	39+915	SAN MARCOS BARANGAY ROAD	0.0	0.0	0.0
	40+282	Road(UNKNOWN)	-0.2	0.0	0.0
	40+635	HANGGA ROAD	0.0	0.0	0.0
	40+834	HOLCIM STREET	0.0	0.0	0.0
	40+850	IBA ESTE STREET	1.3	0.5 - 1.5	1.5
	41+025	IBA O'ESTE STREET	-0.2	0.0	0.0
	41+186	HAZEL STREET	-0.7	0.5 - 1.5	1.5
	41+710	COLEGIO DE CALUMPIT ROAD	1.5	0.0	1.5
	42+440	P. VILLENA STREET	0.6	1.5 above	1.5
	42+688	PROVINCIAL ROAD	1.7	0.5 - 1.5	1.7
	43+107	S. LOPEZ STREET	0.0	0.0	0.0
	43+310	GATBUCA BARANGAY ROAD	1.5	0.0	1.5
	43+415	Road(UNKNOWN)	2.0	0.5 - 1.5	2.0
	43+775	Road(UNKNOWN)	1.0	1.5 above	1.5
	43+895	Road(UNKNOWN)	1.5	1.5 above	1.5
APALIT	44+345	DALAN BAKA ROAD	1.3	1.5 above	1.5
	44+865	SULIPAN ROAD	0.2	0.0	0.2
	45+215	MACABEBE-CALUMPIT-APALIT ROAD	1.6	0.0	1.6
	46+725	APALIT-MACABEBE-MASANTOL ROAD	1.5	0.0	1.5
MINALIN	49+235	STA. MARIA ROAD	1.0	0.0	1.0
STO. TOMAS	54+920	P. GOMEZ / OSMEÑA STREET	1.2	0.0	1.2
	54+970	MAGSAYSAY ROAD	0.5	0.0	0.5
	55+171	ROAD(UNKNOWN)	1.5	0.5 - 1.5	1.5
	55+825	BALUT STREET	1.5	0.5 - 1.5	1.5
SAN FERNANDO	56+209	SAN PEDRO ROAD	1.2	0.0 - 0.5	1.2
	57+625	ROSAL STREET	0.5	0.0	0.5
	57+738	STA. LUCIA PUROK 12	0.7	0.0 - 0.5	0.7
	57+804	STA. LUCIA PUROK 6	0.7	0.0 - 0.5	0.7
	57+920	SANTO NIÑO VIEJO ROAD	0.2	0.5 - 1.5	1.5
	58+215	CAPITOL BOULEVARD	0.5	0.5 - 1.5	1.5
	58+548	LAPU LAPU STREET	0.0	0.0 - 0.5	0.5

CITY / MUNICIPALITY	STATION	NAME OF ROAD			
			Interview	NOAH (m)	Design Flood Height (m)
	59+410	MACABACLE STREET	0.0	0.0	0.0
	59+775	JOSE ABAD SANTOS AVENUE	0.7	0.0	0.7
	60+005	DE LEON STREET	0.0	0.0	0.0
	60+218	SANTAN STREET	0.0	0.0 - 0.5	0.5
	60+380	ROSAL STREET	0.0	0.0	0.0
	60+603	Road(UNKNOWN)	0.0	0.0	0.0
	61+005	MC ARTHUR HIGHWAY (MANILA NORTH ROAD)	0.0	0.0 - 0.5	0.5
	61+361	DON RAMON AVENUE	0.2	0.0 - 0.5	0.5
	61+537	BARANGAY SAN AGUSTIN ROAD	0.4	0.0 - 0.5	0.5
	62+640	BARANGAY SAN VICENTE QUEBIAWAN ROAD	0.0	0.0	0.0
	63+022	SAN MIGUEL AVENUE I	0.3	0.0	0.3
	63+075	SAN MIGUEL AVENUE II	0.3	0.0 - 0.5	0.5
	63+969	JAO MAPA STREET	0.0	0.0	0.0
	64+432	SUBURBIAN ROAD	0.0	0.0	0.0
	64+452	PUROK I ROAD	0.0	0.0	0.0
	64+968	SARION-MALPITIC ROAD	-	0.0	0.0
	65+500	SINDALAN BYPASS ROAD	0.8	0.0 - 0.5	0.8
	66+205	VILLA BARCELONA ROAD	1.0	0.0	1.0
	66+830	TAGUMPAY STREET	0.5	0.0	0.5
	69+547	BALITI ROAD	0.0	0.0	0.0
	71+375	ITALIAN ROAD	0.0	0.0	0.0
	71+959	ROXAS STREET	0.0	0.0 - 0.5	0.5
	72+200	DOVE STREET	0.0	0.0	0.0
	72+345	N. AQUINO STREET	0.0	0.0	0.0
	72+515	NARCISO DRIVE	0.0	0.0	0.0
ANGELES	72+756	PABLO TORRES STREET	0.0	0.0 - 0.5	0.5
	74+005	MC ARTHUR HIGHWAY (MANILA NORTH ROAD)	0.0	0.0	0.0
	74+206	M. CAÑO STREET	0.0	0.5 - 1.5	1.5
	74+516	SANTO ENTIERO STREET	0.0	0.0 - 0.5	0.5
	74+820	PLARIDEL STREET	0.0	0.0	0.0
	75+105	LIMASAWA STREET	0.0	0.0	0.0
	75+487	P. DE GUZMAN STREET	0.0	0.0 - 0.5	0.5
	75+630	HENSON / JAKE GONZALES BOULEVARD	0.0	0.0	0.0
	76+027	ARAYAT ROAD	0.0	0.0	0.0
	76+676	MALABANIAS ROAD	0.0	0.0 - 0.5	0.5
	77+001	GALURA I STREET	0.0	0.5 - 1.5	1.5
	77+050	GALURA II STREET	0.0	0.5 - 1.5	1.5
	77+778	FIELDS AVENUE	0.0	0.0	0.0
	77+845	MANUEL A. ROXAS HIGHWAY	0.0	0.0	0.0
	77+930	1ST STREET	0.0	0.0 - 0.5	0.5

4.3 E&M System

4.3.1 Outline

DOTr plans the commencement of MCRP from Malolos to CIA and starting an interoperable train operation with NSCR at May 2022. The inauguration of NSRP-South and the extension of MCRP from CIA to NC

C are planned after that. DOTr plans 3 types of train service in MCRP.

1) Commuter service
2) Commuter express service
3) Airport limited express service

Commuter and commuter express service are for daily commuter passengers. Commuter train stops every station and commuter express skips some stations to shorten travel time. Airport limited express service is designed for CIA airline passengers. This service is planned connecting CIA and the center of Manila within 1 hours.

Source: JICA Design Team

Figure 4.3.1 Line Image of MCRP, NSCR and NSRP-South

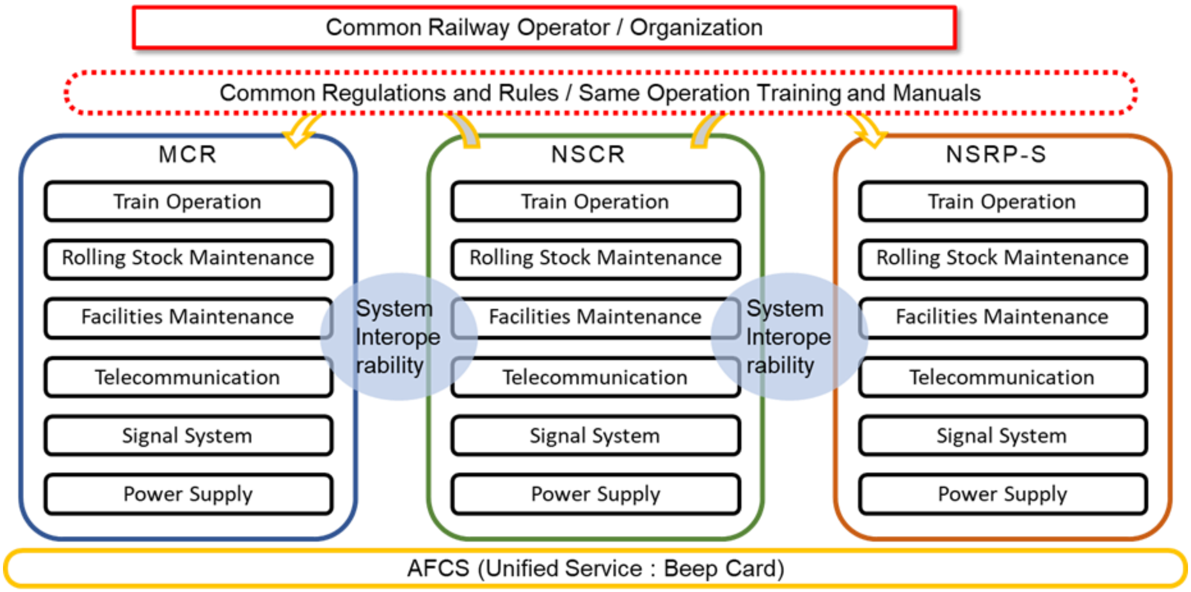
(1) Preconditions of MCRP E&M System

MCRP is planned as the extension line of NSCR (Malolos ~ Tutuban). The technical specifications and the basic performances of E&M system shall be compatible with NSCR for safe, stable and economical railway operation. From this view point, this project has some special preconditions for designing railway system and rolling stock.

1) Interoperability

The basic specifications of rolling stock and E&M system (gauge, axle weight, power supply system, signalling system, communication system, etc.) in each line shall be compatible for keeping a safe and stable train operation.

DOTr is planning to establish PRI (Philippine Railway Institute) for enacting common railway regulations and rules in the Philippines. PRI will issue driver' license and railway engineer certification also. DOTr plans to employ common railway operator for MCRP, NSCR and NSRP-South. Those DOTr policies help to achieve the safe and stable interoperability in MCRP and NSCR.



Source: JICA Design Team

Figure 4.3.2 Image of Common Railway Operator

2) Technical Standards and Technical Specifications

The railway system and rolling stock for MCRP are designed in accordance with the railway technology and related regulations in Japan for safe and reliable railway operation. The Technical Standards and Technical Specifications shall be defined for keeping a safe and stable train operation, and for manufacturing high quality and standardized railway system.

Table 4.3.1 Outline of Technical Standards and Technical Specifications

Contents		Related Standards
Technical Standards	• Minimum requirement for operating railway safe and stable. • Railway principals and guidance for the railway system considering the O&M and the interoperability	• Technical Regulatory Standards on Japanese Railways • Japanese Railway Industry Standards • Japanese Electro Technical Committee • International Electrotechnical Commission • International Organization for Standardization • Philippine Electrical Code etc.
Technical Specifications	• Basic parameters to design the railway system and the structures. • Proposing based on Technical Parameters • Using related Standards for determining parameters	
PDPS Work	• PDPS (particular Design Performance Specification) for Railway system with technical discussions and field studies considering Technical Standards and Technical Specifications.	

Source: JICA Design Team

3) Technical Parameters

In consideration of the interoperability and the common maintenance among MCRP and NSCR, the same technical parameters for railway system, including rolling stock, shall be applicable to all 3 lines. The main technical parameters such as rolling stock envelopment, power supply system and signalling system, and maintenance regulations shall be consistent among MCRP and NSCR. The following table shows the proposed main technical parameters subject to modification in the course of progress in this study work.

Table 4.3.2 Technical Parameters Regarding the Interoperability with NSCR

	ITEM	Technical Parameters of NSCR	
1	Train Operation	General	Trains drive on right hand side. One-man train driver operation.
2	Rolling Stock Design	General	Acceleration(Design):3.3km/h/s (Weighting 20t/car,1350V,0~30km/h Instantaneous acceleration) or more
		Gauge	1,435mm (Standard Gauge)
		Electric Power Supply	DC1,500V overhead catenary
		Capacity of Train	Calculated by 7person/m^2
		Rolling Stock Gauge	Refer to Detailed design
		Coupler	Leading car: tight lock coupler Intermediate car: semi-permanent coupler
		Body Structure	MAX:1,9500mm (Length)×2,950 mm (Width)×3,655 mm (Height)
			MAX Height 4,150mm, when pantograph is folded, 1,130～1,150 mm(Height of floor)
			Straight structure without hem aperture
			Maximum longitudinal compression force of rolling stock end is 490kN.
			Material used for the car body shall comply with the Japanese Ministerial Ordinance article 83
			Adopting front strengthened structure of the car, and Securing survival space of driver in case of an accident (common structure of Japanese commuter rolling
			Driver unit : right side
		Maximum Axle Weight	16t
		Door Layout	4 doors as commuter trains
		Standards	Technical Regulatory Standards on Japanese Railways, Japanese Industry Standards(JIS), Japanese Railway Industry Standards(JRIS), Japanese Electro
3	Rolling Stock Maintenance Facility	General	Common Design method
			Employing same designed maintenances facilities
			Basic way of Inspection and Repair for Rolling Stock
		Maintenance Category	Departure Inspection(Before departure),Daily Inspection (Within 6days),Monthly Inspection(Within 3 months :90days), Semi Overhaul(Within 4 years or Within
4	Signal system	General	CBTC
5	Power Supply System	General	Substation facilities comply with JIS, JEC etc. and NSCR specifications
		Voltage for Operation	1,500V
		Method of Receiving Electric Power	The same method of NSCR
6	Power Distribution System	General	Distribution facilities comply with JIS, JEC etc. and NSCR specifications
		Voltage of distribution Line	6.6kV
		Voltage of Supplying Loads	440V / 230V
7	Over Head Contact System	General	The OCS complies with JIS, JEC etc.
		Maximum Train Speed	160km/h
		Weather Conditions	Philippine's weather data
		Track gauge	Standard gauge (1,435mm)
8	Communication System	Common Backbone System	System: SDH or equivalent IP
			Speed: 1Gbpt to 10Gbps
			Redundancy: Duplicated Devices with STP
			Segment: Data & LAN, CCTV, PIS, PA, BMS, AFC
			Utilities: NMS, QoS
		Signal Backbone System	Necessary specification will be prepared based on an applicable signal system for CMR and NSCR-South.
		Radio System	Necessary specification will be prepared based on an applicable signal system for CMR and NSCR-South.
		Dispatcher Communication System	Necessary specification will be prepared based on an applicable signal system for CMR and NSCR-South.
		Voice and Data System	MDF: RJ45 24Port with Patch-Code(Cat5e)
			Redundancy: L/A Up-link and SW Stacking
			Authentication: WEB and MAC
		IP Telephone	PBX: PCM time division, storage program control
			Protocol: VoIP and QoS
			Traffic: 6HCS
		CCTV System	Camera: PTZ and/or Fixed Type,Format:MPEG-4,Commpression:H.264
		Time Server and Master Clock	Reference Time:UTC from GPS,Protcol:NTP
		Others	Backplane: more than 24Gbps,Throughput: at least 1Gbps
			Cable:OFC(SM with 0-disperison wavelength),Throughput: at least 1Gbps
			EMC:appleied, RAMS: applied
9	AFCS	General	The Beep cards system shall be employed
10	Others	Platform Screen	No applicable
		Construction gauge	The same gauge of NSCR

Source: JICA Design Team

(2) Airport Limited Express Train

This airport limited express service shall provide a comfortable travel experience to airline passengers. According to the specifications of NSCR, the maximum train speed between Malolos and Tutuban is limited at 120km/h. To connect CIA and the center of Manila within 1 hour, the maximum speed of the limited express train shall be 160km/h at MCRP. The rolling stock, signalling system and OCS (Overhead Catenary System) of MCRP shall have enough performance for safe and stable train operation at 160km/h. JDT researches Keisei Sky Liner and Narita Express in Japan which connect Narita Airport and the center of Tokyo, and uses these railway systems as a reference of CIA airport limited express train.

Source: JICA Design Team

Figure 4.3.3 Keisei Sky Liner (Left) and Narita Express (Right)

(3) Platform Screen Door (PSD)

According to the discussion of JICA and DOTr at the end of June 2018, the installing PSD to every MCRP, NSCR and NSRP-South station is decided. PSD is widely used in urban railways for keeping the safe of passengers at platforms from an accident contact with trains.

There are 2 types of PSD that are widely used. One is full height PSD and another is half height PSD. Full height PSD is usually used in subways for reducing air-conditioning energy consumption at platform. Half height PSD is used for subways and railways because of an easiness of construction and a good visibility of operator. Half height PSD is suitable for MCRP because a main line is planned as an elevated track.

Source: JICA Design Team

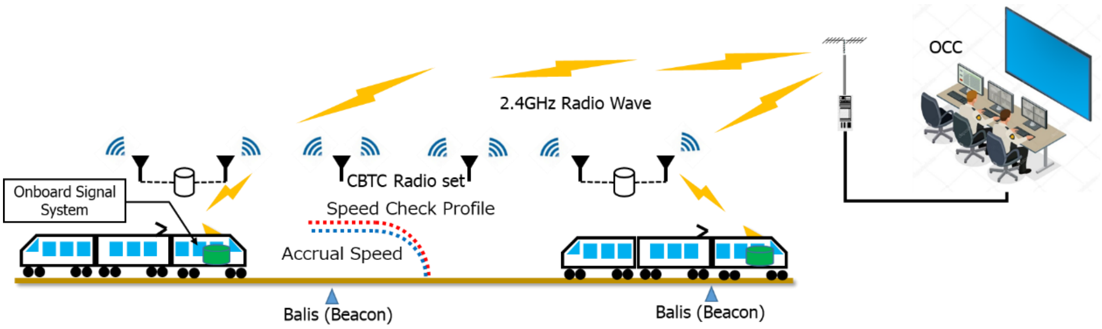
Figure 4.3.4 Image of Platform Screen Door

Basic functions and specifications of PSD for MCRP are considered as the followings.

- PSD operation is synchronized with CBTC signalling system.
- Train stops at the exact position for open/close PSD by ATO system. (ATO: Automatic Train Operation)
- PSD operation is synchronized with train driver's train door operation command.
- Safety sensor is equipped for preventing a passenger to be caught in PSD.
- PSD can be operated manually by station staff at the emergency situation.
- The difference of door location and number of Airport limited express and Commuter train shall be cleared by using a wide width open PSD.

(4) Signalling System

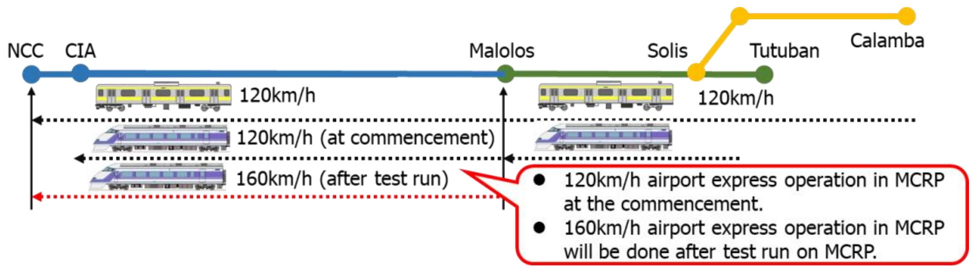
DOTr is planning to employ CBTC (Communication Based Train Control) signalling system for MCRP. CBTC is widely applied to urban railways in the world. CBTC is a modern signalling system using radio wave and computer system and can achieve less way-side signal equipment and track circuit. CBTC is an integrated signalling system including all functions of ATP (Automatic Train Protection), ATS (Automatic Train Supervision), ATO (Automatic Train Operation) and CBI (Computer Based Interlocking), and is optimized to control frequent and patterned commuter train operation in urban area. The same CBTC system shall be employed in 3 lines to keep interoperability.



Source: JICA Design Team

Figure 4.3.5 Schematic of CBTC System

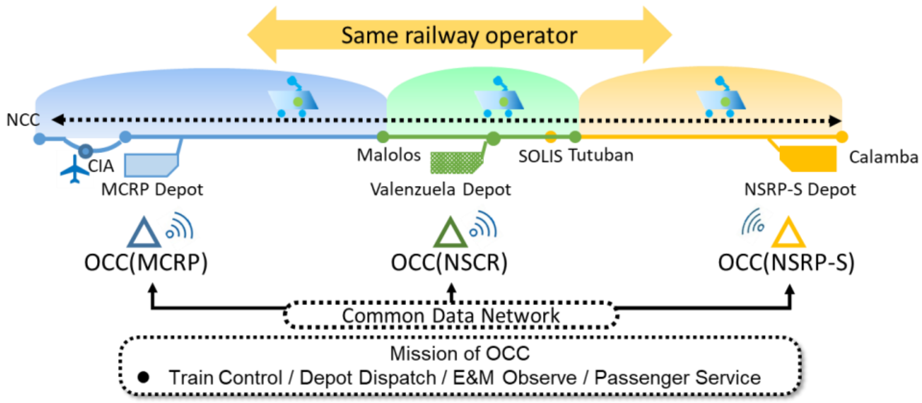
Generally, CBTC is adapted to urban commuter railway. Maximum speed of commercial operation under CBTC is about 120~130km/h. Japanese signal venders agree that CBTC can control safe train operation at 160km/h in principle, but the test running after commencement of MCRP will be required to speed up from 120km/h to 160km/h for confirming the stable and reliable signal control at 160km/h. JDT researches and studies the suitable test plan.



Source: JICA Design Team

Figure 4.3.6 160km/h train operation plan at MCRP

OCC (Operation Control Center) is required for railway operation control. The location of OCC shall be proposed based on the easiness of train operation and cooperation with E&M and rolling stock engineers. From those points, OCC of MCRP is proposed to construct in MCRP depot. The hand-over of train control will be required at the border of MCRP and NSCR signalling system. Because of same CBTC signalling system will be installed and same operator will manage both lines, the train operation procedure and system interface at the border can be proposed in not so complicated design and rules.



Source: JICA Design Team

Figure 4.3.7 Schematic of common operation of OCC

(5) Power Supply System

MCRP adopts DC 1,500V catenary system for power supply, because the same system is used for NSCR. The electrical power supply in the Philippines is provided by regional electric power supply companies. Electric power suppliers are different in MCRP according to their franchise area. The power supply plan shall require coordination among those regional electric power supply companies and area management organizations.

The location, number and capacity of substations will be proposed based on the train operation conditions and other related preconditions. Generally, the interval of substation for DC 1,500V supply system to commuter railway is 3 ~ 5 km, to secure stable power supply to OCS. The actual locations shall be proposed based on the train operation plan, power supply performance and easiness in constructing substations, including land acquisition.

(6) Depot location

The location of MCRP depot is proposed near CIA. The stable yard, OCC and maintenance facilities for rolling stock and E&M shall be constructed in MCRP depot. JDT is designing the depot facilities based on the specifications and character of MCRP railway system. Especially, facilities for rolling stock maintenance will be proposed based on Japanese reliable and periodical preventive maintenance method.

(7) Training Center

DOTr plans to have a public establishment for railway operations, to be so called the railway institute (PRI: Philippine Railway Institute) in charge of establishing railway rules and regulations, issuing railway driver's license, and educating railway operators nationwide. Each railway operator may set up its own training plan or safety drills to comply with the public railway regulations and rules to be enacted by DOTr. JDT proposes a basic training plan and facilities in MCRP and NSRP-South based on the PRI plan and training facilities of Japanese railway operators.

(8) AFCS (Automatic Fare Collection System)

MCRP and NSRP-South introduces an AFC (automated fare collection) system using common public transportation IC card (Beep Card) for passenger's convenience. Three types of the train service (commuter, commuter express and limited express) are planned in MCRP. According to DOTr's plan, the express train service does not require any additional fare, but the limited express train requires an additional express-fare, as well as a reservation system. To shorten system development period, JDT proposes the paper ticket reservation system for airport limited express which is independent with Beep card system. The passengers shall purchase a reservation express ticket at ticket vending machine in advance. The passenger will pass the ticket gate with Beep card and take the reserved airport express train. The conductor in the train will check the validity of reservation ticket with handy terminal. The passenger will get off at the destination and pass through the ticket gate with Beep card.

(9) Rapid Construction Plan

The commencement of MCRP phase I (Malolos ~ CIA) is planned at May 2022. The construction and commissioning period is about 3 years. The rapid construction method shall be considered in E&M and rolling stock design works.

4.3.2 Train Operation Plan

(1) Pre-Conditions for Train Operation Plan

1) Railway Construction Plan

Though JDT refers to the previous studies on MCRP line by JOIN, and on NSRP-South line by ADB, the railway construction plan is assumed as follows in response to the request of GOP:

- All sections of MCRP line (about 70km, 7 stations) are to be opened in 2022 and connected to NSCR at Malolos station:
- All sections of NSRP-South line (about 72km, 21 stations) are to be opened in 2023 and connected to NSCR at Solis station:

2) Through-operation plan

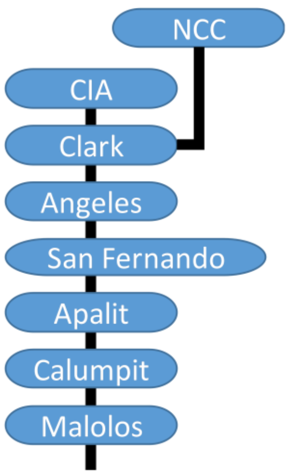
Through-operation is implemented among NSCR, MCRP and NSRP-South lines so that the passengers can move on each line without transferring trains.

3) Alignment Planning

a) Alignment planning of MCRP line

MCRP line is based on discussions in a series of meetings with DOTr for the following items.

- Branch to NCC and CIA at Clark (Figure 4.3.8)

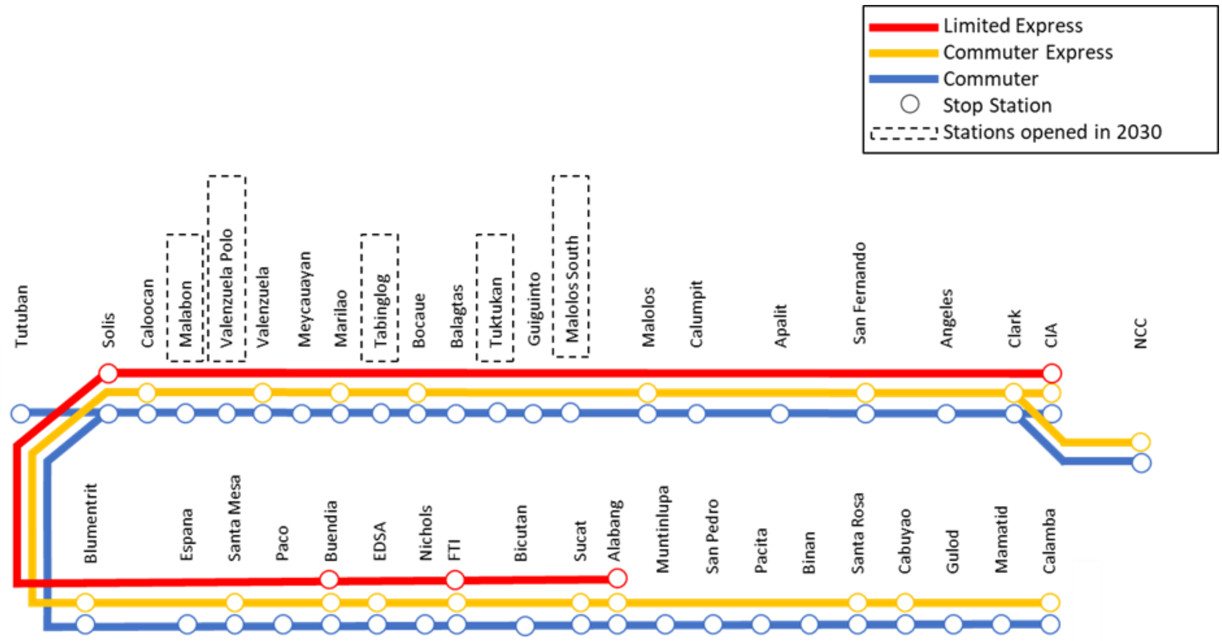


Source: JICA Design Team

Figure 4.3.8 Alignment planning of MCRP line

(2) Types of the train service

In the 3rd Coordination Meeting, it was agreed with DOTr that Commuter express in addition to Limited express and Commuter were considered. Limited express trains basically will be operated in the section between Alabang and CIA. Commuter express trains and commuter trains will be operated as the through-operation in all sections. Limited express trains will be operated between CIA and Makati city in response to the request of DOTr. At the 4th Coordination Meeting Alabang station has turnouts for turn back, so it is being considered that Limited express trains will be operated between Alabang and CIA. Figure 4.3.9 is a route map and stops for each type of trains.



Source: JICA Design Team

Figure 4.3.9 Route map and stops for each type of trains

(3) System capacity

1) Train capacity

In this study, JDT considers configuration of all trains as 8 cars. The capacity of each train is shown Table 4.3.3 and Table 4.3.4.

Table 4.3.3 Train capacity (Express)

Train composition	No. of passengers		
	Seated	Standing	Total
8 cars	400	0	400

Source: JICA Design Team

Table 4.3.4 Train capacity (Commuter express, Commuter)

Train composition	No. of passengers		
	Seated	Standing	Total
8 cars	414	1,828	2,242

The number of standing passengers is calculated based on 7 passengers/m^2

Source: JICA Design Team

2) Number of operated trains in peak hour

In the 4th Coordination Meeting, it was decided that the future requirements of design would be 2 Limited express trains/hour, 4 commuter express trains/hour, and 6 commuter trains/hour in NSCR.

And considering the capacity of NSCR, train operation plan until the facility enhancement is completed was agreed with DOTr that 1 Limited express train/hour, 4 commuter express trains/hour, and 5 commuter trains/hour.

(4) Traveling time

The traveling time is calculated by train performance curve based on the data of rolling stocks and alignment. Regarding the alignment data, the data of MCRP line was July 2018 and the data of NSCR line was NSCR report and the data of NSRP-South line was February 2018. In addition, the waiting time for other train which is limited express and commuter express is added. Figure 4.3.10 shows the regular running time of limited express train, and Figure 4.3.11 and Figure 4.3.12 show the regular running time of commuter express train and commuter train.

Traveling Time (NCC→Calamba)				Station	Traveling Time (Calamba→NCC)			
Limited Express train					Limited Express train			
Running time	Dwell time	Traveling Time	Pattern of stops		Pattern of stops	Running time	Dwell time	Traveling Time
			●	CIA	●			1:15:30
05:30						05:45		
	00:00	0:05:30		Clark			00:00	1:09:45
02:30						02:30		
	00:00	0:08:00		Angeles			00:00	1:07:15
06:15						06:00		
	00:00	0:14:15		San Fernando			00:00	1:01:15
04:45						04:45		
	00:00	0:19:00		Apalit			00:00	0:56:30
02:45						02:45		
	00:00	0:21:45		Calumpit			00:00	0:53:45
03:15						03:00		
	00:00	0:25:00		MALOLOS			00:00	0:50:45
02:00						02:00		
	00:00	0:27:00		MALOLOS SOUTH			00:00	0:48:45
01:30						01:30		
	00:00	0:28:30		GUIGUINTO			00:00	0:47:15
01:30						01:30		
	00:00	0:30:00		TUKTUKAN			00:00	0:45:45
01:30						01:30		
	00:00	0:31:30		BALAGTAS			00:00	0:44:15
02:15						02:15		
	00:00	0:33:45		BOCAUE			00:00	0:42:00
01:45						01:45		
	00:00	0:35:30		TABINGLOG			00:00	0:40:15
01:30						01:30		
	00:00	0:37:00		MARILAO			00:00	0:38:45
01:00						01:00		
	00:00	0:38:00		MEYCAUYAN			00:00	0:37:45
01:45						01:45		
	00:00	0:39:45		VALENZUELA			00:00	0:36:00
01:45						01:45		
	00:00	0:41:30		VALENZUELA POLO			00:00	0:34:15
02:00						02:00		
	00:00	0:43:30		MALABON			00:00	0:32:15
01:00						01:00		
	00:00	0:44:30		CALOOCAN			00:00	0:31:15
01:45						01:45		
	01:30	0:46:15	●	SOLIS	●		01:30	0:28:00
03:00						03:15		
	00:00	0:50:45		Blumenrit			00:00	0:24:45
01:30						01:30		
	00:00	0:52:15		Espana			00:00	0:23:15
01:30						01:30		
	00:00	0:53:45		Santa Mesa			00:00	0:21:45
02:30						02:45		
	00:00	0:56:15		Paco			00:00	0:19:00
02:45						02:15		
	01:30	0:59:00	●	Buendia	●		01:30	0:15:15
02:30						03:00		
	00:00	1:03:00		EDSA			00:00	0:12:15
02:15						02:00		
	00:00	1:05:15		Nichols			00:00	0:10:15
02:00						01:30		
	01:30	1:07:15	●	FTI	●		01:30	0:07:15
01:30						02:00		
	00:00	1:10:15		Bicutan			00:00	0:05:15
02:30						02:30		
	00:00	1:12:45		Sucat			00:00	0:02:45
03:00						02:45		
		1:15:45	●	Alabang	●			
1:11:15	0:04:30	1:15:45		Total		1:11:00	0:04:30	1:15:30

Source: JICA Design Team

Figure 4.3.10 Estimated Traveling Time between Stations of Limited Express

Traveling Time (CIA→Calamba)								Station	Traveling Time (Calamba→CIA)							
Commuter Express				Local train					Commuter Express				Local train			
Running time	Dwell time	Traveling Time	Pattern of stops	Running time	Dwell time	Traveling Time	Pattern of stops		Pattern of stops	Running time	Dwell time	Traveling Time	Pattern of stops	Running time	Dwell time	Traveling Time
			●				●	CIA	●			1:50:45	●			2:21:30
06:15				06:15						06:15				06:15		
	00:30	0:06:15	●		00:30	0:06:15	●	Clark	●		00:30	1:44:00	●		00:30	2:14:45
03:00				03:30						03:00				03:45		
	00:00	0:09:45			00:30	0:10:15	●	Angeles			00:00	1:41:00	●		00:30	2:10:30
08:45				09:00						08:45				09:15		
	00:30	0:18:30	●		00:30	0:19:45	●	San Fernando	●		00:30	1:31:45	●		00:30	2:00:45
07:00				07:30						07:00				07:30		
	00:00	0:26:00			00:30	0:27:45	●	Apalit			00:00	1:24:45	●		00:30	1:52:45
03:00				04:00						03:00				04:00		
	00:00	0:29:00			00:30	0:32:15	●	Calumpit			00:00	1:21:45	●		00:30	1:48:15
04:15				04:45						04:15				04:45		
	00:30	0:33:15	●		00:30	0:37:30	●	MALOLOS	●		00:30	1:17:00	●		00:30	1:43:00
02:30				02:55						02:15				02:55		
	00:00	0:36:15			00:30	0:40:55	●	MALOLOS SOUTH			00:00	1:14:45	●		00:30	1:39:35
01:30				02:40						01:45				02:40		
	00:00	0:37:45			00:30	0:44:05	●	GUIGUINTO			00:00	1:13:00	●		00:30	1:36:25
01:30				02:20						01:30				02:20		
	00:00	0:39:15			00:30	0:46:55	●	TUKTUKAN			00:00	1:11:30	●		00:30	1:33:35
01:30				02:20						01:30				02:20		
	00:00	0:40:45			00:30	0:49:45	●	BALAGTAS			00:00	1:10:00	●		00:30	1:30:45
02:45				03:30						02:45				03:30		
	00:30	0:43:30	●		00:30	0:53:45	●	BOCAUE	●		00:30	1:06:45	●		00:30	1:26:45
02:15				02:45						02:00				02:45		
	00:00	0:46:15			00:30	0:57:00	●	TABINGLOG			00:00	1:04:45	●		00:30	1:23:30
02:00				02:35						02:00				02:35		
	00:30	0:48:15	●		00:30	1:00:05	●	MARILAO	●		00:30	1:02:15	●		00:30	1:20:25
01:30				02:00						01:30				02:00		
	00:00	0:50:15			00:30	1:02:35	●	MEYCAUYAN			00:00	1:00:45	●		00:30	1:17:55
02:15				02:45						02:15				02:45		
	00:30	0:52:30	●		00:30	1:05:50	●	VALENZUELA	●		00:30	0:58:00	●		00:30	1:14:40
02:00				02:30						02:00				02:30		
	00:00	0:55:00			00:30	1:08:50	●	VALENZUELA POLO			00:00	0:56:00	●		00:30	1:11:40
02:00				02:55						02:00				02:55		
	00:00	0:57:00			00:30	1:12:15	●	MALABON			00:00	0:54:00	●		00:30	1:08:15
01:15				01:50						01:15				01:50		
	00:30	0:58:15	●		00:30	1:14:35	●	CALOOCAN	●		00:30	0:52:15	●		00:30	1:05:55
02:00				02:25						02:15				02:25		
	00:00	1:00:45			00:30	1:17:30	●	SOLIS			00:00	0:50:00	●		00:30	1:03:00
03:30				03:30						03:15				03:30		
	00:30	1:04:15	●		00:30	1:21:30	●	Blumentrit	●		00:30	0:46:15	●		00:30	0:59:00
01:45				02:00						01:45				02:00		
	00:00	1:06:30			00:30	1:24:00	●	Espana			00:00	0:44:30	●		00:30	0:56:30
01:45				02:15						01:45				02:00		
	00:30	1:08:15	●		00:30	1:26:45	●	Santa Mesa	●		00:30	0:42:15	●		00:30	0:54:00
02:45				03:15						03:00				03:15		
	00:00	1:11:30			00:30	1:30:30	●	Paco			00:00	0:39:15	●		00:30	0:50:15
02:45				02:45						02:30				02:45		
	00:30	1:14:15	●		00:30	1:33:45	●	Buendia	●		00:30	0:36:15	●		00:30	0:47:00
02:45				02:45						02:45				02:45		
	00:30	1:17:30	●		00:30	1:37:00	●	EDSA	●		00:30	0:33:00	●		00:30	0:43:45
02:30				02:45						02:15				02:45		
	00:00	1:20:30			00:30	1:40:15	●	Nichols			00:00	0:30:45	●		00:30	0:40:30
01:45				02:00						01:45				02:15		
	00:30	1:22:15	●		00:30	1:42:45	●	FTI	●		00:30	0:28:30	●		00:30	0:37:45
01:45				02:00						01:45				02:00		
	00:00	1:24:30			00:30	1:45:15	●	Bicutan			00:00	0:26:45	●		00:30	0:35:15
03:00				03:30						03:00				03:30		
	00:30	1:27:30	●		00:30	1:49:15	●	Sucat	●		00:30	0:23:15	●		00:30	0:31:15
03:00				03:00						03:00				03:00		
	00:30	1:31:00	●		00:30	1:52:45	●	Alabang	●		00:30	0:19:45	●		00:30	0:27:45
02:15				02:30						02:15				02:30		
	00:00	1:33:45			00:30	1:55:45	●	Muntinlupa			00:00	0:17:30	●		00:30	0:24:45
02:15				03:00						02:00				03:00		
	00:00	1:36:00			00:30	1:59:15	●	San Pedro			00:00	0:15:30	●		00:30	0:21:15
01:15				02:00						01:15				02:00		
	00:00	1:37:15			00:30	2:01:45	●	Pacita			00:00	0:14:15	●		00:30	0:18:45
01:30				02:15						01:15				02:15		
	00:00	1:38:45			00:30	2:04:30	●	Binan			00:00	0:13:00	●		00:30	0:16:00
02:45				03:00						02:45				03:00		
	00:30	1:41:30	●		00:30	2:08:00	●	Santa Rosa	●		00:30	0:09:45	●		00:30	0:12:30
03:00				03:00						03:00				03:00		
	00:30	1:45:00	●		00:30	2:11:30	●	Cabuyao	●		00:30	0:06:15	●		00:30	0:09:00
02:15				02:30						02:15				02:30		
	00:00	1:47:45			00:30	2:14:30	●	Gulod			00:00	0:04:00	●		00:30	0:06:00
01:30				02:30						01:30				02:30		
	00:00	1:49:15			00:30	2:17:30	●	Mamatid			00:00	0:02:30	●		00:30	0:03:00
02:30				03:00						02:30				03:00		
		1:51:45	●			2:21:00	●	Calamba	●				●			
1:43:45	0:08:00	1:51:45		2:02:00	0:19:00	2:21:00		Total		1:42:45	0:08:00	1:50:45		2:02:30	0:19:00	2:21:30

Source: JICA Design Team

Figure 4.3.11 Estimated Traveling Time between Stations of Commuter Express and Commuter (Between Calamba and CIA)

Traveling Time (NCC→Calamba)								Station	Traveling Time (Calamba→NCC)							
Commuter Express				Local train					Commuter Express				Local train			
Running time	Dwell time	Traveling Time	Pattern of stops	Running time	Dwell time	Traveling Time	Pattern of stops		Pattern of stops	Running time	Dwell time	Traveling Time	Pattern of stops	Running time	Dwell time	Traveling Time
			●				●	NCC	●			1:57:15	●			2:28:00
13:00				13:00						12:45				12:45		
	00:30	0:13:00	●		00:30	0:13:00	●	Clark	●		00:30	1:44:00	●		00:30	2:14:45
03:00				03:30						03:00				03:45		
	00:00	0:16:30			00:30	0:17:00	●	Angeles			00:00	1:41:00	●		00:30	2:10:30
08:45				09:00						08:45				09:15		
	00:30	0:25:15	●		00:30	0:26:30	●	San Fernando	●		00:30	1:31:45	●		00:30	2:00:45
07:00				07:30						07:00				07:30		
	00:00	0:32:45			00:30	0:34:30	●	Apalit			00:00	1:24:45	●		00:30	1:52:45
03:00				04:00						03:00				04:00		
	00:00	0:35:45			00:30	0:39:00	●	Calumpit			00:00	1:21:45	●		00:30	1:48:15
04:15				04:45						04:15				04:45		
	00:30	0:40:00	●		00:30	0:44:15	●	MALOLOS	●		00:30	1:17:00	●		00:30	1:43:00
02:30				02:55						02:15				02:55		
	00:00	0:43:00			00:30	0:47:40	●	MALOLOSSOUTH			00:00	1:14:45	●		00:30	1:39:35
01:30				02:40						01:45				02:40		
	00:00	0:44:30			00:30	0:50:50	●	GUIGUINTO			00:00	1:13:00	●		00:30	1:36:25
01:30				02:20						01:30				02:20		
	00:00	0:46:00			00:30	0:53:40	●	TUKTUKAN			00:00	1:11:30	●		00:30	1:33:35
01:30				02:20						01:30				02:20		
	00:00	0:47:30			00:30	0:56:30	●	BALAGTAS			00:00	1:10:00	●		00:30	1:30:45
02:45				03:30						02:45				03:30		
	00:30	0:50:15	●		00:30	1:00:30	●	BOCAUE	●		00:30	1:06:45	●		00:30	1:26:45
02:15				02:45						02:00				02:45		
	00:00	0:53:00			00:30	1:03:45	●	TABINGLOG			00:00	1:04:45	●		00:30	1:23:30
02:00				02:35						02:00				02:35		
	00:30	0:55:00	●		00:30	1:06:50	●	MARILAO	●		00:30	1:02:15	●		00:30	1:20:25
01:30				02:00						01:30				02:00		
	00:00	0:57:00			00:30	1:09:20	●	MEYCAUYAN			00:00	1:00:45	●		00:30	1:17:55
02:15				02:45						02:15				02:45		
	00:30	0:59:15	●		00:30	1:12:35	●	VALENZUELA	●		00:30	0:58:00	●		00:30	1:14:40
02:00				02:30						02:00				02:30		
	00:00	1:01:45			00:30	1:15:35	●	VALENZUELAPOLO			00:00	0:56:00	●		00:30	1:11:40
02:00				02:55						02:00				02:55		
	00:00	1:03:45			00:30	1:19:00	●	MALABON			00:00	0:54:00	●		00:30	1:08:15
01:15				01:50						01:15				01:50		
	00:30	1:05:00	●		00:30	1:21:20	●	CALOOCAN	●		00:30	0:52:15	●		00:30	1:05:55
02:00				02:25						02:15				02:25		
	00:00	1:07:30			00:30	1:24:15	●	SOLIS			00:00	0:50:00	●		00:30	1:03:00
03:30				03:30						03:15				03:30		
	00:30	1:11:00	●		00:30	1:28:15	●	Blumenrit	●		00:30	0:46:15	●		00:30	0:59:00
01:45				02:00						01:45				02:00		
	00:00	1:13:15			00:30	1:30:45	●	Espana			00:00	0:44:30	●		00:30	0:56:30
01:45				02:15						01:45				02:00		
	00:30	1:15:00	●		00:30	1:33:30	●	Santa Mesa	●		00:30	0:42:15	●		00:30	0:54:00
02:45				03:15						03:00				03:15		
	00:00	1:18:15			00:30	1:37:15	●	Paco			00:00	0:39:15	●		00:30	0:50:15
02:45				02:45						02:30				02:45		
	00:30	1:21:00	●		00:30	1:40:30	●	Buendia	●		00:30	0:36:15	●		00:30	0:47:00
02:45				02:45						02:45				02:45		
	00:30	1:24:15	●		00:30	1:43:45	●	EDSA	●		00:30	0:33:00	●		00:30	0:43:45
02:30				02:45						02:15				02:45		
	00:00	1:27:15			00:30	1:47:00	●	Nichols			00:00	0:30:45	●		00:30	0:40:30
01:45				02:00						01:45				02:15		
	00:30	1:29:00	●		00:30	1:49:30	●	FTI	●		00:30	0:28:30	●		00:30	0:37:45
01:45				02:00						01:45				02:00		
	00:00	1:31:15			00:30	1:52:00	●	Bicutan			00:00	0:26:45	●		00:30	0:35:15
03:00				03:30						03:00				03:30		
	00:30	1:34:15	●		00:30	1:56:00	●	Sucat	●		00:30	0:23:15	●		00:30	0:31:15
03:00				03:00						03:00				03:00		
	00:30	1:37:45	●		00:30	1:59:30	●	Alabang	●		00:30	0:19:45	●		00:30	0:27:45
02:15				02:30						02:15				02:30		
	00:00	1:40:30			00:30	2:02:30	●	Muntinlupa			00:00	0:17:30	●		00:30	0:24:45
02:15				03:00						02:00				03:00		
	00:00	1:42:45			00:30	2:06:00	●	San Pedro			00:00	0:15:30	●		00:30	0:21:15
01:15				02:00						01:15				02:00		
	00:00	1:44:00			00:30	2:08:30	●	Pacita			00:00	0:14:15	●		00:30	0:18:45
01:30				02:15						01:15				02:15		
	00:00	1:45:30			00:30	2:11:15	●	Binan			00:00	0:13:00	●		00:30	0:16:00
02:45				03:00						02:45				03:00		
	00:30	1:48:15	●		00:30	2:14:45	●	Santa Rosa	●		00:30	0:09:45	●		00:30	0:12:30
03:00				03:00						03:00				03:00		
	00:30	1:51:45	●		00:30	2:18:15	●	Cabuyao	●		00:30	0:06:15	●		00:30	0:09:00
02:15				02:30						02:15				02:30		
	00:00	1:54:30			00:30	2:21:15	●	Gulod			00:00	0:04:00	●		00:30	0:06:00
01:30				02:30						01:30				02:30		
	00:00	1:56:00			00:30	2:24:15	●	Mamatid			00:00	0:02:30	●		00:30	0:03:00
02:30				03:00						02:30				03:00		
		1:58:30	●			2:27:45	●	Calamba	●				●			
1:50:30	0:08:00	1:58:30		2:08:45	0:19:00	2:27:45		Total		1:49:15	0:08:00	1:57:15		2:09:00	0:19:00	2:28:00

Source: JICA Design Team

Figure 4.3.12 Estimated Traveling Time between Stations of Commuter Express and Commuter (Between Calamba and NCC)

(5) Train operation schedule

In the 4th Coordination Meeting, it was decided that the future requirements of design would be 2 Limited express trains/hour, 4 commuter express trains/hour, and 6 commuter trains/hour in NSCR.
And considering the capacity of NSCR, train operation plan when the line is to be opened was agreed with DOTr that 1 Limited express train/hour, 4 commuter express trains/hour, and 5 commuter trains/hour.

1) Draft train operation plan of Malolos-CIA opened in 2022 (peak hour)

Draft train operation plan of Malolos-CIA opened in 2022 (peak hour) is 1 Limited express train/hour, 4 commuter express trains/hour, and 5 commuter trains/hour. As a reason, in the report of NSCR, it was planning that 10 commuter trains/hour and considering the capacity of NSCR.

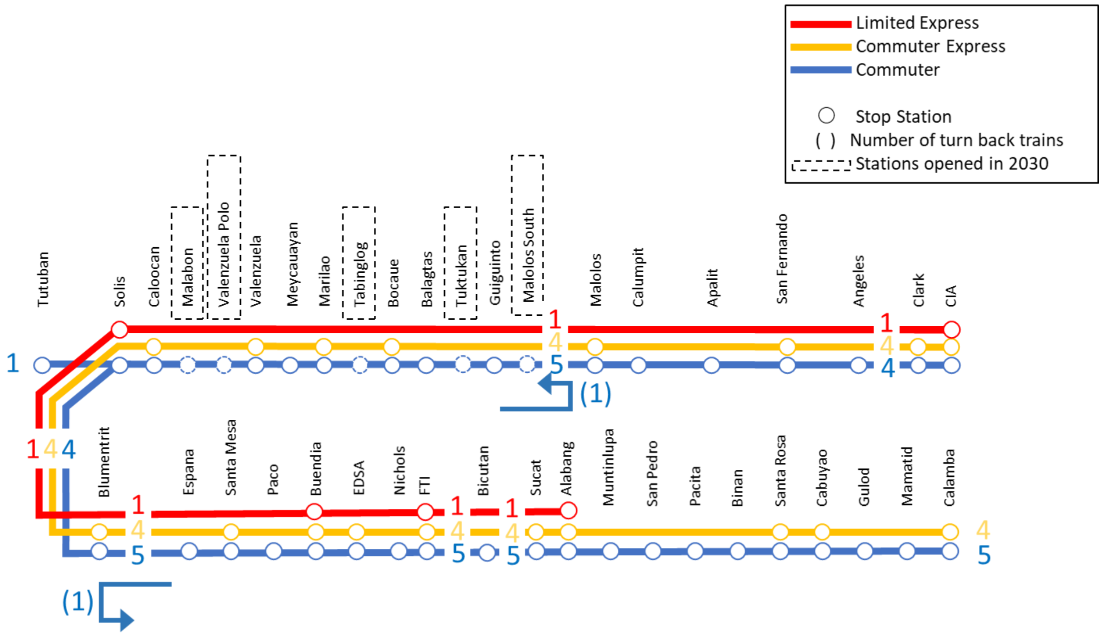
Regarding commuter, JDT considered the turn back in Malolos which has turnout. Figure 4.3.13 shows the operation plan.

Source: JICA Design Team

Figure 4.3.13 Draft train operation plan of Malolos-CIA opened in 2022 (peak hour)

2) Draft train operation plan of NSRP-South opened in 2023 (peak hour)

Draft Train operation plan of NSRP-South opened in 2023 (peak hour) is considering the transport capacity of NSRP-South and the demand of Tutuban. Figure 4.3.14 shows the operation plan.

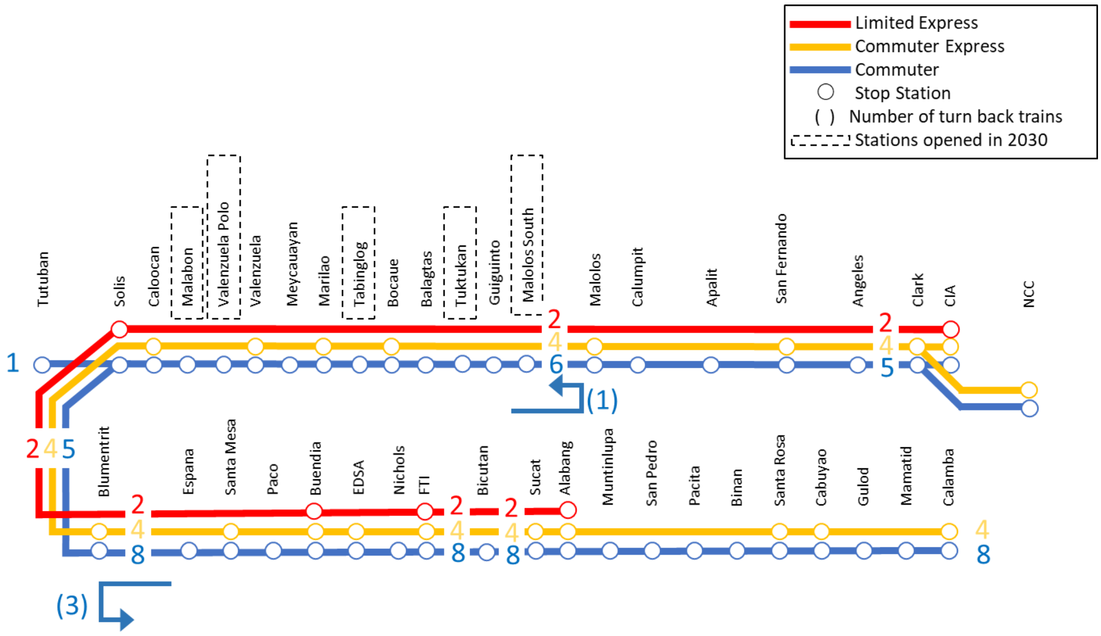


Source: JICA Design Team

Figure 4.3.14 Draft train operation plan of NSRP-South opened in 2023 (peak hour)

3) Draft train operation plan in 2040 (peak hour)

Draft train operation plan in 2040 (peak hour) is 2 Limited Express trains/hour, 4 Commuter Express trains/hour, and 6 Commuter trains/hour in NSCR is considering the transport capacity of NSRP-South and demand of Tutuban. Figure 4.3.15 shows the operation plan.



Source: JICA Design Team

Figure 4.3.15 Draft train operation plan in 2040 (peak hour)

(6) Result of train operation plan

Based on the train operation plan, JDT calculated the number of stabling train sets at each depot, total train kilometer per day. The number of stay train sets at each depot and the total train kilometer per day of Malolos-CIA opened in 2022 are shown Table 4.3.5 and Table 4.3.6.

Table 4.3.5 Total train kilometer of each train in 2022

Type/Location	Total train km (km/day)
Limited Express	3,799
Commuter (Include Commuter Express)	23,782

Source: JICA Design Team

Table 4.3.6 Number of stabling train sets at each depot in 2022 (exclude spare train sets)

Type/Location	North Depot	Valenzuela Depot	Alabang St.	Total
Limited Express	**2**	**1**	**1**	**4**
Commuter (Include Commuter Express)	16	10	0	26

Source: JICA Design Team

The number of stabling train sets at each depot, total train kilometer per day of NSRP-South opened in 2023 are shown Table 4.3.7 and Table 4.3.8 respectively.

Table 4.3.7 Total train kilometer of each train in 2023

Type/Location	Total train km (km/day)
Limited Express	5,048
Commuter (Include Commuter Express)	32,406

Source: JICA Design Team

Table 4.3.8 Number stabling train sets at each depot in 2023 (Exclude spare train sets)

Type/Location	North Depot	Valenzuela Depot	South Depot	Alabang St.	Total
Limited Express	2	0	0	2	4
Commuter (Include Commuter Express)	19	6	18	0	43

Source: JICA Design Team

The number of stabling train sets at each depot, total train kilometer per day in 2040 are shown Table 4.3.9 and Table 4.3.10.

Table 4.3.9 Total train kilometer of each train in 2040

Type/Location	Total train km (km/day)
Limited Express	9,048
Commuter (Include Commuter Express)	36,503

Source: JICA Design Team

Table 4.3.10 Number of stabling train sets at each depot in 2040 (Exclude spare train sets)

Type/Location	North Depot	Valenzuela Depot	South Depot	Alabang St.	Total
Limited Express	4	2	0	2	8
Commuter (Include Commuter Express)	21	6	25	0	52

Source: JICA Design Team

(7) Train drivers plan

Based on the train operation plan, JDT calculated the number of the required train drivers. JDT tentatively calculated the numbers from the existing organization, considering driver in the Philippines work for 4 hours a day. The number of train drivers is shown Table 4.3.11, Table 4.3.12, and Table 4.3.13.

Table 4.3.11 Number of required train drivers in 2022 (Include NSCR)

Attendance per day	Number of drivers
105	185

Source: JICA Design Team

Table 4.3.12 Number of required train drivers in 2023 (Include NSCR)

Attendance per day	Number of drivers
160	278

Source: JICA Design Team

Table 4.3.13 Number of required train drivers in 2040 (Include NSCR)

Attendance per day	Number of drivers
187	328

Source: JICA Design Team

4.3.3 Rolling Stock Design Plan

(1) Outline

MCRP is planned to enable an interoperable train operation with NSCR by the same railway operator. Based on these prerequisites and operation plan accommodating the passenger demand forecast, JDT will propose the specifications of rolling stocks for limited express for airport access and for commuter train service in this work.

In this section, the specifications of limited express train and commuter train are described.

The proposed train configurations are shown in Table 4.3.14. The number of cars in one train- set is 8 cars, but it has the possibility that the number of cars in one train-set will be 10 cars in the future. The number of train sets is yet to be evaluated and proposed since the train operation plan has not been finalized.

Table 4.3.14　Required Train Type for MCRP Project

Required Train Type	Limited Express Type	Commuter Type
Train Configuration	8 cars	8 cars
Number of required Train-set	To be decided based on Operation Plan	

Source: JICA Design Team

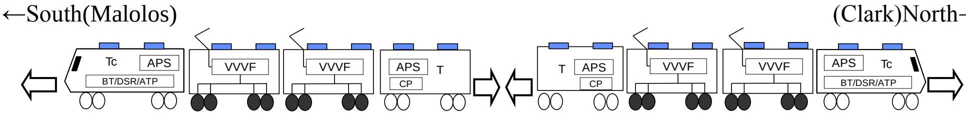
(2)　Preconditions for Rolling Stock Design Plan

1)　Commuter Train

The standards and specifications applying to the rolling stock shall be adapted from those of rolling stock described in reports of NSCR Detailed Design Study (DD) because of the interoperation with NSCR. On the other hand, the specifications and performance of the rolling stock shall pay attention to the latest technology trends, manufacturer’s production record, and so on.

Table 4.3.15 shows the draft specifications and performance of commuter trains of MCRP. Those may be reviewed according with the progress of the study and work.

Table 4.3.15　Specifications and Performance of MCRP Commuter Train (Draft)

No	Item	Specification, Performance
1	Basic	Commuter Train　DC1,500V Tc: Trailer Car with driver’s cab　M: Motor car　T: Trailer car
2	Basic Configuration	In case of 4M4T (Tc+M+M+T+T+M+M+Tc)　(Empty weight　264t)　following is for reference ←South(Malolos)　(Clark)North→  32.5t ATP DSR BT APS / 34.0t VVVF PT / 34.0t VVVF PT / 31.5t APS CP / 31.5t APS CP / 34.0t VVVF PT / 34.0t VVVF PT / 32.5t ATP DSR BT APS Legend ●:Motor Axle　○:Trailer Axle　⇦:Tight lock coupler ATP: Automatic Train Protection,　DSR: Digital Space Radio, VVVF: VVVF inverter, CP: Compressor, APS: Auxiliary power Supply, PT: Pantograph,　BT: Battery,　▬ : Air Conditioner
3	Performance	Acceleration(Design):3.3km/h/s Deceleration(Design):4.2km/h/s (Max service brake, Instantaneous deceleration) 4.7 km/h/s (Emergency brake, Instantaneous deceleration) Design operation Max speed:120km/h
4	Gauge	1,435mm(standard gauge)
5	Electric system	DC1,500V　overhead catenary
6	Capacity	Leading car: 266(45), Intermediate car : 285(54) (　　):seat number calculated by 7person/m^2 (Standee)
7	Body	Material: Light weight stainless steel or Aluminium MAX:19,500mm (Length)×2,950 mm (Width)×3,655 mm (Height) MAX Height 4,150mm, when pantograph is folded,　1,130～1,150 mm (Height of floor) Straight structure without hem aperture Driver unit : right side The length of leading cars may be longer than above
8	Bogie	Bolster less type, Max axle weight:16t

No	Item	Specification, Performance
9	Coupler	Driver's cab side of leading-car, and between 4th intermediate-car and 5th intermediate-car: tight lock coupler Others : semi-permanent coupler Connectable with NSCR train without adapter
10	Current Collection	Single arm type 4 pantographs/1 train-set (With high voltage train line)
11	Traction Motor	3-phased totally enclosed high efficiency induction motor 4 units / M car Non- disassembly bearing exchange type
12	Driving device	Parallel cardan
13	Propulsion system	VVVF inverter(Self cooling) 1C4M×4sets/train-set The device for VVVF inverter will be applied Hybrid-SiC due to more energy saving. Maximum current of train-set : Approx.3,200A (Powering) , Approx.5,000A (Regenerating)
14	Brake system	Electric command linked to ATP, combined type of electric and pneumatic, Security brake. Regenerative priority (Entire control, Rainy mode control) Parking brake(leading car), Slide control(Trailer car)
15	Compressor	With air drier 2 or 3 units/train-set Main power: 3-phase 440V・60Hz
16	Auxiliary Power Supply	SIV: 3-phase inverter with IGBT or Hybrid-SiC (self-cooling)　4 units/train-set DC1500V→3-phase 440V・60Hz, single-phase AC220V・60Hz, DC100V Maximum current of train-set : Approx.500A
17	Battery	Sintered alkaline storage battery: DC100V　2 units/train-set
18	Door system	Electric (With adjacent door control backup function) or Pneumatic (With weakened function)
19	Lighting system	Crew cab, Saloon, Headlight, Tail light, Door・Emergency car side light: LED type
20	Fun	Line flow fun
21	Air conditioner	ON/OFF type 3-phase 440V・60Hz Distribution mounting of 2 units /a car
22	Heater	Not mounted
23	PA system	Passenger broadcast: automatic volume control function with a variance amplification, automatic broadcast and outside speaker Broadcast simultaneously by the crew operating unit (Inside and outside) Intercom between crew cab, Interactive emergency communication equipment (with conversation function with the OCC and a broadcast function from the OCC)
24	Space Radio	Digital space radio
25	ATP	CBTC
26	Destination Display	Collective setting by TMS monitor, front and side display (with collar LED)
27	CCTV	Saloon security camera (4 units /a car) Aggregated each car HUB, displayed in TMS monitor and stored in memory in the cab via Ethernet
28	Saloon Display	LCD type (17 inch wide)　8 units/car various guidance display
29	Train Management System (TMS)	Control transmission for powering and service brake command, Monitor transmission for destination, guidance and air conditioner command etc. Trouble monitoring and memory with support guidance, inspection function on the train, On-board driving information system (24hour each device condition memorized) Display function for pressure gage, ammeter, powering and braking conditions etc. Ethernet type・Control transmission : duplex and loop system or duplex and ladder system with redundancy,　Information of CCTV and Monitor transmission for guidance etc. : single system
30	Universal Design	Identification band (cleat) on the floor just before the door Indicator light and chime (inside and outside) at opening and closing doors Wheel chair (free) space
31	Others	Preparation for WiFi etc.

Source: JICA Design Team

2) Limited Express Train

Access to the CIA from Manila City Central is similar to that of Narita airport from Tokyo City Central, from the view point of the distance, traveling time, maximum speed and transportation capacity. This Narita airport access train is a suitable reference for MCRP limited express train.

There are 2 types of Narita airport access railway services which are separately operated by JR East and Keisei railway. The travel time from Ueno to Narita airport. (64.1km) is 44 minutes by “Keisei Sky Liner” with the maximum speed of 160 km/h. The travel time from Tokyo to Narita airport (79.2 km) is 56 minutes by “JR East N’EX” with the maximum speed of 130 km/h. Because the car body dimensions of “N’EX” is larger than that of “Sky Liner”, “N’EX” can provide more comfortable passenger space than “Sky Liner”.

To achieve the interoperable train operation in NSCR and MCRP, the rolling stock gauge and structure gauge shall be the same in 2 lines. From the view point for common use of the depot facilities, stabling tracks, etc., the same size of rolling stock for limited express and commuter shall be proposed. JDT will propose MCRP limited express train concept in consideration of N’EX’s passenger cabin design and Sky Liner’s bogie and running performance.

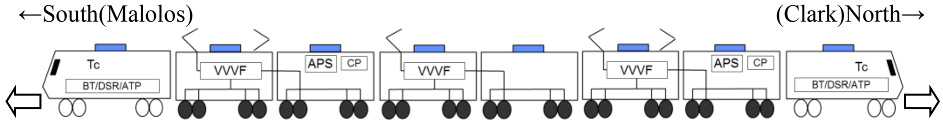
Source: JICA Design Team

Figure 4.3.16 Keisei Sky Liner

Source: JICA Design Team

Figure 4.3.17 Narita Express (N’EX) of JR EAST

Table 4.3.16 Specification and Performance of MCRP Limited Express Train (Draft)

No	Item	Specification, Performance
1	Basic	Limited Express Train DC1,500V Tc: Trailer Car with driver's cab M: Motor car
2	Basic Configuration	6M2T (Tc+M+M+M+M+M+M+Tc) (Empty weight 315t) following is for reference ←South(Malolos) (Clark)North→  38.0t ATP DSR BT / 40.0t 2VVVF 2PT / 40.0t APS CP / 40.0t 2VVVF 1PT / 39.0t / 40.0t 2VVVF 2PT / 40.0t APS CP / 38.0t ATP DSR BT Legend ●:Motor Axle ○:Trailer Axle ⇦:Tight lock coupler ATP: Automatic Train Protection, DSR: Digital Space Radio, VVVF: VVVF inverter, CP: Compressor, APS: Auxiliary power Supply, PT: Pantograph, BT: Battery, : Air Conditioner
3	Performance	Acceleration(Design, starting):3.0km/h/s Deceleration(Design):4.2km/h/s(Max service brake, Instantaneous deceleration) 4.7 km/h/s(Emergency brake, Instantaneous deceleration) Design operation Max speed:160km/h
4	Gauge	1,435mm(standard gauge)
5	Electric system	DC1,500V overhead catenary
6	Capacity	About 400(seats)
7	Body	Material: Light weight stainless steel or Aluminium MAX:19,500 mm (Length)×2,950 mm (Width)×3,655 mm (Height) Reading car length may be longer. MAX Height 4,150mm, when pantograph is folded, 1,130～1,150 mm(Height of floor)
8	Bogie	Bolster less type, Max axle weight:16t
9	Coupler	Driver's cab side of leading car: tight lock coupler Intermediate car, and the other side of leading car : semi-permanent coupler Connectable with NSCR train without adapter
10	Current Collection	Single arm type 5 pantographs/1 train-set (With high voltage train line)
11	Traction Motor	3-phased totally enclosed high efficiency induction motor 4 units / M car Non- disassembly bearing exchange type
12	Driving device	Parallel cardan
13	Propulsion system	VVVF inverter(Self cooling) 1C4M×6sets/train-set The device for VVVF inverter will be applied Hybrid-SiC due to more energy saving. Maximum current of train-set : Approx.4,000A (Powering) , Approx.5,350A (Regenerating)
14	Brake system	Electric command linked to ATP, combined type of electric and pneumatic, Security brake. Regenerative priority (Entire control, Rainy mode control) Parking brake(leading car), Slide control(all cars)
15	Compressor	With air drier 2 or 3 units/train-set Main power: 3-phase 440V・60Hz
16	Auxiliary Power Supply	SIV: 3-phase inverter with IGBT or Hybrid-SiC (self-cooling) 2 units/train-set DC1,500V→3-phase 440V・60Hz, single-phase AC220V・60Hz, DC100V Maximum current of train-set : Approx.300A
17	Battery	Sintered alkaline storage battery: DC100V 2 units/train-set
18	Door system	Electric or Pneumatic (With weakened function)
19	Lighting system	Crew cab, Saloon, Headlight, Tail light, Door・Emergency car side light: LED type
20	Fun	Line flow fun

No	Item	Specification, Performance
21	Air conditioner	ON/OFF type 3-phase 440V・60Hz Under consideration (including ventilation function)
22	Heater	Not mounted
23	PA system	Passenger broadcast: automatic volume control function with a variance amplification, automatic broadcast and outside speaker Broadcast simultaneously by the crew operating unit (Inside and outside) Intercom between crew cab, Interactive emergency communication equipment (with conversation function with the OCC and a broadcast function from the OCC)
24	Space Radio	Digital space radio
25	ATP	CBTC
26	Destination Display	Collective setting by TMS monitor, with collar LED
27	CCTV	Saloon security camera Aggregated each car HUB, displayed in TMS monitor and stored in memory in the cab via Ethernet
28	Saloon Display	Under consideration
29	Train Management System (TMS)	Control transmission for powering and service brake command, Monitor transmission for destination, guidance and air conditioner demand etc. Trouble monitoring and memory with support guidance, inspection function on the train, On-board driving information system (24hour each device condition memorized) Display function for pressure gage, ammeter, powering and braking conditions etc. Ethernet type・Control transmission : duplex and loop system or duplex and ladder system with redundancy, Information of CCTV and Monitor transmission for guidance etc. : single system
30	Universal Design	Identification band (cleat) on the floor just before the door Indicator light and chime (inside and outside) at opening and closing doors Wheel chair space
31	Toilet	2, One of them is a wheelchair accessible type Under consideration
32	Others	Under consideration about Wi-Fi, power supply and USB, etc.

Source: JICA Design Team

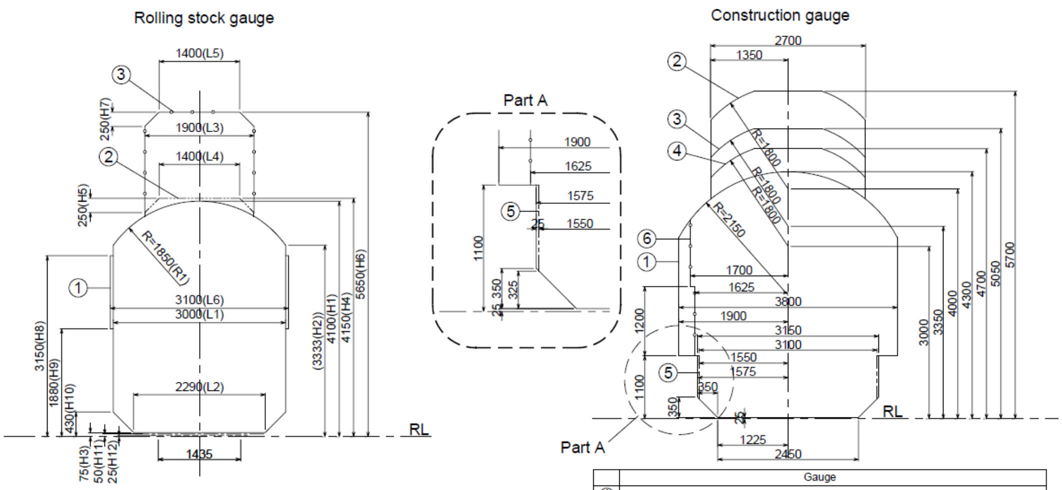
(3) Car Body (Common to Limited Express Train and Commuter Train)

1) Car Body material

Recently, stainless steel and aluminium alloy are widely used as the car body material for commuter train because of the high strength and light weight. There is a tendency to use light aluminium alloy for subway train, which requires higher acceleration performance to accommodate comparatively short distance between stations. Limited express train also requires high acceleration characteristics as much as possible. Both aluminium alloy and stainless steel can be applied to the car body in this project.

2) Rolling Stock Gauge and Construction Gauge

Considering through operation to NSCR, the Rolling Stock Gauge shall be the same dimensions as reports of NSCR-DD. Figure 4.3.18 shows the proposed dimensions of Rolling Stock Gauge and Construction Gauge. This is the same as commuter vehicles described in reports of NSCR-DD. Regarding the technical specification of rolling stock for MCRP, Japanese Industrial Standards (JIS) will be basically applied. According to item 8.2.2.1 and item 8.2.2.1A in JIS E 4041 (2009), Kinematic Rolling Stock Gauge does not have to be considered if Static Rolling Stock Gauge is stipulated as below.



		Gauge	
	——	Basic	H1,H2,H3,H10,L1,L2,R1
②	—·—·	Gauge when current collector is folded.	H4,H5,L3,L4
③	—o—	Gauge in relation to top of roof when current collector is operated.	H6,H7,L3,L5
①	═	Gauge in relation to signs,marker lamps, car side lamps.	H8,H9,L6
	— — —	Gauge in relation to parts that do not move vertically due to action of bogie spring.	H11,L2
	- - - -	gauge in relation to sanding pipe,obstacle deflector, brake shoe and other parts that do not exceed the wheel rim width.	H12

	Gauge
①	Basic Gauge
②	Gauge for track on which trains run receiving supply of direct current.
③	Gauge for tunnels, bridge, overpass, along track on which trains run receiving supply of direct current.
④	Gauge for tunnel section in case of using rigid overhead wire or safe supporting system.
⑤	Gauge only platform edge. —‑‑‑— Remark : It can be applied when the passage velocity of a train is 120 km/h or less. The use in the case of 120 km/h or more is forbidden strictly.
⑥	Gauge only Platform screen door. ‑o‑‑o‑— Remark : It can be applied when the passage velocity of a train is 120 km/h or less. The use in the case of 120 km/h or more is forbidden strictly.

Source: JICA Design Team

Figure 4.3.18 Rolling Stock Gauge and Construction Gauge for NSRP

(4) Capacity, Train Configuration and Accommodations for Rolling Stock (Commuter Train)

1) Capacity and Train Configuration

The passenger capacity is as same (7 standees/m2) as reports of NSCR-DD. The number of passenger capacity for each car, based on floor space which, excepted for 250mm from seat, and having both valid width over 550mm and valid height over 1900mm, is shown below, where values in bracket ( ) are the seat capacities. The proposed train composition for MCRP is eight (8) cars based on the operation plan.

- Leading Car : 266 (45) persons
- Intermediate Car : 285 (54) persons
- Capacity of train (8 cars) : 2,242 (414) persons

The proposed configuration of commuter train set for MCRP will be two (2) trailer cars with cab, four (4) motor cars and two (2) trailer cars in total of eight (8) cars, i.e., 4M4T (MT-ratio 1:1). The train configuration based on the operation plan will be detailed by JDT.

2) Accommodations

Considering similar environment, e.g., travelling time, objectives, preferences, etc., of commuting passengers in Metro Manila to that in Tokyo, commuter trains in Tokyo are considered as the reference for MCRP. An example of the accommodation for commuter train in Tokyo is shown in Figure 4.3.19.

Source: Tokyo Metro

Figure 4.3.19 The example of accommodation for the commuter train in Tokyo

3) Number of Passenger Door and Pitch of Passenger Door

The number of passenger door per car should be decided in consideration of stopping time at station, number of passenger, and door positon of PSD and Rolling Stock.

PSD will be installed in Malolos-Clark Railway Project, so pitch of opening width of PSD and train passenger doors should be fit to get on and off the train. In this project, train configuration will be changed from 8-cars to 10-cars in the future, so even if the train configuration is changed, passenger doors of each configuration train should fit the opening pitch of PSD completely. Moreover, in case of coexisting operation of 8-cars trains and 10-cars trains, passenger door pitch and PSD pitch should fit completely.

To make it possible, door pitch of the leading cars and intermediate cars should be the same and at regular intervals. Therefore, the specification based on “JRIS-R1001 Standard Specification Guideline for Commuter Trains” regulated by “Japan Association of Rolling Stock Industries” is proposed.

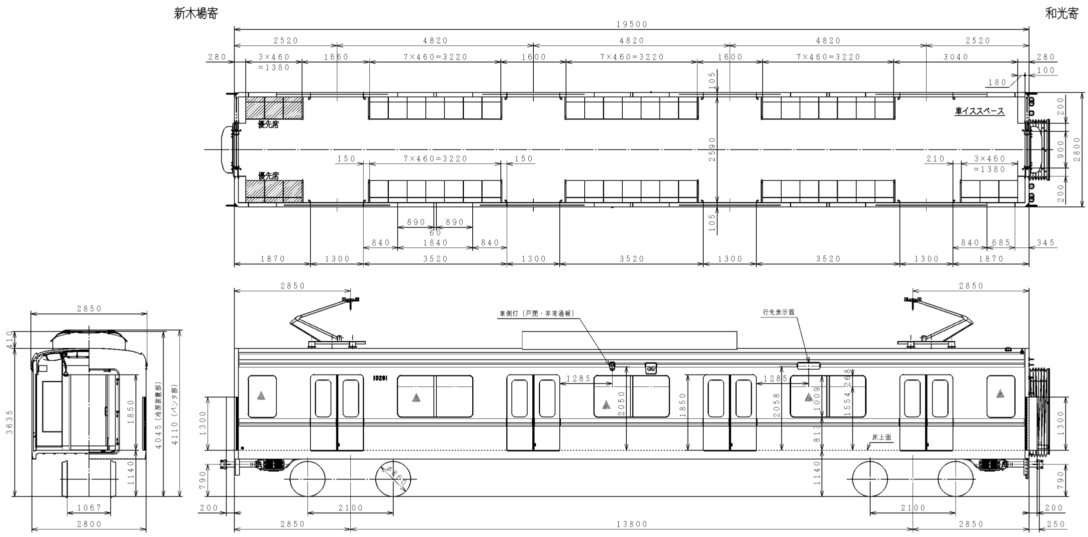


Figure 4.3.20 Sample of subway commuter train in Japan (Motor car)

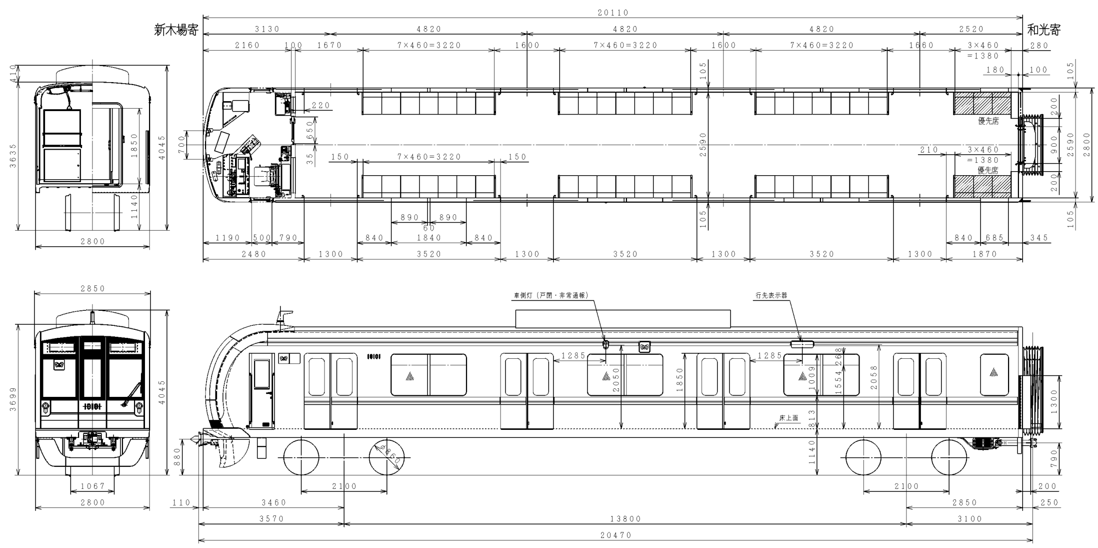


Figure 4.3.21 Sample of subway commuter train in Japan (Trailer car with driver cab)

(5) Capacity, Train Configuration and Accommodations for Rolling Stock (Limited Express Train)

1) Total Passenger Capacity and Train Configuration

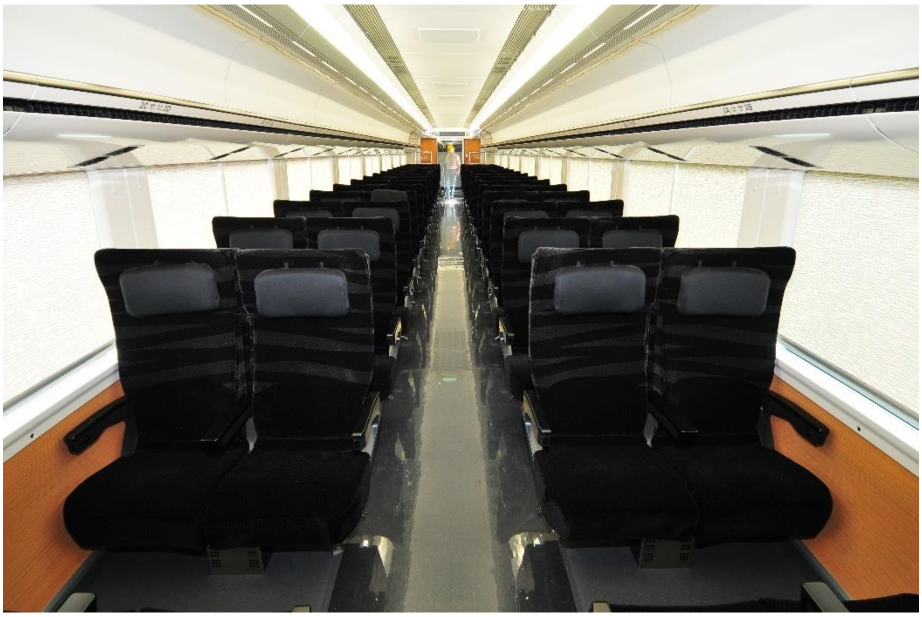
For common use of the depot facilities and stabling tracks, the body of limited express train should be the same size as that of commuter train. JDT proposed the intermediate car's body size as 19,500×2,950×3,655 mm (leading car may be little longer).

The total number of seats per train is about 400 persons in 8cars train set. Those numbers shall be reviewed in further study.

2) Accommodations

The facility of passenger cabin of JR East "N'EX" may be a good reference for the airport limited express train. N'EX consists of one First class passenger car and 5 coach class cars. Figure 4.3.22 shows the coach class cabin interior of N'EX. The seat layout of all cars is 2×2. JDT uses this cabin interior as a reference for proposing the passenger cabin design of Limited Express Train.

There shall be two set(s) of toilet facility in 8 car train set. At least one toilet set shall be accessible to wheel chair person. The large luggage space shall be provided near the cabin entrance.



Source: JR East

Figure 4.3.22 Sample of passenger cabin for Limited express train

3) The Number of Passenger Door

The number of passenger doors per car may be one or two. But it needs to be further studied considering number of the stopping station and breakdown of the passenger demand into getting on and off.

(6) Acceleration and Deceleration for Commuter Train

1) Acceleration

The acceleration performance of commuter train for MCRP is determined in consideration of the demand forecast, the alignment and the energy saving of train operation in particular. In principle, these are adapted from report of NSCR-DD as follows:

Starting acceleration : 3.3 km/h/s (at the condition of 20ton/car load, Design value),
Maximum speed : 120 km/h.

2) Deceleration

The deceleration performance of commuter train for MCRP is shown below. These are the same as the deceleration of report of NSCR-DD.

Maximum service braking : 4.2 km/h/s (at the condition of 20ton/car load, design value),
Instantaneous emergency braking : 4.7 km/h/s (at the condition of 20ton/car load, design value).

The specifications of deceleration performance of MCRP are determined in consideration of the demand forecast, the alignment and the energy saving of train operation in particular.

(7) Acceleration and Deceleration for Limited Express Train

1) Acceleration

The acceleration performance of Limited Express train for MCRP is determined in consideration of the demand forecast, the alignment and the energy saving of train operation in particular as follows:

Starting acceleration : 3.0 km/h/s (at the condition of 7ton/car load, Design value),
Maximum speed : 160 km/h.

2) Deceleration

The deceleration performance of Limited Express train for MCRP is shown as below. These are the same as the deceleration of commuter train for MCRP.

Maximum service braking : 4.2 km/h/s (at the condition of 7ton/car load, design value),
Instantaneous emergency braking : 4.7 km/h/s (at the condition of 7ton/car load, design value).

The specifications of deceleration performance of MCRP are determined in consideration of the demand forecast, the alignment and the energy saving of train operation in particular.

(8) Bogie (Common to Limited Express Train and Commuter Train）

The bogie of limited express and commuter train shall be the same basic specifications as report of NSCR-DD and should comply with the specifications proven in service shown below. In addition, the bogie for limited express shall be designed considering safe and stable performance in running at the maximum speed of 160 km/h.

Bogie Type	: Bolster-less type
Primary Suspension	: Coil Springs
Secondary Suspension	: Air Springs
Bogie Frame	: to be fabricated by steel, welded hollow girder in H shape

(9) Main Electric Equipment

1) Objective of Design

The same design policy of report of NSCR-DD shall be applied to the specifications of main electric equipment for MCRP. To ensure the safety and stable railway operation in MCRP, much of technical knowledge and know-how accumulated in Japanese manufacturers is favourably applied, including introduction of new technology like SiC element, etc. Design of the electric equipment proven in Japan should be applied to the rolling stock for MCRP as much as possible.

The design of electric equipment shall employ fail-safe concept against an unusual malfunction with providing a redundancy in the system. The equipment for recording of operational information and failure analysis shall be employed as a measure to realise fail-safe concept.

The design of electric equipment shall consider easy maintenance and energy saving. For example, application of the totally-enclosed high-efficiency traction motor (the non-disassemble type for replacing the bearings) will result in tight pollution protection of the internal of motor, easy replacement of the bearings, reduction of loss, and energy saving by increasing regenerative power.

With those design considerations, easy maintenance and high energy saving can be realized, thereby ensuring stable operation of the rolling stock in longer operation life.

2) Propulsion System for Commuter Train

In consideration of sufficiency in the normal running conditions, redundancy in the system upon unusual malfunction, energy saving and easy maintenance, as well as appropriate margin in the passenger demand, the specifications for propulsion system are proposed as below:

- Self-cooling and four(4) traction motors control system,
- Hybrid-SiC device,
- Application of high-efficiency totally enclosed traction motor and Non-disassemble type for replacing the bearings,
- Capable of continuous round-trip when the one (1) unit cut (equivalent to the cut of four(4) motors), (Part of regenerative function will be restricted.)
- Capable of one round-trip when the two (2) unit cut (equivalent to the cut of eight(8) motors), (Part of regenerative function will be restricted or all of regenerative function will be cut.),
- The 8 cars-composition train without any failure is able to tow or rescue the failed 10 cars-composition train at the uphill slope of 35‰.

Recently, electrical devices made of SiC (Silicon-Carbide) has been widely applied to VVVF inverter in Japan to achieve further energy saving. The manufacturers in Japan have enabled mass production of such VVVF inverter. The possibility of applying the SiC system will be considered.

An example of reducing the energy consumption using the high-efficiency induction motor and SiC system at Tozai-Line of Tokyo Metro is shown in Figure 4.3.23. Tokyo-Metro has achieved substantial reduction in the energy consumption of 26% compared with the conventional VVVF system brought by regenerative braking at the high-speed area.


Tokyo Metro Series 05


Tokyo Metro Series 15000

Car Type	Rate of Electric Power Consumption of Powering	Rate of Regenerative Electric Power	Regenerative Factor	Rate of Electric Power Consumption	Reduction Effect of Electric Power Consumption
	kWh/c・km	kWh/c・km	%	kWh/c・km	%
Series 05 with VVVF invertor	2.04	0.83	40.1%	1.21	
Series 15000 with VVVF invertor and High Efficiency Induction Motor	1.87	0.84	45.4%	1.03	-14.9
Series 15000 with SiC and High Efficiency Induction Motor	1.82	0.93	51.1%	0.89	**-26.4**

Source: Tokyo Metro

Figure 4.3.23 Reduction Effect of Electric Power Consumption Attributed by High Efficiency Motor and SiC

3) Propulsion System for Limited Express Train

Same as commuter train, in consideration of sufficiency in the normal running conditions, redundancy in the system upon unusual malfunction, energy saving and easy maintenance, as well as appropriate margin in the passenger demand, the specifications for propulsion system are proposed as below:

- Self-cooling and four(4) traction motors control system,
- Hybrid-SiC device,
- Application of high-efficiency totally enclosed traction motor and Non-disassemble type for replacing the bearings,
- Capable of continuous round-trip when the one (1) unit cut (equivalent to the cut of four(4) motors),
- (Part of regenerative function will be restricted.)
- Capable of one round-trip when the two (2) unit cut (equivalent to the cut of eight(8) motors),
- (Part of regenerative function will be restricted or all of regenerative function will be cut.),
- The train without any failure is able to tow or rescue the failed 10 cars train-sets at the uphill slope of 35‰.

As well as the system of Commuter Train, regarding the VVVF inverter for Limited Express train, the possibility of applying the SiC system will be considered.

4) Brake System

Service brake, emergency brake and security brake shall be equipped. The security brake is also served as a backup upon breakdown of the emergency brake. In the leading car, parking brake is equipped to be used when a vehicle is placed.

The service brake is to undertake the regenerative braking force of the trailer car in order to maximize the effective use of regenerative braking. When the regenerative braking force is insufficient to the required total braking force, firstly pneumatic braking force is applied to the trailer car. In case insufficiency persists, the secondary pneumatic braking force is applied to the motor car. The brake system will control the brake force balance for all train set by sharing regenerative brake and service brake in trailer car while it keeps a good riding condition and prevents from skidding.

During rainfall, the vehicle towards the top is prone to skid. In order to minimize ride deterioration by skidding and braking distance, the braking force in the preceding vehicle is reduced and the additional braking force shall be supplemented at the succeeding vehicle. At the same time, the required braking force for the entire vehicle is ensured by TMS. Regenerative braking should be restricted to an appropriate torque.

The trailer cars of commuter train are equipped with a skidding suppression device in order to prevent damage to the wheel. The motor cars of commuter train are not equipped with this device, because the skid-slide is controlled by the propulsion system. While, all cars of limited express train are equipped with this device.

5) Signalling system

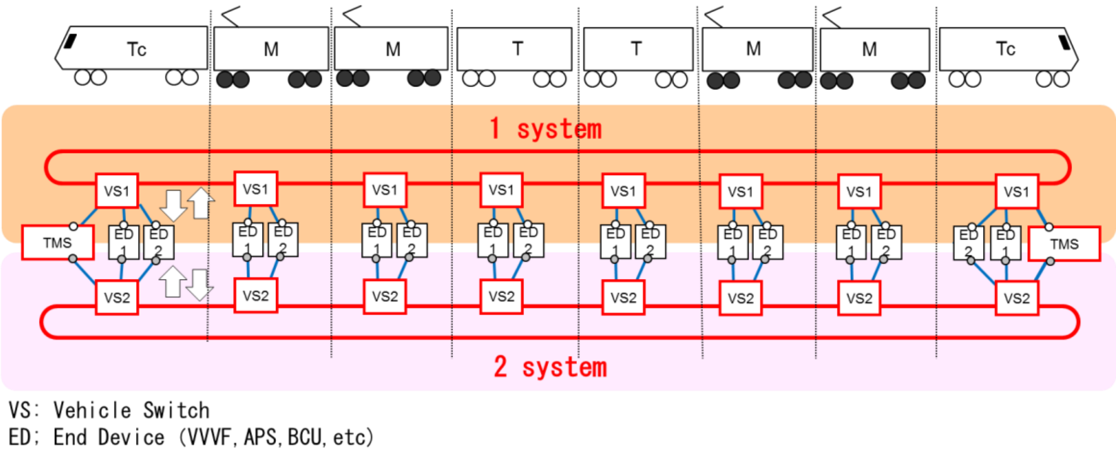
CBTC has been determined to be adopted to the signalling system of NSCR. So the signalling system of MCRP shall also employ CBTC to realise the interoperability with NSCR.

6) Train Management System (TMS)

TMS is a network and information system for the various commands and information management in the train set. TMS shall be designed to sufficiently keep the service record in Japan or other countries. TMS should have versatility and redundancy and employ the design complying with the respective international standards.

100 Mbps network shall be installed in the train set. The various commands, the operating information of each device and the video of CCTV will be transmitted by TMS network. Information transmitted shall be displayed on the TMS monitor in the driver cab and be stored in the memory of the TMS. The stored information can be checked upon failure or trouble. In Japan, this operating information record is extremely helpful to grasp the situation upon trouble and to identify the failure in equipment, etc.

The control command system of train operation consists of two independent systems and each forms a loop network configuration. When one loop is down, all system can continue to operate normally with the other loop. Even if the transmission is interrupted in the middle of the loop, all system can continue to operate normally by being transmitted from the other way round. Usually TMS employs the loop system diagram for keeping a high redundancy. It is also applicable to ladder type duplex system for keeping the same high reliability.



Source: JICA Design Team

Figure 4.3.24 Image of TMS Network

7) PSD Control

PSD will be introduced to MCRP. Various methods of PSD control have been introduced into Japanese railway. Oldest method with mass record is that when the operator operates the door opening / closing button of the cab, the PSD and the vehicle door open and close in cooperation. PSD system operates exchanging information between the on-board antenna and the ground antenna. It is necessary for PSD to be applicable for Limited express train, because MCRP operates also Limited express train. Interface between PSD systems and Rolling Stock, specification of both system are under consideration.

Source: Tokyo Metro

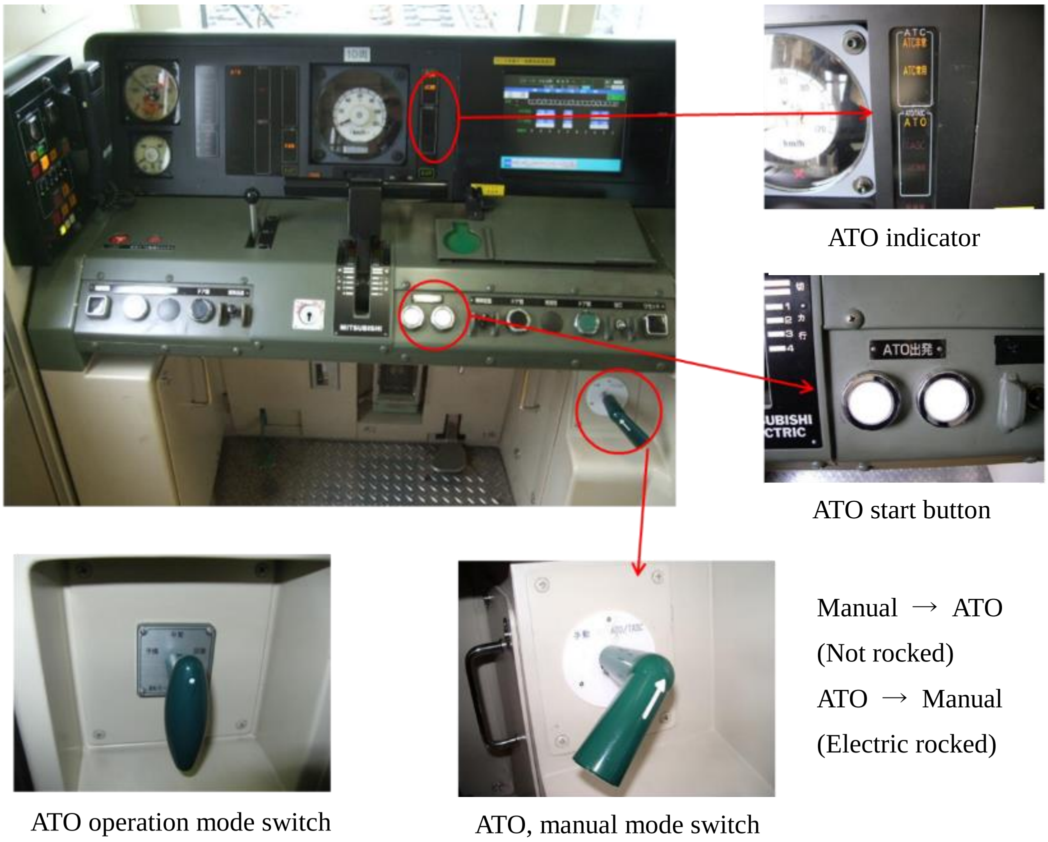
Figure 4.3.25 Sample of PSD of Tokyometro Namboku Line (Full Height type)

Source: Tokyo Metro

Figure 4.3.26 Sample of PSD of Tokyometro Fuku-toshin Line (Half Height type)

8) Driver Cab (meter indicator, radio operator, ATP switch, door opening / closing switch)

In addition to the master controller, a meter indicator for CBTC, a radio controller for, an ATP switch, a door opening and closing button, etc, are required for the driver cab.



Source: Tokyo Metro

Figure 4.3.27 Sample of ATO･PSD switch (Tokyometro, 10000 series)

It is necessary that the functions not used in other lines are invalidated by the line recognition of the driver key and the changing switch. Also, it is necessary to consider the circuit configuration that takes into consideration the abnormality.

9) Countermeasures against inductive interference

Generally, in case on board antenna of ATP is mounted on Rolling stock, in order to eliminate the influence of electromagnetic noise from the motor, the auxiliary power supply, the VVVF inverter, etc., the on-board antenna is required to be separated from the devices or another on-board antenna by a certain distance or more. Therefore, since the on-board antenna is generally mounted at the top of the car, it tends to avoid mounting the motor and the auxiliary power supply in the leading car. Even if it is inevitably installed, it is necessary to take measures such as installing a shielding plate or to secure a certain distance or more from the noise source, but the requirement varies depending on the manufacturer.

It is desirable that the on board antenna is mounted on nearby the center of bogie as possible in order to secure coupling the on board antenna and the ground antenna at curve. Therefore, this is contradictory to requiring separation from the motor as a countermeasure against inductive interference.

In the request for the mounting of the on-board antenna of a certain manufacturer, it is required to take a distance of 3.5 m or more from another on-board antenna or the high-frequency noise source.

In Japan, inductive interference to on-board antenna caused by electromagnetic generator unit is difficult to settle especially on through service operation where several units from different brand are involved because in some cases, a large cost may arise and it's important that we be aware of it.

10) Stopping accuracy at station fixed point stopping for PSD

According to ever study, PSD system will be set on MCRP. In this case, Rolling stock design and consistency with ground system considering ATO operation and Stopping accuracy at station fixed point stopping shall be required.

In this project, reduction of regenerative force, or regenerative fault will be sometimes happened. In this case, the pneumatic braking force is necessary. Therefore, deceleration characteristics may change due to maintenance such as monthly inspection and regular inspection or disturbance such as grease or water adhesion between the wheel tread and the brake shoe, so which can cause deterioration of the ATO stopping accuracy. In the Japanese subway, some trains are equipped with ATO can grasp the characteristics of the vehicle sequentially and correct the ATO vehicle model to reduce the influence of changes in deceleration characteristics and individual differences on stopping accuracy, and some trains are equipped with braking shoe which can remove grease attached to the wheel tread. Above should be used as a reference.

In addition to stopping accuracy, it is necessary to pay attention to ride comfort from the viewpoint of passenger service, and it is necessary to design an optimum stopping pattern such as the low deceleration stopping pattern while keeping the predefined running time.

For high stopping accuracy and comfortable ride ATO operation, main things to consider are as follows.

- Increasing regenerative voltage limiter for regenerative brake stabilization
- Brake shoes with less friction coefficient fluctuation against speed range, disturbance (oil, water etc.)
- Periodic cleaning of bogie (removal of oil on brake shoe and wheel tread)
- Suitable station stopping pattern for each station (ATO programing)
- Brake force balance between regenerative brake and pneumatic brake
- Velocity sensor that can detect accurately up to extremely low speed range
- Learning function of Rolling stock characteristics (learn and modify deceleration characteristics over time)

(10) Concept of design life (Common to Limited Express Train and Commuter Train)

Commuter trains operated in Japan are manufactured to a design life as shown below. Moreover, railway operator has achieved the high availability and reliability by appropriate maintenance and supervision, investigating cause of failure, and implementing appropriate countermeasure in cooperation with the manufacturers.

- Body / bogie : over 30 years
- Power conversion element, filter capacitor : over 25 years
- General electrical parts : over 12 years
- Some special parts : about over 8 years

(11) Standards (Common to Limited Express Train and Commuter Train)

The following Japanese standards are used for the both projects as for commuter train described in report of NSCR-DD:

- JIS (Japanese Industrial Standards),
- JRIS (Japanese Railway Industrial Standards),
- Ministry of Land Infrastructure, Transport and Tourism (MLIT) (JAPAN).

(12) Maintenance (Common to Limited Express Train and Commuter Train)

1) Maintenance Type and Cycle

The type and cycle of maintenance of rolling stock shall be as follows from the typical maintenance practice in Japan.

Table 4.3.17 Type and cycle of maintenance (Draft)

Category		Period
Departure Inspection		Before departure
Light Maintenance	Weekly Inspection	Within 6 days
	Monthly Inspection	Within 3 months (90 days)
Heavy Maintenance	Semi overhaul	Within 4 years or Within 600,000 km
	Overhaul	Within 8 years or Within 1,200,000 km
	General overhaul (Renewal)	Every 10 to 15 years
Other Maintenance	Unscheduled Repair	Whenever necessary

Source: JICA Design Team

2) Maintainability

Without maintenance, rolling stock is not secured to be in order over the service period. If the operator intends to operate the rolling stock without trouble, it should be properly maintained. Maintenance is very important for railway operation for preventing troubles. There are three types of the maintenance, namely breakdown maintenance, preventive maintenance and condition-based maintenance, described hereunder.

- Breakdown Maintenance
  Upon break down of rolling stock in operation, the operator takes it to the depot, repairs there, and then reuses. Disadvantage of this maintenance is a disruption in the railway schedules.
- Preventive Maintenance
  The operator regularly takes rolling stock to depot and periodically repairs as required. Advantage of this maintenance is to prevent unexpected breaking down of the rolling stock in operation, thereby avoiding disruption in the operation schedule.
- Condition-Based Maintenance
  Each device of rolling stock is monitored at all times, and when there is a sign of breakdown in the device, the operator takes that rolling stock to depot and repairs it.

Theoretically, the advantage of this maintenance is continuous use of the rolling stock full time until its failure. It is therefore called advanced maintenance. In practice, difficulties in identifying the sign of breakdown in reasonable advance, use of the rolling stock full time until onset of breakdown is not possible. Many railway operators in the world adopt the preventive maintenance method for the reason that there is no disruption in the operation schedule. This maintenance method is considered as the best option among others for stable train operation.

Irrespective of the maintenance methods above mentioned, it is essential to plan appropriate budget to secure sufficient amount of consumable parts, spare parts, and repair parts. Those parts should be always available upon repair of rolling stocks.

4.3.4 Depot Facility and Equipment for Rolling Stock

The railway transportation system is an essential public infrastructure to serve for socio-economic activities. Because of the importance and responsibility for public human activities, it should be absolutely safe for handling a large number of passengers. Also, rolling stock for the railway is required to be kept in a good condition for the above role and function. By practicing the preventive maintenance, it is indispensable to keep the railway system sustainable and highly safe. Facilities and equipment to be provided at depot for maintenance is also described in this section, in respect of the design policy and conditions considered in the Project(s).

(1) Policy to Design

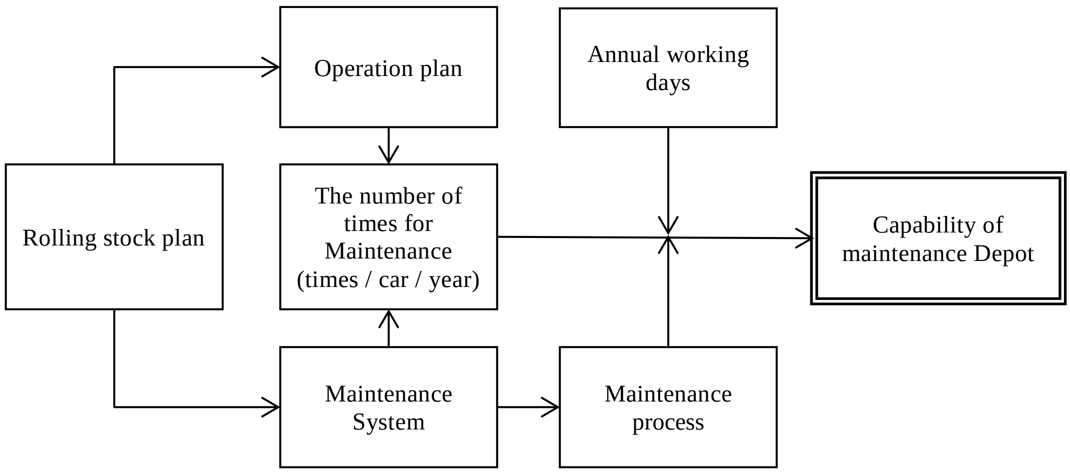
"Inspection", "repair", and "cleaning" for rolling stock maintenance shall be consistent with the rolling stock itself. The following conditions are considered adequate for maintenance facilities in the depot(s) (Figure 4.3.28).

- Maintenance for rolling stock
  - Rolling stock type (EMU trains) and the number of cars in a train set
  - Maintenance categories (as same as in NSCR-DD, Table 4.3.2)
  - Work flow of each maintenance (as the same method as in NSCR-DD)

- Operation plan
  - Required number of train sets for operation
  - Kilometric performance per day and train set
  - Section of train operation

- Number of working days
  - Annual working days per year in the Philippines (as same as in NSCR-DD conditions)

Capacity of the depot(s), and its required facilities and equipment are determined following the schematic flow chart as shown in Figure 4.3.28.



Source: JICA Design Team

Figure 4.3.28 Planning Flow for Maintenance Depot

In addition, the following basic concepts will be considered into the design.

- Facilities will be reasonably allocated to secure high work efficiency,
- Introduction of latest and proven facilities will be planned for shortening the inspection process and improving productivity, and,
- By introducing these facilities, improvement in maintenance quality and working environment will be achieved as well.

(2) Pre-conditions for Design

DOTr considers interoperability among three lines and requested that all these depots, including one in Valenzuela for NSCR, will be commonly used for MCRP and NSRP-South rolling stocks.
Pre-conditions for designing the Depots and workshop under this request are the followings.

1) Rolling Stock

Rolling Stock was already described in 4.3.3. There are 3 packages in the Project(s);

- MCRP Limited express train,
- MCRP Commuter train, and,
- NSRP-South Commuter train.

These trains have 8 cars for one train-set and future additional plan: 10 cars for one train-set. In addition, Commuter trains have the common specifications for operation with NSCR Commuter train.

2) Rolling Stock Maintenance System

Table 4.3.18 shows Rolling Stock Maintenance System for Commuter trains.

Table 4.3.18 Basic Rolling Stock Maintenance System for Commuter Trains

Category		Period	Maintenance Content
Departure Inspection		Before departure	Check in-service monitoring, visual check of major parts of cars.
Light Repair	Weekly Inspection	Within 6 days	Check status of bogies, wheels, pantograph, doors and other items while cars are connected. Replace consumables for brakes, pantographs and other items.
	Monthly Inspection	Within 3 months (90 days)	Confirm the status of cars and their functions while cars are connected. Replace consumables, measure voltage of auxiliary circuits, control circuit and other circuits, inspect functioning of main circuit, etc.
Heavy Repair	Semi overhaul	Within 4 years or Within 600,000 km	Remove bogies, wheels, wheel axles, brakes, main motors and other major parts, perform detailed inspection and replace parts
	Overhaul	Within 8 years or Within 1,200,000 km	Disassemble almost all parts, perform detailed inspection of devices.
	General overhaul (Renewal)	Every 12 to 15 years	General overhaul shall carry out replacement of the major electronic parts with new one. If it is necessary, the interior is renewed.
Other Maintenance	Unscheduled Repair	Whenever necessary	Replace broken-down parts. (Bogies, pantograph, air conditioner, etc.).
	Wheel re-profiling	150,000km	Use wheel profiler to correct wheel shape and maintain ride comfort level.
Train Preparation	Turn back cleaning	Every shop-in and turn back	Pick up trash.
	Daily cleaning	Within 3 days	Interior cleaning (floor and window) Exterior cleaning (front and rear windshield) Car-body side panel cleaning by automatic car-body washer
	Monthly cleaning	Within 1 month (30 days)	Interior cleaning (floor waxing and all interior parts cleaning) Exterior cleaning (car-body, front and rear windshield)

Source: JICA Design Team

This maintenance system is same as NSCR Commuter train. On the other hand, Table 4.3.19 shows Rolling Stock Maintenance System for Limited Express train.

Table 4.3.19 Basic Rolling Stock Maintenance System for Limited Express Train

Category		Period	Maintenance Content
Departure Inspection		Before departure	Check in-service monitoring, visual check of major parts of cars.
Light Repair	Weekly Inspection	Within 6 days	Check status of bogies, wheels, pantograph, doors and other items while cars are connected. Replace consumables for brakes, pantographs and other items.
	Monthly Inspection	Within 3 months (90 days)	Confirm the status of cars and their functions while cars are connected. Replace consumables, measure voltage of auxiliary circuits, control circuit and other circuits, inspect functioning of main circuit, etc.
Heavy Repair	Semi overhaul	Within 4 years or Within 600,000 km	Remove bogies, wheels, wheel axles, brakes, main motors and other major parts, perform detailed inspection and replace parts. Paint car body.
	Overhaul	Within 8 years or Within 1,200,000 km	Disassemble almost all parts, perform detailed inspection of devices. Paint car body.
	General overhaul (Renewal)	Every 12 to 15 years	General overhaul shall carry out replacement of the major electronic parts with new one. If it is necessary, the interior is renewed.
Other Maintenance	Unscheduled Repair	Whenever necessary	Replace broken-down parts. (Bogies, pantograph, air conditioner, etc.).
	Wheel re-profiling	100,000km	Use wheel profiler to correct wheel shape and maintain ride comfort level.
Train Preparation	Turn back cleaning	Every shop-in and turn back	Pick up trash.
	Discharge Sewage	Within 2 days	Discharge sewage from tank on the train.
	Daily cleaning	Within 3 days	Interior cleaning (floor and window) Exterior cleaning (front and rear windshield) Car-body side panel cleaning by automatic car-body washer
	Monthly cleaning	Within 1 month (30 days)	Interior cleaning (floor waxing and all interior parts cleaning) Exterior cleaning (car-body, front and rear windshield)

Source: JICA Design Team

There are a little difference specifications and their operations between Commuter train and Limited Express train. For example, Limited express train has the toilet, and, the car body of Limited express may be painted. JICA Design Team assumed that Wheel re-profiling will be conducted within 100,000km because the kilometric performance of Limited Express train is longer than Commuter trains. Moreover, JICA Design Team also assumed that the car body of Limited Express train needs to be painted when Heavy Repair is conducted.

3) Candidate Sites for Depot and Workshop

Candidate Sites for Depot and Workshop are the land connecting to Clark station and the land near Mamatid connecting to Calamba Station (as described in Figure 4.3.1).

4) Train Operation Plan

Train Operation plans were already described in 4.3.2. This Train Operation Plan based on the forecast demand that was requested to study by JICA on last June at JICA-FF mission and agreed from JICA and DOTr is treated as the pre-condition of design. Number of stabling trains is shown in Table 4.3.20. On Table 4.3.20, Valenzuela Depot will be constructed on NSCR line, North Depot will be constructed on MCRP line, and South Depot will be constructed on NSRP-South line.

Table 4.3.20 Number of Stabling Trains at Each Depot in 2040 (tentative)

Type / Location	North Depot	Valenzuela Depot	South Depot	Alabang Station	Total
Limited Express	4	2	0	2	8
Commuter (Include Commuter Express)	21	6	25	0	52

Source: JICA Design Team

The kilometric performance of this is shown in Table 4.3.21.

Table 4.3.21 Kilometric performance of each train in 2040 (tentative)

Type	Total Kilometric performance	Number of Train set for operation	Average of Kilometric performance for operation
Limited Express	9,048 km / day	8	1,131 km / day / train-set
Commuter (Include Commuter Express)	36,503 km / day	52	702 km / day / train-set

Source: JICA Design Team

This train operation plan is determined.

5) Valenzuela Depot and Workshop

When design is conducted, the capacity of Valenzuela Depot and Workshop should be considered. In the Project(s), Verification for Rolling Stock operation will be only conducted.]

6) Through operation between NSRP-South and MMSP

This study were requested by DOTr and is under studying. However, based on the train operation considering this through operation, it is not necessary to add the Depot facility and equipment for rolling stock at North Depot and Workshop. The reasons are that the only MMSP trains will be operated for this through operation and 5 MMSP trains will be stabled at only South Depot. Therefore, in this report, the facility and equipment plan for this through operation is not described. If these pre-conditions will be changed, the design of each facility and equipment have to be examined again. Moreover, if necessary, the design have to be conducted again.

(3) Setting Conditions for Design

Based on Pre-conditions, the setting conditions are made as follows.

1) Facility Plan with Consideration on Rolling Stock Packages

It should be mentioned that Depot and Workshop in NSCR project is out of scope in the Project(s). The depot facilities and equipment will be designed according to the specifications for each type of rolling stock. In NSCR project, the bidding for rolling stock is on design-build basis. It means the contractor shall design the rolling stock on a condition that their maintenance is to be conducted at Valenzuela depot. The facilities and equipment, including special tools, jigs and test equipment, to be provided shall be also designed to meet the requirement for maintenance at Valenzuela depot. In order not to affect the bid prerequisites of NSCR, it is proposed that the depot plan at Valenzuela for NSCR will not be changed, and those depots for MCRP and NSRP-South will be designed without considering NSCR trains. The reason for this is that NSCR line will be opened earlier than other two lines and the bid documents of NSCR rolling stock are not opened at this moment.

In case the depots for MCRP and NSRP-South have not become available upon interoperable services among three lines, the maintenance and cleaning for MCRP and NSRP-South commuter trains can be conducted at Valenzuela depot, because these commuter trains share the same specifications as NSCR train. However, in this case, the operator of Valenzuela depot has to ensure the capacity and specifications of facilities and equipment, whether all trains can be accommodated there or not. In consideration of the above and the prerequisites explained in 4.3.1, the proposed plan for depots in MCRP and NSRP-South is summarized in Table 4.3.22. Red highlights on Table 4.3.22 means the scope of this project. This table was agreed with DOTr at 5th Coordination Meeting.

Table 4.3.22 Depot and Workshop Function Plan

Place / Function	North Depot and Workshop				Valenzuela Depot and Workshop (Ref.)				South Depot			
	NSCR Com. (Ref.)	MCRP Exp.	MCRP Com.	NSRP Com.	NSCR Com. (Ref.)	MCRP Exp.	MCRP Com.	NSRP Com.	NSCR Com. (Ref.)	MCRP Exp.	MCRP Com.	NSRP Com.
Stabling Rolling Stock	Done	Done	Done	Done	Done	Done	Done	Done	Done		Done	Done
Weekly Inspection	Done	Done	Done	Done	Done	Done	Done	Done	Done		Done	Done
Monthly Inspection		Done	Done		Done							Done
Wheel re-profiling		Done	Done		Done							Done
Unscheduled Repair		Done	Done		Done							Done
Train Preparation	Done	Done	Done	Done	Done	Done	Done	Done	Done		Done	Done
Heavy Repair		Done	Done	Done	Done							

Note Com.: Commuter train, Exp.: Limited Express train, Heavy Repair: Semi overhaul, Overhaul, and General overhaul.

Source: JICA Design Team

2) Depot Function

a) Basic method of Maintenance works

Depot has basically 5 functions; “Stabling”, “Light Repair”, “Unscheduled Repair”, “Wheel re-profiling”, and, “Train Preparation”. The main purpose of maintenance works at Depot is not to overhaul equipment, but to check or inspect the condition and the function of a rolling stock in operating condition. Therefore, these maintenance works is conducted in operating condition. It is not necessary to uncouple the train set to one by one. This method is being considered into design of Depot.

b) Major Facilities and Equipment

Major facilities and equipment are shown in Table 4.3.23.

Table 4.3.23 Major items of facilities/equipment for Depot

Kind of Function	Major items of facilities/equipment
Stabling	Stabling Tracks for 10 cars’ length
Light Repair	(Light Repair Shop) Pit, Deck, Height scaffold, Front car maintenance platform, Disconnect switch
Unscheduled Repair	(Unscheduled Repair Shop) Bogie replacing equipment, Underfloor equipment lifter, Movable lifting platform, Overhead traveling crane
Wheel re-profiling	(Wheel Re-profiling Shop) Underfloor wheel re-profiling lathe, Shunting locomotive
Train Preparation	(Light Repair Shop) Deck, Sewage discharge pipe (In Depot Area) Automatic car body washer,

Source: JICA Design Team

There are mainly 2 differences from Valenzuela Depot. These differences are Front car maintenance platform and Sewage discharge pipe, and these are used for Limited Express train maintenance. The reason for installation of Sewage discharge pipe is that Limited Express train has toilet facilities. And, the reason for installation of Front car maintenance platform is that the worker can’t conduct maintenance of wiper on front car without this platform because there may be a long-nose shape on front car of Limited Express train.

3) Workshop Function

a) Basic method of Maintenance work

Workshop has the function to overhaul. When Heavy repair is conducted, it is necessary to uncouple the train-set to overhaul equipment and parts. This method is being considered into design of Workshop.

b) Major Facilities and Equipment

Major facilities and equipment are shown in Table 4.3.24.

Table 4.3.24　Major items of facilities/equipment for Workshop

Kind of Function	Major items of facilities/equipment
Semi overhaul, Overhaul, and, General overhaul	(Workshop) Lifting Jack Bogie inspection and repair facilities Disassembly and Assembly facilities for Parts Car body repair facilities Parts inspection and repair facilities Signalling testing and inspection facilities (Painting Shop in the workshop) Car body painting machine (Final Adjustment Shop in the Workshop) Pit, Deck, Height scaffold, Disconnect switch, and, Wheel load measuring System (Common) Shunting locomotive

Source: JICA Design Team

There is a difference from Valenzuela Depot. This difference is Car body painting machine for Limited express. This necessity was already described in 4.3.4(2).

4) Required Time for Maintenance and Annual Working Days

From above pre-conditions and setting conditions, Required Time is set. And also, Annual Working days is set based on the present condition in the Philippines as shown in Table 4.3.25.

Table 4.3.25　Required Time and Annual Working days for each Maintenance (tentative)

Category		Required Time	Annual Working days
Light Repair	Weekly Inspection	2 hours / train	363 days/year, 16 hours/day (2 shifts)
	Monthly Inspection	1 day (8 hours) / train	241 days/year, 8 hours/day (daytime)
Heavy Repair	Semi overhaul	(Commuter) 17 days / train (Limited Express) 19 days / train	241 days/year, 8 hours/day (daytime)
	Overhaul	(Commuter) 10 days / train (Limited Express) 22 days / train	241 days/year, 8 hours/day (daytime)
Other Maintenance	Unscheduled Repair	(depends on failure content) (Assumption : 10 days)	241 days/year, 8 hours/day (daytime)
	Wheel re-profiling	2 hours / car	241 days/year, 8 hours/day (daytime)
Train Preparation	Discharge Sewage	2 hours / train	363 days/year, 16 hours/day (2 shifts)
	Daily cleaning	2 hours /train	363 days/year, 16 hours/day (2 shifts)
	Monthly cleaning	1 day (8 hours) / train	241 days/year, 8 hours/day (daytime)

Source: JICA Design Team

"Required Time" on Table 4.3.25 has been still studied because this table will be determined after Facilities and Equipment Layout is designed.

(4) Basic Design

In this section, results of studies, calculations, and, designs are described.

1) Rolling Stock Operation Plan and Required Capability of Depot and Workshop

Rolling Stock Operation Plan has to be made considering Maintenance work schedule and Train Operation. This Plan should be made at the same time as when Required Capability of Depot and Workshop is calculated.

Moreover, Maintenance base for each rolling stock should be determined because there are 4 rolling stock package including NSCR Commuter train. Based on Table 4.3.22, Table 4.3.26 is set.

Table 4.3.26 Base Depot and Workshop of Rolling Stock

Package	Base Depot	Base Workshop
Ref.) NSCR Commuter train	Valenzuela Depot	Valenzuela Workshop
MCRP Limited Express train	North Depot	North Workshop
MCRP Commuter train	North Depot	North Workshop
NSRP-South Commuter train	South Depot	North Workshop

Source: JICA Design Team

As a result of this study, Rolling Stock Operation Plan is shown in Table 4.3.27 and Table 4.3.28.

Table 4.3.27 Rolling Stock Operation Plan for Commuter train (tentative)

<table>
<tr><th rowspan="2">Depot / Workshop</th><th colspan="2">For Operation</th><th colspan="4">For Maintenance</th><th rowspan="2">Total</th></tr>
<tr><th>Operation</th><th>Stand-by</th><th>Heavy Repair</th><th>Monthly Inspection</th><th>Wheel re-profiling</th><th>Monthly Cleaning</th></tr>
<tr><td>North</td><td>21 trains</td><td>1 train</td><td>2 trains</td><td colspan="3">2 trains</td><td>26 trains</td></tr>
<tr><td>Ref.) Valenzuela</td><td>6 trains</td><td>1 train</td><td>1 train</td><td colspan="3">1 train</td><td>9 trains</td></tr>
<tr><td>South</td><td>25 trains</td><td>1 train</td><td></td><td colspan="3">2 trains</td><td>28 trains</td></tr>
<tr><td>Total</td><td>52 trains</td><td>3 trains</td><td>3 trains</td><td colspan="3">5 trains</td><td>63 trains</td></tr>
</table>

Source: JICA Design Team

Table 4.3.28 Rolling Stock Operation Plan for Limited Express train (tentative)

<table>
<tr><th rowspan="2">Depot / Workshop</th><th colspan="2">For Operation</th><th colspan="4">For Maintenance</th><th rowspan="2">Total</th></tr>
<tr><th>Operation</th><th>Stand-by</th><th>Heavy Repair</th><th>Monthly Inspection</th><th>Wheel re-profiling</th><th>Monthly Cleaning</th></tr>
<tr><td>North</td><td>4 trains</td><td></td><td>1 train</td><td colspan="3">2 trains</td><td>7 trains</td></tr>
<tr><td>Ref.) Valenzuela</td><td>2 trains</td><td>1 train</td><td></td><td colspan="3"></td><td>3 trains</td></tr>
<tr><td>South</td><td></td><td></td><td></td><td colspan="3"></td><td></td></tr>
<tr><td>Alabang Station</td><td>2 trains</td><td></td><td></td><td colspan="3"></td><td>2 trains</td></tr>
<tr><td>Total</td><td>8 trains</td><td>1 train</td><td>1 train</td><td colspan="3">2 trains</td><td>12 trains</td></tr>
</table>

Source: JICA Design Team

These tables are planned considering Table 4.3.29 that is the result of calculation under pre-conditions and setting conditions.

Table 4.3.29 Required capability of Depot and Workshop (tentative)

(train-set / day)

Type	Depot & Workshop	Heavy Repair	Light Repair		Wheel re-profiling	Train Preparation		
			Monthly Inspection	Daily Inspection		Monthly Cleaning	Daily Cleaning	Discharge Sewage
Limited Express train	North	0.60	0.20	0.20	0.04	0.67	0.39	0.58
	Ref.) Valenzuela	(None)	(None)	0.11	(None)	(None)	0.39	(None)
	South	(None)	(None)	(None)	(None)	(None)	(None)	(None)
Commuter train	North	1.71	0.33	0.58	0.03	1.46	1.13	(None)
	Ref.) Valenzuela	0.46	0.23	0.20	0.02	0.51	0.39	(None)
	South	(None)	0.54	0.63	0.05	1.57	1.21	(None)

Source: JICA Design Team

Table 4.3.29 shows the number of train sets that can be maintained at one time. The number of Limited express train-sets for overhaul at the same time is 0.60 train-sets. However, since electric multiple unit (EMU) works in a train formation, 0 or 1 train-set can be in maintenance for overhaul at the same time. Furthermore, it is necessary to secure train-sets for maintenance as train-sets cannot be operated while in maintenance. Therefore, the number of spare Limited express trains for Heavy Repair is 1 as shown in Table 4.3.28. Each required number of spare train-set can be calculated the same way (Table 4.3.27 and Table 4.3.28).

2) Facility Plan of Depot and Workshop

Based on 4.3.4 (4) 1), the calculation result of required number of facility line is as shown in Table 4.3.30.

Table 4.3.30 Depot and Workshop Facilities / Equipment Plan (tentative)

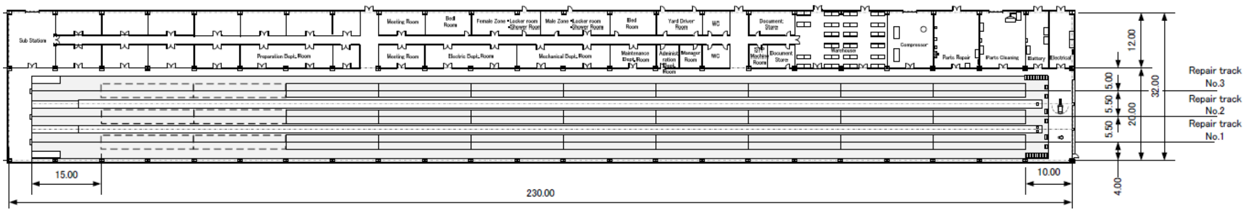
Facilities and Equipment	North Depot and Workshop	Valenzuela Depot and Workshop (Ref.)	South Depot
Stabling Rolling Stock	33	15	19
Light Repair	1	1	1
Wheel re-profiling	1	1	1
Unscheduled Repair	1	1	1
Train Preparation	2	2	1
Overhaul	1	1	0

Source: JICA Design Team

As a result of calculation, Facilities and Equipment at Valenzuela Depot and Workshop can be also satisfied with the required capability after opening MCRP and NSRP-South (Table 4.3.27, Table 4.3.28, and Table 4.3.29).

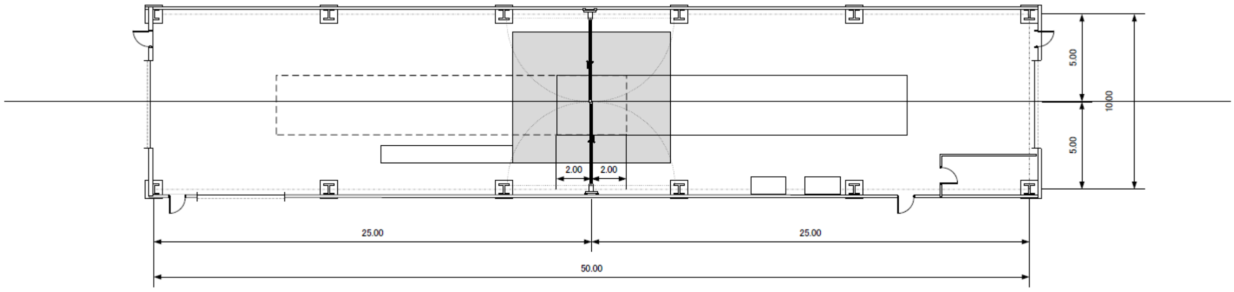
3) Shop Layout

Shop Layouts have been designed considering work flow of all maintenance. These are finalized after all studies are finished. Shop Layouts for each maintenance are as follows.



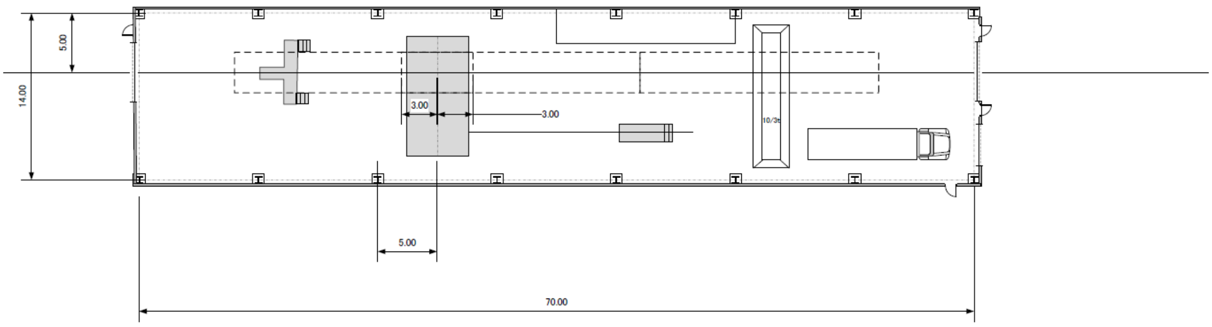
Source: JICA Design Team

Figure 4.3.29 Shop Layout for Light Repair and Train Preparation



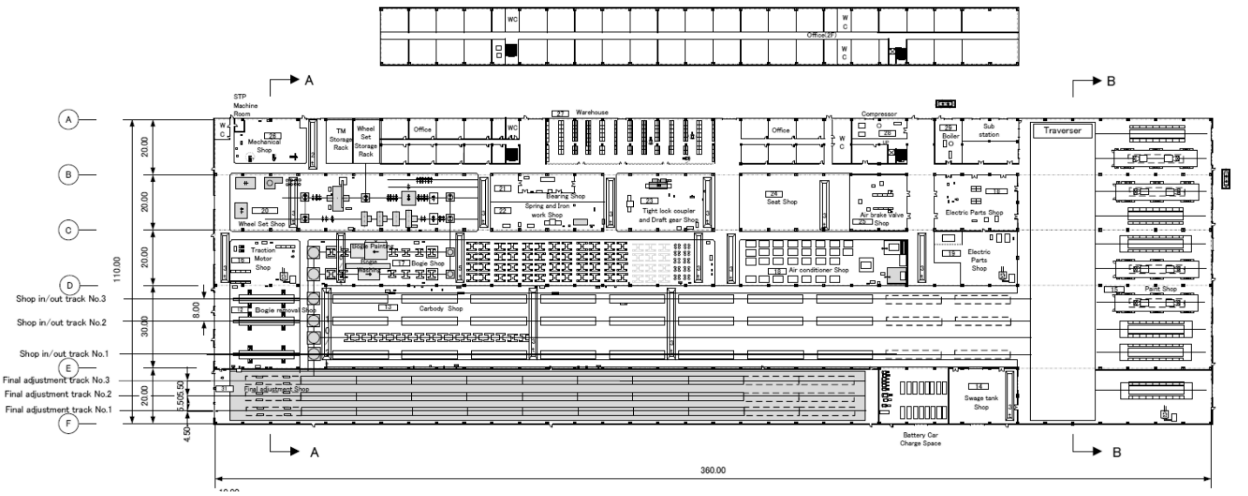
Source: JICA Design Team

Figure 4.3.30 Shop Layout for Wheel re-profiling



Source: JICA Design Team

Figure 4.3.31 Shop Layout for Unscheduled Repair



Source: JICA Design Team

Figure 4.3.32 Shop Layout for Workshop

4) Depot and Workshop Layout

D Depot and Workshop Layout has also been designed considering work flow of all maintenance. Figure 4.3.33 shows North Depot and Workshop Layout. This layout will be finalized after all discussions and studies are finished.

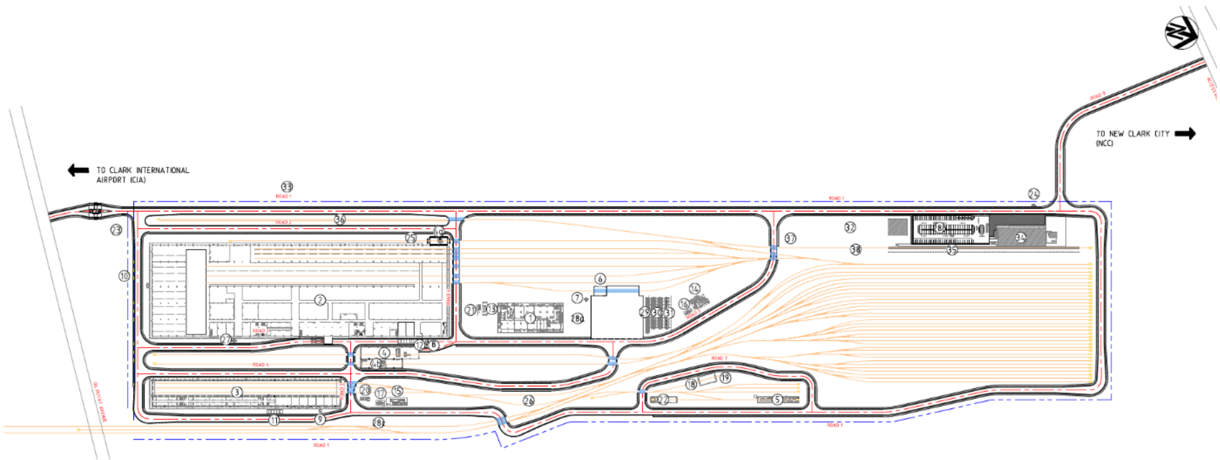


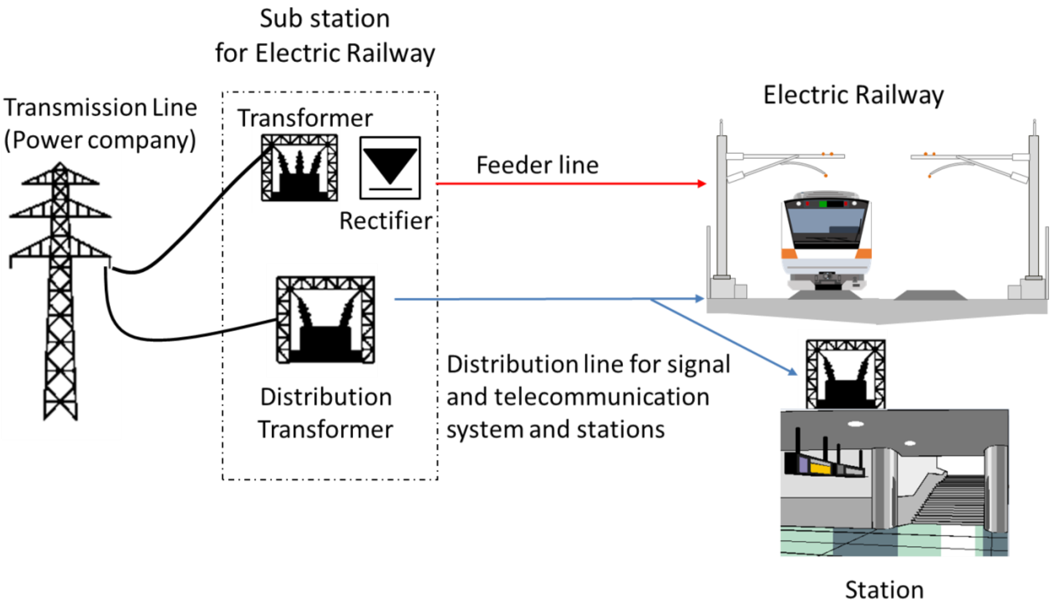
Figure 4.3.33 North Depot and Workshop Layout

(5) Detailed Design Approach of Facility and Equipment to be provided at Depot

The facility and equipment in each depot will be designed cooperating with civil, architecture, rolling stock, and, other E&M experts. Moreover, the layout of Depot and Workshop will be finalized after all studies are finished.

4.3.5 Power Supply System

As described in Figure 4.3.34, the rolling stocks are proposed to adopt DC electric multiple units, which require power supply system for the rolling stocks sufficient for train operation in this project. This section describes the power supply system for electric railway. Electric power for electric railway is generally supplied from the power grid of power supply organization in the area. The receiving electric power at substation is three-phases for electric railway. Figure 4.3.34 shows schematic chart of power supply system for electric railway



Source: JICA Design Team

Figure 4.3.34 Schematic chart of Power supply system (DC type)

"Feeding" means supplying electric train with electric power. There are two types of feeder system, DC and AC feeding systems. Characteristics of the feeding system are shown in Table 4.3.31. DC feeding system is usually adopted in urban commuter railway. The interval of substations for DC feeding system becomes short to prevent drop in DC voltage. On the other hand, AC feeding system is usually adopted for high-speed railway or low frequent train operation line. AC feeder system requires transferring power in three phases to single phase. High-speed railway requires much power to operate. If high-speed railway adopts DC feeding system, large current flows and voltage drop will cause difficulty in maintaining stable operation. Moreover, requirement of many substations in this system is not practical. AC feeding system has a comparative advantage for high-speed railway. In case of employing AC feeding system for urban railway, the number of substations can be reduced, compared to DC feeding system. However, it is required to install transformers on each rolling stock. Suitable power feeding system shall be chosen considering total design of the railway system, including cost implication.

Table 4.3.31 Characteristic of Feeding systems

Contents	DC feeding system		AC feeding system	
			AT*[1] method	BT*[2] method
Supplying Voltage to train	600-750V	1500-3000V	20kV or 25kV	20kV or 25kV
Substation Distance	1-2 km	3-10 km	About 50km	About 30km
Feeding Method	Parallel		Single way	Single way
Consideration issues	Galvanic corrosion		Induction problems	

*1 AT: Auto Transformer feeding system (2×25kV feeding system)
*2 BT: Booster Transformer feeding system

Source: JICA Design Team

For MCRP, DC supplying system is proposed for the following reasons:

- Compatibility with the NSCR project,
- Number of operating trains,
- Interoperability,
- Total investment cost of rolling stocks and substations.

(1) Substation

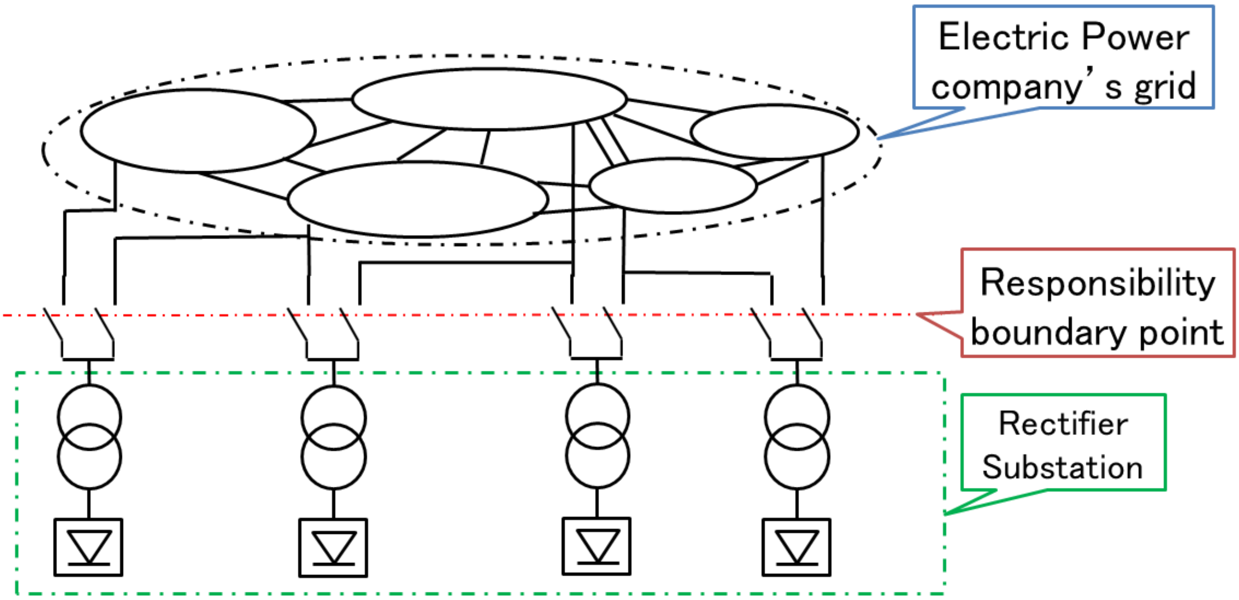
1) Receiving power method

Electric railway system is generally supplied from the power grid of a power supply organization, like MERALCO in the Philippines. There are two general methods of power supply. One is to receive power directly from the power grid. The other is to provide a dedicated supply system by preparing power receiving substations and dedicated transmission line. Figure 4.3.35 shows overview of these two methods. Receiving power is provided active/standby two lines.

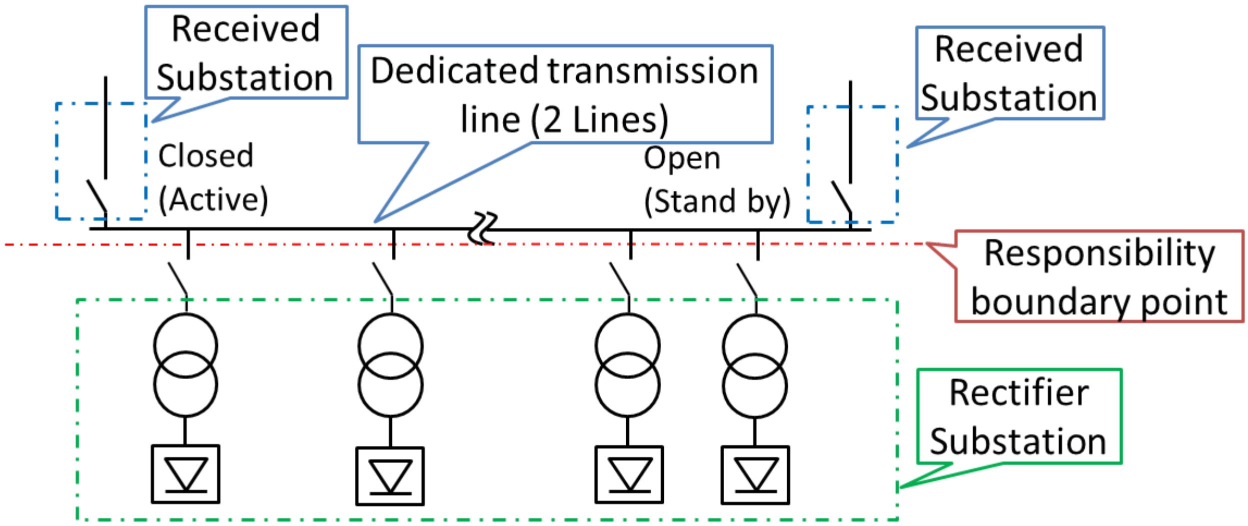
JDT negotiated with MERALCO about the possibility of supplying to the whole line of MCRP by the dedicated supply system method. According to the meeting, it is possible to supply only from MERALCO, however, in the case of other electric power supply companies are able to supply the electric power to their coverage area, MERALCO is not allowed to supply the electric power over the boundary by the franchise low.

JDT negotiated with each electric company PERCO III, SFELAPCO, AEC and CEDC and after several meetings, all the electric power supply companies confirmed it is possible to supply enough electric power to MCRP in their jurisdiction. As a result, the electric power supply to MCRP line is from five (5) electric power companies including MERALCO in compliance with the franchise low.

According to the franchise law in Philippines, each power company is mandated to supply in designated areas. Along the MCRP, there are several power supply companies according to each coverage area in its jurisdiction. If their supplying boundary has to be kept, parallel feeding cannot be allowed over the boundary. It will be need to install more substations or Battery Post (BP). JDT propose Battery Post (BP) system at all boundary areas which enable to move the rolling stock with passengers from the truck to the adjacent station using battery power during emergency and on electric power outrage case, including cost implication.



(a) Receiving from the power grid directly



(b) Constructing power receiving substations and dedicated transmission line

Source: JICA Design Team

Figure 4.3.35 Receiving power methods

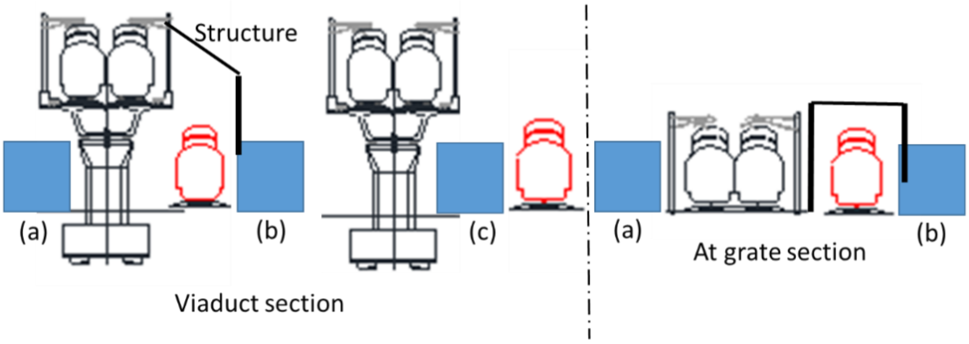
2) Substation location

Substation locations shall satisfy following preconditions:

Distance between substations	: from 3 km to 5 km as long as possible
Away from Station location	: at least 200m
Substation area	: at least 500m^2 (the land width: at least 10 m)

Construction within ROW of PNR, as much as possible

In an elevated section, Substation shall be installed under viaduct, at a grate section, next to the tracks. It shall consider the freight project. Figure 4.3.36 shows the image of substation installation. In the elevated section, there are three types of installation, (a), (b) and (c), at the grade section, there are two types of installation, (a) and (b) .In case of installation location next to the Freight line, it is required to construct a structure to overpass the freight line.



Black line: commuter   Red line: Freight line

Source: JICA Design Team

Figure 4.3.36 The image of substation installation

Based on the preconditions and results of site inspection, the every substation location is proposed for Table 4.3.32. JDT is under consideration about the alignment from CIA to NCC. The number of substations in this section will be required at most five.

Table 4.3.32 Substation locations (Between Malolos and CIA)

Substation number	The distance from Solis Station
No.10	37k 200m
No.11	41k 400m
No.12	46k 000m
No.13	49k 260m
No.14	55k 000m
No.15	59k 370m
No.16	63k 720m
No.17	67k 720m
No.18	71k 900m
No.19	76k 100m
No.20	80k 400m
No.21	84k 450m
No.22	For North Depot

Source: JICA Design Team

In the case of the franchise low is strictly applied, four (4) Battery Posts are required to add at all the boundaries among five (5) electric companies and one (1) additional Substation is required as Table 4.3.33.

Table 4.3.33 Substation locations (Between Malolos and CIA)

Substation No.	The distance from Solis Station
No.10	37k 236m
No.11	42k 300m
BP-1	44k 350m
No.12	46k 220m
No.13	51k 210m
No.14	55k 600m
BP-2	55k 810m
No.15	57k 800m
No.16	62k 800m
No.17	67k 800m
No.18	72k 000m
BP-3	72k 520m
No.19	73k 000m
No.20	76k 040m
BP-4	77k 800m
No.21	79k 850m
No.22	84k 450m
Depot SS	At North Depot

SS: Substation, BP: Battery Post

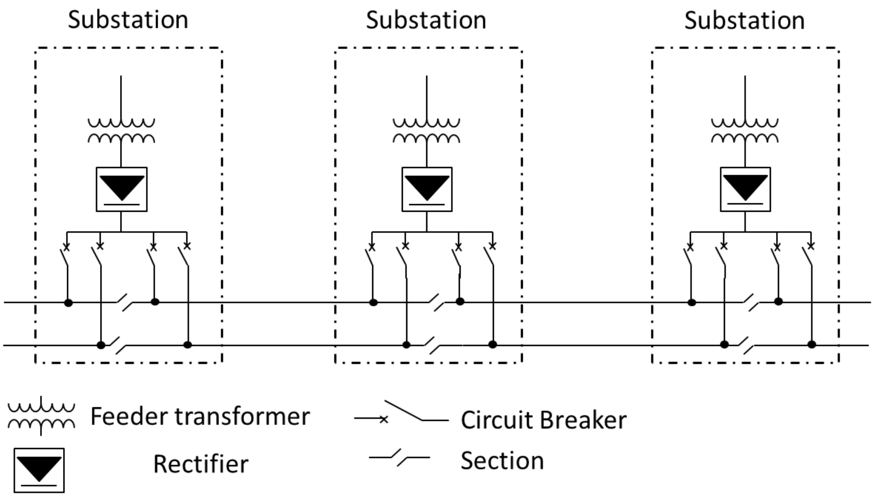
Source: JICA Design Team

However, JDT has to solve following issues:

- Negotiating with electric power companies about receiving method and boundary discussion continuously
- Checking Transmission lines location and the distance to substations for railway
- Location site inspections with MERALCO, PELCO, SFELAPCO, AEC, CEDC and other

3) Substation facilities outline

Figure 4.3.37 shows an example of basic DC feeding system composition. DC feeding system is normally parallel feeding method, other than from both ends of the line to the adjacent substations. Section will be required to distinguish feeding areas.



Source: JICA Design Team

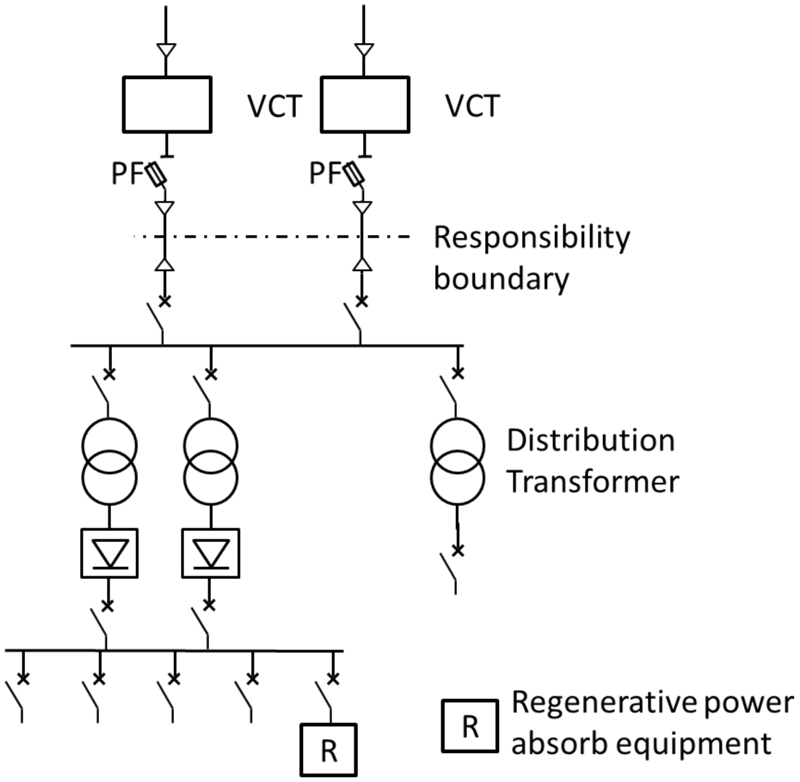
Figure 4.3.37 DC feeding system composition

Substation facilities can be classified into three major elements. They are i) receiving facilities, ii) transformers and rectifiers, and iii) facilities of supply to railway. Table 4.3.34 shows main substation facilities. Figure 4.3.38 shows single-line diagram of Substation in instance.

Table 4.3.34 Main Facilities at Substation

Division		Facilities
Receiving facilities from power supply company		Disconnection Switch, Circuit Breaker, Power Fuse(PF) Voltage Current Transformer for measuring (VCT)
Transformers and Rectifiers		Feeding Transformer, Distribution Transformer, Rectifier Voltage Transformer for measuring (VT) Current Transformer for measuring (CT)
Facilities of supplying to railway	Feeder	Disconnection Switch, Circuit Breaker for DC Voltage Transformer for DC measuring (DVT) Current Transformer for DC measuring (DCT) Regenerative energy absorbing equipment, Batteries
	Distribution line	Disconnection Switch, Circuit Breaker, VT, CT

Source: JICA Design Team



Source: JICA Design Team

Figure 4.3.38 Example of the Single-Line Diagram

4) General standards and regulations for Substation facilities

The Substation facilities shall be satisfied the following main Standards and Regulations etc.:

- Technical regulatory standards on Japanese railways (TRTRS): 2012
- The interpretation of the technical regulatory standards on Japanese railways: 2005
- IEC 60044-1, JEC 1201-2007 for CT
- IEC 60044-2, JEC 1201-2007 for PT
- IEC 60076 for Power transformer
- JIS C 4304-2013 for Power transformer
- JIS C 4306-2013 for Power transformer
- JEC 2200-1995 for Power transformer
- IEC 60287 for cable current capacity calculation
- IEC 60502 for 1～30kV cables
- IEC 60850 for IEC Railway Applications-Supply Voltage of traction systems
- IEC 60947 for HV and LV switchgear
- JIS C 4620-2004 for HV switchgear
- JEM 1425-2011 for HV switchgear
- JEC 2300-2010 for HV switchgear
- JEC2310-2015 for HV switchgear

- IEC 61992 for IEC Railway Applications Fixed installation –DC Switch gear
- JIS C 8201 for LV switchgear
- JEM 1038-1990 for LV switchgear
- JEM 1265-2006 for LV switchgear
- JEC 2300-2010 for LV switchgear
- JEC 2310-2015 for LV switchgear
- NATIONAL STRUCTUAL CODE OF THE PHILIPPINES 2015

5) Special Specification

The substation facilities shall be took in consideration with the following specifications:

- Receiving facilities: Receiving voltage and protection coordination etc. by the power supply company designation.
- Traction voltage range : Between 1,800V and 1,000V
- Voltage regulation of Rectifier: 6%
- Distribution standard voltage : 6,600 V
- Feeder cable : XLEP cable or equivalent cable with terminal and cable support to Viaduct/Pillar
- Return cable : PVC cable or equivalent cable with terminal and cable support to Viaduct/Pillar
- Substation area : Fence on perimeter, CCTV installation, and supervision at OCC
- Countermeasures for voltage rise by regenerative power:
- Regenerative power absorb facilities
- Power storage system for energy conservation (Battery Post)

6) Substation Capacity

Substation capacity is determined by power for feeding system and for distribution power system.

a) Preconditions for feeding system

Table 4.3.35 shows preconditions for feeding system.

Table 4.3.35 Preconditions for feeding system

Train headway	5 minutes (Each bound)
Maximum acceleration current	4,000A (Limited Express) 3,200A (Commuter)
Auxiliary power supply capacity of Rolling stocks	600 kVA
Train weight	424 tonnes

Source: JICA Design Team

b) Estimated rectifier capacity

To determine the rectifier capacity, it has to be calculated the instant maximum power and the one hour average maximum power. The rectifier capacity has to cover both maximum power. And the calculation is considered for the following two cases:

Normal Operation (Refer to Figure 4.3.39)

In this case, every substation is working with required conditions and can supply the power to feeders. Figure 4.3.39 shows an example of basic DC feeding system composition. DC is normally parallel feeding method, other than from both ends of the line to the adjacent substation. Section will be required to distinguish feeding areas. For example Substation Sb's feeding distance is (L1+L2)/2.

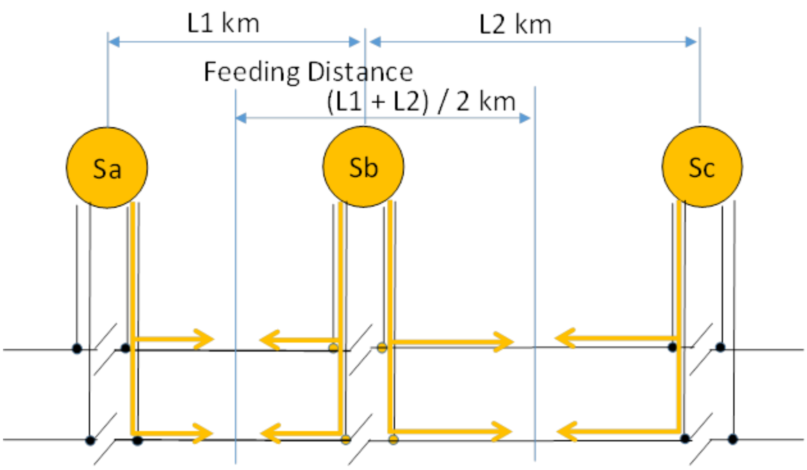


Figure 4.3.39 Normal DC feeding composition

Emergency Operation (Refer to Figure 4.3.40)

In this case, an adjacent substation is shut down with some reason. Figure 4.3.40 shows an example DC feeding composition. For example Substation Sc is shut down, Sb's feeding distance is (L1/2+L2) which is longer than normal operation and more DC power required as shown Table 4.3.36.

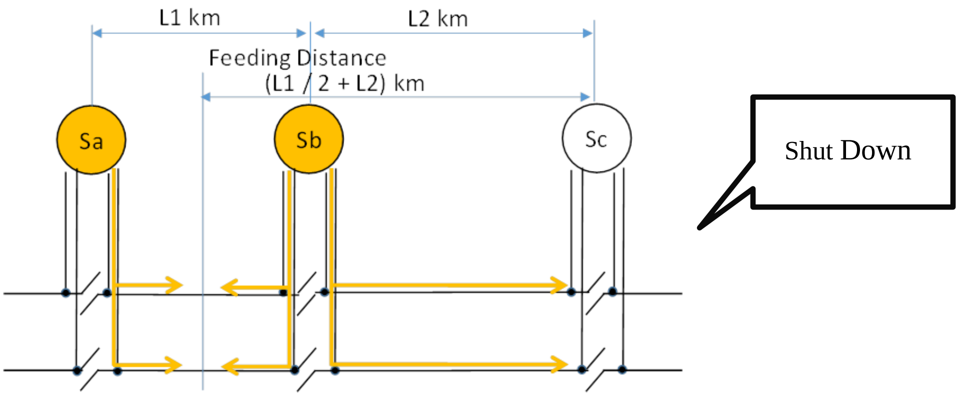


Figure 4.3.40 Emergency DC feeding composition

Table 4.3.36 shows estimated rectifier capacity of respective substation between Malolos and CIA.

The rectifier capacity has to cover both maximum power. This capacity is 6,000kW of type D or type E. it is needed more detail calculation which type is better. It is installed two sets of rectifier as active and stand by system, except for the rush hour. In this system, it becomes easy to make the maintenance plan.

JDT will further calculate the rectifier capacities of every substation in detail.

c) Estimated distribution power transformer capacity

According to estimated consumption of stations, signalling house, telecommunication house etc. and possibility of distribution power line distance, the capacity of distribution power transformer at a substation is estimated 3,000 kW and other. (Refer to Table 4.3.36)

JDT will further calculate the distribution transformer capacities of every substation in detail.

Table 4.3.36 Estimated Rectifier and transformer capacity

									DC Rectifier (DC)			Elec. Power (AC,3- phase)	Total Elec. Power Requirement (kVA)
Line and Station	SS/Sta.	No.	From starting point						Normal Operation(kW)		Emergency Operation(kW)	Transformer Capacity (kVA)	
			km	m			Distance SS to SS (m)	Feeding Length (m)	One hour Average Maximum Power	Instant Maximam	One SS Shut Down ①	②	①+②
NSCR	SS	9	34	142									
Malolos	Sta.		34	142									
MCRP	SS	10	37	200			3,058	3,629	2,916	11,786	14,948	3,000	17,948
Calumpit	Sta.		42	499									
MCRP	SS	11	41	400			4,200	4,400	3,261	12,640	16,539		16,539
MCRP	SS	12	46	0			4,600	3,930	2,913	11,777	15,778	3,000	18,778
Apalit	Sta.		46	476									
MCRP	SS	13	49	260			3,260	4,500	3,335	12,820	17,601		17,601
MCRP	SS	14	55	0			5,740	5,055	3,747	13,799	18,461	3,000	21,461
San Fernand	Sta.		58	562									
MCRP	SS	15	59	370			4,370	4,360	3,232	12,568	16,290		16,290
MCRP	SS	16	63	720			4,350	4,115	3,038	12,090	15,876		15,876
MCRP	SS	17	67	600			3,880	4,090	3,031	12,074	15,794		15,794
MCRP	SS	18	71	900			4,300	4,250	3,150	12,368	16,055	4,000	20,055
Angeles	Sta.		73	800									
MCRP	SS	19	76	100			4,200	4,250	3,150	12,368	16,055	3,000	19,055
Clark	Sta.		78	803									
MCRP	SS	20	80	400			4,300	4,175	3,094	12,230	15,933		15,933
MCRP	SS	21	84	450			4,050	4,050	2,242	10,019	15,729	3,000	18,729
CIA	Sta.		86	630									
MCRP	SS	22											Study in progress
CIA Depot													

Source: JICA Design Team

7) Remote control

Control equipment is installed for operation and protection of main facilities at a substation. Control equipment consists of protective relay, measuring equipment, monitors, detectors, switch gears, display and program controller for configuring logic program. This controller can aggregate measuring data and transmit them to P-SCADA (Power- Supervisory Control and Data Acquisition System) at OCC. P-SCADA protocol is took in consideration the compatibility of the system of NSCR as well.

There are usually no supervisors at substations. Substations facilities are supervised and control by P-SCADA. P-SCADA is used by operators at OCC.

8) Consideration issues

JDT will further study the following issues:

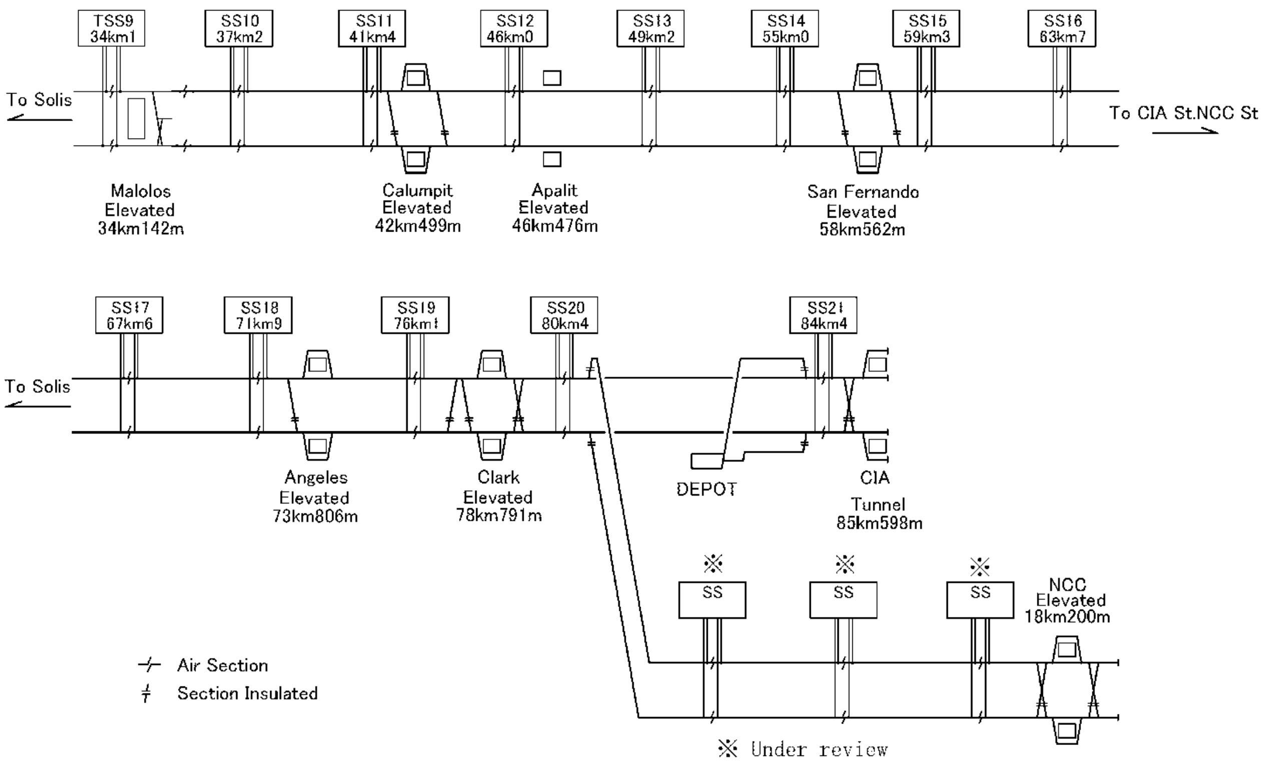
- Adjustment about receiving facilities specification with power companies
- Capacity calculation for depot
- Power supply upon emergency in detail
- Machine layout ,foundation, structures, and electricity house etc. in substations
- Voltage drop countermeasure
- Testing and commissioning procedure
- Operation, training and maintenance planning
- Battery Post

(2) Overhead Catenary system

1) Outline

The Works included in the Overhead Contact System (OCS) is the main line of MCRP and Rolling stock depot including access tracks. In part of this section, a maximum speed is planned 160km/h, and the OCS shall be required its speed.

Supplying voltage is DC 1,500 V at the standard. OCS specifications shall be considered with construction, examinations, synthesis adjustment and maintenance vehicles. Figure 4.3.41 shows the route alignment of MCRP.



Source: JICA Design Team

Figure 4.3.41 Rout Alignment of MCRP

2) Conditions related to OCS

In the consideration to the OCS component and equipment on the basic design, it is required the following several conditions:

- Civil structure and orbit conditions (Refer to Table 4.3.37)
- Rolling stocks characters (Refer to Table 4.3.37)
- Ambient conditions and Environment parameters (Refer to Table 4.3.38)
- Traction voltage conditions (Refer to Table 4.3.39)

Table 4.3.37 Conditions related to the OCS consideration

Items		Malolos-Clark	Clark-CIA	Clark-NCC
Civil Structure	Viaduct	36.3 km	3.1 km	16.0 km
	Embankment	7.5 km	1.5 km	------
	Tunnel	------	2.6 km	2.0 km
	Curve radius	More than 300 m		
Orbit Specification	Track gauge	1,435 mm		
	Rail classification	UIC 60		
Train	Maximum speed	160 km/h	120 km/h	160 km/h

Source: JICA Design Team

Table 4.3.38 Ambient Conditions and Environments Parameters

Items	Values
Ambient Temperature	Max. : 40℃ Min. 15℃
Max. Solar radiation value	1kW/m^2
Max. Wind power	54m/s (Consideration to atmospheric pressure and humidity at the Typhoon)
Frequency of lightning	Over 25/km^2/year
Salt damage	N/A
Earthquake resistant Level	Level 2

Reference Source: NSCR Final Report

Table 4.3.39 Traction Voltage condition

No.	Requirements	Basic value	Source
1	Over-voltage	1850V	Ref. of specification in TSS (Traction Substation) and rolling stock
2	Under-voltage	900V	Ref. of rolling stock spec.
3	Design-voltage of minimum voltage at a point pantograph receiving for from the TSS	1000V	

Reference Source: NSCR Final Repo**3)**

3) Related standard and regulations

The OCS shall be satisfied the following main Standards and Regulations etc.:

- Technical regulatory standards on Japanese railways (TRTRS): 2012
- The interpretation of the technical regulatory standards on Japanese railways: 2005
- JIS E 2001-2002: Electric traction contact lines –Vocabulary
- JIS C 3803: 1977 Glossary of terms for insulator and bushing
- JIS E 4001: 2011 Railway rolling stock-vocabulary
- IEC 60913: 1988 Electric traction overhead lines
- IEC 60059: 1999 standard current ratings and the series
- IEC 60273 Characteristics of Indoor and Outdoor Post Insulators for Systems with Nominal Voltages Greater Than 1000 V
- IEC 60287: 2015 Calculation of permissible current in cables at steady state rating and the series
- IEC 60494: 2013 Rolling stock pantographs and the series
- IEC 61000-5-1: 2016 Electromagnetic compatibility (EMC). Installation and mitigation guidelines. General considerations. Basic EMC publication and the series
- IEC/TR 61245, Artificial pollution tests on high-voltage insulators to be used on d.c. systems
- IEC 62561: 2012 Lightning protection system components (LPSC) and the series
- JEC-2374: 2015 Gapless metal oxide arrester

4) Contact line system

a) General contact line system and their characteristics

DC supply system is proposed for the feeder system in previous subsection. The type of contact line system for DC supply shall be studied here. Contact line system is classified into three major types, i.e., i) OCS, ii) Rigid Suspension System and iii) Third Rail System. Outline of these systems is shown in Table 4.3.40.

Table 4.3.40 Outline of Contact Line System

	OCS	Rigid Suspension System	Third Rail System
Current Collection	Stable Current Collection at Higher Running Speed	Less Smooth Pantograph Dynamics Need to many supports	Unstable Current Collection at Higher Running Speed
Running Speed	More than 100 km/h	Maximum Approx. 100km/h	Maximum Approx. 80 km/h
Maintenance Work	Maintenance Work at Higher Place	Easy Maintenance for RSS and Track work	Easy Maintenance but Danger of Electrical Shock at Track Work
Electrical Shock Accident	Less	Less	Protection for Electrical Shock Required
Initial Investment	High	High	Low
Natural Disaster	Affected by Strong Wind and Earth Quake	Depend on the location	Less Affected by Strong Wind and Earth Quake
Impact on Urban Landscape	Impact on Surrounding Landscape	Depend on construction location	Small Impact on Surrounding Landscape
Section to be adopted	Tunnel, At-grade and Elevated Section	Tunnel Section	Tunnel, At-grade and Elevated Section

Source: JICA Design Team

Because of the maximum speed in MCRP, at the maximum 160 km/h, OCS is the only applicable option except underground section if any.

A special attention is needed in OCS, which requires sufficient followability of pantographs as the train speed increases. There are several types of OCS structure Table 4.3.41 shows some of these representative structures.

Simple catenary is used for train speed about 100km/h or/and moderate frequency of train services. This catenary requires generally feeder to prevent significant drop of supplying voltage and to secure enough current capacity and permissible temperature of contact wires. This structure is also simple and has an advantage of lower cost.

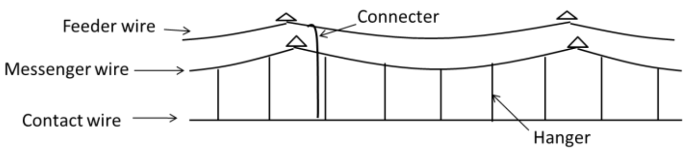
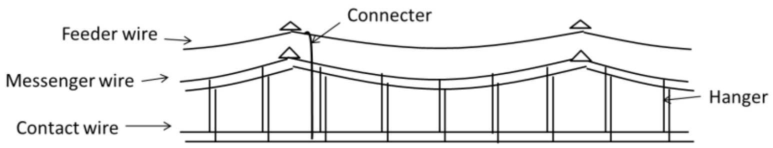
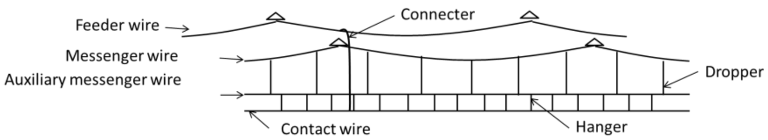
As the train speed or the service frequency increases, compound catenary is adopted in Japan. This catenary structure is a bit complex. The construction cost and maintenance cost become higher than simple catenary.

Twin simple catenary comprises two simple catenaries installed in parallel. This catenary is applicable to sections where train service frequency changes from middle to high. This system can reduce the additional equipment cost for increasing load capacity. However, it requires complexed structure.

Hence, maintenance is difficult and requires higher cost. This catenary is not suitable for new line construction.

Overhead Rigid Suspension System comprises a formed rigid aluminium conductor profile with a catenary wire inserted at the bottom. The system has a disadvantage of contact loss at pantograph in high speed operation. Moreover, it is required many supports to consider deflection of the rigid casing. On the other hand, from its simple configuration, it is advantageous for easy maintenance, less risk in wire cut and less space requirement overhead, which enables smaller diameter of tunnel works. Because of these advantages, it is widely applied to tunnel sections of subway, etc., without high speed operation.

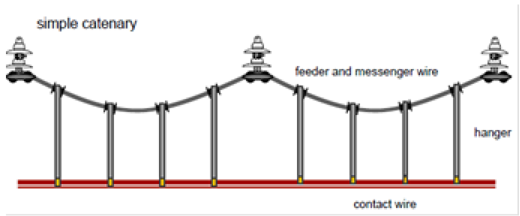
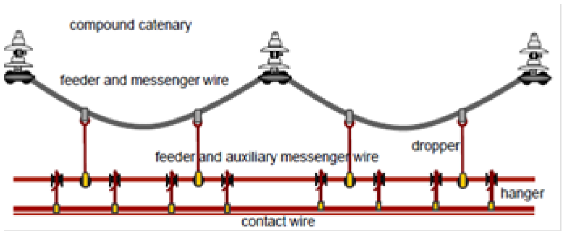
Table 4.3.41 Outline of OCS

Overhead Catenary System	Usage
Simple catenary 	Train density: Middle Train speed : Middle (Less than about 120km/h) Workshop/Depot
Twin simple catenary 	Train density: High Train speed : Middle (Less than about 120km/h)
Compound catenary 	Train density : High Train speed : High (More than 100 km/h)
Overhead Rigid Suspension System 	Subway without high speed operation (less than 80km/h)

Source: JICA Design Team

The feeder messenger system is one of overhead catenary systems. The wire of this system functions both as messenger and feeder (Refer to Table 4.3.42). In Japan, this system is adopted in narrow tunnels, etc. With the development of tension balancer, this system is widely used for replacement of twin simple catenary system for its simple configuration. The system requires less number of wires than other catenary systems and enables cost reduction in construction and O&M. It also has a simple appearance preferable from an aesthetic point of view. It has been widely used for DC traction system and applied to a high speed operation at 160km/h in Narita-Airport access line.

Table 4.3.42 Feeder-Messenger Catenary System

Feeder-Messenger Catenary System	Usage
	• Use messenger as feeder. In case of current capacity shortage, two feeder-messengers are installed in parallel. • Spread as a simple integration of twin simple catenary system. • Adoption to new lines construction
	• Use messenger and auxiliary messenger as feeders. • Realization of 160km/h operation, in the Narita-airport access line which "Keisei sky liner" is running.

Source: JICA Design Team

In view of the above, the feeder messenger system is proposed in this project considering lower cost in construction and maintenance and its simple facilities. Table 4.3.43 shows its catenary system in each section.

Table 4.3.43 Catenary System in each Sections

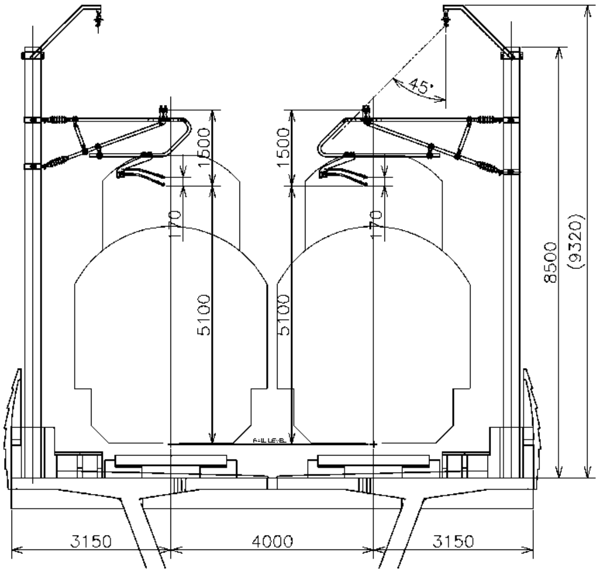
Section	Planned Operation Speed	Applicable Catenary System
Main Line - Open Section	160 km/h	Feeder messenger compound catenary system M: PH 356 (24.5 kN) - Aux: PH 356 (14.7 kN) - Tr: GTM 170 (14.7 kN)
Main Line -Tunnel Section	Below 120 km/h	Feeder messenger simple catenary system M: PH 356 (19.6 kN) × 2-Tr: GTM 170 (14.7 kN)
Access tracks	- -	Feeder messenger simple catenary system M: PH 356 (19.6 kN) - Tr: GTM 170 (9.8 kN)
Depot	- -	Simple catenary system +feeder M: St 90 (9.8 kN) - Tr: GT 110 (9.8 kN)+F: H325(11.8kN)

Source: JICA Design Team

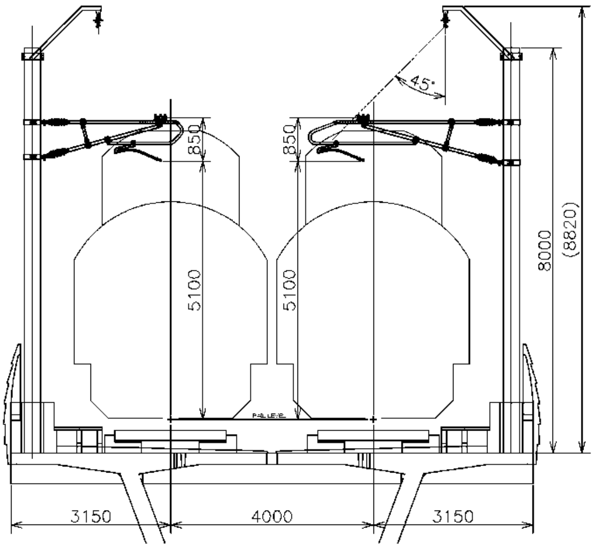
b) Structure Chart

In the general method, feeder wire is installed above the catenary. Pole is required the length for a feeder supporting arm. However, feeder messenger catenary system is not required its length, because the wire of this system functions both as messenger and feeder. That is why Pole length can become shorter at least 1 m and more. Figure 4.3.42 shows the structure charts.

A tunnel section is planned near CIA station. The structure chart for this tunnel is shown in Figure 4.3.43.



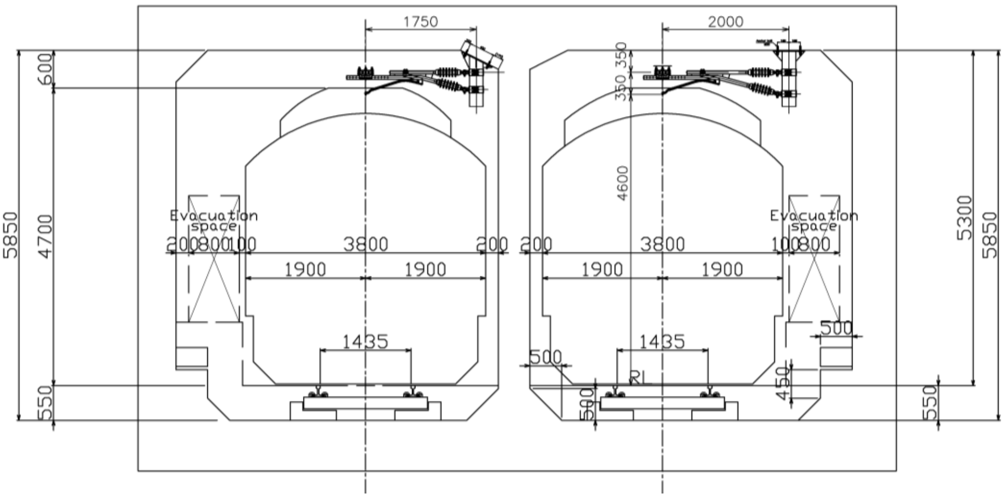
Feeder messenger Compound Catenary



Feeder messenger Simple Catenary

Source: JICA Design Team

Figure 4.3.42 Structure chart of overhead catenary system



Source: JICA Design Team

Figure 4.3.43 Feeder messenger catenary system - Structure Chart of Box tunnel

c) Span of OCS poles

Table 4.3.44 shows the standard span of OCS poles. It is determined with consideration of a contact wire deviation at the curve section.

Table 4.3.44 Standard OCS pole span

Section	Standard span
Straight section	40 m
Curve section	Variation according to curve radius
Special section	Maximum 55 m

Source: JICA Design Team

d) Contact wire height

Table 4.3.45 shows Standard contact wire height of OCS from the rail level.

Table 4.3.45 Standard Contact wire height

Section		Standard Contact wire height
Open section		5,100mm (Max. 5,200mm / Min. 4,600mm)
Tunnel section		4,600mm (Max. 4,700mm / Min. 4,550mm)
Depot	Storage track	5,100mm (Max. 5,200mm / Min. 4,600mm)
	Repair house	5,300mm (Max. 5,400mm / Min. 5,250mm)

Source: JICA Design Team

e) Return Circuit

Rail is a part of electrical circuit, and called return circuit. In general, there is an insulation resistance between the rail and the ground. However it may decrease by ambient environment and equipment conditions. In this case, a leakage current flows through the ground. This current is one of the factors causing electrolytic corrosion of the buried pipe etc. As a countermeasure to this, there is also a way to lay out a return cable that makes up a track and a parallel circuit. In Japan case, double insulated track fasteners shown in Figure 4.3.44 are adopted as countermeasure of the leakage current. Table 4.3.46 shows the insulation performance of the rail and this fastener. The leakage current doesn’t flow by these resistances difference. It has become unnecessary that return cables are installed along with tracks by this fastener.

For MCRP, it is proposed to adopt this fastener, as the reduction of construction cost.

Source: JICA Design Team

Figure 4.3.44 Double insulated track fastener

Table 4.3.46 Insulation performance

Contents	**Type**	Resistance value
Rail	UIC 60	0.0262Ω/km
Between Fastener and ground	--	140 Ω/km

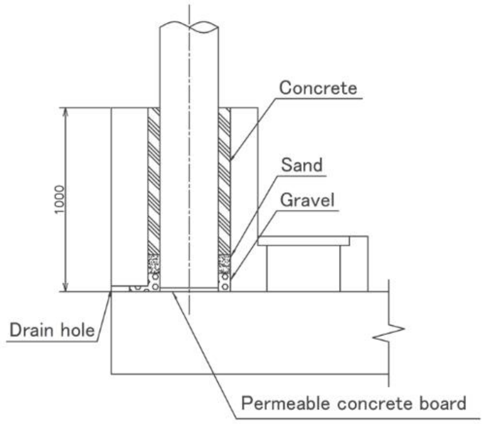
Source: JICA Design Team

f) Pole foundation and pole

There are two types of pole foundation, one is the bolt type and the other is the open dump type. In civil work, the Open dump type foundation is more efficient than bolt type foundation. In the case of the open dump type foundation, there is a gap between a pole and a foundation. It has to be filled to fix the pole. The filling methods are two types, one is filling sand and packing mortar, and the other is filling concrete.

The Filling sand and packing mortar method has to be done maintenance of the mortar packing, because it may be cracked. On the other hand, the filling concrete method is unnecessary to be done maintenance and is applied to the new earthquake resistant design as well. Figure 4.3.45 shows the pole foundation schematic.

The Pole of the OCS shall be adopted a steel pipe column, because of lightweight, toughness and avoiding resonance phenomena.



Source: JICA Design Team

Figure 4.3.45 pole foundation (Viaduct section)

g) Guy

Guy shall be installed for reinforcement at the detention pole.

h) Automatic Tension Balancer

Every wire expands and contracts depended on ambient temperature. The tension of wire has to be maintained constantly, because of not slacking contact wire. Automatic tension balancer shall be installed. Table 4.3.47 shows the type and classification of the balancer.

Table 4.3.47 Type and use classification of Automatic tension balancer

Type	Use classification	How to use
Automatic tension balancer Spring type	For Compound catenary and simple catenary type 53.9kN	If catenary length is 800 m or more, both, If catenary length is less than 800m, Attach it to one end of catenary.
	For simple catenary type 24.5kN	
	For simple catenary Type19.8kN	
Manual tension device	Wire turnbuckle	Attach to the active side at both ends of the feeder messenger, auxiliary messenger and contact wire.

Source: JICA Design Team

i) Measure against Lightning

Protective wire and arresters shall be installed for protecting the OCS from lightning.

The standard interval of arrester nitration is 500 m or less.

j) Disconnecting Switch and Rail Leakage Current Suppressing Device in the Depot

In the depot, a disconnecting switch shall be installed for rolling stocks maintenance. Table 4.3.48 shows disconnecting switch type of each location.

A Rail leakage current suppressing device shall be installed at each track in depot, if necessary.

Table 4.3.48 Disconnecting Switch Type

Location	Drive system		Pole		Remark
	Manual	Motor	Mono	Twins	
Access line	○		○		For electricity classification
Stabling rolling stock	○		○		
Train preparation Automatic car body washer	○		○		
Unscheduled Repair		○		○	
Wheel re-profiling		○		○	

Source: JICA Design Team

5) Further issues to be studied

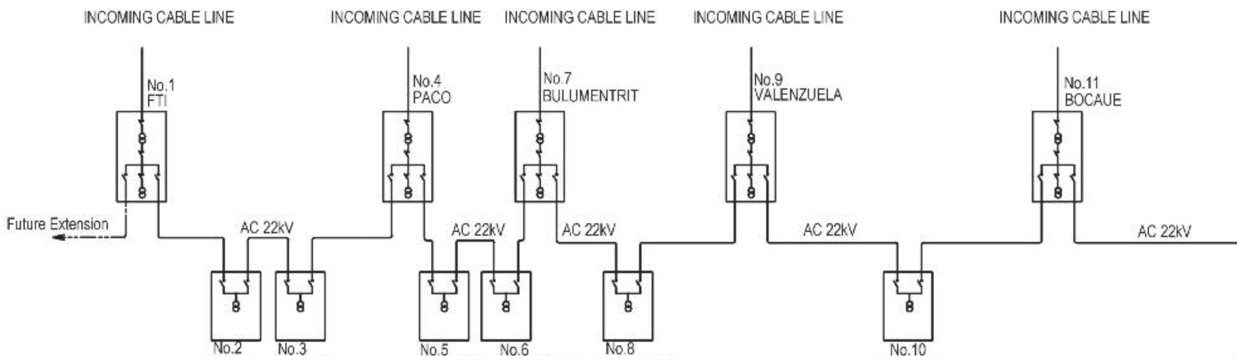
JDT will further study on details as follows:

- Pole foundation structure and load calculation.
- Study for seismic design method of OCS pole.
- Power system of Depot.
- Sign type and shape.

(3) Power distribution system

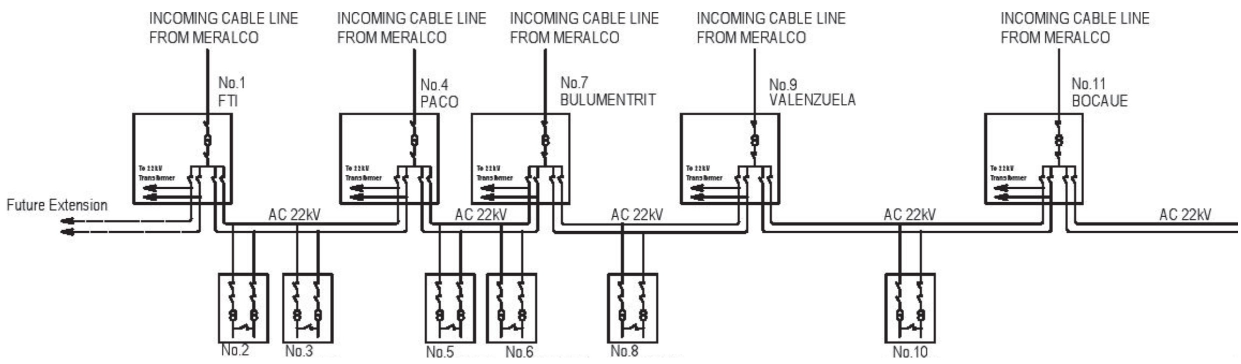
1) Power distribution system outline

For NSCR 6.6 kV power distribution is adopted and standardized step-down transformer from 34.5kV to 6.6kV is selected for this possible. The same distribution system is one of the candidates for this project. The power distribution system is installed along with the tracks and supplies power to the load of stations, signalling houses, telecommunication houses, equipment for depot and buildings related for railway operation etc. Two types of power distribution system are considered applicable to this project. One is loop system, and the other is parallel system. They are schematically shown in Figure 4.3.46 and Figure 4.3.47, respectively. The loop system has advantages in its lower cost than the parallel system and existing use in the Philippines. If more reliability is required, the parallel system should be considered.



Source: JICA Design Team

Figure 4.3.46 Example of Loop Type Power Distribution System



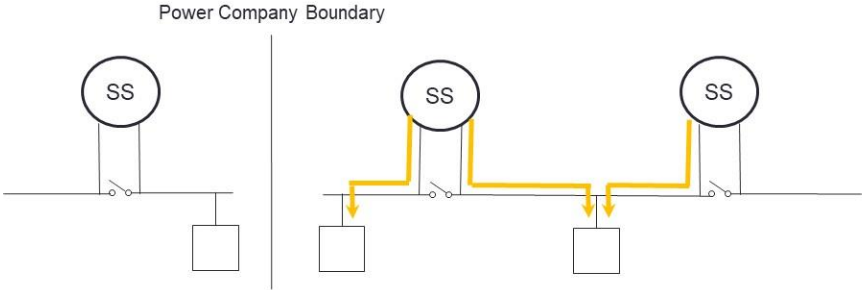
Source: JICA Design Team

Figure 4.3.47 Example of Parallel Type Power Distribution System

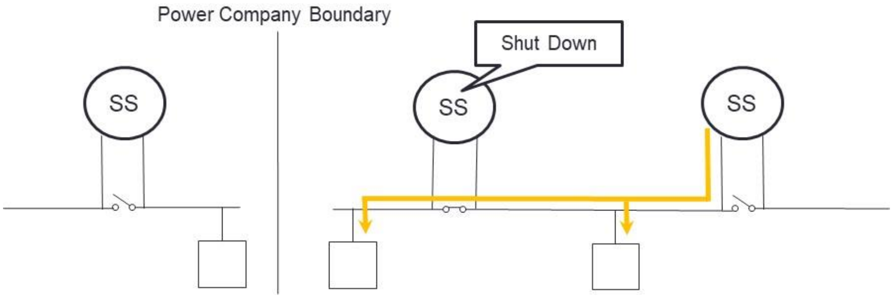
The loop system has the following advantages:

- Simple network
- Easy operating and maintenance, because of existing system in Philippine
- Lower construction cost

According to the Franchise law in Philippines, for each power company the designated area is determined. The Railway system has to be complied with the Franchise law as well. If the loop system, shown in Figure 4.3.46, is adopted, the distribution line to the power company boundary becomes from only one substation supplying. This substation outage will make this line not to supply. Therefore, JDT propose the extended power distribution system shown in Figure 4.3.48. Normally, electric power is supplied from a substation in the vicinity (Figure 4.3.48(a)). In case of substation outage, electric power can be supplied to this interruption section by inserting a circuit breaker for extended distribution. (Figure 4.3.48 (b))



(a) Normal supplying



(b) Substation outage

Figure 4.3.48 Example of Extension Type Power Distribution System

2) General Standards and regulations for power distribution system facilities

The power distribution system facilities shall be satisfied the following main Standards and Regulations etc.:

- Technical regulatory standards on Japanese railways (TRTRS): 2012
- The interpretation of the technical regulatory standards on Japanese railways: 2005
- IEC 60044-1, JEC 1201-2007 for CT
- IEC 60044-2, JEC 1201-2007 for PT
- IEC 60076 for Power transformer
- IEC 60287 for cable current capacity calculation
- IEC 60502 for 1～30kV cables
- IEC 60598 Classification of an illuminator
- IEC 60850 for IEC Railway Applications-Supply Voltage of traction systems
- IEC 60947 for HV and LV switchgear
- JIS C 4304-2013 for Power transformer
- JIS C 4306-2013 for Power transformer
- JIS C 4620-2004 for HV switchgear
- JIS C 8201 for LV switchgear
- JEC 2200-1995 for Power transformer
- JEC 2300-2010 for HV and LV switchgear
- JEC 2310-2015 for HV and LV switchgear
- JEM 1038-1990 for LV switchgear
- JEM 1265-2006 for LV switchgear
- JEM 1425-2011 for HV switchgear
- NATIONAL STRUCTUAL CODE OF THE PHILIPPINES 2015

3) Special specification

The distribution power system facilities shall be took in consideration with the following specifications:

- Distribution standard voltage: 6,600 V for primary, 400V or 230V for secondary, 60Hz frequency.
- Distribution power system for High voltage : 3-phase 3 wire system
- Distribution power system for Low voltage : 3-phase 4 wire system
- Voltage regulation rate for 6,600 V : Within 10 %
- Distribution power line shall be used Cables.
- Cables shall be installed in troughs or ducts etc.
- Transformers are required a manual tap changer for adjusting voltage.
- Transformer capacity shall be determined in consideration with load demands of supplying facilities
- Power supply system shall be separated operating facilities like signalling system and telecommunication system, and other facilities like stations.

4) Demarcation in stations and buildings

The scope of work for distribution power system is to supply power to the load of stations and buildings related for railway operation etc. Distribution power system construction shall be based on the demarcation shown in Table 4.3.49.

Table 4.3.49 Demarcation in station and buildings

		Facilities for 6,600V	MDB* for Low voltage	Cable between MDB and each DB**	DB	Cables for electrical facilities	AC***	LS****
In station	Electrical Room	D	D	A	A	A	A	A
	Signalling room	-	-	D	D	S	A	A
	Telecommunication Room	-	-	D	D	T	A	A
	Electrical Facilities for stations	-	-	A	A	A	A	A
Independence	Electrical house for operating facilities	D	D	D	D	D	A	D
	Signalling house	-	-	D	D	S	A	D
	Telecommunication house	-	-	D	D	T	A	D
Buildings		D	D	A	A	A	A	A

*	MDB : Main Distribution Board
**	DB : Distribution Board
***	AC : Air Conditioner
****	LS : Lighting system
D	distribution power system work
A	Architecture work
S	Signalling system work
T	Telecommunication system work

5) Outside Facilities in the Depot

It shall be required lighting system for the access roads of each building and for the corridors for drivers in stable tracks, as distribution power system work.

The following equipment as well is installed in the Depot.

- LED ON OFF indicator (outdoor large size).
- LED ON OFF indicator (indoor large size) height
- LED ON OFF indicator (indoor small size) under food hold
- Power simple disconnection container and return automatic switching arrangement
- Check stand ascent and descent door on the roof
- Disconnection container investment warning (flashlight)
- Disconnection container investment warning (buzzer)

6) Emergency Generator and Tunnel section Facilities

OCC and CIA station shall be required to install emergency generator for disaster prevention, fire and outage of electric power company.

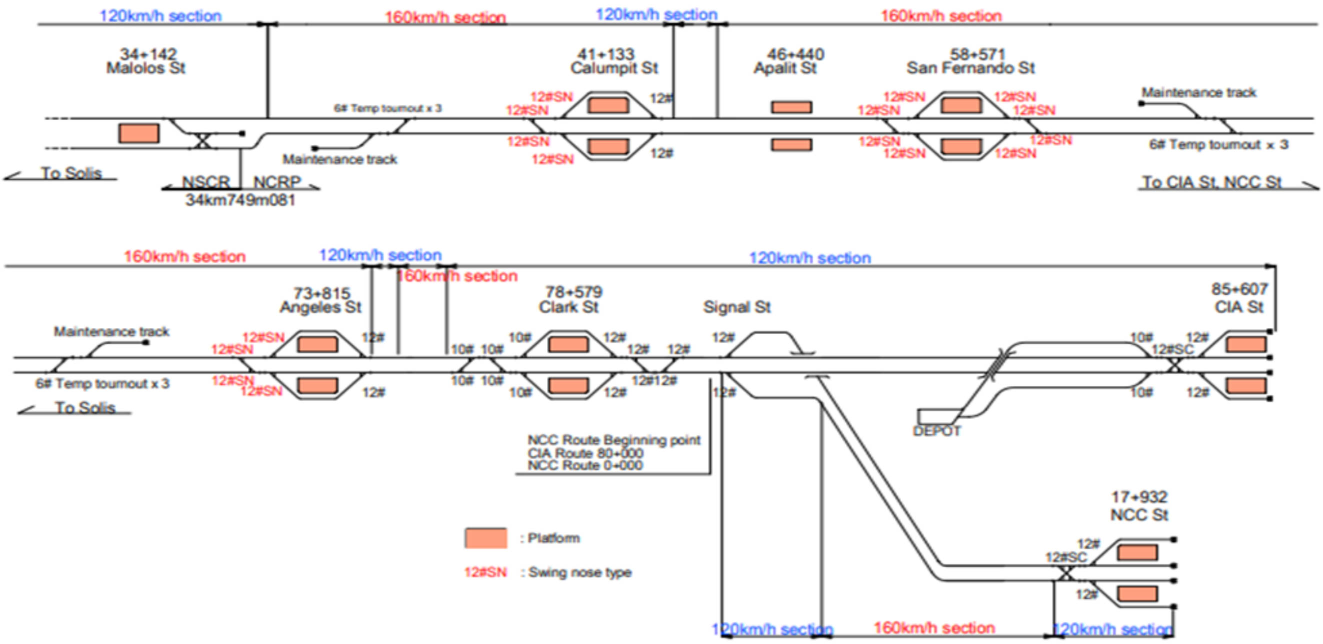
CIA station is planned as the underground station and there is about 2 km tunnel section. In the tunnel section, drainage pump and lighting etc. equipment are required. Therefore, it has to be considered how to supply the equipment.

4.3.6 Signalling System

(1) Premise of Signalling System and Target Line

1) Target line; Calumpit St. to NCC St. (6 stations, 51.5km)
(Calumpit St. to NCC St. (7 stations, 69.6km))
2) Maximum operation speed; 160km/h (elevated area)
3) Target train traffic density; 5 min. headway
4) Vehicle formation; 8-car formation (10-car formation in future)
5) Train driving direction; Right side
6) Reverse direction operation; No reverse direction operation. (under consideration)
7) Single track parallel operation; Not carried out. (Implemented as an abnormality response operation)
8) Limited Express operation; Implementation. Plan to overtake at Malolos St. to CIA St.
9) Emergency operation; Returning at the station on the way
10) Mutual direct operation; Needed mutual direct operation with NSCR, NSRP-South and MMSP
11) Train operation;
   - Main line to Depot access line; One driver operation with ATO
   - Depot; One driver manual operation without ATO
12) Operation way in Depot;
   (i) Control up to Depot access line by ATO. However, taking into consideration the conditions of the track layout. The final control range is decided at Detail/Design phase. (Since the serial parking is needed in Depot, it is difficult to drive by ATO up to the stabling yard, so the direction of manual driving.)
   (ii) From the Depot access line to the stabling yard; One-driver manual operation by the ATP on board signal without ATO.
   (iii) From the Stabling yard to the factory and the maintenance line; With manual operation in Depot mode. In Depot mode, the driver performs manual operation according to the display of the shunting signal installed on the track side.
13) Fixed point stop: Fixed point stop control by ATO is required.
14) Train protection device: Install a push button for train protection on the platform, and transmit emergency stop signals from the ATP ground device to the target train by operation of passengers and station staff. (Handling of emergency button is under consideration.)
15) OCC (Operation Control Center) building; Installation in Depot area.
16) OCC room; Installation in OCC building.
17) CER (Central Signal Equipment Room); Installation in OCC building.

18) SER (Station Signal Equipment Room); Installation in Stations with turnout and stations without turnout.
19) Measures against power failure: Installation UPS as a measure against power failure for OCC, CER equipment and station signal equipment.
    (i) For OCC, CER equipment; Since it switches to emergency power supply in case of power failure or outage, 30 minutes UPS power supply is installed in CUR (Central signal UPS Room).
    (ii) For SER equipment; Since there is no emergency power supply in case of power failure or outage, 3 hour UPS power supply shall be installed in SUR (Station signal UPS Room).
20) Target line and station layout is shown in .



Source: JICA Design Team

Figure 4.3.49 Target line and station layout

21) Stations with turnout; 6 stations (Calumpit St., San Fernando.St., Angeles St., Clark St., CIA St., NCC St.)
22) Stations without turnout; 1station (Apalit St.)
23) Depot;
    (i) Signalling equipment is installed to CER (Central Equipment Room) in OCC building in Depot.
    (ii) Power system for OCC and CER equipment are installed to CUR (Central UPS Room).
24) Intermediate Signal Equipment Room; Installed at three places.
    - ISER No.1 (Middle of Nichols St. and Calumpit St., 37km236m)
    - ISER No.2 (Middle of Apalit St. and San Fernando St., 51km210m)
    - ISER No.3 (Middle of San Fernando St. and Angeles St., 66km200m)

(2) Basic concept and Standard

In the signalling system, the following specified standards are referred to. Consider the contents of these standards.

1) Design Criteria and Standard

<Design Criteria>

(i) CBTC shall be used as ATP (Automatic Train Protection).

(ii) Train detection;

a) For stations with turnout; it is assumed to be the track circuit detection.

b) For Depot; it is assumed to be the track circuit detection.

c) For Main line / stations without turnout; it is assumed to be CBTC detection (counting distances by tachometer on the train, and correction by Balise (absolute point) on the ground.

(iii) Detection of the broken rail:
Since the track circuit is laid in the station with turnout and Depot, the broken rail detection is possible. There is no track circuit for train detection for the main line / stations without turnout, so the broken rail detection cannot be performed. Therefore, a track circuit of about 1 to 2 loops between stations is installed for the broken rail detection.

(iv) Backup when CBTC fail;
As a backup system at CBTC failure, make one train in a track circuit loop between stations to operate.

(v) In CBTC, the communication between the train and the ground ATP equipment shall be based on 2.4 GHz radio communication.

(vi) The ATP system shall satisfy the operation of 5 minutes interval headway.

<Design Standard>

For the Signalling system, the following specified standards shall be applied.

(i) CBTC standard; IEEE 1474.1 shall be applied.

(ii) The other system and equipment; JIS or EN/IEC shall be applied.

(iii) Common to the whole system; EN/IEC shall be applied for RAMS, Safety and EMC standard.

<u>JIS standard</u>

(i) Ministry Ordinance, Technical Standard regarding Railway, MLITT

(ii) JIS: Japanese Industrial Standard

(iii) JEITA: Japan Electronics and Information Technology Industry Association

<u>EN/IEC standard</u>

(i) ISO: International Standards Organization

(ii) EN: European Norm
(iii) ETCS: European Train Control System
(iv) EIRENE: European Integrated Radio Enhanced Network
(v) ETSI: European Telecommunications Standards Institute
(vi) IEC: International Electro-Technical Commission
(vii) IEEE: The Institute of Electrical and Electronics Engineers, Inc. (in the USA)

For the Signalling system, the following specified standard shall be referred. The contents on these standards shall be considered.

<u>EMC related</u>

(i) EN 50121/IEC 62236 Railway applications- Electromagnetic compatibility

<u>Safety, RAMS related</u>

(i) IEC 61508 Functional safety of electrical/electronic/programmable electronic safety –related systems
(ii) EN 50126/IEC 62278 Railway applications – Specification and demonstration of reliability, availability, maintainability and safety (RAMS)

<u>Other EN/IEC standard</u>

(i) EN 50128/IEC 62279 Railway applications- Communication, Signalling and processing systems – Software for railway control and protection systems
(ii) EN 50159-1/IEC 62280-1 Railway applications – Communication, Signalling and processing systems – Part 1: Safety-related communication in closed transmission systems
(iii) EN 50159-2/IEC 62280-2 Railway applications – Communication, Signalling and processing systems – Part 1: Safety-related communication in open transmission systems
(iv) EN 50129/IEC 62425 Railway applications - Communication, Signalling and processing systems - Safety related electronic systems for Signalling
(v) IEC 62427 Railway applications - Compatibility between rolling stock and train detection systems.
(vi) IEEE1474.1

<Other IEC/JIS standard>

In case to comply with the JIS standard system, it is needed to apply the following standards or equivalent or higher standards.

IEC61000,IEC60364,IEC60529,IEC60947,IEC62498,JIS E 3001,JIS E 3003,JIS E 3011,JIS E 3013,JIS E 3014,JIS E 3015,JIS E 3017,JIS E 3018,JIS E 3019,JIS E 3020,JIS E 3021,JIS E 3022,JIS E 3031,JIS C 3102,JIS E 3303,JIS C 3401,JIS C 3605,JIS H 8641.

2) System Assurance

System assurance to ensure that the requirements for safety, reliability, availability, and maintainability (RAMS) for signalling system shall be carried out.

System assurance activities shall include RAMS activities and the preparation of all supporting documentation. System assurance activities shall comply with the requirement in accordance with EN50126 or IEC62278 Railway applications – Specification and demonstration of reliability, availability, maintainability and safety (RAMS).

System RAMS plan and its associated RAMS analysis shall be undertaken at system level to demonstrate the reliability, availability, maintainability and safety plan.

RAMS report including the internal audit result by the CONTRACTOR's organization and audit by third party specialist shall be submitted.
The report indicating that the safety of ATP system with CBTC and Interlocking (CBI) system satisfies SIL4, including the internal audit result by the CONTRACTOR's organization and audit by third party specialist shall be submitted. Also SIL4 shall be applied to ORP (Over Run Protection), FSP (False Starting Protection) and TSR (Temporary Speed Restriction).

3) RAMS Index

The Signalling system failure of more than 30 minutes interrupting the train operation shall be less than 0.5/year.

(i) Availability Target:
  a. ATP (Ground Equipment), CBI; 99.99 %
  b. ATP (On board Equipment);99.99 % (for each train)
  c. ATS; 99.98%

(ii) Maintainability Target: MTTR: 1.5Hr

It shall be ensured that the Signalling system meets this value based on the reliability calculation.

4) Safety Requirement

Signalling system consists of main components as follow;

(i) Automatic Train Protection System – ATP*1 (Ground system and Onboard equipment)
(ii) Train Detection System – TD*1
(iii) Computer Based Interlocking System –CBI*1
(iv) Automatic Train Operation—ATO *2
(v) Automatic Traffic Supervision System – ATS*2
(vi) ORP (Over Run Protection)*1
(vii) FSP (False Starting Protection)*1
(viii) TSR (Temporary Speed Restriction)*1

Safety design concept shall be applied according to RAMS standard.

*1; Vital component; SIL4 shall be applied.
*2; Non vital component

Concerning the safety of the Signalling system, EN 50129/IEC 62425 shall be referred.

The safety level of TD system, ATP system with CBTC and Interlocking system (CBI) shall satisfy the SIL4 in IEC 61508.

The safety principle material related to the above systems shall be made and submitted.

Each expected failure rate related to the above systems shall be calculated and respectively show the safe failure and hazard failure.

It shall be required to be accompanied by the internal audit material by the CONTRACTOR's organization or third party specialist audit.

A frequency allocation from the relevant authority shall be obtained if necessary.

5) Reliability Requirements

With respect to the sub-systems that interfere with the train operation in case of system failure, reliability shall be enhanced with the redundant method.

The reliability calculation sheets concerning all sub-systems in the Signalling system shall be submitted.

6) Maintenance Requirements

Fundamentally, the system shall be designed based on low maintenance requirements

The monitoring system shall be conducted in order to support the maintenance staff to focus on the failure with journal data of transmitting/receiving signal level record and operation record.

7) Electromagnetic Compatibility (EMC) Requirements

The EMC of signalling system after the installation of these systems shall be evaluated.

The EMC evaluation stated above shall be carried out complying with EN50121/IEC62236.

The signal and noise level shall be measured especially in the site near the substation.

The EMC based on this measured data shall be evaluated.

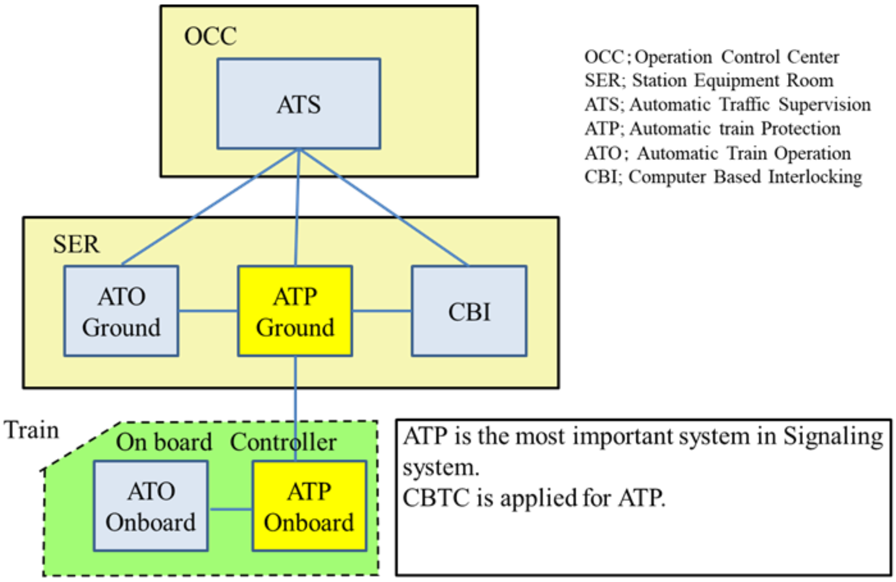
The data confirmation shall be submitted to the Employer for approval after site testing.

(3) Signalling system outline

1) Signalling system configuration

The configuration of general signalling system is shown in Figure 4.3.50.

Introduction of ATO is under consideration.



Source: JICA Design Team

Figure 4.3.50 Signalling system configuration

2) Main function of Signalling system

The functions of the main subsystems (ATP, ATO, CBI, and ATS) of the signalling system are shown in Table 4.3.50.

Table 4.3.50 Main function of Signalling system

Subsystem	Function	Comment
ATP(Automatic Train Protection)	ATP carries out automatic brake control cooperated between ground equipment and onboard equipment in order to ensure safety to avoid trains collision.	SIL 4 is applied
ATO(Automatic Train Operation)	ATO controls all phases of train operation from acceleration to precise stopping, cooperated with ATP which only controls braking to ensure safety.	
CBI(Computer Based Interlocking system)	CBI set and lock routes related to each train located in an area under its responsibility, in order to ensure safety.	SIL 4 is applied
ATS(Automatic Traffic Supervisory)	ATS carries out train tracking, monitoring of train and traffic, route control, diagram management, and rescheduling of diagram when diagram is disturbed.	

SIL4; Safety Integrity Level 4, Dangerous side failure rate; below10^{-9}/h

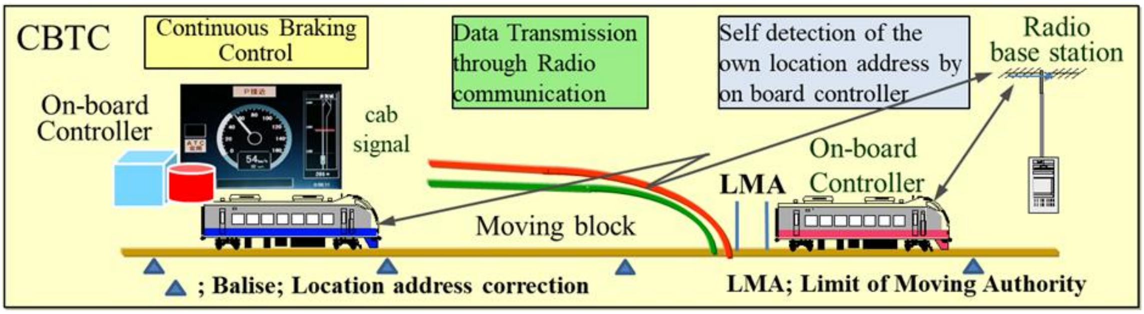
Source: JICA Design Team

3) Automatic Train protection (ATP)

The most important system in the signalling system is ATP (Automatic Train Protection). CBTC (Communication Based Train Control) is applied, CBTC is the latest technology for urban railway which is a state-of-the-art signalling system that uses radio communication.

a) Outline of CBTC

Overview of CBTC is shown in Figure 4.3.51.



Source: JICA Design Team

Figure 4.3.51 Outline of CBTC

In CBTC, radio communication is used instead of track circuit. The preceding train detects the own train position, and the on board equipment transmits the data to the following train by radio communication through CBTC ground equipment. The following train controls the brake pattern so as to stop until the front of LMA (Limit of Moving Authority). This is not the fixed block system, and it is the moving block system.

CBTC is State of art technology in Signalling system, and today it is being introduced to many urban railway in the world.

b) Key issue of CBTC

i) Broken rail detection.

Broken rail may cause a serious accident. No problem in conventional ATP because of using Track circuit (TC).

In case of CBTC, Basically TC is not used. (Partially used in Turnout station and Depot.) Then how to realize this function is important issue. But broken rail detection is realized by the introduction of a simple TC structure (1 or 2 loop between stations) for even TC unnecessary area (station without turnout and main line).

ii) Back up when CBTC fails or unavailable.

CBTC shall be a reliable system. However, if the CBTC fails, it is necessary to provide a minimum backup system.

As the backup system of the train detection means, the track circuit is installed 1 or 2 loops between the stations, as for train detection, there is a proposal of an axle counter other than the track circuit, but in this case, it is decided to introduce a track circuit considering broken rail detection.

iii) Strengthening means for 2.4GHz Radio Communication

In case of CBTC, as general purpose radio frequency 2.4 GHz is used, this frequency band may be disturbed, then the following means are adopted. Radio communication security measures consistent with the features of the proposed CBTC shall be adopted. The following is an example of radio communication security measures.

a. Radio transmission enhancement measures; Measures to improve the radio propagation performance.
    - Frequency changing, Receiving position changing, and Time changing (Twice transmission) etc.
b. Improvement of security
    - Encryption；AES,
    - Authentication technology; ISO/IEC9798-2

iv) Safety and Reliability

a. Vital (Critical) component; SIL4 is applied-----ATP, CBI
b. SIL4 (Safety Integrity Level 4); Dangerous failure rate 10-9/h or less.

c) ATP system (CBTC) Evaluation Summary

CBTC is generally capable of the 90 seconds interval headway operation for the signalling system (assuming no facility constraints).

Since CBTC uses radio communication for data transmission, compared to Digital ATP that performs data transmission through the track circuit, installation and maintenance costs of the ground facilities are small.

CBTC has a lot of experience in urban railways around the world, and Japanese manufacturers have also gained experience of CBTC, so the application of CBTC is appropriate as the ATP system of MCRP.

However, MCRP is planning mutual operation with NSCR and NSRP-South. Consistency with the signalling system related to the mutual operation must also be considered.

d) ATP system (Ground system, On-board equipment)

a. On-board ATP equipment shall calculate the continuous brake profile with information from Ground ATP system to continuously control brake application.
b. Communication method between On-board and the ground should be with Radio Frequency (RF).
c. The headway calculation for implementing train headway of 5 minutes at Calumpit St. and CIA St shall be submitted for Employer's Representative approval.
d. The Cab signal layout, DMI (Driver Machine Interface) and design of operation mode switch shall be submitted.
e. The operation method by ATP (operation mode, interface etc.) shall be considered and adjusted with the Rolling stock tem

e) Data Transmission System

The aim of the Data Transmission System is a bi-directional, reliable, and secured data exchange between OCC and station signal equipment and wayside equipment.

The data transmission between Ground Signalling system and On-board equipment shall be realized by 2.4GHz Radio communication system.

These optical fiber cables shall be provided by Communication system.

4) Train Detection system (TD)

(i) Train detection at CBTC is the on-board detection method. Based on Balise on the ground, measure the traveled distance by a tachometer of on board equipment and find the position of the train. In the case of a tachometer, there is a possibility of errors due to slipping of wheels and so it is necessary to use a correction by Balise in combination.

(ii) Besides this, there are methods such as correction by Doppler radar or correction by wireless. Since these differ according to the CBTC method, the bidders need to propose the required technology at the time of bidding.

(iii) SIL 4 must be applied since the train detection system is an important structural component of ATP and is a vital component.

(iv) Train detection system in station with turnout, Depot access line and Depot

  a. Track circuit is applied.

(v) Train detection system in main line and station without turnout

  a. CBTC detection is applied.

  b. Track circuit is installed to main line and station without turnout as a backup system which is 1 or 2 loop between stations is installed in case of CBTC failure or unavailable.

(vi) The track circuit shall withstand DC 1500 V, maximum current 4200 A.

(vii) The train detection device shall conform to EN 50121 / IEC 62236 in order to prevent induction by induction action or the like.

(viii) Broken rail detection by track circuit is applied to all rails except the maintenance line.

(ix) To keep the track circuit resistant to lightning surge, install arresters, varistors, etc. in the equipment.

5) Automatic Train Operation system –ATO

(i) Outline of ATO

ATO in this project have two main functions, PSD control and running control. Regarding PSD control, the PSD control device in this section refers to devices for ensuring PSD control interlock and transmission between the ground and onboard. And can prevent misoperations by the crew member.

Meanwhile, ATO shall control departing at platform and running between stations and stopping at fixed position in platform automatically, and shall provide not only high stop accuracy for fixed position but also comfortable cruise for passengers in any situations.

(ii) Function of ATO

i) PSD control

ATO shall control PSD by electromagnetic coupling, between onboard antenna and on-grand antenna for PSD control installed between rails, which enable control information and status information send/receive.

  a. Interlocks for PSD control

  PSD control passenger shall not endanger passengers, by interlocks. The basic matters to be observed for interlocks of PSD control are as follows.

    A. PSD control shall be valid when train stops fixed position and, is not commanded for propulsion and, stop solidly by brake force.

    B. PSD control shall be initiated by door open/close operation by crew.

C. Both train doors and PSD shall not open when crew intends to open doors in wrong side which does not correspond with the platform side. In this situation, crew shall be alarmed misoperation, by alarm sounds and so on.

D. Train door and PSD shall open/close in combination. Only either of train door and PSD shall not open/close.

ii) Running control

Running control shall be initiated by crew operation. Running from place of departure to fixed position of arrival station shall be controlled automatically based on grand-antennas for correcting calculated distance. Train shall be controlled not only to stop at fixed position correctly without position correction and to keep predetermined running time, but also to run comfortably and energy-saving.

a. Numbers of grand-antennas and position of grand-antennas

The basic matters to be observed for grand-antennas installation are as follows, however, contractor shall consider suitable numbers and position of grand-antennas for stop accuracy and comfortable cruise.

b. Basic Control

A. Stopping at station/ out of station

Braking notches shall be commanded to stop solidly in consideration of gradient, when train stop. Braking notches shall be low as possible in consideration of ride comfort when starting.

B. Staring control at station/out of station

Train shall start by crew’s starting operation. Propulsion notches and starting jerk shall be controlled to reduce shock when starting. Movement for back direction shall be not acceptable; of course, ride comfort shall be not deteriorated even if brake notch commands and propulsion notch commands are lapped when starting.

C. Running between stations, off propulsion control, constant speed control

Running between stations shall be assumed to keep predetermined running time, however, coaster operation shall be adopted as possible for improving ride comfort and saving-energy. Especially coaster operation shall be adopted actively during down slope section to save energy. Also, rapid acceleration and deceleration shall be not adopted for improving ride comfort. On the other hand, in case of constant speed control is commanded when recovery operation set, train shall be controlled to follow target speed which is defined within range not to over the CBTC brake pattern even at any gradient.

D. Stopping at fixed position

Low deceleration shall be kept constant during decelerating as possible, control for reducing train stopping shock such as weakening braking force just before stopping. Also, stopping pattern shall suppress stopping at over position as much as possible.

(iii) Requirements for ATO

The ATO equipment is effective only when the ATP equipment is operating. If ATP is not working, ATO shall not operate. ATO shall operate within the limit speed of ATP.

(iv) Others

a. Regarding the operation method by ATO, it is necessary to adopt the acceleration / deceleration control command according to the operation curve based on manual operation in principle.

In the case of it is forced to change for improving ride comfort etc., confirm with the Rolling Stock team on the simulation that the performance of the propulsion system has no problem.

b. The operation method by ATO (operation mode, interface etc.) shall be considered and adjusted with the Rolling stock team.

6) CBI (Computer Based Interlocking system) - CBI

(i) CBI is a computer-based interlocking system that controls the interlock with the related point machine and the signal. CBI sets a route. Also, the CBI shall be held until the train passes through the set route and it shall be fail-safe. SIL4 shall be applied for CBI.

(ii) As CBI, there are distributed CBI and centralized CBI. Here, distributed CBI is described as a base, but bidders shall propose an appropriate CBI system.

a. In the case of distributed CBI, CBI will be installed to the stations with turnout: 6 stations (Calumpit St.、San Fernando St.、Angeles St.、Clark St.、CIA St.、NCC St.). The CBI of Depot is installed at CER in OCC. Depot access line is controlled from CBI of Depot.

(iii) CBI is managed by ATS (Automatic Train Supervision). If ATS fails, CBI is manually controlled by OCC's IL-CT. When functions are disconnected due to OCC ATS and IL-CT failure, CBI is controlled by IL-ST of each station with turnout.

(iv) CBI is an important component in terms of safety, and it must comply with the basic concepts and corresponding standards in Section 1.2. Also, since it is a vital component, SIL 4 shall be applied.

(v) The CBI shall have the following functions.

a. Lock after setting route
b. Track locking while the train is passing through the set route
c. While the train is approaching, when canceling the route, the route shall be locked for a fixed period
d. While traveling on a point machine, the point machine shall be locked

(vi) CBI shall maintain fail-safe

(vii) CBI shall be independent from TD and ATP. Even if TD or ATP fails, the CBI must operate safely.

7) Automatic Traffic Supervision system -ATS

The ATS system shall have the train schedule (diagram) management function, the train tracking function, the automatic route control function, the operation adjusting function and the man-machine communication function.

The ATS system collects information necessary for train operation from the signalling system. Data transmission is performed through a fiber optic cable of the communication system management.

(i) Train schedule (diagram) management function; this shall include the following contents.

a. The basic diagram is planned by a dispatcher who is supported to make train diagram in the train diagram planning system.

b. For the basic diagram, weekday diagram, holiday diagram, spares (4 types of patterns) shall be made.

c. The practicable diagram is made from the basic diagram. The practicable diagram has the day diagram, the previous day diagram and the next day diagram. The practicable diagram shall be monitored based on the actual train operation in the ATS. Also, the actual result schedule (diagram) is managed in accordance with the actual train operation results.

d. The ATS performs route control according to the practicable diagram. It is also necessary to check the train number which is input from on board controller. When the train diagram is changed, the practicable diagram shall be changed, and the route control shall be executed accordingly.

e. There are three kinds of train types as follows.

a) Commuter train

b) Rapid Commuter train

c) Limited express train

When making train diagram or changing train diagram, it is necessary to set 2 or 3 required driving time for each train type and each station.

(ii) Train tracking function; this includes the following contents.

a. Based on the train detection data reported from the train and the train number data, all the trains are always tracked, and the train position and train number are displayed on the terminal (ATS-T) and the large display panel in OCC.

b. Processing train number data in the computer (ATS) and train number data getting from on board equipment shall always be compared; if there´s a discordance between these two, an alarm shall be triggered.

(iii) Route control function; this shall include the following contents.

a. The route control function has three route setting modes.

a) Automatic route setting mode by ATS based on the practicable diagram.

b) Manual route setting mode from the ATS-T terminal in operation of the ATS (In this time, it is possible to set it by interrupting the automatic route control mode of ATS. Also, the train number is displayed.),

c) In case of ATS failure in which both ATS and ATS-T are unusable, a manual route setting mode by IL-CT which is a CBI terminal in OCC.

b. In order for the train to enter the station, When train approach, it is necessary to set the route (home route) in the place.

c. Departure route shall be set a certain time before departure time. However, if the train is delayed, its route will be set immediately. That route will be set soon to regain the delay.

d. Automatic route setting shall be carried out under the following conditions.
   - The route is not occupied.
   - Conflict and facing route are not set.
   - The entrance route shall be restored after the train has entered.
   - The departure route shall be restored when the train enters the route and passes through a section outside the route.

(iv) Operation adjusting function; this shall include following contents.

- When the train operation is disturbed by any accident, ATS shall support the traffic dispatcher by the operation adjusting function.
- ATS shall have the following functions for the recovery of train delay.
- To automatically adjust the stopping time at all stations;
- Diagram modification shall be proposed by the communication with traffic dispatcher.
- The contents of diagram modification are shown as follows but not limited to:
- The train diagram modification function is shown in Table 4.3.51.

Table 4.3.51 Train diagram modification function

Item	Contents
New train diagram	New train diagram which is not prepared in the practicable diagram that day
Cancel of diagram	Cancel operation of a particular train and a certain station
Diagram revival	Revival of prepared but unused diagram
Order exchange	Change the order of specific trains after appointed station
Operation exchange	Change appointed diagram to other diagram after appointed station
Destination change	Change the appointed train destination
Arrival Line change	Change the arrival line of appointed train at appointed station
Time shift	Shift the time of appointed diagram towards before/after the time.

Source: JICA Design Team

(v) Large video display; This shall be used as the operation indicator (Mimic Panel)

a. The following information shall be indicated on the large video display and ATS Terminal in OCC:
   - All the main line track lay out including Depot access line
   - Train location and train number
   - Route setting (Route lock)
   - Point Machine directional condition
   - Other necessary indication

b. The following operation records shall be memorized and printed out when necessary.
   - Records of arrival/departure time for each train
   - Operation records in comparison with practicable diagram and actual time
   - Operation records by dispatchers.
   - Failure records

(vi) Train Diagram making system; this shall be provided for supporting diagram planning staff in OCC.

The train diagram making system shall use an ATS-DS as dedicated terminal in Off line, also have at least the following functions.

a. Enter the operation curve (performance curve) data of the train created by the operation plan division so that the minimum train running time data etc. can be calculated.
b. Be able to make diagrams based on running time data of train, time interval data between stations, stop time data at station, platform effective track length, track number,
c. Be able to copy a diagram to make another diagram or to make a pattern drawing. Also, the manually entered diagram shall be automatically checked the rationality of the diagram.
d. When making train diagram, it is necessary to set 2 or 3 required driving time for each train type and each station.
e. The train diagram making system shall be used to make the basic diagram and the practicable diagram. This system has the storage capacity to store six kinds of diagrams.
   - Basic diagram; Weekdays, holidays, and spare four basic diamonds
   - Practicable diagram; The day diagram, the previous day diagram, and the next day diagram

8) Signalling system in Depot

(i) There are the stabling yard and the maintenance yard (including work shop and car washing plant) in Depot.

(ii) The signalling system (including CBI) of Depot is installed in the CER (Central Signal Equipment Room) of the OCC.

(iii) Entering / Departing train operation is carried out between the Depot access line and the stabling yard. The entering train is at Depot access line, the departing train is at the stabling yard, the driver switches to the Normal Depot mode, and operate manually according to the on board signal (with the destination line indication), the speed is limited to less than 25 km / h. The brakes are applied automatically when the limit speed (25 km / h) is exceeded.

(iv) Control of entering / departing signal of train is automatically controlled by Depot PRC. Moreover, the operation status can be monitored by IL-DT which is Depot operation terminal in OCC. When Depot PRC fails, connect IL-DT to Depot CBI and perform manual control.

(v) The train operation of the maintenance yard is controlled manually (less than 25 km / h) from the IL-DT by the shunting signal (or shunting indicator) and the route indicator.

(vi) Install ORP (Over Run Protection) at the end of the stabling yard. When the train exceeds the limit stop point, it is stopped by the emergency brake.

(vii) The route setting operation of Depot is executed by the operation of "Start point to destination point".

(viii) Route indicator

The route indicator shall be installed together with the shunting signal (including the shunting indicator) in order to indicate the direction of the route signal. The route indicator shall be a two-digit numeric indicator and shall be visible for more than 100 m

9) Miscellaneous Signalling system

(i) Train number

- Train number shall be input from DMI of train cab when train start. Train number is transmitted from DMI to ATP(ground) and ATS through CBTC radio, Train number shall be used for the train tracking check and route control check in ATS

(ii) Signal monitoring

- Objective of Signalling Monitor is to supply Facility Maintenance Dispatcher with the information of system working status, system failure and maintenance.
- Signalling monitor shall monitor working status, failure, and sequential movement of each sub-system, including power supply system for Signalling system and ATS system.
- Signalling monitor shall also collect failure information at each subsystem of ATP, TD system.
- Signalling Monitor shall transmit the three following information statuses for each Signalling sub-system and ATS system.
  - Serious Failure : Immediate repair should be required.
  - Minor Failure : Minor failure in which train operation is uninterrupted.
  - Normal status : Information of normally working condition is transmitted.

(iii) Substitution Block system

a. Purpose of substitution block system; the substitution block system is a backup system in the case of CBTC failure. In this case, the CBI and the track circuit must be available.

b. In this case, the substitution block system sets one to two block between stations (including station with turnout and stations without turnout).

c. Operation of substitution block system is done by OCC dispatcher. The dispatcher confirms that the preceding train leaves the preceding station, that there is no train between the preceding station and the train station, and tells the driver the permission by train radio.

d. In this case, the speed of the train is limited to 25 km / h or less.

e. If OCC is not available, use IL-ST of station BMS.

(iv) Shunting Signal, Shunting indicator

a. Shunting signal shall be installed for Shunting work in the stations with turnout and Depot

b. Function of shunting signal

a) The shunting signal is provided for each route of the train to be shunted. However, when there are two or more route from the same line, and a route indicator is attached, the shunting signal can be shared.

b) The shunting signal is used in two display types, Y (Go) and R (Stop). In addition, semi-automatic type is adopted as the shunting signal.

c) The shunting signal shows the stop signal in the following cases.

- When a train on the protection area of the shunting signal
- When the point machine in the area of the shunting signal is not turned on to the opening direction
- When another train takes a vehicle contact limit at a branch point or an intersection point and interferes with the protection section of the shunting signal.
- The visible distance of the shunting signal shall be 200 m or more during the daytime and fine weather.
- The shunting signal is used in two display types, Y (Go) and R (Stop). In addition, semi-automatic type is adopted as the shunting signal.

c. The shunting indicator shall be installed in Depot.

d. Function of Shunting indicator

a) The shunting indicator shall be installed in the case that the route shunting is carried out by the sign.

b) The shunting indicator shall be indicated by the opening of the route, the related point machine locked.

c) When there are two or more route from the same line, a shunting indicator can be shared, in this case, the route indicator shall be installed.

d) When a shunting signal is installed at the same point with shunting indicator, the mechanism can be shared with their mechanism.

e) The visible distance of the shunting signal shall be 200 m or more during the daytime and fine weather.

(v) Point machine

a. The Electric point machine internally locks and the tongue rail has been tightened after changing the branch from stereotaxic to disposition (or disposition to stereotactic), and notifies the CBI that the locking is done.

b. Having a mechanism that can be manually changed by handles.

c. Since the control power is turned off at the time of manual change, it can be changed manually.

d. Electric point machine is installed to the branch in the stations with turnout, Depot access line and Depot except maintenance line.

e. Have a conversion time that can correspond to the operation headway 5 minutes.

f. Install a manual controlled turning machine (with arrow feather handle) on the branch of Depot maintenance line.

(vi) Overrun Protection system (ORP)

a. Objective of Overrun Protection is as follows.
   - Stop just before the buffer stop.
   - Over run protection for shunting area.
   - Turn back operation in terminal station

b. This function is realized with ATP (on-board equipment) and Balise.

c. ORP is a vital component.

(vii) False Starting protection

In order to suppress the false departure of the train when the stop signal is on in the station with turnout and Depot, False starting protection function is realized by Onboard ATP/ATO equipment.

In the equipment of ATP / ATO, if the driver intends to start when the departing signal is not ON, the brake is automatically applied.

(viii) Power supply system

a. The power system receives AC power of 3 phases 400 V (60 Hz) from each low voltage distribution room of each station and Depot. And the power supply device supplies electric power without instantaneous interruption according to the type of power supply required by each signal equipment. (except the point machine motor)

b. Power supply system shall keep power supply for at least 30 minutes in OCC, and for at least 3 hours in stations whenever power failure occurs.

c. The power supply system has a redundant configuration.

d. The power system shall enhance insulation and ensure adequate surge protection.

e. The earth of the isolation transformer shall be connected to the common earth terminal of the building

(ix) Temporary speed restriction system (TSR)

a. The purpose of the TSR is to temporarily restrict the train speed in some specific section.

b. The TSR shall impose the restricted speed to ATP system.

c. The data of TSR is displayed on the screen by the OCC dispatcher. The TSR data is transmitted to the on-board equipment through the TSR server and the ATP ground equipment.

(x) Signage

The following signs shall be set at side of the main track and track in the depot. The sign is an appropriate symbol in English. (But not limited to this)

a. Train stop sign
b. Once stop sign
c. Track name
d. Exchange line sign

(xi) Balise (train position correction, ORP)

a. The train is informed of its position by Balise.
b. Balise is set in track.
c. Balise is used for train position correction and ORP (Over Run Protection).

(xii) Maintenance support tool

a. When a control failure occurs, it is necessary to prepare a maintenance tool for each subsystems having display function for acquisition and analysis of time series event data for rapid analysis of failure.
b. The target devices are interlocking system (CBI) and ATP on-board equipment.
c. Data acquisition and display method;
   a) CBI; acquisition data; CBI input data, CBI output data
      Display method; Maintenance terminal for CBI, IL-CT
   b) ATP on-board equipment; acquired data; Balise input data, CBTC input / output data
      Display method: Maintenance terminal for on-board equipment
   c) ATP ground equipment; acquisition data; CBTC input/output data.
      Display method; Maintenance terminal for CBTC

(xiii) TID (Train Information Display) Terminals, Server

a. TID terminal is the terminal that displays the train traffic situation.
b. Installation location: Station, Depot, OCC, etc.
c. Number of terminals: 15 in total
d. TID server is a server gathering train traffic information and distributes it to terminals. The installation location is in CER.

10) Operation mode

(i) The operation mode is classified into a train operation mode and a system operation mode.

(ii) Each mode has several degrade modes depending on the failure mode.

(iii) Train operation mode;

The train operation mode is shown in Table 4.3.52.

a. ATO / ATP mode
   a) Normally, operation of the main line is performed in ATO / ATP mode.
   b) Shunting operation of the main line is also performed in ATO / ATP mode.

b. ATP mode
   a) Normal main line mode
      - Manual operation under ATP monitoring (Maximum speed is limited to 160 km / h.)
      - Operation at ATO failure
      - Shunting operation in the station can be also performed in ATP normal main line mode.
   b) Normal Depot mode
      - Manual operation under ATP monitoring in Depot (Maximum speed is limited to 25 km / h.)
      - ORP (Over Run Protection) is used together. Automatic stop when it is likely to become over run.
      - In this case, onboard signal is used.

c. Restriction mode, ATP cut off mode
   a) Restriction mode
      - Operation mode when Ground ATP fails.
      - It is a manual operation with On-board ATP.
   b) Cut Off mode
      - Operation mode when On-board ATP fails
      - It is a manual operation without ATP.
   c) Wayside signal mode
      - It is a manual operation by Wayside signal (Shunting signal or Shunting indicator) in Depot.

Table 4.3.52 Train operation mode

Train operation mode		Note
ATO/ATP mode		a) Normal operation on Main line b) Shunting on Main line with ATO
ATP mode	Normal main line mode	a) Manual operation with ATP (Max. speed is 160 km/h) b) Operation when ATO fails.
	Normal Depot mode	a) Manual operation with ATP (Max. speed is 25 km/h*1) b) With ORP (Over Run Protection) c) With On-board signal
Restriction mode, ATP Cut off mode (Rolling stock mode)	Restriction mode	a) Operation when Ground ATP system fails. b) Manual operation with On-board ATP c) Max. speed is 25km/h*1.
	Cut-off mode	a) Operation when Onboard ATP fails. b) Manual operation without ATP
Wayside signal mode		a) Operation with the wayside signal in Depot. Area. b) Maximum speed is 25km/h*1.

*1: Specific speed is under consideration

Source: JICA Design Team

(iv) System operation mode

Shows the system operation mode with the degrade mode in case of ATS failure.

a. The operation mode when the ATS is normal is the automatic mode (Automatic mode), and ordinary automatic route control is performed. The terminal ATS-T in OCC displays the operation status of the train. The train schedule is displayed on ATS-DS, and when any diagram disturbance occurs, use ATS-DS in order to adjusting diagram.

b. Even during normal ATS operation, the dispatcher can set the manual route using ATS - T. In this case, the train number is also displayed on the ATS-T.

c. When ATS fails, ATS-T cannot be used, so use the IL-CT (terminal of CBI) in OCC to connect with the CBI of the station with turnout and set the manual route.

d. When OCC's ATS and IL-CT are disconnected due to any failure etc., these cannot be used in OCC, IL-ST located at station with turnout is connected with CBI and set manual route.

Table 4.3.53 System operation mode

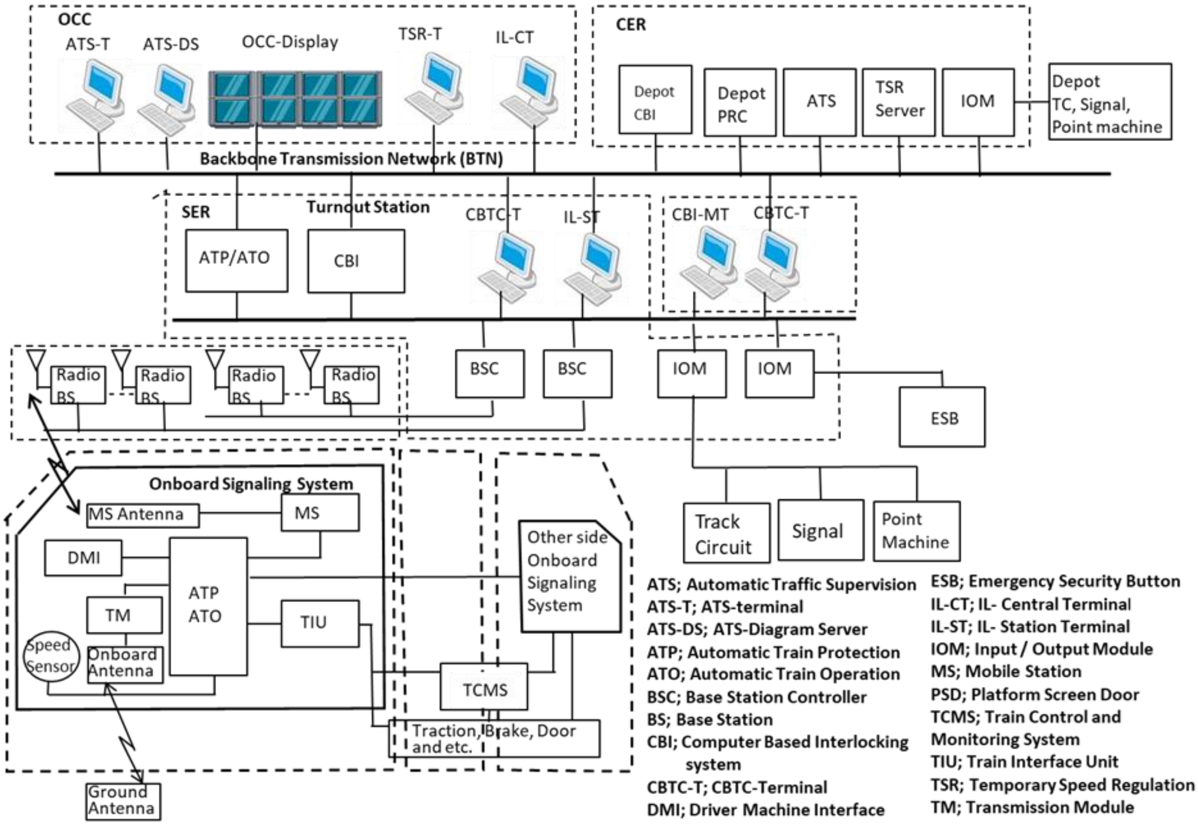
System operation mode		Note
ATS control mode	Automatic	a) Normal operation b) ATS system performs route control automatically. c) ATS-T; Train traffic status d) ATS-DS; Diagram management
	Manual(Temporary manual intervention)	a) Dispatcher performs route control manually by using ATS-T.
IL-CT operation mode (When ATS fails)		a) Dispatcher performs route control manually by using IL-CT to every station with turnout.
Station IL-T operation mode (When ATS and IL-CT fails)		a) Station staff performs route control manually by using station IL-ST to each station with turnout

ATS-T; Automatic Traffic Supervision- Terminal, ATS-DS; ATS-Diagram server
IL-CT; Interlocking system – Central Terminal
IL-ST; Interlocking system – Station Terminal

Source: JICA Design Team

11) System configuration

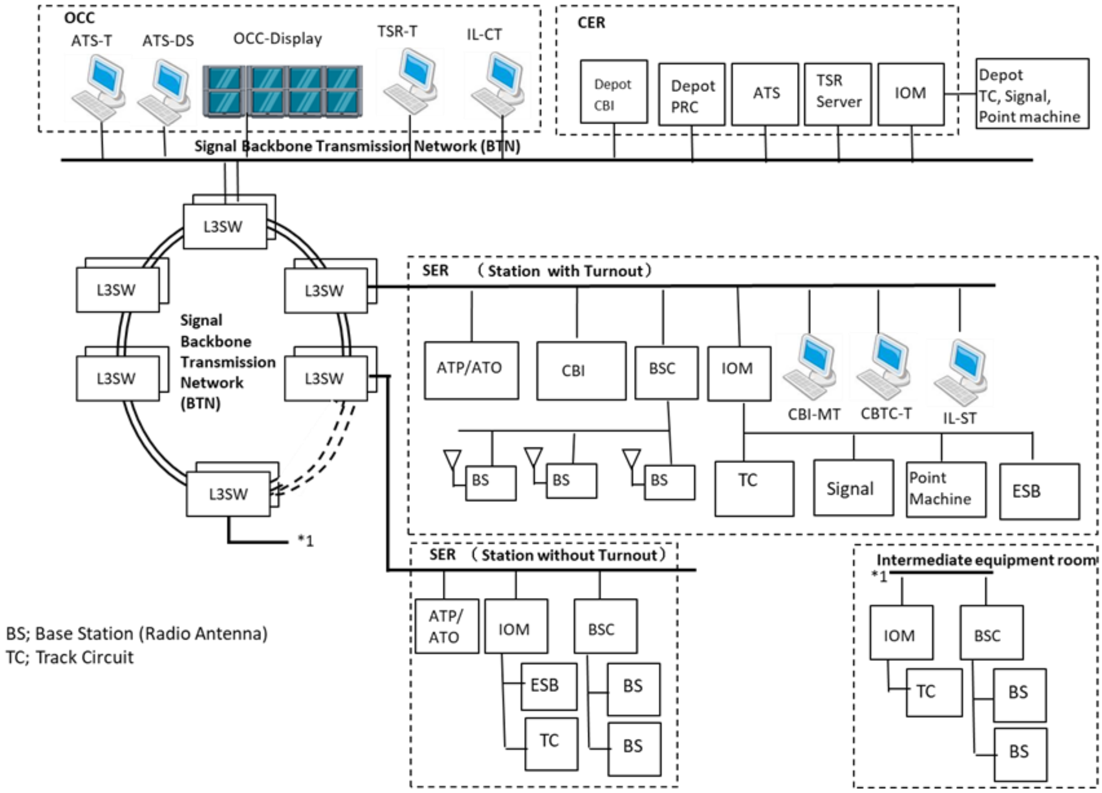
(i) System configuration is shown in Figure 4.3.52.



Source: JICA Design Team

Figure 4.3.52 Signalling system configuration for MCRP

(ii) Signal Backbone Transmission Network (BTN) is shown inFigure 4.3.53. Optical fiber cables, which is used for this system, provided by Communication system.



Source: JICA Design Team

Figure 4.3.53 Signal Backbone Transmission Network(BTN) configuration

(4) Requirement Specification (Performance, Interface)

1) Performance Requirement

Performance requirement is shown in Table 4.3.54.

Table 4.3.54 Performance requirement

Item	Requirement
1. Train Detection system	
a) Main line, without turnout stations	a) CBTC with bi-directional digital transmission system which utilizes radio to send data between ground and on-board equipment shall be adopted. b) Rail broken detection by track circuits should be adopted. The track circuit mentioned above should work as the backup system when CBTC system fails. However this system is not required to operate in minimum headway. c) As Backup system when CBTC fails, Track circuit (Uninsulated Track Circuit) is used with 1 or 2 loop between stations.
b) Stations with turnout, Depot and Depot Access line	Track circuit (Insulated Track Circuit) shall be adopted for exact train detection.
2. Interlocking system	
a) Method	a) Computer Based Interlocking system(CBI) shall be adopted b) There are two types of CBI: distributed type and centralized type. • In the case of distributed CBI, CBI is installed at the station with turnout. The CBI of Depot is installed at CER in OCC. Depot access line is controlled from CBI of CIA station. . • In the case of the centralized CBI, the logic of CBI of all stations with turnout are integrated into the centralized CBI installed at CER. The input / output module with each signal equipment is located at each stations with turnout. The CBI of Depot is installed at the CER of the OCC. c) The appropriate CBI system shall be proposed.
b) Redundancy	Hot standby duplex or 2 out of 3 configuration shall be adopted.
c) System cycle	System cycle shall be less than 200～400ms.
d) Safety level	Safety level shall comply with clause 1.2.4 (Safety Requirement) SIL4 shall be applied.
e) Number of routes	More than 200 routes per system are required.
3. CBTC system	
a) Reference standard	IEEE1474.1 compliant
b) Redundancy	SIL4 shall be applied to parts where safety design is required among CBTC, CBI and On-board equipment. For these equipment Hot stand-by Duplex or 2 out of 3 redundant systems shall be adopted.
c) On-board speed control method	On-board equipment shall generate brake and speed profile pattern, based on received data to automatically initiate brake in case of restricted speed is exceeded.
d) On-board rack	On-board equipment shall be mounted on 19 inch rack.
e) Train IF	Train IF shall be relay contact or TCMS interface.
f) Odometry	On-board equipment shall use 2 wheel sensors and Doppler radar.
g) ODDRS(Onboard Driving Data Recording System)	a) On-board equipment shall have ODDRS which is compliant with IEC62625.
h) Main Information between on-board and ground equipment	The information shall contain the following but not limited to: a) Track Condition (Ground →On-board); b) Movement Authority (Ground →On-board); c) Position report (On-board →Ground); d) Temporary Speed Restriction (Ground →On-board) e) Train number (On-board →Ground/ Ground →On-board)
i) Safety level	Safety level shall comply with Clause 1.2.4 (Safety Requirement)

Item	Requirement
j) On-board Fail-safe CPU	On-board CPU shall consist of 2 MPUs and comparator to guarantee the fail-safe calculation output in compact size.
k) On-board Power consumption	Total power consumption of On-board unit shall be less than 600W.
l) Train Number input	a) Method On-board setting which shall be done by the driver, shall not be changed by unintentional operation. b) Transmission between on-board and ground Radio communication shall be adopted continuously. c) Train Number 8 figures numeric shall be adopted.
4.ATS	
a) Control method	It shall be computerized control.
b) Redundancy	It shall be duplicated system or equivalent system. It shall be applied the hot standby method to ensure continuity of control.
c) External transmission	Optical Fiber Cable LAN shall be adopted.
d) Transmission speed	It shall be equal or more than 100Mbps
e) System Configuration	It shall be central convergence or equivalent
f) Train Diagram types	They include followings but not limited to: The basic diagram; weekday diagram, holiday diagram and spare basic diagram The practicable diagram; the day diagram, the previous diagram and the next day diagram
g) Console type	It shall be graphic user interface with VDT or equivalent
h) Mimic panel type	It shall be large display
5. Miscellaneous system	
5-1 Signal maintenance terminal	
a) Human machine interface	Human machine interface shall be done by laptop or desktop personal computer or equivalent.
b) Memory	Memory shall be equal or more than 40GB HDD.
c) Redundancy	Single system can be applied.
5-2 Point machine	
a) Switching time	Switching time shall be decided as follows: Main line: less than 8 sec. Depot area: less than 8 sec.
b) Supplying Voltage	Supplier should select the suitable supplying voltages (control and detection). AC230V,DC24V(for control)
c) Environmental condition	Structure of the machine shall be water proof.
5-3 Overrun Protection system	
a) Method	ORP profile on-board is generated based on location from way-side
b) Transmission	Balise or equivalent shall be utilized.
c) Transmission Module	It shall be Balise or equivalent module.
5-4 Power Supply system for station	
a) Uninterrupted time	It shall be more than 3 hours.
b) Redundancy	It shall be Duplex system or equivalent.
5-5 Power Supply system for OCC and Depot	
a) Uninterrupted time	It shall be more than 30 minutes.
b) Redundancy	It shall be Duplex system or equivalent.
5-6 Temporary Speed Restriction	
a) Method	TSR shall be imposed to any place on the main line.

2) Technical Requirement

(i) Fail Safe Technology

a. The fail-safe principles for all subsystems and their detailed methods shall be clarified.

b. The following subsystems shall comply with the requirements of safety requirements (1.2.4 safety requirements). For the safety of the signalling system, reference shall be made to EN 50129 / IEC 62425.

Basically, the safety level of each device shall meet IEC 61508 SIL 4.

a) Interlocking system (CBI)
b) CBTC system (Ground system, On-board equipment)
c) Train detection system
d) ORP (Over Run Protection)
e) FSP (False starting protection)
f) TSR (Temporary speed restriction system)

(ii) Communication Recovery Technology

The communication protocol between the on-board equipment and the CBTC ground equipment and the recovery technology at the time of abnormality are considered and submitted as documents and shall be approved by Employer.

(iii) Ergonomic Technology (specification OCC systems)

Systems with human-machine interface such as console and mimic panel for ATS system shall be designed to conduct human engineering. Especially color for indication, switches and buttons layout for operation shall be designed with ergonomic technology.

(iv) Redundancy Technology

a. CBTC consists of Ground system and On-board equipment. Ground system is redundant and shall be designed to operate even if the equipment and / or component fails. If a failure occurs in Ground system, it is necessary to immediately issue a fault alarm and inform the OCC.

b. CBTC shall be clarified the safety and reliability of the train in the RAMS process.

c. The following systems (devices) are required for redundant systems.

a) CBI: To ensure security, 2 out of 3 or 2 out of 2 configuration and their redundant for further reliability shall be adopted. Regarding redundancy, in order to ensure continuity of control, it shall be Hot Stand-by method.

b) ATS; Since SIL 4 in safety is not required, it is necessary to adopt a normal dual system configuration, but as for redundancy, it shall be Hot Stand-by method to ensure continuity of control.

3) Interface Requirement

The Signalling system shall require the interface of Civil contractor with other contractors (based on contract package about stations and Depot), and the interface to Track work and Architecture of items stated below. (At a minimum but not limited to).

Interface requirement is shown in Table 4.3.55.

Table 4.3.55 Interface requirement

Requirement section	Requirement Item	Document or Drawing
Structural (Elevated section and Depot)	Structural drawing for Signalling Devices and Cable trough installed at track side in Depot	Detailed drawing of installation location
Structural (Underground section)	Structural drawing for Signalling Devices and Cable trough installed at track side in underground station area.	Detailed drawing of installation location
Architecture (Elevated section and Depot)	Space, Specification and cable route of CER、CUR in Depot (OCC)	Floor space of CER, CUR in OCC, and cable duct
	Space and Specification of Control Room in OCC, and cable route	Layout of OCC control room, cable duct
	Space and Specification of SER, SUR in stations, and cable route	Floor area of SER, SUR at each station, cable duct
	Space and Specification of BMS in stations, and cable route	Floor area of BMS at each station, cable duct
Architecture (Underground section)	Space and Specification of Station Management room (BMS) at each station, and cable route	Floor space of BMS in each station, and cable duct
	Space and Specification of SER and SUR in underground section, and cable route	Floor space of SER and SUR in each station, and cable duct
Rolling Stock	ATP/ATO equipment for on-board/ground radio bi-directional data transmission.	Interface specification including timing.
	Mounting ATP/ATO equipment	ATP/ATO device drawing
	Mounting Antenna	Antenna drawing
	1) Balise for train position correction of tachometer 2) Balise for ORP; 3) Balise for FSP (False starting protection) is not needed because of Onboard signal by CBTC.	Interface specification including timing
	DMI as a Train Number setting device	DMI drawing
	EMC between on-board and Track circuit	Using frequency and tolerant noise level etc.
	EMC between on-board and CBTC	Using frequency and tolerant noise level etc.
Telecommunication System	Master Clock	Interface specification
	Back bone Transmission system	core number and OFC Specification
	Signalling equipment in OCC and Passenger information display (PID)	Interface specification
	Mounting Telecommunication equipment at Console in OCC (CER) and SER.	Layout and Optical fiber interface
Power Distribution System	Power Distribution Board Interface	Power consuming capacity
Catenary, Substation	Track circuit allocation for considering return circuit	Location of Impedance bond

Requirement section	Requirement Item	Document or Drawing
Track work	Insulation of Track circuit Track circuit constant Balise layout in the track Track traversing duct Train protection equipment for Set-off device	Layout of Track circuit Leakage current (attenuation / km) Balise layout, Balise drawing Cable specification Specification of Train protection equipment.

(5) OCC (Operation Control Center) Facility

1) Overview

There is a central traffic monitoring large display and a terminal used for monitoring and control of train traffic situation. These systems are connected to ATS, signalling system, interlocking system (CBI), and passenger service system.

2) OCC functions and structure

(i) The mission of OCC Operator

a. Train traffic Operator (Dispatcher)
- Train tracking, Traffic monitoring
- Diagram management, Diagram re-scheduling at Diagram disturbance

b. Depot train traffic Operator
- Depot entrance and Departure management and control by Depot PRC (Programmed Route Control)

c. Power system Operator
- Power system status monitoring
- Power system failure monitoring, management

d. Telecommunication Operator
- Telecommunication Equipment failure monitoring and operation
- Weather information monitoring (wind, rain, temperature, earthquake)
- CCTV monitoring（Platform, Concourse, etc.）

e. Signalling system Operator
- Signalling system failure monitoring (Main line and Depot)

f. Train traffic dispatching manager
- OCC total Management
- Mainly Train traffic monitoring , Diagram monitoring and management

(ii) Operator clarification and Terminal large display

a. Large display shall have 8 logical screens (physical screen; 4 displays)

b. Contractor shall make appropriate proposals on the number of terminals, the operator desks and the display contents of large displays in OCC.

c. OCC Operator classification and terminals is shown in Table 4.3.56.

Table 4.3.56 OCC Operator classification and terminals (example)

Operator	System	Terminal	Large Display (logical screen)
Train traffic Operator Depot Operator	ATS Depot PRC CBI	Main line;ATS-T×2、ATS-DS×2 Depot;IL-DT×2、TSR Terminal×1, TID×1 ATS Failure back up;IL-CT×2	Main line;3 Depot;1
Power system Operator	P-SCADA	Terminal×2	Power system;2
Telecommunication Operator	Communication CCTV	Communication terminal×2 CCTV monitoring×3	CCTV;2
Signalling system Operator	Signalling system monitor	Signal monitor×1	
Dispatching (Operation) manager	ATS	ATS-T×2、ATS-DS×1、TSR Terminal×1、 IL-DT×1、TID×1	

Source: JICA Design Team

3) Explanation of Terminals

(i) ATS-T; Terminal for ATS. The train traffic status and the route control status monitored by ATS are displayed. ATS-T is also used even when the operator manually sets the route during ATS automatic route control.

(ii) ATS-DS; Terminal for ATS. Used to display and set train diagram. It is also used to change the diagram easily with the mouse operation at the diagram adjustment.

(iii) TSR-T (TSR terminal); TSR-T is used when Temporary Speed Restriction is set. It is installed at OCC, and used by OCC Operator.

(iv) IL-DT; IL-DT is a terminal for Depot PRC, Used to display the train operation status and the route control status, also it is used to set the rout. When the route of the maintenance yard is set, IL-DT is connected with Depot CBI, and set manually.

(v) IL-CT; IL-CT is a terminal for CBI, located in OCC. When ATS and ATS-T cannot be used due to failure or unavailable, IL-CT is directly connected to CBI, and manual route setting is carried out.

(vi) Signal monitoring terminal; Signal monitoring terminal is the terminal for Signal Operator in OCC. The alarm monitoring and alarm data collection are carried out.

(vii) TID-T; TID-T is a terminal for station staff and the train traffic operation related staff. TID-T is installed to OCC and stations TID-T is used for the monitoring only, Control input cannot be performed.

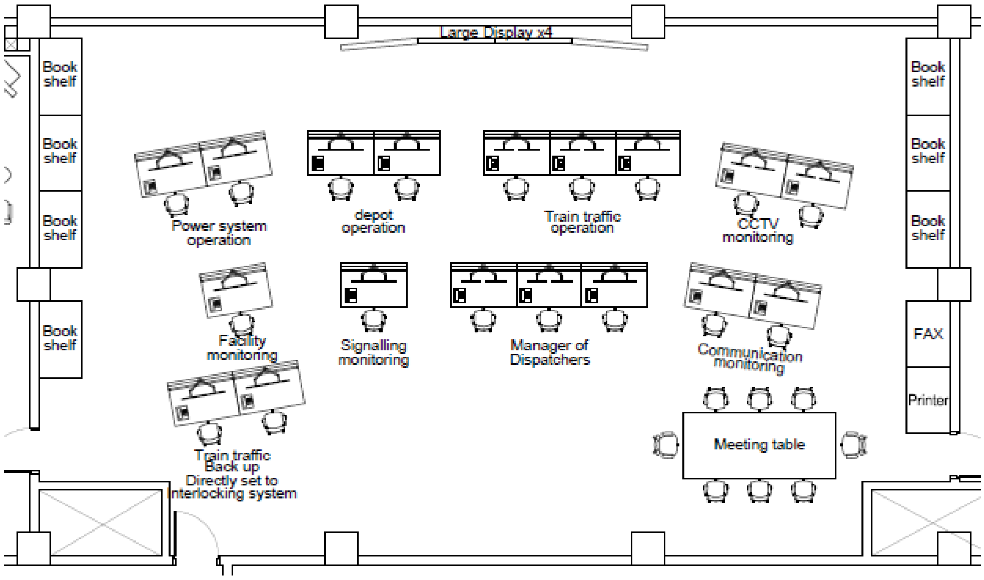
(viii) IL-ST; IL-ST is a terminal for CBI which is installed to station with turnout. When IL-CT is not available, the manual route setting by IL-ST is carried out.

4) Equipment layout

(i) OCC Equipment layout is shown in Figure 4.3.54.

(ii) Furniture procurement; The following furniture shall be procured by signalling system.

- Operator desk with chair; 18
- Meeting table with 8 chairs; 1
- Book shelf; 7



Source: JICA Design Team

Figure 4.3.54 OCC Equipment Layout

(6) Test

1) Test overview

The test is divided into the following stages. Define the test and decide the procedure and implement it.

(i) Type test

(ii) Factory acceptance test (carried out before shipment of equipment)

a. Hardware test

a) All hardware equipment shall be tested before shipment.

b) Three types of tests are required.

- Equipment test
- Environmental test
- Interface test (hardware level)

b. Software test

a) Communication protocol test of each type of interface

b) Terminal Human Interface Test

c) Function test

d) Performance test

(iii) Site acceptance test and integrated test

(iv) Trial run

2) Test general
3) Test plan and procedure
4) Test cost
5) Test record

(7) Operation and Maintenance Support

O&M support is as follows.

1) Operation and Maintenance document
2) Software Support
3) Security obligations
4) Support during Defects Liability Period
5) Workshop Repair
6) Support and call-out services
7) Monthly Maintenance Meeting
8) Spares
9) Special tools and test equipment
10) Documentation

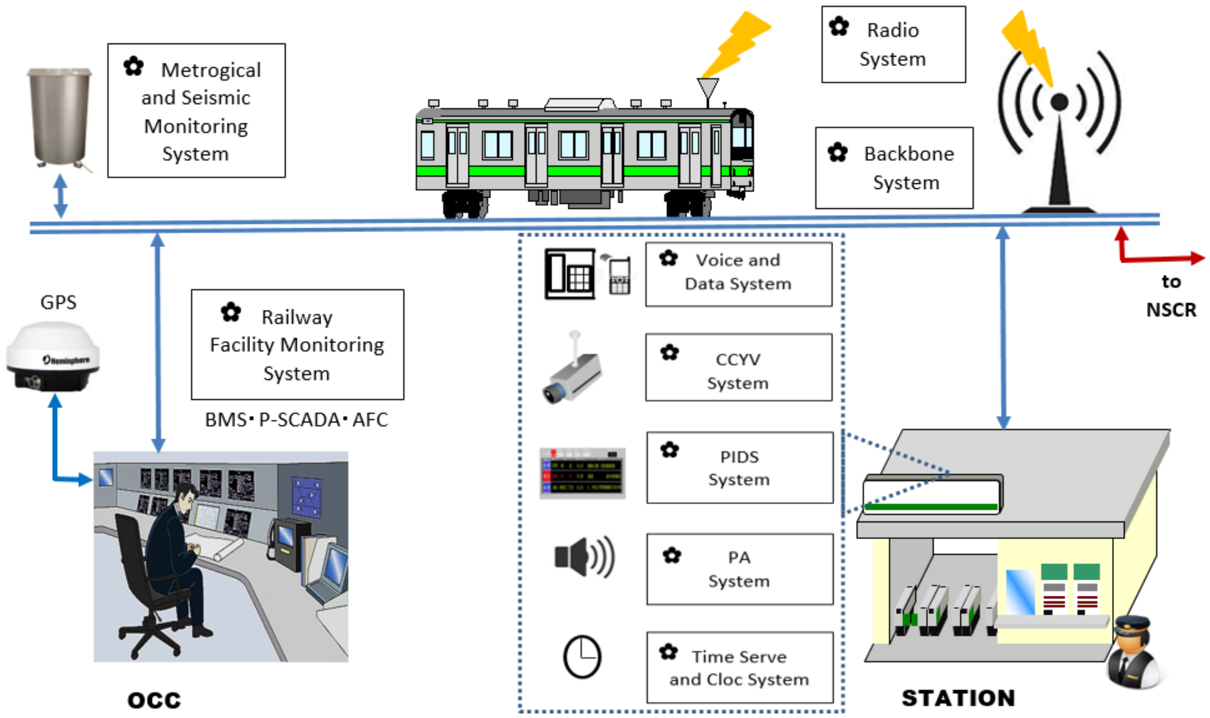
(8) Training

1) Scope of Training
   Training is as follows. Define the training items and decide the procedure and implement it.
2) General Requirement
3) Training courses
4) Operating Courses
5) Maintenance Courses
6) Training Materials

4.3.7 Communication system

(1) System Overview

The Communication system is to be provided for safety and functionality of the train operation and convenience of passengers with organic connections among relevant railway facilities and systems for the Malolos-Clark-Clark-CIA/NCC Railway (MCR). Furthermore, necessary interoperability with the preceding North-South Commuter Railway (NSCR) shall be secured considering the mutual direct operation in the future.



Source: JICA Design Team

Figure 4.3.55 System Overview

(2) Scope of Work

The communication system covers the following subsystems as scope of work.

1) Backbone System

The Backbone system is provided for the following subsystems described below shared on common VLAN as high speed, large capacity and full redundancy with optical fiber cables laid in the cable trough on both sides of the viaduct, and connected to the downward via L3 switches at the CER in the OCC and stations. Whole the works after the L3 switch is scope of each subsystem.

Necessary Interoperability to the NSCR in included in this system. The Backbone network for the signalling system is not included as scope of signalling system.

2) Radio System

The Radio system is provided for voice communication channels between/among OCC and train crews, station staffs, shunting stuffs using space wave digital trunk line. The communication is connected from train antenna to the backbone via AP and CTF in the station or along the viaduct.

Further, emergency train pretention and/or train operation information (TIS) are included in this system.

Countermeasures for radio interference and redundancy scheme are furnished as essential functions.

Frequency and bandwidth of the radio wave are subject to assign by National Telecommunication Commission (NTC).

3) Voice and Data System

The Voice and Data system is provided for IP telephone, common LAN and handy Telephone systems inside OCC, stations, Depo and the other railway facilities. Excusive lines between/among OCC and train crews, station stuffs and shunting stuffs together with digital voice recorder are furnished as essential functions.

The system is configured with router, server, IP-PBX and L2/L3 network switches over the protocol of SIP, RTP, QoS and the other necessary ones.

Incoming from PLDT (Telephone) and ISP (Internet) are received and integrated at the OCC and distributed to each station via the above backbone system.

4) Closed Circuit Television System (CCTV)

The CCTV System is provided for the monitoring and/or surveillance of the following configured by controller, recorder and various cameras backbone for the purposes of safety and security. The power to the fixed and PTZ (PAN, Tilt, Zoom) cameras is supplied via UTP with PoE without additional power. The cameras are arranged in OCC, Depot, Station and on Board. The on-board cameras and related wiring are installed by rolling stock contractor.

5) Passenger Information Display System (PIDS)

The Passenger Information System is provided for the notification of train operation statuses for convenience of passengers at necessary location in each station with using LCDs via network system configured by connecting work station, control unit and display boards. For the notification, operation information is updated by Programmed Route Control system (PRC) and the time information is obtained from the time server.

6) Public Address System (PA)

The Public Address System is provided for the announcement of train operation status, precaution against train approaching and accidental information from OCC and/or each station for safety and convenience of passengers configured by connecting amplifier, line selector, speakers and microphone. Speech generating devices are used for prerecorded message as needed.

7) Time Server and Master Clock System

The Time Server and Master Clock System is provided for synchronization of the accurate time to relevant sub-systems not only the clock system but also using GPS at the OCC. The Master Clock system receive the time signal from the server system and display it on the slave clocks via sub-master clock in each station building. The power to the slave clocks is supplied via UTP with PoE without additional power.

8) Meteorological send Seismic Monitoring System

The Metrological and Seismic Monitoring System is provided for prevention of possible damage suffered from designated natural disaster to the railway facilities and safety of passengers. The natural disaster is predicted by information from the sensor of Rain Gauge, Seismograph and Water Level.

9) Power Supply for Communication System

The Power Supply for the Communication System is provided for relevant equipment and devices via the exclusive UPS. The wirings from the UPS in OCC, stations and among them are included in this scope of work. Related grounding works to the common grounding work provided by the power supply system are also included in this scope work.

10) Communication Channels for Railway Facilities

The Communication channels for the other Railway Facilities are provided for data transmission lines of BMS, Power-SCADA, Railway-Signal and AFC with using VLAN and/or independent shared cores of the FOC on the Backbone system.

The installation divisions between communication system and the other respective railway facilities are at the L2 and/or L3 switches in the OCC and station CERs.

Necessary numbers and locations of the digital and analogue monitoring and operation points are follow the requirement of each discipline. All the signals of the above are converted to the IP protocol on the communication network.

(3) Design Criteria and Standards

The communication system is to be designed, manufactured, installed and tested in compliance with the following relevant standards, codes, local regulations and environmental conditions.

I Standards

1) DOTr Order, Philippines
2) Public Telecommunication Policy Act (NTC)
3) International Organization for Standardization (ISO)
4) International Electrical Codes (IEC)
5) Comité International Spécial des perturbations Radioélectriques (CISPR)
6) International Telecommunication Union - Telecommunications (ITU-T)
7) International Telecommunication Union - Radio communications (ITU-R)
8) The Internet Engineering Task Force Series Standard (IETF)

Standard	Series	Description
ANSI/IEEE	802	IEEE Standard for Information Technology-Telecommunication and information exchange between systems – Local and metropolitan area networks – Specific requirements
CISPR	22	Information Technology Equipment – Radio disturbance characteristics – Limits and methods of measurement
EIA	568B	Specification of twist pair cable for LAN
ISO	3864	Graphic symbols – Safety colors and safety signs
	11801	Information technology – Generic cabling for customer premises
	144156	Information technology – Coding of Audio visual objects
IEC	60332	Tests on electric and optical fiber cables under fire conditions
	605215	Tests device to verify protection against spraying and splashing water
	60754	Tests on gases evolved during combustion of materials from cables
	607154	Optical fiber cable
	62236	EMC Directive
	62305	Protection against lightning
NEPA	Article70	National Protection Association
ITU-T	G series	Transmission system and media, digital systems and networks
	I series	Integrated services digital network
	K series	Protection against interference
	Q series	Switching and Signalling
ITU-R	General	International Principle of Radio Frequency Allocation, Elimination of Radio Interference

II Environmental Condition

1) Temperature

- Indoor (Open Area) 30℃ or lower
- Equipment Room 25℃ or lower
- Outdoor 40℃ or lower

2) Relative humidity

- Indoor 90% or lower
- Outdoor 100% or lower

3)	Altitude	200 or lower
4)	Reference Wind Velocity	40m/sec
5)	Lightning Area	Sever Lightning Area
6)	Sault Damage District	around 10Km from coastline
7)	Flood and Earthquake	Action Required

III Preliminary Investigation

A preliminary investigation shall be carried out prior to the design at the site to clarify the spectrum of radio wave including propagation, signal disturbance and interference in details. The investigation using a survey vehicle shall measure electrical field intensity spectrum with method of not only passive but also active. The results of the investigation shall be reflected in the design of this system. Assignable frequency and bandwidth shall be confirmed with NTC to reflect them in the design of this system.

(4) Specified Requirements

I Common Requirements

1) General

- Safety, reliability and durability shall be secured under given circumstances with adopting proper protection scheme and reasonable equipment and materials.
- Redundancy of the system shall be secured with adopting duplicated and stacked equipment and materials with applying LA, STP and VSS protocol/systems.
- Total of initial and running costs shall be minimized with using high quality equipment and material and applying high efficiency engineering. Consideration shall be payed to energy saving.
- Consideration shall be paid to simplification of the maintenance and monitoring works with applying new network technology.
- EMC specified in IEC shall be met to secure satisfactory electromagnetic compatibility in the given circumferential environment.
- RAMS specified in IEC shall be applied to secure safety and reliability of the system.
- Cooling inside the equipment room, ventilation for equipment housing temperature monitoring shall be implemented to consider heat radiation of the equipment and devices.
- The communication system shall be so designed as to enable continuous operation over 10 years. The service life of the cables shall be over 20 years.
- Frame grounding for housings of the equipment and shield grounding for the cables shall be with equipotential grounding system.
- Whole the equipment configured shall be protected from possible rust and corrosion in the local environment.

2) Network

- Transmission scheme on the backbones shall be based on IP/SDN to secure mutual direct operation between the adjacent lines and obtain optimum routing with STP free.
- SNMS shall be implemented covering whole the network system for operation and monitoring.
- Bandwidth of the terminal devices shall allow a margin of 50% to the total value.
- QoS shall be implemented for the IP line involved with voice.
- The time reference to synchronize among the sub-systems shall be acquired from GPS.

3) Equipment and Materials

A. Equipment

- The time reference to synchronize among the sub-systems shall be acquired from GPS.
- The LA, LLDP and ARP shall be implemented in whole the equipment configuration here.
- The backplane capacity of the switches shall be more than 24Gbps.
- The throughput of the equipment configured here shall be, at least, 2Gbps.
- The equipment configuration here shall be installed on the 19 inch-rack in the equipment room.
- Countermeasures against earthquake shall be applied to the 19 inch-rack.
- Temperature monitoring system for the equipment configured shall be implemented. Equipment.

B. Cable

- OFC shall be used with single mode (SM) in the vicinity of the zero-dispersion wavelength. In case of short distance, cables with multi-mode (MM) may be accepted.
- Termination of the OFC shall be made only at the ADM or CTF.
- UTP shall be adopted with 10/100/1000base-T (Cat5e) in consideration of Giga-Bit network in the future.
- Cables including OFC shall be of rodent proof and laid protected by conduits and/or trough. Allowable bending radius shall be secured. Tension member where used shall be with non-metallic type as general rule.
- DTS shall be implemented for the long distance OFC lines.
- Cables laid inside building shall basically be of flame retardant, low smoke and non-halogen.

C. Antenna

- Antenna shall be selected in type in accordance with the following.
  Directional type for open space, LCX for defined space, Omni-direction for indoor area.
  Diversity type shall be applied as a standard.
- Antenna pole on the viaduct shall be capable of withstanding wind pressure load calculated based on reference wind velocity and installed on the beam at the bridge pier.
- LCX shall be hanged with clamp on the inner wall of the tunnel and necessary terminator shall be attached at the end of them.
- Measured shall be taken against possible lightning and/or weathering.

4) Requirements on the Others

- The communication wirings for passenger services and facilities as the building equipment shall throughout be applied with IP network.
- Power supply to the terminal devices in the communication systems shall be made from PoE switches (HUB) as much as possible.
- Power supply to whole the communication equipment shall be made via UPS.
- Capacity of the UPS shall be 30KVA for the stations and 50KVA for the OCC as reference.
- Basically, the equipotential grounding shall be applied with the equipotential system.

II Respective Requirements

1) Backbone System

- Media: OFC specified in the above (4)-3)-B with minimum of 40 cores.
- System: SDN/IP (Multiplexed)
- Band Width: 1Gbps to 10Gbps
- Redundancy: Duplicated Device and LA/STP
- Segment: Data and LAN, CCTV, PIS, PA , BMS, P-SCADA, AFC
- Monitoring: SNMP

2) Radio System

- System: Digital Trunk Spatial Propagation (between base and vehicle)
- CNR: not less than 35dB, receiving sensibility: not less than -110dB,
  EBR: not be more than 3 × 10-3.
- Frequency: 150-400MHz (carrier)
- Bandwidth: less than 25KHz

- Roaming scheme: Measures shall be applied on high speed traveling parts.
- Time slot: 4Channels (Voice x1, Data x1, Voice & Data Common Use x2)
- Output Power: 4W or more (base), 0.3W or more (train), 0.3W or more (mobile)
- Fresnel Zone: to keep 60% of calculated radius in open area
- Link Budget: to allow a margin of 20dB in propagation loss calculation.
- Delay Interference: Measures shall be taken for possible delay and interference of radio.
- Contents: dispatcher communication, site communication on shunting
  TIS data transmission (on board equipment is provided by rolling stock)
- Train Protection Radio: Direct activation system is adopted independently.
  (necessary equipment is provided by rolling stock)

3) Voice and Data System

A. Dispatcher Communication System

- Service: Dispatcher Telephone and Data Transmission for train operation (dedicated line)
- Exchange: IP-PBX (PCM time division, storage program control)
- Communication Channels:
  a. between OCC and operator (main line),
  b. between OCC and operator (depo),
  c. between OCC and station (stuff), d. between stuffs (station, railway, and depot)
- Calling System:
  a. Individual call, b. Group call c. Simultaneous call
- Priority of Call:
  a. Standard call, b. Priority call, c. Emergency call
- Call recording devices shall be implemented.
- Monitoring: SNMP with MIB.

B. Voice and Data System

➢ NETWORK

- Service: General Purpose Telephone (IP) and LAN (premise)
- Lead-In: Telephone (PLDT), LAN (ISP) at the OCC building
- MDF: Terminal RJ45 24Ports with Patch-Code (Cat5e)
- Redundancy: Combination of L/A Up-Link and SW stacking
- Authentication: Authentication on WEB and MAC authentication (each port)

- Ports: L2SW with 1000base-T 24Ports and SFP 2slots
- Wiring: Main Line on common backbone (VLAN Segments)
- Add/Drop lines on UTP (Cat5) via L3L2Switches.

➢ IP Telephone

- Exchange: IP-PBX (share the above exchange)
- Protocol: VoIP and Quality of Service (QoS)
- Traffic: 6HCS
- Channel: Trunk Line 30% Nos. of desk, extension line Nos. of Desk.
- Power for Handset: from PoE Switching Hub

➢ Premise LAN

- Router: 10/100/1000base-T × 2ports, SW 8 ports
  Non-Blocking 2Gbps
- UTM: Throughput 2Gbps
  Function; Anti-virus, anti-spam, WEB filtering
- Server: File server, mail server, WEB server, groupware

4) CCTV System

- Service: Video monitoring and recording
- Camera: PTZ and/or fixed type
  Location; OCC, depot, under viaduct, station (platform, concourse)
  Image format; MPEG-4 (CIF available)
  Image compression; H.264
  Numbers of pixel; 1,280 × 1,024 (5:4) or 1,280 × 960 (4:3)
  IP code; IP66
  Lens; varifocal (for fixed type)
  On board CCTV; provided by rolling stock
- Monitor: Desktop type LCD 19 inch, wall Type LCD 40 inch
  Screen division: 1, 1/4, 1/9, 1/16, 1/25, 1/36
  Installation site; OCC and each station
- Recorder: Digital type (DVR-HDD)
  Preservation period; 30days-24hours
- Controller: PTZ shall be controlled from the monitor
  Operation shall be simplified using GUI
  Monitoring shall be continuous using NVMS

- Door Monitor Unit: Monitoring around door for driver' confirmation
  Screen Division: 1/4; Camera exclusive use
- Network: IP protocol with 10/100/1000base-T
  Cable; UTP CAT5e via common backbone
  Bandwidth of camera: 100Mbps as reference
  Actual bandwidth shall be set considering compression ratio, frame number and presence of moving body detention device.

5) Passenger Information Display System (PIDS)

- Service: Information display on train operation, safety caution, accident information, delay information, emergency evacuation, passenger guide, advertisement, etc.
- Display Board: LCD or LED
- Numbers of Pixel; 1,920 × 1,080 (double faces)
- Location; platform, concourse, staircase and ticket barrier in the station
- Display Input: PRC(train operation), TSMCS(time), FACP(emergency evacuation)
  Work station (operation disk in OCC and station)
- Network: IP protocol with 10/100/1000base-T
  Cable; UTP CAT5e via common backbone
  Power supply; separated

6) Public Address System (PA)

- Service: Information broadcast on train operation, safety caution, accident Information
  Delay information, emergency evacuation
- Broadcast Area: Platform, concourse, staircase and ticket barrier in each station
- Broadcast Input: Microphone and DVAS (OCC), microphone including remote and wireless ones (each station)
- Priority: No.1 Built-in amplifier Microphone, No.2 Remote Microphone,
  No.3 Wireless Microphone, No.4 Automatic Broadcasting, No.5 Spare Input
  Regardless the above, if emergency any broadcasting facilities are equipped, they shall be with the highest priority. In case where lower priority announce is disturbed by higher priority announce, it shall be continued just after completion of the higher priority one. However, announcements for train operation (Departure and Arrival) are excluded.
- Speaker: Loudspeaker (10W or more), rustproof, waterproof, fireproof
  speakers in the office area shall be with attenuator.

- Amplifire: the capacity shall, at lease, total wattage of all the speakers connected.
  Location; OCC and each Station
  SPL; above 20dB from ambience noise level
- Network: IP protocol with 10/100/1000base-T
  Cable; UTP CAT5e via common backbone
  Speaker wiring; PVC 1.2mm (high impedance system)
  Remote microphone code: Exclusive code specified my manufacturer

7) Time Server and Master Clock System

- Reference Time: UTC(coordinated universal time)
  Acquired the time using GPS antenna with calibration unit
- Master Clock: Time Server built-in, NTP protocol with time monitor
  Distribute time signal to the sub-systems and sub-master clock
  Power interruption back-up; 3hurs, with salve clock-stop function
- Sub-Master Clock: Mounted in every station to drive respective slave clocks.
- Slave Clock: Mounted in each station, OCC, various workshops, each substation
  Type: Analogue and/or digital type (single face and double face)
  Mounting: Wall hanging and/or suspended type
  Reference Size: 600φor equivalent square shape
- Network: IP protocol with 10/100/1000base-T
  Cable; UTP CAT5e via common backbone
  Slave Clock Wiring; PVC 1.2mm (from sub-master clock)

8) Metrological and Seismic Monitoring System

- Sensor: Anemometer Max 70m/s, resolution=1m/s
  Rain Gauge less and above 40mm/h, resolution=0.1mm, 0.5mm
  Seismometer 3 directions-3000gal, 0.3-10Hz
- Location: San Fernand Station (Anemometer, Rain Gauge, Seismometer)
  Malolos Station (Anemometer, Rain Gauge)
- Indication and Recording: OCC (Operation Console)
- Wiring: UTP Cat5E (from sensor to common backbone)
- Power Supply: Solar panel as attachment
- Measurement: Continuous data acquisition,
  Check the data reach alarm set points (dry contact).

9) Power Supply for Communication Equipment and Devices

- UPS: Input; 3Phase-3Wire 400V or 3Phase-4Wire 400V(60Hz)
  Output; 1Phase-2Wire 230V or 3phse-4Wire 400V (60Hz)
  Power Supply: via Inverter (in normal), via bypass circuit (in emergency)
- Power interruption backup: 3hour (station), 1hour (OCC)
- Reference capacity: 30KVA(station), 50KVA(OCC)
- Wiring: XLPE/PVC on cable tray or in conduit
- Allowable voltage drop: within 2% from UPS distribution board
- Allowable short circuit current: 10KVA(OCC), 15KVA(station)
- Grounding: PVC Wire (with the size not melted by grounding fault current)
  Connection; from bonding points at communication system to copper grounding bar in EPS and/or electrical room provided by building electrical works.

10) Communication Channels for Railway Facilities

- Applied facility: BMS, Power-SCADA, AFC and Railway Signal
- Line: on VLAN for BMS, FOC
  in separate Cores for Power SCADA, AFC and Railway Signal
- Installation Division: L2/L3 Switches in CER
- Original Data: Analogue and Digital
- Transmission Data: Converted to IP Protocol
- Numbers of Point: provided by each facility

(5) Attached Drawings

1) Schematic Diagram (Reference)

- Backbone System
- Radio System
- Voice and Data System
- CCTV System
- Passenger Information Display System (PIDS)
- Public Address System (PA)
- Time Server and Master Clock System
- Metrological and Seismic Monitoring System
- Communication Channels for Railway Facilities

- Power Supply for Communication Equipment and Devices

2) Communication Equipment Room Layout Plan (Typical)

- Station and OCC Building

3) Communication Field Devices Plot Plan (Typical)

- Station
- OCC Building
- Depot Area

4) Wayside Cable Container Installation Plan

(6) Incidental Condition

I Testing and Commissioning

1) The testing and commissioning shall, at least, include the following items.

a. factory acceptance tests
b. Installation Tests
c. partial acceptance tests
d. system acceptance tests, commissioning

2) The installation tests shall, at least, include the following items, checks.

a. cleaning
b. performance
c. rate value of equipment
d. position and level
e. termination and marking
f. protection of cable
g. cable bending radius
h. terminal condition
i. separation distance
J. matching with drawing
k. grounding connection
l. power sauce breaker

3) The partial acceptance tests shall, at least, include the following items.

The tests and check shall be performed with cooperation between NMS work station and site devices.

a. equipment single bogy tests
b. system total tests
c. alarm Confirmation

4) The system acceptance tests shall, at least, include the following items.

   The contractor shall provide the tests procedure beforehand. The tests and check shall be performed with cooperation between NMS work station and site devices.

   a. function confirmation
   b. performance confirmation
   c. software confirmation
   d. communication check between devices
   e. visual confirmation of equipment performance
   f. interface confirmation
   g. demonstration in operation

II Spare Parts and Consumable

1) All necessary and sufficient spare parts and consumables shall be provided for the communication system.

2) The spare parts provided shall be 10% of installed ones in quantity. The following units of equipment shall, at lease, be included in the spare parts.

   - Network switch, router
   - ADM, CTF, antenna, SPD, OFC
   - Telephone handset, mobile handset
   - CCTV camera, PIDS display, PA microphone and speaker
   - Sub-mater clock, slave clock

III Special Tools and Testing Apparatus

1) Necessary and sufficient special tools shall be provided for maintenance and repair service in the communication system.

2) Diagnostic apparatus shall be provided to check function and status of the communication equipment.

3) The diagnostic apparatus shall be provided with the following

   a. operation manual
   b. calibration manual
   c. spare printed board
   d. spare parts and consumable
   e. connection cable and connector
   f. software (with source code)

IV Operation and Maintenance Manual

1) Operation and maintenance manual and the drawing related shall be on International System of Units (SI) system and written in English.

2) The operation and maintenance manual shall be provided with necessary and sufficient contents to ensure the work and to facility understanding by using chart, drawing, picture, illustration and the like.

3) The operation and maintenance manual shall, at lease, include the following.

    a. Safety instruction in the work site
    b. Item and Interval for the periodical inspection
    c. Trouble shooting in details
    d. Replacement and repair of the component parts

V Practical Training

1) Training on the communication system shall be provided for the operation and maintenance stuff.

2) The Training shall include the following.

    a. daily inspection and recording
    b. operation and control
    c. calibration measuring instrument
    d. monitoring of communication system
    e. troubleshooting
    f. OJT

3) The practical training plan shall, at least, include the following.

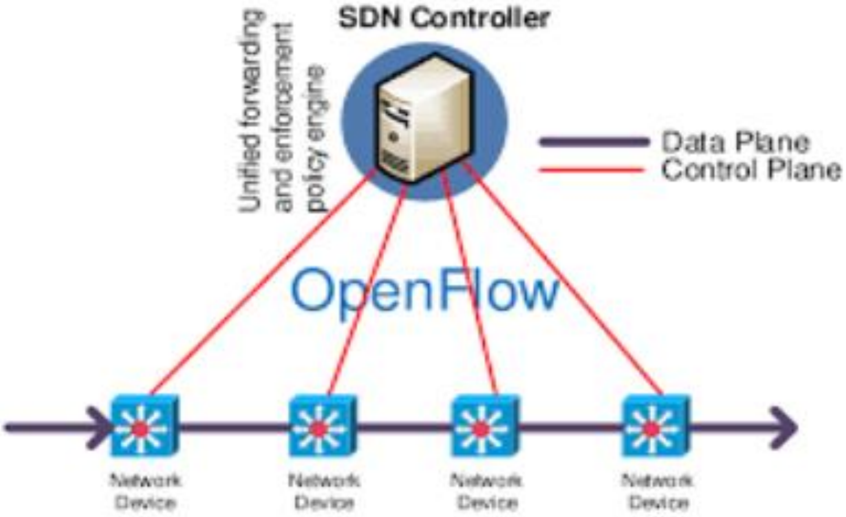
    a. training contents
    b. time and place
    c. text and training material

(7) Key Scheme

The following key schemes are adopted to meet the requirements for the communication system.

1) Software Defined Network (SDN)

The SDN is adopted to the backbone system to secure effective utilization of circuits, advanced transmission quality and reliable flexibility using software as open flow, not the ASIC (Exclusive Integrated Circuit) hardware on the IP optical network. The SDN was successfully applied for the East Japan Railway company in Japan.



Source: Technical Document (NEC)

Figure 4.3.56 SDN Conceptual Diagram

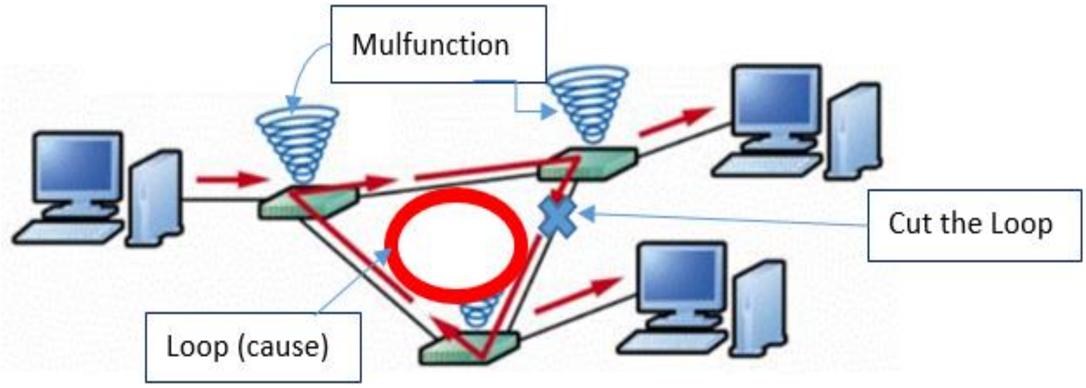
Conceptional diagram for the SDN is shown on the Figure 4.3.56. In this, communication is separated into two functions, one is layered routing (red line) processed by the controller and the other is data transmission (black line) forwarded by the network switches according to the stored software centralized and flexibly.

The headers on the packet and/or frame such as physical port No (L1), MAC address, VLAN ID (L2), IP Address, MPLS label (L3) and the like can be set for optimum routing. The network functions such as STP and/or AL, load balancing, QoS (priority and class-base queueing) and the like are obtained with this system.

Further, Necessary maintenance, repair, system up-date and the like are executed only on the software with resetting and/or rewriting of it without wasting spare parts.

2) Loop Broadcast Storm Prevention

There is a possibility of system shutdown on a layer 2 network caused by accidental loop formation trouble as shown on the Figure 4.3.57. Usually, SPT and/or LA have been applied to solve the problem as a traditional measure.

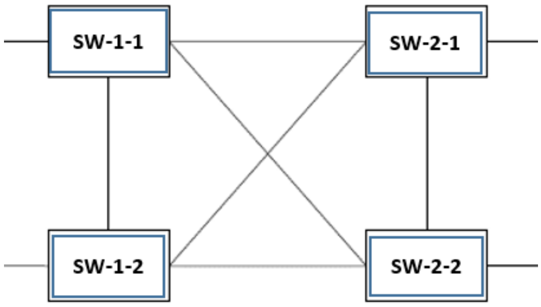


Source: Technical Document (NEC)

Figure 4.3.57 Loop Broadcast Storm Trouble

The measures by the STP and/or LA are changed to the exclusive software loaded on L2/L3 switches including routers and controller to protect the system from loop broadcast storm totally in this system. With this, it is possible to realize reliable, safe, flexible and STP free system.

Obviously, it is indispensable to provide not only switching formation but also crosswise connects among the relevant switching apparatuses to secure redundant communication routes fiscally as shown on the Figure 4.3.58.



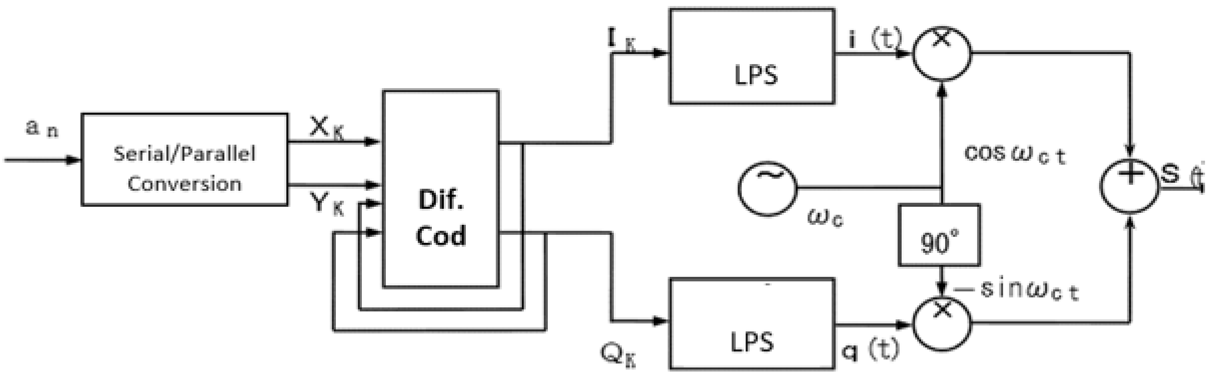
Source: JICA Design Team

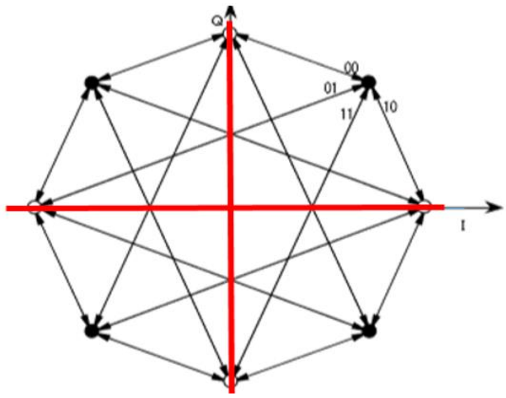
Figure 4.3.58 Crosswise Connects among Switches

3) Carrier Modulation (π/4 Shift QPSK)

π/4 shift QPSK is adopted as carrier modulation on the radio system to secure narrow bandwidth, fault-tolerant and high sensitive performance under both of urban and rural circumstances. The π/4 shift QPSK is applied to most railways especially in Asian countries.

Typical block diagram for the π/4 shift QPSK is shown on the Figure 4.3.59.





2−1 Phase Transition

Xk	Yk	ΔΦ
1	1	$-3\pi/4$
0	1	$3\pi/4$
0	0	$\pi/4$
1	0	$-\pi/4$

Source: Telecommunication Materials (Japanese Government)

Figure 4.3.59 Phase Transition

As shown on the Figure 4.3.59, phase transition of the π/4 shift QPSK never pass the zero point and stay the same phase as π/4 (45℃) of phase is always added to the preceding position at every modulation (symbol). Further, the signal is modulated with two (2) bits of base band signal, it is possible to suppress the change of phase. Accordingly, it is simple and clear to judge the base band bits are High or Low even though the signal is with narrow band in noise environment.

(8) Link Badged Calculation

This Link Budget Calculation is to confirm validity of the radio system on some key points. Although, the parameters used here are set within the limits of the Specified Requirement mentioned, they are not binding the practical ones on the Design Stage. System Parameter

1) Fresnel Zone

The radio frequency applied and distance between both antennas are set to 400MHz (wave length 1m) and 4Km in an open rural area by assuming. Fresnel zone radius is calculated using the following formula6. In addition, the calculated value can be reduced to within its 60% practically.

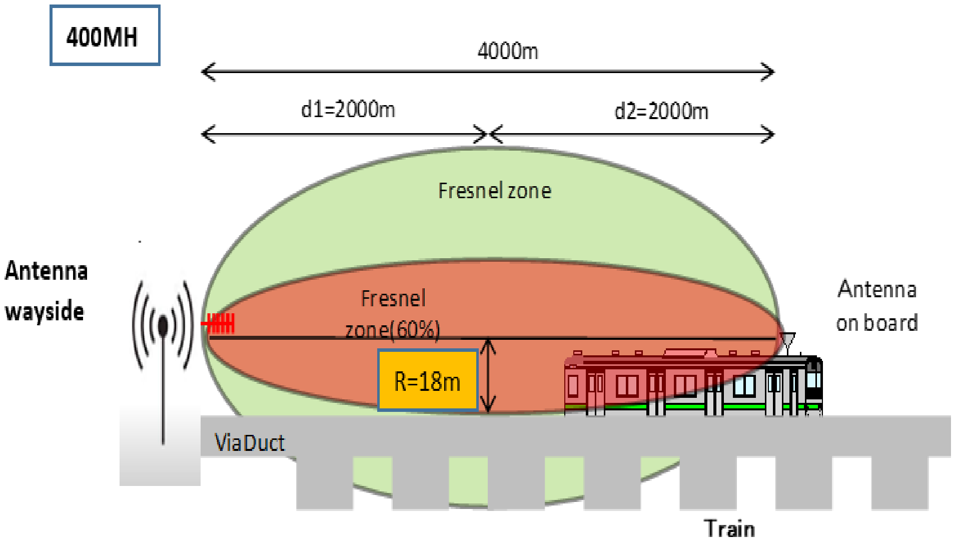
$$\text{Fresnel Radius (m)} = \sqrt{\lambda \times (d1 \times d2) / (d1 + d2)}$$

where; λ = wave length (m), d1 and d2 = Midpoint Distance (m)
shown on the Figure 4.3.60.

The Fresnel Sone Radius is calculated with substituting the parameter on the Figure 4.3.60.

$$\text{Fresnel Radius} = \sqrt{\lambda \times (d1 \times d2) / (d1 + d2)}$$
$$= \sqrt{1m \times (2000m \times 2000m) / (2000m + 2000m)}$$
$$\approx 35m$$

<u>Allowable Fresnel Radius = 35m × 60% = 20m (Antenna Height)</u>

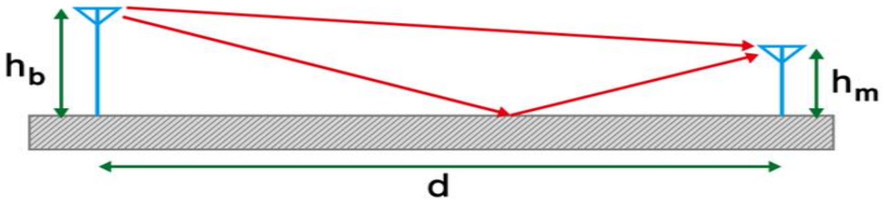


Source: JICA Design Team

Figure 4.3.60 Fresnel Zone

2) Free Space Propagation Loss

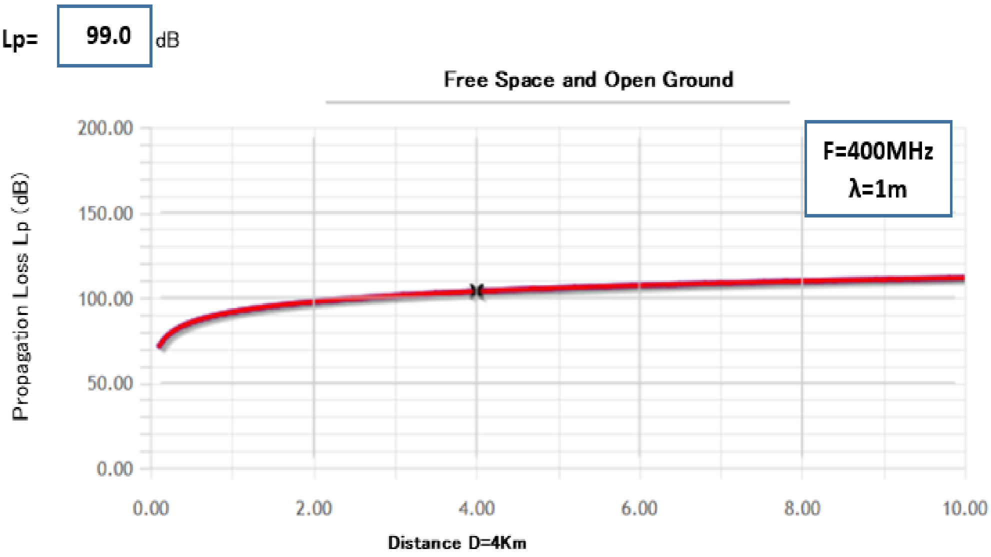
Attenuation of radio wave by propagation in free space is calculated by COTS software using the following parameter including the result of the above Fresnel Zone radius.



Antenna Height (BTS)	Hb= 20m
Antenna Height (Train)	Hm= 7m
Frequency	F=300MHz
Distance between Antennas	d=4Km
Reflection Efficiency is neglected	

Output curve of the COTS (Commercial Of The Shelf) software is shown as the following figure from the intersection of the propagation loss curve and 4Km distance on the scale.

<u>Free Space Propagation Loss is obtained as -99dB (≥ -100dB)</u>



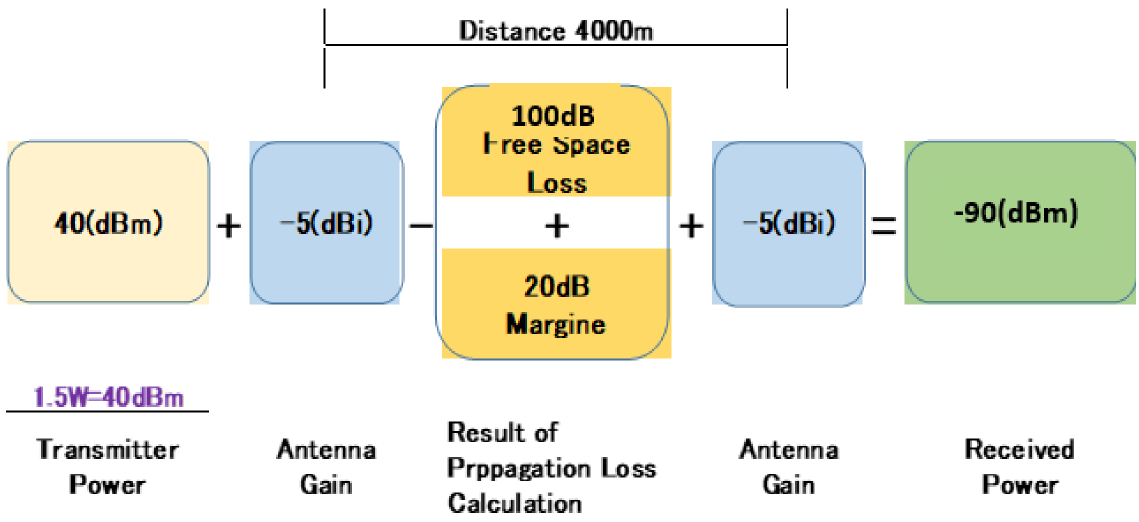
Source: JICA Design Team

Figure 4.3.61 Propagation Loss Graph

3) Gain Calculation

In addition to the above results, output power of transmitter, antenna again and safety margin are set respectively as 1.5W (train), -5dBi and 20dB to substitute in the Link Budget Calculation and obtain -90dB as input power of receiver. As necessary input power level of the receiver is -115dB in the usual condition, stable reception quality is expected as the following through In and Out aggregation in the budget.

<u>**90dBm (Gain at Receiver) ≥ -115dBm (Sensibility at Receiver)**</u>



Source: JICA Design Team

Figure 4.3.62 Link Budget Calculation

(9) Major Material Installation

The major materials for the communication system are installed as per the following Table 4.3.57.

Table 4.3.57 Major Material Installation

No.	Station	Km	CCU	OFC	L3SW	L2SW	AP	CCTV	PIDS	PA	FMS	UPS
1	Malolos		○	◎	◎	◎	◎	◎	◎	◎	◎	◎
	Malolos~Calumpit	8.2		◎		◎	◎	◎				
2	Calumpit		○	◎	◎	◎	◎	◎	◎	◎	◎	◎
	Calumpit~Apalit	4.2		◎		◎	◎	◎				
3	Apalit		○	◎	◎	◎	◎	◎	◎	◎	◎	◎
	Apalit~San Fernando	12.1		◎		◎	◎	◎				
4	San Fernando		○	◎	◎	◎	◎	◎	◎	◎	◎	◎
	San Fernando~Angeles	15.2		◎		◎	◎	◎				
5	Angeles		○	◎	◎	◎	◎	◎	◎	◎	◎	◎
	Angeles~Clark	4.9		◎		◎	◎	◎				
6	Clark		○	◎	◎	◎	◎	◎	◎	◎	◎	◎
	Clark~CIA	5.9		◎		◎	◎	◎				
7	CIA		○	◎	◎	◎	◎	◎	◎	◎	◎	◎
	Claerk~NCC	18.2		◎		◎	◎	◎				
8	NCC		○	◎	◎	◎	◎	◎	◎	◎	◎	◎
	Total	68.7										

Source: JICA Design Team

4.3.8 AFCS (Automatic Fare Collection System)

(1) Definitions and Abbreviations

1) Definitions

Antenna: Unit for data communication with contactless IC card

Black list: List of cards deemed to be rejected by the system

Card: In this specification, the word “card” stands for contactless IC card.

Clearing house: An organization to collect and distribute information to settle payment between member organizations

Contactless IC card: A card which transmits data by modulated radio frequency signal

Employer: Department of Transportation

Employer’s Representative: The agent who consults the employer to examine the specifications and the system

O&M Company: Company that undertakes to operate and maintain the AFC system

Security access module: A module that contains key data for encryption and mutual authentication for communication between the card and the device

2) Abbreviations

AFC(S)	Automatic Fare Collection (System)
AG	Automatic Gate
CCS	Central Computer System
GS	General Specification
HT	Handheld Terminal
LAN	Local Area Network
MCBF	Mean Cycle Between Failure
POS	Point Of Sales Terminal
SAM	Security Access Module
SCS	Station Computer System
SJT	Single Journey Ticket
SVC	Stored Value Card
TVM	Ticket Vending Machine
UPS	Uninterrupted Power Supply

Source: JICA Design Team

3) Related rules and standards

ISO/IEC14443	Identification Cards – Contactless Integrates Circuit Cards – Proximity Cards
ISO/IEC15408	Information Technology -- Security Techniques -- Evaluation Criteria for IT Security
ISO24014-1	Public Transport – Interoperable Fare Management System – Part 1 Architecture
Republic ACT No.7277	The Magna Carta for Disable Person
(confidential)	Transpo™ Automatic Fare Collection Scheme – Core Operating Rules
(confidential)	PPP for the Automatic Fare Collection System Project for LRT Lines 1&2 and MRT 3 Minimum Performance Standards and Specifications

Source: JICA Design Team

(2) Scope of Works

1) General

a) This system is installed in the Malolos-Clark Railway and is capable of interoperating with existing LRT 1, 2, MRT 3 AFC systems, and with the AFC system of the north - south commuting line which is planned to be constructed in the future. In the future, the card will be developed as a common card that can be used for multiple purposes in the Manila metropolitan area, including new or expanded transportation facilities.

b) Central Clearing House System and Card 1st Issuer are prepared at the higher level of this system for settlement and 1st Issuing of the common use cards.
Upon constructing this system, the interface with the clearing house and the card must receive information from the clearing house operator side and card issuer side, and obtain the necessary cooperation.

c) Since this system is required to be equivalent to the existing AFC system as described above, the performance should conform to the MPSS (Minimum Performance Standards and Specifications) in the Concession Agreement of "PPP for the Automatic Fare Collection System Project for LRT Lines1 & 2 and MRT3" except section 2.12 (Level 4 Infrastructure MPSS).

d) The airport access limited express train is scheduled to be operated, and we are considering introducing a limited express ticket sale system including the seat reservation necessary for getting on the train. The results of the study up to the present are shown in the appendix at the end.

e) The mutual train operation between the NSCR-south line and the subway is scheduled. The system supplier must prepare in advance the expansion of the system accompanying it and make it possible to deal with the system upgrade without major change.
The main influence on the anticipated system is as follows.

   i) There is a possibility of increasing / decreasing the number of station terminal equipment required due to increase / decrease in passenger demand.
   ii) Processing contents of the station terminal equipment, the station computer, the central computer, the central clearing house become complicated as the range of sale and fare adjustment of tickets / cards includes the subway line.
   iii) Subway issue SJT gathered at the station shall be returned to the subway operator.

2) Scope of Equipment Supply

a) Main Components of the System

The main components of the AFC system shall be, but not limited to the following.

   i) Station computer system
   ii) Automatic Gate, Ticket Vending Machine, Point of Sales, Handheld Terminal, and Uninterruptible Power Supply
   iii) Central Computer System
   iv) Cash Handling System
   v) Contactless IC Card

b) Station AFC Facilities

The station facilities shall, as a minimum, include the following.

   i) Station computers and Station Assist Terminals
   ii) Automatic Gates
   iii) Ticket Vending Machines
   iv) Point of sales / Analyzer, Dispenser
   v) Handheld Terminals
   vi) Special Tools for cash counting
   vii) Furniture within AFC Rooms, Customer Service Rooms and Control Rooms.
   viii) Uninterruptible Power Supplies in AFC UPS Rooms

ix) Power Supply distribution facilities
x) Cable Routes and earthing
xi) Local Area Network (LAN) and Interfaces to the Communication Backbone Network

c) OCC AFC Facilities

The OCC facilities shall, as a minimum, include the following.

i) Central Computer and assist terminal
ii) AFC Room Facilities
iii) Local Area Network (LAN) and Interfaces to the Communication Backbone Network
iv) Cable Routes and earthing

d) Maintenance Shop and Training Room

i) Maintenance facilities
ii) Training devices
iii) LAN Facilities
iv) Cable Routes and earthing

e) AFC OCC Interface to External Locations

The interfaces to external transmission networks shall be supplied, as a minimum, to provide communication links to the following.

i) Central Clearing House
ii) Off-Site Sales Terminals (in future)
iii) Commercial Banks and Credit Card Agencies for the handling of financial transactions (in future)
iv) Future AFC systems provided by other Service Provider

f) AFC Ticket Media

The initial quantity of smartcards shall be provided.
Additional cards will be procured separately by the Employer as and when required.
The card media for revenue operation for one year and the initial minimum quantity of 1,000 card media for test purposes shall be provided by the system supplier.

g) Spare parts, Special Tools and Test, Training Equipment

The followings, as a minimum, shall be supplied.

i) Spare units and spare parts
ii) Maintenance tools and test equipment
iii) Training equipment

h) Software

i) At least the following software including development system, operating system, antivirus system, etc. shall be supplied.

- Central Computer System
- Station Computer System
- Automatic Gate
- Ticket Vending Machine
- Point of sales / Analyzer, Dispenser
- Handheld Terminal

ii) Each software shall be downloadable from the central computer.

3) Installation

a) The installation work of equipment and cables in the system shall be included as the AFC scope.

b) Construction boundaries at each station are as follows.

i) For power supply and ground, after the distribution board in the AFC UPS room
ii) For communication, after the connection port of the communication backbone network in the communication equipment room

c) The construction boundaries in the OCC building are as follows.

i) For power supply and ground, after the distribution board in the AFC room, ground is after common ground point
ii) For communication, after the connection port of the communication backbone network in the communication equipment room

4) Documentation

The following documents shall be submitted.

i) System specification, Software specification, Hardware Specification, Software source code
ii) Operation manual for the station stuff
iii) Maintenance manual for the maintenance staff
iv) Installation related drawings
v) Consumables list, maintenance parts list

5) Training

The necessary training shall be given to the number of station staff and maintenance staff who are necessary at the commencement of the revenue service.

(3) System Description

This section defines system description.

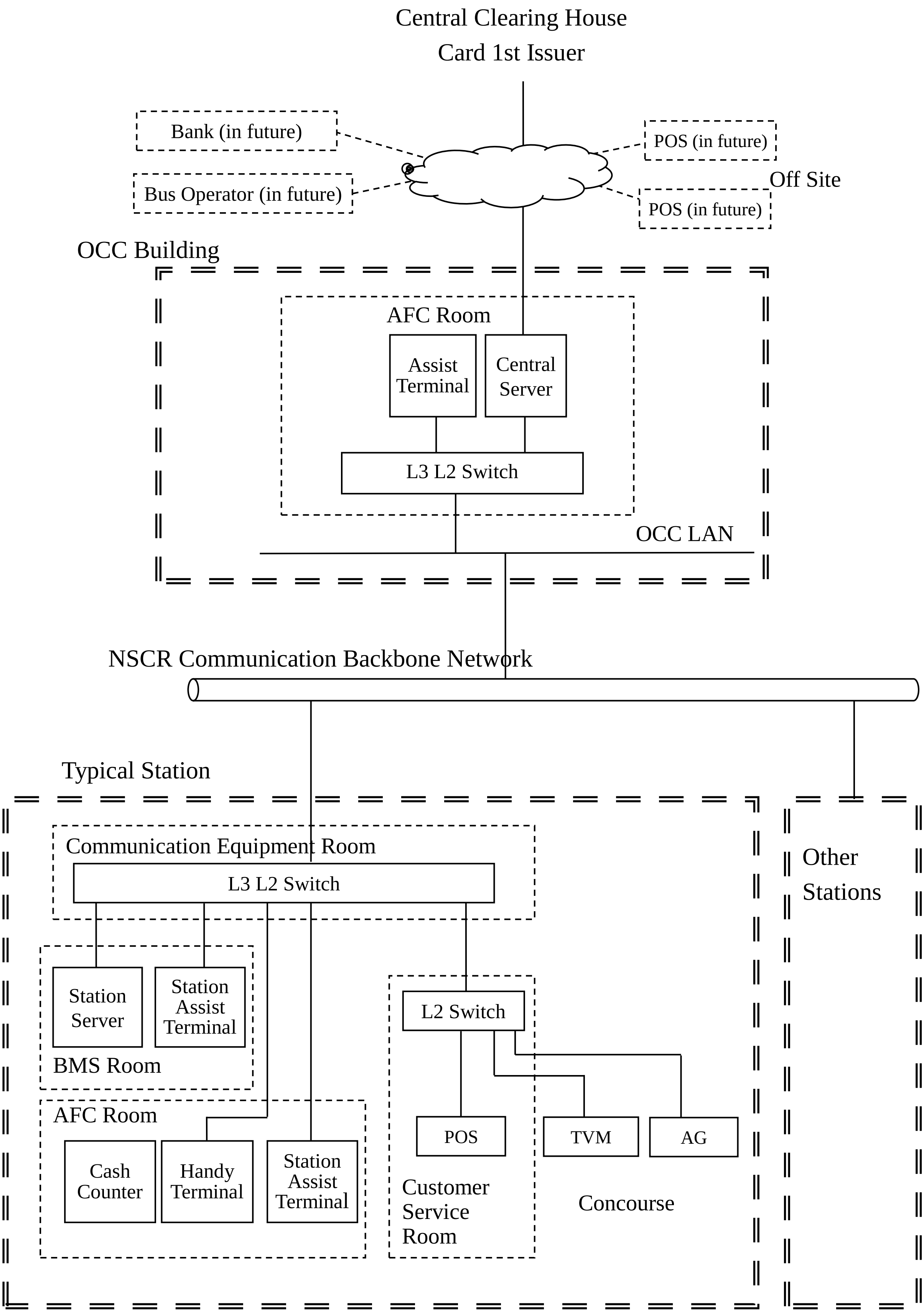
1) Common Use Card

a) Cards used in this system shall be mutually usable with LRT and MRT in Grater Manila Area. And cards used in this system shall be mutually usable with the north - south commuting line, which are planned. That is, cards issued in this system are valid for LRT, MRT, the north - south commuting line and the reverse is also true.

b) For clearing of common usage cards, Central Clearing House System is prepared at the higher level of this system, and card history management, security management, blacklist management, etc. are performed in addition to clearing work.

c) All card media of this AFC system shall be contactless IC cards.

d) The basic structure of this system is shown in Figure 4.3.63.



Source: JICA Design Team

Figure 4.3.63 AFC System Basic Structure

2) Type of Tickets

a) There shall be at least 2 types of tickets.

i) Single journey ticket (SJT)
ii) Stored value card (SVC)

b) Anonymous SVC will be used for the staffs of the O&M Company.

c) At the commencement of revenue service, SJT and SVC shall be anonymous. But the personalized card service for the SVC shall be taken into consideration in system design. This means that the system shall be able to be accepted these new cards without any system modification when personalized cards are newly issued in the future under the condition no discount applied to these cards.

3) General Operation

a) Recycle and Deposit

i) All types of ticket which are anonymous shall be recycled.
ii) SVC shall require deposit. The amount of deposit shall be able to be changed by the O&M Company without software modification, and shall be encoded within each card. The system supplier shall propose minimum and the maximum limit for data range of setting deposit amount.
iii) Measures shall be taken to avoid deceiving deposit return by false or copied card, including claims by disguising those cards as damaged. These measures shall be proposed and submitted to the Employer's Representative for review in coordination with the O&M Company.

b) Card issuance and Card Status

i) Card issuance is how and when to write secure information within cards for use.
ii) Card issuance shall be conducted in 3 steps.

- (zero)th issuance
  0^{th} issuance is to format the card, encode unique serial ID number and manufacture's transportation security key in the card. Transportation security key or some other measures for transportation security shall be proposed by the 1^{st} issuer.

- First (1st) issuance
  1^{st} issuance is to release manufacture's transportation key (or some other transportation security), encode using the 1^{st} issuer's format on the card. The card shall not be used yet at this step.
  The 1^{st} issuer shall be responsible for 1^{st} issuance, excluding testing card, training card, and maintenance card. 1^{st} issuance of testing card, training card, and maintenance card shall be handled by the system supplier.

- Second (2nd) issuance

  The O&M Company shall be responsible for 2^{nd} issuance, excluding testing card, training card, and maintenance card. 2^{nd} issuance of SJT and SVC shall be handled at station machines.

  2^{nd} issuance of testing card, training card, and maintenance card shall be handled by the system supplier.

iii) Cards which are not 2^{nd} issued shall not be used by passengers.

iv) When returned, cards shall be encoded with card return information, in order to deactivate and to avoid faulty use.

v) Card status shall be able to be checked by every related machine included in the system. Information of card status change shall be collected to the central server to be referred by AFC machines when required.

c) Generate the O&M Company's Security Key

i) The O&M Company's security key data shall be decided in consultation with the card 1st issuer and the central clearing house operator.

ii) How to generate the O&M Company's security key shall be proposed by the system supplier and shall be submitted to the Employer's Representative for review in coordination with the O&M Company.

d) Card Printing

i) Card printing for SJT and SVC shall be conducted by the card 1^{st} issuer.

e) Unique Card Identification Number

i) Every card shall be numbered uniquely for system identification and card stock management.

ii) This unique card identification number shall be able to be inscribed on the card, as to be easily defined case of card damage.

iii) This unique card identification number shall include the following information.

- Issue data
- Issue operator code
- Issue machine number
- Serial number

iv) The number of digit and available characters shall be proposed by the system supplier in consultation with the card 1^{st} issuer. It shall be approved by the Employer or the Employer's Representative in coordination with the O&M Company.

f) Confirmation of Card Information

Information within the card shall be able to be confirmed at TVM, POS and HT.

g) Refunds

i) The measures to refund unused SJT and SVC shall be provided.
ii) The measures to refund used SJT and SVC shall be operable by only station POS.
iii) The refund system shall be considered for the measures against fraud, both passengers and staff.
iv) The refund system shall be considered for collecting handling fee.

h) Pricing

i) Actual pricing should be fixed 24 months prior to the start of revenue service.
ii) The system supplier shall submit plans for finalization of fare to the O&M Company.

4) Single Journey Ticket

a) Fare Structure

Requirements for the fare structure of the system include the following.

i) The system shall support graduated fare structure. It shall be flexible enough to support zone (or partly zoned) fare structure.
ii) The system shall be able to provide fare discount.
iii) The system shall be able to change the version of fare easily, for example but not limited to, holding at least two fare versions which can be switched by date and time.
iv) The system shall be able to support at least 16 types of fare within one version for SJT, which is for future discount. Each type of fare shall be able to support at 256 fare stages, which is for future increase of lines or stations.

b) Issue (including 2nd issuance)

i) SJT shall normally be issued by the TVM. But station POS shall also be equipped to issue SJT.
ii) TVM shall indicate on the display names of stations for passengers’ convenience when purchasing.
iii) Person to travel single journey shall purchase a SJT with amount of necessary fare. Purchased amount of fare shall be encoded within SJT card.
iv) TVM shall be able to give change back to him.

c) Validity

SJT is valid only for the purchased fare amount without exit from any gate during the date and time specified by the system.

d) Enter Gate

i) The SJT holder shall touch his ticket on the read / write antenna unit of the entry gate. The entry gate shall acknowledge the transaction both audibly and visually. The discounted tickets (in the future) shall be able to be distinguished.

ii) The passenger gate shall check the validity of the ticket.

iii) When a ticket was detected as invalid, the entry gate shall close and not allow the ticket holder to proceed within the paid concourse, and the gate shall display appropriate message to the station staff and the ticket holder.

e) Exit Gate

i) The SJT holder shall insert his ticket into the ticket insert slot. The exit gate shall acknowledge the both audibly and visually. The discounted tickets (in the future) shall be able to be distinguished.

ii) The passenger gate shall check the validity of the ticket.

iii) When a ticket holder gets off at a station where the fare is equal or less than the purchased amount, the gate shall allow the ticket holder to pass through the gate and the ticket shall be captured. The ticket holder renounces its right for further riding even if under fare without any refund.

iv) When a ticket holder gets off at a station further than his planned destination excess of his purchased amount, he has to adjust fare before exit the gate.

v) The gate shall encode exit information within the card.

vi) When an inserted ticket was detected as invalid, the exit gate shall close and not allow the ticket holder to proceed out of the paid concourse, and the gate shall display appropriate message to the station staff and him, and the ticket shall be returned to him.

f) Adjust Fare

i) When a ticket holder needs to adjust fare, he shall pay necessary amount of fare handled by POS terminal at customer service room.

ii) Amount of fare adjustment shall be encoded in the SJT card. It shall be encoded separately from the initially purchased amount.

g) Recycle

i) Cards captured and collected in the exit gate or at the POS terminal shall be able to be recycled.

ii) The detailed measures for recycling cards shall be proposed by the system supplier.

h) Deactivate or Damage

i) When SJT is deactivated or damaged, it shall be handled by POS terminal.

ii) Handling fee for reissuing the card shall be required according to the reason of deactivation or damage.

5) Stored Value Card

a) Fare structure

Requirements for the fare structure of the system are as follows.

i) The system shall support graduated fare structure.

ii) The system shall be able to provide discount fares.

iii) The system shall be able to change the version of fare data table easily, for example, holding at least two fare versions which can be switched by date and time.

iv) The system shall be able to support at least 16 types of fare within one generation for stored fare. Each type of fare shall be able to support at 256 fare stages.

v) It should be considered that a mutual direct train operation is carried out with routes operated by other carriers in the future and fares are spanning two routes.

b) Issue (including 2nd issuance)

i) SVC shall normally be issued by the TVM. But station POS shall also be equipped to issue SVC.

ii) TVM shall indicate on the display amount of initial top-ups when issued.

iii) Person to purchase SVC pays for the top-ups plus the deposit. Amount of top-ups and that of deposit shall be encoded separately within SVC.

iv) TVM shall be able to give change back to him.

c) Top-ups

i) SVC can be topped-up.

ii) Top-ups of the SVC shall be operated by TVM or POS terminal.

d) Validity

SVC is valid until either the card expiration date, or specified period from the last time used, whichever comes earlier. The specified period shall be able to be changed by the O&M Company.

e) Enter Gate

i) The SVC holder shall touch the SVC on the read / write antenna unit of the entry gate. The entry gate shall acknowledge the transaction both audibly and visually. The discounted tickets (in the future) shall be able to be distinguished.

ii) The passenger gate shall check the validity of the card. This check includes that the minimum fare is left in the card.

iii) When a card was detected as invalid, the entry gate shall close and not allow the card holder to proceed within the paid concourse, and the gate shall display appropriate message to the station staff and the card holder.

f) Exit Gate

i) The SVC holder shall touch the card on the card antenna unit of the exit gate. The exit gate shall acknowledge the both audibly and visually. The discounted tickets (in the future) shall be able to be distinguished.

ii) The exit gate checks the remainder of the card. When the remainder is enough, the exit gate deducts the fare between the origin and the destination. When the remainder is not enough for adjustment at the exit gate, the card holder shall be blocked at the exit gate. He has to adjust fare before gate, and then exit the gate.

iii) It should be considered that the possibility to settle the cards entered on the route of another operator by mutual direct train operation.

iv) The gate shall encode exit information within the card.

v) When a touched card was detected as invalid, the exit gate shall close and not allow the card holder to proceed out of the paid concourse, and the gate shall display appropriate message to the station staff and him.

g) Adjust Fare

i) When a card holder needs to adjust fare, he can adjust or top-up more than the shortened amount at the customer service room.

ii) Amount of fare adjustment shall be encoded in the SVC. It shall be encoded separately from the top-up amount.

h) Return

i) SVC can be returned at POS terminal in customer service room. When returned, deposit plus the remaining stored value is returned to the card holder, deducting handling fee.

ii) To handle returning of SVC shall be able to set and changed easily by O&M company.

iii) The system shall be able to handle plural types of handling fee, according to not the reason.

iv) Due date for the deposit return shall be able to be set and changed easily by the O&M company.

i) Recycle

i) Cards collected at the POS terminal shall be able to be recycled.

ii) The detailed measures for recycling cards shall be proposed by the system supplier.

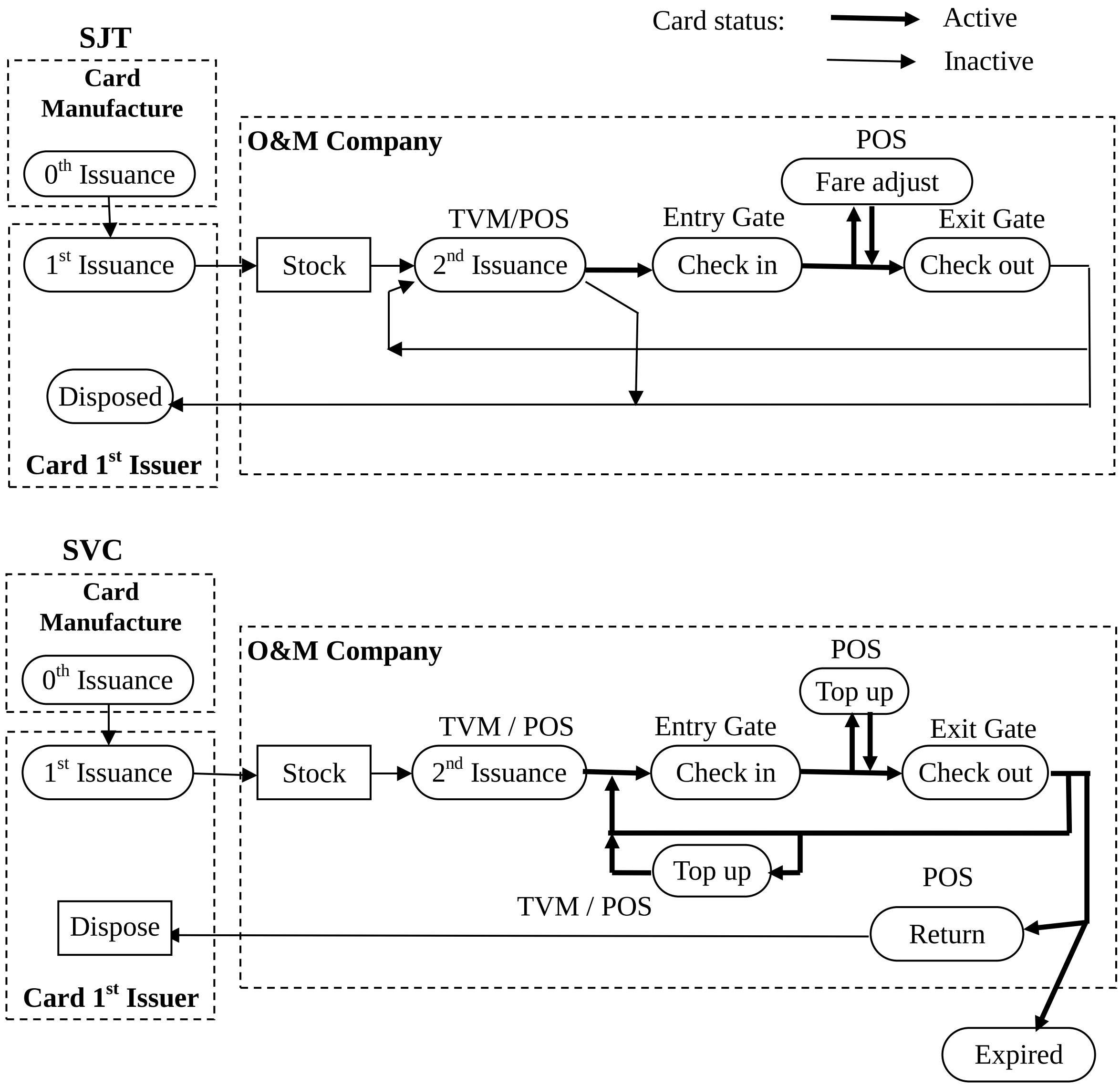
j) Deactivate or Damage

i) When SVC is deactivated or damaged, it shall be handled by the POS terminal.

ii) Handling fee for reissuing the card shall be required according to the reason of deactivation or damage.

6) Card Lifecycle

The card lifecycle is shown in Figure 4.3.64.



Source: JICA Design Team

Figure 4.3.64 Card Lifecycle

7) Monitoring

a) Equipment Monitoring

i) Station computer shall monitor real time status of at least following AFC equipment.

- Ticket vending machine
- Automatic gate
- Point of Sales / analyzer dispenser

ii) Center computer shall monitor real time status of at least following AFC equipment.

- Ticket vending machine
- Automatic gate
- Point of Sales / analyzer dispenser
- Station computer

iii) Assist terminal shall be included as a part of the central computer, which will be placed in OCC building. Monitoring information on the central computer can also be monitored on the assist terminal.

The operator shall be able to receive the real time status of at least following AFC equipment on the assist terminal.

- Ticket vending machine
- Automatic gate
- Point of Sales / analyzer dispenser
- Station computer

Assist terminal shall be able to extract transaction of specific card from clearing house system via central computer. The result shall be able to output by data or by printing.

b) Card Status Monitoring

i) The card status change information shall be collected at the central computer and be sent to the clearing house. Card status change includes, but not limited to, the followings.

- 2nd issue
- Enter gate
- Exit gate
- Top-ups
- Fare adjustment
- Return

ii) The card's status and its past records can be confirmed on the POS terminal.

c) Card Stock Management

i) All returned cards excluding SJT card shall be sent to ACF Room in the OCC building. SJT card shall be able to be recycled within the station, which means to be re-issued from the TVM or the POS terminal.

ii) Central computer shall produce card stock management data. This data shall include, but not limited to, those numbers of card at each station.

- 2nd issued card
- Returned card
- Damaged card
- Deactivated card
- Expired card (Past due date of deposit return)
- Theoretical amount of valid card shall be calculated in the central clearing house system.

d) Blacklist Monitoring

i) The central computer shall create a list of duplicated or fraudulent cards detected by the system. Those detected card shall be blacklisted, which means that the list of numbers is

downloaded to AFC equipment to be rejected by the system. The list shall be sent to the central clearing house and integrated as the new blacklist.
Administrative staffs of the O&M Company shall be able to output the blacklist.

ii) The system shall allow administrative staffs of the O&M Company to add a list of blacklisted card.

8) Emergency Mode

a) Means shall be provided to place all automatic gates in emergency mode. In an emergency mode, gates shall be opened for passengers to exit without tickets.

b) There shall be an alternative means, provided mechanically, to set all gates to emergency mode. This shall not depend on the availability of the central computer, the station computer, network connection, nor the power supply.
This alternative means shall consider measures against fraud.

9) Calendar and Operating Day

a) Operating Day
The AFC system shall have at least two dates, calendar date and operational date.
The Calendar date means the Gregorian calendar date.

b) Calendar

i) The calendar date and time shall be acquired from telecommunication at least once a day.
ii) The central computer shall acquire time from the Master Clock. Each station computer shall acquire time from the central computer.
iii) TVM, AG, POS and HT shall acquire time from the station computer.

10) Data Transmission

a) General

i) The security for all data transmission shall be considered. Especially data transmission related to revenue data shall employ high-security encryption in order to avoid data modification.
ii) The general ways of data transmission shall be employed, so that the O&M Company will be able to replace part of the system easily in the future.
iii) The secure measures against data loss shall be considered.

b) Transmission data

i) Central computer shall receive through station computer the transaction data from AFC machines including at least the followings.
- TVM
- AG
- POS

- HT
- Station computer

ii) Transaction data shall be made whenever there is a change in the status of the card. The central computer shall transfer the data to the central clearing house.

iii) If there is a possibility that the transaction might be incomplete, machines shall send temporary transaction data, in order to avoid the loss of data.

iv) The system supplier should consider that the central computer to be able to exchange data with other servers, such as server for bus service, or e-cash server.

v) Transaction data shall be able to be retained in each machine and in station computer at least seven (7) days, considering troubles such as network failure. Measures for offline data collection shall be considered.

vi) Transaction data shall be transferred and stored in financial system of the O&M Company NOT included in this contract for at least ten (10) years.

c) Revenue Data

i) Central computer shall receive revenue (including accounting information, cash amount, and stocktaking of the cards) data through station computer.

ii) Revenue data shall indicate sum for each calendar date.

iii) The central computer shall transmit revenue data to financial server of the O&M Company.

iv) Each station computer shall be able to print out the revenue data of each station.

v) Assist terminal shall be able to print out the summary of each station.

vi) Measures shall be taken to monitor loss or lack of revenue data in each station.

d) Traffic Data

i) Central computer shall receive traffic data through station computer.

ii) The central computer shall transmit traffic data to financial server of the O&M Company.

iii) Each station computer shall be able to print out the traffic data of each station.

iv) Assist terminal shall be able to print out the summary of each station.

e) Operation and Maintenance Data

i) Each station computer shall be able to collect and output the operation and maintenance data of each station.

ii) Central computer shall receive operation and maintenance data through station computer upon request from the assist terminal.

iii) Assist terminal in OCC building and assist terminal in maintenance shop shall be able to output operation and maintenance data received by the central computer.

f) Downloads

i) The central computer shall download to the station computers all fare tables, operating parameters, commands, blacklist and software upgrades for AFC equipment including at least the followings.

- TVM
- AG
- POS
- Station computer

ii) Station computer, installed at all stations, shall perform data and software transfer function for AFC equipment including at least the followings.

- TVM
- AG
- POS
- Station computer

iii) At least two generation of fare, operating parameters, and software shall be managed by system.

11) Others

a) The operation for card and system security shall be proposed by the **system supplier** to obtain Notice of No-objection by the employer's representative to coordinate with the O&M Company.

b) The maximum number of station capable to be handled by the system shall be proposed by the **system supplier** to obtain the Notice of No-objection by the employer's representative to coordinate with the O&M Company.

(4) System Requirements

1) General Requirements

a) General

The requirements in this section shall be considered in addition to those specified in the general specification.

b) Power Supply and Grounding

i) Power supply is 60Hz, 220V AC single phase or 380V three phase. Voltage varies ±10%

ii) The UPS shall be provided in the AFC-UPS room for each station, and the operation of the AG in the station for at least 30 minutes against power failure shall be guaranteed.

iii) The system supplier shall provide a UPS in the AFC-UPS room and guarantee the operation of the AG in the station for at least 30 minutes against power failure.

iv) AGs, TVMs and POS terminals in stations shall not start shutting down unless power trouble lasts for more than 1 minute.

c) Climate Conditions

i) AFC equipment shall consider hot and humid climate conditions in Manila. The climate condition shall be referred to Section NN of GS.

ii) The limit of climate conditions (including temperature and humidity) that AFC machines can operate normally, shall be clarified.

iii) AFC equipment shall consider shutting down in order to retain revenue data, in case air-conditioning unit breaks down and could not maintain normal operations.

d) The coordination shall be taken with the related people on architecture, installation, power supply, wiring and the air conditioning of related rooms.

e) Design Life

i) Design life shall be more than 10 years.
ii) Life expectancy of total AFC system shall be at least 5 years from the commencement of revenue service.
iii) These 5 years does not include years for development or testing.

f) Data Retain

i) The AFC system shall consider measures against any damage or loss of data. The measurements shall be considered from the point of view of both software and hardware.
ii) The AFC system shall consider measures against power failure or trouble.
iii) The AFC system shall consider measures against network failure.
iv) The AFC system shall retain backup data for operation trace for 30days or more. Targeted machine shall include, but not limited to, the followings.
- TVM
- POS terminal
- AG
- HT
- Station computer
- Central computer

g) Software Requirements

i) The list of all software shall be submitted to the Employer's Representative.
The software shall be considered being maintainable and re-configurable by the O&M Company.
ii) All data transmission shall consider security. The system supplier shall submit security design for data transmission to the Employer's Representative for review in coordinate with the O&M Company.
iii) Software design shall consider measures against vandalism or fraud.

h) Hardware Requirements

i) Hardware design of AFC machines shall consider the followings.
- Measures against vandalism (including wrenched open or damage touch-panels)
- Measures against fraud
- Measures against dust
ii) The AFC system shall be designed considering passengers' safety and convenience, especially the aged, children, expected mothers, and the handicapped.

iii) The AFC system shall be designed considering the safety and convenience of operating staffs.

i) Use by the Handicapped

i) The operation of AFC equipment by the handicapped passenger shall be clarified.
ii) The handicap includes the followings.
- Total blindness
- Weakness in sight
- Color blindness
- Use of wheelchair

j) Size and Weight

i) The size and weight of AFC facilities shall be provided to related system suppliers.
ii) TVM shall consider front-opened type, but rear-opened type can be acceptable.
iii) The width of the normal- type automatic gate shall be at 550mm wide between the machines. The width of the wide-type automatic gate shall be at least 900mm wide between the machines, considering the use of wheelchair passengers. The system supplier shall propose width between the machines to the Employer's Representative for review. The width of each gate machines shall be 300mm or less, unless first coordinated with the other system suppliers, and then be reviewed by the Employer's Representative in coordinate with the O&M Company.

k) Bills and Coins

i) The TVM shall accept Philippines bills and coins. Acceptable types of bill and coin shall be proposed by the system supplier, and be reviewed by the Employer's Representative in coordinate with the O&M Company.
ii) Acceptable bills and coins shall be finalized 24 months prior to the start of revenue service. Finalization cost shall be included in the contract. Cost to handle new bills or coins issued after finalization is not included in this project, and shall be discussed with the Employer's Representative in coordinate with the O&M Company.
iii) The acceptance rate of Philippines bills and coins shall be reported to the Employer's Representative and the O&M Company before start of the static commission. The acceptance rate shall be measured by:
- Fresh bills and coins; and
- Used (circulating) bills and coins

Rejected bills and coins and the reason shall be shown to the Employer's Representative and the O&M Company.

iv) The TVM shall detect and reject fate or unacceptable bills and coins, unless impossible for considerate reason.
v) The TVM shall have escrow function.

vi) The TVM shall be able to accept plural number of bills and coins for each passenger.

vii) The TVM shall be able to give change to the passengers. It shall have money circulating function (inside the TVM), in order to avoid inconvenience of passengers and station staffs.

viii) The TVM shall be designed so that station staffs do not need to touch money, unless troubles such as jamming occur. Cash cassette of AFC machines shall be locked. The number and variation of locks shall be reviewed by the Employer's Representative in coordinate with the O&M Company. Each cassette shall be labeled with its own identification number. This identification number shall be identified electronically by machine. The station staff shall input his / her identification number before removing the cash cassette, in order to record cash handling operation.

ix) Machines such as TVM shall be designed so that it can count the number of bills and coins inside.

l) Card Handling

i) Machines such as TVM shall be designed so that station staffs do not need to touch card, unless troubles such as jamming occur. Card cassettes of AFC machines shall be locked. The number and variation of locks shall be reviewed by the Employer's Representative in coordinate with the O&M Company. Each cassette shall be labeled with its own identification number. This identification number shall be identified electronically by machine. The station staff shall input his / her identification number removing the card cassette, in order to record card handling operation.

ii) Machines such as TVM and POS terminal shall be designed so that can count the number of cards inside the machine.

m) Revenue Closing

i) TVM and POS terminal requires revenue closing.

ii) Revenue closing shall include the followings.

- Collecting cash
- Reloading cash (for change)
- Collecting cards
- Reloading cards
- Reloading consumables (if required)

iii) Data shall be uploaded to central computer through the station computer.

iv) Time required for revenue closing shall be no more than ten (10) minutes for each machine.

v) AG shall not require manned revenue closing.

n) Maintenance Requirements

i) Not more than one maintenance person shall be required to repair the following, but not limited to, machines.

- TVM
- AG
- POS terminal
- Station computer
- Cash handling equipment
- Money trolley

ii) Units shall be considered to shorten the time required to repair for the following, but not limited to, machines.

- TVM
- AG
- POS terminal
- Station computer

o) Reliability Requirements

i) Reliability of TVM, AG, and POS terminal shall be measured by mean cycles before failure (MCBF).

ii) MCBF shall be counted as failures which require parts replacement, and shall not consider failures such as jam or those which are by other external causes.

iii) MCBF of TVM, AG, and POS terminal shall be 100,000 cycles or more.

iv) The demonstration of the system complying with the reliability requirements shall be taken.

2) Security

a) The security of AFC system shall be secured from the following, but not limited to, viewpoints.

i) Forgery, modification, misappropriation of tickets

ii) Equipment malfunction, mis-operation, illegal operation, violent destruction

iii) Loss, damage, alteration of data in equipment, data on communication line

iv) Any damage to equipment due to power failure, lightning surge, malfunction

b) The data retained in each equipment shall be kept for at least one week if the host equipment cannot receive it.

3) Performance

a) The AFC system shall be able to process passengers on weekday peak hour at each station smoothly, based on the demand forecasts.

b) Consider the processing time of AG and the number of AGs so that the passengers shall exit within 3 minutes.

c) Consider the processing time of TVM and POS, and the number of them so that the passenger waiting time shall be less than 3 minutes.

d) The performance of this system shall basically satisfy the performance indicated in the concession agreement of the AFC system project of LRT 1 & 2 and MRT 3 (the Concession

Agreement of "PPP for the Automatic Fare Collection System Project for LRT Lines 1 & 2 and MRT 3"-- except Section 2.12 Level 4 Infrastructure MPSS).

4) Trial Estimation of Required Equipment

Estimate the peak hour demand from the demand forecast data and make a rough estimate of the number of devices in 2040.

a) Assumptions

i) Inwards traffic flow is fairly constant though the peak 15minutes.

ii) Approximately 1/3 of the peak hour numbers pass through in the peak 15 minutes. (the peak within the peak)

iii) Exit traffic arrives in train load every 6 minutes and should be cleared within 3 minutes.

iv) Rate of passage of gate
Entry gate: = 45 pass/min (no ticket insertion)
Exit gate: = 45 pass/min for SVC (no ticket insertion)
= 20 pass/min for SJT (with ticket insertion)

v) Time for Ticket purchase or add value by TVM= 15sec

vi) Time for Ticket purchase or add value at POS terminal in the customer service room = 20sec

vii) Take up of SVC = 80%

viii) SVC users add value every 12 trips in average.

ix) Fare adjustment at POS terminal in the customer service room are performed for 1% of exit passengers and it takes 30sec each.

x) Ticket sales are performed for 80% in TVM and for 20% at POS terminal in customer service room.

xi) Two additional machines per station for AG and TVM, and one machine for POS, have been added in this estimation.

xii) Devices for issuing limited express tickets are not included here.

Table 4.3.58 Number of Automatic Gate, TVM and POS

		AG	TVM	ENT POS	EXT POS
1	Clark to NCC	7	6	3	2
2	Clark to CIA	4	3	2	2
3	Clark	14	12	5	2
4	Angeles.	5	4	2	2
5	San Fernando	9	8	3	2
6	Apalit	5	5	2	2
7	Calumpit	5	5	2	2
Total		49	43	19	14

Source: JICA Design Team

(5) Equipment, Design and Materials Requirements

1) Automatic Gate

a) General

This section defines requirements for Automatic Gate (AG).

b) Type of AG

i) The following two types of AG shall be considered.
- Normal-width
- Wide-width

ii) Wide-width gate shall be able to be used by wheelchairs.

iii) Normal-width gate shall have 3 types of traffic directions.
- Entry Gate which is specially for entry aisle
- Exit Gate which is specially for exit aisle
- Reversible Gate which is bi-directional aisle

iv) Wide-width gate shall be bi-directional.

c) Requirements

i) The gate shall pass at least sixty (60) passengers per minute (counted in the testing condition).

ii) AG shall be with flap-door barriers in order to increase the throughput and realize the wide gate for wheelchair. Design of the gate shall be reviewed by the employer's representative in coordinate with the O&M Company. Table 4.3.59 is a comparison of two types of flap type doors as a reference.

Table 4.3.59　Comparison of the door type of AG

	Flap Door (Japanese stile)	**Retractable Door (fan stile)**	**Turn Stile Door**
Appearance			
Throughput	45 (max60) passengers/min	45 (max60) passengers/min	35 (max45) passengers/min
Wide Gate for Wheelchair	Applicable	Applicable	Not Applicable
Passenger Safety	High (The passenger can pass safely without hitting children's head and pregnant body.)	Low (There is a possibility that the doors hit children or pregnant women.)	--
Availability	High (It can be used without damage by passenger and machine trouble.)	Low (The doors are liable to be damaged by passenger or cause machine trouble.)	--
Machine Size (Width)	Narrow =< 200mm	Wide Approx. 300mm	Wide Approx. 300mm

Source: JICA Design Team

iii) Measures shall be taken to prevent an unauthorized person. These measures shall be reviewed by the Employer's Representative.

iv) The gate status shall be indicated to passengers.

v) The gate shall be normally closed. The gate shall be able to be opened by station staff in case of emergency.

vi) The gate shall consider safety of children, expected mothers, the aged, and the handicapped.

vii) The gate shall be capable of being operated in the following configurations.

- Controlled entrance, locked exit
- Controlled exit, locked entrance
- Free Exit, Free entrance
- Locked entrance, locked exit
- Controlled entrance, controlled exit

The differing configurations indicated above shall be determined by SCS, which transmits the necessary commands to set the AGs in their preselected mode.

viii) The gate shall collect the SJTs at the exit and store them in the cassette. The cassette is carried to TVM and it shall be able to be used for the next SJT issue.

ix) The ticket insertion slot of exit gate shall be shaped that the passengers easily insert their tickets.

2) Ticket Vending Machine

a) General

This section defines requirements for Ticket Vending Machine (TVM).

b) Basic Functions

i) TVM must have at least following functions for passengers.
- Issue Stored Value Card (SVC) and Single Journey Ticket (SJT).
- Collect deposit for SVC.
- Top-up SVC.
- Show the data inside the card.

ii) The TVM shall issue receipts on passengers demand.

c) Credit Card

The TVM shall consider future use of credit cards.

d) Interface for Passengers

The TVM shall have touch-panel interface.

i) It should be considered that station names are indicated on the display when passenger buys SJT.

ii) Language to be used shall be English as standard and Tagalog language can be selected.

iii) Man-machine Interface design of the TVM shall be reviewed by the Employer's Representative in coordinate with the O&M Company.

e) Other Requirements

i) The TVM shall be accessible to wheelchair users without difficulty.

ii) The TVM shall be able to handle four (4) passengers per minutes (counted in the testing condition).

3) Point of Sales / Analyzer-Dispenser

a) General

This section indicates requirements for Point of Sales / Analyzer-Dispenser (POS)

b) Basic Functions

i) POS shall be the window machine which is operated by a station staff and shall have at least the following functions.
- Issue Stored Value Card (SVC) and Single Journey Ticket (SJT)
- Collect deposit for SVC
- Top-up SVC
- Adjust fare for SVC and SJT
- Show the data inside the card
- Analyze the data inside the card

c) Requirements

i) POS shall include secure cash drawers.
ii) POS shall be able to request card information to the center computer.
iii) The information of processed card shall be sent to the CCS.
iv) POS shall have a passenger display for show the price of the ticket, the remaining value inside the card, excess fare and so on.

4) Station Computer System

a) General

i) This section indicates requirements for Station Computer System (SCS).
ii) SCS shall be provided at each station.

b) Requirements

i) The SCS exchanges information with the AFC equipment through the LAN in the station. It also exchanges information with CCS through communication backbone network between stations and OCC.
ii) The main function of SCS is as follows.
- Transaction data and event data collection and transmission
- Cash data and Card data collection and transmission
- Ticket recycle management
- Ticket data inquiry
- Passenger flow data generation and transmission
- Machine status monitoring and control
- Data and parameter management
- Blacklist management
- Time management
- Stuff account management
- Data input/output management
- Log data/ maintenance record management

iii) Station computer shall have security protection for data and user access.

5) Central Computer System

a) General

i) This section indicates requirements for Center Computer System (CCS).
ii) CCS is placed in the OCC building.

b) Requirements

i) The CCS shall include assist terminal for monitoring and control.
ii) The main function of CCS is as follows. (*) Sign means sending and/or receiving the data with the central clearing house.

- Transaction data and event data collection and transmission (*)
- Cash data and card data collection and transmission
- Ticket inventory management
- Ticket data inquiry (*)
- Passenger flow data generation and transmission
- Machine status monitoring and control
- Data and parameter management
- Blacklist management (*)
- Time management
- Stuff account management
- Data input/output management
- Log data/ maintenance record management
- SAM authentication and transaction authentication (*)

iii) The central computer system generates fare data and distributes it to the AFC equipment via the station computer. The fare data includes not only the inside of this system but also the fare data if there is a line of other businesses that can cross each other without passing through the gate.

iv) The following functions are performed by the central clearing house.

- Clearing function
- Black list generation management
- Card status (including balance information) management
- Security key management
- SAM management

v) Central computer shall be able to handle expected number of passengers until 2030 including other future lines

vi) The data capacity requires for the central computer shall be engineered and proposed.

6) Handheld Terminal

The Handy Terminal is placed at each station and used offline for card information checking, entrance / exit processing. Transaction data is sent to the station computer when connected to the station LAN.

7) Smart Card

a) General Requirements

i) The card media shall be the same media used in the system of LRT1,2, MRT3 (ISO/IEC14443 Type A)

ii) Shape of the card shall be credit card size;

- SJT: (85.47-85.72mm)×(53.92-54.03mm)×(0.50±0.05mm）
- SVC: (85.47-85.72mm)×(53.92-54.03mm)×(0.80±0.05mm）

iii) Base material of the card shall be PET or other types of that are environmentally benign when incinerated.

iv) Data retention period shall be at least 10 years for SVC and 5 years for SJT in normal use.

(6) Communication Network and Interface

1) Communication Network

a) General

i) This section indicates requirements for communication network.

ii) Data communication network shall be provided between station AFC equipment, station computer system, central computer system, card issuing system, card recycling system, and stuff-pass issuing system. Cash handling equipment is not required to be connected to the network.

iii) Optical fiber cables between stations and the OCC building shall be prepared by the Telecommunication system.

iv) Network facilities in stations and the OCC building shall be prepared as AFC facilities.

b) Requirements

i) Requirements for cable are as follows.

- The cable shall meet national or international standards appropriate to data processing and data transmission required.
- The measures to define cables easily apart from other systems shall be proposed.
- The cable shall be manufactured from fire retardant, low smoke, halogen free materials.
- The cable shall be sufficiently shielded to minimize its susceptibility to external noise.
- The cable shall be anti-termite, rodent and pest resistant. If chemicals are used, those shall conform to the requirements of related Philippines regulation.

ii) Installation of the cable shall be carried out in accordance with requirements of Philippines laws, regulations, and standard. The special attention shall be paid to, but not limited to, the cable installation through fire protection wall.

iii) Network facilities shall consider measures against power failure, in order to protect or conserve data.

iv) Network engineering shall be proposed to and be approved by the Employer or the Employer’s Representative. Network engineering includes the followings.

- Protocol used for all data communication, such as TCP/IP, and addresses
- Network components and their performance
- Operating speed of LAN in stations and OCC building
- Measures against illegal access to LAN
- Measures against data loss in case of power failure

(7) Cash and Card Handling

1) Cash Handling

a) General

i) This section indicates requirements for cash handling.

ii) Cash handling is assumed to be conducted in the AFC room of each station.

iii) Cash handling equipment shall include, but not limited to, the followings.

- Coin sorting and counting equipment
- Coin bagging equipment
- Bill counting equipment; and
- Money trolley

iv) Consumables for cash counting and handling are not included in the contract.

b) General

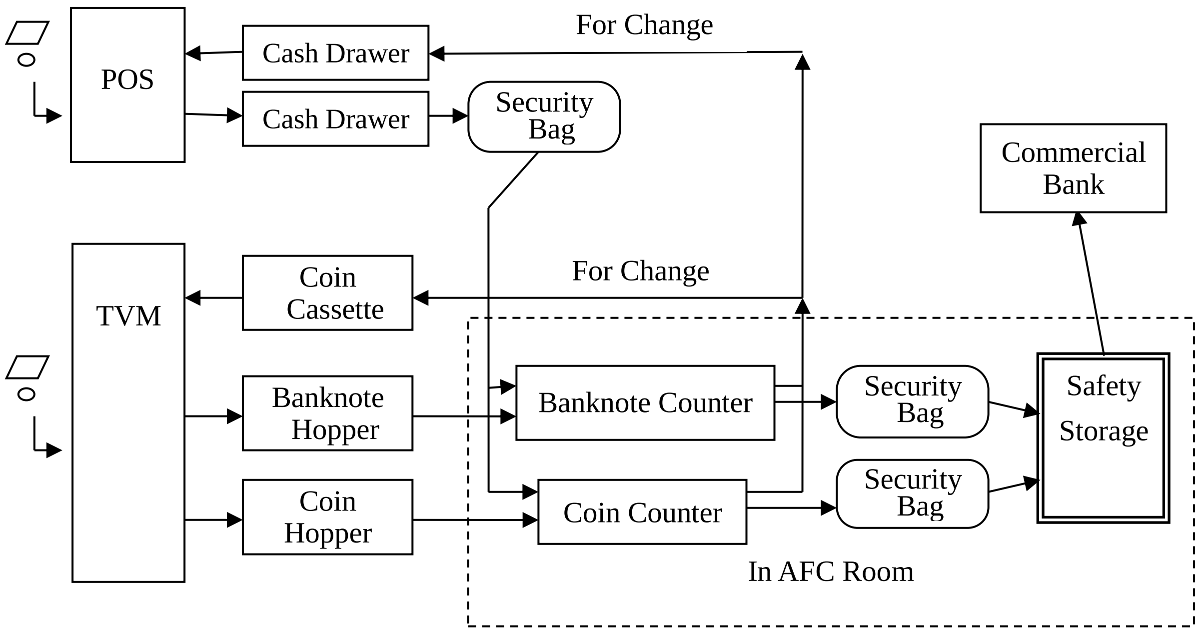
i) The following matters shall be proposed to the Employer's Representative in coordinate with the O&M company and be reviewed.

- Operation of cash handling
- The number of cash handling equipment at each station

ii) Cash counting equipment shall have functions to check the types of bill or coin.

iii) Money trolley shall be designed for one-manned operation.

iv) Cash handling is shown in Figure 4.3.65.



Source: JICA Design Team

Figure 4.3.65 Cash Handling

2) Card Handling

a) General

This section indicates requirements for card handling.

b) Requirements

i) The cards shall be supplied by the 1st issuer outside this contract and be recycled as shown in Figure 4.3.64 Card life cycle

ii) The card stock, the cards in the equipment, the number of cards temporarily stored in the AFC room for recycling, the cards recovered due to defects, and the cards returned must always be clearly managed.

iii) The cards shall be kept in a safe or locker with key and can be taken out only by authorized persons.

(8) Installation

1) Installation of AFC equipment

i) The AFC equipment shall be set up at a specified place. AGs and TVMs must be installed avoiding direct sunlight, raindrops and splashes.

ii) Equipment shall be fixed so as not to fall over or move due to earthquake, mischief etc., securing operation space and maintenance space.

2) Installation Duct and Cables

i) The power cable and communication cable to be supplied to the AFC equipment shall be installed.

ii) Cables shall be installed in measurement that is safe to each environment. Also, there shall be no danger to passengers and station staff.

iii) The communication cable shall be installed so that the influence of noise from the power cable is minimized as much as possible.

(9) Testing, Commissioning and Verification

1) This section indicates the requirements for tests to be performed on AFC equipment included in the contract.

2) At least, but not limited to, following tests shall be conducted.

a) Independently witnessed tests: confirm that each unit is completely functioning

b) First article inspection: evaluate for each type whether the product manufactured first meets specifications and quality

c) Factory acceptance tests: confirm that each product / system function and quality before delivery

d) Partial acceptance tests: Partial sequential function confirmation, such as confirmation of standalone function of each device, communication function with upper computer, function of the upper computer, etc. after site installation
e) System acceptance tests: Test the entire system, including stations, central computer, and clearing house
f) Integration testing & commissioning: Run the whole system in almost the same form as actual use, and confirm that all processes, including result data, are processed without problems.

3) The simulation for testing shall be provided in case the interfacing equipment is not available, or in case testing patterns is not cleared enough by testing machines. In case the interfacing equipment is not available, the interfacing tests shall be conducted as soon as the interfacing equipment is ready.

(10) Consumables and Spare Parts

1) The consumables, spare parts and its list necessary for operation and maintenance of the AFC system shall be prepared.
2) Consumables and spare parts shall be prepared for three years including warranty period.

(11) Training

1) The maintenance training and operation training shall be conducted for the related staff of the O&M Company.
2) The training program shall enable staff to operate, service, enhance, maintain, and interact with AFC facilities.
3) The training plan shall be conducted under the assumption that the O&M Company's staff have no knowledge or experience concerning related systems. Final level of training shall be aimed as that the staff are fully adequate of the object.
4) The competent instructors, training manuals, training facilities, all necessary aids and materials in support of all training courses shall be provided.

(12) Maintenance

1) Repair or restore works at site shall be conducted by unit replacement, unless approves by Employer or the Employer's Representative in coordination with the O&M company.
2) Machines shall be designed that unit replacement shall be able to be conducted basically by one person.
3) In the maintenance shop, a maintenance assistance terminal and a printer shall be provided to inform the equipment operation status and trouble information, of all the stations, and printout the maintenance report.
4) Machines shall be designed and maintenance training shall be conducted so that repair or restore works at site shall be within 30 minutes after the arrival of maintenance staff. This repair or restore works do not include resuming from damages caused by vandalism, theft, fire or nature disaster.

5) Maintenance data shall be able to be checked by the Operation Company whenever required.
6) The maintenance reports shall be submitted to the Operation Company via the Employer's representative.

(13) Packaging, Shipping, Storage and Delivery

1) It shall be considered so that quality will not be impaired in the packing, shipping, transportation and storage of equipment, units and parts. In particular, it should not be affected by long-term high temperature and high humidity environment by shipping service and vibration during land transportation.
2) Quality shall not be impaired during storage in site.

4.3.9 Platform Screen Doors (PSD)

(1) Introduction

In modern urban railways, Platform Screen Doors (PSD) system has been introduced in consideration of safety at the station platforms (including barrier-free for passengers with disabilities). JDT proposes introduction of PSD in MCRP as well.

(2) Characteristics of PSD

The advantages and disadvantages of PSD are presented in Table 4.3.60.

Table 4.3.60 Advantages and Disadvantage of Platform Screen Doors

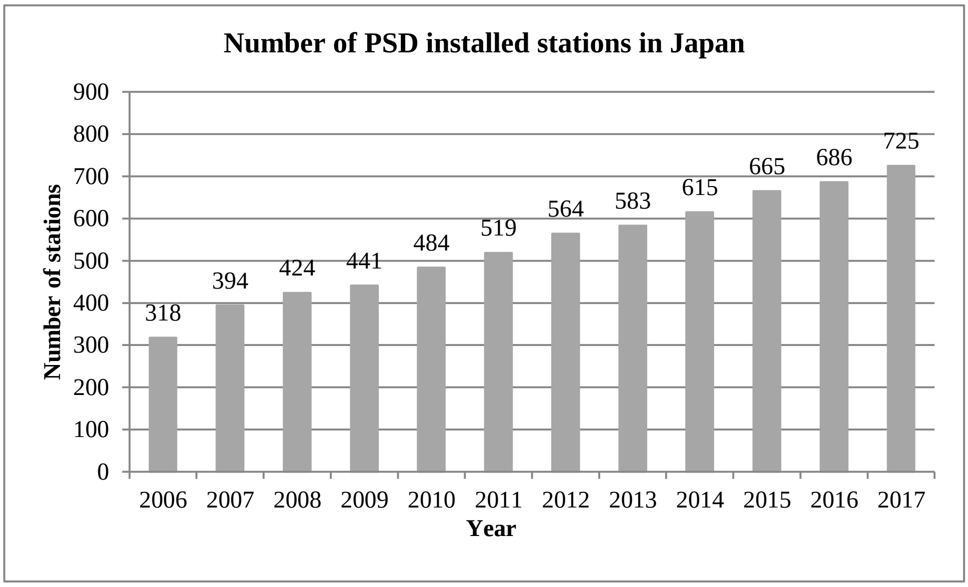
Advantage	Disadvantage
Not only prevent passengers on the platform from falling on the track, but also prevent train delays due to falling and contact accidents.	Increasing initial cost (including augmentation of relevant signals and communication facilities, etc.).
Since the safety on the platform improves by installing PSD, staff for safety confirmation is reduced, and safety management of the station is possible with a minimum number of staff.	When PSD are installed, the number and position of the doors of the rolling stock are limited by the opening position of the PSD. It will be difficult to change the number and position of the doors of the rolling stock after installing the PSD.
When full-height PSD are installed in an underground station, conditioned air at underground station remains in the platform, enabling efficient and economical cooling with reduced cooling energy consumption. (Reducing energy consumption by about 40%).	Because stop time of train is increased by about 5 to 10 seconds per station due to opening and closing of PSD, transport capacity at the peak is decreased.

Source: JICA Design Team

In urban railways, introducing PSD makes it possible to prevent delays in train operation due to accidents on the platform, thereby improving convenience. The following shows the introduction status of PSD in major cities in Japan and Asia.

1) PSD in Japanese Railway

After the Barrier Free Act is enacted in Japan in 2006, a law promoting easier movement for the elderly and disabled, consideration was given to the safety of elderly people and persons with disabilities. As a result, the introduction of PSD in railway system has been advanced. As of the end of March 2018, PSDs are installed in 73 routes (725 stations) including Shinkansen, conventional line, subway, monorail and new lines. Half-height PSDs are widely introduced.



Source: Ministry of Land, Infrastructure and Transport (Japan)

Figure 4.3.66 Number of PSD installed stations in Japan

2) PSD in Urban Railways in Asian Cities

Status of PSD installation in urban railways in Asian Cities is shown in Table 4.3.61.

Table 4.3.61 Status of PSD in Asian Cities

Line	Length	Date of commencement	PSD	
Delhi Metro Line1,2,3,4,5,6	190km	2002	E	None
			U	None
Singapore North South Line	45km	1987	E	Half
			U	Full
Singapore East West Line	57km	1987	E	Half
			U	Full
Bangkok MRT	21km	2004	U	Full
Beijing Metro Line 4	28km	2009	E	Half
			U	Full
Hong Kong MRT West Rail Line	31km	2003	E	Half
			U	Full
Ho Chi Minh MRT Line 1	24km	2020 Under Construction	E	Half
			U	Full
Jakarta MRT Line 1	16km	2019 Under Construction	E	Half
			U	Full

Note: E: Elevated Station, U: Underground Station

Source: JICA Design Team

(3) Type of PSD

There are two types of PSD 1:) Full-height PSD and 2:) Half-height PSD. The main features of Full-height PSD and Half-height PSD are shown in Table 4.3.62. Generally, Half-height PSDs are often introduced in at-grade stations and elevated stations in consideration of installation cost, Full-height PSDs are often introduced in underground stations for the purpose of high level of safety and air conditioning efficiency. Both types are introduced in Japan.

Table 4.3.62 Features of Full-Height PSD and Half-height PSD

	Full-Height Type	**Half-Height Type**
Appearance		
Summary	Wall-like structure provided on the platform, and it is a structure which prevents any passenger body to be let out to the railway side.	Wall-like structure with a height of about 1.3m provided on the platform. There is less oppressive feeling for passenger than Full-height PSD.
Initial Cost	High (about twice expensive than Half-height PSD)	Medium
Safety	Very high	High (There is no contact with the rolling stock unless intentionally overcomes the fence.)
Air-conditioning Efficiency	Effective (About 40% energy consumption can be reduced)	-
Suitable station type	Underground Station	Elevated and at-grade Station

Source: JICA Design Team

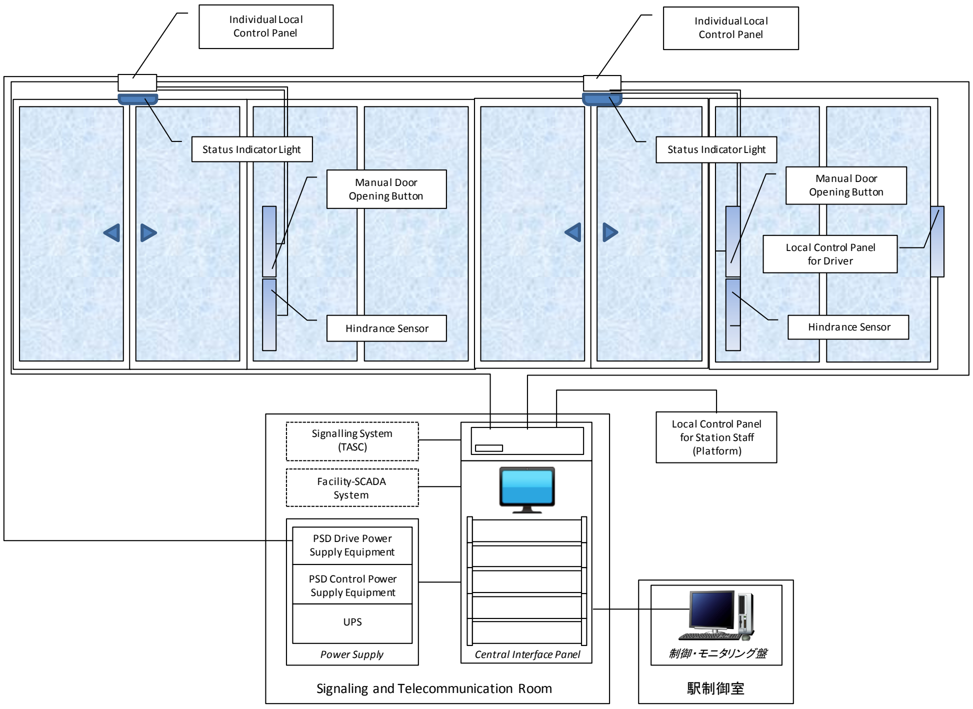
There are total of 7 stations including 1 underground station and 6 elevated station in MCRP, whereas JDT proposes to introduce Half-height PSD at all stations. Because the initial cost can be reduced by unifying specifications at all stations and Half-height PSD have similar performance as Full-height PSD in terms of passengers' safety. In CIA station, as regards express trains, the wide screen door is required since the door position of the express train is different from the one of the commuter train. But there is no plan that the wide screen door with Full-height PSD is introduced. From the above, JDT proposes to introduce Half-height PSD at all stations.

(4) System configuration of PSD and cooperation between PSD and other systems

1) System configuration of PSD

System configuration of the PSD is shown in Figure 4.3.67 and Figure 4.3.68.

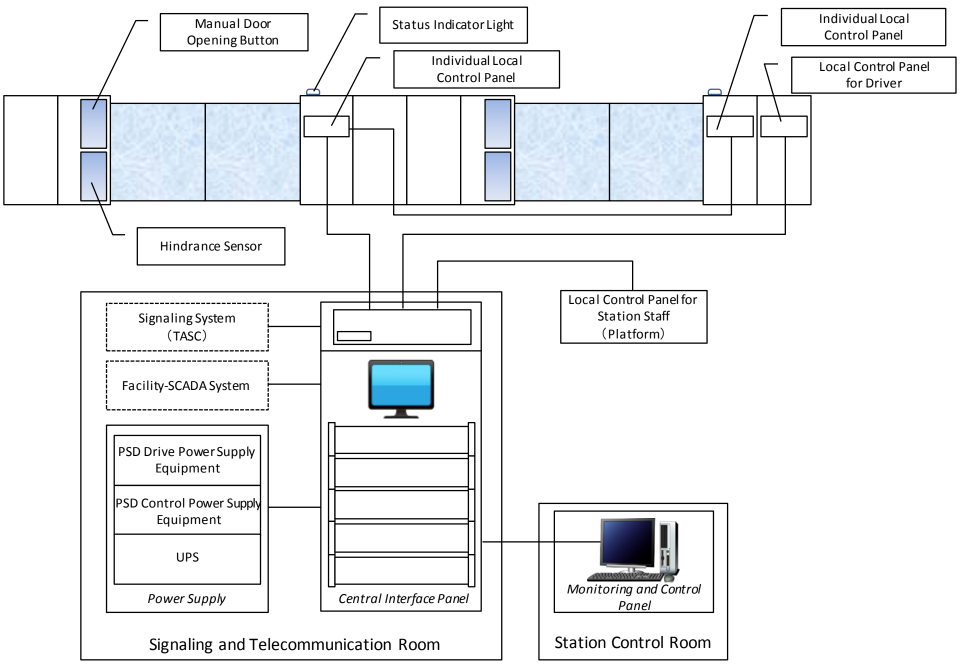
a) Full-height PSD



Source: JICA Design Team

Figure 4.3.67 System Configuration of Full-height PSD

b) Half-height PSD



Source: JICA Design Team

Figure 4.3.68 System Configuration of Half-Height PSD

2) Cooperation between PSD and other systems

a) Introduction of PSD requires coordination with signalling system, telecommunication system and rolling stock. Since it is required to accurately stop the car at the sliding door part of the PSD, safe and accurate train control by the signalling system must be realized. Train controlled by signalling system is executed by the following path: ground signalling equipment (including TASC: Train Automatic Stopping Controller) - Communication path - ground antenna (CBTC) - Radio communication (train control by CBTC) – on-board antenna - Radio communication (train control by CBTC) – on-board signalling equipment (CBTC including ATP, ATO).

b) When the train stops at station, the stop control of the train is carried out by the above-mentioned path. The TASC ground unit and the TASC on-board unit obtain the information of position of the entering train in platform, and train stops at the accurate position of the sliding door of the PSD with an accuracy of ± 350 mm. The PSD system receives a signal that the train has stopped at the correct position from the signalling device, then opens and closes the door.

c) The operation status of the PSD is monitored by the central facility monitoring system (SCADA facility).

3) Normal operation

During normal operation, the train and the PSD interchange signals and mutually confirm the status, and perform door opening / closing operation to ensure passenger safety. Specifically, when the train arrives, the PSD opens first, then the train door opens. When the driver performs a door closing operation at the time of departure, the train door first closes, and then the PSD closes. In case the operation of the PSD is not completed due to objects getting caught or the passengers being left behind, the train is not allowed to start.

4) Handling in case of trouble

Handling in the event of trouble can be divided into different cases. When failure occurs in individual door of PSD, disabling the operation of the failed door from the PSD by the driver’s control panel, which is designed to operate for each individual door, should return to normal operation. When failure occurs in the whole PSD system, disconnecting the interlock function between the train and PSD enables the train to depart. This operation can be carried out from either the driver's control panel or the station attendant control board. The failure information is sent as alarm to the station control room or the central facility monitoring system and corresponding necessary repair is done.

(5) Measures to be required by installing PSD

1) Determination of the number of cars to be set and the number of doors

While introducing PSD to the railway system, it is necessary to determine the number of train sets, the number of doors per train car and the specification of PSD accordingly. Regarding the number of train cars to be formed, PSD will also be in line with the 8-car train set, as it is assumed that trains of 8-car per train set will be operated from the beginning of operation. In addition, there is a plan to increase to 10-car per train set in the future, PSD also have a system structure that can be extended to 10-car train set. Regarding the number of doors per train car, there are two types of commuter train and limited express train, which are different from each other. The commuter train is designed to have 4 doors per one train car per side to ensure common specifications with the Metro Manila Subway Project. Limited Express train is planned with 2 doors per train car per side to secure more seats. As a result, it is necessary for PSD to refer to 4 doors type, recognize the train type, and have a function of selecting which PSD doors to be opened. In order to handle with both express and commuter trains, it is necessary to adopt a wide screen door design to accommodate the difference in door position.

2) Maintenance frequency

Periodic maintenance is required for the signalling system (train control function by CBTC including ATO), car (brake performance) and PSD system, because PSD introduces high accuracy of stop position of the car within ± 350 mm. Maintenance frequency of signalling system and PSD system is shown in Table 4.3.63.

a) Maintenance of signalling system (the function of stopping the train at a predetermined position

Table 4.3.63 Maintenance of Signalling System (TASC Track Antenna)

Maintenance Item	Frequency (Time/Month)	Inspection Time (Time/Unit)	No. of Units/station
1. Function Inspection			
1) Repeater	2	0.5	2
2) Controller	2	1.0	1
3) TASC Track Antenna	2	0.2	8
2. Visual Inspection			
1) Repeater	4	0.1	2
2) Controller	4	0.1	1
3) TASC Track Antenna	4	0.1	8

Source: JICA Design Team

b) Maintenance of PSD System

Table 4.3.64 Maintenance of PSD System

Maintenance Item	Frequency	Inspection Time	No. of Units/Station
1. Operation Inspection	Everyday	5 Minutes / Station	–
2. Function Inspection			
1) Insulation resistance and wire fixing	1 time / Year	15 Minutes/ Unit	64
2) Controller	1 time/6months	15Minutes/Unit	64
3. Visual Inspection	1 time/3months	1 Hour/Station	–

Source:JICA Design Team

3) Reliability Provision

There are no international standards indicating reliability of PSD. However, PSD system is responsible for train operation and passenger safe getting on and off as well as signalling system. Therefore, JDT proposes that reliability of PSD in MCRP is defined as follows, with reference to the reliability of PSD shown in the procurement of PSD system in recent years.

- Design Life: 20 years
- MCBF (Mean Cycle Between Failures): more than 2,000,000
- MTTR (Mean Time to Repair): less than 60 minutes

4) Installation requirements

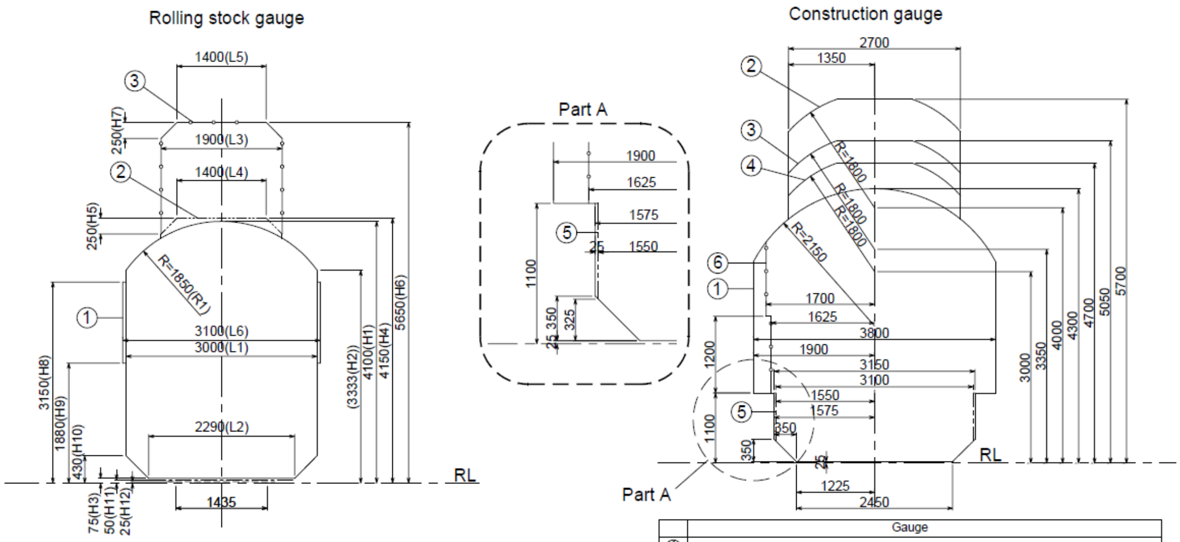
The requirements for installing PSD are as follows.

a) Securing load capacity and insulation treatment of platform

In the case of the half-height PSD proposed in MCRP, since weighing approximately 2,000 kg to 2,500 kg per train car, it is necessary to secure platform load capacity. In addition, in order to prevent the influence on the passenger by the potential difference between the train car and PSD, insulation treatment of the connection part between the platform and PSD is necessary, and insulation coating is also applied to PSD main body.

b) Reduced Construction Gauge

Because the PSD is installed close to the car, it is necessary to reduce construction gauge on platform. Reduced construction gauge is shown in



		Gauge	
		Basic	H1,H2,H3,H10,L1,L2,R1
②		Gauge when current collector is folded.	H4,H5,L3,L4
③		Gauge in relation to top of roof when current collector is operated.	H6,H7,L3,L5
①		Gauge in relation to signs,marker lamps, car side lamps.	H8,H9,L6
		Gauge in relation to parts that do not move vertically due to action of bogie spring.	H11,L2
		gauge in relation to sanding pipe,obstacle deflector, brake shoe and other parts that do not exceed the wheel rim width.	H12

	Gauge
①	Basic Gauge
②	Gauge for track on which trains run receiving supply of direct current.
③	Gauge for tunnels, bridge, overpass, along track on which trains run receiving supply of direct current.
④	Gauge for tunnel section in case of using rigid overhead wire or safe supporting system.
⑤	Gauge only platform edge. Remark : It can be applied when the passage velocity of a train is 120 km/h or less. The use in the case of 120 km/h or more is forbidden strictly.
⑥	Gauge only Platform screen door. Remark : It can be applied when the passage velocity of a train is 120 km/h or less. The use in the case of 120 km/h or more is forbidden strictly.

Figure 4.3.69 Reduced construction gauge of PSD

(6) Quantity of PSD

The quantity of PSD proposed to introduce to MCRP is shown in Table 4.3.65. The total quantity is 768 doors because one side of platform (with track) consists of 32 doors.

Table 4.3.65 Quantity of PSD

No	Line Name	Station Name	Station Type	PSD Type	Tracks	PSD	Doors
1	MCRP	CIA	Underground	Half-height	4	4	128
2	MCRP	Clark	Elevated	Half-height	4	4	128
3	MCRP	Angeles	Elevated	Half-height	4	4	128
4	MCRP	San Fernando	Elevated	Half-height	4	4	128
5	MCRP	Apalit	Elevated	Half-height	2	2	64
6	MCRP	Calumpit	Elevated	Half-height	4	4	128
7	MCRP	Malolos	Elevated	Half-height	2	2	64
		TOTAL			24	24	768

Source: JICA Design Team

4.4 Stations And Architecture

4.4.1 Location of the Stations

(1) Location of Calumpit Station

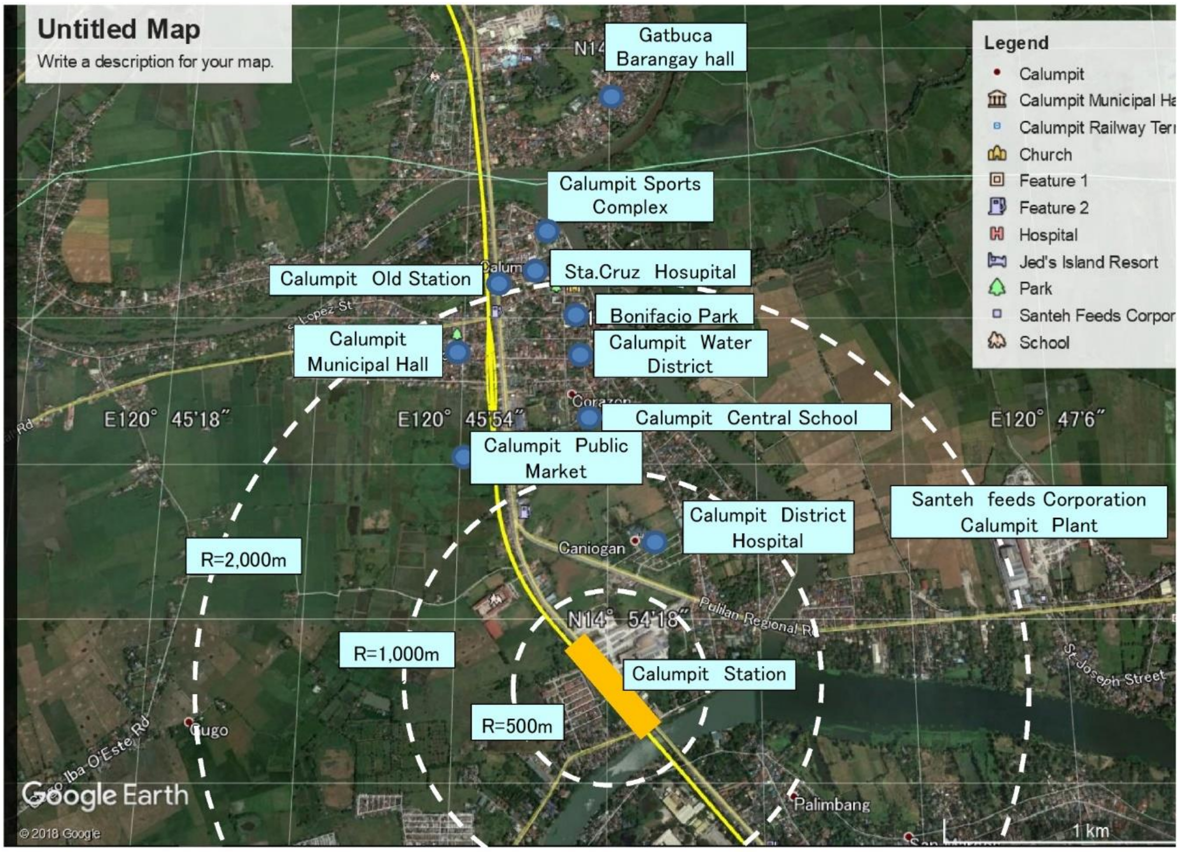
JICA Design Team studied three options for Calumpit station, the Old PNR Calumpit Station location, a site near the Town Hall, and the current proposed location near Caniogan triangle, based on the LGU's request. The LGU has plan to develop the Caniogan triangle. that's why the location of Calumpit station was decided by studying the following comparisons.

Table 4.4.1 Selection of Location

	Old PNR Calumpit Station		Option near the Town Hall		near Caniogan triangle	
Vicinity	In a heavily built up area	C	In light to medium built-up area, close to Town Hall	A	LGU proposed site, in a light to medium built area	A
Necessity for Additional Land	Necessary	B	Necessary (80 PAHs)	B	Necessary (35 PAHs)	B
Access to Arterial Road	Direct Access to Mac Arthur Highway	A	Direct Access to Mac Arthur Highway	A	Direct Access to Mac Arthur Highway	A
Vicinity Obstacle	Most structures inside the PNR ROW	C	Most structures inside the PNR ROW	C	A few structures inside the PNR ROW	B
Overall Result		B		B		A

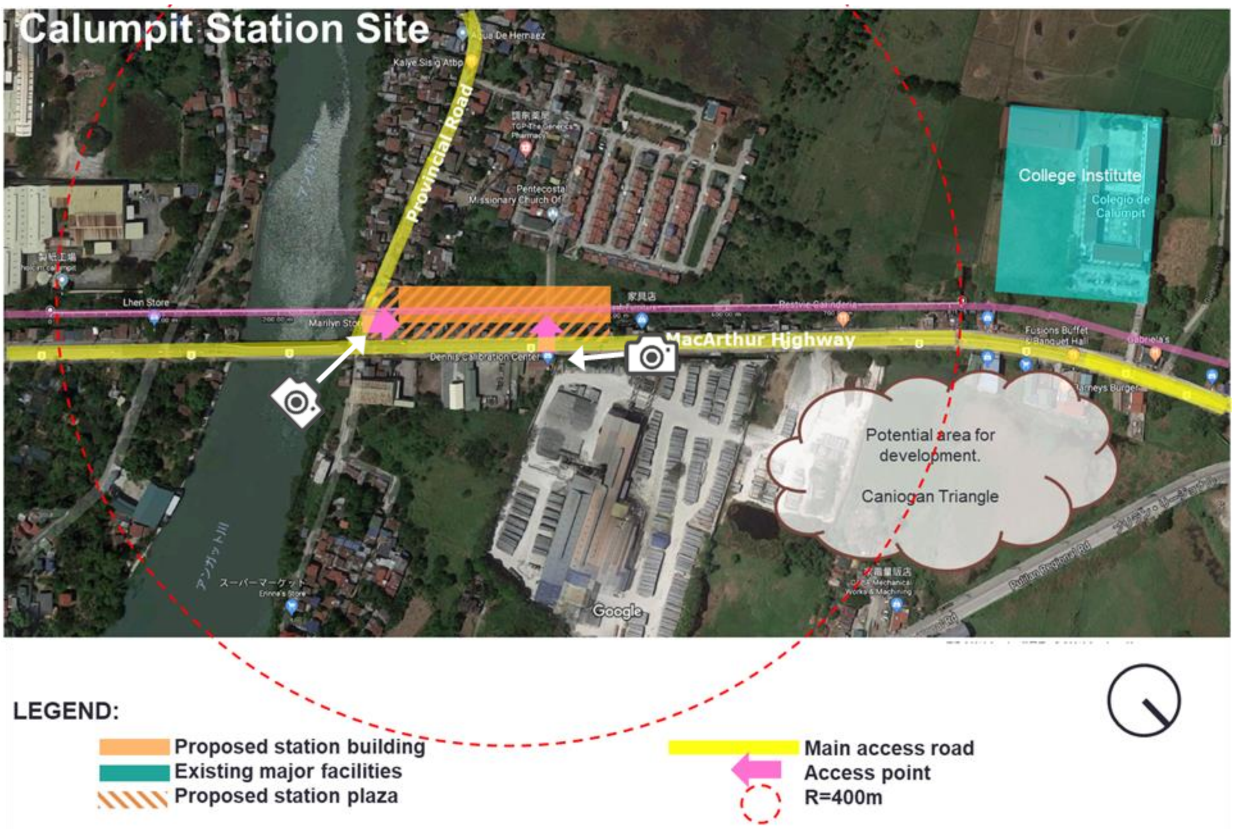
Note: **A**: Excellent, **B**: Good, **C**: Poor

Source: JICA Design Team



Source: JICA Design Team

Figure 4.4.1 Location of Calumpit Station



Source: JICA Design Team

Figure 4.4.2 Site Plan of Calumpit Station

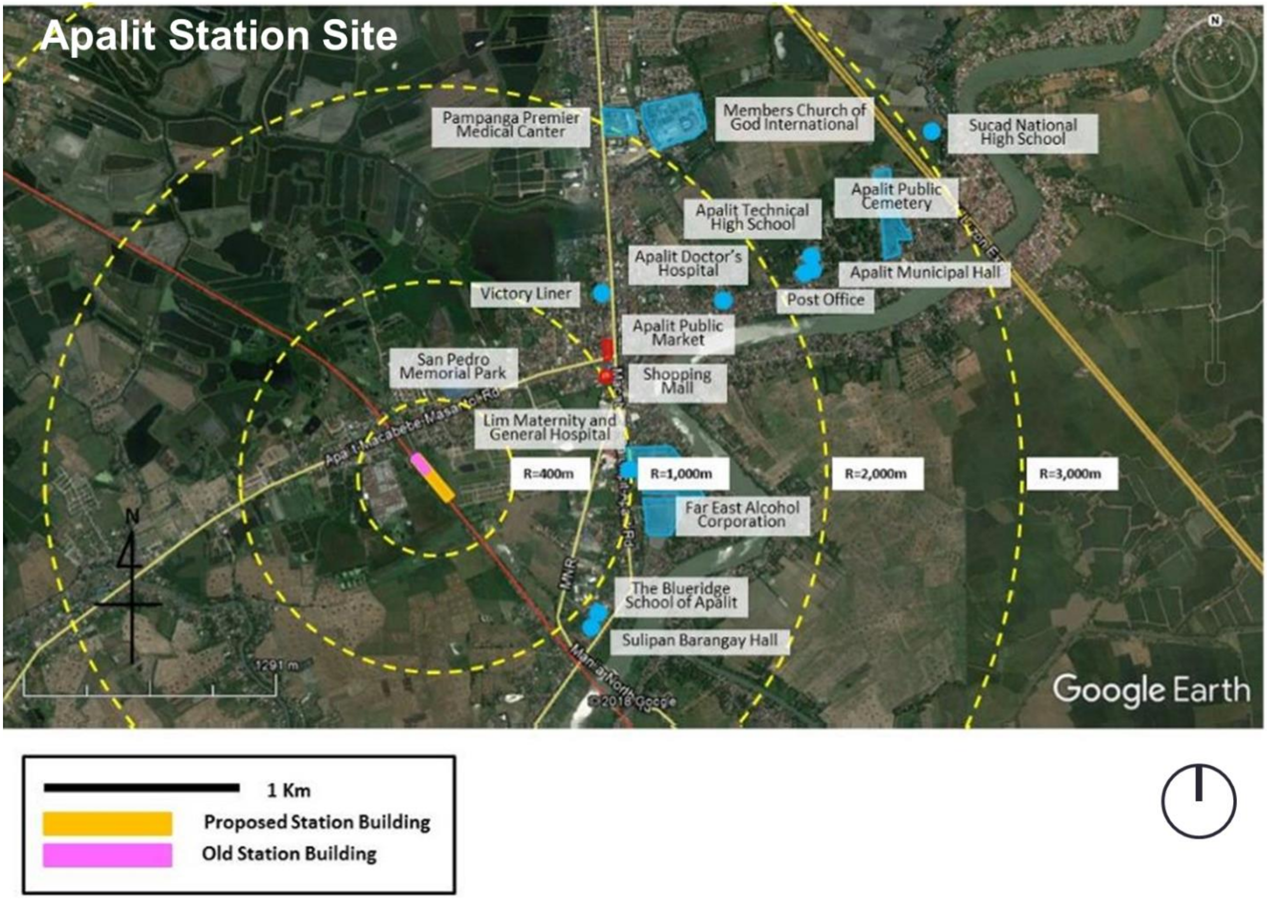
Source: JICA Design Team

Figure 4.4.3 Site Picture Around Calumpit Station

(2) Location of Apalit Station

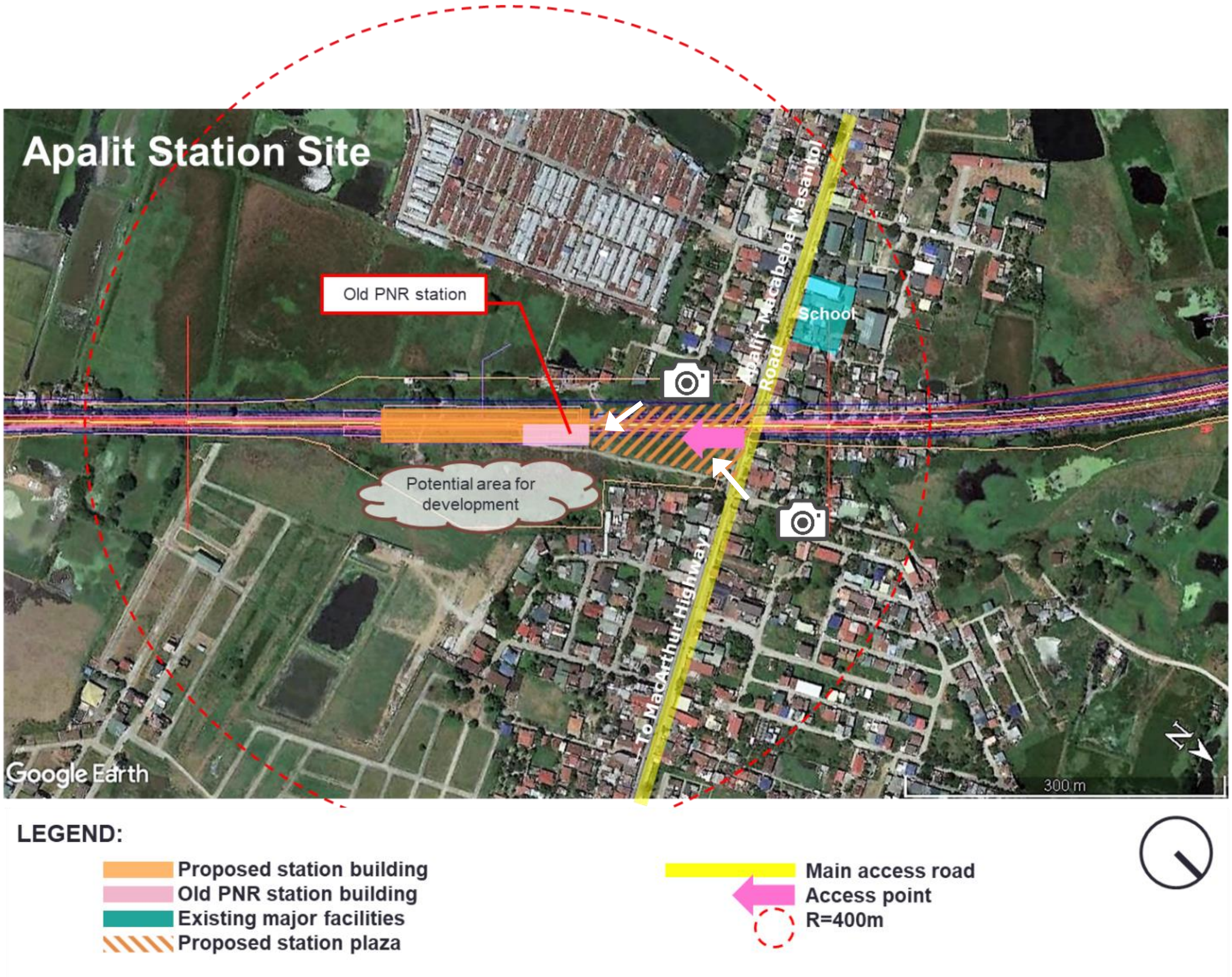
The location of the new Apalit station is at the same place where the old PNR station is located at a certain distance from MacArthur Highway and is in an "unoccupied" area. Since the necessity for additional land is little or no need as PNR ROW and is large enough to host both a medium-sized commuter station and station plaza, so it can be installed in north and northeast side of the existing station building and within the PNR ROW.

JICA Design Team proposed the location of the station which has an indirect access to MacArthur Highway (Apalit-Macabebe Rd.) as the access to arterial road and got the approval from DOTr, finally the location of Apalit station was decided.



Source: JICA Design Team

Figure 4.4.4 Location of Apalit Station



Source: JICA Design Team

Figure 4.4.5 Site Plan of Apalit Station

Source: JICA Design Team

Figure 4.4.6 Site Picture Around Apalit Station

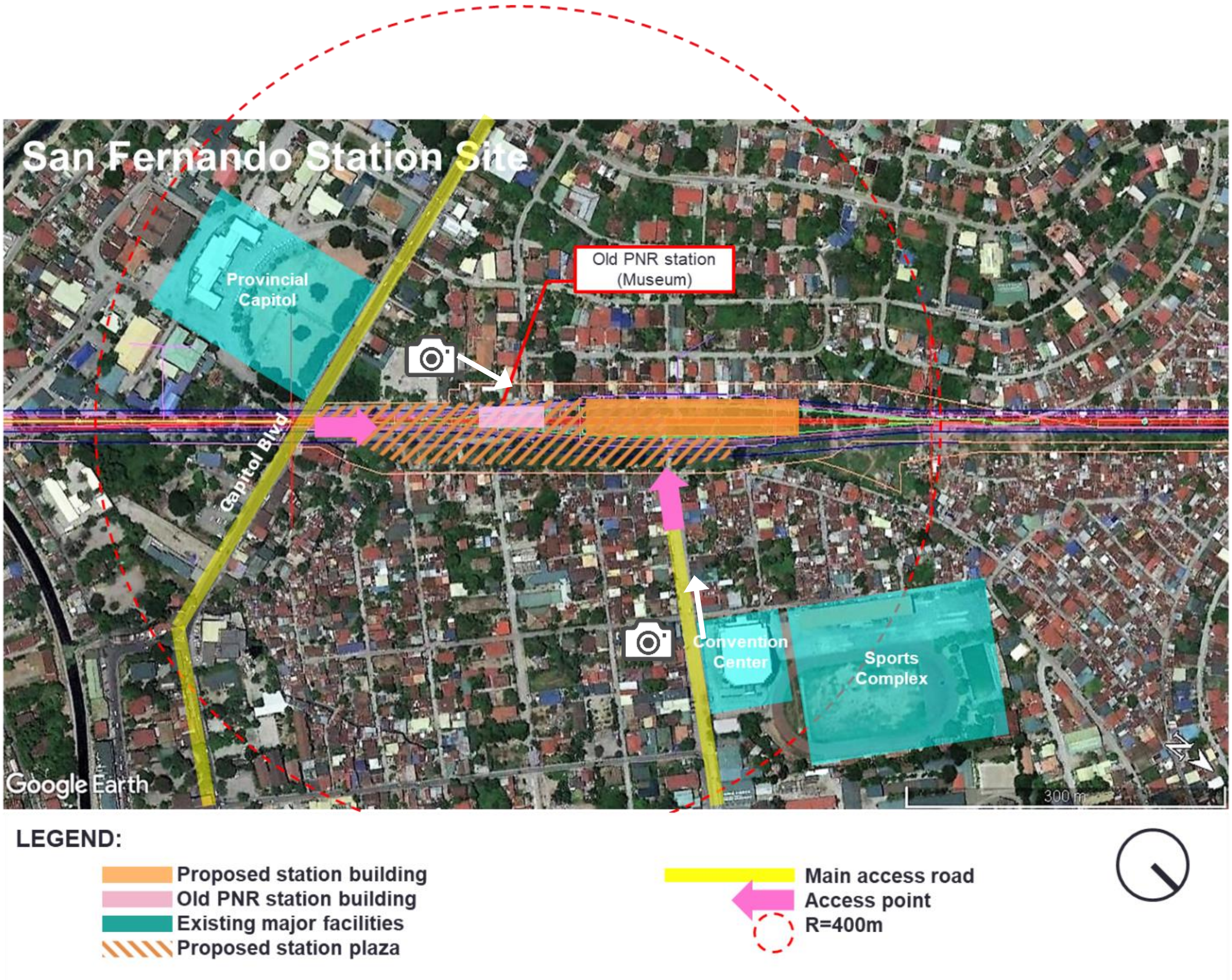
(3) Location of San Fernando Station

The location of the new San Fernando station is at the same place where the old PNR station is located at some distance from MacArthur Highway and in a medium built-up area. Since the necessity for additional land is little or no need, if PNR ROW is fully recovered from present occupants (to host both a large commuter station and the station plaza), so it can be installed in southeast of the existing station building and within the PNR ROW.

JICA Design Team proposed the location of the station which has an indirect access to MacArthur Highway (via Capitol Road) as the access to arterial road and got the approval from DOTr, finally the location of San Fernando station was decided.

Source: JICA Design Team

Figure 4.4.7 Location of San Fernando Station



Source: JICA Design Team

Figure 4.4.8 Site Plan of San Fernando Station

Source: JICA Design Team

Figure 4.4.9 Site Picture Around San Fernando Station

(4) Location of Angeles Station

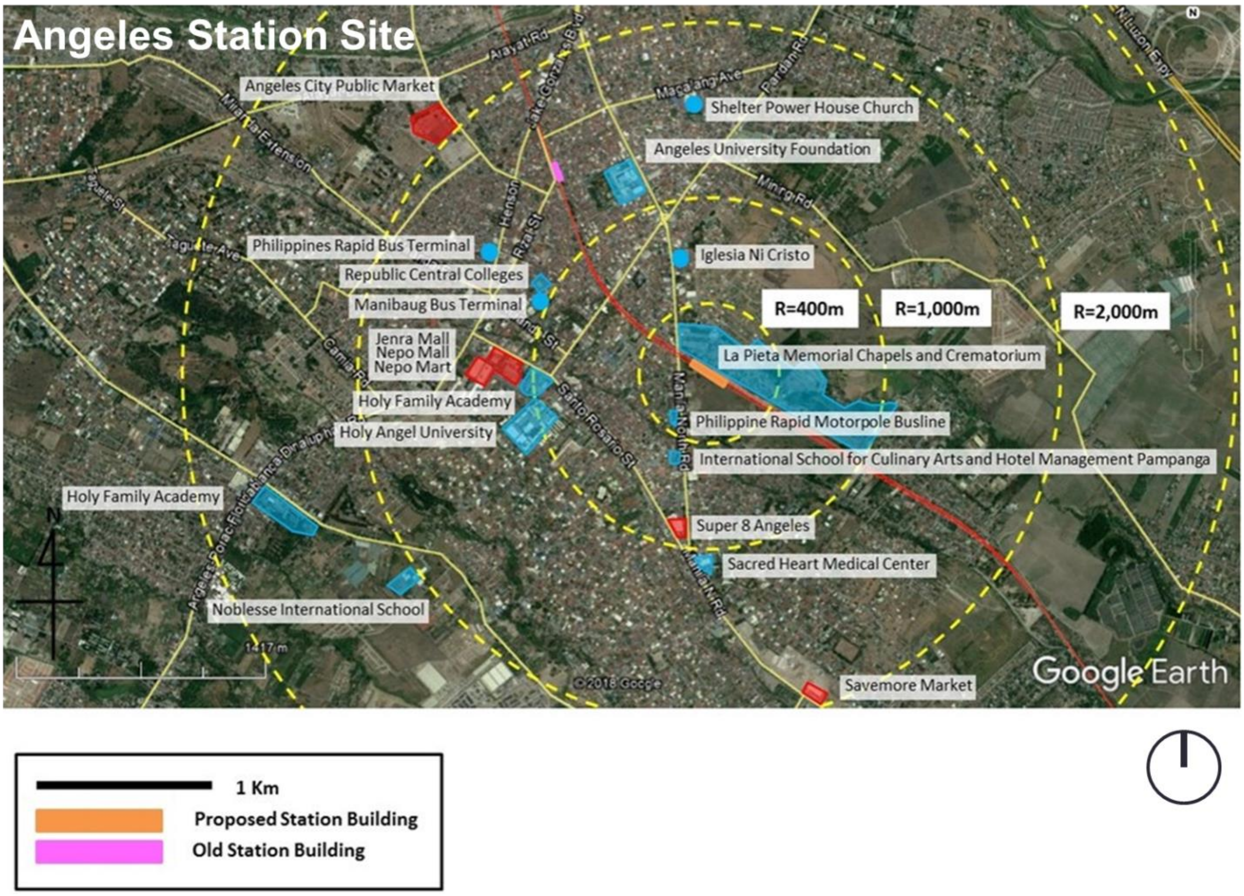
JICA Design Team proposed the location of the station about 1500m south from the old PNR station by studying the following comparisons in Table 4.4.2, and got the approval from DOTr, finally the location of Angeles station was decided.

Table 4.4.2 Selection of Location

	Proposed Angeles Station		Old PNR Angeles Station	
1. Vicinity	In a light to medium built-up area.	A	In a heavily built-up area.	C
2. Necessity for Additional Land	There is need for additional land.	B	Necessary even if PNR ROW is fully recovered from present occupants.	B
3. Access to Arterial Road	Direct access to MacArthur Highway.	A	Indirect access to MacArthur Highway (via Henson Road).	C
4. Vicinity Obstacle	Few obstacles.	A	All structures inside the PNR ROW.	C
5. Distance Between Stations	There is a reasonable distance between Clark and San Fernando.	A	The distance to Clark Station is short.	C
Overall Result		A		C

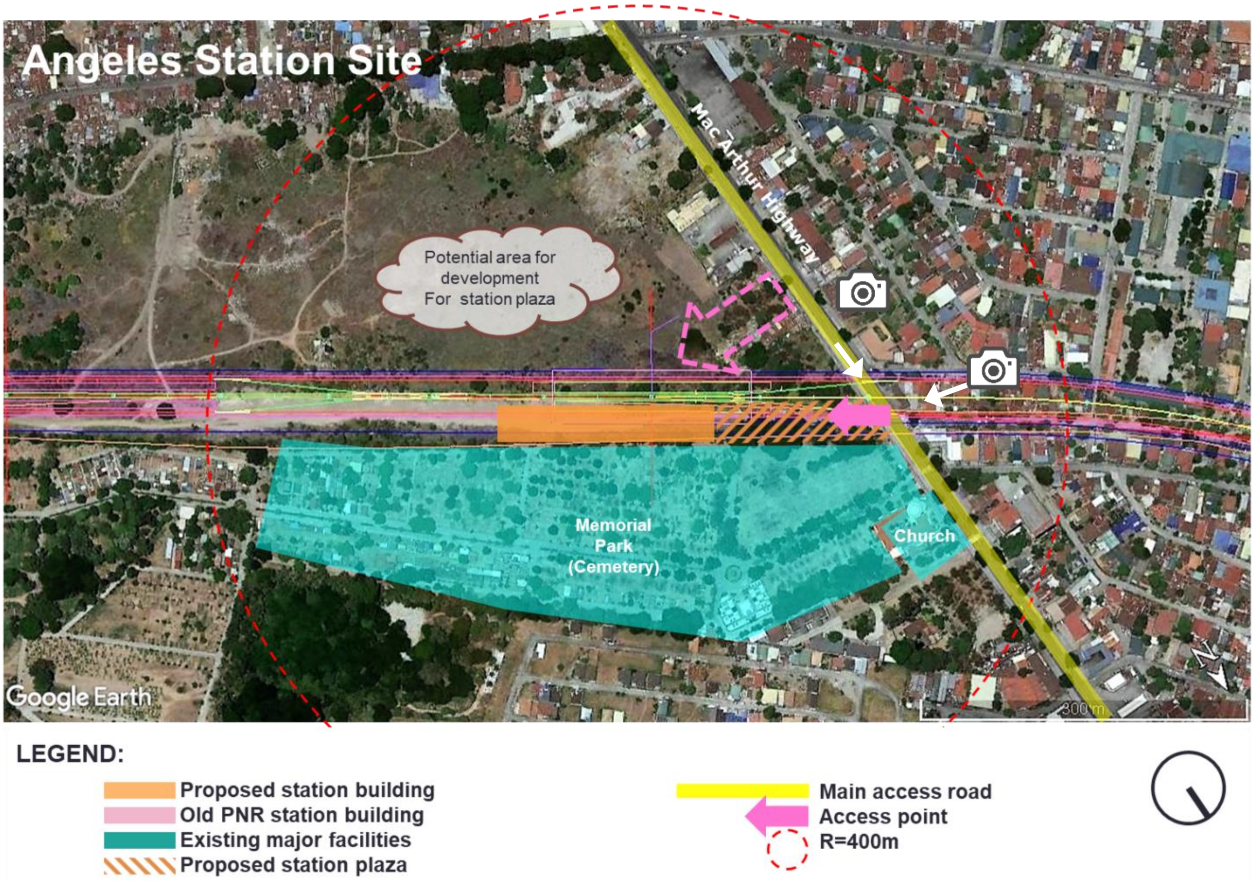
Note: A: Excellent, B: Good, C: Poor

Source: JICA Design Team



Source: JICA Design Team

Figure 4.4.10 Location of Angeles Station



Source: JICA Design Team

Figure 4.4.11 Site Plan of Angeles Station

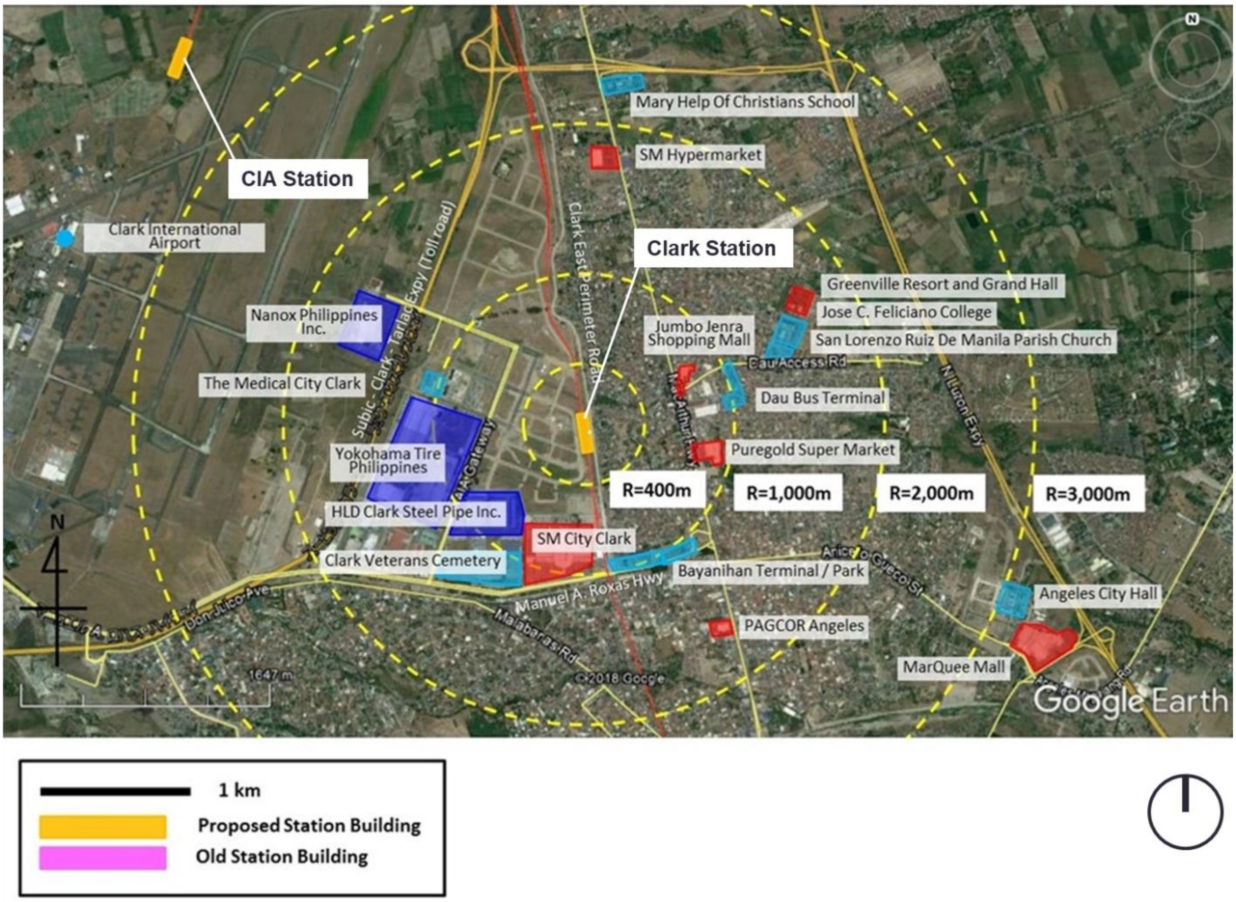
Source: JICA Design Team

Figure 4.4.12 Site Picture Around Angeles Station

(5) Location of Clark Station

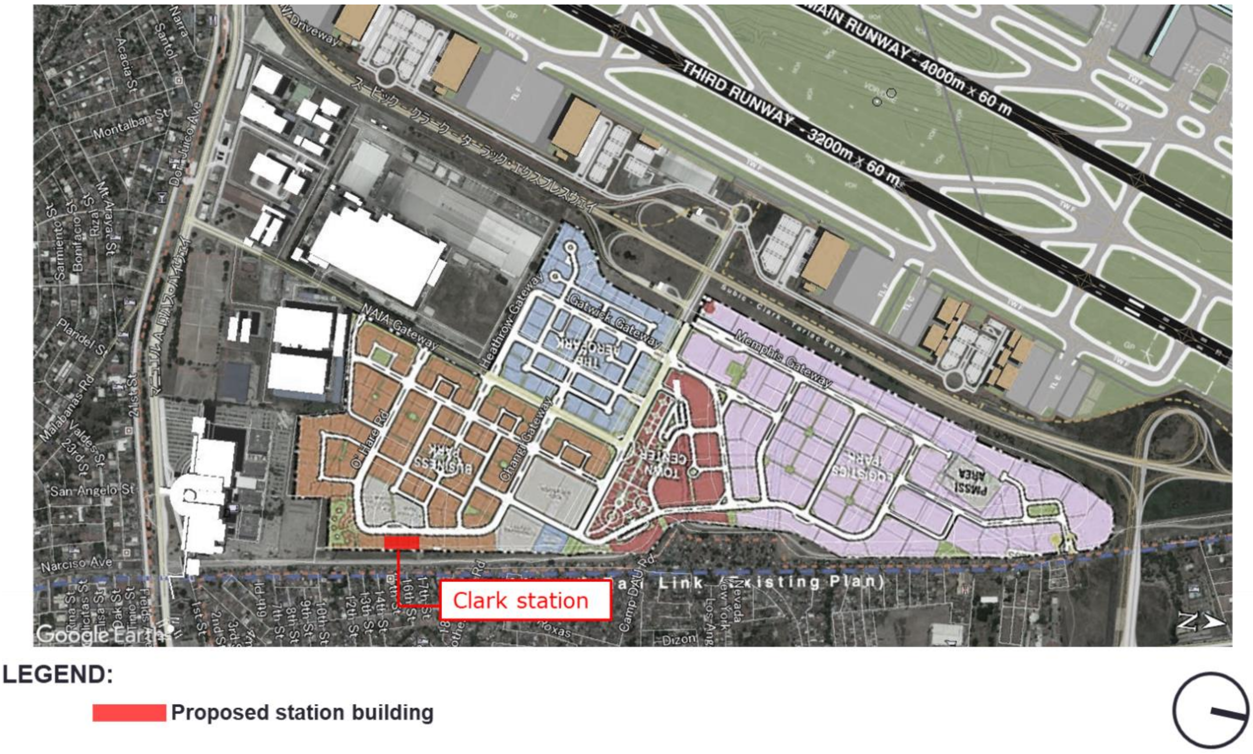
Since Clark station is close to the development area, the connection between the development area and the station should be considered.

JICA Design Team has proposed the location of the station on the basis of the future expansion plans of SM MALL and got the approval from DOTr, finally the location of Clark station was decided.



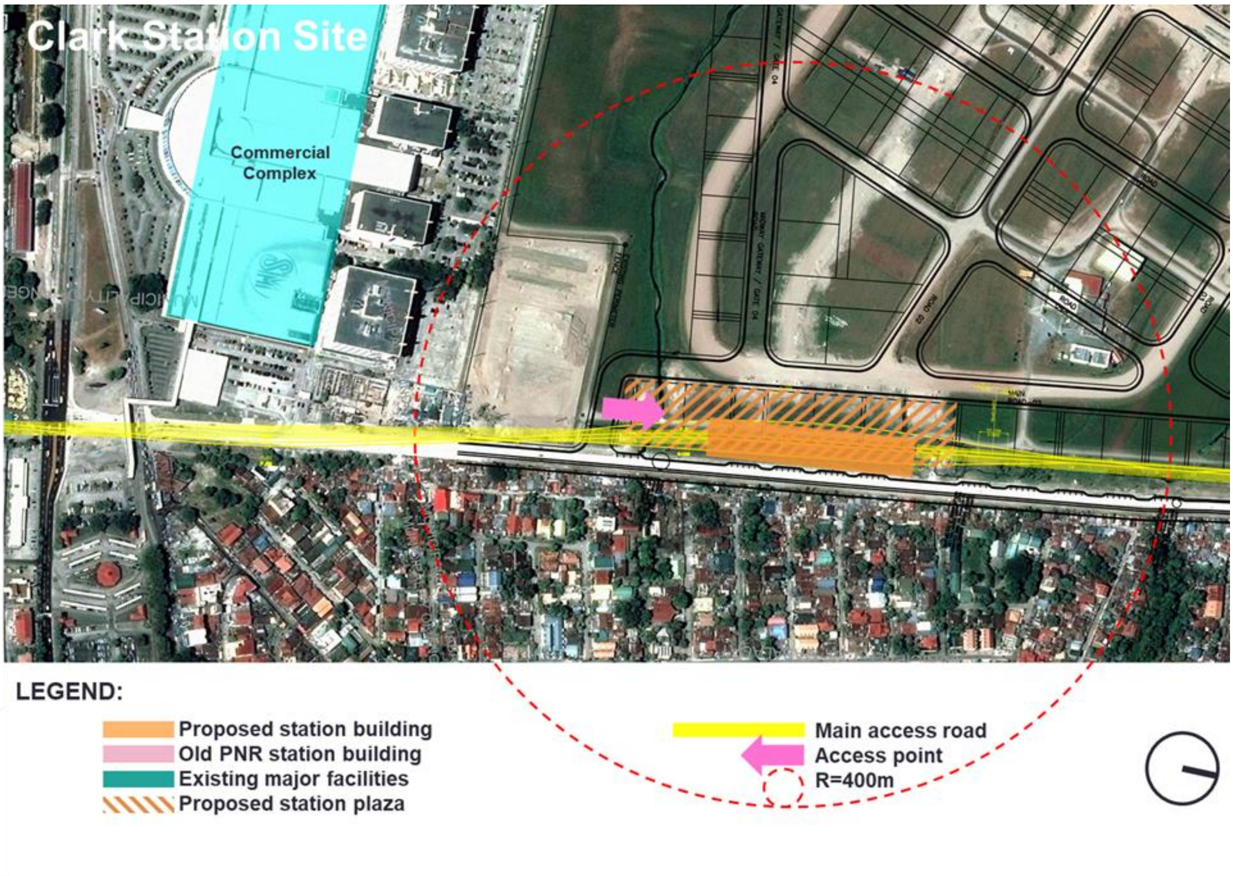
Source: JICA Design Team

Figure 4.4.13 Location of Clark Station



Source: JICA Design Team

Figure 4.4.14 Site Plan of Clark Station



Source: JICA Design Team

Figure 4.4.15 Site Plan of Clark Station

Source: JICA Design Team

Figure 4.4.16 Site Picture Around Clark Station

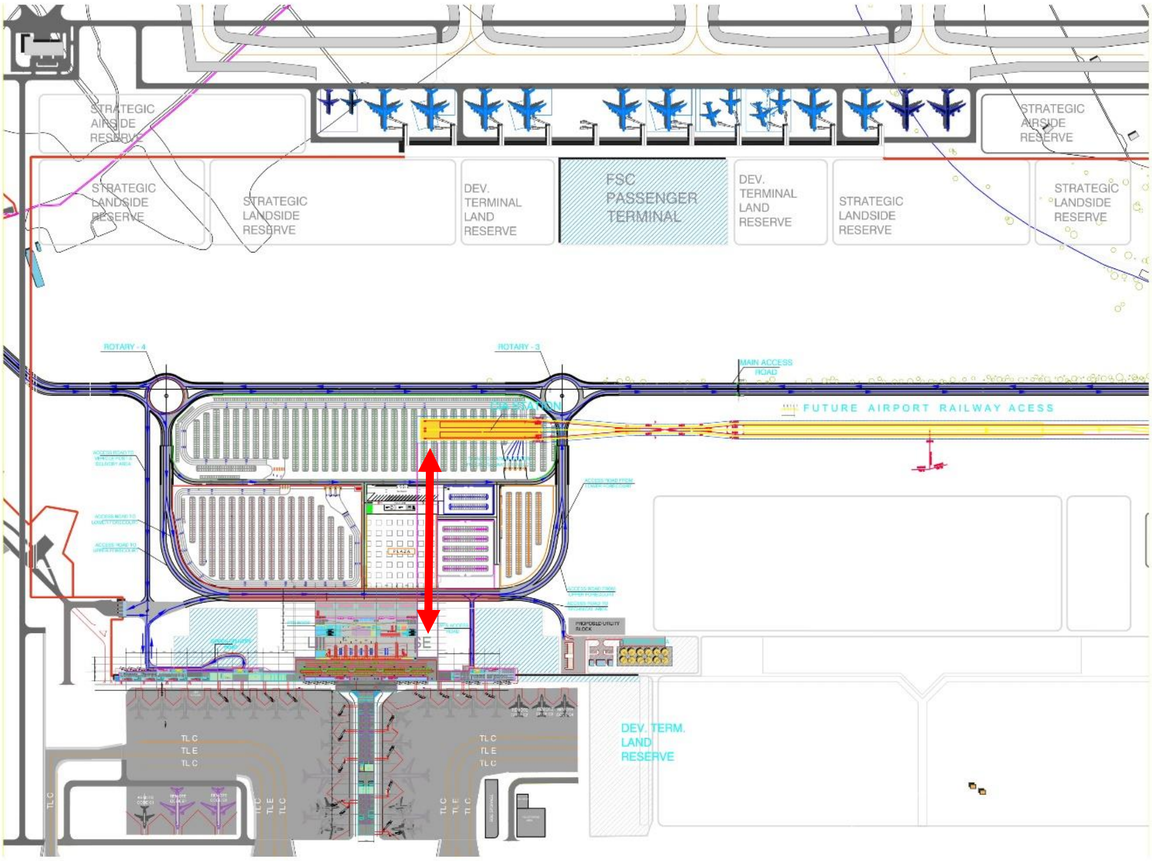
(6) Location of CIA (Clark International Airport) Station

Since CIA station is located at almost equidistance between all airport terminals, the connection between the airport terminals and the station should be considered.

JICA Design Team has proposed the location of the station on the basis of the future expansion plans of Clark International Airport and got the approval from DOTr, finally the location of Clark station was decided.

Source: JICA Design Team

Figure 4.4.17 Location of CIA Station



Source: JICA Design Team

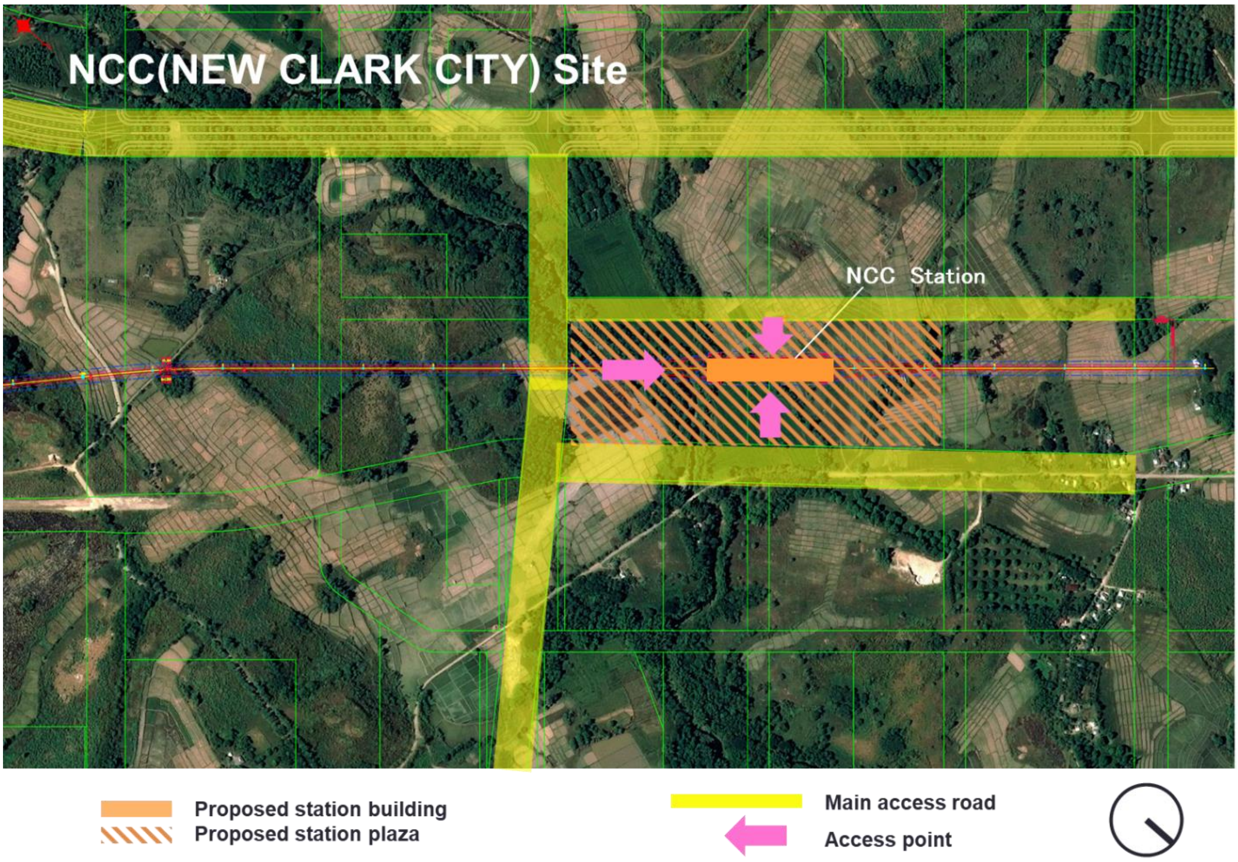
Figure 4.4.18 Sample Site Plan of CIA Station

Source: JICA Design Team

Figure 4.4.19 Site Picture Around Apalit Station

(7) Location of NCC(New Clark City) Station

That matter of NCC is still in discussion with DOTr. That location assumes the following in the Figure 4.4.20.



Source: JICA Design Team

Figure 4.4.20 Sample Site Plan of NCC Station

Source: JICA Design Team

Figure 4.4.21 Site Picture Around NCC Station

4.4.2 Design Policy of the Station

(1) Design Standard of Station Building

The implemented design standards for the design of the station buildings are mostly Philippine standards. However, in certain instances where the local standards are limited or do not consider some relevant aspects of the design, the design follows Japanese standards.

Table 4.4.3 Building Design Standard

Subject	Philippine Laws/ Standards	Japanese Standards
Urban Planning and Environment	• RA7279 - urban development & housing act of 1992 • P.D.s and IRRs (as applicable) e.g. 1586 – environmental impact statement system; 1216 – open spaces; 1151 – environmental policy; 1152 – environmental code; 1067- water code; 957 – subdivisions & condominiums; 953 – tree-planting; 856 – sanitation code; 757 – national housing authority; 296 – clear waterways; • duly-approved local government unit (LGU) Zoning Ordinance (ZO, with official zoning map/ OZM) i.e. based on the duly-approved Comprehensive Land Use Plan (CLUP) • special development-related LGU ordinances, as applicable • environmental laws and regulations e.g. clean air (RA8749), clean water (RA9275), solid waste management (RA9003), toxic waste (RA6969), climate change adaptation (RA9729), disaster risk reduction & management (RA10121), environmental impact assessment, heritage conservation (RA10066); indigenous peoples (RA8371), environmental planning (RA10587), resettlement & socialized housing (BP220), department of environment & natural resources (DENR) department administrative orders (DAOs), • Housing and Land Use Regulatory Board (HLURB) issuances e.g. guidebooks, guidelines, standards, manuals, etc. • Department of public works & highways (DPWH) Design Guidelines, Criteria & Standards (DGCS) Vol. 6 Public Buildings & Other Related Structures 2015 • Department of transportation (DOTr) transportation planning studies	N/A
Building and Space Planning / Barrier-Free Design	• PD1096 - National Building Code of the Philippines (NBCP), its 2004 Revised Implementing Rules and Regulations (IRR) and derivative regulations (DRs), including DPWH issuances such as DAOs and Memorandum Circulars (MCs) • Referral Codes of the NBCP (both laws and self-regulatory documents) such as BP344 - Accessibility Law; the Philippine Electrical Code (PEC), the Mechanical Code, the National Philippine Electrical Code Plumbing Code of the Philippines, DPWH 2000 architectural code of the Philippines (ACP, as applicable) and the like • DPWH DGCS Vol. 6 Public Buildings & Other Related Structures 2015 • DPWH-promulgated 2015 Philippine Green Building Code (PGBC) • Department of Energy (DoE) Guidelines on Energy Conserving Design on Buildings, 2008 • RA6716 - rainwater collection • 2016 NBCP: Illustrated data compact disc (CD)applicable standards by other infrastructure agencies such as the Department of Transportation (DOTr) • applicable DOTr standards • RA386, the 1949 New Civil Code of the Philippines • BP 344 - Accessibility Law and its IRR • RA7277, The Magna Carta for Disabled Persons	• The Building Standard Law of Japan. • Ordinance of the Building Standard Law of Japan • Guideline to Improve Barrier Free Access for Public Transport Passenger Facilities for the Enforcement of 2006 LAW N.19. Edited by Ministerial Ordinance MLITT of Japan

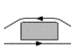
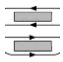
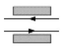
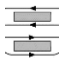
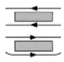
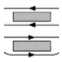
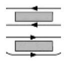
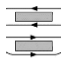
Subject	Philippine Laws/ Standards	Japanese Standards
Fire Protection and Safety Evacuation Design	• PD1096 - National Building Code of the Philippines (NBCP) & 2004 Revised IRR • RA 9514 - Fire Code of the Philippines (FCP) and IRR of 2008 • Philippine Mechanical Engineering Code • Philippine Electrical Code • DPWH DGCS Vol. 6 Public Buildings & Other Related Structures 2015 • Illustrated FCP	• The Building Standard Law of Japan (Ministerial Ordinance, MLITT of Japan) • The Fire Laws of Japan (The Fire Defense Agency of Japan)
Building Material	• 2013 DPWH Standard Specifications • PD1096 - National Building Code of the Philippines (NBCP) & its 2004 Revised IRR • DPWH Bureau of Research & Standards (BRS) certification, if applicable • Dept. of Trade & Industry (DTI) Bureau of Product Standards (BPS) product certification, if applicable • National Structural Code of the Philippines (NSCP) 2015	• Japanese Industrial Standards (JIS)

Source: JICA Design Team

(2) Station Matrix

As of June 2018 the station matrix is as follows:

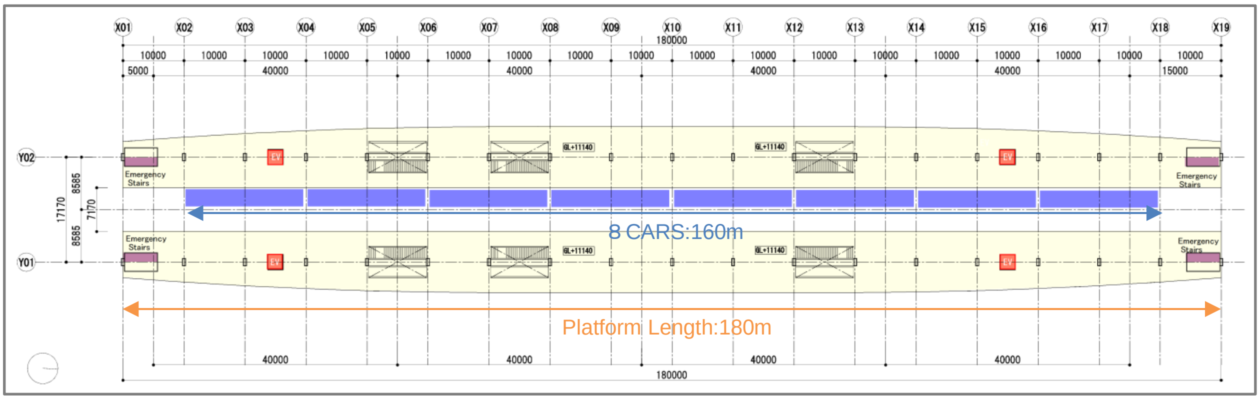
Table 4.4.4 Station Matrix

Station	Malolos	Calumpit	Apalit	San Fernando	Angels	Clark	CIA	NCC
Chainage	34km142m	41km133m	46km438m	58km571m	73km815m	78km579m	85km940m	17km932m
Platform Type.	Island (3 stories)	Island (3 stories)	Outboard (2 stories)	Island (3 stories)	Island (3 stories)	Island (3 stories)	Island (Under Grand)	Island (Under Grand)
Schematic								
Required Minimum Platform heights (Rail Level + 1.09m)		ASL 20.810	ASL 18.28	ASL 19.48	ASL 104.600	ASL 126.415	ASL 117.301	ASL 59.84
	ASL 17.280						ASL 116.790	ASL 60.467
		ASL 19.720	ASL 17.190	ASL 18.390	ASL 103.510	ASL 125.325	ASL 116.211	ASL 58.750
Required Rail Level	ASL 16.190						ASL 115.700	ASL 59.377
Concourse heights	ASL 8.540	ASL 13.270	ASL 6.750	ASL 11.940	ASL 97.060	ASL 118.875	ASL123.511 ASL123.000	ASL66.050 ASL66.477
Current Site Level (High portion / Low portion)	*ASL 7.86*	*ASL 7.39*	*ASL 6.75*	*ASL 7.08*	*ASL 91.46*	*ASL 111.25*	*ASL 136.56*	*ASL 71.08*
	ASL 7.04	*ASL 7.31*	*ASL 5.41*	*ASL 7.00*	*ASL 86.56*	*ASL 109.81*	*ASL 131.55*	*ASL 69.44*
Hight from Current Level to RL (High portion / Low portion)	*8.33 m*	12.33	10.44	11.31	12.05	*14.075*	20.349	12.33
	9.15 m	12.41	11.78	11.39	16.95	*15.515*	15.85	10.06

Source: JICA Design Team

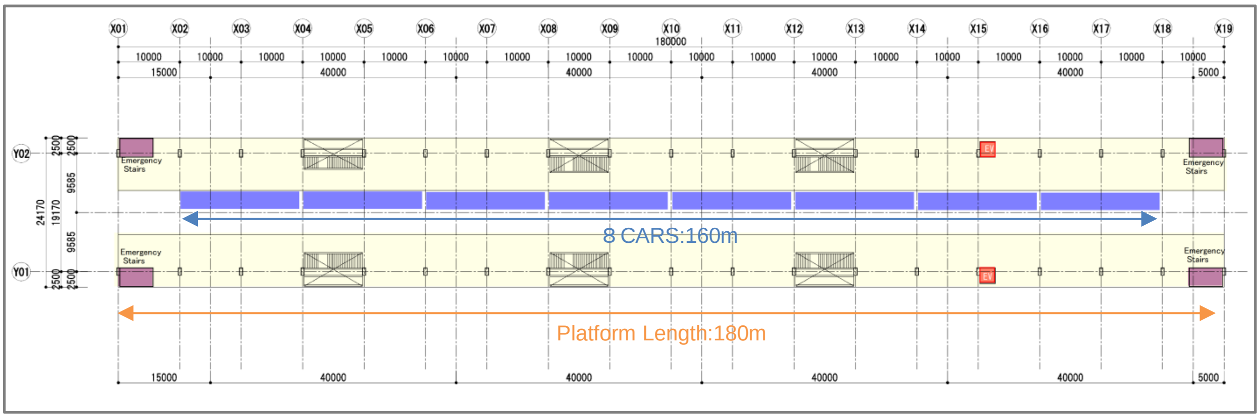
(3) Required Dimension of the Station

The length of the platform is determined by the number of trains (8 car-train) plus an additional 10m of free space at both ends of the platform.



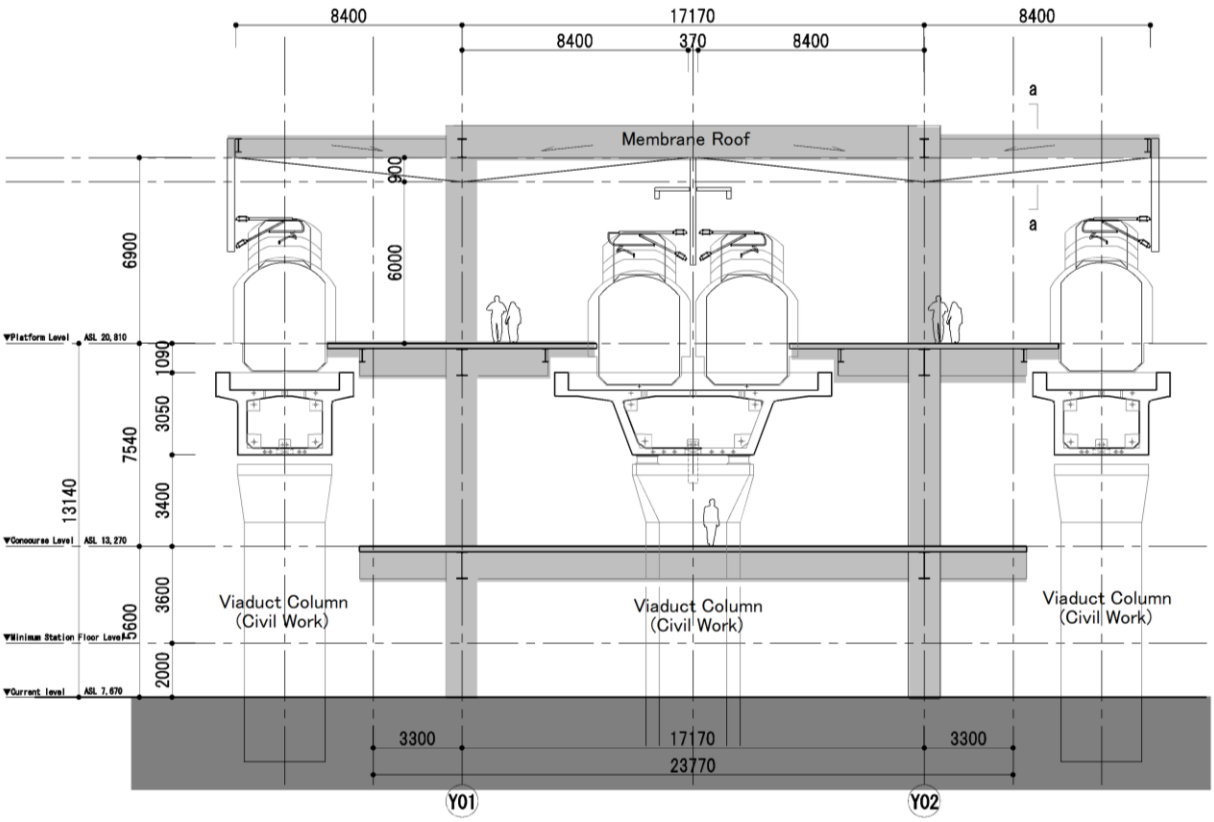
Source: JICA Design Team

Figure 4.4.22 Platform Plan (Island Type)



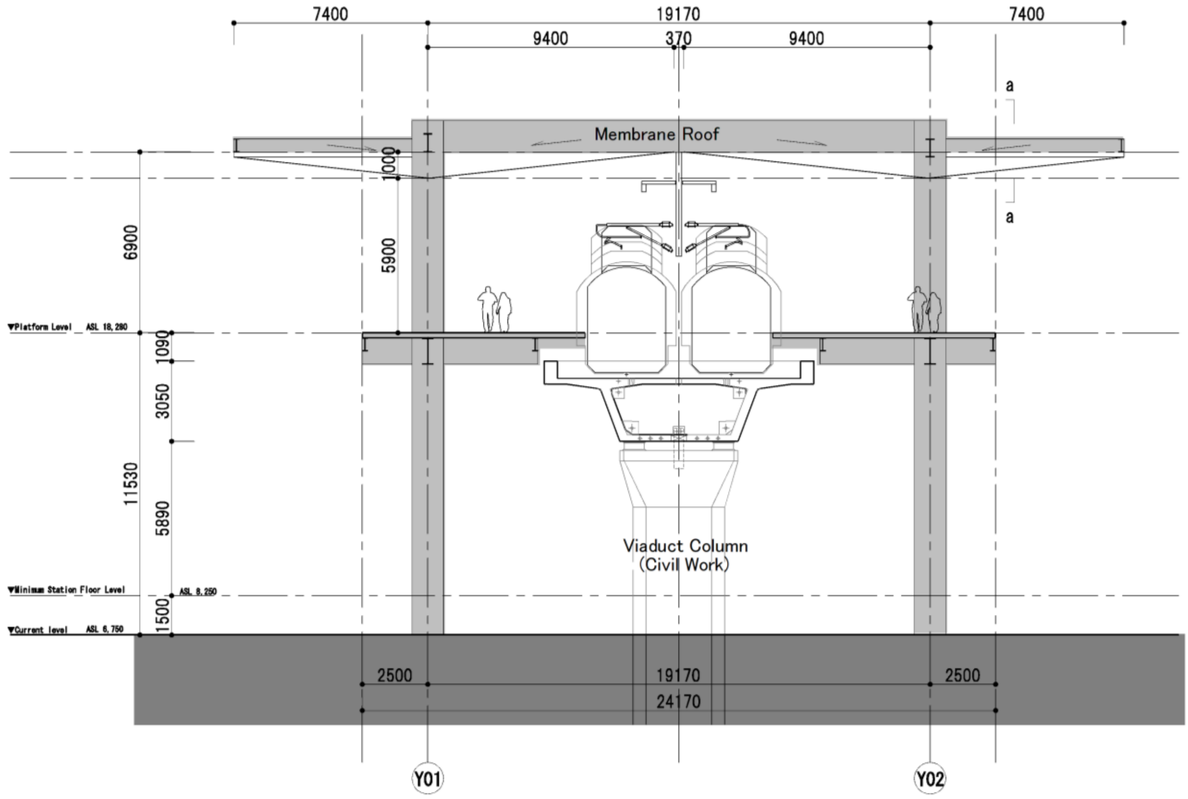
Source: JICA Design Team

Figure 4.4.23 Platform Plan (Outboard Type)



Source: JICA Design Team

Figure 4.4.24 Station Cross Section (Island- Type Platform)



Source: JICA Design Team

Figure 4.4.25 Station Cross Section (Outboard- Type Platform)

(4) The Necessary Rooms and Number of Equipment

1) The Necessary Rooms

The necessary rooms in the station, including the back support room, are shown in Table 4.4.5.

Table 4.4.5 The Necessary Rooms

Rooms	Floor Area(㎡)	Calumpit	Apalit	San Fefnando	Angels	Clark	CIA	NCC
SER (Signalling Equipment Room)	100	●	●	●	●	●	●	
SUR (Signalling UPS Room)	50	●	●	●	●	●	●	
Telecommunication Equipment Room	50	●	●	●	●	●	●	
Telecommunication UPS Room	45	●	●	●	●	●	●	
Male Driver's Room	9㎡/person	–	–	–	–	–	3persons	1Person
Male Toilet (Driver's Room)	9	–	–	–	–	–	●	●
Female Driver's Room	9㎡/person	–	–	–	–	–	3persons	1Person
Female Toilet (Driver's Room)	9	–	–	–	–	–	●	●
Common Room	30	–	–	–	–	–	●	●
Driver's waiting Room	5㎡/person	–	–	–	–	–	15persons	6persons
Customer Service		●	●	●	●	●	●	●
Training Room	2.5㎡/person	20persons	–	40persons	–	–	20persons	–
Maintenance office	150㎡/person	30persons	–	60persons	–	–	30persons	–
Station Office	200	●	●	●	●	●	●	
AFC Room (Auto Fare Correction)（1 or more)	30	●	●	●	●	●	●	
AFC UPS Room	20	●	●	●	●	●	●	
STAFF Room（or Pantry/Locker)（休憩室としての)	2.5㎡/person +15	8persons (39lockers)	8persons (39lockers)	9persons (42lockers)	8persons (39lockers)	10persons (47lockers)	20persons (96lockers)	11persons (50lockers)
Staff Room Toilet, Male	8	28persons	13persons	44persons	13persons	15persons	43persons	16persons
Staff Room Toilet, Female	8	28persons	13persons	43persons	13persons	15persons	42persons	15persons
Station Manager's Room	30	1person	1person	1person	1person	1person	1person	1person
Platform Supervisor Booth	N/A							
Domestic Water Tank Room	100	●	●	●	●	●	●	
Fire Water Tank Room	100	●	●	●	●	●	●	
Blower Room for Wastewater Treatment	12	●	●	●	●	●	●	
Railway Electrical Room	100	●	●	●	●	●	●	
Station Elctrical Room	100	●	●	●	●	●	●	
Distribution Board Room	25	●	●	●	●	●	●	
EPS Room 1&2 (&3&4)		●	●	●	●	●	●	
First Aid Room	20	●	●	●	●	●	●	
PWD Toilet	9	●	●	●	●	●	●	
Male Public Toilet	40	●	●	●	●	●	●	
Female Public Toilet	40	●	●	●	●	●	●	
Janitorial Storage	30	●	●	●	●	●	●	●
Security Room	10	(12 lockers)	(12 lockers)	(12 lockers)	(12 lockers)	(12 lockers)	(12 lockers)	(12 lockers)
Breastfeeding Room	9	●	●	●	●	●	●	
Baby Changing Room	9	●	●	●	●	●	●	
Storage	not necessary	●	–	●	–	–	●	–
Elevator Shaft		●	●	●	●	●	●	
Paid Concourse		●	●	●	●	●	●	
Unpaid Concourse		●	●	●	●	●	●	
Platform		●	●	●	●	●	●	
Cleaner Waiting Room	100	–	–	–	–	–	●	–
Machine Room	2000	–	–	–	–	–	●	
Tunnel Ventilation Room	800	–	–	–	–	–	●	
Waste Water Pump Room	25	–	–	–	–	–	●	
Sepitic Tank Room	25	–	–	–	–	–	●	
Generator Room	100	–	–	–	–	–	●	

Source: JICA Design Team

2) The Number of Equipment

The Number of AFC Equipment is calculated from the demand forecast of each station under the following conditions:

- One tenth of daily data is regarded as peak hour data (the sum of entries and exits).
- 100% Peak hour data as Entry, and 75% as Exit.
- This is estimated based on the daily data in 2040.

To plan the number of more than numerical value in the table below, taking into account the future of the increased use.

Table 4.4.6 Number of AFC Equipment

	2040									2040
	Peak hour / x 0.06 (0.5x0.12)	Peak hour Entry (100%)	Peak hour Exit (75%)	Entry Gate	Exit Gate	Total	Gate Total (+2)	TVM	ENTPOS	EXITPOS
NCC	8,175	8,175	6,131	4	7	11	13	12	5	1
CIA	847	847	635	1	1	2	4	3	2	1
Clark	6,711	6,711	5,033	4	6	10	12	10	4	1
Angeles	2,143	2,143	1,607	2	2	4	6	5	2	1
San Fernando	2,808	2,808	2,106	2	3	5	7	6	3	1
Apalit	1,582	1,582	1,187	1	2	3	5	4	2	1
Calunpit	1,736	1,736	1,302	1	2	3	5	5	2	1

Source: JICA Design Team

The Number of toilets at commuting railway station is calculated from the demand forecast of each station under the following calculation in the table below, based on the guideline of JRTT.

JRTT: Japan Railway Construction, Transport and Technology Agency

Table 4.4.7 The Rationale Calculation Table

Male Urinal	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Female WC	2	3	4	5	6	7	8							
Male WC	2	3	4	5										
The number of all passengers par one day	10	15	20	25	(Ten thousand people)									

Source: JICA Design Team

To plan the number of more than numerical value in the table below, taking into account the future of the increased use.

Table 4.4.8 Number of Toilets

Station Name	Calumpit	Apalit	San Fernando	Angeles	Clark	CIA	NCC
MALE URINAL	5	5	6	5	11	4	11
FEMALE WC	3	3	4	3	6	3	6
MALE WC	2	2	3	2	4	2	4

Source: JICA Design Team

4.4.3 Basic Architectural Design of Station

(1) Architectural Design of Station Building

Considering the station matrix shown in the above Table 4.4.4 and the characteristics of each station, such as the location, access, environment and other relevant factors, the JICA Design Team designed the stations as schematic picture showed on Figure 4.4.26, Figure 4.4.27, Figure 4.4.28, Figure 4.4.29.

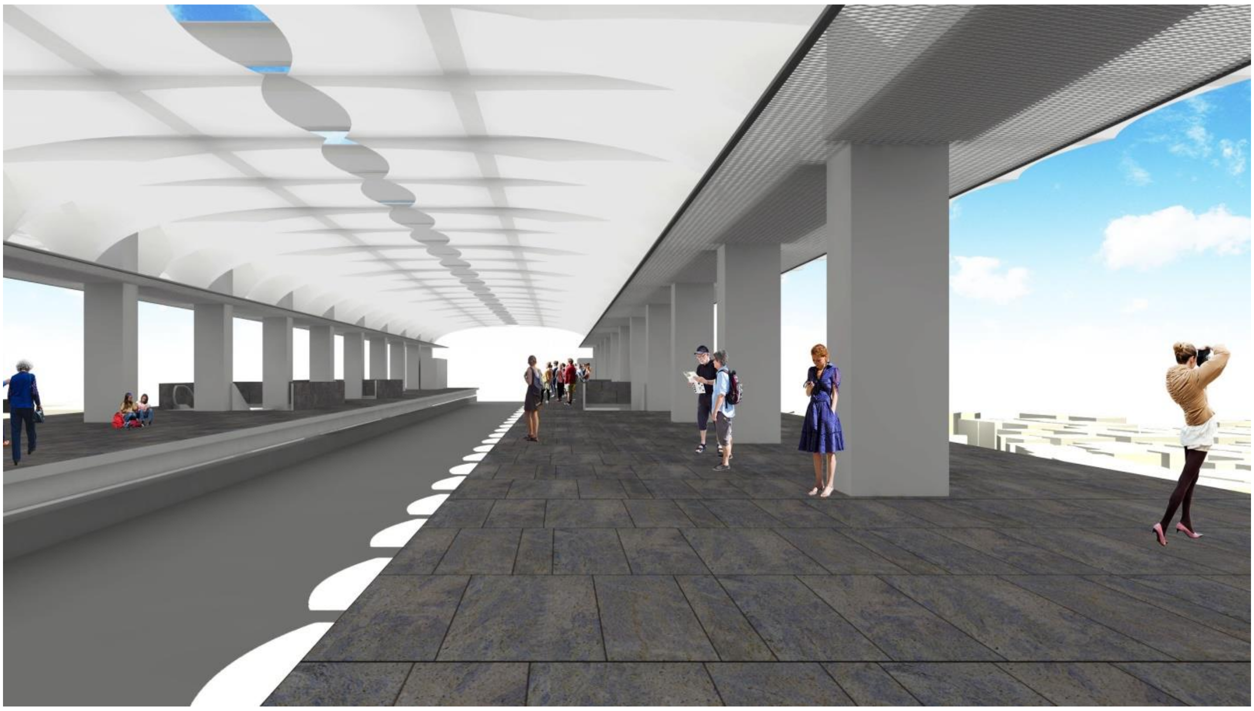
Note: These images might be different from the actual images.

Source: JICA Design Team

Figure 4.4.26 Schematic Exterior View of Station Building-1

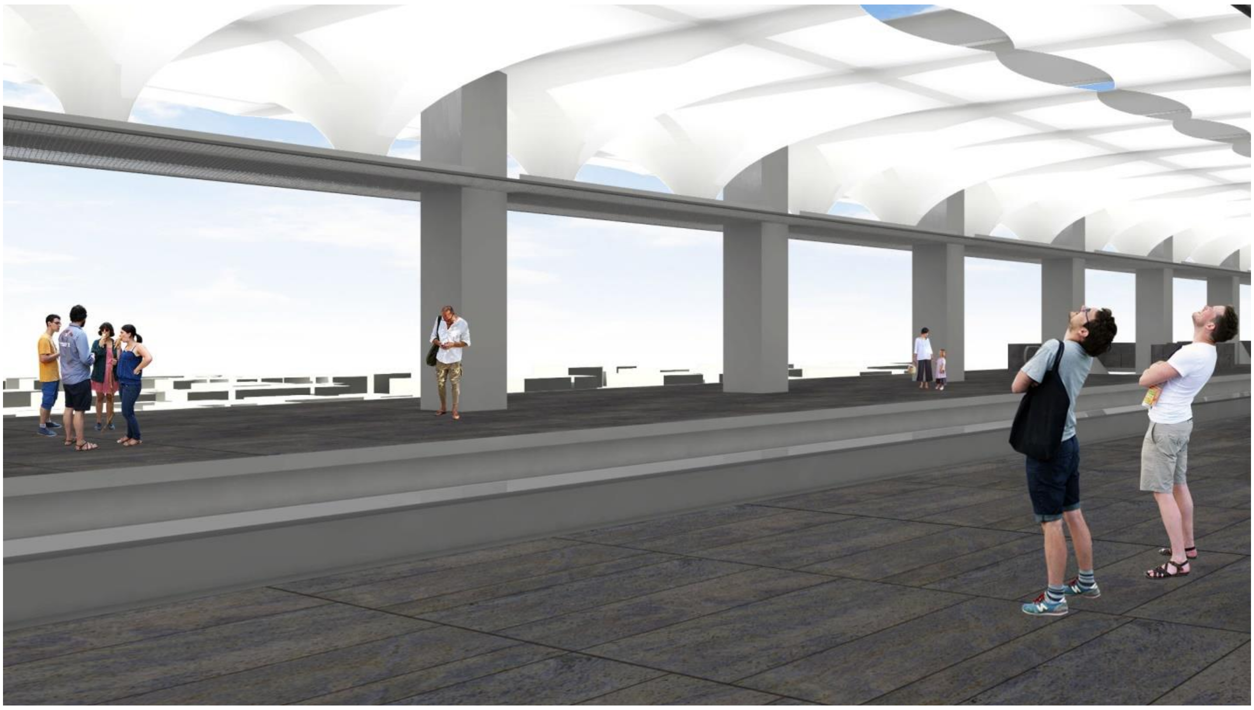
Source: JICA Design Team

Figure 4.4.27 Chematic Exterior View of Station Building-2



Source: JICA Design Team

Figure 4.4.28 Schematic Interior View of Station Building-1



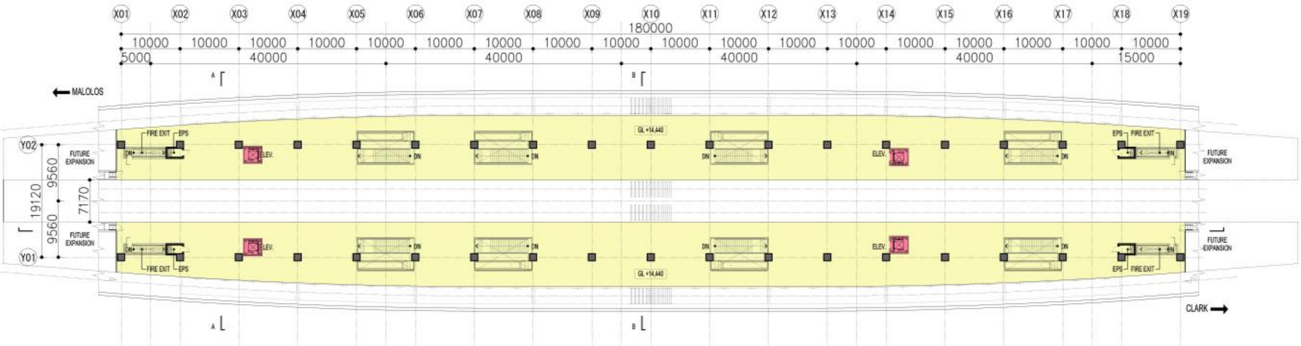
Source: JICA Design Team

Figure 4.4.29 Schematic Interior View of Station Building-2

(2) Station Plans and Sections

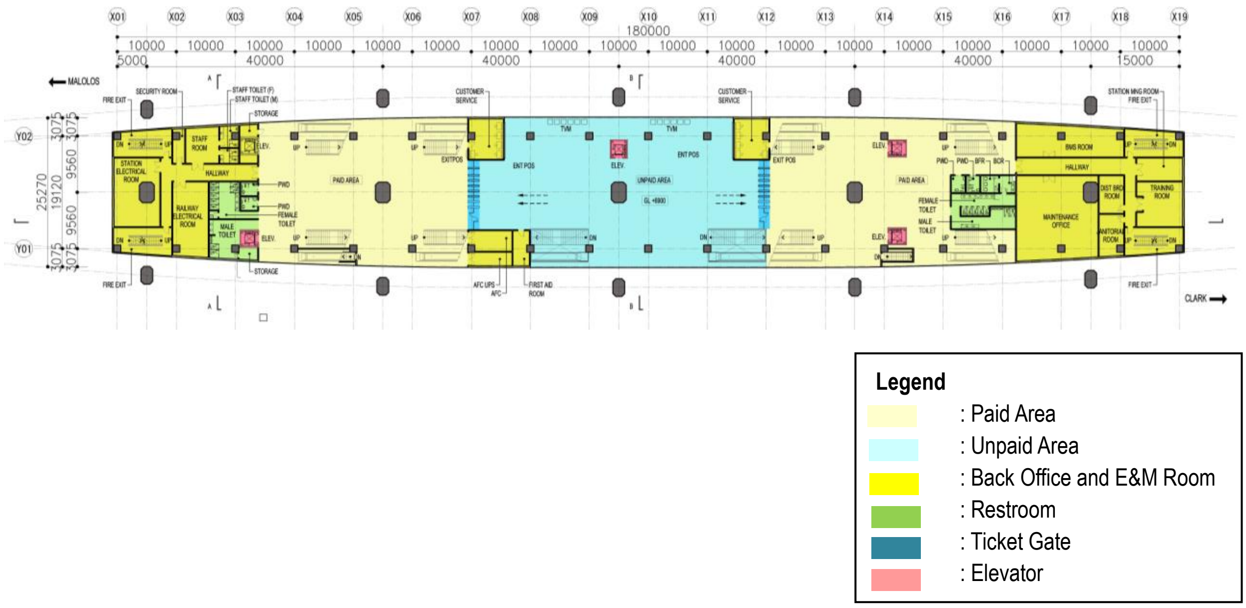
The layout of each station has been designed according to the type, characteristics and size of the station. The details of each station layout are explained below.

1) Calumpit Station (2 island-type platforms 4tracks, 3-layer elevated station, 2 ticket gates)



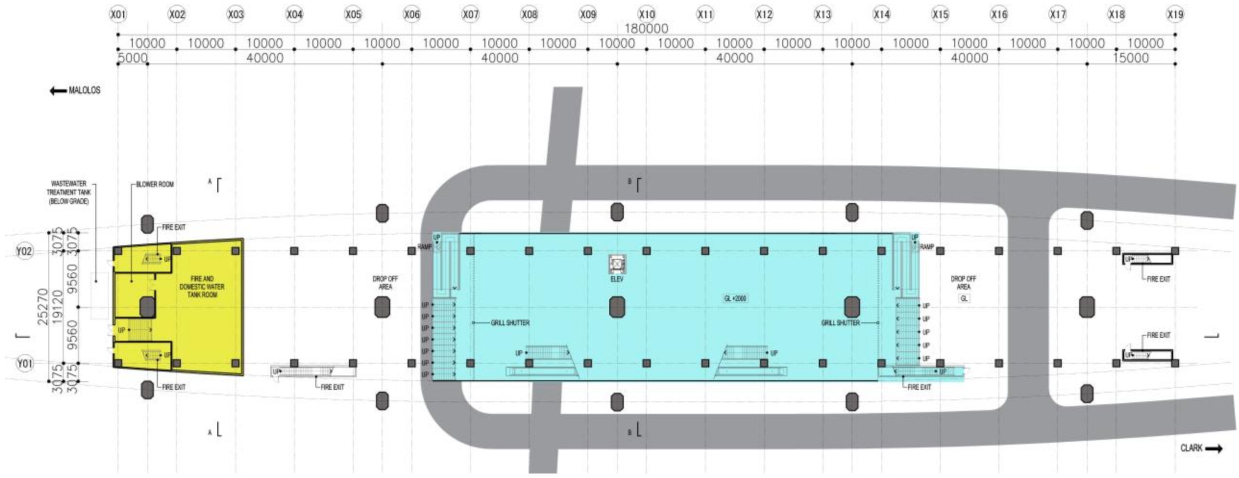
Source: JICA Design Team

Figure 4.4.30 Calumpit Station Platform Level Plan



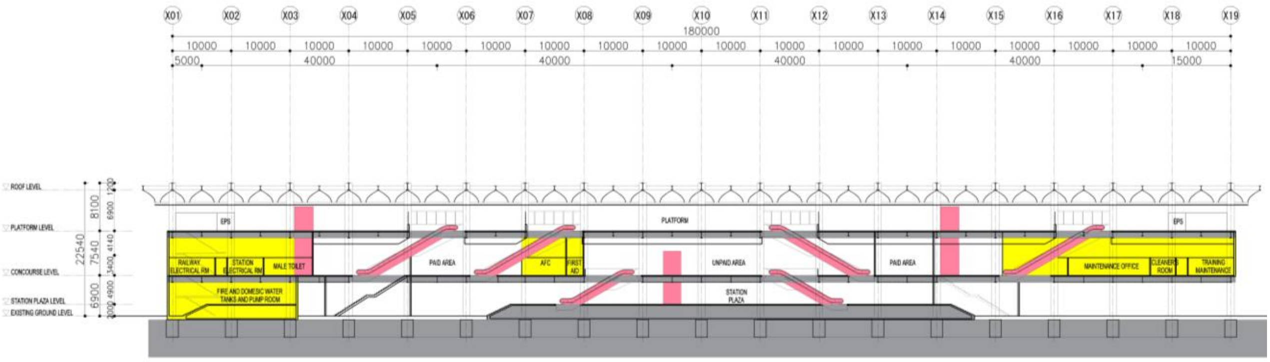
Source: JICA Design Team

Figure 4.4.31 Calumpit Station Concourse Level Plan



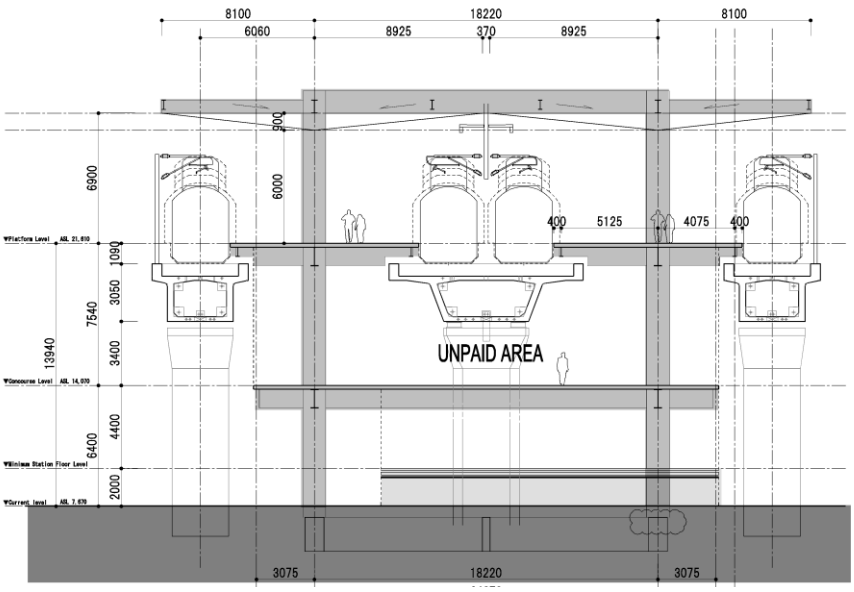
Source: JICA Design Team

Figure 4.4.32 Calumpit Station Ground Level Plan



Source: JICA Design Team

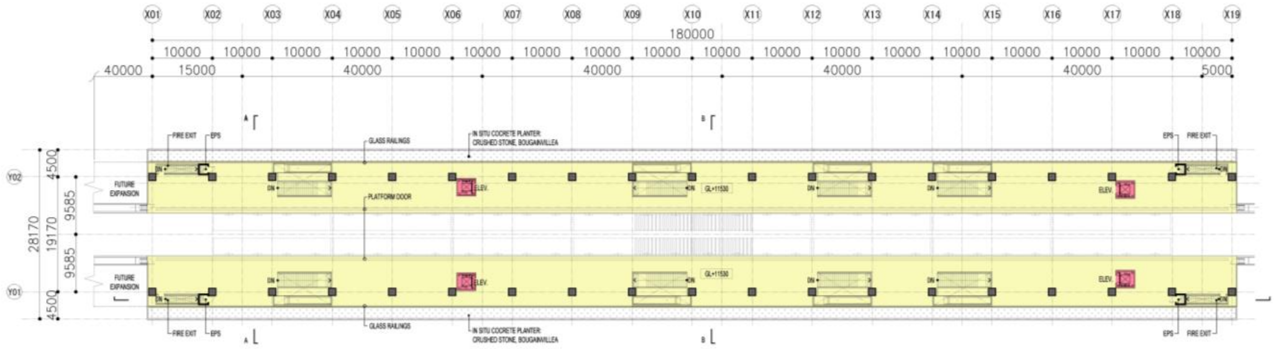
Figure 4.4.33 Calumpit Station Longitudinal Section



Source: JICA Design Team

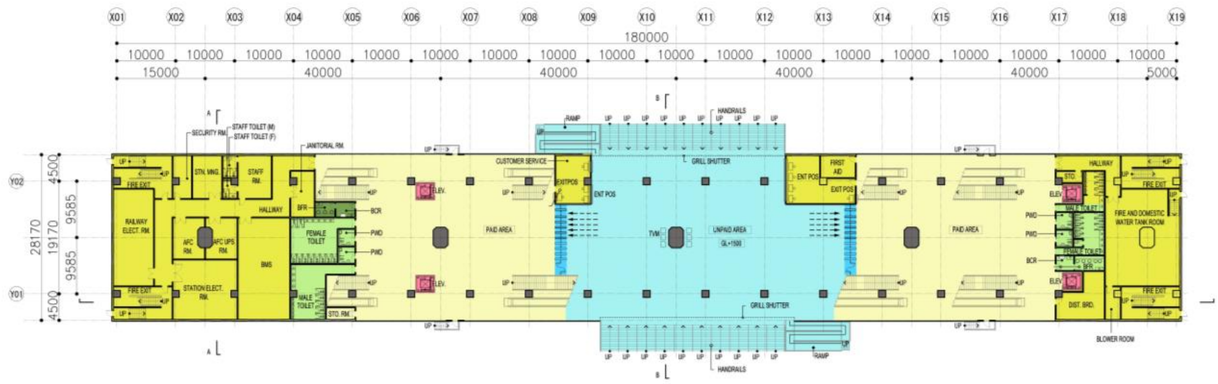
Figure 4.4.34 Calumpit Station Cross Section

2) Apalit Station (2 outboard-type platforms 2tracks, 2-layer elevated station, 2 ticket gates)



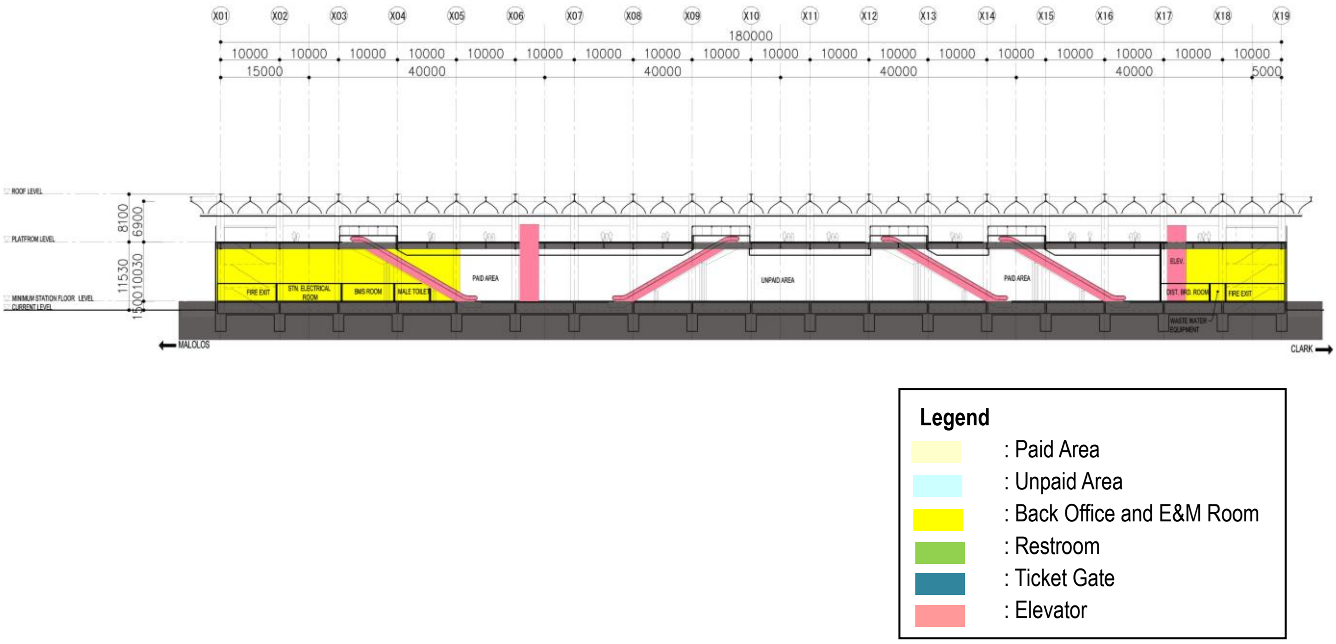
Source: JICA Design Team

Figure 4.4.35 Apalit Station Platform Level Plan



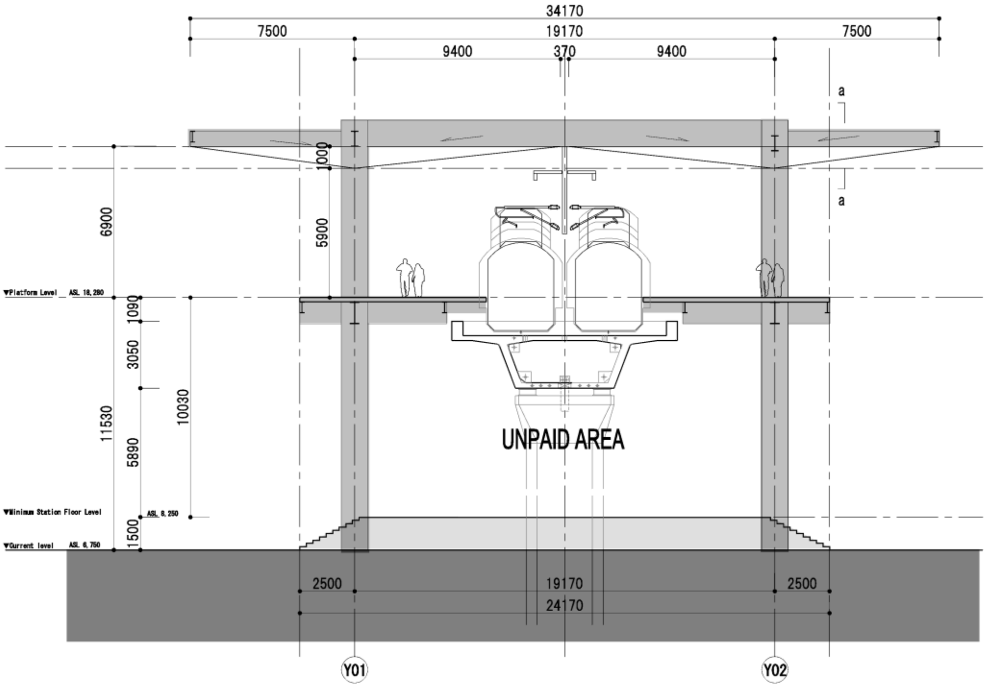
Source: JICA Design Team

Figure 4.4.36 Apalit Station Ground Level Plan



Source: JICA Design Team

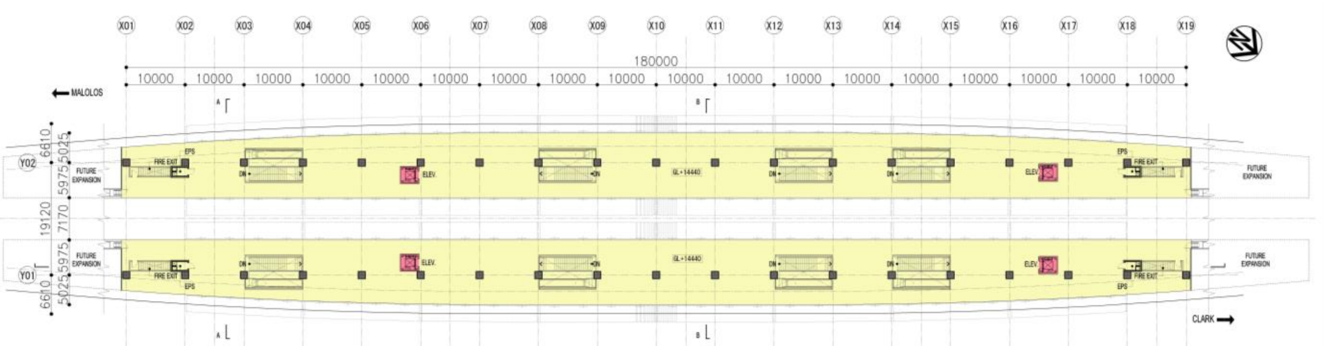
Figure 4.4.37 Apalit Station Longitudinal Section



Source: JICA Design Team

Figure 4.4.38   Apalit Station Cross Section

3) San Fernando Station (2 island-type platforms 4tracks, 3-layer elevated station, 2 ticket gate)

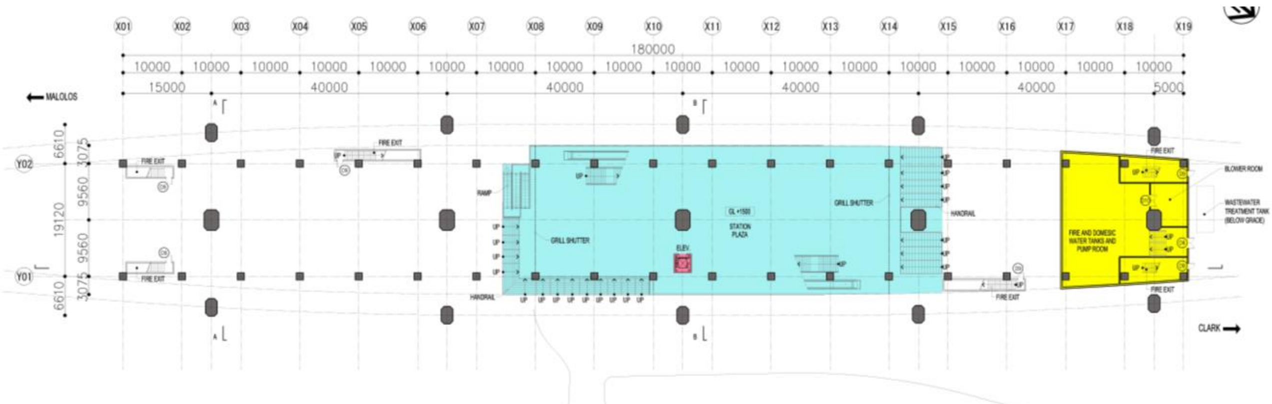


Source: JICA Design Team

Figure 4.4.39 San Fernando Station Platform Level Plan

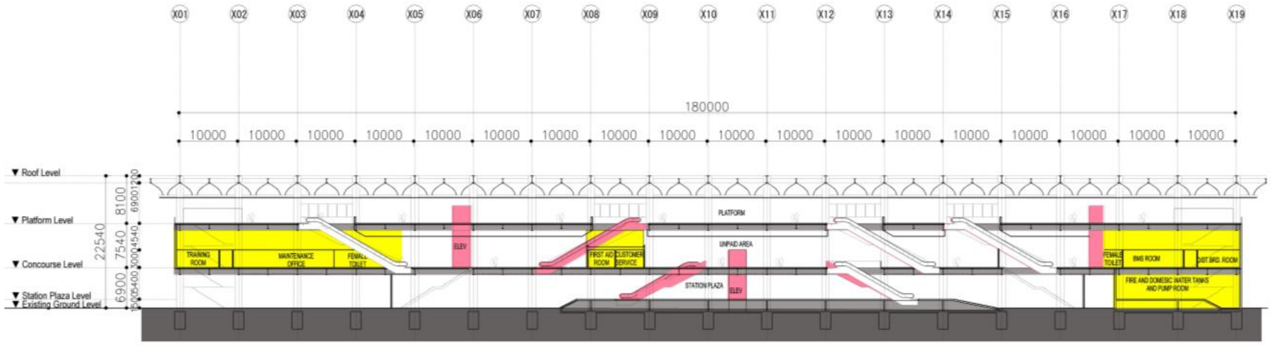
Source: JICA Design Team

Figure 4.4.40 San Fernando Station Concourse Level Plan



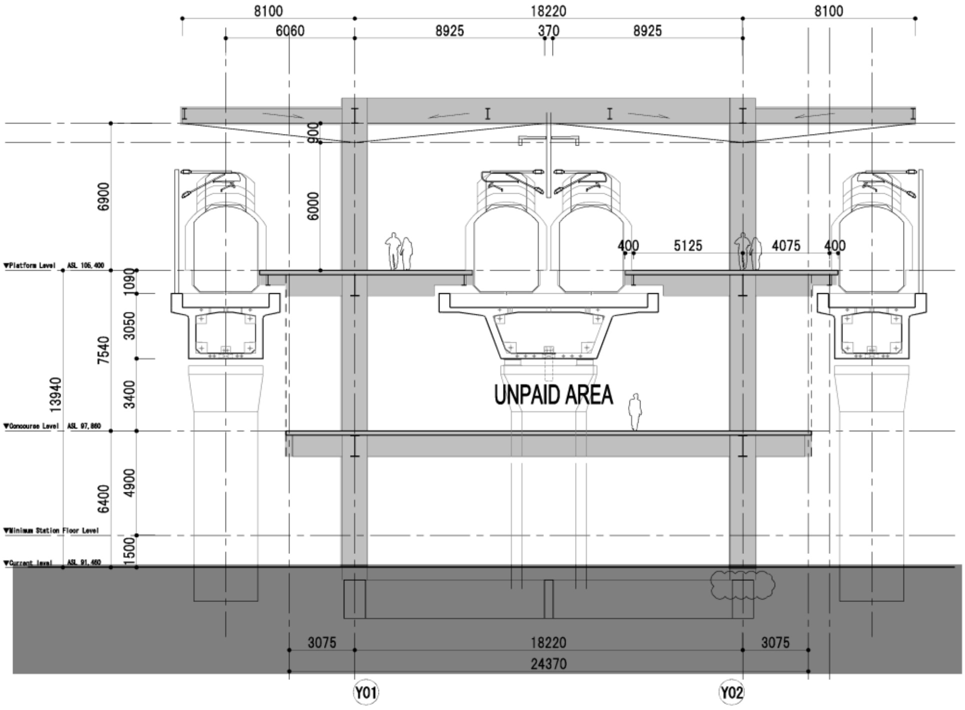
Source: JICA Design Team

Figure 4.4.41 San Fernando Station Ground Level Plan



Source: JICA Design Team

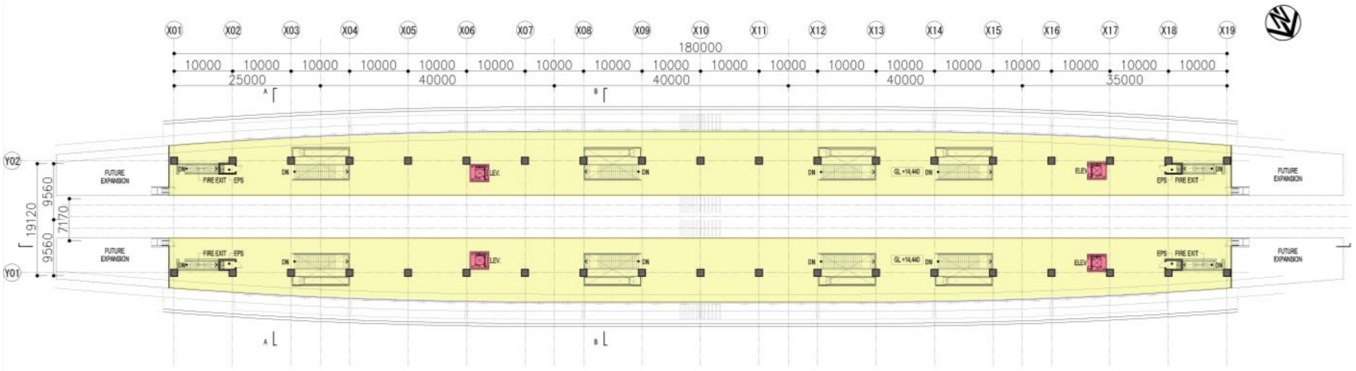
Figure 4.4.42 San Fernando Station Longitudinal Section



Source: JICA Design Team

Figure 4.4.43 San Fernando Station Cross Section

4) Angeles Station (2 island-type platforms 4tracks, 3-layer elevated station, 2 ticket gates)

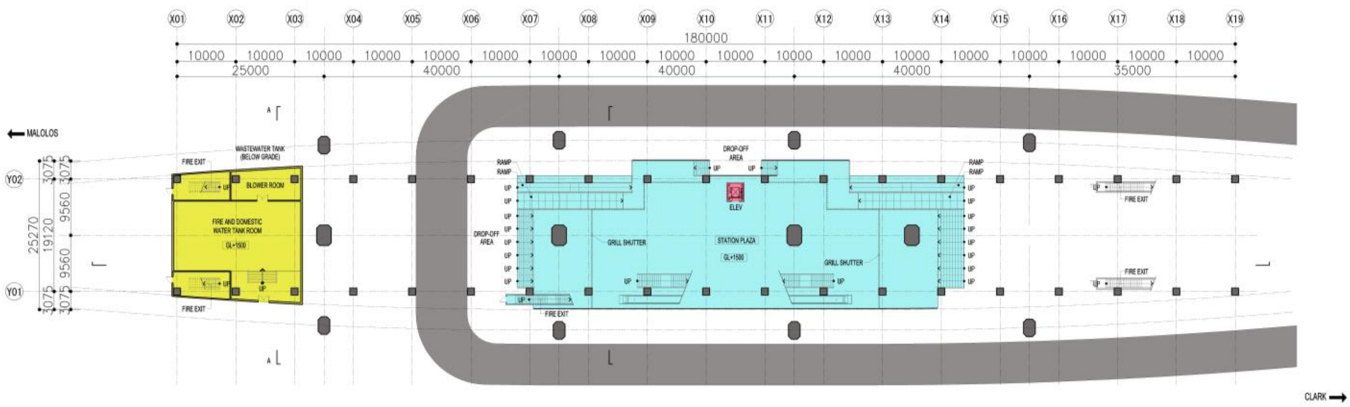


Source: JICA Design Team

Figure 4.4.44 Angeles Station Platform Level Plan

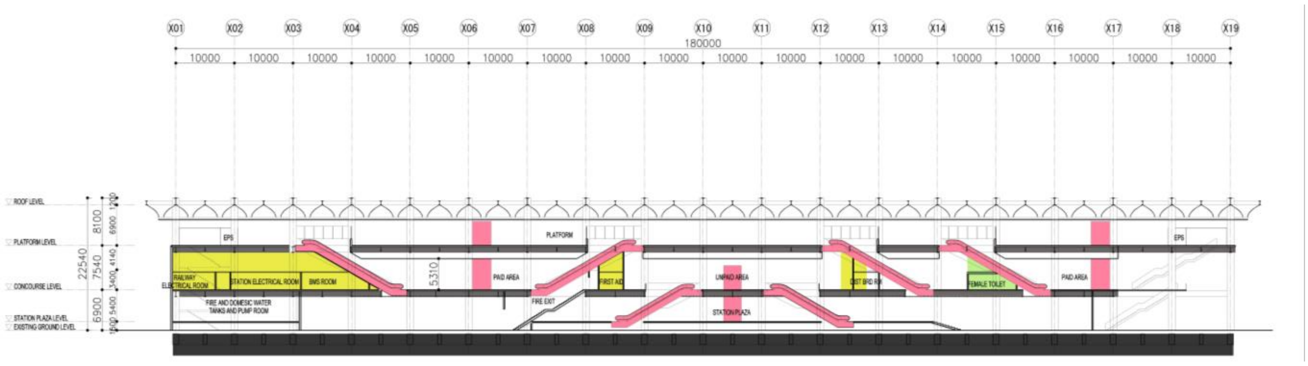
Source: JICA Design Team

Figure 4.4.45 Angeles Station Concourse Level Plan



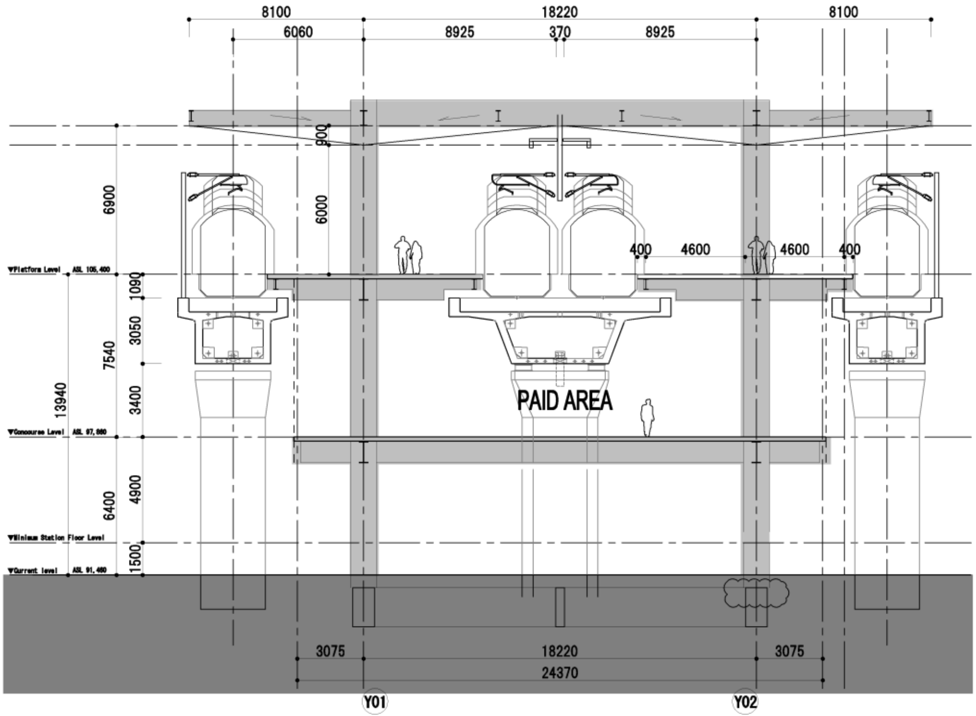
Source: JICA Design Team

Figure 4.4.46 Angeles Station Ground Level Plan



Source: JICA Design Team

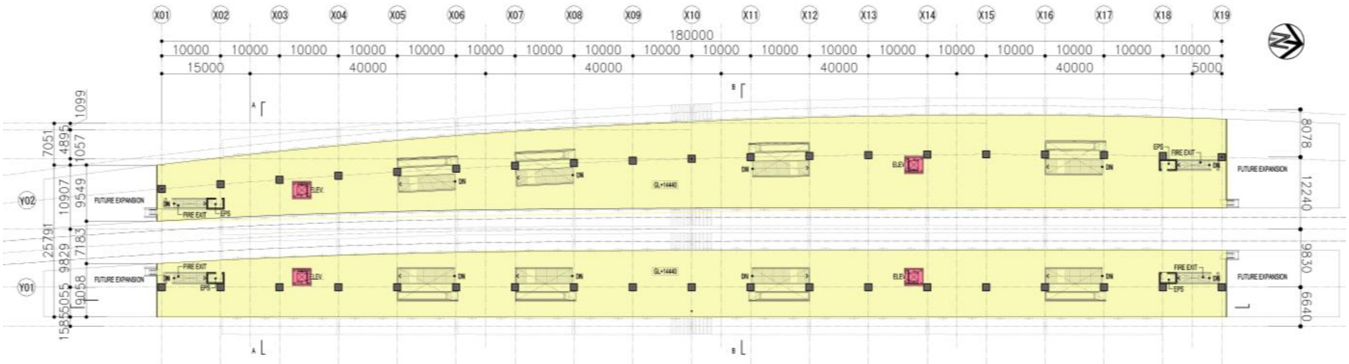
Figure 4.4.47 Angeles Station Longitudinal Section



Source: JICA Design Team

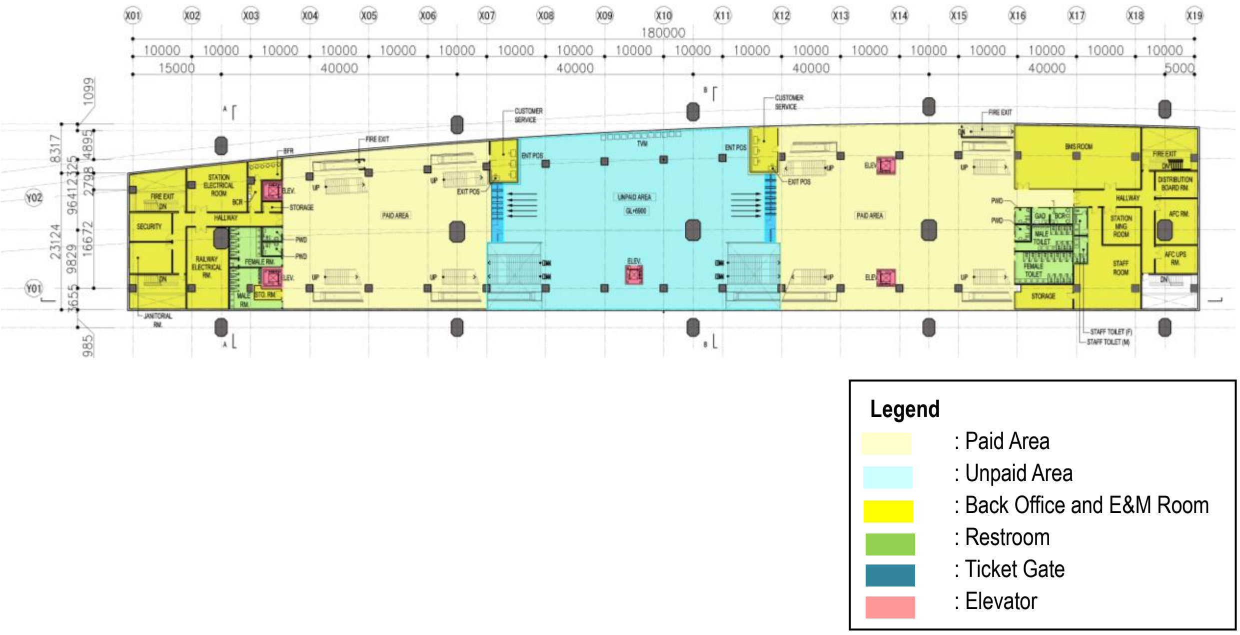
Figure 4.4.48 Angeles Station Cross Section

5) Clark Station (2 island-type platforms 4tracks, 3-layer elevated station, 2 ticket gates)



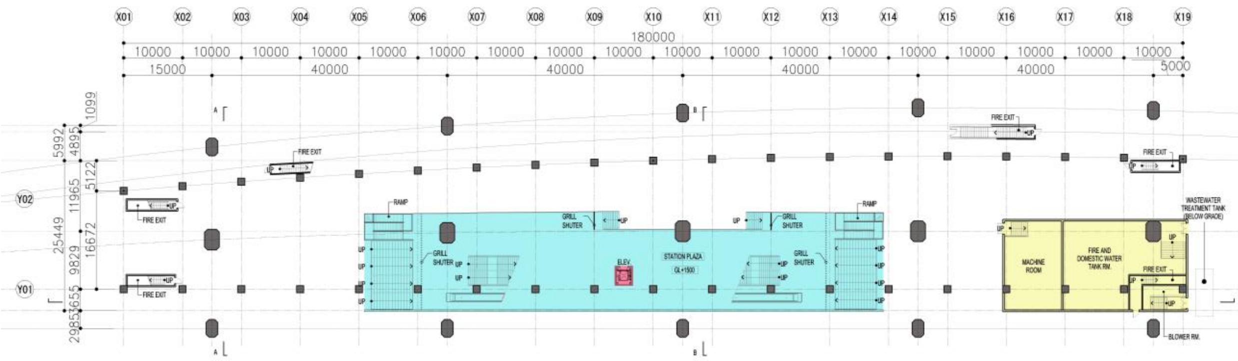
Source: JICA Design Team

Figure 4.4.49 Clark Station Platform Level Plan



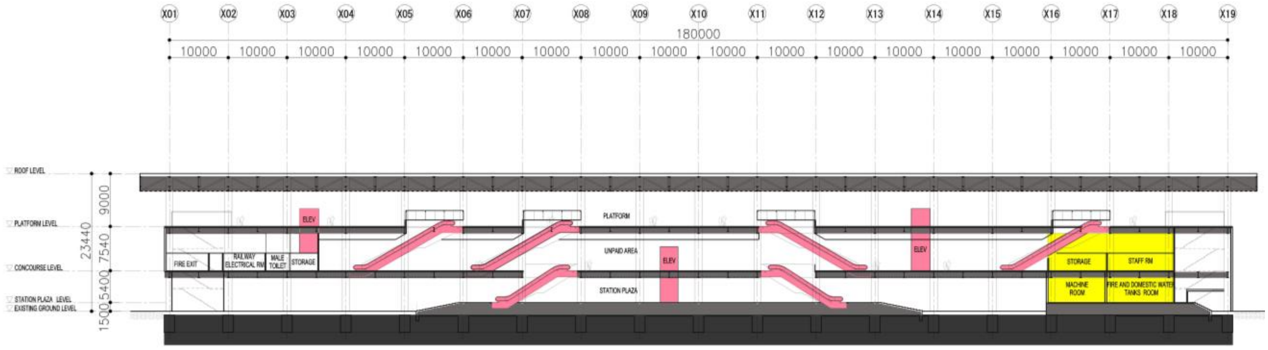
Source: JICA Design Team

Figure 4.4.50 Clark Station Concourse Level Plan



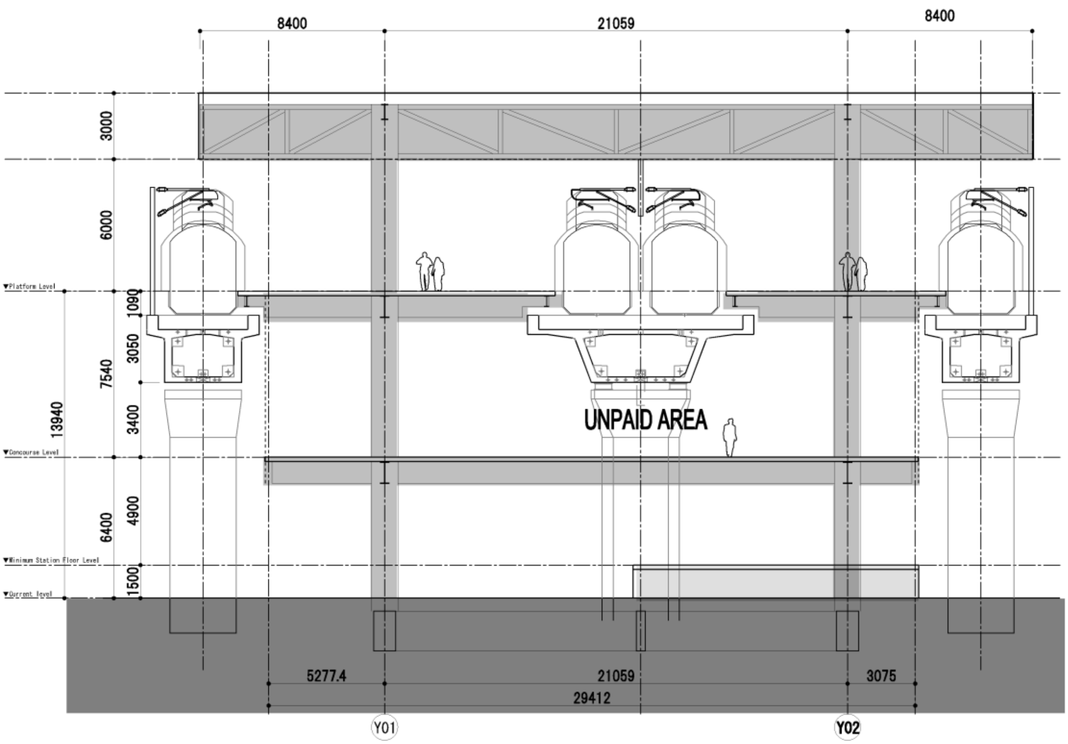
Source: JICA Design Team

Figure 4.4.51 Clark Station Ground Level Plan



Source: JICA Design Team

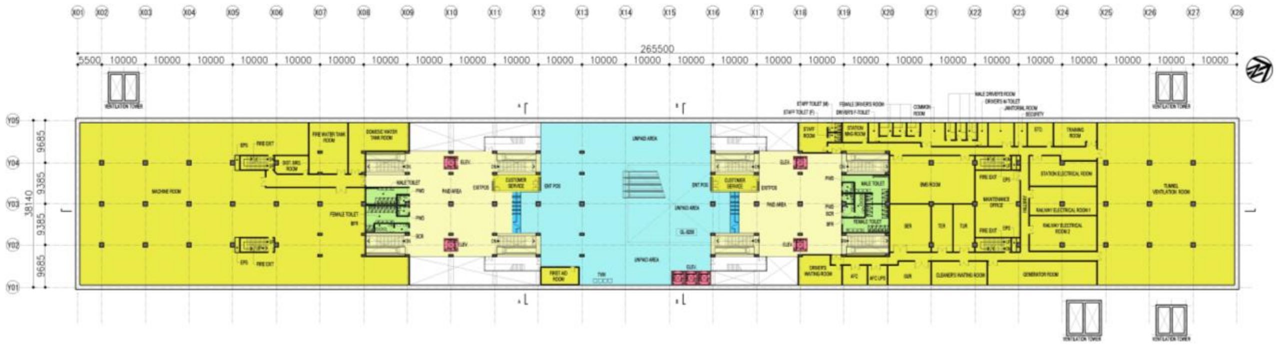
Figure 4.4.52 Clark Station Longitudinal Section



Source: JICA Design Team

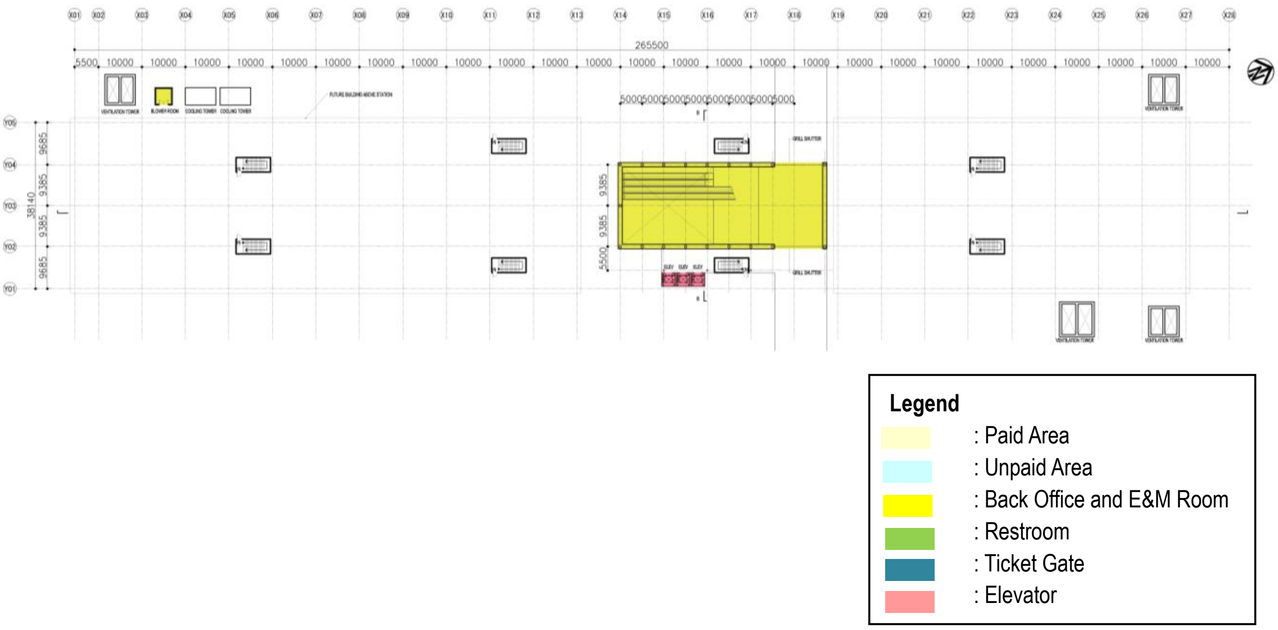
Figure 4.4.53 Clark Station Cross Section

6) CIA Station (2 island-type platforms 4tracks, 3-layer over-track station, 1 ticket gates)



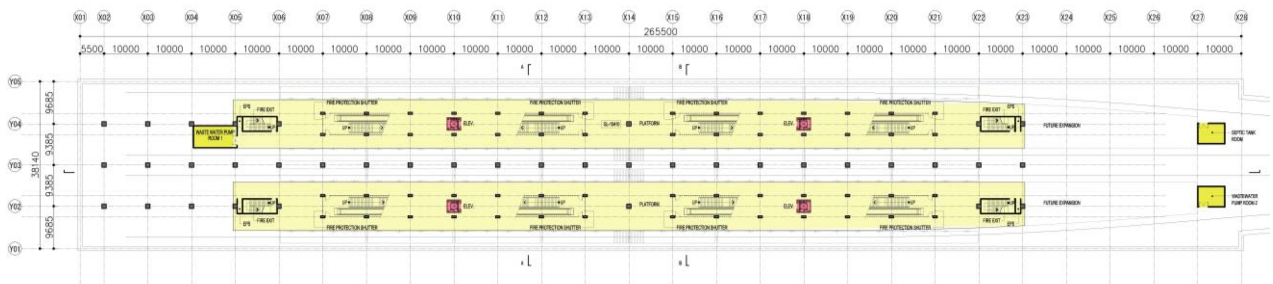
Source: JICA Design Team

Figure 4.4.54 CIA Station Concourse Level Plan



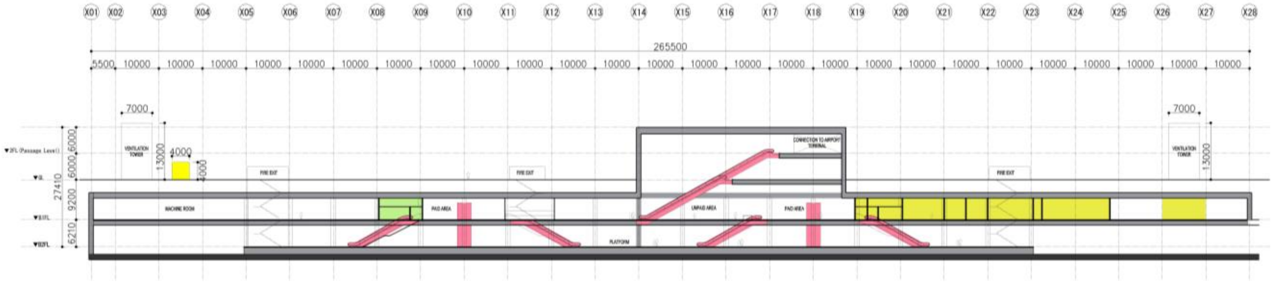
Source: JICA Design Team

Figure 4.4.55 CIA Station Ground Level Plan



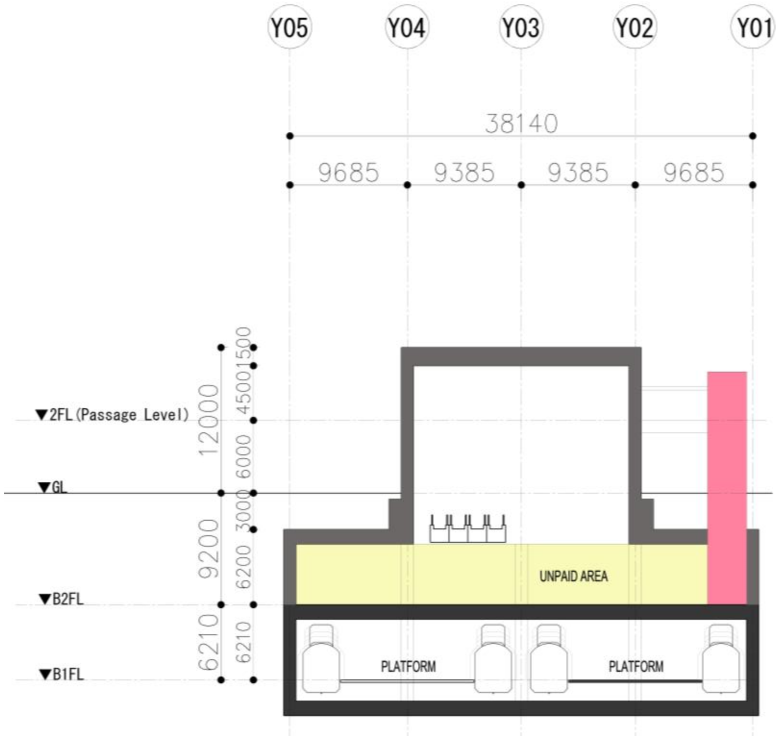
Source: JICA Design Team

Figure 4.4.56 CIA Station Platform Level Plan



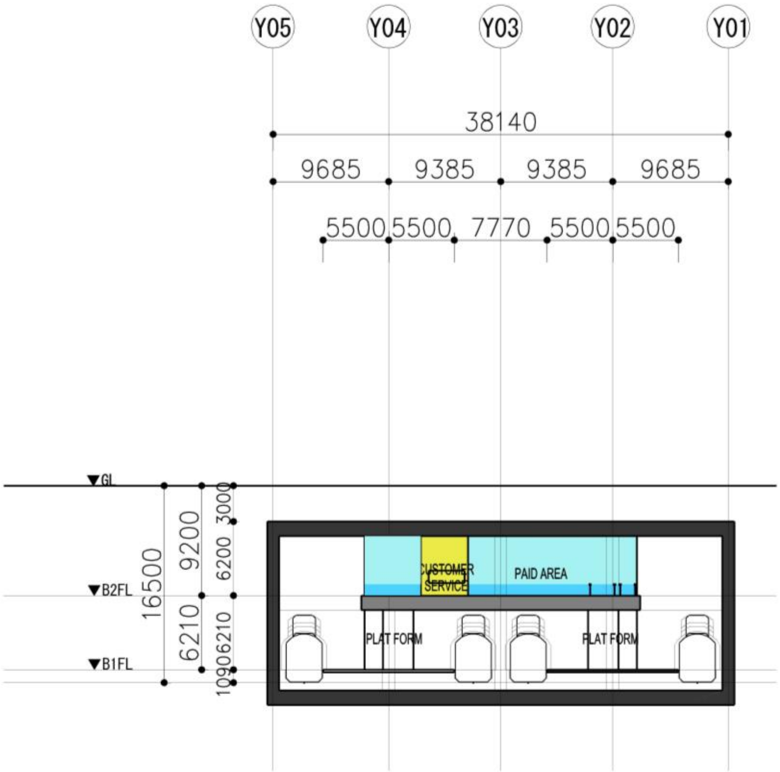
Source: JICA Design Team

Figure 4.4.57 CIA Station Longitudinal Section



Source: JICA Design Team

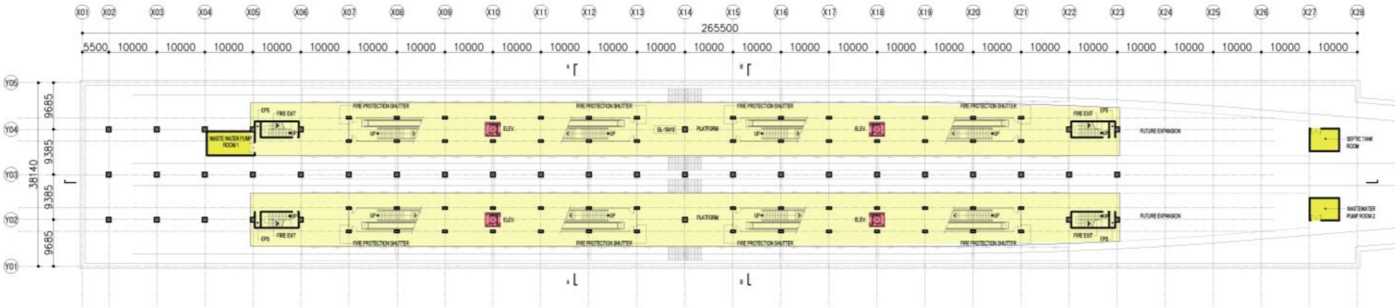
Figure 4.4.58 CIA Station Cross Section-1



Source: JICA Design Team

Figure 4.4.59 CIA Station Cross Section-2

7) NCC Station (2 island-type platforms 4tracks, 3-layer elevated station, 2 ticket gates)

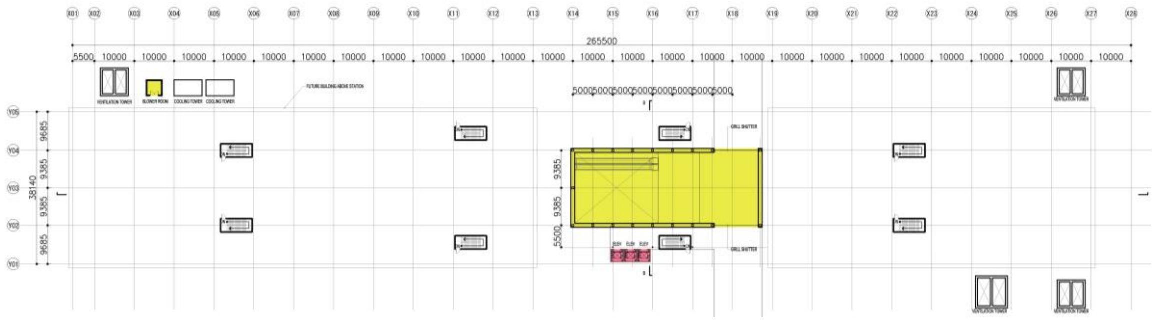


Source: JICA Design Team

Figure 4.4.60 NCC Station Platform Level Plan

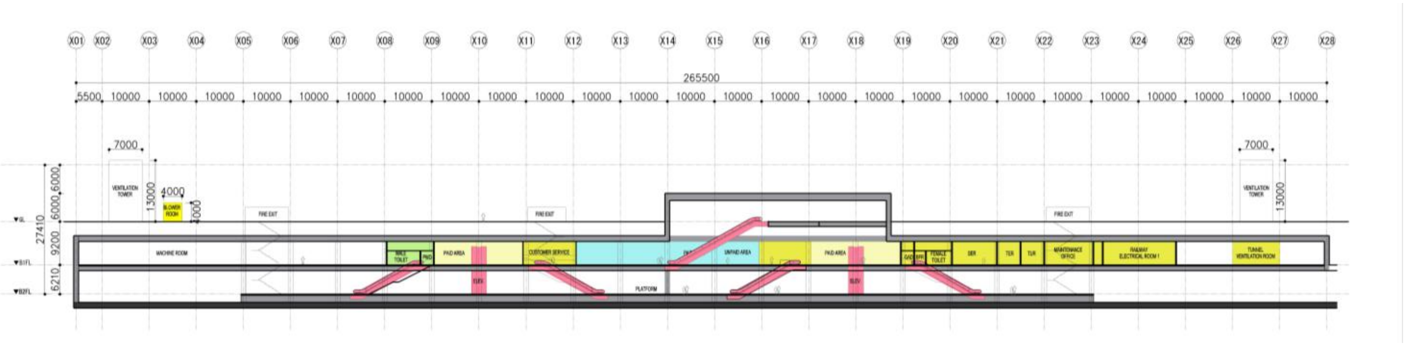
Source: JICA Design Team

Figure 4.4.61 NCC Station Concourse Level Plan



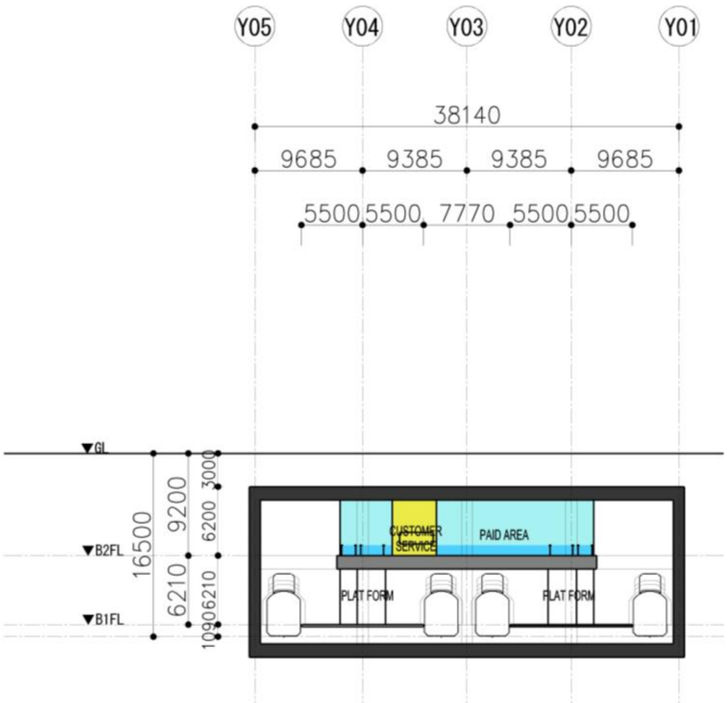
Source: JICA Design Team

Figure 4.4.62 NCC Station Ground Level Plan



Source: JICA Design Team

Figure 4.4.63 NCC Station Longitudinal Section



Source: JICA Design Team

Figure 4.4.64 NCC Station Cross Section

(3) Finishing Materials

Finishing materials of the station buildings are as follows:

Table 4.4.9 Finishing of Exterior

Parts	Finishing	Remarks
Exterior Floor, Stairs	• General: Honed granite • Platform: Honed granite	• Non-slip finish for stairs and ramp
Exterior Wall	• Perforated glass fiber reinforced concrete panels • Precast concrete wall panels	
Openings	• Doors: Steel door, glass door • Windows: Aluminum frame window, Stainless steel frame window	
Roof	• Polytetrafluorethylene (PTFE) tension membrane with TiO2 coating • Fireproof paint finish on hot dip galvanized steel beams	
Ceiling	• Station Plaza: Ulin louvers, Noncombustible insulation, Painting on steel beams	

Source: JICA Design Team

Table 4.4.10 Finishing of Interior

Major Rooms	Finishing
Concourse	• Floor: Honed granite • Wall: Perforated glass fiber reinforced concrete panels, Terrazzo Tiles • Ceiling: Stainless steel mesh acoustic ceiling
Offices	• Floor: Ceramic tile • Wall: Polyester coated calcium silicate panels • Ceiling: Lay in metal ceiling
WC	• Floor: Ceramic tile on waterproof bed • Wall: Mosaic tiles • Ceiling: Stainless steel mesh acoustic ceiling
Machine Rooms	• Floor: Self levelling epoxy paint finish with hardener, Raised access floor system with panels • Wall: Polyester coated calcium silicate panels • Ceiling: Lay in metal ceiling

Source: JICA Design Team

(4) Universal design

Elements of Adopting Universal Design Concept are described below.

a) Continuous Easy-transferred Path

- A safe passageway form the entrance on the ground to the platform is clearly specified priority implementation.
- Signage include guide tiles/textured paving blocks is necessary to support to move smoothly the above passageway.

b) Safety Plan

- Take thorough countermeasures to ensure safety plan, e.g. no steps on the floor or appropriate alternative solution, equipment for fall prevention and crash prevention
- Unconsidered steps are restricted for safe and secure.

c) Adequate Dimensions

Adequate dimensions for space shall be decided after considering various action spaces, caring spaces, change in direction, the view height for signage and so on.

d) Economy, Efficiency & Flexibility

No need to pay special consideration for the elderly and the physically-challenged, but need to pay kind consideration for all. It is more economical, efficient and flexible.

e) Handle-ability & Visibility

In principle, easy-understand station plan is priority to aim. User-friendly design for multilingual guide support this effectively.

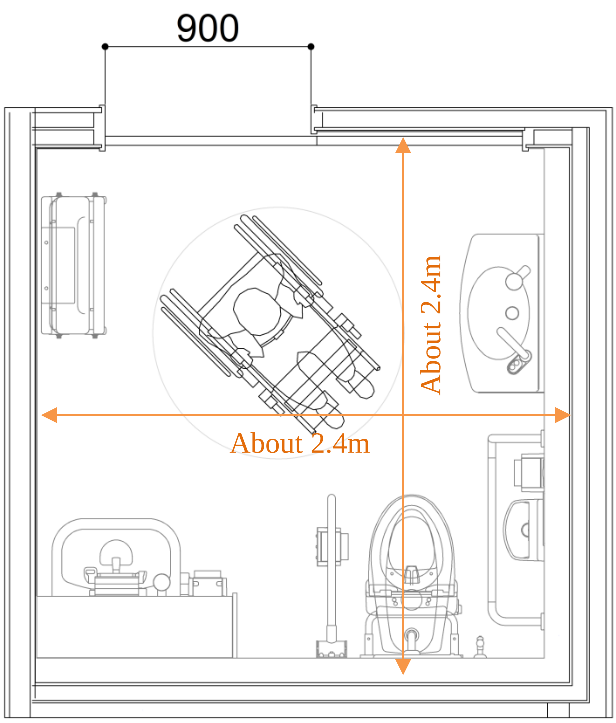
1) Installation standards

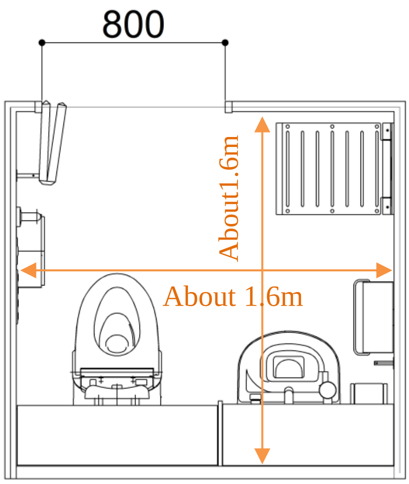
In considering the universal design in this project we should consider not only "BP 344 - Accessibility Law and its IRR" of the Philippines but also "Guideline of passenger facilities to improve ease of public transport use by the elderly and the disabled" of Japan.

2) Multipurpose toilet

We should install more than one multipurpose toilets for men and women who can use without any hesitations, including disabled, elderly, mother and baby, including LGBT (sexual minorities).

The following show an example plan of multipurpose toilet shared by men and women for a wheelchair user priority type (Figure 4.4.65) and a simple private room type (Figure 4.4.66).





Source: JICA Design Team

Figure 4.4.65 Wheelchair User Priority Type Multipurpose Toilet

Figure 4.4.66 Simple Private Room Type Multipurpose Toilet

(5) Substation: Location and Plan

The location and plan of substation shall be consulted and coordinated with local electric company. The substations shall be designed to be located under the viaduct in order to facilitate efficient workability and maintenance of the facility. Typical plan of substation is shown in Figure 4.4.67.

Source: JICA Design Team

Figure 4.4.67 Typical plan of Substation

4.4.4 Basic Structural Design of Station

(1) Structural Design for the Stations

The station buildings are designed to meet the standards the "National Structural Code of the Philippines 2015 (NSCP)" , "The Building Standard Law of Japan" and "Structural Relation Technical Standards Explanation for the 2015 Version Building (Ministry of Land, Infrastructure and Transport, etc.)".

(2) Structural Materials

Major structural materials to be used in the Project conform to ASTM (American Society of Testing and Materials) or JIS (Japanese Industrial Standard) as follows:

- Concrete: Normal concrete of design standard strength f'c = 31 MPa (to be applied to elements other than the below)
  Normal concrete of design standard strength f'c = 36 MPa (to be applied to the bored in-situ concrete piles)
- Reinforcing Bars: Deformed bars
  D10, D12 (or D13) ASTM A615 Grade 40, or JIS G3112 SD295A
  D16 and larger ASTM A615 Grade 60, or JIS G3112 SD390
- Structural Steel: ASTM A36 "Carbon Structural Steel", or
  JIS G3101 SS400, SN400B, SN490B "Rolled Steel for General Structure"

(3) Structural Planning of the Station

1) Upper Structure

The main features of upper structure are as follows;

- The main structure of the stations is a steel rigid frame.
- Calumpit, Apalit, SanFernando and Angeles stations each have a 10m span in the longitudinal direction, and an 18m single span in the transverse direction. The platform and roof structures have cantilevered beams to support slabs in the transverse direction.
- The main columns and the beams are I-sections, and the beams are joined to the columns by diaphragms to make the highly rigid joints.
- The column bases are embedded in the foundations to increase strength and rigidity.
- Each floor has concrete deck slabs to provide lateral stiffness, and the slabs are connected to the steel beams by shear connecters to distribute stresses.
- Membrane material is used for the roof finishing and the shear stiffness of the roof structure is provided by steel horizontal braces in order to reduce weight.
- There is a possibility to have solar light panels on roof top - the weight of these is considered as live loading in the structural analysis.
- The station structures and civil engineering structures, such as viaducts and piers, are designed independently. Expansion joints are provided between the platforms and the viaducts to prevent the transmission of loads and vibrations. The station structures are also divided in the longitudinal direction by expansion joints to reduce the effects of differential settlement of the ground, thermal stresses and seismic stresses caused by earthquake phase difference.

2) Foundation Structure

The main features of foundation structure are as follows;

- Depending on the results of geological surveys, cast-in-place concrete pile foundations are adopted in each station to support the heavyweight buildings. The bottom of the foundations will be supported by firm ground.
- Foundation girders are provided in both lateral directions in order to distribute pile-top bending moments effectively. The girders avoid civil engineering structures such as viaducts.
- The section of the foundation girders is decided considering embedded depth of columns.
- Should pile foundations be adopted, cast-in-place concrete piles will be used as large loads are expected for the station structures.

3) Structural Analysis and Safety Assurance

a) Design Loads

The structural analyses are carried out in consideration of the following loads combined according to the NSCP:

- Dead load (reaction of tensile stress by roof membrane structure should be considered)
- Live load (load of solar light panel should be considered on roof top)
- Wind load
- Earthquake load
- Soil and water pressure (against underground structures)
- Thermal load

b) Structural Analysis

The safety checks of the structural members are carried out by the load and resistance factor design (LRFD) method in accordance with the NSCP. The seismic base shear coefficients and the parameters adopted to determine the coefficients are as shown in the table below;

Table 4.4.11 Evaluation of Base Shear Coefficients at each station

Building			Calumpit,Angeles	SanFernand	Apalit
Direction			Both Directions	Both Directions	Both Directions
Seismic Zone			Zone 4	Zone 4	Zone 4
Seismic Zone Factor	**Z**		0.4	0.4	0.4
Soil Profile Type	**$S_A \sim S_E$**		To be determined based on the results of geological surveys		
Seismic Coefficients	**Ca**	**min 0.32Na(S_A)**	0.32	0.32	0.32
		max 0.44Na(S_E)	0.44	0.44	0.44
	Cv	**min 0.32Nv(S_A)**	0.32	0.32	0.32
		max 0.96Nv(S_E)	0.96	0.96	0.96
Maximum Moment Magnitude			A (7.0≦M≦8.4)		
Closest Distance to known Seismic Source			15km≦D	15km≦D	15km≦D
Near-Source Factor	**Na**		1.0	1.0	1.0
	Nv		1.0	1.0	1.0
Evaluation Method of Base Shear Coefficient			Static	Static	Static
Importance Factor	***1**		1.00	1.00	1.00
Structure Material			Steel	Steel	Steel
Basic Seismic-Force Resisting System	***2**		SMRF	SMRF	SMRF
R Factor	**R**		8.0	8.0	8.0
Overstrength Factor	**Ωo**		3.0	3.0	3.0
Building Height above Ground (m)	**h_n**		20.84	22.04	18.43
Fundamental Period of Vibration (Sec.)	**T**	**$=C_t(h_n)^{3/4}$**	0.832	0.868	0.759
	C_t		0.0853	0.0853	0.0853
Base Shear Coefficient	**C**	**min (S_A)**	0.048	0.046	0.053
		max (S_E)	0.138	0.138	0.138

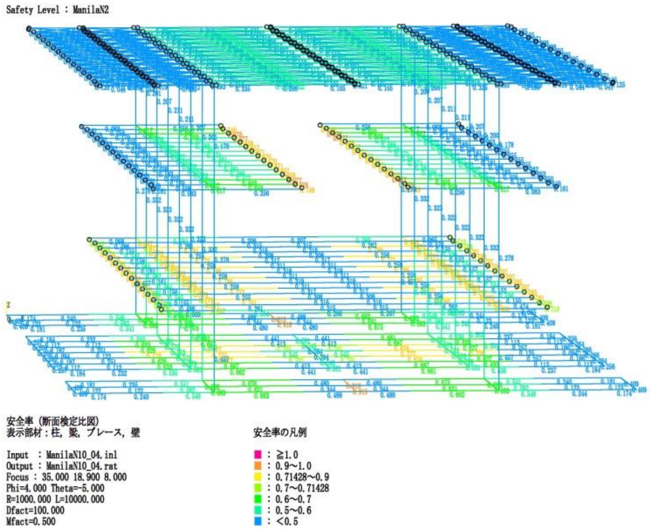
*1 Specified based on NSCP, which may different from those specified by Japanese codes.
*2 SMRF :Special Moment-Resisting Frame

Source: JICA Design Team

The safety of the structure against severe earthquake motions is confirmed by ultimate state lateral capacity calculations based on the Building Standard Law of Japan. It is confirmed that the computed ultimate state lateral capacity of each story is equal to or greater than the design lateral shear force in accordance with the following;

- The standard shear coefficient of calculation for severe earthquake motions is 1.0. The strength coefficient for building use is 1.25.
- The calculation is done by incremental loading analysis which is static nonlinear analysis.
- The hysteric behavior of material is assumed to be perfect elastoplastic. The ultimate state story drift is limited to 1/100.

An example of structural analysis model of the whole structure is shown below.



Source: JICA Design Team

Figure 4.4.68 Structural Analysis Model

4.4.5 Station Electrical and Mechanical Systems

(1) General

The feasibility Study of the elevated stations and the underground station has been addressed and summarized in this report.

The systems include Station Electrical and Mechanical (E&M) systems, including fire protection system and sanitary plumbing system.

The elevated station facilities will consist of six (6) elevated stations. The underground station facilities will consist of one underground station and the facilities for the tunnel.

All the station facilities system will be designed for 8 cars train operation and design target year in 2040.

The design consideration/basis shall follow the local design code/requirements and/or MLIT-J (Ministry of Land, Infrastructure, Transport and Tourism of Japan) design guide books/requirements and Japan Fire Code/requirements and the like.

To assist the Contractor with the construction design of the works, the Consultant/Employer has provided the detail design and outline design details for to address various aspects of the E&M building services as indicated in Table 4.4.12.

Table 4.4.12 Design Contractual Obligations Under Construction Contract

Work Items	Design	Design Responsibility
• LV power supply • Lighting fixtures, and socket outlet • Fire alarm services • Lightning protection service • Grounding services • Water supply, plumbing and drainage services • AC and ventilation service • Fire protection services	Detail Design provided by Employer Contractor to adjust where required and the Detail Design shall accommodate to the equipment	Design responsibility by Employer
• Building management system • Waste treatment plant system	Employer to provide outline design Contractor to develop the Outline Design shall accommodate to the E&M system-wide equipment	
Combined Services Drawings (CSD) and Structural Electrical Mechanical Drawings (SEM)	GC/Employer shall instruct the Contractor to provide the CSD and SEM Drawings Contractor to develop the CSD and SEM drawings to accommodate the equipment/systems	Design responsibility by Contractor to elaborate the CSD and SEM drawings

Source: JICA Design Team

(2) Design Criteria

The design of the E&M systems of the station shall be based on the applicable local codes, regulations and standards issued by the statutory authorities or agencies, as well as the latest Japanese Standards and codes of practice which shall include the following where applicable:

1) Code and Standards

Relevant Philippines Code and Standards for Design and installation services for Building, Fire and Mechanical, Plumbing and Drainage, Electrical services

Such as:

- National Building Code of Philippines
- Philippine Mechanical Engineering Code
- Philippine Electrical Codes, Part I & II
- Philippine Fire Code and Revised Fire Code of Philippines - Implementing Rules and Regulation of Act-No9514 otherwise known as the Fire Code of the Philippines of 2008(IRR-Act No9514)
- Metropolitan Water works and Sewage System (MWSS)
- Local Water Utilities Administration Standards (LWUA)
- Mayniland Water Service Incorporation (MWCI) Standards
- Building Electrical and Mechanical Installation Code of Industry in Philippines
- National Plumbing Code of the Philippines 2000 (NPCP)
- Revised National Plumbing Code of the Philippines

The following standards also shall be applied where the station E&M equipment is not specified in the above mentioned standards;

- Relevant standard issued in the Manual of Building E/M services for Design guide-line and construction by the Ministry of Land Infrastructure, transport and Tourism (MLIT-J) of Japan
- Relevant Japanese Industrial Standards (JIS)
- Relevant Japan Building Code and Standards (JBC)
- Relevant Japan design Manual for Mechanical System of the Society of Hearting, Air-conditioning and Sanitary Standards of Japan (HASS-J)
- Relevant Japan Fire Code and Standards (JFC)

2) Noise Conditions

Designed Noise Condition shall not exceed requirements as per Local Building/Environmental Codes and Standards and relevant Japan standards as follows:

Urban, Residential area	---	50db (A)
Urban mixed area	---	55db (A)
Urban, non-residential	---	65db (A)
Industrial area	---	65db (A)

3) E&M equipment Failure Tolerance Strategy

The station E&M system can tolerate a single equipment failure and the station operation can be continued with a degraded of 75% of services. A 20% of spare capacity and 150% sizing strategy of Major and/or Railway system room AC equipment, water and Fire Pumps, electrical control panel and etc. are reserved in it the design so that it will be sufficient capacity to meet in future introduction of modifications that O&M contractor will consider necessary. Duty and Standby arrangement and served policy had been adopted consider to achieve this purpose

4) Design Target Year

The system configuration and equipment sizing to meet target year of after completion of construction has been based on in year 2040. The Equipment room spaces to meet with demand of target year will be 20 years' design life.

(3) Station Electrical Systems

The station electrical system shall be as follows;

- LV power supply system
- Lighting fixtures system and Socket outlet (Receptacle) system
- Grounding System
- Lightning Protection System
- Fire Alarm and Detection system
- Building Management System

1) LV Power Supply System

Low voltage power supply shall be distributed by HV loop distribution power supply of the railway system, the station facility from the station railway distribution transformer located at each station building.

Power supply for important equipment at underground station, such as disaster prevention system shall be distributed as emergency load by generator of railway system.

The local electric cooperative distribution transformers shall be provided for sole use of the station facility. Utilization voltage shall be 380 volts for three- phase voltage, 220 volts for single-phase voltage. The interior wiring shall be insulated copper building wires running in conduits.

The facility shall have provision for connecting all essential loads such as lighting, convenience outlets and computers.

Electrical system shall consist of main low voltage power supply, low voltage distribution and wiring, normal lighting/socket outlets, building management system, fire detection and alarm system and lightning protection system.

Each station’s low voltage power supply shall be supplied and derived from the railway system network dedicated traction substation by the railway system of this project.

The secondary low voltage power supply of the station will distribute normal power supply to station E&M systems for all stations and to AFC of the railway system at elevated station.

2) Lighting Fixtures System and Socket Outlet (Receptacle) System

The main purpose is to provide general, localized and task illumination for different lighting requirements. The supply of the lighting system shall be 220 volts, 60Hz with LED type lighting fixtures.

All platform lighting systems shall be operated automatically from BMS. All non-automatic lighting circuits shall be operated from manual switches installed in the respective rooms/areas. The wiring method to be implemented shall be installed in the ceilings or walls and in intermediate metal conduit (IMC) for exposed installations.

The locations and specifics regarding the exit signs and lighting shall follow the local codes and/or MLIT-J requirements.

Emergency lights shall be self-contained with battery back-up.

The self-contained battery sets shall automatically recharge when normal power is available.

For exterior or damp location, surfaces or imbedded, watertight receptacles for lighting switches shall be mount.

The wiring method to be used shall be for installations embedded in walls or floor slabs and IMC for exposed installations. The facility shall be provided with 220 volt general purpose receptacle outlets.

All receptacles shall be grounding type. The location of the receptacle outlets shall be based on the furniture arrangement of the facility.

Lighting Level and Type and Number of Socket Outlet shall be indicated in Table 4.4.13.

Table 4.4.13 Lighting Level and Type of Small Power Outlet

Room	Lighting Level N/E (lux)	Small Power	Remarks
Paid concourse	150 / 1	T54	Each TSO shall cover an area of 25m in radius
Unpaid concourse	150 / 1	T54 x FSU	Each TSO shall cover an area of 25 m in radius. One FSU to be provided for one tenant
Platform	150-200 / 1	T54	Each TSO shall cover an area of 25m in radius
Customer service	500 / 1	3xTSO	
POS	500 / 1	2xTSO	
AFC room	300 / 1	2xTSO	
First aid room	500 / 1	1xTSO	
AFC UPS	300 / 1	2xTSO	
COM equipment room	300 / 1	2xTSO	
COM UPS	300 / 1	2xTSO	
SER	300 / 1	2xTSO	
SUR	300 / 1	2xFSU	
Escalator	150 / 1		
Elevator hall	150 / 1		
Security staff room	300 / 1	2 x TSO	
Station manager room	500 / 1	2 x TSO	
Station staff/BMS room Meeting corner	500 / 1	8 x TSO	
Staff W/C (M&F)	150 / 1	3x FSU	
Staff pantry	300/1	2x FSU	
Station storage room	150 / 1	2xFSU	
Corridor	100 / 1	FSU	Each TSO shall cover an area of 25 m in radius
Cleaners room	200 / 1	1 x FSU	
OCS room	300 / 1	1xFSU	
WC (M/F/D)	200 / 1	3x T54	One T54 is fixed in each WC
Railway electrical room	300 / 1	4 x FSU	
Station electrical room	300 / 1	4 x FSU	
Fire services / water tank / pump room	300 / 1	2 x T54	Two T54 are fixed in each room
Refuge store	150 / 1	1 x FSU	
Elevator machine pit		1 x FSU	
Elevator shaft pit		1 x FSU	
Distribution Board Room / EPS	300 / 1	1 x TSO	
Gender & Development	500 / 1	1 x TSO	
Breast Feeding Room	500 / 1	1 x TSO	

Abbreviation
N/E/D : Normal / Emergency
T54 : Twin Socket outlet with IP54
TSO : Twin Socket outlet
FSU : Fused Spur Unit

Source: JICA Design Team

3) Lightning Protection System

A lightning protection system shall be designed for each elevated station, each substation and auxiliary buildings.

The building shall be protected from lightning strike by implementing a pre- caution lightning streamer of lightning protection system consisting of air terminals, down conductors, ground rods and ground ring. The code and requirements shall be in complying with Philippine code and requirements and/or MLIT-J Electrical Design requirement.

4) Grounding system

Grounding system shall be equipotential grounding. This system should be for the purpose of suppressing the potential difference between each other's equipment. Equipotential grounding terminal bar shall be provided for connection in the following rooms.

- Station electrical room
- Railway electrical room
- Distribution board room
- OCS room
- AFC room
- AFC UPS room
- SER room
- SUR room
- COM room
- COM UPS room
- BMS room

5) Fire Alarm and Detection System

An addressable type of fire alarm system shall be provided and installed in accordance with the requirements of the Philippine Electrical Code, Part 1, Philippine Fire Code and/or MLIT-J electrical design requirement.

The system shall consist of analog addressable smoke and temperature detectors, manual pull stations and fire alarm assembly. Loop-type wiring shall be provided in all circuits.

The minimum size of the conduit to be used shall be 20 mm in nominal diameter by the design requirement and shall be rigid for embedded and underground installations and Electrical Metallic Tubing (EMT) for concealed applications. MLIT-J Fire Code and requirements.

Fire Alarm and Detection System shall be provided for all of station area as shown in Table 4.4.14:

Table 4.4.14 Provision of Fire Alarm and Detection System

Room	Fire Protection Provision
	Detection
Paid Concourse	PS
Unpaid Concourse	PS
Station Platform	PS
Staircase	PS
Escalator	PS
Elevator-Entrance & Exit	PS
AFC Room	PS
Customer Service	PS
AFC UPS	PS
SER Room	PS
SUR Room	PS
COM Room	PS
COM UPS	PS
Station Master Room	PS
Station Staff Room / BMS	PS
First Aid Room	PS
Staff W/C (M&F)	PS
Storage	PS
Corridor	PS
Cleaners Room	PS
WC (M / F / D)	HD
Railway Electrical Room	PS
Station Electrical Room	PS
Fire Services / Water Tank / Pump Room	PS
POS	PS
Security Staff Room	PS
Pantry	PS
OCS Room	PS
Elevator Shaft	PS

Abbreviation:
PS : Optical Type Smoke Detector
HD : Heat Detector
BLANK : No Provision

Source: JICA Design Team

6) Building Management System

A Building Automation System for all stations will be provided by a common alarm status control.

All equipment alarm conditions and status shall be displayed on a CPU software. The systems and items shown in Table 4.4.15 shall be monitored and displayed in the status system.

Table 4.4.15 Provision of Building Management System

Items	Operation	Indication	
		Status	Alarm
Low Voltage Switchgear for the station building (Main Breaker)	Open / Close	Open / Close	Fault
Low Voltage Switchgear for the station building (Branch Breaker)		Open / Close	Fault
Fire Pump No.1,2 & Jockey Pump		Run / Stop	Fault
Fire Water Tank		Low & High	
Potable Water Pump No.1,2		Run / Stop	Fault
Potable Reservoir Tank		Low & High	
Waste Water Treatment Plant			Fault (Lump)
Ventilation Fans			Fault
Air Conditioners			Fault
Lighting System (Platform : 10% of the total)	On / Off	On / Off	Fault
Lighting System (Platform : 50% of the total)	On / Off	On / Off	Fault
Lighting System (Platform : 100% of the total)	On / Off	On / Off	Fault
Roller Shutter Door		Open / Close	Fault
Escalator	Operation On / Off	Service / Not service	ES (*1) EF (*2)
Elevator	Operation On / Off	Service / Not service	ES (*1) EF (*2)
Fire Alarm Control Panel			Fault (Lump)

*1 ES: Emergency Stop
*2 EF: Escalator/Elevator Fault

Source: JICA Design Team

Individual monitoring devices shall be installed in the same room such as the fire alarm. Security CCTV camera shall be mounted in the applicable location inside station and its server and monitor shall be installed in the BMS room.

(4) Station Mechanical System

The station mechanical system shall be as follows:

- Air-conditioning system
- Ventilation system
- Fire protection system

1) Air Conditioning

The air conditioning system is comprised of air-conditioning and mechanical ventilation for the elevated stations and the underground station.

For non-air-conditioned areas such as concourses and platforms in the elevated stations, water tank and pump rooms and all the storage rooms, sufficient air exchange by means of natural ventilation or mechanical ventilation will be provided in accordance with local code requirements, or the design guidelines of the MILT-J (Ministry of Land, Infrastructure, Transport and Tourism of Japan) and other authorized Japanese technical codes.

The capacity of the air conditioning system for railway equipment rooms such as SER, SUR, COM equipment room, COM Equipment UPS room, AFC and AFC UPS room shall be sufficient to provide 150% of the anticipated cooling load, including the allowances for stand-by equipment.

Each air-conditioned room will be provided with a mechanical ventilation system for fresh air intake.

As the elevated stations are basically open stations and all areas are equipped with fire proof/smoke proof materials, no provision has been provided for smoke exhaust systems in line with MLIT-J requirements for elevated station structures. Reagrding the underground station, the platform and concoourse shall be provided with smoke exhaust system, as indicated in 4.4.5 (6) Underground Station Mechanical System.

Non-air-conditioned rooms such as toilets, station/railway electrical rooms and distribution board rooms will be fitted with mechanical ventilation systems. Each of the rooms will be controlled by mechanical ventilation based on the volume of air changes or the room temperature not exceeding 40 degrees centigrade, as indicated in Table 4.4.16.

2) Design Provision for AC and Ventilation Systems are specified below.

The design provision for AC and ventilation systems are specified below:

- Consist of individual air-conditioning (cooling only) systems and ventilation fans.
- Centrifugal Chillers, cooling towers, pumps and air handling units shall be provided for the platform in the underground station.
- Natural ventilation will be sufficient for concourses and platforms in the elevated stations as these areas are semi-open/open spaces.
- The structure of the elevated stations will not be provided with smoke exhaust systems in accordance with MLIT-J and design requirement.
- The platforms and concouse in the underground station shall be provided with smoke exhaust system, as indicated in 4.4.5 (6) Underground Station Mechanical System.

Table 4.4.16 Machine Equipment Design Condition

Design Conditions	Outdoor Temperature: 34.5 degrees C (DB), 26.3 Degrees C (MCWB)				
Room	**AC and Ventilation Provisions**		**AC Equipment /Ventilation**	**Operation and Control Requirements**	**Remarks**
Paid Concourse	NV				
Unpaid Concourse	NV				
Platform	NV				
Customer Service	A/C	25^0C DB, 50% RH, OA/Exh $25m^3$/hr for person	Split Unit HRV	Type 1	2--6 staffs
AFC Room	A/C	22^0C DB, 50% RH, OA/Exh $25m^3$/hr for person	Split Unit Stand-by at 75% each HRV	Type 1	3 staffs
AFC UPS Room	A/C	22^0C DB, 50% RH, OA/Exh	Split Unit Stand-by at 75% each Exhaust Fan	Type 2	
SER Room	A/C	22^0C DB, 50% RH, OA/Exh	Split Unit Stand-by at 75% each HRV	Type 2	
SUR Room	A/C	22^0C DB, 50% RH, OA/Exh	Split Unit Stand-by at 75% each Exhaust Fan	Type 2	
Communication Equipment Room	A/C	22^0C DB, 50% RH, OA/Exh	Split Unit Stand-by at 75% each HRV	Type 2	
Communication Equipment UPS Room	A/C	22^0C DB, 50% RH, OA/Exh	Split Unit Stand-by at 75% each Exhaust Fan	Type 2	
First Aid Room	A/C	25^0C DB, 50% RH, OA/Exh $25m^3$/hr for person	Split Unit Exhaust Fan	Type 1	
Security Room	A/C	25^0C DB, 50% RH, OA/Exh $25m^3$/hr for person	Split Unit HRV	Type 1	
Station Manager Room	A/C	25^0C DB, 50% RH, OA/Exh $25m^3$/hr for person	Split Unit HRV	Type 1	
BMS Room	A/C	25^0C DB, 50% RH, OA/Exh $25m^3$/hr for person	Split Unit HRV	Type 1	
Maintenance Office	A/C	25^0C DB, 50% RH, OA/Exh $25m^3$/hr for person	Split Unit HRV	Type 1	
OCS	A/C	25^0C DB, 50% RH, OA/Exh $25m^3$/hr for person	Split Unit HRV	Type 1	
Training Maintenance	A/C	25^0C DB, 50% RH, OA/Exh $25m^3$/hr for person	Split Unit HRV	Type 1	
Staff Room	A/C	25^0C DB, 50% RH, OA/Exh $25m^3$/hr for person	Split Unit HRV	Type 1	
Storage	MV	Exhaust, 5ACH	Exhaust Fan	Type 2	
Staff Male Toilet	MV	Exhaust, 15ACH	Exhaust Fan	Type 4	See note 3
Staff Female Toilet	MV	Exhaust, 15ACH	Exhaust Fan	Type 4	See note 3
Driver Waiting Room	A/C	25^0C DB, 50% RH, OA/Exh $25m^3$/hr for person	Split Unit HRV	Type 1	
Shower Room	MV	Exhaust, 5ACH	Exhaust Fan	Type-4	
Cleaners Room	MV	Exhaust, 10ACH	Exhaust Fan	Type 4	
Male Toilet	MV	Exhaust, 15ACH	Exhaust Fan	Type 4	See note 3

Design Conditions	**Outdoor Temperature: 34.5 degrees C (DB), 26.3 Degrees C (MCWB)**				
Room	**AC and Ventilation Provisions**		**AC Equipment /Ventilation**	**Operation and Control Requirements**	**Remarks**
Female Toilet	MV	Exhaust, 15ACH	Exhaust Fan	Type 4	See note 3
Toilet for the Disabled	MV	Exhaust, 15ACH	Exhaust Fan	Type 4	See note 3
Railway Electrical Room	MV	Max 40^0C (HL)	2 Fans (75% flow for each)	Type 2	See note 1
Station Electrical Room	MV	Max 40^0C (HL)	2 Exhaust Fans (75% flow for each)	Type 2	See note 1
Distribution Board Room	MV	Max 40^0C (HL)	2 Exhaust Fans (75% flow for each)	Type 2	See note 1
Fire & Domestic Water Tanks and Pump Room	MV	Exhaust, 4ACH	2 Exhaust Fans (75% flow for each)	Type 4	See note 1
Wastewater Treatment Plant Equipment Room	MV	OA Supply, Design air flow rate required by the plant	OA Supply Fan	Type 4	See note 1
Elevator Shaft	MV	Max 40^0C (HL)	Exhaust Fan	Type 1	

Abbreviation

A/C : Air conditioning
ACH : Air change per hour
DB : Dry Bulb
FAN : Ventilation Fan
HL : Design flow rate shall be calculated based on the heat load.
HRV : Heat Recovery Ventilator
MV : Mechanical Ventilation
NV : Natural Ventilation
RH : Relative Humidity
WB : Wet Bulb
TYPE 1 : Thermostat Control of Room Temperature, Continuous Operation based on the station operation hours.
TYPE 2 : Thermostat Control of Room Temperature, Continuous Operation at 24 hours/day, 7 days/week
TYPE 3 : Two fans in Parallel Software Timer Control of 24 hours/day, 7 days/week for the first fan, Temperature Sensors / Thermostat Control for the second fan
TYPE 4 : Software Timer Control at 24 hours/day, 7 days/week
TYPE 5 : Software Timer Control operation based on the station operation hours

Notes

(1) Each of two duplex fans/AC Units shall be equipped with minimum 75% of the design air flow rate.
(2) The air pressure balance shall be considered between the independent room and the adjacent spaces.
(3) Segregated extraction system
(4) The makeup conditioned air for the mechanical ventilated areas shall be drawn from the adjacent conditioned areas.

Source: JICA Design Team

The AC design concepts for each room shall include the following:

a) Cooling Load Calculation

Cooling load calculations for the conditioned areas shall be performed as follows:

b) Design Conditions

Outdoor: 34.5°C dry bulb (DB), 26.3°C mean coincident wet bulb (MCWB)
(ASHRAE 2009, MANILA Cooling DB/MCWB)

Indoor: Staff Room, Train Operation Room, Station Control Room
25°C (DB), 50% RH ±10%
Equipment Rooms (Signal/Telecom/AFC Room)
22°C (DB), 50% RH ±10%

Indoor Air Quality
For design air flow rates of ventilation and air-conditioned spaces, refer to the above table of the design requirements.

3) Fire Protection

a) Fire protection systems for all the structures in the project shall comply with the requirements of the Revised Fire Code of the Philippines and the Japan Fire Code and Regulations.
b) All the station structures shall be protected by a fire hydrant system, with standby-fire pumps and the hydrant nozzle where water pressure is manually controlled. The pump operation will be remote-controlled at each hydrant push-button in accordance with local Fire Codes and regulations. All the underground occupied spaces such as staff rooms in the underground station shall be protected by a sprinkler system, with dedicated standby-fire pumps.
c) Electrical rooms and such concerned electrical board rooms not exceeding 500m^2 for the elevated stations structures shall be provided with carbon dioxide fire suppression system as specified in the Japan Fire Code and Requirement of MLIT-J.
In contrast, those rooms shall be provided with fire separation walls and fire-resistant material control in accordance with local codes and/or the Japan Fire Code and requirement of MLIT-J for purpose of fire prevention and the minimum operation cost.
d) All the interfaced information shall be coordinated with the local Fire Departments and any other concerned authorities.

The Fire Protection Provision is shown in Table 4.4.17.

Table 4.4.17 Provision of Fire Protection

Room	Fire Protection Provision		
	Fire Hydrant/ Hose Reel	Portable Fire Extinguisher	Clean Gas extinguishers
Paid Concourse	Y	Y	
Unpaid Concourse	Y	Y	
Platform	Y	Y	
Staircase-Entrance & Exit	Y	Y	
Staircase-General	Y		
Escalator-Entrance & Exit	Y		
Elevator-Entrance & Exit	Y		
Customer Service 1&2	Y	Y	
AFC Room	Y	Y	
AFC UPS	Y	Y	CO_2 portable Room Fire separation and materials controls
SER Room	Y	Y	CO_2 portable, Room Fire separation and materials controls
SUR Room	Y	Y	CO_2 portable, Room Fire separation and materials controls
COM Equipment Room	Y	Y	CO_2 portable, Room Fire separation and materials controls
COM UPS Room	Y	Y	CO_2 portable, Room Fire separation and materials controls
Station Manager Room	Y	Y	
Staff Room/BMS Room	Y	Y	
First Aid Room	Y	Y	
Staff Toilet (Male & Female)	Y	Y	
Station Store	Y	Y	
Corridor	Y	Y	
Cleaners Room	Y	Y	
WC (Male / Female / the Disabled)	Y	Y	
Railway Electrical Room	Y	Y	CO_2 portable, Room Fire separation and materials controls
Station Electrical Room	Y	Y	CO_2 portable, Room Fire separation and materials controls
Fire Pump / Water Tank / Pump Room	Y	Y	
Refuge Store	Y	Y	
Mainline Traction Substation	CO_2 fire suppression system	Y	

Abbreviation:
PS: Optical Type Smoke Detector
HD: Heat Detector
LD: Linear Heat Detector
Y: Yes
BLANK; No Provision

Source: JICA Design Team

(5) Station Plumbing System

The proposed sanitary/plumbing system shall be as follows:

- Water distribution system
- Sanitary drainage and vent system including storm water, wastewater treatment plant

The sanitary plumbing system design shall be undertaken in accordance with the following:

i) National Plumbing Code of the Philippines (NPCP), 2000; and
ii) MLIT-J design guide-book and requirements (Japan).

1) Water Distribution System

The station water supply system shall be designed based on the following:

a) The water storage tank and booster pumping unit shall be supplied for hand washing, toilet flushing and building cleaning etc.
b) The water tank shall have a one-day capacity in according to local authority requirements, and be of prefabricated, above-floor construction with a separation wall for maintenance purposes.
c) The water supply system shall comprise a booster pumping system with variable speed motor pumps.
d) The design flow rate shall be developed in accordance with the fixture unit method. Simultaneous use of fixtures shall be considered according to actual or assumed percentage of use.
e) Equivalent fixture units shall be based on the Philippine Plumbing Code and/or MLIT-J requirements and shall comprise the water saving performance of the installed fixtures and fittings. The number of fixtures in toilets will be based on the passenger demand forecast, as well as on the station layout plan and local building code requirements.
f) The design flow rate and flow pressure shall be based on the Philippine Plumbing Code and/or MLIT-J design guide book.

2) Sanitary Drainage and Vent System

The station sanitary drainage and vent system shall be designed based on the following:

a) The waste water from toilet flushing shall be collected to a waste treatment plant located on the station ground floor in accordance with local authority requirements. The treatment plant shall be compliant with local codes and regulations.
b) Each station shall have an on-site waste-water treatment plant; the treated water quality shall be less than BOD 50ppm in compliance with the local regulations and requirements and/or Japan Waste Water Calculation Requirement.
c) Other waste water will be discharged directly by a gravity drain to the public sewage system, including rail water.

d) The sanitary waste drainage system shall be designed using drainage fixture unit values as given in Philippine Plumbing Code and/or MLIT-J design guide-book.

e) The sanitary waste drainage systems shall be designed with a minimum slope of two percent (2%) for less than or equal to 75 mm diameter pipe, and one percent (1%) for more than or equal to 100 mm diameter pipe, or the slope permitted by the Philippine Code and/or MLIT-J Code.

f) The size of vent system pipe shall be designed in accordance with the Philippine Code and/or MLIT-J design guide-book.

g) Regarding the underground station, waste-water tank for the toilet located in the underground floor and the pumps that pump away from the tank to the waste-water treatment plant shall be installed of sufficient capacity. The pump shall be submersible and be installed to provide 100% spare capacity. Duty and standby pumps shall be provided with power taken from a secure supply. The pumps with local control panel shall be controlled by high and low level in the sump. In case the water level rises above high level, all two pumps shall work simultaneously. Extra high level sump shall generate an alarm signal. The pumps shall be mounted on guide rails for ease of maintenance.

(6) Underground Station Mechanical System

The underground station mechanical system shall be as follows:

- Air Conditioning System
- Tunnel Ventilation System
- Hydrant and Water Pipe Connection (Siamese connection) in Tunnel
- Drainage and Pump system

1) Air Conditioning

Air Conditioning system is comprised of Air Conditioning and mechanical ventilation for underground station.

For platform and concourse area, Air Conditioning system shall be provided by Central Air conditioning system. For air-conditioned area such as staff room for station, railway equipment room, air conditioning system shall be provided by individual air conditioning.

For all area in underground station, sufficient air exchange by means of mechanical ventilation will be provided in accordance with local code requirements, or the design guidelines of the MILT-J (Ministry of Land, Infrastructure, Transport and Tourism of Japan) and other authorized Japanese technical codes.

The capacity of smoke exhaust ventilation in platform shall be required by Fire Prevention Standards for Underground Stations of MILT-J.

Table 4.4.18 Machine Equipment Design Condition for Underground Station

Design Conditions	Outdoor Temperature: 34.5 degrees C (DB), 26.3 Degrees C (MCWB)				
Room	**AC and Ventilation Provisions**		**AC Equipment /Ventilation**	**Operation and Control Requirements**	**Remarks**
Paid Concourse	A/C	29^0C DB, 68% RH, Cooling, Smoke Exhaust	AHU/Fan	Type 1	
Unpaid Concourse	A/C	29^0C DB, 68% RH, Cooling, Smoke Exhaust	AHU/Fan	Type 1	
Platform	A/C	29^0C DB, 68% RH, Cooling, Smoke Exhaust	AHU/Fan	Type 1	
Customer Service	A/C	26^0C DB, 50% RH, OA/Exh 30m^3/m^{2}hr ,Smoke Exhaust	Split Unit/VRF or FCU HRV	Type 1	2--6 staffs
AFC Room	A/C	24^0C DB, 45% RH, OA/Exh 10m^3/m^{2}hr	Split Unit/VRF Stand-by at 75% each HRV	Type 1	3 staffs
AFC UPS Room	A/C	24^0C DB, 45% RH, OA/Exh 10m^3/m^{2}hr	Split Unit/VRF Stand-by at 75% each Exhaust Fan	Type 2	
SER Room	A/C	24^0C DB, 45% RH, OA/Exh 10m^3/m^{2}hr	Split Unit/VRF Stand-by at 75% each HRV	Type 2	
SUR Room	A/C	24^0C DB, 45% RH, OA/Exh 10m^3/m^{2}hr	Split Unit/VRF Stand-by at 75% each Exhaust Fan	Type 2	
Communication Equipment Room	A/C	24^0C DB, 45% RH, OA/Exh 10m^3/m^{2}hr	Split Unit/VRF Stand-by at 75% each HRV	Type 2	
Communication Equipment UPS Room	A/C	24^0C DB, 45% RH, OA/Exh 10m^3/m^{2}hr	Split Unit/VRF Stand-by at 75% each Exhaust Fan	Type 2	
First Aid Room	A/C	26^0C DB, 50% RH, OA/Exh 30m^3/ m^{2}hr ,Smoke Exhaust	Split Unit/VRF or FCU Exhaust Fan	Type 1	
Security Room	A/C	26^0C DB, 50% RH, OA/Exh 30m^3/ m^{2}hr ,Smoke Exhaust	Split Unit/VRF or FCU HRV	Type 1	
Station Manager Room	A/C	26^0C DB, 50% RH, OA/Exh 30m^3/ m^{2}hr ,Smoke Exhaust	Split Unit/VRF or FCU HRV	Type 1	
BMS Room	A/C	24^0C DB, 45% RH, OA/Exh 10m^3/m^{2}hr	Split Unit/VRF HRV	Type 1	
Maintenance Office	A/C	26^0C DB, 50% RH, OA/Exh 30m^3/m^{2}hr ,Smoke Exhaust	Split Unit/VRF or FCU HRV	Type 1	
OCS	A/C	24^0C DB, 45% RH, OA/Exh 10m^3/m^{2}hr	Split Unit/VRF or FCU HRV	Type 1	
Training Maintenance	A/C	26^0C DB, 50% RH, OA/Exh 30m^3/ m^{2}hr ,Smoke Exhaust	Split Unit/VRF or FCU HRV	Type 1	
Staff Room	A/C	26^0C DB, 50% RH, OA/Exh 30m^3/ m^{2}hr, Smoke Exhaust	Split Unit/VRF or FCU HRV	Type 1	

Design Conditions	Outdoor Temperature: 34.5 degrees C (DB), 26.3 Degrees C (MCWB)				
Room	**AC and Ventilation Provisions**		**AC Equipment /Ventilation**	**Operation and Control Requirements**	**Remarks**
Storage	MV	Exhaust, $10m^3/m^2hr$	Exhaust Fan	Type 2	
Staff Male Toilet	MV	Exhaust, $30m^3/m^2hr$	Exhaust Fan	Type 4	See note 3
Staff Female Toilet	MV	Exhaust, $30m^3/m^2hr$	Exhaust Fan	Type 4	See note 3
Driver Waiting Room	A/C	25^0C DB, 50% RH, OA/Exh $30m^3/m^2hr$, Smoke Exhaust	Split Unit or FCU HRV	Type 1	
Shower Room	MV	Exhaust, $30m^3/m^2hr$	Exhaust Fan	Type-4	
Cleaners Room	MV	Exhaust, $30m^3/m^2hr$	Exhaust Fan	Type 4	
Male Toilet	MV	Exhaust, $30m^3/m^2hr$	Exhaust Fan	Type 4	See note 3
Female Toilet	MV	Exhaust, $30m^3/m^2hr$	Exhaust Fan	Type 4	See note 3
Toilet for the Disabled	MV	Exhaust, $30m^3/m^2hr$	Exhaust Fan	Type 4	See note 3
Railway Electrical Room	MV	Max 40^0C (HL), $10m^3/m^2hr$	2 Fans (75% flow for each)	Type 2	See note 1
Station Electrical Room	MV	Max 40^0C (HL), $10m^3/m^2hr$	2 Exhaust Fans (75% flow for each)	Type 2	See note 1
Distribution Board Room	MV	Max 40^0C (HL), $10m^3/m^2hr$	2 Exhaust Fans (75% flow for each)	Type 2	See note 1
Fire & Domestic Water Tanks and Pump Room	MV	Exhaust, $10m^3/m^2hr$	2 Exhaust Fans (75% flow for each)	Type 4	See note 1
Wastewater Treatment Plant Equipment Room	MV	OA Supply, Design air flow rate required by the plant	OA Supply Fan	Type 4	See note 1
Elevator Shaft	MV	$30m^3/m^2hr$ -Max 40^0C (HL)	Exhaust Fan	Type 1	

Abbreviation

A/C : Air conditioning
ACH : Air change per hour
AHU : Air Handling Unit
DB : Dry Bulb
FAN : Ventilation Fan
FCU : Fun Coil Unit
HL : Design flow rate shall be calculated based on the heat load.
HRV : Heat Recovery Ventilator
MV : Mechanical Ventilation
NV : Natural Ventilation
RH : Relative Humidity
VRF : Variable Refrigerant Flow
WB : Wet Bulb
TYPE 1 : Thermostat Control of Room Temperature, Continuous Operation based on the station operation hours.
TYPE 2 : Thermostat Control of Room Temperature, Continuous Operation at 24 hours/day, 7 days/week
TYPE 3 : Two fans in Parallel Software Timer Control of 24 hours/day, 7 days/week for the first fan, Temperature Sensors / Thermostat Control for the second fan
TYPE 4 : Software Timer Control at 24 hours/day, 7 days/week
TYPE 5 : Software Timer Control operation based on the station operation hours

Notes

(1) Each of two duplex fans/AC Units shall be equipped with minimum 75% of the design air flow rate.
(2) The air pressure balance shall be considered between the independent room and the adjacent spaces.
(3) Segregated extraction system
(4) The makeup conditioned air for the mechanical ventilated areas shall be drawn from the adjacent conditioned areas.

Source: JICA Design Team

2) Tunnel Ventilation System

The Tunnel Ventilation System shall be provided in tunnel ventilation room adjoining station. The Tunnel Ventilation System shall be designed based on the following:

a) The Tunnel Ventilation System size shall be calculated.
b) The Tunnel Ventilation System shall be installed to enhance tunnel temperature control by removing a portion of train generated heat while the train is within the bounds of a station.
c) This system shall involve the fans to induce airflow, silencer in accordance with acoustic criteria and filter.
d) The Tunnel Ventilation System shall be operated during normal conditions and emergency condition to remove smoke in the tunnel in case of fire in the rolling stock.
e) In case of fire in tunnel, Tunnel Ventilation System shall be provided with power from a secure supply during emergency condition

3) Hydrant and Water Pipe Connection (Siamese connection) in Tunnel

The Hydrant and Siamese connection shall be installed in tunnel in case that fire happen in the rolling stock in the tunnel and the train stops. The Hydrant and Siamese connection shall be designed based on the following:

a) If the distance between the hydrant of the adjoin stations exceeds 500 m, the hydrant and water pipe shall be installed in tunnel.
b) The hydrant for water outlet shall be installed at the interval of 200 m or less in tunnel.
c) Horizontal tunnel water pipe main size shall be calculated.
d) House storage cabinet shall be provided close to station end. Each cabinet shall be equipped with four (4) 65 mm diameter, 30 m length coiled synthetic hoses and one multi-purpose branch pipe with shut off facilities.

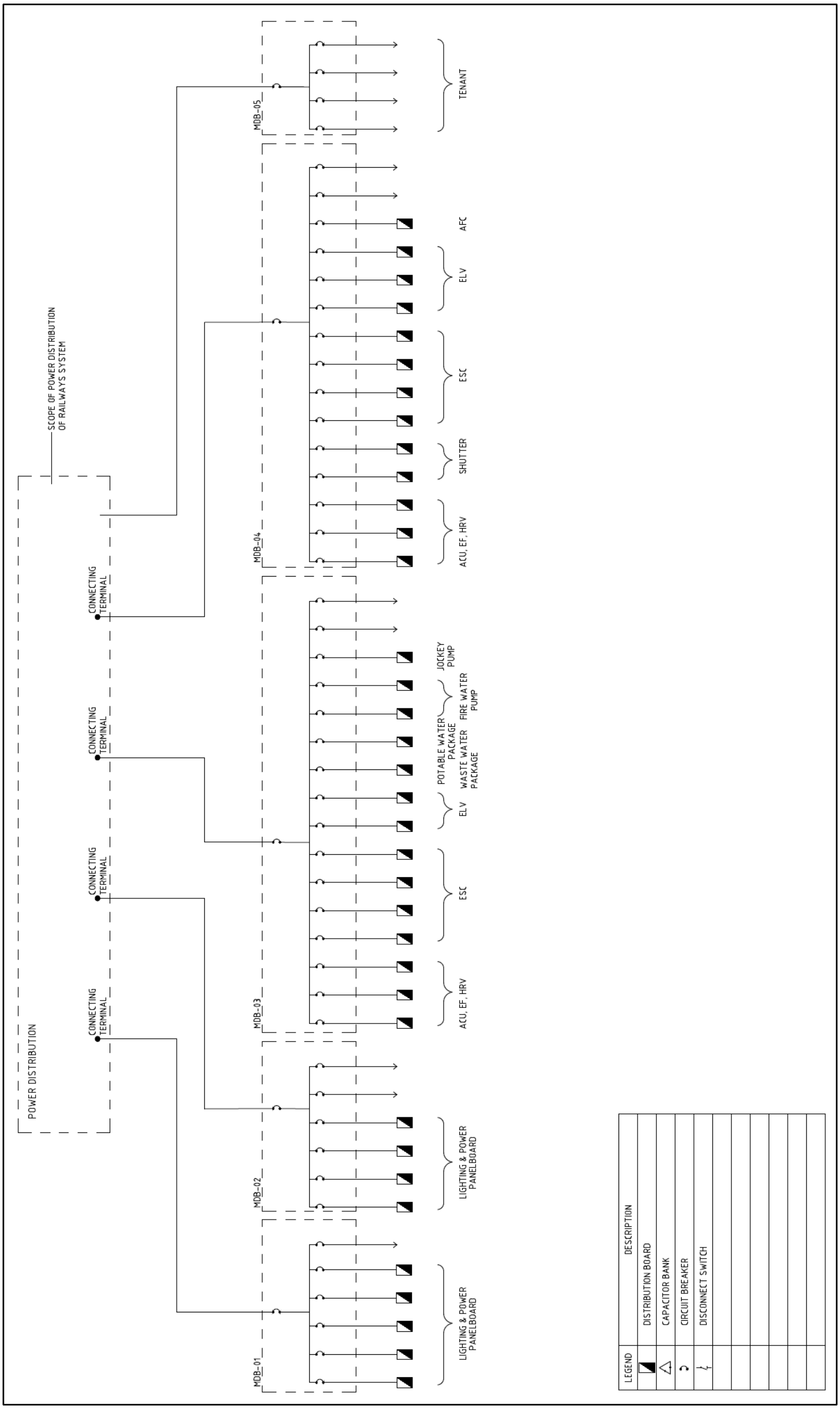
4) Drainage and Pump system

The Drainage and Pump system shall be designed to prevent flooding of the station and based on the following:

a) The Drainage and Pump system shall be installed of sufficient capacity to handle water leakage from tunnel.
b) The pump shall be submersible and be installed to provide 100% spare capacity.
c) Duty and standby pumps shall be provided with power taken from a secure supply.
d) The pumps with local control panel shall be controlled by high and low level in the sump.
e) In case the water level rises above high level, all two pumps shall work simultaneously.
f) Extra high level sump shall generate an alarm signal.
g) The pumps shall be mounted on guide rails for ease of maintenance.

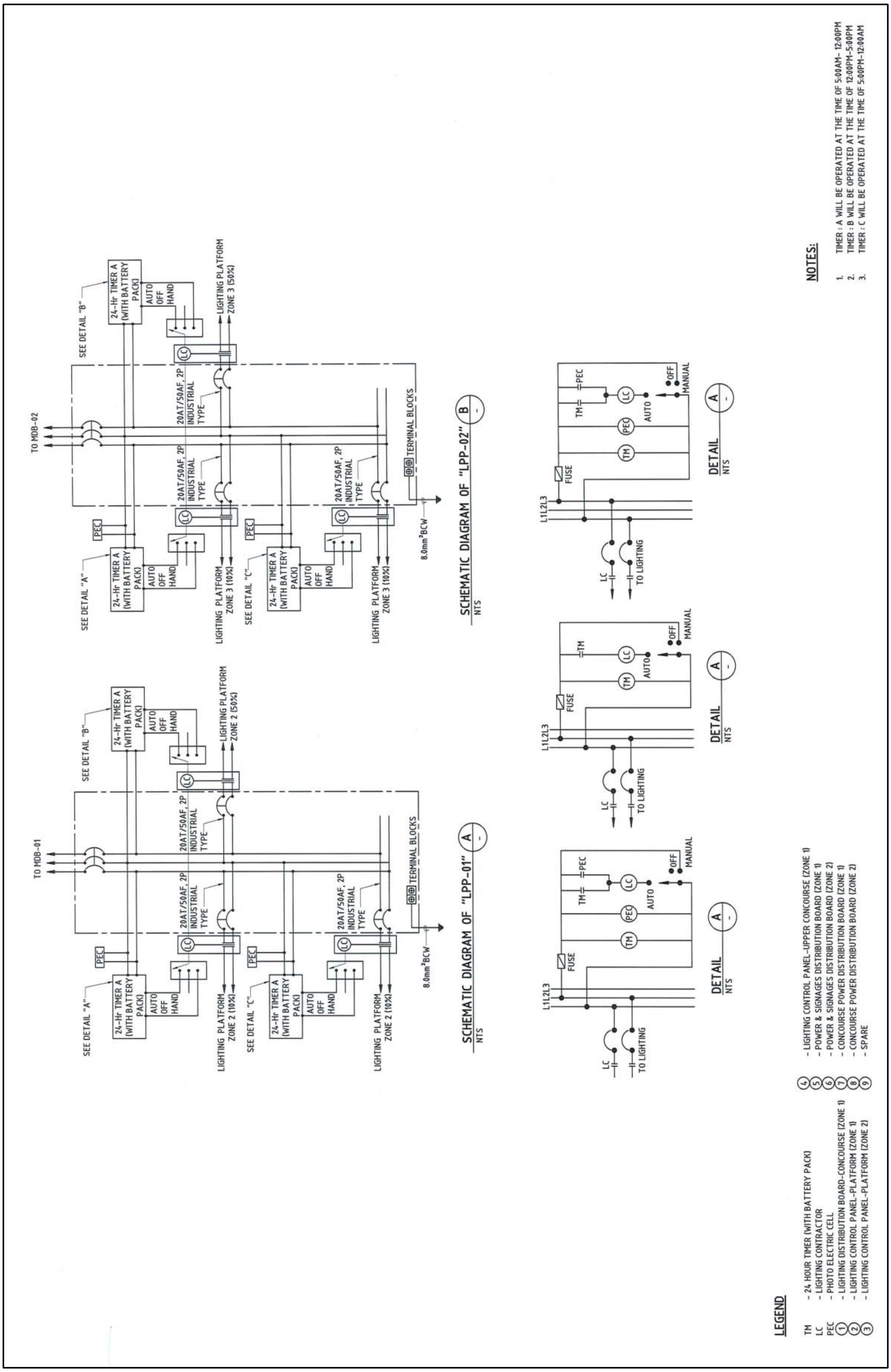
4.4.6 Station System Schematics

Station System Schematics as attached.



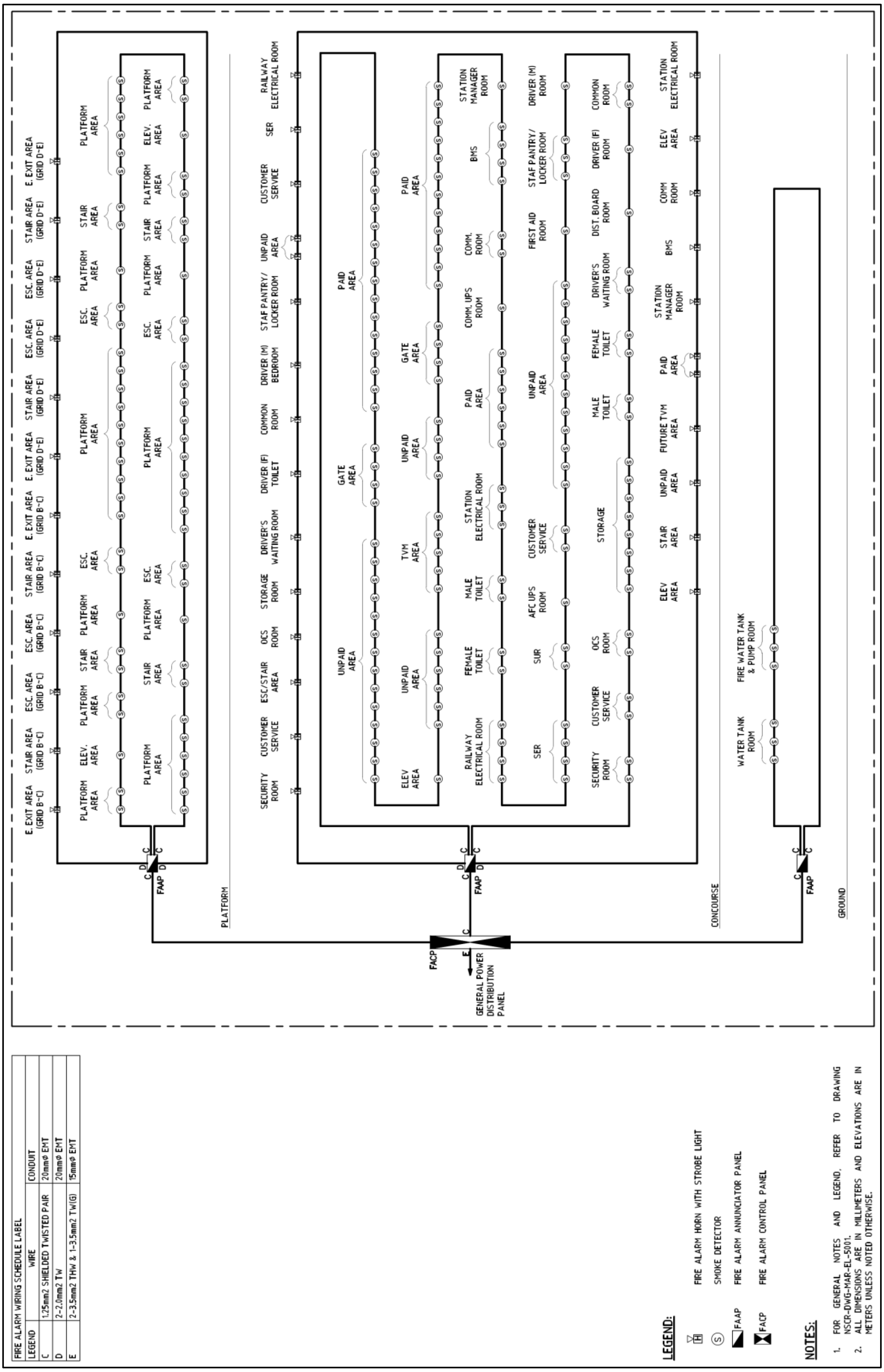
Source: JICA Design Team

Figure 4.4.69 LV Power Supply System Schematic



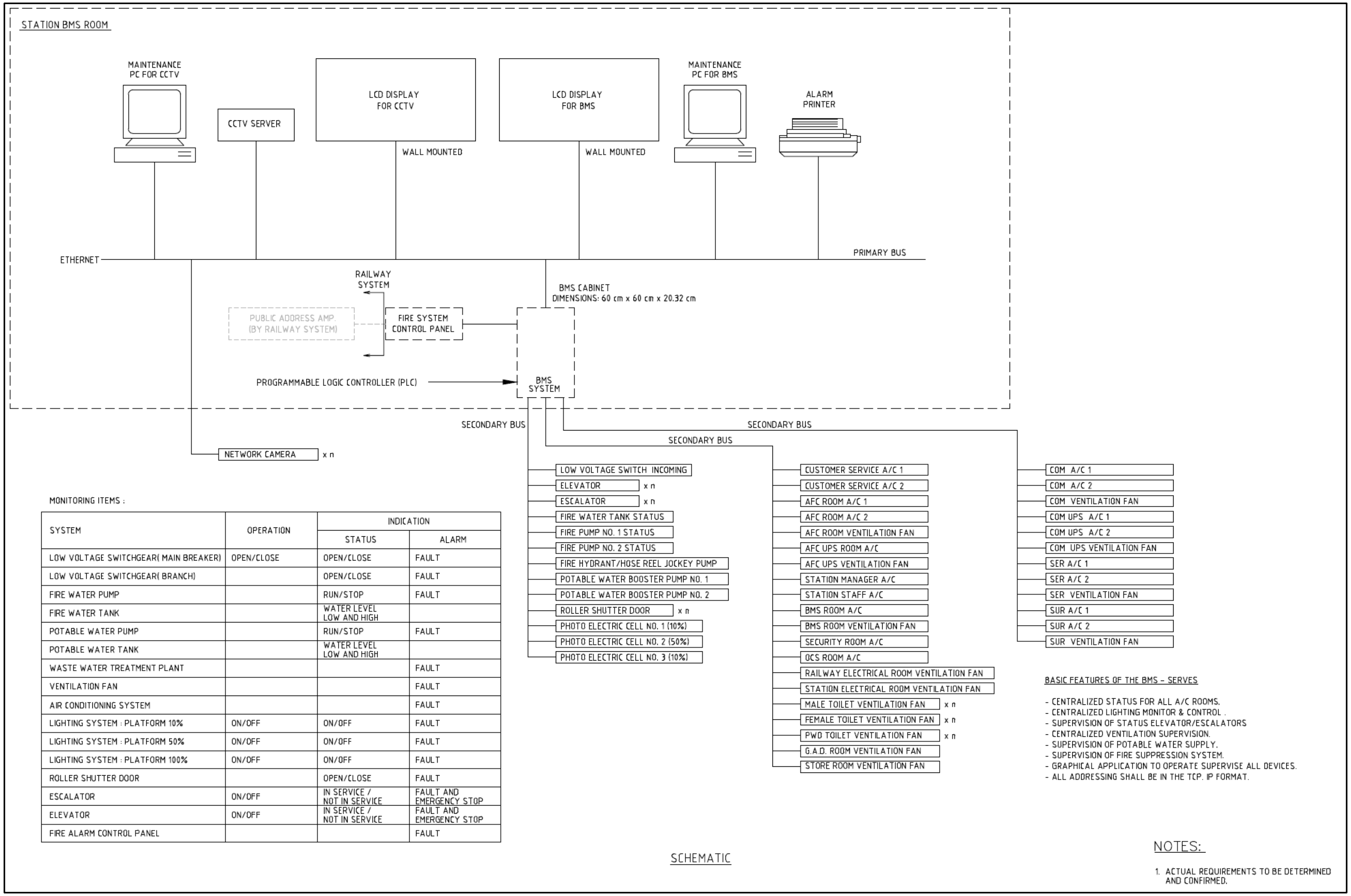
Source: JICA Design Team

Figure 4.4.70 Lighting Fixture Control Board Schematic



Source: JICA Design Team

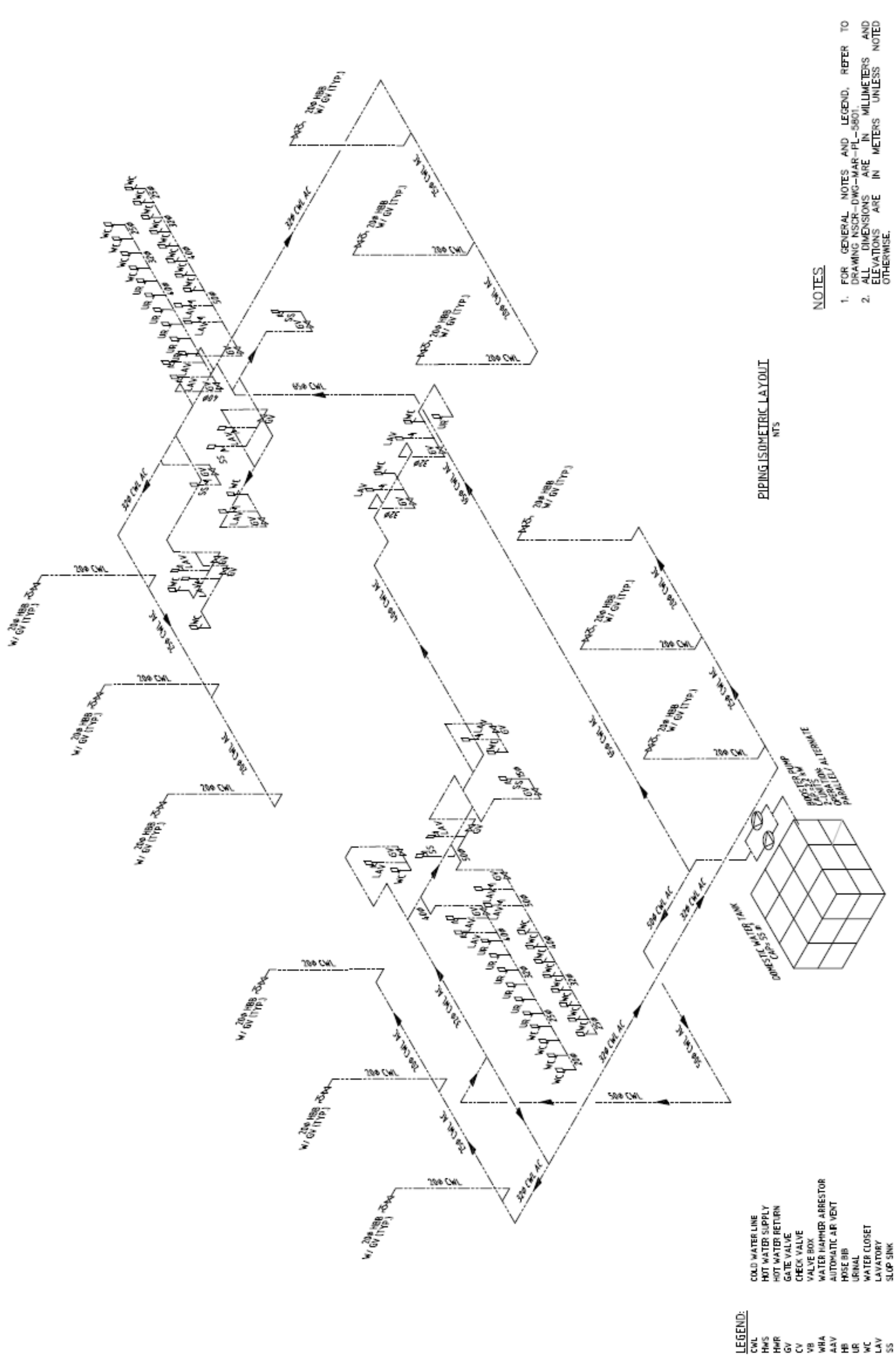
Figure 4.4.71 Fire Alarm System Schematic



SYSTEM	OPERATION	INDICATION	
		STATUS	ALARM
LOW VOLTAGE SWITCHGEAR(MAIN BREAKER)	OPEN/CLOSE	OPEN/CLOSE	FAULT
LOW VOLTAGE SWITCHGEAR(BRANCH)		OPEN/CLOSE	FAULT
FIRE WATER PUMP		RUN/STOP	FAULT
FIRE WATER TANK		WATER LEVEL LOW AND HIGH	
POTABLE WATER PUMP		RUN/STOP	FAULT
POTABLE WATER TANK		WATER LEVEL LOW AND HIGH	
WASTE WATER TREATMENT PLANT			FAULT
VENTILATION FAN			FAULT
AIR CONDITIONING SYSTEM			FAULT
LIGHTING SYSTEM : PLATFORM 10%	ON/OFF	ON/OFF	FAULT
LIGHTING SYSTEM : PLATFORM 50%	ON/OFF	ON/OFF	FAULT
LIGHTING SYSTEM : PLATFORM 100%	ON/OFF	ON/OFF	FAULT
ROLLER SHUTTER DOOR		OPEN/CLOSE	FAULT
ESCALATOR	ON/OFF	IN SERVICE / NOT IN SERVICE	FAULT AND EMERGENCY STOP
ELEVATOR	ON/OFF	IN SERVICE / NOT IN SERVICE	FAULT AND EMERGENCY STOP
FIRE ALARM CONTROL PANEL			FAULT

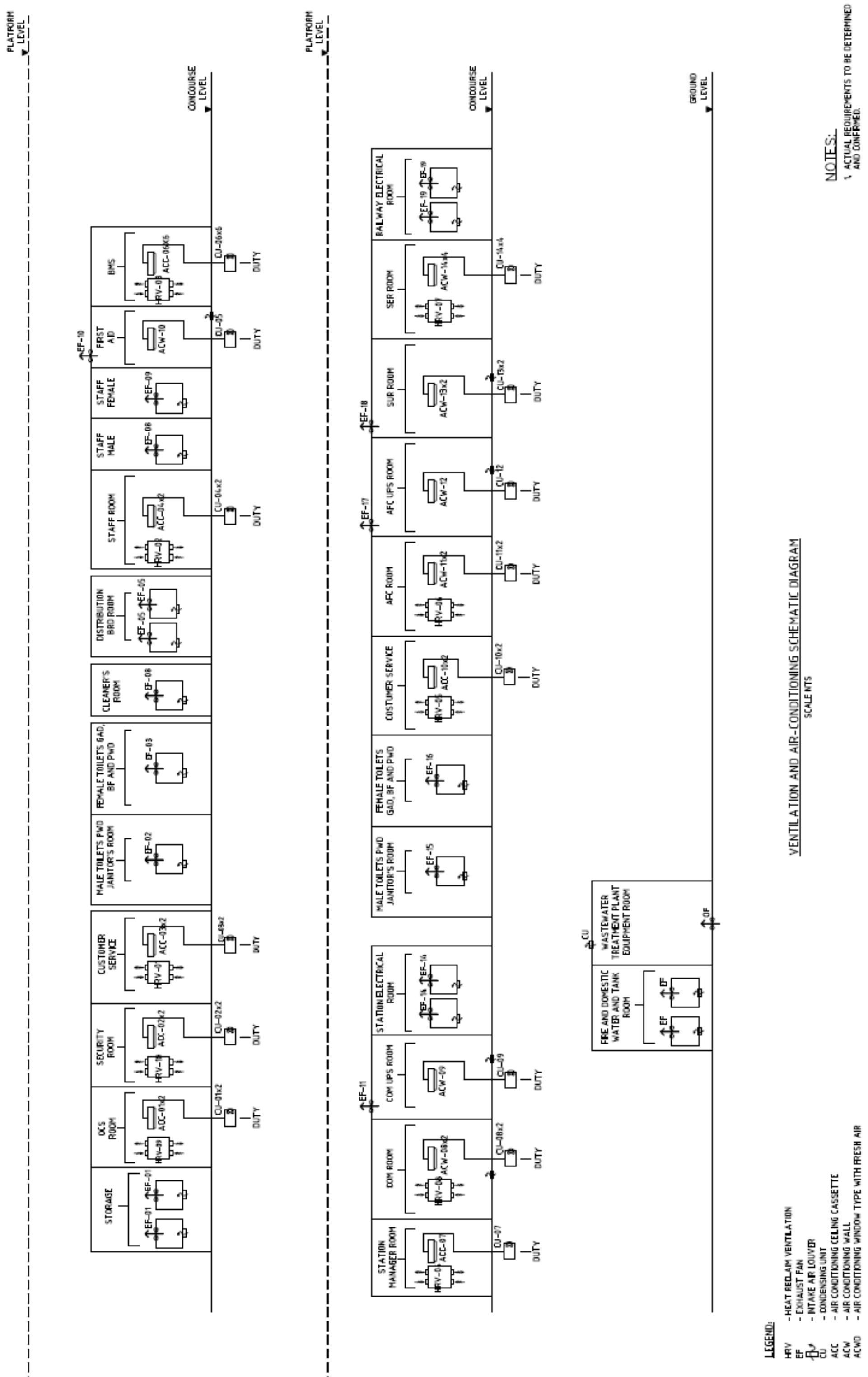
Source: JICA Design Team

Figure 4.4.72 Building Management System Schematic



Source: JICA Design Team

Figure 4.4.73 Water Supply System Schematic



Source: JICA Design Team

Figure 4.4.74 Air Conditioning and Ventilation System Schematic

4.5 North Depot

4.5.1 Design Concepts of the Depot

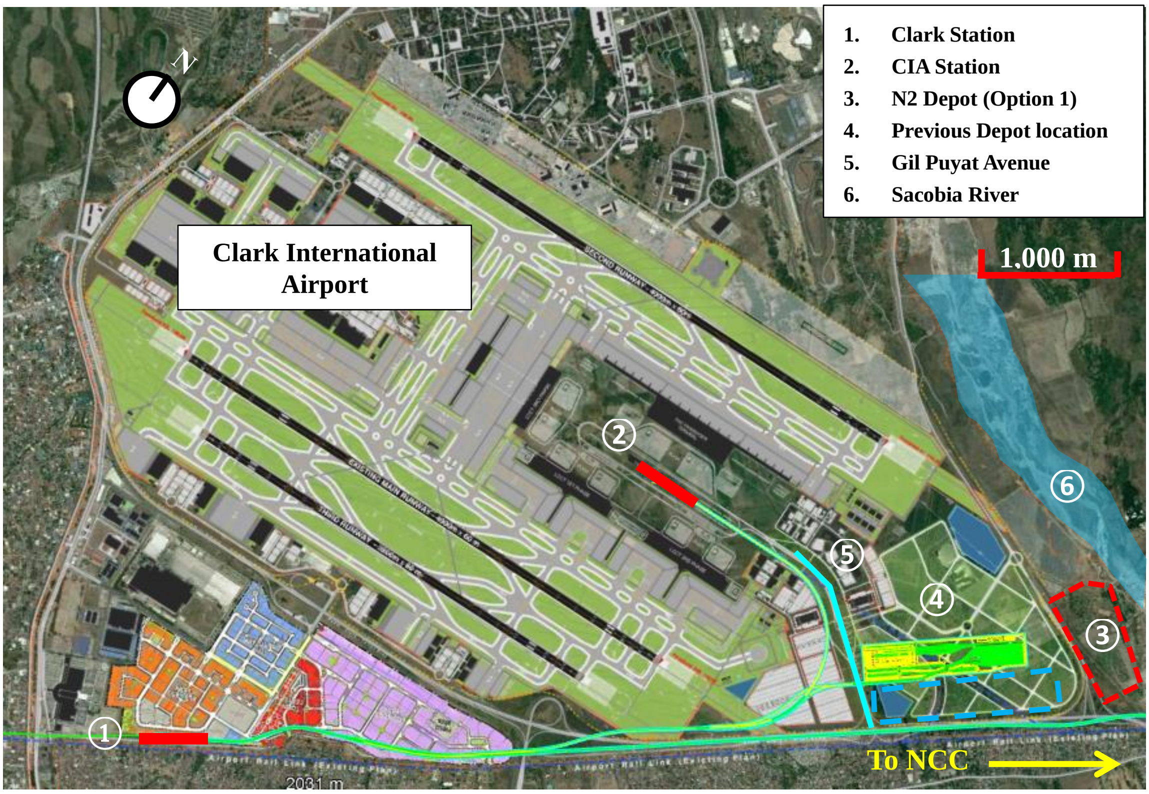
The North Depot was initially planned to be located north-east of Clark International Airport between Prince Balagtas Avenue and Sacobia River (Option 1). However, it was later concluded to relocate the North Depot from its initial location to an area between Prince Balagtas Avenue and Gil Puyat Avenue (Option 2) because of the following reasons:

a. The results of the flood analysis after the depot construction showed that the depot increased the flooding level a t the depot location and its surrounding localities.
b. The site survey showed that the many houses are residents in the original depot location proposal (Option 1), as shown in Figure 4.5.15.

The summary of the flood analysis after the influence of the construction of the depot structure is presented in 4.5.9. In this context, this section describes the North Depot at the new location (Option 2).

(1) Location of Depot

The North Depot is to be located north of Clark International Airport (CIA), between Prince Balagtas Avenue and Gil Puyat Avenue and the approximate total area of the depot is around 33 hectares. In addition, the Subic Clark Railway Depot is planned to be located next (east side) of the North Depot. Figure 4.5.1 shows the location of the North Depot and its current and future surrounding features.



Source: JICA Design Team

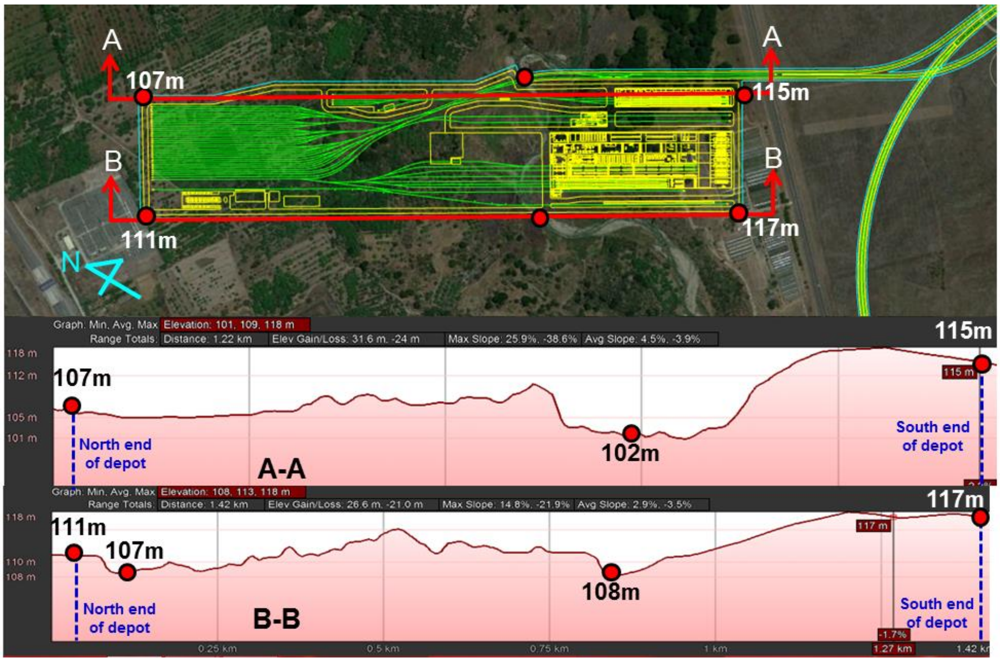
Figure 4.5.1 Location of North Depot

(2) Natural Condition of Depot Site

1) Terrain

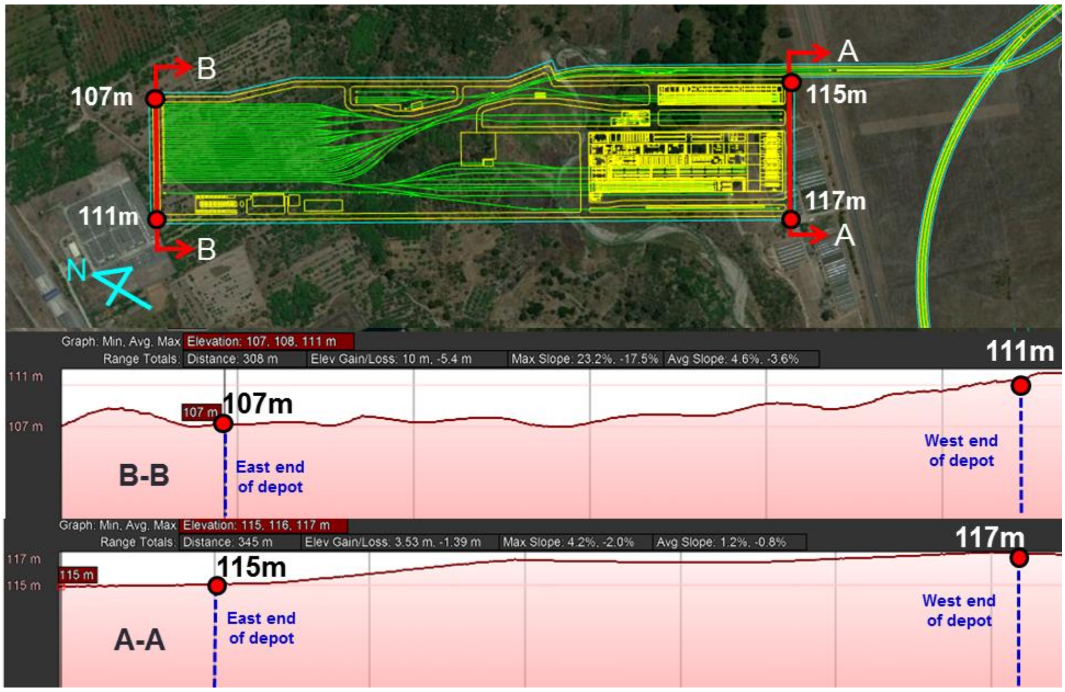
The topographical conditions of the final North Depot site are presented in Figure 4.5.2 and Figure 4.5.3 extracted from the satellite data of Google Earth. Dolores River crosses the depot layout from west to east as shown in Figure 4.5.4. Longitudinally (A-A and B-B cross sections in Figure 4.5.2), the ground elevation decreases drastically from approximately 117m ~115 m a.s.l to 107 m a.s.l along. Transversally (west-east), the ground elevation of the depot is higher on the west side of the depot, decreases by approximately 2~4m towards the eastern side of the depot (Figure 4.5.3). Based on the above, the maximum height of the depot is 117m a.s.l on the south west side, and the minimum elevation is 107m a.s.l on the north east side, with a maximum height difference of 10m.

Additionally Dolores River (Figure 4.5.4) traverses the depot from west to east, decreasing in elevation from the west (108m a.s.l) to the east (102m a.s.l.), with a total height difference of 6m and with a slope gradient of approximately 2%.



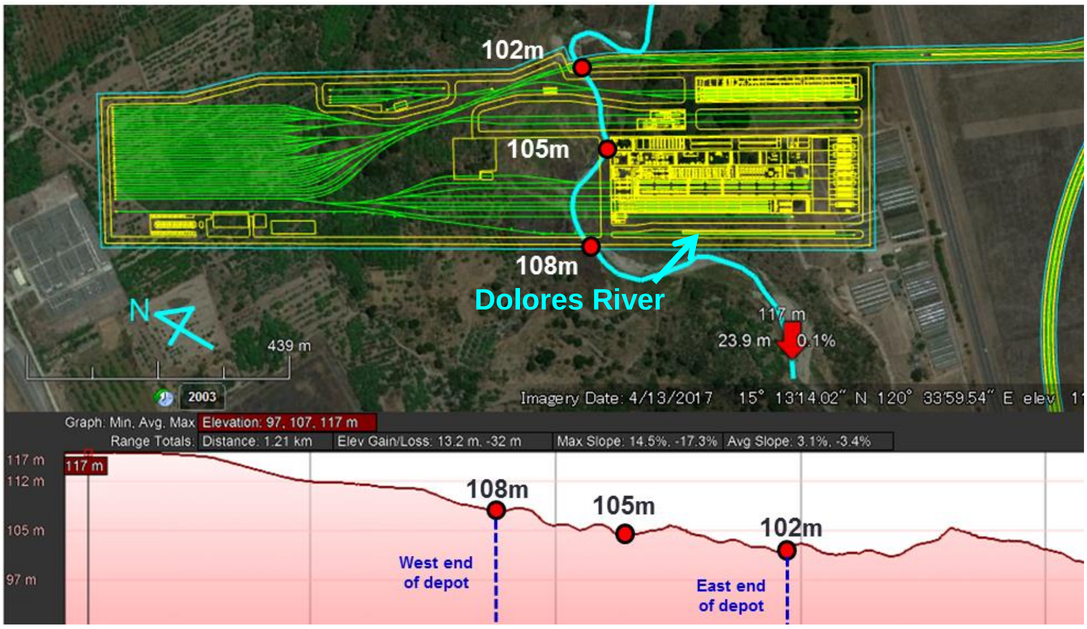
Source: JICA Design Team

Figure 4.5.2 Topography of depot location showing longitudinal (north – south) elevations



Source: JICA Design Team

Figure 4.5.3 Topography of depot location showing transvers (east – west) elevations



Source: JICA Design Team

Figure 4.5.4 Topography of Dolores River from west to east direction

(3) Design Condition of North Depot

1) Facilities in the Depot

The track structure in the depot is Ballasted Track and the required facilities shown below should be placed properly.

a) Train storage tracks
b) Rolling stock maintenance facilities
c) Operation control center (OCC)
d) Catenary and track maintenance shops
e) Sub stations
f) Sewage treatment plant, storm water reservoir, emergency facility
g) Access road inside depot, car parking, light, fence etc.

Table 4.5.1 Required Number of Tracks and Facilities in the North Depot

Item	No. of tracks	Remark
Storage track	33 tracks	Two additional trains can be parked in the Light Repair Shop
Access track	1 double-track	
Light repair track	3 tracks	For regular inspection at Light Repair Shop
Car washing track. (Automatic)	1 track	
Wheel re-profiling track	1 track	
Final adjustment track	3 tracks	in the Main workshop
Unscheduled repair track	1 track	
Shop-in/ -out track	3 tracks	in the Main workshop
Underfloor cleaning track	1track	
Track maintenance car track	1 track	
Stabling track for OCS	1 track	

Source: JICA Design Team

2) Permissible Deformation of the Railway Truck in the Depot

The track of the depot is proposed to be ballasted. The permissible deformation of the railway track, it is the ballasted track, in the case of liquefaction during an earthquake or consolidation settlement of the ground under the depot can be determined as shown in Table 4.5.1 Required Number of Tracks and Facilities in the North Depot in accordance with "Design Standards for Railway Structures and Commentary - Earth Structure" published by Railway Technical Research Institute.

Table 4.5.2 Permissible Deformation of the Railway Tracks (Ballast Track)

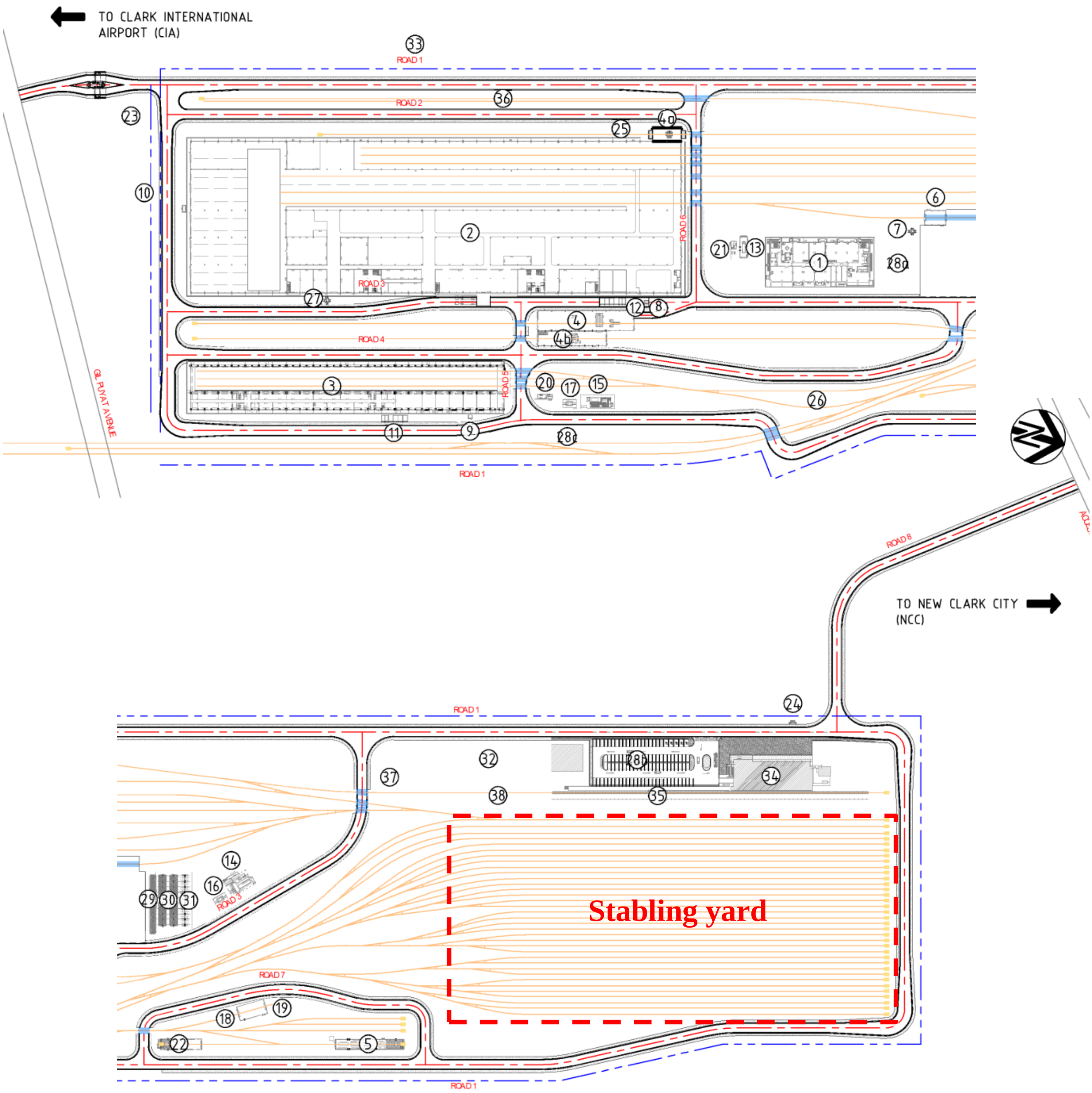
Level of the settlement	Grade 2
Situation of damage	Small
Criterion for ballast track	Normal Embankment; less than 20cm Gap between an abutment or a earth retaining structure and the backfill; less than 10cm

Source: Design Standards for Railway Structures and Commentary-Earth Structure" (Railway Technical Research Institute)

(4) Depot Track and Facilities Layout

1) Stabling Tracks

North Depot have 33 stabling tracks arranged in 1 storage yard. An additional two tracks in Light Repair Shop can be utilized as stabling tracks, to give a total space of 35 train parking spaces. Also North Depot have an access track which is double track and at-grade coming from Clark station and crossing Gill Puyat Avenue. The stabling track layout is presented in Figure 4.5.5



Source: JICA Design Team

Figure 4.5.5 Layout of the South Depot Stabling Tracks

2) Buildings and Facilities of the Depot

The buildings and the railway system facilities necessary for the maintenance and operation of the depot are shown in Table 4.5.3 and the location of the facilities are shown in Figure 4.5.5.

Details of the buildings and its E&M facilities are described in section 4.3.

Table 4.5.3 Facilities and Building necessary in the South Depot

List of Building and Facility (No. of building and Facilities are shown in Figure 4.5.5)	
1. OCC BUILDING	20. FIRE WATER TANK
2. WORKSHOP	21. SUPPLY AND FIRE WATER TANK
3. LIGHT REPAIR SHOP	22. TRACK MAINTENANCE OFFICE
4. WHEEL RE-PROFILING SHOP	23. SECURITY HOUSE 1
4a. UNDERFLOOR CLEANING SHOP	24. SECURITY HOUSE 2
4b. UNSCHEDULED REPAIR SHOP	25. RAIL CAR WATER TIGHTNESS TEST SYSTEM
5. CATENARY MAINTENANCE VEHICLE SHOP	26. CAR WASHING TRACK
6. SHUNTING CAR SHOP	27. FUEL PUMP TANK FOR BOILER IN WORKSHOP (UNDERGROUND)
7. FUEL PUMP HOUSE	28. CAR PARKING (216 SPACES)
8. OIL STORAGE FOR WORKSHOP	29. BICYCLE PARKING WITH ROOF
9. OIL STORAGE FOR LIGHT REPAIR SHOP	30. COVERED MOTORCYCLE SHED (83 SPACES)
10. HAZARDOUS STORE	31. OPEN MOTORCYCLE SHED (44 SPACES)
11. GARBAGE SHED FOR LIGHT REPAIR SHOP	32. DETENTION BASIN 1
12. GARBAGE SHED FOR WORKSHOP	33. DETENTION BASIN 2
13. TRUCK GARAGE	34. TRAINING CENTER
14. SUBSTATION 1	35. MOCK-UP PLATFORM 1
15. SUBSTATION 2	36. MOCK-UP PLATFORM 2
16. DISTRIBUTION BOARD SPACE 1	37. LEVELCROSSING FOR TRAINING
17. DISTRIBUTION BOARD SPACE 2	38. MOCK-UP TRACK
18. MAINTENANCE CAR SHOP	
19. FUEL PUMP AND TANK FOR MAINTENANCE	

Source: JICA Design Team

3) Internal Roads

The internal roads in the depot are designed in consideration of the width necessary for the transportation of the train cars or large size equipment and accessibility between buildings and facilities within the depot.

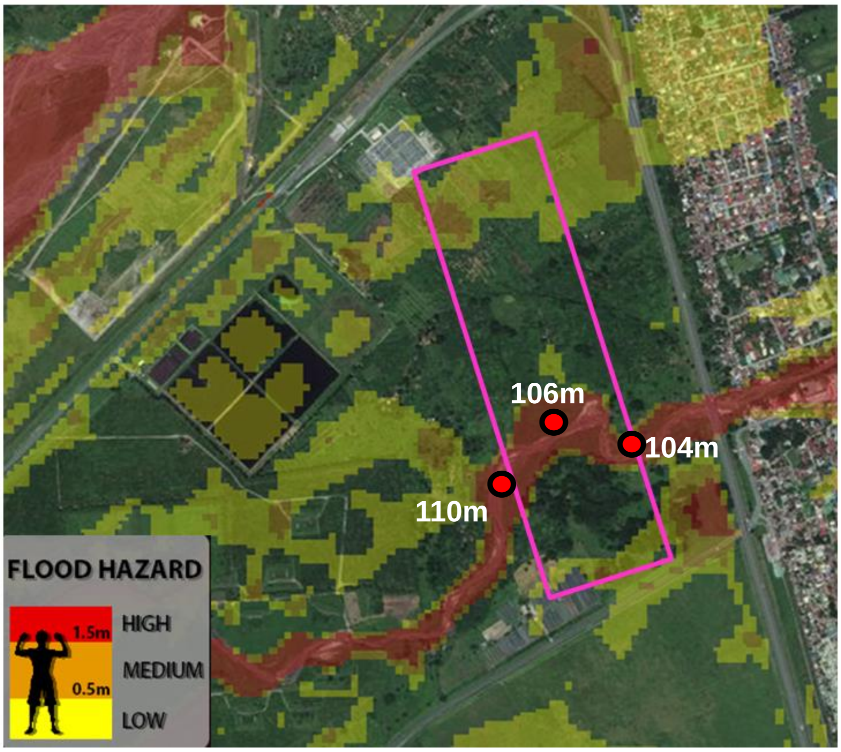
The internal roads of the depot are planned in consideration of the points listed below.

1. Provide 2-lane roads on the outer periphery of the depo layout as much as possible for the access, loading and unloading of heavy trucks carrying train cars, heavy machinery, ballast, and other heavy duty utilities used in the depot.
2. Build roads between buildings and facilities and access to parking lots.
3. The internal roads are designed in accordance with the standard specified by DPWH; the width of the peripheral depot road is 3.35 m (total width is 0.5+3.35+3.35+0.5=7.7m), the width of the other internal roads is 5.0 m (1lane) to 7.7 m (2 lane).
4. The corners of the roads are widened to enable trailers carrying train cars to make the curve considering the trajectory of the trailers.

Also 1 m to 2 m width footpath arranged beside the internal roads within an area which does not affect the usage of buildings or facilities in the depot.

4) Height of Depot

The height of the depot is determined based on the ground elevation and the highest flood level of Dolores River. In addition, the depot formation level shall consider the depot access tracks. As shown in Figure 4.5.6, the maximum flood level of the Dolores River predicted by the NOAH flood hazard map reaches does not overflow to surrounding area seriously. A detailed flood analysis of the Dolores River shall be conducted after complete topographic survey for the north depot to establish the maximum flood level of the Dolores River.
In addition, this hazard map expected that the maximum 1.5m depth flood will be occurred both in north side and south side of the depot area.



Source: JICA Design Team

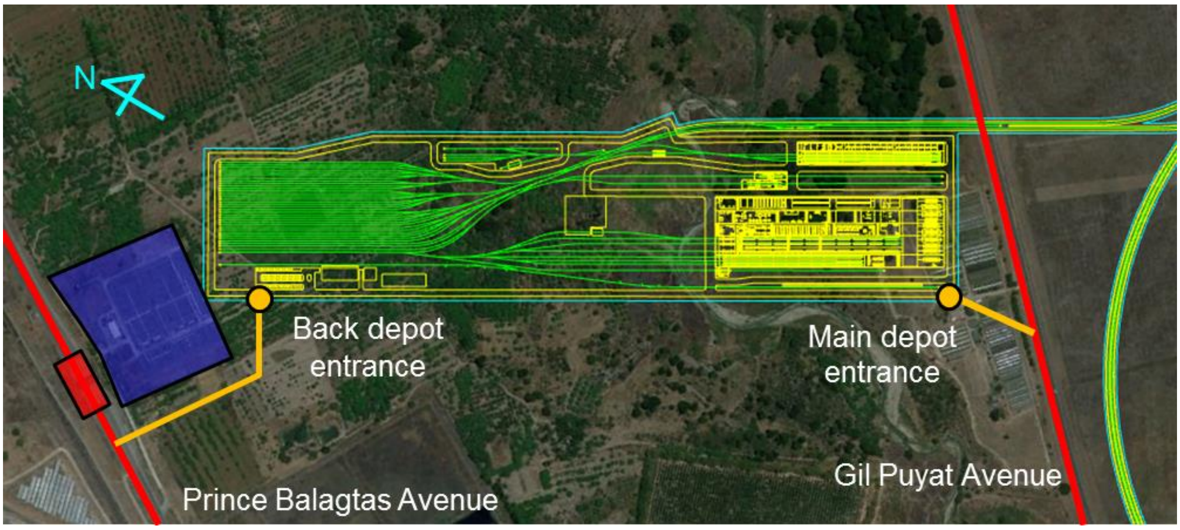
Figure 4.5.6 NOAH 100 year return period flood levels at depot site

5) Depot Access Roads

The main road to access the depot shall be planned considering convenient accessibility for employees, visitors, transportation of equipment such as new train car, ballast, sleeper, rail etc. during the operation of the depot. Additionally, it is also crucial to secure convenient and efficient roads that will allow access during construction.

The North Depot is located between Prince Balagtas Avenue (4 lanes) on the north and Gil Puyat Avenue (4 lanes) on the south, giving ideal accessibility to the depot during its construction and operation. Both roads serve as the main accesses from Subic-Clark Tarlac Expressway (SCTEX) and MacArhur highway into Clark International Airport (CIA). In this regard, the depot will have two access routes, one on the south-west of the depot from Gil Puyat Avenue, and another entrance on the north-west from Prince Balagtas Avenue (Figure 4.5.7).

Given that it is expected that Gil Puyat Avenue will become the main entrance to Clark International Airport (CIA), it is planned that Gil Puyat Avenue will mainly serve as access for light to medium size vehicles while the entrance of Prince Balagtas Avenue will serve mainly for large vehicles transporting materials, rolling stock and other heavy equipment during the construction and operation of the North Depot.



Source: JICA Design Team

Figure 4.5.7 North Depot access roads

(5) Settlement at Depot Location

Based on the soil investigation and laboratory test results, a settlement and liquefaction assessment has to be determined. If required, adequate counter measures to reduce any adverse impact to the depot structures will be designed. Due to the large embankment needed as the supporting structure in the North Depot and the soil conditions of the area, it is expected that soil improvement will be required at the depot site. A detailed analysis and assessment will be conducted once the geotechnical parameters are available.

(6) Depot Crossing with Dolores River

Since the North Depot is planned to be on top of Dolores River, the upstream (west side) and downstream (east side) of the river is planned to be connected by means of a box culvert beneath the depot. The cross section of the box culvert will be determined after the topographical survey of the depot location is completed. The size of the box culvert shall be sufficient in size as not to affect the natural river stream and flood level upstream of the depot location.

(7) Drainage System

The drainage system in the depot include the storage track yard shall be designed properly.

The perimeter drainage is also installed along the periphery of the depot between the retaining wall and boundary to prevent that the rainwater fallen outside of the depot will not flow into the depot. Details of the drainage system are described in section 4.5.6.

(8) Other Facilities

Other facilities such as the entrance, guard house, lighting system, fence, etc. shall be located and designed properly. Details of the fence and the gate are described in section 4.5.7.

4.5.2 Design of the Depot Buildings

The Depot is expected to be the hub of the entire railway system and service. Being central to railway system as well as containing the Operations Control Center and administrative offices, the Depot is expected to be the repository of all key technologies for the system i.e. rail system, rolling stock, O&M operations, and the like. As such, it must be maintained as a highly secure area that must be safe even if external threats are present at the host site but it must never pose a danger to the host community.

(1) Design Policy and Concepts in the Depot Buildings Design

Design policy of the Depot buildings are as follows:

1) Design policy

The implemented design standards for the design of the station buildings are mostly Philippine standards. (see Table 4.5.4 below). However, in certain instances where the local standards are limited or does not consider some relevant aspects of the design, the design follows Japanese standards.

Table 4.5.4 Building Design Standard

	Philippine Laws/ Standards	Japanese Standards
Urban Planning and Environment	• RA7279 - urban development & housing act of 1992 • P.D.s and IRRs (as applicable) e.g. 1586 – environmental impact statement system; 1216 – open spaces; 1151 – environmental policy; 1152 – environmental code; 1067- water code; 957 – subdivisions & condominiums; 953 – tree-planting; 856 – sanitation code; 757 – national housing authority; 296 – clear waterways; • duly-approved local government unit (LGU) Zoning Ordinance (ZO, with official zoning map/ OZM) i.e. based on the duly-approved Comprehensive Land Use Plan (CLUP) • special development-related LGU ordinances, as applicable • environmental laws and regulations e.g. clean air (RA8749), clean water (RA9275), solid waste management (RA9003), toxic waste (RA6969), climate change adaptation (RA9729), disaster risk reduction & management (RA10121), environmental impact assessment, heritage conservation (RA10066); indigenous peoples (RA8371), environmental planning (RA10587), resettlement & socialized housing (BP220), department of environment & natural resources (DENR) department administrative orders (DAOs),	N/A

	Philippine Laws/ Standards	Japanese Standards
	• Housing and Land Use Regulatory Board (HLURB) issuances e.g. guidebooks, guidelines, standards, manuals, etc. • Department of public works & highways (DPWH) Design Guidelines, Criteria & Standards (DGCS) Vol. 6 Public Buildings & Other Related Structures 2015 • Department of transportation (DOTr) transportation planning studies	
Building and Space Planning / Barrier-Free Design	• PD1096 - National Building Code of the Philippines (NBCP), its 2004 Revised Implementing Rules and Regulations (IRR) and derivative regulations (DRs), including DPWH issuances such as DAOs and Memorandum Circulars (MCs) • Referral Codes of the NBCP (both laws and self-regulatory documents) such as BP344 - Accessibility Law; the Philippine Electrical Code (PEC), the Mechanical Code, the National Philippine Electrical Code Plumbing Code of the Philippines, DPWH 2000 architectural code of the Philippines (ACP, as applicable) and the like • DPWH DGCS Vol. 6 Public Buildings & Other Related Structures 2015 • DPWH-promulgated 2015 Philippine Green Building Code (PGBC) • Department of Energy (DoE) Guidelines on Energy Conserving Design on Buildings, 2008 • RA6716 - rainwater collection • 2016 NBCP: Illustrated data compact disc (CD)applicable standards by other infrastructure agencies such as the Department of Transportation (DoTr) • applicable DoTr standards • RA386, the 1949 New Civil Code of the Philippines • BP 344 - Accessibility Law and its IRR • RA7277, The Magna Carta for Disabled Persons	• The Building Standard Law of Japan. • Ordinance of the Building Standard Law of Japan • Guideline to Improve Barrier Free Access for Public Transport Passenger Facilities for the Enforcement of 2006 LAW N.19. Edited by Ministerial Ordinance MLITT of Japan
Fire Protection and Safety Evacuation Design	• PD1096 - National Building Code of the Philippines (NBCP) & 2004 Revised IRR • RA 9514 - Fire Code of the Philippines (FCP) and IRR of 2008 • Philippine Mechanical Engineering Code • Philippine Electrical Code • DPWH DGCS Vol. 6 Public Buildings & Other Related Structures 2015 • Illustrated FCP	• The Building Standard Law of Japan (Ministerial Ordinance, MLITT of Japan) • The Fire Laws of Japan (The Fire Defense Agency of Japan)
Building Material	• 2013 DPWH Standard Specifications • PD1096 - National Building Code of the Philippines (NBCP) & its 2004 Revised IRR • DPWH Bureau of Research & Standards (BRS) certification, if applicable • Dept. of Trade & Industry (DTI) Bureau of Product Standards (BPS) product certification, if applicable • National Structural Code of the Philippines (NSCP) 2010	• Japanese Industrial Standards (JIS)

Source: JICA Design Team

2) Sustainable design (Environment protection, natural energy);

a) Environmental load-reducing and attention to circumference environment;

The depot must never become an environmental nuisance to the host community at any time during its entire design life.

b) Natural energy (Solar panel system);

Design for roof-mounted solar panels where feasible on the OCC and WS building if it will be necessary in the future.

3) Design for the Philippine climate and culture.

a) Seismic design;

Refer to the 4.5.4 Structure Design for the Depot Buildings.

b) Thermal insulation;

Design for the Tropics (the hot-humid Philippine climate)

Solar and prevailing (and storm) wind orientations of the Depot building;

c) Easy maintenance;

Use simple form and smooth materials.

d) Security;

Safety, security and privacy will be considered in the design.

Security camera are arbitrarily installed in the building.

(2) Design Specifications of Depot Buildings

1) Building/ Structure Types

The Depot buildings to be built above grade are as follows:

- Operation control center (OCC) building;
- Workshop;
- Light repair shop;
- Unscheduled repair shop;
- Underfloor air-blow shop;
- Wheel re-profiling shop;
- Catenary maintenance vehicle shop;
- Shunting car shop;
- Fuel pump house;
- Oil storage for workshop;
- Oil storage for light repair shop;
- Hazardous store;
- Garbage shed for light repair shop;
- Garbage shed for workshop;
- Truck garage;

- Substation 1;
- Substation 2;
- Distribution board space 1;
- Distribution board space 2;
- Maintenance car shop;
- Water pump house 1;
- Water pump house 2;
- Track maintenance office;
- Security house 1;
- Security house 2;
- Bicycle parking shed;
- Motorbike parking shed

4.5.3 Architectural Design for the Depot Buildings

(1) Building Design

Building design of Depot are as follows:

1) Most of the Depot buildings shall be at 1 level, but roof height will be very high due to building usage;
2) The vertical access system shall consist of an array of stairs, elevators (only as absolutely needed) and ramps;
3) The height of the Depot building is in relation to adjacent/ neighboring buildings/ structures, which affect shadows cast and wind speed/ air movement for ventilation purposes;
4) Natural ventilator and high side light are applied for saving energy.

1) Plan of Buildings

Plans of the Depot buildings are as follows:

a) The Column put in equally intervals span make contribute for structural performance and economic efficiency.
b) Area of room is accounted by demands of functions and needed personnel numbers.
c) Efficient pipe plan and avoidance of leaking water under rooms by concentrating the area using water and aligning the vertical position is
d) Hall way is simply short for daily operations and escape in emergency.

2) Elevation

Elevation planning of the Depot buildings are as follows:

a) Depot buildings is unified design image by adopting integrated exterior wall finishes of building.

b) It is harmonious for landscape to adopt soft colors on exterior materials with simple design.
c) Windows and louver of buildings are designed by considering function and operations.
d) The size of doors is designed by referring to demands of E/M system team.

3) Section

Section planning of the Depot buildings are as follows:

a) Height of ceiling is basically 2.7m but be arbitrarily modified by considering condition.
b) The room high ceiling is put on upper floor of the building for considering structural stability.

(2) Finishing Materials

Finishing materials of the Depot buildings are as follows:

1) Exterior Finishing

a) Wall: exterior cladding of insulated aluminum composite panel on painted steel frames;
b) Roof: built up steel supports; pre-painted metal roof with injected insulation; provide roof-mounted solar panels where feasible if it will be necessary in the future.

1) Interior Finishing

a) Floor: polished concrete flooring or epoxy-painted concrete flooring (where required);
b) Wall: interior walls shall be of concrete hollow block (CHB) construction and gypsum board;
c) Ceiling: exposed roof insulation.

4.5.4 Structure Design for the Depot Buildings

(1) Structural Materials

Major structural materials to be used in the Project conform to ASTM (American Society of Testing and Materials) or JIS (Japanese Industrial Standard) as follows:

- Concrete: Normal concrete with the design standard strength f'c = 31 MPa (to be applied to other than the below)
  Normal concrete with the design standard strength f'c = 36 MPa (to be applied to the in-situ concrete bored piles)
- Reinforcing Bars: Deformed bars
  D10, D12 (or D13) ASTM A615 Grade 40, or JIS G 3112 SD295A
  D16 and more ASTM A615 Grade 60, or JIS G 3112 SD390
- Structural Steel: ASTM A36 “Carbon Structural Steel”, or
  JIS G 3101 SS400 “Rolled Steel for General Structure”

(2) Structural Basic Design

The primary function of the Depot is the maintenance and inspection of the rolling stocks and the associated infrastructure in the Project, which will be of an industrial nature. Among these series of the buildings, the Workshop (hereinafter referred to as WS) and the Light Repair Shop (LRS) are the main buildings. In addition to those, the Operations Control Center (OCC) and the Training Center (TC) Building are planned within the Depot.

1) Workshop and Light Repair Shop

a) The salient structural features of the superstructures of the WS and LRS

The salient structural features of the superstructures of the WS and LRS include the followings:

i) Steel roof and wall cladding on the cold formed purlins and girts are provided on the structural steel beams and columns;

ii) The internal structural steel columns with the steel corbels are provided to support the overhead gantry cranes where required. Dependent on the gantry crane capacity and function, sufficient clearance shall be secured above and below to ensure the performance requirements as specified by the manufacturer and Depot engineers are satisfied;

iii) The lateral resistance against earthquake or strong wind in the transverse direction is via portal action, assuming semi-fixed supports consisting of anchor bolts and steel base plates for the portal columns.
Through the provision of the horizontal roof braces, the longitudinal lateral loads caused by earthquake or strong wind are transferred to the vertical wall bracing, which then transfer the lateral load down to the foundation level;

iv) Among the primary beams in the WS, those with a span of 30 m are planned to be truss type beams in order to reduce both their self-weight and construction cost.

v) The mezzanine level in the WS consists of the in-situ RC slabs supported on the permanent steel formwork on the structural steelwork beams (with shear studs) and columns;

vi) To eliminate the adverse effects on the structures due to temperature fluctuation, and to remove accumulation of erection errors, two or three expansion joints are introduced in the longitudinal directions of each building, which make each building component less than 100 meters in length; and

vii) Considering the roof huts for natural ventilation installed on the main roof are structures that are set on the long span beams, they are planned to be of lightweight structures with high safety.

b) The slab and foundation structures on the ground floor of the WS and LRS

The slab and foundation structures on the ground floor of the WS and LRS include the followings:

i) Concrete slabs on the ground floor are planned to have suitable abrasion resistance against vehicular and forklift wheel loads;

ii) As the floor is planned as suspended structural slabs, no expansion joints are introduced on the ground floor. However, since the concrete casting area is so large, it is envisioned that the ground floor will be cast in a number of sections separated by the construction joints. Typically, the contractor will propose the location and details of the construction joints based on their batching volume capacity and their ability to manage the curing requirements as per the specification. The proposed construction joints shall be detailed so as to mitigate any potential issues due to the concrete contraction between the adjacent concrete casting sections;

iii) A number of floor pits with varying shapes and depths to maintain the rolling stocks are planned on the ground floor. After commencement of the construction work for the ground floor slab, it may be necessary to revise the layout and/or extent of these floor pits to coordinate the specific machinery to be installed. To minimize any undesirable effects to the primary structures, no foundation beams in the transverse direction are installed to the areas where a number of floor pits are planned. Any column supported directly by the pile cap without employing foundation beams are planned to have a pair of piles, regardless of the axial force of the column, in order to resist the bending moment transmitted from the column base through tension/compression pile couple forces;

iv) To minimize undesirable effects of noises and vibrations caused by the piling work to the neighborhood, cast-in-place concrete bored piles are planned, which generate minimal noises and vibrations compared to other piling methods, such as driven precast concrete piles. The pile tips are to penetrate a minimum of 1.0 x pile diameters into the supporting soil strata with N-values of over 50. Where the supporting strata appears near the ground surface and the slenderness ratio of the piles becomes consequently less than 5.0, such piles may be increased in length to penetrate into the supporting strata by more than 1.0 x pile diameters to attain the adequate pile slenderness ratio; and

v) A rigid foundation structure (building structure support foundations and track support foundations are integral) has the following benefits over a non-rigid foundation structure (building structure support foundations and track support foundations are independent):
   - Increased resistance to seismic loading due to mobilization of a greater number of piles compared to a non-rigid foundation structure;
   - Reduced likelihood of differential settlement occurring with an integral foundation structure. In a non-rigid foundation, the foundation elements supporting the tracks and the elements supporting the building structure are independent, thus if one area of the buildings is founded on a poorer material then an adjacent area, differential settlement is likely to occur.

c) The structural analysis and safety assurance of the WS and LRS

The outline of the structural analysis and the safety assurance of the WS and LRS are as follows:

i) The structural analysis for both the WS and LRS are carried out by an elastic analysis as the three-dimensional frames including the foundation beams;

ii) The structural analyses are carried out in consideration of the loads prescribed in the NSCP as follows;

- Dead loads
- Live loads
- Wind loads
- Earthquake loads
- Soil lateral loads including lateral water pressure (applicable to the sub-grade structures)
- Self-straining forces arising from temperature fluctuation.

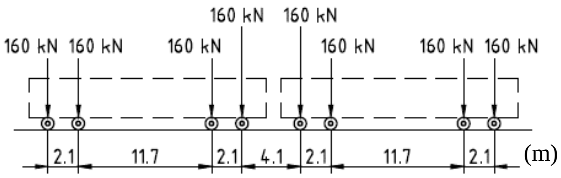
iii) As the NSCP does not prescribe live loads representing the weight of forklifts or rolling stocks moving about in the buildings, the live loads on the ground floor of the WS and LRS are evaluated considering the wheel pressures and the impact factors caused by forklifts and rolling stocks as follows;

Live loads applying to:

- Floor slabs and secondary foundation beams: 20 kPa
- Primary foundation beams, columns and foundations: 18 kPa
- Evaluation of earthquake weight: 13 kPa

iv) Point loads due to train wheel loading are as follows;

- Axle loads (160kN) with axle spacing are as shown below;
- Maximum number of successive cars = 10 car units



v) Gantry Loads;

Overhead gantry loads in the WS shall be as specified by the gantry supplier. Until a gantry supplier has been engaged on the Project, conservative loads based on the gantry Safe Working Load (SWL) have been estimated for the design of the structural supports.

vi) The seismic base shear coefficients and the parameters adopted to determine the coefficients are as shown in the Table 4.5.5;

Table 4.5.5 Evaluation of Base Shear Coefficients at the WS and LRS

Building		WS		LRS	
Direction		Longitudinal	Transverse	Longitudinal	Transverse
Seismic Zone		Zone 4			
Seismic Zone Factor	**Z**	0.4			
Soil Profile Type		To be determined based on the results of the geological survey.			
Seismic Coefficients	**Ca**	0.32Na ~ 0.44Na, depending on the Soil Profile Type			
	Cv	0.32Nv ~ 0.96Nv, depending on the Soil Profile Type			
Maximum Moment Magnitude		A (8.4≥ M ≥ 7.0)			
Closest Distance to known Seismic Source	**D**	D ≥ 15.0 km			
Near-Source Factor	**Na**	1.0			
	Nv	1.0			
Evaluation Method of Base Shear Coefficient		Static		Static	
Importance Factor*1	**I**	1.0		1.0	
Structure Material		Steel Structure		Steel Structure	
Basic Seismic-Force Resisting System*2		SCBF	SMRF	SCBF	SMRF
R Factor		6.0	8.0	6.0	8.0
Building Height above Ground (m)	**hn**	19.31		9.37	
Fundamental Period of Vibration (Sec.)	**T**	0.45	0.79	0.26	0.46
Base Shear Coefficient *3	**C**	0.12 ~ 0.18	0.051 ~ 0.14	0.13 ~ 0.18	0.088~ 0.14

*1 Specified based on NSCP, which may differ from those specified by Japanese codes.
*2 SCBF: Special Concentrically Braced Frame
SMRF: Special Moment-Resisting Frame
*3 "Base shear coefficient" varies depending on the Soil Profile Type.

Source: JICA Design Team

vii) The safety assurance of the structural members is carried out by the "Load and Resistance Factor Design" (LRFD) method in accordance with the NSCP; and

viii) In addition to the preceding items, the structural safeties against extremely large earthquakes are proved by confirming the horizontal seismic bearing capacities of the buildings exceed the bearing capacities required by Japanese codes.

d) Typical Cross Section of the Structural Members

The cross-sectional dimensions of structural members representing each building are shown in the Table 4.5.6;

Table 4.5.6 Typical Section Dimensions for Structural Members at WS and LRS

Structural Members	WS	LRS
Primary Columns	W33x263 W33x221	W27x161 W24x117
Primary Beams (Transverse Direction)	W36x231	W24x146 W24x117
Truss Beam (Transverse Direction)	Beam Height: 1,800mm (Chord) W12x106 (Lattice) W10x49 Beam Height: 2,400mm (Chord) W14x132 (Lattice) W14x68	(N.A.)
Primary Beams (Longitudinal Direction)	W18x86	W14x68
Secondary Beams	W18x86 W18x76 W14x30	W14x53 W12x35 W10x30
Steel Mullions	W27x161 W16x40 W8x28	W16x67 W8x35
Vertical Braces (Longitudinal Direction)	2L-4x4x1/2 2L3-1/2x3-1/2x7/16	2L3-1/2x3-1/2x7/16 L3x3x3/8
Roof Braces	2L3x3x3/8	L3x3x1/4

Source: JICA Design Team

2) OCC Building

a) The salient structural features of the OCC Building

The salient structural features of the OCC building include the followings:

i) The OCC Building consists of in-situ reinforced concrete moment frames supporting reinforced concrete slabs with non-load bearing exterior and interior concrete hollow block walls;

ii) Regardless of the above, the roof beams with a span of larger than 10m over the OCC Room are planned to be made of steel;

iii) Same as the WS and LRS, cast-in-place concrete bored piles are planned to support the OCC building;

iv) The floors on the ground floor are planned to be reinforced concrete slabs supported by foundation beams in both longitudinal and transverse directions;

v) The external walls and the internal walls that need fire resistance are made of hollow concrete blocks;

vi) A basement floor is planned to secure the adequate room for piping of the building facilities under the entire ground floor; and

vii) To cater for the large number of services and utilities within the OCC building, critical areas such as the OCC Room shall have a sunken floor to cater for ‘false’ flooring and/or topping slab requirements. To ensure the Finished Floor Level (FFL) is consistent across the entire floor area, the structural beams and slabs shall be lowered accordingly.

b) The structural analysis and the safety assurance of the OCC Building

The outline of the structural analysis and the safety assurance of the OCC building are as follows:

i) The structural stress analysis for the OCC building is carried out by an elastic analysis as the three-dimensional frames including the foundation beams;

ii) The structural analysis is carried out in consideration of the loads prescribed in the NSCP as follows;
- Dead loads
- Live loads
- Wind loads (applicable to the roof steel structures)
- Earthquake loads
- Soil lateral loads including water lateral pressures (applicable to the sub-grade structures).

iii) The seismic base shear coefficients and the parameters adopted to determine the coefficients are as shown in the Table 4.5.7;

Table 4.5.7 Evaluation of Base Shear Coefficients at the OCC Building

Building		OCC Building
Direction		Both Directions
Seismic Zone		Zone 4
Seismic Zone Factor	**Z**	0.4
Soil Profile Type		To be determined based on the results of the geological survey.
Seismic Coefficients	**Ca**	0.32Na ~ 0.44Na, depending on the Soil Profile Type
	Cv	0.32Nv ~ 0.96Nv, depending on the Soil Profile Type
Maximum Moment Magnitude		A (8.4≥ M ≥ 7.0)
Closest Distance to known Seismic Source	**D**	D ≥ 15.0 km
Near-Source Factor	**Na**	1.0
	Nv	1.0
Evaluation Method of Base Shear Coefficient		Static
Importance Factor*1		1.0
Structure Material		Reinforced Concrete Structure
Basic Seismic-Force Resisting System		Special reinforced concrete moment frames
R Factor		8.5
Building Height above Ground (m)	**hn**	23.1
Fundamental Period of Vibration (Sec.)	**T**	0.77
Base Shear Coefficient *2	**C**	0.049 ～ 0.13

*1 Specified based on NSCP, which may differ from those specified in Japanese codes.
*2 “Base shear coefficient” varies depending on the Soil Profile Type.

Source: JICA Design Team

iv) The safety assurance of the structural members is carried out by the “Load and Resistance Factor Design” (LRFD) method in accordance with the NSCP; and

v) In addition to the preceding items, the structural safety against extremely large earthquakes is proved by confirming the horizontal seismic bearing capacity of the building exceeds the bearing capacity required by Japanese codes.

c) Typical Cross Section of the Structural Members

The cross-sectional dimensions of structural members representing the OCC building are shown in the Table 4.5.8;

Table 4.5.8 Typical Section Dimensions for Structural Members at OCC Building

Structural Members	Floor	Cross Sections (mm)	
Primary Columns	4th, 5th Floor 2nd, 3rd Floor B1st, Ground Floor	B × H = 900 × 900 1,050 × 1,050 1,100 × 1,100	
Primary Beams		Longitudinal Dir.	Transverse Dir.
	Roof 5th Floor 4th Floor 3rd Floor 2nd floor	B × D = 500 × 800 600 × 800 600 × 900 600 × 900 650 × 1,000	600 × 850 600 × 850 700 × 950 800 × 1,000 900 × 1,100
	Ground Floor	B × D = 650 × 1,000, 650 × 1,000 ~ 1,400	
Foundation Beams	Basement Floor	B × D = 1,000x2000, 650 × 2,000	
Secondary Beams	Roof to 2nd Floor Ground Floor	B × D = 400 × 800, 350 × 600 B × D = 500 × 1,000	
Floor Slabs	Roof to 2nd Floor Ground Floor	t = 150 200	

Source: JICA Design Team

4.5.5 Electrical and mechanical Design for the Depot Buildings

(1) General Design Principles

This section presents the basic design criteria and standards established for the mechanical and electrical systems of the Train Depot facilities within the design scope of the Building Mechanical and Electrical Systems (hereinafter referred to as “Building M&E Systems”).

The mechanical systems include ventilation and air-conditioning, plumbing, water supply and fire protection, and pumping system. The mechanical elements include piping, valves, pumps, ducts, sprinklers, fittings and other mechanical devices.

The electrical systems, on the other hand, include lighting, power supply and emergency power system. The systems also include low voltage power distribution, lightning and utility distribution piping for Train Depot Equipment. The electrical elements consist of wirings, circuit breakers, receptacles, lighting fixtures, and other electrical devices.

The Train Depot area will be developed to accommodate several buildings necessary for the upkeep and continuous usage of the trains during the revenue service.

(2) Design specifications

1) Design Codes, Standards and Criteria

The development of Basic Design of the Building Mechanical and Electrical Systems was based on the approved local codes, standards and design guidelines usually applied to similar and related infrastructure projects in the country and other applicable international manuals as recommended by various concerned government agencies.

2) Electrical System

The electrical systems proposed for the Depot area / facility, which include lighting, power supply and emergency power supply were designed based on the following approved local codes, standards and guidelines and other applicable and acceptable international manuals. And also follow MLIT-J Design Code Standard Guideline, such as:

(a) Low Voltage Power Distribution System・Lighting・Receptacle・Lightning Protection System
- a) Philippine Electrical Code, Parts I & II
- b) National Building Code of the Philippines
- c) Institute of Electrical and Electronics Engineers, Inc. (IEEE)
- d) Occupational Safety and Health Administration (OSHA)

(b) Fire Detection and Alarm System
- a) Philippine Electrical Code, Parts I & II
- b) Revised Fire Code of the Philippines
- c) Institute of Electrical and Electronics Engineers, Inc. (IEEE)
- d) Occupational Safety and Health Administration (OSHA)
- e) Fire Code of Japan

3) Mechanical System

(a) Ventilation and Air-Conditioning System
- a) Philippine Mechanical Engineering Code
- b) National Building Code of the Philippines

(b) Plumbing
- a) Revised National Plumbing Code of the Philippines
- b) Philippine Mechanical Engineering Code
- c) National Building Code of the Philippines

(c) Fire Protection System
- a) Philippine Mechanical Engineering Code
- b) National Building Code of the Philippines
- c) Revised Fire Code of the Philippines
- d) FM Global Standards
- e) Fire Code of Japan

(d) Water Supply Distribution and Pumping System

a) Local Water Utilities Administration Standards

b) Manila Water Services Incorporated (MWCI) Standards

c) Philippine Mechanical Engineering Code

d) National Building Code of the Philippines

(3) Electrical Design for the Depot Buildings

1) Low Voltage Power Distribution System

The system will be provided to provide low voltage power for lighting system, receptacle system and the building M&E equipment. Low voltage power will be distributed from the Power Sub-Station to each building distribution panel for power and lighting requirements of each floor of the building, and to the motor control panel to supply power for electric motor driven equipment such as elevators, pumps, power tools and other electrical devices.

Power supply for important building electrical equipment and vital operational load relating the Railway System will be distributed as essential power supply connected with emergency generator.

The Photovoltaic system also secures PV panel installation space and piping route.

a) Low Voltage Feeder Lines

Low voltage feeder line, which extends from main low voltage distribution board in the electric room to the building distribution panels will be of 3 phase, 4 wire, 400 / 230V, 60 Hz. Feeder cables will be laid on cable tray/ladder and connected to each of the building distribution panels for lighting and power requirements of the building and of mechanical equipment in the facility.

b) Power Distribution for Mechanical Equipment

Low voltage power separately circuited from Local distribution panel for mechanical equipment will be 3 phase, 3wire, 400 V, 60 Hz. Earth leakage circuit breaker will be provided to protect the circuit of the mechanical equipment installed outside the building and/or under high humid conditions.

c) Grounding system

Grounding system shall be designed based on equipotential grounding method. Equipotential ground system will be employed to control the electric potential difference between the equipment. Equipotential grounding terminal bar will be provided for the connection of the Railway System.

2) Interior Lighting System

a) Interior Lighting Fixtures

Types of the interior lighting fittings will be selected in consideration of architectural constrains and according to the usage conditions in locations, size and designs. Distributed power cabling extended from local distribution panel to lighting fittings will be controlled by room lighting switches provided on nearby doors.

Illumination level for rooms and areas will be planned as follows;

b) Operation Control Center

Room	Type	Lux
• Telecommunication Equipment Rm.:	LED, Reassessed	300
• Electrical Rm.:	LED, Ceiling mounted	300
• Signal Equipment Rm.:	LED, Reassessed	300
• UPS Rm. (Depot):	LED, Reassessed	300
• Entrance Lobby:	LED, Downlight	200
• Toilet, Shower Rm.:	LED, Downlight	150
• Kitchen Rm.:	LED, Reassessed	300
• Monitor Rm.:	LED, Reassessed	300
• Central Control Rm.:	LED, Low-Bay	500
• Office	LED, Reassessed	300
• Conference Rm.:	LED, Reassessed	300
• Corridor:	LED, Downlight	200

c) Workshop/Light Repair Shop

Room	Type	Lux
• Office:	LED, Reassessed	300
• Conference Rm.:	LED, Reassessed	300
• Mech. & Elec. Rm.:	LED, Ceiling mounted	200
• Toilet, Shower Rm.:	LED, Downlight	150
• Locker Rm.:	LED, Reassessed	150
• Working Area:	LED, High-Bay	300
• Corridor:	LED, Downlight	200
• Storage:	LED, Ceiling mounted	100

d) Emergency and Exit Lighting

Emergency lights, battery built-in type, and exit lights will be provided at the required locations as per the requirements of the relevant building Laws. Emergency lights having dedicated circuit will be satisfied with the illumination level more than 1 lux. Type of emergency light will be of LED battery built-in type 9W×2.

Exit sign, battery built-in type will be provided for the evacuation of the occupants. Exit signs are required to be normally “On” and capable of lighting more than 30 minutes. Distance between exit signs will be 20 – 30 meters as per the local Laws.

3) Receptacle System

Single phase receptacles will be provided at the certain points of the room and spaces inside the building. Type of the receptacle required is 1phase, 2 wire 220, V 2P+E (16A), and one single circuit will be required to connect not more than 6 receptacles. Occupied rooms will be provided with wall recessed type and non-occupied rooms will be surface mounted type receptacles. Earth leakage circuit breaker will be considered to protect the receptacle and the circuit installed outside the building and/or under high humid conditions.

Wiring shall be with PVC conduit, schedule 40 for installations embedded in wall or floor slab and IMC (Intermediate Metal Conduit) for exposed installations. The rooms and areas shall generally be provided with general purpose receptacle outlets 220 V, 2P+E (16A). All general purpose receptacles shall be of the grounding type. Location of receptacle outlets shall be based on the fixture arrangement of the facility.

4) Fire Detection and Alarm System

For the purpose of early detection and notification of fire, automatic fire detection and alarm system will be provided in each of the rooms within the building. System consists addressable type fire alarm panel, smoke and heat detectors and wirings and will be required to comply with FCP (Fire Code of the Philippines) and Fire Service Act, Japan where applicable.

5) Low Voltage Power Distribution Cabling for Depot Equipment

Low voltage power distribution system will be provided for Depot equipment including overhead crane installed inside the buildings such as Main Work Shop, Light Repair Shop, Wheel Pro-filing Shop, and other buildings. Low voltage power will be required to separately distribute from low voltage circuit for building services provided on the main distribution board of the electric room. System will be required to distribute the power for receptacles of the Depot Equipment for maintenance.

6) Lightning Protection System

The building shall be protected from lightning strike by a conventional type of lightning protection system consisting of air terminals, down conductors, ground rods and ground ring.

Lightning protection system will be provided on the roof of the buildings in order to safe guard the people and buildings from the fire risk and related hazards associated with lightning exposure.

Design of the system and the equipment in types and locations will be required to comply with the requirements of the Codes and Standards of local Building Codes.

7) Building Remote Monitoring System

Operation Control Center Rm. in OCC will be provided with Building Remote Monitoring System to monitor and control the building mechanical electrical systems. The systems shown in the table will be monitored through the supervisory monitoring equipment located in Operation Control Centre Rm.

System	Condition/Indication	Critical Alarm
• Lighting control:	-	Trouble with Alarm
• Air-conditioning:	-	Ditto
• Elevator.:	-	Ditto
• Security:	Surveillance & Unlocking	Ditto
• Sub-station:	Power outage	Ditto
• Generator):	On/Off Operation	Ditto
• CCTV:	-	Ditto
• Water supply pump:	-	Ditto
• Drainage pump:	-	Ditto
• Sprinkler pump:	-	Ditto
• Fire Alarm (OCC):	Fire Alarm	Ditto
• Fire Alarm (MWS):	Ditto	Ditto
• Fire Alarm (LRS):	Ditto-	Ditto
• Fire Alarm (Small building):	Ditto-	Ditto
• Facilities at each station:	On/Off Operation	Ditto

8) Access Control System

In consideration of the operation of the security system, access control equipment is installed in the

OCC building where important equipment is installed. The zoning controlled area is divided into a general area and an office area, and electric locks and numeric keypads are installed in corridors and entrances. The status display monitor of the electric lock is installed in the OCC Building Monitoring Room.

(4) Water supply and drainage Design for the Depot Buildings

The different components of the mechanical systems under this scope include the following:

(a) Plumbing Water Supply System (Domestic Cold / Hot Water)
(b) Waste Water and Sewage Drainage System and Plumbing Fixtures
(c) Fire Protection System (Outdoor Hydrant System, Hose Reel &Stand Pipe System,)

The minimum requirements for the design of the Plumbing System of the Project shall be largely determined by the applicable provisions of standing planning and design regulations, professional and construction codes and standards as presented above. Said requirements shall form part of the Plumbing Design Criteria that will be evolved for the Project.

1) General Design Principles

The policy in designing plumbing systems is to provide economy and reliability and each system shall comply with applicable published codes, standards and specifications.

The systems should be designed to affect the greatest possible economy, meaning that:

a) All fixtures, equipment and piping material shall be compatible with the design life of the structure; and

b) In permanent type structures, piping arrangement shall be concealed; and

c) Energy conservation shall also be considered.
   The systems shall be designed with reliability as key criteria since interruption of a service would drastically reduce the efficiency of a facility.
   The systems shall be designed stressing simplicity, cleanliness and functionality. Ornate decoration is not required. Materials should be non-combustible and in material selection, health and sanitation should be considered, not only for personnel served by the systems, but also for operating and maintenance personnel.

d) The water supply system shall be designed to provide a flow of water to meet the peak demand requirements of the building. Pipe sizes will be based on maximum velocities. A minimum flowing pressure of 15 psi at the highest level fixtures shall be provided, except for fixtures equipped with thermostatic valves, blowout pattern water closets, urinals and fire hose racks, which require a minimum pressure of 25 psi. Maximum water pressure entering the building will be 60 psig. If the supply water pressure is higher, a pressure regulating valve shall be provided.

2) Estimating water demand and determining pipe size

The following procedure will be employed in determining water requirements and pipe sizes for the water supply system of the facility:

a) Determine the maximum and minimum water-working pressures in the street main and the elevation of the main at the building site to be supplied;

b) Select the kind of pipe to be used;

c) Estimate water demand from the National Standard Plumbing Code;

d) Develop a schematic evaluation of the complete water system. All fixtures and risers will be identified by letters, numbers or a combination thereof. All valves and fillings will be shown;

e) Add all water supply requirements for other building equipment, such as lawn sprinklers and air conditioning equipment and other usages to the estimated water demand;

f) Determine sizes of mains, branches and risers in accordance with the National Standard Plumbing Code;

g) The greatest equivalent length of pipe from the street main to the most remote fixture will be used to determine pipe function; and

h) Size pipes on the basis of minimum required water pressure with velocities of 5 to 8 feet per second depending on the type of pipe material.

Other water supply appurtenances will be designed as required to provide an efficient but economical plumbing system. Some of these appurtenances include water hammer arrestors or air chambers, check valves for sanitation, bypass lines and others. Hot water equipment will be designed as required, but normally, office buildings located in tropical areas are not provided with this system.

3) Plumbing Drainage System (Wastewater and Sewerage Drainage System and Plumbing Fixtures)

The plumbing drainage system involves the collection of waste water from toilet facilities through sewer pipes and septic tanks. The design of the system involves determination of the required pipe sizes for waste pipes and vents.

Oily waste will be drained through a separate drain piping system with a grease interceptor. Waste water effluence from the grease interceptor are provided immediately under the kitchen sink. This is to remove grease and minimize clogging of sewer. Grease interceptor can be placed outside the building as it carries the source of grease will be discharged to the external sewer main.

Similar to the water supply system, the plumbing drainage system of a facility is designed based on the number of fixtures installed in the facility. The equivalent number of fixture units is determined using tables and graphs presented in various plumbing design manuals, notably the National Standard Plumbing Code. From the derived number of fixture units, the corresponding design discharge is determined from the same manual.

Pipe sizes are determined by applying the method of open-channel flow and using Manning's Equation, where:

Q = 1/n R2/3S1/2

Where:

Q = Design discharge in cubic meter per sec
n = Roughness coefficient of pipe
R = Wetted perimeter of pipe
S = Hydraulic gradient of pipe

Based on the same design discharge, the corresponding capacity of storage tank for wastes and the required capacity of the proposed treatment system are also determined.

After determining the required pipe sizes and location of storage and treatment facilities, the system layout is finalized to include the required venting system.

(5) Ventilation and Air-Conditioning Design for the Depot Buildings

The different components of the mechanical systems under this scope include the following:

(a) Air-Conditioning and Ventilation System
(b) Utility (Steam/Compressed Air) Distribution Piping for Depot Equipment

1) Air-Conditioning System

In general, the factors or elements to be considered during the design process for the air conditioning and ventilation systems are as follows:

(a) Temperature and Humidity

(b) Adequate collection of discharge water from evaporation, condensers, and machinery

(c) For centralized air conditioning system, ducts will be designed with non-combustible materials
   i) Provision of access doors at all automatic dampers, fire dampers, thermostats, and other apparatus for servicing and inspection.
   ii) Provision of fire resistant materials around walls where ducts pass to prevent passage of flames and smoke.
   iii) Outside design condition will be established in accordance with the prevailing weather conditions in the Philippines as published by the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA).
   iv) Indoor design conditions will be established in accordance with the prevailing practice or as per Client's requirements.
   v) Design parameters and assumptions will be established based on the following factors:
   Thermal Coefficient (Glass, Roof and Exterior Wall)
   Fresh Air Supply at a rate of 7.5 CFM/person, other areas will be ventilated at a rate of 10 air changes per hour

(d) Outside Design Conditions
Outside design conditions for the project were obtained from the ASHRAE Fundamentals handbook as follows;

Cooling Design (0.4 %) Temp. : 35.0°C (dry bulb) / 27.7°C (wet bulb)

(e) Inside Design Temperature
Inside air-Conditioning design temperature conditions for this project will be as follows;

Space	Summer
Occupied Spaces (Offices, etc.)	25.0℃ (DB) / 50% RH
Communication Rooms Control Center	22.0℃ (DB) / 50% RH

(f) Equipment Heat Release Data and Building Population
Actual equipment heat release data will be obtained from the equipment manufacturer; building population will be estimated from the proposed organizational structure; time of use data will be defined for heat load calculation and capacity of the air conditioning equipment

will be determined, all of which will be used to establish the required equipment to support the inside design temperature conditions within the facility.

(g) Type of Air-Conditioning System

- Offices and occupied rooms in Shop Buildings:
  Individual air-cooled split type air-conditioning unit will be recommended for the offices and other occupied rooms in the Workshop and Light Repair Shop to minimize power consumption while providing comfort economically. Spot cooling for certain work area in Work Shop will be provided with mobile type spot cooling equipment for industrial use.
- OCC (Operation Control Center) Building;
  VRF (Variable Refrigerant Flow Control) multi-split type air conditioning system will be provided for the OCC.

2) Ventilation System

Ventilation air (fresh air) volume required for proper ventilation of the non- air-conditioned rooms and space will be generally determined according to the size and use of the rooms/space.

Shop Area of the Workshop, Sub-station Room. Mechanical and Electrical Rooms. Battery Rm. Storage Room., Toilet, Kitchen, etc. will be provided with ventilation fans in power roof ventilators, supply and exhaust air fans, etc. Required ventilation rate (air change rate per hour) will be determined in compliance with the requirement of ASHRAE Standards and/or applicable local laws and standards. Following are the air change rates for each type of the rooms to apply in the design of the ventilation system.

- Electrical Rooms : 10 L/s-m^2
- Sub-station (Transformer Rm.) : 5 – 10 ACH
- Switchgear Room. : 5 – 10 ACH
- Battery Room. : 4 ACH
- Shop Area in Work Shop : 8-10 ACH
- Pump Room. : 5 ACH
- Warehouse : 2 ACH
- Storage : 7.5 L/s-m^2
- Toilet : 35 L/s per WC or Ur
- Kitchen : 3.5 L/s-m^2

3) Utility (Steam/Compressed Air) Distribution Piping for Depot Equipment

a) Steam Distribution System:

Steam distribution system will be provided for Depot equipment installed in Main Work Shop. Provision of air compressor unit and its auxiliary subsystems in the Compressor Room. will be in separate design group (out of design scope of Building M&E System. Design for this system by Building M&E will be only air distribution piping between air compressor and Depot equipment.

Required steam for Depot equipment is estimated in total of 37.4 m^3/min. and 7.5 m^3/min under usage factor of 20% respectively. Design for distribution piping will be in compliance with the requirements of Philippine Mechanical Engineering Code.

b) Compressed Air Supply System

Compressed air distribution system will be provided for the operation of machine tools and Depot equipment and this system will be installed in Main Work Shop and Light Repair Shop. Provision of air compressor unit and auxiliary subsystems will be by separate design group (out of design scope of Building M&E System. Design for this system by Building M&E System will be only compressed air distribution piping between air compressor unit and machine tools/Depot equipment. Required pressure of the machine tools and Depot equipment is 0.49 MPa in maximum. Design for distribution piping shall be in compliance with the requirements of Philippine Mechanical Engineering Code.

(2) Fire Fighting System Design for the Depot Buildings

1) General Design Principles

An effective firefighting system shall be provided for all building facilities in the Depot, including fire protection provisions and response mechanism (including evacuation and fire-fighting).

2) Fire Protection System (Outdoor Hydrant System, Hose Reel &Stand Pipe System,)

Design process calls for establishment of various parameters and criteria such as:

i) Classification as to type of occupancy
ii) Type of Equipment

Portable equipment such as fire extinguishers are also required in critical areas.

a) hydrant

hydrant are required in every building with four or more storeys in height. Size shall be capable of delivery adequate quantity of water or 900 liters per minute from each of any three outlets. These will be located within enclosed stairway landings or near such stairways as possible or immediately inside of an exterior wall and within 300 mm of an opening in a stairway enclosure of a balcony. All 100 mm standpipes will be equipped with a two (2) way Siamese fire department connection.

b) Water Pumping

Installation of pumping equipment to supply buildings/ structures from existing water supply system will be provided as necessary and designed in accordance with the rules and regulations of the local government building codes. Appurtenances include pressure tank which will be sized based on the building population and appropriate water demand load. Adequate storage capacity will be provided as required.

c) Combination Automatic Wet Sprinkler System and Wet Standpipe System

The Facilities/Buildings shall be provided throughout with a combination automatic wet sprinkler system and wet standpipe system in accordance with the Revised Fire Code of the Philippines, with the exception of the Electrical, Transformer, Genset Rooms and some small structures.

1 - 1/2” fire hose stations complete with hose, nozzle and Type ABC Portable Fire Extinguishers shall also be installed and strategically located to be used by the building occupants to supplement the sprinkler system in extinguishing small fires.

Fire Department Connections shall likewise be provided for the Fire Department’s use.

d) Exterior Hydrant System

Exterior Fire Hydrants shall likewise be provided for the Entire Train Depot Area. Number and layout of the exterior hydrants shall be in accordance with the requirements of the Fire Code of the Philippines.

e) Fire Pumps

Fire Pumps shall be provided for the facility to serve the fire water requirement of the entire facility.

The Fire Pumps and its components shall be UL listed / FM approved. The Fire Pump serving the buildings shall be horizontal split case, or vertical turbine type as required taking water from a 45,000 gallon fire reserve to meet the minimum 30 minute fire demand.

f) Sprinkler System and Inert Gas Extinguishing Systems

Buildings and structures requiring fire sprinkler protection shall be provided with hydraulically designed sprinkler systems. The systems will be designed using the Area/Density Method including hose stream allowance and duration of fire water supply requirements. Current design of the shop area of the Work Shops and multi-story Operation Control Centre (OCC) including Electrical rooms show certain area or rooms to be protected with pre-action and or wet type sprinkler system respectively. Sprinkler system requires provision of pumps and the fire water storage tank and the respective capacities will be determined as per the requirements of Fire Code of the Philippines and Fire Service Act, Japan where applicable.

Operation Control room monitoring train operation is equipped with electronic control consoles, monitors and telecommunication equipment such that inert gas extinguishing system will be provided as per the Fire Code of the Philippines and Fire Service Act, Japan where applicable.

g) Stand pipe and Hose Reel System

Fire standpipe systems shall be provided in the buildings and structures where appropriate and the capacity will be determined in accordance with the requirements of local Laws. The basic design of the Operation Control Centre (OCC) proposes multi story building structure, and therefore OCC will be protected with stand pipe system in accordance with Fire Code of the Philippines and Fire Service Act, Japan where applicable.

h) Gas Suppression Systems

Operation Control Rm. with train operation electronic control consoles, monitors and telecommunication equipment will be required to provide inert clean gas extinguishing system. All other rooms/areas containing sensitive and expensive electronic equipment shall likewise be provided with gas suppression system as per the Fire Code of the Philippines where applicable.

i) Fire Extinguishers

Fire extinguishers will be provided in all the buildings and auxiliary houses in the Train Depot area. Type, locations and capacity of the fire extinguishers will be determined in accordance with applicable local fire laws. Main Work Shop, Light Repair Shop and Wheel Re-Profiling Shop having large spaces will need mobile type fire extinguishers in addition to the portable type.

j) Location of Fire Hydrant

The location of the Exterior Hydrant System shall be in accordance with the requirements of the Fire Code of the Philippines and will be based on the following:

a) Hydrant piping shall be sized to ensure 2.8 kg/cm^2 (40 psi) residual pressure at the hydraulically remotest point.
b) The velocity in the hydrant main shall not exceed 3.5 m/s (11.5 fps).
c) Exterior hydrants shall be provided at a maximum spacing of 152 meters (500 ft.) distance.
d) Building shall be deemed to be protected by a hydrant if the hydrant is within 15 meters of the building.

4.5.6 Water supply, Drainage, Sewerage System

(1) Water Supply System

1) General

The proposed water supply system of the depot will consist of a water main line to be connected to the existing service provider in the area. Control and regulating valves will be installed at strategic locations within the water line network to facilitate distribution and maintenance.

2) Applicable Design Code, Standard and Design Condition

The design of the water supply system will be based on the guidelines and standards of the service provider and other local codes such as those of the local water utilities required amount of water supply

The required amount of water supply was estimated based on the projected users of the depot and on the specific requirement for each particular fixture and equipment requiring water supply. The total unit water demand is the sum of the unit consumption plus the unaccounted-for water.

3) Study for Water Supply Facility

a) Method of Water Supply System

The water supply source to depot is based on water supply from a water supply company. If impossible, we develop self-water source by well etc.

There are two types of water supply systems. One uses an elevated tank and the other is a pressure water supply by pump system. We will consider and select the optimal method.

b) Design Volume of Water Supply

The required amount of water supply will be reviewed and set based on the projected users and the specific requirement for each particular fixture and equipment requiring water supply.

c) Storage Requirement

It is a standard engineering practice for water supply to provide sufficient amount of water to meet a variable demand. Generally, the source capacity is designed to cope with the maximum-day water demand. Furthermore, the storage capacity is provided to meet the excess demand during peak hours.

The storage capacity is estimated based on operational requirements, emergency storage and fire-fighting storage.

4) Plan and Design of Receiving Tank

The receiving tank (storage tank) should be installed as necessary.If installing a receiving tank, The receiving tank has two purposes. One is the domestic water supply and the other is the fire-fighting system.

5) Plan and Design of Distribution Pump

Set capacity and number of distribution pumps according to demand of vehicle base.

6) Plan and Design of Water Supply Pipeline

The water supply pipeline is designed under all the roads within the depot in order to distribute water to all buildings, outside taps, fire hydrant, and other facilities.

(2) Drainage System

1) General

The drainage system of the facility consists of the following:

a) Exterior storm drainage system – functions include the collection and conveyance of surface discharge from building drain boxes and street or road drainage system.
b) Pavement surface drainage system – functions include the collection and conveyance of surface runoff discharge roads or paved surfaces through curb inlet manholes and drainage pipelines.

It should be noted that the Depot site is green space. After the Depot is built, the coefficient of run - off will rise. Therefore, the amount of runoff will increase.

Therefore, a retarding basin will be provided for the purpose of suppressing outflow of rainwater.

By setting up the adjustment Retarding Basin, the flooding of rivers of the discharge destination will be limited within the same amount of discharge as existing.

2) Applicable Design Code, Standard and Design Condition

The design of the drainage system is based on applicable local codes, standards and criteria included in the National Building Code of the Philippines, Department of Public Works and Highways, national entities having jurisdiction of the drainage system when the pipe outlet of the proposed development is connected to the existing national road drainage system, and those of the Department of Environment and Natural Resources, when the discharge outlet is connected to existing natural bodies of water such as creeks and rivers and other natural waterways.

3) Design Storm Water Amount

a) Applicable Calculation Method for Amount of Storm Water

The amount of rain water is calculated using the Rational Formula, which uses the storm rainfall intensity – duration – frequency data obtained from the rainfall stations managed by the Philippine Atmospheric Geophysical Astronomical Services Administration (PAGASA). This data is derived using the temporal storm durations ranging from 5 minutes to 48 hours for 2 to 100 years of recurrence interval. This method is acceptable for catchment areas smaller than 3 km^2.

The hydraulic analysis of the drainage structures like the side ditches, and storm drainage pipes to determine the actual carrying capacities of these sections or structures is based on the basic open channel principle using the following equations:

i) Flow rate

Q = AV

where:
A = flow area in m^2
V = mean velocity "V" by Manning's equation:

ii) Velocity

$$V = \frac{1}{n} R^{\frac{2}{3}} S^{\frac{1}{2}}$$

where:
V = mean velocity in m/sec
R = hydraulic radius in m
S = channel slope in m/m
n = roughness coefficient

iii) Hydraulic radius

R = A / P

where:
A = flow section area in m^2
P = wetted perimeter in meters

b) Runoff Coefficient

The runoff coefficient, C, is dependent on the type of surface where the surface runoff will flow and the values differ for vegetated and paved surfaces.

c) Return Period

The return period varies from 2 to 100 years recurrence interval.

d) Concentration Time

The temporal storm durations range from 5 minutes to 48 hours, though the estimated concentration time is calculated as the time elapsed for the surface runoff to travel from the farthest point to the point of discharge.

e) Drainage/Catchment Area

The drainage catchment area is the whole area of the Depot facility, which measures about 40 hectares. Each drainage line however, will have different catchment areas depending on the development plan proposed for a particular area.

4) Drainage Collection System

a) Summary

The proposed drainage collection system of the facility is composed of underground drainage pipes connecting the drainage inlet manholes at specific intervals, covered concrete U - Ditch with perforated holes whenever there is not sufficient cover for the installation of underground drain pipes, under-drains for areas with high ground water table and open ditch or canals and catch basins for unpaved area drainage.

b) Water Collection Method

The rainwater collection method will be examined separately for road drainage, railway tracks drainage, and construction drainage. They will be adopted the optimum water collection method.

5) Road Drainage

The road surface drainage is collected in an L-type street core with a road crossing slope, and collected in a box culvert drainage type.

6) Railway Tracks Drainage

The trajectory of the Depot is constructed ballast trajectory. Therefore, the rainwater in the rail way will be drained by means of a French drain.

7) Building Drainage

The rainwater captured on the building is collected on the rooftop and then drained with a vertical gutter to a collection system on the ground.

8) Rainwater Retarding Basin

a) Location

The rainwater adjustment reservoir should be installed in a location that will not interfere with other facilities.

b) Structure

The capacity of the Retarding Basin is equal to the volume of rainwater to be collected.

(3) Sewerage System/Wastewater Treatment Plant (WWTP)

1) General

The proposed sewerage system of the depot facility intends to provide the required sanitation standards as mandated by the concerned agencies protecting the natural resources and environment of the project area. The system includes wastewater collection, storage and treatment structures.

2) Applicable Design Code, Standard and Design Condition

The design of the sewerage system of the facility will be based on the applicable guidelines, criteria and standards as recommended by the service provider in the project area and those as established by the local and national authorities as contained in the National Plumbing Code of the Philippines, and those as by the Manila Waterworks and Sewerage System and other applicable international codes and manuals.

a) Effluent Standards

Water quality standards and general drainage standards have been published by the Ministry of the Environment of the Philippines and domestically adopted.

Table 4.5.9 The Effluent Standard

Item	Unit	Classification of water bodies
		C
COD	mg/L	100
BOD	mg/L	50
SS	mg/L	100
T-N	mg/L	14
T-P	mg/L	1
Total CO	MPN/100ml	10,000
Oil and Grease	mg/L	5

Source: the effluent standards of DENR Administrative Order No. 2016-08 for Class C Inland Water.

The wastewater treatment method is determined so as to satisfy the above criteria.

3) Amount of Wastewater, Influent of Wastewater and Effluent Standard

a) Summary

The determination of wastewater flow rates are a basic step in the planning and design of a sewer system. These flow rates determined from available wastewater flow data and actual flow measurement or by calculations in the absence of measurements are as follows:

Average Daily Flow (ADF)* is the average flow rate occurring over a 24-hour period based on available flow data or calculations. It is used for evaluating a treatment plant capacity and the basis of establishing other flow rates.

Maximum Daily Flow (MDF) is the maximum flow rate over a 24-hour period. The MDF is used in the design of facilities involving retention time such as retention ponds and chlorine-contact tanks.

Peak Hourly Flow (PHF) * refers to the peak sustained hourly flow rate occurring during a 24-hour period. PHF is used for the design of the collection and interceptor sewers, pumping stations, etc.

Minimum Daily Flow (MDF) is the minimum flow rate that occurs over a 24-hour period. MDF is important in the sizing of pipes or conduits where solids may settle at low flow rates.

Minimum Hourly Flow (MHF) is the minimum sustained hourly flow rate occurring over a 24-hour period. MHF is most useful in the design of treatment plant facilities.

Sustained Flow (SF) refers to the flow rate value sustained or exceeded for a specified number of consecutive days. SF is used in sizing equalization basins and other plant hydraulic components.

b) Determination of Wastewater Volume and Sewage Volume

As for the amount of wastewater and sewage at the base of the Depot, the amount of wastewater will calculate from the amount of water used by the equipment assumed in each building. In addition, the amount of sewage will calculate by multiplying the per capita wastewater unit based on the number of working employees assume in each building.

c) Inflow Water Quality

Inflow water quality was set as follows. The value was determined referring to hearing result from Railway Technical Research Institute.

Table 4.5.10 Inflow Water Quality for the Depot

Items	Unit	Influent		
		Sewage	Liquid Waste	
			Work Shop	Light Repair Shop
pH	-	-	2.3 ~ 12.9	2.0 ~ 7.2
COD	mg/ℓ	180	100	74
BOD	mg/ℓ	387	100	59
SS	mg/ℓ	300	150	55
Oil	mg/ℓ	-	120	15
Total Coliforms	MPN/100ml	-	-	-

Source: JICA Design Team

4) Selection of Treatment Process

a) Summary

For the selection of the sewage treatment system, it is necessary to consider the arrangement of the facilities and the wastewater treatment, etc., and select them.

b) Facility Placement Plan

Placement of the facility is currently under consideration.

As a premise, the wastewater treatment facility should be located near the facility where wastewater and sewage are generated. The conditions are shown below.

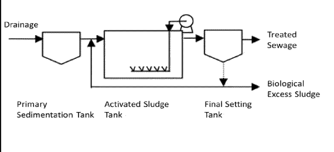
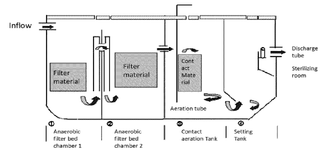
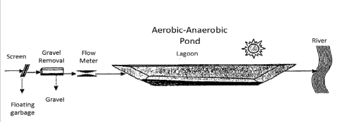
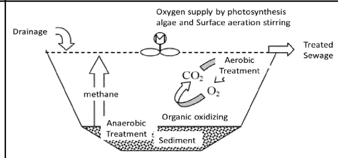
i) Wastewater Treatment Facility

- Install an oil separator near the facility where wastewater is generated.
- If a pump is required, install it with an oil separator.
- If it is advantageous to install the wastewater facility in the building, it is installed in the building.
- The treated water treated with the wastewater is discharged in the rainwater piping in the site.

ii) Sewage Treatment Facility

- The sewage treatment facilities to include such treatment facilities include, OCC, workshop, and the light repair shop. Since the facility is dotted, consider the individual processing rather than a set processing.
- OCC and the workshop consider the consolidation processing because facilities are nearby.

Table 4.5.11 Comparison of Wastewater Treatment Process

Type		Conventional Activated Sludge Process	Combination Treatmet Septic Tank	Waste Stabilization Pond	Aerated Lagoon
Structure					
Mode of Processing		Aerobic treatment process	An-aerobic treatment process + Aerobic treatment process	An-aerobic treatment process + Aerobic treatment process	An-aerobic treatment process + Aerobic treatment process
Technical Summary		Convetinoal Activated Sludge Process is generally used in developed countries including Japan. Even though this cost is high and not appropriate in developoing countries, this process is the most fundamental technology in domestic waste water treatment. Suspended solid is removed in primary sedimentation tank. After the process, the effluent flow into activated sludge tank and organic matter is decomposed and removed in the tank. Activated sludege flow with treated water so that the sludge is settled and separeted from the treated water in final settling tank. The settled sludge is returned into the activated sludge tank and it is recycled.	This treatment system can be applied to the place which is not established the centralized sewerage system in the developped country. Combination treatment septic tank is treated not only wastewater from the toilet but also wastewater from the kitchen and the bath room. Removable rate of BOD is more than 90 % and effluent quality of BOD is less than 20 mg/litter	Waste water is treated by aerobic and anaerobic bacteria based on oxygen from algae in ponds. Oxygen is supplyed from air and photosynthetic reaction, which is significantly long.	Waste water flow into a large pond called "lagoon" and settleable organic matter is settled down in the bottom of the pond and it is decomposed into methane. On the other hand, soluble organic matter is decomposed into carbon dioxide by aerobia using oxygen from aeration and photosynthetic reaction by algae.
Compariso n	Electric power expense & chemical expense	Poor	Fair	Good	Fair
		Need larger electric power than other method	Requires only low voltage facilities and it is not necessary to use the chemical agent.	Not need electric power and chemical	Need only electric power of pump, Not need chemical cost
	installing area	Fari	Good	Poor	Poor
		The second smollest place	Most smallest place	Most largest place	The second largest place
	Operation & Maintenance	Poor	Good	Good	Fair
		A manager having technical knowledge is necessary to maintain activated sludge. Grime processing facilities are necessary.	Periodical maintenance is required, however, maintenance itself is very simple. One time of sludge removal is required	(The maintenance requiremments of ponds are siognificatnly simple but must be run regularly.)	(Waste water is drained annually and scrape out sludge left in the bottom of lagoon, which is based on the condition of settlement. The sludge is dried in land and used by local farmers as fertilizers)
	odor	Fair Primary sedimentation basin is odor	Good Combination treatment septic tank is installed under the ground, therefore, there is no odor.	Poor Dich is opened , therefore ,there is odor.	Poor Dich is opened , therefore ,there is odor.
	Results & applicability in developing countries	Fair	Good	Fair	Fair
		There is a case that small scale facility (2,400m3/day) is operated in Bangkok city in Thai but there is no facility having scalce of (500m3/day).	Combination treatment septic tank is small sized treatment faciliy and it is applicable in Depot. Maintenance is easy and only one time of sludge removable is reuired. Recently this system becomes wildly used in the developping contry.	Maintenance is easier than others, and this processing method has low cost. In addition, as for this processing method, it is adopted most in developing countries However, It is difficult by the following conditions. It is difficult to secure plottage to set up this processing facilities. In addition, a house sticks to the outskirts, and a bad smell becomes the problem.	This processing method is adopted a lot in the developing countries of Southeast Asia. However, It is difficult by the following conditions. It is difficult to secure plottage to set up this processing facilities. In addition, a house sticks to the outskirts, and a bad smell becomes the problem.
Construction Expense		Construction cost is expensive	Construction cost is medium.	Construction cost is cheap	Construction cost is medium.
Operationj & Maintenance Cost		Construction cost is expensive	Operation and maintenance cost is also medium.	Construction cost is cheap	Operation and maintenance cost is also medium.
Suitability for this project		Not applicable	Most applicable	Not applicable	Not applicable

references"Life drainage processing technique handbook for developing countries" (Daiwa/Raschel/GEF/Environmental technology spread support project in Asia)
references Duncan Mara "Domestic WASTEWATER TREATMENT IN DEVELOPING COUNTRIES"

Source: JICA Design Team

(4) Sewer Network System

1) Summary

For the planning and design of the sewer network system, apply DPWH or DENR criteria.

a) Pipe Material

Sewer pipes shall be made of inert materials or internally coated with inert materials. The purpose of using inert materials is to prevent corrosion problems from hydrogen sulfide.

Such inert sewer pipes include clay pipes, PVC pipes, & PVC lined concrete pipes with T-lock. Other pipes that are manufacturer-certified as inert can be used.

The choice for the pipe material should consider local conditions such as possibility of septicity, soil characteristics, external loadings abrasion and other related considerations that might result in problems.

The choice of pipe materials should also consider conditions of construction. Pipes which require special provisions for handling, bedding, backfilling, inspection, and/or testing should not be accepted. The impact of the construction of the sewage on the traffic and congestion must be carefully considered, as to dig the pit, install the sewage pipe, backfill the pit and resume normal road operations in a rapid manner.

Force mains may be steel and ductile iron pipes. Due to a normal full flow, hydrogen sulphide corrosion is insignificant.

b) Minimum Pipe Size

Sewer pipes transporting wastewater shall not be less than 300 mm in diameter. However, a service connection could use a minimum pipe size of 100 mm in diameter with larger sizes in accordance with the National Plumbing Code of the Philippines, except that for multiple dwelling unit structures, a minimum of 150 mm diameter is recommended.

Sewer pipes may be designed to have a full flow or a half-full flow at PHF, depending upon funding for the increase in size resulting from design at half full. A design for a half-full flow at PHF allows for an accordance of infiltration and inflow from wet weather events.

c) Depth

All sewers should be sufficiently deep to receive the wastewater flow from basements.

The soil cover over the buried pipe should be adequate for structural consideration. The recommended soil covers depths are similar to those used in drainage pipes for RCPPC.

a) Sewer laterals and submain (200 mm to 500 mm) – 1.5 m
b) Mains and submains (600 to 3,000 mm dia) – 2.1 m
c) Sub-laterals not subject to traffic loads – 1.0 m

d) Slope and Minimum Velocity

All sewers shall be designed and constructed to yield mean velocities, when flowing full, of not less than 0.6 m/s, based on the Kutters formula using an "n" value of 0.013. The minimum slopes (m/100m) should be provided;

Table 4.5.12 Relationship between Pipe Diameter and Minimum Slope

Sewer Size (mm dia)	Minimum Slope (m/100m)
200 (8")	0.40
300 (12")	0.22
450 (18")	0.12
600 (24")	0.08
750 (30")	0.058
900 (36")	0.046

Source: JICA Design Team

The minimum velocity of 0.6 m/s of the pipe flowing full is to minimize any settling of solids. A maximum velocity of 3 m/s at full flow is allowed to protect pipe from scouring.

The pipe diameter and slope shall be selected as to obtain the greatest practical velocities to minimize any settling problems.

e) Alignment

Sewer pipes 600 mm or less in diameter shall be laid in a straight alignment between manholes. Sewers larger than 600 mm may be laid on a curved alignment. The maximum radius shall be four times the pipe diameter. Interceptor shall be placed immediately before and after a segment of a curve sewer line.

The sewer line should be normally located along the southern and western portion of a street or road.

f) Design Period for Sizing of Sewer Pipes

Sewer pipes and outfalls should normally be sized to serve a projected population of 50 years. Otherwise the sizing of all sewers shall be the concession period of 25 years.

g) Appurtenant Structures

The following criteria and guidelines will be used on the following appurtenant structures of the sewer system.

i) Interceptor Boxes or Sewer Manholes

Interceptor boxes or sewer manholes should be installed: at the end of each line; at all changes in grade, size, or alignment; at all intersections and at the specified spacing of:

- Not greater than 120 m for 400 mm pipe or less

- Not greater than 150 m for 450 mm to 1,000 mm pipe,
- Not greater than 250 m for 1,100 mm and larger pipe.

When the difference in elevation between the incoming and outgoing sewers is 0.60 m or more, a drop manhole should be used whereby the flow falls vertically through an outside pipe and enters the manhole near the bottom.

The minimum diameter of manholes should be 1.20m. Larger diameters are preferable for large diameter interceptors. The minimum diameter of manholes is 0.56 m.

ii) Inverted Siphon

Inverted siphons are usually employed whenever it is necessary to divert the sewer in order to pass under streams and other obstructions.

The pipe sizes for the siphon should be selected to secure velocities of not less than 0.90 m/s at the average flows. If there is sufficient head to permit the minimum velocity, a single pipe can be used. Should there is little head, several pipes in parallel can be used.

iii) Pipeline Laying Plan

Regarding the installation plan of the pipeline, it was installed a pipe that satisfies the conditions described in the outline.

(5) Intermittent Pump Station/Man Hole Pump

The pumping station structures and electromechanical equipment should be located at appropriate sites as to protect it from any physical damage by large floods and assure its full operation during large floods.

The station should be accessible by maintenance vehicles during all weather conditions.

The wastewater pumping station should be of the wet well/ dry well type. Other types such as suction lift pumps or submersible pumps stations may be considered during the engineering design stage.

1) Design Capacity and Lift

The pumping station should have the capacity to handle a flow equal to twice the peak dry weather flow, in order to allow infiltration / inflow equal in flow to the peak dry weather flow.

For planning purposes, the lift or head provided by a pump station will be at most 10 m.

Pumps shall be multiple –units to have the station operate varying delivery rates at approximately the rate of inflow to the station. At least one (1) stand by- pump shall be provided with a capacity equal to that of the largest pump.

4.5.7 Fence and Gate

The fence (perimeter wall) shall be installed around the depot and the gate shall be installed at the entrance.

(1) General

A fence (perimeter wall) and gate is necessary for the security and safety of the depot. Any unauthorized persons are restrained to enter the depot perimeter are totally forbidden to trespass. Additionally, special care has to be given to the danger imposed by fires occurring in the neighbouring residences. In this sense, the perimeter wall will serve as a barrier to external threats to the depot.

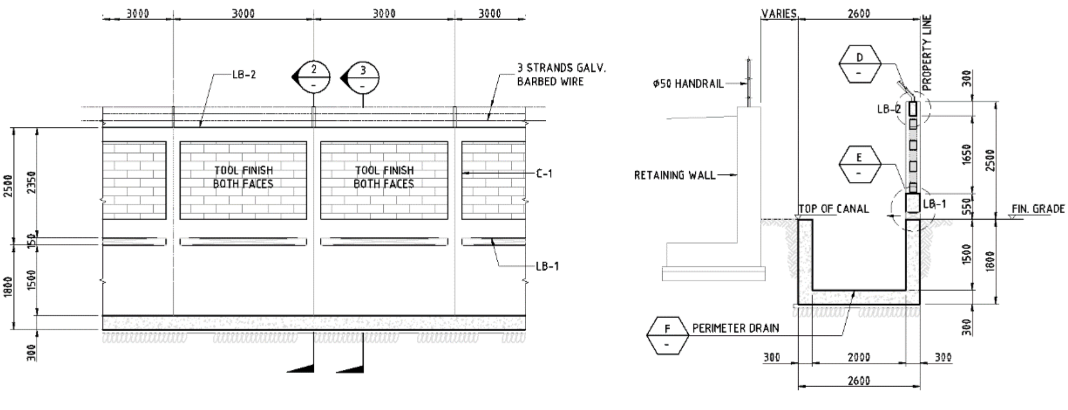
(2) Applicable Design Code, Standard and Design Condition

The 1977 National Building Code of the Philippines (NBCP), subsection P.D.No. 1096 and its IRR, shall primarily be the bases for the position and height of the fence (perimeter wall) and gate system. The Department of Public Works and Highway (DPWH) specifies the standard drawing of the fence (Perimeter wall).

The design and construction of the gate system shall comply with applicable local design/ construction/ industry codes, particularly on welding standards and on foundation/ wall reinforcement requirements.

(3) Selection of Type of Fence

The fence (perimeter wall) will be a bearing wall structure with spikes placed at the top of the wall following the standard drawing of DPWH (see Figure 4.5.8 below).



Source: JICA Design Team

Figure 4.5.8 Fence for Depot

(4) Selection of Type of Gate

The main entrance of the dep at the vehicle base adopts an open gate. Also, the gate of the back gate is similarly set to an open gate.

4.5.8 Training Center

In this Chapter, a detailed explanation is provided regarding the architectural design, structural design, and electrical and mechanical design in the Training Center (hereinafter referred to as TC) building. CHAPTER 6.2.3 provides a detailed explanation of the TC purpose of establishment and training details, and CHAPTER 4.5.2 provides a detailed explanation of the various conditions such as natural conditions, land formation, facility layout and infrastructure where TC will be located.

(1) Design Principles of the TC Building

1) Design standards and concept

The design standards, laws and guidelines for the TC building will conform to those applicable to depots. The design concept for the TC building is shown below.

- Construction that is environmentally- and people-friendly (energy conservation, natural lighting, natural ventilation)
- Functional spaces (bright indoor spaces, comfortable training environment)
- Easy-to-maintain building (interior and exterior that is easy to clean and highly-durable)
- Flexible structure (design that is adaptable to changes in training details and an increase in trainees)

(2) Design Specifications of the TC Building

1) Purpose of establishment

The purpose TC is development of railway operator’s resources for MCRP, NSCR and NSRP-South by means of on-site training or drill for their employees for reskilling and training countermeasures in railway accidents.

2) Training participants and training details

- The training participants will be train operation managers, drivers, OCC operators and station staff and some inspection engineers for electric and railway facility departments employed by each railway operator, and the content of the training will mainly include ordinary/regular training and accident restoration training such as railroad accident prevention and technical skills improvement.
- Training participants will receive regular training in groups of 5-30 people. Also, approximately once every year, firehouse, police office, ambulance and local government staff will participate in response training for disasters and major accidents.
- Each training program will be completed in half a day or a full day, so there is no need for accommodation. Also, service management training is suited to the OCC, so such training will not take place at the TC. The basic training details and periods are shown in Table 4.5.13.

Table 4.5.13 Basic Training Plan in TC

Training course	Planned by	Trainee	Outline of training/drill	Period/ Participant
Regular Training	Railway operator	Station attendant	● Operation and daily check of ticketing machines ● Operation of safety and service equipment at station ● Service training for station passengers	• 1~2hrs • Monthly • 5~10 trainees
		Train driver	● Case study for preventing railway accidents ● Safety train operation training with a train simulator ● Emergency measures when train trouble happens	
Practice/ Re-skill Training	PRI	Train driver	● General training and licensing of driver is done by PRI ● Train drivers need to be trained and pass exams to keep their certificates/licenses every 3 years at PRI. ● Practice running and training based on line characters will be done in training center.	• According to PRI's regulations
Railway Incident Drill	Railway operator	Station attendant /Driver/E&M Engineers	● Drill for smooth recovery work from railway incidents ● Recovery drill using a reserved train and test track ● The script will be proposed based on the actual incidents	• 1 day • 1~2/year • ~30
Disaster/ Safety Drill	Railway operator and related organization	Station attendant/ Train driver/ Related organization	● Cooperation with firehouse, police office, ambulance etc. ● Disaster evacuation drill (Earthquake / Flood etc.) ● Countermeasures for vandalism, firefighting, blackout etc.	• 1 day • Once /year • ~100

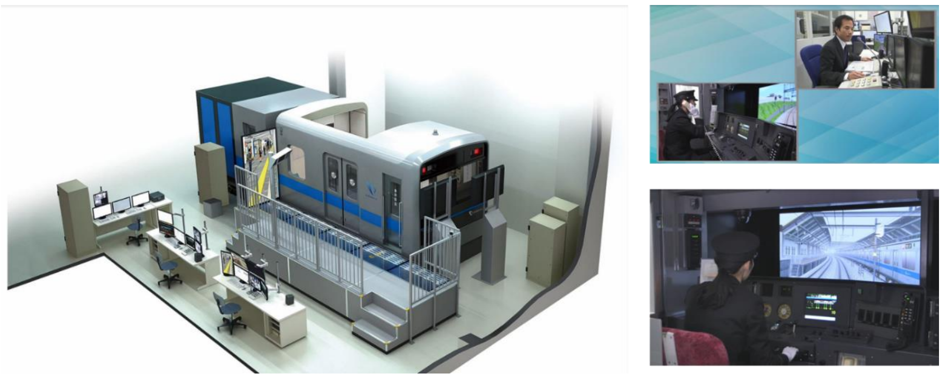
Source: JICA Design Team

(3) Proposed Training facilities

According to the basic plan of PRI and the case study of EJR training facilities, JDT proposes training facilities as outlined below. Those are designed for daily or annual safety or reskill training for operators in the railway operation division.

1) Indoor facilities

- Lecture rooms (Small room: ~20 employees, Main room: ~100 employees),
- Train simulator (Half size: ~10m long) with a large video screen for projection, where pre-programmed will be some scenarios for evacuation or accident training,
- Platform and station concourse mockup next to the train simulator for service and safety drill of station staff,
- E&M equipment, including rolling stock equipment, system models for basic operation functions and recovery operations.

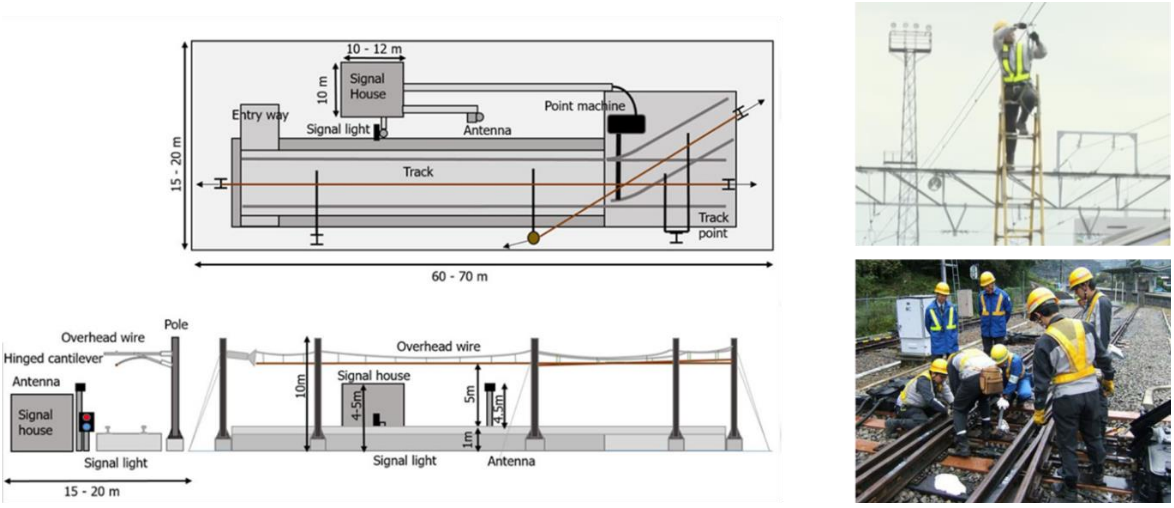


Source: Simulation system vender

Figure 4.5.9 Image of Train Simulator Training System

2) Outdoor facilities

- Full sized track mock up (approx.60m) for trouble recovery training,
- Training/test track (approx. 600m) for evacuation training with actual train, which will be used not only for training but also commissioning run after rolling stock maintenance.
- Mock-up stations (approx. 180m for 8-car train) at the both ends of the training/test track. The one is an independent station and the other is an extension of the TC building.



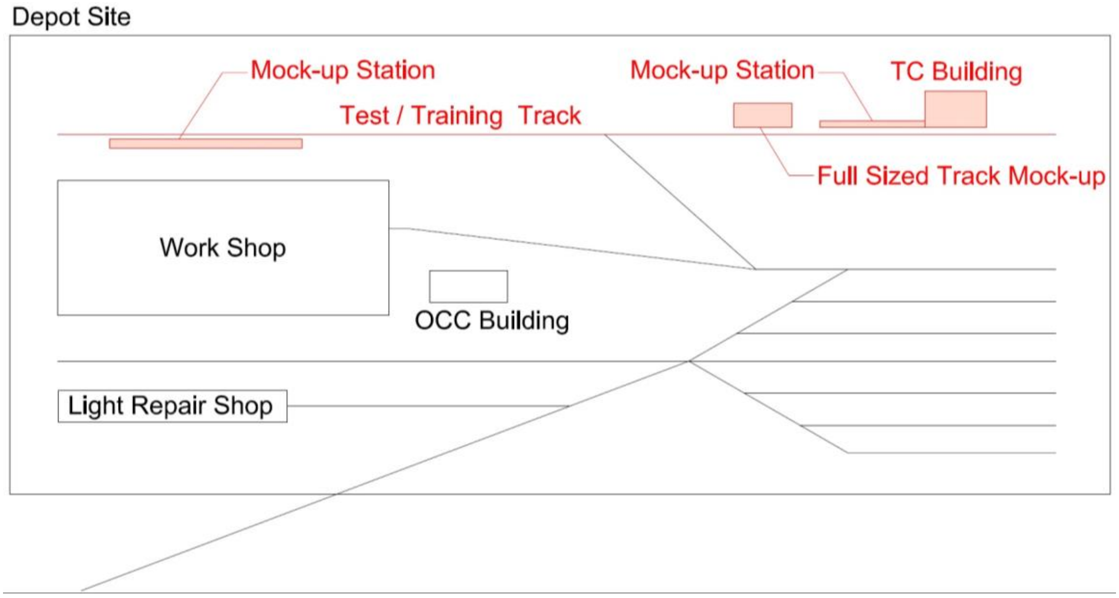
Source: JICA Design Team

Figure 4.5.10 Image of Full-sized Track Mockup

3) Image of the TC building and outdoor facility layout

The TC building and facilities are constructed in North depot. The layout and design of those facilities shall be considered to the ease of use of training program. The building is proposed in two stories layout. The ground floor is to be used for a practical or reskill training with a train simulator, station mock up and training equipment. The 2nd floor is for lecture and meeting rooms. Because lectures will be arranged for both small and large parties dependent on the program, small and large size rooms are considered. The building shall be constructed near test track, because trainees can quickly access to an actual train training at test track after having a lecture or simulator training in the building. The platform shall be constructed at the both end of test track for having a train operation training regarding the safety on platform. Also crossing shall be constructed in the middle of test track for having a traffic accident drill.

Because on-site training will be completed in half ~ one day according to the practice of EJR, the training center will not have dormitory for trainees. In the case of reskill drill of driver requires several days period, it is better to use hotel facilities near the depot because of the easiness of facility management.



Source: JICA Design Team

Figure 4.5.11 Diagram of Outdoor Equipment and Training Center Building Layout

4) Main facility procurement

Procurement for the main facilities comprising the TC is shown in Table 4.5.14

Table 4.5.14 Demarcation of Major Works

Item	Architecture	Civil	Railway System
TC building / Mock-up station	●		
Training equipment			●
Outdoor training facilities (Test/Training Track)		●	●
Outdoor training facilities (Mock-up Track)		●	●
Outdoor construction (road and landscaping)		●	
Electrical work	●	●	●
Mechanical work	●	●	

Source: JICA Design Team

(4) Architectural Basic Design of the TC building

1) Outline of Buildings and Facilities

a) Building

- TC main building : RC construction 2stories approx.1,750 m^2
- Electric service building : RC construction 1story approx.65 m^2

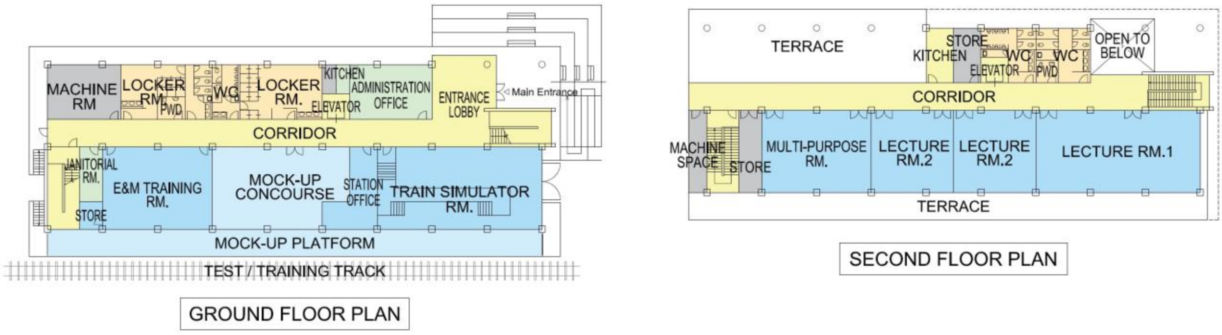
b) Outdoor Facilities

- Mock-up station : 3m × 180m, 3m × 125m
- Water receiving tank : 1 place
- Waste water treatment facility : 1 place
- Rain Water Storage Tank : 1 place

2) Plans

Floor plans of the TC building are as follows;

- A mock-up station for training will be set up on the ground floor. Large and heavy training equipment will be installed on the ground floor.
- On the Second floor, a lecture room and an outdoor terrace for waiting and refreshing will be set up.
- Area of room is accounted by demands of functions and numbers of trainees and teaching staff.
- Water utilities such as WCs and shower rooms are arranged intensively to make maintenance easier.
- Simple and short circulations make contribute for efficient training and emergency evacuation.



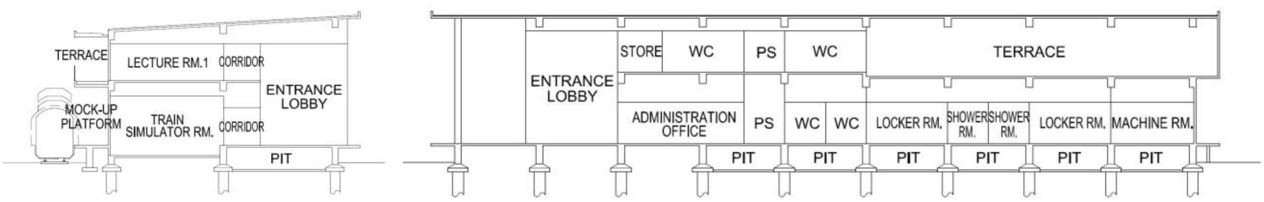
Source: JICA Design Team

Figure 4.5.12 Floor Plans of the TC Building

3) Sections

Section planning of the TC building is as follows;

- Height of ceiling will be basically 3.0m but be arbitrarily modified by considering condition.
- The ground floor level will be same as the mock-up platform at GL+1,400mm. However, the Train Simulator Room floor level is set at GL+600mm with respect to the introduction of equipment for installation.
- The Ground Floor height is a height that is no hindrance to the introduction of equipment for installation.
- The roof is an inclined roof suitable for the installation of solar power generation panels.



Source: JICA Design Team

Figure 4.5.13 Section of the TC Building

4) Essential Rooms

The essential rooms in the TC building and their proposed content and scale are shown in Table 4.5.15

Table 4.5.15 Training Center Essential Rooms

Room Name	Description	Size
Entrance Lobby		
Administration office	• Reception, business/ lecture/ security personnel office	Approx. 9m x 6m
Train Simulator RM.	• 1 x full-scale simulator	Approx. 18m x 9m
Mock-up Concourse Station Office	• Ticket vending machine, ticket gate, window counter • Service and safety equipment store	Concourse: Approx. 15m × 9m Office: Approx. 3m × 9m
Mock-up Platform	• Platform length: Approx. 54m • Platform width: Approx. 3m	
E&M Training RM.	• Establish rolling stock and signal equipment cut model, etc.	12m × 9m with small warehouse
Lecture RM. 1	• Seating capacity: Approx. 100 people • Head conference table (for three people) • Audio-visual equipment	
Lecture RM 2&3	• Seating capacity: Approx. 20 people • Individual desks	
Multi-Purpose RM.	• Multi-purpose room (spare room)	
Locker RM.	• Male and female • Locker size: 3-person or 6-person per unit	
Shower RM.	• Male and female	
WC	• Male, female and disabled	
Kitchen	• Shared kitchenette	
Terrace	• Outdoor space for waiting/rest periods	

Source: JICA Design Team

5) Finishing

The exterior and interior finishing of the TC building are shown in Table 4.5.16 and Table 4.5.17.

Table 4.5.16 Exterior Finish

Parts	Finishing	Remarks
Exterior Floor, Stairs	• General: Stone • Mock-up Platform: Stone	• Non-slip finish for stairs and ramp • Mock-up Platform should be the same specifications as the real stations
Exterior Wall	• Painting on plastering, Decorative accent tile	
Openings	• Doors: Steel door, Glass door, Wooden door in part • Windows: Aluminum frame window, Stainless steel frame window, Steel frame window	
Roof	• Rooftop: Pre-painted metal roofing sheet with injected insulation • Eaves Ceiling: Painting on plastering, Aluminum composite panel (wooden pattern)	• Solar power generational panel installation

Source: JICA Design Team

Table 4.5.17 Interior Finish

Major Rooms	Finishing
Entrance Lobby	• Floor: Stone • Wall: Painting on plastering, Decorative accent tile • Ceiling: Painting on board, Aluminum composite panel (wooden pattern)
Train Simulator Room E&M Training Room Lecture Room Multi-Purpose Room	• Floor: Stone • Wall: Painting on plastering • Ceiling: Sound Absorbing Gypsum Board
Mock-up Concourse	• Floor: Stone • Wall: Fluoride resin coated steel panel, Glass screen in part • Ceiling: Aluminum composite panel
Station Office	• Floor: Ceramic tile • Wall: Painting on plastering, Glass screen in part • Ceiling: Sound Absorbing Gypsum Board
Administration Office	• Floor: Ceramic tile • Wall: Painting on plastering • Ceiling: Sound Absorbing Gypsum Board
Corridor	• Floor: Stone • Wall: Painting on plastering • Ceiling: Painting on board
WC Shower Room	• Floor: Ceramic tile on waterproof bed • Wall: Ceramic tile on waterproof bed • Ceiling: Painting on board
Locker Room	• Floor: Ceramic tile • Wall: Painting on plastering • Ceiling: Painting on board
Staircase	• Floor: Stone, Ceramic tile, Stair nosing tile • Wall: Painting on plastering • Ceiling: Painting on board
Store	• Floor: Ceramic tile • Wall: Painting on plastering • Ceiling: Sound Absorbing Gypsum Board
Machine Room	• Floor: Dust dirt proof durable painting • Wall: Painting on plastering, Soundproof walls • Ceiling: Painting on concrete slab
Terrace	• Floor: Artificial wooden deck • Wall: Painting on plastering • Ceiling: Painting on plastering, Aluminum composite panel (wooden pattern)

Source: JICA Design Team

6) Furniture and Equipment

The major furniture and equipment for the TC building are shown in Table 4.5.18

Table 4.5.18 Major Furniture and Equipment

Item	Description	Quantity	Place to install
Student table	Steel made for 3 persons, folding type	36	Lecture room 1
Student desk	Steel made Individual type	80	Lecture room 2, 3, Multi-purpose room, E & M training room
Student chair	Steel made stackable chair	208	Lecture room 1, 2, 3, Multi-purpose room, E & M training room, Train simulator room
Lecture table set	Teacher's desk and chair with AV control panel, cable junction for PC	5	Lecture room 1, 2, 3, Multi-purpose room, E & M training room
White board	Portable type	6	Lecture room 1, 2, 3, Multi-purpose room, E & M training room, Train simulator room
AV set	Ceiling-mounted video projector, video screen, microphone and loud speaker system	4	Lecture room 1, 2, 3, Multi-purpose room
Sub monitor	Ceiling-suspended video monitor	6	Lecture Room 1
Office desk set	Steel made office desk and chair set	20	Administration office, Station office
Cabinet / Book shelf	Steel cabinet with lock 900 × 450 × 1,800 Steel open shelf 900 × 450 × 1,800	25	Multi-purpose Room, E & M training room, Train simulator room, Administration office, Station office, store
Locker	Steel made 900 × 500 × 1800	24	Male / female locker room
Lounge sofa set	Long bench and chair for 5 persons	3	Entrance lobby
Station bench	Steel made passenger bench for 3 persons	10	Mock-up plat form, mock-up concourse
Round table and chair set	Outdoor dining table set for 4 persons	6	Terrace
Planter box	Wood made 900 x 300	12	Terrace
Café chair	High chair for café counter	7	Kitchen
Others	Curtain, blind, roll screen,		

Source: JICA Design Team

(5) Structural Basic Design of the TC Building

1) Design standards/construction materials

Structural design standards, laws and guidelines will conform to those applicable to the MCRP-Depot. The same type and specification of structural materials used in the depot buildings will be used.

2) Overview of the Soil Strata of the Proposed Site

As the construction site has not yet been determined, this will depend on an investigation conducted in the future. The foundation structure will also be according to an investigation conducted in the future.

3) Building structural characteristics

- The building construction type will be a reinforced concrete pure framed structure, and the walls will be constructed so as not to bear a horizontal force or a vertical force.
- The floor of the Ground Floor will be reinforced concrete slabs that are supported by underground beams.
- The slabs and beams of the double floor or the waterproofing floor will be lower than the overall section and the finished surface of the floor will be designed to be at the same level as the entire floor.

- Exterior walls and interior walls that require fireproofing, sound insulation and waterproofing will be concrete hollow blocks, while other interior walls will be gypsum / cement boards with lightweight steel frames.
- Inclined reinforced concrete slabs will be used for the roof, and a foundation will be provided that supports solar power generation equipment.

4) Structural analysis and safety verification method

- The structural analysis and safety verification method for the TC building will conform to the MCRP-Depot buildings.
- Safety verification of member cross sections will conform to NSCP standards and will be carried out according to "Load and resistance factor design."
- In addition to the preceding items, the structural safety against extremely large earthquakes are proved by confirming the horizontal seismic bearing capacity of the building exceeds the bearing capacity required by Japanese codes.
- The seismic shear force coefficient and the various conditions for setting the coefficient are shown in Table 4.5.19

Table 4.5.19 Seismic shear force coefficient and the conditions for setting the coefficient

Building		Training Center Building
Direction		Both Directions
Seismic Zone		Zone 4
Seismic Zone Factor	**Z**	0.40
Soil Profile Type		To be determined based on the results of the geological survey.
Seismic Coefficients	**Ca**	0.32Na ~ 0.44Na, depending on the Soil Profile Type
	Cv	0.32Nv ~ 0.96Nv, depending on the Soil Profile Type
Maximum Moment Magnitude		A（8.4≥ M ≥ 7.0）
Closest Distance to known Seismic Source		D ≥ 15 km
Near-Source Factor	**Na**	1.0
	Nv	1.0
Evaluation Method of Base Shear Coefficient		Static
Importance Factor*1	**I**	1.0
Structure Material		Reinforced Concrete Structure
Basic Seismic-Force Resisting System		Special reinforced concrete moment frames
R Factor		8.5
Building Height above Ground (m)	**hn**	12.2
Fundamental Period of Vibration (Sec.)	**T**	0.48
Base Shear Coefficient *2	**C**	0.113～0.155

*1 Significance factor defined by NSCP that is different to the one used in Japan.
*2 Differs according to type of soil.

Source: JICA Design Team

- Loads to be considered as special loads are shown in Table 4.5.20.

Table 4.5.20 Special Loads of the TC Building

Location	Load	Proposed Weight *1
Train Simulator Room	Cut Model of Railway Vehicle	about 170KN
	Oscillating equipment	about 40KN
E&M Training Room	Bogie training Model	about 75KN
	Pantograph Training Model	about 0.5KN
Roof	Solar power generation panel	about 1500N/㎡

*1 proposed weight for basic design

Source: JICA Design Team

5) Proposed Sections of Major Structural Members

Cross sections of the representative structural members used in the TC building are shown in Table 4.5.21.

Table 4.5.21 Proposed Sections of Structural Members of the TC Building

Structural Members	Floor	Cross Sections (mm)
Primary Columns	GF to 2F	BxH = 750 × 750, 800 × 800
Primary Beams	Roof 2F	BxD = 600 × 800, 600 × 700 BxD = 600 × 900, 500 × 700
Foundation Beams	GF	BxD = 700 × 1,800
Secondary Beams	2F to RF GF	BxD = 400 × 700, 300 × 500 BxD = 500 × 700
Floor Slabs	2F to RF GF	t = 150 t = 200

Source: JICA Design Team

(6) Electrical and Mechanical Basic Design of the TC Building

1) General

This Chapter will show the scope, basic equipment details and design standards and conditions for the mechanical and electrical facilities in the TC building in the Depot.

Electrical facilities include power supply facilities, main line/power distribution equipment, lighting equipment, receptacle systems, lightning protection systems, and communications equipment, and it comprises electrical devices, wiring, circuit breakers, receptacles, lighting equipment and other mechanical/electrical equipment parts.

Mechanical facilities include air conditioning and ventilation equipment, water supply, drainage and sanitary facilities, firefighting equipment and transportation equipment, and mechanical equipment parts include air conditioners, ventilators, pumps, sanitary utensils, piping, valves, ducts, firefighting equipment, elevators, accessories and other mechanical devices.

Also, in response to the Philippine Green Building Code, occupancy sensors for lighting control, highly-efficient transformers, solar power generation systems, high-efficiency air conditioners, heat reclaim ventilation, water-conserving sanitary fixtures and rainwater recycling equipment will be used.

2) Design specifications

The design standards, laws and guidelines for the TC building shall conform to those applicable to the Depot. The design specifications for the main electrical equipment and mechanical equipment are shown in Table 4.5.22.

Table 4.5.22 Electrical and Mechanical Design Specifications

Item	Design requirements	Applicable standards/laws
Lighting equipment	• Illumination level of the major area Lecture room 500 lx Mock-up concourse 300 lx Corridor 100 lx	• IES (Illuminating Engineering Society of North America) Standards
Lightning protection system	• ESE (Early Streamer Emission) air terminal system	• Philippine Electrical Code
Fire detection and alarm system	• Fire alarm devices (Fire alarm control panel, Fire alarm annunciator panel, Fire alarm horn with strobe light, Smoke detector, Heat detector)	• Revised Fire Code of the Philippines • Fire Service Act of Japan
Air conditioning/ventilation System	• Outdoor environment: 37.7℃(dry bulb) • Indoor temperature and humidity: Habitable rooms: 24.0℃(dry bulb) 55% (relative humidity) Simulator Room: 22.0℃(dry bulb) 50% (relative humidity) • Ventilation: Habitable rooms: 25 Cubic meters/hr. per person WC: 10 times/hr. ventilation Warehouse, locker rooms, showers: 8 times/hr. ventilation	• Outside design condition; The Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA). • Air flow ventilation system; Standards applicable to the Depot.
Fire extinguishing System	• Indoor Fire Hydrant System • Standpipe System • Inert Gas Fire Extinguishing Equipment （Simulator room） • Fire Extinguisher	• Revised Fire Code of the Philippines
Water supply System	• Number of users: Approx. 250 people • Water supply volume: 100 litters/person per day	• The Manual of Building E/M services for Design guide-line and construction by the Ministry of Land Infrastructure, transport and Tourism of Japan (MLIT-J).
Wastewater treatment System	• Effluent standards: Chemical Oxygen Demand: 100 mg/litter Biochemical Oxygen Demand: 50 mg/litter Suspended solids: 100 mg/litter • Number of people treated: 250 people • Wastewater discharge volume:85 litters/person per day	• The effluent standards; Administrative Order No. 2016-08 for Class C Inland Water, Department of Environment and Natural Resources (DENR) • Wastewater discharge volume; Standards applicable to the Depot.

Source: JICA Design Team

3) Electrical Facilities of the TC Building

a) Power Supply System

- Receiving panel, Transformer, Main distribution board and Emergency Generator will be provided and installed by E&M.
- Grounding system shall be designed based on equipotential grounding method. Equipotential ground system will be employed to control the electric potential difference between the equipment.
- Solar power generation panels will be installed on the rooftop. Power conditioner and battery system will be installed for use of the TC building.

b) Low Voltage Power Distribution System

- Power will be supplied to the electric lighting distribution panels, power control boards, elevators, pumps, and other machinery for the building facility load.
- The main line will be laid on the cable rack from the low voltage distribution board and wiring will be provided to each distribution board and power board (3-phase 4-wire 380/220 V 60 Hz).
- Wiring will be provided to indoor power equipment from the power board (3-phase 3-wire 380 V 60 Hz). Circuits for power equipment installed in exterior and humid locations will be protected using earth leakage circuit breakers.

c) Interior Lighting System

- Wiring will be provided to indoor lighting from the electric light circuit board as well as installations such as switches and various machinery. The form, size and shape of lighting equipment will be determined according to each location in the facility with adjustments for construction design.
- Emergency lighting (in-built battery type) and exit lights will be provided in necessary locations in accord with standard laws. Emergency lighting will have dedicated circuits and will ensure necessary floor level lighting along evacuation routes at more than 10 lx. The main type of emergency lighting will be 9Wx2 LED lamps (in-built battery type). In order to lead facility users along evacuation routes, emergency exit lights (in-built battery type) will be provided. Emergency exit lighting is to be kept lit at normal times using the regular power source, and it must be capable of being lit by battery for more than 30 minutes during power outages. Exit lighting will be established at 20 to 30-meter intervals.

d) Receptacle System

Single phase receptacles will be provided at various points inside the building from the electric light circuit board. The receptacles will be single-phase 2-wire 220V 2P+E (16A), and there will be receptacles in about six locations per circuit. Habitable rooms will be provided with wall-embedded receptacles and other rooms will have exposed receptacles. Receptacle circuits will be protected in exterior and humid locations using an earth leakage circuit breaker. Receptacle installation locations will be established on the basis of equipment placement in the facility.

e) Lightning Protection System

A lightning protection system consisting of air terminals, down conductors, ground rods and ground rings will be installed in order to protect the building from lightning. The lightning protection system will be provided on the roof of the building to ensure that the people and buildings are safe from dangers and fires caused by lightning. The type of lightning protection system and the location of installation will comply with the construction standards and laws in the Philippines.

f) Communications System

- Telephone system, On-site telecommunications network equipment, Broadcasting equipment and CCTV/Surveillance system will be provided and installed by E&M.
- Projectors, screens, audio equipment and wireless microphones will be installed for the purposes of lectures and training/practice.
- Receivers will be set up for the purpose of the early detection and notification of fires, and wiring ducts and equipment for each sensor will be supplied and installed. The installation of equipment will be performed based on the Fire Code of the Philippines and Fire Service Act of Japan. The system will also be installed for the purposes of training for the handling of disaster prevention equipment inside station buildings.

4) Mechanical Facilities of the TC Building

a) Air-Conditioning and Ventilation System

- Air-conditioning zoning will be carried out with consideration for room usage, room environment conditions, direction and the temperature burden and usage periods of machinery.
- With regard to the type of air conditioner, a suitable combination will be selected from among multiple packaged AC units, outside air processing units and heat reclaim ventilation with consideration for ease of maintenance and ease of renewability.
- Air conditioner unit ON/OFF and temperature settings in each room and each area will be controllable using a centralized remote control.
- In order to remove waste heat and odors, ventilators will be installed in rooms such as the locker room, WC, shower room and store.

b) Equipment Alarm System

Failure alarms such as water tank, pumps, elevator, a sewage treatment plant will be received at the administration office of the TC building.

c) Fire Fighting System

i) Indoor Fire Hydrant System

- Indoor Fire Hydrant System will be installed for training purpose.
- The fire extinguishing pump will be installed in Machine Room-2, and the fire extinguishing water tank will be installed in the underground pit.

ii) Standpipe System

- Standpipe System will be installed at primary locations for the firefighting activities.

iii) Inert Gas Fire Extinguishing Equipment

- Inert gas fire extinguishing equipment will be installed in Simulator Room where the precision equipment is located.

iv) Fire Extinguisher

- Fire extinguisher will be installed to conform to relevant codes.

d) Wastewater Treatment System

- A sewage treatment plant and a septic tank will be installed to conform to the effluent standards of Department of Environment and Natural Resources (DENR).

e) Elevator equipment

- An elevator which is the same specification as the typical station will be installed for training purposes.

5) Sanitary Facilities of the TC Building

a) Water supply system

- The TC building system branches out from the water supply service pipe in the Depot to supply water to necessary locations after being temporarily stored in the exclusive water tank via the water meter.
- The water supply system is comprised of a receiving tank and pressurization water supply system.
- The hot water supply system is an individual system.

b) Sanitary equipment

- Various user-friendly sanitary equipment will be established by selecting equipment appropriate for the intended use.
- Water-conserving fixtures will be used.

- Toilets accessible by the disabled will be installed in compliance with Accessibility Law of the Philippines (BP 344 - Accessibility Law and its IRR).

c) Drainage system

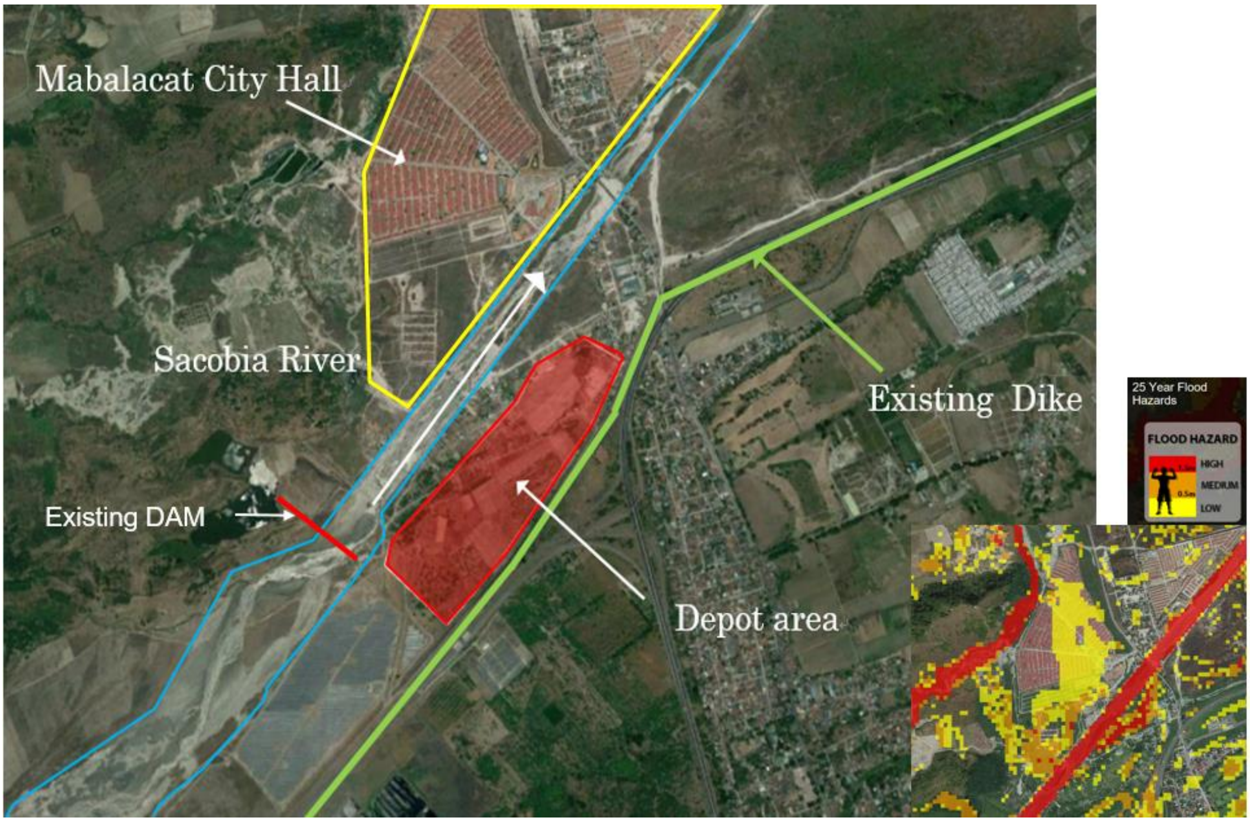
- There will be an indoor distributor system for sewage and miscellaneous wastewater, which will merge outside and connect to the drainage facilities in the Depot.
- Rainwater drainage will connect to the rainwater main pipe in the Depot via the rainwater inlet.
- Rainwater will be stored in the underground tank for emergency water source and be usually used for spraying plants and cleaning.

4.5.9 Flood Analysis of the impact of North Depot structure to the surrounding areas

This describes the results of the flood analysis of Sacobia River and its surrounding areas after the construction of the depot north of Clark International Airport and within the Sacobia River flow channel (Option 1, see Figure 4.5.1).

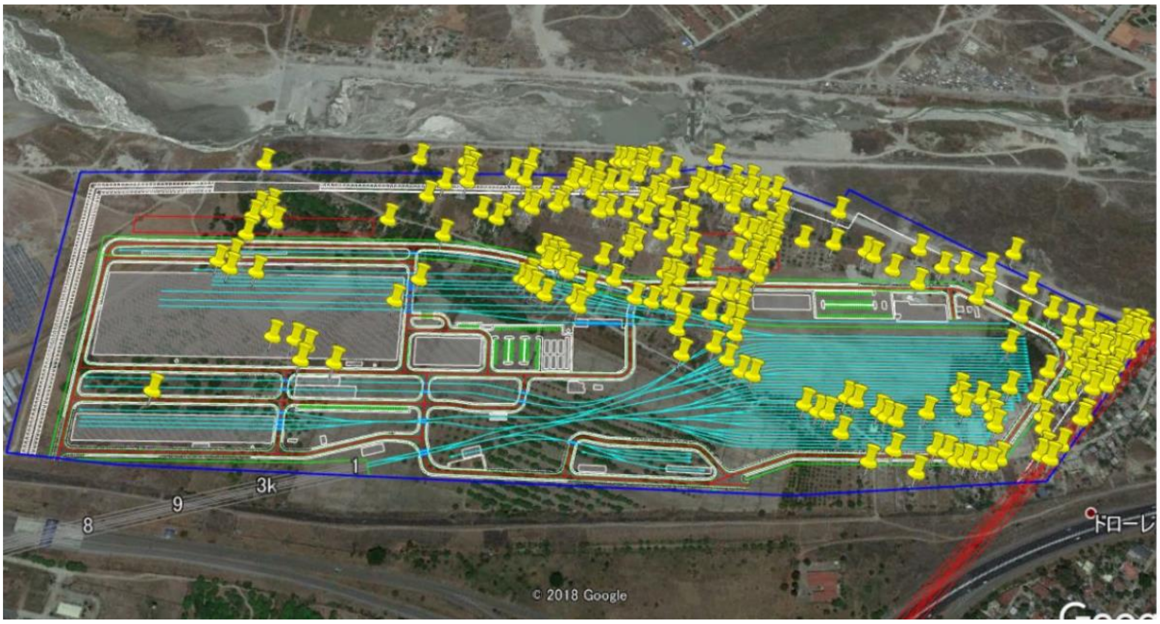
(1) Location and surrounding conditions of North Depot (Option 1)

Figure 4.5.14 shows the conditions of the North Depot location (Option 1) and its surrounding areas. On the south-eastern side of the North Depot location (Option 1) there is an existing embankment (mega dike) and on the east side and upstream end of the depot location there is an existing dam. Moreover, on on the other side of Sacobia River is Mabalacat City Hall. In addition, Figure 4.5.15 shows the identified households and structures currently located at the North Depot (Option 1) location.



Source: JICA Design Team

Figure 4.5.14 North Depot location and surrounding features



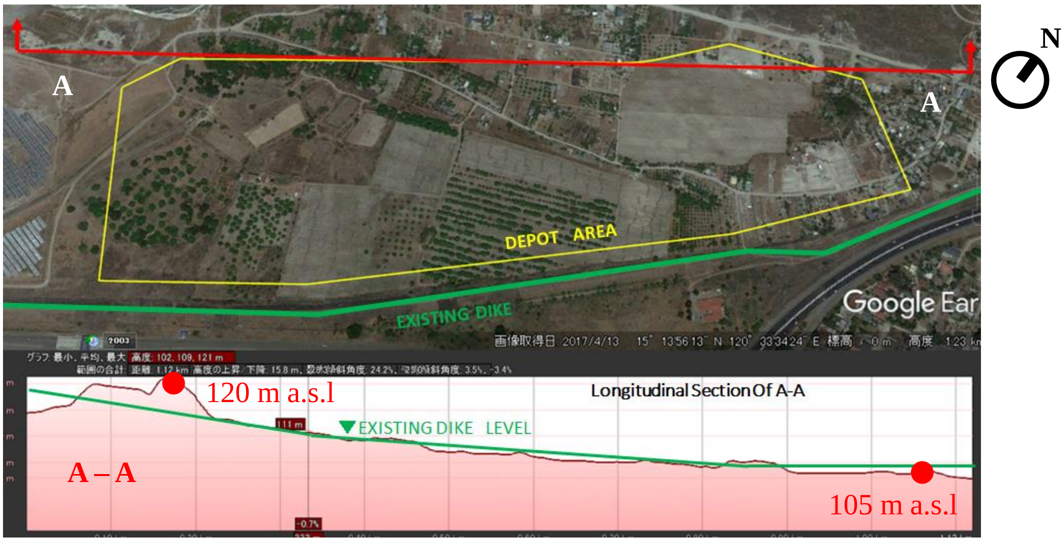
Source: JICA Design Team

Figure 4.5.15 Identified households and structures at the North Depot (Option 1) location

(2) Site formation of North Depot location (Option 1)

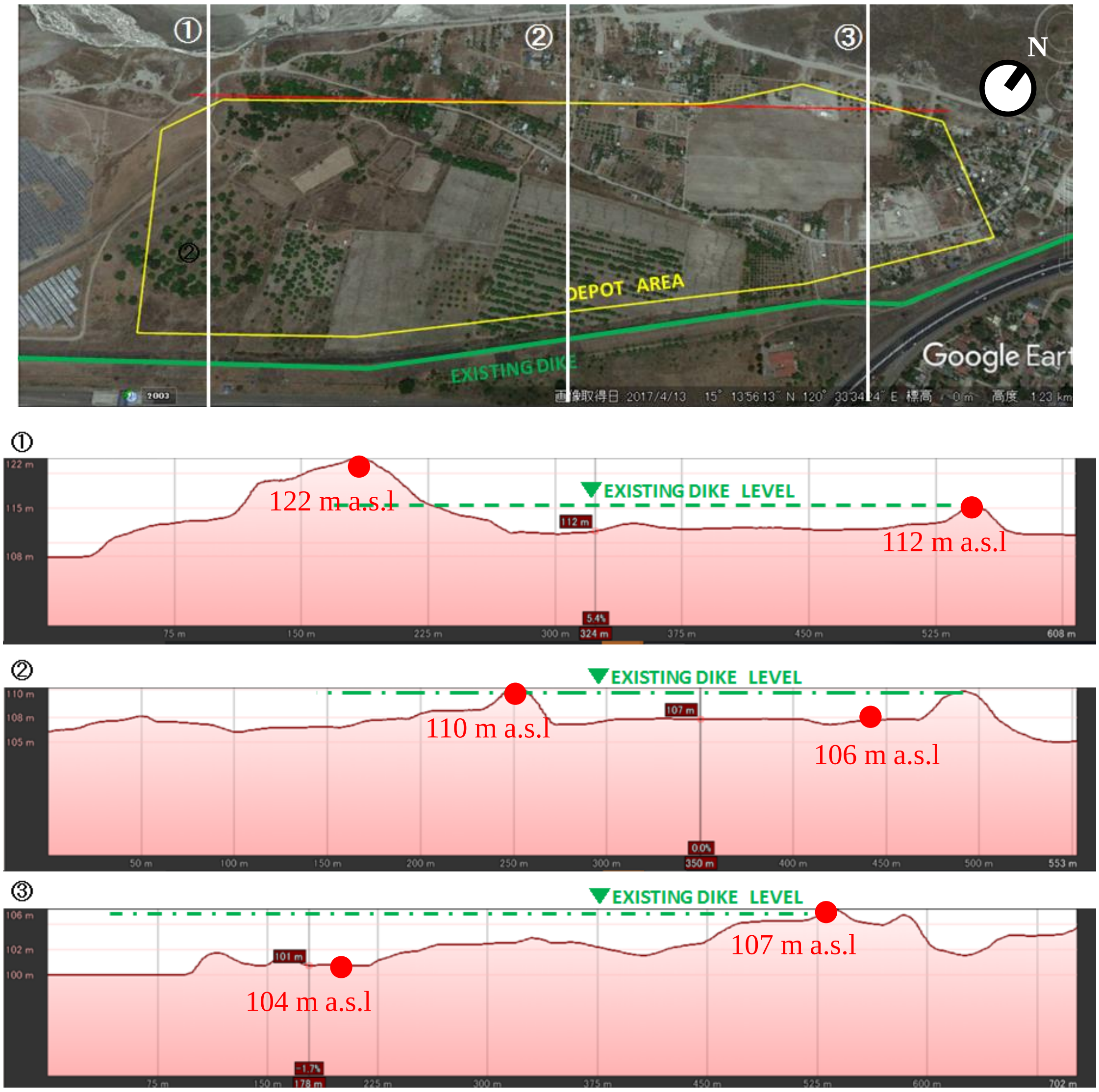
1) Terrain

The topographical conditions of the North Depot site are presented in Figure 4.5.16 and Figure 4.5.17. Longitudinally (west-east), the ground elevation of the depot site along Sacobia river edge (A-A cross section in Figure 4.5.2) decreases from west to east. Namely, the ground elevation decreases drastically from 122 m to 105 m above the sea level (hereinafter referred to as "a.s.l."). Transversally (north – south), the ground elevation of the depot site varies from the edge of Sacobia river to the existing river dike. Figure 4.5.17 shows the transverse elevations at three different sections of the depot (option 1) site. Transversally, as shown in cross section 1, the highest elevation is on the north-west side of the depot at 122m a.s.l. On the other hand, the lowest elevation of the depot is on the north-east side of the depot at 104m a.s.l. In this sense, the terrain elevation decreases from north to south on the west side of the depot site, and the elevation decreases from south to north on the eastern side of the depot site.



Source: JICA Design Team

Figure 4.5.16 Longitudinal (west-east) Topographic Level of North Depot



Source: JICA Design Team

Figure 4.5.17 Transverse (north-south) Topographic Level of North Depot

(3) Sacobia River Flood Analysis

1) Analysis Conditions

a) Study Case

i) Simulation, using 2-D continuity and mass-momentum equations of inflow discharge plus rainfall on location for different configurations.(※Consider 2050 Climate Change Condition)

Case1. Current condition

Case2. Embankment of the depot.（Embankment Height=110,118,120m）

ii) Validation of runoff and flood level

iii) Flooding countermeasures to protect Mabalacat City and surrounding areas

iv) Summary of construction cost and construction period.

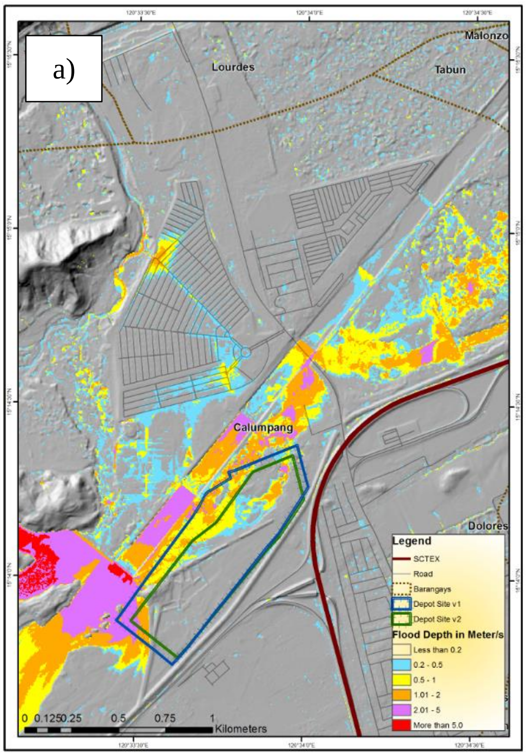
v) Evaluation.

b) Analysis Conditions

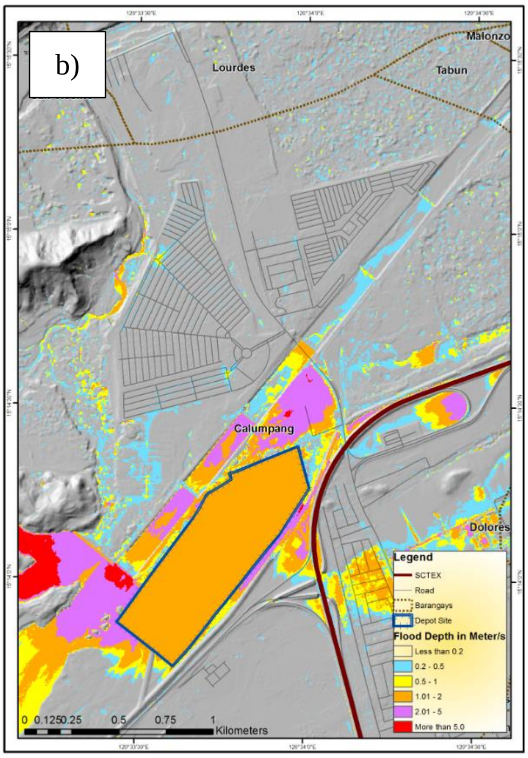
The flood analysis simulation boundary conditions and methodology are:

- 5m resolution/grid size
- Uniform rainfall rate (1/100 return period considered 2050 climate change) input (peaking at maximum discharge)
- Spatial infiltration rates applied
- Uses LIDAR DEM acquired in 12-15 February 2013 (1m resolution)
- Uses coefficient of roughness based on DPWH guideline Volume 3
- Uses a shallow water approximation of the St.Venant equation.

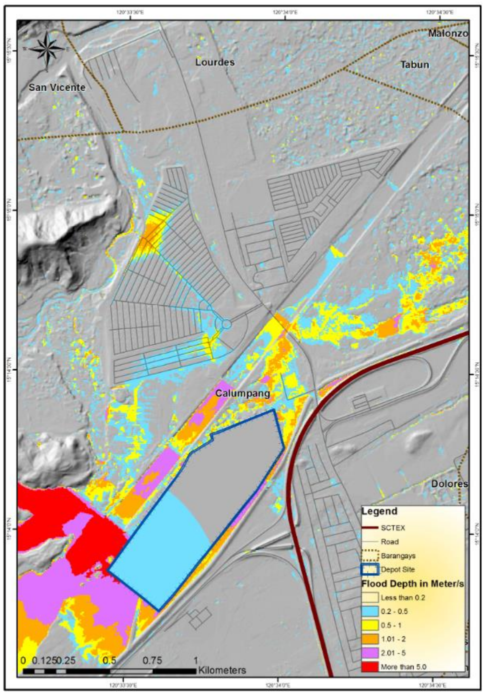
2) Analysis Results



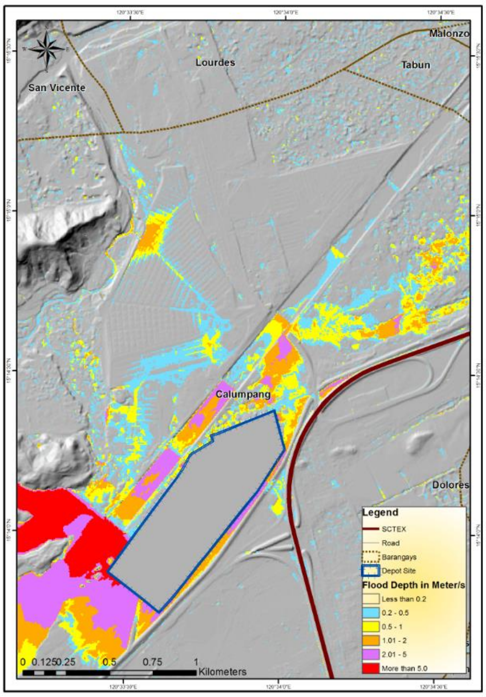
Case 1: Present condition
(before construction of depot



Case 2: Flooding condition after construction
of depot (H=110m)



Case 3: Flooding condition after
construction of depot (H=118m)



Case 4: Flooding condition after
construction of depot (H=120m)

Source: JICA Design Team

Figure 4.5.18 Flooding analysis results

3) Comparison and discussion of flooding analysis results at the present conditions and after the construction of depot structure (H=120m)

Figure 4.5.18 shows the flooding analysis results of the current condition and after the construction of the depot structure at various elevations. Figure 4.5.19 on the other hand shows the impact in flooding in the surrounding areas caused by the construction of a depot structure 120m in height.

In the following three locations, the flooding increased compared to the current condition, namely:

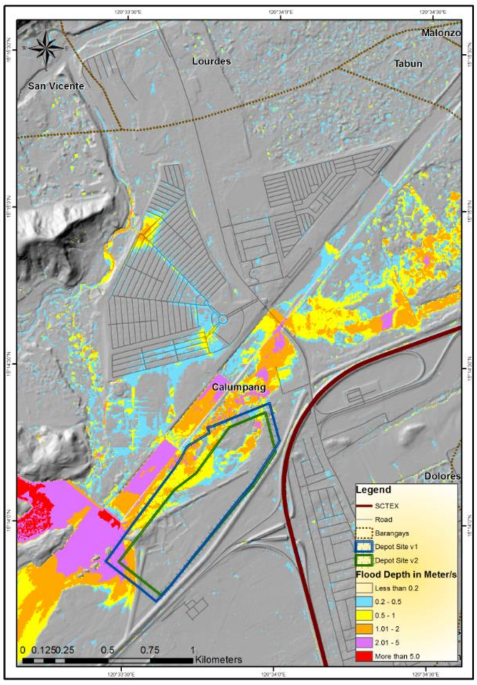
1. The height in flooding in the northern and southern sides of Mabalacat City
2. The increment in accumulated water in the upstream side increases and reaches to the sides of the depot site.
3. The flooding height increases between the depot embankment and the the SCTEX embankment.

Based on the above analysis and findings, building the depot within the river channel of Sacobia River will have a negative effect on the flooding in the surrounding areas of the depot. In order to protect the depot from flooding, it is necessary to increase the formation level of the depot to about 120m a.s.l.

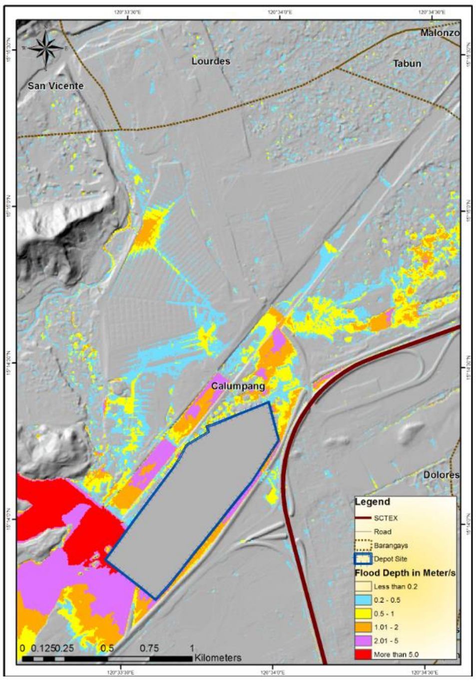
In addition, in order to protect the vehicle base from the flood, it is necessary to raise the base surface of the base to

Also, as shown in Figure 4.5.19, as a result of the increment in the flooding level in Mabalacat City, it is expected that many residents on the other side of the river would be affect, which would have to be relocated to avoid any possible future catastrophes .

Therefore, based on the above flooding analysis and justification, it was decided to change the location of the depot at the Sacobia River channel (Option 1).



Case 1: Present condition (before construction of depot



Case 4: Flooding condition after construction of depot (H=120m)

Source: JICA Design Team

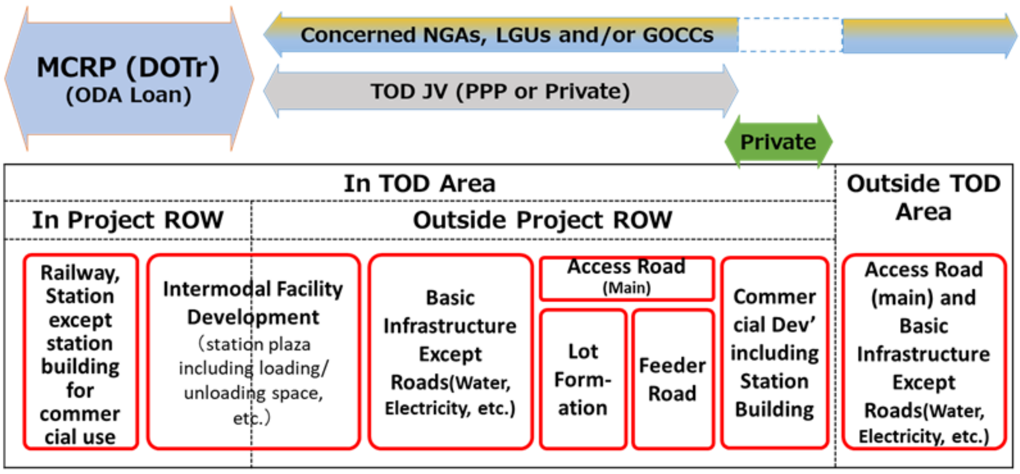
Figure 4.5.19 Comparison of flood analysis of the present condition and after the construction of depot structure (H=120m)

CHAPTER 5 TRANSIT ORIENTED DEVELOPMENT (TOD)

5.1 TOD Approach

The development of railway infrastructure is expected to contribute to improve inter-regional, inter-city, urban corridor connectivity, promote local economic activities and sustainable development. However, those effects are not always achieved by the development of railway infrastructure only; the comprehensive approach for encouraging the use of public transport is required. Transit Oriented Development (TOD) is a development approach that promotes public transportation with multiplier effects attained through the integration of transportation development with other types of development e.g., commercial, office, and residential development in the vicinity of mass transit stations. Therefore, although many of the infrastructure which comprise TOD are not directly included in the MCRP as shown at Figure 5.1.1, it is essential to establish a consensus on the importance of TOD among the potential stakeholders especially LGUs as the planning and supervising authority of the area development in their respective localities.

On the other hand, there has been no comprehensive and planned TODs in the Philippines. Therefore, the lack of capability of stakeholders for planning, developing and managing TODs is one practical limitation. Furthermore LGUs which are expected to be the main stakeholders in the TOD initiatives, have long-standing fiscal limitations and capabilities to finance such. Therefore, it is important to show the image of the TOD concept for each station area and the process for enabling the TOD projects from technical, regulatory framework and financial perspectives. TOD concept for each station is shown Appendix 5.2-6.



Source: JICA Design Team

Figure 5.1.1 Image of responsible parties for developing TOD related infrastructure/facilities

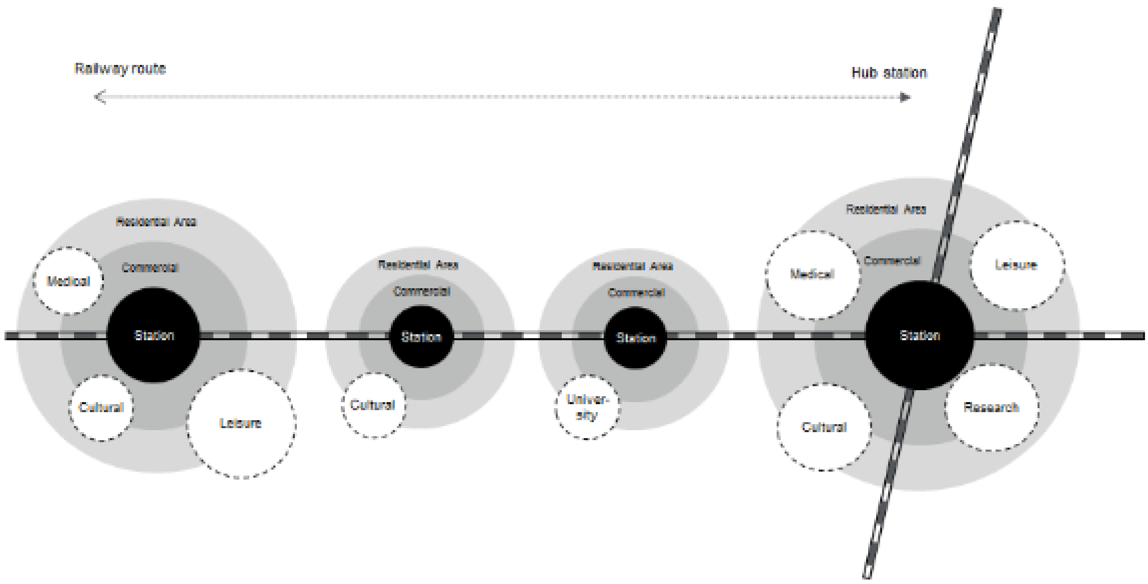
5.1.1 Definition of TOD

Although idea of TOD has been diffused recently, there has been no unified definition. However, it can be said that TOD is the approach for creating dense mixed-use and dense area development near public transportation hub. The enhancement of transportation capacity and accessibility as well as the promotion of integrated property development are essential to implement a successful TOD that contributes to the promotion of public transportation.

Table 5.1.1 Sampling of Definitions of TODs

“A multidisciplinary planning and design strategy to ensure compact, mixed-use, pedestrian and two-wheeler friendly, and suitably dense urban development organized around transit stations” (World Bank Group)
"A mix of commercial, residential, office and entertainment centered around or located near a transit station. Dense, walkable, mixed-use development near transit attracts people and adds to vibrant, connected communities.” (Federal Transit Administration in the U.S Department of Transportation)
“Practice of developing or intensifying land-use near stations”(M. Boarnet and R. Crane)
“A mixed-use community that encourages people to live near transit and to decrease their dependency on driving” (P. Still)
“A compact community, centered on a transit station that, by design, invites residents, workers, and shoppers to drive their cars less and ride mass transit more” (M. Bernick and R. Cervero)

Source: World Bank Group, the U.S Department of Transportation, and ADB



Source: Integrated Station-City Development – the Next Advanced of TOD / Nikken Sekkei

Figure 5.1.2 Integrated TOD Concept Along the Railway

For applying the idea of TOD to the MCRP, the concerned NGAs initiated by DOTr has created the TOD Policy Statement (DRAFT) as shown at Table 5.1.2. The TOD Policy Statement is expected to let the stakeholders of both NGAs and LGUs set the common definition and goal of TOD and their role for planning, developing and managing related projects through the support and cooperation of private entities if necessary.

Table 5.1.2 TOD Policy Statement (DRAFT)

Principle # 1: TOD must be inclusive. It must accommodate and cater to all income groups and sectors of Philippine society to ensure equitable access to the benefits that TOD generates.
Principle # 2: TOD may be flexible in size. Depending on its considered and projected economic viability, a TOD can be as small as an area with a 400-meter radius a 1,000- meter radius of a transit station. It can also be separate from the transit station provided that, it is connected and easily accessible to the transit station.
Principle # 3: The land for TOD shall be unified in purpose. The land parcels for developing a TOD project should be unified in purpose such that developments around the station have a mixture and balance of commercial, social and cultural functions.
Principle # 4: The TOD should be mixed-use, walkable, bicycle-friendly, and with adequate public open space. It should be able to accommodate a mix of land uses and land users, including especially public parks and open spaces. Its layout should foster walking and bicycling and overall, promote a healthy and safe environment. It should also integrate existing developments in the area whenever possible.
Principle # 5: Planning and Development of TOD sites should consider the need for future feeder network developments. Design, planning and implementation of TOD site development activities should take into account prospective needs to establish feeder networks that may involve other modes of mass transport. Establishing trunk and feeder networks can further strengthen the viability of ridership and further enhance the convenience of the traveling public.
Principle # 6: The TOD sites along the rail line should complement each other. Each TOD site should strategically complement each other and optimize the convenience of accessing different establishments along the rail line. Redundant establishments along the rail line should be avoided to ensure that the benefits of TOD policy along the entire line is optimized**.**
Principle # 7: The TOD should be economically and financially viable as much as possible. It should take into consideration the marketability and economic viability of its components in order to achieve financial sustainability.
Principle # 8: The TOD must be environmentally responsible and disaster-resilient. It must respect the natural environment and establish measures to minimize ecological disturbance as well as to address disaster risks and climate change considerations.
Principle # 9. The planning of TOD shall be done under the partnership of the National Government and Regional Bodies as well as concerned Local Government Units. The National Government shall work with regional bodies and concerned LGUs in a coordinated manner to ensure that their respective mandates and concerns are integrated into the TOD plan.
Principle # 10. The financing and implementation of the TOD projects will be under the supervision of the National Government. A TOD Management Committee and a Technical Working Group will be established by concerned National Government Agencies for the purpose of steering the TOD concept particularly in the funding or financing of the TOD's implementation, as well as the management of the revenue that is expected to be generated by the TOD's operations
Principle # 11: The LGUs must, to the extent possible, be active partners in supporting the viability of the railway project. The importance of LGUs as active partners and cooperators in their respective TOD areas is a central aspect of this initiative. Considering that the railway project will undoubtedly impart economic benefits to localities, the relevant LGUs must contribute to the long-term viability of the railway project.
Principle # 12: Formal coordination and cooperation between all key governance actors are essential for effective delivery of TOD initiatives. Synergy among national government agencies, concerned local governments and if necessary, private sector is essential in TOD development. This extends to the management and maintenance of the TODs in an efficient and effective manner.

Source: TOD Technical Working Group

5.1.2 Effect of TOD

As TOD is a comprehensive area development approach, its effects and impacts reach a wide range of sectors such as economic, environmental and social ones. The combination of the use of the public transportation system and dense and mixed-use area development with open space and walkers and bicycle-friendly facilities are expected to contribute to vibrant economy with improved efficiency, preservation of greenery, less energy consumption, good health and higher quality of life.

Table 5.1.3 Effects of TOD

Sector	Examples of Effect
Economical	• Time Saving • Energy Saving • Space Efficiency • Infrastructure Cost Saving • Functional • Enables Agglomeration Economy • Synergy & Creativity
Environmental	• Air Pollution Reduction (CO2, Lead, GHGs and other harmful air contaminants) • Land & Greenery Preservation • Care of Biodiversity • Higher aesthetic value of the locality
Social	• Enhanced access to Jobs, Services and Other Opportunities • Housing Provision

Source: JICA Design Team

5.2 Scope of the TOD Study

5.2.1 Selection of Targeted Station

All the stations of MCRP except Malolos are the targets of the TOD study; Calumpit, Apalit, San Fernando, Angeles, Clark, CIA and NCC.

5.2.2 Clarification of TOD Concept

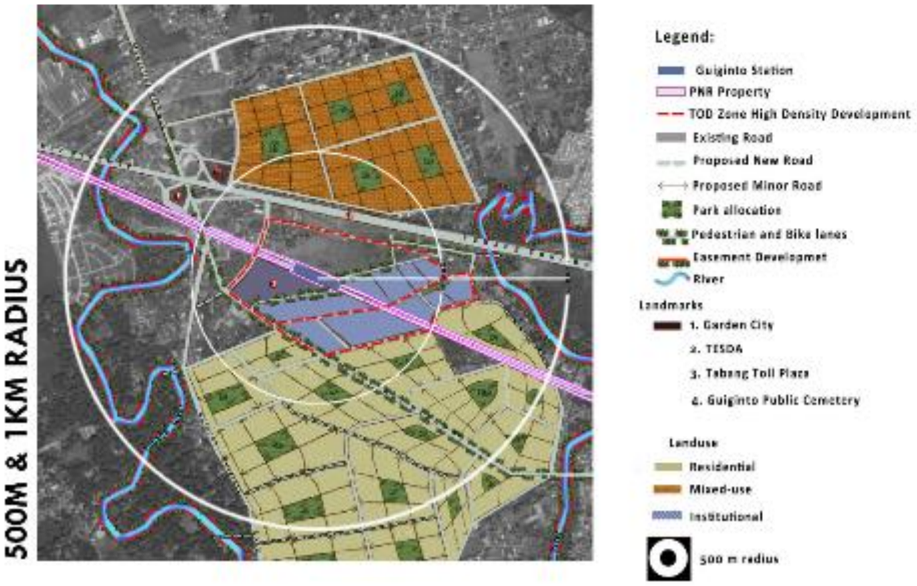
The primary TOD concept, planning, and TOD effect will be identified depending on the distance from the stations. Land use, bird’s-eye view and station plaza will be created as a part of conceptual works and development perspectives.

The primary TOD concept is suggested based on existing national, regional, provincial and local plans (e.g. Philippine Development Plan, National Spatial Strategy, National Physical Framework Plan, Regional Framework for Physical Plan, Provincial development and Physical Framework Plan, Comprehensive Land Use Plan (CLUP) and Comprehensive Development Plan (CDP), ordinances related to land use, development activities and tax system, discussion with concerned agencies.

Table 5.2.1 Target of TOD Concept

Distance	Primary TOD Concept	Planning	TOD Effect
0m~200m	Office, Commercial, Transport connection	Land Use, Bird-eye View, Station Plaza	Tax increment
200m~500m	Commercial, Condominium, Public sector	Land Use, Bird-eye View	Tax increment estimation
500m~1000m	Commercial, Residential, Public space (e.g. Park)	Land Use, Bird-eye View	None

Source: JICA Design Team



Source: JICA Design Team

Figure 5.2.1 Land Use (Sample)

Source: JICA Design Team

Figure 5.2.2 Bird's Eye View (Sample)

Source: JICA Design Team

Figure 5.2.3 Station Plaza (Sample)

5.2.3 Project Delivery Structure

As TOD is comprehensive area development approach, there is no definite or uniformed project delivery structure. In other words, the adequate project delivery structure will be decided considering various factors such as land ownership, capability of implementing agencies, and market interest, among others. On the other hand, considering the limited capability of LGUs, the overarching assistance from NGAs are essential for the successful implementation of TODs. In general, when there is a publicly- owned land in TOD areas where revenue generating activities (e.g. commercial and residential development) are expected, carrying out PPPs including JV are possible project delivery options. On the other hand, there is no public owned land, it is desirable to initiate private development based on the concept of TODs by setting a TOD masterplan and related guidelines (for more detail, please see Appendix 5.3).

5.2.4 Financing TOD

As it mentioned earlier, financing TOD related projects is one of the biggest challenges for concerned agencies. Among them, the financial capability of LGUs are limited and they cannot allocate budget for the investment on TOD related projects in current public finance framework.

Tax revenue increment (TIF) which is the financing system based on the estimation of the future land value increase and increased tax revenue which is widely adopted in local government in the United States would have a beneficial effect at the national and local government level through the implementation of TOD. Land value would be increased by enhancing accessibility and convenience that will redound to higher tax revenue such as through real property tax (RPT). On the other hand, the legal framework for implementing comprehensive TOD has yet to be formed in Philippines.

Therefore, the study shows an enabling process for adopting TODs with possible institutional arrangements (please see Appendix 5.5-6).

CHAPTER 6 WORK IMPLEMENTATION PLAN

6.1 Preliminary Construction Plan

6.1.1 Overview

A construction plan at the detailed design stage is a plan to carry out construction work based on drawings and specifications which are made taking into account surveys and geotechnical investigations. It is expected that the most appropriate plan will be prepared after fully examining the schedule of each work, proposed project schedule, construction period, safety, quality assurance, economic efficiency, and environmental impact. However, a construction plan in this report is prepared based on the plan at the current stage since surveys, geotechnical investigations, and designs are not yet finished.

6.1.2 Outline of Construction

According to the MCRP Construction Plan submitted in December 2017, the MCRP has the total length of 50.4km, consists of 40.7km of the viaduct portion and 9.7km of the embankment portion. However, almost the entire MCRP will be a viaduct and because the embankment portion has been revised due to the high-cost and long construction period induced from the ground conditions. In this report, the embankment portion is deleted.

Construction of a viaduct consists of superstructure, substructure and foundation works. As for superstructure work, a span length of 40m is selected as a typical span length and precast box girders will be used. Substructure work will be a single cast-in-situ pier, and cast-in-situ piles are proposed for foundation work.

Issues between Malolos and CIA are the following;

- Lahar from the eruption of Mt. Pinatubo exists in and around the city of San Fernando. It is important to carry out thorough geological surveys, and prepare a design reflecting the lahar ground. It is necessary to plan for construction activities considering how to treat lahar especially during the rainy season.
- The areas between KM47 and KM55 are swampy and low-lying areas with poor drainage to Manila Bay. During the rainy season, stagnant water may stay in these areas. Once water stays, it takes about a week until water subsides. It takes another 1 to 2 weeks until the ground conditions recover to the original state in order for construction to be carried out. Thus, sufficient study with due consideration to embankment height and range is needed when constructing temporary access roads.
- The MCRP has acute angle crossings with MacArthur Highway and SCTEX, and their span length is expected to be 140m. Therefore, a plan minimizing an impact to the traffic during the construction is needed.

- It is necessary to minimize impact during construction at a river crossing, especially when a working platform is provided by an embankment at the river. When impact on the river is large, it is possible to provide a temporary access road using jetty.
- There are several locations where high voltage cables, telecommunication lines, and water pipelines cross or run through the project alignment. These utility lines need to be treated before construction starts. Relocation method of these obstructing utility lines shall be discussed with relevant agencies, and shall be recommended to the DOTr in the early stage.
- A segment casting yard is an important factor in viaduct construction. Selection of proposed yards shall be carried out as early as possible and recommended to the DOTr so that securing of casting yards can be done before the start of the construction.
- Some of the construction areas are occupied by settlers and these settlers need to be treated by RAP before construction starts.
- Simultaneous start of the construction is needed along the whole alignment since rapid construction is requested for this project. Therefore, securing subcontractors for piling work and superstructure work etc. will affect the completion of the project.

6.1.3 Schedule Planning

Through discussions with the DOTr, it was decided that the targeted opening of the MCRP is in May 2022, construction start date is May 2019, and the completion of all civil work will be the end of year 2021. Therefore, securing sufficient number of erection girders, segment formwork, and piling rigs will be very critical.

In order to carry out superstructure work, substructure work has to be completed beforehand. This means the selection of competent subcontractors for substructure work is vital to the project. As for segment fabrication which will be used in superstructure work, there is no record of segment fabrication in the Philippines, so special consideration such as hiring experienced personnel etc., is needed.

There is concern over noise, vibration, and lighting since the construction will be carried out day and night.

6.1.4 Construction Method

(1) Construction of Viaduct

1) Superstructure Work

A span-by-span method is a method of constructing a viaduct. In this method, the alignment and cross section of segments produced by match casting process will be fitted and jointed between 2 segments. Normally, all segments for 1 span are lifted by an erection girder and jointed by post tensioning. Other possible methods are supporting segments by an underslung girder or falsework.

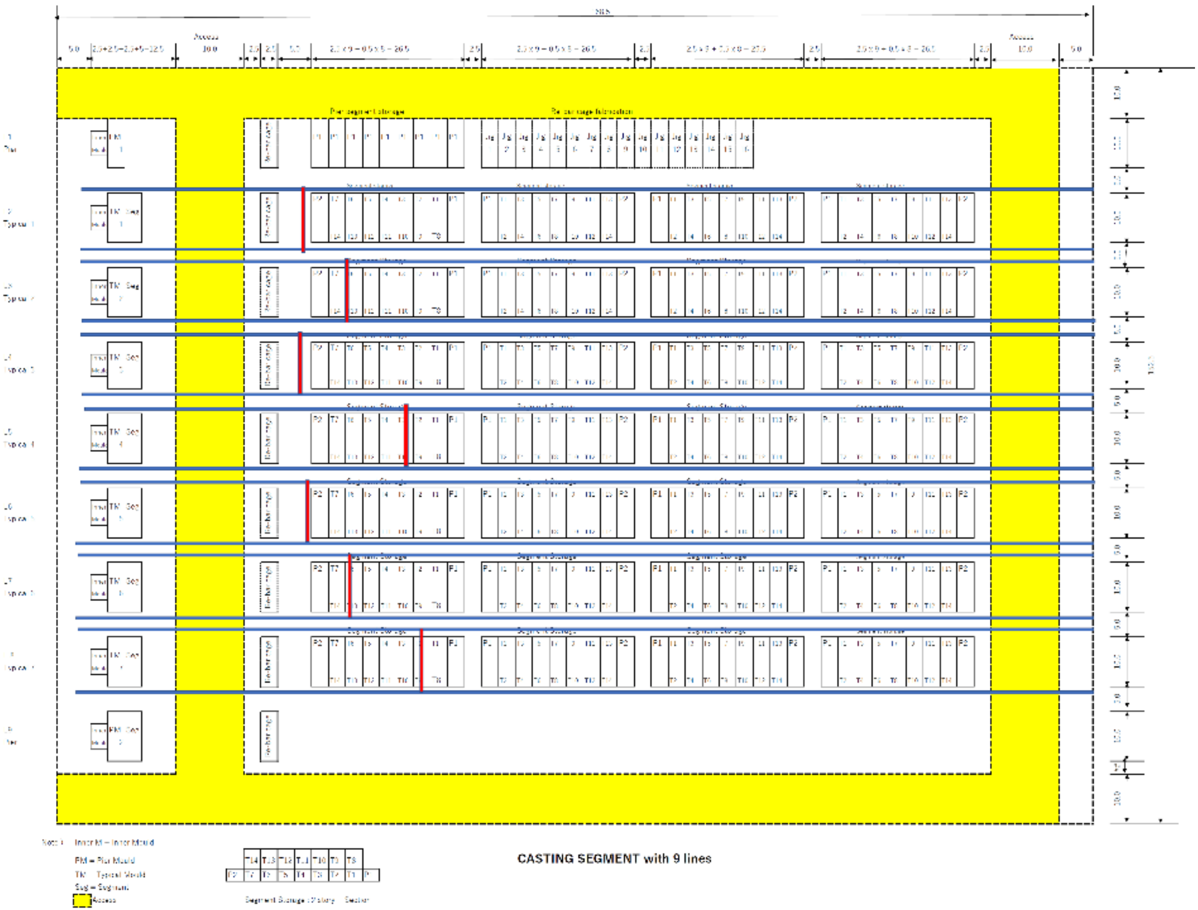
a) Fabrication of Segment

The shape of bridge girders used in continuous viaduct bridges for railway varies depending on a span length. When a span length is 15m to 30m, T-shaped girders are used. Typically box girders are used for a span length of 30m to 60m. In this project, a span length of 40m will be selected as a typical span length considering transporting of segments and short construction period.

For a construction method, 2.5m precast segments fabricated by match casting process will be used to construct box girders and these box girders will be installed by span-by-span method using an erection girder.

Additionally acquired lands will be used for segment fabrication. A typical casting yard consists of fabrication molds, survey equipment tables for alignment control, storage area, rebar cutting yard, rebar cage jigs, cranes, temporary laboratory etc. A concrete batching plant will be requested when necessary.

Two types of molds are needed; a typical segment and a pier segment. The number of mold depends on the size of storage area and the speed of segment erection. However, in order to make full use of molds, 7 of typical type and 2 of pier type are suggested. The current plan is shown in Figure 6.1.1.



Source: JICA Design Team

Figure 6.1.1 Proposed Casting Yard

Segment fabrication procedure is as follows.

- Attach a segment carrier (movable bottom plate) to a fixed outer formwork
- Install a match-cast segment (previously produced segment) as per required alignment
- Install rebar and inner formwork, then cast concrete against the match-cast segment
- After checking the concrete strength, the outer formwork is stripped and the match-cast segment is pulled out using a segment carrier
- Finally, the new segment is pulled out

This newly produced segment will become the next match-casting segment. Geometry control will be very important because those segments will become final geometry of the viaducts. A casted segment will be moved to a storage yard after required marking. Production rate is 1 no./day for a typical segment while 1no./2days for a pier segment. Concrete supply has a big impact on the production cycle time.

DAY 1

Time	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	1	2	3	4	5	6
P1	Tra	S5	S5	S6	S6	S6	S6	S7	S7	S7	S8	S8	Con	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu
T1	S1	S2	S3	S4	S5	S6	S7	S8	Con	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	S9		
T2		S1	S2	S3	S4	S5	S6	S7	S8	Con	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	S9	
T3			S1	S2	S3	S4	S5	S6	S7	S8	Con	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	S9
T4				S1	S2	S3	S4	S5	S6	S7	S8	Con	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu
T5					S1	S2	S3	S4	S5	S6	S7	S8	Con	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu
T6						S1	S2	S3	S4	S5	S6	S7	S8	Con	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu
T7							S1	S2	S3	S4	S5	S6	S7	S8	Con	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu
P2														Tra	S5	S5	S6	S6	S6	S6	S7	S7	S7	S8

DAY 2

Time	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	1	2	3	4	5	6
P1	Cu	S9	S1	S2	S3	S3	S3	S3	S4	Tra	S5	S5	S6	S6	S6	S6	S7	S7	S7	S8	S8	Con	Cu	Cu
T1	S1	S2	S3	S4	S5	S6	S7	S8	Con	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	S9		
T2		S1	S2	S3	S4	S5	S6	S7	S8	Con	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	S9	
T3			S1	S2	S3	S4	S5	S6	S7	S8	Con	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	S9
T4	S9			S1	S2	S3	S4	S5	S6	S7	S8	Con	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu
T5	Cu	S9			S1	S2	S3	S4	S5	S6	S7	S8	Con	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu
T6	Cu	Cu	S9			S1	S2	S3	S4	S5	S6	S7	S8	Con	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu
T7	Cu	Cu	Cu	S9			S1	S2	S3	S4	S5	S6	S7	S8	Con	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu
P2	S8	Con	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	S9	S1	S10	S10	S10	S2	S3	S4	Tra	S5

Note)

Survey as-built	(S1)
Shift Match cast	(S2)
Strike Formwork and sift cast segment	(S3)
Clean mould and install bottom formwork	(S4)
Set cast segment as mutch cast	(S5)
Install re-bar cage and stressing sheath and others	(S6)
Insert inner mould	(S7)
Final inspection	(S8)
Cast concrete	Con
Curing	Cu
Check concrete syrength	(S9)
Strike inner formwork	(S10)
Transport match cast segment to pier mould	Tra

Source: JICA Design Team

Figure 6.1.2 Daily Casting Cycle of Segment

Number of typical spans that can be fabricated is shown below;

Table 6.1.1 Number of Typical Span Fabrication per Month

Month	Fabricated Span (assuming 100% rate of operation) a	Fabricated Span with 80% rate of operation b = a*80%	Total Length m c = b*40m	Remarks
1	0	0	0	The first month is for fabrication practice
2	7	5.6	224	
3	21	16.8	672	
4	35	28.0	1,120	
5	49	39.2	1,568	
6	63	50.4	2,016	
7	77	61.6	2,464	
8	91	72.8	2,912	
9	105	84.0	3,360	
10	119	95.2	3,808	
11	133	106.4	4,256	
12	147	117.6	4,704	
13	161	128.8	5,152	
14	175	140.0	5,600	

Source: JICA Design Team

Note: 80% rate of operation can be achieved by applying countermeasures against rain such as roofing at concrete casting yard etc.

b) Transporting Segment

Segments will be transported by a trailer using public roads from a segment casting yard to an installation location and will be stored there temporarily. Segments shall be stored and stacked in two layers within the span so that they can be directly lifted by a girder. In order to do so, segment width of 2.5m is planned.

When an installation location is above a river or a road where temporary storage is impossible, segments will be transported to the erection girder using the top of the already erected segments.

c) Installation Method

An erection girder will be transported to a designated location and then assembled. When it is assembled, the girder will be lifted to the top of the pier head by two cranes, followed by attaching various components to the girder. After a trial operation, the erection girder can start lifting a segment which is stored below the span.

A segment is lifted by a winch, then the segment is received by hoists of the erection girder. Then the next segment is lifted and received by the girder. After the whole segments for 1 span are lifted, they are temporarily tightened by post tensioning bars. Thereafter, post tensioning is carried out in accordance with the design procedure and followed by moving the span into the designated position.

d) Parapet, Protective Concrete Layer, Cable Trough, OCS Pole Foundation

Precast parapets will be installed by anchor bolts at both sides of the superstructure. The length of a parapet is 2.5m which is the same as that of a segment. During installation, height and alignment shall be checked and tightened temporarily. Installation is completed only when grouting and tightening of anchor bolts are done.

Subsequently, position checking of starter bars for the track shall be done and defective portions shall be repaired. Casting of protective concrete layer shall be proceeded, then followed by construction of cable troughs and OCS pole foundations.

Handover to a track laying contractor shall be done only after all of above mentioned work are finished.

2) Substructure Work

A footing work consists of earth retaining, excavation, pile head treatment, and footing construction.

Excavation depth of a footing is expected to be approximately 5m, and earth retaining by such as sheet piles is needed. Typically, sheet piles are installed by a vibro hammer. When sheet piling has to be carried out near existing structures, the use of a silent piler etc. might be requested instead of a vibro hammer.

For construction of a pier, steel formwork system shall be used in order to speed up the construction. A construction method which reduces scrap materials shall be taken into consideration.

Concrete shall be casted once, two times or even more depending on the height of the pier. Laitance on construction joints shall be treated.

After completion of pier construction, pier head construction shall be carried out. Steel formwork system shall be used as well for construction of pier heads. Concrete working platforms are needed for formworks. Bearings will be installed temporarily at first, then after box girder installation, permanently installed.

Rebar fabrication shall be carried out in accordance with the bar bending schedule prepared beforehand. A working platform shall always be secured and safety always comes first when installing rebar.

Drainage pipes from superstructure are installed inside piers. Therefore, when casting concrete on a pier, it is necessary to take appropriate measures against deformation and dislocation of pipes which will be caused by heat curing and concreting.

3) Foundation Work

In the current design, all piles are cast-in-place piles. The following are the result of interviews from piling companies.

- Drilling work shall be carried out using an earth drill. During drilling, bentonite slurry shall be used as a measure against collapse of soil. Reverse circulation drilling method can be used for construction in a river when an earth drill cannot access to the pier location in a river.
- Bentonite slurry stabilizer shall be supplied by a pump installed in a backup plant. Depending on the capacity of a pump, 100m to 200m construction work can be done. After the completion of each 100m to 200m work, a backup plant shall be relocated.
- Concrete casting shall be carried out using a tremie pipe.
- Piling companies own ten to eighteen piling rigs and additional rigs could be arranged if necessary.
- Bentonite used as stabilizer is treated by a specialized subcontractor.

All work (viaduct, station building, bridge etc.) need to be started simultaneously as rapid construction is requested by the DOTr. Thereby, a total of 25 or more piling rigs are expected.

Soft ground exists along the project alignment based on on-going geological investigations. On soft ground, there is a concern about stability of soil. Countermeasures such as casing shall be used as protection for soil. Collapse of soil may occur during extraction of casing, but this could be prevented by using permanent casing etc.

a) Plant Facilities

1. Piling Rig
2. Auxiliary Crane
3. Backhoe
4. Dump Truck
5. Bentonite Mixing Plant
6. De-Sanding Facilities
7. Bentonite Silo
8. Generator
9. Stabilizer Transfer Pump

As previously mentioned, items five to nine of a backup plant need to be relocated every 100 to 200m depending on stabilizer transporting distance. Loss of time due to the relocation of a backup plant needs to be taken into consideration for schedule programming.

b) Piling Work

- Insert a casing pipe in the ground using the pile center provided by survey as a reference point
- After the insertion, check the position of the casing pipe
- Set up a piling rig and start drilling
- Drilling work is carried out using an earth drill. During drilling, stabilizer (bentonite slurry) shall be always kept in higher level than groundwater level
- When the excavated depth is confirmed, circulate stabilizer and remove slime precipitates

- Insert a prefabricated rebar cage after confirming that slime is being treated
- Tubes used for quality control shall be attached to a rebar cage beforehand
- Insert the rebar cage up to the required depth, and fix it temporarily using the casing
- Once the position is confirmed, carry out the second slime treatment
- Cast concrete
- A tremie pipe is used for concrete casting. The bottom of the tremie pipe shall be kept in the concrete at least 2m in order to keep the poor quality concrete, concrete mixed with bentonite slurry during the initial concrete casting, at the top of the casted concrete
- Check the final height of concrete
- Pull out the casing before concrete is hardened
- The quality of piles shall be tested by sonic test etc.

4) Equipment / Material Delivery

Equipment and materials are delivered to the site using public roads. Common equipment / materials will be transported to the site during daytime, while oversized equipment / materials will be delivered outside the regulated time or after obtaining permits from authorities concerned.

Once the equipment / materials are delivered to the site, temporary access roads are used to move them. However, where temporary access roads are not provided due to a river or road crossing, equipment and materials shall be transported using only public roads.

Large vehicles such as concrete truck, trailer, and dump truck etc. are banned at certain times of the day in some areas. Thus, it is necessary to conduct a prior survey and take proper measures by obtaining special permits etc.

(2) Construction of Viaduct (Widening Section)

Viaducts near the stations where express trains overtake commuter trains must be widened so that sidetracks can be provided. A station building has four track lines composed of three box girders, thus widening is needed for a section from typical span portions to a station building. A span-by-span method for segment erection cannot be used for this widening sections and a cast-in-situ method will be used instead.

After the construction of a widening section, the erection girder is moved into the station building and segments will be installed by this erection girder. Segment installation by an erection girder is not possible at both sides of the station building, so construction of segments will be carried out using falsework from the ground level.

It is necessary to carefully study the timing of viaduct construction at these sections because it will affect the schedule of station building construction.

Piling work and foundation work of station buildings and viaducts will be carried out at the same time. Thereafter, construction of box girders will be carried out together with the construction of station buildings.

(3) Construction of Viaduct (Long Span)

Since the MCRP has acute angle crossings with MacArthur Highway and SCTEX, constructing a bridge of regular span is difficult. Therefore, its span length will be 140m.

For a long span bridge, the following bridge types are being considered.

- Steel Truss Bridge
- Arch Bridge (PC Box Girder)
- Truss Bridge with and Additional Pier at the Middle Point
- PC Box Girder Bridge (Cantilever Method),
- Extradosed Bridge (PC concrete girder)

After evaluating the above methods, an extradosed bridge by PC concrete girders will be adopted in this project. This method is similar to that of a cable stayed bridge. The main girder of an extradorsed bridge will be supported by main towers and outer cables. Main towers will be constructed at both sides of MacArther Highway / SCTEX, and the main girder will be constructed by cantilever method. Along with constructing the cantilever portion of the main girder, cables will be installed from the main towers, post-tensioned, and then anchored to the main girder sequentially.

Other than the above locations, there are several river crossings and road crossings where the span length exceeds 40m. For these locations, a balanced cantilever method shall be adapted.

A balanced cantilever construction method is to construct main girders by attaching segments at opposite ends of the cantilever supported by a pier.

(4) Construction of Depot

A depot needs a wide land. Earthwork accounts for a large portion of constructing a depot. Therefore, there is a need for selecting borrow pits and soil disposal areas. It has been decided that a depot will be constructed on the CIA premises. Since the basic design will be made from now on, a construction method will be described in the next report.

1) Land Preparation

A large amount of embankment materials will be needed. 20ton to 36 ton Dump tracks will be used to transport embankment materials. In order to avoid inundation, the embankment height shall be 2m from the ground level.

2) Operation and Maintenance Buildings

There are over 20 buildings (large to small) to be constructed for operation and maintenance. Construction of these buildings will be carried out after land preparation work. There are several buildings with pile foundations. It is expected that the construction schedule will be very tight.

3) Road inside Depot

A further evaluation is necessary

4) Pavement inside Depot

A further evaluation is necessary

(5) Construction of Drainage

1) Viaduct Drainage System

Water will be collected in a catch basin located in the middle of each span and will be drained to the ground through drainage pipes of a box girder and a pier. Then, drained water will flow into the ground drainage system.

2) Depot Drainage System

The location of the depot has been finalized. A further evaluation is necessary.

(6) Construction at River Crossing

Bridge piers need to be constructed in the rivers and along the waterfront. Construction in the rivers has to be planned carefully considering effects on rivers. When it is necessary to construct an access to rivers, influence on the rivers must be fully evaluated.

1) Bag Bag River

There will be two bridge piers in the river. For construction method, the following are being considered.

- a temporary jetty
- construction of a working platform by reclamation

The advantage of a temporary jetty is that construction work can be carried out regardless of the season. However, this method will affect the overall schedule. Meanwhile, construction of a working platform by reclamation will affect the overall schedule only a little. However, since the river will be narrowed, influence on the river must be fully studied and if necessary, construction during the dry season will be considered.

2) Rio Grande River

There will be three bridge piers in this river. A construction method can be the same two types as described above.

3) Apalit River

Three piers will be constructed in the river. No water flows along both banks of the river. Therefore, the construction of piers can be done by providing a working platform which is constructed by a simple embankment. However, as for the middle of the river, the previously mentioned two methods need to be studied.

4) Abacan River

There will be two bridge piers in this river. The river is largely scoured, but the actual river width is only a few meters depending on the season. Thus, it is possible to carry out the construction of piers on the ground. Heavy machinery shall be evacuated when a flood occurs.

5) Sapang Balen (Meandering Creek)

The project alignment crosses the meandering river. The ground level of the west side of the river and that of the east side differ by a few meters.

Where scouring might occur, a footing foundation needs to be lowered to the river bed level. During the construction activities, a portion of the river will be occupied. However there is sufficient land available around the river and the construction can be carried out without any problem. It is necessary to make an evacuation plan in case of flooding.

(7) Cut and Cover Tunnel

A cut and cover tunnel with a length of 2.5km will be constructed between Clark Station and CIA Station after completion of a viaduct.

In general, an earth retaining method using sheet piles is applied. The deepest point of the excavation will be 20m and at CIA station, excavation width will reach 43m. This means retaining walls, intermediate piles, bracing, walings etc. shall be considered. Since accelerated construction is required, these temporary work plans will have a large impact on the overall project progress. Instead of an earth retaining method, an open excavation method can be another option. However, if an open excavation method is used, excavation width will protrude from a construction boundary. Therefore, further study on temporary storage for excavated soil etc. is needed.

6.1.5 Major Equipment & Facilities

Main equipment and facilities are listed below.

(1) Batching Plant

Based on site investigations, there are several ready-mix concrete suppliers along the construction areas. These suppliers provide low-strength to high-strength concrete to the DPWH and private companies. All these suppliers have plans in case of material (aggregates and cement) shortage. For these reasons, it is assumed that concrete supply will not be a problem. Nevertheless, there is a possibility to put up a batching plant in a segment casting yard when segment fabrication is taken into account.

(2) Segment Fabrication Facilities

Planning of segment casting yards will affect actual fabrication of segments. Therefore, it is important to receive advice from experienced experts etc.

(3) Machinery for Earthwork

Machinery for earthwork such as shovel dozers and backhoes etc. will be used for construction of temporary roads and piers. Since these machinery are commonly used in construction work in the Philippines, there is no problem arranging them.

(4) Crane

Cranes are also commonly used in the Philippines. However, available cranes over 200-ton are limited.

(5) Segment Erection Girder

As a result of accelerated work, it is expected that 2km to 2.5km of viaduct will be constructed by 1 erection girder. This means that a total of 21 erection girders shall be used for the overall construction. It will take approximately 1 year to procure new erection girders. Therefore, it is essential to secure a contractor who owns erection girders.

(6) Piling Rig

As construction of stations, long span bridges, and typical span bridges starts simultaneously, the project needs a total of 20 to 25 piling rigs. It is noticeable that the number of piling rigs in the Philippine is limited as a result of interviews with local piling contractors. Therefore, it is necessary to secure the delivery of piling rigs from overseas through early negotiation with piling contractors.

6.1.6 Major Materials

(1) Concrete

Ready-mixed concrete will be used.

(2) Cement

There are several local cement production companies.

(3) Rebar

Investigation is still ongoing.

(4) Aggregate

Investigation is still ongoing.

(5) Formwork

Special attention is needed for procurement period on steel formwork systems i.e. segment molds.

6.1.7 Temporary Facilities

(1) Temporary Yard

A temporary yard will consist of the followings.

Table 6.1.2 Temporary Facilities

Temporary Facility	Area (m^2)
Office (Contractor & Engineer), Laboratory	2,000 m^2
Workers' Quarter (1,000 workers)	5,000 m^2
Warehouse	1,000 m^2
Rebar, Formwork Fabrication Yard	3,000 m^2
Batching Plant	7,000 m^2
Segment Casting Yard	42,000 m^2
Storage Area	23,000 m2
Total	**83,000 m^2**

Source: JICA Design Team

Note: the above mentioned casting yard areas are required to fabricate typical span segments as denoted in 6.1.4(1)1)a). They have to be adjusted depending on the length of the sections to be constructed.

(2) Main Site Office

A site office should be set up within the construction site so that a contractor can easily monitor daily construction activities. The same could be said for an Engineer's site office. In addition to a site office, satellite offices may be needed since this is a long distance railway project. As for a laboratory, there is an option of sub-contracting the work. Thus, setting up a material laboratory in the temporary yard will be evaluated at a later stage.

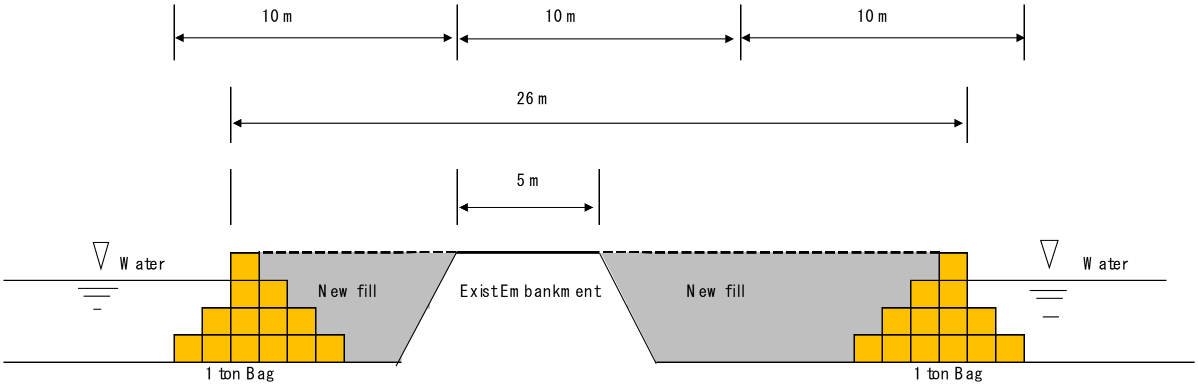
(3) Satellite Office

A satellite office is needed when the main site office is far from the construction site. It is typically a container office equipped with electricity, water, and toilet etc. A supervisor shall be stationed at this satellite office all the time.

(4) Temporary Access Road

A temporary access road is an important factor for transporting equipment and materials. All temporary roads including roads which run through urban areas and narrow areas must be always maintained in good condition. A drainage system must be carefully designed. Otherwise, water puddles might embrittle roads and affect transport of equipment and materials. At the planning stage, it is important to design durable roads which won't be damaged during the dry and rainy seasons. Measures against dust should be considered for the sake of neighbors.

Temporary access roads in swampy areas especially need due consideration. Figure 6.1.3 shows schematic drawing in swampy areas.



Filling quantity	(7+2)/2 x 2 x 8,000 m =	72,000 m 3
	(12+7)/2 x 2 x 8,000 m =	152,000 m 3
1 ton bag	13 x 2 x 0.5m 3 x 8,000 m =	104,000 m 3
Total filling quantity		328,000 m 3

Source: JICA Design Team

Figure 6.1.3 Temporary Access Road at Swampy Area

(5) Access Route

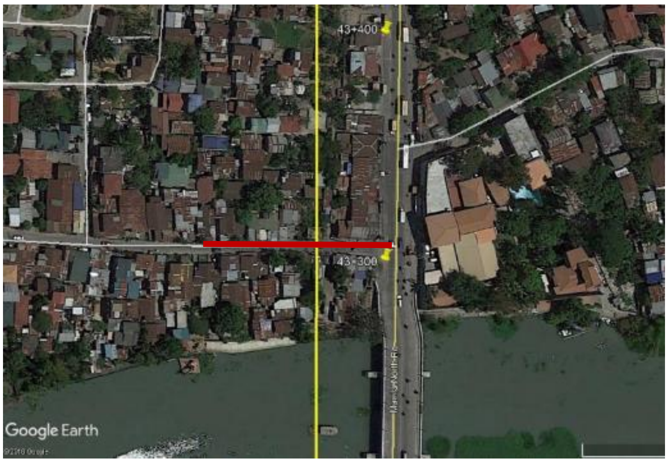
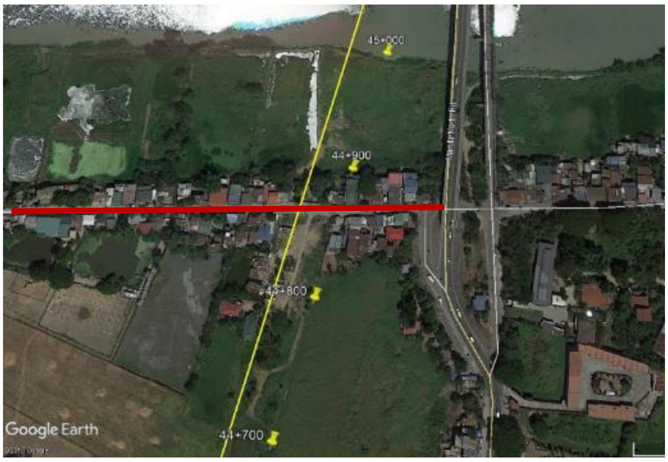
Heavy machinery (piling machine, crane, and backhoe etc.) is delivered to the site by trailers. And a prior study on traveling routes is needed. When passing through residential areas or village roads, it is important not to cause nuisance to residents.

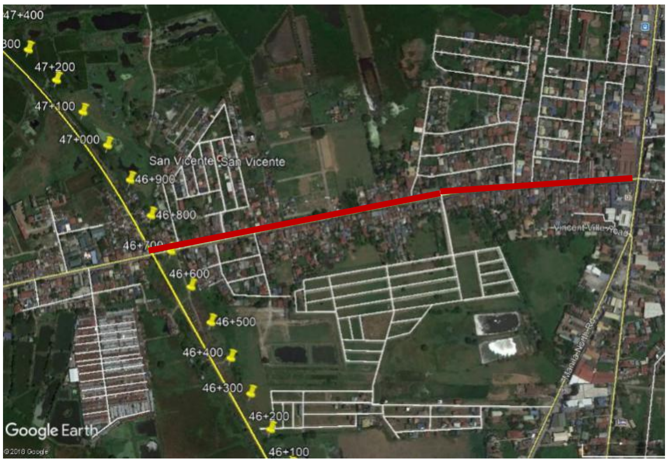
Access roads are shown in Table 6.1.3.

Table 6.1.3 Access Roads (Top of Photos facing North)

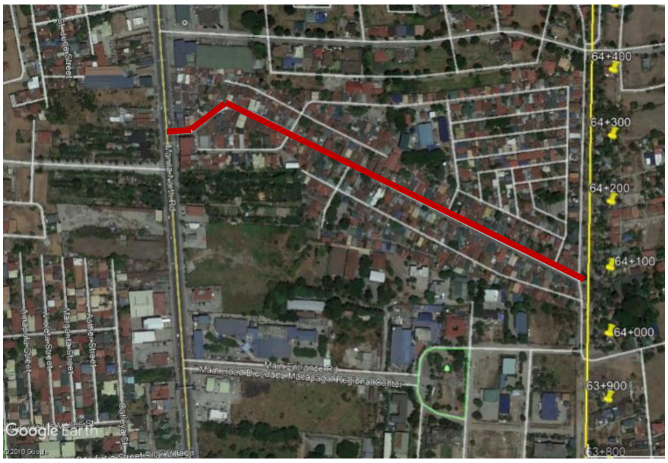
No.	Station	Width (m)	Access	Aerial Photograph
1.	KM 35+130	14.00	Manila North Road Sampaguita Street,Bulihan, Malolos Heights Subd. Malolos,Bulacan 40m West of Manila North Road	
2.	KM 37+200	5.00	Manila North Road Provincial Road, Longos, Carmen V. Luna Street Hangga Street Malolos, Bulacan 38 m West of Manila North Road	
3.	KM 39+850	5.00	Manila North Road Provincial Road Calumpit,Bulacan 54 m West of Manila North Road	

No.	Station	Width (m)	Access	Aerial Photograph
4.	KM 40+848 KM 41+030	5.00 5.00	Manila North Road Provincial Road, Gugo Iba Este, Calumpit,Bulacan 38m West of Manila North Road Provincial Road 32m West of Manila North Road	
5.	KM 41+740	5.00	NLEX, Pulilan Calumpit Road Gugo Iba Este Road, Gugo,Calumpit, Bulacan 36m West of Manila North Road.	
6.	KM 42+700	7.00	Manila North Road Gugo,Iba Este Calumpit,Bulacan Provincial Road 45m West of Manila North Road	

No.	Station	Width (m)	Access	Aerial Photograph
7.	KM 43+300	6.00	Manila North Road Provincial Road Gatbuca Calumpit,Bulacan 36m West of Manila North Road	
8.	KM 44+850	7.00	Manila North Road Provincial Road Capalangan, Calumpit Bulacan 110m West of Manila North Road	
9.	KM 45+220	6.00	Macabebe Calumpit Apalit Road Provincial Road Sulipan, Apalit, Pampanga 50m West of Manila North Road	

No.	Station	Width (m)	Access	Aerial Photograph
10.	KM 46+710	8.00	Manila North Road Apalit,Mcabebe, Masantol Road San Vicente Apalit, Pampanga 1200m West of Manila North Road	
11.	KM 49+000	8.00	NLEX, Manila North Road Sta Maria Road San Simon, Pampanga 4020m West of Manila North Road	
12.	KM 54+900	6.70 7.00	Manila North Road San Vicente Alba Road, Municipal Road Moraz Dela Paz, Pampanga 500m West of Manila North Road	

No.	Station	Width (m)	Access	Aerial Photograph
13.	KM 56+000	6.00	Manila North Road Balut Street, San Pedro Road Moraz Dela Paz, Pampanga 950m West of Manila North Road	
14.	KM 58+160	6.00	NLEX,MNR J. Abad Santos Ave.,Capitol Road V. Tiomico Street Sto Rosario, Pampanga 1160m West of Manila North Road	
15.	KM 59+800	13.40	NLEX, MNR, Jose Abad Santos Avenue Dolores,San Fernando Pampanga 373m West of Manila North Road	

No.	Station	Width (m)	Access	Aerial Photograph
16.	KM 61+000	24.00	Manila North Road Lazatin Blvd. Quebiawan, San Fernando Pampanga	
17.	KM 61+350	10.5	Manila North Road Brgy. San Agustin Road San Fernando Pampanga 120m East of Manila North Road	
18.	KM 64+080	6.70	Manila North Road Brgy. Del Rosario Access Road San Fernando Pampanga 727m East of Manila North Road	

No.	Station	Width (m)	Access	Aerial Photograph
19.	KM 65+500	21.00	Manila North Road Brgy.Del Rosario Road, Malpitic, San Fernando Pampanga 740m East of Manila North Road	
20.	KM 66+800	9.00	Manila North Road Maligaya – Tagumpay Street, Sindalan, San Fernando Pampanga 1380m East of Manila North Road	
21.	KM 69+520	7.00	Manila North Road Baliti Road Panipuan, San Fernando Pampanga 1100m East of Manila North Road	

No.	Station	Width (m)	Access	Aerial Photograph
22.	KM 74+020	7.00	NLEX - Angeles Exit Pandan Road Pulung Bulo, San Fernando, Pampanga	
23.	KM 74+520	7.00	NLEX Pandan Road,Santo Entiero Street Pulung Bulo, Angeles, Pampanga 3.30km West of Manila North Road	
24.	KM 75+650	Ave. 7.00	NLEX , Pandan Road, Magalang Ave. Manila North Road P De Guzman Street 3.50km West of Manila North Road	

No.	Station	Width (m)	Access	Aerial Photograph
25.	KM 76+000	7.50	Manila North Road Arayat Road Virgen Dela Dios, Angeles, Pampanga 530m West of Manila North Road	
26.	KM 76+660	6.00	Manila North Road, Salome Street, Malabanas Street Angeles, Pampanga 736m West of Manila North Road	
27.	KM 77+800	14.00	NLEX, Aniceto Gueco Street Manuel A. Roxas Highway Angeles City, Angeles, Pampanga 4 km West of Manila North Road	

Source: JICA Design Team

(6) Road Detour

Road detour will not be needed any more due to design change.

(7) Material Storage Yard

While materials for immediate use are delivered to the site and stored there temporarily, materials to be stored for a long time will be stored and will be managed in a material warehouse or a storage yard provided in a segment casting yard.

(8) Machinery Yard

Since machinery will be moved as work progresses, a machinery yard is not particularly necessary. However, temporary storage of machinery in flood-prone areas must be avoided, and machinery must be shifted to safe areas after the end of each working day.

(9) Segment Casting Yard

Construction of a viaduct accounts for a large portion of this project. Therefore, securing segment casting yards will be vital in this project.

Based on site investigations, the following locations are recommended for temporary yards. Land acquisition is needed before construction starts since the proposed fabrication yards are situated outside the PNR ROW.

Table 6.1.4 Proposed Casting Yard

No.	Area (m²)	Lot Owner	Station	Access	Temporary Yard
1.	147,332	Donato Sarmiento Et Al Reymundo Cruz Vicente Santos Juliana and oters	KM 40+250	Manila North Road , Brgy. Calumpang , Longos Calumpit, Bulacan	
2.	138,110	Gregorio A. Nunag Petronila D. Gozun	KM 46+300	Manila North Road , Gugo Iba Este Road Calumpit, Bulacan	
3.	96,066	Gomery Galang Gomez	KM 65+500	NLEX, Panipuan, Mexico San Fernando Pampanga	
4.	286,318	Allan Timbol	KM 73+200	Manila North Road Old PNR Railway Angeles City, Pampanga	

Source: JICA Design Team

(10) Batching Plant

Based on site investigations, there are several suppliers of ready-mix concrete along the project alignment. The quality of concrete should be satisfactory since these suppliers supply concrete to private companies and the DPWH. These suppliers provide various strength of concrete, low-strength to high-strength (8,000psi), and they can provide 50Mpa concrete which will be used in this project. As a result of interviews with these suppliers, it is assumed that they can supply sufficient concrete.

Provided that a contract package is 16km and there will be only one segment casting yard, a batching plant may be provided in a segment casting yard to secure stable supply of concrete for fabrication of precast segments. When setting up a batching plant in a segment casting yard, impacts of dust, noise, and drainage system on the environment have to be taken into account.

(11) Rebar / Form Fabrication Yard

A rebar & form fabrication yard should be located within or near the construction site. It is necessary to reinforce the yard by concrete etc. as a measure against heavy rain.

(12) Electricity / Water Supply

Site offices, batching plants and segment casting yards need water and electricity supply. Sufficient time shall be allocated for applying for water and electricity supply. Meanwhile, it is necessary to consider providing generators and water tanks as well.

(13) Workers' Quarters

In the Philippines, accommodation facilities for workers should be provided in general. Hygiene management of the workers' quarters and an impact to neighborhood should be carefully considered when constructing an accommodation facility.

(14) Warehouse

A proper warehouse is needed to store materials and equipment. It is necessary to take anti-theft measures since important materials will be stored in the warehouse.

6.1.8 Consideration for Surrounding Areas

(1) Urbanized Areas

In order to ensure the safety of neighbors, measures such as temporary fencing / hoarding of the site must to be taken to prevent them from entering the site.

Measures against dust generated from construction vehicles should be taken by spraying water etc., and measures against noise during weekends and nighttime should be taken too.

(2) Rural Areas

Measures against drainage and dust generated from the construction sites have to be taken.

(3) Flood Prone Areas (Measures against Flood)

The low-lying areas in Pampanga are frequently flooded and they are difficult to be used as temporary access roads, material storage or machinery yards. Areas sandwiched between the Pampanga River and the Angat River are flood-prone areas and poorly drained. Once a widespread flood occurs, stagnant water may stay for a week until water subsides, and it is important to check the weather forecast daily. When bad weather such as typhoon comes, an immediate evacuation and moving out all materials and equipment to higher ground are needed.

(4) Lahar Areas (as Bearing Ground / Embankment Material)

Lahar is very much like mudflow but it contains volcanic ash and has a lighter specific gravity than volcanic ashes. It is difficult to use lahar as an embankment material. However, it is necessary to study whether lahar can be used as an embankment material when it is mixed with cement. In addition, it may be worth to study whether lahar can also be used as bearing ground when constructing a viaduct.

After the eruption of Mt. Pinatubo, lahar flowing downstream occurred. The project area has been affected by this lahar. In some areas, thick lahar sediment has remained. Therefore, a careful geological survey is needed. Impact of lahar should be considered when preparing a foundation design and construction plan. Pile foundations need to be penetrated in the hard strata.

(5) Swampy Areas

Swampy area spreads approximately 8km (from KM47 to KM55) along the project alignment. Access to the site in the swampy area is as follows;

KM46.8 1.2 km from Manila North Road (two-lane road)
KM49.3 4.0 km from Manila North Road (two-lane road)
KM55.0 5.0 km from Manila North Road (two-lane road)

Thus, access in the 8km-long swampy area exists at both ends of the swamp and 2.5 km from the south end.

In order to secure temporary access roads, embankment will be required. It is very likely that embankment work will be carried out by spreading soil from accessible locations. In such a case, it is necessary to secure solid ground that can tolerate transport of heavy machinery and materials, by replacing/removing unsuitable soil and placing geotextile etc. for soil improvement.

When periodic relocation of a backup plant for piling work, and delivery & removal of an erection girder are taken into account, widening of embankment might be needed at certain sections. Also, it is important that the embankment height is designed so that the embankment will not submerge during floods.

When sliding displacement occurs or ground subsidence amount is large due to the soft ground of the embankment in swampy areas, construction of the embankment can be done by load reduction method using EPS (Expanded Polystyrene) blocks. Another possible option is ground improvement method, but considering the tight schedule, this method is unrealistic.

Refer to Figure 6.1.3 for a sample of embankment in swampy area.

(6) Road Crossing

Where the MCRP crosses an existing road, piers will be constructed at both ends of the road, and then segments will be erected using an erection girder. Impact on the traffic is not significant.

It is necessary to coordinate with authorities concerned such as police etc., for the construction where traffic control is needed. Locations where segments cannot be temporary stored below a viaduct, segments shall be carried using the top of an already constructed viaduct.

If there are obstructions such as high voltage overhead cables, relocation is needed before construction starts. As for the crossings with MacArthur Highway and SCTEX, it is already described in the previous pages.

(7) Aviation Regulations

A construction plan around the CIA should be well prepared in accordance with the aviation regulations. Since there is a height restriction, there is a possibility that the section between Clark Station to CIA station may become underground.

6.1.9 Borrow Pit / Soil Disposal Area

(1) Borrow Pit

A survey for possible borrow pits are now on-going. There are several river sand pits along the Sacobia River. Waste soil other than river sand contains gravel, and can be used as embankment material for temporary roads etc. All borrow pits are owned and managed by private companies, not by government agencies based on the information gathered up to now. Further information gathering shall be carried out.

(2) Soil Disposal Area

Areas designated by LGUs shall be used as soil disposal areas. Based on the site investigation and study, the following locations are recommend for disposal areas at this time and will be finalized in the next report.

Table 6.1.5 Proposed Disposal Area (Top of Photos facing North)

No.	Station/ Location	Area (ha)	Province / Municipality	Aerial Photograph
1.	Near Tabang, Malolos Interchange	7.00	Bulacan / Tabang, Guiguinto PEO-HACC	
2.	KM 35+200	12.00	Bulacan / Bulihan, Malolos PGB-PEZA	
3.	KM 54+900	3.00	Pampanga / Mesalipit, Sto. Tomas	

No.	Station/ Location	Area (ha)	Province / Municipality	Aerial Photograph
4.	CSEZ-Subzone D,	100.00	Sitio Kalangitan, Capas,Tarlac	

Source: JICA Design Team

6.1.10 Utility Lines and Adjacent Structures

There are overhead high voltage cables and telecommunication cables etc. in the construction site and adjacent areas. At the time of planning, the height limit issue needs to be studied carefully because height limit is set up for construction activities below the overhead cables. Obstructing utility lines have to be relocated, and consultation with utility companies is needed prior to the start of construction work.

For underground water pipelines, it is necessary to collect information and confirm the exact location by a trial excavation. At present, five electricity companies, seven telecommunication companies, and six water companies have been identified.

Discussion with agencies concerned are still on-going. Once a detour plan is agreed with agencies concerned, it will be submitted to the DOTr.

6.1.11 Preparation and Action by Employer prior and during Construction

The following items shall be dealt by the Employer before construction starts.

(1) Relocation of Utilities

Relocation of obstructing utilities, especially high voltage cables and steel towers.

(2) Securing ROW

Resettlement of residents within the ROW.

(3) Securing Segment Casting Yard

Securing construction yards including segment casting yards.

(4) Tree Cutting / Preservation

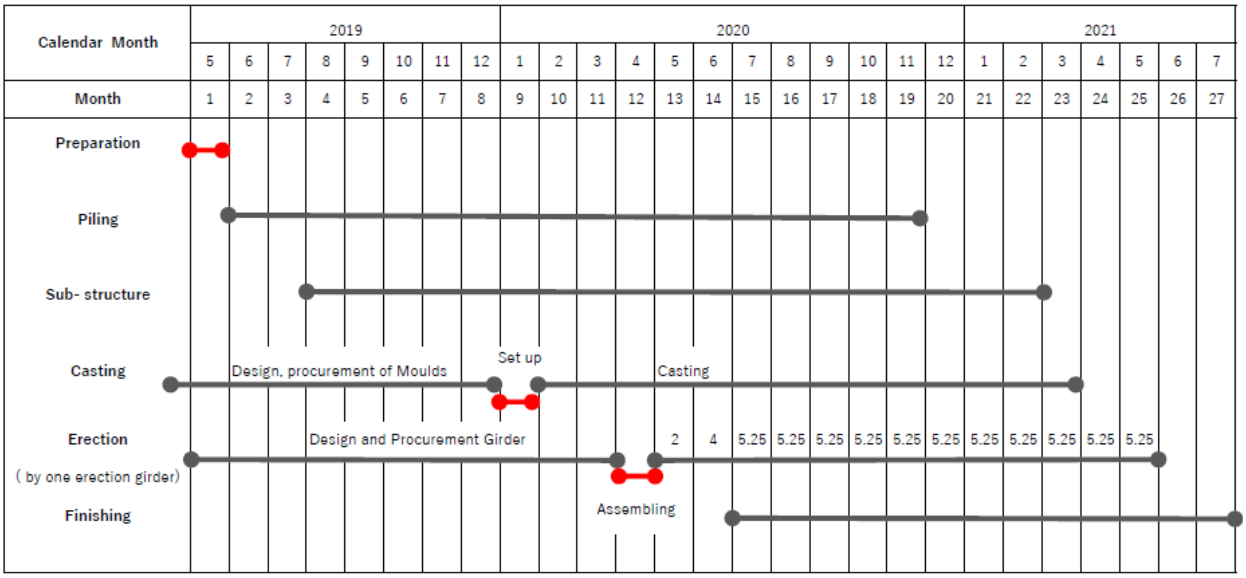
There is a need to prepare a plan for trees growing in the construction areas.

6.1.12 Construction Schedule

Since rapid construction is required for this project, the construction schedule will be very tight. Only 27 months is allocated as the construction period of civil work.

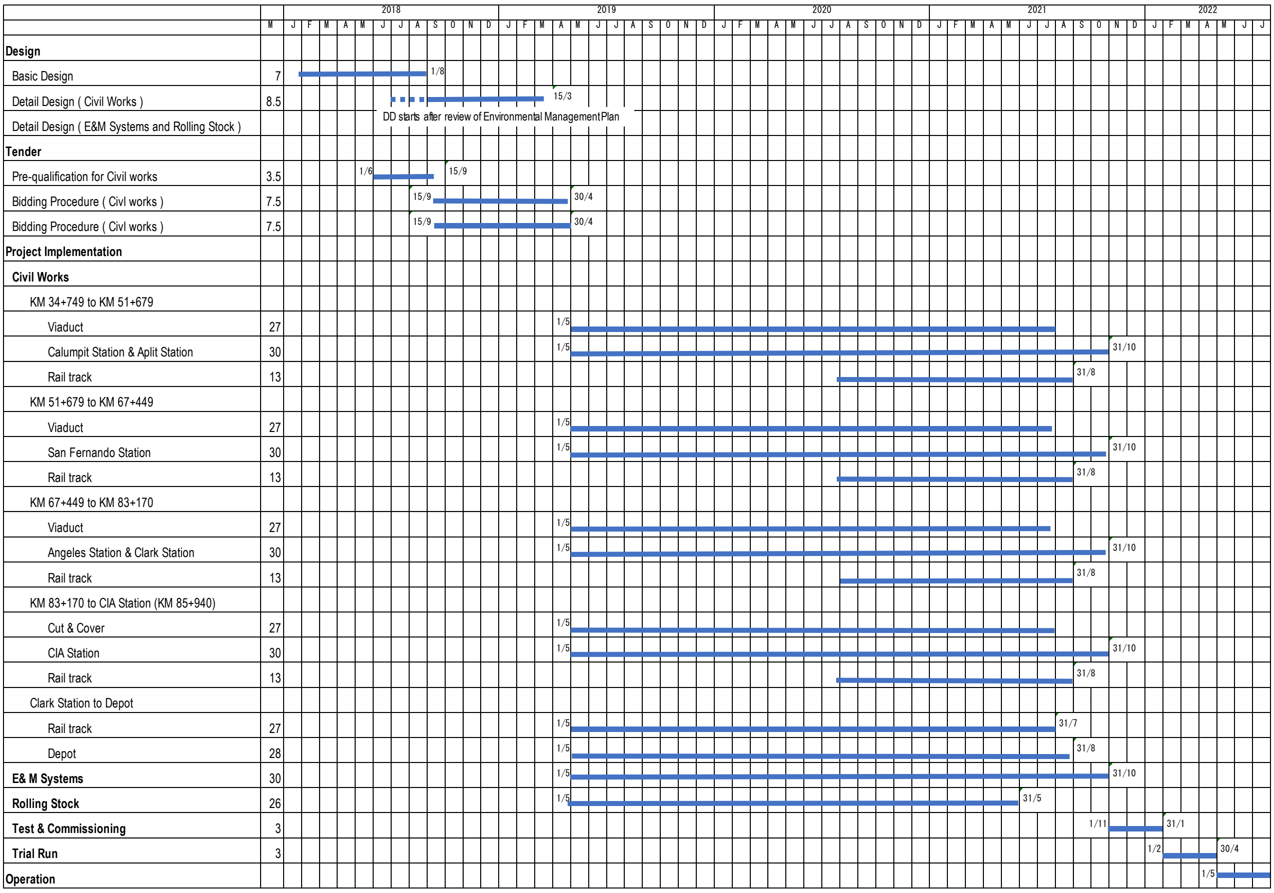
Delivery of molds which will be used for segment fabrication and erection girders for installation of segments takes approximately eight months and one year because designing and fabrication are needed.

Molds and erection girders have never been designed and fabricated in the Philippines. In order to expedite the work, skilled experts shall be hired from overseas. With due consideration to the situation, thirteen months is set for the construction period of the superstructure work. The overall schedule was planned based on this setup.



Source: JICA Design Team

Figure 6.1.4 Viaduct Construction Schedule



Source: JICA Design Team

Figure 6.1.5 Overall MCRP Schedule

6.1.13 Contract Package

Contract packages are as follows.

Table 6.1.6 Contract Package

Contract Package	Contract Length (m)	Viaduct	Casting Yard		Station / Depot
			Area (ha)	CY to Main Road	
CP N-01	16,930	Full	14.7	Adjacent to site	Calumpit / Apalit
CP N-02	15,770	Full	13.8	Adjacent to site	San Fernando
CP N-03	15,721	Full	13.9	Adjacent to site	Angeles / Clark
CP N-04	5,643	At & Under ground	Nil	Nil	CIA
CP N-05	-	-	Nil	Nil	Depot

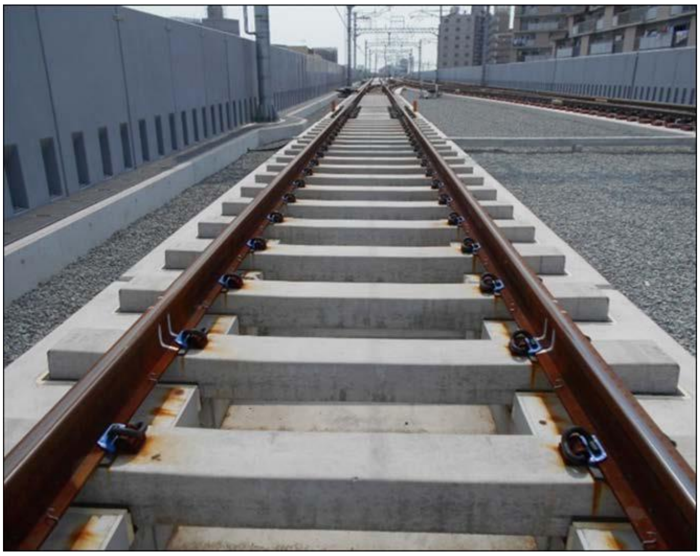
Source: JICA Design Team

The viaduct portion is divided into three packages, while the underground section including CIA station to the depot is considered as one package. The depot makes one package.

6.1.14 Track Construction Method and Procedure

(1) Elastic Sleeper Directly Fastened Track

A ballastless track presupposes maintenance-free. An elastic sleeper directly fastened track shall be laid on the roadbed which sufficiently support load so that no deformation will occur. On a viaduct or a bridge, a track shall be laid on top of the concrete slab. On an embankment or a steel bridge, a concrete slab work shall be carried out and then a rack shall be laid on top of the slab.



Source: The Detailed Design Study of The NSCR Project: Final Report (Nov. 2017) JICA

Figure 6.1.6 Ballastless Track in Main Line

1) Survey for Trackwork

Surveys shall be carried out once roadbed on structures is completed for more than 500m continuously. Reference markers shall be installed at both sides of the roadbed at the formation level.

2) Transport of Materials

Rails, elastic sleepers, rail fastening system etc. will be carried up on top of viaduct structures and transported to each predetermined location.

3) Assembling of Track Panel

Rails and elastic sleepers shall be assembled into a track panel using preinstalled reference markers as reference points.

4) Trackbed Concrete

Rails and elastic sleepers shall be assembled into a track panel using preinstalled reference markers as reference points.

5) Welding of Rail

First, a track panel shall be completed with a 25 m rail. After the track panel is fixed by hardened concrete, rails shall be welded to become a long continuous welding rail. This long rail will be loosened and fastened again to prepare against constant longitudinal axial force.

6) Rail Grinding

Top of the long rail shall be ground in order to reduce noise and vibration. As a result, the rail lifetime is extended.

7) Alignment Adjustment

Track alignment shall be corrected precisely.

8) Construction Speed

An average construction speed of Elastic Sleeper Directly Fastened Track is 400m/month

50m/3day × 3day/1time × 8times/month = 400m/month

(2) Ballasted Track

Maintenance of a ballasted track is relatively easy even if roadbed deformation occurs. A ballasted track is generally laid on the soil roadbed. For durability and ease of maintenance, an asphalt layer shall be laid on the roadbed and then a ballasted trackbed shall be laid on top of this asphalt layer.

Source: JICA Design Team

Figure 6.1.7 Ballasted Track in Depot

1) Survey for Trackwork

Surveys shall be carried out once a roadbed is completed for more than 500m continuously. Reference markers shall be installed at both sides of the roadbed at the formation level.

2) Transport of Materials

Rails, PC sleepers, crushed stones, rail fastening system etc. shall be carried up on top of viaduct structures and transported to each predetermined location.

3) Assembling of Track Panel

Rails and elastic sleepers shall be assembled into a track panel using preinstalled reference markers as reference points.

4) Spraying of Ballast (crushed stone)

Crashed stones satisfying the quality standard are scattered around the track panel.

5) Welding of Rail

First, a track panel shall be completed with a 25 m rail. After the track panel is fixed by crashed stones, rails will be fastened each other by fish plates to prepare against constant longitudinal axial force.

6) Rail Grinding

Top of the long rail shall be ground in order to reduce noise and vibration. As a result, the rail lifetime is extended.

7) Alignment Adjustment

Track alignment shall be corrected precisely.

8) Construction Speed

Ana average construction speed of Ballasted Track is 50m/day×25days＝1250m/month.

6.1.15 Construction of Elevated Station

All stations are being reviewed due to the rapid construction. CIA station will be an underground structure. Therefore, a method of construction for is not described in this report.

6.2 Traffic Management Plan

6.2.1 Scope of the Study

(1) Aim of "Traffic management"

This chapter describes the road traffic control of the Projects. Department of Transportation (DOTr) shall prepare a general traffic management and safety management plan and shall be appoint to overlook the traffic management and coordinate with the Local Government Units (LGUs) before the implementation of the Project. Items such as the Traffic Impact Assessment (TIA) and Traffic Management Plan (TMP) are likely to be requested for approval, by Department of Environment and Natural Resources (DENR). Conducting TIA would be a required condition in Environmental Compliance Certificate (ECC), which was issued by DENR on 13th August, 2018. Description related to TIA in ECC is shown below.

- Conduct a detailed Traffic Impact Assessment (TIA) in coordination with the concerned LGU for every proposed station prior to project construction integrating proposed road expansion projects (if any) of the concerned government agencies.
- Transport of heavy structures shall be scheduled during the period that may not cause traffic in the area.

An outline of TIA and TMP is shown in Table 6.2.1.

Table 6.2.1 Outline of TIA and TMP

Item and procedure	Contents	Elements examined
1) Selection of sites requiring measures	• Determine the sites where existing traffic may be affected by construction works (sites requiring measures). • Conduct actual traffic survey on existing traffic volume and travel time at several appropriate sites selected.	• Structure of road and crossing • Construction plan, temporary road for construction • Existing and future traffic volume
2) Forecast of negative impacts	• Based on the result of 1), impacts on sites requiring measures are forecasted. (Deterioration of road congestion, increase of travel time)	• Degree of congestion and travel time
3) Study of countermeasures	• Study measures to minimize negative impacts of 2)	• Detour • Traffic control and lane control • Sign and marking • Public relations, orientation
4) Interviews with concerned authorities	• Conduct interviews to gather opinions of concerned authorities regarding to the construction impacts on the existing traffic and the TMP.	• Road manager • Traffic manager • Utility manager, LGUs

Source: JICA Design Team

The JICA Design Team (JDT) supports DOTr in acquiring permissions by presenting a plan of DOTr after concrete examination for TIA and TMP.

(2) Feature of the Project and Object of 'Traffic Management'

1) Feature of the Project

Features of the Project are shown below.

- The length of the proposed line is approximately 70 km connecting with NSCR that will go through the Central Business District (CBD) of Mero Manila from north to south. The urban development along the proposed line has been progressing without appropriate public transport planning.
- Due to the inefficient public transportation system and sever traffic congestion, the citizens spend many hours daily on moving. As a consequence, it has become apparent negative social impact.

2) Objected Traffic

Trunk roads such as MacArthur Highway runs parallel to proposed line. The traffic generated by the Projects will affect congestion and other negative outcomes on the roads mentioned above, and on access roads to construction yards of the line and depots. Outline of the Traffic is shown in Table 6.2.2.

Table 6.2.2 Traffic raised by the Project

Period	Construction Period	Operation Period
Item	Construction vehicle for contractor Conveying vehicle for equipment for supplier	Feeder transport for station Reduction in modal shift from private vehicle to Rail

Source: JICA Design Team

(3) Traffic Assessment Survey (Actual traffic survey)

Traffic assessment survey is planned to understand the current traffic condition along the line and to obtain the data for traffic analysis in future and construction period. The items below should be considered.

- Flexibility in expanding the area for survey outside the National Capital Region (NCR),
- Detour routes considering progress of construction as planned in this study,
- Routes and time zones used for transportation of construction materials, machinery and rolling stock, considering location of construction yard, depot and substation,
- Assuming egress/ access routes from/to the existing stations for passengers.

The following considerations are to be incorporated in specifications of the survey.

- The field survey is scheduled on Thursday and Saturday in June 2018 as regular weekday and weekend when unusual traffic is hardly anticipated unlike national holidays, etc.;
- Continuous monitoring of the traffic over 24-hours is conducted in order to identify changes in the situation of daytime and nighttime to obtain the midnight/daytime traffic ratio;
- Particular attention is needed to the traffic signal without systematic control and difficulties in identifying the dwell length at road crossing resulted from chronic congestion.

Outline of the surveys is shown in Table 6.2.3.

Table 6.2.3 Planned Contents of Actual Traffic Surveys

Item	Description	Date
Target Road	Affected road during/ after construction of the proposed line	
Contents	1) Classified Directional Vehicle Volume Counts (CDVVC) 16h/ 24h, Weekday/ Weekend 2) Directional Pedestrian Counts (DPC) 16h/ 24h, Weekday/ Weekend	June 21 (Thursday) June 23 (Saturday)
	3) Lane Configuration in Intersection Survey (LCIS) Width, Direction, Length for dwelling for left turn	Before June 21 (Thursday)
	4) Signal Indication Survey (SIS) 7:00-9:00, 17:00-19:00, Weekday only	June 21 (Thursday)
	5) Travel Time and Delay Survey (TTDS) Northbound/ Southbound, Morning/ Afternoon/ Evening, Weekday only	June 21 (Thursday)

16h; 6:00 - 22:00, 24h; 6:00 - 6:00 of the next day

Source: JICA Design Team

(4) Feature of Survey

Table 6.2.4 below provides explanations of the other considerations not covered by the Department of Public Works and Highways (DPWH) TIA Guideline, but found to be addressed in this study.

Table 6.2.4 Other Issues to be addressed other than those covered by the DPWH TIA Guideline

Survey Type	CDVVC/DPC
TIA Guideline	DPWH has no specific guideline on the standard time period for traffic volume or pedestrian volume count surveys (e.g. 16-hour or 24-hour survey). The duration of traffic survey usually depends upon the data necessary to evaluate current travel demand within the study corridor and should capture peak periods.
This Survey	24-hour vehicle and pedestrian count surveys are conducted at a few survey stations.
Concept of This Survey	The 16-hour time period is sufficient to capture peak periods for both AM and PM. However, for critical strategic locations, 24-hour traffic and pedestrian count surveys were conducted. They are the representatives of a few areas.

Survey Type	SIS
TIA Guideline	DPWH has no specific guideline on the number of hours required to be able to obtain all permutations of traffic signal cycle.
This Survey	SIS is undertaken during weekday (Thursday) morning (7:00 AM – 9:00AM) and afternoon / evening (5:00 PM – 7:00 PM) peak periods.
Concept of This Survey	It is unnecessary to conduct 24-hour SIS because it is enough to survey peak hours only.

Survey Type	Queue Length measurement
TIA Guideline	There are several survey methods in measuring/estimating queue lengths (manual counting of vehicles, video-based traffic monitoring, using vehicle detectors, analysis of traffic flow's shockwave profile, etc.).
This Survey	Queue length measurement is not conducted for this survey.
Concept of This Survey	Queue length is difficult to measure/calculate since it is confirmed the queue is propagated to the adjacent intersection. Instead, we conducted surveys of travel and running speed in the morning, afternoon and night time by TTDS survey, and confirmed the traffic condition at each survey site based on the speed distribution.

Source: JICA Design Team

(5) Methods

The surveys are undertaken for either periods of 16 hours (from6:00AM to 10:00PM) and 24 hours (from 6:00AM to 6:00AM of the following day) on a weekday (Thursday) and a weekend (Saturday). Surveyors count all traffic by vehicle type using 11 classifications and by directions at every 15-minute interval.

The total number of vehicles is converted to Passengers Car Unit (PCU), which is a metric unit used in transportation engineering to assess traffic-flow rate on roads or highway. Table 6.2.5 below shows the PCU equivalent of each vehicle classification.

Table 6.2.5 PCU Equivalent per Vehicle

Vehicles	PCU
Private Vehicles	1.0
Jeepney	1.3
UV Express	1.0
Bus (Large)	2.5
Coaster	2.0
Truck (Medium)	2.0
Truck (Large)	2.5
Motorcycles	0.3
Tricycles	0.3
Construction Vehicles	2.5
Others (Bicycles, non-motor)	0.3

Source: JICA Design Team

(6) Capacity Analysis

1) Types of Analysis

The types of analysis that are performed for further assessment are as follows:

- Road sections capacity analysis of intersections,
- Queuing analysis,
- Intersection delay and level of service (LOS),
- Signal optimization of signalized intersections.

For the intersection analyses, the traffic engineering software, will be utilized. The analyses by the Software are conducted in accordance with the Highway Capacity Manual (HCM) 2010, issued by the Transportation Research Board of the National Academies of Science in the United States. HCM is a most widely used and accepted traffic analysis technique that serves as standards of several countries in defining their respective road capacity manuals.

For this study, level of service (LOS) is the parameter being used to examine the capacity of road sections and intersections. LOS is a standard index used to analyze the operating conditions of a given roadway segment or intersection. It is standard norm for public roads to maintain LOS D or better at existing intersections and roadway segments. A grade system of the LOS is defined by VCR as shown below.

2) Road Section Capacity Analysis

Volume Capacity Ratio (VCR) is used as indicator of the road section's degree of congestion as shown in Table 6.2.6. It is derived by dividing the actual traffic volume/ hour by the road's capacity. In theory, if the value of VCR approaches 0.85 or greater, the subject road section is already congested. Table 6.2.6 relates the congestion ratios (based on VCR) to the categories of LOS.

Table 6.2.6 VCR Criteria for Road Section Capacity Analysis

LOS	Characteristics	VCR
A	Condition of free flow with high speeds and low traffic volume wherein drivers can choose desired speeds without delays.	0.00 – 0.19
B	In stable flow zone wherein drivers have reasonable freedom to select their speed.	0.20 – 0.44
C	In stable flow zone wherein drivers are restricted in selecting their speed.	0.45 – 0.69
D	Approaches unstable flow and nearly all drivers are restricted. Service volume corresponds to tolerable capacity.	0.70 – 0.84
E	Traffic volumes near or at capacity and flow is unstable with momentary stoppages.	0.85 – 1.00
F	Forced or congested flow at low speeds with long queues and delays.	greater than 1.00

Source: JICA Design Team

3) Queuing Analysis

Queue length is one of the primary measures of intersection performance, whether signalized or unsignalized. Queue develops when demand exceeds capacity or when arrival headway is less than the service time. Queue length is expressed in terms of meters (m). Queue length in meters is calculated by multiplying total vehicles in queue by 7.62 meters (25 feet).

4) Intersection Delays and LOS

Another main operating parameter in determining LOS in an intersection as specified in HCM 2010 is the average vehicle control delay per vehicle. Delays are calculated in terms of seconds per vehicle (sec/veh) per approach and for the entire intersection.

Unsignalized and signalized intersections have different delay ranges primarily due to driver expectation. Signalized intersections are designed to carry higher volumes of traffic and therefore higher levels of delay are acceptable. Table 6.2.7 summarizes HCM's description of the different LOS levels for unsignalized and signalized intersections, respectively.

Table 6.2.7 LOS Criteria for Unsignalized and Signalized Intersections (HCM)

LOS	Average Control Delay per Vehicle		Remarks
	Unsignalized	Signalized	
A	≤10	≤10	Progression is very favorable; most vehicles arrive during green signal; most vehicles do not stop. Short cycle lengths may also contribute to low delay.
B	10< ≤15	10< ≤20	Progression is good and/or cycle lengths are short. More vehicles stop than for LOS A, causing higher levels of average delay.
C	15< ≤25	20< ≤35	Progression is fair and/or cycle lengths are longer. Individual cycle failures may begin to appear at this level. The number of vehicles stopping is significant, though many vehicles still pass through without stopping.
D	25< ≤35	35< ≤55	Progression is unfavorable, cycle lengths are long, or has a high flow rate to capacity ratio. Many vehicles stop, and the proportion of vehicles not stopping diminishes. Individual cycle failures are obvious.
E	35< ≤50	55< ≤80	Progression is poor, cycle lengths are long, and has a high flow rate to capacity ratio. Individual cycle failures are frequent occurrences.
F	50<	80<	Progression is very poor, cycle lengths are long. Many individual cycle failures. Arrival flow rates exceed the capacity of the intersection. This level is considered unacceptable to most drivers.

Source: JICA Design Team

5) Signal optimization of signal intersection

Traffic conditions changes over time. One way of maintaining desired LOS at intersections is by regularly updating the intersection's traffic signal cycle lengths, phasing and timing to correspond to the current traffic flow conditions.

(7) Result of Analysis

1) Current Traffic Condition

Feature of current traffic condition is shown below.

- Peak hour in current traffic is 7:00 – 8:00 AM weekday.
- Almost full capacity at major intersections in peak hour.

Results of analysis will be organized with estimated future traffic condition.

2) Estimated Future Traffic Condition

An estimation of growth ratio of general traffic in future is progressing by demand forecast expert. Analyses in future will be done after provided it.

6.2.2 Economic loss due to traffic congestion during construction period

Economic loss due to traffic congestion during construction period will be estimated considering a result of Traffic Impact Assessment (TIA). Table 6.2.8 shows estimated severe traffic congestion points during construction period.

Table 6.2.8 Traffic congestion points in construction period

Area	Point	Description
South Section	Malolos Station	➢ Construction while operating Malolos - Tutuban section ➢ It will be crowded by feeder transportation for commuter/ student and construction vehicle.
Middle Section	Downtown of Angeles	➢ Construction site, Bus/ Jeepney terminals and trunk roads are in close. ➢ Amusement center area are attractive for visitors even in night time.
North Section	Bridges on Sacobia River	➢ Increasing construction vehicles for development in Clark Green City (CGC) ➢ Two bridges, Mabalacat Bridge on Manila North Road/ MacArthur Highway and Sacobia River Bridge, are close to construction site.

Source: JICA Design Team

6.2.3 Coordination with Participant

Traffic congestion has already occurred on the proposed railway alignment, and the reasons for the congestion are clearly defined. It is also important to get the cooperation of administrative agencies and the full support of the local leaders in the area in order to implement these traffic management measures, and for railway operators to grasp the development of the region in the future and to take part in the role of reducing the influence on the traffic along railroads. The related organizations are listed below and the adjustment with them is described.

- **LGUs**: LGUs are responsible for the development of their area, and it is necessary for the business entities to adjust for the construction in this area and the measures for traffic related to railway management.
- **DENR**: Construction project contractor and the railway administrator are responsible for the negative impact on the broader environment caused by new traffic along the railroad (for example, the increase in noise vibration due to the dump truck during the construction period, the increase in the noise vibration of the feeder car efforts for noise and air pollution accompanying concentration) are required. These efforts need to comply with the standards enacted by the national law, and it is important for the business entities to coordinate mainly with DENR.

6.3 Guideline for Safety Management Plan

6.3.1 Basic Policy of Safe Management Plan

JICA prepared The Guidance for the Management of Safety for Construction Works in Japanese ODA Projects in September 2014 (hereinafter referred to as “the Guidance”) and has been making efforts to secure the safe construction works of the ODA projects based on “the Guidance” and to establish and spread the Japanese “Safety Culture” in Japanese ODA projects.

As the management of safety in construction works is one of the important targets of ODA projects, it is very important to plan and execute an effective safety control of the construction works to prevent occupational and public accidents in MCRP (hereinafter referred to as the Project).

According to the purpose of JICA in connection with the ODA construction works mentioned above, this Guideline for Safety Management Plan (hereinafter referred to as “the Guideline”) that will show the basis on the safety management plan of the construction works to be prepared by the Contractor will be prepared based on “the Guidance” and will form a part of the Tender Documents of the Project.

The specific areas to be considered carefully in preparing the detailed safety management plan by the Contractor may include the following:

- Heavily crowded residential areas where electric wires are stretching densely in all directions through the areas,
- Areas adjacent to streets with heavy traffic and/or narrow access roads to the construction sites,
- Widely spreading swampy areas approximately from Km 50+400 to Km 53+400 where many fish ponds are scattering,
- Areas where the bridges crossing big rivers will be proposed at Km 40+965, Km 43+245 and Km 45+070,
- The long-span bridge that will diagonally cross over the existing heavily crowded Mac Arthur Highway at Km61+005 where high tension electric wires are crossing over the Highway,
- In the areas where the proposed Project railway line will cross the existing main city or village roads, the electric lines are mostly densely extending over the roads or stretching along the roads, and
- Some limiting regulations may exist against the Project construction works inside CIA territory.

6.3.2 Studies being Undertaken

The studies and work that are being undertaken in connection with the safety management of the construction works of the Project are as follows:

- Detailed study and confirmation of the Guidance for the Management of Safety for Construction Works in Japanese ODA Projects prepared in September 2014,
- Detailed study and confirmation of Final Report on NSCR-SOUTH LINE (PNR SOUTH) Project,
- Reconnaissance survey and confirmation of the site conditions of the Project area,

- Brief study and confirmation of the laws and regulations in the Philippines concerning the safety management on construction works of the Project, and
- Confirmation of the results/outputs of the detailed design of the Project structures and reflection of them to the Guideline.

6.3.3 Tentative Table of Contents

The table of contents of the Guideline for Safety Management Plan tentatively proposed will be as follows:

1. General Rules
   (1) Purpose
   (2) Scope of Application
   (3) Safety Management Plan
   (4) Roles and Responsibilities of Project Stakeholders
2. Basic Policies for Safety Management
   (1) Basic Principles
   (2) Compliance with Relevant Laws and Regulations
   (3) Safety Management by PDCA
3. Safety Plan
   (1) Composition
   (2) Compliance with Composition
4. Method Statements on Safety
   (1) Composition
   (2) Sample Template
   (3) Technical Guidance for Safe Execution of Works
5. Common Technical Guidance for Safe Execution (by Type of Works)
6. Special Technical Guidance for Safe Execution (by Type of Works)
   (1) Construction of Girder by Span-by-Span Method
   (2) Construction of Girder by Cantilever Method
   (3) Construction of Girder by Cast-in-Place Concrete Method
   (4) Cast-in-Place Concrete Foundation (Earth-drill Method)
   (5) Foundation Improvement Works
7. Technical Guidance for Safe Execution (by Type of Accidents)
   (1) Measures for Prevention of Train Accident
   (2) Measures for Prevention of Electric Accident
   (3) Measures for Prevention of Other Accidents
8. Requirements for Construction Works inside CIA Territory

6.4 Project Financing and Overall Schedule

6.4.1 Project Financing

The MCRP is to be financed by both JICA and ADB.

Construction of viaduct portions will be financed by ADB, while E&M systems and procurement of rolling stock will be financed by JICA.

The major work area of CP N-04 falls within the CIA, and most of the alignment may become underground if one of mitigation plans to avoid interface with existing structure will be selected. The CIA is currently under operation, and this means high safety and security performance level of a well experienced contractor is required.

CP N-05 needs a well interface coordination with the depot equipment for design and installation. To avoid this interface coordination risk, it is preferable to include provisions of depot equipment into this contract package.

Track work is included in the E&M Railway System Package (CP N-06).

Table 6.4.1 Source of Fund

Contract Package	Major Work Item	Source of Fund
CP N-01	Viaduct, Station, Approx. 17km	ADB
CP N-02	Viaduct, Station, Approx. 16km	ADB
CP N-03	Viaduct, Station, Approx. 16km	ADB
CP N-04	Approach, U/G Station, Approx. 5.5km	ADB
CP N-05	Depot, Depot & Workshop Equipment	ADB
CP N-06	E&M Systems (Signaling, Communication, AFC, Power Supply, etc.), Trackwork	JICA
CP N-07	Rolling Stock	JICA

Source: JICA Design Team

6.4.2 Overall Schedule

Since commencement of the MCRP operation has been set on May 1st 2022 by the DOTr, accelerated construction for this project is required to meet this target opening date.

Furthermore, at least 36 months are needed for civil work, E&M system work, and procurement of rolling stock. Therefore, it is necessary that the construction work starts on May 1st 2019.

In order to achieve this construction commencement date, it is necessary to select contractors in early stage by inviting bidders with basic design. While selecting contractors, the detailed design by the JDT will be continued and completed.

Negotiation for finalization of the contract with selected contractors shall be carried out based on this detailed design. This bidding procedure enables the construction work to start in May 2019.

Figure 6.4.1 shows the overall schedule which has been consented by JICA and the DOTr.

Regarding the detailed procurement plan of rolling stock, refer to section 4.3.6.

The following are some remarks on the overall schedule in Figure 6.4.1.

1. Prequalification process is not required for Civil Packages (CP N-01, N-02, N-03, N-04 & N-05) under the ADB loan based on local regulations. Qualifications of contractors, however, shall be included in bidding documents.

2. Bidding Procedure
   1) Civil Packages under the ADB loan
      - Drafts of bidding documents will be prepared by JDT based on basic design and be submitted to JICA after comments from DOTr/ARUP (DOTr's consultant) are incorporated. These documents will be finalized by DOTr with help from ARUP, and they have to be concurred with by ADB.
      - ARUP will assist in the bidding procedure for civil packages.
      - ARUP will evaluate the contractor's proposal and assist DOTr in finalizing contract agreements based on the detailed design.
      - JDT will assist ARUP in evaluating and finalizing the contract, with instruction from JICA.
   2) E&M and Rolling Stock under the JICA loan
      - Bidding documents will be prepared by JDT.
      - A consultant for bidding assistance will assist in bidding procedure and evaluate the contractor's proposal. A bidding assistance consultant is expected to be assigned by JICA. DOTr may ask ARUP to help DOTr in case JICA fails to assign a bidding assistance consultant.

3. Construction Supervision (CS)
   - Draft TOR of consultant selection will be prepared by JDT.
   - A CS consultant shall be one single consultant who will manage all construction phases among all contract packages.
   - A CS consultant shall be selected at least 3 months before the work starts.
   - Fund for CS consultant services will be financed by JICA for all contract packages.

The following work to be implemented by the GOP is also very important in order to achieve the target date.

- Land acquisition/RAP will be completed prior to the commencement of work.
- Major utilities (high voltage electric line, etc.) shall be relocated prior to the commencement of work.
- Tree relocation shall be coordinated by DOTr as early as possible and shall be completed prior to the commencement of works.

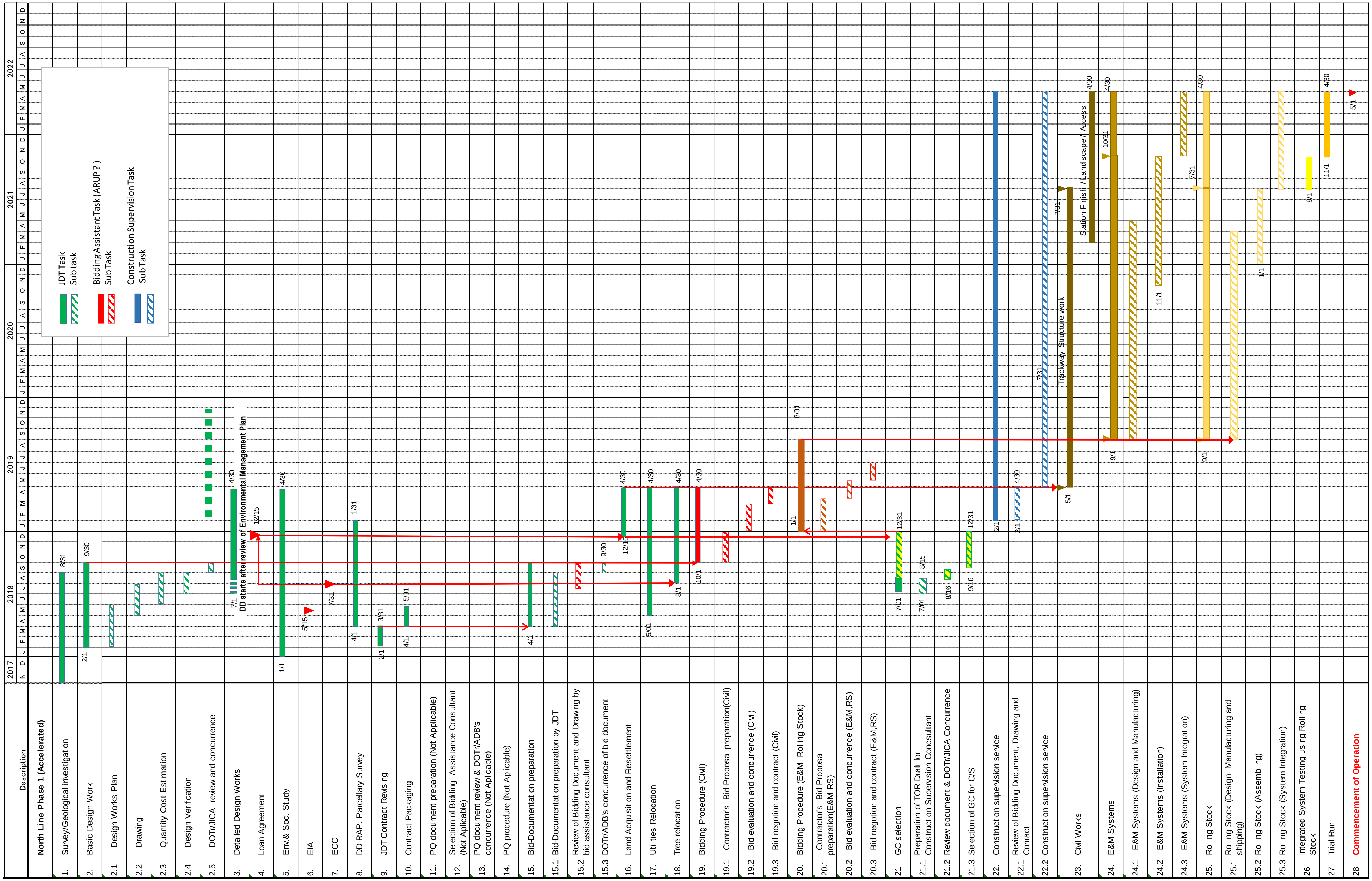


Figure 6.4.1 MCRP Overall Schedule

Source: JICA Design Team

CHAPTER 7 PMO and O&M

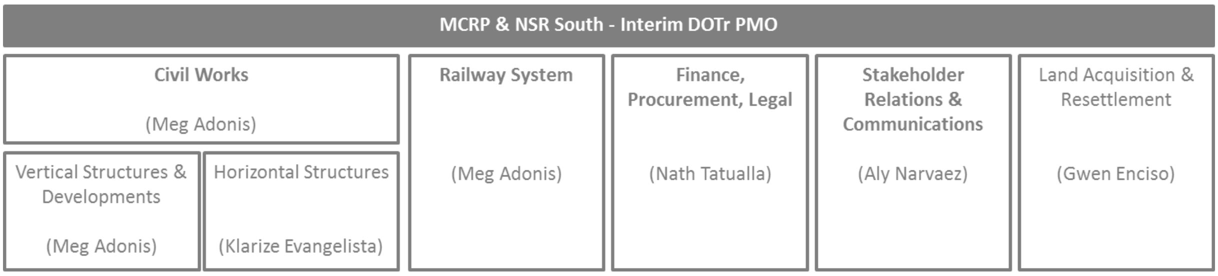
7.1 PMO

In this section, Project Management Office (PMO) of DOTr is described. It is the official entity which must be created by the department order or same-level document to help facilitate the smooth implementation of the project.

7.1.1 Organization Structure

(1) PMO at BD/DD phase

As of January 2018, six counterpart personnel of DOTr PMO in charge of MCRP and NSRP-South have been appointed to liaise with JDT for each discipline/jurisdiction as shown in the figure below. For issues requiring interface among the disciplines/jurisdictions, coordination among these officers will be arranged. For example, if there are legal issues in civil works, the personnel in charge of civil works respond in coordination with others in legal area.



Source: JICA Design Team based on the information Provided by DOTr

Figure 7.1.1 Organization Structure of DOTr PMO (Interim)

(2) PMO at Construction phase

Since man-power and knowledge for massive document-review and coordination work among stakeholders will be required in DOTr during construction phase, an increase in capacity of DOTr PMO is indispensable. DOTr also understand that they have to strengthen its human resources, and mentioned that the organization shown in Figure 7.1.1 will be reformed to the official PMOs with 25 officers as many as MMSP's PMO by early 2019 as shown in Figure 7.1.2.

In particular, risks related to site availability, interconnectivity, construction and approvals are expected to be managed by the key personnel in DOTr PMO who possesses qualification listed in the Table 7.1.1 below.

Table 7.1.1 Key Positions of PMO

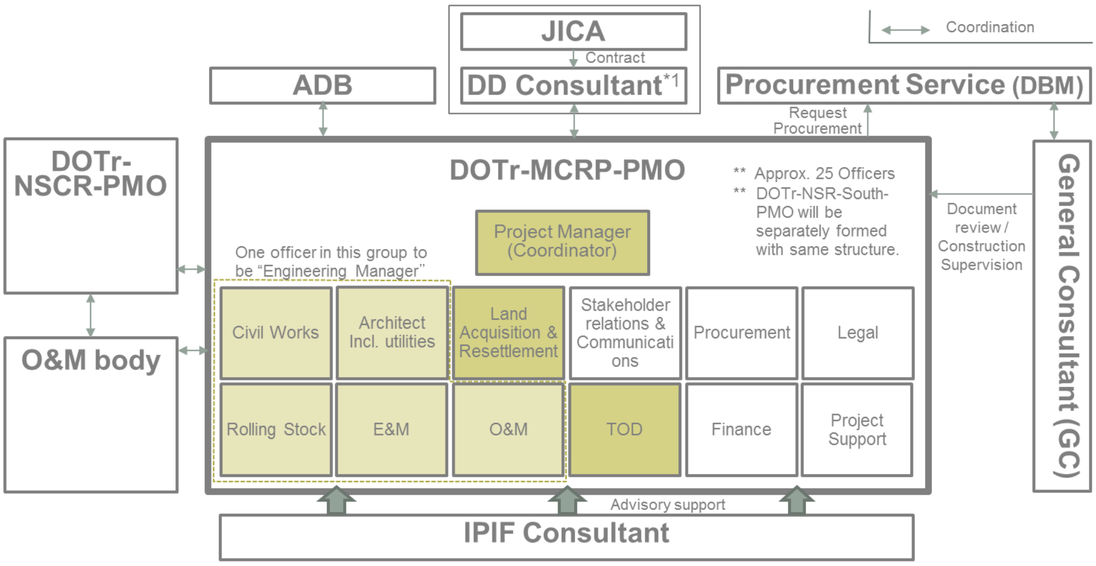
Major Risks *1					
Types of Risks	Description	In Charge			
Availability of Site	Risk that tenure/access to a selected site which is not presently owned by government or Private Partner cannot be negotiated. Risk of costs and delays in negotiating land acquisition	x	x	x	
Interconnectivity	Interconnectivity refers to the physical linkage of a project to another or to part of a network.	x	x		x
Construction	Risk that events occur during construction that prevent the facility from being delivered on time and on cost.	x	x		
Approvals	Risk that additional necessary approvals required during the course of the project cannot be obtained.	x	x		
Key Personnel *2					
Positions	Role / Criteria *2				
Project Manager (PM)	PM must act as a coordinator with external entities to run the project smoothly. He/She must possess B.S. in Engineering and, at least, five (5) national infrastructure projects' experience in project coordination. Project Management Professional certification holder is preferable.				
Engineering Manager (EM) *3	EM must be an internal coordinator to organize engineering team in PMO unit. He/She must possess B.S. in Engineering and, at least, five (5) national infrastructure projects' experience in engineering position. M.S. in Engineering is preferable.				
Land Acquisition & Resettlement	This position is expected to report critical issues in its team to PM. He/She must possess a bachelor decree and three (3) national infrastructure projects' experience in land acquisition & settlement position.				
Transit Oriented Development (TOD)	This position is expected to report critical issues in its team to PM/EM. He/She possess B.S. in Engineering and three (3) national infrastructure projects' experience in transport.				

*1: From Generic Preferred Risks Allocation Matrix (GPRAM) by the PPP Center of the Philippine

*2: It is not final, now under DOTr's consideration.

*3: Engineering Manager (EM) is an internal coordinator to organize engineering team (Civil /Architect /RollingStock /E&M /O&M) in PMO unit from a cross-cutting perspective. One officer in engineering team should take this position.

Source: JICA Design Team



According to "objective and purpose of the assignment" of Infrastructure Preparation and Innovation Facility (IPIF) consultant for transportation, they are expected to support DOTr with project preparation activities by providing access to international sources of innovation, expertise, advice, and best practices.

Source: JICA Design Team based on the information provided by DOTr and ADB website

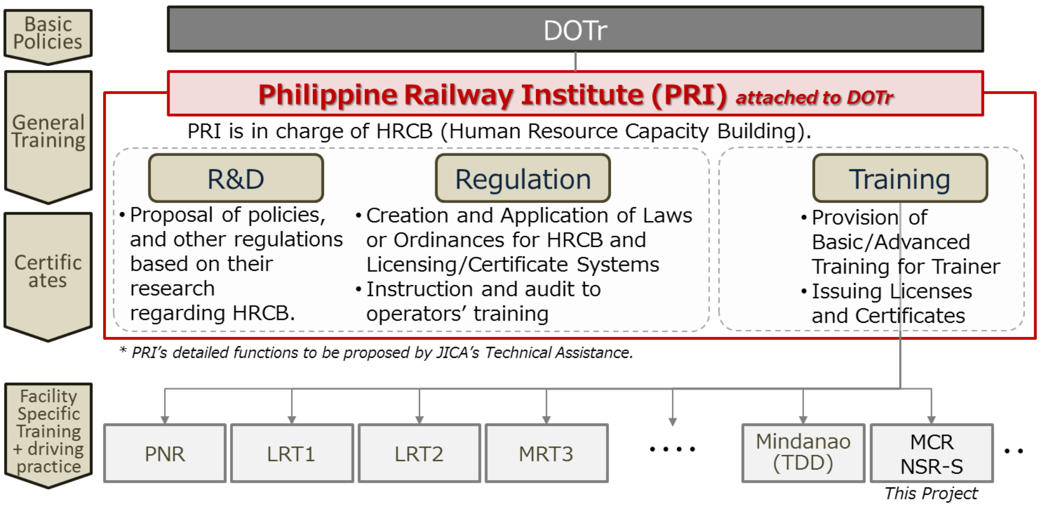
Figure 7.1.2 DOTr PMO for MCRP during Construction Phase

(3) Governmental Bodies After Construction Phase

As of the reporting date, there are two operating bodies attached to DOTr: PNR and LRTA. PNR is the entity established under Republic Act No. 4156 to serve as the instrumentality of the Government of the Philippines in providing a nation-wide railroad and transportation system. LRTA is a wholly owned government corporation created in July 12, 1980 under EO No. 603, as amended by EO No. 830 dated September 1982 and EO No. 210 dated July 1987 respectively. LRTA is primarily responsible for the construction, operation, maintenance and/or lease of light rail transit systems in the Philippines.

In addition to those two bodies, new bodies are now being planned to secure operational quality of railway operators in the Philippines. The one is Philippine National Railway Authority (PNRA) which is proposed as a part of "Philippine National Railway Restructuring" by the House Bill No. 6593 in October 2017. In this bill, the said Authority will regulate all aspects of the existing and the future railway operated ether by government and by private sector in Philippines.

The other one is Philippine Railway Institute (PRI) which is expected to promote/foster human resource capacity building. The establishment and capacity enhancement of PRI is scheduled to be supported by JICA technical assistance for 5 years from spring 2018. As shown in Figure 7.1.3, PRI is expected to have R&D and regulatory functions, and to provide general training to railway operators. Each railway operator must perform its facility-oriented-trainings as per regulations and training curriculums provided by PRI.



Source: JICA Design Team based on the information provided by DOTr

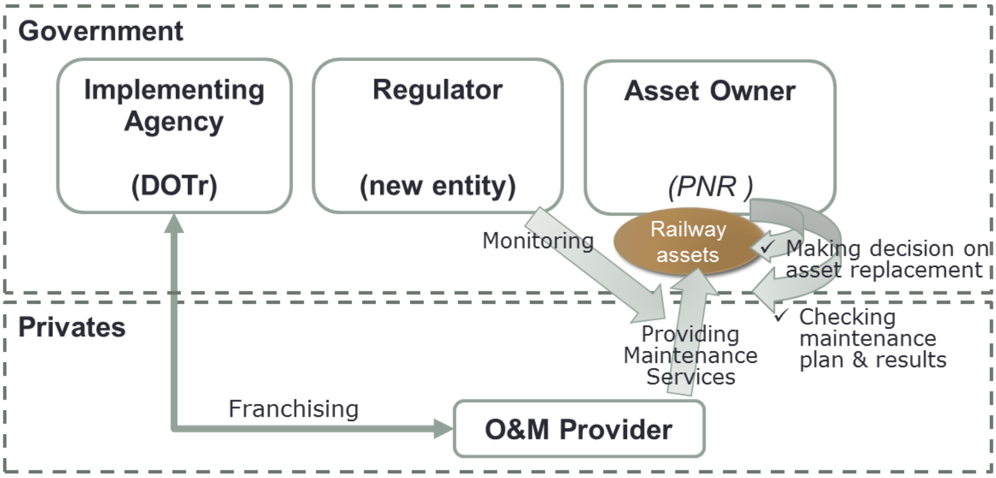
Figure 7.1.3 Concept of Philippine Railway Institute

In this project, the hybrid style PPP scheme is considered by GOP as other infrastructure projects are trying to apply same scheme under the ‘Build, Build, Build’ program. Under this scheme, the asset is retained by government, while the O&M services are provided by the private. Clark International Airport expansion project is the first hybrid PPP project rolled out under the Duterte administration. It is the joint project of DOTr and BCDA which takes the role of project implementer and asset owner. O&M service provider is being selected through the bidding invited by the project implementer: i.e. BCDA. The successful bidder will provide O&M services as per the standards set-out by the related regulators such as Civil Aviation Authority of the Philippines (CAAP).

In railway sector in South-East-Asia, Singapore public transport sector is applying a similar scheme. O&M services are provided by the railway operators, and the assets are owned by governmental body, namely Land Transport Authority (LTA). In terms of asset management, LTA has responsibility of: 1) supervising railway operators' maintenance plan and activities, and 2) making a decision on asset replacement.[1]

In the MCRP/NSRP-South, it is planned that a governmental entity other than the regulator hold the assets like Clark airport project. As of the reporting date, PNR is considered to be a default candidate of asset owner. The project implementing agency will be DOTr same as NSCR project. (Figure 7.1.4)

[1] LTA website, https://www.lta.gov.sg/apps/news/page.aspx?c=3&id=aaf9044c-a3aa-49b5-a74a-61d634a7aa14



There may theoretically be two alternative options for an asset owner: one of Government Financial Institutions (GFIs) in terms of financial viewpoint, and a newly established body for this purpose.

Source: JICA Design Team based on the information provided by DOTr

Figure 7.1.4 Assumed Scheme related to Railway Assets

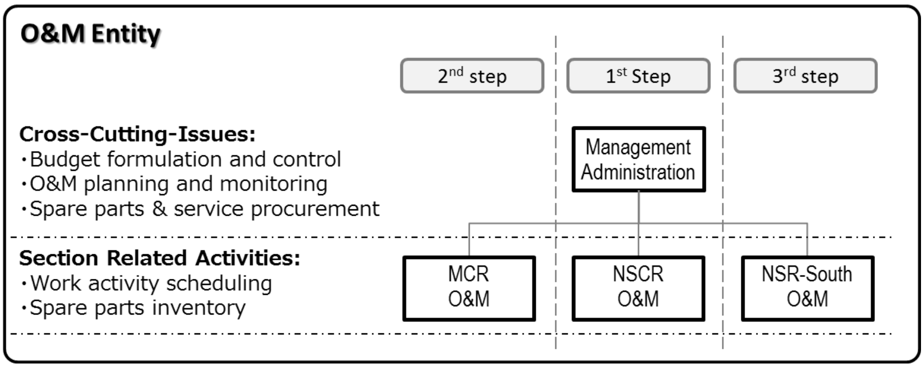
7.2 O&M Organization

In this section, described hereunder is the organization in charge of railway O&M after the completion of construction.

7.2.1 Study Policies on O&M Organization

Under the DOTr's policies, O&M is to be implemented as O&M service provider in a PPP scheme. DOTr has expressed its opinion to JDT that study on O&M organization is not required in this study, since TOR for O&M services will be formed by a transaction advisor. However, some factors of O&M organization, such as staff number, are required for design of facilities. O&M cost is required for assessment of the project viability. From those reasons, O&M organization has been studied as the basis for the project formulation and implementing framework.

DOTr is planning three sections: NSCR already on-going by ODA loan, MCR and NSR-South, to be seamlessly operated by a sole entity. In other words, an entity operating NSCR will extend its scope to MCR and then to NSR-South. In this scenario, basic structure of O&M organization will be composed of two layers as shown in Figure 7.2.1. Upper layer will cover cross-cutting issues, while lower layer will take care activities related to the section.



Source: JICA Design Team

Figure 7.2.1 Basic O&M Structure

7.2.2 Study Method for O&M Organization

As described in the previous subsection, O&M organization structure is to be assumed as the basis for the project formulation and implementing framework. There are largely two factors: staff number for facilities design and O&M cost for assessment of the project viability.

As for management & administration layer, since its facility will be prepared at NSCR stage, only cost aspect is considered by index calculation in this study. As for the MCR O&M layer, since it is purely railway line section specific elements, the number of workforce should be estimated for facility design based on the assumed O&M activity, and cost must be accordingly estimated as per calculated man-power.

Table 7.2.1 Study Method for O&M Organization

Layer		# of People	Personnel Cost
Head Quarter	Increase in man-power will be required to cover MCR line.	(It is not calculated in this project.)	To be estimated by index calculation
MCR Unit	Purely added to NSCR organization.	To be estimated based on O&M activities assumed by JDT	To be estimated as per man-power assumed in the left column.

Source: JICA Design Team

7.2.3 O&M Organization

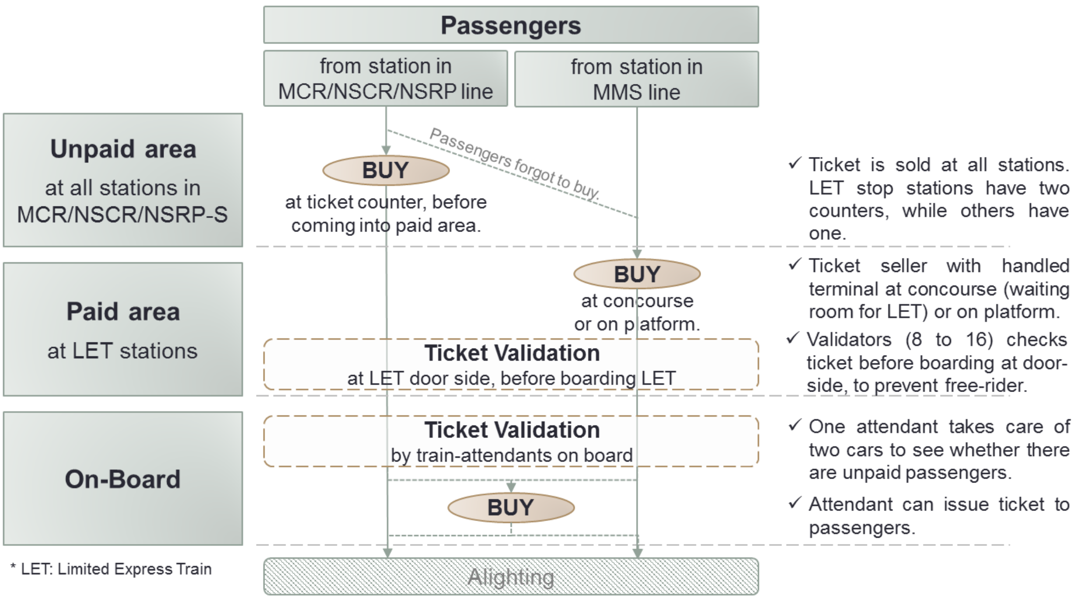
From the viewpoint of its characteristics as a railway operator, it can be largely divided into three parts: operation, maintenance and human resource training.

On the assumption that all cross-cutting issues, such as making train-diagram for all 3 sections, consolidating inspection and maintenance work plan, and procurement works, are managed by management and administration level, the following tasks are allocated to MCR O&M unit.

(1) Operation

Railway services are collaboratively operated by people at train, station and OCC. Train contains a driver and attendants in case of limited express for ticket validation. Station covers ticketing, passenger inquiries and securing train approaching/departing. OCC manages train operation and monitors station/facility condition remotely. In addition to the tasks above, train crew management has to be considered at the depot area.

As described in the Chapter 4, tickets for traveling and limited express train seat reservation are separately handled. Ticket for traveling is managed as existing urban railway does. Ticket for limited express train seat is the one newly introduced in this project. In order to design the required equipment and the O&M unit for the ticket handling, its process is assumed as follows: Basically, a passenger has to buy limited express ticket before the station gate. For a passenger unable to do so, such as a passenger coming from MMS line, a ticket seller is allocated at a waiting room or on a platform of the limited express train stop stations. Validators are assigned at limited express door positions on a platform to check the ticket before boarding. For further confirmation, an attendant accompanying each two train-cars checks whether a seat unsold is occupied by a passenger or not using a handheld terminal connected to a server. In case that a passenger without a seat ticket is found, an attendant sells a ticket using a handheld terminal.



Source: JICA Design Team

Figure 7.2.2 Limited Express Ticket Selling and Validating Method

(2) Maintenance

It is expected to conduct planned inspection and maintenance properly as per the overall plan comprehensively consolidated at management and administration layer. Resource allocation planning and spare parts & tools inventory are performed at the depot of each line. It is better that workers for inspection and emergency response are located at the place near track and/or station to restore facility/track etc as earlier as possible.

JDT assumes that Planning and management work and inspection work are conducted by direct-hiring, and the site work is performed by external service providers in consideration of local business circumstances.

(3) Human Resource Training

Training and capacity building of railway operators is one of the most important factors for safe and stable railway operation. As indicated in the section 7.1, each railway operator is expected to cover facility specific training at its own premises based on the PRI's common training/education programs.

As mentioned in the previous paragraph, MCR/NSR-South railway operator will cover operational aspect including inspection work by direct-hiring, while maintenance work is performed by external entities under service provider agreement. In this regard, its training will focus on only operational aspect to maintain its own resource's technical level. Maintenance workers must be trained by service provider to full fill the agreement with O&M organization.

Although the detailed training courses shall be determined according with PRI's training and human development policies and guidelines, any documents have not yet been issued from PRI at this reporting date. In order to proceed the training facility design, hereinunder, JDT assumes the basic training courses in MCR and NSR-South in reference to Japanese railway operator's training program, basic strategy of PRI and the discussions with DOTr.

Generally, training courses in Japan consist of 2 categories: 1) regular training for keeping an ability for safe railway operation; and 2) accident recovery drill. As per PRI and DOTr training strategy, Driver's reskill training and safety countermeasure training are added. As a result, four categories are defined under the operator's training courses.

Left: example of accident recovery, Right: example of regular training

Source: JICA Design Team

Figure 7.2.3 On-Site Training at East Japan Railway

As mentioned previously, since railway services are collaboratively operated by people at train, station and OCC, those people must be periodically trained. OCC system is generally equipped with a stand-alone training mode in its own. Therefore, OCC operator training should be performed in the OCC building. As for the remaining two categories, since it is difficult to conduct a training at its workplace, it must be provided in the place exclusively for training purpose, i.e. training center.

Under the concept of a sole railway operator for a series of 3 lines: MCR, NSCR and NSR-South, Training program should be considered based on common operation rules and manners. Constructing a common training center for MCR and NSR-South has an advantage rather than 2 individual training centers not only because of economic reason but improving the quality of operator’s skill in cooperative training. Training center is usually located in the depot because of the easiness of using reserved cars and test track and having a joint training with E&M engineers without interference to mainline operation. Because MCR depot is scheduled to be constructed earlier than that of NSR-South, the location of common training center for both lines should be in MCR depot to provide a training as earlier as possible.

The following items are basic training courses to be provided in the training center.

1) Regular Training

Every drivers and station attendants shall take a monthly regular training (1~2 hrs.) for keeping a good operation skill and an aware of safe railway operation. In consideration of facility/equipment capacity such as train simulator, E&M equipment study kit and station mock up, 5~10 trainees are suitable for this training class.

2) Accident Recovery Drill

It is not only for reskill of each railway stuff but also to achieve a smooth and effective cooperation work between train operation department and E&M engineers in railway accident. This training shall be held at test track and reserved train for studying an actual recovery operation.

3) Practice/Re-skill Training

PRI proposes the annual reskill drill for drivers. PRI is expected to issue common railway driver’s license in the Philippines. The drivers will have practice training at each operator’s line before starting a commercial operation and reskill drill every 3years. The detail program will be decided when PRI disclose driver’s license program. Those programs will be implemented with a train simulator training and practice running in the training center.

4) Safety countermeasure drill

The purpose of this drill is improving knowledge and skill of railway stuff to cope with emergency situations (emergency cases such as fire, vandalism etc)

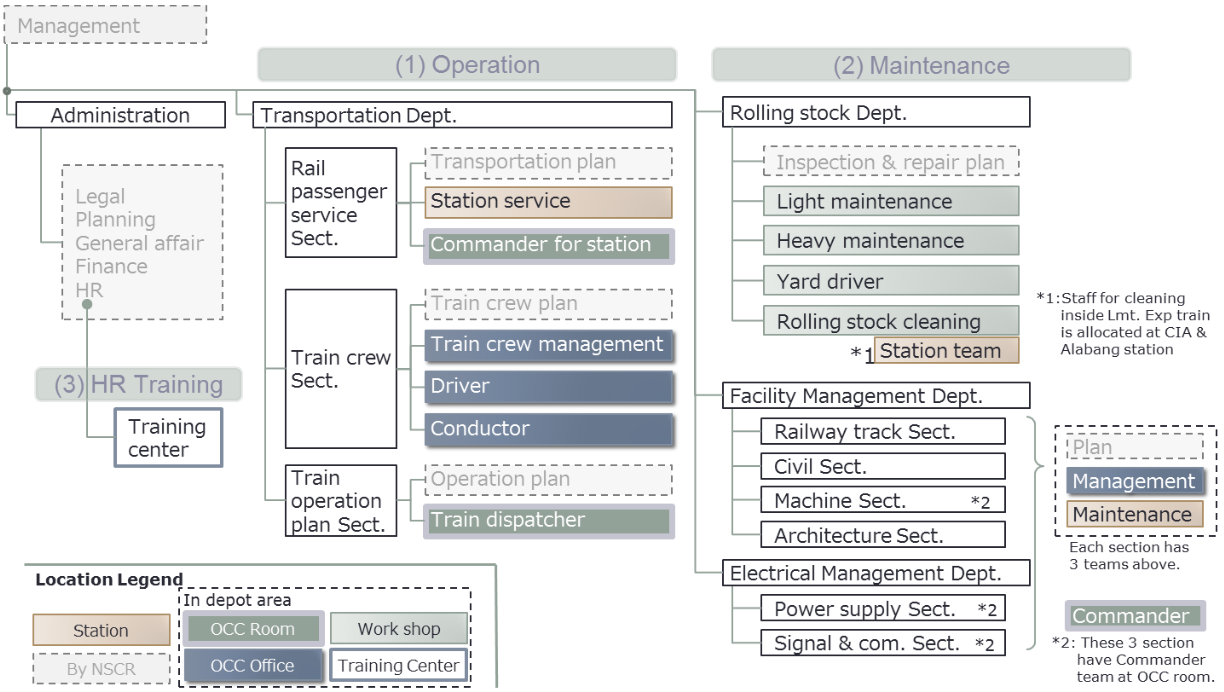
Table 7.2.2 Basic Training Plan of MCR/NSR-South

Training Course	Trainee	Outline of Training/Drill	Course Period/ Duration/#of Trainees
Regular Training	• Station attendant	• Operation and daily check of ticketing machines • Operation of safety and service equipment at station • Service training for station passengers	Monthly • 1 ~ 2 hours • 5~10 trainees
	• Train driver	• Case study for preventing railway accidents • Safety train operation training with a train simulator • Emergency measures in case of train trouble	
Accident Recovery Drill	• Station attendant • Train driver • E&M Engineer	• Recovery drill using a reserved train and test track * The script is prepared based on the actual accidents * joint-training with train operation division and engineering	• Once a year • 1 day • 50~100 trainees
Practice /Re-skill Training	• Train driver	• Practice running and training based on operator's line characters. <precondition> PRI covers the following points: * General training & licensing of driver * Periodical training and examination (every 3 years)	As per PRI regulation
Safety Countermeasure Drill	• Station attendant • Train driver	• Firefighting drill • Emergency evacuation drill (Black out / Flood etc.) • Countermeasures for vandalism	• Once a year • 1 day • 10~20

Details of training courses must be developed by O&M company as per PRI guidelines and its company policies.

Source: JICA Design Team

Based on the concept described above, the organization structure is drawn up as shown in Figure 7.2.4 and the number of required staff for the MCR O&M section is figured out in Table 7.2.4 respectively.



Source: JICA Design Team

Figure 7.2.4 O&M Organization Structure

Table 7.2.3 The Number of Required Staff for the MCR Operation as of May/2022

Organization Structure			Work location					Human-power					
				RollingStock Depot				Position					Total
				OCC									
Department	Section	Role	Station	OCC room	Office	Work shop	Training center	Manager	Chief	Staff	Inspection Engr.	Service Provider	
Operation													
Transportation	Rail passenger service	Station service: Sales of tickets. Passenger inquiry correspondence, safety confirmation of train departure on the platform	*					6	30	242	-	-	278
		Commander for station: Monitoring of stations, Passenger inquiry correspondence, Adjustment of crew and rolling stock with other lines in case of incident		*				1	5	18	-	-	24
		Ticket validator: Limited Exp. ticket sales and validation on platform	*					-	-	45	-	-	45
	Train crew	Train crew management: formulation and management of crew plan concerning crews in own line section. inventory control of goods			*			1	-	26	-	-	27
		Driver: Train operation. Correspondence in the case of unusual incident			*			-	6	110	-	-	116
		Attendant: Ticket validation and sales on limited exp.			*			-	-	105	-	-	105
	Train operation plan	Train dispatcher: Monitoring of train operation at way-side/in yard premises. Data-input of train-diagram for own line section. Formulation and management of train operation plan on own line section in the case of incident		*				-	-	20	-	-	20
Total								8	41	566	-	-	615
Total by Hiring Types											615	-	615

Table 7.2.4 The Number of Required Staff for the MCR Maintenance /Training as of May/2022

Organization Structure			Work Location					Human-power					
				RollingStock Depot				Position					
				OCC									
Department	Section	Role	Station	OCC room	Office	Work shop	Training center	Manager	Chief	Staff	Inspection Engr.	Service Provider	Total
Maintenance													
Electrical Management	Power supply	Management: *1						1	3	15	-	-	19
		Inspection engineer: Inspection of substation, overhead contact line and power distribution. Emergency restoration in case of incident	*2			*2		-	-	-	240	-	240
		Maintenance commander		*				-	5	10	-	-	15
	Signal and communication	Management: *1			*			-	2	8	-	-	10
		Inspection engineer: Inspection of signal &communication. Emergency restoration in case of incident	*			*		-	-	-	160	-	160
		Maintenance commander		*				-	5	10	-	-	15
Facility management	Railway track	Management: *1			*			1	1	7	-	-	9
		Inspection engineer: Inspection of track. Emergency restoration in case of incident	*			*		-	-	-	80	-	80
	Civil	Management: *1			*			-	1	4	-	-	5
		Inspection engineer: Inspection of structure. Emergency restoration in case of incident	*			*		-	-	-	80	-	80
	Machine	Management: *1			*			-	1	4	-	-	5
		Inspection engineer: Inspection of machinery. Emergency restoration in case of incident	*			*		-	-	-	20	-	20
		Maintenance commander: Monitoring of machinary, Providing work orders to maintenance team		*				-	5	10	-	-	15
	Architecture	Management: *1			*			-	1	4	-	-	5
		Inspection engineer: Inspection of building equipment. Emergency restoration in case of incident	*			*		-	-	-	20	-	20
Rolling stock	Light maintenance (daily inspection, emergency responding)					*		1	6	12	-	47	66
	Heavy maintenance (monthly &annual inspection, overhauling)					*		5	6	14	-	260	285
	Train operation inside yard premises					*		-	-	22	-	-	22
	Rolling stock cleaning: cleaning of train at depot and terminal station.		*			*		-	-	-	-	174	174
Training													
Human resources	Training center	Training plan					*	1	1	2	-	-	4
		Training operation					*	-	-	8	-	-	8
Total								9	37	130	600	481	1,257
Total by Hiring Types											776	481	1,257

*1: Formulation and management of inspection and repair plan on own line section. Inventory control of goods.
*2: They are allocated to Depot, San Fernand and Calumpit station.

Source: JICA Design Team

7.2.4 O&M Cost Estimation

Based on the O&M organization assumed in the previous subsection, O&M cost is estimated herewith for a part of project IRR calculation presented in the subsection 8.3.

(1) Estimation Method

In order to reflect the concept of sole operator for a series of 3 sections, O&M cost is estimated based on the following policies on the presumption that an entity operating NSCR extend its services to north and south respectively. Because of railway industry nature, O&M cost composes 4 items: personnel, electrical power, maintenance and other administration cost. Personnel cost for O&M unit and power cost are direct cost which is incurred directly in each section. Those items are simply evaluated as direct charge based on required staff number and power consumption. The other two costs are estimated based on the indirect costs (indirectly incurred such as management and administration layer) is accounted by allocating NSCR cost on a basis of indicators like operating-km.

Based on this calculation method, O&M costs of MCRP and NSRP-South can be estimated respectively. Whole O&M cost including NSCR project can be also extracted. Table 7.2.5 shows cost items and its calculation methods.

Table 7.2.5 O&M Cost Composition and Calculation Methods

Items	Description	Calculation
Personnel	Employee of Management and Administration	(MCR's O&M personnel cost / NSCR's O&M personnel cost) x NSCR's administration personnel cost
	Employee of O&M Org. *1	# of people [nos.] x average personnel cost [PHP/nos.]
Electric Power *2	Electric Power for Operation Activities	Consumption [kWh] x Tariff price [PHP/kWh]
Maintenance	Material and Outsourcing services	(MCR's operating km / NSCR's operating km) x NSCR's maintenance cost *3
Other administration *4	Tax, stamp fee, professional services etc	(Personnel + Power + Maintenance) x 0.3

*1: Salary level is estimated at the level of an entity established under the Philippine corporation code. Departments and staff number required by the O&M organization will be extracted based on functions required for railway O&M activities.
*2: Consumption [kWh] is estimated based on the JDT's design. Tariff price [PHP/kWh] is based on Industrial, PHP5.65/kWh@2015, announced by the Department of Energy (DOE).
*3: It includes man-power-out-sourcing fee and consumables.
*4: Other miscellaneous includes Common Carrier Tax (CCT), stamp fee, professional service fee etc are included here.

Source: JICA Design Team

(2) Results

Based on the assumption above, O&M cost is estimated as Table 7.2.6 below.

Table 7.2.6 Estimated O&M Cost of MCR Section

Items [Million PHP@2018]	2022	2023	2025	2040
	Open to CIA from May	-	Extend to NCC	Train Head is Increased
Personnel	673	673	690	725
Electric Power	2,499	2,499	2,789	2,950
Other administration*1	1,534	1,534	1,703	1,820
O&M Total	4,706	4,706	5,182	5,495

*1: It includes maintenance cost.

Source: JICA Design Team

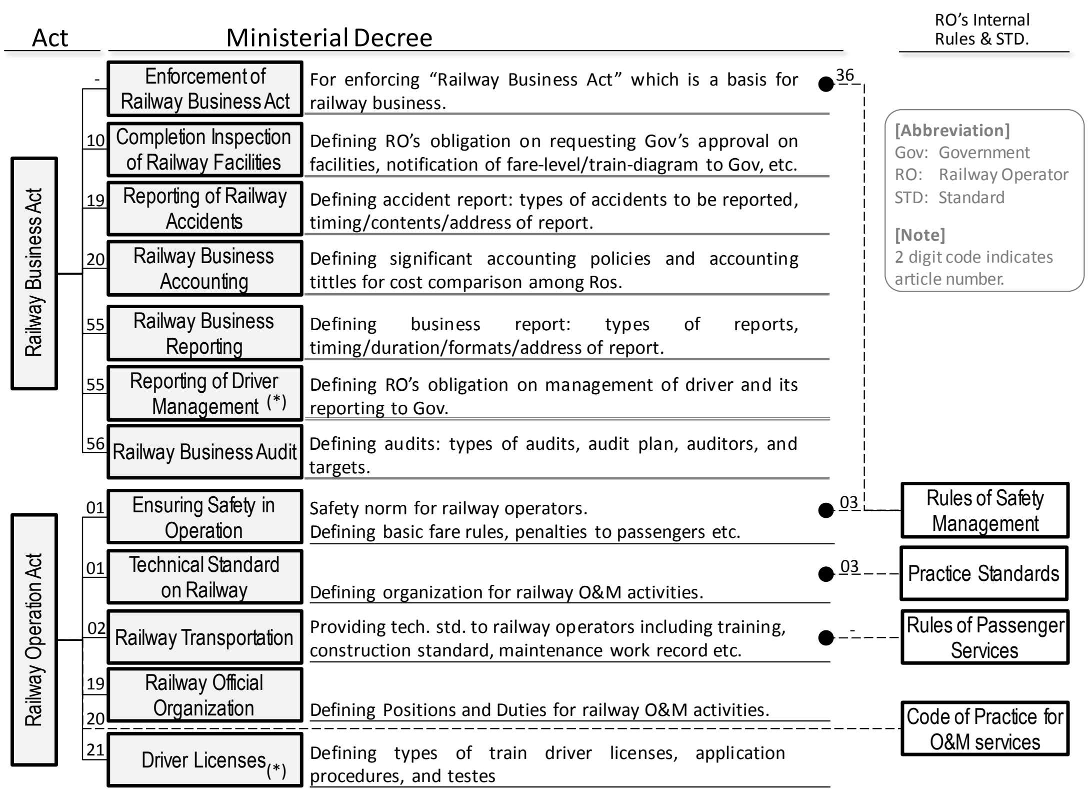
7.3 Consideration Points at Operation Stage

In this section, the points to be considered by the regulator and the O&M company at the operation stage are described respectively.

7.3.1 Consideration Points under the Regulator at Operation Stage

Currently, all railway transport is operated directly by regulatory bodies: PNR, LRTA, and DOTr without any common regulations and standards. In other words, they are running railway business based on its own internal rules and standards. The Bill no. 6593 pointed out that this framework has not successfully regulated the railway systems in ensuring that they are efficient, safe and comfortable modes of transportation. Under this situation, it becomes a challenge for GOP to regulate railway operation provided by a private entity.

In Japan, there are two acts and a lot of ministerial decrees comprehensively regulate railway business from the various viewpoints: planning, construction, operation, maintenance, statutory reporting, auditing, and abolishing. In order to ensure safe and sustainable operation, railway operators develop its internal rules and standards based on the said regulations. In particular, formulation of “rules of safety management”, “practice standards” and “code of practice for O&M services” are stipulated in Japanese acts and decrees. (Figure 7.3.1)



(*) The guidelines for train driver licenses and management will be developed by the PRI project.

Source: JICA Design Team based on MLIT’s information

Figure 7.3.1 Japanese Acts & Ministerial Decrees and Operator’s Rule related to Railway Sector

It is expected the regulator to form the railway act, standards and supervising flamework such as monitoring and audits to regulate the railway operations ether by government and by privates in whole Philippines. For NSCR/MCR/NSR-South lines, in particular, the following three points must be taken into account in terms of PPP scheme.

(1) Service Level

In general, the level of the service provided by an operator is assessed via Key Performance Indicator (KPI). The regulator must deeply understand what kind of KPIs must be set, and define its monitoring method and frequency to effectively and efficiently manage the service. In addition to normal O&M activities, the rules for emergency response must be defined. In Japan, the Enforcement of Railway Business Act stipulates that railway operators must prepare "Rules of Safety Management". (Figure 7.3.1)

(2) Long-term Plan on Assets

Under the hybrid PPP scheme, the asset ownership is retained at the GOP, while the O&M services are provided by a private entity. In this case, long-term asset plan including the decision whether to replace or repair the assets should fall into the GOP responsibility, since infrastructure asset's life cycle is longer than PPP concession period. It is better to make a decision on asset replacement from the viewpoint of asset owner like Singapore public transport authority does it. The regulator and the asset owner must collaboratively develop asset management processes under clear policies and objectives.

(3) Fare-Level

Philippines scored high growth rate recently. It could affect O&M activities from the viewpoint of financial sustainability. In order to immunize against high economic growth rate risk exposure, fare-setting must regularly be reviewed by the regulator whether it reflects current economic condition in Philippines. The regulator must obtain fare-revision framework.

7.3.2 Consideration Points under O&M Company at Operation Stage

(1) Financial Aspect

At the beginning phase including the duration before starting commercial operation, O&M company will have to run its business with few operating-cash-in-flow. In order to respond this situation, financial support by GOP mentioned in the chapter 7 and current-assets held in the O&M company are indispensable. In particular, current-assets: cash and cash equivalent; and inventories such as spare parts for maintenance must be secured to sustainably run its business before starting commercial operation. Taking into consideration these points, the Financial statements of O&M company: financial position, comprehensive income and cash flows, will be like the tables shown in the chapter 8.

(2) Technical Aspect

Internal rules and standards of O&M company are the basis for managing O&M activities efficiently and safety. In Japan, the ministerial decrees including "Technical Regulatory Standards on Japanese Railways" are set forth to secure the safe and stable railway transport. Under these decrees, a railway operator is required to formulate its internal rules and detailed implementation standards that reflect the actual state of affairs at individual railway business operators. For example, the following points must be developed by themselves under its operation policies.

1) Human Resource Development

As mentioned in the section 7.2, basic training plan described in this chapter is tentatively assumed menu for training facility design work. O&M company must develop the internal rules for human resource development and the details of training courses as per PRI's guidelines and it company policies.

2) Facility Optimization

Signs are tools for supporting smooth and safe operation. In Japan, operators develop own rules to adopt its own facility nature. Its figures and types vary depends on operator's rule. In this project, O&M company may be required to develop its own rules and standards in this area to operate in safe and effective.

3) Emergency Response

When an accident happens, an operator must respond immediately and efficiently to keep the damage at a minimum. To be able to take action in the actual situation, developing internal rules and regularly conducting drills are indispensable.

7.4 PPP Feasibility

7.4.1 Overview of PPP Legal Systems in the Philippines

The legal framework for PPPs in the Philippines dates back to 1990 with the enactment of the Republic Act 6957 entitled, "An Act Authorizing the Financing, Construction, Operation and Maintenance of Infrastructure Projects by the Private Sector, and for other Purposes". Certain sections of the said law were eventually amended through Republic Act 7718 (otherwise known as the "BOT Law" and its accompanying Implementing Rules and Regulations (IRR) in 1994. Later on, the Aquino Administration that took office in 2010 recognized the importance of PPP as a means of private sector-led infrastructure development scheme and made further amendments to the IRR of the said law to facilitate the country's PPP program.

In 2010, PPP legal systems were functionally reinforced through Executive Order No. 8. 2010, transferring the institutional attachment of the Build-Operate and Transfer (BOT) Center from the Department of Trade and Industry (DTI) to the National Economic and Development Authority (NEDA). The organization was eventually renamed the Public-Private-Partnership Center of the Philippines (PPP Center). After launching many successful PPP projects, there has been a move to further revise this BOT Law into a so-called "PPP Act". Among the items being considered for inclusion in the proposed PPP Act are modernization of the BOT Law, institutionalization of the existing best practices and prioritization of the PPP program so it can help accelerate national infrastructure development. As of August 2018, the draft bills are at a stage of consolidation at the respective committee level and are under review at both the House of Senate and House of Representatives.

The Duterte Administration that took office in 2016 looked into promoting "Hybrid PPPs" wherein the public funding through the General Appropriations Act (GAA) allocations and Official Development Assistance (ODAs) are utilized for infrastructure development while with operations and maintenance of these said infrastructures are undertaken through PPPs. It appears the application of this type of PPP is assumed for projects with large capital outlays such as railway and airport projects.

The amended Implementing Rules and Regulations (IRR) of the BOT Law specifies various kinds of PPP modalities such as Build-Operate-Transfer (BOT) and Build-Transfer-Operate (BTO). Generally, in PPP projects in the Philippines, the private sector is expected to maintain the infrastructure and collect fares from users. In this sense, the private sector assumes demand risks in many cases. This type of contract scheme was adopted in many toll highway projects. In the selection of a private operator, certain bid parameters are set for instance wherein the bidder with the highest concession fee (price for the rights to operate the facility) is awarded.

In the meantime, in cases wherein financial viability is low but economic benefits of a private investment may be high in a PPP project, the implementing agency is allowed to offer funding support in the form of Viability Gap Fund (VGF) to the private sector. In the selection of a private operator, the bidder with the lowest VGF is awarded the PPP contract.

Table 7.4.1 PPP Modalities based on the BOT Law

PPP Modality	Role of Private entities	Fee Collection
Build-Operate-and Transfer (BOT)	Financing, construction of an infrastructure facility, and O&M over a fixed term	Based on the BOT contract. Tolls, fees, rentals, and charges are collected from facility users
Build-and-Transfer (BT)	Financing and construction of an infrastructure or development facility	Based on an agreed payment schedule, the total investments expended on the project with a reasonable rate of return will be received
Build-Own-and-Operate (BOO)	Financing, construction, ownership, O&M of an infrastructure or development facility. The project proponent may assign O&M to a facility operator	Tolls, fees, rentals or other charges are collected from facility users to recover its total investment, O&M costs plus a reasonable return
Build-Lease-and-Transfer (BLT)	Financing and construction of an infrastructure or development facility, and leasing to the government	Based on an agreed schedule, lease payments are received
Build-Transfer-and-Operate (BTO)	Financing and construction of an infrastructure facility on a turn-key basis. Operation by the project proponent once the title of the facility is transferred to the government.	Based on the BTO contract
Contract-Add-and-Operate (CAO)	Additional construction to an existing infrastructure facility which it is renting from the government	Based on the CAO contract. Under agreed terms and schedule, rental payment will be made to the government
Develop-Operate-and-Transfer (DOT)	Construction and operation of a new infrastructure, inclusive of development of adjoining property	Fee collection based on the DOT contract and benefits from higher property or rent values etc.
Rehabilitate-Operate-and-Transfer (ROT)	Refurbishment and O&M of existing facility	Based on the ROT contract
Rehabilitate-Own-and-Operate (ROO)	Refurbishment, O&M of existing facility. Unless the operator is in violation of its franchise, it can continue to operate the facility in perpetuity	Based on the ROO contract. The government has an option to share income with the project proponent.

Source: Amended IRR of the BOT Law

Another characteristic of PPPs in the Philippines is that it allows submission of unsolicited proposals. Private sector proponents may submit unsolicited proposals for projects in which some economic benefits can be derived. Such proposals must not be listed in the government specified priority project list of implementing agencies. However, even for those listed projects, the private sector can still submit unsolicited proposals and may be accepted if it utilizes a new concept and technology to implement such.

Unsolicited proposal projects are not eligible for any government guarantee, direct subsidies and direct government investment. In the case of the Philippines, right-of-way (ROW) is also considered as a kind of government support and therefore it should not be considered in unsolicited proposals. On the other hand, provision of land by the government for a lease expense of private sector is not considered as government support and can be considered in unsolicited proposals.

If an unsolicited proposal is approved through government evaluations by NEDA and the concerned Implementing Agency (IA), the IA confers an Original Proponent status on the proponent that submitted the original proposal. The IA then posts essential aspects of the proposed unsolicited project on general newspapers for 3 weeks to solicit possible alternative proposals that would be compared against the original one. In 60 days, if no alternative proposal is submitted, then the Original Proponent is awarded the project. On the other hand, if an alternative proposal provides better terms to the government, the Original Proponent is given a chance to match the offer of the alternative bid or propose even better terms and in such case, the Original Proponent will win the bidding. On the other hand, if the Original Proponent does not match the alternative proposal or provide better terms than the ones offered by the alternative proposal, the entity that submitted the most favorable alternative proposal is awarded the contract. Such system is often referred to as the “Swiss Challenge” system.

7.4.2 Current Policy on PPP Application to Projects

As mentioned, the Duterte Administration promotes, especially in large projects, “Hybrid PPP” where the public sector, including ODAs, undertakes infrastructure development and operation and maintenance is carried out through a PPP scheme.

It is assumed that the PPP scheme is applied to O&M part of the projects covered by this study (“Malolos-Clark Railway Project” and “North-South Railway Project-South Line (Commuter)”, with the 180km section between NCC and Calamba including NSCR which is separately planned).

7.4.3 PPP Utilization in the Railway Project in the Philippines

(1) Recent Trend

As of February 2018, there are three railway-related PPP projects that have been contracted to the private sector and three more are under review or evaluation (one of them being an unsolicited proposal) according to the PPP project pipeline of the PPP Center. The contract period of LRT Line 1 Cavite Extension and O&M is 32 years as it involves large infrastructure development. However, railway passenger fare collection system development and operation is contracted for less than 10 years due to the relatively low project cost. Operation and Maintenance of LRT Line 2 is a project, which is focused on operations and maintenance and has a relatively shorter 15 year contract term.

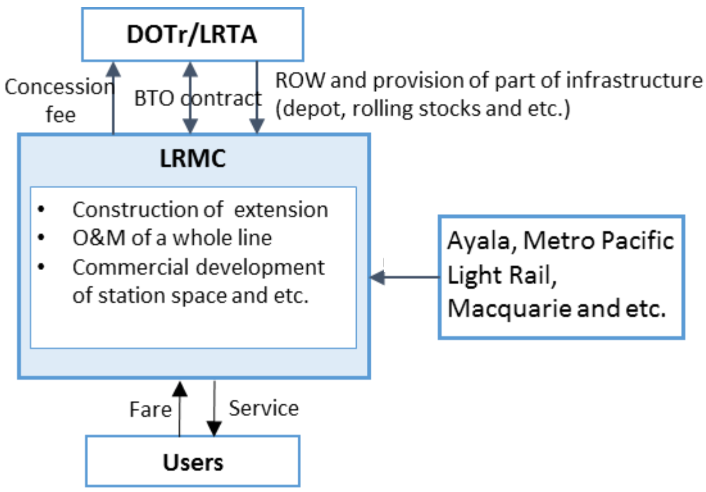
Among the risk allocation aspects between public and private sector in railway PPPs, demand risk is an especially predominant element. In LRT Line 1 Cavite Extension and O&M, while the concessionaire is responsible for demand risks, it is entitled to acquire the fare box revenue and implement station area development to further boost commerciality.

In the Operation and Maintenance of LRT Line 2, fare box revenue belongs to DOTr. However, during its PPP project development stage, revenue sharing by the public and private sector was also examined from the perspective of incentivizing private sector.

Table 7.4.2 Railway related PPPs in the Philippines as of February 6th, 2018

Project Name	Summary	PPP Modality	Total Project Cost (Billion PHP)	Status
Automatic Fare Collection System (AFCS)	Replacement of old ticketing system to contactless-based smart card technology called the Beep Card on LRT Line 1 and 2 and MRT Line 3, with the introduction of a centralized back office that will perform apportionment of revenues. The private sector operates and maintains the fare collection system.	10 years inclusive of 2 years for development / delivery	1.72	Completed
MRT Line 7 Project	Financing, design, construction, operation & maintenance of the 23-kilometer elevated railway line from San Jose Del Monte, Bulacan to MRT 3 North Avenue in Quezon City and the 22-kilometer asphalt road from Bocaue Interchange of the North Luzon Expressway (NLEX) to the intermodal terminal in Tala.	BGTOM	62.70	On-going civil works
LRT Line 1 Cavite Extension and O&M	Extension of the LRT Line 1 from its existing Baclaran Station to the future Niyog Station in Bacoor, Cavite which is approximately 11.7 kilometers. The approximately 32.4 kilometers of whole stretch of the integrated LRT 1 will be operated and maintained by the private proponent.	BTO 32 years inclusive of construction	64.90	Ongoing soft renovation and upgrades of LRT Line 1 existing system
Operation and Maintenance of LRT Line 2	The O&M of the existing LRT Line 2 from Recto to Santolan, the 4-kilometer East Extension from Santolan to Masinag and any future extensions to be implemented by the government during the term of the project.	O&M contract (15 years)	No CAPEX	Under review of implementing agency
LRT Line 6 Project	The financing, design, construction, operations and maintenance, including procurement of the rolling stocks and systems, of a new 19-kilometer light rail line from Niyog to Dasmariñas City in Cavite.	BGTOM/ BT+O&M	65.09	Under review of implementing agency

Source: PPP Center



Source: JICA Design Team

Figure 7.4.1 PPP structure of LRT Line 1 Cavite Extension and O&M

Table 7.4.3 Railway related Unsolicited Proposal in the Philippines as of Feb. 6th, 2018

Project Name	Summary	PPP Modality	Total Project Cost (Billion PHP)	Status
East-West Rail Project	The financing, design, construction, operation and maintenance of a mostly elevated 9.4-kilometer railway line with 11 stations from Diliman, Quezon City to Lerma, Manila. The proposal was submitted by the consortium of East West Rail Transit Corporation and AlloyMTD.	TBD	TBD	On-going evaluation of the members of the ICC-Technical Working Group

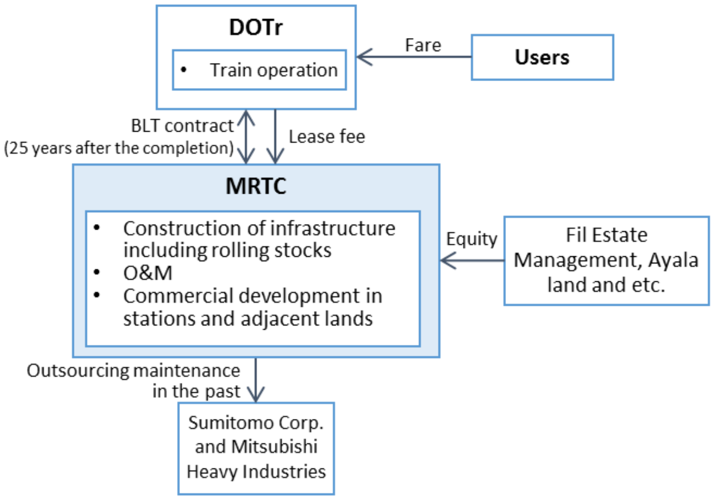
Source: PPP Center

(2) PPPs in the Philippines before the enactment of the amended BOT Law (MRT3 PPP project)

A railway project not listed in the PPP Center project pipeline is the MRT3 (Manila Metro Rail Transit System) project. MRT3 is an elevated railway developed along EDSA which is considered the busiest road in Metro Manila, connecting south and north part of Metro Manila. The length of the line is 16.9 km, going through major parts of Manila such as Ortigas and Ayala. MRT3 started its partial operation in 1999 and went on full operation the year after.

In 1995, DOTC (now called DOTr) signed a Build-Lease-and-Transfer (BLT) contract with MRTC (Metro Rail Transit Corporation), a private consortium. Under the contract, after MRTC built the railway-related infrastructure, it was set to lease the infrastructure to DOTC for 25 years. Then DOTC was responsible for its operation. The MRTC on the other hand, was responsible for maintenance and gains maintenance fee revenues from DOTC. Until 2012, MRTC outsourced the maintenance work to Japanese companies (Sumitomo Corporation and Mitsubishi Heavy Industries, Ltd.). In addition, MRTC was entitled to develop the land related to the railway for commercial use.

In order to implement the project, MRTC raised USD 190 million from a loan syndication including Export-Import Bank of Japan (currently called Japan Bank for International Cooperation or JBIC). However, over the course of the infrastructure development, the company ran out of money and received additional funding of USD 465 million in 1997. The facility came from export credit agencies of Japan and the Czech Republic, as well as some international and domestic private banks. After the start of operation, DOTC was supposed to take demand risk and pay predetermined lease fee as well as maintenance fee to MRTC. Noticeably, the lease fee was set relatively high compared to infrastructure development cost and passenger fare was set low, leaving DOTC with a substantial burden to service the demand risk and the lease fee.



Source: JICA Design Team

Figure 7.4.2　PPP structure of MRT 3 project

After the contract of maintenance works with the Japanese companies expired in October 2012, other local and international companies took over the task through contracts with shorter durations than the original one. Such contract terms proved counterproductive as contract cancellations occurred before maturity due to supposed shortcomings from maintenance providers' side. This unstable maintenance structure is generally assumed as one of the main reasons for the relatively high number of operational troubles and system malfunctions of MRT3. In line with this situation, JICA started a technical study of the entire system MRT3 system and there is a move to improve the infrastructure and operations.

Table 7.4.4　History of maintenance contract of MRT 3

Period	Contractor	Contents	Service Term	Amount
1997-2012	Japanese Companies (Sumitomo Corporation and Mitsubishi Heavy Industries)	Maintenance & Spare parts	10 years + three extensions	1.4 million USD / month
2012-2013	Local companies (PH-Trams)	Maintenance only (each month)	One year	57 million PHP / month
2013-2014	Autre Porte Technique Global Inc. (APT Global)	Maintenance only	One year and six months	131.28 million PHP / month
2015	Schunk Bahn-und Industrietechnik GmbH (SBI) and Commbuilders & Technology Philippines Corporation (CB&T).	Maintenance & Spare parts	Six months	57 million PHP / month
2016-2017	Korean companies (Consortium of 5 companies including Busan Transportation Corporation and others)	Maintenance, overhaul 43 Rail stocks, refurbishment of signal system, etc.	Three years however the contract was terminated in 2017	3.9 billion PHP for three years(About 9.4 billion JPY)

Source: JICA Design Team

7.4.4 Railway PPPs in Other Countries

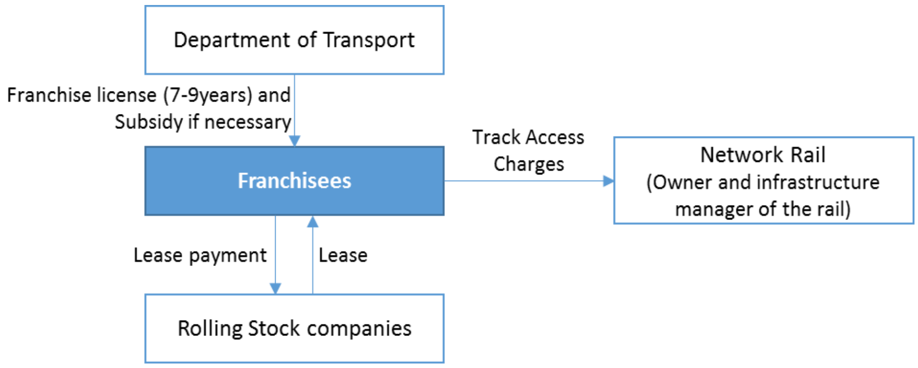
PPPs have already been adopted in many developing and developed countries. Railway PPPs are generally classified into two types: one is the full package PPPs in which a concessionaire finances, designs, constructs and manages the infrastructure for a certain period. The other type is structured wherein the concessionaire is in charge of O&M while the public sector is responsible for financing, designing and constructing the infrastructure. If the project is carried out as a PPP, it is highly likely that the operation and maintenance phase of this project will be managed through a PPP scheme. This section summarizes the characteristics of other railway PPPs in operation elsewhere in the world: franchise PPPs in the UK and Sydney LRT PPP, an Availability Payment type PPP.

(1) Passenger Railway Franchises in the UK

Under the initiative by the Conservative administration in the UK, nationally owned and managed British Rail was privatized in 1994. Unlike the privatization of the Japanese National Railways in Japan, the privatization of the British Rail broke the railway system into several operational sections: passenger transportation services, freight services, railways, rolling stocks, among others. In terms of passenger transportation services, the existing railway network was reorganized into 25 different train operating companies (TOCs) depending on regions and routes. TOCs were then offered to private companies as separate franchise for generally 7-9 year franchise term. Each TOC franchisee is selected through bidding process. At the bidding, the government presents passenger transportation service requirements (service level, upgrading, performance etc. of train service) as well as conditions on fare setting. Bidder which proposes the lowest subsidy from the government (or the highest payment to the government in case of TOCs where surplus is expected) is deemed the winner of the bidding. As British Rail was horizontally privatized, ownership and maintenance of railway infrastructure was passed on to Railtrack, a newly established company that was later acquired by Network Rail in 2002. Therefore, the railway infrastructure maintenance is not included in the scope of TOC franchisees. On the other hand, TOC franchisees are supposed to pay fees to Network Rail for their rail usage.

Moreover, TOC franchisees neither purchase nor possess rolling stocks: they lease rolling stocks from either one of three Rolling Stock Companies (ROSCOs) which were established through the British Rail privatization. As for the station facilities and space, TOC franchisees rent them from the Network Rail and obtain sub-rental incomes from retail businesses.

The purpose of adopting a franchise scheme in the UK's rail system was meant to achieve both improved high quality service and reduction of subsidy utilizing private sector know-how and experience. However, it is worth noting that the amount of subsidy has not been reduced despite privatization. Moreover, cancellation of franchise contracts due to low profitability before and during franchise contract execution resulted in erosion of trust in the consistency of railway service. To avoid the inconsistency of the railway service, in recent years, the UK Government negotiated directly with the incumbent operators. These cases are called "Direct Awards".



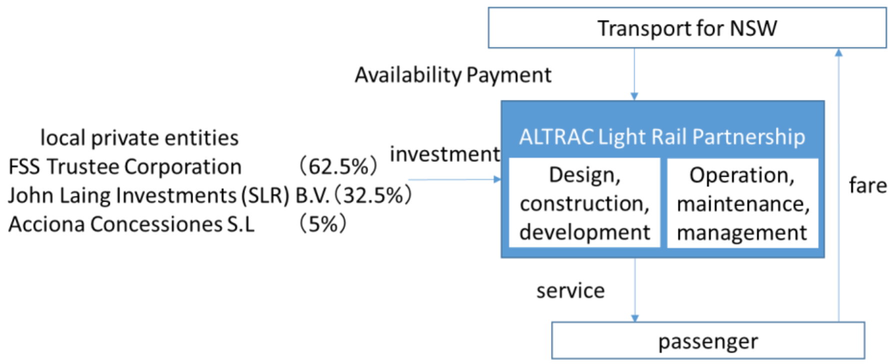
Source: JICA Design Team

Figure 7.4.3 Structure of Railway passenger franchises in the UK

(2) Sydney Light Rail PPP project

Australia introduced PPP in 1980s due to severe fiscal shortfalls of the government. However, the application of the scheme was limited to some areas such as road and water utility systems. In 2008, the Council of Australian Governments (COAG) approved the National PPP Policy and Guidelines. The guideline rationalized related basic PPP polices and guidelines across the Commonwealth, states and Territory. Its main feature is clear demarcation that core project services should be provided by public sector and non-core service (services other than core service such as cleaning, security and maintenance of social infrastructure) is handled by the private sector. This demarcation was intended to avoid causing material inconvenience to people’s lives in the case of the private sector bankruptcy. According to the guideline, projects with capital expenditures costing more than 50 million Australian Dollars are subject to Value for Money (VfM) analysis. Through these efforts, the PPP scheme in the country was utilized in a wide array of infrastructure development and operation in both economic (road, railway, airport etc.) and social (school, hospital, penitentiary etc.) infrastructures.

Sydney Light Rail PPP is a light railway project implemented under a 20-year PPP contract between Transport for NSW, a New South Wales government agency and ALTRAC Light Rail Partnership. The light railway system connects Circular Quay in the Central Business District (CBD) in Sydney and Randwick and Kingsford in the Southeastern suburban part of the city. The 12km (19 stops) CBD and South East Light Rail line (CSELR) costs 2.1 billion Australian Dollars with a target start-up in 2019 is currently under construction. The VfM of this project is estimated 92.5 million Australian Dollars.



Source: JICA Design Team

Figure 7.4.4 Structure of Sydney Light Rail PPP

With the necessary ROW provided by the public sector, the concessionaire undertook construction of the CSELR including design, construction and development. In line with this, once the infrastructure system is completed, it also operates and maintains the system together with the IWLR, an existing line. Demand risk is 100% borne by Transport for NSW. The public sector sets the fare amount, collects fare box revenue and makes monthly Service Payments to the concessionaire, which includes availability payment. If the concessionaire fails to meet certain pre-agreed standards such as timely operation, Service Payment is reduced as per SLR PPP's output specification. On the other hand, incentive payments are provided in line with positive customer satisfaction and revenue management.

Table 7.4.5 Sydney Light Rail PPP Service Payment calculation

	Addition / subtraction	Service Payment components	Measurement
(a)	+	Availability fee	Indexed
(b)	+	Insurance component	Benchmarked
(c)	+	Life cycle component	Indexed
(d)	-	Availability deduction	Measured against missed services
(e)	-	Timeliness deduction	Measured against frequency and total journey time
(f)	-	Service quality deduction	Measured against service quality KPIs
(g)	-	Revenue management deduction	Measured against service quality KPIs
(h)	+	Energy amount bid	Measured against the base energy volume and base network volume
(i)	-	Energy adjustment	Measured against a demand usage strategy designed to minimize network demand charges
(j)	+	Customer satisfaction payment	Measured against service quality KPIs
(k)	+	Revenue management payment	-
(l)	+	Asset management adjustment	Measured against compliance with the maintenance work program
(m)	+	Floating rate amount	Measured against quarterly interest rate movements
(n)	-	Final completion deduction amount	Calculated in months where OpCo has not achieved final completion
(o)	-	Transport for NSW's share of gross commercial revenue	-
(p)	-	Ticket collection amount	-
(q)	-	Traffic signal aggregate delay amount	Measured against the traffic signal delay set out in the SPR

Source: Transport for NSW, "Sydney Light Rail Public Private Partnership Contract Summary"

For measurement of service quality performed by the concessionaire, the following 8 key performance indicators (KPIs) were set out.

Table 7.4.6 Sydney Light Rail PPP service KPI

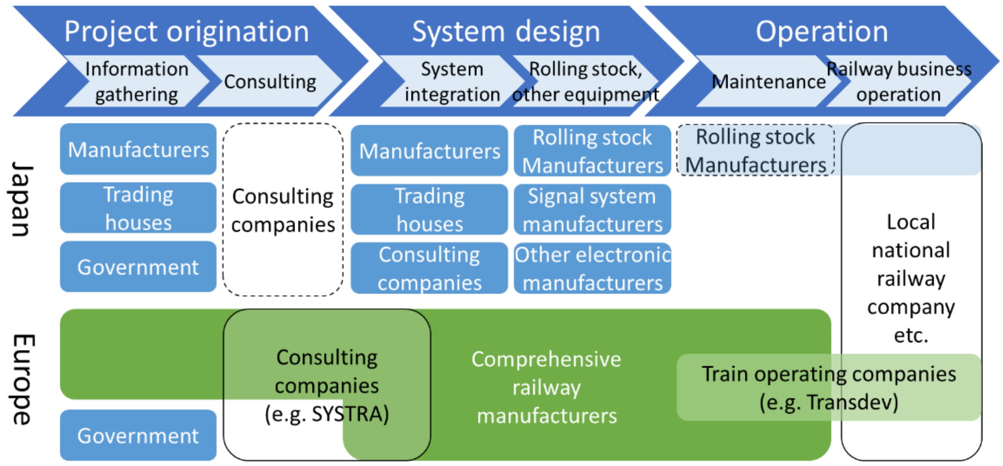
KPI #	Service Quality KPIs	KPI weighting
1	Vehicle cleanliness, condition and graffiti	20%
2	Stop and interchange cleanliness, condition and graffiti	10%
3	Corridor cleanliness, condition and graffiti	4%
4	Customer information	10%
5	Complaints management	4%
6	Customer satisfaction survey	36%
7	Asset Availability: systems at stops	6%
8	Asset Availability: systems on LRVs	10%
	Total	**100%**

Source: Transport for NSW, "Sydney Light Rail Public Private Partnership Contract Summary"

(3) Railway PPP Players around the World

According to UNIFE, an association of the European rail industry, the annual average world railway industry market from 2013 to 2015 is about 159 billion EUR (20.7 trillion JPY). Rolling stock and service segments take up 72% of the market and each sector is expanding at an annual rate of 5.8% and 4.9%, respectively. The expansion of the market is expected to continue and the market size from 2019 to 2021 is estimated to reach 185 billion EUR (24.1 trillion JPY).

Since a PPP scheme is expected to be adopted for the O&M of this railway project, railway O&M PPP players around the world are reviewed and summarized in the following sections.



Source: JICA Design Team based on MLIT "Overseas Expansion Strategy (Rail)"

Figure 7.4.5 Japanese and European Railway Businesses in Overseas Market

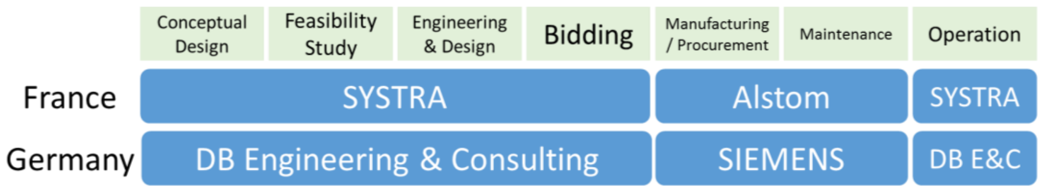
1) Japanese Players

Compared to European integrated railway businesses which typically cover most of railway business segments from upstream to downstream, Japanese counterparts are rather delineated across the value chain. Recently, some Japanese companies started to supply rolling stock together with maintenance service as a package. Hitachi supplied rolling stocks and launched a maintenance business in UK. On the other hand, East Japan Railway Company, together with Mitsui & Co. and Dutch Abellio, started a railway franchise business in also in the UK. Japan Transport Engineering Company supplied rolling stocks for the Purple Line in Bangkok, Thailand with maintenance services to be provided by Japan Transportation Technology (Thailand) Co. Ltd., a JV between East Japan Railway Company, Marubeni Corporation and Toshiba. However, railway system packages deal including rolling stock and O&M in PPP is still relatively limited for Japanese businesses.

2) The Other Players

In Europe, a system has been developed which enables European railway businesses to consistently engage in railway project from its inception phase. For example, in France, SYSTRA, an engineering company with extensive expertise in railway O&M, which is 42% owned by SNCF and another 42% by RATP respectively, helps their parent companies and their related railway operation companies such as an SNCF subsidiary Keolis expand their overseas railway businesses. The company operates in 20 countries and 55% of its employees are foreigners.

European comprehensive railway manufacturers such as Alstom of France and SIEMENS of Germany collaborate with railway consulting companies such as SYTRA and DB Engineering & Consulting. It may be in their interest to incorporate EU standards into project specification to ensure European companies would have competitive advantages. As illustrated in Figure 7.4.6, comprehensive railway manufacturers also tie up with operators in their home country in bidding competitions as seen in joint bidding by Alstom and SNCF for high speed railway projects in Brazil and India.



Source: JICA Design Team based on MLIT "Overseas Expansion Strategy (Rail)"

Figure 7.4.6 Typical Railway Business Formation in Europe

The Mass Transit Railway (MTR), a railway operator in Hong Kong is aggressively expanding its overseas operations. The company participates in a number of overseas railway operation projects which include Beijing Metro Line 4 thirty year PPP, Shenzhen Metro Line 4 BOT, Stockholm Metro O&M concession, franchise businesses in the UK, Melbourne Metro O&M concession, Macau LRT Operation Consultancy and so on. The world largest rolling stock manufacturer CRRC Corporation Limited of China expands its business through a package strategy. It sells rolling stocks together with maintenance service and it has set up a comprehensive maintenance service base in Malaysia.

Table 7.4.7 Railway O&M Related Companies

Entities (Country)	Overview	Revenue	O&M Related Activities
DB Engineering & Consulting (Germany)	• Owned by DB AG • Established in 2016 through a merger of DB ProjektBau (current DB's engineering company for infrastructure projects in Germany) and DB International (current DB's international engineering and consulting company) • More than 4.300 employees from 73 nations, located in 30 countries (5 core countries (Qatar, South Africa, Israel, Brazil, and USA) • Engineering: Design, Project management and project control, Realization management and construction supervision, Design review and acceptance test, Environment, geotechnics and surveying, Consulting: Business consulting, O&M, Logistics-	-	• UAE Etihad Rail DB Operation - operations through a JV • Qatar Integrated Railway Project: supporting operations as "shadow operator" • Metro Kochi India: consulting on O&M • China CRH: technical advisory to the maintenance of the high-speed fleet • South Africa: operations consulting for coal transport • Sydney Metro (North-West Rail Link): project management services in commissioning and operations
Systra (France)	• Railway engineering consulting firm • 42% owned by SNCF and RATP respectively • 20 overseas subsidiaries with 30 offices • 55% foreign employees • Main activity is consulting with occasional O&M Engagement	612 million EUR (2016)	• South Europe Atlantic HSL • Nantes-Châteaubriant Tram-Train • EOLE – Westward extension of the RER Line E • High Speed 1 – HSR Link between London and the Channel Tunnel • Manila Metro/LRT – Line LRT 1 • Chile: Santiago Metro (MRT) technical assistance
Keolis (France)	• 70% owned by SNCF • Actively engaged in overseas urban railway O&M • Operating in 21 cities in 16 countries • Employs 55,000 foreigners • International revenue breakdown (2016): Continental Europe 49%, North America 23.9%, Australia & New Zealand 21%, UK 5.9%	5,075 million EUR (2016)	• Norway: Bergen tram operation • The Netherlands: rail service • Germany: 12 year commuter rail (Rhine-Ruhr) operation contract • UK: 3 rail franchises (Southeastern, London Midland, Govia Thameslink Railway) and 2 tram network operation contracts (10 year operation contract for Metrolink in Manchester and Nottingham Trams) • North America: 2 USA rail network operations (VRE in Washington DC and KCS in Boston) and 1 Canadian tram network (Waterloo) to be launched in 2018 • Australia: 2 PPP contracts (10 year PPP O&M contract for the first new integrated multimodal public transport network (buses, ferries and a new light rail system) in Newcastle / 15 year O&M contract for Gold Coast tram network)

Entities (Country)	Overview	Revenue	O&M Related Activities
RATP Group (France)	• State-owned public transport operator headquartered in Paris, France. • Formed in 1948, as the public transport operator for the city of Paris. • Whilst the RATP's Paris operations are still a major part of the business, its operations have now extended to include businesses around the globe. These include involvement in the operation of bus, tram, rapid transit and inter-city rail services, located in Europe, Asia, Africa and the Americas (international revenue: 13%) .	5,447.8 million EUR (2016)	• RATP Dev Transdev Asia (RDTA), a JV with Transdev, operating: Metro Manila LRT Line 1, Seoul Metro Line 9 together with Veolia (divested), Mumbai Metro Line 1, Hong Kong tramways • Algeria: metro and tramway network operations • Morocco: Casablranca LRT • South Africa: Gautrain, regional express train • Italy: Florence tramway, 2 regional rail lines in Tuscany, Italy (minority share) • USA: the Washington DC tramway operation (5 years)
Transdev (France)	• Created by the merger of Veolia Transport and Transdev in 2011 • Operates in 19 countries. • Competitive in bus and tram businesses	6,600 million EUR (2017)	• New Zealand: Auckland Transport (AT) operation contract • Ireland: Dublin’s light rail network operation • Spain: Barcelona light railway operation
MTR (Hong Kong)	• Hong Kong railway system developer & operator • Actively engaged in TOD along its network • Aggressively expanding overseas railway operations	55.4 billion HKD (2017) 8 trillion JPY * *1 KD = 14.5 JPY	• China: Beijing Metro Line 4 PPP / 4 Daxing Line O&M concession / 14 PPP (shadow tariff scheme) / 16 O&M concession (to be a PPP after full open), Hangzhou Metro Line 1 PPP / 1 Extension O&M concession / 5 (PPP, vertically separated, 25 year O&M, shadow tariff scheme) (under construction), Shenzhen Metro Line 4 BOT • Macau LRT Taipa Line (consultancy) • UK: 2 franchise (TfL Rail/Elizabeth Line, South Western Railway) • Stockholm Metro, MTR Express, Stockholm Commuter Rail (10 year concession including rolling stock maintenance) • Australia: Melbourne Metropolitan Rail Service (7 + 3 year O&M concession), Sydney Metro Northwest PPP the design, construction and financing, as well as the future O&M (under construction))
CRRC Corporation Limited (China)	• the largest rolling stock manufacturer in the world • employs 187,000 people, active through 70 subsidiaries in 103 countries including US, UK, Malaysia and South Africa • shifting to overseas expansion from rolling stock manufacturing for domestic market • one-stop business model including catenary and rail maintenance on top of rolling stock	207 billion RMB (3.5 trillion JPY) (2017) *1 RMB = 17 JPY	• O&M company in Malaysia • Tel Aviv metro (16 year maintenance contract)

Source: JICA Design Team

7.4.5 PPP Feasibility

(1) Risk Analysis

As pointed out before, the O&M of the 180km railway between NCC-Calamba or MCRP, NSRP-South including separately developed NSCR, is expected to be undertaken through a PPP. A set of general risk factors in railway PPP is shown in Table 7.4.8.

The PPP Center of the Philippines developed and published the Generic Preferred Risk Allocation Matrix (GPRAM). It shows rationales behind each risk allocation and bearable risk by public and private sector for practical foundation in PPP project formulation. For the risk allocation between public and private sector for this project, based on GPRAM, given that this is a railway project as well as an O&M PPP must be taken into consideration. Major related risks with this project are shown in Table 7.4.8

Table 7.4.8 Major Related Risks Listed in GPRAM

Type of Risk	Definition / Rationale
Availability of Site	Risk that tenure/access to a selected site which is not presently owned by government or Private Partner cannot be negotiated. Risk of costs and delays in negotiating land acquisition.
Risk Allocation with O&M Contractor	
Inter-Operability Risk	Interoperability risk refers to the risks associated with achieving clear and efficient operational arrangements with other facility operator/s. This will have to be considered in the project design and operation system requirements.
Commissioning	Risk that either the physical or the operational commissioning tests which are required to be completed for the provision of services to commence, cannot be successfully completed.
Exchange Rate	Risk that during operation, exchange rates may move adversely, affecting the Private Partner's ability to service foreign denominated debt and obtain its expected profit.
Inflation	Risk that value of payments received during the term is eroded by inflation.
Financing Unavailable	Risk that when debt and/or equity is required by the private firm for the project, it is not available then and in the amounts and on the conditions anticipated.
Sponsor Risk	Risk that the Private Partner "is unable to provide the required services or becomes insolvent".
Change in Ownership	Risk that a change in ownership or control of the Private Partner results in a weakening in its financial standing or support or other detriment to the project.
Tax Changes	Risk that before or after completion, the tax impost on the Private Partner, its assets or on the project, will change.
Lessee Risk	Risk that the major critical assets necessary for the operational stage of the project are acquired through leases and that the Private Partner defaults on those lease obligations. This leads to the assets being foreclosed and the operations of the project being interrupted.
Inputs/Operating Cost Overrun	Risk that required inputs during the operations stage cost more than anticipated, are of inadequate quality or are unavailable in required quantities.
Changes in Output Specification Outside Agreed Specification Range (Including Modifications and Augmentations)	Risk that government's output requirements are changed after contract signing whether pre or post commissioning.
Operator Failure/Short Fall in Service Quality	Risk that a subcontract operator may fail financially or may fail to provide contracted services to specification" (Failure may lead to service unavailability and a need to make alternate delivery arrangements with corresponding cost consequences.)

Type of Risk	Definition / Rationale
Technical Obsolescence or Innovation	Risk that the nature of the contracted service or its method of delivery is not keeping pace, from a technological perspective, with competition and/or public requirements. Private Partner's revenue may fall below projections either via loss of demand (user pays model) to competing services and/or operating costs increasing. Government may wish to change specifications of contracted service.
Third party liability	Risk that third parties file suits or claim damages against government for faults of the Private Partner and vice versa.
Demand Risk	Risk that operating revenues fall below forecast as a result of decrease service volume (i.e., traffic volume, water or power consumption) attributable to an economic downturn, competition in the relevant market tariff increases or change in consumer habits.
Changes in Competitive Network	Risk that an existing network is extended/changed/re-priced so as to increase competition for the facility.
Ancillary Commercial Businesses	Risk that ancillary commercial business operations adversely impact the Private Partner's fulfillment of PPP contractual obligations and/or pose additional exposures for government.
Industrial Relations	Risk of strikes or industrial action causing delay and cost to the project.
Approvals	Risk that additional necessary approvals required during the course of the project cannot be obtained.
Changes in Law/Policy	Risk of a change in law/policy of government only, which could not be anticipated at contract signing and which has adverse effects on revenues, capital expenditure or operating cost of the Private Partner.
Economic Regulation	Risk that where there is a statutory economic regulator involved there are pricing or other changes imposed on the private firm which do not reflect its investment expectations.
Availability of Government Appropriations	Risk in delays in government contractual payments to the Private Partner arising from unavailability of government budgetary appropriations.
Changes in Statutory Rates of General Application	Risk of changes in minimum wages and other regulated rates of general application affecting the Private Partner.
Force Majeure Risk	Risk that inability to meet contracted service delivery (pre or post completion) is caused by reason of force majeure events.
Default and Termination	Risk of 'loss' of provision by the Private Partner of contracted services upon the premature termination of project contract.
Residual Value on Transfer to Government	Risk that on expiry or earlier termination of the services contract the asset is not in the required condition term.
Risk Allocation with Design & Construction Contractor	
Interconnectivity Risk	Interconnectivity refers to the physical linkage of a project to another or to part of a network.
Construction	Risk that events occur during construction that prevent the facility from being delivered on time and on cost.
Maintenance and Refurbishment	Risk that design and/or construction quality is inadequate resulting in higher than anticipated maintenance and refurbishment costs.

Source: JICA Design Team based on the GPRAM by the PPP Center of the Philippines

There are some aspects wherein conventional PPP risk allocation would not apply for this project. For instance, the construction risk or completion risk should be borne by the public sector because design and construction is undertaken by the public sector. Therefore, some points in risk allocation and mitigation are shown below which need special attention in designing a railway PPP, especially if the project will mainly involve O&M.

a) Construction / Completion Risk

In GPRAM, it is basically assumed that a vertically integrated project is undertaken by the private sector. Therefore, construction and delay risk arising from construction is allocated to the private sector. Some mitigation measures are presented in GPRAM such as ensuring the implementing agency produce a Feasibility Study well in advance of the procurement process and ensuring ROW issues resolved before contract execution. In Sao Paulo Metro Line 4, a vertically separated project, public sector was obligated to inform the private sector of a possible delay 2 years prior to the original revenue start-up date. The project turned out to be delayed by almost 4 years due to procurement litigation, unavailability of counterpart funds, accidents caused by engineering defects resulting in 7 deaths and resettlement problems. These have led to the private partner seeking compensation for deferred revenues in operation. Finally, the private partner won arbitration with the state of Sao Paulo over compensation for the lost revenues. According to a World Bank evaluation, it is suggested to agree on very stiff penalties for delays in construction as well as bonus for earlier completion in PPP contract. Aside from these, it is suggested to set up clearly defined mechanisms to handle unanticipated delays. In the Sydney LRT PPP project, detailed “Relief Events” which allow certain penalties as well as incentives for delays and early completion were set out beforehand.

Table 7.4.9 Completion Risk Mitigations

Project	Mitigations / Suggested Contract Provision(s)
Sao Paulo Metro Line 4	Public sector to provide with a 2 year advance notice to private sector if delay can be expected.
Sydney LRT PPP	• Party in default is to bear delay risk / liability in the areas such as;. Public sector: approvals, legal challenges to the approvals, early works, Private sector: modification to planning approvals after financing close, responsibility to comply planning approvals, commissioning etc. • Pain and gain share mechanism (final completion deduction from Availability Payment / bonus payment for early completion) • Termination right for the public 2 years after the original completion date • “Relief Events” which are beyond private sector’s control allow certain project delays • Delay notice within 10 days after “Relief Events”
HSL-Zuid (The Netherlands)	• The project was composed of 3 major parts; infrastructure (public), rolling stock (Infrasepeed, a PPP JV) and operation (HSA a.k.a. NS Highspeed, the other PPP). • Delayed by a couple of years by incompatibility design of rolling stocks. • Eventually, completion risk was borne by the public to keep the operator unharmed.

Source: JICA Design Team

b) Maintenance and Refurbishment Risk

In GPRAM, poor design and/or construction quality resulting in higher than anticipated O&M costs is attributed to the private sector assuming a vertically integrated project. Because this railway project is vertically separated and the public sector undertakes infrastructure development, it is not likely that the private sector bears maintenance and refurbishment costs caused by defective infrastructure development by the public sector. In order to achieve proper risk allocation and secure appropriate operator capability, O&M PPP procurement must accompany adequate information disclosure to private bidders at the time of bidding. Maintenance and refurbishment scope for the private sector must be clearly defined.

Table 7.4.10 Maintenance and Refurbishment Risk Mitigation

Project	Mitigation
Connex franchise in Victoria, Australia	• If the state decides that the latent defect requires rectification, it will pay for costs over and above the agreed level (initially 7 million AUD, later lowered to 3.5 million in favor of the private sector). • If it doesn't, neither the state nor the franchisees pay anything and there is no change to the infrastructure defect.

Source: JICA Design Team

The franchise agreement between the state of Victoria, Australia and Connex a railway operator specifies latent defect liabilities. This arrangement caps the maintenance and refurbishment risk of defects not known at the start of the franchise term at 3.5 million AUD for the private sector. The allocation of this risk is supposed to be reasonable from a VfM perspective as it reduces the unknown risks to the franchisees, who would have sought a premium to accept these risks. Usually, in vertically integrated PPP projects, construction sub-contractors eventually rectify any latent defects for a specified period of time from the date of practical completion (for example, 12 months). Nevertheless, as with identified defects, latent defects which arise at any time will remain the primary liability of the private sector through its contract with the public sector.

c) Demand Risk

According to the GPRAM, risk that operating revenues fall below forecast is borne by the private sector in concession PPPs because concession PPP is regarded as a financially independent modality. On the other hand, in availability PPPs, the public sector bears the demand risk. In concession PPPs, when demand and revenue can be estimated with relative certainty, the private sector is in a better position to mitigate risk through commercial management practices. In concession PPPs which are economically viable but not financially viable, a mitigation measure is presented; the public sector may assume some (capped) demand risks; and, the public sector may want to share 'super-profits' in concession PPPs. On the other hand, in availability PPPs, government is best placed to control/manage demand and the Availability Payment is made irrespective of facility usage.

Generally speaking, demand forecast in green-field projects is associated with relatively higher uncertainty compared with that in brown-field projects. Therefore, various attempts are made in railway projects in order to properly share demand risk between public and private sector such as minimum revenue guarantee and demand risk mitigation band.

Table 7.4.11 Railway Demand Risk Mitigations

Mitigation	Project	Overview
Minimum Revenue Guarantee	Seoul Metro Line 9	• When PPP concessionaire's actual revenue falls below certain level of originally agreed breakeven point, the gap between the actual and the certain level is paid by Seoul Metropolitan Government. • When actual revenue exceeds more than 10% of the breakeven point, the exceeding gap is refunded to the public sector. • After commencement of the service, when the actual revenue falls below 90% of the breakeven point, the gap was funded by the public sector. However, when the actual revenue fells even further below 50% of breakeven point, there is no subsidy from the public sector). • This initially 90% threshold was set to decrease by 10% in every 5 years and continues for 15 years until 2023. • The line stated in 2009 and for the 12 month period stated on July 2009, the public sector paid 14.2 7 billion KRW (1.427 billion JPY). • Finally, after disputes over fare setting between Seoul Metropolitan Government and the private sector, the Minimum Revenue Guarantee system was abolished.
Demand Risk Mitigation Band	Sao Paulo Metro Line 4	• When passenger number falls below the expected volume by 10%, the state government pays subsidy to the private sector SPC. The amount of subsidy differs by the extent to the shortfall in the passenger number (band). If the passenger number exceeds more than 10% of the expectation, the SPC make payments to the public sector.

Source: JICA Design Team

d) Economic Regulation Risk

In concession PPP contracts, concessionaires are usually given certain discretion to petition the revision of passenger fares to some degree. However, in consideration for passenger sentiment, approving public agencies tend to withhold fare rise approvals in many cases. Clear and appropriate fare setting and revision arrangement in PPP contract and proper implementation of such arrangement is needed. Consistent and stable regulatory framework which allows fare rise reflecting the change of economic environment during the project period is important to secure financial PPP viability.

Table 7.4.12 Fare Setting Cases

Project	Overview and notes
Seoul Metro Line 9	■ Fare setting and revision system The base initial fare of 1,000 KRW was set with the discretion to raise fare every year with CPI cap. ■ Implementation - The fare increase proposed by the private sector was not approved by the public for political considerations and the approved fare was set below cost. Consequently, SPC loss increased and due to the minimum revenue guarantee, public subsidy burden increased as well. - A lawsuit was filed for fare setting and Seoul Metropolitan Government won the case. In 2013, major shareholders of the original concessionaire divested the investment. Afterwards, fare setting became Seoul Metropolitan Government's sole direct discretion matter.
Sao Paulo Metro Line 4	■ Fare setting and revision system - Fare right after start up is set around 1 USD (irrespective of travel distance) and to be revised annually. - Because public transportation fares in Sao Paulo is integrated, the SPC can hold 100% of the fare revenue arising from passengers using only Line 4. It can hold 50% of fare revenue from passengers making transfers to or from the other lines.
Bangkok SkyTrain	■ Fare setting and revision system - Within an authorized fare range, PPP concessionaire can change fare at its own discretion in every 18 months. Concessionaire is required to give a 30-day advance notice to both the public sector (BMA) as well as passengers. - The authorized fare range normally allows 7% fare rise without authority approval if Bangkok CPI exceeds 5%. If it exceeds 9%, USD-THB exchange rate, interest rate, electricity price and some other factors can be incorporated in fare setting. However, this requires MBA approval. ■ Implementation Since the opening in December 1999, not until 2007 the concessionaire could raise the fare. Only twice (June 2012 and Oct. 2017) the concessionaire could raise fare after 2017 since then.

Source: JICA Design Team

(2) Possible PPP Schemes

In designing a feasible PPP framework for this railway project, the appropriate project risk sharing mechanism between the public sector and the private sector is a key factor to draw substantial interest from private companies. Considering the particular risks identified in O&M type of PPPs, two types of PPP model may be presumed for this project with properly allocated project risks between the public and private side, based on the analysis of the aforementioned general railway PPP risk characteristics.

a) Concession Term

Generally, project term of the O&M PPP tends to be short since this type of PPP requires less initial investment of private companies. The amount in this case, the private O&M entity should fully recoup their investments through their operation of the facilities in a shorter span of time, compared to other modalities of PPP. In line with this, after a certain period from the start of operation, the project term of another subsequent O&M PPP project should be longer than the initial O&M PPP project, if the subsequent PPP contract imposes the private company to renew and replace decrepit equipment or machineries during the operation and maintenance.

Given that, two PPP examples customized to the project are simulated in this study: one is an O&M type with 10 years of project term, and the other is also an O&M type, but with 15 years of project term as the latter incorporates larger investments including replacement of certain equipment of the infrastructure.

b) Demand Risk

Since O&M of this railway project covers MCR, NSCR and NSRP South as one inclusive engagement, the demand risk should be assessed on an integrated basis for these 3 sections. Further, uncertainty of the demand during the operation is assumed to be relatively higher in such a green field project compared to brown field projects. The uncertainty of the demand risk is likely to be unmanageable for private companies, and would be reluctant to bid for the O&M concession, resulting in a less competitive PPP procurement bidding. Thus, the demand risk is better shouldered by the public sector employing a form of availability payment after the inception of the operation and maintenance phase in the first O&M PPP case.

On the other hand, in the second mode of O&M PPP, it would be assumed that within the first 10 years of operation and maintenance of the facility, the private companies would have accumulated substantial experience in predicting future demand with far less volatility. This indicates that a user fee payment structure wherein demand risk is borne by a private company can be feasible in the second mode of O&M PPP. It is thus assumed that a user-payment type of PPP for the second O&M PPP option in this study is utilized.

c) Construction / Completion Risk

Since the construction work will be delivered through a traditional type of public procurement and would be exclusive from the undertakings of the O&M concessionaire, the risk of construction delay is beyond the control of the private company. The inherent tightness of the planned schedule for MCR construction work would expose the private company to the possibility of significant risks that the delay of the construction causes substantial idling losses from staffing costs, training costs, maintenance parts costs, among others. Therefore, it is crucial that the public and private sector agree to a compensation coverage mechanism to compute for reparations in case scheduled project completion dates would experience delays.

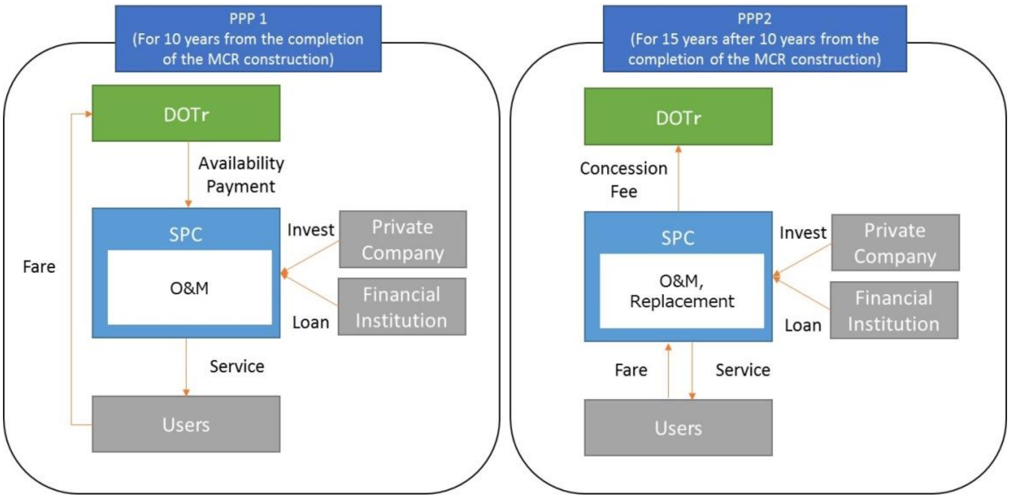
It is important to note that the commercial viability and ridership of the subject rail line is inherently linked to whether the surrounding transportation networks are implemented in line with the planned schedule. Since the predicted demand of the railway is significantly sensitive to the situation of the surrounding transportation networks, this interconnectivity risk also needs to be closely managed. As mentioned in the Chapter 4, the said transportation networks incorporate both the existing networks and ongoing or planned networks. Implementation of these planned transportation networks in line with timelines and schedules is beyond control of the private sector. Thus, in the case of the user-pay type of PPP, of which demand risk is managed by the private company, it is required that the public sector assumes compensation in case of losses arising from shortfalls from the original estimated demand due to realized interconnectivity risk.

Table 7.4.13 Examples of Possible PPP Schemes

Type	PPP 1st Phase	PPP 2nd Phase
Private company Role	O&M	O&M, Renewal
Target Alignment	MCR + NSCR + NSRP South	MCR + NSCR + NSRP South
Project Period	For 10 years from the completion of the MCR construction	For 15 years after 10 years from the completion of the MCR construction
Revenue for Private	Availability Payment	User-Pay
Main Risk handled by Public	Demand Risk Completion Risk	Interconnectivity Risk

Source: JICA Design Team

The possible PPP schemes for this railway O&M project are illustrated in Figure 7.4.7.



Source: JICA Design Team

Figure 7.4.7 Examples of Possible O&M PPP Schemes

d) Role of Private Sector

The role of private sector in these O&M PPPs are O&M and replacement investment. Some expected roles of the O&M PPP concessionaires are illustrated in Table 7.4.14.

Table 7.4.14 Examples of Role of Private Sector

Type	PPP 1st Phase 10 years after MCR completion	PPP 2nd Phase 11th year and forward after MCR completion
Role of Private Sector	• Planning of O&M (O&M organization design, business processes design, operational plans, management plans by system, safety management plans) • Operation of the entire railway system • Maintenance of the entire railway system (inspection, renewals, RAMS (Reliability, Availability & Maintainability Studies) plan, degraded operations plans, procurement strategies, etc., monitoring mechanisms to technical and safety requirements))	On top of the PPP 1st phase roles; investment of replacement components

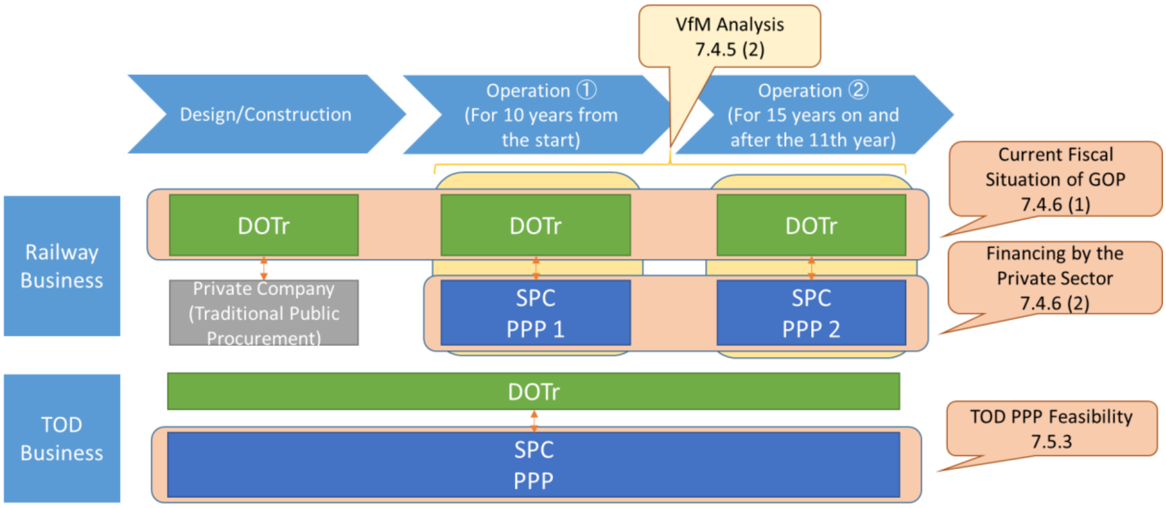
Source: JICA Design Team

(3) VfM

1) PSC and PPP-LSC Calculation Methods

In PPP project formulation process in the Philippines, appraisal and approval of proposed PPP projects commences upon submission of a project by an implementing government agency to the Investment Coordination Committee (ICC). Then the ICC Technical Working Group undertakes specific aspects of the appraisal of the PPP project. According to 4.5 b) in the Guidelines and Procedures for the appraisal of PPP Projects, published by the PPP Center, Value for Money (VfM) analysis is required. The objective of this VfM analysis is to simulate the cost efficiencies of a particular project implemented as a PPP as well as carried out as a conventional public procurement. The analysis compares Public Sector Comparator (PSC), an estimate of hypothetical, whole-of-life cost of the project delivered by government, against PPP Life Cycle Costs (PPP-LCC), an estimate of the whole-of-life cost when the project is carried out as a PPP.

In this section, a preliminary VfM analysis will be carried out in order to assess how much of VfM the aforementioned PPP structures would potentially have. Following this section, this report also includes an analysis of fiscal impact on the GOP, financial feasibility of PPPs, and TOD project feasibility analysis. The each perspective of the analysis is elaborated in Figure 7.4.8.

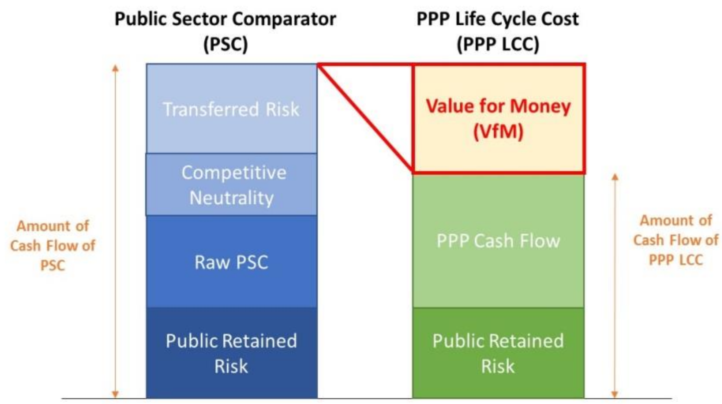


Source: JICA Design Team

Figure 7.4.8 Analysis Perspectives

2) PSC and PPP-LSC Calculation

As stated in the previous section, computation of PSC and PPP LCC for the VfM analysis must be performed in accordance with the pertinent provisions on PPPs in the Philippines. The components in the PSC and PPP LCC are represented in Figure 7.4.9.



Source: JICA Design Team

Figure 7.4.9 Components of PSC and PPP LCC

a) PSC

PSC is an estimate of hypothetical risk-adjusted costs if a project were to be implemented by the government. PSC includes the following components:

(i) Raw PSC

Raw PSC provides a base costing under the public procurement method where the underlying asset or service is owned by the public sector.

(ii) Transferred Risk

The expected value of risks to be transferred to a private company, represented by a multiple of the probability and the amounts when they occur. On PPP LCC side, this risk is not shown because it is covered by insurance funded by the public sector.

(iii) Public Retained Risk

Any expected value of the risk not to be transferred to a private company and retained by the government.

(iv) Competitive Neutrality

PSC should be computed on a basis that there is no net financial advantage of public ownership. This means that the PSC's value should not include the factors of competitive advantage that accrue to a government business by the virtue of its public ownership.

b) PPP LCC

The components of PPP LCC are as follows:

(i) PPP Cash Flow

The amount paid to (or received from) the private company when a project is delivered by a PPP.

(ii) Public Retained Risk

Any expected value of the risk not transferred to a private company and is retained by the government. In principle, this should be equal to the Public Retained Risk in PSC. Therefore, this does not affect VfM analysis.

To calculate VfM, the team utilize the project cash flow calculated in the financial and economic analysis. In addition, impact of financial instruments, depreciation, and so on will likewise be reflected. The analysis does not take into account the risk adjustments

On the other hand, PPP LCC calculation should reflect reduction/increase of the costs/revenues resulting from more efficient operation delivered by the private company. Further, it is necessary to calculate presumable amount of the concession fees or availability payments which can be calculated from the general profit levels expected by the private company.

All of those cash flows should be discounted by the long-term risk free rates for comparison.

Below is the result of the preliminary VfM calculation.

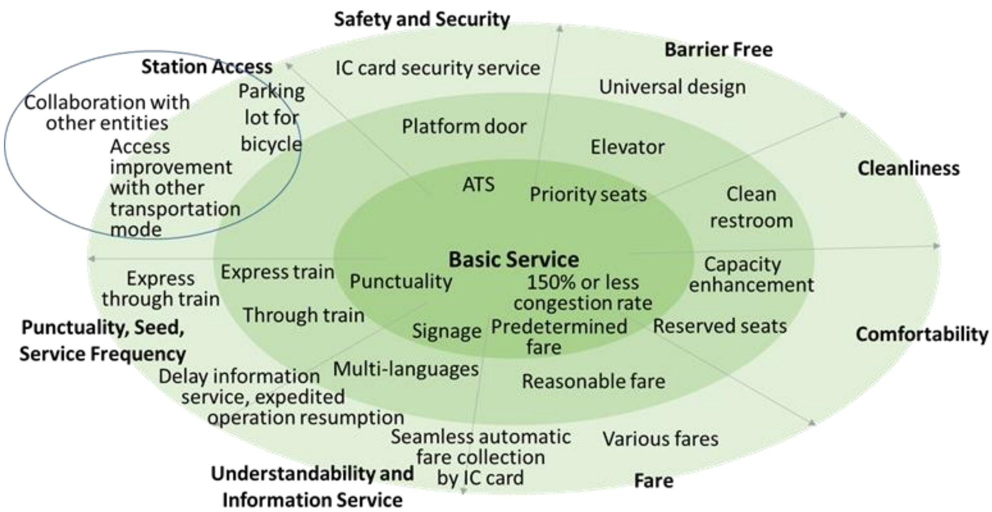
Table 7.4.15 Preliminary VfM Calculation

O&M Type	NPV in Public (PhP million)	Cost Reduction or Revenue Increase in Private (%)	NPV for Public in PPP (PhP mllion)	VfM (%)
PPP 1 (10 years from FY2022)	85,084	Cost Reduction 10%	92,037	8.2
		Cost Reduction 20%	100,800	18.5
PPP 2 (15 years from FY2032)	188,030	Cost Reduction 20%	186,172	-1.0
		Cost Reduction 20% Revenue Increase 10%	215,534	14.6

Source: JICA Design Team

(4) Requested Service Level Standards

Figure 7.4.10 shows services Japanese railway operators usually offer. The Basic Services that should be made available to the passengers are shown in the center of the figure. More diversified and sophisticated services are illustrated toward the peripheral part of the figure. For this railway project, it is desirable to redefine the services other than Basic Service based on the current condition of the Philippines. Generally speaking, compared to the other modes of transportation, rail transport is characterized by large volume, high-speed travel, stability, safety, energy efficiency and low carbon emissions. These railway attributes and the local needs of the Filipino People should be incorporated in setting service level standards the IA expects from the O&M concessionaire. This point will be further examined in the O&M concessionaire procurement process by the Transaction Advisor and defined in detail in requested service level standards.



Source: JICA Design Team based on MLIT "Current Statues of Urban Railway Service and its Problems"

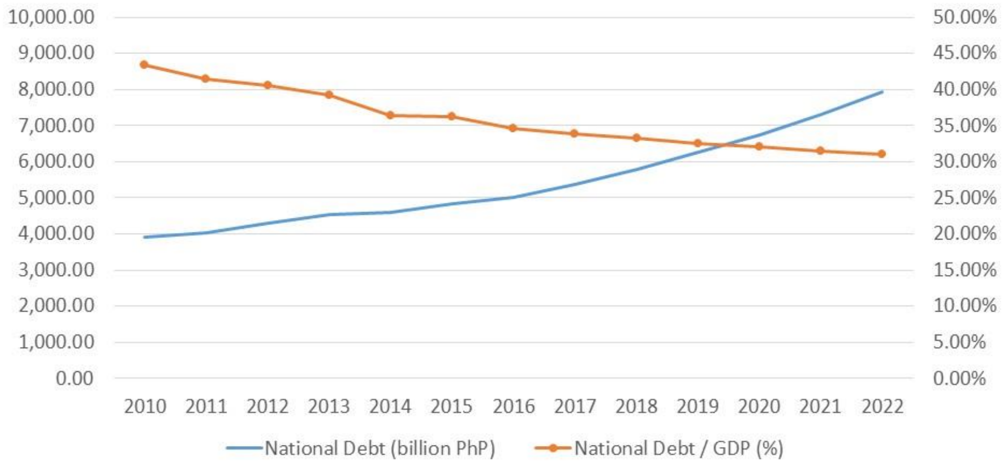
Figure 7.4.10 Railway Service Concept

7.4.6 Financing the Project

(1) Current Fiscal Situation of the Philippines Government

1) Current Fiscal Situation of the Philippines Government

Whereas the amount of the national debt of the Philippines has been rising due to increased investment spending in infrastructure programs to spur economic growth, the rate of national debt to GDP has been on a downward trend as a result of the outpacing national economic growth. To maintain this positive trend, the Duterte Administration is pushing this ratio from 5% to 7% of GDP, the rate of which had been successfully raised in part by the momentum set by the preceding Aquino Administration. While bolstering infrastructure spending, the Duterte Administration is undertaking a comprehensive tax reform program in order to raise revenues to further cover the expanding infrastructure spending. Given this situation, the general outlook by rating companies in terms of sovereign risk of the Philippines has been "stable" due to the constancy of the managed fiscal balance, despite some economic uncertainties under the current administration.



Source: IMF Outlook (2017.Oct)

Figure 7.4.11 National Debt and the rate of the National Debt to GDP

Railway projects are one of the most prioritized areas in the infrastructure development campaign. For instance, an annual 7.1 billion PhP has been budgeted for North-South Railway Project Phase 2 (PNR South) for the year 2017 and 2018. On the other hand, another 2.5 billion PhP each has been allocated to the NSCR project for the same years. The budget allocations for the major railway projects in the Philippines are shown in Table 7.4.16. In addition to the public budget, it is said that the ODA runs second among the identified sources for infrastructure financing in the country and private sector participation is regarded as the third source.

Table 7.4.16 Budget for the Main Railways 2017-2018

Particulars	2017 (GAA) (billion PhP)	2018 (Proposed) (billion PhP)
Mindanao Railway Project Phase 1	-	6.6
North South Railway Project Phase 2	7.1	7.1
MRT Line 3 Rehabilitation and Capacity Expansion	1.0	1.0
LRT Line 2 West Extension Project	0.1	0.6
LRT Line 2 East Extension Project	0.4	0.9
LRT Line 1 South (Cavite) Extension Projects	3.4	1.3
North-South Commuter Railway (NSCR) Project	2.5	2.5

Source: Technical Notes on the 2018 Proposed National Budget

The Department of Budget Management (DBM) has sought to release allotments of government agencies earlier. Hence, government agencies are enabled to carry out early procurement activities to immediately implement projects at the start of the fiscal year. Moving forward, the shift to a yearly cash-based Budget starting 2019 will further hasten the processes of government spending. The DBM also allocated the budget for Right-of-Way (ROW) payments for big-ticket projects, intending to reduce bottlenecks in the implementation of infrastructure projects. The combined ROW allocation for the DPWH and DOTr has surged from P4.2 billion in the 2015 GAA to P32.6 billion in the 2017 GAA. In the 2018 GAA, an even larger budget of P34.9 billion with the DPWH and DOTr receiving P20.5 billion and 14.4 billion, respectively has been allocated.

In spite of a more aggressive fiscal utilization policy for railway sector development, however, the existing railway operations of LRT1, LRT2, and MRT3, and PNR have not been successfully and efficiently carried as shown in the table below.

Table 7.4.17 Current Financial Operating Results of Existing Railways

Items	PNR (FY2016)	MRT3 (FY2017)	LRTs (FY 2017)
Service Revenue (million PhP)	457	26	1,272
Government Subsidy (million PhP)	810	7,094	819
Net Profit (million PhP)	166	454	-2,707

Source: Websites of Commission on Audit, DBM, MRT and LRTA

Inefficient railway operations would most likely be improved through government budgetary augmentation especially in terms of covering maintenance and other operating expenditures. In case of MRT3, apart from the aforementioned PhP 1 billion allocation for the MRT Line 3 Rehabilitation and Capacity Expansion, the government spent around 5 billion pesos as subsidy for the operation of the said problematic rail line in 2017. DOTr on the other hand envisages the new entity to operate and maintain the MRT3 would have perform better through improved budgetary requirement insights when the results of the due diligence study currently being carried out by JICA in line with identifying the necessary rehabilitation works for the said rail system.

In view of better managing railway operations in the country, three standing legislative committees of the House of Representatives endorsed a proposed bill to create the Philippine National Railway Authority in March 2018. In this bill, the Philippine National Railway Authority shall regulate all aspects of the operations of railway corporations, while it shall set the necessary routes, fares and standards on safety and security as well as managing franchise or concession agreements of the railway operations in the country. The bill also mandates the authority to establish three separate subsidiary corporations (the Luzon Railway Corp., Visayas Railway Corp. and Mindanao Railway Corp.) to operate railways in each island group.

2) Financing Options

As described above, the Duterte Administration expressed interest in implementing this railway project as a Hybrid PPP wherein the government would construct the infrastructure part of the project and later bid out the operation and maintenance of the infrastructure to a private sector as a PPP project. From the perspective of finance in the GOP, it is predicted that the expenditures would outweigh revenues, especially in the immediate term. In order to cover the shortfall, the GOP may consider two viable options; one is issuance of national bonds and the other is accessing loans from external organizations.

Table 7.4.18 National Government Financing, 2017-2018

Items	2017 (million PhP)	2018 (million PhP)
Surplus/(Deficit)	(482,085)	(523,588)
Gross Financing	**727,739**	**888,277**
External(Gross)	182,770	176,269
Program Loan	42,470	84,214
Project Loan	30,300	41,055
Bonds and other inflows	110,000	51,000
Less: Amortization	139,600	61,923
External(Net)	**43,170**	**114,346**
Domestic(Gross)	544,969	711,958
Less(Net Amortization)	3,359	5,030
Domestic(Net)	**541,610**	**706,928**

Source: Technical Notes on the 2018 Proposed National Budget

The GOP can issue long-term national bonds, or so-called “Treasury Bonds” with the options of six tenures: 2, 5, 7, 10, 20, and 25 years. However, the government has not been known to issue bonds with specific purposes such as those earmarked for financing railway infrastructure development. These bonds have normally been issued in order to compensate the deficit brought about by netting out annual revenues and expenditures. The sovereign risk of the Philippines is evaluated by Standard & Poor’s, a major private rating company. As of January 31st, 2018, the long-term securities are rated as stable with the “BBB” rating.

Table 7.4.19 Outstanding Bonds (Sorted by tenure, January 2017)

Type	Tenure (year)	Numbers of issuance	Issue Date (Range)	Maturity Date (Range)	Coupon Rate (%)	Face Amount (million PhP)
Treasury Bond	3	1	2017.1-2017.3	2020.3	3.3750	45,000
	5	3	2013.5-2017.10	2018.3-2022.1	2.1250-4.0000	313,256
	7	8	2011.8-2017.10	2018.8-2024.4	3.5000-5.0000	596,743
	10	11	2008.1-2017.7	2018.11-2027.4	4.0000-8.8750	408,429
	10 (Variable)	Various	Various	Various	Variable Rate	7,043
	20	36	1998.1-2017.7	2018.1-2037.7	3.6250-15.0000	319,340
	25	9	2000.11-2012.8	2025.11-2037.8	5.7500-18.2500	235,982
Retail Treasury Bonds	3-25	11	2012.10-2017.4	2020.4-2037.10	3.2500-7.3750	1,213,771
Benchmark Bonds*	10-25	7	2010.12-2016.1	2020.12-2040.9	3.6250-8.1250	909,298
Others						75,076
Total						**4,125,941**

* The refunding bond issued from the exchange with the existing bond and the newly issued bond with longer tenure

Source: JICA Design Team prepared from the website of the Bureau of the Treasury

In terms of borrowing, the GOP may consider financing from ADB as a viable option aside from the Yen Loan facility with the Special Terms for Economic Partnership (STEP) from the Japanese government.

Table 7.4.20 Major Conditions of Comparable Finance Options

Financing Options		Allowable coverage of total project cost	Interest Rates (%)	Grace Period (year)	Maximum Tenure (year)	Procurement Condition
National Bonds		-	4.919	-	-	-
		-	6.533	-	10	
			6.001	-	20	
ODA loans from the Government of Japan	Standard	Calculated based on GNI	0.50	10	30	Untied
	Option 1	Same as above	0.45	7	25	Untied
	Option 2	Same as above	0.40	6	20	Untied
	Option 3	Same as above	0.35	5	15	Untied
	STEP	Up to 100%	0.10	12	40	Tied
ADB	Sovereign Loan Scheme (Project Loan)	Not specified	1% (grace period) / 1.5% (O&M period)	8	32	Untied
	LIBOR Based Loan	Not specified	Referred to 6 months LIBOR + Premiums	Case by case	19	Untied

Source: JICA Design Team prepared from the website of JICA and ADB

Since the O&M component of the project is envisioned to be delivered through a PPP, the possible financing option for this portion of the project would be loans from private banks or funds or investments from private entities. In addition, international public financing such as loan facilities from JBIC and IFC are primarily focused on construction of infrastructure. Thus, the possibility to apply those financing options may be relatively low for this particular aspect of the project.

3) Fiscal Impact on the GOP

In this sub-section, expected fiscal impact on the GOP by this project and financial viability of Hybrid PPP will be analyzed through financial statements for the GOP. Furthermore, based on the appropriate risk allocation in the O&M PPP scheme, sensitivity analysis will be conducted for some risk factors, such as revenue risk, finance risk (including foreign exchange rates, interest rates) and macro-economic risk (including inflation). The financial statements will be developed with the cash flows provided in Chapter 8.

(2) Financing the Project

1) Business Models

As described in Table 7.4.13, two possible options of PPP schemes are set for a simulation purpose with a coverage of O&Ms for all MCRP, NSCR and NSRP-South; one for 10 years after completion of MCRP construction, and the other for 15 years from the 11th year after completion of MCRP.

The implementing entity envisaged would be a Special Purpose Company (SPC) which is established by several concerned private entities with respective specializations and tasks in the collaborative venture. Financial models for the SPC will be prepared for each option (1&2). Some main conditions are assumed as shown in Table 7.4.21.

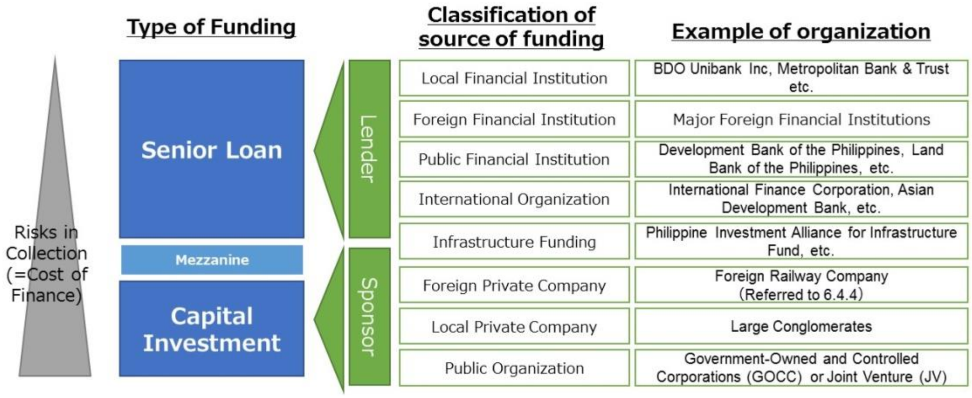
Table 7.4.21 Main Financial Model Preconditions of the SPC

Items	PPP 1	PPP 2
Implementing Company	SPC established by private entities	
Period of Construction	(Construction is out of the scope)	(Construction is out of the scope)
Period of Operation	For 10 years (after the opening MCRP)	For 15 years (from the 11th years after the opening of MCRP)
Core Business (Railway)	Railway Operation and O&M	Railway Operation, O&M, and Replacement
Main Revenue	Availability Payment from DOTr	User-pay
Range of Replacement	(N/A)	(to be confirm)
OPEX	Cost for operation and maintenance	
Financing Method	(to be confirm)	(to be confirm)
Dividend	Certain dividend based on the corporation law in the Philippines	
Tax	30% of the income tax	
Required Rate of Return	Setting the Equity IRR referred to the market level	

2) Financing Options

As this PPP entity for O&M is assumed to be an SPC, financing options for the SPC will be discussed in this section.

Generally, for infrastructure projects, project finance is employed in order to reduce the project risks for PPP PSCs. However, since this project is focused on O&M, which requires relatively less initial investment, a wide range of financial options can be employed.



Source: JICA Design Team

Figure 7.4.12 Options for Infrastructure Finance

In general, loans take up 70-90% of total financing in project finance. Consequently the portion of loan for the financial modeling also follows suit, considering the feature of this O&M PPP. Lender assumption also reflects the local context.

On the other hand, due to the foreign investment regulations in the Philippines, foreign companies are not allowed to invest more than 40% of total capital of local public project companies. For example, in LRT1, a foreign company, Macquarie Infrastructure Holdings holds only 10% of Light Rail Manila Corporation (LRMC), the LRT1 concessionaire. On the other hand, its local counterpart Ayala Corporation and Metro Pacific Light Rail Corporation, holds 35% and 55% of LRMC respectively.

On top of the financing options above, private railway PPP concessionaires, whether train operator or maintenance service provider, may benefit from financing risk protection provided by public entities such as export credit agencies. For example, some risks beyond private concessionaire’s control such as political risk and commercial risk can be mitigated through insurances provided by Nippon Export and Investment Insurance (NEXI). Similar undertaking is provided by the World Bank Group through its Multilateral Investment Guarantee Agency (MIGA). MIGA promotes foreign direct investment (FDI) into developing countries to help support economic growth, reduce poverty, and improve people's lives. All of these protections will benefit private concessionaire by providing access to funding, lowering borrowing costs and increasing tenor.

Table 7.4.22 Insurance Products to Mitigate Political Risk and Commercial Risk

Institution	Political / Country Risk	Commercial / Credit Risk
NEXI	Restriction/prohibition of exchange dealings, Raise in tariffs, Restriction/prohibition of imports, War, Revolution, Natural disasters, Inability of export due to political risks, Inability to collect export proceeds or prepaid money, Stocks acquired through overseas investment is confiscated due to political risks	Inability to collect export proceeds or loan due to counterparty bankrupt, Borrower repay default on the loan, Inability to export or import because the counterpart went bankrupt before exporting or importing
MIGA	Currency inconvertibility, Transfer restriction, Expropriation, War, Terrorism, Civil disturbance etc.	

Source: JICA Design Team based on NEXI and MIGA

In practice, in a 30-year UK railway franchise scheme, Hitachi, a Japanese rolling stock manufacturer and John Laing, a UK construction company set up a rolling stock maintenance company with financial support from NEXI and JBIC. The SPC of the 4.5 billion GBP investment project, 70% owned by Hitachi and the other 30% by John Laing, secured about 4.3 billion GBP debt financing including 1.8 billion GBP from JBIC. NEXI provided Overseas Untied Loan Insurance to cover the loans extended to the SPC by 5 Japanese banks. The insurance covers 97.5% of the Political / Country Risk and 90% of the Commercial / Credit Risk of the facility.

3) Market Sounding

In order to evaluate the PPP feasibility, it is essential to communicate with the potential investors and operators to confirm if the PPP option will be workable for them from both financial and technical perspectives.

4) Expected Financial Statements

Financial Statements, including profit and loss statements, balance sheet and cash flow statements, were prepared. At present, a pure publicly run, integrated project is assumed for analysis. Some highlights are shown below.

Table 7.4.23 Highlights of Income Statements (Million PhP)

FY	2022	2025	2035	2040
Revenue	8,282	27,885	36515	41,349
OPEX	9,305	13,105	13,105	16,466
Interest	4,446	5,446	4,244	2,946
Depreciation	11,964	16,569	16,569	1,6549
Net Income	-17,433	-7,235	2,597	5,368

Table 7.4.24 Highlights of Balance Sheets (Million PhP)

FY	2022	2025	2035	2040
Current Asset	-	26,208	23,851	-
Fixed Asset	6,46,271	687,929	522,239	439,393
Liabilities	533,669	633,522	503,771	370,844
Paid in Capital	139,558	141,941	141,941	156,024
Retained Earnings	-26,956	-61,325	-100,622	-92,842

Table 7.4.25 Highlights of Cashflow Statements (Million PhP)

FY	2022	2025	2035	2040
Operating Activities	-1,196	14,601	36,515	41,349
Investment Activities	-103,744	-18	-	-
Financing Activities	104,940	-	-26,937	-21,936

Table 7.4.26 Key Profitability and Financial Soundness Figures

Profitability	**Equity IRR (after tax)**	-4.7%
	Average EBITDA Margin	44.1%
	Timing of Surplus	FY2033
	Timing of Dividends	FY2056
Financial Soundness	**DSR (DSCR)**	1.05
	Average Equity Ratio	30%

This project is expected to turn into the black in 2033. However, due to the interest payment for the massive borrowings, financial soundness is quite low.

5) Sensitivity Analysis

In this section, revenue and O&M cost impact on Equity IRR is examined.

Table 7.4.27 Preconditions for the Sensitivity Analysis

Revenue				
90%	95%	100%	105%	110%
n/a	-9.0%	-4.7%	-1.8%	-0.2%

O&M costs				
90%	95%	100%	105%	110%
-7.3%	-6.0%	-4.7%	-3.6%	-2.5%

If revenue goes up by 10%, dividend payments will be generated in FY2045 and it will be possible to recover the invested capital. It is shown that operation of the railway system by an efficient operator is also desirable from the perspective of the Philippines public finance.

7.4.7 Main Points in Selecting O&M PPP Concessionaire

The current administration intends to adopt a "Hybrid PPP" scheme for this project. Considering the lessons from the previous railway PPP projects, this sub-section identifies the focal points in the selection of O&M PPP concessionaire as follows.

(1) Consistency with the infrastructure project Recent Trend

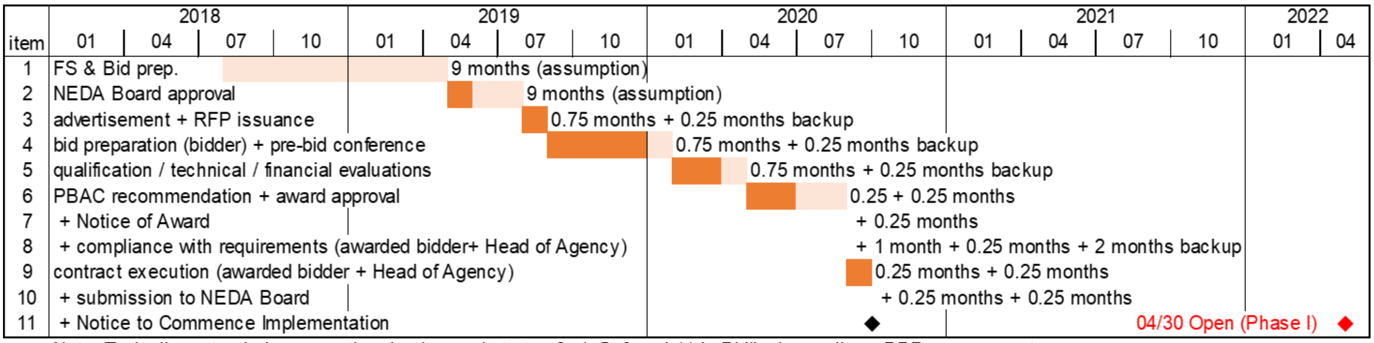
In conventional PPP contracts, the design, construction and O&M of the infrastructure are bundled. The bidder can freely propose the best infrastructure system satisfying the minimum service standards and output specifications set out by IAs. However, in the case of this project, the contractors that are responsible for the design and construction of the railway infrastructure may be different from the PPP O&M concessionaire. Therefore, at the bidding stage, it is important to set adequate evaluation criteria and desirable organizational structure and functions for railway operation to ensure that the bidders will be able to examine their capability to meet the minimum service and performance standards as well as output specifications.

(2) Risk Allocation

As for risk allocation of PPP projects, the PPP Center published the Generic Preferred Risk Allocation Matrix (GPRAM) that identifies list of risks, preferred allocation, and corresponding possible risk mitigation strategies. However, in the GPRAM, the private entities tend to be responsible for more risks than the public entities. Therefore, considering the characteristics of railway sector and the O&M aspects of the project, the risk allocation between public and private should be thoroughly examined; it is important to identify how much government support and subsidy is needed based on the concept of the GPRAM.

(3) Timeline

Considering Philippine Government plans to start the railway service by April 2022, it is ideal for the public entity and the concessionaire to enter into a contract by the beginning of 2021: a year before the start of operations. It should be considered that the procurement process of PPPs has specified durations of activities and can take a longer time than traditional public procurement. Moreover, in case of bid failure, the review of the project structure also requires longer time to undertake. Therefore, the Implementing Agencies need to carefully set the role of private entities and conditions for delivering tasks through PPPs which will be beneficial to both the public and private sides; taking into consideration the opinion and sentiments from potential private entities that may be involved in advance.



Note: Typically, extended process time is observed at step 2, 4, 5, 9 and 11 in Philippines railway PPP procurement.

Source: JICA Design Team

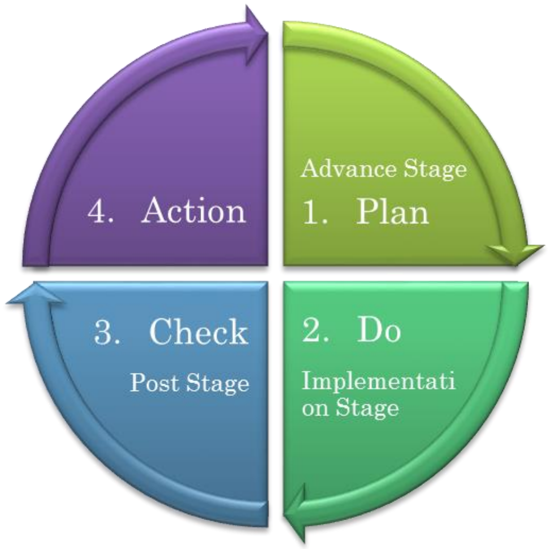
Figure 7.4.13 O&M PPP Procurement Schedule

CHAPTER 8 PROJECT IMPACT ANALYSIS

8.1 Operation and Effect Indicators

8.1.1 Purpose of Project Evaluation

In order to effectively monitor and evaluate this project, this section sets the project evaluation framework. The project is evaluated based on the "Handbook for JICA Project Evaluation (Ver1.1), JICA Evaluation Department, May 2016" (Handbook). As indicated by the "Guideline for JICA Project Evaluation (Ver. 2), JICA Evaluation Department, May 2014" (Guideline), the purposes of the project evaluation are to 1) improve projects thorough Plan-Do-Check-Act (PDCA) cycle and 2) secure accountability to the stakeholders including Japanese nationals and the recipient country.



1. Plan – Advance (Ex-ante evaluation)	Before the project implementation, examine project's appropriateness, planned contents, expected impacts, and indicators, and etc.
2. Do – Implementation Stage (Implementation)	Monitor periodically based on the contents of ex-ante evaluation
3. Check – Post Stage (Ex-post evaluation)	Post the project completion, examine effectiveness, impact, efficiency, sustainability of the project. Also, summarize the lesson learned and proposition from the project
4. Action (Feedback-Action)	Reflect the results of the evaluation to similar projects

Source: JICA Design Team as reconstructed from "JICA Operation Indicator and Effect Indicator Handbook (Ver. 1.1) in ODA Loan Projects, JICA Evaluation Department, May 2016."

Figure 8.1.1 PDCA Cycle

This project is at the stage where "1. Plan (Ex-ante evaluation)" is applicable. Evaluation criteria used at this stage – i.e., 1. Plan (Ex-ante evaluation) – will continue to be used to evaluate the progress of the project and evaluate the same ex-post.

8.1.2 Project Evaluation Method

The project evaluation method follows the procedures, intents and other elements detailed in the "JICA Operation Indicator and Effect Indicator Reference in ODA Loan Projects, JICA Evaluation Department, July 2014" (Reference), which is referenced under the chapter entitled "Reference for Project Evaluation, Examples of Standard Indicators, and etc." in the Handbook. As mentioned, the purposes of the Project are to improve experience of passengers through the utilizations of existing urban transportation networks, in addition to improving the speed and convenience of the access to the airport, and as such, the following railway-related indicators suggested in the Reference have been adopted for project evaluation use. As the methods of calculation for these indicators suggest, railway operators collect the said information for self-monitoring purpose. Thus they will be able to provide the results upon request. In addition, the issues and lessons with the results of each indicator will be shared to responsible agencies, such as DOTr.

Table 8.1.1 Criteria Used for Project Evaluation

Indicator		Method of calculation
Operation Indicator	Number of Running Trains (number of trains/day)	Number of trains in operation / day
	Total Train Kilometer per Day (km/day)	Total kilometers a serviced train operated x Number of serviced train
	Operating Rate (%)	(365-(non-operated days))/365 where non-operated days are equal to the days required for heavy repair and those reserved for unscheduled repairs
Effect Indicator	Volume of Transportation	Total number of passengers x distance each passenger traveled
	(000 passenger-km)	
	Travel Time between Station (minutes)	Time required to travel between stations

Source: JICA Design Team

8.1.3 Evaluation Results

The results of each indicator will be tallied as follows. As mentioned above, targets for 2027 will be evaluated based on the results provided by the railway operator.

Table 8.1.2 Operations and Effects Indicators – Outcomes

<table>
<tr><th colspan="3">Indicator</th><th>Baseline
(Actual Value in 2018)</th><th>Target
(2027)</th></tr>
<tr><td rowspan="6">Operation Indicator</td><td rowspan="2">Number of Running Trains (number of trains/day)</td><td>Limited Express</td><td>-</td><td>44
(CIA-Alabang)</td></tr>
<tr><td>Commuter Express and Commuter</td><td>-</td><td>261
(CIA-Calamba)</td></tr>
<tr><td rowspan="2">Total Train Kilometer per Day (km/day)</td><td>Limited Express</td><td>-</td><td>5,043
(CIA-Alabang)</td></tr>
<tr><td>Commuter Express and Commuter</td><td>-</td><td>32,249
(CIA-Calamba)</td></tr>
<tr><td rowspan="2">Operating Rate (%)</td><td>Limited Express</td><td>-</td><td>86%</td></tr>
<tr><td>Commuter Express and Commuter</td><td>-</td><td>87%</td></tr>
<tr><td rowspan="4">Effect Indicator</td><td colspan="2">Volume of Transportation (000 passenger-km)</td><td>-</td><td>29,450
(CIA-Calamba)</td></tr>
<tr><td rowspan="3">Travel Time between Stations (minutes)</td><td>Limited Express</td><td rowspan="3">Approximately 5 hours
(Note)</td><td>75.75
(CIA-Alabang)</td></tr>
<tr><td>Commuter Express</td><td>111.75
(CIA-Calamba)</td></tr>
<tr><td>Commuter</td><td>141.00
(CIA-Calamba)</td></tr>
</table>

Note: Assuming use of road between CIA and Metro Manila (approximately two hours depending on congestion and choices of route) as well as railway between Tutuban-Mamatid (two and a half hours)

Source: JICA Design Team

8.2 Qualitative Impacts

In this section, the impacts from socio-economic and health/environmental standpoint are analyzed. These impacts are summarized as follows:

Table 8.2.1 Impacts from Socio-economic and Health/Environmental Standpoint

Perspectives	Items	Impacts
Socio-economic	**Population increase**: access to business and commercial areas will improve, and as a result, the population is expected to increase as the areas will become more attractive as residence areas	As detailed in Chapter 3.4.2 "Socio-economic Framework of the Study Area", the future population growth in adjoining provinces is estimated to be much higher than of Metro Manila (contribution of the railway development to population increase can be grasped to a certain extent by comparing populations increases between project area and Metro Manila, but, in order to understand population increase more comprehensively, considerations of other factors, such as the developments of road, medical and educational facility, will also be necessary.).
	Enterprise attraction: productivity increase as the result of access improvements is expected to attract enterprise in forms of new establishments or expansion	At this time, no railway exists in the north area of Metro Manila while residential areas continue to expand from central area to Malolos and further north. Also currently, Tutuban-Mamatid services are limited (two services each in the morning and evening) and requires more than two hours' travel time. The Project is expected to offer frequent service and faster connections. As analyzed in in Chapter 3.4.2 "Socio-economic Framework of the Study Area", the railway development is sought to contribute to the vitalization of local economy through the increase of number of workers in adjoining provinces[1].
		The project is sought to contribute to the socio-economic developments of localities through synergies with such development projects as below: • New Clark City: Development projects to become the Philippines' most modern and first technologically-integrated city with a mix of residential, commercial, agro-industrial, institutional, and information technology developments. • MCA Preliminary Master Development Plan: Development master plan setting Clark Freeport Zone (CFZ), Angeles City, San Fernando and Mabalacat as inner core • Central Luzon Regional Development Plan 2017-2022: Vision for the region to have globally competitive human resources, a highly productive and profitable agricultural sector, seamless and integrated physical access, and a transshipment and logistics hub
	Improved access: railway development will improve the access of the neighboring residents	The project is expected to result in one hour connection between Clark and Metro Manila (currently requiring approximately two hours using roads) and less than one hour connection between Solis and Calamba (currently Tutuban-Mamatid railway services are limited with two services each in the morning and evening, requiring more than two hours travel time.)
Health/ Environmental	**Increased health of neighboring residents**: decrease in diseases resulting from air pollutions **Better environments**: reduction in greenhouse gas emission to which this project contributes will result in better environments	As the residents' transportation modality shifts from road vehicle to railway, road traffic volume and thereby the volume of CO_2 emitted from road vehicles is expected to lessen. As a result, the incidence of diseases of the neighboring residents caused by air pollution etc., is expected to diminish. To be analyzed in the sub-sections "Road Traffic Impact during Construction", "Health Benefits" and "Mitigating the Impacts of Climate Change"

Source: JICA Design Team

[1] If Transit Oriented Development (TOD) for the areas neighboring the station is promoted, there may be a need for comprehensive evaluation as to the impacts not only of the railway development but TOD onto enterprise attractions. Such evaluation may not be feasible for this study: the evaluation can possibly be led by LGUs and shared by the concerned institutions. Evaluation criteria can include such items as, working population, number of newly set-up enterprises and construction permits, etc.

8.2.1 Road Traffic Impact during Construction

This section analyses the economic losses brought about by traffic restriction during constriction. Below shows the estimated severe traffic congestion points during construction period. Closures of the construction sites and trunk roads, insufficient detour routes, and etc., are expected to result in the economic losses.

Table 8.2.2 Traffic Congestion Points during Construction Period

Area		Point	Description
MCRP	North Section	Bridges on Sacobia River	• Increasing construction vehicles for development in NCC • Two bridges, Mabalacat Bridge and Sacobia River Bridge, are close to construction site.
	Middle Section	Downtown of Angeles	• Construction site, Bus/ Jeepney terminals and trunk roads are close by. • Amusement center area are attractive for visitors even in night time.
	South Section	Malolos Station	• It will be crowded by feeder transportation for commuter/ student and construction vehicles.
NSRP-South	North Section	FTI	• Construction while operating PNR • Considering Subway Project is crucial, especially extension operation between South Line and the Subway. • Construction of transition section underground/ ground level will affect general traffic.
	Middle Section	Bicutan, Alabang	• Construction while operating PNR • Construction site, PNR and trunk roads are close. • Queuing length for level crossing is not enough.
	South Section	Mamatid, Calamba	• Poor road network around proposed depot site • Detour route is limited for lack of road network in the east side of PNR.

Source: JICA Design Team

8.2.2 Health Benefits

Railway developments can provide benefits that are often overlooked – i.e., health benefits. Below are 3 such health benefits identified in relation to the project being examined quantitatively:

- Reduction of respiratory disease caused by hazardous substances and particulate matter
- Reduction of fatalities and injuries
- Promotion of increased physical activities

Railway transport will help reduce health hazards: As the residents' transportation modality shifts from road vehicle to railway, road traffic volume and thereby the volume of hazardous substances emitted from road vehicles is expected to lessen. Thus, health benefit, or the decreased risk of health hazards – e.g., respiratory disease caused by hazardous substance – is expected.

Railway transport provides safer means of travel, reducing fatalities and injuries caused by road accidents: Train-related accidents happen at a lesser rate, and with much lower passenger fatality rates than vehicle travel does. Further, railway transit centers have higher levels of security monitoring and enforcement that can redound to reduced crime rates than other areas.

Railway transport promotes increased physical activities: Individuals using railway transport may experience increased physical activity level through walking to and from the identified access points to the train stations. Increased physical activity in turn may help lower the risk of many serious diseases, such as heart and vascular diseases, stroke, diabetes, and depression.

8.3 Project Evaluation Approach

The evaluation is based on the data available as of August 28, 2018.

This evaluation assumes the two requirements – i.e., 2022 opening of MCRP and one-hour connection between Clark and Metro Manila, both of which are the goals set by the Duterte Administration. As the technically feasible opening schedules that will meet the said requirements, Stage 1 opening between Malolos and CIA in May 2022, and Stage 2 opening between Clark and NCC in January 2025, are assumed in this evaluation, though the Stage 2 opening between Clark and NCC is not included in the target scope of this evaluation. As for the opening date of NSRP-South, whole line opening of NSRP-South in 2023 are assumed (staged opening in NSRP-South is not yet reflected in this project evaluation.) May 2022 opening is assumed for NSCR. Therefore, in this section, the scopes of the evaluation are two folds:

- Whole Network (thereafter referred to as Whole Network) – i.e., MCRP (Stage 1), NSRP-South and NSCR
- MCRP (Stage 1) and NSRP-South

The following parameters have been used to evaluate the impact of the projects.

Table 8.3.1 Parameters Used for Project Evaluation

Parameter	Figure Employed
PhP/Yen Exchange Rate	2.08
USD/Yen Exchange Rate	111
VAT	12% of total Construction Cost
Import Tax	3% of Construction Cost (other than Consulting Fee) as applied to International Portion only
Physical Contingency	5% of Civil Works, Depot, E&M, Rolling Stock and Price Contingency and 10% of Land Acquisition
Price Contingency (International Portion)	1.80%/year of Civil Works, Depot, E&M and Rolling Stock
Price Contingency (National Portion)	1.00%/year of Civil Works, Depot, E&M and Rolling Stock
Base Year/Month for Cost Estimation	2018/June
Administration Fee	3% of Construction Cost and 5% of Land Acquisition

Source: JICA Design Team

8.4 Project Evaluation of the Whole Network

In this section, the efficiency of economic resource allocations that the Whole Network is expected to deliver to the national economy is analyzed. “The Economic Internal Rate of Return (EIRR)”, “The Economic Net Present Value (ENPV)”, and “Benefit and Cost Ratio (B/C)”, are used as the evaluation indicators. In evaluating, literature such as "JICA Project Evaluation Handbook (Ver.1.1)" (2016/JICA), Evaluation Methodology Manuals for Railway Projects" (2012/MLIT), and "Guidelines for the Economic Analysis of Projects" (2017/ADB) are used as reference.

The economic benefits are estimated by comparing to "with project" case (a case wherein the project has been implemented), and "without project" case (a case wherein project implementation is forgone or not implemented). The evaluation period is assumed for 39 years, including the operation period of 35 years. The costs, revenues and benefits throughout the evaluation period are present-valued to 2018. In addition, the cash flow analysis that summarizes the cost, revenue and benefit is conducted.

8.4.1 Economic Cost

The economic cost is derived from the financial cost estimated in the financial analysis, as adjusted for items as transfer payment, land acquisition, land relocation compensation, and price contingency. The amounts in national price terms have been converted to international competitive market price terms using Standard Conversion Factor (SCF). O&M cost components have also been converted from financial costs to economic costs using SCF.

(1) Elimination of Transfer Payment

Such items as import tax and Value Added Tax (VAT) included in the financial costs are not the inputs of goods and services into the project, but the transfers of currencies from investors to government treasuries. Therefore, these taxes should be eliminated from the economic costs.

(2) Land Acquisition Cost and Relocation Cost

In principle, the economic value of land should reflect its opportunity cost and determined by what the land would have been used for without the project. In relation to the project being examined, the land to be acquired are assumed to be not utilized currently and therefore the opportunity cost is assumed to be 30% of the land acquisition costs.

Resettlement of the residents is assumed for the project, and the construction cost of the relocation facilities and houses are accounted for as part of economic cost as it is considered an opportunity cost.

On the other hand, cash assumed to be paid to the relocating residents as compensation is not counted as opportunity cost, and thus zero economic cost is assumed.

(3) No Price Contingency

In compliance with the previously referred Guideline, EIRR estimation does not include price contingencies.

(4) Conversion Factor

Since national price of goods and services is distorted by such factors as customs duty, subsidy and import restrictions, and thus not comparable to international price, in economic analysis, national price is adjusted using Standard Conversion Factor (SCF). SCF is assumed to be 0.83, derived as the inverse of 1.20 which is the shadow exchange rate currently adopted by NEDA as per "ICC Project Evaluation Procedures and Guidelines."

As the labor cost includes shadow wage paid to unskilled labor, such cost is accounted for as the opportunity cost. Conversion factor of 0.6 is applied to unskilled labor portion of the labor to reflect its low productivity as compared to skilled labor.

The estimated economic cost including investment cost and O&M cost are as follows:

Table 8.4.1 Investment Cost (Economic Cost)

[redacted]

Source: JICA Design Team

Table 8.4.2 O&M Cost (Economic Cost)

(Mil. PhP)	2022	2025	2035	2040
Manpower	1,165	1,596	1,596	1,596
Power	3,954	5,436	5,436	5,436
Administration	2,995	4,416	4,416	4,416
O&M Cost Total	**8,114**	**11,448**	**11,448**	**11,448**

Source: JICA Design Team

Replacement costs for E&M and rolling stocks are considered in the evaluation. As for E&M, major components are assumed for replacement at the end of their economic lives. Minor replacements for rolling stocks are assumed to occur from the 15th and full replacement is implemented from 30th years after the opening of railway services, with each over a 5-year period.

As some infrastructure are thought to have longer economic lives than that of the evaluation period, the reasonable estimated residual values of such at the end of the project evaluation period will also be considered.

8.4.2 Economic Benefit

The economic benefit of Whole Network is calculated based on the methodology explained in this section.

In the process of calculating the core economic benefits of the Whole Network, Vehicles Operation Cost (VOC) and Travel Time Cost (TTC) are the two major components considered for inclusion into economic benefits. The construction of the railway network is expected to reduce traffic volume, which will then result in shorter travel times and faster vehicle operating velocity.

Greenhouse gas (hereinafter referred to as GHG) reduction which this project contributes is also considered for the inclusion into economic benefits.

(1) Vehicles Operation Cost (VOC)

VOC used for the EIRR estimations covers major transportation methods used in the Philippines. The economic benefit is expressed as the reduction in VOC "with" and "without" the Project. It is calculated by applying the following formula to each transportation method.

Unit VOC (PhP/passenger car unit (PCU)) x distance traveled x volume (PCU)

Unit VOC comprises of the eight elements; (1) fuel costs, (2) lubricant costs, (3) tire costs, (4) repair costs, (5) depreciation costs, (6) capacity opportunity (interest) costs, (7) crew costs and (8) overhead costs. Unit VOC is adopted from that under JICA report "The project for capacity development on transportation planning and database management in the Republic of the Philippines MMUTIS update and enhancement project (MUCEP)"

Table 8.4.3 show the adopted unit VOC.

Table 8.4.3 Unit VOC

Speed (km/hour)	VOC Unit (PhP/PCU/1,000km)			
	Public	Motorcycle	Car	Truck
0	32,063	35,230	40,833	63,675
5	46,386	35,230	40,833	63,675
10	26,025	20,120	23,032	34,882
20	15,902	12,307	13,848	20,362
30	12,559	9,640	10,705	14,762
40	10,784	8,197	9,111	12,102
50	10,370	7,507	8,208	10,886
60	10,710	7,367	7,982	10,201
70	11,397	7,447	7,997	9,964
80	12,258	7,687	8,181	10,281
90	13,070	8,123	8,660	10,952

Source: JICA Design Team

(2) Travel Time Cost (TTC)

TTC is expressed as the reduction in the values of passenger's time between "with" and "without" the project. It represents the value of travel time to the economy. It is estimated using the following formula for each transportation method.

Unit TTC (PhP/PCU) x hours traveled (distance/speed) x volume (PCU)

Unit TTC represents the monetary value of time (VOT) per hour. It is based on the mode of transportation and household income, both of which are taken from MUCEP as adjusted for the time passage since the date of report as well as the escalation in line with the projected growth in the Gross Regional Domestic Product (GRDP) per capita[2].

Unit TTC, as shown on Table 8.4.4, is calculated for each transportation method as the value of travel time, derived based on the hourly wage in the survey conducted at the time of MUCEP. The Unit TTC (as often called VOT) is adjusted for the "gross up" to include the benefit component that is the cost directly associated with the employment of labor, but not accounted for in the household income - e.g., employer contribution to the social security system and fringe benefits. Such benefit component in the Philippines is estimated to be 20% of the hourly wage. Based on MUCEP, business trip is assumed to account for 43% of all trips whereas the rest or 57% is personal trips. Personal and business trips are assumed to have 70% and 100% value, respectively, of the unit TTC.

Table 8.4.4 Unit TTC

Unit TTC (PhP/hour/PCU)			
Public	**Motorcycle**	**Car**	**Truck**
770	324	208	75

Source: JICA Design Team

(3) Greenhouse Gas (GHG) Reduction

In sub-section, GHG emission reduction this project contributes is quantified. Such quantification is done based on the JICA Climate-FIT (Mitigation) (JICA Climate Finance Impact Tool / Mitigation) Draft Ver. 2.0 March 2014. GHG emission reduction quanified is shown on Table 8.4.5.

Table 8.4.5 GHG Emission Reduction

(tCO_2/year)		
2025	**2035**	**2040**
207,273	685,477	924,579

Source: JICA Design Team

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[2] GRDP per capita is estimated to be 6.0%. It is based on the average GRDP per capita for the year 2015/2016 and 2016/2017 for the three regions: NCR (National Capital Region), Region III (Central Luzon) and Region IV-A (Calabarzon), as weighted in proportion to the provincial population in each region wherein Whole Network is intended – i.e., Bulacan and Panpanga for Region III and Laguna for Region IV-A. GRDP per capita is assumed to grow at 6.0% per annum till 2034, at 3%% from 2035 to 2039, and at zero (no growth) from 2040.

Table 8.4.6 shows the economic benefit of GHG emission reduction this project is expected to contribute. It is calculated using the following formula:

GHG emissions reduced (tCO_2) x price of carbon (PhP)

Price of carbon adopted is PhP 912/tCO_2, derived by multiplying 14.90 Euro/tCO_2, or the closing price of carbon of as of June 1, 2018 as quoted on the EU Emissions Trading System (EU ETC) and 61.227, the Euro/Philippine Peso exchange rate on the same day.

The economic benefits derived by following the aforementioned steps are as follow:

Table 8.4.6 Economic Benefit Results

(Mil. PhP)	2022	2025	2035	2040
VOC	14,616	30,799	33,878	46,046
TTC	13,989	32,161	51,882	87,291
CO_2	(72)	189	625	843
Economic Benefit Total	**28,533**	**63,149**	**86,385**	**134,181**

Source: JICA Design Team

8.4.3 Result of Economic Analysis

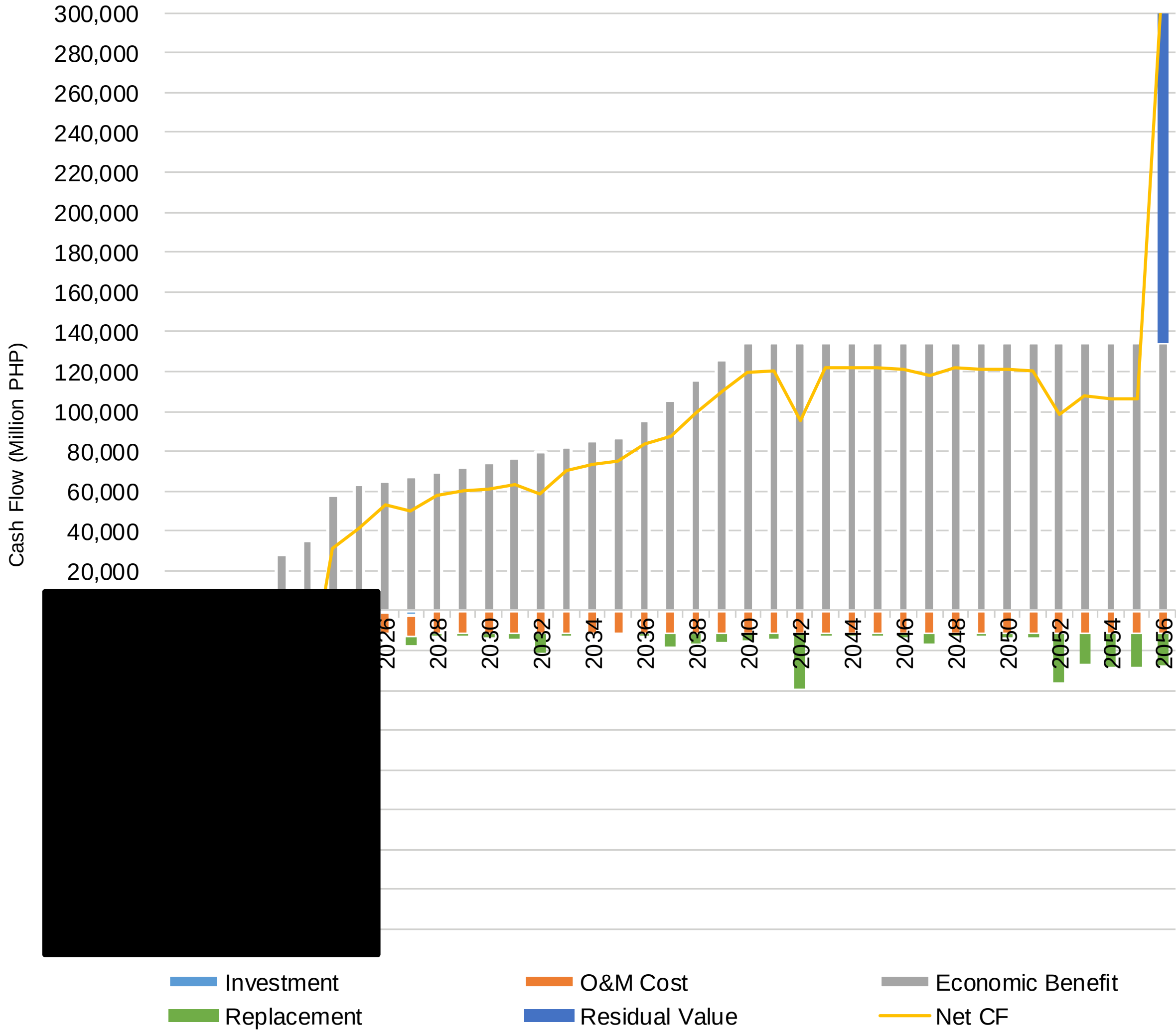
Using on the economic costs and benefits derived from above, economic cash flows of the project period are constructed as below, based on which EIRR, ENPV and B/C have been calculated. 10.4% is the evaluated EIRR, which is above the NEDA's hurdle rate or the NEDA Social Discount Rate of 10% as indicated in NEDA's guideline. By using the Social Discount Rate of 10%, ENPV is calculated at 17,515 million PhP, and B/C derived is 103.3%.

Table 8.4.7 Economic Analysis Results

EIRR	10.4%
ENPV	17,515
B/C	103.3%

	[redacted]	Replacement	O&M	Total Cost	Economic Benefit	Residual Value	Net Cash flow
2018	[redacted]	-	-	(6,474)	-		(6,474)
2019	[redacted]	-	-	(108,881)	-		(108,881)
2020	[redacted]	-	-	(139,037)	-		(139,037)
2021	[redacted]	-	(1,801)	(137,215)	-		(137,215)
2022	[redacted]	-	(8,114)	(97,244)	28,456		(68,788)
2023	[redacted]	-	(10,950)	(76,991)	35,489		(41,502)
2024	[redacted]	-	(11,448)	(26,536)	57,903		31,366
2025	[redacted]	-	(11,448)	(21,937)	63,149		41,212
2026	[redacted]	-	(11,448)	(12,106)	65,181		53,076
2027	-	(3,315)	(11,448)	(14,763)	67,300		52,537
2028	-	(169)	(11,448)	(11,617)	69,508		57,892
2029	-	(432)	(11,448)	(11,879)	71,811		59,932
2030	-	(2,079)	(11,448)	(13,526)	74,214		60,688
2031	-	(2,373)	(11,448)	(13,821)	76,721		62,900
2032	-	(9,473)	(11,448)	(20,921)	79,337		58,416
2033	-	(169)	(11,448)	(11,617)	82,068		70,451
2034	-	-	(11,448)	(11,448)	84,919		73,471
2035	-	-	(11,448)	(11,448)	86,385		74,937
2036	-	(432)	(11,448)	(11,879)	95,708		83,829
2037	-	(6,249)	(11,448)	(17,697)	105,395		87,698
2038	-	(4,750)	(11,448)	(16,197)	115,461		99,264
2039	-	(4,149)	(11,448)	(15,597)	125,924		110,327
2040	-	(3,419)	(11,448)	(14,867)	134,181		119,314
2041	-	(2,502)	(11,448)	(13,950)	134,181		120,231
2042	-	(27,740)	(11,448)	(39,187)	134,181		94,993
2043	-	(601)	(11,448)	(12,048)	134,181		122,133
2044	-	(432)	(11,448)	(11,879)	134,181		122,302
2045	-	(432)	(11,448)	(11,879)	134,181		122,302
2046	-	(1,647)	(11,448)	(13,095)	134,181		121,086
2047	-	(4,963)	(11,448)	(16,410)	134,181		117,771
2048	-	(792)	(11,448)	(12,240)	134,181		121,941
2049	-	(1,395)	(11,448)	(12,842)	134,181		121,338
2050	-	(1,924)	(11,448)	(13,371)	134,181		120,809
2051	-	(2,077)	(11,448)	(13,525)	134,181		120,656
2052	-	(24,294)	(11,448)	(35,742)	134,181		98,439
2053	-	(15,181)	(11,448)	(26,629)	134,181		107,552
2054	-	(16,659)	(11,448)	(28,107)	134,181		106,074
2055	-	(16,659)	(11,448)	(28,107)	134,181		106,074
2056	-	(15,635)	(11,448)	(27,083)	134,181	209,492	316,590

Source: JICA Design Team



Source: JICA Design Team

Figure 8.4.1 Cash Flow of Economic Cost and Benefit

8.4.4 Sensitivity Analysis

A sensitivity analysis considers the impacts of positive and negative changes to the project in various economic environments. To that end, the level of impacts from increasing or decreasing the economic cost and benefit to EIRR is analyzed.

Under the current assumptions, NEDA’s hurdle rate of 10% is achievable unless 10% or more economic cost overrun or 5% or more decrease in benefits does not occur.

Table 8.4.8 Sensitivity Analysis of Economic Evaluation

		Investment								
		120%	115%	110%	105%	100%	95%	90%	85%	80%
	120%	8.7%	9.0%	9.4%	9.7%	10.1%	10.5%	11.0%	11.5%	12.0%
	115%	8.8%	9.1%	9.4%	9.8%	10.2%	10.6%	11.1%	11.5%	12.1%
	110%	8.9%	9.2%	9.5%	9.9%	10.3%	10.7%	11.1%	11.6%	12.2%
	105%	8.9%	9.2%	9.6%	9.9%	10.3%	10.8%	11.2%	11.7%	12.3%
O&M	100%	9.0%	9.3%	9.7%	10.0%	10.4%	10.8%	11.3%	11.8%	12.3%
	95%	9.1%	9.4%	9.7%	10.1%	10.5%	10.9%	11.4%	11.9%	12.4%
	90%	9.1%	9.4%	9.8%	10.2%	10.6%	11.0%	11.5%	12.0%	12.5%
	85%	9.2%	9.5%	9.9%	10.2%	10.6%	11.1%	11.5%	12.0%	12.6%
	80%	9.2%	9.6%	9.9%	10.3%	10.7%	11.1%	11.6%	12.1%	12.7%

		Economic Cost (Investment, O&M, Replacement)								
		120%	115%	110%	105%	100%	95%	90%	85%	80%
	120%	10.4%	10.8%	11.3%	11.8%	12.3%	12.9%	13.5%	14.1%	14.9%
	115%	10.0%	10.4%	10.9%	11.3%	11.8%	12.4%	13.0%	13.6%	14.3%
	110%	9.6%	10.0%	10.4%	10.9%	11.4%	11.9%	12.5%	13.1%	13.8%
	105%	9.1%	9.5%	10.0%	10.4%	10.9%	11.4%	12.0%	12.6%	13.3%
Benefit	100%	8.7%	9.1%	9.5%	9.9%	10.4%	10.9%	11.5%	12.1%	12.7%
	95%	8.2%	8.6%	9.0%	9.4%	9.9%	10.4%	11.0%	11.5%	12.2%
	90%	7.7%	8.1%	8.5%	8.9%	9.4%	9.9%	10.4%	11.0%	11.6%
	85%	7.2%	7.6%	8.0%	8.4%	8.9%	9.3%	9.9%	10.4%	11.0%
	80%	6.7%	7.1%	7.5%	7.9%	8.3%	8.8%	9.3%	9.8%	10.4%

Source: JICA Design Team

8.4.5 Financial Analysis

The main purpose of financial analysis is to analyze the financial feasibility of the project. Financial Internal Rate of Return (FIRR), Financial Net Present Value (FNPV), and Revenue and Cost Ratio (R/C) are used as the evaluation method.

Evaluation period is same as the economic analysis – i.e., 39 years including the operation period of 35 years.

8.4.6 Financial Cost

The project's financial costs are the initial investment costs – i.e., capital expenditures (CAPEX) – and operation and maintenance (O&M) costs – i.e., operational expenditures (OPEX)). The total financial costs will include physical contingencies and price contingencies (price escalation).

The financial investment cost, O&M costs and replacement costs are estimated as follows:

Table 8.4.9 Investment Cost (Financial Cost)

[redacted]

Source: JICA Design Team

Table 8.4.10 O&M Cost (Financial Cost)

(Mil. PhP)	2022	2025	2035	2040
Manpower	1,403	1,922	1,922	1,922
Power	4,764	6,549	6,549	6,549
Administration	3,134	4,621	4,621	4,621
O&M Cost Total	**9,301**	**13,092**	**13,092**	**13,092**

Source: JICA Design Team

Replacement costs for E&M and rolling stocks are considered in the evaluation. As for E&M, major components are assumed for replacement at the end of their economic lives. Major replacements for rolling stocks are assumed to occur from the 15th and full replacement is implemented from 30th years after the opening, with each over a 5-year period.

As some infrastructures are thought to have longer economic lives than that of the evaluation period, the reasonable estimated residual values of such infrastructures at the end of the project evaluation period will also be considered.

[3] Figures for Civil Works, Depot, E&M, Rolling Stock and Consulting are based on the information from DOTr and JICA report: "The Supplementary Survey on North-South Commuter Rail Project (phase II-A) in the Republic of the Philippines: Final Report" (November 2015)

8.4.7 Financial Revenue

Financial revenue comprises of two streams: 1) a fare revenue from railway operations and 2) a non-fare revenue consisting of advertising and space rentals around and within the railway station. Fare revenue is calculated as per the formula below.

Fare Revenue: Σ (Ridership x Train Fare)

Ridership: Number of Passengers (Annual)

Train Fare: Commuter Service: fixed fair of 22PhP + 2PhP/km x travelled distance (km)

Train Fare: Express Service: fixed fair of 22PhP + 4PhP/km x travelled distance (km)

As elaborated in Table 3.5.12 and Figure 3.5.7 of Chapter 3, the assumed fare setting is expected to provide the highest revenue.

Throughout the evaluation period, the non-fare revenue is assumed to be 10% of the fare revenue. A ridership projection used for the revenue is adopted from Chapter 3.

As some infrastructure are thought to have longer economic lives than that of the evaluation period, the reasonable estimated residual values of such at the end of the project evaluation period will also be considered.

Table 8.4.11 Financial Revenue

(Mil. PhP)	2022	2025	2035	2040
Fare Revenue	7,529	25,350	33,195	37,590
Non-Fare Revenue	753	2,535	3,320	3,759
Revenue Total	**8,282**	**27,885**	**36,515**	**41,349**

Source: JICA Design Team

8.4.8 Financial Evaluation

The cash flow throughout the entire evaluation period is derived as the functions of the aforementioned financial costs and revenues, and utilizing the cash flow, FIRR, FNPV and R/C are calculated. FIRR is 0.5% and therefore the Whole Network is under NEDA’s hurdle rate Weighted Average Cost of Capital (WACC.) WACC is estimated to be 4.3% (in calculating WACC, project cost is categorized by funding source – i.e., JICA, ADB and the government of the Philippines, then for each funding source, cost of funds in real term is estimated.)

FNPV is -401,595 Mil PhP and R/C is 56.0% using 4.885% as WACC.

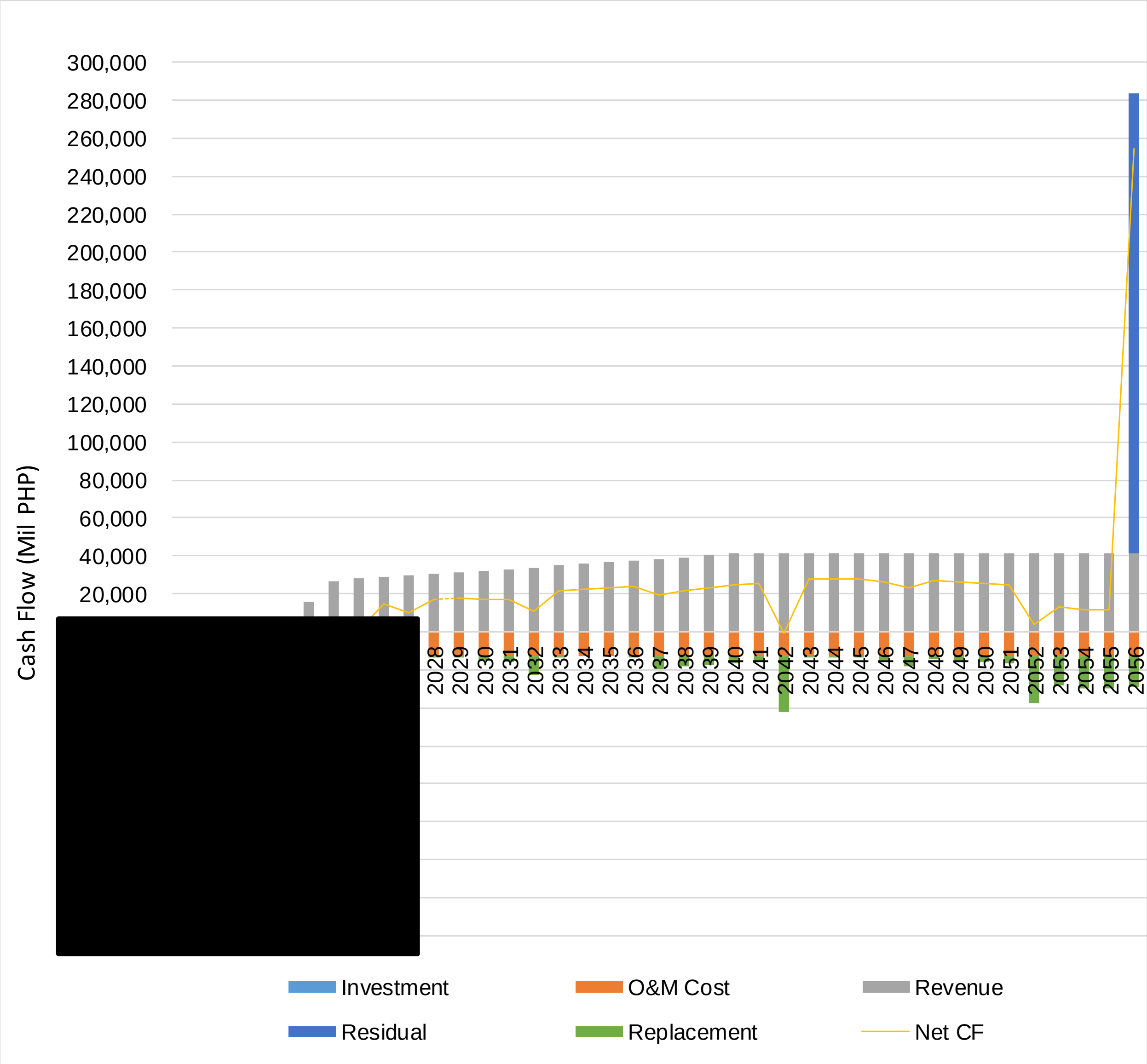
Relatively low demand in light of rather significant initial investment is the cause of the results above. The Government of the Philippines is considering the PPP modality wherein O&M of the Project is entrusted to a private sector operator. PPP may help improve the FIRR by reducing O&M costs through efficient operations and invoking more demands through marketing.

Table 8.4.12 Result of Financial Evaluation

FIRR	0.5%
FNPV	-401,595
R/C	56.0%

	[redacted]	Replacement	O&M	Total Cost	Revenue	Residual Value	Net Cash flow
2018	[redacted]	-	-	(12,272)	-	-	(12,272)
2019	[redacted]	-	-	(143,441)	-	-	(143,441)
2020	[redacted]	-	-	(184,679)	-	-	(184,679)
2021	[redacted]	-	(2,097)	(183,918)	-	-	(183,918)
2022	[redacted]	-	(9,301)	(132,823)	8,282	-	(124,541)
2023	[redacted]	-	(12,513)	(106,728)	15,531	-	(91,197)
2024	[redacted]	-	(13,092)	(33,064)	26,371	-	(6,694)
2025	[redacted]	-	(13,092)	(26,872)	27,885	-	1,013
2026	[redacted]	-	(13,092)	(13,971)	28,748	-	14,777
2027	-	(3,447)	(13,092)	(16,539)	29,611	-	13,071
2028	-	(279)	(13,092)	(13,371)	30,474	-	17,103
2029	-	(455)	(13,092)	(13,547)	31,337	-	17,789
2030	-	(2,261)	(13,092)	(15,353)	32,200	-	16,846
2031	-	(2,644)	(13,092)	(15,736)	33,063	-	17,326
2032	-	(9,734)	(13,092)	(22,827)	33,926	-	11,099
2033	-	(279)	(13,092)	(13,371)	34,789	-	21,418
2034	-	-	(13,092)	(13,092)	35,652	-	22,559
2035	-	-	(13,092)	(13,092)	36,515	-	23,422
2036	-	(455)	(13,092)	(13,547)	37,482	-	23,934
2037	-	(6,404)	(13,092)	(19,496)	38,448	-	18,952
2038	-	(5,042)	(13,092)	(18,134)	39,415	-	21,281
2039	-	(4,308)	(13,092)	(17,401)	40,382	-	22,982
2040	-	(3,599)	(13,092)	(16,692)	41,349	-	24,657
2041	-	(2,502)	(13,092)	(15,594)	41,349	-	25,754
2042	-	(29,367)	(13,092)	(42,459)	41,349	-	(1,110)
2043	-	(734)	(13,092)	(13,826)	41,349	-	27,523
2044	-	(455)	(13,092)	(13,547)	41,349	-	27,802
2045	-	(455)	(13,092)	(13,547)	41,349	-	27,802
2046	-	(1,806)	(13,092)	(14,899)	41,349	-	26,450
2047	-	(5,253)	(13,092)	(18,345)	41,349	-	23,003
2048	-	(993)	(13,092)	(14,085)	41,349	-	27,264
2049	-	(2,066)	(13,092)	(15,158)	41,349	-	26,191
2050	-	(2,779)	(13,092)	(15,871)	41,349	-	25,478
2051	-	(3,400)	(13,092)	(16,492)	41,349	-	24,857
2052	-	(24,487)	(13,092)	(37,580)	41,349	-	3,769
2053	-	(15,291)	(13,092)	(28,383)	41,349	-	12,966
2054	-	(16,818)	(13,092)	(29,911)	41,349	-	11,438
2055	-	(16,818)	(13,092)	(29,911)	41,349	-	11,438
2056	-	(15,726)	(13,092)	(28,818)	41,349	242,006	254,536

Source: JICA Design Team



Source: JICA Design Team

Figure 8.4.2 Cash Flow of Financial Cost and Revenue

8.4.9 Sensitivity Analysis

The sensitivity analysis considers the impacts of the changes in the financial environments to the Project. In line with this, the impacts of the changes in the financial costs and revenues to FIRR is analyzed.

Under the current assumptions, NEDA's hurdle rate will not be achievable even if revenue is 20% more from the currently projected level accompanied by the 20% reduction in investment cost.

Table 8.4.13 Financial Sensitivity Analysis

		Investment								
		120%	115%	110%	105%	100%	95%	90%	85%	80%
	120%	-0.7%	-0.6%	-0.4%	-0.2%	0.0%	0.2%	0.5%	0.7%	1.0%
	115%	-0.6%	-0.4%	-0.3%	-0.1%	0.1%	0.3%	0.6%	0.8%	1.1%
	110%	-0.5%	-0.3%	-0.1%	0.0%	0.3%	0.5%	0.7%	1.0%	1.2%
	105%	-0.4%	-0.2%	0.0%	0.2%	0.4%	0.6%	0.8%	1.1%	1.3%
O&M	100%	-0.3%	-0.1%	0.1%	0.3%	0.5%	0.7%	0.9%	1.2%	1.5%
	95%	-0.2%	0.0%	0.2%	0.4%	0.6%	0.8%	1.1%	1.3%	1.6%
	90%	-0.1%	0.1%	0.3%	0.5%	0.7%	0.9%	1.2%	1.5%	1.7%
	85%	0.0%	0.2%	0.4%	0.6%	0.8%	1.1%	1.3%	1.6%	1.9%
	80%	0.1%	0.3%	0.5%	0.7%	0.9%	1.2%	1.4%	1.7%	2.0%

		Financial Cost (Investment, O&M, Replacement)								
		120%	115%	110%	105%	100%	95%	90%	85%	80%
	120%	0.5%	0.8%	1.1%	1.5%	1.9%	2.2%	2.6%	3.1%	3.5%
	115%	0.2%	0.5%	0.8%	1.2%	1.5%	1.9%	2.3%	2.8%	3.2%
	110%	-0.2%	0.2%	0.5%	0.8%	1.2%	1.6%	2.0%	2.4%	2.9%
	105%	-0.5%	-0.2%	0.1%	0.5%	0.9%	1.2%	1.6%	2.1%	2.5%
Revenue	100%	-0.9%	-0.6%	-0.2%	0.1%	0.5%	0.9%	1.3%	1.7%	2.2%
	95%	-1.3%	-1.0%	-0.6%	-0.3%	0.1%	0.5%	0.9%	1.3%	1.8%
	90%	-1.7%	-1.4%	-1.1%	-0.7%	-0.3%	0.1%	0.5%	0.9%	1.4%
	85%	-2.2%	-1.9%	-1.5%	-1.1%	-0.8%	-0.4%	0.1%	0.5%	0.9%
	80%	-2.7%	-2.4%	-2.0%	-1.6%	-1.2%	-0.8%	-0.4%	0.0%	0.5%

Source: JICA Design Team

8.5 Project Evaluation of MCRP (Stage 1) and NSCR-South as One Railway Project

In this sub-section, the economic and financial feasibility of MCRP (Stage 1) and NSRP-South as one interrelated railway network is analyzed.

8.5.1 Economic Evaluation

The following investment cost, O&M cost, and benefits are used for economic analysis.

Table 8.5.1 Investment Cost (Economic Cost)

[redacted]

Source: JICA Design Team

Table 8.5.2 O&M Cost (Economic Cost)

(Mil. PhP)	2022	2025	2035	2040
O&M Cost	4,493	7,847	7,847	7,847

Source: JICA Design Team

Table 8.5.3 Economic Benefit

(Mil. PhP)	2022	2025	2035	2040
Economic Benefit	16,936	51,905	83,021	115,241

Source: JICA Design Team

Replacement costs for E&M and rolling stocks are considered in the evaluation. As for E&M, major components are assumed for replacement at the end of their economic lives. Major replacements for rolling stocks are assumed to occur from the 15th and full replacement is implemented from 30th years after the opening, with each over a 5-year period.

As some infrastructure are thought to have longer economic lives than that of the evaluation period, the reasonable estimated residual values of such at the end of the project evaluation period will also be considered.

Using the economic costs and benefits derived from above, economic cash flows of the project period are constructed below, based on which EIRR, ENPV and B/C have been calculated. 11.5% is the calculated EIRR, which is above the NEDA Social Discount Rate of 10%. Using the said figure, ENPV is calculated at 63,659 million PhP, and B/C derived is 115.5%.

Table 8.5.4 Result of Economic Evaluation

EIRR	11.5%
ENPV	63,659
B/C	115.5%

	[redacted]	Replacement	O&M	Total Cost	Economic Benefit	Residual Value	Net Cash flow
2018	[redacted]	-	-	(2,890)	-		(2,890)
2019	[redacted]	-	-	(72,999)	-		(72,999)
2020	[redacted]	-	-	(108,669)	-		(108,669)
2021	[redacted]	-	(1,088)	(104,543)	-		(104,543)
2022	[redacted]	-	(4,493)	(82,748)	16,936		(65,812)
2023	[redacted]	-	(7,348)	(69,866)	24,391		(45,476)
2024	[redacted]	-	(7,847)	(20,889)	48,125		27,235
2025	[redacted]	-	(7,847)	(18,336)	51,905		33,569
2026	[redacted]	-	(7,847)	(8,505)	54,380		45,875
2027	-	(2,649)	(7,847)	(10,495)	56,999		46,504
2028	-	(135)	(7,847)	(7,982)	59,774		51,792
2029	-	(345)	(7,847)	(8,191)	62,714		54,523
2030	-	(1,661)	(7,847)	(9,507)	65,833		56,325
2031	-	(1,896)	(7,847)	(9,742)	69,141		59,398
2032	-	(7,568)	(7,847)	(15,415)	72,652		57,238
2033	-	(135)	(7,847)	(7,982)	76,382		68,400
2034	-	-	(7,847)	(7,847)	80,343		72,497
2035	-	-	(7,847)	(7,847)	83,021		75,175
2036	-	(345)	(7,847)	(8,191)	89,429		81,237
2037	-	(5,239)	(7,847)	(13,086)	96,074		82,988
2038	-	(4,041)	(7,847)	(11,888)	102,967		91,079
2039	-	(3,562)	(7,847)	(11,408)	110,118		98,710
2040	-	(2,978)	(7,847)	(10,825)	115,241		104,416
2041	-	(2,246)	(7,847)	(10,092)	115,241		105,149
2042	-	(22,160)	(7,847)	(30,007)	115,241		85,234
2043	-	(480)	(7,847)	(8,327)	115,241		106,915
2044	-	(345)	(7,847)	(8,191)	115,241		107,050
2045	-	(345)	(7,847)	(8,191)	115,241		107,050
2046	-	(1,316)	(7,847)	(9,163)	115,241		106,079
2047	-	(3,964)	(7,847)	(11,811)	115,241		103,430
2048	-	(633)	(7,847)	(8,479)	115,241		106,762
2049	-	(1,114)	(7,847)	(8,961)	115,241		106,280
2050	-	(1,537)	(7,847)	(9,384)	115,241		105,858
2051	-	(1,659)	(7,847)	(9,506)	115,241		105,735
2052	-	(20,889)	(7,847)	(28,736)	115,241		86,506
2053	-	(13,609)	(7,847)	(21,456)	115,241		93,786
2054	-	(14,790)	(7,847)	(22,637)	115,241		92,605
2055	-	(14,790)	(7,847)	(22,637)	115,241		92,605
2056	-	(13,972)	(7,847)	(21,818)	115,241	176,066	269,489

Source: JICA Design Team

8.5.2 Financial Evaluation

The financial investment cost and O&M costs, as well as financial revenues are estimated as follows:

Table 8.5.5 Investment Cost (Financial Cost)

[redacted]

Source: JICA Design Team

Table 8.5.6 O&M Cost (Financial Cost)

(Mil. PhP)	2022	2025	2035	2040
O&M Cost	5,119	8,910	8,910	8,910

Source: JICA Design Team

Table 8.5.7 Financial Revenue

(Mil. PhP)	2022	2025	2035	2040
Revenue (Fare revenue and Non Fare revenue)	6,586	25,250	32,125	36,345

Source: JICA Design Team

Replacement costs for E&M and rolling stocks are considered in the evaluation. As for E&M, major components are assumed for replacement at the end of their economic lives. Major replacements for rolling stocks are assumed to occur from the 15^{th} and full replacement is implemented from 30^{th} years after the opening, with each over a 5-year period.

As some infrastructure are thought to have longer economic lives than that of the evaluation period, the reasonable estimated residual values of such at the end of the project evaluation period will also be considered.

The cash flow throughout the entire evaluation period is derived as the functions of the aforementioned financial costs and revenues, and utilizing the cash flow, FIRR, FNPV and R/C are calculated. FIRR is 1.5% and therefore the project is below NEDA’s hurdle rate – i.e., WACC. WACC is estimated to be 4.885% (in calculating WACC, project cost of MCRP and NSRP-South is categorized by funding source – i.e., JICA, ADB and the Government of the Philippines, then for each funding source, cost of funds in real terms is estimated). FNPV is -251,708 Mil PhP and R/C is 64.6% under the WACC of 4.885%.

Table 8.5.8 Result of Financial Evaluation

FIRR	1.5%
FNPV	-251,708
R/C	64.6%

	[redacted]	Replacement	O&M	Total Cost	Revenue	Residual Value	Net Cash flow
2018	[redacted]	-	-	(4,434)	-	-	(4,434)
2019	[redacted]	-	-	(99,341)	-	-	(99,341)
2020	[redacted]	-	-	(147,461)	-	-	(147,461)
2021	[redacted]	-	(1,262)	(143,732)	-	-	(143,732)
2022	[redacted]	-	(5,119)	(114,852)	6,586	-	(108,267)
2023	[redacted]	-	(8,331)	(98,254)	22,977	-	(75,277)
2024	[redacted]	-	(8,910)	(26,340)	23,735	-	(2,605)
2025	[redacted]	-	(8,910)	(22,690)	25,250	-	2,560
2026	[redacted]	-	(8,910)	(9,789)	25,938	-	16,149
2027	-	(2,754)	(8,910)	(11,664)	26,625	-	14,961
2028	-	(223)	(8,910)	(9,133)	27,313	-	18,180
2029	-	(363)	(8,910)	(9,274)	28,000	-	18,727
2030	-	(1,806)	(8,910)	(10,717)	28,688	-	17,971
2031	-	(2,112)	(8,910)	(11,023)	29,375	-	18,353
2032	-	(7,776)	(8,910)	(16,687)	30,063	-	13,376
2033	-	(223)	(8,910)	(9,133)	30,750	-	21,617
2034	-	-	(8,910)	(8,910)	31,438	-	22,528
2035	-	-	(8,910)	(8,910)	32,125	-	23,215
2036	-	(363)	(8,910)	(9,274)	32,969	-	23,696
2037	-	(5,363)	(8,910)	(14,273)	33,813	-	19,540
2038	-	(4,275)	(8,910)	(13,185)	34,657	-	21,472
2039	-	(3,689)	(8,910)	(12,599)	35,501	-	22,902
2040	-	(3,122)	(8,910)	(12,033)	36,345	-	24,313
2041	-	(2,246)	(8,910)	(11,156)	36,345	-	25,189
2042	-	(23,460)	(8,910)	(32,370)	36,345	-	3,975
2043	-	(586)	(8,910)	(9,496)	36,345	-	26,849
2044	-	(363)	(8,910)	(9,274)	36,345	-	27,071
2045	-	(363)	(8,910)	(9,274)	36,345	-	27,071
2046	-	(1,443)	(8,910)	(10,353)	36,345	-	25,992
2047	-	(4,196)	(8,910)	(13,107)	36,345	-	23,238
2048	-	(793)	(8,910)	(9,703)	36,345	-	26,642
2049	-	(1,650)	(8,910)	(10,561)	36,345	-	25,785
2050	-	(2,220)	(8,910)	(11,130)	36,345	-	25,215
2051	-	(2,716)	(8,910)	(11,626)	36,345	-	24,719
2052	-	(21,043)	(8,910)	(29,954)	36,345	-	6,391
2053	-	(13,697)	(8,910)	(22,607)	36,345	-	13,738
2054	-	(14,917)	(8,910)	(23,827)	36,345	-	12,518
2055	-	(14,917)	(8,910)	(23,827)	36,345	-	12,518
2056	-	(14,044)	(8,910)	(22,955)	36,345	203,851	217,241

Source: JICA Design Team

CHAPTER 9 ENVIRONMENT AND SOCIAL CONSIDERATION

9.1 Assistance on Environmental Impact Assessment

9.1.1 Preparation of the Environmental Impact Statement

(1) Study Background

A previous Chinese funded project, the Northrail Project, had already received an Environmental Compliance Certificates (ECC) for two sections; the Clark-Valenzuela section in 2000 and the Valenzuela-Caloocan section in 2007. Although started, this project was terminated in 2012 after a legal dispute. The project was taken over by JICA and became the North South Commuter Railway (NSCR) Project. The ECC for Malolos-Clark expired in 2015 due to the 5 years validity of ECC, but the ECC for Valenzuela-Caloocan was renewed and extended to include Caloocan-Tutuban by the issue of an Environmental Performance Report and Management Plan (EPRMP).

After a discussion with DENR-EMB on December 5, 2017, they classified the Malolos – Clark Railways Project (MCRP) as a New Project under Category I and thus required the preparation of a new EIS and obtaining ECC.

Source: Northrail, http://www.northrail.com.ph/h1.php (Accessed on Jan. 2018)

Figure 9.1.1 Proposed Alignment of the Northrail Project

(2) Study Outline

In order to achieve the ECC for the MCRP, an Environmental Impact Statement (EIS) has been prepared following the JICA Guidelines for Environmental and Social Considerations 2010 (JICA Guidelines) and Asian Development Bank Safeguard Policy Statement 2009 (ADB SPS). The following activities were completed in the preparation of the EIS.

Table 9.1.1 Study Framework

	Items	Contents
1	Baseline condition of environmental & social consideration	Study initial environmental and social condition of project area
2	Review legal framework relevant to EIA	• Law and Regulation on EIA, Public Participation, Information Disclosure • Comparison of Philippines Policies and JICA Guidelines • Responsible Governmental Authorities
3	Impact Assessment and Analysis of Alternatives	Impact assessment including "without-project case"
4	Scoping	Clarification of items to consider and assessment methods. • Technical Scoping: February 9, 2018
5	Baseline Survey on environmental and social conditions	Land use, natural environment, socio economic condition etc. • Pedology: January 27 - February 16, 2018 • Terrestrial Ecology: February 3-7, 2018 • Hydrology/Hydrogeology: February 12, 2018 • Fresh Water Quality: February 6-8, 2018 • Ground Water Quality: February 8.21, 2018 • Freshwater Ecology: February 6-7, 2018 • Air quality: January 27 – February 7, 2018 • Noise and Vibration: January 27 – March 6, 2018 • Perception Survey: February 6 –23, 2018
6	Predict environmental impacts	Required Information for prediction, prediction methodology and results
7	Elaborate the feasible mitigation measures	Adequacy and Validation of mitigation measures and compensation
8	Develop Environmental Monitoring Plan	Review on implementation arrangement, method and frequency
9	Clarify budget, funding sources	Cost and budget for implementation of mitigation measures and monitoring plan
10	Identify Institutions and Organizations relevant to EIA	Grievance Redress Mechanism, EMP & EMoP implementation mechanism
11	Support to hold the stakeholders' meetings and information sharing	Disseminate project outline and gather stakeholder opinions and comments • IEC: December 2017 - January 2018 • Public Scoping: January 22-23, 2018 • Public Hearing: June 26,27,29, 2018
12	Review Draft EIS and Obtaining ECC	Submit draft EIS to EMB for review and obtain ECC • Submission: May 11, 2018 • Issuance of ECC: August 13, 2018
13	Conduct Additional Survey	Conduct of wet season sampling, analysis, and report. • Air, water, noise, fauna and flora survey : July – August 2018

Source: JICA Design Team

(3) Study Schedule

The schedule is as follows.

Table 9.1.2 EIA Schedule

Activity	2017	2018										
	12	1	2	3	4	5	6	7	8	9	10	11	12
Review of FS and previous projects	■												
Review of legal framework	■												
LGU and NGAs Meetings	■	■											
Public Scoping		■											
Technical Scoping			■										
Baseline Survey (Desktop)	■	■	■										
Baseline Survey (Field survey and analysis)			■	■									
Prepration of EIA rpeort			■	■	■	■							
ECC application and EIA review						■	■	■	■				
Public Hearing							■						
ECC Issuance									■				

Source: JICA Design Team

9.1.2 Project Outline

(1) Project Area

The MCRP will maximize the use of the existing Right-of-Way (ROW) of the Philippine National Railways (PNR) and traverse ten Local Government Units (LGUs). From Malolos, the length of the MCRP is approximately 44 km up to Clark and around 67 km up to NCC, and 7.4 km spur line form Clark to CIA. The location map of the proposed MCRP showing all the intermediate stations is shown in Figure 9.1.2.

(2) Project Component

The MCRP will utilize the existing PNR ROW land acquisition over its length and will include the following components:

- Main Railway line
- Viaduct / bridges
- Embankment
- Bridge crossings (rivers/highways)
- Tunnel
- Stations: Stations will be elevated and underground and will have a ROW width of 60 m (including the tracks), and a length of around 250 m. The basic station layout is two separate platforms, serving two tracks. Some stations will have a single platform at the center.

- Station related facilities within ROW 60m such as loading /unloading space, extended road, pedestrian roof, parking and soft landscape.
- Depot including Workshops and Operations Control Center, Maintenance and workshop buildings, Access tracks, Train storage tracks, Workshop for heavy rolling stock maintenance, Light repair shop, Catenary and track maintenance shops, repair shop, Wheel re-profiling Shop, Car washing track, Test track, Sub stations, Sewage treatment plant, storm water reservoir, emergency facility, Access road inside depot, car parking, light, fence etc.
  E&M System (Signal system, Over Head Contact System, Communication System, Substations etc.)
- Drainage
- Maintenance Base
- Maintenance Access Roads
- Construction Yards: Offices, Laboratory, Worker's quarter, warehouse, Fabrication Yard, Batching Plant, Segment Casting Yard
- Borrow Pit/Soil Disposal Areas

It should be noted that under the EIS, the construction yards are considered as a one of temporary facilities, however a separate ECC will be required and will be obtained by contractors.

(3) Impact Areas

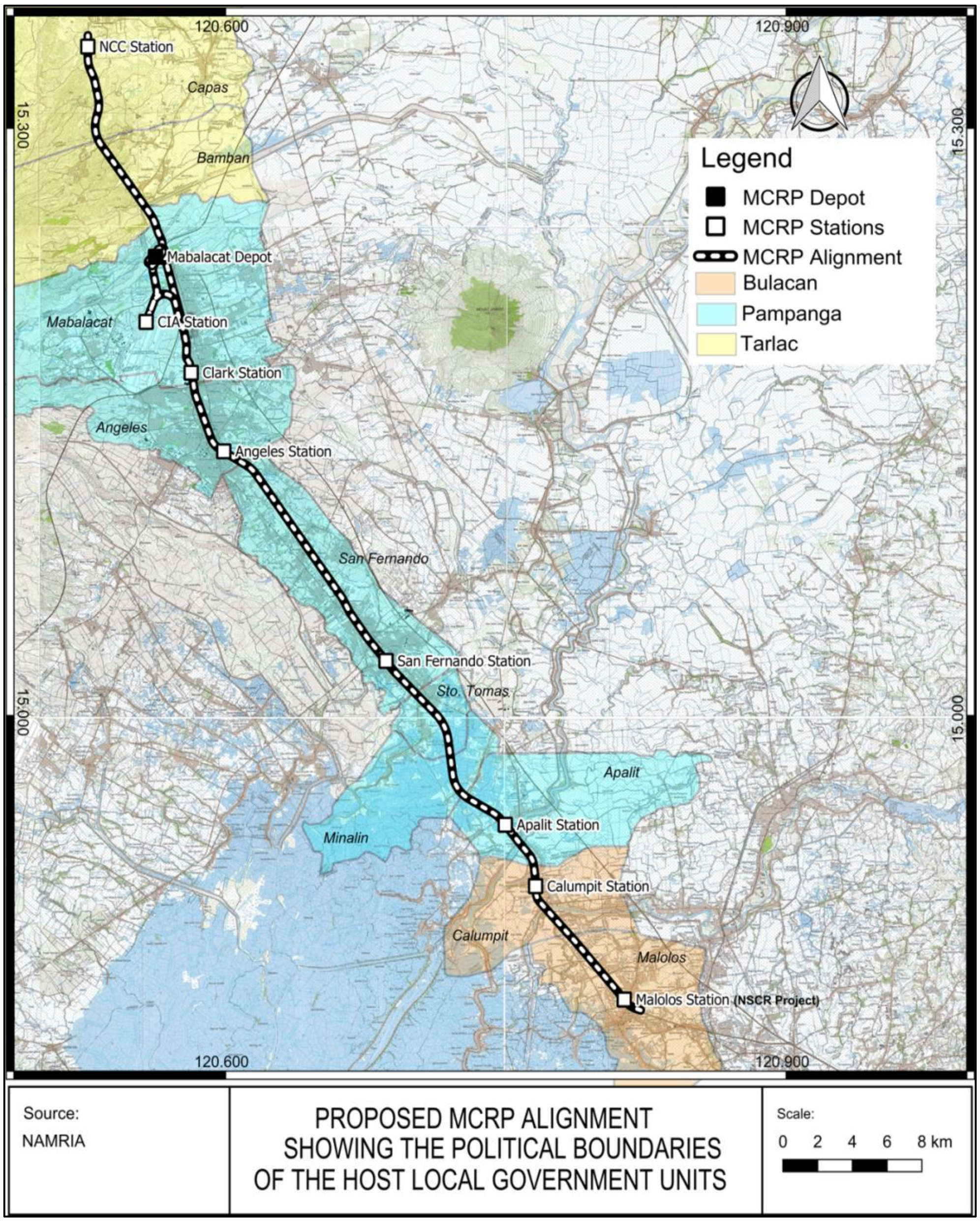
The direct impact areas (DIA) has a width of approximately 30 m and a total length of 74.4 km, most of which is the existing PNR ROW. Additionally, the DIA at the MCRP Stations will be of a width of approximately 60m. Also, the location of the proposed North Depot will be included in the DIA.

In terms of environmental effects, the DIA can also spread wider than the ROW where, for instance, noise, pollution, sediments travel further. Where this is the case the impact area is mentioned in the section. In terms of socio economic benefits, the DIA areas include the host LGUs which are the project beneficiaries for employment, business opportunities, and reduced road congestion. The indirect impact areas cover the nearby LGUs who will see benefits from the greater economic growth in the region and the entire country.

Table 9.1.3 Municipalities and Cities the Proposed Alignment traverses

Region	Province	Municipalities and Cities
Region III Central Luzon	Bulacan	Malolos City
		Municipality of Calumpit
	Pampanga	Municipality of Minalin
		Municipality of Apalit
		Municipality of Santo Tomas
		City of San Fernando
		Angeles City
		Mabalacat City
	Tarlac	Municipality of Bamban
		Municipality of Capas

Source: JICA Design Team



Source: JICA Design Team

Figure 9.1.2 Project Alignment Showing LGUs' Political Boundaries

9.1.3 Baseline Condition on Environmental and Social Consideration

The initial conditions data and other information was collected from secondary sources such as a literature review and previous projects.

(1) Air Quality

An ambient air quality sampling study was conducted as part of the JICA Study on Railway Strategy for Clark- Metropolitan Manila for the Greater Capital Region (2012) (Pre-FS) for MCRP area, at the applicable sampling point of Angeles, San Fernando, Malolos. The findings of the study are summarized in to Table 9.1.4. All sampling sites conform to the DENR standards except for O_3.

Table 9.1.4 Summary of Air Quality Survey Results under Previous Projects

Sampling Station	Sampling date	Ambient Air parameter						
		PM_{10} (µg/NCM)	TSP (µg/NCM)	Pb (µg/NCM)	CO (ppm)	NO_2 (µg/NCM)	SO_2 (µg/NCM)	O_3 (µg/NCM)
Angeles	2012.10.20/ 23	48	129	<0.003	0.69	3	<0.05	932
San Fernando	2012.10.20/ 23	25	155	<0.003	0.46	3	<0.05	925
Malolos	2012.10.19	62	95	<0.003	1.15	3	<0.05	659
DENR Standard (NAAQS/NAAQGV)		150	230	1.5	30	150	180	140

Note: Shaded cells highlight non-conforming measurement

Source: JICA Study on railway Strategy for Clark- Metropolitan Manila for the Greater Capital Region (2012), Final report

(2) Water Quality

A water quality survey was also conducted under the Pre-FS. The sampling sites for the Pre-FS included Abacan River and Calulut Creek. In addition, DENR-EMB conducts regular water quality surveys at 16 rivers running to Manila Bay including Pampanga River, and Angat River. Survey results are summarized in to Table 9.1.5. The results show that Abacan River is highly polluted.

Table 9.1.5 Summary of Surface Water Survey Results under Previous Projects

Parameter	Pampanga river	Angat river	Abacan river	Calulut Creek	DENR Class C Standard Water [1]
Sampling date	**2014.1-3**	**2014.1-3**	**2012.10.22**	**2012.10.22**	
pH			8.5	7.4	6.5 – 8.5
Temperature (ºC)			24	29	Not more than 3º C increase
Arsenic (As)			<0.01	<0.01	0.05 mg/L
Copper (Cu)			<0.05	<0.05	0.05 mg/L
Mercury (Hg)			<0.001	<0.001	0.002 mg/L
Free Cyanide			<0.01	<0.01	0.05 mg/L
Nitrate (NO_3)	0.3	0.8	27.8	14.9	10 mg/L
Cadmium (Cd)			<0.003	<0.003	0.01 mg/L
Lead (Pb)			<0.01	<0.01	0.05 mg/L
BOD 5-Day 20 ºC	5	4	5	11	7 mg/L
Chloride (Cl-)			14	16	350 mg/L
Chromium Hexavalent			<0.001	<0.001	0.05 mg/L
Dissolved Oxygen	3	3	6	5	5.0 mg/L
Oil & Grease			2.4	1.7	2 mg/L
Phosphate (as Phosphorous)	0.13	0.06	1.12	2.36	0.4 mg/L
Phenol			<0.01	<0.01	0.005 mg/L
MBAS			<0.1	<0.1	0.5 mg/L
TSS	32	6	117	10	Not more than 30 mg/L increase
Coliform			540,000	160,000	5,000 MPN/ 100 mL

Note: Shaded cells highlight non-conforming

1. Class C: (a) Fishery Water for the propagation and growth of fish and other aquatic resources. (b) Recreational water for class 2 activities (boating, etc.) (c) Industrial Water supply class 1 (from manufacturing processes after treatment) DAO 1990/34

Source: JICA Study on railway Strategy for Clark- Metropolitan Manila for the Greater Capital Region (2012), Final report

(3) Noise Level

A noise survey was also conducted under Pre-FS. Sampling points were Angeles, San Fernando, and Malolos station. The results are summarized in Table 9.1.6. All the sites failed to conform to the DENR standard for commercial areas, the Class B standards at one point in the day.

Table 9.1.6 Summary of Noise Level Survey Results under Previous Projects

Sampling points	Sampling date	Mean Noise Level dBA			
		Morning (5 AM-9 AM)	Day time (9 AM-6 PM)	Evening (6 PM-10 PM)	Night (10 PM-5 AM)
Angeles	2012.10.20	53.9	65.0	54.6	55.3
San Fernando	2012.10.20	62.9	56.2	58.0	49.9
Malolos	2012.10.19	56.3	65.1	55.9	50.8
DENR Noise Standard for Class B (Commercial)		60.0	65.0	60.0	55.0

Note: Shaded cells highlight non-conforming

Source: JICA Study on railway Strategy for Clark- Metropolitan Manila for the Greater Capital Region (2012), Final report

(4) Topography and Geomorphology

1) Geology

Central Luzon Plain: The Central Plain of Luzon is the largest on the island in terms of land area. The plain stretches over 200 km from Lingayen Gulf to Manila Bay and is 80 km wide. It is bounded by two major rivers; the Cagayan to the north, and the Pampanga to the south. In the middle of the plain rises the solitary volcanic cone of Mount Arayat. The western coasts of Central Luzon are typically flat extending east from the coastline to the Zambales Mountains, the site of Mount Pinatubo, renowned for its enormous 1991 eruption. The plain is composed of sediments from the Quaternary and Tertiary period, the volcanic sediments of the Quaternary period and after, and the layer of ash, rocks and silt from the recent the Mount Pinatubo eruption.

Pampanga Delta: The delta was formed by the Pampanga River; the headwaters are at the Sierra Madre and runs a south and southwesterly course until it drains into the north of Manila Bay. Its main tributaries are the Peñaranda and Coronel-Santor Rivers on the eastern side of the basin and the Rio Chico River from the northwest side.

The Manila Bay Delta: The delta was formed as the large river delta expanded by the mixture of sediment from the Pasig River, sediment caused by the erosion river banks, and a large volume of coast sediment. The land slopes towards Manila Bay and is less than 4 m above sea level at the coastline.

2) Active Faults

An active seismic fault traverses the project alignment based on the Distribution Map of Active Faults in the Philippines (PHIVOLCS, 2000). The nearest earthquake generator is the West Valley Fault which runs through Bulacan, Metro Manila and Laguna, and could deliver a magnitude of 7.5[1]. If the West Valley Fault moves, the whole of Metro Manila will be affected in varying degrees include strong ground shaking, damaged infrastructure and utilities, and a potentially a very large casualty count.

(5) Climatology and Meteorology

The meteorological considerations at the MCRP site is described in Table 9.1.7 using the meteorological data from CIA Station, the nearest PAGASA Synoptic Station is located at 15°11’7.77” N and 120°32’56.05” E in Clark, Pampanga with an elevation of 151.6 m.

Table 9.1.7 Meteorological Data Recorded at CIA Synoptic Station (1997-2010)

Month	Rainfall Data		Temperature						Relative Humidity (%)	Wind Direction/velocity	
	Amount (mm)	No. of Rainy Days	Max (°C)	Min (°C)	Mean (°C)	Dry Bulb (°C)	Wet Bulb (°C)	Dew Point (°C)		Wind Direction (16 point)	Wind Velocity (ms-1)
January	17.4	3	30.1	20.5	25.3	24.8	20.8	19	70	NW	3
February	18.6	3	31	20.7	25.9	25.4	21.1	19.2	68	ENE	3
March	28.4	4	32.6	21.8	27.2	26.8	22	20	66	NE	3
April	65	7	34	23.2	28.6	28.2	23.2	21.2	65	E	3
May	221.8	10	32.7	23.9	28.3	27.7	24	22.6	73	SE	2
June	241.2	18	31.5	23.6	27.6	27	24.3	23.3	80	S	3
July	422.6	22	30.6	23.5	27	26.3	24.2	23.4	84	S	3
August	429.4	24	30.1	23.5	26.8	26	24.2	23.5	86	S	2
Septembe	293.1	21	30.5	23.2	26.9	26	24	23.2	85	S	2
October	177	12	31.1	23	27	26.5	23.6	22.5	78	NW	3
Novembe	78	8	31	22.4	26.7	26.2	22.8	21.5	75	N	3
December	34.2	6	30.2	21.3	25.8	25.2	21.5	19.9	72	NW	3
Annual	2026.8	143	31.3	22.6	26.9	26.3	23	21.6	75	S	3

Source: Clark International Airport Station, PAGASA (1997-2010)

1) Climate

Using the Modified Coronas Climate Classification System, Bulacan, Pampanga, and Tarlac where the proposed MCRP is to be located fall under a Type I climate classification. Type I climate is characterized by two pronounced seasons, dry season from November to April and wet season from May to October with maximum rain period from June to September. Areas under this type of climate are generally exposed to the southwest monsoon during the rainy season and get a large proportion of rainfall from tropical cyclones occurring during the maximum rainy period.

2) Wind Regime

There are two seasonal wind regimes, the northeasterly winds and the southwesterly winds. From November to May, the wind blows on a northeasterly direction with an average wind velocity of 3.0 m/s. From June to October, the southwesterly winds prevail with an average wind velocity of 2.5 m/s.

[1] Daligdig and Besana, 1993

3) Rainfall

The monthly average rainfall at the project site ranges from 17 mm (January) to 429.4 mm (August), with an annual average of 2027 mm. The least number of rainy days per month occurs in November to April; while the highest number or rainy days per month occur in May to October, which leads to flooding in low-lying areas.

4) Temperature and Relative Humidity

The annual mean average temperature recorded at CIA Station is 26.9 °C with January being the coldest month having an average temperature of 25.3 °C, while the month of April is the warmest with an average temperature 28.6 °C. The mean annual relative humidity is 75.0 %. The months of July to September are the most humid.

5) Frequency of Extreme Events

Climatological extreme values from CIA Station are recorded for the monthly and annual summaries of temperature, rainfall, and wind speed. The record annual high temperature is 37.0 °C which occurred in April 23, 2010 and May 10, 2002 while the lowest recorded temperature is 15.8 °C which occurred in January 15, 2009. The amount of annual average extreme greatest rainfall is 274.5 mm occurred in July 22, 2012 while the annual average extreme highest wind is 47 m per second westerly direction occurred in June 13, 2010.

6) Cyclone Frequency

The most number of cyclones occur during the months of June to December. These tropical cyclones are associated with the occurrence of low pressure areas (LPA) normally originating from the North Western Pacific Ocean of the Philippine Area of Responsibility (PAR) and generally moving northwestward. From 1948-2016 (period of 68 years) PAGASA determined an annual average of 20 tropical cyclones in the PAR with nine of these passing through the Philippine landmasses. PAGASA had tracked 28 tropical cyclones that crossed in the Province of Bulacan while 27 tropical cyclones that crossed the Province of Pampanga from 1948-2016. The month of October has the most number of tropical cyclones for both Bulacan and Pampanga.

(6) Hydrology

The hydrological characteristics of the area are defined by the Pampanga River Basin. The Pampanga River Basin system is the fourth largest basin in the Philippines. It is broadly divided into three sub-basins namely: Pampanga Main River Basin, Pasac River Basin (or alternatively known as the Pasac-Guagua Allied river basin) and the Angat River Basin. The headwaters of these three basins originate from different mountain areas with separate river channels draining into the Manila Bay.

(7) Protected Area

1) International Protected Area

International Union for Conservation of Nature (IUCN) classifies protected areas according to their management objectives. The categories are recognized by international bodies such as the United Nations and by many national governments as the global standard for defining and recording protected areas and as such are increasingly being incorporated into government legislation. Based on the IUCN, Philippines has a total of 390 protected areas composed of category II: National Park (37), category III: Natural Monument or Feature (8), Category IV: Habitat/Species Management Area (17), Category V: Protected Landscape/ Seascape (145), and Category VI: Protected area with sustainable use of natural resources (183).

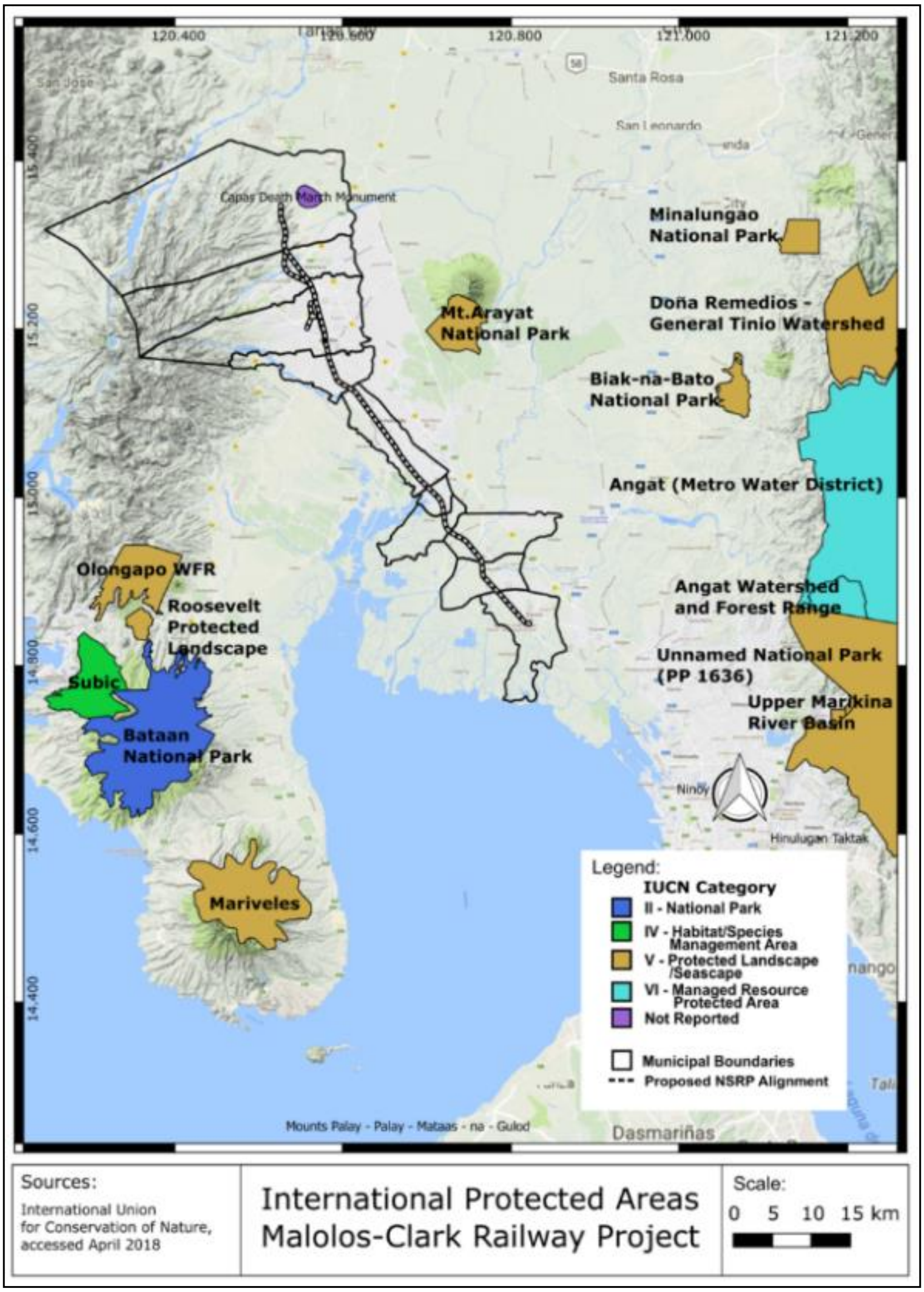
The protected areas located within 50 km of the project alignment is shown in Table 9.1.8 and Figure 9.1.3. The alignment of MCRP does not pass directly through any protected area.

Table 9.1.8 International Protected area nearby Project area

Category	Protected area	Location	Area (ha)	Distance from the Project (km)
II	Bataan National Park	Morong, Bataan	31,000	45
IV	Subic Watershed Forest Reserve	Subic, Zambales	84,500	47
V	Roosevelt Protected Landscape	Olongapo, Zambales and Dinalupihan, Bataan	786	45
V	Olongapo Naval Base Perimeter	Olongapo, Zambales	582	30
V	Mt. Arayat National Park	Arayat and Magalang, Pampanga	3.715	13
V	Biak - na – Bato National Park	Antipolo and Rodriguez, Rizal	2,117	40
VI	Mt. Angat Watershed Forest Reserve (Metro Water District)	Angat, Bulacan	62,309	40
Not Reported	Capas Death March Monument	Capas, Tarlac	7	5.5

Note: The classification of IUCN Management Category (Ia, Ib, II, III, IV, V or VI) adopted for national protected areas. For reporting on international protected areas the option of listing ‘Not Applicable’ is accepted. For national protected areas where an IUCN category has not been adopted ‘Not Reported ‘can be listed.

Source: IUCN, https://protectedplanet.net/search?q=Philippines (Access in January 2018)



Source: IUCN, https://protectedplanet.net/search?q=Philippines (Access in January 2018)

Figure 9.1.3 International Protected Areas

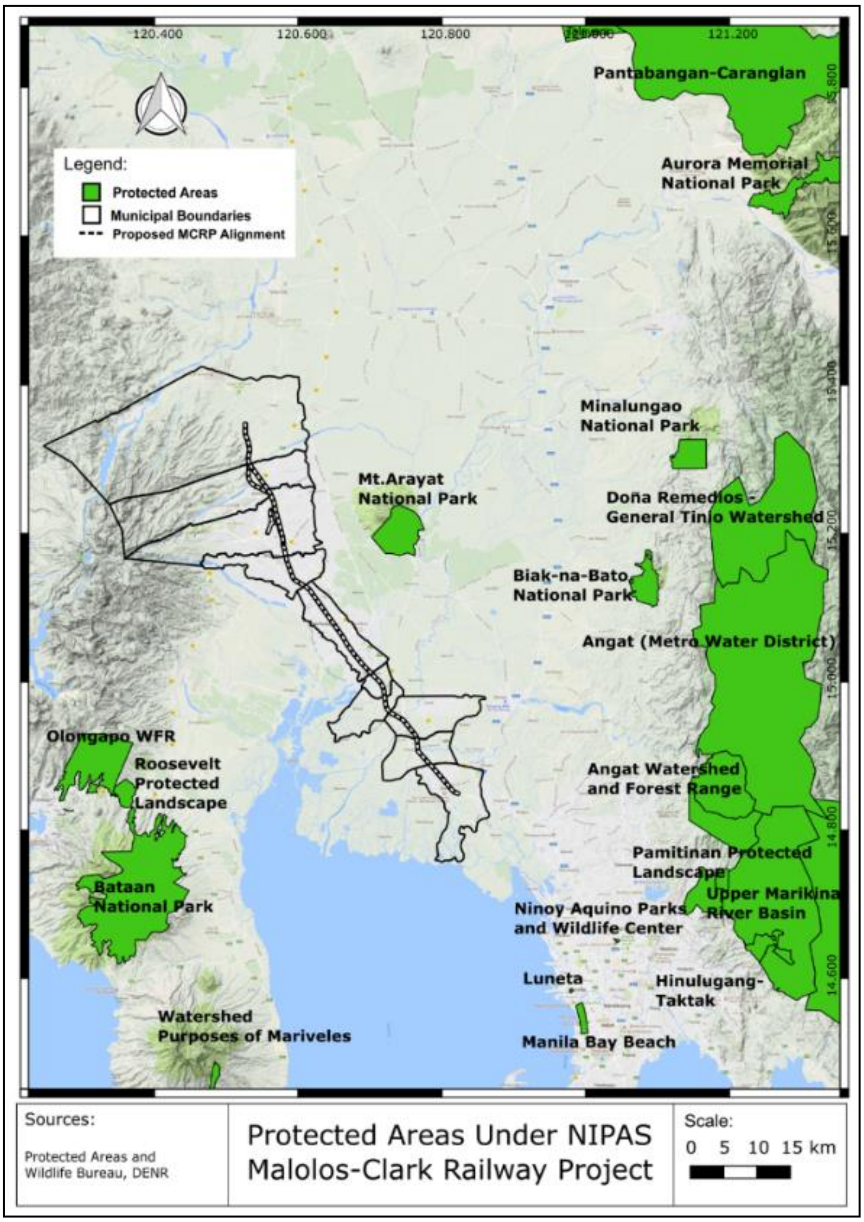
2) Protected area under the Philippine Law

The National Integrated Protected Areas System (NIPAS) Act of 1992 (Republic Act No. 7586) and its Implementing Rules and Regulations (DAO No. 92-25) as amended by DAO 2008-26 (2009) provides the legal framework for the establishment and management of protected areas in the Philippines. There are eight categories of protected areas under the NIPAS; Strict Nature Reserve, Natural Park, Natural Monument/Natural Landmark, Wildlife Sanctuary, Protected Landscape and Seascapes, Resource Reserve Natural Biotic Areas/ Anthropological Reserve, and Other. Protected areas located within 50 km from the project alignment are shown in Table 9.1.9 and Figure 9.1.4. The alignment of MCRP does not traverse the protected area under NIPAS.

Table 9.1.9 Protected Area under NIPAS nearby the Proposed MCRP

Category	Protected Area	Location	Area (ha)	Distance from the Project (km)
Natural Park	Mt. Arayat National Park	Arayat and Magalang, Pampanga	3,715	13
	Biak-na-Bato National Park	San Miguel and Doña Remedios Trinidad, Bulacan	2,117	40

Source: Protected Areas and Wildlife Bureau, DENR



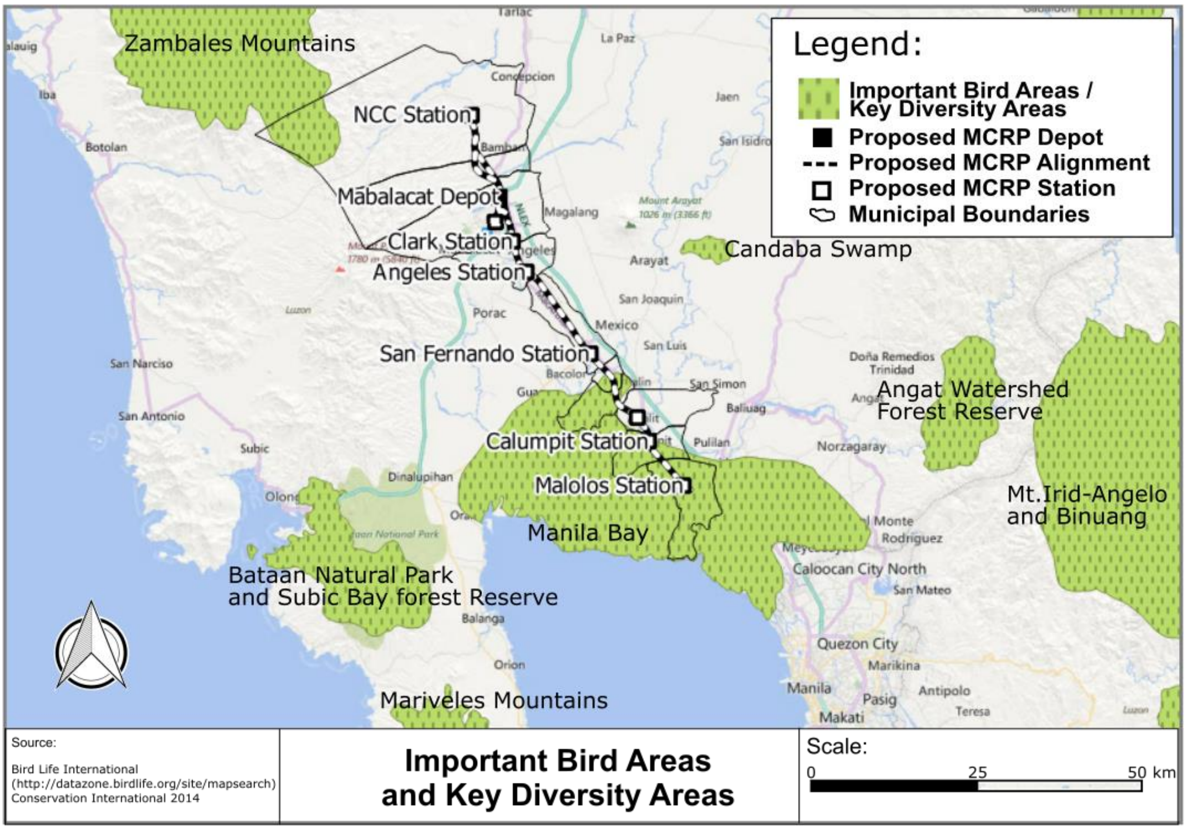
Source: Protected Areas and Wildlife Bureau, DENR

Figure 9.1.4 Protected Areas under NIPAS

3) Other important areas for biodiversity

The Important Bird Areas Program (IBAs) is a global effort to identify and conserve areas that are vital to birds and other biodiversity coordinated by the international NGO, Bird Life International. As part of the East Asia-Pacific Migratory Flyway, the Philippines has 117 IBAs covering 32,302 km^2 that act as refuge for as many as 115 globally threatened species of water birds. In 2006, DENR protected terrestrial Key Biodiversity Areas (KBAs) using data from IBAs, the 2004 IUCN Red List, as well as point locality data from published literature, experts and scientists, and museum collections. A total of 228 KBAs were identified in the Philippines, integrating a selection of 128 terrestrial and 123 marine KBAs delineated in 2006 and 2009, respectively. These KBAs cover over 106,000 km^2 and are home to 855 species, including 396 globally threatened, 398 restricted-range, and 61 category species. It is important to note that while KBAs are recognized as priority conservation areas, not all of them are covered by protective legislation. In fact, the majority of them remain unprotected or at least only partially protected.

The proposed alignment of the MCRP will traverse Manila Bay (130,465 ha) in Malolos, Minalin and Sto. Tomas, which is designated as IBA and KBA, however it is not protected under legislation. The alignment is 15 km away from Candaba Swamp, which is also designated as IBA and KBA. Many migrating birds are observed in Manila Bay during the migration season and winter. Some vulnerable species are also recorded. The location map is shown in Figure 9.1.5.



Source: 1) Bird Life International (http://datazone.birdlife.org/site/mapsearch) 2) Conservation International 2014

Figure 9.1.5 IBA and KBA location Map

(8) Endangered Species

The proposed alignment of MCRP, will traverse a mountainous area with an Ancestral Domain, the Agricultural area of Pampanga and Bulacan and Manila Bay of IBA and KBA. At Manila Bay, it has been recorded that the Philippine Duck (*Anas luzonica*) can be found which is endemic to the Philippines and classified as Vulnerable in the IUCN Red List of Threatened Species, as well as the Black-faced Spoonbill (*Platalea minor*) which is also Vulnerable in the IUCN Red List.

(9) Historical and Cultural Heritage

In the Philippines, the National Historical Commission of the Philippines (NHCP) declares the heritage in accordance with NHCP Guideline on the Identification, Classification, and Recognition of Historic Sites and Structures in the Philippines (2011) under RA 10066 (2009). Structures and site that; 1) Possess demonstrable historical significance, 2) are at least 50 years old, and 3) 70 % authentic are qualified for consideration.

Under the Project, there are two type of historical structures 1) historical and cultural heritage declared by NHCP, and 2) old PNR structures over 50 years. Table 9.1.10 and shows the list of historical and cultural heritage declared by NHCP located in close proximity to the proposed MCRP. Due to the proposed structure and alignment, distance to heritage is yet to be finalized. In addition, within the project area, old PNR stations and railway bridges are distributed along the proposed alignment. These structures are considered to meet the above-mentioned conditions. In case heritage sites are predicted to have negative impact by the project, and the PNR structures are identified to be preserved by heritage authorities, the Project will prepare preservation measures together with NHCP, DOTr and the PNR.

Table 9.1.10 Historical and Cultural Heritage Accredited by NHCP

	Heritage	Location	Distance from the Project (km)
1	Bayan ng Kalumpit	Calumpit	0.12
2	Pamintuan House	San Fernando	0.42
3	Santos-Hizon Heritage House	San Fernando	0.45
4	Lazatin House	San Fernando	0.23
5	Cuyugan-Dayrit Ancestral House	San Fernando	0.70
6	Hizon-Singian Ancestral House	San Fernando	0.41
7	Church of Apalit	Apalit	2.58
8	Death March	San Fernando	0.01
9	Himpilang Daang Bakal ng San Fernando	San Fernando	0.00
10	Artillery Memorial	Mabalacat	0.45

Source: NHCP

(10) Ancestral Domain

Republic Act No. 8371, otherwise known as the Indigenous Peoples Rights Act of 1997 (IPRA) recognizes and promote the rights of Indigenous Cultural Communities (ICCs)/ Indigenous Peoples (IPs) and the law recognized the rights of Indigenous peoples over their ancestral domains and provided for a process of titling of lands through the issuance of Certificates of Ancestral Domain Titles (CADT) or Certificate of Ancestral Land Title (CALT). The proposed alignment between CIA to NCC runs in the vicinity of Aeta CADT issued in 2009.

National Commission on Indigenous Peoples (NCIP) is established as the primary government agency responsible for the formulation and implementation of policies, plans and programs to promote and protect the rights and well-being of IPs. The NCIP AO No.1 (2006) is the first Free, Prior and Informed Consent (FPIC) Guidelines that spells out the procedure for obtaining FPIC from affected communities. Development interventions in the Philippines which overlap with the territories of ICCs/IPs are required by law to obtain consent from the concerned ICCs/IPs through the FPIC administered by the NCIP in accordance to the NCIP Administrative Order No.3 (2012) which in effect repealed NCIP AO No. 1 of 2006. In the case that the project alignment traverse through the Ancestral Domain, the necessary procedures will be followed.

The comparison table of IP definition between World Bank OP 4.10 and RA 8371 is shown in Table 9.1.11. There are no policy gaps seen between these two definitions, and IPs are also subject to consideration under the JICA Guideline.

Table 9.1.11 Comparison of IP definition between OP 4.10 and RA 8371

World Bank OP 4.10	RA 8731
Self-identification as members of a distinct indigenous cultural group and recognition of this identity by others.	A group of people or homogenous societies identified by self-ascription and ascription by other, who have continuously lived as organized community on communally bounded and defined territory, and who have, under claims of ownership since time immemorial, occupied, possessed customs, tradition and other distinctive cultural traits.
Collective attachment to geographically distinct habitats or ancestral territories in the project area and to the natural resources in these habitats and territories.	A group of people or homogenous societies identified by self-ascription and ascription by other, who have, through resistance to political, social, and cultural inroads of colonization, non-indigenous religions, and culture, became historically differentiated from the majority of Filipinos.
Customary cultural, economic, social, or political institutions that are separate from those of the dominant society and culture.	
An indigenous language, often different from the official language of the country or region.	

Source: JICA Design Team

(11) Demography

The population data of the municipalities and cities covered by the MCRP are presented in Table 9.1.12.

Table 9.1.12 Population of Project Area

Municipality/ City	Land Area (km^2)	Total Population		Growth Rate 2010 - 2015 (%)	Population Density (person/km^2)	Household Population	
		2010	2015			2010	2015
Malolos	67.25	234,945	252,074	1.46	3,748	50,949	56,255
Calumpit	56.25	101,068	108,757	1.52	1,933	21,414	24,219
Apalit	61.47	101,537	107,965	1.27	1,756	20,509	22,801
Minalin	48.27	44,001	47,713	1.69	988	8,490	9,527
Sto. Tomas	21.30	38,062	40,475	1.27	1,900	7,696	8,675
San Fernando	67.74	101,537	306,659	40.40	4,527	59,237	66,370
Angeles	63.37	326,336	411,634	5.23	6,496	72,791	94,666
Mabalacat	166.77*	215,610	250,799	3.26	1,503[1]	46,441	55,991
Bamban	251.98	62,413	69,466	2.26	276	12,987	14,739
Capas	377.66	125,852	140,202	2.28	371	25,868	30,762

Source: 2010 and 2015 Census of Population and Housing, Philippine Statistics Authority、* From Mabalacat City CLUP, 2011-2020

(12) Socio Economy

According to the World Economic Outlook Database prepared by the International Monetary Fund (IMF), the GDP per Capital of 2017 was USD 3,022, which shows the steady economic growth over the last 10 years except the year 2009 which impacted by the 2008 financial and economic crisis. In addition to the robust private consumption, growth in investment becomes prominent especially between 2014 and 2016. The contribution rate in 2014 was 0.9 which increased to 4.0 in 2015 and 5.7 in 2016. This shows that the leading factor of economic growth is shifting from private consumption to investment. By the type of industry, Agriculture, Forestry and Fisheries has dropped 1.3% from the previous year. The drought caused by the El Niño at early 2016 caused significant damage to these industries. On the other hand, mining has increased 8.4 % comparing to the previous year. Construction has increased considerably by 13.7 %. The rest of industry increased 7.4% in service, 8.9 % in Estate and BPO, and 7.6% in finance.

(13) Land use

The existing Land use of proposed alignment is summarized into the Table 9.1.13. The MCRP traverses mainly agricultural field (36%) and residential (39%).

Table 9.1.13 Land use along the proposed alignment (km)

LGUs	Agricultural Land	Residential	Commercial	Industrial	Educational/ Religious/ Health	Green field/ waterbody	Others	Total
Malolos		4.9						4.9
Calumpit		3.9	1.6	0.3	0.1	0.2		6.1
Apalit	4.4	0.6			0.1	0.1		5.2
Minalin	2.2	0.2						2.4
Santo Tomas	3.5	1.0				0.1		4.6
San Fernando	2.7	11.3	0.4	1.0	1.2	0.0		16.6
Angeles		3.2	0.9	0.5	1.0			5.6
Mabalacat	2.3	1.6		0.1		0.1	7.0*	11.1
Bamban	6.6			0.1				6.7
Capas	3.2					2.3		5.5
Total	**24.9**	**26.7**	**2.9**	**2.0**	**2.4**	**2.8**	**7.0**	**68.7**
	36%	**39%**	**4%**	**3%**	**3%**	**4%**	**10%**	**100%**

Note: *Clark Special Economic Zone

Source: JICA Design Team

9.1.4 Legal and Institutional Frameworks on Environmental Impact Assessment

9.1.4.1 Laws and Regulations of Environmental Impact Assessment

Any private or public projects or activities which are likely to have foreseeable adverse effects on the natural and social environment are subject to the Philippine Environmental Impact Statement System (PEISS). Some of the most important laws and guidelines related to PEISS are shown in Table 9.1.14.

Table 9.1.14 Important Laws and Manuals of PEISS

Laws and manuals	Stipulation
Presidential Decree No. 1152 (1977)	Philippines' Environmental Code. Comprehensive environmental management with mitigation measures were addressed and concept of the environmental impact assessment was introduced for the first time.
Presidential Decree No. 1586 (1978)	PEISS was established to conduct EIA study for the environmentally critical projects and the projects in the environmentally critical areas.
Presidential Proclamation No. 2146 (1981) and No. 803 (1996)	Proclaiming Environmentally Critical Areas and types of projects as Environmentally Critical Projects and within the scope of PEISS establish under PD No. 1586.
DENR Administrative Order No. 30 Series of 2003 (DAO 03-30)	Providing the implementing rules and regulations for the Philippine Environmental Impact Statement (EIS) System of PD No. 1586.
DENR Administrative Order No.2017 15	Guidelines on Public Participation under the Philippine Environment Impact Statement System
DENR Administrative Order No. 2018-18	Establishing a Centralized Management and Coordinative Mechanism at The Regional Offices of DENR, MGB and EMB, and Designating The DENR Regional Director as The Regional Executive Director Providing Overall Command of Regional Operations
EMB Memorandum Circular 2007-002	Revised Procedural Manual for DAO 03-30
DENR Memorandum Circular 2010-14	Standardization of Requirement and Enhancement of Public Participation in the Streamlined Implementation of the PEISS
EMB Memorandum Circular 2010-002	Clarification to DENR Memorandum Circular No. 2010-14 and Other EIS System Policy Issuances
EMB Memorandum Circular 2010-004	Guideline for Use of Screening and Environmentally Critical Area (ECA) Mapping Systems
EMB Memorandum Circular 2011-005	Incorporating Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA) concerns in the PEISS
EMB Memorandum Circular 2014-005	Guidelines of Coverage Screening and Standardized Requirement under the PEISS amending relevant portions of EMB MC 2007-002

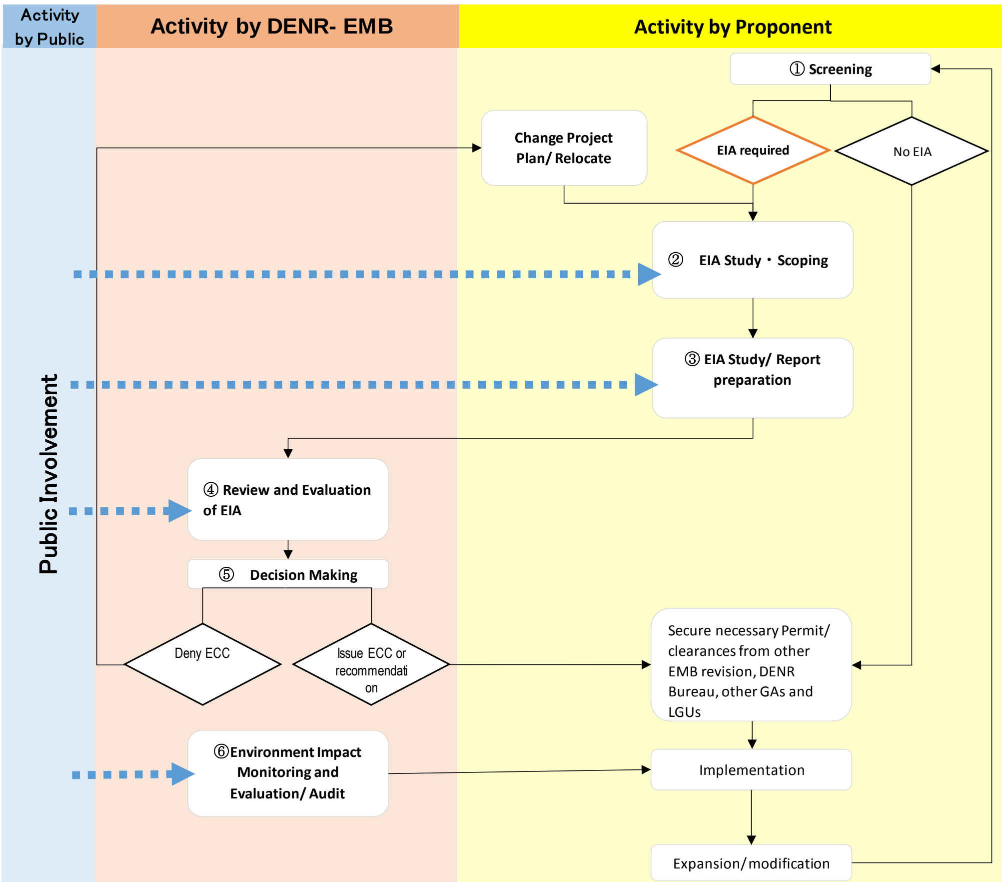
Source: JICA Design Team

9.1.4.2 Responsible Government Authorities

The Department of Environment and Natural Resources (DENR) is the government entity responsible for environmental administration. The Environmental Management Bureau of DENR (DENR-EMB) is responsible for the issuance of decision making documents such as Environmental Compliance Certificate (ECC) and Certificate of Non-Coverage (CNC) for PEISS. EMB Regional Offices in respective regions are primarily responsible for the consultation and supervision of development projects.

9.1.4.3 Environmental Impact Assessment System in the Philippines (PEISS)

The Philippine EIA Process has six sequential stages 1) Screening, 2) Scoping, 3) EIA Study and Report Preparation, 4) EIA Review and Evaluation, 5) Decision Making, and 6) Post ECC Monitoring, Validation and Evaluation/Audit stage. A summary flowchart of the complete process is presented in Figure 9.1.6.



Source: Revised Procedural Manual for DENR Administrative Order No. 30 Series of 2003 (2008)

Figure 9.1.6 Summary Flowchart of EIA Process

9.1.4.4 Projects required to implement EIA

At the Screening stage, the project is assessed as to whether it should go through the EIA process or not. Projects which have been originally declared as Environmentally Critical Projects (ECPs) or projects in Environmentally Critical Areas (ECA) predicted to have significant impacts on the quality of the environment are subject to PEISS. The projects have been classified into four major groups; Category A: Environmentally Critical Projects, Category B: Non-Environmentally Critical Projects (NECP) Located in ECA, Category C: Environmental Enhancement or Direct Mitigation Project, and Category D: Non-Covered Project (Memorandum Circular No.2014-005, Revised Guidelines for Coverage Screening and Standardized Requirements).

9.1.4.5 Types of reports required for granting of ECC

The EIA-covered projects will require the documents listed below, depending on project type, location, magnitude of potential impacts and project threshold, which differ according to the level of EIA and DENR EMB decision making process.

- Environmental Impact Statement (EIS);
- Programmatic Environmental Impact Statement (PEIS);

- Environmental Performance Report and Management Plan (EPRMP);
- Programmatic Environmental Performance Report and Management Plan (PEPRMP);
- Initial Environmental Examination (IEE) Checklist Report;
- Project Description Report (PDR)

All documents need to be prepared by the project proponent and submitted to EMB Central Office or the Environmental Impact Assessment Division of the respective EMB Regional Offices. The outcome of the EIA Process is the issuance of decision documents, which can be an ECC, a CNC or a Denial Letter.

For Category A projects (new single project), ECC application documents (EIS) need to be submitted to EMB central office to have decisions made by EMB Director and/or DENR Secretary.

9.1.4.6 Scope of Items to be examined and Contents to be assessed in the EIA

The outline contents for an EIA Report for new, single project is defined in the Memorandum Circular No. 2010-14 "Standardization of Requirements and Enhancement of Public Participation in the Streamlined Implementation of the Philippine EIS System" by DENR (June 29, 2010).

9.1.4.7 Public Participation, Public Consultation and Information Disclosure

The PEISS stresses the importance of public participation. According to DENR Administrative Order No. 2017 15, from the early stage of a project, the public for whom there is a potential to have direct/ indirect impact, are provided accurate project information and involved in a series of public discussions. Public participation will be demonstrated through the following activities:

- The Information, Education and Communication (IEC).
- Public Scoping
- Public Hearing
- Information Disclosure of EIA and Environmental Permissions
- Involvement of Indigenous Peoples in Decision-Making Process (If applicable).

9.1.4.8 Environmental Monitoring and Management Plan needs to be formulated

(1) Objectives

Under the PEISS, the primary purpose of monitoring, validation and evaluation of a project is to ensure the implementation of sound environmental management within that project as stipulated in the ECC and other related documents. Specifically, it aims to ensure the following:

- Compliance with the conditions set in the ECC;
- Compliance with the Environmental Management Plan (EMP) commitments;
- Measuring the effectiveness of environmental measures to prevent or mitigate actual project impacts as outlined in the EMP; and

- Continuous updating of the EMP for sustained responsiveness in addressing environmental impacts of undertakings.

(2) Responsible organization

1) Project Proponent

The Proponent issued with an ECC is responsible for monitoring their projects. A proponent is required to submit an ECC Compliance Monitoring Report (CMR) on a semi- annual basis to the designated monitoring EMB office on a semiannual frequency. The detailed report on compliance to environmental standards specific to environmental laws will be submitted through the Self-Monitoring Report (SMR) on a quarterly basis to the concerned EMB office.

The Proponent will also establish Environmental Guarantee Funds (EGF) which is funds to pose a significant public risk or where the project requires rehabilitation or restoration, and Environmental Monitoring Fund (EMF) which is a fund to support the activities of MMT based on the Annual Work and Financial Plan approved by the EMB. The Proponent is to discuss and agree on the amount of EGF and EMP, and operation procedure, specifying in the MOA on MMT.

2) Multipartite Monitoring Team (MMT)

Based on DENR Administrative Order (DAO) No. 2017-15, the MMT will be set up by Proponents, composing representatives of relevant stakeholders including LGU, NGOs, community leaders, NGAs. As such, the EMB and the DOTr, being principal project parties, are no longer be members of the MMT. The MMT will be set up by Proponents, and will be primarily responsible of validating the proponent's environmental performance and submits findings/recommendations semi-annual as a Compliance Monitoring and Validation Report (CMVR) to the concerned EMB office. The EMB provides oversight guidance to the MMT and consider its reports and recommendations in its impact and compliance evaluation. On the other hand, the DOTr will provide funds for the MMT activities.

3) Environmental Management Bureau (EMB)

The Environmental Management Bureau is primarily responsible for the over-all evaluation/audit of the Proponent's monitoring and the MMT's validation. EMB regional office will set up Taskforce comprising the Environment Impact Assessment Management Division (EIAMD) and Pollution Control Division (PCD) personnel jointly evaluate the effectiveness of environmental management measures being implemented by Proponent. The team will undertake hearing, field survey or sampling survey as necessary. The team will also document its evaluation findings as Compliance Evaluation Report which EMB Central Office will provide policy guidance and if necessary conduct monitoring and validation of performance audit. If EMB regional office / EMB central office found violation, fines and penalties will be imposed to the proponent, or may issue Cease and Desist Order.

(3) Disclosure of Monitoring Results

During the Construction as well as Operation, the Project Proponent is required to continue public participation, public consultation and information disclosure. CMR, SMR, MMT and CMVR are subject to public disclosure. The Project Proponent has full accountability to Stakeholders on the latest Environmental Management and Monitoring Plan and any modification of the project, any activities against the ECC.

9.1.4.9 Comparison of PEISS and JICA Guidelines/ ADB SPS

Below are the results of a gap analysis between current relevant regulations in the Philippines and the JICA Guidelines and ADB SPS. Counter measures are also proposed to fill the gap.

Table 9.1.15 Gap between JICA Environmental Guidelines, ADB SPS and Relevant Regulations in the Philippines on EIA

Topic	JICA Guideline	ADB SPS	Relevant Regulations in the Philippines	Main Gap	Countermeasures for Filling Gaps
EIA	JICA supports and examines appropriate environmental and social considerations undertaken by project proponents etc. to avoid or minimize development projects' impacts on the environment and local communities, and to prevent the occurrence of unacceptable adverse impacts.	Set of specific safeguard requirements that borrowers/clients are expected to meet when addressing social and environmental impacts and risks. Through their due diligence, review, and supervision. ADB will ensure that borrowers/clients comply with these requirements during project preparation and implementation. Over time ADB may adopt additional safeguard requirements or update existing requirements to enhance effectiveness, respond to changing needs, and reflect evolving best practices.	EIA is a process that involves predicting and evaluating the likely impacts of a project (including cumulative impacts) on the environment during construction, commissioning, operation, and abandonment. It also includes designing appropriate preventive, mitigating, and enhancement measures addressing these consequences to protect the environment and the community's welfare". (Revised Procedural Manual for DAO 2003-30,1.0,2))	No significant gaps between harmonized policy and the Philippines law	Not Applicable
Compliance with National legislations and international treaties	• Projects comply with the laws or standards related to the environment and local communities in the central and local governments of host countries; it also confirms that projects conform to those governments' policies and plans on the environment and local communities. • Projects do not deviate significantly from the World Bank's Safeguard Policies, and refers as a benchmark to the standards of international financial organizations; to internationally recognized standards, or international standards, treaties, and declarations, etc.; and to the good practices etc. of developed nations including Japan, when appropriate. (Sec.2/2.6/2, 3)	Apply pollution prevention and control technologies and practices consistent with international good practice, as reflected in internationally recognized standards such as the World Bank Group's Environmental, Health, and Safety (EHS) Guidelines.	Proposal for activities which are outside the scope of the management plan for protected areas shall be subject to an environmental impact assessment as required by law before they are adopted, and the results thereof shall be taken into consideration in the decision-making process. No actual implementation of such activities shall be allowed without the required ECC under the Philippine EIA System. In instances where such activities are allowed to be undertaken, the proponent shall plan and carry them out in such manner as to minimize any adverse effects and take preventive and remedial action when appropriate. The proponent shall be liable for any damage due to lack of caution, on indiscretion. (NIPAS Act)	No significant gaps	Not Applicable
Impacts to be Assessed	• The impacts to be assessed with regard to environmental and social considerations include impacts on human health and safety, as well as on the natural environment, that are transmitted through air, water, soil, waste, accidents, water usage, climate change, ecosystems, fauna and flora, including trans-boundary or global scale impacts. These also include social impacts, including	• Avoid, minimize, mitigate and/or offset for adverse impacts and enhancement of positive impacts through environmental planning and management • Conduct an environmental assessment for each proposed project to identify potential direct, indirect, cumulative, and induced	• The country's statutory framework requiring Environmental Impact Assessment (EIA) for all projects that will affect environmental quality is embodied in Presidential Decree (PD) 1151 of 1977. • Under the EIA process, the proponent shall assess the direct and indirect impacts of a project on the	No gap in the environment items and content. However, standards on soil, bottom sediment and	International standards such as WHO's, IFC's and developed countries' standards will be referred to in order to evaluate

Topic	JICA Guideline	ADB SPS	Relevant Regulations in the Philippines	Main Gap	Countermeasures for Filling Gaps
	migration of population and involuntary resettlement, local economy such as employment and livelihood, utilization of land and local resources, social institutions such as social capital and local decision-making institutions, existing social infrastructures and services, vulnerable social groups such as poor and indigenous peoples, equality of benefits and losses and equality in the development process, gender, children's rights, cultural heritage, local conflicts of interest, infectious diseases such as HIV/AIDS, and working conditions including occupational safety. Items to be addressed in the specific project are narrowed down to the needed ones through the scoping process. • In addition to the direct and immediate impacts of projects, the derivative, secondary, and cumulative impacts as well as impacts associated with indivisible projects will also be assessed with regard to environmental and social considerations, so far as it is rational. The life cycle impact of a project period is also considered. • Various kinds of relevant information are needed in order to assess impacts on the environment and local communities. There are, however, uncertainties in predicting such impacts caused by the incomplete understanding of impact mechanisms and the limited information available. Therefore, if the scale of uncertainty is considered to be large, project proponents etc. provide environmental and social considerations that include preventive measures as much as possible.	impacts and risks to physical, biological, socioeconomic (including impacts on livelihood through environmental media, health and safety, vulnerable groups, and gender issues), and physical cultural resources in the context of the project's area of influence. Assess potential Trans-boundary and global impacts, including climate change. Use strategic environmental assessment where appropriate.	biophysical and human environment and ensuring that these impacts are addressed by appropriate environmental protection and enhancement measures. (DAO 2003-30)	vibration have not been prepared yet	these items.
Alternatives	Environmental impact must be assessed and examined from the earliest possible planning stage. Alternatives or mitigation measures to avoid or minimize adverse impact must be examined and incorporated into the project plan.	Examine alternatives to the project's location, design, technology, and components and their potential environmental and social impacts and document the rationale for selecting the particular alternative proposed. Also consider the no project alternative	• The PEISS manual requires that the proponent should implement the alternative analysis and incorporate into EIS in the feasibility study stage. • PEISS process manual (2008) by DENR requires that the proponent should consider environmental social impacts of the project and implement the initial scoping in the pre-feasibility study stage.	No significant gaps	Not Applicable
EMP	• Impact examination must include analysis of E&S costs and benefits in the most quantitative terms possible as well as qualitative analysis,	• Avoid, and where avoidance is not possible, minimize, mitigate, and/or offset adverse impacts and	The PEISS manual requires the EMP as a substantive content of an EIA report. The EMP should detail the impacts mitigation	No significant gaps	Not Applicable

Topic	JICA Guideline	ADB SPS	Relevant Regulations in the Philippines	Main Gap	Countermeasures for Filling Gaps
	and they must be conducted in close harmony with economic, financial, institutional, social, and technical analysis of projects. • The findings of the examination must include alternatives and mitigation measures, and be recorded as separate documents or include mitigation of potential adverse impacts to the level of no significant harm to third parties, and the polluter pays principle. • EMP also provide for workers - safe and healthy working conditions, and prevent accidents, injury, and disease • Establish preventive and emergency preparedness and response measures to avoid, minimize the adverse impacts and risks to the health and safety of the local communities	enhance positive impacts by means of environmental planning and management. • Prepare an environmental management plan (EMP) that includes the proposed mitigation measures, environmental monitoring and reporting requirements, related institutional or organizational arrangements, capacity development and training measures, implementation schedule, cost estimates, and performance indicators. Key considerations for EMP preparation include mitigation of potential adverse impacts to the level of no significant harm to third parties, and the polluter pays principle.	plan, areas of public information, education and communication, social development program proposal, environmental monitoring plans (with multi-sectoral public participation for EIS-based projects) and the corresponding institutional and financial requirements/ arrangements of proposed project or undertaking.		
Consultation	• Project proponents etc. consult with local stakeholders through means that induce broad public participation to a reasonable extent, in order to take into consideration, the environmental and social factors in a way that is most suitable to local situations, and in order to reach an appropriate consensus. • Project proponents etc. to publicize in advance that they plan to consult with local stakeholders, with particular attention to directly affected people, in order to have meaningful meetings. • In the case of Category A projects, encourages project proponents etc. to consult with local stakeholders about their understanding of development needs, the likely adverse impacts on the environment and society, and the analysis of alternatives at an early stage of the project, and assists project proponents as needed. • Consultations with relevant stakeholders, such as local residents, should take place if necessary throughout the preparation and implementation stages of a project. Holding consultations is highly desirable, especially when the items to be considered in the EIA are being selected, and when the draft report is being prepared. (Appendix 2)	• Carry out meaningful consultation with affected people and facilitate their informed participation. Ensure women's participation in consultation. Involve stakeholders, including affected people and concerned nongovernment organizations, early in the project preparation process and ensure that their views and concerns are made known to and understood by decision makers and taken into account. Continue consultations with stakeholders throughout project implementation as necessary to address issues related to environmental assessment. Establish a grievance redress mechanism to receive and facilitate resolution of the affected people's concerns and grievances regarding the project's environmental performance. • For category-A projects, ADB ensures that the borrower or private sector sponsor carries out public consultation at least twice: (a) once during the early stages of	• As part of the social preparation process at pre-Scoping, Information, Education and Communication (IEC) is now explicitly required at the minimum of PEIS/EIS-based applications for which Public Scoping is a requirement. The IEC serves as a basis for preliminary identification of stakeholders and related issues in preparation for the Scoping proper. The conduct of the EIA Study shall include local stakeholders, who may serve as local expert sources, aides/guides, and resource persons in primary data collection to optimize access to indigenous knowledge of the environment. • As a form of disclosure of the EIA findings, Public Hearing is required for all new ECPs for which Public Scoping was undertaken and for PEIS-based applications. If necessary EMB should conduct Public Consultations.	No significant gaps	Not Applicable

Topic	JICA Guideline	ADB SPS	Relevant Regulations in the Philippines	Main Gap	Countermeasures for Filling Gaps
		EIA field work; and (b) once when the draft EIA report is available, and before loan appraisal by ADB.			
Information Disclosure	• In principle, project proponents etc. disclose information about the environmental and social considerations of their projects. • JICA encourages project proponents etc. to disclose and present information about environmental and social considerations to local stakeholders. (Sec.2/2.1/1, 6) • Project proponents etc. in the preparation of documents in an official or widely used language and in a form understandable by local people. (2.1/1, 6,7) • For Category A project, JICA publishes the status of host countries' submission of major documents on environmental and social considerations on its website. Prior to its environmental review, JICA also discloses EIA reports and environmental permit certifications 120 days prior to concluding agreement documents. JICA discloses a translated version of EIA reports, subject to approval by project proponents etc.	• Disclose a draft environmental assessment (including the EMP) in a timely manner, before project appraisal, in an accessible place and in a form and language(s) understandable to affected people and other stakeholders. • Disclose the final environmental assessment, and its updates if any, to affected people and other stakeholders	• As a form of disclosure of the EIA findings, Public Hearing (PH) is required for all new ECPs for which public scoping was undertaken and for PEIS-based applications. Before the PH, relevant documents have to be opened to the public. • Full copies of the EIA Report are made accessible at the concerned EMB Offices, libraries/development council offices of the host cities. Concerned Barangays are also provided with the Executive Summary of the EIA Report. Copy of ECC is also submitted to other permitting agencies including funding institutions.	No significant gaps between Harmonized Policy and the Philippines' laws.	Not Applicable
Monitoring and Disclosure	• JICA confirms with project proponents etc. the results of monitoring the items that have significant environmental impacts. This is done in order to confirm that project proponents etc. are undertaking environmental and social considerations for projects that fall under Categories A, B, and FI. • Project proponents etc. must supply the information necessary for monitoring confirmation by JICA by appropriate means, including in writing. When necessary, JICA may also conduct its own investigations. • JICA discloses the results of monitoring conducted by project proponents etc. on its website to the extent that they are made public in project proponents etc. (Sec.3/3.2/3.2.2/1, 7)	Implement the EMP and monitor its effectiveness. Document monitoring results, including the development and implementation of corrective actions, and disclose monitoring reports.	• The Proponents issued ECCs are primarily responsible for monitoring their projects. They are required to submit two kinds of monitoring reports, the ECC Compliance Monitoring Report (CMR) on semi-annual frequency and the Self-Monitoring Report (SMR) on a quarterly basis to the concerned EMB RO. • During project implementation, LGUs are represented in the Multipartite Monitoring Teams (MMTs), teams which are composed of various stakeholders which generally form the pillar for local vigilance to project performance. • Major features of the MMT are: 1. Provides appropriate checks and balances in monitoring of project implementation. 2. Validates the proponent's performance. 3. Recommends courses of action to	No significant gaps. between Harmonized Policy and the Philippines' laws	Not Applicable

Topic	JICA Guideline	ADB SPS	Relevant Regulations in the Philippines	Main Gap	Countermeasures for Filling Gaps
			EMB through the Compliance Monitoring and Validation Report (CMVR). • The EMB-DENR remains to be the primary actor for the overall evaluation of the proponents monitoring and the MMTs validation.		
Site selection	Projects must, in principle, be undertaken outside of protected areas that are specifically designated by laws or ordinances for the conservation of nature or cultural heritage (excluding projects whose primary objectives are to promote the protection or restoration of such areas). Projects are also not to impose significant adverse impacts on designated conservation areas. (Appendix 1. 4-2)	Do not implement project activities in areas of critical habitats, unless (I) there are no measurable adverse impacts on the critical habitat that could impair its ability to function, (ii) there is no reduction in the population of any recognized endangered or critically endangered species, and (iii) any lesser impacts are mitigated. If a project is located within a legally protected area, implement additional programs to promote and enhance the conservation aims of the protected area. In an area of natural habitats, there must be no significant conversion or degradation, unless (i) alternatives are not available, (ii) the overall benefits from the project substantially outweigh the environmental costs, and (iii) any conversion or degradation is appropriately mitigated. Use a precautionary approach to the use, development, and management of renewable natural resources.	All designated, critical habitats shall be protected, in coordination with the local government units and other concerned groups, from any form of exploitation or destruction which may be detrimental to the survival of the threatened species dependent therein. For such purpose, the Secretary may acquire, by purchase, donation or expropriation, lands, or interests therein, including the acquisition of usufruct, establishment of easements or other undertakings appropriate in protecting the critical habitat. (RA 9147)	No significant gaps	Not Applicable

Source: JICA Design Team

9.1.4.10 Environmental Standards

Presidential Decree 1152, otherwise known as the "Philippine Environment Code (1977)", establishes specific environment management policies and prescribes environmental quality standards. This is supplemented by Office of the President Executive Order 192 (1987) which mandates the EMB, among others to; 1) formulate environmental quality standards such as the quality standards for water, air, land, noise and radiation, 2) recommend rules and regulations for environmental impact assessment and provide technical assistance for their implementation and monitoring, and 3) formulate rules and regulations for the proper disposition of solid wastes, toxic and hazardous substances.

JICA and ADB recognize national environmental standards for projects. If national environmental standards differ with international standards, the more stringent standards will be adopted. However, if sufficient justification exists, the country/national standards will apply.

Table 9.1.16 Environment Standards applied to the Project

item	National Standard	International Standard
Ambient Air Quality	• DAO No. 2000-81, Ambient Air Quality and Emission Standards • DAO No. 2013-13, Provisional National Ambient Air Quality Guideline Values for Particulate Matter 2.5 (PM2.5)	• World Health Organization Air Quality Guidelines for PM, O_3, NO_2 and SO_2
Surface water Quality	• DAO No. 2016-08, Water Quality Guidelines	• Environmental Quality Standards for Water Pollution of the Japan Ministry of Environment
Effluent	• DENR's General Effluent Standards of 2016	• IFC Indicative Guideline Values for Treated Sanitary Sewage Discharges (2007)
Groundwater Standards	• Department of Health Administrative Order No. 2017-0010, Philippine National Standards for Drinking Water (PNSDW) • DAO No. 2016-08, Water Quality Guidelines and General Effluent Standards	• WHO Guidelines for Drinking Water Quality (2011)
Ambient Noise Quality (*)	• National Pollution Control Commission Memorandum Circular No.002 Series of 1980, Section 78 (1980), Noise Environment Standards	• Noise guideline values for the new project and large-scale modification of the conventional railway in Japan Environmental Agency, 1995
Ambient Vibration Quality	-	• BS 5228-2:2009 Code of practice for noise and vibration control on construction and open sites - Part 2: Vibration, provides source data, prediction methodologies, mitigation measures and management • Technology and Laws Regulation for Pollution Control, 2000, Japan Environmental Management Association for Industry
Soil Quality	• The Bureau of Soils and Water Management Soil Fertility Rating • National DAO 2013-22	• Dutch Target and Intervention Values (2000)
Soil Contamination		• Dutch Target and Intervention Values (2000)

Note: * As of October 2018, noise and vibration standard to be applied during operation is under discussion with ADB, DOTr and EMB.

Source: JICA Design Team

9.1.4.11 Other Environmental Laws and Regulations

Major environmental laws and regulations, which might be relevant to the project, must also be observed. The PEISS states obligations to strictly comply with the environmental laws, regulations and standards, which have been established by the Philippine government.

Table 9.1.17 Philippines Environmental Laws, and Regulations

Items	Laws, Regulations and Environmental Quality Standards
Biodiversity	• Republic Act (RA) No.7586 (1992), National Integrated Protected Areas System (NIPAS) Act • RA No. 9147 (2001), Wildlife Resources Conservation and Protection Act • Executive Order (EO) No. 247, Prescribing Guidelines and Establishing a Regulatory Framework for the Prospecting of Biological and Genetic resources, there by-products and derivatives for Scientific Purposes and for other Purposes • DENR Administrative Order (DAO) No. 2004-15 Establishing the List of Terrestrial Threatened Species and their Categories and the List of other Wildlife species pursuant to RA 9147 otherwise known as the Wildlife Resources and Conservation Act of 2001 • DAO 2007-24, Establishing the National List of Threatened Plants and their categories and the List of other Wildlife Species
Forestry	• Presidential Decree (PD) No. 705 (1975), Forestry Reform Code • PD 953 (1976), Requiring the planting of trees in certain places and penalizing the unauthorized cutting, destruction, damaging and injury of certain trees, plants, and vegetation • EO No. 193 s. 2015, Expanding the Coverage of the National Greening Program (NGP)
Pollution Control (Water)	• PD No. 1067 (1976), Water Code • RA 9275 (2004), Clean Water Act • DAO No. 2005-10, IRR of the Clean Water Act
Pollution Control (Air)	• RA No. 8749 (1999), Clean Air Act
Pollution Control (Waste)	• RA No. 6969 (1990), Toxic Substances, Hazardous and Nuclear Wastes Control Act • PD No. 856, Sanitation Code • DAO 2006-10, Guidelines on the Categorized Final Disposal Facilities • DAO 2006-09, General Guidelines on the Closure and Rehabilitation of Open Dumpsites and Controlled Disposal Facilities • DAO 2013-22, IRR of RA 6969 • RA 9003, Ecological Solid Waste Management Act • DAO 1994-28, Interim Guidelines for the Importation of Recyclable Materials containing Hazardous Substances • DAO 1997-28, Amending Annex A of DAO 1994-28 • DAO 2001-34, IRR of RA 9003
Historical/ Cultural Heritage	• RA No. 10066 (2009), Providing for the Protection and Conservation of the National Cultural Heritage, Strengthening the National Commission for Culture and Arts (NCCA) and its Affiliated Cultural Agencies and for Other Purposes • RA No. 10086 (2010), Strengthening Peoples' Nationalism through Philippine History by changing the nomenclature of the National Historical Institute into the National Historical Commission of the Philippines (NHCP), Strengthening its powers and functions, and for other purposes
Ancestral Domain, Indigenous People	• RA No. 8371 (1997), Indigenous Peoples Rights Act • National Commission on Indigenous People (NCIP) Administrative Order (AO) No. 1 series of 1998, Rules and Regulations implementing RA 8371 otherwise known as "Indigenous Peoples Rights Act of 1997 • NCIP AO No. 1 series of 2004, Guidelines on the Formulation of the Ancestral Domain Sustainable Development and Protection Plan • NCIP AO No. 1 series of 2006, The Free and Prior Informed Consent Guidelines of 2006 • NCIP AO No. 3, series of 2012, Revised Guidelines on Free and Prior Informed Consent and related Processes
Climate Change and Disaster Risk Reduction	• RA 9729 (2009), Climate Change Act • Climate Change Commission (CCC) AO No. 2010-01, IRR of RA 9729 • EO No. 174, Institutionalizing Philippine Greenhouse Gas Inventory Management and Reporting System • RA 10121 (2010), Philippine Disaster Risk and Management Act • RA 10174 (2012), People's Survival Fund • EMB Memorandum Circular (MC) 2011-005, EIA Technical Guidelines Incorporating Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA) concerns

Source: JICA Design Team

9.1.5 Comparison on Alternatives

Comparison analysis of alternatives on ROW, structure, and depot was conducted to present the justification made for the proposed option including the without project option. Analysis was made from the perspective of environment and social considerations, as well as engineering and construction cost etc. without a weighting being applied.

9.1.5.1 Without Project Option

Public transportation access from the suburbs to Metro Manila is limited to roads, and the amount of traffic causes a bottleneck for further development in the northern direction. The northern part of the metropolis up to CIA has no operating railway, and residential areas are already expanding without sufficient public transportation. The without project option would have to rely on methods to make road use more efficient. Many of these are already in place (bus lanes, traffic management, junction improvements) and traffic congestion continues to rise. The northern suburbs would continue to develop as land is cheaper and more of the city becomes polluted. Traffic would increase and the time losses associated with traffic continue to rise. Therefore, if MCRP which is the railway system linking the northern part of the metropolis to Metro Manila stays undeveloped, sustainable growth of local industry will be hampered and the environment of the area will deteriorate further due to the traffic congestion and air pollution. Therefore, the negative effects of not pursuing the Project lead to the conclusion that it is not an option.

9.1.5.2 ROW Alternative Option

(1) Alternative Option

The alternative ROW of MCRP which links the northern part of the Metro Manila from Malolos to NCC will use the existing PNR ROW as much as possible in order to minimize land acquisition and involuntary resettlement. However, from CIA station to NCC station are being new alignment, the alternative option includes an option passing outside of the existing ROW.

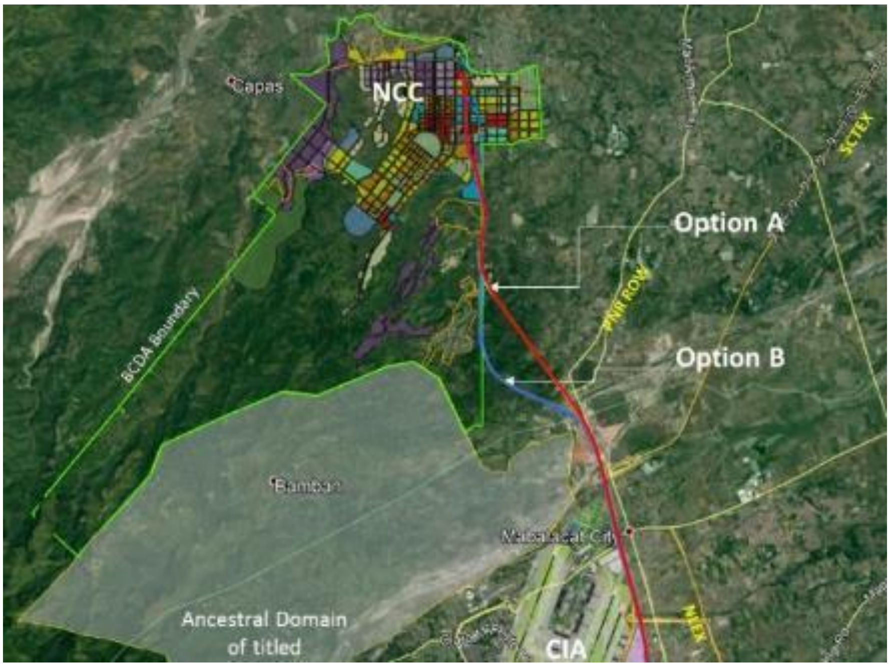
(2) Result of Alternative Comparison

ROW alternatives were considered for two sections; CIA to NCC and Clark to CIA.

1) CIA to NCC Section

Option A has a shorter tunnel and partially utilizes the Government Agency; Bases Conservation and Development Authority land (BCDA). On the other hand, Option B maximizes the use of BCDA property but will require a longer tunnel. Based on the NCIP Field Based Investigation on August 29, 2018, the Project obtained Certificate of Non Overlap on September 19, 2018 from NCIP, which confirms the Project does not traverse or overlap the Ancestral Domain (AD) areas. Considering the cost and construction duration for tunneling, Option A was chosen as the better route from CIA to NCC. The result of alternative analysis is shown in Table 9.1.18.

Table 9.1.18 Comparison of ROW Alternative for CIA-NCC Route

	Option A	Option B
Alternative options		
Social Environment		
Land Acquisition	B: Slightly more land acquisition (44,7 ha) compared to Option B.	A: Minimum land acquisition (41.9 ha)
Affected Households	A: Very few	A: Very few
Historical/Cultural Heritage	A: No historical/cultural heritage along the alignment	A: No historical/cultural heritage along the alignment
Indigenous People · Ethnic Minorities	A: Does not pass through Ancestral Domain area	A: Does not pass through Ancestral Domain area
Natural Environment		
Protected Area	A: No Protected Area along the alignment	A: No Protected Area along the alignment
Biodiversity	B: Passes through Sacobia River which was affected by the eruption of Mt Pinatubo	B: Passes through Sacobia River which was affected by the eruption of Mt Pinatubo
Pollution Prevention		
Noise and Vibration	B: Tunnel blasting might cause noise and vibration pollution which can be mitigated	C: Tunnel blasting might cause noise and vibration pollution longer period than Option A, which might be mitigated
Air Pollution	B: Tunnel blasting might cause air pollution which can be mitigated.	C: Tunnel blasting might cause air pollution longer period than Option A, which can be mitigated
Water Pollution	B: Few impact	B: Few impact
Others		
Construction Difficulty	C: Needs longer Safety Management because of use of Tunnel Boring Machine (TBM)or explosives for the tunnel excavation	C: Needs longer Safety Management because of use of Tunnel Boring Machine (TBM)or explosives for the tunnel excavation
Construction Period	B: The tunnel length is 2.2 km, and will be shorter than Option B.	C: The tunnel length is 3.0 km and will need a longer period of time.
Construction Cost	A: Construction cost is less than Option B	B: Construction cost is higher than Option A
Total Evaluation	A: Noise and pollution impact can be minimized, and technically and financially suitable and preferred alignment.	B: Pollution will be generated longer period.

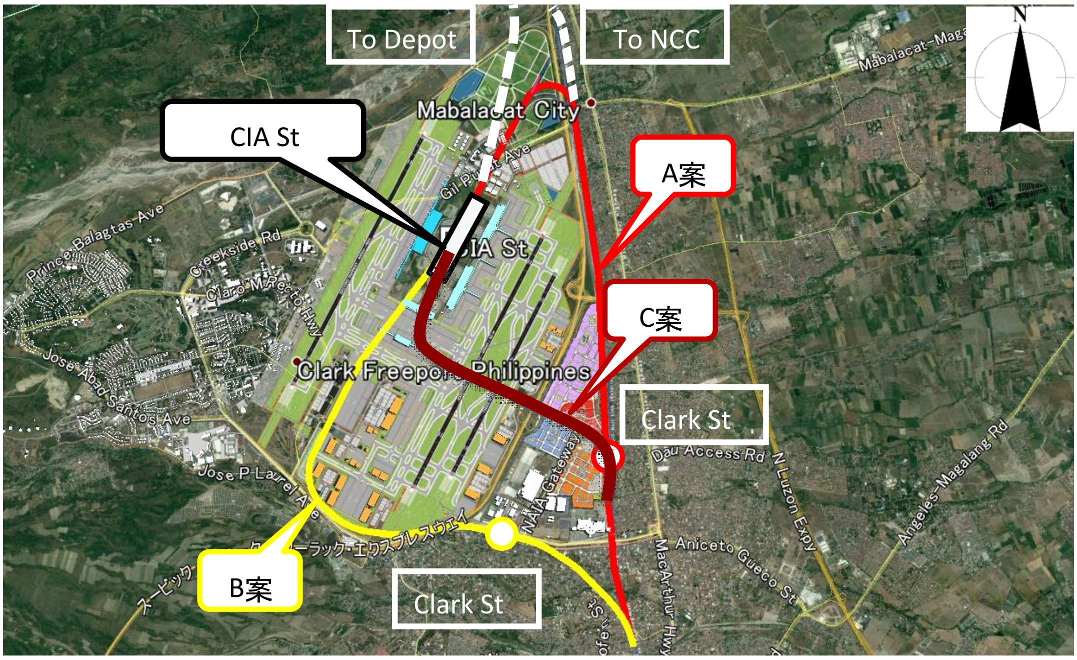
Note: A: Excellent, B: Good, C: Poor

Source: JICA Design Team

2) Clark to CIA Section

For the segment between Clark and CIA, three alternatives were compared including Option A (Viaduct +Underground Option) which follows the PNR ROW turning left to CIA station after passing the airport, Option B (Underground Option①) which locates Clark Station to the south of the airport and connects to CIA, and Option C (Underground Option②) which follows Option A, but run through the runway to reach to CIA station. After a series of discussions, Option A is selected as a preferred option.

Table 9.1.19 Comparison of ROW Alternative for Clark-CIA connecting routes

	Option A (Viaduct + Underground Option)	**Option B (Underground Option①)**	**Option C (Underground Option②)**
Alternative options	 		
Social Environment			
Land Acquisition	B: Land acquisition (10.6 ha) needed more than Option C but less than Option B	C: Land acquisition (11.2 ha) needed the Most	A: Land acquisition (8.0 ha) needed the least
Affected Households	B: Few	C: Many	A: Very limited
Historical/cultural Heritage	A: No historical/cultural heritage along the alignment	A: No historical/cultural heritage along the alignment	A: No historical/cultural heritage along the alignment
Natural Environment			
Protected Area	A: No Protected Area along the alignment	A: No Protected Area along the alignment	A: No Protected Area along the alignment
Biodiversity (Wetland)	A: No vegetation or wetland along the route	A: There is a partial vegetation within CIA, but this area will be passed by shield, so there will be no impact	A: No vegetation or wetland along the route
Others			
Construction Difficulty	A: Viaduct construction is not difficult. Underground Structure of short length is the "Cut and Cover" construction method is not difficult.	C: High technology is needed as it is necessary to protect the highway at the south of the airport while making the railway pass	C: Very complicated technology is needed as it is a shield construction under the currently used runway
Construction Period	A: The segment is the longest with 10.9 km, but it is constructed with 8.0 km viaducts and the 2.9 km cut	B: The total length is 9.6 km, but as it passes through the south of the airport, it cannot be constructed by viaduct and	C: The total length is the shortest with 7.5 km, but the tunnel length is the longest with 2.8 km

	Option A (Viaduct + Underground Option)	**Option B (Underground Option①)**	**Option C (Underground Option②)**
	and cover underground structure and the construction period is the shortest.	construction period will be long	and construction period will be long
Construction Cost	A: Most economical	C: Same as Option C	C: Expensive because of tunnel construction
Evaluation	A: Passengers going to CIA from NCC will need to transfer at Clark Station. After discussion with DOTr, although it is not as convenient, this Option was chosen because of technical and financial consideration.	C: The construction cost is expensive as a part of the route has to go underground in order to avoid visual interference for the takeoff/landing of airplanes, and there are fewer merits compared to Option A so it is not chosen.	C: This option is not chosen as the route inside the airport is to be underground, and there are fewer merits compared to Option A for construction period and construction cost

Note: **A**: Excellent, **B**: Good, **C**: Poor

Source: JICA Design Team

9.1.5.3 Structure Alternative Option

(1) Alternative Option

For railway structures, alternative options for the below three types were considered.

- Elevated structure (Viaduct)
- Underground structure
- Embankment structure

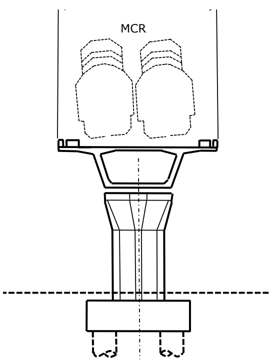
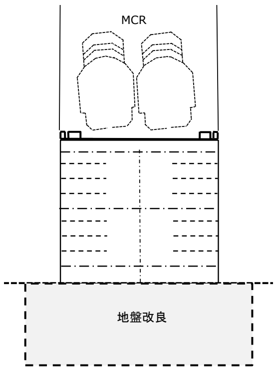
(2) Result of Alternative Comparison

The result of comparison the above-mentioned alternatives are shown in Table 9.1.20 andTable 9.1.21. At section where there is crossing with arterial roads or flood prone areas, viaduct is recommended. Underground has less impact on environment and social consideration, and has few obstacles that cannot be avoided if using the existing PNR ROW, but is not preferred option to adopt due to lengthy construction period and high cost.

1) Malolos – NCC section

Malolos- NCC section will require many road crossings with arterial roads. There are also flood prone areas. Table 9.1.20 shows the comparison of the viaduct option with the embankment option.

Table 9.1.20 Comparison of MCRP Structural Type (Malolos-NCC)

	Elevated Structure Option	**Embankment Structure Option**
Appearance		
Social Environment		
Land Acquisition	A: The necessary ROW is the narrowest	B: Wider ROW is necessary than elevated structure for the amelioration of the soil
Affected Households	Resettlement of PAPs within the ROW is necessary	B: Resettlement of PAPs within the ROW is necessary
ROW	A: The necessary ROW between stations is 30m, and 60m at station	A: The necessary ROW between stations is 30m, and 60m at station
Dividing of local community	B: Minor impact of community division	C: significant impact of community division
Natural Environment		
Protected Area	B: Less impact than embankment option is expected	C: Significant impact is expected
Biodiversity	B: Less impact than embankment option is expected	C: Significant impact is expected
Flooding Risks	A: As it is an elevated structure, the tracks will not be submerged in case of flooding	C: As the embankment will act as a dam, additional drainage will be necessary to minimize flooding
Pollution Prevention		
Noise	B: Noise will be generated along the railway, but the impact can be mitigated by installing the noise barrier.	Boise will be generated along the railway, but the impact can be mitigated by installing the noise barrier
Air Pollution	B: The operation of construction machinery and vehicles during construction is expected to generate air pollution	B: There will be many vehicles loading embankment material during construction and air pollution is expected
Water Pollution	A: Limited impact	A: Limited impact
Ground Subsidence	A: No ground subsidence	C: There is risk of land subsidence in case of soft ground
Engineering		
Construction Difficulty	A: Not difficult	A: Not difficult
Construction Period	B: Long	B: Long as soil improvement is necessary
Construction Cost	A: Lower cost than underground	A: Same as elevated structure as soil improvement is necessary
Operation /Maintenance	A: Maintenance and cost is less than embankment structure	C: Maintenance and cost is the lowest, but in case of ground subsidence or condition change, reparation is very difficult
Disaster Prevention	B: Relatively safe	A: Relatively safe and measures are easy compared to Option A.
Earthquake	A: Seismic design is applied	A: Seismic design is applied

	Elevated Structure Option	Embankment Structure Option
View from the Windows	A: Good	A: Good
Landscape views towards	B: Being elevated structure makes more open than embankment structure, but the design needs to consider integration to the surrounding landscape	C: embankment make views more obstructed than elevated structure, the design needs to consider integration to the surrounding landscape
Physical Conditions	B: Minor impact to the road	C: Minor impact to the road
Evaluation	【Malolos-Clark】 A Less dividing of local community, biodiversity and flooding risks are less. Impact on landscape and existing roads is smaller than embankments and it is the most suitable structure	【Malolos-Clark】 B It has advantages over viaducts on disaster prevention, but the impacts on community dividing, biodiversity, flooding risks, landscape and existing roads are greater and there are fewer merits compared to elevated structure

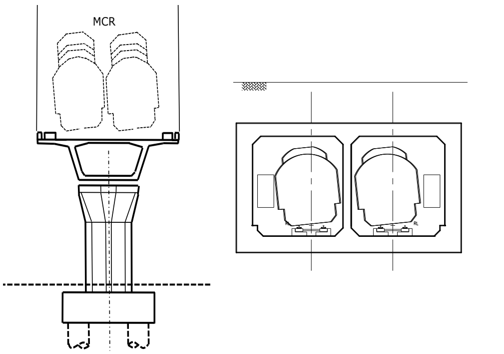
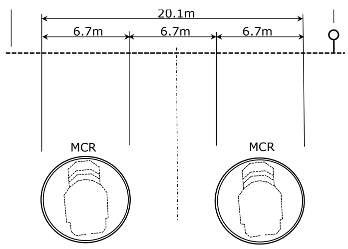
Note: A: Excellent, B: Good, C: Poor

Source: JICA Design Team

2) Clark-CIA section

Table 9.1.21 shows the structure alternatives for the Clark-CIA section, which includes the underground option at the airport as considered in Table 9.1.19.

Table 9.1.21 Comparison of MCRP Structural Type (Clark-CIA)

	Option 1 Viaduct + Underground	Option 2 Underground
Appearance		
Social Environment		
Land Acquisition	A: The necessary ROW is the narrowest	C: The necessary ROW is the widest
Affected Households	B: Resettlement of PAPs and ISFs within the ROW is necessary	A: No resettlement needed for the land above the tunnel
ROW	A: The necessary ROW between stations is 30m, and 60m at station	B: The necessary ROW between stations is 30m, and 60m at station
Dividing of local community	B: Little impact of community division	A: No impact of community division
Natural Environment		
Protected Area	B: Smaller impact is expected	A: Tunnel structure have very limited impact on the ground
Biodiversity	B: Smaller impact is expected	A: Tunnel structure have very limited impact on the ground
Flooding Risks	B: In the section of the elevated structure, the tracks will not be submerged in the event of flooding. Measures to prevent flooding in the tunnel in the section of underground structures are necessary; however, it is a short limited section.	C: Need to take measures to prevent submersion in the tunnel in case of flooding

	Option 1 **Viaduct + Underground**	**Option 2** **Underground**
Pollution Prevention		
Noise and minimum	B: There will be noise along the railway, which can be mitigated by installing noise barriers.	A: There will be no noise along the railway
Air Pollution	B: The operation of construction machinery and vehicles during construction is expected to generate air pollution	B: During construction, transportation of excavated soil by vehicle is expected to generate air pollution
Water Pollution	B: Limited impact at Viaduct section. Possible impact on underground water during construction, however, a section is short and minimum.	C: Possible impact on underground water during construction
Ground Subsidence	A: No ground subsidence	A: Low risk of flooding because of underground structure
Engineering		
Construction Difficulty	A: Not difficult to compare Option B.	C: difficult
Construction Period	B: Long	C: Longest
Construction Cost	A: Lower cost than Option B.	C: Very high in cost
Operation /Maintenance	A: Maintenance time and cost is less than Option B	C: Maintenance time and cost is the higher
Disaster Prevention	B: For the section of the elevated structure, relatively safe and measures are easy compared to Option B. The underground structure is short and minimum impact.	C: If fire occurs in the tunnel, it will become a large disaster
Earthquake	A: Structures are designed in consideration of earthquakes	A: Structures are designed in consideration of earthquakes
View from the Windows	A: Pleasant	C: No view
Landscape	B: Elevated structure feels liberated, but the design needs to consider integration to the landscape	A: No impact on landscape because of underground structure
Physical Conditions	B: Minor impact to the road	A: No impact on roads
Evaluation	【Clark-CIA】 A The overall evaluation is lower regarding affected households, dividing of local community, impacts on roads, but construction period, construction cost, operation/maintenance is better, so this option was adopted after discussion with DOTr.	【Clark-CIA】 B This option is better than the elevated option for social and environmental aspects, but as the construction period is long and the construction cost is expensive, this option was not adopted.

Note: A: Excellent, B: Good, C: Poor

Source: JICA Design Team

9.1.5.4 Depot Site Alternative Options

For depot site, three options were compared. Due to the Ancestral Domain (AD) located at the north of Sacobia River, it is very difficult to secure land with sufficient area to accommodate the depot. Proposed options have no overlaps with AD. However, in accordance with the NCIP AO No.3, Series of 2012, the confirmation of non-overlap to the AD requires through a field-based investigation (FBI) to finalize the depot location for Option 1. During the FBI conducted on August 29, 2018, it is confirmed that the Option 1 does not overlap with AD according to the FBI report. A Certificate of Non-Overlap was issued on September 19th, 2018.

Table 9.1.22 Alternative Comparison for MCRP Depot Site

	Option 1 Along Sacobia River near CIA	Option 2 Around NCC Food Terminal	Option 3 North of CIA and next to Subic Clark Depot
Location			
Social Environment			
Land use	A: Approximately 48 ha land proposed by DOTr	A: approximately 42 ha sufficient for the purpose is available	A: Approximately 33 ha proposed by DOTr
Land Acquisition	A: No Land Acquisition required	A: No Land Acquisition required	B: No Land Acquisition is required, however there is one leaseholder contracted with CIAC.
Resettlement	C: Resettlement of approximately 120 ISFs	A: No resettlement expected	B: Potential loss of Leaseholder's Income
Natural Environment			
Protected Area	A: No encroachment to the protected area	A: No encroachment to the protected area	A: No encroachment to the protected area
Land Alteration	C: Loss of Grasses and shrubs, patches of planted trees (approx. 48 ha)	B: Loss of Some rice fields, grassland, approx. 100 trees (approx. 42 ha)	A: 10,000 mango trees (tree plantation), vegetable farm (cucumber, cabbage etc.). (approx. 33 ha)
Pollution			
Noise and Vibrations	C: Potential risk of noise and vibration impact on residential area	B: Little impact of noise and vibration as there is no residential area nearby	B: Little impact of noise and vibration as there is no residential area nearby
Water	B: Risk of water pollution of Sacobia river due to mud water discharged during construction	A: There is low Risk of water pollution.	B: Risk of water pollution of Dolores river due to mud water discharged during construction
Flood	B: Within the Flood Defense wall	A: not flood prone area	A: not flood prone area
Engineering			
Construction Difficulty	A: Not difficult	B: More difficult	A: Not difficult
Construction Period	B: Long	C: Longer	B: Long
Construction Cost	A: Short railroad siding, favorable cost wise	C: Long railroad siding, not favorable cost wise	A: Short railroad siding, favorable cost wise

	Option 1 Along Sacobia River near CIA	Option 2 Around NCC Food Terminal	Option 3 North of CIA and next to Subic Clark Depot
Operation	A: Near CIA, convenient for commuting B: Only trains operated to CIA Station can easily be forwarded to the depot.	C: Far from CIA and less convenient for commuting C: Time consuming to forward trains to the depot.	A: Near CIA, convenient for commuting B: Only trains operated to CIA Station can easily be forwarded to the depot.
Access	B: Limited in land condition and difficult to provide access for northbound line	A: Flexible in land condition possible to provide access to both northbound and southbound line	B: Limited in land condition and difficult to provide access for northbound line
Evaluation	B: As there is no need of land acquisition and the site is outside the Ancestral Domain, however significant resettlement is required.	C: There are no residential affected by noise and vibrations, and the site is outside the Ancestral Domain. However, because of cost and less convenience, the total evaluation is low.	A: There is no residential affected by noise and vibrations, and the site is outside the Ancestral Domain. In addition, this is not flood prone area. However, road diversion is required.

Note: A: Excellent, B: Good, C: Poor. Please note that the depot site option 3 is added in September 2018.

Source: JICA Design Team

9.1.6 Scoping and TOR for the Survey on Environmental and Social Considerations

9.1.6.1 Scoping

Based on the preferred alternatives of ROW, structure type and depot location, the scoping of EIA was conducted and shown in Table 9.1.23.

Table 9.1.23 Draft Scoping of MCRP

No	Items	Evaluation: Pre/During construction	Evaluation: Operation	Reason of evaluation
Pollution Control				
1	Air Pollution	B-	B-	**Construction Phase:** Construction works and operation of construction equipment and machinery will generate air pollution. **Operation Phase:** Air pollution will be mitigated by reducing traffic congestion.
2	Water pollution	B-	C	**Construction Phase:** Turbid water generated at the construction site might have bad effect on water pollution. **Operation Phase:** Non-treated water from stations and maintenance facilities might have an impact on water pollution.
3	Soil pollution	B-	C	**Construction Phase:** Poor maintenance of construction equipment, machinery and vehicles may cause soil contamination by leak of oil. **Operation Phase:** Maintenance facility of depot may cause soil contamination by leak of oil.

No	Items	Evaluation: Pre/During construction	Evaluation: Operation	Reason of evaluation
4	Waste	B-	C	**Construction Phase:** Construction work will generate a vast quantity of excavation soil. **Operation Phase:** Illegal dumping from stations and depot may cause impacts on the environment.
5	Noise and Vibration	B-	C	**Construction Phase:** Construction works will cause noise and vibration to surrounding environment **Operation Phase:** Operation of trains may cause noise around viaduct sections. The impact of vibrations to the old PNR structures needs to be take in to account.
6	Ground subsidence	C	C	**Construction/Operation Phase:** In case of construction on soft ground, appropriate methods need to be adopted to avoid ground subsidence,
7	Odor	D	D	**Construction /Operation Phase:** No odor will be generated due to the project characteristics (Railway project).
8	Bottom sediment	B-	C	**Construction Phase:** Turbid water generated at the construction site might impact on bottom sediment. Poor maintenance construction machinery and vehicles may cause bottom sediment contamination by leak of oil.
Natural Environment				
9	Protected Area	D	D	**Construction /Operation Phase:** The project will traverse through Manila Bay.
10	Ecosystem	B-	B-	**Construction Phase:** There are IBAs and KBAs of Manila Bay. The construction might reduce swamps or cut down trees. **Operation Phase:** The activity of the depot might have an impact on the ecosystem.
11	Hydrology	C	C	**Construction /Operation Phase:** Constructions of piers in the river might impact on hydrology.
12	Ground Hydrology	C	C	**Construction Phase:** Underground excavation and installation of underground structures might impact the water level and quality of groundwater.
13	Geographical features	C	C	**Construction Phase:** Excavation and installation of structures might cause ground subsidence.
Social Environment				
14	Resettlement/ Land Acquisition	A-	A-	**Construction Phase:** Approx. 224 Households need to be relocated which will impact on PAPs. **Operation Phase:** There might be an impact if appropriate measures are not taken.
15	Poor people	A-	A-	**Pre-Construction /Construction Phase:** Resettlement of the poor within the project site is expected. **Operation Phase:** Poverty might worsen if appropriate measures are not taken.
16	Ethnic minorities and indigenous peoples	C	C	**Construction /Operation Phase:** The alignment has potential to pass through Ancestral Domain between CIA and NCC. The impact of the project needs to be evaluated.
17	Local economies, such as employment, livelihood, etc.	B-/+	C	**Construction Phase:** In case of resettlement, it might impact on transportation business such as taxi and jeepneys. On the other hand, construction will generate local employment. **Operation Phase:** It is highly possible that train will be used for long distance and taxi and jeepneys will be used for short to middle distance paratransit from the station.

No	Items	Evaluation		Reason of evaluation
		Pre/During construction	Operation	
18	Land use and utilization of local resources	B-/+	B+	**Construction Phase:** There will be a significant negative impact on land use due to the rails and depot. **Operation Phase:** The productive usage of vacant land in the outskirts will be stimulated by the operation.
19	Water usage	C	C	**Construction / Operation Phase** The impact is still unknown.
20	Existing social infrastructures and services	C	C	**Construction / Operation Phase** The scale of the impact cannot be assumed at this time.
21	Social structure such as social capital and local decision-making institutions	C	C	**Pre-construction / Construction / Operation Phase** The scale of the impact cannot be assumed at this time.
22	Misdistribution of benefits and damages	B-	B-	**Construction Phase:** Misdistribution of benefits might cause conflict among the stakeholders. **Operation Phase:** Around the station is more convenient compared to the only rail section, both “benefits” and “damages” will occur.
23	Local conflicts of interest	B-	B-	**Construction Phase:** There might be local conflicts generated by land acquisition procedure and payment of compensation. **Operation Phase:** Station areas will benefit more than the rail only section, and unequal business opportunities might create local conflicts.
24	Historical/ Cultural heritage	C	C	**Construction / Operation Phase:** In the Philippines, structures older than 50 years are classified as Historical/Cultural Heritage, so the preservation of old PNR stations and other structures need to be verified.
25	Landscape	B-	C	**Construction Phase:** There might be some impact during construction, but they will be small and short-term. **Operation Phase:** If viaducts will cross over other structures, the height might have an impact on landscape.
26	Gender	C	C	**Construction / Operation Phase:** The impact cannot be determined at this time.
27	Children’s rights	C	C	**Construction / Operation Phase:** The impact on school route is yet unknown.
28	Infectious diseases such as HIV/AIDS	B-	D	**Construction Phase** Risk to infectious diseases like HIV/AIDS may increase among construction workers. **Operation Phase:** Since the project aims improvement of urban transportation, the project will not directly concern on the spread of infection risks of HIV/AIDS.
29	Working conditions (including occupational safety)	B-	B-	**Construction Phase:** Inappropriate safety measures of contractor will deteriorate occupational safety. **Operation Phase:** Inappropriate safety measures of railway operator will deteriorate occupational safety.

No	Items	Evaluation		Reason of evaluation
		Pre/During construction	Operation	
Others				
30	Trans-boundary impacts or climate change	B-	B+/-	**Construction Phase:** Operation of construction machinery and vehicles will contribute to greenhouse gas (CO_2) emission. **Operation Phase:** Although electricity usage will generate greenhouse gas, modal shift from vehicles to railway that has a better energy efficiency will reduce greenhouse gas.
31	Accidents	B-	B-	**Construction Phase:** There is a risk of accident on construction activity. **Operation Phase:** Viaducts are accident-prone areas.
32	Risk of flood	C	C	**Construction / Operation Phase:** Sections of the project alignment are flood-prone areas, verification that the project does not increase the risk of flooding needs to be done.

Note: Impact Items refer to "JICA Guidelines for Environmental and Social Considerations April 2010"
A+/- Significant positive/negative impact is expected,
B+/- Positive/negative impact is expected to some extent
C Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)
D No impact is expected

Source: JICA Design Team

9.1.6.2 TOR of Environment and Social Considerations

Based on the draft scoping, the TOR for field survey including survey items, purposes, locations and methods, was prepared as shown in the Table 9.1.24.

Table 9.1.24 TOR for MCRP Field Survey

	Items	Survey Items	Methodology
Pollution Control			
1	Air Pollution	• The national and international standards • Sensitive receptors in vicinity of the project area • Bassline condition of air quality along the project including sensitive receptors. • Impact of air pollution emitted by construction heavy machinery and vehicles, train operation and corresponding mitigation measures.	• Literature review/ Review existing survey results • Conduct bassline survey of air quality at 8 sampling points including sensitive receptors. • Study a construction plan, such as construction method, period, place, parameters, types of machinery and vehicles
2	Water pollution	• The national and international standards • River, creek and lake might be affected by the project • Baseline condition of surface water quality of rivers and lakes along the project alignment • Baseline condition of groundwater around the project area. • Impact of surface /ground water quality during construction, operation, and corresponding mitigation measures.	• Review existing survey results conducted by EMB • Conduct baseline survey of surface water quality of rivers and lakes along the project alignment at 16 points. • Conduct baseline survey of groundwater level and quality around the project site at 10 sampling points evenly distributed within the stretch of the existing PNR ROW. • Predict and evaluate the impediments to meeting quality standards of DAO 2016-08

	Items	Survey Items	Methodology
3	Soil pollution	• The national and international standards • Existing contaminated site/ potential site might be contaminated by the project • Baseline condition of soil quality at sample points and potential contaminated sites • Impact of soil quality during construction/ operation and corresponding mitigation measures.	• Literature review and maps of the project area • Review existing survey results • Conduct baseline survey of soil quality at 10 soil sampling sites including stations, depot, and other areas along the proposed alignment, and 1 sampling site for potential contaminated site. • Review the construction plan, such as construction method, period, place, parameters, types of heavy machinery and vehicles,
4	Waste	• The estimated volume of excavated soil and construction waste • Disposal methodology of each LGUs • Impact of generated solid waste on the current waste treatment during construction/ operation and corresponding mitigation measures.	• Literature review • Data and information on waste consumption and issues gathering by each affected LGUs. • Review the construction plan, such as construction method, period, place, parameters, types of heavy machinery and vehicles
5	Noise and Vibration	• The national and international standards • Existing sensitive receptors in vicinity of project area and distance from alignment • Baseline condition of noise and vibration at project area including sensitive receptors. • Noise prediction for construction and operation activities at affected area, and corresponding mitigation measures.	• Review existing survey results • Conduct baseline survey of noise and vibration during morning, daytime, evening, and night-time at 15 sampling points including sensitive receptors and measure Equivalent Sound Level (L_{Aeq}) and Vibration acceleration level (L_{va}) of during construction and operation • Review construction plan including method, period, place, parameters, types of heavy machinery and vehicles at sensitive receptors.
6	Ground subsidence	• Baseline condition of soil type • Impact of project activities on ground subsidence and corresponding mitigation measures during construction and operation	• Review available reports, geologic literature and information from Mines and Geosciences Bureau (MGB), Philippine Institute of Volcanology and Seismology (PHIVOLCS), Philippine Atmospheric, Geophysical and Astronomical Services (PAGASA), and National Mapping and Resource Information Authority (NAMRIA) • Review the construction plan, such as construction method, period, place, parameters, types of heavy machinery and vehicles. • Conduct assessment by PHIVOLCS
7	Bottom sediment	• River, creek and lake sediments might be affected by the project • Impact of potential construction activities on bottom sediment and corresponding mitigation measures during construction.	• Review construction plan including construction method, period, place, parameters, types of heavy machinery and vehicles, as well as similar projects, predict the generation of turbid water and oil leak.
Natural Environment			

	Items	Survey Items	Methodology
8	Ecosystem	• Identify any fauna and flora listed in IUCN/ DAO 2007-11 • Baseline condition of terrestrial fauna and flora in/around the project site, and freshwater ecology • In case impacts are predicted, identify affected area and location, and prepare the effective and mitigation measures during construction and operation and long-term and monitoring to be implemented, as specified in the guidelines JICA FAQ.	• Literature review and review existing survey results • Interview and hearing in/around project area • Conduct baseline survey of terrestrial fauna and flora in/around the project site at 6 transect points. • Conduct freshwater ecology at the same 15 sampling point with surface water. • Review the construction plan such as construction method, period, place, parameters, types of heavy machinery and vehicles. • Confirm whether 1) the project will not cause any negative impact to the value of biodiversity and their supporting ecological process exist in the Area for Critical Natural Habitat, 2) the project will not cause any reduction in number of threatened species based on the species' listing on either the (global) IUCN Red List and/or on regional/national lists.
9	Hydrology	• River, creek and lake might be affected by the project • Mitigation measures for river flow if structures are installed in rivers	• Review of CLUPs of the host LGUs and other secondary data such as existing literature and maps of MGB, NAMRIA, and PHIVOLCS. • Review construction plan and check structures installed at river crossing.
10	Hydrogeolog y	• The national and international standards • Baseline condition of groundwater level around the project area. • Impact of potential construction and operation activities on groundwater and corresponding mitigation measures	• Review of CLUPs of the host LGUs and other secondary data such as existing literature and maps of MGB, NAMRIA, and PHIVOLCS. • Review existing survey results • Conduct baseline survey of groundwater level around the project site by existing geological survey and field survey at 10 sampling points evenly distributed within the stretch of the existing PNR ROW, • Review the project operation plan such as construction method, period, place, parameters, types of heavy machinery and vehicles.
11	Geographical features	• Baseline condition of geographical features project area • Impact of potential construction and operation activities on geographical features and corresponding mitigation measures	• Review of available reports, geologic literature, and information from MGB, PHIVOLCS, PAGASA, and NAMRIA. • Review the project operation plan such as construction method, period, place, parameters, types of heavy machinery and vehicles.
Social Environment			
12	Resettlement/ Land Acquisition	• National legal framework and international guidelines on RAP. • Baseline condition of Project Affected People (PAPs) based on the census and Social Economic Survey (SES). • Potential impacts to PAFs and affected area and location, and corresponding mitigation measures incorporated into the Resettlement Action Plan (RAP).	• Literature review • Conduct census and socio-economic survey, resettlement and develop land acquisition policy. Livelihood and income program under RAP. • Clarify land tenure of affected area with relevant agencies • Gather opinions of PAPs through public scoping/hearing, perception survey, Stakeholder Consultation Meeting (SCM), focus group discussion (FGD) and interviews.,
13	Poor people	• the existence of the poor and vulnerable people in the project area • Potential impacts on poor and vulnerable people to be relocated based on the results of the SES and corresponding mitigation measures under RAP	• Conduct census and socio-economic survey, resettlement and Land acquisition policy. Livelihood and income program under RAP. • Conduct of public scoping/hearing, perception survey, SCM, and FGC for vulnerable group

	Items	Survey Items	Methodology
14	Ethnic minorities and indigenous peoples (IP)	• The existence of ethnic minorities and IPs through RAP. • Potential overlap with ancestral domain. • Potential impact on IPs are confirmed based on SES, and corresponding mitigation measure. • A Draft IPP with mitigation measures, if applicable.	• Coordinate with relevant agencies such NCIP • Apply NCIP Field based investigation
15	Local economies, such as employment, livelihood, etc.	• Baseline condition of local economy, and livelihood of the project area. • Potential impact on employment and livelihood of PAFs and affected communities' due to resettlement, and corresponding mitigation measures. • Potential benefits to the local communities through the implementation of the project.	• Review of available secondary data, relevant studies, and other information from Philippine Statistics Authority (PSA), CLUP and Socio-economic Profile of the host LGUs • Conduct public scoping/hearing, perception survey/SES to verify the current income and livelihood of PAPs, and impact to local businesses. • Based on the results of the SES and SCMs, confirm the PAPs profile and prepare the compensation and livelihood restoration measures in the draft RAP. • Conduct SCM and FGD for transport operators and evaluate the impact on transport sector, and business owners
16	Land use and utilization of local resources	• Existing land use of the project area • Potential impacts on change of land use and corresponding mitigation measures	• Gather information and data on land use in and around the project area including Comprehensive Land Use Plan (CLUP), through existing information and data, and field reconnaissance • Consult to LGUs, relevant agencies
17	Water usage	• Baseline condition on water consumption, ground water usage around the project site and its capacity • Potential impact to water usage, and proposed mitigation measures.	• Literature review, Site survey, Interview and hearing to the relevant agencies • Conduct a survey on the use of ground water in the project area • Data and information on water consumption and issues gathering by each affected LGUs. • Conduct the supply of drinking water through SES. • Review the construction plan such as construction method, period, place, parameters, types of heavy machinery and vehicles.
18	Existing social infrastructures and services	• Existing social infrastructures and services and its capacity in the project affected area • Potential impacts to existing social infrastructures and services, and proposed mitigation measures	• Literature review, Site survey, Interview and hearing to the relevant agencies • Review the construction plan such as construction method, period, place, parameters, types of heavy machinery and vehicles. • Verify the relocation sites and associated infrastructures (water, electricity, etc.).
19	Social structure such as social capital and local decision-making institutions	• Existing social structure such as social capital and local decision-making institutions • Potential impact of the project to the existing social structure and corresponding mitigation measures.	• Conduct census and socio-economic survey, resettlement and relocation site development under RAP, and identify the number of displaced person • Review the construction plan such as construction method, period, place, parameters, types of heavy machinery and vehicles.
20	Misdistribution of benefits and damages	• The project affected people and their profile through SES • Potential impact on the misdistribution of benefits and damages and corresponding mitigation measures under RAP	• Conduct census and socio-economic survey, resettlement and Land acquisition policy. Livelihood and income program under RAP. • Review the project operation plan such as construction method, period, place, parameters, types of heavy machinery and vehicles. • Conduct SCM and FGD.

	Items	Survey Items	Methodology
21	Local conflicts of interest	• Existing economic status of PAPs by the RAP study, local conflicts of interest. • Potential gaps between PAPs and non PAPs and corresponding mitigation measure incorporated into the draft RAP • Potential gap in PAPs income before/after resettlement	• Conduct census and socio-economic survey • Interview and hearing of PAPs • Conduct SCM and FGD for transport operators and evaluate the impact on transport sector, and business owners.
22	Historical/Cultural heritage	• Existing and potential historical/cultural heritage in the project site • Potential impacts of project design and activities to the existing and potential heritage, and corresponding mitigation measures.	• Literature review, interview and hearing to NHCP and concerned agencies • Review of maps and existing information and data, and field reconnaissance on potential heritage under the project • Field reconnaissance and interview to PNR on PNR stations and railway bridges within the project site, • Review the project design and construction plan such as construction method, period, place, parameters, types of heavy machinery and vehicles.
23	Landscape	• Existing landscape value of the project area. • Proposed structures design • Potential impacts of project design and activities to the existing landscape value, and corresponding mitigation measures.	• Review of maps and existing information and data, and field reconnaissance • Conduct of public scoping/hearing, perception survey, SCM to present the proposed design and gather opinion
24	Gender	• The ratio of female and male PAFs, ratio of female headed households in vulnerable group • Potential impact on the female households, potential female train users, and the necessity of special assistance • Corresponding mitigation measure in facility design in attention to women and vulnerable.	• Review project design and the gender action plan developed in the project. • Identify the gender issues in the project area through reviewing the gender action plan and verify if the facility design is considerate of women and traffic disadvantaged. • Conduct FGD on vulnerable group including female head household
25	Children's rights	• Location of educational intuitions around the project site and school-commuting roads • Potential roads to be blocked during construction • Availability and distance to educational institution at relocation sites • Potential impacts on school roads by potential blocking, and mitigation measure	• Review of maps and existing information and data, and field reconnaissance • Conduct SES, to identify the impact to number of PAS under the school age • Review the construction plan such as construction method, period, and place. • Verify the relocation sites and associated infrastructures (school, etc.).
26	Infectious diseases such as HIV/AIDS	• Prevalence of infectious diseases such as HIV/AIDS in the project area. • Potential impact on the prevalence of HIV/AIDS during the construction	• Review existing information and data on trend of infectious disease in the project area through relevant agencies • Review similar projects on the prevalence of HIV/AIDS by influx of construction workers
27	Working conditions	• National and international registration on work environments • Health and safety measures during construction in the light of other projects.	• Literature review and review of previous and similar projects • Review the construction plan such as construction method, period, place, parameters, types of heavy machinery and vehicles

	Items	Survey Items	Methodology
Others			
28	Trans-boundary impacts or climate change	• Possibility of GHG reduction by the railway project • Reduction measures on GHG during construction and operation • Predict and evaluate impact of the project to the climate change and vies-versa.	• Review of previous and similar projects • Collect and review of existing studies on micro climate of the project area and its changes from PAGASA CIA Station • Predict effectiveness of GHG reduction by the project based on demand forecast data, and estimated electricity use. • Survey the construction equipment, machinery and vehicles which will emit GHG based on construction plan.
29	Accidents	• Applicable national and international registration • Trend of traffic accidents in the project area • Potential impact of the project on traffic volume in the area • Potential increase in traffic accidents, and corresponding mitigation measure. • the risk of occupational accidents during construction and operation based on other projects, and corresponding safety measures during construction and operation	• Collect existing trend on traffic accidents and occupational accidents at construction sits • Literature review on the potential impacts and risks of railway project on health of people living in surrounding communities, • Confirm established relationships between hazards of railway operations and health risks and effect to people • Review of previous and similar projects • Study the location of new stations, and potential increase in traffic volumes in surrounding area during operation linked to TOD.
30	Risk of flood	• The drainage morphology of the project area • The susceptibility and occurrence of flood around the project site • Potential impact on increase in the flood risk by the project and appropriate mitigation measures	• Collect and review existing study on Local climate of the project area in its trend on rainfall and extreme events such as typhoon • Study the flood prone area under the project area • Review the project operation plan.

Source: JICA Design Team

9.1.7 Results of the Survey on Environmental and Social Considerations

9.1.7.1 Pollution Control

(1) Air Pollution

The field survey was conducted from January 27 to February 7, 2018. The 24-hour ambient concentrations of TSP, PM_{10}, $PM_{2.5}$, Pb, SO_2, NO_2 and 1-hour ambient concentrations of O_3 and CO were recorded at nine pre-established sampling stations along the MCRP alignment. WHO Air Quality Guidelines (AQG) were exceeded for PM_{10} at San Fernando, Angeles and Dolores. Results comply with the national standards however WHO AQG were exceeded for $PM_{2.5}$ at San Fernando only. SO_2 was exceeded at Calumpit and Apalit which may be attributed to emissions from vehicle traffic, mostly tricycles. Full results are summarized in Table 9.1.25.

(2) Groundwater Quality

The survey of ground water quality was conducted between February 12 and 14, 2018 from nine groundwater sampling stations. The wells were constructed between 1960 and 2017 and the depths range from 7 to 31 m. Usage varies from occasional community drinking water supply, cooking, bathing, livestock watering, and commercial gardening. All yield clear water but four out of nine had objectionable odor. As such, drinking water generally comes from the commercial "mineral" water or from the local water utility. No groundwater well passes the PNSDW standards for drinking water and four out of nine failed the DENR Class A (Potable ground water). A summary of the results is presented in Table 9.1.26.

Table 9.1.25 Ambient Air Sampling Results

Para-meter	Unit	Sampling Stations									Standards	
		AAQ1-Malolos Station	AAQ2-Calumpit Station	AAQ3-Apalit Station	AAQ4-San Fernando Station	AAQ5-Angeles Station	AAQ6-Mabalacat Station	AAQ7-Dolores Station	AAQ8-Bamban Station	AAQ9-NCC Station	DENR	WHO
Date	-	Jan. 27 (1445 H) -Jan. 28 (1445 H)	Jan. 28 (2107 H) -Jan. 29 (2107 H)	Jan. 30 (1052 H) - Jan. 31 (1052 H)	Jan. 31 (1217 H) -Feb. 01 (1217 H)	Feb. 01 (1604 H) - Feb. 02 (1604 H)	Feb. 03 (0013 H) - Feb. 04 (0013 H)	Feb. 04 (0714 H) - Feb. 05 (0714 H)	Feb. 05 (0904 H) - Feb. 06 (0904 H)	Feb. 06 (1248 H) - Feb. 07 (1248 H)		
Prevailing Wind Direction	-	NE	N	NNE/ENE	N	N	NW	N	NNW	ENE/WNW		
Highest Wind Speed	m/s	4.02	3.58	3.58	3.13	4.02	3.13	3.58	6.26	1.79		
Ave. Wind Speed	m/s	2.90	2.41	2.52	2.20	2.66	1.81	2.57	4.97	0.77		
Calm Winds	m/s	0	0	0	0							
Ave. Temp	C	24.8	27.3	27.0	27.0	26.7	26.0	25.5	24.3	25.2		
Ave. Barometric Pressure		29.85	29.85	29.86	29.89	29.91	29.94	29.92	29.93	29.89		
Ave. Relative Humidity	%	83	70	70	76	71	66	72	72	65		
TSP	ug/m^3	55.58	54.69	77.15	119.65	181.63	95.93	111.36	18.52	81.85	230	-
PM_{10}	ug/m^3	42.21	26.86	48.87	70.51	88.34	45.79	91.49	16.07	44.35	150	50
$PM_{2.5}$	ug/m^3	18.31	15.65	22.05	30.45	22.83	17.81	21.3	11.94	10.62	50	25
SO_2,	ug/m^3	4.42	130.19	134.93	ND	ND	ND	ND	ND	ND	180	20
NO_2	ug/m^3	7.55	16.18	14.19	5.08	1.6	3.66	4.25	3.79	5.67	150	-
Pb	ug/m^3	ND	ND	ND	ND	0.0004	0.0043	0.0002	ND	ND	-	-
CO	ug/m^3	1.14	1.14	ND	ND	ND	ND	10.29	ND	ND	35,000	30,0002
O_3	ug/m^3	ND	ND	ND	ND	ND	ND	ND	ND	ND	140	-

Note: ND means less than method detection limit (MDL), Values in red indicates exceedance to WHO Guideline Values

Source: WHO Ambient Air Quality Guidelines, April 30, 2007, WHO Air Quality Guidelines for Europe (2000)

Table 9.1.26 Groundwater Quality Sampling Results

Parameters	GW-1 Calumpit Dug Well	GW-2 Calumpit	GW-3 Apalit	GW-4 San Fernando	GW-5 Angeles	GW-6 Mabalacat	GW-7 Bamban	GW-8 Bamban Spring	GW-9 Capas	PNSDW 2017	DENR WQG Class A	WHO 2017
Use	Irrigation	Irrigation	cooking / bathing	cooking / bathing	drinking	washing / bathing	washing / bathing	drinking	washing / bathing			-
Date of sampling	2/21/18	2/21/18	2/21/18	2/21/18	2/21/18	2/21/18	2/21/18	2/21/18	2/21/18			
Time of sampling (H)	1730	1650	1600	0820	0905	0930	1000	1100	1235			
Physical Characteristic												
pH	6.81	7.62	7.93	6.62	6.46	6.38	6.52	6.35	6.94	6.5-8.5	6.5-8.5	-
Color, TCU	5	5	<5	<5	<5	<5	<5	<5	10	10	50	-
Water temperature	29	30.8	30.7	27.9	28.2	28.3	28.6	27.6	29.1	-	26-30	-
Electric Conductivity	1,415	1,322	1,571	326	493	690	456	530	307	-	-	-
Total Dissolved Solids, mg/L	694	651	770	160	242	338	224	260	151	600	-	-
With objectionable odor	No	Yes	Yes	Yes	No	No	No	No	Yes	No		-
Cations and Anions												
Sodium, mg/L	160	110	120	15	21	29	11	9.1	3.4	200	-	-
Potassium, mg/L	3.1	23	10	6.4	7.2	15	3.4	1.9	0.29	-	-	-
Calcium, mg/L	50	130	96	15.3	29.9	33.6	26	10	12	-	-	-
Magnesium, mg/L	28	20	43	6.39	13.1	10.3	11	5.6	8.4	-	-	-
Bicarbonate, mg/L	301	405	267	86.3	113	113	141	113	283	-	-	-
Chloride, mg/L	257	170	321	31	61	40	11	3.6	4.1	250	250	-
Sulfate, mg/L	19	56	43	69	87	69	82	13	8	250	250	-
Nitrate-N, mg/L	0.3	0.35	0.13	0.18	0.55	6	0.21	0.21	0.19	50	-	50
Toxic and Other Deleterious Substances												
Arsenic, mg/L	<0.0009	<0.0009	<0.0009	0.0016	0.0022	0.0012	<0.0009	<0.0009	<0.0009	0.01	0.1	0.01
Cadmium, mg/L	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.003	0.003	0.003
Chromium Hexavalent, mg/L	0.0024	0.0043	<0.0021	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.05	0.01	0.05
Cyanide, mg/L	0.0112	0.0164	0.0191	0.0458	0.0333	0.0386	0.007	0.0055	0.0045	0.05	0.07	-
Lead, mg/L	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	0.01	0.01	0.01
Total Mercury, mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.001	0.001	0.006
Microbes												
Fecal Coliforms, MPN/100 mL	>8	>8	<1.1	<1.1	<1.1	<1.1	>8	1.1	<1.1	-	<1.1	ND
Total Coliforms, MPN/100 mL	>8	>8	<1.1	<1.1	<1.1	<1.1	>8	1.1	<1.1	<1.1	-	ND

Note: The highlighted cells are the results that exceed the national and International standard

Source: PNSDW, DAO 2016-18, WHO Guidelines for Drinking Water Quality (2011)

(3) Surface Water

A freshwater quality survey was conducted between February 6 and 8, 2018 to assess the physical-chemical properties of rivers and creeks to be crossed by the proposed MCRP. To obtain a general picture of freshwater conditions, samples were collected at 15 sampling sites. This sample represents small to large flow rate river systems within rural, agricultural, urbanized and industrialized areas in Bulacan, Pampanga and Tarlac. Creeks with low flow that traverse highly urbanized areas of San Fernando, Angeles and Mabalacat are receiving high loadings of various types of water pollutants and scattered solid wastes. Table 9.1.27 summarizes the results.

All survey points failed the standard for BOD (an indicator of the amount of putrescible organic matter present) and the Japanese standards for free cyanide, which is set at 0. Cyanide can be a sign of mining, agricultural, industrial or natural processes. Four sampling points failed to meet standards for oil and grease, including SW-5 and SW-6 with significant boat traffic. Three sites (SW-2, SW-3, and SW-15) exceed limits on Chloride, signifying salt-water intrusion possibly from over extraction of ground water. TSS was exceeded significantly at SW-15 but this was identified as erosion from an upstream construction project.

Table 9.1.27 Results of Freshwater Quality Sampling

Parameters	SW-1	SW-2	SW-3	SW-4	SW-5	SW-6	SW-7	SW-8	SW-9	SW-10	SW-11	SW-12	SW-13	SW-14	SW-15	Reference Values [a] DENR AO 2016-08		Japan Standards	
																Class A	Class C	Class A	Class C
River	Bulihan River	Labangan River	Bagbag River	Pampanga River	Malalam River	Masaluso River	Sto. Nino Creek	Calutcut Creek	Abacan River	Paranum Creek Tributary	Quitangui l River	Sapang Balen	Sacobia River	Banban River	Cutcut River Tributary				
Class (DENR 2016-08)	C	C	NYC	C	NYC	NYC	C	C	C	NYC	NYC	C	NYC	A	NYC				
Date	2/7/18	2/7/18	2/7/18	2/7/18	2/7/18	2/7/18	2/7/18	2/7/18	2/6/18	2/6/18	2/6/18	2/6/18	2/6/18	2/6/18	2/6/18				
Time	1830 H	1735 H	1620 H	1515 H	1155 H	1300 H	0925 H	0830 H	1715 H	1630 H	1530 H	1445 H	1230 H	1120 H	0945 H				
Depth, cm	25	200	213.33	200	1.7	100	45	10	20.67	7.5	20	16.67	19.33	18.33	17.5	-	-	-	
Width, m	5	>100	>100m	>100	26.67	10	7.33	4.63	8.3	3	4.67	5.33	7.97	8.5	1.88	-	-	-	
Flowrate, m/s	5	>100	>100m	>100	26.67	10	7.33	4.63	8.3	3	4.67	5.33	7.97	8.5	1.88	-	-	-	
Color (TCU)	5	5	10	10	42	33	20	14	10	10	10	20	<5	10	<5	50	75	-	
TSS, mg/L	21.2	31.0	37.8	37.3	86	27.0	20.5	17	13.5	32.5	3.0	33.0	93.0	5.0	1100	50	80	≤25	≤50
Temperature, °C	26	29.8	28.6	30.2	28.9	28.8	28.3	26	29.7	29.6	29.1	31.7	30.2	31.2	26.2	26-30	25-31	-	--
pH	6.7	7.26	7.09	7.3	7.2	6.87	6.76	6.95	6.48	6.53	5.99	6.75	6.17	7.13	6.95	6.5-8.5	6.5-9.0	6.5-8.5	6.5-8.5
DO, mg/L	1.62	10.95	6.08	7.94	4.22	1.04	1.55	3.8	3.93	2.18	9.17	8.76	15.98	11.22	11.13	5 (min)	5	≥7.5	≥5
BOD, mg/L	10	9	8	9	49	21	154	25	9	271	12	10	28	12	144	3 (max)	7	≤2	≤5
Fecal Coliform, MPN/100 mL	240	34	35,000	2300	17,000	17,000	24x10^{5}	16x10^{5}	920	34x10^{5}	<1.8	350	79x10^{2}	24x10^{3}	920	1.1	200	-	-
Total Coliform, MPN/100 mL	240	240	35,000	13,000	92,000	17,000	24x10^{5}	16x10^{5}	2400	17x10^{6}	<1.8	920	24x10^{3}	24x10^{3}	920	-	-	≤1,000	-
Conductivity, uS/cm	510	3,139	4,190	322	2,037	877	654	677	500	436	340	884	1,398	387	220	-	-	-	-
Cl, mg/L	69	1623	1205	41	220	110	43	48	34	87	13	160	47	2.9	531	250	350	-	-
Nitrate as N, mg/L	0.109	0.655	0.391	0.207	0.0686	0.0594	0.0605	0.0763	0.171	0.61	0.162	0.163	0.0738	0.065	0.137	7	7	<10	<10
Phosphate as P, mg/L	0.238	0.0723	0.123	0.0938	2.88	1.79	1.52	2.62	0.998	1.04	0.081	0.516	0.853	0.235	3.72	0.163[b]	0.163 [b]	-	-
Cu, mg/L	0.0228	0.0361	0.0257	0.0441	<0.005	<0.005	<0.005	<0.005	0.0267	0.0416	0.0234	0.0343	0.0109	<0.005	0.0158	0.02	0.02	-	-
As, mg/L	0.0018	0.003	<0.0009	0.0018	0.004	0.0031	0.0045	0.0031	0.0029	0.002	0.0022	<0.0009	0.0044	0.0034	0.0053	0.01	0.02	≤0.01	≤0.01
Cd, mg/L	0.0041	0.0041	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.0041	<0.002	<0.002	<0.002	0.0041	0.00840	<0.002	0.003	0.005	≤0.01	≤0.01
Cr, mg/L	<0.002	<0.002	<0.002	<0.002	0.004	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.0021	0.0025	0.01	0.01	≤0.05	≤0.05
Pb, mg/L	0.0530	0.0327	0.017	0.0282	<0.006	0.0157	<0.006	<0.006	0.0241	0.0137	0.0327	<0.006	<0.006	<0.006	<0.006	0.01	0.05	≤0.01	≤0.01
Hg, mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.001	0.002	≤0.0005	≤0.0005
CN, mg/L	0.0289	0.0243	0.0368	0.0399	0.0619	0.0714	0.0521	0.0516	0.0274	0.0269	0.0261	0.0389	0.0328	0.00962	0.0564	0.07	0.1	Not detectable	Not detectable
O&G, mg/L	1.6	1.1	<0.5	1.1	19.7	2.19	1.34	1.65	3.2	1.7	<0.5	1.1	0.816	1.44	<0.5	1	2	-	-
Organophosphate, mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.001	0.003	-	-
Phenol, mg/L	0.03	0.02	0.02	0.02	0.02	0.03	0.05	0.03	0.03	0.02	0.01	0.02	0.02	0.03	0.05	<0.001	0.05	-	-
Surfactant, mg/L	0.0443	0.0407	0.0492	0.07	0.0679	0.0282	1.05	0.0671	0.0827	1.07	<0.007	0.0999	0.189	0.227	0.835	0.2	1.5	-	-

Note: The highlighted cells are the results that exceed the standard standard. Not yet classified: NYC

a Reference values are maximum allowable limits unless specified as range or minimum (min).

b The reference values under the column of PO_4-P are conversions (0.3261) of the 0.5 mg/L and 5 mg/L PO_4 values in DAO 2016-08

(4) Soil Fertility

To establish baseline levels of soil fertility samples were collected during January 28 to February 7, 2018 at nine established sampling stations. Levels of pH, in Stations S-1 and S-2 were high signifying poor land for agriculture. Organic Matter in Stations S-1, S-3, S-4 and S-9 was low also signifying generally poor soil condition. With respect to contamination or problematic elements in the soil, levels of Cadmium and lead at Stations S-2 and S-3 is higher than the national standard and Dutch standard. S-3 very close to Dutch Intervention Value. The level of Arsenic in Station S-1 is also higher than the national and Dutch standard.

Table 9.1.28 Results of Soil Analysis

Parameters	Sampling Stations									BSWM [1]		
	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9			
Soil Type	Bigaa Clay Loam	Quingua Silt Loam	San Fernando Clay	Quingua Silt Loam	Angeles Fine Sand	Angeles Coarse Sand	Angeles Fine Sand	Tarlac Loam	Tarlac Loam	-		
pH	9.1	8.34	8.82	8.29	7.24	6.78	7.81	8.34	8.35	5.5-8.5		
Organic Matter, %	0.99	1.7	0.36	0.58	1.06	2.18	2.17	2.15	0.89	1-8; >3**		
Primary Nutrients												
Total Kjeldahl Nitrogen,	1,400	250	240	260	250	280	240	250	2,000			
Phosphorus, mg/kg	436	349	398	93	43	126	75	395	192	>10; >20**		
Potassium, cmol/kg	1,460	2,194	1,951	525	494	348	513	118	107	>0.25		
Secondary Nutrients												
Calcium, cmol/kg	145.8	310.7	73.35	14.40	2.73	18.85	10.11	1.38	3.35	-		
Magnesium, cmol/kg	83.13	102.6	65.80	20.87	14.94	10.53	20.47	5.68	6.82	>0.50		
Micronutrients												
Available Iron, mg/kg	37,01	50,42	51,801	8,706	7,486	16,721	4,811	3,895	22,830	>4.5		
Available Copper, mg/kg	68.1	115	582	45	20	28	37	15	26	>0.2		
Available Manganese, mg/kg	922	941	2,756	212	477	296	192	126	621	>1.0		
Available Zinc, mg/kg	673	502	1,187	259	50	1,615	14	71	54	>1.5; >1.0**		
Trace Metals										**PNS/ BAFS 40:2016**	**Dutch Standards [2]**	
											Target Values	**Intervention Values**
Lead, mg/kg	23	103	476	41.8	19.9	35	18.1	20.4	27.8	50	85	530
Mercury, mg/kg	<0.05	0.07	0.17	0.08	<0.05	<0.05	<0.05	<0.05	<0.05	20	0.3	10
Cadmium, mg/kg	0.7	2.17	11.2	0.8	1.37	0.620	1.99	1.97	1.96	2	0.8	12
Arsenic, mg/kg	32	2.17	1.95	2.32	0.660	0.790	1.33	0.885	<0.4	5	29	55
Chromium Hexavalent,	<0.2	0.35	<0.2	5.5	12	12	3.0	<0.2	10	150	100	380

Note: The highlighted cells are the results that exceed the standard.
** Limits applicable to dry land crops
Target Values of Dutch Standard– indicates the level at which there is a sustainable soil quality;
Intervention Values of Dutch Standard– representative of the level of contamination above which there is a serious case of soil contamination;

Source: [1] The Bureau of Soils and Water Management Soil Fertility Rating
[2] Dutch Target and Intervention Values (2000)

(5) Soil Contamination

Risk of soil contamination was identified at two sites, the old Municipal Covered Dumpsite in Calumpit and at the Metro Clark Sanitary Landfill in Capas. Samples were collected between March 15, 2018 and

March 19, 2018 using composite sampling. Table 9.1.29 shows the results of the soil contamination analysis. At the both sampling points, parameter were within the standards.

Table 9.1.29 Results of Soil Contamination Analysis

Parameters	Sampling Station		Dutch Standard
	CS-1	CS-2	Intervention Value
pH	3.7	8.5	2.0 < pH < 12.0 [1]
Arsenic, mg/kg	<0.001	<0.001	55
Barium, mg/kg	<0.04	<0.04	625
Copper, mg/kg	0.0629	<0.005	190
Zinc, mg/kg	0.192	0.049	720
Iron, mg/kg	0.116	<0.009	3,000-100,000 [2]
Cadmium, mg/kg	0.0138	<0.002	12
Chromium, mg/kg	0.03	<0.03	380
Lead, mg/kg	0.0233	0.1232	530 m
Manganese, mg/kg	2.58	0.207	30-5,000 [2]
Mercury, mg/kg	<0.0001	<0.0001	10
Selenium, mg/kg	0.001	<0.001	100
Nickel, mg/kg	0.077	<0.02	210
Oil and Grease, mg/kg	8.57	2.3	-
Cyanide, mg/kg	<0.001	0.00724	20

Source: Dutch Target and Intervention Values (2000), [1]DAO 2013-22, [2] Leeper, 1978

(6) Waste

According to the National Solid Waste Management Commission (NSWMC), the Region III generate waste of 3,632 tons per day in 2012. The World Bank (2012)[2], estimates that solid waste being produced by Philippine cities will go up by 165 % per day as a consequence of a projected 47.3 % rise in urban population by 2025 and a projected doubling of municipal solid waste (MSW) generation per capita at 0.9 kg per day by 2025 from the current 0.5 kg, presenting a direct correlation between the per capita level of income in cities and the amount of waste per capita that is generated. Table 9.1.30 shows the predicted volume of solid waste generated by each host LGU.

During the construction, in addition to the domestic solid waste, a total of 800,000 m^3 of soil will be disposal as result of soil excavation and backfilling operations for construction. Under the chapter 6, it has been confirmed that the existing soil disposal sites have sufficient capacity to take soil waste generated by the Project. The contractor will require to finalize the soil disposal site to be used in coordination with LGUs and contract with the operator prior to the construction.

[2] "What a Waste: A Global Review of Solid Waste Management" World Bank (2012)

Table 9.1.30 Predicted Waste Generation by LGU 2016-2020 (tons per year)

LGUs	population	2015	2016	2017	2018	2019	2020
Malolos	64,404.9	64,404.91	66,062.06	67,761.85	69,505.38	71,293.77	73,128.1
Calumpit	19,848.15	19,848.15	20,358.85	20,882.69	21,420.00	21,971.15	22,536.4
Apalit	107,965	19,703.61	20,105.73	20,516.05	20,934.7	21,361.98	21,797.94
Minalin	47,713	5,224.57	5,331.20	5,440.00	5,551.02	5,664.30	5,779.90
Sto. Tomas	40,475	4,432.01	4,522.46	4,614.76	4,708.94	4,805.04	4,903.10
San Fernando	306,659	78,351.37	79,950.38	81,582.02	83,246.96	84,945.88	86,679.4
Angeles	411,634	105,172.49	108,177.72	111,268.84	114,448.27	117,718.56	121,082.29
Mabalacat	250,799	64,079.14	65,386.88	66,721.31	68,082.97	69,472.42	70,890.22
Bamban	69,466	12,677.55	12,883.05	13,091.88	13,304.10	13,519.76	13,738.92
Capas	140,202	25,586.87	26,001.63	26,423.12	26,851.44	27,286.70	27,729.02

Source: LGU-SWM-SCMAR revised March 2016

(7) Ambient Noise Level

1) Field Survey Results

In order to get a baseline for noise levels along the proposed MCRP, noise levels were measured at 15 stations including potential sensitive receptors. All the sites showed levels exceeding NPCC standards but the type of noise varied from rural birdsong, roosters and crickets at the rural site to vehicle noise and talking at the urban sites. The results are summarized in Table 9.1.34.

2) Prediction of Noise Level during Construction

The results of the prediction of noise from the construction are shown in Table 9.1.31. Without the acoustic barrier, the noise levels of a pile driver will exceed the maximum allowable level at 90 dB even at 20m distance. The predicted noise levels of rock drilling, compressor slope surface spray and asphalt pavement mixing exceed maximum allowable level up to 10 m from the edge of the ROW. With the 3 m high temporary acoustic barrier, except the receiving point at the edge of ROW of pile driver works, the predicted noise levels of all types of construction work will be below the maximum allowable noise levels during the construction.

Table 9.1.31 Results of Prediction of Construction Noise

Construction Work		Distance from the Edge of the ROW to Receiving Point (m)					Maximum Allowable Noise Level 2 (dBA)	
Type 1	Power Level (dB)	0	5	10	15	20		
Without temporary wall								
Pile drivers	135	111.4	106.2	102.9	100.6	98.7	90	Class 1
Rock drilling (soft rock)	119	95.4	90.2	86.9	84.6	82.7	85	Class 2
Slope surface spraying	108	84.4	79.2	75.9	73.6	71.7	75	Class 3
Asphalt pavement	108	84.4	79.2	75.9	73.6	71.7	75	Class 4
With temporary wall (3.0 m)								
Pile drivers	135	90.4	89.2	88.9	86.6	84.7	90	Class 1
Rock drilling (soft rock)	119	74.4	73.2	72.9	70.6	68.7	85	Class 2
Slope surface spraying	108	63.4	62.2	61.9	59.6	57.7	75	Class 3
Asphalt pavement	108	63.4	62.2	61.9	59.6	57.7	75	Class 4

Note 1): Technical Handbook for Environmental Impact Assessment of Roads, 2007

2): 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. This classification does not include work in which pile drivers are used in combination with earth augers.

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

Class 3 Work which requires air compressor (limited to those compressors which use power other than electric motors with a rated output of 15 KW or more in excludes air compressors powering rock drills, jack hammers and pavement breakers)

Class 4 Operation involving batching plant (limited to those with a mixer capacity of 0.5 or more cubic meters) and/or asphalt plants (limited to those with mixer capacity of 200 KG or more). Batching plants for the making or mortar are excluded.

3) The highlighted cells are the results that exceed the standard.

3) Prediction of Noise Level during Operation

Noise level during operation is predicted based on the following assumption.

Table 9.1.32 Assumption applied for prediction

Items	Conditions
Prediction points	1.2 m height at 0, 10, 20, 30, 40, 50 m from the edge of railway ROW
Structural condition	Railway structure: Viaduct
	Truck structure: Slab track
	Installation of Ballast for noise reduction
	Rail type: Long rail
	Train length: 160 m (20 m x 8 cars)
Total Number of Operated Trains (one-way)	Day Time (7:00 ~ 22:00) : 150
	Night Time (22:00 ~ 24:00 & 6:00 ~ 7:00) : 55
	Train velocity: maximum 120 km/h

Source: JICA Design Team

The guideline values for receptor noise levels are set to be 12.5 m from the center of the nearest track. The noise standard for training operation is adopted for “the new project and large-scale modification of the conventional railway in Japan Environmental Agency, 1995” due to the absence of standard in Philippines for railway operation. The DENR environmental standards for noise is used as a reference only. The outline of results shows that the predicted noise levels will exceed the guideline values for night time. A noise barrier is one of the abatement measures to reduce the noise level. Table 9.1.33 shows the predicted noise level with a different height of noise barrier.

Table 9.1.33 Prediction of Noise Level during Train Operation

Mitigation measures	Day/ Night	Distance from ROW						Japanese Guideline values [1] (LAeq)
		0 m	10 m	20 m	30 m	40 m	50 m	
Barrier H=1.1 m	Day	58.1	58.6	58.3	59.0	59.5	59.0	60
	Night	56.0	56.5	56.2	56.9	57.3	56.8	55
Barrier H=1.5 m	Day	57.8	58.1	58.1	58.1	57.8	57.7	60
	Night	55.7	55.9	56.0	55.9	55.7	55.5	55
Barrier H=2.0 m	Day	57.6	57.1	57.1	56.6	55.7	55.5	60
	Night	55.4	55.0	55.0	54.4	53.6	53.4	55

Note: 1) Noise guideline values for the new project and large-scale modification of the conventional railway in Japan Environmental Agency, 1995 2), Day: 7am- 22pm/ Night: 22pm-7am. 3) The highlighted cells are the results that exceed the standard.

Source: JICA Design Team

Further modelling was completed to assess the height of a noise barrier and its mitigating effects to bring the noise level to 55 dBA as a likely nighttime requirement (assuming optimization of train operation):

- A 1 m and 1.5 m height noise barrier or parapet: The noise level during the night is predicted to be above 55 dBA.
- A 2 m height noise barrier installed: The noise level at distance from 10m and more will be below 55 dBA.

Noise level should be further reduced in the noise sensitive areas (sensitive receptors). Based on the study on the noise level experienced by sensitive receptors within 50 m distance from the alignment, the predicted noise level shows that with a 2 m height noise barrier Japanese's standards will be meet for those located at 10m and beyond.

Table 9.1.34 Summary of Results for Manual Monitoring of Ambient Noise Levels

Station Number	Time		Date	Noise Levels, dBA (Slow Response)				DENR Standards
				Min		Max	Mean	Median
Station 1	Morning	0710 H	28/01/2018	60.1	66.1	61.8	64.5	Class AA* 55 dBA
	Daytime	1321 H	28/01/2018	60.6	81.5	68.3	74.7	Class AA* 60 dBA
	Evening	1900 H	27/01/2018	53.6	82.8	59.3	68.6	Class AA* 55 dBA
	Nighttime	2300 H	27-28/01/2018	60.1	65.6	61.4	64.3	Class AA* 50 dBA
Station 2	Morning	0704 H	29/01/2018	62.7	80.1	70.1	77.7	Class AA 45 dBA
	Daytime	1305 H	29/01/2018	59.1	78.5	79.5	73.1	Class AA 50 dBA
	Evening	1905 H	29/01/2018	59.3	78.3	65.9	76.8	Class AA 45 dBA
	Nighttime	2304 H	28-29/01/2018	7.3	78.5	63.7	74.2	Class AA 40 dBA
Station 3	Morning	0658 H	31/01/2018	54.3	73.5	63.0	70.1	Class AA 45 dBA
	Daytime	1259 H	30/01/2018	55.5	78.5	79.5	72.7	Class AA 50 dBA
	Evening	1858 H	30/01/2018	53.7	70.8	59.6	68.4	Class AA 45 dBA
	Nighttime	2259 H	30-31/01/2018	50.0	62.4	53.9	57.2	Class AA 40 dBA
Station 4	Morning	0729 H	02/03/2018	52.6	69.4	62.3	66.8	Class A 50 dBA
	Daytime	1645 H	03/03/2018	60.0	69.8	64.7	68.9	Class A 55 dBA
	Evening	1801 H	03/03/2018	58.2	71.2	65.4	69.5	Class A 50 dBA
	Nighttime	2222 H	06/03/2018	51.7	66.6	58.6	64.4	Class A 45 dBA
Station 5	Morning	0654 H	01/02/2018	54.3	58.9	55.6	56.8	Class A 50 dBA
	Daytime	1255 H	31/01/2018	46.3	69.3	56.5	64.1	Class A 55 dBA
	Evening	1854 H	31/01/2018	52.2	61.8	56.6	57.7	Class A 50 dBA
	Nighttime	2304 H	31/01/ - 01/02/2018	56.1	58.0	56.7	57.5	Class A 45 dBA
Station 6	Morning	0456 H	03/03/2018	50.5	71.2	62.6	68.9	Class AA 45 dBA
	Daytime	0956 H	02/03/2018	59.1	83.4	68.7	81.0	Class AA 50 dBA
	Evening	2003 H	06/03/2018	57.2	73.6	64.0	69.0	Class AA 45 dBA
	Nighttime	2344 H	6-7/03/2018	47.0	57.8	52.3	55.7	Class AA 40 dBA
Station 7	Morning	0630 H	03/03/2018	56.2	72.3	63.1	69.4	Class A 50 dBA
	Daytime	1139 H	02/03/2018	56.7	67.9	61.1	64.7	Class A 55 dBA
	Evening	2040 H	02/03/2018	52.7	78.6	62.2	70.7	Class A 50 dBA
	Nighttime	2234 H	02/03/2018	50.4	77.9	69.6	77.6	Class A 45 dBA
Station 8	Morning	0656 H	02/02/2018	57.5	66.6	61.4	64.8	Class AA**50 dBA
	Daytime	0957 H	02/02/2018	57.7	67.5	63.6	67.2	Class AA**55 dBA
	Evening	1857 H	01/02/2018	57.7	67.3	62.3	66.6	Class AA**50 dBA
	Nighttime	2156 H	01/02/2018	55.1	67.2	60.4	64.8	Class AA**45 dBA

Station Number	Time		Date	Noise Levels, dBA (Slow Response)				DENR Standards	
				Min		Max	Mean	Median	
Station 9	Morning	0747 H	03/03/2018	48.70	70.50	58.70	67.20	Class A	50 dBA
	Daytime	1335 H	02/03/2018	59.60	63.30	61.37	62.70	Class A	55 dBA
	Evening	1755 H	02/03/2018	57.60	85.40	68.28	79.40	Class A	50 dBA
	Nighttime	2324 H	06-07/03/2018	56.50	81.00	64.92	72.40	Class A	45 dBA
Station 10	Morning	0740 H	07/03/2018	57.10	66.80	61.67	64.90	Class AA	45 dBA
	Daytime	1554 H	02/03/2018	57.80	74.70	66.27	73.60	Class AA	50 dBA
	Evening	1929 H	02/03/2018	60.20	79.90	70.66	79.40	Class AA	45 dBA
	Nighttime	2210 H	06/03/2018	55.20	72.30	59.63	64.10	Class AA	40 dBA
Station 11	Morning	0655 H	03/02/2018	52.60	68.30	59.01	60.90	Class A	50 dBA
	Daytime	1224 H	03/02/2018	60.40	72.10	62.94	69.40	Class A	55 dBA
	Evening	1844 H	03/02/2018	62.10	77.50	68.43	75.70	Class A	50 dBA
	Nighttime	0105 H	03/02/2018	62.70	76.40	65.07	65.70	Class A	45 dBA
Station 12	Morning	0559 H	07/03/2018	56.90	73.00	62.05	68.20	Class A	50 dBA
	Daytime	1103 H	03/03/2018	57.20	80.90	67.80	74.40	Class A	55 dBA
	Evening	1754 H	06/03/2018	54.10	73.40	65.32	71.50	Class A	50 dBA
	Nighttime	0350 H	07/03/2018	59.10	63.30	61.42	62.90	Class A	45 dBA
Station 13	Morning	0604 H	05/02/2018	61.6	73.7	67.1	71.0	Class A**	55 dBA
	Daytime	1304 H	04/02/2018	63.5	80.4	70.8	79.0	Class A**	60 dBA
	Evening	1855 H	04/02/2018	52.7	70.2	63.1	67.8	Class A**	55 dBA
	Nighttime	2254 H	04-05/02/2018	51.4	64.9	59.0	63.1	Class A**	50 dBA
Station 14	Morning	0701 H	05-06/02/2018	54.4	73.2	61.6	67.8	Class AA	45 dBA
	Daytime	1300 H	05/02/2018	54.3	71.1	60.3	67.7	Class AA	50 dBA
	Evening	1900 H	05/02/2018	56.9	63.3	59.1	62.3	Class AA	45 dBA
	Nighttime	2300 H	06/02/2018	57.1	67.9	58.2	60.3	Class AA	40 dBA
Station 15	Morning	0700 H	07/02/2018	49.7	66.9	57.3	62.4	Class A	50 dBA
	Daytime	1402 H	06/02/2018	47.2	65.1	54.5	59.9	Class A	55 dBA
	Evening	1913 H	06/02/2018	49.5	67.3	55.9	64.0	Class A	50 dBA
	Nighttime	2302 H	06-07/02/2018	47.6	57.9	50.0	54.6	Class A	45 dBA

Notes: * Areas directly fronting or facing a four-lane or wider road. A +10 dBA correction was applied to the NPCC Noise standards in these stations.
** Areas directly fronting or facing a four-lane road. A +5 dBA correction was applied to the NPCC Noise standards in these stations.

(8) Ambient Vibration Level

1) Field Survey and Results

A vibration study for the proposed MCRP was conducted on February 12-20, 2018, were measured at 15 sampling stations established along the proposed MCRP. The summary of observed peak values for velocities (mm/s) is shown in Table 9.1.35 while Table 9.1.36 shows the average vibration velocity (mm/s) for each of the stations during certain periods of the day.

The areas with the highest levels of vibration are in the North Depot (Brgy. Dolores), La Pieta Memorial Cemetery, Sindalan Memorial Park, Quebiawan Elementary School, Sto. Tomas/Brgy. Sto. Niño, and Mabalacat Cemetery. In Capas, vibration level spiked to 32.0 mm/s corresponding to the passing of a huge truck carrying backhoe equipment. Similarly, in North Depot (Brgy. Dolores), vibration level spiked to 29.0 mm/s corresponding to the passing of huge truck carrying sand and gravel. In Mabalacat Cemetery, vibration level spiked several times reaching up to 26.0 mm/s as large aircrafts ascending from the nearby Clark runway cause disturbance on the ground. In all other sites, the dominant source of impulsive and short duration vibration is commonly the passing of vehicular traffic.

Table 9.1.35 Summary Peak Velocity (mm/s) for Each Station

Sampling Stations	Recorded Peak Velocity (mm/s)	Peak Time (Velocity & Vibration)	BS 5228-2:20093 Tolerable Effect Threshold (10 mm/s) [1]
North Depot, Brgy. Dolores	29.0	8:51 PM	Above
Bamban	10.1	7:00 AM	Above
Mabalacat Cemetery	26.0	1:51 PM	Above
Lakandula	7.6	10:52 PM	Below
INC/Brgy. Sta. Teresita	11.8	4:27 PM	Above
Angeles Station	13.6	12:00 PM	Above
La Pieta Memorial Cemetery	13.0	6:25 AM	Above
Sindalan Memorial Park	12.0	10:59 AM	Above
Quebiawan Elementary School	15.8	9:39 AM	Above
San Fernando Station	9.4	7:09 AM	Below
Sto. Tomas/Brgy. Sto. Niño	13.0	5:55 PM	Above
Apalit Station	6.5	4:23 AM	Below
Calumpit	10.0	1:20 PM	Threshold
Malolos	9.2	1:26 PM	Below
Capas	32.0	4:08 AM	Above

Note: The highlighted cells are the results that exceed the standard.

Source: JICA Design Team

Table 9.1.36 Summary of Average Vibration (in mm/s) for Each Station

Sampling Stations		Vibration Level (mm/s)			
		Morning (5 am – 9 am)	Day (9 am – 6 pm)	Evening (6 pm – 10 pm)	Night (10 pm – 5 am)
North Depot, Brgy. Dolores	1	7.87735	9.17196	9.95773	6.95615
	2	8.48811	9.0053	9.05045	7.01569
	3	8.91991	8.9437	9.9508	7.39966
Bamban	1	5.91803	5.17791	4.80164	5.13468
	2	6.53883	6.13931	6.12888	5.93606
	3	7.32152	6.69258	6.31838	6.49052
Mabalacat Cemetery	1	9.76048	10.9555	17.15917	10.23125
	2	8.67168	9.94621	15.17268	9.59615
	3	9.02573	9.71456	15.69867	9.13919
Lakandula	1	5.82093	6.30257	6.34295	5.71426
	2	3.74839	4.13648	4.23236	3.77939
	3	3.30793	3.75879	3.85278	3.28708
INC/Brgy. Sta. Teresita	1	5.70298	7.08218	6.77936	5.75071
	2	6.04906	6.95778	6.62504	5.45534
	3	7.82933	8.71727	8.32436	6.88854
Angeles Station	1	8.21655	8.05897	6.00236	7.41689
	2	7.08479	6.21927	4.7675	5.77263
	3	5.58902	5.96171	4.06028	5.18094
La Pieta Memorial Cemetery	1	10.08698	10.9043	9.73584	8.29985
	2	9.33757	9.95866	8.69615	7.55301
	3	9.25606	10.14978	9.44869	8.0549
Sindalan Memorial Park	1	8.22066	9.029	7.70542	7.17551
	2	7.12942	7.51216	6.53327	7.00525
	3	8.36373	8.87986	8.26864	7.94387
Quebiawan Elementary School	1	10.61093	11.5244	10.80395	10.74102
	2	9.8812	11.31707	10.67649	10.24383
	3	12.56935	13.57628	13.3145	12.21174
San Fernando Station	1	7.1033	6.78161	5.42175	6.21761
	2	6.54811	6.68436	5.5923	6.00949
	3	5.30876	5.52461	5.19356	4.81884
Sto. Tomas/Brgy. Sto. Niño	1	9.80058	10.4536	8.45934	9.62035
	2	8.73593	9.27358	7.18827	8.25563
	3	9.63897	9.82015	7.84647	9.55053
Apalit Station	1	4.43312	5.15312	4.07527	3.5759
	2	3.69336	3.40258	2.60602	2.72647
	3	3.51373	4.87197	4.30169	3.83949
Calumpit	1	5.15935	6.82134	6.12556	4.44539
	2	4.14313	5.08501	4.72209	3.72946
	3	5.72584	7.48115	7.18716	4.98179
Malolos	1	7.48236	7.31739	7.32151	6.61595
	2	8.0491	8.1098	7.72538	7.44936
	3	8.05465	8.04957	7.59031	7.57901
Capas	1	6.87711	5.4819	5.44875	11.19401
	2	7.65601	4.71937	4.32209	11.75241
	3	8.28705	6.12291	5.84689	12.79351

Note: The highlighted cells are the results that exceed the standard.

2) Prediction of Vibration Level during Construction

Construction operations, such as a pile driving and rock drilling, cause ground vibrations that spread through the ground and diminishes in strength with distance. Ground vibrations from construction activities do not often reach the levels that can damage structures, but can achieve the audible and perceivable ranges for humans very near the construction site.

The vibration Level on receiving points was calculated based on the prediction model developed in Technical Handbook for Environmental Impact Assessment of Roads, Japan (2007). The operations of a pile driver and rock drilling will affect the area around the Project site, including the old PNR stations, since the vibration is beyond the human perceptive threshold. Asphalt pavement will also affect the area within 10 m distance from the edge of the construction limit. Only the vibration of slope surface splay is below the human perceptive threshold. Pile drive work will reach to 55 dB at 83 m from the edge of ROW.

Table 9.1.37 Results of Prediction of Construction Vibration

Construction Work		Distance from the Edge of the ROW to Receiving Point (m)					Perceptive threshold of vibration for human (dB)2	BS 5228-2:20093
Type [1]	Vibration Level (dB)	0	5	10	15	20		
Pile drivers	81	79.7	75.3	72.5	70.3	68.4	55	10 mm/s (converted to 136.9 VdB: ISO)
Rock drilling (soft rock)	64	62.8	58.8	56.3	54.5	53.1		
Slope surface spraying	48	46.7	42.3	39.5	37.3	35.4		
Asphalt pavement	59	57.7	53.3	50.5	48.3	46.4		

Note:
1 Technical Handbook for Environmental Impact Assessment of Roads, 2007
2 Technology and Laws Regulation for Pollution Control, 2000, Japan Environmental Management Association for Industry
3 BS 5228-2:2009 (BSI British Standards: Code of practice for noise and vibration control on construction and open sites)
4.The highlighted cells are the results that exceed the standard.

Source: JICA Design Team

3) Prediction of Vibration Level during Operation Phase

Vibration of buildings and houses near the MCRP alignment due to the train operation may affect people and quality of life and/or decrease working efficiency. There are no established prediction methods for vibration due to train operation since the mechanism of occurrence and transmission of train vibration is very complex. Therefore, the vibration levels are often predicted by using the regression equations based on the actual measurements of the similar cases of train operation and structures for reference. The MCRP will use the similar type of trains and structures as the existing railways in Japan, therefore, the model developed for the East-Osaka Urban Rapid Transit was used for the estimate of vibration level. The vibration level, VL is estimated in Table 9.1.38. In the case of the viaduct (slab), VL at the edge of the ROW is estimated 54.2 dB and is below the perceptible threshold of humans (55 dB). However, in the case of embankment (ballast), the estimated VL at distance from 0 m to 10 m will be over the perceptible threshold of human (55 dB).

Table 9.1.38 Estimated Vibration Level VL (dB)

Type of Structure	Distance from ROW					Threshold VL (dB)*
	0	5	10	15	20	
Viaduct (slab)	54.2	51.4	49.6	48.1	47.0	55
Embankment (Ballast)	61.2	58	55.8	54.2	52.9	

Note: 1) * Technology and Laws Regulation for Pollution Control, 2000, Japan Environmental Management Association for Industry. 2) The highlighted cells are the results that exceed the standard.

Source: JICA Design Team

(9) Ground subsidence

Subsidence usually takes place in areas underlain by limestone and compressible materials like peat or clays. It can also take place when groundwater is excessively extracted from an area. In the case of the proposed MCRP, there are no limestone formations beneath the alignment. The presence of significant deposits of clay notably at the location of stations in the areas underlain by geology type Qh shall be confirmed during the design of the foundation for these structures.

Seismic activity can lead to subsidence in certain soils. A study conducted by Thenhaus, Hanson and Algermissen of the United States Geological Survey and the Philippine Institute of Volcanology and Seismology (1995) estimated peak ground horizontal accelerations that have a 10% probability of being exceeded in 50 years for rock conditions, medium soil and soft soil conditions in the Philippines. In the case of the MCRP, the rocks underlying the segments from Mabalacat to Capas are underlain by consolidated volcanic deposits deemed to fall under medium soil category. The segments from North Depot to the Malolos Station are underlain by unconsolidated sediments which are deemed to fall under the soft soil category. A more detailed geotechnical assessment of the MCRP alignment is ongoing to determine stability of the structures under these conditions.

(10) Bottom sediment

Organisms that live in the bottom sediments of the rivers can be negatively affected by construction disturbance and by soil settling out from erosion caused by construction operations. At particular risk of disturbing sediments is the construction of piers in the rivers that the MCRP Line will cross such as Angat River, Pampanga River, Sulpan Channel Floodway, Malam River, Pambaling River and Abacan River. The construction of piers will disturb sediment around the pier and downstream for the duration of pile driving and pier construction. Scouring of the bottom sediment downstream of the finished piers can occur during fast flows. Hydrological studies will be used to determine the best design for the pier base to minimize this impact but the extent of this effect will be limited.

9.1.7.2 Natural Environment Condition

(1) Protected Area

The proposed alignment of the MCRP will not traverse any protected areas, however it traverses Manila Bay (130,465 ha) in Malolos, Minalin and Sto. Tomas. The Manila Bays area is delineated as an IBA and KBA but it is not protected under the National nor International Law.

(2) Ecosystem

1) Terrestrial Flora

A survey of terrestrial flora was conducted on February 4-7, 2018 at five established sampling stations. The survey was conducted using transect and quadrant methods, interviews with the local residents and records of flora and fauna collection from scientific literature.

a) Transect Plot Profiles

Table 9.1.39 and Figure 9.1.7 show the location and general vegetation condition of the different plots from the five transect plots (Barangays; Aranguren and Cut-cut in Capas; Barangay San Roque in Bamban, Barangay San Matias in Sto. Tomas and Barangay Lourdes) established in the proposed MCRP alignment. The transects were identified and selected based on the presence of vegetation units across the proposed alignment, including the presence of major landscape features such as small ecological units (e.g. creek, rivers, etc.). Additionally, the presence of high value species such as those endemic, threatened plant and tree species located either on a patch of forest or aggregate within the proposed alignment also served as basis for selecting sampling sites. At each transect, nine quadrants (20m x 20m) were laid out along a 2 km transect at every 250 m interval. Transect 4 and Transect 5 are within Manila Bay.

Table 9.1.39 Terrestrial Flora Sampling Station

Sampling Station	Coordinates	Vegetation Type	Human Activity
Transect 1 – Barangay Aranguren, Capas, Tarlac	N 15°31'34.87" E120°20'19.77"	Rice farms; shrub and grasslands; Open wooded lands; Sparse vegetation	Planting, cultivation, Human settlement, pasture for carabao, Construction of road for the Green city project
Transect 2 – Barangay Cutcut, Capas, Tarlac	N 10°18'39.92" E120°31'43.38"	Sugar cane plantation, open shrub and woodlands, grasslands with few scattered trees	Human settlement
Transect 3 – Bamban, Tarlac	N 15°16'46.32" E124°31'45.32"	Secondary growth of open wooded land with some portion of open shrub and grasslands; bamboo vegetation and Banana.	Human settlement, Kaingin, privately owned ranch(cow)
Transect 4 – Barangay San Matias, Sto. Tomas	N 15°59’51.47" E120°42'55.28"	Fishponds and wetlands that includes diverse floral species of ground, shrub and herbaceous layer. Sparse tree vegetation includes those located at trails and open spaces.	Human settlement
Transect 5 – Barangay Lourdes, Minalin	N 14°58'04.21" E120°43'19.31"	Same as T4, the area is heavily dominated by both active and abandoned fishponds as well as wetlands that includes diverse floral species of ground, shrub and herbaceous layer. Sparse tree vegetation includes those located at trails and open spaces.	Human settlement

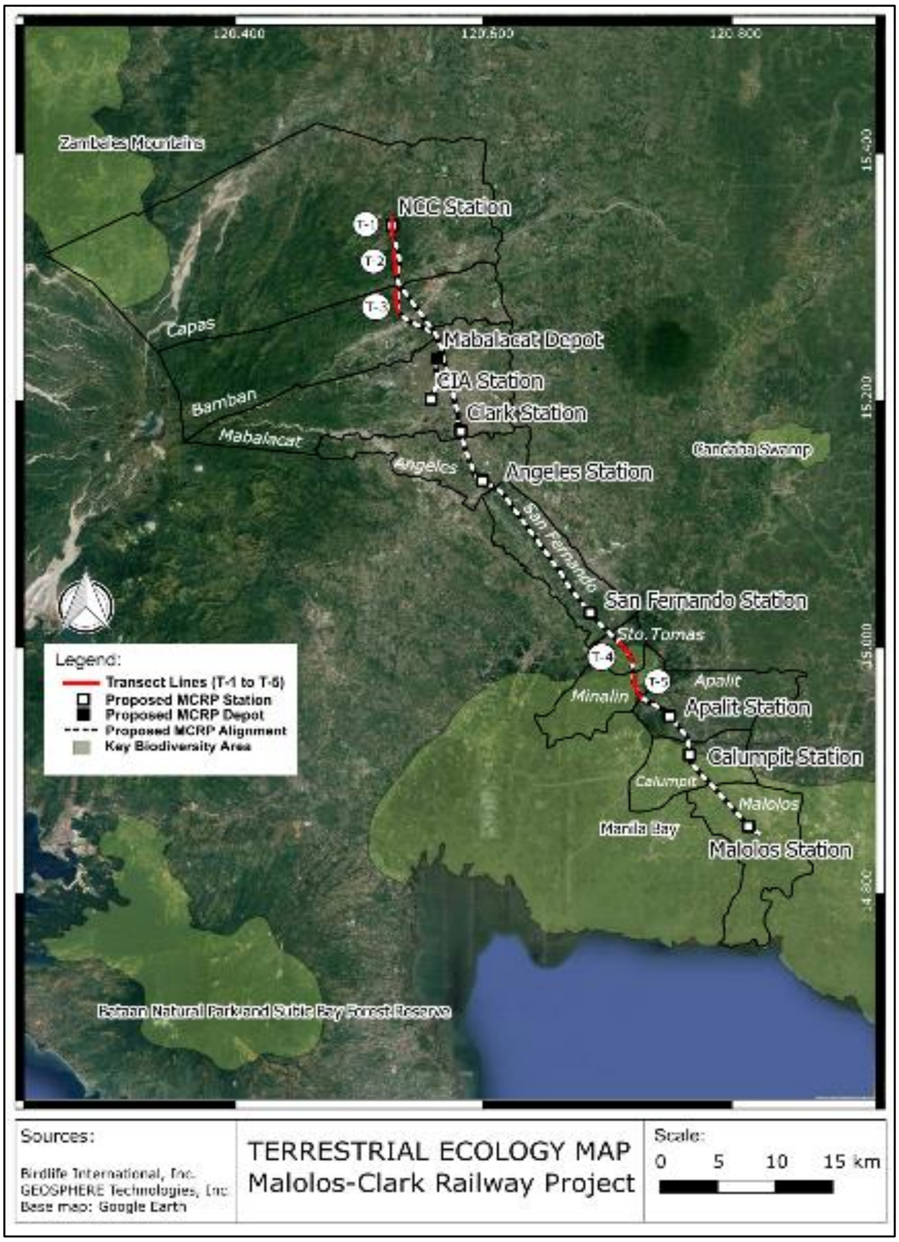


Figure 9.1.7 Location of Transects

b) General Vegetation

Almost two thirds of the areas along the railway alignment are occupied by agricultural landscapes and settled areas. The transect plots considered to have vegetation of the highest conservation significance is Transect 3. It has the characteristics of young secondary growth such that the vegetation in the area contains more native trees and endemic species. Overall the survey found, 40% of the vegetation communities are native, however invasive plant species such as the opportunistic and light tolerant species smother most of the sections in the proposed alignment. Furthermore, all endemic species are recorded from the regenerating plot (Transect 3), while most of the introduced species are found on the newly abandoned areas (Kaingin).

c) Species Diversity

One hundred eight (108) morpho-species, 107 genera belonging to 45 families were documented in five transect plots. Dominant families in the said transect plots were Fabacae, Moraceae, Anacardiaceae, Lamiaceae, Euphorbiaceae, Annonaceae, Malvaceae, Poaceae, Convulvolaceae and Asteraceae. Artocarpus ovatus Blanco were recorded in Transect 3 only.

Table 9.1.40 Species Diversity, Dominant Families and Abundance per Transect

Sampling Stations	Species Number	Individuals Number	Dominant Plant Families
Transect 1	46	174	• **Shrub species**: Tithonia diversifolia (Hemsl.) A. Gray, Urena lobata, Chromolaena odorata and Stachytarpeta jamaicensis, etc. • **Tree species**: Leucaena leucocephala, Trema orientalis (L.) Blume, Macaranga tanarius (L.) Muell.-Arg., Ficus ulmifolia, Ficus odorata, Ficus nota, Ficus septica Burm. f. Melanolepis multiglandulosa, Mallotus philippinesis, Streblus asper, Gmelina arborea, etc. • **Herbaceous layer**: Mimosa pudica L., Mikania cordata (Burm. f.) B.L. Rob., Tridax procumbens, Alternanthera sessilis, Sorghum halopense, etc.
Transect 2	19	156	• **Herbaceous layer**: Ipomoea triloba, Tridax procumbens, Mikania cordata (Burm. f.) B.L. Rob., etc. • **Shrub species**: Lantana camara L., Chromolaena odorata, Bridelia stipularis, Sida acuta and Sida rhomboidifolia, etc. • **Tree species**: Artocarpus altilis, Leucaena leucocephala, Trema orientalis (L.) Blume, Macaranga tanarius (L.) Muell.-Arg., Ficus ulmifolia, Ficus nota, Ficus septica Burm. f. Melanolepis multiglandulosa, Chionanthus ramiflorus, Gmelina arborea, Canarium luzonicum, etc.
Transect 3	22	175	• **Shrub species**: Lantana camara L., Chromolaena odorata, Solanum ferox, Ficus spp., Hedyotis sp., Borreira ocymoides, etc. • **Tree species**: Artocarpus ovatus, Ficus psuedopalma, Leucaena leucocephala, Garuga floribunda, Trema orientalis (L.) Blume, Macaranga tanarius (L.) Muell.-Arg., Ficus septica Burm. f., M. multiglandulosa, Munitigia calabura, Artocarpus blancoi, etc. • **Herbaceous layer**: Mimosa pudica L., Stachytarpeta jamaicensis, Mikania cordata (Burm. f.) B.L. Rob., Caesalpinia latisiliquum, Tridax procumbens, etc.
Transect 4	18	154	• **Tree species**: Leucaena leucocephala, Samanea saman, Pithecelobium dulce, Trema orientalis (L.) Blume, Macaranga tanarius (L.) Muell.-Arg., Ficus septica Burm. f., Gmelina arborea, etc. • **Herbaceous layer**: Zehneria indica (Lour.) Keraudren Centrosema pubescens, Ipomoea triloba, Mikania cordata (Burm. f.) B.L. Rob., Passiflora foetida, Tridax procumbens, etc. • **Grass species**: Thysanolaena latifolia, Sorghum halepense, Saccharum spontaenum, etc.
Transect 5	24	132	• **Shrub species**: Solanum torvum, Sida acuta, Chromolaena odorata, etc. • **Tree species**: Gmelina arborea, Trema orientalis (L.) Blume, Macaranga tanarius (L.) Muell.-Arg. Morinda citrifolia L., Ficus septica Burm. f. Melanolepis multiglandulosa, etc. • **Herbaceous layer**: Coccinea grandis (L.) Voigt, Centrosema pubescens, Passiflora foetida, Mikania cordata (Burm. f.) B.L. Rob., Caesalpinia latisiliquum, Tridax procumbens, etc. • **Grass species**: Imperata cylindrica, Thysanolaena latifolia, Sorghum halepense, Saccharum spontaenm, etc.

Table 9.1.41 Species Diversity by Flora Type

Type	Species Diversity	Frequently occurring species
Tree Flora	62 morpho-species with 52 genera 24 families	Artocarpus altilis, Ficus ulmifolia, Muntigia calabura, Premna odorata, Leucaena leucocephala, Gmelina arborea, and Macaranga tanarius. Artocarpus ovatus which were recorded in Transect 3 only
Intermediate and Understorey	58 morpho-species with 55 genera 25 families	Most abundant species: Wild sunflower (*Tithonia diversifolia*) and Hagonoy (*Chromolaena odorata*) and Kulot-Kulot (*Urena lobata*). The most dominant families: Asteraceae (mainly shrubs) and Malvaceae. The Asteraceae are predominantly shrubs, while the Malvaceae are mainly herbaceous plants.
Ground Cover	33 species	Dagad (23.21%), Uuko (5.47%), and a species of tuberous annual vine, Kalalaknit (4.86%)

d) Biodiversity Value

Endemic and Indigenous Species

Of the total 127 taxa identified to species level, 42 species were found to be Philippine endemics or have natural habitat confined only to this country by DENR Administrative Order No. 2017-11 (Flora) and DENR Administrative Order 2004-15 (Fauna). Important among the list are those species that are also included in either the Philippine red list or in the International Union for Conservation of Nature (IUCN). These include Antipolo, Piling liitan, Niog-Niogan, and Anubing (Table 9.1.42). Under the Transect 4 and Transect 5 within Manila Bay, there are no endemic and indigenous species recorded.

Table 9.1.42 List of Philippine Endemic Species Recorded at the Established Transects

Species	Common Name	Family Name	Endemism	Transect Plot(s) where Species Occurred	No. of trees found in transects
Artocarpus blancoi (Elmer) Merr.	Antipolo	MORACEAE	PE	T3 and opportunistic survey	12
Artocarpus ovatus Blanco	Anubing	MORACEAE	PE	T3 only	9
Canarium luzonicum (Blume) A. Gray	Piling liitan	BURSERACEAE	PE	T2 and opportunistic	1
Ficus pseudopalma Blanco	Niog-Niogan	MORACEAE	PE	T3	29
Ficus ulmifolia Lamk	Is-Is	MORACEAE	PE	T1, T2, T3	37
Ficus nota (Blanco) Merr	Tibig	MORACEAE	PE	T1, T3	3
Ficus odorata (Blanco) Merr.	Pakiling	MORACEAE	PE	T1	30

Note: **PE: Philippine Endemic Species

Threatened Species

Five species recorded from MCRP alignment are listed as threatened species. Noteworthy among the list are the critically endangered (CR) Smooth Narra (*Pterocarpus indicus*) (IUCN), a premium tree species that was historically used for railroad ties, Molave (*Vitex parviflora*) (DAO 2007-01). Even if Narra is widely seen in the whole country, its basis of its conservation status is its low population in the wild. Other threatened tree species which are also Philippine Endemic tree species such as Is-Is (*Ficus ulmifolia*), Piling liitan (*Canarium luzonicum*), and Antipolo (*Artocarpus blancoi*). These species are observed in mixed vegetation patches as sparse individual trees within transect plots and regarded as keystone species for fauna such as bats, birds and other frugivorous mammals and vertebrates. Under the Transect 4 and Transect 5 within Manila Bay, there are no endemic and indigenous species recorded.

Table 9.1.43 List of Threatened Species Recorded at the Established Transects

Species	Common name	Family	IUCN 2016 ver.3	DAO 2007-01	Transect Plot(s) where Species Occurred	No. of trees found in transects
Artocarpus blancoi	Antipolo	MORACEAE	VU		T3 and opportunistic survey	12
Canarium luzonicum	Piling liitan	BURSERACEAE	VU		T2 and opportunistic survey	1
Ficus ulmifolia	Is-is	MORACEAE	VU		T1, T2, T3	37
Pterocarpus indicus	Narra	FABACEAE	VU	CR	T1, T3	5
Vitex parviflora	Molave	LAMIACEAE	VU	EN	T2 and T3	11

2) Terrestrial Fauna

The terrestrial fauna survey was focused on the terrestrial vertebrate groups of Philippine wildlife; birds, mammals, amphibians and reptiles (herpetofauna).

a) Transect Profiles

The survey was conducted at five transects same as Terrestrial Flora. Transect 4 and Transect 5 are within Manila Bay identified as IBA/KBA.

b) General Fauna

A total of 89 fauna species were observed, composed of 71 species of birds, 3 species of mammals (2 volant and 1 non-volant) and 15 species of amphibians and reptiles (5 species of frog, 5 species of lizards and 5 species of snakes). There are no endangered or endemic birds, mammals and herpetofauna species recorded that will be affected by the construction of the proposed MCRP.

c) Species Diversity

Due to the differences in the habitat types in the five transects, different species compositions are observed. All sites have high anthropogenic disturbance due to close proximity to human settlement. Among the fauna observed, birds have the highest number of species and individuals observed. Transect 5 has the highest number of species recorded with 41, possibly due to the presence of migratory birds in the area. The same effect was recorded with Transect 4 in Barangay San Matias. These areas are mainly composed of marshland and privately-owned fish ponds which teem with fish and other aquatic resources which the birds feed on. Pampanga is a ‘stop-over’ area of migratory birds flying south to Australia during the months of December to March. The 28% of the birds recorded across all transect were migrants.

Table 9.1.44 Species Diversity by Transects

Fauna	Sampling Stations	Species Number	Individuals Number	Dominant Fauna
Birds	Transect 1	22	227	Passeridae *Passer montanus*, Hirundinidae *Hirundo rustica*, Hirundinidae *Hirundo tahitica*
	Transect 2	26	205	Pycnonotidae *Pycnonotus goiavier*, Passeridae *Passer montanus*, Estrildidae *Lonchura atricapilla*
	Transect 3	23	92	Pycnonotidae *Pycnonotus goiavier*, Laniidae *Lanius cristatus*, Columbidae *Geopelia striata*
	Transect 4	25	552	Recurvirostridae *Himantopus himantopus*, Laridae *Chlidonias hybrid*, Laridae *Sternula albifrons*
	Transect 5	41	2463	Recurvirostridae *Himantopus himantopus*, Laridae *Chlidonias hybrid*, Laridae *Sternula albifrons*
Mammals	Transect 1	2	31	Pteropodidae *Cynopterus brachyotis*, Muridae *Rattus tanezumi*
	Transect 2	2	15	Pteropodidae *Cynopterus brachyotis*, Muridae *Rattus tanezumi*
	Transect 3	2	7	Pteropodidae *Macroglossus minimus*
	Transect 4	0	0	-
	Transect 5	1	6	Pteropodidae *Cynopterus brachyotis*
Herpetofauna	Transect 1	7	33	Bufonidae *Rhinella marina*, Gekkonidae *Hemidactylus frenatus*
	Transect 2	6	16	Bufonidae *Rhinella marina*, Gekkonidae *Gekko gecko*
	Transect 3	8	26	Bufonidae *Rhinella marina*, Elapidae *Naja naja*
	Transect 4	2	2	Scincidae *Eutropis multicarinata borealis*, Scincidae *Eutropis multifasciata*
	Transect 5	6	23	Bufonidae *Rhinella marina*, Gekkonidae *Hemidactylus frenatus*

Table 9.1.45 Species Diversity by Fauna type

Type	Species Diversity	Frequently occurring species
Birds	71 species 35 families	*Geopelia strata, Hirundo rustica, Megalurus palustris, Passer montanus, Pycnonotus goiaver,*
Mammals	3 species 2 families	*Cynopterus brachyotis, Macroglossus minimus, Rattus tanezumi*
herpetofauna	15 species	*Rhinella marina, Gekko gekko, Lycodon* cf. *capucinus*

d) Biodiversity Value

Based on the IUCN conservation status, all of the bird, mammal and herpetofauna species recorded are of 'Least Concern', and are abundant and are not in any danger of becoming extinct.

There is little variation in mammal species observed at the survey sites. All captured and recorded species are native species and introduced species of mammals that are highly adapted to disturbed areas especially areas near human settlements. The amphibians and reptiles observed are mostly species that inhabits varied habitat types and appears to thrive even in degraded and man-made environments; hence forest loss might not be a significant threat to these.

e) Impacts of project on Manila Bay IBA/KBA

Those anticipated bird species, which have been categorized as endemic and valuable under IUCN red list during the initial survey prior to the scoping, were not recorded during the field survey.

The following is a summary of project impacts predicted on Manila bay IBA/KBA.

- It can be observed that only a small portion of the project site is within the Manila Bay IBA/KBA.
- A portion of the IBA/KBA in Malolos to Calumpit is heavily urbanized with patches and intermittent rice fields. Some migratory birds (if there are), may occupy these rice fields but are likely to be a minority considering that these areas are heavily disturbed and polluted.
- Migratory birds from Candaba may not be affected because it is surmised that food and habitat are sufficient in that area and they may not fly to the project site to forage and roost. Besides, migratory birds have been observed to have fidelity to a roosting or feeding site.
- As a behavior, migratory birds often fly to wetlands where food is plentiful and roosts are available rather than to urbanized and built up areas. They are not observed to fly to areas where there is high pollution and disturbance from anthropogenic activities.
- The birds in the Sto. Tomas (San Matias) and Minalin (Lourdes) sites will surely be affected especially if the waters in the fishponds will be drained to give way to construction. However, if ponds in the side of the project site will not be disturbed, some birds especially those which are native/residents and/or residents will not leave or leave for a time, but may eventually come back.
- Most of the avifaunal species observed during monitoring are observed to be already acclimatized to anthropogenic activities such as fishpond operations, construction of buildings, disturbance near residential areas, etc. If these species will be displaced by the activities of the MCRP, it is surmised that in time, they will come back to their old haunts and habitats near the project site.
- It is recommended that to verify whether migratory birds from the Candaba Swamp or Bataan also fly to the Manila IBA/KBA, a long-term study/research shall be conducted (radio telemetry/GPS tracking) by the concerned agencies.

In conclusion, the effect of the MCRP to terrestrial vertebrate wildlife will be minimal at the Manila Bay IBA/KBA because of the following reasons:

- The site of the project will only pass through a portion of the Manila Bay IBA/KBA where in the Bulacan side are areas which are urbanized, highly populated and mostly disturbed, and in Pampanga, most of the sites go through privately owned fishponds.
- Although the Pampanga sites harbor a number of migratory birds, these are mostly migrant/residents and are of Least Concern (IUCN). Two species of birds in the area are Endemic to the Philippines but are common and are also of Least Concern.

3) Freshwater Ecology

The freshwater ecology along the alignment of the proposed MCRP was assessed by collecting biological samples at the same 15 stations established for surface water quality on February 6-7, 2018.

a) Species Diversity

Plankton Community

At least 17 taxa representing three algal divisions were found at the 15 stations. *Chlorophyta* (green algae) was the most abundant phytoplankton division representing 52% of the total count, followed by Bacillariophyta (diatoms) comprising 35.7% of the total phytoplankton. *Cyanophyta* (blue-green algae) only 5.1% of the total phytoplankton. Of the 17 identified phytoplankton taxa, eight belong to *Chlorophyta*, six taxa to *Bacillariophyta*, while three taxa to *Cyanophyta*.

The abundance and occurrence of *Fragilaria, Pediastrum and Melosira* at majority of the surveyed stations which are known to frequent eutrophic waters support the observation of polluted waters. Some taxa such as *Microcystis* spp. are known to produce toxins and produce unwanted odor and taste in drinking water. *Pediastrum s*pp. which are abundant in slow, stagnant and nutrient-rich rivers also impart unwanted odor.

Zooplankton community

A total of 28 taxa representing three animal phyla are found. The community was largely dominated by Rotifera, comprising 90.3% of the total count, while low proportions were recorded for Arthropoda (9.5%) and Protozoa (0.1%). The dominance of Rotifera at majority of the surveyed stations is indicative of polluted, nutrient-enriched (eutrophic) waters. Several species of *Brachionus* such as *B. caudatus, B. urceolaris*, and *B. calyciflorus* as well as *Keratella tropica*, which were recorded at high densities in most sites are bio indicators of eutrophic or organically-enriched conditions.

Macrobenthos Community

At least 14 taxa representing three animal phyla were found at the 15 stations combined. *Arthropoda*, particularly Insecta, largely dominated the macrobenthos community representing 68.1% of the total count, followed by *Mollusca* (31.6%). Meanwhile, Annelida was recorded at low proportion (0.3%). *Macrobenthos* were not observed at three sites, SW-4, SW-7 and SW-11.

The dominance of *Melanoides*, an algal-grazing gastropod as well as of *Chironomidae* at most surveyed stations are suggestive of polluted conditions. These taxa are bio indicators of eutrophic, nutrient-rich condition/ poor water quality. Domestic waste dumping and industrial effluents are possible sources of organic matter and nutrients, and all types of pollutants.

Fish and Other Aquatic Animals

The presence of fish was determined by interviews with fishermen and locals. Only Stations SW-2, SW-4, SW-5, SW-6 and SW-8 were reported as fishing areas (minor fishing activity) by the locals. The locals reported a total of 12 fish and other aquatic animals that can be caught at the above-mentioned stations. Tilapia, Bangus, Dalag, Shrimps, Crabs and Turtles have been reported as frequent catch at the site. Eight taxa of fish and aquatic animals were reported at SW-2, while three taxa each at the remaining stations.

b) Biodiversity Value

Phytoplankton communities at Stations, SW-2, SW-3, SW-4, SW-5, SW-6, SW-9 and SW-10 were more diverse than that observed at the rest of the stations. The same trend was observed for zooplankton communities.

(3) Surface Hydrology

The segment of the MCRP alignment from Malolos to CIA and up to the North Depot will traverse the flood plains of the major river systems of Central Luzon. The segments of line from North Depot to San Fernando will intersect the main channels and tributaries of the rivers originating from the western upper slopes of Mt. Pinatubo 11 times. The hilly to mountainous segment from North Depot to NCC Station is drained by east flowing rivers and streams. The alignment will intersect the valleys of these waterways at least five times. The segment of the MCRP line from San Fernando to Malolos is drained by the lower reaches of the west flowing San Fernando River, Pampanga River, Angat River and their respective tributaries. The line crossed these waterways 16 times. Overall, the MCRP alignment crosses rivers and streams at 33 locations. The Hydrological study to determine flood level will be conducted later on.

(4) Underground Hydrology

The Groundwater Availability Map of the Philippines (1997) shows that the MCRP alignment will traverse an area classified as having “Local and Less Productive Aquifers”. From North Depot to NCC Station, groundwater occurs under unconfined conditions within the interstices of rocks and sediments. The water table is at an estimated depth range of 6 m to 15 m depending on elevation. The thickness of the aquifer is not known. Shallow wells, which are pumped manually or with the aid of low capacity centrifugal pumps, are used for domestic and irrigation. From Malolos Station to North Depot groundwater occurs under unconfined conditions within unconsolidated sediments. The water table is at an estimated depth range of 1 m to 12 m. The thickness of the aquifer is not known. Shallow tube wells are used to extract water which is used mainly for washing.

(5) Geographical features

1) Geomorphology

The proposed MCRP traverses the boundary of the Bataan Volcanic Chain and the Central Plain of Luzon (CPL). The Sierra Madre Range corresponds to a long mountain chain, which extends from Cagayan in the north to the Bicol in south. It is characterized by steep and dissected slopes with foothills on the west, which abuts against the CPL. The steep slopes favor erosion and dissection by west flowing rivers and streams which flow towards CPL. The eroded sediments are subsequently deposited into the adjacent plain. The Bataan Volcanic Chain corresponds to a line of volcanoes, which include Mt. Mariveles, Mt. Natib and the active Mt. Pinatubo. It serves as the western boundary of the CPL. The terrain is characterized radial drainage system, which discharges to CPL. The CPL corresponds to a long natural depression, which extends from Lingayen in the north to Manila Bay in the south. It is bounded on the west and east by the Bataan Volcanic Chain and Sierra Madre Range, respectively. It received eroded sediments from the said Range.

2) Lithology and Stratigraphy

The geologic formations within a 10 km corridor along the proposed MCRP route consist of two geologic formations namely the Recent Deposits, Quarternary Alluvium (Qh) and the Bamban Formation, Quaternary Volcanic Pyroclastics (QVP). The Qh deposits vary in proportion to the distance from their origin. Between Angeles Station and North Depot there are lahar deposits, towards Malolos Station they are alluvial river deposits. The segment from San Fernando to Apalit is dominated by clay, as indicated by the swampy condition of this area. In urban areas these deposits are overlain by pavements and fill. QVP includes pyroclastics and tuffaceuous sedimentary rocks. This material and its weathered derivatives underlie the segment after the Mabalacat River crossing up to the NCC Station.

3) Regional Tectonic Setting

The Philippines is located in a tectonically active region near the boundary between the Philippine Sea Plate and the southeastern edge of the Eurasian Plate. The active zone of deformation is a complex system of subduction zones, collision zones and marginal sea basin. The major earthquake generators relevant to the proposed MCRP include the Philippine Trench, the Philippine Fault, West Marikina Valley Fault, and the Manila Trench.

4) Geologic and other Natural Hazards

The natural hazards which can interact with the MCRP include flooding, landslides, typhoons and seismic and volcanic related hazards. The earthquake related hazards include ground rupture, ground shaking, and liquefaction. The volcanic related hazards include pyroclastic events, ash fall, and lahar flow along rivers.

The gently sloping to hilly sections of the segment from North Depot to NCC Station has low to moderate susceptibility to landslides based the Mine and Geoscience Bureau (MGB). Special engineering methods are used to ensure slope stability after construction of the pile and pile cap based on the susceptibility of the slope to landslips.

Clusters of earthquakes occur at the northeast offshore of Baler, Quezon and southwest offshore between Mindoro and Batangas. Any strong seismic events within the area of the Clark station to the CIA station will have greatest impact on the underground structures and railway operations of this segment of the alignment. The segments from Mabalacat to Malolos fall under underlain by the Qh sediments where groundwater is deemed shallow are potentially vulnerable to liquefaction in the event of a major earthquake occurrence.

The hazard of seismic ground ruptures is insignificant due to the MCRP line’s distance from the faults in the area. The nearest active volcano from the proposed MCRP is Mt. Pinatubo. The crater of this volcano is approximately 25 km west of the proposed MCRP. During the 1991 eruption of Mt.

Pinatubo, the pyroclastic flows extended down to the upstream sections of Sacobia and Abacan Rivers but did not affect the area to be traversed by the proposed MCRP. However, the ash generated by Mt. Pinatubo covered the line of the entire MCRP route.

The sections of the MCRP pass close to the lower slopes of Mt. Pinatubo are underlain by lahar which represents remobilized volcanic deposits from the 1991 eruption. According to the Volcanic and Earth Hazard assessment conducted by PHIVOLCS, the MCRP zone is categorized in Zone 4, and considered safe from lahars. However, the route may be affected by sediment laden stream flows during heavy rains and this can potentially affect the major railway crossings at Mabalacat River and Abacan River. In the event of another major eruption, lahar could again be formed and affect the bridge piers on segments of MCRP which cross major rivers and streams.

5) Pedology

a) Soil Types

The proposed MCRP will traverse at eight types of soil namely: Bigaa Clay Loam, Quingua Silt Loam, San Fernando Clay, Lapaz Fine Sand, Angeles Fine Sand, Angeles Coarse Sand, Angeles Sandly Loam and Tarlac Loam.

b) Soil Erodibility

The erodibility of the soils along the alignment is generally very low due to vegetation cover, flat topography and water content of the soil. However, for the Mabalacat area, some of the land surface has little land cover. The baseline condition for erodibility for this area can be considered vulnerable. The river bank soils along the alignment are generally stable because the soil types are mixed with clay particles aiding stability.

9.1.7.3 Social Environments

The data was collected through literature review, interviews, perception survey and results of Resettlement conducted under the project.

(1) Demography

The following study on demography is based on the 2015 census by Philippine Statistics Authority (PSA).

1) Population

The proposed MCRP will start from Malolos a city of 252,074 inhabitants. As the line heads north it passes through many small towns and cities, Mabalacat, San Fernando, and Angeles being the largest, all of which have over 250,000 inhabitants with Angeles having over 411,634 in 2015. The smallest city is Sto. Tomas with 40,475 and Minalin with 47,713 inhabitants. All the cities are growing with San Fernando growing fastest at 7.3% increase from 2012. The slowest growth is Sto Tomas at 1.3%, other cities are growing at a rate of between 1.2% and 3.3%.

2) Gender and Age Profile

In terms of population of the host LGUs, according to PSA 2015, there are slightly more males than females, with 50.4% males and 49.6% females. On average 28.9% of the various LGU's population is under 14 years with only 4.5% over 65.

3) Literacy Rate and Educational Attainment Profile

In 2015, 99. 5% of the population over 10-years old were basically literate across the LGU's crossed by the MCRP. In terms of educational attainment, the population 5 years old and over have achieved different levels of education. 42.0% have achieved a high school education, 11.0% are in college undergraduate education, and 12.0 % have a degree. At each LGU, high school graduates are the majority, which followed by undergraduate education /academic degree holders in Malolos and San Fernando (over 26.0 %), whereas in Capas, Bamban, Apalit and Minalin), elementary graduate follows (over 30.0 %).

(2) Resettlement/Land Acquisition

station. However, some portion will be outside the existing PNR ROW. Thus, the Project will require land acquisition and resettlement of affected people in compliance to the RA 10752, JICA Guideline and ADB SPS.

1) Resettlement of Informal Settlers

The majority of the alignment in Malolos has already been cleared (in preparation for the Northrail Project). However, ISFs have established houses within PNR ROW, and will be resettled and provided with such other assistance possible under the project.

Based on the census and social economic survey (SES) conducted by the Resettlement Action Plan (RAP), the number of ISFs is approx.1,173 families, which is 83 % of total project affected families (1,416). In all the LGUs, there are more ISFs than legal PAFs. The bulk of ISFs are in San Fernando (664 families), Calumpit (286 families) and Angeles (176 families).

2) Land acquisition

The entire PNR alignment is the property of the PNR, an agency of the DOTr. Hence, there are no tenure issues with regard to ownership of the alignment. However, the section from the proposed Clark Station to NCC Station will be located outside the existing PNR ROW and to avoid the heavily built-up areas along the ROW, some portion will maximize the use of the BCDA property.

Private Land Owners: Based on the survey conducted by the Resettlement Action Plan, the MCRP will affect an estimated total of 366 legal landowners for the section that alignment will run outside of PNR ROW and BCDA property, where the project will require land acquisition.

BCDA: The BCDA is a government agency and development corporation mandated by RA 7277 to strengthen the Philippine Armed Forces while creating economic development and opportunities in the country. The alignment goes through some areas within BCDA jurisdiction in Pampanga and Tarlac. The MCRP railway stations in Clark and in NCC, viaduct columns, underground, service access, drainage facilities and tunnels in Bamban are within the BCDA property, including the North depot.

CIA: The railway station in CIA will be located inside the airport premises and operated by the Clark International Airport Corporation (CIAC). The property the Clark Freeport zone and Clark Special Economic Zone is owned by Clark Development Cooperation which DOTr has agreement to use the property.

Ancestral Domain: Between the section of CIA and NCC, there are CADTs of Aeta issued in 2009. The project conducted the necessary procedure in consultation with NCIP and obtained Certificate of Non Overlap on September 19th, 2018

(3) Poor people

The average annual per capita poverty threshold of Region III in 2015 was about PhP 22,767 per capita. Based on SES, the total of 111 households (6%) are living below the poverty line. Regards to the vulnerable groups (1261 PAFs), the majority of these are babies/toddler (63%). The rest are elderly (24%), persons with disabilities (6%), and pregnant women (3%).

(4) Ethnic minorities and indigenous peoples

1) Profile of Indigenous People

There are two ethnic tribes near the vicinity of the proposed MCRP, namely, Aeta and Abelling.

Aeta/Ayta: Aeta/Ayta inhabit mostly the highlands or mountain regions of Pampanga and Tarlac. Aeta have preserved their ethnic identity through their language, belief system and consciousness. Aeta communities still employ subsistence patterns practiced by their forebears, such as hunting, foraging, and swidden cultivation. There are approximately 4,200 Ayta in a number of Sitios of Bamban and Capas, Tarlac, Mabalacat and Sapangbato, Pampanga, and Zambales (Stock 2005). There are currently eight Aeta GK Villages in Bamban, Tarlac.

Abelling: Abelling (Abelling/Abellen/Aberling/Aborling) tribe is a little known cultural minority found in the mountainous part of Western Tarlac. Around 290 Abelling families are spread out in the mountain ranges in Sitio San Pedro, Barangay Iba, San Jose, and Tarlac. According to oral history, they have been hunting and gathering in the province of Tarlac even before the Aetas. Today, most Abellings are farmers, carpenters and fishermen. They rely heavily on the forests around them for food, shelter and medicine.

2) Certificate of Ancestral Domain Title

On December 16, 1997, the NCIP issued a Certificate of Ancestral Domain Claim, covering the area of approximately 5,515 hectares of the SACOBIA property in favor of the Aeta tribes. A Certificate of Ancestral Domain Title (CADT) was issued in 2006 by the NCIP, covering the portions of Mabalacat

City in Pampanga and parts of Bamban, Tarlac. To address this issue, BCDA entered a Joint Management Agreement with the CDC, NCIP and the Aeta tribes in the area, namely the Samahang Tribung Aeta ng CADT 025, Bamban Aeta Tribal Association (BATA), and the Mabalacat Aeta Tribal Association.

As of 2010 Census of NCIP Region III for Tarlac, CADT-025 has an IP population of 2,973. Adjacent to CADT 025 are the approved CADTs of the Labayku and Kakai. Labayku CADT has an IP population of 2,591 while Kakai CADT has an IP population of 3,052. A portion of the MCRP alignment will be passing through the municipalities of Bamban and Capas in Tarlac where ancestral domain areas are known to be located. Two ROW alternatives were considered for CIA to NCC to be verified by NCIP. Based on the letter provided by the NCIP dated April 24, 2018, both options will not traverse or overlap the Ancestral Domain (AD) areas in Bamban. However, with regards to the North Depot, due to the close proximity to the Ancestral Domain, a field based investigation (FBI) by NCIP is required to obtain a certificate of non-overlap. During the FBI undertaken on August 29, 2018, it was confirmed that the site does not overlap with AD and a Certificate of Non Overlap was issued on September 19th, 2018.

(5) Local economies, such as employment, livelihood, etc.

1) Local Economy

According to the PSA, growth rates of Gross Regional Domestic Product (GRDP) of Region III is described in Table 9.1.46 in the absence of GDP data available at municipality/city level. In 2016-2017, construction sector is the largest growth in industry, followed by Manufacturing.

Table 9.1.46 GRDP Growth Rates by Industrial Origin at Current Prices (%)

INDUSTRY/YEAR	13-14	14-15	15-16	16-17
I. AGRICULTURE, HUNTING, FORESTRY & FISHING	17.4	-8.7	0.3	11.9
a. Agriculture and Forestry	20.0	-9.7	0.5	11.7
b. Fishing	1.6	-1.2	-1.2	13.2
II. INDUSTRY SECTOR	18.6	4.3	15.1	15.2
a. Mining and Quarrying	(20.1)	-28.1	15.6	-8.7
b. Manufacturing	21.8	3.3	16.9	13.4
c. Construction	11.8	11.9	5.6	25.3
d. Electricity, Gas and Water Supply	6.9	-2.1	21.1	12.6
III. SERVICE SECTOR	5.5	8.1	8.2	8.4
a. Transportation, Storage & Communication	4.4	7.4	3	4.1
b. Trade and Repair of Motor Vehicles, Motorcycles, Personal and Household Goods	2.9	4.8	8.6	7.6
c. Financial Intermediation	11.0	12.1	9.2	9.1
d. Real Estate, Renting & Business Activities	7.1	9.1	8.8	10.4
e. Public Administration & Defense; Compulsory Social Security	5.8	-0.2	10.7	11.3
f. Other Services	3.0	11.0	12	10.5
GROSS DOMESTIC PRODUCT	12.8	3.5	9.8	11.9

Source: the Philippine Statistics Authority

The Table 9.1.47 below summaries the classification of LGU income[3] and main economic activities.

Table 9.1.47 LGU Income and main economic activities

Municipality	Class	Main economic activities
Malolos	1st Class	Commerce and industry
Calumpit	1st Class	Commerce and agriculture including fishery, poultry and livestock. Others (ceramics, pottery and ornamental plants)
Apalit	1st Class	Agriculture, commerce and trade, industry, and tourism. Agriculture includes crop production, fish production (aquaculture), and livestock and poultry raising (agri-industrial)
Minalin	4th Class	Agriculture, commerce and trade, and tourism
Sto. Tomas	4th Class	Agriculture, industry, commerce and trade, and tourism. Pottery, automotive, commercial
San Fernando	1st Class	Services (55%), industry (36%), remaining 9% in agriculture, fishery and forestry
Angeles	1st Class	Service (Retailing, Services and Real Estate, food and nocturnal business), manufacturing and farming
Mabalacat	1st Class	Agriculture (rice production, corn, livestock, commercial poultry production)
Bamban	2nd Class	Agriculture, industry, and commerce and trade
Capas	1st Class	Commerce and trade, agriculture, industry and tourism

2) Labor Force and Employment

In the absence of available data on employment at municipality/city level, the regional level data from the PSA were used in the study. The Labor Force Participation Rate of Region III for 2015 is 60.9%, which was lower than year 2014(62.3%). Out of the LFPR, the employment rate of Region III for 2015 is 93.9%, which has a slight increase from 2014 (91.7%). Meanwhile, the unemployment rate for 2015 is 6.1%, which is lower than the 2014 (8.3%). The total gainfully employed workers (15-64 years old) of the host LGUs of the proposed MCRP, as based on the 2015 Census of Population and Housing of the PSA, is 501,305 or 66.7%, Angeles is the highest as 277,574, followed by San Fernando 206,158, and Malolos 172,135 among the host LGUs.

3) Income and Livelihood

In 2015, the average income of household in Region III is PhP 299,000 per capita. According to the perception survey, that majority (53. 0%) are family which husbands are the primary providers of income, which 54.2 % are earning from their regular salaried jobs. Based on SES, 52.2 % of household income of PAFs are between PhP 10,000 – PhP 29,999 and 21.4 % have incomes PhP 30,000 and above.

[3] DOF Department Order No. 23-08 : Income brackets for re-classification of Provinces, Cities and Municipalities in the Philippines

Classification based on Income	CITY	MUNICIPALITY
First Class (1st Class)	PhP 400M or more	PhP 55M or more
Second Class (2nd Class)	PhP 320 or more but less than PhP 400M	PhP 45M or more but less than PhP 55M
Third Class (3rd Class)	PhP 240M or more but less than PhP 320M	PhP 35M or more but less than PhP 45M
Fourth Class (4th Class)	PhP 160M or more but less than PhP 240M	PhP 25M or more but less than PhP 35M
Fifth Class (5th Class)	PhP 80M or more but less than PhP 160M	PhP 15M or more but less than PhP 25M
Sixth Class (6th Class)	Below PhP 80M	Below PhP 15M

(6) Land use and utilization of local resources

According to the Comprehensive Land Use plan of each host LGUs, main land use are mostly Agriculture/ fisheries followed by residential. Agricultural land in Malolos 45.4 %, Calumpit 66.0 %, Sto Thomas 43.6 %, San Fernando 45.0 %, Angeles 34.4 %, and Mabalacat 72.0 %. Fisheries are main land use in Minalin which comprises 63.3 %, and other LUGs also cover large area, Malolos 24.6 %, Sto Thomas 21.0 %. On the other hand, in Bamban and Capas, main land use is military reservation, 55.0 % and 53.1% respectively. 96.1 % of Land in Minalin is categorized as alienable and disposable land due to the flat terrain.

The alignment of the proposed MCRP traverses various land uses and already developed areas, including commercial, agricultural, aquaculture, industrial, and residential areas from Malolos, Bulacan to Capas, Tarlac. Areas become more densely built-up as the proposed MCRP travels through the urban centers of San Fernando and Angeles.

(7) Water usage

In the Philippines, 28.5 billion m^3 of water was withdrawn from various sources in 2000: 74% (21.1 billion m^3) was used for agricultural purposes, 9% (2.6 billion m^3) for industrial processes, and 17% (4.9 billion m^3) for domestic consumption. Under the MCRP host LGUs, water is supplied from local ground water. Local Water Utilities Administration establishes groundwater data banking and monitoring system to utilize as a tool in groundwater management and in assessing groundwater availability through the establishment of a continuing monitoring program for groundwater levels, extraction rates and water quality conditions. The following shows the host LGUs where water is mainly supplied by local water utilities.

Table 9.1.48 Average Production and Consumption Data by LGUs

Municipality/ City	Monthly Production (m^3 / month)	No. of connection				Average water consumption (m^3 / month)			
		Domestic	Government	Commercial	Bulk	Domestic	Government	Commercial	Bulk
Malolos	-	46,917		1,424	0.00	15.96	0.00	45.03	0.00
Calumpit	572,340	20,704	126	342	0.00	22.94	22.94	22.94	0.00
Apalit*		12,919				23			
San Fernando	1,246,376	39,310	200	1,778	0.00	21.33	172.60	38.97	0.00
Angeles	1,556,641	46,492	227	3,845		23.26	190.14	38.43	0.00
Mabalacat	897,804	36,707	173	1,374	3.00	20.52	69.89	29.06	18.00

Source:Local Water Utilities Administration, Philippine Water Districts, Average Production and Consumption Data, 2018/ * AquaFED, private operators delivering performance for water-users and public authorities, 2015,

For the Project, the total water requirement for the estimated 30 months construction of viaducts, stations, piers, piles and pile caps is about 2,390 m^3 per day. The estimated daily water consumption at the different stage of project development is presented in Table 9.1.49.

Table 9.1.49 Average Production and Consumption of MCRP

Project Stage	No. of Personnel (Peak Requirement)	No. of Sites	Daily Consumption per Sites (m3)	Total Daily Consumption (m3)
Pre-construction	200	1	20	20
Construction	23,900	5	478	2,390
Operation	1,400	8	17.5	140

Note: per capita water consumption is 100 liters per day. During construction, 5 contract packages which translate to 4,780 persons per site. During Operation, 8 major sites which correspond to the stations and depot which translate to 175 persons per site.

(8) Existing social infrastructures and services

1) Power Supply

Manila Electric Company (MERALCO) is Bulacan's main power distributor and provider. MERALCO provides electrical power in two barangays of Apalit, namely Balucuc and Calantipe. In the other ten barangays of Apalit, as well as the whole Minalin and Sto. Tomas, Pampanga Electric Cooperative, Inc. (PELCO III) provides the electrical power. San Fernando is provided mainly by the San Fernando Electric Light & Power Company, Inc. (SFELAPCO), Angeles is provided mainly by Angeles Electric Corporation (AEC), Mabalacat is provided mainly by the electric cooperative PELCO II, and Bamban and Capas is provided mainly by Tarlac Electric Cooperative (TARELCO).

2) Water Supply

The majority of the households in the host LGUs have access to water, primarily supplied by the water service providers either private supplier, water districts, or local government units. Host LGUs where water districts supply water are Malolos (the City of Malolos Water District), Calumpit (Calumpit Water District), San Fernando (City of San Fernando Water District), Angeles (Angeles City Water District), and Mabalacat (Mabalacat Water District). Minalin, Apalit, Sto. Thomas, Bamban and Capas are supplied by the subsidiaries of Balibago Waterworks System Inc. such as Apalit Waterworks, Crystal Liquid Philippines, Inc.

Based from 2010 Census of Population and Housing of the PSA, eight out of ten host LGUs of the proposed MCRP mainly source their drinking water from their own faucet connected from the community water. On the other hand, Malolos and Bamban use bottled water as the main source of their drinking water. Other households of the host LGUs source their drinking water from the shared faucet tapped community water system, own use tubed/piped deep well, shared tubed/piped deep well, tubed/piped shallow well, dug well, protected spring, unprotected spring, lake/river/rain and peddler.

3) Sewerage

The sewerage system located in the Clarke Special Economic Zone (CSEZ) is the only sewerage system in the study area. The sewerage system is being managed by the Clark Water Corporation and is separated for storm drainage and sewage. The present sewage effluent is being treated in the biological wastewater treatment plant with a capacity of 8,023 m^3/day to accommodate the effluent of about 16,280 population and receive the effluent from a number of industrial, commercial and institutional houses/buildings with the CSEZ. The rest of the municipalities and cities have no sewerage system and the effluent is discharge directly into the nearest stream.

Majority (96.6%) of the total households of the host LGUs are using water-sealed toilet of which 85.2% or 258,184 households have their own water-sealed toilet with septic tank. However, there are still households that do not have sanitary toilet facilities.

4) Communication

The communication service facilities in the host LGUs are available include postal, internet, land-based and cellular phones as well as newspapers, radio stations and television. Provincial / regional newspaper, radio station and TV station are available. In addition, some host LGUs has local radio station (Malolos, San Fernando and Angeles), and local newspaper (Angeles).

5) Protective Services

For peace and order of the community, at national level, Police Regional Offices 3 manages and administrates Police Stations in the region. At each LGU, police station and outposts are established and LGU and Barangay also provide the protective service to their communities which comprises with volunteer residents, such as Barangay Peacekeeping Operations (BPO) and Barangay Peacekeeping Action Team (BPAT). According to the Police Region III, the police to population ration of the Region III in 2015 is 1:1,198, which in Bulacan is 1:1,911, Pampanga is 1:1664, and Tarlac is in 1:941. According to the index of crime status of the Region III for 2018, Bulacan, Pampanga and Tarlac has high number in theft followed by physical injuries, and robberies.

Fire protection is provided by Bureau of Fire Protection (BFP) Region III. In 2012, 267 staff in Bulacan, 358 in Pampanga and 174 in Tarlac are assigned. Vehicles and equipment are owned by BFP but also LGUs. 60-70 % of fire start from residences and majority are through electrical short circuits especially when households use appliances and wirings that are not International Chamber of Commerce (ICC) approved. BFP encourage every barangay to have their own fire brigade so we will have the necessary first responders during reported fire incidents in their barangays.

6) Solid Waste Management

Solid waste disposal is the responsibility of the LGU’s in accordance to the RA 9003 or the Ecological Solid Waste Management Act has been in force since 2000. At present, most LGUs administer their own collection systems or contract out this service to private contractors. Nationwide, about 40 to 85 % of the solid wastes generated is collected. Uncollected waste ends up mostly in rivers, esteros and other water bodies, thus, polluting major water bodies and clogging the drainage systems, which results to flooding during heavy rains (NSWMC). Open dumping remains the general practice of waste disposal in the country as controlled dumpsites and sanitary landfills (SLFs) are very limited despite RA 9003 requires LGU s to close their existing open dumpsites by year 2006 and to establish controlled disposal facilities or SLFs.

Most of the garbage generated by the host LGUs are collected by the garbage trucks and disposed of in the sanitary landfill ; Metro Clark Sanitary Landfill in Capas, Tarlac. Materials Recovery Facilities are also provided in some barangays. Other households dispose of their garbage by dumping in pits (unburned), burning, composting, burying, and feeding to animals.

7) Medical Service

According to the report on health priority Region III, the Region has three retained hospitals, one mental ward, one extension, 5 provincial hospitals, 26 district hospitals, 250 rural health units, 1356 Barangay Health Stations, and 33 birthing stations (DOH Annual report 2001). Bulacan has hospital bed rate per 1000 population is 0.8, doctor/nurse/midwife per 100,000 is 3.1, 4.9 and 18.3 (DOH2008). In case of any emergency during the construction, each host LGUs has hospitals near the project site (within 1 km radius) except Bamban and Capas. In Minalin and Sto. Thomas, patients need to visit hospitals in neighboring LGUs which is still within 1 km radius.

According to the perception survey, 31.7% of the respondents get medical treatment in the hospital, slightly more than those that get treatment at barangay health centers (28.3 %). A significant percentage also opts for treatment at private clinics (28.3 %), while a few still get treated by herbalists, or simply at home (self-treatment).

8) Open Space and Recreational Area

Based on the standards for recreational facilities, a minimum of 500 sq.m. /1,000 population for Municipal Park, Minimum of 0.5 h. per 1,000 population for playfield/athletic field is needed (Annex V of Volume V – Land Use of HLURB Guidelines). The host LGUs have designated open and recreational areas which are also incorporated in their Land Use Plan. The most common sports facilities in the host LGUs are basketball court. In Angeles, PNR ROW have been transformed into a community garden, children's playground and a peoples' park.

(9) Social structure such as social capital and local decision-making institutions

A high volume of internal migration will stress basic services in cities. Many barangays are experiencing high population growth from migration including ISFs. LGUs receiving ISF have responsibilities to allocate land and integrate migrants into welfare systems. Some LGUs are refusing to take any PAFs from other LGUs. On the other hand, with the trend of the migration from Metro Manila towards Central and Northern Luzon, the municipality sees itself as a developing competitive advantage in agro-processing and agro-industrial products, which can cater to the demands of Tarlac and neighboring provinces.

Among host LGUs, except Mabalacat where, 97.9% of residents in 2010 had been living there 5 years previously in migration is high. Population of Malolos grows at 4.3% through a combination of migrants and natural growth. Calumpit is growing due to its proximity to developing towns like Malolos City and Apalit. Sto. Tomas is seen as an expansion area for San Fernando and has an influx of migrants from other regions particularly those speaking Kapangpangan originating to the north. Angeles continues to have migration resulting in the increase of informal settlers in the City. After Metro Manila, Angeles is one of the strongest informal settlements magnets in the country. Minalin does not experience much migration but has informal settlers near the river easement. In Bamban, a large number of incomers are Kapampangan natives. Indigenous Aeta are also migrating to this area. Capas also has an influx of Indigenous peoples in the municipality.

On the other hand, natural disasters are also causing people to move. Apalit is experiencing migration because of flooding in nearby Municipalities. People are leaving some barangays in San Fernando to return to lands damaged twenty years ago in the Pinatabo eruption. Net outmigration from Dolores is likely the result of the recent resettlement of families living informally along the PNR ROW into the Northville resettlement area.

Based on the census and social economic survey conducted under the Resettlement Action Plan. The project is expected to displace approximately 1,400 PAFs. Relocation sites for displaced PAFs will be also identified and coordinated with LGUs in accordance to in city relocations, and where basic and social infrastructure can be provided. Financial assistance by the proponent will be also provided to the receiving LGUs to cover all operation expense for social infrastructure such as health, education, transport, waste management, etc.

(10) Misdistribution of benefits and damages

The project will cause negative impacts on those affected persons required to relocate. Based on the census and SES conducted by the Resettlement Action Plan, the total number affected is approximately 1,400 PAFs/ 5,800 PAPs, 1,100 structures. In addition, during construction, some local businesses might experience a temporary disturbance. Those affected directly as well as indirectly will be compensated fairly through RAP and at relocated site, they have to have same or better living condition than exiting with basic infrastructure, livelihood and income basis. On the other hand, through the development of MCRP, the land development is expected to increase along or near the corridor and station area, which will boost the local economy.

(11) Local conflicts of interest

Local conflicts of interest could come from the effects falling unequally on one group over others. If negative affects impact predominantly one group then conflict may arise, particularly if there is existing rivalry. Pre-construction and construction there may be a conflict among community and LGUs who have to be displaced and temporary affected and among communities' migrants arriving and locals. Based on the census and social economic survey conducted by the RAP. The project separately preparing RAP to provide fare compensation for those affected by the project to ensure that their livelihood and income stay same or better than prior to the project. As mentioned above, financial assistance by the proponent will be also provided to the receiving LGUs.

(12) Historical/Cultural heritage

There are 9 historical and cultural heritage monuments or buildings have been declared by NHCP within the vicinity (within 500 m) of the proposed MCRP includes Bayan ng Kalumpit, Pamintuan House, Santos-Hizon Heritage House, Lazatin House, Hizon-Singian Ancestral House, Death March, Himpilang Daang Bakal ng San Fernando, Artillery Memorial. In accordance with the Republic Act No.10066, Section 18, the project is required to detail the possible impacts in the EIA report. The project will avoid any direct negative impacts to the above existing heritage by ensuring the propose alignment to have sufficient distance from the heritage structures and providing design in consideration to the location of pier foundation, The project will also develop appropriate mitigation measure against indirect impact such as vibration during the construction, if any predicted. The Project will consult the proposal with NHCP, National Museum and National Commission for Culture and the Arts prior to the implementation.

Besides the above, a total of 21 PNR structures were identified to meet the condition of structures “over 50 years” during the site investigations with JICA Design Team and PNR in March 2018. The JICA Design Team and PNR Proposal have developed their proposal and will present to NHCP, National Museum and National Commission for further discussion on requirements for preservation of listed item. For those identified to be conserved, the project will conduct a measurement survey and develop sufficient protection measure against direct and indirect impact such as vibration during the construction. Building condition survey will be also conducted by DOTr prior to construction and mitigation measure will be updated as required. Project will seek for approval on the proposed protection measures from NHCP, National Museum and National Commission for Culture and the Arts prior to the implementation.

Table 9.1.50 Old PNR Stations and Bridges with the Project Area

No.	Category	Heritage	Year	Coordinates	LGU
1	Bridge	Bulihan Creek	1891	14°51'57.91" N, 120°48'13.24" E	Bulihan creek, Malolos
2	Bridge	Unknown Creek	1891	14°52'14.30" N, 120°47'58.56" E	Malolos
3	Bridge	Bagbag River	1891	14°54'4.69" N, 120°46'17.26" E	Cabangan Bridge, Angat River, Calumpit,
4	Bridge	Unknown Creek	1891	14°54'18.63" N,120°46'4.38" E	Calumpit
5	Bridge	Gugo Iba O' Este Road	1891	14°54'23.95" N,120°46'1.04" E	Calumpit
6	Station	Calumpit Station	1891	14°54'58.58" N, 120°45'57.30" E	Calumpit
7	Bridge	Rio Grande / Apalit River	1891	14°55'9.73" N, 120°45'55.88" E	Apalit River, Apalit
8	Bridge	Unknown creek	1891	14°57'11.65" N, 20°44'16.33" E	Apalit
9	Station	Apalit Station	1892	14°56'41.05" N, 20°44'57.86" E	Minalin
10	Bridge	Cabalantian Creek	1892	14°57'30.79" N 120°43'42.34" E	Minalin
11	Bridge	Sapang Matulid Creek	1892	14°58'0.11" N, 120°43'20.39" E	Minalin
12	Bridge	Malalam River	1892	14°58'9.85" N, 120°43'18.33" E	Minalin
13	Bridge	Marapu Creek	1892	14°58'25.41" N, 120°43'16.01" E	Minalin
14	Bridge	Masaluso River	1892	14°58'52.09" N, 120°43'12.10" E	Minalin
15	Bridge	Sto. Tomas Bridge, Pampbaling / Masaluso River or at Megildo River	1892	14°59'33.16" N, 120°43'4.60" E	Santo Tomas
16	Station	Santo Tomas Station	1892	15° 0'20.33" N, 120°42'26.69" E	Santo Tomas
17	Station	San Fernando Station	1892	15° 1'36.59" N, 120°41'12.08" E	San Fernando
18	Station	Angeles Station	1947	15° 8'37.44" N, 120°35'28.81" E	Angeles
19	Station	Angeles Station	1982	15° 8'41.38" N, 120°35'27.56" E	Angeles
20	Bridge	Abacan River	1892	15° 9'10.05" N, 120°35'17.19" E	Angeles
21	Bridge	Balibago Creek	1892	15° 9'40.34" N, 120°35'5.72" E	Balibago creek, Angeles

Note: The list is based on visual validation conducted in March 2018.

Source: JICA Design Team

(13) Landscape

The majority of landscape along the MCRP is agricultural land and residential. The noteworthy landscape significance in the vicinity is the landscape of Manila Bay and Mount Pinatubo.

1) The Wetland of Manila Bay (Apalit, Minalin, and Sto. Tomas):

This large, enclosed sea bay is fringed by shallow intertidal mudflats and sand flats. Relicts of mangrove swamp survive, particularly in the Bataan area, but most have been converted to large areas of aquaculture ponds and salt pans. Large numbers of migratory shorebirds use the intertidal mudflats, fishponds and salt pans in Manila Bay in winter and during the migration seasons. Wading birds visit mainly drained fish ponds and areas of intertidal mudflat. The proposed alignment will traverse through the middle of fishpond landscape. There may be some impact on the landscape from loss of habitat and interrupted views.

2) Mount Pinatubo and surrounding area

Mount Pinatubo is located approximately 25.0 km west of the proposed MCRP. It is an active strato-volcano in the Zambales Mountains that erupted on July 16, 1991 and was considered as the century's biggest volcanic eruption. Despite the hazards it poses, Mt. Pinatubo is fast-becoming a tourist attraction due to its natural landscape and it also serves as the gateway to the historic town of Capas in the province of Tarlac.

(14) Gender

Under the RAP, Gender Impact Assessment was conducted for PAFs after reports indicating a lack of awareness on the issue of gender and vulnerable groups during infrastructure projects and not addressing the needs of the PAPs. Based on SES, out of the 1,400 households, male-headed households is 51% while 49% are female-headed households. They are usually trip to markets, school, and health center, which walking is the first and fast means and save cost. In terms of concern and issue of the project, common answers are losing their homes and livelihood, being moved away from work and children's school, and uncertainty of the life at the relocation site.

(15) Children's rights

In the Philippines, children start schooling at 5 years old. The public-school term starts from June and finishes in April. According to Housing and Land Use Regulatory Board (HLURB), the maximum distance for a pupil or student to walk from residence to school site is 3 km, while the maximum time from residence to school aboard public conveyance is 30 minutes. Table 9.1.51 shows the educational facilities in the host cities include public and private day care centers, elementary schools, high schools and college facilities. Some are within 50m from the proposed alignment.

Table 9.1.51 Educational Institutions in host LGUs

LGU s	Elementary school (G1-6)	Junior high (G7-10)	Senior high*	Educational institution within 50 m from proposed alignment
Malolos	46: public	12: public	25	No affected schools within 50 meters
Calumpit	24	5: public	8	Calumpit National High School, Calumpit College, St. Anthony Academy of Bulacan
Apalit	15: public	7: public	12	No affected schools within 50 meters
Minalin	12: public/ 2: private	4: public/ 2: private	4	No affected schools within 50 meters
Sto. Tomas	8 :public/ 5 private	2 : public / 1: private	3	Sapa Elementary School
San Fernando	37 public / 28 private	20 public	34	Let's Play Provincial Day Care Center, St. Scholastica Grade School, Quebiawan Elementary School, Maimpis Elementary School
Angeles	43 public/67 private	13 public / 35 private	39	Angeles Public School Teachers Credit, Angeles Elementary School, LSE Day Care Center, Lourdes Sur Day Care Center, United Church of Christ (with Kindergarten)
Mabalacat	40 public	16 public / 31 private	28	No affected schools within 50 meters
Bamban	22 public	2 public	5	No affected schools within 50 meters
Capas	31 public	8 public	11	No affected schools within 50 meters

Note * Senior high: high schools, private and public universities and colleges, technical-vocational schools,

Source: Department of Education

(16) Infectious diseases such as HIV/AIDS and Community health

Prevalent diseases along MCRP are malaria and dengue fever and sexual diseases. HIV/AIDS cases have increased to 10,500 in 2016 and the Philippines has become the country with the fastest growing HIV/AIDS epidemic in Asia and the Pacific, and has become one of eight countries that account for more than 90.0 % of new HIV infections in the region. (Joint United Nations Program on HIV/AIDS). As of 2017, NCR (309 cases /32.0 %), Region 4A (135 cases /14.0 %) and Region III (107 cases /11.0 %) are the top three regions with reported cases of HIV/AIDS. According to 2015 annual report of Department of Health Regional Office 3, the Number of HIV/AIDS are 18 in Bulacan, 22 in Pampanga, and 3 in Tarlac 3 respectively. On, which in total record of each provinces including asymptomatic from 1984 are 884, 762 and 189 respectively. Malaria cases started decline since 2009, however the number of Dengue fever cases are increasing. From 2014 to 2015, cases are increased 24.0 % in Bulacan, 56.0 % in Pampanga and 31.0 % in Tarlac.

(17) Working Conditions

1) Occupational Injuries and Diseases

According to PSA, the number of occupational accidents in the Philippines reached a total of 44,739 in 2015, a decline of 5.7 % from 2013. Despite this reduction, the resulting occupational injuries in 2015 grew by 3.8 % from 49,118 in 2013 to 50,961, cross industries, manufacturing accounted for the highest shares of total occupational injuries in 2015 and 2013 at 50.4 %. (25,667) and 48.1 %. (23,641), respectively. Construction industry share of accidents in 2013 was 4.3%, which increased in 2015 to 10.1%. In 2013, more than half (58.3% or 306) of the 525 cases of occupational injuries with workdays lost in the construction industry were caused by superficial injuries and open wounds. Other types of injuries include foreign body in the eye (12.4%); fractures (10.1%); and dislocations, sprains and strains (7.2 %). Laborers and unskilled workers were the mostly injured in the construction industry posting the highest share at 70.1 %. The rest of the occupations showed comparatively lower shares of injuries which include craft and related trade workers (10.5 %); plant and machine operator s and assemblers (7.4 %); and technicians and associate professionals (5.9 %). Total of 4,175 cases of occupational diseases were recorded in the construction industry in 2013. By type of disease, 5 in every 8 occupational diseases (62.5 % or 2,610), were caused by other work related musculoskeletal diseases. This was followed by other diseases with relatively fewer cases namely: back pains (5.6 %); occupational dermatitis (4.9 %) and essential hypertension (4.4 %).

2) Occupational Safety and Health Practices

The Occupational Safety and Health (OSH) Standards is set as mandatory by the Department of Labor and Employment. It aims to protect every working man and woman against the dangers of injury, sickness or death through safe and healthful working conditions. Employers are required to submit a Summary Report including; Work Accident/Illness Report, Annual Exposure Data Report, Report of Safety Organization, Minutes of the Meetings of Health and Safety Committee, Annual Medical Report.

The seven out of every 10 establishments in construction industry implemented the following OSH policies/programs: accident prevention program (78.9%); accident investigation program (70.5%); and drug free workplace policy program (68.1%); DOLE-approved construction safety and health (67.5%); and monitoring/surveillance of occupational and work - related injuries and illnesses (67.2%).

As preventive and control measures against work safety and health hazard, almost all of the establishments in construction had posted safety signage or warnings (98.3%) and provided workers orientation on safety and health hazards at work (98.2%) as part of its preventive and control measures against work safety and health hazards in the workplace.

In addition, a total of 921 establishments in construction had availed of various work safety and health related trainings/seminars for their employees: 40 hour construction safety training (90.4%); fire safety training (67.4%); and 1 - Day occupational safety and health Orientation (64.7%) etc.

(18) Trans-boundary impacts or climate change

1) CO_2 emissions

a) CO_2 Emissions during construction

The fuel consumption for the use of construction equipment, service vehicles as well as transport of construction materials were estimated. The total CO_2 emissions during construction are estimated at 691.5 MT CO_2/yr.

b) CO_2 Emissions during Operation

The electricity consumption during project operation is estimated to be at 420,118,650 kWh/yr. The assumption is based on the daily power requirements for the operation of the train, stations and facility depot. GHG Protocol's Purchased Electricity Calculation Tool with default emission factor from the global warming potentials values of the 2014 IPCC Fifth Assessment Report was utilized to automatically calculate the total CO_2 emissions. The total CO_2 emissions during operation are estimated at 211,056.52 MT CO_2/yr. The Philippines Second National Communication (SNC) on Climate Change has projected 100,402,000 MT of CO_2 for 2020. Using the projection of SNC, the proposed MCRP is expected to contribute approximately 0.00069% during the construction phase and approximately 0.21% during the operation phase.

2) Climate Risk/ Climate Change

The climate change scenario for the Philippines as published by PAGASA in February 2011 indicates that the provinces of Bulacan, Pampanga and Tarlac will receive an impact from Climate change. The Climate Risk and Vulnerability Assessment was also conducted to meet ADB requirements following the ADB the Climate Risk Management Framework[4]. The detail report is enclosed in to ANNEX 9.1.1.

a) Rainfall and Temperature

The projected seasonal rainfall and temperature change for the period of 2006-2050 in Bulacan, Pampanga and Tarlac are as follows.

Table 9.1.52 Projected seasonal change for the period of 2006-2050 (%)

Province	2006-2035				2036-2050			
	Dec. - Feb.	Mar. - May	Jun. - Aug.	Sep. - Nov.	Dec. - Feb.	Mar. - May	Jun. - Aug.	Sep. - Nov.
Rainfall (%)								
Bulacan	4.2	-23.0	12.8	-2.9	-13.2	-36.4	23.6	-3.3
Pampanga	16.3	-18.8	4.4	-5.1	-15.4	-26.4	13.9	-7.2
Tarlac	26.0	-13.7	-1.6	-9.6	-6.7	-18.2	8.8	-5.5
Temperature (°C)								
Bulacan	0.9	1.1	0.9	1.0	1.9	2.1	1.7	1.9
Pampanga	1.0	1.1	0.9	1.0	2.1	2.2	1.8	2.0
Tarlac	1.1	1.1	1.0	1.1	2.2	2.2	1.9	2.1

b) Frequency of Extreme Events

The province of Bulacan will have 1,984 days with maximum temperature of above 35 °C during the 2006-2035 period and 3,126 days during the 2036-2050 period; 6,302 dry days during the 2006-2035 period and 6,220 dry days during the 2036-2050 period; and 13 days with rainfall above 200 mm during the 2006-2035 period and 17 days during the 2036-2050 period.

[4] Guidelines for Climate Proofing Investment in the Transport Sector, ADB, 2011

Moreover, the province of Pampanga and Tarlac will have 1,855 days with maximum temperature of above 35 °C during the 2006-2035 period and 3,108 days during the 2036-2050 period; 5,701 dry days during the 2006-2035 period and 5,754 dry days during the 2036-2050 period; and 12 days with rainfall above 200 mm during the 2006-2035 period and 12 days during the 2036-2050 period.

(19) Accidents

During the construction, the linear development of the project will potentially disturb existing roads/streets it crosses as well as will impact to the main roads in the vicinity. During the operation, the project will lead to greater traffic in the area of the station with consequent risks. Transport Led Development projects will seek to re-order local road network to reduce road conflicts and accidents. Predicted traffic volume is currently under study.

(20) Flood Risk

Due to the region being low-lying are (e.g. Pampanga Delta, Poponto and Central Tarlac), flooding usually accompanies typhoons and monsoons. The two most extensive river basin areas that usually affected by flooding are the Agno River Basin and the Pampanga Delta. The DPWH has put in place flood forecasting and early warning systems in these two areas. Unfortunately, the capacity of the existing drainage and flood water canals is no longer enough to accommodate the peak flow. Thus, localized flooding during rainy season or after a heavy downpour has become normal. The increasing occurrence of high intensity, short duration rainfall brought by climate change and global warming phenomenon exacerbates this problem. The national government has likewise invested in programs and projects to alleviate the flooding problem in these areas. Local governments (such as Tarlac and San Fernando Cities) have also invested in improving the drainage systems in their respective urban areas.

According to the Flood Susceptibility Map of Region III prepared by the Mines and Geosciences Bureau (MGB), under the project area, the segments from Mabalacat to San Fernando, and Calumpit Station to Malolos Station have moderate susceptibility to flooding and experience floods of 0.5-1 m. The segments from the immediate banks of the main channels of Mabalacat and Abacan Rivers, from San Fernando Station to Calumpit Station are areas with High Susceptibility to Flooding where flood heights exceed 1 m. These areas area are usually flooded for several hours during heavy rains. The depot alongside the Sacobia River, at the existing level the land was flooded in the past by the increase of river volume caused by the fall of ash from the massive 1991 Mount Pinatubo eruption coinciding with typhoon rains.

9.1.8 Identification, Prediction and Assessment of Environment Impact

Based on the results of the survey, potential impact of the project is assessed.

Table 9.1.53 Impact Assessment based on the Survey

No	Items	Assessment in Scoping		Assessment based on Survey results		Assessment of Impact
		Pre/During construction	Operation	Pre/During construction	Operation	
Pollution Control						
1	Air Pollution	B-	B-	B-	B+/-	**[Construction Phase]** (-) Generation of dusts and particulate matter, and gas emissions due to earthworks, demolition and site clearance including removal of topsoil, moving of excavated material and transporting, and operation of equipment, machineries and service vehicles. The effect of the identified impacts is low and short-term. **[Operation Phase]** (+) Operation of railway will contribute to the ease of traffic congestion and decrease of air polluting emissions. (-) Vehicle exhaust emissions and dust could increase in the vicinity of stations due to increased traffic. Activities at the depot might also aggravate the quality of air within its vicinity.
2	Surface Water pollution	B-	C	B-	B-	**[Construction Phase]** (-) Excavation, levelling, stock piling and dewatering of pier excavation within or near the river banks would cause short term slight increase in sediments and turbidity of rivers and/or streams along the proposed railway. (-) Improper handling of stockpiles of excavated soil could be exposed to erosion especially during rainy season and may be discharged to water bodies through run-off which will contribute to the siltation / sedimentation of nearby drainage systems or natural waterways. (-) Wastewater from temporary facilities area, improper handling of solid waste generated by workforce, and fuel, lubricant and hydraulic oil discharges from poorly maintained construction equipment, machineries and heavy vehicles would cause short-term deterioration of nearby water body. **[Operation Phase]** (-) The long-term uncontrolled discharge of wastewaters from commuter station and depot may cause deterioration in nearby surface water.
	Ground Water pollution	B-	C	B-	B-	**[Construction Phase]** (-) Construction activities might impede groundwater flow. Additionally, water flows in the springs and where the water naturally comes out, may be decreased due to groundwater discharge from drainage of surrounding grounds of the tunnel site. (-) Risk of groundwater contamination may come from accidental spillage of oil and fuel from storage tanks, poor disposal of other chemicals, chemicals used in pile driving. **[Operation Phase]** (-) the long-term overland discharge of untreated wastewaters from the train stations and depot may cause degradation of quality of nearby groundwater
3	Soil pollution	B-	C	B-	B-	**[Construction Phase]** (-) Improper management of solid waste generated from the demolition of existing structures, clearing of ROW, and construction workforce may cause land contamination. (-) untreated wastewater from temporary facilities might contaminate nearby soil. (-) Soils may become contaminated in the event of leaks and accidental spills of fuels and lubricants from construction vehicles and machineries, as well as other hazardous chemicals like paints and solvents. **[Operation Phase]** (-) Improper management of solid wastes and wastewater generated by railway users/ employees at station and depot may result to land contamination. (-) Leaks of detergents, lubricants agents and used oil at the depot may contaminate soil.

No	Items	Assessment in Scoping		Assessment based on Survey results		Assessment of Impact
		Pre/During construction	Operation	Pre/During construction	Operation	
4	Waste	B-	C	B-	B-	**[Construction Phase]** (-) Improper management of domestic wastes by construction workforce, hazardous solid wastes, and residual construction materials will cause problems of disposal. (-) Poor management of disposal of excess soil as a result of soil excavation and backfilling operations may end up be discharged to water bodies through run-off and could cause increased sedimentation in nearby rivers. **[Operation Phase]** (-) Improper management of domestic wastes, hazardous solid wastes, will cause problems of disposal at LGUs.
5	Noise	B-	C	A-	A-	**[Construction Phase]** (-) Increase in noise level due to earthmoving, demolition and earth balling, and operation of equipment, machineries, and service vehicles. The noise levels of pile driver and rock drilling will exceed the maximum allowable noise levels of construction work (90 dBA). **[Operation Phase]** (-) The predicted noise level of train operation will exceed the guideline values for Night (55 dBA) even at the edge of the ROW.
	Vibration	B-	C	A-	B-	**[Construction Phase]** (-) The operations of pile driver and rock drilling will affect the area around the project site including NHCP heritage site and old PNR structures, since the vibration level (VL) is above the human perceptive threshold (55 dB). **[Operation Phase]** (-) Vibration is not expected to affect humans or buildings in case of viaduct, however in case of embankment, it will exceed for the building within 10m of the track.
6	Ground subsidence	C	C	B-	B-	**[Construction / Operation Phase]** (-) The soft soil particularly in the segment from North Depot to the Malolos Station may be at risk during a strong earthquake that makes construction structures unstable. (-) the tunnel boring activities might cause ground subsidence at the underground, which may lead to the building movement in the urban area.
7	Bottom sediment	B-	C	B-	B-	**[Construction Phase]** (-) Piling works of viaduct/bridges piers in the rivers, will cause short term adverse impact on bottom sediment quality in and out of the rivers, especially during rainy season. (-) Solid wastes or contaminants such as fuel, lubricant and hydraulic oil discharges from poorly maintained construction equipment, machineries and heavy vehicles generated during construction, as well as domestic wastes generated may adversely affect water and sediment quality. **[Operation Phase]** (-) Slight change to downstream sediments due to bridge piers in river.
Natural Environment						
8	Protected Area	D	D	D	D	There is not protected area along the alignment.
9	Ecosystem (terrestrial flora)	B-	B-	B-	D	**[Construction Phase]** (-) Earthworks, disturbance to vegetation, vehicle movement and other factors have the potential to introduce additional weeds to the area and to spread existing populations of introduced flora along the length of the proposed rail alignment. (-) Loss of the critically endangered, endangered, and vulnerable species namely: Antipolo, Piling liitan, Is-is, Narra and Molave in the project area through vegetation removal and land clearance. **[Operation Phase]** During the operation phase, no vegetation removal and clearing are expected, so that there would be no threat to the existence and/or loss of important local flora species.

<table>
<tr><th rowspan="2">No</th><th rowspan="2">Items</th><th colspan="2">Assessment in Scoping</th><th colspan="2">Assessment based on Survey results</th><th rowspan="2">Assessment of Impact</th></tr>
<tr><th>Pre/During construction</th><th>Operation</th><th>Pre/During construction</th><th>Operation</th></tr>
<tr><td rowspan="2">9</td><td>Ecosystem (terrestrial fauna)</td><td>B-</td><td>B-</td><td>B-</td><td>B-</td><td>[Construction Phase]
(-) Removal of vegetation, generation of noise, vibration, illumination, and vehicular movement which can disrupt animal activities.
(-) Vegetation clearing and other site preparation activities will destroy grasslands/marshland and some tree patches which serve as shelter and food for most wildlife species, especially amphibians, which will lead to loss of habitats. Especially fishponds/swamps and wetlands in Pampanga, which is the feeding area of the migratory birds will be destroyed by construction will lead to loss of migratory birds in the area.
[Operation Phase]
(-) Generation of noise, vibration, illumination, and vehicular movement which can disrupt animal activities.
(-) Regular maintenance of ROW may involve the use of mechanical methods, such as mowing or pruning machinery, in addition to manual hand clearing and herbicide use, all of which can disrupt wildlife and their habitats.</td></tr>
<tr><td>Ecosystem (Freshwater Ecology)</td><td>B-</td><td>B-</td><td>B-</td><td>B-</td><td>[Construction Phase]
Little or minimal impacts on aquatic bodies as most sampling stations are already heavily polluted as a result of domestic and industrial activities in the area except those less affected by human activities, such Masaluso River and Cutcut River Tributary.
(-) Disruption of water flow by earth-moving activities may affect nearby aquatic habitats which serve as shelter, spawning and nursery grounds for aquatic animals.
(-) Erosion of sediments through land clearing and stockpiles of sediment may end up as runoff to nearby sections especially during storm and heavy rains. These may adversely affect plankton and macrobenthos fauna.
(-) Water pollution from spills of vehicles, domestic sewage of workers may give rise to eutrophication, changes in composition of aquatic fauna and mortality of highly sensitive species of fish and aquatic insects.
(-) loss of fish by illegal fishing by workers.
[Operation Phase]
(-) Spills from train during normal operations and occasionally due to accidental spills from train and at depot will cause negative impacts on aquatic animals.
(-) An increase of the local population induced by the railroad could result in an undesirable increase of domestic wastes which may pollute freshwater bodies and adversely affect aquatic organisms</td></tr>
<tr><td>10</td><td>Hydrology</td><td>C</td><td>C</td><td>A-</td><td>B-</td><td>[Construction Phase]
(-) construction of stations and viaduct pier may clog existing drainage systems and block creeks, canals and other waterways, may cause sedimentation and flooding in the surrounding areas during heavy rainfall.
[Operation Phase]
(-) The proposed MCRP embankments may induce flooding and inundation due to drainage overflows, surface run-off and siltation.
(-) Viaduct pier installed in rivers may impact to the exiting water flow and may induce local flooding.</td></tr>
<tr><td>11</td><td>Ground Hydrology</td><td>C</td><td>C</td><td>D</td><td>D</td><td>[Construction Phase]
Concreting works at the stations and depot will bring about increase in water consumption. However, the amount is not significant and will not affect the water supply needs of the host LGUs.
[Operation Phase]
Railway operations will not contribute to the depletion of the local groundwater resources or compete in water use with local residents and establishments.</td></tr>
</table>

No	Items	Assessment in Scoping		Assessment based on Survey results		Assessment of Impact
		Pre/During construction	Operation	Pre/During construction	Operation	
12	Geographical features	C	C	B-	B-	**[Construction Phase]** (-) Permanent and major modification of the terrain at the segments Clark to CIA and the hilly areas from North Depot to the NCC Station can temporarily destabilize the slopes. (-) The immediate banks of the main rivers (Sacobia and Bamban) and from Malolos to San Fernando is vulnerable to flooding. The upper slopes to the far west of the MCRP line are steep to very steep and have high susceptibility to landslides. **[Operation Phase]** (-) Landslide and lahar flows can block the railway route or hit the moving train and damage the railway cars. Ash fall can reduce visibility and cause stoppage of operations. Ground shaking can bring about liquefaction and settlement of the track and stations foundation and can also damage bridge crossings.
Social Environment						
13	Land acquisition/Resettlement	A-	A-	A-	A-	**[Construction Phase]** (-) Resettlement and disturbance to properties are unavoidable along the proposed railway alignment, station, and depot. The total of approx. 1,400 Project Affected Families (PAFs) will be displaced due to the loss of their dwellings (Refer to Draft Resettlement Action Plan (RAP)). (-) The acquisition of additional land for the project ROW for the proposed stations and curved alignment, displacement of households, businesses and commercial establishments, and displacement from the source of livelihood are unavoidable. **[Operation Phase]** (-) Payment of compensation, preparation of relocation sites might be delay and insufficient livelihood and income restoration program are provided. This will delay restoration of livelihood and income of PAFs and worse the living standard prior to the construction.
14	Poor people	A-	A-	A-	A-	**[Pre-Construction / Construction Phase]** (-) Most of the affected approx. 1,200 ISFs are regarded as the poor. Issues of vulnerable group are not take into account and the resettlement of ISFs might worsen their livelihood by loss of income etc. **[Operation Phase]** (-) Improvement of their economic situation and relocation sites might take a longer and livelihood make get worse comparing to prior construction.
15	Ethnic minorities and indigenous peoples	C	C	C	B-/+	**[Construction Phase]** (-) in case of Depot site encroach the Ancestral Domain, the culture and lifestyle of Aetas present in the area may be affected (-) The influx of construction workers who may not be familiar with the culture of Aetas may cause social conflicts and may influence the IP culture due to access on different resources. (-) The development within or near their community may cause changes in their cultural beliefs and heritage. Also, the pace of lifestyle will increase to keep up the demand of employment and lifestyle opportunities and also change their perception on values. **[Operation Phase]** (-) The development within or near the IP community may cause changes in their cultural beliefs and heritage. (+) Some Aeta may increase the pace of their lifestyle to keep up with development in the area and the convenience of the mass transport may improve their living as well as their perception on values of these conveniences.

<table>
<tr><th rowspan="2">No</th><th rowspan="2">Items</th><th colspan="2">Assessment in Scoping</th><th colspan="2">Assessment based on Survey results</th><th rowspan="2">Assessment of Impact</th></tr>
<tr><th>Pre/During construction</th><th>Operation</th><th>Pre/During construction</th><th>Operation</th></tr>
<tr><td>16</td><td>Local economies, such as employment, livelihood, etc.</td><td>B-/+</td><td>C</td><td>B-/+</td><td>B-/+</td><td>[Pre-Construction / Construction Phase]
(-) The project may lead to a decline or eventual loss of business in affected areas. Land acquisition will force commercial establishments and farmers may need to move out and might cause income loss and unemployment. Livelihood of the local community such as commercial establishments, vendors and tenants, may experience temporary disturbance during construction.
(+) The construction activities will create temporary employment of about 12,000 workers skilled and unskilled laborers.
(+) the demand for retail and other services by the manpower influx may increase economic activities and benefits for some local businesses.
[Operation Phase]
(+) the operation of the MCRP will provide employment to approx. 1,400 employees for manning the stations, operations and maintenance of trains at the depot.
(+) The MCRP will boost regional economic activities at the stations attracting future commercial development as well as along the route through provision of an efficient mass transit system and promotes urban and economic development by enhancing workforce mobility between the industrial zones.
(-) Influx of migrant workers during operation of the proposed MCRP will intensify the competition for jobs of locals</td></tr>
<tr><td>17</td><td>Land use and utilization of local resources</td><td>B-/+</td><td>B+</td><td>B-</td><td>B+</td><td>[Construction Phase]
(-) Plans, zoning ordinances, and economic development programs of the affected LGUs and national government agencies with similar road and infrastructure projects in the vicinity of the alignment might be affected.
[Operation Phase]
(+) The proposed MCRP will provide a more efficient and safer transportation facility. As a results, land development is expected to increase along or near the corridor through conversion of low density residential areas to higher density residential and commercial uses.
(+) The proposed MCRP may enhance the access to tourist destinations in the host LGUs because of shorter time and the easy access</td></tr>
<tr><td>18</td><td>Water usage</td><td>C</td><td>C</td><td>B-</td><td>D</td><td>[Construction Phase]
(-) There are small creeks in agricultural area might be temporary blocked due to civil works.
(-) During construction, concreting works will bring about increase in water consumption about 10 m^3 per day. However not significant and will not affect the water supply needs of the host LGUs.
[Operation Phase]
Very minimum impact which water usage (in total 96 m3 per day) will be limited to the drinking water requirement of the operations staff, maintenance of comfort rooms and the regular cleaning of the stations, depot and cars.</td></tr>
<tr><td>19</td><td>Existing social infrastructure s and services</td><td>C</td><td>C</td><td>B-</td><td>B-</td><td>[Construction Phase]
(-) Temporarily interruption of utility services during relocation.
(-) Loss of public open spaces in the area such as People’s Park in Angeles, Pampanga and Malabanas People’s Park in Angeles, Pampanga which utilizing PNR ROW.
(-) Increase in demand for resources such as power and water supply, additional schools, markets and community service facilities, etc. in the resettlement areas is expected.
(-) Solid waste or soil generated by the construction activities may overload the local disposal site.
[Operation Phase]
(-) Development of infrastructure such as power and water supply, additional schools, markets and community service facilities, etc. might take longer at the resettlement areas as well as take longer to integrate into each host LGU and provider.</td></tr>
</table>

No	Items	Assessment in Scoping		Assessment based on Survey results		Assessment of Impact
		Pre/During construction	Operation	Pre/During construction	Operation	
20	Social structure such as social capital and local decision-making institutions	C	C	B-	B-	**[Pre- Construction/ Construction Phase]** (-) The approx. 1200 ISFs will be relocated to the existing/newly developed relocation sites, which might impact to the existing barangay's/ residents' societies. (-) The influx of ISF due to the delay in construction. **[Operation Phase]** (-)Integration of existing residents and new settlers might take longer at the relocation sites. The impacts to barangay's/ residents' societies might continue.
21	Misdistribution of benefits and damages	B-	B-	B-	B-	**[Pre- Construction/ Construction Phase]** (-)The total of 1,400 PAFs are required to be displaced due to the loss of their dwellings. (-) Some commercial and business establishment and farmers along the proposed alignment will be displaced and will lose income temporarily. (-) Fair compensation are not paid to those affected people. **[Operation Phase]** (-) Provision of compensation and restoration of livelihood of PAFs might take a longer period of time.
22	Local conflicts of interest	B-	B-	B-	B-	**[Pre- Construction/ Construction Phase]** (-) The total of 1,200 ISFs will be displaced, which might cause a conflict between existing residents and new settlers at the relocation sites. (-) Migrant workers may also bring in cultures and views not acceptable to the locals and other social ills. **[Operation Phase]** (-) Conflict resolution between existing residents and new settlers might take longer at the relocation sites.
23	Historical/ Cultural heritage	C	C	B-	B-	**[Pre- Construction/ Construction Phase]** (-) the old PNR Structures will be affected by the proposed MCRP, which might require to remove or relocated. During construction, vibration might cause the negative impact to the state of structure. (-) NHCP heritage of Gov. Macario Arnedo Park, and Death March Marker in San Fernando, Pampanga and Grotto of Our Lady of Lourdes in Bamban, Tarlac might be impacted by vehicle access and vibration generating construction activities. **[Operation Phase]** (-) In sufficient provision of mitigation measure on the old PNR Structures and exiting NHCP heritage will deteriorate the value.
24	Landscape	B-	C	B-	B-	**[Construction Phase]** (-) Improper handling and disposal of construction and domestic wastes may result in visual pollution and will have an aesthetic impact on the landscape, but temporary. **[Operation Phase]** (-) The existing surrounding landscape value of wetlands and at Tarlac might be disturbed by the proposed vertical structures.
25	Gender	C	C	B-	B-	**[Pre- Construction/ Construction Phase]** (-) Lack of awareness on the issue of gender and vulnerable groups will results the project not sufficiently addressing the needs of female and vulnerable groups. **[Operation Phase]** (-) Train system might lack in needs of gender-sensitive facilities and furnishings. (-) Poor access of solo parents to employment and other livelihood opportunities.
26	Children's rights	C	C	B-	B-	**[Construction Phase]** (-) the blocking of access roads will lead to possible disruption for access to school. (-) Involuntary resettlement might affect school activities in case relocation would be conducted during the school year.

No	Items	Assessment in Scoping		Assessment based on Survey results		Assessment of Impact
		Pre/During construction	Operation	Pre/During construction	Operation	
						(-) Relocation site might lack in educational institutions or cause difficult to access. (-) Potential risks of displacement and loss of livelihood may increase threats of increased poverty to households already living below poverty threshold. Loss of income will cause them potential exclusion and difficulty in their access to basic social services compromising the well-being of the household members specially children and women. **[Operation Phase]** (-) development of social infrastructure including school, and improvement of the economic situation of vulnerable group might take longer.
27	Infectious diseases such as HIV/AIDS, Community Health	B-	D	B-	B-	**[Construction Phase]** (-) Potential air, noise and water pollutants generated by the construction of the proposed MCRP may have adverse impacts on the health and safety of residents of nearby communities, specifically those along the project boundary. (-) Most construction workers will be hired locally. However, infectious diseases such as HIV/AIDS might be spread due to workers from outside. (-) 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. **[Operation Phase]** (-) The health of employees working at the stations and depot may be affected from exposure to unsanitary conditions.
28	Working conditions (including occupational safety)	B-	B-	B-	B-	**[Construction Phase]** (-) there are potential construction activities such as site preparation, excavation work which will involve excavation of previously contaminated area. (-)Workers may be exposed to ergonomic stress and increased levels of noise, air and water pollutants, and heat, as well as physical hazards associated with heavy lifting, moving heavy equipment, etc. (-) Increased risk of construction-related accidents due to improper work ethic and requirement to construct quickly. **[Operation Phase]** (-) Improper work ethics might threat health and safety of workers and passenger at the stations and depot. (-) The health of employees working at the stations and depot may be affected from exposure to unsanitary conditions
Others						
29	Trans-boundary impacts or climate change	B-	B+/-	B-	B+/-	**[Construction Phase]** (-) The operation of construction machines and vehicles will emit CO_2 temporarily but the impact on global warming will be slight. (-) Intense rainfall would potentially cause damage to embankment and earthwork due to soil erosion, landslides, and flooding. High temperature and heat waves would potentially cause heat stress to workers. **[Operation Phase]** (+) The emission of GHG will decrease due to the modal shift, "electrification" of passenger railway systems and increase of vehicle travel speeds. (-) Climate change will impact to the operation of railway. Extreme events may disrupt operations and add costs to operation.
30	Accidents	B-	B-	B-	B-	**[Construction Phase]** (-)Traffic accidents are likely to occur due to the increase of construction vehicles, unmanaged temporary access, and change in traffic pattern. **[Operation Phase]** (-) There may be increased vehicular flow in areas adjacent to stations and depot that may cause traffic accidents.
31	Risk of flood	C	C	B-	B-	**[Construction Phase]** (-) Frequency of typhoons as well as the slope and drainage characteristics of the areas where the proposed MCRP is to be located is susceptible to flooding and inundation. Especially from Malolos to Angeles, and from the main channels of

No	Items	Assessment in Scoping		Assessment based on Survey results		Assessment of Impact
		Pre/During construction	Operation	Pre/During construction	Operation	
						Mabalacat and Abacan Rivers, from San Fernando Station to Calumpit Station is susceptible to flooding and inundation. (-) The improper handling, storage, and hauling of stockpiles of excavated materials/spoils, the proposed MCRP may potentially induce flooding and cause inundation due to sediment run-off, siltation and drainage overflow. (-) The pier of the proposed MCRP may block the waterways which may cause sedimentation and flooding in the surrounding areas during heavy rainfall. (-) Due to the construction of impervious structures such as the viaducts, storm water run-off may increase that would change the flood storage capacity of waterways and its floodplains **[Operation Phase]** (-) Embankment may act as a dam to cause flooding and inundation in upstream areas.

Note: Impact Items refer to "JICA Guidelines for Environmental and Social Considerations April 2010"
A+/- Significant positive/negative impact is expected,
B+/- Positive/negative impact is expected to some extent
C Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)
D No impact is expected

Source: JICA Design Team

9.1.9 Environmental Management Plan and its Implementation Cost

The Environmental Management Plan (EMP) as shown on Table 9.1.54, presents the mitigation/enhance measures for the impacts that may arise during the Pre-Construction, Construction, and Operational Phases of the proposed Project.

9.1.10 Environment Monitoring Plan

The Environmental Monitoring Plan (EMoP) as shown on Table 9.1.55, will be prepared to monitor the environment impact and effectiveness of measures during the construction and operation. The EMoP will also include the items to be monitored, monitoring methodology, time and frequency, monitoring points, and cost and implementation intuition.

Table 9.1.54 Environment Management Plan for the Proposed MCRP

items	Potential Impact	Prevention/Mitigation/Enhancement Measures	Responsible Institution	Estimated Cost (PhP)
General				
Pre-construction, Construction and Operation activities		Comply with the relevant laws: • RA 6969: storage, transport, handling, treatment and disposal of hazardous waste - Secure hazardous waste generator's ID from DENR-EMB; - Provision of hazardous materials storage area; - Hazardous materials/ wastes will be stored in appropriate container properly sealed and labelled; - Hazardous waste will be hauled by an accredited transporter; - Hazardous waste will be treatment by a registered treater (TSD Facility). • RA 9003: management and disposal of solid wastes - Waste segregation, recycling, provision of waste color coded bins, etc.; - Provision of Material Recovery Facility (MRF); - Regular hauling of solid wastes through the LGU or private contractor. • RA 8749: comprehensive air pollution control policy - Secure permit to operate for all air pollution source installations (i.e. generating set); - Regular inspection and preventive maintenance of heavy equipment, machineries and service vehicles to meet the DENR Emission Standard; - Regular cleaning and clearing of construction access / sites surfaces of spoils and debris from construction equipment and vehicles and wetting of ground soil in the construction site when necessary; - Control vehicle movement maintaining the speed limit within the construction site to <10 kph and provide cover to loaded trucks. • RA 9275: comprehensive water quality management and for other purpose - Secure discharge permit; - Provision of Wastewater Treatment Facility at the depot; - Provision of three-chambered septic tank at each station. • PD 442: Labor Code of the Philippines, as amended (including Occupational Safety and Health Standards) - Gender equality will be considered in hiring of workers; - Include medical certificate in the requirements for hiring of workers to ensure that they are fit to work. Ensure that they are provided with proper training on construction, occupational health and safety, and emergency response procedure. - Provide appropriate personal protective equipment (PPE) to all construction workers, particularly to the personnel working on heights, heavy and electrical equipment. - Establish Health and Safety Desk or Medical Station at the active construction sites to monitor and safeguard the health of the workers and local residents and to provide immediate response during unexpected incidents/emergencies.; - Close coordination with the nearest hospitals in the active construction site for immediate transfer and/or further evaluation and medical management of the patient; • PD 856: Sanitation Code of the Philippines - Provide safe and clean water for drinking; - Provision of appropriate sanitary facilities such as portable toilets and waste bins.	• DOTr PMO • Contractors • Operator • LGUs • MMT	Included in the contractor and operator's service fee on health, safety and environmental management: • RA 6969: PhP 100,000/yr • RA 9003: PhP 400,000 /yr • RA 8749: PhP 400,000/yr • RA 9275: PhP 400,000/yr • PD 442: PhP 6,000 / worker • PD 856: PhP 50,000/yr • Sanitary facility: PhP 200,000 / per site • Emergency Response Plan and Health and Safety Management Plan: Php 300,000 • Health and Safety Desk or Medical Station: Php 200,000/per site • PhP 1,500 / man-hour

items	Potential Impact	Prevention/Mitigation/Enhancement Measures	Responsible Institution	Estimated Cost (PhP)
		• Implementation of Emergency Response Plan and Health and Safety Management Plan to include but not limited to: - Distribution of manual/guideline for workers/employee on health and safety, environment management; - Orientation and continuous training of qualified workers/ employee/ operator on Environment Management, Basic and Construction Occupational Safety and Health, Scaffolding Safety, Fire Safety and Safe Use of Chemicals at Work; - Provision of earthquake, fire drills for workers; - Provision of appropriate PPE for workers; - Provision of security personnel. • Regular monitoring of site condition		
Pollution Control				
Air Pollution	• Degradation of air quality due to dust generation from transportation of excessive soil / spoil to fill area construction activities • Degradation of air quality due to gaseous emissions from machineries and service vehicles	**[Construction]** • Minimize the removal of vegetation and alteration of topography if possible. • Adjust construction activities in consideration to weather system, identifying periods of high winds and drought that aggravated dust transport. • Conduct prompt inspection and regular maintenance of heavy equipment, machineries and service vehicles to meet the DENR Emission Standards • Control vehicle movement maintaining the speed limit within the construction site to <10 kph and minimize vehicle transport by maximizing the use of site generated materials • Conduct regular cleaning and clearing of construction access / sites surfaces of spoils and debris from construction equipment and vehicles and wetting of ground soil in the construction site when necessary. Stock pile and trucks loaded with spoils will be covered. • Implement materials handling program or a site protection and rehabilitation program. • Monitor air quality at identified nearby sensitive receptors regularly and evaluate effectiveness of the air pollution reduction measures provided. • Use electric or fuel-efficient equipment, machineries and vehicles and maximize its operation if possible	• DOTr PMO • Contractors	Construction cost to be finalized during the DED: • PhP 1,500 / man-hour • Monitoring: PhP 30,000 to 80,000 / per sampling station depending on the parameter/s to be monitored
Water Pollution.	• Degradation of surface water quality • Threat to abundance, frequency and distribution of species	**[Pre-Construction/ Construction]** • Design and implement the temporary drainage of waste water from construction yard/ facilities/ camp, surface water runoff drainage systems to minimize discharge. • Design and install sewage treatment facility and separate non-sewage wastewater for stations and Depot in compliance to the Sanitation Code of the Philippines. In addition, depot will have interceptor tank to remove oil and fuel from surface water. • Compliance with RA 9275, secure discharge permit. **[Construction]** • Install wastewater treatment, portable sanitary facilities at construction sites/yards • Conduct proper inspection and regular maintenance of construction machineries, equipment, vehicles and wastewater treatment equipment and facilities with appropriate measure to collect any leakage • Comply with environmental permitting requirements for the storage, transport, handling, and treatment of hazardous material/ wastes and contaminated soil in accordance with RA 6969 and solid waste / soil management plan, which include minimization of waste/soil generation,	• DOTr PMO • DED consultants • Contractors • LGUs	DED cost / construction cost to be finalized during the DED: • Php 50,000/per discharge permit • Treatment facility: Php 5,000,000/site • Php 1,500/man-hour • Php 100,000/yr for Hazard waste disposal. • Php 400,000 /yr

items	Potential Impact	Prevention/Mitigation/Enhancement Measures	Responsible Institution	Estimated Cost (PhP)
		segregation, and proper disposal including the temporary storage by contractor in accordance with RA 9003 • Implement material handling program or a site protection program. • Conduct regular monitoring of surface water quality and effluent quality at discharge point		for Solid waste disposal • Php 25,000/per sampling station
	Degradation of groundwater quality	**[Pre-Construction]** • Plan and Implement appropriate construction methods (i.e. excavation, backfilling, stockpiling) based on geological and geotechnical investigations. • Install sedimentation / filtration pond at tunnel construction area. **[Construction]** • Comply with environmental permitting requirements for the storage, transport, handling, treatment, and disposal of hazardous material/ wastes and contaminated soil in accordance with RA 6969, and solid waste / soil management plan, in accordance to RA 9003.	• DOTr PMO • Contractors • LGUs • MMT	construction cost to be finalized during the DED:
Soil Pollution	Degradation of soil quality (soil contamination)	**[Construction]** • Proper inspection and maintenance of machines and equipment. • Strictly implement solid waste management plan and proper disposal by contractor in accordance with RA 9003, hazardous waste disposal in accordance with RA 6969. • Conduct soil quality monitoring in case of any possible contamination events occur.	• DOTr • Contractor	Construction cost to be finalized during the DED • Php 1,500/man-hour • Php 25,000/ per sampling station
	Exposure to contaminated soil	**[Pre-Construction/ Construction]** • Identify a potential contaminated site and conduct of soil sampling survey at potential contained site, if necessary. • Conduct Environmental Site Assessment (ESA) if there is suspected contamination on the proposed location of facilities (e.g. depot). In case traces are detected, construction activities on site will be paused until a soil management plan is developed and implemented in consultation to the DENR – EMB. • Storage, handling, transport, treatment and disposal of contaminated soil will be in accordance with RA 6969 **[Construction]** • Conduct continuous monitoring of toxic level to ensure that contaminants will not pose hazards.	• DOTr PMO • DED consultants • Contractors • LGUs • MMT	DED cost / construction cost to be finalized during the DED: • Php 25,000/ per sampling station • ESA Phase I Php 150,000 /site • ESA Phase II Php 1,000,000/site • ESA Phase III depends on extent of contamination. • Php 1,500/man-hour
Waste	• Devaluation of land value • Increased demand on waste disposal	**[Construction]** • Disposal of solid waste, excavated soil, hazardous waste at the identified disposal sites in each LGUs. • Strictly implement solid waste management plan and proper disposal by contractor in accordance with RA 9003, hazardous waste disposal in accordance with RA 6969. • Conduct regular monitoring of disposal status in compliance to RA 9003 and RA 6003. • Conduct Social Development Plan (SDP) including waste management to the communities	• DOTr • Contractors • LGU • MMT	To be included in the contractor's Service Cost: • Php 1,500/man-hour • SDP: Php 15,000 /per person

items	Potential Impact	Prevention/Mitigation/Enhancement Measures	Responsible Institution	Estimated Cost (PhP)
	• Improper handling of excavated soil	**[Pre-Construction/Construction]** • Plan and implement recycling and reuse of excavated soil to be utilized for the project/ other project as much as possible. In case of excessive soil to be generated, identify the capacity of existing soil dump site and the final spoil disposal site. **[Construction]** • Place excavated materials on appropriate dump sites or spoils area and with adequate containment. • Strictly implement construction plan, soil management plan, and proper disposal by contractor in accordance to RA 9003, minimization of waste, segregation.	• DOTr PMO • DED consultants • Contractors	DED cost / construction cost to be finalized during the DED: • Php 3,000 /haul per track • Php 400,000 /yr for Solid waste disposal
Noise and Vibration	• Increase in ambient noise level • Threat to existence and/or loss of important local species and habitat • Threat to abundance, frequency and distribution of species	**[Pre-Construction/ Construction]** • Select sites (i.e. construction yard, temporary facilities, access route) in consideration to sensitive receptors including ecologically significant areas (if any) likely to be affected • Design and install effective noise barriers and absorbers along the alignment especially in areas with sensitive facilities. • Design and adopt long rails and ballast-less track with elastic and absorbent sleeper support to minimize noise generation from train operation **[Construction]** • Implement construction activities in consideration to time, duration, and scale to optimize the use construction equipment, machineries, and vehicles in accordance to the noise emission standard. • Minimize alteration of topography and removal of vegetation. • Install noise control devices such as mufflers and noise suppressors to all construction equipment and machineries. Use of electric instead of diesel powered equipment, hydraulic tools instead of pneumatic tools. • Conduct regular inspection and preventive maintenance of heavy equipment, machineries and service vehicles to meet the DENR Emission Standard • Provide appropriate PPE to construction workers • Monitor noise levels at identified nearby sensitive receptors (residential, school and hospital areas) including ecologically significant area/s (if any) likely to be affected by the operation and evaluate effectiveness of the noise reduction measures provided.	• DOTr PMO • DED consultants • Contractors	DED cost / construction cost to be finalized during the DED • Php 1,500 /man-hour • PPE: Php 8,000 /personnel • Php 25,000/per sampling station • Php 30,000/ per meter noise barrier
	• Increase in ambient vibration level and threat to the health and safety of sensitive receptors • Threat to existence and/or loss of important local species and habitat • Threat to abundance, frequency and distribution of species	**[Pre-Construction / Construction]** • Select sites in consideration to sensitive receptors including ecologically significant areas (if any) likely to be affected. • Conduct building condition survey of old PNR structures and buildings adjacent to the alignment to provide proper protection provision measures and continuous monitoring from the impact of vibration. **[Construction]** • Implement construction activities in consideration of time, duration, and scale of construction to optimize the use construction equipment, machineries, and vehicles with minimal vibration generation. • Select construction equipment and machineries matching the scale of the construction and with minimal vibration generation if possible • Provide training on vibration mitigation and provide appropriate PPE to construction workers;	• DOTr PMO • DED consultants • Contractors • LGUs	DED cost / construction cost to be finalized during the DED • Php 1,500 /man-hour • Php 25,000 /per sampling station • Php 15,000/ per training

items	Potential Impact	Prevention/Mitigation/Enhancement Measures	Responsible Institution	Estimated Cost (PhP)
		• Monitor vibration levels including identified nearby sensitive receptors, old PNR structures including ecologically significant area/s (if any) likely to be affected by the operation and evaluate effectiveness of the vibration reduction measures provided.		
Ground subsidence	• Loss of soil strength, settlement of soil, lateral spreading, bearing failure, floatation of embedded structures, damage to overlaying structures, in the event of natural disaster • Damage to railway infrastructure and risk to the life of construction workers	**[Pre-Construction/Construction]** • Design and implement appropriate foundation and structures based on combination of geotechnical, geodetic and hydrologic study, and seismicity studies, and in compliance with the National Building Code and the Structural Code of the Philippines and internationally accepted guideline. • Plan and implement appropriate construction method, schedule, and activities based on combination of geotechnical and geological investigations, and seismicity studies in coordination with the PHIVOLCS. **[Construction]** • Install sufficient protection measure such as soil improvements during excavation activities and implement appropriate materials handling program or a site protection and rehabilitation program. • Proper inspection of all installed and constructed / ongoing construction structures and facilities.	• DOTr PMO • DED consultants • Contractors	DED cost / construction cost to be finalized during the DED: • Php 1,500/man-hour • Soil Improvement: Php 30,000 / m^2
Bottom sediment	• Disturbance on bottom sediment and degradation of surface water • Siltation • Induce of turbidity	**[Pre-Construction]** • Based on the hydrological and geodetic surveys, design bridge piers that will minimize installation within the rivers and select appropriate construction materials to be used. • Minimize the removal of vegetation cover, alternation of topography as much as possible. • Plan and implement construction activities in consideration to the water course, embankment, and dry season. • Coordinate with NWRB, DPWH and LGUs for necessary permit **[Construction]** • Install protection measures for soil erosion and bottom sediment around the bridge piers if necessary. • Place excavated material in temporary staging area with provision for silt traps/ siltation pond to avoid silt draining to waterways, degradation of surface water quality and clogging of waterways, if necessary. • Conduct regular surface water quality monitoring.	• DOTr PMO • DED consultants • Contractors • LGUs • MMT	DED cost / construction cost to be finalized during the DED: • Php 1,500/ man-hour • Soil erosion control: Php 30,000 / m^2 • Php 25,000 /per sampling station
Natural Environment				
Ecosystem (Flora)	Removal of vegetation along the proposed MCRP particularly the planted trees at FTI, Solis and other areas along the ROW	**[Pre-Construction]** • Prior to any clearing activity, clearly mark the ROW to avoid the unnecessary clearance of tree cutting. • Conduct 100% inventory of the affected trees along the alignment to determine the total counts, category, and characteristics of affected trees and minimize removal particularly in areas adjacent to vegetation of higher conservation significance as much as possible. Native/endemic/ indigenous species of trees, shrubs and grasses shall be specified for replacement trees. • Wildlings of the endangered and threatened species, if any, will be collected before construction, placed in the nursery, and give priority during nursery operation to be used for rehabilitation of areas that will be affected by project. • For tree replanting, areas not part of the development within the ROW, around the stations and depot will be prioritized for replanting activity to create buffer zone and to improve habitat for	• DOTr PMO • Contractors • LGUs	Construction cost to be finalized during the DED • PhP 1,000,000 for the 100% tree inventory • PhP 100/ sapling • Php 1,500/ man-hour

items	Potential Impact	Prevention/Mitigation/Enhancement Measures	Responsible Institution	Estimated Cost (PhP)
		wildlife. For those that cannot be replanted within the project area, coordination with the DENR and LGUs on the identification of area for the potential trees that will be relocated. • Secure tree cutting permit in compliance with DENR Memorandum Order No. 2012-02. **[Construction]** • Conduct tree planting activities to compensate site clearing activities. • Conduct regular monitoring on survival of replanted trees and replant if necessary.		
Ecosystem (Fauna)	• Threat to Existence and/or Loss of Important Local Species • Threat to Abundance, Frequency and Distribution of Important Species • Hindrance to Wildlife Access	**[Pre-Construction/ Construction]** • Design, plan and implement the project that will minimize vegetation clearing, alteration of landform, generation of noise, vibration, illumination, and vehicular movement particularly in areas adjacent to flora of higher conservation significance (i.e. Antipolo, Is-is, Narra) and in the vicinity of ecological significant areas. • Prepare and implement a tree and vegetation management plan as part of the construction plan considering the significance to fauna (local bird species) such as installing buffer zone, minimizing the use of herbicide and machinery as much as possible. • Coordinate with BMB-DENR and SCPW for the conservation of migratory birds if required.	• DOTr PMO • DED consultants • Contractors • LGUs • MMT	DED cost / construction cost to be finalized during the DED • Php 1,500/man-hour
Hydrology	Impact to water flow	**[Pre-Construction /Construction]** • Design and install sufficient drainage system including temporary drainage system during construction to accommodate the surface water runoff from the project and avoid any flooding in the rea caused by the project in consideration to the existing drainage system and flood storage capacity • Based on the hydrological, geological study and local climate change data from PAGASA, design and install train system in robust to flood and related extreme events including temporary construction drainage, train structure to be above the flood level, installation of drainage pumping system, etc. • Based on the hydrological, design and install viaduct piers. • Coordinate with DPWH and LGUs on the integration of proposed drainage plan to the project area. **[Construction]** • Minimize removal of vegetation and alteration of topography as much as possible. • Install soil erosion control such as protection of slope and bank silt trap to minimize siltation of waterways as required. • Strictly implement construction plan, operating instructions and solid waste/ soil management plan, which include minimization of waste/soil generation, segregation, and proper disposal by contractor in accordance to RA9003. • Regular inspection and prompt maintenance of the drainage system, all installed structures and facilities and improve/ enhance capacity when possible.	• DOTr • DED consultants • Contractors	DED cost / construction cost to be finalized during the DED • Php 1,500/man-hour • Drainage: Php 15,000/m
Hydrogeology	Depletion of water resource/ competition in water use	**[Construction]** • Utilize surface water from the local water service provider/s • Conduct regular monitoring of water consumption at construction site • Implement water conservation program such as use of rain harvested/ recycled water at construction yard/ camp.	• DOTr PMO • Contractors • LGU • MMT	To be included in the contractor's Service Cost: • Php 1,500/man-hour • water conservation

items	Potential Impact	Prevention/Mitigation/Enhancement Measures	Responsible Institution	Estimated Cost (PhP)
				program: Php 300,000 / per site
Geographical Features	Permanent and major modification of the terrain and alteration of landform	**[Pre-Construction /Construction]** • Formulate appropriate design measures for the protection on slopes and banks, soil improvement / ground reinforcement to minimize ground failure during construction based on the results of the geological survey and geotechnical investigations.	• DOTr • DED consultants • Contractors	DED cost / construction cost to be finalized during the DED: • Php 1,500/man-hour • Soil erosion control: Php 30,000 / m^2
	Soil erosion	**[Pre-Construction/ Construction]** • Design and install of appropriate mitigating measures to prevent or minimize slope failure during construction based on the results of the geo hazard assessment and geotechnical investigations. **[Construction]** • Minimize the removal of vegetation cover as much as possible, provision of slope stabilization measure/s, when necessary. • Install surface water runoff drainages system, protection of slope and bank as required. • Implement appropriate materials handling program or a site protection and rehabilitation program including but not limited to the following; - Scheduling of clearing and excavation activities in speedy manner during dry season if possible. - Installation of temporary erosion ponds or silt traps around the major work areas. - Placement of excavated materials on appropriate staging site or spoils area and with adequate containment. Limit stock pile height up to 2 m high only. - Installation of fence at the stockpiles of sand and gravel to reduce sediment transport during heavy rains including reduction of storage time in the work areas. • Utilize heavy equipment for transporting, hauling and excavating material from one area to another so as to avoid spills into drainage system	• DOTr PMO • DED consultants • Contractors	DED cost / construction cost to be finalized during the DED: • Php 1,500/man-hour
	• Loss of soil strength, settlement of soil, lateral spreading, bearing failure, floatation of embedded structures, damage to overlaying structures, in the event of natural disaster • Damage to railway infrastructure and risk to the life of construction workers	**[Pre-Construction/Construction]** • Design and implement appropriate foundation and structures based on combination of geotechnical, geodetic and hydrologic study, and seismicity studies, and in compliance with the National Building Code and the Structural Code of the Philippines and internationally accepted guideline. • Design and install emergency escape route, early warning (alarm) system, emergency power supplies in the design of the structure particularly in the viaduct. • Plan and implement appropriate construction method, schedule, and activities based on combination of geotechnical and geological investigations, and seismicity studies in coordination with the PHIVOLCS. **[Construction]** • Install sufficient protection measure such as soil improvements during excavation activities and implement appropriate materials handling program or a site protection and rehabilitation program.	• DOTr PMO • DED consultants • Contractors	DED cost / construction cost to be finalized during the DED: • Php 1,500/man-hour • Soil improvement: Php 30,000/ per square meter

items	Potential Impact	Prevention/Mitigation/Enhancement Measures	Responsible Institution	Estimated Cost (PhP)
		• Proper inspection of all installed and constructed / ongoing construction structures and facilities. • Coordinate with the PHIVOLCS during earthquake and volcanic events to adjust construction schedule. Conduct earthquake drills for workers.		
Social Environment				
Resettlement/ Land Acquisition	Displacement of Residents and commercial establishments along the project alignment	**[Pre-Construction]** • Design train system maximizing the existing PNR ROW and BCDA property to minimize additional land acquisition. • Conduct sufficient stakeholder consultation meetings to disclose the project, affected area, timeline, compensation package, grievance redress mechanism etc. • Implement Resettlement Action Plan (RAP) in coordination with LGUs, lot owners and other concerned stakeholders and agencies in acquiring the land and/or securing ROW, and justly compensated prior to displacement. • Prepared and Implement RAP in coordination with KSAs/NHA, LGUs, lot owners and other concerned stakeholders and agencies in acquiring the land and/or securing ROW, relocation of ISFs and justly compensated prior to displacement. **[Pre-Construction/ Construction]** • Conduct external and internal monitoring to ensure that displacement activities are conducted in compliance to the RAP. • If PAFs raise an issue, ensure prompt response and resolution per established Grievance Redress Mechanism (GRM)	• DED consultants • DOTr PMO • LGUs	DED cost / To be included in RAP Budget
Poor people	• Displacement of ISFs • Disturbance of livelihood • Loss of income	**[Pre-Construction]** • Prepare and implement RAP to ensure that ISFs are provided with proper relocation sites and/or justly compensated and Livelihood and income restoration. • Prior to displacement, secure and/or develop relocation sites in coordination with the concerned LGUs, Key Shelter Agencies, and other concerned stakeholders with conducive living condition and basic utilities, services and amenities. • Conduct sufficient stakeholder consultation meetings to disclose the project, affected area, timeline, compensation package, grievance redress mechanism etc. **[Pre-Construction/ Construction]** • Conduct external and internal monitoring to ensure that displacement activities are conducted in compliance to the RAP. • If PAFs raise an issue, ensure prompt response and resolution per established Grievance Redress Mechanism (GRM)	• DOTr PMO • DED consultants • LGUs • NHA	DED cost / To be included in RAP Budget
Ethnic minorities and indigenous peoples	Cultural/Lifestyle Change	**[Pre-Construction]** • Conduct Field-Based Investigation of depot site in accordance to the NCIP AO No. 3, 2012. If section of the project site is within an Ancestral Domain, additional measures will be implemented in close coordination with the NCIP and LGUs. • Ensure resolution of issues by the indigenous community (if any) in coordination with NCIP and LGU.	• DOTr PMO • DED consultants • Contractors • LGUs	DED cost / construction cost to be finalized during the DED • FBI cost: Php 20,000
Local economies, such as employment,	Generation of Local Employment	**[Pre-Construction /Construction]** • Close coordination with the host LGUs (barangay level) regarding the hiring of temporary workers to ensure that the workers being considered are legitimate residents in the area.	• DOTr PMO • Contractors • LGUs	To be included in RAP Budget / To be included in the

items	Potential Impact	Prevention/Mitigation/Enhancement Measures	Responsible Institution	Estimated Cost (PhP)
livelihood, etc.		• Those affected by the Project will be prioritized for employment in consideration to gender equality. • Provide skill trainings to PAFs under livelihood and income generation program developed by RAP.		Construction Cost • IEC: Php 50,000/ per meeting with Barangay /LGU • Training: Php 15,000/ per PAFs
	Loss/ disturbance of local commercial establishments, vendors, agricultural land	**[Pre-Construction]** • Conduct sufficient stakeholder consultation meetings to disclose the project, affected area, timeline, compensation package, grievance redress mechanism etc. • Prepare and Implement Resettlement Action Plan in coordination with LGUs, business owners and vendors, employers and agricultural land owners and justly compensated for their income loss prior to displacement. **[Pre-Construction/ Construction]** • Prepare and implement livelihood and income restoration for PAPs whose present means of livelihood is no longer viable and will have to engage in a new income activity. • Conduct Social Development Plan (SDP) including livelihood training include business owners and vendors, employers and agricultural land owners affected by the project including venders • Conduct external and internal monitoring agencies to ensure that displacement activities are conducted in compliance to the RAP. • If PAFs raise an issue, ensure prompt response and resolution per established GRM	• DOTr PMO • DED consultants • LGUs • NHA	DED cost / To be included in RAP Budget: SDP: Php 15,000/ per person
Land use and utilization of local resources	Incompatibility with the Existing Land Use	**[Pre-Construction]** • Information sharing to the affected LGU to align and ensure that proposed MCRP shall be accommodated in their future land use plan • Identification of future land use of surrounding areas that will result to a significant increase of transportation-oriented developments in cooperation with urban planners of LGUs to adopt in the future developments.	• DOTr PMO • LGUs	N/A
Water usage	Depletion of water resource/ competition in water use	**[Construction]** • Utilize surface water from the local water service provider/s • Conduct regular monitoring of water consumption • Implement water conservation program such as use of rain harvested/ recycled water at construction yard/ camp.	• DOTr PMO • Contractors • LGU • MMT	To be included in the contractor's Service Cost • Php 1,500/man-hour • water conservation program: Php 300,000/ per site
Existing social infrastructures and services	Increased demand on public infrastructure	**[Pre-Construction / Construction]** • Prepare and implement Resettlement Action Plan (RAP) in consideration of relocation site to be sufficiently provided essential infrastructure covering the expected demand of basic services and resource and social programs at relocation sites in coordination with LGUs.	• DOTr PMO • LGUs • NHA, KSAs	To be included in RAP Budget
	Loss of outdoor spaces	**[Pre-Construction / Construction]** • Coordinate with the respective LGUs and PNR regarding the possible measures for the transfer/provision or relocation of public parks and other recreational facility.	• DOTr PMO • LGUs	To be included in RAP Budget

items	Potential Impact	Prevention/Mitigation/Enhancement Measures	Responsible Institution	Estimated Cost (PhP)
	Disturbance on utility	**[Pre-Construction]** • Prepare and implement utility relocation plan in coordination with utility companies such as water, electricity, telephone, gas and oil, • Prepare and implement protection plan during relocation activities	• DOTr PMO • Contractors • LGU	To be included in the contractor's Service Cost: • Php 1,500/man-hour
	Impact on Public Access	**[Pre-Construction/ Construction]** • Maintain the existing public access as much as possible, based on the study on public access at affected barangay, • In case of any temporary disclosure during construction, minimize the impact to the daily life of affected communities such as access to social infrastructure in coordination with host LGUs for the schedule of construction activities. • Disseminate information to the public, barangay, and LGUs on the potential impact to the existing public access and mitigation measure through the project activities. • Provision of diversion route with appropriate health and safety measures. In case of any changes, prompt update on the diverted routes to the concerned communities and LGUs, • Assignment of traffic guide to provide assistance to the road users.	• DOTr PMO • DED consultants • Contractors • LGUs	DED cost/ To be included in the Construction Cost: • Php 1,500/man-hour • IEC: Php 50,000/ per meeting with Barangay /LGU
Social structure such as social capital and local decision-making institutions	Conflict between existing residents and new relocates	**[Pre-Construction / Construction]** • Prepare and implement Social Development Plan (SDP) in coordination with the host LGUs to align projects or programs to their development plans	• DOTr PMO • LGUs • NHA, KSAs	To be included in RAP Budget / the DOTr's service fee: SDP: Php 15,000/ per person
	In-migration to the project area	**[Pre-Construction / Construction]** • Plan and implement construction schedule to shorten time between the pre-construction and construction as much as possible. • Install fencing and guarding of the proposed project to restrict the public from entering the ROW.	• DOTr PMO • Contractors • LGUs	To be included in the contractor's Service Cost • Php 10,000/per meter of fence
Misdistribution of benefits and damages	• Displacement/ Disturbance of Properties • Change/Conflict in Land Ownership • Impact on Livelihood and Income (i.e. farming, business)	**[Pre-Construction]** • Prepare and implement Resettlement Action Plan (RAP) to ensure that PAFs are justly compensated for the loss of income by the project prior to displacement. • Conduct external and internal monitoring agencies to ensure that displacement activities are conducted in compliance to the RAP. • Implement Resettlement Action Plan in coordination with KSAs/ NHA, LGUs, lot owners and other concerned stakeholders and agencies to address the issue on land acquisition and relocation of informal settlers. **[Construction]** • If PAFs raise an issue, ensure prompt response and resolution per established GRM	• DOTr PMO • LGUs • KSAs	DED cost / To be included in RAP Budget
Local conflicts of interest	Potential conflict among PAFs, LGUs and other government infrastructure projects	**[Pre-Construction]** • Close coordination with BCDA, DPWH, and other relevant agencies • Prepare and implement Resettlement Action Plan (RAP) to ensure that PAFs are justly compensated for the loss of income by the project prior to displacement. • Conduct external and internal monitoring agencies to ensure that displacement activities are conducted in compliance to the RAP.	• DOTr PMO	

items	Potential Impact	Prevention/Mitigation/Enhancement Measures	Responsible Institution	Estimated Cost (PhP)
		• Prepare and implement arrangement on financial assistant to the receiving LGUs of PAFs. **[Construction]** • If PAFs raise an issue, ensure prompt response and resolution per established GRM		
Historical/Cultural heritage	Impacts on /Cultural Historical resources	**[Pre-Construction/Construction]** • Conduct literature review and site validation of the potential historic structures in coordination with PNR and NHCP; • Perform measured survey of the identified historic structures including its foundation and building condition. • Coordinate closely with the NCCA, National Museum, NHCP, concerned LGUs, and PNR for verifying the qualification of those structures and provide necessary protection measures. • Prepare and implement a protection plan for those identified PNR structures which shall be maintained **[Construction]** • Close coordination with the National Museum on the appropriate course of action in case of any archaeological finds.	• DOTr PMO • DED consultants • Contractors • LGUs	DED cost / construction cost to be fin finalized during the DED: • Php 1,500/man-hour • Php 100,000 / per m^2
Landscape	Degradation of aesthetic view	**[Pre-Construction/ Construction]** • Design and install facilities to harmonies with the surrounding environments (shape, color, size, etc.) • Identify and plant trees within the ROW that will not be covered by development to act as buffer zone, green corridor and to lessen aesthetic sore brought by construction and railway structures **[Construction]** • Maintain the construction site/ yards tidy and clean and rehabilitate after construction. • Provision for temporary screens/ walls to minimize the visual clatter.	• DOTr PMO • DED Consultant • Contractors	DED cost / construction cost to be finalized during the DED: • Php 1,500/man-hour • Php 10,000/ per meter of screen
Gender	Degradation of Livelihood Opportunities and improvement of Safety by lack of consideration	**[Pre-Construction/ Construction]** • Prepare and implement RAP to ensure that gender equality and needs of vulnerable group are well addressed • Design and install train system in consideration to the following: - Strategic placement of security and lighting within the vicinity of the stations; - Adopt universal design • Employ workers in consideration to gender equality. • Include gender sensitive livelihood and skills training program in the SDP with due consideration to vulnerable group	• DOTr • DED consultants • Contractors • LGUs	DED cost / To be included in the Construction Cost: • Php 1,500/man-hour • SDP Php 15,000/per person
Children's rights	Impact to School Access	**[Pre-Construction/ Construction]** • Prepare and implement RAP in consideration of relocation site to be sufficiently covered the expected demand on access to educational institution in coordination with LGUs. • Based on the study on public access at affected barangay, maintain the existing public access as much as possible. • In case of any temporary disclosure during construction, minimize the impact to the daily life of affected communities such as access to social infrastructure in coordination with the DepEd and host LGUs for the schedule of construction activities. • Disseminate information to the public, barangay, and LGUs on the potential impact to the existing public access and mitigation measure through the project activities. • Relocation activities to be conducted in consideration to school term.	• DOTr PMO • DED consultants • Contractors • LGUs	DED cost/ To be included in the Construction Cost: • Php 1,500/man-hour • IEC: Php 50,000/ per meeting with Barangay /LGU

items	Potential Impact	Prevention/Mitigation/Enhancement Measures	Responsible Institution	Estimated Cost (PhP)
Infectious disease/ community health and safety	Degradation of public health	**[Pre-Construction / Construction]** • Formulation and implementation of IEC Plan to inform the affected LGU and local communities and the general public about 1) the project, project activities, duration, possible project impacts and incorporate their comments and inputs in the design, 2) the potential impact of project activities to air quality, noise, vibration, and climate change, and corresponding health and safety mitigation measures, and 3) the Grievance Redress Mechanism to handle complaint/s if any. • Plan for construction sites/facilities/yard and access route in consideration to health and safety of local communities. • Plan and implement social development plan including health and safety of local community **[Construction]** • Provide safety officers to monitor the health and safety of the local community. If any complains rises, immediately identify the causes and evaluate built-in measures. • Install fencing of the construction site, provision of signage and posters, and guarding of the access point to ensure that the area is not accessible to the public. • Implement Emergency Response Plan and Health and Safety Management Plan.	• DOTr PMO • DED consultants • Contractors • LGUs	DED cost / construction cost to be finalized during the DED: • Php 1,500/man-hour • IEC: Php 50,000/ per meeting with Barangay /LGU • Php 10,000/ per meter of screen
	Increase risk of infectious disease	**[Pre-Construction / Construction]** • Include medical certificate in the requirements for hiring of workers to ensure that they are fit to work. Ensure that they are provided with proper training on construction, occupational health and safety, and emergency response procedure. • Provide safe and clean water for drinking, appropriate sanitary facilities such as portable toilets and waste bins. • Prepare and implement occupational Health and Safety Management Plan	• DOTr PMO • Contractors • LGU	Included in the contractor's service fee on health, safety and environmental management: • Php 50,000/month for clean drinking water
Working conditions (including occupational safety)	Increase risk of accidents at construction sites	**[Pre-Construction / Construction]** • Prepare and implement occupational Health and Safety Management Plan • Plan of construction including storage of equipment and machinery, and access route of heavy vehicle considering health and safety of workers • Provide appropriate personal protective equipment (PPE) to all construction workers, particularly to the personnel working on heights, heavy and electrical equipment. • Establish Health and Safety Desk or Medical Station at the active construction sites to monitor and safeguard the health of the workers and local residents and to provide immediate response during unexpected incidents/emergencies. • Close coordination with the nearest hospitals in the active construction site for immediate transfer and/or further evaluation and medical management of the patient.	• DOTr PMO • Contractors • LGUs	Included in the contractor's service fee on health, safety and environmental management • PhP 4,000/ personnel for PPE • Php 1,500/man-hour • Health and Safety Desk or Medical Station: Php 200,000/ site
Others				
Trans-boundary impacts or climate change	Exhaust emission from movement of equipment and vehicles, excavated soil carried by vehicles and	**[Pre-Construction]** • Minimize the removal of vegetation and alteration of topography if possible. **[Construction]** • Conduct proper inspection and preventive maintenance of heavy equipment, machineries and	• DOTr PMO • DED consultants • Contractors	DED cost / construction cost to be finalized during the DED:

items	Potential Impact	Prevention/Mitigation/Enhancement Measures	Responsible Institution	Estimated Cost (PhP)
	other heavy loaders	service vehicles to meet the DENR Emission Standard • Use electric or fuel-efficient equipment, machineries and vehicles and maximize its operation if possible		• Php 1,500/man-hour
	• Restrictions/ disruption of construction due to soil erosion/landslides/ and flooding. • Slower drainage, soil erosion, disruption in construction by increased rainfall • Overheating of construction equipment, vehicles / heat stress by high temperature and heat waves	**[Pre-Construction]** • Take account of change in local micro climate such as rainfall, temperature pattern for 2020 and 2050 in project design criteria and schedule of construction works. • Based on the hydrological and geodetic study, design and install train system which is robust to climate change and related extreme events including drainage, passenger facilities and structures (viaduct and embankment) i.e. train facilities to be above the flood level, installation of drainage pumping system. **[Construction]** • Adjust construction activities in consideration to local climate / extreme events such as extreme heat to avoid overheating of construction equipment and service vehicles and cause heat stress to workers. • Implement Emergency Response Plan.	• DOTr PMO • DED consultants • Contractors	DED cost / construction cost to be finalized during the DED: • Php 1,500/man-hour
Accidents	Increase on traffic accidents	**[Pre-Construction/ Construction]** • Conduct Traffic Impact Assessment (TIA) and based on the results of TIA, prepare and implement Traffic Management Plan (TMP), coordinate to the concerned LGUs and transport operator/s and get their inputs and approval • Schedule transport of heavy structures during period when there are fewer vehicles on the road and posting of appropriate traffic signage and warnings. • Disseminate information to the general public, host barangays, and LGUs on the potential impact of the project to the existing access and provide mitigating measures. • Implement Emergency Response Plan and Health and Safety Management Plan	• DOTr PMO • DED consultants • Contractors • LGUs	DED cost / construction cost to be finalized during the DED: • PhP 10,300,000 for TIA
Risk of Flood	Flooding and inundation by sediment run off, siltation, drainage overflow, clogging	**[Pre-Construction/ Construction]** • Design and install sufficient drainage system including temporary drainage system during construction to accommodate the surface water runoff from the project and avoid any flooding in the area caused by the project, in consideration to the existing drainage system and flood storage capacity. • Based on the hydrological, geological study and local climate change data from PAGASA, design and install train system in robust to flood and related extreme events including temporary construction drainage, train structure to be above the flood level, installation of drainage pumping system, etc. • Coordinate with DPWH and LGUs on the integration of proposed drainage plan to the project area. **[Construction]** • Minimize the removal of vegetation and alteration of topography as much as possible. • Install soil erosion control such as protection of slope and bank silt traps to minimize siltation of waterways as required. • Strictly implement construction plan, operating instructions and solid waste / soil management plan, which include minimization of waste/soil generation, segregation, and proper disposal by contractor in accordance to RA 9003	• DOTr PMO • DED consultants • Contractors • LGUs • MMT	DED cost / construction cost to be finalized during the DED • Php 1,500/man-hour • Soil Erosion Control: Php 30,000/m^2 • Drainage: Php 15,000/m

items	Potential Impact	Prevention/Mitigation/Enhancement Measures	Responsible Institution	Estimated Cost (PhP)
		• Regular inspection and prompt maintenance of the drainage system, all installed structures and facilities and improve/ enhance capacity when possible.		
Operation				
Pollution Control				
Air Quality	• Degradation of air quality in the vicinity of the station and in depot area • Increase in Vehicle Exhaust emission and entrained dust due of increased movement of people	• Select appropriate operation and maintenance equipment that are fuel efficient to reduce emission. • Conduct regular inspection and maintenance of heavy equipment, machineries, facilities and service vehicles and facilities such as generator etc. to meet the DENR Emission Standard • Regular cleaning and clearing of road from spoils and debris and wetting of ground in the periphery of the depot when necessary. • Comply with environmental permitting requirements for the storage, transport, handling, and treatment of hazardous material/ wastes and contaminated soil in accordance with RA 6969 at depot area, and provide appropriate PPE for the concerned personnel • Control service vehicle movement by maintaining the speed limit to <10 kph within the construction site. Minimize vehicle transport by maximizing the use of site generated materials. • Monitor air quality at the identified sampling stations	• DOTr • Operator • LGUs	Included in the operation and maintenance cost: • Php 1,500/man-hour • Php 25,000/per sampling station
Water Quality	• Degradation of groundwater quality • Degradation of surface water quality • Threat to abundance, frequency and distribution of species	• Comply with environmental permitting requirements for the storage, transport, handling, and treatment and disposal of hazardous material/ wastes and contaminated soil in accordance with RA 6969. • Conduct proper inspection and prompt maintenance of the installed wastewater treatment facilities. • Compliance to RA 9275 including but not limited to securing of discharge permit. • Conduct proper inspection and regular maintenance of drainage system and treatment facility. • Conduct of regular effluent quality monitoring	• DOTr PMO • Operator • LGUs	Included in the operation and maintenance cost • Php 1,500/man-hour • Php 25,000/per sampling station
Soil Quality	Change in soil quality/fertility	• Conduct proper inspection and prompt maintenance of machines and equipment, and facilities • Strict implementation of solid waste management plan and proper disposal by an accredited contractor in accordance with RA 9003, hazardous waste disposal in accordance with RA 6969. • Conduct of soil quality monitoring at the depot site	• DOTr • Operator	Included in the operation and maintenance cost • Php 1,500/man-hour • Php 25,000/per sampling station
Noise Quality	Reduction of noise due to decrease in traffic volumes	• Provide incentives to and information dissemination activities to encourage commuters to use rail transit over other modes of transport	• DOTr • Operator • LGUs	Included in the operation and maintenance cost • Php 1,500/man-hour, • Php 25,000/ per sampling station • Php 30,000/ per meter noise barrier
	Increase in ambient noise level	• Optimize the number of train operation at night time to reduce generated noise • Provision of effective height of noise barriers on each side of the track especially on areas with sensitive receptors such as school, hospital, residential area • Provision of noise control device such as muffler to all stationary sources (i.e. generator set) • Regular inspection and proper maintenance of trains and tracks to ensure its optimal operation and functionality • Monitor noise levels including identified nearby sensitive receptors including ecologically significant area/s (if any) likely to be affected by the operation and evaluate effectiveness of the noise reduction measures provided.		

items	Potential Impact	Prevention/Mitigation/Enhancement Measures	Responsible Institution	Estimated Cost (PhP)
Vibration Quality	Increase in ground vibration level	• Monitor vibration levels including identified nearby sensitive receptors, old PNR structures, historical heritages including ecologically significant area/s (if any) likely to be affected by the operation and evaluate effectiveness of the vibration reduction measures provided. • Regular inspection, proper maintenance and reconditioning of trains and tracks such as rail grinding, slip-slide detectors and maintenance or replacement of suspension system, brakes and wheels	• DOTr • Operator • LGUs	Included in the operation and maintenance cost • Php 25,000/ per sampling station • Php 1500/man-hour
Waste	• Degradation of land value • Change in soil quality	• Strictly implement solid waste management plan in accordance to RA 9003, and treatment of hazardous chemicals and contaminated soil in accordance with RA 6969. • Conduct of monitoring on disposal handling. Conduct soil quality monitoring when necessary.	• DOTr PMO • Operator • LGUs	Included in the operation and maintenance cost PhP 1,500/man-hour
Natural Environment				
Ecosystem	• Loss of Habitat • Threat to Existence and/or Loss of Important Local Species • Hindrance to Wildlife Access	• Minimized noise, vibration, illumination, and vehicular movement in significant fauna area (alignment sections in Malolos to Minalin under Manila Bay Biodiversity Area). • Continuous planting of replacement tress if any. • Conduct monitoring on survival of replanted trees and replant if required. • Implement vegetation management plan considering significant fauna (local bird species) to minimize the use of herbicide and machinery as much as possible.	• DOTr PMO • Operator	Included in the operation and maintenance cost: • Php 1500/man-hour
Hydrology	• Increase of flood occurrence and worse the impact	• Conduct Proper Inspection and prompt maintenance of the installed drainage system and improve/enhance capacity when possible.	• DOTr PMO • Operator • LGU	Included in the operation and maintenance cost: • Php 1,500/man-hour
Geographical Features (Natural Hazard)	• Damage to tracks • Risk to the life of passengers and workers • Damage to passenger facilities.	• Conduct inspection in the event of natural hazard occurrence to assess damage of structures • Regular Coordination with the PHIVOLCS for earthquake and volcanic events to adjust the train schedule as necessary. • Conduct earthquake drills for train users are also advised • Conduct proper inspection and prompt maintenance checks to every single installed structure and facility and improve/ enhance capacity when possible • Upgrades or install new technological advances when available are also encouraged for the continued operation of MCRP	• DOTr PMO • Operator	Included in the operation and maintenance cost: • Php 1,500/man-hour
Social Environment				
Local Economy such as employment and livelihood etc./ gender	Local employment	• Coordinate closely with the host LGUs, specifically at the barangay level regarding the hiring of regular workers to ensure that the workers being considered are legitimate residents in the area in consideration to gender equality.	• DOTr • Operator • LGUs	Included in the operation cost: • Php 1500/man-hour
Social structure such as social capital and local decision-making institutions	Influx of ISFs	• Install fencing and provide guards to prevent the settlement of ISFs along the ROW	• DOTr • Operator • LGUs	Included in the maintenance cost: • Php 10,000/per meter of fence

items	Potential Impact	Prevention/Mitigation/Enhancement Measures	Responsible Institution	Estimated Cost (PhP)
Historical/Cultural heritage	• Conservation of old PNR structure and parks • Improve access to tourist destination	• Continuous conservation activities of old PNR structures in coordination with PNR and LGUs	• DOTr • Operator • LGUs	Included in the bud get of proponent: • Php 100,000/ per m^2
Landscape	Impairment of visual aesthetic	• Maintain tree planting to minimize the visual impact by the project and harmonies to the surrounding environments in open areas within the ROW, depot and around the stations, to create green corridor.	• DOTr PMO • Operator • LGUs	Included in the operation and maintenance cost: • Php 1500/man-hour • PhP 100 / sapling
Infectious disease	Increase risk of infectious disease of employee and community	• Implement the Occupational Health and Safety Management Plan. • Provide sanitary facilities or utilities in all stations and depot.	• DOTr • Operator • LGUs	Included in the health and safety and environmental management plan: • Occupational Health and Safety Management Plan: Php 300,000 • Sanitary facilities Php 200,000 /location
Work Environments	Increase risk of accidents	• Implement the Occupational Health and Safety Management Plan. • Provide appropriate PPE to all personnel undertaking maintenance work. • Implement the Emergency Response Plan	• DOTr • Operator • LGUs	Included in the health and safety and environmental management plan: • Occupational Health and Safety Management Plan: Php 300,000 • PPE: PhP 4,000/ per personnel (safety shoes, hard hat, reflector vest, gloves and ear plug)
theirs				
Climate Change	• Restrictions/ disruption of railway operation due to soil erosion/landslides/ and flooding.	• Regular inspection and preventive maintenance of railway structures and facilities to ensure optimum working condition; • When necessary, install improvement of railway system to make it more resilient to temperature and rainfall increase;	• DOTr PMO • Operator • LGUs	Included in the operation and maintenance cost • Php 1,500

items	Potential Impact	Prevention/Mitigation/Enhancement Measures	Responsible Institution	Estimated Cost (PhP)
	• Slower drainage, soil erosion, disruption in construction by increased rainfall • Overheating of construction equipment and vehicles and overheating of track buckling and signaling problems	• Planting of vegetation as much as possible in open areas at the depot, around the stations and along the railway track; • Implementation of an Emergency Response Plan;		/man-hour • Php 100/per sapling • Emergency Response Plan: Php 300,000
	Reduction of Greenhouse Gases	• Provide incentives and information dissemination activities to encourage commuters to use rail transit and its benefits over other modes of transport (Modal Shift) • Plant and manage vegetation as much as possible to open areas at the depot, around the stations and along the railway track • Conduct energy/water conservation program such as use energy efficient products (i.e. LED lights) and monitor carbon footprint monitoring • Conduct regular inspection and proper maintenance of railway systems and facilities, and equipment and machinery	• DOTr PMO • Operator • LGUs	Included in the operation and maintenance cost • Php 1,500 /man-hour, • Php 100/per sapling • Energy/ water conservation program
Accident	Increase risk of accidents	• Provide security guards in all stations to direct passengers on the safe zone. • Establish a TOD Committee, which compose of the Traffic Management of LGUs, Planning Office, PNR, DPWH, and DOTr to plan and implement TOD in consideration to the loading and unloading area and the circulation of the traffic as well as the integration of transport facility within the station	• DOTr • Operator • LGUs	Included in the operation and maintenance cost
Flood risk	Increase of flood occurrence and worse the impact	• Coordinate with PAGASA / PHIVOLCS and adjustment of train schedules. • Implement proper inspection and prompt maintenance of drainage systems and improve/ enhance capacity when possible	• DOTr • Operator • LGUs	Included in the operation and maintenance cost: • Php 1,500/man-hour

Source: JICA Design Team

Table 9.1.55 Environment Monitoring Plan for the Proposed MCRP

Environmental Item	Parameters	Sampling and Measurement Plan			Lead Person	Estimated Cost
		Method	Frequency	Location		
PRE-CONSTRUCTION PHASE						
Natural Environment						
Ecosystem	• Number of trees cut/ transplanted • Number of trees replaced	Inventory	Monthly until ROW is cleared prior to construction	Project ROW/ nurseries	• DOTr PMO • Contractor	Part of pre-construction cost: • PhP 10,000,000
Social Environment						
Resettlement/ Land Acquisition	Compensation for affected land, structures and improvements	Consultation Meeting and Survey with PAPs	Monthly until ROW is fully acquired	Affected barangays	DOTr-PMO	Included in the RAP cost: • PhP 50,000/ meeting Barangay Level
	Resettlement of PAPs to the relocation sites	Consultation Meeting and/or Survey with the PAPs	Monthly until ISFs are all relocated	Affected barangays	• DOTr- PMO • NHA/ SHFC • LIAC	Included in the RAP cost • PhP 50,000/ meeting Barangay Level
	• Livelihood program • No. of Participants	• Consultation Meeting and/or Survey with the PAPs • Livelihood Trainings and Seminars	Quarterly until the end of livelihood restoration program	Affected barangays	• DOTr- PMO • LGUs	Included in the RAP cost • PhP 50,000/ meeting Barangay Level • Training: PhP 15,000 / pert PAPs
CONSTRUCTION PHASE						
Pollution Control						
Air Quality	Dust level	• Ocular observation • Interview to residents of affected barangay	Daily observation Monthly interview	In and around construction sites Affected Barangay	• DOTr PMO • Contractor	Included in the construction cost: • Php 1,500 /man-hour
	TSP (µg/NCM), PM_{10} (µg/NCM) $PM_{2.5}$ (µg/NCM), SO_2 (µg/NCM), NO_2 (µg/NCM), Pb (µg/NCM), CO (mg/NCM), O_3 (µg/NCM)	• TSP, PM_{10}: High Volume; Gravimetric method • $PM_{2.5}$: e-sampler, gravimetric • SO_2, NO_2,CO,O_3: grab sampling; absorbing solution	• Quarterly (24-hr Sampling except for CO and O_3 which is 1-hr sampling) • Immediately based on complaints	Established 9 monitoring stations near active construction sites	• DOTr PMO • Contractor • MMT • Third Party Sampling Firm	Included in the EMF: • PhP 800,000/ quarter • PhP 25,000.00/ per sampling station
Water pollution	Color (TCU), TSS, ph, Temp (℃), DO (mg/L), BOD (mg/L), Fecal Coliform (MPN/100 mL), Total Coliform (MPN/100 mL), Conductivity, Chloride (mg/L), Nitrate as N (mg/L), Phosphate as P (mg/L), Copper (mg/L), Arsenic (mg/L), Cadmium (mg/L), Chromium (mg/L),	• Ocular inspection • Grab sampling DAO 2016-08 Approved method	• Daily inspection • Quarterly sampling	15 sampling points: Bulihan River, Labangan River, Bagbag River, Pampanga River, Malalam River, Sto Niño River, Calutcut Creek, Abacan River, Paranam Tributary, Quitanguil River, Sapang Balen, Sacobia River,	• DOTr PMO • Contractor • Third party sampling firm • MMT	Included in the EMF: • PhP 25,000.00/ per sampling station

Environmental Item	Parameters	Sampling and Measurement Plan			Lead Person	Estimated Cost
		Method	Frequency	Location		
	Lead (mg/L), Mercury (mg/L), Cyanide (mg/L), O&G (mg/L) Organo-phosphates (µg/L), Phenols (mg/L), Surfactants (mg/L)			Bamban River, Cutcut River		
Water pollution (effluent)	Ph, Temp, DO, mg/L(min) Color, TCU, BOD5, mg/L(max) Fecal Coliform, MPN/100 mL O&G, mg/L	• Grab sampling (In situ for pH and T Using pH meter and temperature probe) • DAO 2016-08 Approved methods	Quarterly	Surface water established sampling stations near active construction sites; temporary facility and depot discharge points	• DOTr PMO • Contractor • Third Party Sampling Firm • MMT	Included in the EMF: • PhP 25,000.00/ per sampling station
Soil pollution	• Quantity • Occurrence of accidental spills • Condition of equipment and machinery	• Ocular inspection, • Regular reporting, meeting	Daily visual inspection, Monthly reporting and meeting, In case of spill, immediate action is required	Area of construction and temporary facilities	DOTr Contractor	Included in the engineering cost: • Php 1,500 /man-hour
	Trace metals: Pb, Hg, Cd, As, $Cr+^{6}$ (mg/kg), Proper removal of contaminated soil, Substance/s that spill (e.g. Oil, diesel and Grease)	• Soil sampling as necessary; • Monitoring of handling of hazardous chemical against RA6969.	As needed	Contaminated site, if any	• DOTr PMO • Contractor • Third Party Sampling Firm • MMT	Included in the Construction cost: • PhP 25,000.00/ per sampling station
Waste (excavated Soil)	• Volume disposed • Disposal method • Management of soil against soil	• Ocular inspection, • Regular reporting, meeting	Daily visual inspection, Monthly reporting and meeting, Immediately in case of spill	Area of construction	• DOTr PMO • Contractor	Included in the engineering cost: • Php 1,500/man-hour
Waste (Solid Waste)	• Volume • Disposal method • Management of against solid waste management plan	Ocular inspection, Regular reporting, meeting	Daily visual inspection, Monthly reporting and meeting,	Area of construction and temporary facilities and disposal site	• DOTr PMO • Contractor	Included in the engineering cost • PhP 3,000 / per haul per track
	Soil fertility level (if necessary), pH, N, P, K, micronutrients, and heavy metals	Soil sampling and analyses for fertility	As required		• DOTr PMO • Contractor	• PhP 25,000/ per sampling station
Noise	Noise Level	• Ocular observation • Direct Reading/ Sound Level Meter • Interview to residents of affected barangay	• Daily observation • Monthly interview • Noise level measurement when necessary	In and around construction sites, Affected Barangay	• DOTr PMO • Contractor	Included in the Construction cost: • PhP 30,000/unit of noise meter (price base on Extech 407760 with data logger)

Environmental Item	Parameters	Sampling and Measurement Plan			Lead Person	Estimated Cost
		Method	Frequency	Location		
	Noise Level (dBA)	Direct Reading/ Sound Level Meter for	Monthly (morning, daytime, evening and nighttime when applicable) Immediately based on complaints	Established monitoring stations including sensitive receptor (within 50 m from alignment)	• DOTr PMO • Contractor • MMT • Third Party Sampling Firm	Included in the EMF: • PhP 25,000/ per sampling station
Vibration	Vibration Level	• Ocular observation • Interview to residents of affected barangay	Daily observation Monthly interview	• In and around construction sites • Affected Barangay	• DOTr PMO • Contractor • MMT	Included in the Construction cost • Php 1,500/man-hour
	Vibration Level (dBA)	Vibrometer	• Monthly during pile driving • Quarterly Monitoring	• Nearest receptor at the active construction area • Established monitoring stations including sensitive receptor (within 50 m from alignment) • Old PNR structure / NHCP accredited cultural/historical structures (within 50 m from alignment) • Buildings adjacent to the project area.	• DOTr PMO • Contractor • MMT • Third Party Sampling Firm	Included in the EMF: • PhP 25,000 / per sampling station
Ground subsidence	Level of ground subsidence	Visual observation/ Measurement of level	Monthly or as needed	Area of construction and temporary facilities	• DOTr PMO • Contractor	Included in the Construction cost • Php 1,500/man-hour
Natural Environment						
Ecosystem	• Number of trees cut • Provision of required number of tree seedling • Survival rate of the species introduced	• Ocular inspection of replacement stock at nurseries, receiving area before and after planting; • Counting/ estimating numbers	Quarterly	Designated tree planting Site/receiving area (LGU/ DENR designated site/s), buffer area/nurseries.	• DOTr PMO • Contractor	Included in the Construction cost • Php 1,500/man-hour
Hydrology	• Occurrence of flooding	• Ocular inspection and observation of choke points • Check PAGASA bulletin	Daily during rainy season	Area of construction and temporary facilities	• DOTr PMO • Contractor	Included in engineering cost: • Php 1,500 /man-hour
Geographical features	Occurrence of erosion of slopes, stockpile, etc.	Ocular inspection of site/s	Daily	Area of construction and temporary facilities	• DOTr PMO • Contractor	Included in the Construction cost • Php 1,500/man-hour

Environmental Item	Parameters	Sampling and Measurement Plan			Lead Person	Estimated Cost
		Method	Frequency	Location		
Social Environment						
Local economy/ Gender	Number of PAFs, locals, females hired	Survey status of employment	Throughout construction phase	Project Sites	• DOTr • Contractor	Included in the Construction cost • Php 1,500 /man-hour
Livelihood	SDP implementation Record, IEC implementation Record, Participants list	Interview with residents of affected barangay, relocatees	Throughout construction phase	• Affected Barangay • Barangay with relocated sites	• DOTr PMO • Contractor	Included in the Construction cost • Php 1,500 /man-hour
Infectious diseases such as HIV/AIDS	Infectious disease, Degradation of health condition of workers/ communities	• Survey trend of epidemic disease • Health Check-up of workers	Monthly throughout construction phase	Construction yard/ affected barangay	• DOTr PMO • Contractor	Included in the Construction cost • Php 1,500 /man-hour
Work Environment	Working Environment Measurement (WEM)	• BWC-OSHC/NIOSH method	Quarterly Throughout construction phase	Project Site	• Third party sampling firm • DOTr • Contractor	Part of construction cost • PhP 10,000/ per sampling station
	Number of Accident	Occurrence of accidents related construction work	Weekly, In case of accidents, immediately	Project Site	• DOTr PMO • Contractor	Included in the Construction cost • Php 1,500 /man-hour
Others						
Accidents	• Number of accident involving communities	• Survey occurrence of accidents with local communities • Interview to affected communities	• Regular monitoring throughout construction phase • In case of accidents, immediately	Affected Barangay	DOTr Contractor	Included in the Construction cost: • Php 1,500/man-hour
	• Traffic congestion • Traffic volume	Survey traffic volume	Weekly monitoring of traffic condition	Main intersection near construction area	• DOTr PMO • Contractor	Included in the Construction cost: • Php 1,500/man-hour
Flood risk (during rainy season)	Occurrence of flooding	• Ocular inspection and observation of choke points • Check PAGASA bulletin	Daily during rainy season	Area of construction and temporary facilities	• DOTr PMO • Contractor	Included in engineering cost: • Php 1,500 /man-hour
OPERATIONAL PHASE						
Pollution Control						
Air Pollution	TSP (ug/NCM), PM_{10} (ug/NCM), $PM_{2.5}$ (ug/NCM). SO_2 (ug/NCM), NO_2 (ug/NCM), Pb (ug/NCM), CO (mg/NCM), O_3 (ug/NCM)	• TSP, PM_{10}: High Volume; Gravimetric method • $PM_{2.5}$: e-sampler, gravimetric • SO_2, NO_2: grab sampling; absorbing solution	• Annually (24-hr Sampling except for CO and O_3 which is 1-hr sampling, • Immediately based on the complaints	Stations and Depot	• DOTr PMO • Operator • MMT	Included in the EMF: • PhP 800,000/ quarter • PhP 25,000 / per sampling station

Environmental Item	Parameters	Sampling and Measurement Plan			Lead Person	Estimated Cost
		Method	Frequency	Location		
Water Quality (Effluent)	Ph, Temp, DO, mg/L (min), Color, TCU, BOD5, mg/L (max) Fecal Coliform, MPN/100 mL, O&G, mg/L	• Grab sampling • In situ for pH and Temp using pH meter and temperature probe) • DAO 2016-08 approved methods	Quarterly	discharge points	• DOTr PMO • Operator • Third party sampling firm • MMT	Included in the EMF: • PhP 25,000 / per sampling station
Waste	• Volume • Disposal method • Management of against solid waste management plan	• Ocular inspection, • Regular reporting	• Daily visual inspection, • Monthly reporting	• Passenger facility • depot	• DOTr PMO • Operator	Included in the Operation & Maintenance cost: • Php 1,500/man-hour
	Soil fertility level (if necessary) pH, N, P, K, micronutrients, and heavy metals	Soil sampling and analyses	As necessary	• Depot	• DOTr PMO • Operator • Third Party Sampling Firm	Included in the EMF • PhP 25,000/ per sampling station
Soil pollution	• Quantity • Occurrence of accidental spills • Condition of equipment and machinery	• Ocular inspection, • Regular reporting, meeting • Monitoring of handling of hazardous chemical against RA6969.	Daily visual inspection, Monthly reporting and meeting, in case of spill, immediate action is required	Area of construction and temporary facilities, Depot	DOTr Contractor	Included in the engineering cost: • Php 1,500/man-hour
	Trace metals: Pb, Hg, Cd, As, $Cr+^6$ (mg/kg), Proper removal of contaminated soil, Substance/s that spill (e.g. Oil, diesel and Grease)	• Soil sampling as necessary;	As needed	Contaminated site, if any	DOTr PMO Operator Third Party Sampling Firm	Included in the Operation & Maintenance cost: • PhP 25,000 / per sampling station
Noise and Vibration	Noise levels	Direct Reading/ Sound Level Meter	• Semi Annually (daytime and night time) • Immediately based on the complaints	Established monitoring stations at sensitive receptor (within 50 m from alignment)	• DOTr PMO • Operator • Third party sampling firm	Included in the EMF: • PhP 25,000/ per sampling station
	Vibration Level (dBA)	Vibrometer	• Immediately based on the complaints	Complained area	• DOTr PMO • Operator • Third party sampling firm	• Included in the EMF: PhP 25,000/ per sampling station
Ground subsidence	Level of ground subsidence	• Visual observation; • Level measurement	• Visual observation: daily • Measurement: monthly		• DOTr PMO • Operator	Included in the Operation & Maintenance cost • Php 1,500 /man-hour
Natural Environment						
Ecosystem	Number of trees surviving	Ocular inspection of health and vigor	Quarterly	Transplanted areas	• DOTr PMO • Operator	Included in the Operation & Maintenance cost • Php 1,500/man-hour

Environmental Item	Parameters	Sampling and Measurement Plan			Lead Person	Estimated Cost
		Method	Frequency	Location		
Social Environment						
Work Environment	Occurrence of accident/s	• Monitoring of work environments • Regular Meeting	Monthly	Project Sites	• DOTr PMO • Operator	Part of Operation & Maintenance cost • Php 1,500/man-hour
Others						
Accident	• Number of Accident • Increase in accident involving communities	• Help desk • Monitoring • Documentation	• Regular monitoring • In case of accidents, immediately	Project Sites Area with stations and Depot	• DOTr • Operator	Part of Operation & Maintenance cost • Php 1,500/man-hour
	Traffic congestion • Traffic volume	• Survey traffic volume • Actual traffic observation and documentation • Help Desk	Regular monitoring throughout operation phase	Project Site	• DOTr • Operator	Part of Operation & Maintenance cost • Php 1,500/man-hour
Flood risk	Occurrence of flooding	Ocular inspection and observation	Daily during rainy season	Project alignment, train stations and depot facility	• DOTr PMO • Operator	Included in the Operation & Maintenance cost • Php 1,500/man-hour

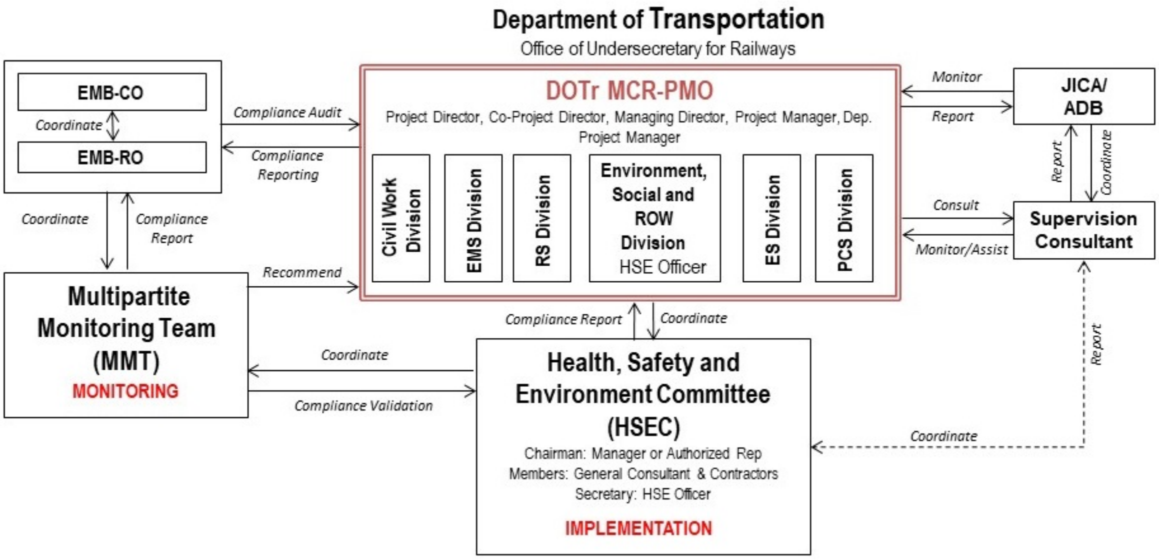
Source: JICA Design Team

9.1.11 Institutional Plan for EMP Implementation

The Institutional Plan is a plan for the creation of a body that will be responsible for the effective implementation and monitoring of the proposed Environmental Management Plan (EMP) whose main thrust is to ensure that environmental, socio-economic, political and public health issues are properly addressed in a timely manner. It provides the necessary mechanisms that will strengthen the relationship of the proponent with the host community, the concerned government agencies and other stakeholders.

9.1.11.1 Institutional Structure

The organizational structure for the EMP implementation constitutes the DOTr PMO and its Environment, Social and ROW Division (ESRD); Health, Safety and Environment Committee (HSEC), Supervision Consultant, Contractor (including Sub-Contractor) and MMT as key entities for its effective implementation. Figure 9.1.8 presents the simplified institutional diagram for the EMP implementation, showing the management/ relationship line among these entities.



Source: JICA Design Team

Figure 9.1.8 Simplified Institutional Plan for Implementing the EMP

DOTr will create a new office or designate one of the railway attached agencies to serve as PMO. Under the PMO, HSEC will be created to implement the EMP during pre-construction and operational phase of the project. The Contractors for the Works will be tasked to implement the EMP for the construction phase. Environmental compliance monitoring will be undertaken by the MMT which will monitor compliance of the contractors and the PMO with the ECC conditions and the EMP/ EMoP in accordance with the JICA guidelines and ADB SPS, as well as DAO 2003-30, DAO 2017-15 and DAO 2018-18.

9.1.11.2 DEPARTMENT OF TRANSPORTATION

The DOTr as the Implementing Agency will be responsible for providing overall policy and guidance with regards to implementation of the proposed MCRP. DOTr will ensure that all the necessary provisions for implementing the EMP and EMoP, including budgets and agreements with other concerned national and local government agencies are included in all contracts, and in accordance with JICA Guideline and ADB SPS.

(1) DOTr Project Management Office (MCRP PMO)

The MCRP PMO will be established as the representative of the Department in all activities pertaining to the planning, design review, and implementation of the project, which will be guided by the Operational Procedures. Project Director, Co-Project Director and Management Director of the MCRP PMO will be responsible for the decision-making, planning and implementation of the overall project activities, whereas a Project Manager and Deputy Project Manager will be acting management of the MCRP. Besides, The Proponent will establishes EGF and EMF by specifying in MOA in consultation with EMB.

(2) Environment Social and ROW Division of MCRP PMO

Under the MCRP PMO, the Environment Social and ROW division (ESR Division) is created and staffed with Health, Safety and Environment Officer (HSEO), Environmental Engineers and other specialists, including environmental consultants who will provide the necessary guidance and technical assistance, and at the same time, together with the office staff, implement the conditions of the ECC and the activities laid out in the EMP and EMoP and in line with JICA guideline and ADB SPS agreed.

(3) Health, Safety and Environment Officer (HSEO)

The Health, Safety and Environment Officer / Pollution Controll Officer, will provide appropriate action on complaints brought before the ESRD-MCRP PMO for resolution. Further, he/she will closely coordinate with the Health, Safety and Environment Unit of the Contractor on matters of mutual concern during Construction Phase. The officer is required to take the compulsory trainings prior to construction starts.

9.1.11.3 Health, Safety and Environment Committee

The HSE Committee will be under the PMO which will also comprise representatives from the DOTr, general consultant and contractors on-site. Their main role and responsibilities are to ensure the compliance to the EMP and EMoP and other conditions stipulated under ECC and act on grievance if any arises during construction.

9.1.11.4 Multipartite Monitoring Team (MMT)

The Multipartite Monitoring Team (MMT) is an independent third-party entity formed after the issuance of the ECC to encourage participation of the project's various stakeholders and to monitor the project's compliance with ECC conditions as well as the EMP and EMoP during the pre-construction, construction and operation phases of the proposed project.

The formation of the MMT will be initiated by the MCRP- PMO through a Memorandum of Agreement (MOA) between the EMB-CO and the MCRP- PMO with conformity of the identified MMT members, in accordance to the DENR Administrative Order (DAO) No. 2017-15 and DAO 2018-18.

9.1.11.5 The Contractor

The Contractor will be jointly responsible for implementing the EMP, and liable to sanctions and penalties to be incurred by DOTr in relation to non-compliance to conditions set in the ECC. It will provide the necessary funds for implementing the EMP, as will be stipulated in the "DOTr Environmental Protection Clauses" of the Bid Documents. As previously stated it shall be jointly (with DOTr) responsible for ensuring that all engineering interventions in the approved EMP, RAP, and ECC issued are included in the TOR.

9.1.11.6 Monitoring and Reporting

In order to ensure the compliance to ECC, EMP and EMoP, MCRP PMO will submit semi- annual Compliance monitoring report and quarterly Self-Monitoring Report to EMB, JICA and ADB until project completion report is issued. Prior to start monitoring activities, MCRP PMO is to prepare a checklist and monitoring form to ensure the compliance to EMP and EMoP as per requirements of JICA and ADB. The result of public consultation information disclosure will be also submitted together with monitoring reports.

9.1.12 Public Participation, Public Consultation and Information Disclosure

During the study and in accordance to the PEISS、DAO 2017-15, JICA guidelines and ADB SDS, assists JICA Design Team assisted DOTr to hold: 1) Information, Education and Communication (IEC) of Stakeholders; 2) Public Scoping; 3) Stakeholder Consultation Meetings (SCM) and Focus Group Discussions (FGD), and 4) Public hearing. Public scoping and Public hearing were conducted under the facilitation by EMB, whereas IEC and SCM were led by DOTr.

9.1.12.1 Information, Education and Communication

A total of 12 IEC activities were held as shown in Table 9.1.56. The notice of IEC was sent by letter from DOTr to LGUs.

Table 9.1.56 IEC conducted during Feasibility Study

Date and Time	Venue	Target Affected LGU	Main Participants	No. of Participants
2017/12/11, 10:00 - 11:30	Malolos Sports and Convention Centre, Malolos, Bulacan	Malolos and Calumpit, Bulacan	• City Officials • Barangay Chairmen • Municipal Officials • Barangay Chairmen	Male: 16 Female :7 Total: 23
2017/12/11, 15:30 - 16:00	Provincial Capital Residence, Malolos, Bulacan	Provincial Government of Bulacan	• Provincial Governor • Provincial Government Staff	Male: 5 Female :7 Total: 12
2017/12/12, 14:00 - 16:00	Apalit Municipal Hall, Pampanga	Apalit, Pampanga	• Municipal Mayor • Municipal Officials	Male: 13 Female :5 Total: 18
2017/12/14, 13:00 - 15:00	Department of Transportation – Central Office, S. Osmeña St., CSFZ, Angeles, Pampanga	BCDA	• BCDA representative • CDC Representative • CIAC Representative • ADB Representative	Male: 6 Female :7 Total: 13
2017/12/14, 17:00 - 18:00	Heroes Hall, Barangay North Tiburcio, San Fernando, Pampanga	San Fernando and Sto. Tomas, Pampanga	• City Mayor of San Fernando • Barangay Chairmen • Municipal Mayor of Sto. Tomas • Municipal Officials	Male: 13 Female :2 Total: 15
2017/12/20, 10:00 - 11:30	Angels City Hall, Pampanga	Angeles, Pampanga	• City Officials • Barangay Chairmen	Male: 12 Female :9 Total: 21
2017/12/22, 10:00 - 11:30	Office of the Governor, Pampanga	Provincial Government of Pampanga	• Provincial Governor • Provincial Government Staff	Male: 6 Female :4 Total: 10
2018/01/04, 14:000 - 11:00	Mabalacat City Hall, Pampanga	Mabalacat, Pampanga	• City Officials	Male: 13 Female :1 Total: 14
2018/01/04, 14:00 - 15:00	Capas Municipal Hall, Tarlac	Capas, Tarlac	• Municipal Officials	Male: 7 Female :6 Total: 13
2018/01/05, 10:00 - 11:00	Bamban Municipal Hall, Tarlac	Bamban, Tarlac	• Municipal Officials	Male: 13 Female :6 Total: 19
2018/01/10, 10:00 - 11:00	Minalin Municipal Hall, Pampanga	Minalin, Pampanga	• Municipal Officials • Barangay Chairmen	Male: 7 Female :6 Total: 13
2018/1/11, 9:00 - 10:30	Provincial Gov. Tarlac	Provincial Government of Tarlac	• Provincial Government Staff	Male: 5 Female :7 Total: 12

Source: JICA Design Team

9.1.12.2 Public Scoping

To identify potential environmental and social impacts of the proposed project, a series of public scoping were conducted on January 22 and 23, 2018 spearheaded by the DENR-EMB assigned case handlers. The notice with the date and venue of the Public Scoping was sent by letter to stakeholders, and posters were placed on bulletin boards or at shopping malls to inform the residents. The said activities were attended by the project proponent (DOTr), other concerned government agencies, LGUs with representatives from affected barangays and local residents. Two public scoping meetings were held as shown in Table 9.1.57 and issues and concerns raised are summarized in Table 9.1.58 and Table 9.1.59.

Table 9.1.57 Summary of Public Scoping

Date and Time	Venue	Target Affected LGU	Main Participants	No. of Participants
2018/01/22 13:00	The Pavilion Hiyas ng Bulacan Convention Center, Malolos, Bulacan	• Malolos • Calumpit • DENR- PENRO Tarlac • MGB Region III	• EIAMD Case Handlers, DENR - EMB Central Office • EMB Region III Representative • DENR – PENRO Bulacan • MGB Region III Representative • Malolos LGUs (Representative from the Office of the Mayor, Vice Mayor, City Councilors and representatives, City Department Heads, concerned Barangay Chairmen, Barangay Councilors and representatives) • Calumpit LGUs (Representatives from the Office of the Mayor and Vice-Mayor, Department Heads, concerned Barangay Chairmen, Barangay Councilors and Representatives) • Residents	Male: 42 Female :43 Total: 85
2018/01/23 13:00	Xevera Basketball Court, Xevera Subdivision, Brgy. Tabun, Mabalacat, Pampanga	• Apalit • Minalin • Sto. Tomas • San Fernando • Angeles • Mabalacat • DENR- PENRO Tarlac • MGB Region III	• EIAMD Case Handlers, DENR - EMB Central Office • MGB Region III Representative • DENR – PENRO Tarlac • Apalit LGUs (Representative from the Office of the Mayor, Vice Mayor, Department Heads and concerned Barangay Chairmen and Councilors) • Sto. Tomas LGUs (Representative from the Office of the Vice Mayor, Mayor, Department Heads, concerned Barangay Chairmen and Councilors) • San Fernando LGUs (concerned Barangay Chairmen) • Angeles LGUs (Representative from the Office of the Mayor and Vice Mayor, Department Heads, concerned Barangay Chairmen and Councilors) • Mabalacat LGUs (Department Heads, concerned Barangay Chairmen and Councilors) • Capas LGUs (Representative from the Office of the Mayor and Vice Mayor, Department Heads) • Bamban LGUs (concerned Barangay Chairmen and Kagawad) • SB Members of Apalit and Sto. Tomas • Residents	Male: 72 Female :37 Total: 109

Source: JICA Design Team

Table 9.1.58 Issues / Concerns raised during Public Scoping (June 22, 2018)

EIA Module	Issues/Suggestions Raised by Stakeholder	Sector or Representative Who Raised the Issue/ Suggestion
Project Description	**Hon. Kagawad Nilo Abarico - Brgy. Balungao, Calumpit, Bulacan:** • We are very much concerned about this project because our drainage canal is only 6 meters away from the railway. We are worried that it will be blocked during construction of the project. • Yes Ma'am, the drainage is within the PNR ROW and it is 6 meters away from the centerline.	**Engr. Cristina Quinalayo – DOTr:** • Is the drainage within the PNR ROW? Is it 6 meters away from the centerline? • This project will have its own drainage canal. If there's existing canal that may be blocked by the structures of the project which may cause flooding in the community, it will be considered later on. Various meetings and site inspection will also be conducted for this project. Hence, I encourage you to please do attend to the meetings regarding this project especially the engineering department in your city or municipality because they are familiar of your drainage design.
	Mr. Orlando Farrales - Chief Tanod of Brgy. Palimbang, Calumpit, Bulacan: Our community is adjacent to the 15 meters ROW from Malolos to Calumpit. There is a high probability that during the construction phase, around 50 houses will be blocked. In case of emergency, how could we get out if DOTr will fence the area during construction?	**Engr. Cristina Quinalayo – DOTr:** In general, any public roads of the municipality and barangay which the community uses to pass through MacArthur Highway will not be blocked. If there are existing private roads that a small group of people uses, it will be surveyed. The results of the survey will determine what houses will be affected and if the drainage will be blocked. We are considering this problem and it will be incorporated later on.
	Atty. Rizaldy Mendoza (City Administrator, City of Malolos): Reiteration of our request to have loading and unloading zone at the entrance of the proposed Malolos Station to avoid traffic congestion in Capital View Park. Also, since we have the fully operational transport terminal, we are requesting for the proposed station be connected to the terminal.	**Engr. Cristina Quinalayo – DOTr:** The DOTr will to form a Transit Oriented Development (TOD) Committee, which will compose of the Traffic Management of LGUs, Planning Office, PNR, DPWH, DOTr to plan the loading and unloading area and the circulation of the traffic as well as the integration of transport facility within the station. Since there is a TOD Committee, it doesn't mean that DOTr will finance the construction of the facilities. The LGUs have three (3) years to plan for this and request for budget.
	Ms. Clarissa Villanueva - MGB Region III: Where will you source the aggregates or sand that will be used in the project? Is it legal?	**Engr. Cristina Quinalayo – DOTr**: For the Phase 2, we will still study where we will obtain the sands. However, for Phase 1, the sand will be from Pampanga because we are considering the qualities of the materials for the post of the railway.
	Hon. Chairman Catalino Claudio - Barangay Calumpang, Calumpit, Bulacan: Regarding the closing of roads that cross PNR ROW we are requesting for consideration in our barangay road. We use this road to pass through MacArthur Highway. Closing this road will also affect the accessibility of Calumpit National High School.	**Engr. Cristina Quinalayo – DOTr:** If there is a possibility that the road crossing PNR ROW will be closed, we will find another way for the residents to access the public road and the school. When we conduct the survey, please inform our personnel or sub-contractors that there will be community and school that will be affected if the road will be closed.
Land	**Ms. Clarissa Villanueva - MGB Region III:** Is the project required to have an EGGAR? The EIA Study is an assessment of the impacts of the project to the environment whereas the EGGAR includes the catastrophic events which may affect the project.	**Engr. Carlo Vic Arida - EMB-Central Office:** EGGAR is required and this will be included in the EIA Study. It is incorporated in the EIS Report where in the geological hazard assessment are already covered.

EIA Module	Issues/Suggestions Raised by Stakeholder	Sector or Representative Who Raised the Issue/ Suggestion
	Ms. Elenita Inosanto - Resident of Brgy. Catmon, Malolos, Bulacan: We are affected by the Project and since the ROW will traverse in our property, our land title will be changed. How long is the process of restitution of title?	**Engr. Cristina Quinalayo – DOTr:** If you are part of the affected barangay and you own a private property, the value of your land will reduce. In general, if the owner of the property is willing to turn-over the property to DOTr, DOTr will be the one to process the transfer. If you have balance in your property tax, we will deduct the payment to the owner. On the other hand, if you didn't comply within 30 days from the offer letter, we will file expropriation to the court. For the duration of processing, it will depend to the issues or problems with the land title. We are planning to set-up a one stop shop for the land title processing in coordination with LRA, DOTr and LGUs.
Water	**Atty. Rizaldy Mendoza - City Administrator of Malolos, Bulacan:** This is a reiteration of our request to restore the cantarilla or the waterways.	**Engr. Cristina Quinalayo – DOTr:** Based on the design, the boundary of the railway alignment is more or less 15 – 15 meters from the centerline of the PNR ROW. It means that the posts of the project will be located within the project boundary. Our design team will maximize the area and will prioritize the project structures particularly the base of the railway. If there will be remaining available area, we will try to maximize them to accommodate your drainage. We are trying our best to comply the other requests of the LGU/community. However, on the restoration of the Cantarilla, it is not a component of this project.
	Mr. Orlando Farrales - Chief Tanod of Brgy. Palimbang, Calumpit, Bulacan: Our drainage system from the barrio proper crosses under the PNR ROW. What will be the plan of DOTr for our drainage? If you will block the drainage, our barrio will be flooded.	**Engr. Cristina Quinalayo – DOTr:** If there are existing drainages within the ROW, may we request the Engineering Department and the LGUs in the area to inform us about the drainage system that would possibly be blocked by the project. We will consider this in our design.
People	**Hon. Vice Mayor Gilbert Gatchalian - City of Malolos, Bulacan:** May we suggest that the Project will have its own hotline or special access with the LGU to have immediate action when the construction phase of the project starts. Also, during the implementation phase, may we request DOTr to establish help desks in case of emergency and if there are damages coming from the boring activities, cracks, noise and air pollution.	**Engr. Cristina Quinalayo – DOTr:** This is noted sir. We'll try to make a hotline. If there are houses, roads that will be affected during construction phase, we will pay for the repair. The JICA Guidelines also require a Grievance and Redress Committee to accommodate any issues regarding the project.

Source: JICA Design Team

Table 9.1.59 Issues / Concerns raised during Public Scoping (June 23, 2018)

EIA Module	Issues/Suggestions Raised by Stakeholder	Sector or Representative Who Raised the Issue/ Suggestion
Project Description	**Hon. Mayor John Sambo - Municipal Mayor of Sto. Tomas, Pampanga:** We are supporting the project 100% and at the same time, the proposed stations: Apalit, San Fernando, Angeles, Mabalacat and so on. On our part, in the Municipality of Sto. Tomas, we are strongly proposing to put up a train station in our municipality. The reason is that the PNR has 3-hectare lot in our municipality and it is bounded by 3 national roads namely: MacArthur Highway, Apalit-Sto. Tomas National Road and the newly build Pasang-Pulpul National Highway. Also, Sto. Tomas is accessible to all western municipalities of Pampanga and with our approved NLEX-Sto. Tomas-NLEX interchange, which NLEX told us that it is from Sto. Tomas to Dinalupihan, Bataan. So, we strongly believed that Sto. Tomas train station is really needed for the commuters.	**Engr. Cristina Quinalayo – DOTr:** Thank you, Sir, for supporting our project. Regarding your additional train station request, may I ask if you already have an official request letter for it?
	Yes, Ma'am. In every consultation, we requested it. Of course, we don't want to bypass this kind of consultation, although we have a resolution in writing addressed to our Hon. Congressman.	• We have a policy in our department, that an official letter request must be submitted for any request of additional train station. This is because our project was approved by NEDA in 2017 including the baseline cost and the seven (7) stations. If there is a request for additional station, we will consider it because it is required by the LGU. However, as of now, we will do first the approved project by NEDA. • We need the request letter for you to pinpoint your proposed location of the train station. Then, we will consider it and since the study of Japanese Team is ongoing, they will officially include in the study the location of the proposed additional train station. • To approve the request for additional train station, we consider the (1) passengers and (2) the major concerns of the Mayor.
	We are still in the feasibility study stage wherein we study the project and where to properly locate the stations. I'm supporting this project but if we look at it, the proposed train station in San Fernando is already traffic tight. Aside from our letter, please include it also in your feasibility study.	As long as you have an official letter request for additional station, we will consider it. Also for any additional station, we will apply it to NEDA and back again to the process.
	Hon. Kagawad Galvan - Barangay in Angeles, Pampanga: How many meters both sides, is the ROW of the old PNR?	**Engr. Cristina Quinalayo – DOTr:** • The PNR ROW is 30m. From the center, 15 m to the right and 15m to the left. Based on the design of the Japanese, the alignment must be straight so the 30m is needed for the adjustment of the curves to avoid accidents. Another reason is that we have freight/cargo at the bottom so we need space for it. • Next week we will conduct a survey to identify the 30m PNR ROW and to determine the condition in the area.
	Hon. Chairman Jerry Magsino – Barangay Tabun, Mabalacat, Pampanga: May I confirm if the alignment will still traverse in front of Xevera?	**Engr. Cristina Quinalayo – DOTr:** No, Sir. We will reroute the alignment because the area is built up. But as of now, we are still studying it.

EIA Module	Issues/Suggestions Raised by Stakeholder	Sector or Representative Who Raised the Issue/ Suggestion
	Hon. Vice Mayor Augusto D. Manlapaz – Municipality of Apalit, Pampanga: This project was first proposed in the term of Former Pres Gloria Arroyo. This project is good for our Province, also for Bulacan, Clark and so on. Based on your Project Timetable, maybe the project will stop or will not proceed when the administration of President Duterte ends.	**Engr. Cristina Quinalayo – DOTr:** Three weeks ago, we met the Former President Arroyo when we presented this project to the Province of Pampanga and she's happy that this project will resume. Moreover, the Phase 1 project will be constructed this year. For the Malolos-Clark, our target date in signing of Loan Agreement is on December 2018. After the signing of loan agreement, the construction of this project will proceed.
	Engr. Romel Santiago – DENR PENRO Pampanga: Are you going to use the existing posts in Bulacan and in Metro Manila for this project?	**Engr. Cristina Quinalayo – DOTr:** • The northern project, which was funded by Chinese before was started in 2009 and was constructed in 2011. In 2012, the project was stopped due to controversial issue. • We studied the posts because we want to reuse them for this project for us to save costs. However, the DPWH has a new guideline for the design structures regarding earthquake resiliency in 2015. Based on the study, the existing structures are not compliant with the new guidelines. If we will use them for the project, we need to retrofit the design to comply with the new guidelines for earthquake resiliency. Even so, it is more expensive to retrofit than to construct a new design. Also, the Japanese will not guarantee the structures because they were not the one who designed the structures. In conclusion, we will not reuse the existing posts.
Land	**Engr. Romel Santiago – DENR PENRO Pampanga:** We would like to assure the optimization of the affected trees along the alignment that can be used by schools and police. May we request DOTr also to secure tree cutting permit and earth balling permit for the trees that can be preserved.	**Engr. Carlo Vic Arida – EMB Central Office:** As part of the EIA Study under the Land Module, we are requiring the proponent to conduct a survey or tree inventory. Also, part of the ECC Condition is for the proponent to secure a tree cutting permit from the DENR. They cannot proceed with the project without the necessary permits.
People	**Mr. Lab Nacu, Staff of Hon. Councilor Edgardo Pamintuan – Angeles City, Pampanga:** Will the traffic in Angeles be affected by the proposed train station?	**Engr. Cristina Quinalayo – DOTr:** • This is related to the concern of Hon. Mayor Sambo earlier about the San Fernando, which has many built up and has heavy traffic. The strategy of DOTr is to form a Transit Oriented Development (TOD) Committee, which includes the Traffic Management of LGUs, Planning Office, PNR, DPWH, DOTr to plan the loading and unloading area and the circulation of the traffic as well as the need of an integrated transport facility within the station. Since there is a TOD Committee, it doesn't mean that DOTr will finance the construction of the facilities. The LGUs have three (3) years to plan for this and have enough time to request for its budget. • There is also a traffic impact assessment that will be conducted for the Project, which includes the study of the roads beside the stations and the impact of the stations on the traffic. • DOTr will send a letter to LGUs requesting the formation of a TOD Committee. • After the formation of the committee, a regular meeting will be conducted to discuss the traffic issues/concerns.

EIA Module	Issues/Suggestions Raised by Stakeholder	Sector or Representative Who Raised the Issue/ Suggestion
	Hon. Chairman Alma Mercado - Barangay Tabun, Angeles City, Pampanga: • What will be the impact of the project in our barangay? • Will our barangay be affected by the project? • No Ma'am. But before, there was a railway which was used to transport sugar cane.	**Engr. Cristina Quinalayo – DOTr:** • Is your barangay near the PNR Station? • The PNR has properties outside the alignment. If the area is a PNR property, PNR will identify whether they will use it or not. However, the ROW from Clark to La Union which was used for the North Rail will be used for this project. For the PNR properties outside the track, as I have said, PNR will identify whether they will use it or not.
	Hon. Chairman Mario Bognot – Brgy. Claro M. Recto: We are monitoring the four barangays that will be affected with the 30M ROW. We are wondering about the existing structures with land titles which are within the PNR ROW? What are we going to do with them?	**Engr. Cristina Quinalayo – DOTr:** We will know later in the survey if the land is a PNR property. If the land owner holds an established land title and will be within the 30 meters ROW, we will give them compensation. Please do read about the R.A. 10752 for the ROW acquisition for the infrastructure project. We will further discuss them during Public Consultation for Resettlement Action Plan.

Source: JICA Design Team

9.1.12.3 Public Hearing

Three sessions of clustered Public Hearing were conducted on 26, 27 and 29 June 2018. These were presided by the EMB-Central Office and the EIARC. The additional issues that were raised during the Public Hearing will be incorporated into the EISR and will be submitted to EMB-Central Office for review by the EIARC. Summary of public hearing is as shown in Table 9.1.60 and issues and concerns raised are summarized in Table 9.1.61, Table 9.1.62 and Table 9.1.63.

Table 9.1.60 Summary of Public Hearing

Date and Time	Venue	Target Affected LGU	Main Participants	No. of Participants
2018/06/26 9:00am	Benigni Hall, Capitol Boulevard, City of San Fernando, Pampanga	• Apalit • Minalin • Sto. Tomas • San Fernando • Angeles • Mabalacat • DENR-PENRO Pampanga • CENRO • DENR Region III • EMB Region III • MGB Region III • DPWH Region III • NCIP Region III • DepEd • DSWD Region III	• EIAMD Case Handlers, DENR-EMB Central Office • EIA Review Committee, DENR-EMB Central Office • MGB Region III Representative • DENR – PENRO Pampanga • DENR Region III • EMB Region III • DSWD Field Office Region III Representative • NCIP Region III • Apalit LGUs (Department Heads and concerned Barangay Chairmen and Kagawad) • Minalin LGUs (Vice Mayor, Department Heads, Councilors, concerned Barangay Chairmen and Kagawad) • Sto. Tomas (Department Heads Barangay Chairmen and Kagawad and residents) • San Fernando (Vice Mayor, Department Heads, concerned Barangay Chairmen and Kagawad and residents) • Angeles (Representative from the Office of the Vice Mayor, Department Heads, Councillor, concerned Barangay Chairmen and Kagawad and residents) • Mabalacat (Department Heads, concerned Barangay Chairmen and Kagawad) • Homeowners Associations, Residents	Male: 93 Female: 81 Total: 174

Date and Time	Venue	Target Affected LGU	Main Participants	No. of Participants
2018/06/27 9:00 am	Multi-Purpose Covered Court, Bamban, Tarlac	• Bamban • Capas • DENR-PENRO Tarlac • DENR Region III • EMB Region III • MGB Region III • DPWH Region III • DepEd • DSWD Region III • BCDA • PHIVOLCS/DOST	• EIAMD Case Handlers, DENR-EMB Central Office • EIA Review Committee, DENR-EMB Central Office • DENR – PENRO Tarlac • DENR Region III • EMB Region III • DSWD Field Office Region III Representative • PCUP Representative • PHIVOLCS/DOST • Tarlac State University • DSWD Region III • BCDA Representative • Bamban LGUs (Department Heads, Councillors, and concerned Barangay Chairmen and Kagawad) • Capas LGUs (Mayor, Department Heads, concerned Barangay Chairmen and Kagawad) • Residents • People's Organizations (TODA)	Male: 54 Female: 30 Total: 84
2018/06/29 9:00 am	The Pavilion Hiyas ng Bulacan Convention Center, Malolos City, Bulacan	• Malolos • Calumpit • DENR-PENRO Bulacan • EMB Region III • MGB Region III • DPWH Region III • NCIP Region III • DepEd • DSWD Region III • BCDA • NCCA	• EIAMD Case Handlers, DENR-EMB Central Office • EIA Review Committee, DENR-EMB Central Office • DENR – PENRO Bulacan • DENR Region III • EMB Region III • MGB Region III Representative • DSWD Field Office Region III Representative • PCUP Representative • DSWD Region III • BCDA Representative • NCCA • DepEd Malolos • Malolos LGUs (City Mayor, Department Heads, Councillors, and concerned Barangay Chairmen and Kagawad) • Calumpit LGUs (Mayor, Department Heads, concerned Barangay Chairmen and Kagawad) • Homeowners Association, Residents • People's Organization (TODA)	Male: 39 Female: 34 Total: 73

Source: JICA Design Team

Table 9.1.61 Issues / Concerns raised during Public Hearing (June 26, 2018)

EIA Module	Issues/Concerns Raised	Proponent's Response
Project Description	**Mr. Rustico Pamintuan** **Resident of Barangay Quebiawan, San Fernando City** Based on the presentation, many households in San Fernando will be affected. Most are illegal settlers and private lot owners. In Quebiawan, all affected households are private land owners. What will be the measurement of the ROW at the left and at the right?	**Mr. Felipe Mallari III – DOTr:** The measurement of the ROW is 15 m on the right and 15 m on the left side.
	Hon. Jerry P. Magsino – Barangay Chairman of Tabun, Mabalacat City As a Barangay Captain, I would like to request the exact data of the alignment. In our Barangay Tabun, there are houses that will be affected. We want to know where the alignment will traverse because we will have a problem if it will traverse in Xevera.	**Ms. Cristina Fernandez – DOTr** As of now, we are only in the Feasibility Study stage, which means the alignment is not yet final and may change depending on the result of the study. We will relay any information to the LGUs as we get further into the finalization stage.

EIA Module	Issues/Concerns Raised	Proponent's Response
	Hon. Jerry P. Magsino – Barangay Chairman of Tabun, Mabalacat City When is the target date of construction?	**Ms. Cristina Fernandez – DOTr** Our timeline indicates third quarter of next year to be the start of construction, which may mean that before the year ends, we will have clear and final designs for the alignment.
	Mr. Danilo B. Manabat – Bantay Bayan/Resident of Barangay Quebiawan, San Fernando Can DOTr use the existing PNR ROW so that no private land owners will be affected?	**Mr. Felipe Mallari III – DOTr** We will actually use the existing PNR ROW, which is 15 m to the right and 15 m to the left of the centreline. We will maximize this space for this project.
	Mr. Danilo B. Manabat – Bantay Bayan/Resident of Barangay Quebiawan, San Fernando Where will the 15 m start?	**Mr. Felipe Mallari III – DOTr** The measurement of 15 m to the right and 15 m to the left will start from the centerline.
	Hon. Edgar Sitchon – Municipal Councilor of Minalin For record purposes, I hope that DOTr will consider putting a station in Minalin. The land in Minalin is very spacious. We in Sto. Tomas and Minalin, it will be very hard for us to access the stations if there will be no station in Minalin.	**Mr. Felipe Mallari III – DOTr** You may present your proposed design to DOTr for consideration.
	Mr. Jocel Sarmiento – CAO III of Angeles City Can we request the exact dimension of the area in Barangay Malabañas that will be affected by the Project? This is to prevent us from issuing building permit to those who wants to build in the area that will be affected.	**Ms. Cristina Fernandez – DOTr** Until the final alignment is done, it is hard to give a definite answer. Technically, if the Notice of Taking is served, the LGU is obligated to not issue any building permit, or improvement, or any construction within the area covered by the notice. Since we do not have that notice yet, constructing on these areas are still permissible, although, we must assess that if there is a possibility that the area will be encroached by the alignment, maybe we should take caution against building construction there.
	Hon. Jerry P. Magsino – Barangay Chairman of Tabun, Mabalacat City Kindly expedite the location of the alignment in Barangay Tabun. We hope to receive any data, even if the alignment is unofficial.	**Atty. John Eduard Ang – EMB Central Office** This is noted.
	Ms. Bernadette Besañez – Barangay Secretary of Quebiawan, San Fernando In our side, the area that will be affected by the Project is owned by Saint Scholastica. There are also business establishments and schools that will be affected. When will we know the exact area that will be affected by the Project?	**Mr. Felipe Mallari III – DOTr** The feasibility study will be finished at the end of this year – this is our timeline.
People	**Mr. Rustico Pamintuan – Resident of Barangay Quebiawan, San Fernando City** My whole house, which was constructed in 2017, will be affected. I hope the Government will consider first the feelings of the private lot owners. During the previous meetings, DOTr focuses on the legal law. As I understand, the approach of the Government to the private lot owners is the law of eminent domain. Then they will assign/transfer us to the LGUs. As far as Quebiawan Private Land Owners is concerned, we must be treated with due respect. When the Government takeover the private land for public use, the government must make an offer that it is a mandatory requirement and we must be fairly compensated.	**Ms. Cristina Fernandez – DOTr** We have a legal process to follow with regards to relocation. We are also partnering with JICA and ADB in this project, and they have strict requirements or standard regarding relocation/resettlement. We will get to that phase.

EIA Module	Issues/Concerns Raised	Proponent's Response
	Hon. Ruvie Lane Margarito – City Councilor of Mabalacat/ Chairman Committee on Indigenous Cultural Communities in Mabalacat We would like to request that before EMB will issue the ECC, make sure that DOTr has secured clearance from National Commission of Indigenous People. We saw that the Project will traverse the Ancestral Domain in Mabalacat, and Bamban.	**Ms. Ledicia dela Cruz – GEOSPHERE Technologies, Inc.** There is an ongoing process; the JICA Design Team is already coordinating this process. There might be a field investigation regarding this. All necessary requirements will be complied with for this project.
	Ms. Natividad Mallari – Resident of Purok 2, Barangay Sta. Lucia, San Fernando • I have a land and I gave it to my youngest child which is in Canada. My children want me to sell the house. When they knew that the railway will be constructed, they are worried that the cost of the property will be lower if the Government will acquire it. I am thankful that based on your presentation, the exact price of the property will be offered to us. • Also, will the Government acquire the entire property? Because I don't want to live there if there is no enough space, if the government will acquire only half of the property.	**Mr. Steven Racadio – DOTr** Based on the JICA mandate regarding properties to be acquired, if the remaining property of the owner will no longer be usable, or will lose its economic value, the entire property will be bought by DOTr.
	Hon. Gennalyn Pascual – Barangay Councilor of Tabun, Mabalacat • We were relocated before when we were washed out by the lahar. When Barangay Tabun was able to recover, we returned to our area where we were washed out. However, the land where we built our houses was said to be the location of the railway. We went to that land because it was given to us by the NHA. How certain that our area will be utilized for the construction of the Project? • Our houses and barangay hall are there. We also want to know if we will be relocated. Are you going to compensate us? Because the response that we received is that we are Informal Settlers and we don't have the right to build our houses there. Will we be able to receive help from DOTr?	**Ms. Cristina Fernandez – DOTr** We are obligated to follow the RA 10752. Regarding ISFs, if you have been there before the cut-off date, meaning you were marked as potentially affected by DOTr, there is a big chance that you will be on the list of entitled for resettlement or relocation.
	Mr. Eric Gonzales – Resident of Barangay Baliti, San Fernando Our house will be affected. We live in that house for fifteen (15) years. As a government employee, we acquired that house through housing loan from GSIS. However, it is not yet paid. What will be the process for it? Who will coordinate with the GSIS regarding the status of our payment? Will you compensate the payment we've made to GSIS? Also, I want to choose the place where will our family be relocated.	**Mr. Felipe Mallari III – DOTr** We will have a separate MOA with GSIS, where DOTr will pay the market value to GSIS.
	Mr. Jude Aldara – Resident of Barangay Sta. Lucia, San Fernando • Someone went to our house and put a yellow sticker. They mentioned that the wall and garage will be considered also in the compensation. • What will be the mode of payment to those who will be affected by the Project? What if the area is an establishment? What if the lot owner is already dead?	**Mr. Felipe Mallari III – DOTr** 50% will be paid outright, while the remaining 50% will be made after the title is transferred to DOTr. We also have special cases where the payment is made to a representative of the owner. In cases where the owner is already deceased, we will transfer the name of the previous owner to your name as current owner.

Source: JICA Design Team

Table 9.1.62 Issues / Concerns raised during Public Hearing (June 27, 2018)

EIA Module	Issues/Concerns Raised	Proponent's Response
Project Description	**Hon. Jose M. Salting, Jr. - Barangay Chairman of Anupol/ABC President** I've heard earlier that the alignment will traverse Sto. Niño, San Vicente then Capas. How about Barangay Anupol? Sto. Niño is adjacent to Anupol and it is impossible to go to Capas without passing through Anupol.	**Ms. Karla Escober – DOTr** • Earlier in the presentation, maps were shown with the barangays and their boundaries. The alignment will be on the left side of Anupol. It will be at San Vicente and Sto. Niño. • If I may show the map, the red is the jurisdiction of Sto. Niño. Anupol is bounded by Sto. Niño and San Vicente on the west. Now, the proposed alignment will start from Mabalacat going up to San Vicente. Lourdes will not be affected. • May I please correct that if I say Capas, I am not directly referring to the Old Capas PNR Station. That is the old route. The new alignment will be directed to the left because the area of the old station is already developed.
	Hon. Marilou Rivera – Barangay Councilor of Cristo Rey, Capas: Barangay Cristo Rey is predominantly residential. What will DOTr do to the roads and houses that will be affected by the Project?	**Mr. Felipe Mallare, III – DOTr** • Sir did you base the alignment in the existing PNR Station? • As what Ms. Karla said, we are still in the Feasibility Study. We are still studying the sections. • But if you are asking if will there be affected households and what will happen to them, this is the answer. If this project will push through, we have an agreement with JICA, our fund provider for this project, that if there are affected persons or properties, they will be given Environmental and Social Considerations. • Also, JICA has "No Worse Policy" which states that if there will be a resettlement, the new living condition of the affected household should be the same or improved compared to its previous.
	Hon. Estella Manlupig – Barangay Chairman of Aranguren, Capas Since New Clark City covers the area of Barangay Aranguren, is there a possibility that our barangay proper will be traversed by the alignment?	**Mr. Felipe Mallari, III – DOTr** Based on our Feasibility Study, Aranguren will be traversed by the alignment.
	Mr. Anastacio Mirag – Resident of Barangay Dela Cruz, Bamban During operation, what will DOTr do in case the train will stop/malfunction?	**Mr. Felipe Mallari, III – DOTr** • Sir it is likely that problems will be encountered soon but at our best efforts, we are doing our everything. In this project, Japan is involved. As we know, their work is of quality and with standards. • If there will be a malfunction while travelling, DOTr is assuming that that will not happen.
	Hon. Johnny M. Sales – Municipal Councilor of Bamban • You mentioned that you are still in feasibility stage. So, from Sto. Niño, San Vicente, apparently, you will traverse Lourdes, San Nicolas, San Roque and Anupol. You mentioned also that we don't have a station in Bamban. • Can you consider also putting a station in Anupol, Bamban? With regards to the volume of populace, as mentioned by Mayor Catacutan, in 2022, there will be more Air Force here. Also, there will be no problem in land based. With regards to the fund, it will be funded by JICA.	**Ms. Ledicia dela Cruz – GEOSPHERE Technologies, Inc.** For now, yes. **Ms. Cristina Fernandez – DOTr** • Sir we are still in the feasibility study. In putting a station, we have three (3) things to consider. First is the ridership or the volume of passengers, second is the impact of the project on the environment, and lastly, the cost. All of which will be studied. • Since Bamban is interested in putting a station in their area, they may relay that to the management and the design team to study if it is feasible.

EIA Module	Issues/Concerns Raised	Proponent's Response
	Mr. Ju-Arthur Ceuz - PCUP Since this project is in feasibility study stage, it means that at the end of this year, probably in December, there will be another meeting like this to present the final result of the feasibility study.	**Mr. Felipe Mallari, III – DOTr** • Yes Sir, we will have a final hearing. Actually, we have three (3) more coordination meetings. On the first coordination meeting, we will present the project to the stakeholders. • On the second coordination meeting, we will present the legal frameworks as well as a more detailed list of affected barangays. • On the last coordination meeting, we will present the final list of affected barangays and the final design.
	Hon. Johnny M. Sales – Municipal Councilor of Bamban Is the train ticket cheap? Can we avail it now?	**Mr. Felipe Mallari, III – DOTr** The train tickets will be similar to the beep cards so that it will be universal. In fact, we are working on making our ticketing system universal.
	Hon. Estella Manlupig – Barangay Chairman of Aranguren, Capas Will there be a station in Barangay Maruglu? I am just wondering because Barangay Maruglu is very far from the Project area.	**Mr. Felipe Mallari, III – DOTr** According to the feasibility study, there will be a small part of Barangay Maruglu that will be traversed.
Land	**Ms. Margarita P. Dizon – Representative from PHIVOLCS** I would like to inform you that last month, PHIVOLCS has conducted a mapping in Bamban and Capas area, particularly in NCC. For sure, hazards are being considered in your design. This year, our maps are under technical review. So by early next year, they will be released and you can use them as basis in your design.	**DOTr** Thank you.

Source: JICA Design Team

Table 9.1.63 Issues / Concerns raised during Public Hearing (June 29, 2018)

EIA Module	Issues/Concerns Raised	Proponent's Response
Project Description	**Justin Caesar Ortiga – Representative from NCCA** The Project of DOTr in the South has no cultural properties. However, for this Project in the North, the original Right of Way has old stations. If not old, most of them are cultural properties or already declared by the National Museum as historical sites in the Philippines. What will DOTr do to the existing stations? Will they not be affected during construction of the elevated structures?	**Mr. Felipe Mallari III – DOTr** Sec. Tugade has issued an order to preserve the old and existing PNR station, maybe convert them to museums.
	Mr. Ricardo del Pilar – Resident of Barangay Balungao, Calumpit Is the location of the station in Barangay Balungao already final or it can be changed? In DOTr's proposed location, traffic congestion occurs particularly during Market Day in Tuesdays and Fridays. The area is also populated. We, however, have a proposed location which is wider. We would like to request DOTr to consider putting the station there instead. There are no houses there and we want that area to have a development.	**Mr. Steven Racadio – DOTr** Your inputs are always considered. More or less, right now, the terminal is planned at the existing Malolos Station. But this may change, depending on the development during detailed engineering design phase.

EIA Module	Issues/Concerns Raised	Proponent's Response
	Hon. Nilo Abarico – Barangay Councilor of Balungao, Calumpit The Local Government Unit of Calumpit has a Position Paper, which was forwarded already to the DOTr. In the Position Paper, our Mayor requested to locate the station at the area before you arrived at Calumpit Institute.	**Ms. Karla Escober – DOTr** When was this submitted? If this was submitted early, then it will have been incorporated in the design. Since we are still in the basic design phase, things are not final yet.
	Mr. Wilfredo Castro – Barangay Secretary of Bulihan There are three (3) intersections in Bulihan that will be traversed by the proposed alignment: Capitol View Park, Alido Subdivision, and Royal Estate. As I understand, the design for those parts is elevated. Can we request DOTr to furnish Barangay Bulihan a copy of the final design? I also understand that the station in Barangay Bulihan is 60m. Please give us also the dimension including the business area that will be affected by the Project.	**Mr. Steven Racadio – DOTr** Ok, Sir. Your concern is duly noted.
	Hon. Melchor Santos – Barangay Councilor of Pio Cruzocosa, Calumpit What is the exact measurement of the station? Is it 15m-15m or 10m-10m?	**Mr. Felipe Mallari III – DOTr** The entire alignment's width will be 30 m, 15 m to the right and 15 m to the left.
	Hon. Melchor Santos – Barangay Councilor of Pio Cruzocosa, Calumpit Will DOTr utilized the whole 30m-30m?	**Mr. Felipe Mallari III – DOTr** Yes sir, we will.
	Mr. Ronaldo Lopez – Staff of ABC President of Malolos Will DOTr use the existing posts, which were constructed before for the North Rail?	**Ms. Cristina Fernandez – DOTr** The structures will be demolished, since they are not aligned with the present project's design.
	Mr. Ronaldo Lopez – Staff of ABC President of Malolos Our City Government is very concern on our Senior Citizen, particularly the PWD. What will they use to easily access the stations, especially that the stations are high? I hope that in your proposed station, they will be considered in the design.	**Mr. Felipe Mallari III – DOTr** The design of the stations will consider the needs of the riding public, especially our Senior citizens and PWDs.
	Hon. Jed Leoncia – Barangay Councilor of Balungao, Calumpit In Barangay Balungao, the old station of Heritage is there. What will DOTr do to the old station? Are you going to traverse the old station, which was planned to be converted into a museum? Is it possible to divert the alignment?	**Mr. Felipe Mallari III – DOTr** Sec. Tugade has issued an order to preserve the old and existing PNR station, maybe convert them to museums. We will preserve these structures.
	Mr. Reynelito Angeles– Resident of Barangay Balungao, Calumpit The proposed station in Balungao is to be located near to our water supply tank. Will it be affected by the Project since the train will generate vibration?	**Ms. Ledicia dela Cruz – GEOSPHERE Technologies, Inc.** These will be considered in the detailed engineering design. Right now, we are in the conceptual stage only, so things may change. Public consultations will be made so that your inputs will be considered during the detailed engineering design phase.
	Hon. Therese Cheryll "Ayee" B. Ople – Board Member of Bulacan Will this Project be implemented? Because for a long time, we hoped for nothing. I hope that in this term of our President Duterte, the desire of not only Maloleño but also Bulakeño will be achieved.	**Mr. Felipe Mallari III – DOTr** There is a great certainty regarding the project pushing through, with your support.

EIA Module	Issues/Concerns Raised	Proponent's Response
	Hon. Therese Cheryll "Ayee" B. Ople – Board Member of Bulacan Who will finance the Project? Is it only the JICA?	**Ms. Karla Escober – DOTr** The project will be funded by JICA and Asian Development Bank (ADB).
	Hon. Therese Cheryll "Ayee" B. Ople – Board Member of Bulacan Will our national government have a counterpart on the funding?	**Ms. Karla Escober – DOTr** We have a counterpart, basically on relocation and compensation.
Water	**Hon. Melchor Santos – Barangay Councilor of Pio Cruzocosa, Calumpit** Calumpit becomes a catch basin when there is flood. When our Government constructed a road, we asked the Contractors on where will the water drain. They said that in Bagbag River. What happened was, the drainage was higher going there up to Malolos. However, Malolos has no river as drainage. Our problem is, we do not know now where to drain the water? Since DOTr has its ROW, why not use it to drain the water down to river?	**Mr. Felipe Mallari III – DOTr** As of now, the final design on drainage is not yet made, since we are only in the feasibility stage. Once we reach detailed engineering design phase, we can consider that.
People	**Mr. Reynelito Angeles– Resident of Barangay Balungao, Calumpit** The Project area in Balungao is in front of the cemetery and Balungao is a flood drain area. Also, the Project area is the access of the students of Balungao, Gugo and Calizon to the Central. What will the students use to access the schools, as well as the people in going to the market and church during the construction of the Project?	**Ms. Karla Escober – DOTr** Thank you for your question. This is a common question in every public hearing we conduct. The provision of access roads will be considered during construction planning. We also have guidelines to do reinstatement services which means that after construction, the roads closed during construction should be opened again, possibly with improvements.
	Ms. Ma. Finena Alano – President of Home Owners Association of Royal Estate in Bulihan, Malolos Clarification on the meaning of the host barangay and what particular area in Barangay Bulihan.	**Mr. Steven Racadio – DOTr** A host barangay is a barangay where the rail will traverse. There will be construction of rail in that Barangay.

Source: JICA Design Team

9.1.12.4 Stakeholder Consultation Meetings

Three rounds of Stakeholder Consultation Meeting (SCM) were held, targeting project affected people under the RAP with the disclosure of the Project in terms of (i) areas that the Project will traverse, (ii) its components such as the stations, depot, and (iii) other features such as envisioned width of the Right-Of-Way (ROW). At the end of each meeting, the invited PAPs were encouraged to participate in the open forum to express their views/opinions. A summary of participants, the main concerns/issues raised during the SCMs is provided in **the section 9.2. RAP.**

9.1.12.5 Focus Group Discussions

The Focus Group Discussion (FGD) was conducted as part of the consultation with the vulnerable sectors affected by the proposed MCRP. The vulnerable sectors covered are the poor, the underprivileged, and the homeless, including socialized housing beneficiaries. Separate FGDs were conducted for other vulnerable groups such as women, elderly, and children under the Gender Impact Assessment component of the RAP. A summary of participants, the main concerns/issues raised is provided in **the section 9.2. RAP.**

9.2 Land Acquisition and Involuntary Resettlement

Though the Project will utilize the existing Philipines National Railway Right of way (PNR ROW) to minimize the size of the land acquisition and magnitude of the displacement associated with it, 1,416 affected households or 5,800 people are assumed to be displaced in the feasibility study stage. The estimated land for the acquisition is 45.5 ha.

The Project will fall in “Category A” of “JICA Guidelines for Environmental and Social Considerations” (2010) (hereinafter referred to as “JICA Guidelines (2010)”) due to its nature: (i) Sensitive Sector: Railway, and (ii) Sensitive Characteristic: Large Scale Involuntary Resettlement.

9.2.1 Preparation of Resettlement Action Plan

The Resettlement Action Plan (RAP) specifies the guidelines and procedures necessary for DOTr to conduct resettlement of Project Affected Persons (PAPs) properly. It ensures that the livelihood and living standards of the PAPs prior to the displacement would be maintained or improved as a result of the NSCR Project, in accordance with the legal framework of the Philippines, the JICA Guidelines (2010) and ADB Safeguard Policy Statement 2009 (hereinafter referred to as “ADB SPS (2009)”).

(1) Framework of the Study

The framework of RAP Surveys, their Objectives and Outcomes are shown in Table 9.2.1.

Table 9.2.1 Framework of RAP Surveys

	Activity	Objective	Outcome
1	Conduct Information, Education and Communication (IEC)	Gather basic data, decide on RAP preparation timeline and Scope of Work.	
2	Conduct Detailed Measurement Survey (DMS), Socio Economic Survey (SES)	• Conduct a ground survey for the PAPs assets that would be lost and make a list. • Finalize statistical data of PAPs. • Confirm compensation for the lost assets and the qualification for livelihood restoration measures.	• DMS Report • List of PAPs, lost assets (structures, land, crops)
3	Conduct Replacement Cost Survey (RCS)	Determine the real market value by usage and by location of structures, land and crops in order to decide the compensation amount.	List of compensation amount for PAPs, lost assets (structures, land, crops, etc.)
4	Conduct Focus Group Discussions (FGD) and Livelihood Restoration Measures	Gather the needs of the Socially Vulnerable and prepare Livelihood Restoration Measures.	• Livelihood Restoration Program • MOM
5	Identify Relocation Sites	Coordinate with NHA, LGUs and other Government Agencies to select relocation sites.	• List of Relocation Sites • Draft MOU with NHA/LGU
6	Conduct Stakeholder Consultation Meeting (SCM)	Provide information about the Project to PAPS and collect PAPs opinion.	• MOM • Attendance list • Pictures
7	Coordinate with related agencies	Coordinate with concerned Government Agencies for land acquisition and the implementation of livelihood restoration measures.	MOM
8	Prepare RAP	Prepare the RAP based on the results of the above-mentioned activities.	RAP
9	Conduct Due Diligence	Verify that resettlement of PAPs relocated before the commencement of this study and that just compensation and livelihood restoration has been implemented in case of relocation conducted for the Project prior the Loan Agreement.	Due Diligence Report (DDR)
10	Conduct Gender Impact Assessment (GIA)	Conduct interview and survey to female PAHs to understand their issues and provide the necessary assistance.	GIA Report

Source: JICA Design Team

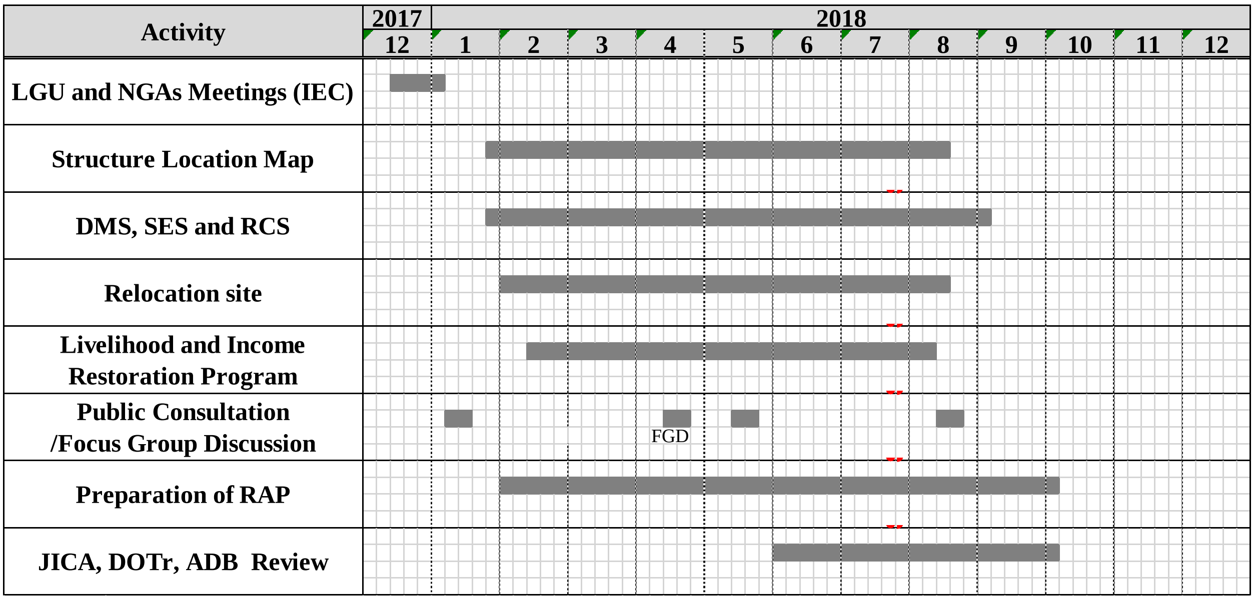
(2) RAP Process

For resettlement, A Draft Rap will be prepared for MCRP. The status of the RAP activities are shown in Table 9.2.2, and the schedule for the Draft RAP is indicated in Table 9.2.3.

Table 9.2.2 Status of RAP Activities

Activity	Status
Review of the planned activities and existing documents	December 2017: Completed
Education and Communication (IEC) Meetings	December 2017- January 2018: Completed
1st Stakeholder Consultation Meeting (SCM)	January 2018: Completed
Socioeconomic Survey	January 2018 – September 2018: Completed
Replacement Cost Survey	February 2018 – September 2018: Completed
Focus Group Discussion (FGD)	April - May 2018: Completed
2nd SCM	May 2018: Completed
3rd SCM	August 2018: Completed
Preparation of Draft RAP	February 2018 - October 2018: Completed
Review of Draft RAP by JICA, DOTr and ADB	June 2018 - October 2018

Table 9.2.3 RAP Schedule



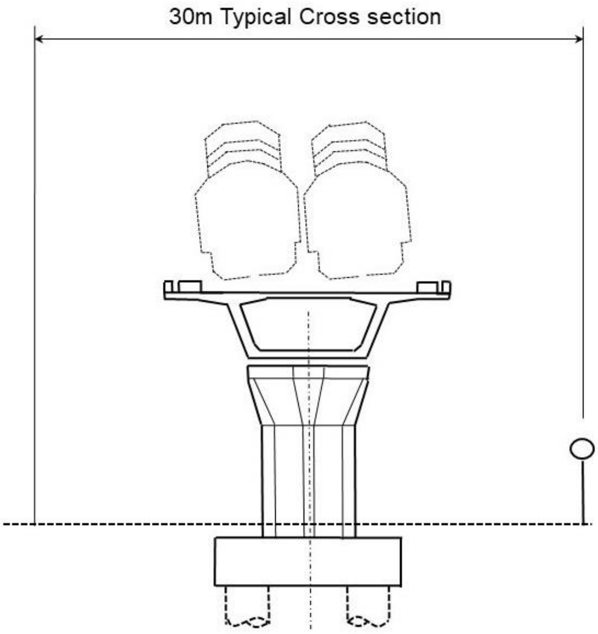
Source: JICA Design Team

9.2.2 Necessity of Land Acquisition

This Project will maximize the utilization of PNR ROW in order to minimize the additional ROW acquisition. Nonetheless, the Project will result to physical displacement of Informal Settler Families (ISFs) living within the existing PNR ROW. Additionally, it will affect access roads located parallel to or across the railway track.

9.2.2.1 Additional ROW for the Railway

The FS RAP ROW for MCRP is set at 30 m (15 meters on each side from the current center line). Additional ROW acquisition might have some impact not only on residential but also on industrial facilities. The additional ROW acquisition might have some impact not only on residential but also on industrial facilities. If the structures of Project Affected Households (PAHs) are severity affected, they will need to be relocated. Typical cross section is attached in Figure 9.2.1.

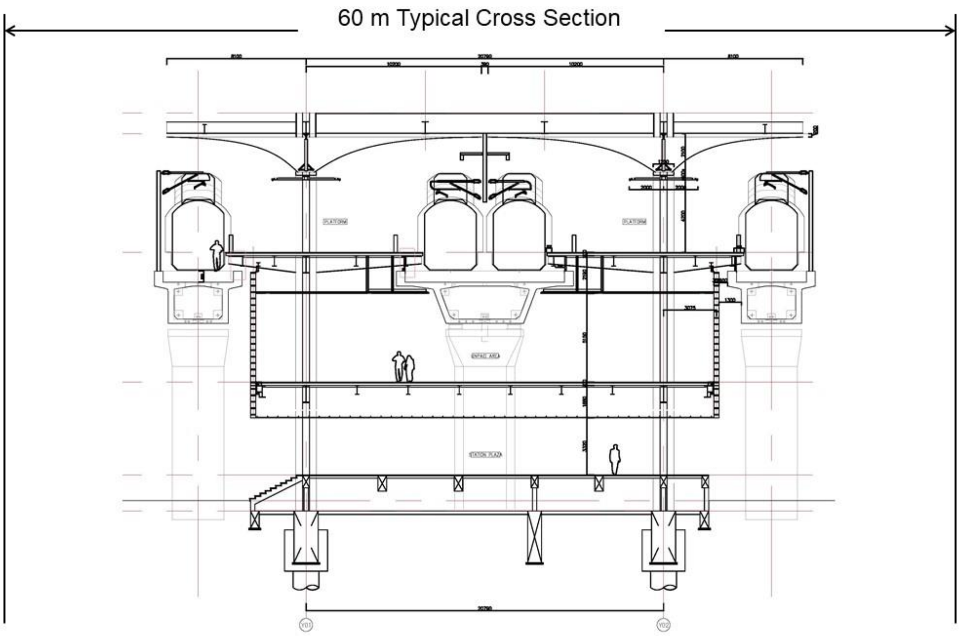


Source: JICA Design Team

Figure 9.2.1 Typical Cross Section

9.2.2.2 ROW for the Stations

Construction of new stations will necessitate additional land acquisition. The ROW width for stations is set as 60 (30m to each side from the current center line) by DOTr. Typical cross section is attached in Figure 9.2.2.

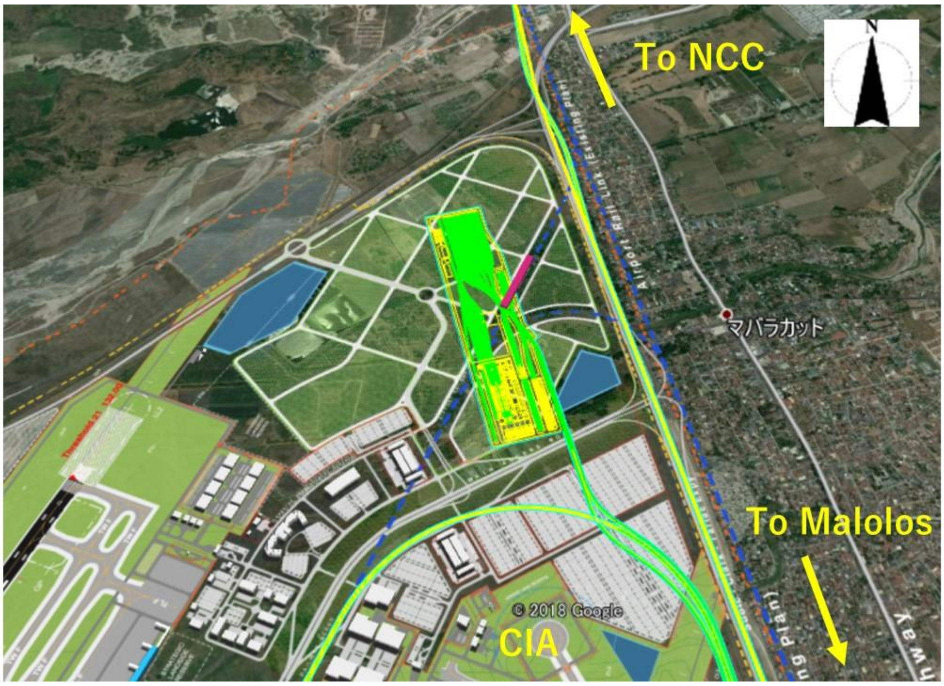


Source: JICA Design Team

Figure 9.2.2 Typical cross section for Stations

9.2.2.3 ROW for Depot Site

The location of the Depot is planned to be constructed north of Clark International Airport (CIA). The lot is currently owned by Bases Conversion Development Authority (BCDA) and will not require additional land acquisition. The depot location is indicated in Figure 9.2.3.



Source: JICA Design Team

Figure 9.2.3 Proposed Depot Site

9.2.3 Legal Framework

9.2.3.1 Philippine's legal framework for Land Acquisition and Involuntary Resettlement

Table 9.2.4 summerizes main requirements of laws and regulations of the Philippines concerning land acquisition and involuntary resettlement.

Table 9.2.4 Philippine Legislation, Guidelines and Policies

Law and Regulations	Requirements
The Philippine Constitution of 1987	• Private property shall not be taken for public use without just compensation. (Article III, Bill of Rights, Section 9) • Urban or rural poor dwellers shall not be evicted nor their dwelling demolished, except in accordance with law and in a just and humane manner. No resettlement of urban or rural dwellers shall be undertaken without adequate consultation with them and the communities where they are to be relocated. (Article XIII, Urban Land Reform and Hosing, Section 10)
Republic Act No. 10752 (An Act to Facilitate the Acquisition of Right-of-Way, Site or Location for National Government Infrastructure Projects and other purposes of 2016)	• This law, enacted in March 7, 2016, repeals Republic Act (RA) No. 8974 (An Act to Facilitate the Acquisition of Right-of-Way, Site or Location for National Government Infrastructure Projects and other purposes). Both laws (RA 8974 and RA 10752) are based on the premise that private property shall not be taken for public use without just compensation (Article III, Section 9 of the 1987 Constitution). RA 10752 was enacted to further strengthen the said constitutional provision and ensure that property owners and project-affected properties in areas where national government infrastructure projects would be given just compensation. Implementing Rules and Regulations (IRR) of RA 10752 is promulgated in May 25, 2016 to carry out the provisions of the said Act. • Main provisions in RA 10752 sought to expedite the implementation of infrastructure projects while ensuring that just and equitable compensation be provided to the project-affected persons. The pertinent revisions in RA 10752 include: (1) expansion in scope of national government projects, (2) refining the modes of acquisition, (3) compensation based on replacement cost for land, structures and improvements, (4) changes in guidelines for expropriation proceedings, (5) payment terms, and (6) appropriation.
Republic Act No.7279 (Urban Development and Housing Act : UDHA of 1992)	• The mandate of this Act is to uplift the conditions of the underprivileged and homeless citizens in urban areas and in resettlement areas by making available to them decent housing at affordable cost, basic services, and employment opportunities. • Defines equitable land tenure system, defines compensation measures for leasehold rights and ensure compensation payment to small property owners. • Eviction and demolition may be allowed (a) for government infrastructure projects with available funding, (b) for persons within danger areas such as esteros and railroad tracks, and (c) for cases with a court order for eviction and demolition. • Socialized housing or resettlement areas shall be provided by the Lodal Government Units (LGUs) or the National Housing Authority (NHA) in cooperation with the private developers and concerned agencies with the basic services and facilities.
Republic Act No.7160 (Local Government Code of 1991)	• The power of eminent domain by the local government unit may not be exercised unless a valid and definite offer has been previously made to the owner, and such offer was not accepted. • Allows LGUs to adopt the provisions in the ROW acquisitions, LGU can possess land immediately after court application for land acquisition by pre-supporting 15% of the fair land price calculated based on tax payment. The remaining amount is determined by the court based on market price at the time of land acquisition.
Republic Act No. 6389 (Agricultural Land Reform Code of 1971)	• Agricultural lessees are entitled to receive disturbance compensation equivalent to five times the average gross harvests on his/her landholding during the last five preceding calendar years.
Republic Act No. 6685 (December 1988)	• National and local public works projects funded by either the national government or local government, including foreign-assisted projects must hire at least 50% of the unskilled and 30% of the skilled labor requirements from bona fide and actual residents in the province, city and municipality who are ready, willing and able, as determined by the governor, city mayor, or municipal mayor concerned.
Republic Act No. 9679 (Home Development Mutual Fund Law of 2009)	• The Pag-IBIG Fund is a mutual provident savings system which is primarily intended for shelter financing among its members. Section 10 states that the Fund shall be private in character, owned wholly by the members, administered in trust and applied exclusively for their benefit. Section 6 of the Act provides that membership in the Fund shall be mandatory upon all employees covered by the Social Security System (SSS) and the Government Service Insurance System (GSIS), and their respective employers.
Executive Order (EO) No. 1035, Series of 1985	• Provides the procedures and guidelines for the expeditious acquisition by the government of private real properties or rights thereon for infrastructure and other government development projects.

Law and Regulations	Requirements
Executive Order No. 48, Series of 2001	• This E.O. declared non-core properties of PNR (i.e. those outside the boundaries of railroad tracks and not utilized for railroad purposes) as socialized housing sites and provided for the disposition of the same to bonafide occupants, through the Housing and Urban Development Coordinating Council (HUDCC)
Executive Order No. 272, Series of 2004	• EO 272 created the Social Housing Finance Corporation (SHFC) and assigned SHFC as the lead government agency for undertaking socialized housing programs that will cater to the formal and informal sectors in the low-income bracket and shall take charge of developing and administering social housing program schemes, particularly the CMP and the Abot-Kaya Pabahay Fund (AKPF) Program (amortization support program and development financing program)
DOTr Department Order No. 2013-05	• The Department Order specifies the composition of the Technical Working Committee for the Acquisition of Sites/Rights-Of-Way for the department's Infrastructure Projects. It states that no infrastructure project shall be bid out and/or shall commence unless the acquisition of site and/or ROW of lots affected by the project are determined/settled as certified by the Committee. • Under the Guidelines on ROW Acquisition, properties may be acquired through the following modes: donation, quit claim, exchange or barter, negotiated sale or purchase, expropriation or other modes as authorized by law. The Guidelines specify that an ocular of the property to be acquired must be conducted.
HLURB Memorandum Circular No. 13, Series of 2017	• The Housing and Land Use Regulatory Board (HLURB) Memo sets the price ceiling for Economic Housing at above PhP450,000 to PhP1,700,000 while a Medium-Cost Housing is above PhP1,700,000 to PhP4,000,000.
DOTr Right-of-Way and Site Acquisition Manual (ROWSAM)	• The ROWSAM was developed to provide clear and specific operational guidelines on ROWA. It aims to guide DOTr staff on the legal processes and procedures necessary to acquire and clear private and public land required for the construction and operation of public transport infrastructure regardless of the funding source(s).
Land Acquisition, Resettlement, Rehabilitation and Indigenous Peoples' Policy (LARRIPP), 2007	• The LARRIP indicates that social impacts of infrastructure projects should be avoided, minimized and/or mitigated. PAPs should be provided with sufficient compensation to ensure that their standard of living prior to the project should be maintained or improved. Project stakeholders should also be consulted regarding the project's design, implementation and operation.
DPWH Right-of-Way Acquisition Manual (DRAM)	• The DRAM was developed in compliance with Section 18 of the Implementing Rules and Regulations (RR), of R.A. 10752, which prescribes that, to provide clear, specific, and operational guidelines for the efficient acquisition of ROW for its infrastructure projects, each IA (i.e., Implementing Agency) shall prepare and implement its own "Manual of Procedures for ROW Acquisition." The DRAM covers the entire ROW acquisition process
NHA Memorandum Circular No. 2427 Series of 2012	• NHA will (i) provide technical assistance to LGUs in preparing project plans and formulating policies and guidelines in implementing resettlement projects and (ii) contribute funds (in the form of grants) for the development of resettlement sites. The LGUs on the other hand shall (i) contribute land for the project and (ii) be the lead project implementer with overall responsibility for the operation and management of the resettlement project to include preparation of overall project plans, site development and housing plans, beneficiary selection, relocation of families and estate management.

Source: JICA Design Team

9.2.3.2 JICA's Policies on Involuntary Resettlement

Key principles of JICA policies on involuntary resettlement are summarized below.

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

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

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

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

V. Compensation and other kinds of assistance must be provided prior to displacement.

VI. For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. It is desirable that the resettlement action plan include elements laid out in the World Bank Safeguard Policy, OP 4.12, Annex A.

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

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

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

The above principles are complemented by the World Bank OP 4.12, since it is stated in the JICA Guideline that "JICA confirms that projects do not deviate significantly from the World Bank's Safeguard Policies." Additional key principles based on the World Bank OP 4.12 are as follows:

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

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

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

XIII. Provide support for the transition period (between displacement and livelihood restoration).

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

XV. For projects that entail land acquisition or involuntary resettlement of fewer than 200 people. An abbreviated resettlement plan is to be prepared. In addition to the above core principles on the JICA policy, it also laid emphasis on a detailed resettlement policy inclusive of all the above points; project specific resettlement plans institutional frame work for implementation; monitoring and evaluation mechanism: time schedule for implementation: and, Detailed Financial Plan etc.

9.2.3.3 Gap Analysis between the Legal Framework of the Philippine, the JICA Guidelines and ADB Safeguard Policies

A comparison of the Philippine's legal framework, the JICA Guidelines (2010) and ADB SPS (2009) was undertaken. The gaps and the Project Policy to bridge the Gaps are as indicated in Table 9.2.5.

Table 9.2.5 Comparison between the JICA Guidelines, ADB Safeguard Policy and Legal Framework on Involuntary Resettlement

	Issue	ADB/JICA	Laws of the Philippines	Gap	Gap Filling Measure
1	Compensation for non-land assets for those without recognized legal rights to affected land.	PAPs who have neither formal legal rights nor recognizable claims to affected land they occupy are to be compensated for the loss of assets other than land, and for other improvements to the land, at full replacement cost, provided they occupied the project area prior to the project cut-off date.	PAPs without legal entitlement to affected land will be eligible for compensation for structures and improvements with following criteria: a. Must be a Filipino citizen; b. Must not own any real property or any other housing facility, whether in an urban or rural area; c. Must not be a professional squatter or a member of a squatting syndicate, as defined in R.A No. 7279, otherwise known as the "Urban Development and housing Act of 1992"; (Section 5(b) of RA 10752)[5] “Squatting syndicates” as defined in section 3 of RA 7279[6] will not be eligible for compensation or assistance. Under Section 15 of IRR of RA 10752, the government shall provide adequate appropriations including the cost of development and implementation of resettlement projects, including planning, social preparation, provision of basic services, community facilities, livelihood restoration and improvement and other activities in the resettlement action plan.	PAPs without legal rights to affected land are potentially ineligible for compensation for non-land losses if they are classified as professional squatters or members of squatting syndicates.	PAPs who do not have legally recognized right to the affected land but who occupy the project affected area prior to the cut-off date are eligible for compensation for all losses, other than land, at full replacement cost. “Squatting syndicates” as defined in section 3 of RA 7279 and who are certified by HUDCC and or other Government Agency (PNR, LGU among others) as such will not be eligible for compensation or assistance. Presence in the project affected area at cut-off date to be validated through census and validated by the Local Inter-Agency Committee.
2	Eligibility for resettlement assistance	Physically displaced persons will be provided with relocation assistance, transitional support and development assistance.	Socialized Housing: Under Section 16 of RA 7279, informal settlers: To qualify for the socialized housing program, a	Restrictions on eligibility for resettlement assistance for those who have previously availed	All relocating PAPs will be eligible for: - relocation assistance, including transportation allowances plus food allowance of PhP150 per person relocated or a food parcel of equal or greater

5 Section 6.6 of IRR of RA 10752 includes additional criterion that PAPs must not occupy an existing government ROW. However, this criterion is not supported in RA 10752 itself.
6 "Squatting syndicates" refers to groups of persons engaged in the business of squatter housing for profit or gain

	Issue	ADB/JICA	Laws of the Philippines	Gap	Gap Filling Measure
		Improve the standards of living of the displaced poor and other vulnerable groups, including women, to at least national minimum standards and provide them with appropriate income sources and legal and affordable access to adequate housing.	beneficiary: a. Must be a Filipino citizen; b. Must be an underprivileged and homeless citizen c. Must not own any real property whether in the urban or rural areas; and d. Must not be a professional squatter or a member of squatting syndicates.	of socialized housing or have real property elsewhere.	amount (as determined by DOTr). AND one of the two following option: (i) Provision of economic and socialized housing[7] or other forms of government assisted housing will be offered to all PAPs who are physically displaced. However, the forms of government assisted housing may vary according to PAPs' degree of vulnerability and affordability level[8]. HLURB Classification and Price Ceiling[9] for government housing projects: Socialized housing (PhP450,000) Economic or Low-Cost Housing (Above PhP450,000 to 1,700,000 Medium Cost Housing Above PhP1,700,000 to 4,000,000 Open Market – Above PhP4,000,000 OR (ii) Those relocating PAPs who are not eligible for socialized housing or who do not avail of it will be entitled to: - cash allowance for rental assistance for 5 months; - Cash compensation to cover the cost of reconnecting the facilities such as water and power. - Transportation to be provided inclusive of transportation of materials, as well as food allowance of Php150 per person relocated or a food parcel of equal or greater amount (as determined by DOTr). "Squatting syndicates" as defined in section 3 of RA 7279 and who are certified by HUDCC as such will not be eligible for resettlement assistance. Members of squatting syndicates

[7] As defined in Section 2, Batas Pambansa (BP) 220, "economic and socialized housing" refers to housing units which are within the affordability level of the average and low-income earners
[8] Affordability level is equivalent to 30% of the gross family income as determined by the National Economic Development Authority (NEDA) from time to time (Section 2, BP 220)
[9] HLURB memorandum Circular No. 13 Series of 2017

	Issue	ADB/JICA	Laws of the Philippines	Gap	Gap Filling Measure
					who do not actually occupy project-affected structures and are residing elsewhere will not be physically displaced and as such will not be eligible for relocation assistance and transitional support.
3	Payment of capital gains tax on land acquired through expropriation.	The rate of compensation for acquired housing, land and other assets will be calculated at full replacement costs. The calculation of full replacement cost will be based on the following elements: (i) fair market value; (ii) transaction costs; (iii) interest accrued, (iv) transitional and restoration costs; and (v) other applicable payments, if any	RA 10752 requires for the property owner to pay the capital gains tax in expropriation proceedings in order to incentivize and promote negotiated sale. Under negotiated sale, the IA shall pay for the account of the seller, the capital gains tax, as well as the documentary stamp tax, transfer tax, and registration fees. The property owner will pay any unpaid real property tax. Under expropriation proceedings, the IA shall pay the documentary stamp tax, transfer tax, and registration fees, while the owner will pay the capital gains tax and any unpaid real property tax.	Payment of capital gains tax by PAP if land is expropriated is inconsistent with principle of replacement cost.	Payment of CGT will be paid by the IA after the ruling by the court in expropriation cases when a PAP is unable to accept the negotiated sale as they lack the paperwork and are required to undergo Extra Judicial Settlement before being recognized as the property owner (for example, in deceased estates that have not been settled). Prompt and complete disclosure of the advantages of Negotiated Sale over Expropriation Proceedings (As provided for by R.A. 10752) shall be made during conduct of the 2nd Stakeholder Consultation Meeting (SCM) to wit: Negotiated Sale Incentives: (i) Outright offer for land price will be based on fair market value) (ii) Payment of CGT shouldered by Implementing Agency (DOTr) (iii) Shorter process (2-6 months if all required documents are complete) Expropriation Proceeding Disadvantages: Initial payment for land based on BIR zonal value and owner needs to present documentary evidence during court hearings to prove that value should be higher (i) Owner needs to hire lawyer (ii) Longer process (may take a year to several years before decision of court for payment of just compensation in favor of the owner becomes final and executory) and orders DOTr to pay the owner the difference. PAPs may still revert from expropriation to negotiation at any point in time before the last day of filing for Motion of the expropriation case. In case the Expropriation Case has been filed in Court:

	Issue	ADB/JICA	Laws of the Philippines	Gap	Gap Filling Measure
					The plaintiff (DOTr) can withdraw the case any time before the filing of the answer by the defendant (PAPs) (Section 1(h) Rule 16 of the 1997 Rules of Court on Civil Procedures) If the answer has been filed there has to be a joint filing by DOTr and owner to withdraw the case (Section 2, Rule 17 of the 1997 Rules of Court on Civil Procedures) In both cases, the acquisition mode would revert back to Negotiated Sale, which will entitle the owner to payment at current market value for land (as indicated in DOTr's letter offer), free of taxes, including CGT, and registration fees in accordance with Section 5(c) R.A. 10752, replacement cost for structures and improvements, and market value for crops and trees under Section 5(a) R.A. 10752.
4	Scope of application of the RAP	Scope to cover direct impacts of land acquisition and restricted land use for the project, including any land acquired for development of resettlement sites specifically for the project.	Unless specifically included in the RAP, Government standards only would be applied.	Potential gap with respect to application of entitlements under RAP to those who are affected by land acquisition to develop resettlement sites for the project.	Any land acquired for resettlement site development specifically for the needs of the project will be included in the scope of RAPs. DOTr will oblige any agency responsible for land acquisition for resettlement sites, such as NHA, to apply the same standards and entitlements as set out in the framework.
5	Payment of compensation and assistance prior to displacement	All compensation and assistance should be provided prior to displacement.	Under R.A. 10752, PAPs will be paid in two installments for their affected properties. The balance in compensation for the land will only be paid after the deed of sale has been completed. The balance of payment for improvements will be paid to the PAPs only after the acquired lands have been cleared of all improvements (i.e., structures, trees, and crops).	Gap on timing for payment	The PAPs will not be displaced until after they have been paid in full the compensation and applicable allowances due to them. For negotiated sale the following arrangements will be applied: For structures: DOTr to pay 100% prior to being displaced, unless the PAP is participating in a government housing project, in which case housing will be provided within the program and amortizations offset by the value of the structure. For land: 1st installment of 50% by DOTr remaining 50% is paid to PAPs when land is officially transferred, but no displacement nor civil works to commence until this transfer is effective

	Issue	ADB/JICA	Laws of the Philippines	Gap	Gap Filling Measure
					and balance paid.
6	Severity of Impact on productive resources after which rehabilitation assistance is required.	Loss of 10% or more of productive or income sources (e.g. farmland, business/ shop)	For agricultural tenants and sharecroppers: Financial assistance equivalent to the average gross harvest for the last three (3) years and not less than P15,000 per hectare (E.O. 1035). For agricultural lessees: Entitled to disturbance compensation equivalent to five times the average gross harvests on his/her landholding during the last five preceding calendar years (R.A. 6389)	Gap with respect to threshold and requirement for livelihood restoration assistance for all cases experiencing loss of productive resources.	Provision of supplementary support for livelihood and income restoration for those whose productive resources as permanently affected by 10% or more.
7	Severity of loss of property after which the entire property will be acquired.	If the residual portion is 20% or less[10] or if the residual portion is no longer viable for use according to original purpose, the entire property will be acquired.	No specific law prescribes acquisition of remaining unviable portion of the acquired property. [11]	No current Government policy on this issue.	If the residual portion is 20% or less or if the residual portion is no longer viable for use according to original purpose, the entire property will be acquired taking also the wishes of the PAP into consideration.
8	Income restoration and livelihood improvement	The borrower/client will include detailed measures for income restoration and livelihood improvement of displaced persons in the resettlement plan. Income sources and livelihoods affected by project activities will be restored to pre-project levels, and the borrower/client will make every attempt to improve the incomes of displaced persons so that they can benefit from the project. For vulnerable persons and households	Requirements for supplementary assistance or training to certain categories of PAPs. However, the requirements do not have specific objectives to restore income earning capacity and are limited in scope and application. Nonetheless, IRR of R.A.10752 states that government appropriations should be available to implement the cost of development and implementation of resettlement projects, and may include livelihood	ADB/JICA guidelines are more specific regarding objectives of restoring income earning capacity and include those whose income generation resources are severely affected.	Income restoration and livelihood improvement measures need to be designed in consultation with PAPs and be adequately resourced to restore income earning capacity of all PAPs whose livelihoods are affected and improve income earning capacity of vulnerable PAPs. The effectiveness of the income restoration and livelihood improvement activities will be monitored and reviewed.

[10] Based on the World Bank Involuntary Resettlement Sourcebook which, JICA applies in its policy, provides that if more than 80% of holdings is acquired, or if residual holdings no longer economically viable, owner will have the option to sell the residual land

[11] The DPWH Land Acquisition Resettlement Rehabilitation and Indigenous Peoples Policy (LARRIPP) 3rd Ed. Series 0f 2007 provides that if portion of the property to be affected is more than 20% of the total land area or even less than 20% if the remaining portion is no longer economically viable or it will no longer function as intended. The owner of this property (land or structures, etc.) will be entitled to full compensation in accordance to RA 8974. The DPWH LARRIPP 2007 is dated, being based on RA 8974, which has been superseded by R.A. 10752.

	Issue	ADB/JICA	Laws of the Philippines	Gap	Gap Filling Measure
		affected, the resettlement plan will include measures to provide extra assistance so that they can improve their incomes in comparison with pre-project levels. The resettlement plan will specify the income and livelihoods restoration strategy, the institutional arrangements, the monitoring and reporting framework, the budget, and the time-bound implementation schedule.	restoration and improvement activities.		
9	Transitional assistance and compensation for lost income.	In the case of physically displaced persons, provide transitional support and development assistance, such as land development, credit facilities, training, or employment opportunities; and opportunities to derive appropriate development benefits from the project. In cases where land acquisition affects commercial structures, affected business owners are entitled to (i) the costs of reestablishing commercial activities elsewhere; (ii) the net income lost during the transition period; and (iii) the costs of transferring and reinstalling plant, machinery, or other equipment.	Section 10(c) of R.A. 10752 provides that the cost of development and implementation of resettlement projects covered by the Act, including planning, social preparation, and other activities under the resettlement action plan shall be provided adequate appropriation to cover the funds needed for such. Section 15 of the IRR of R.A. 10752 further states that when necessary the development cost described above may include land development and housing construction, provision of basic services and community facilities, livelihood restoration and improvement and other activities under the resettlement action plan in coordination with concerned government agencies. Executive Order No. 1035 provides for (1) financial assistance to displaced tenants, cultural minorities and settlers equivalent to the average annual gross harvest for the last 3	Although there are no specific laws and guidelines which mention the transition period, entitlements relating to this may be lumped under "*livelihood restoration and improvement and other activities under the resettlement action plan*" as provided by the latest ROW law and its IRR. In the Philippine laws, there is no provision for compensation for loss of income for medium to large businesses.	Transitional support during the period while PAPs are resettling and re-establishing their livelihoods will be provided aimed at stabilizing their living standards. Compensation to be provided for lost income for businesses affected by this project For PAPs who are owners of medium to large commercial establishments built inside own affected property: Acquire the property but allow the owner of the structure and business use of the land for a defined period to give the owner time to transfer, subject to agreement on a case to case basis; Cash compensation to cover transactional (e.g., permitting) cost of reestablishing the business; Assistance in securing soft loan to enable self-rehabilitation for those restarting business elsewhere; PAPs who are owners of commercial establishments and are leasing space from property owners For those who will continue with their commercial activities elsewhere, rental subsidy for three (3) months based on prevailing average monthly rental for a similar structure of equal type and dimension to the property being leased. Not applicable to lease

	Issue	ADB/JICA	Laws of the Philippines	Gap	Gap Filling Measure
			years and not less than P15,000 per hectare, and (2) disturbance compensation to agricultural lessees equivalent to 5 times the average gross harvest during the last 5 years. Section 7 of R.A. 6389 provides for disturbance compensation for agricultural lessees equivalent to 5 times the average gross harvest in the last 5 years. For PAFs whose structures are severely affected and business/income will be affected, the DPWH LARRIP (2003) provides for rehabilitation assistance with an amount not more than P15,000 (based on the tax record for the business activities)		contracts that will expire within three (3) months at the time of taking; Cash compensation to cover transactional (e.g., permitting) cost of reestablishing the business elsewhere; PAPs who are owners of micro commercial establishments built inside own affected property: Cash compensation to cover income losses during transition period corresponding to stoppage of business activities, but not exceeding six-month period; Cash compensation to cover transactional (e.g., permitting) cost of reestablishing the industry elsewhere; Assistance in securing soft loan to enable self-rehabilitation for those restarting business elsewhere.
10	Disclosure of the RAP	JICA Policy is to make the RAP accessible to the Public through its website before Loan Agreement	The NEDA ICC does not require the RAP to be made available to public.		The RAP will be prepared and accessible to public through the JICA, ADB and DOTr websites. Salient information from the RAP will be disclosed to PAPs prior to and following finalization.
11	Grievance redress mechanism	Appropriate and accessible grievance mechanisms must be established for the affected people and their communities.	Republic Act 9285 (Alternative Dispute Resolution (ADR) Act of 2004) was meant to promote alternative mechanisms to resolve disputes outside of judicial litigation, and to provide the means for using ADR as an effective tool. ADR system adopts such measures as mediation, conciliation, arbitration, or any combination of it to achieve speedy and efficient means of resolving cases pending before all courts.	ADR system is promoted by RA 9285 but it does not stipulate the grievance redress mechanism. There are no specific laws that stipulate the grievance redress mechanisms in the Philippines. [12]	An effective and accessible grievance redress mechanism will be established to resolve disputes outside the judicial system. Prior to start of right-of-way acquisition [13] (ROWA), DOTr will establish a help desk at each city/ municipality to address the concerns of PAPs pertaining to RAP and ROWA. Each help desk must be established immediately before the sending of the Notice of Taking to PAPs by DOTr. A database of PAPs' concerns, actions taken, referrals made, and resolution status of said concerns will be developed and maintained by DOTr. Once the ROWA commences, GRM is triggered and the help desk will serve as recipient and database manager of grievances filed.

[12] In terms of guidelines, Section 3.4 Tracking and Monitoring Implementation of Grievance procedures of the DPWH LAPRAP Tracking Manual of 2003 may be used as reference.
[13] Onset is marked by the sending of the Notice of Taking by DOTr

	Issue	ADB/JICA	Laws of the Philippines	Gap	Gap Filling Measure
12	Census, inventory of losses and establishment of cut-off date for eligibility to entitlements.	Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census, asset inventory, and socioeconomic survey). The borrower/client will establish a cut-off date for eligibility. Information regarding the cutoff date will be documented and disseminated throughout the project area.	Requirement under RA 7279 and its IRR for LGUs to conduct inventory of their ISFs. The conduct of survey and tagging are established practice by the Urban Poor Affairs Office (UPAO). Section 4 of the IRR for Registration of Socialized Housing Beneficiaries states that the city/municipal government will be primarily responsible for carrying out the registration of underprivileged and homeless families within their respective jurisdictions.	No specific requirement for cut-off date.	A census and socioeconomic survey are conducted for the affected areas to prepare the RAP. For informal settlers, the cut-off date is set on the beginning date of the census and tagging. The cut-off date is publicly disclosed during the 1st stakeholder consultation meeting in the project affected areas. Date of Notice of Taking will be the cut-off date for formal property owners.
13	External monitoring	For projects with significant involuntary resettlement impacts, the borrower/client will retain qualified and experienced experts to conduct external monitoring.	Not required	Requirement for external monitoring of projects with significant impacts.	The IA will engage qualified experts to conduct external monitor of implementation of the RAP.
14	Voluntary land donation	Voluntary land donation is not specifically covered under the ADB and JICA policy frameworks.	Voluntary land donations are permitted.	Voluntary land donations are a mode of land acquisition for the project.	Voluntary donation will be an act of informed consent and APs/IPs will not be forced to donate land or other assets with coercion or under duress. Any voluntary donation will follow international best practices and be confirmed through written records and verified by an independent third party.

Source: JICA Design Team

9.2.4 Resettlement Policy of the MCRP Project

9.2.4.1 Basic Resettlement Policy

The Government of the Philippines will adopt a Project Resettlement Policy (the Project Policy) for the MCRP because existing national laws and regulations have gaps with the international standards including JICA's policy as shown in the previous the Gap Analysis. The Project Policy is aimed at filling any gaps in order to help ensuring that PAPs including Informal Settlers Families (ISFs) are able to rehabilitate themselves to at least their pre-project conditions, at the earliest possible time.

This section discusses the principles of the said Project Policy and the entitlements of the PAPs based on the types and degrees of their losses. The MCRP Project Policy is presented below:

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 losing assets, livelihood, or resources will be fully compensated and assisted so that they can improve, or at least restore, their former socio-economic and conditions.

III. Where displacement of business enterprises is unavoidable, all PAPs losing livelihoods will be fully assisted so that they can improve, or at least restore, their former economic conditions.

IV. Rehabilitation assistance will be provided to any PAPs, that is, any person or household or business which on account of project implementation would have 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; and
   - Social and cultural activities and relationships affected or any other losses that may be identified during the process of resettlement planning.

V. All affected people shall 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, nor tenure status and social or economic status, will not bar the PAPs from entitlements to such compensation and rehabilitation measures or resettlement objectives.

VI. All PAPs residing, working, doing business and/or cultivating land within the project impacted areas as of the date of the latest census and socio-economic survey shall be entitled to compensation for their lost assets at replacement cost as well as 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.

VII. PAPs that lose only part of their physical assets but would be left with a portion that will be inadequate to sustain their current standard of living shall be fully compensated. PAPs whose structures are marginally affected shall not be required to relocate or move out, but will be consulted if they intend to reside in the remaining portion of their property.

VIII. People temporarily affected shall be considered PAPs. Contractors shall secure the necessary ECCs for temporary facilities such as workers camps, warehouses for materials, stockpiling areas etc. from the appropriate DENR-EMB offices where they are located. Where these facilities are located in public or private lands, the Contractor shall enter into Lease Agreements and should there be a need for temporary displacement or compensation for affected structures and improvements, the Contractor shall comply with the provisions of R.A. 10752 and the Resettlement Action Plan for MCRP.

IX. 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.

X. The resettlement plans will be designed in accordance with the Project Resettlement Policy.

XI. The Resettlement Action Plan (RAP) as approved by JICA and ADB will be disclosed by DOTr to the public through the following means: posting of approved RAP on DOTr website and distribution to concerned LGUs.

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

XIII. 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, skills development, wage employment, or self-employment, including access to credit. Cash compensation alone, 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.

XIV. 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, and transitional allowance.

XV. 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 identified. Assistance should be provided to help them improve their socio-economic status.

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

XVII. 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.

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

XIX. Displacement must not take place before provision of compensation and other assistance required for relocation. Sufficient social infrastructure and basic services must be provided in the resettlement site prior to relocation. Livelihood restoration measures must also be in place but not necessarily completed prior to construction activities, as these may be on-going activities.

XX. Implementation arrangements for the implementation of the RAP will be 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.

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

9.2.4.2 Cut-Off Dates

The cut-off-date of eligibility refers to the date prior to which the occupation or use of the project area makes residents/users of the same eligible to be categorized as PAPs and be eligible to Project entitlements. In the Project, the cut-off date was declared for the informal settlers only.[14] No cut-off date was declared with regards to formal settlers (i.e., property owners) as this will be reckoned from the issuance of the Notice of Taking (NoT) by the DOTr in accordance with law (Section 11 of R.A. 10752 and Section 16 of its Implementing Rules and Regulations or IRR). Based on these statutes, any new structure or improvement to an existing one on the land covered by the ROW acquisition will not be compensated after the issuance of the NoT.

[14] Informal settling is an unlawful act after 1992 in accordance with Section 30 of R.A. 7279

The indicative dates for the conduct of the census survey and tagging were announced to PAPs through the conduct of the 1stStakeholder Consultation Meeting as shown in Table 9.2.6. For each city/municipality, dates were assigned to prevent the influx of ineligible non-residents who might take advantage of project entitlements.

For the Project, the cut-off dates for each city and/or municipality are set at the beginning date of the census and tagging as shown in Table 9.2.6.

Table 9.2.6 Cut-Off Dates of Eligibility

PROVINCE/ CITY/MUNICIPALITY	BARANGAY	CUT-OFF DATE (First day of census tagging)
BULACAN		
MALOLOS	LONGOS	February 26, 2018
CALUMPIT	PIO CRUZCOSA	February 26, 2018
	SAN MARCOS	February 26, 2018
	CALUMPANG	February 27, 2018
	IBA ESTE	February 27, 2018
	PALIMBANG	February 27, 2018
	BAGBAG	February 27, 2018
	IBA O'ESTE	February 27, 2018
	BALUNGAO	February 28, 2018
	CORAZON	May 30, 2018
	POBLACION	May 30, 2018
	GATBUCA PUTOL	February 28, 2018
PAMPANGA		
APALIT	CAPALANGAN	February 28, 2018
	SULIPAN	February 28, 2018
	SAN VICENTE	February 28, 2018
MINALIN	LOURDES	March 04, 2018
SANTO TOMAS	POBLACION	February 19, 2018
	SAN MATIAS	February 19, 2018
	SAPA (STO. NINO)	February 19, 2018
	MORAS DELA PAS	February 19, 2018
SAN FERNANDO CITY	SAN NICHOLAS	February 19, 2018
	SAN PEDRO CUTUD	March 09, 2018
	STA LUCIA	March 08, 2018
	STO NINO	March 14, 2018
	LOURDES	March 09, 2018
	DOLORES	February 23, 2018
	SAN AGUSTIN	March 08, 2018
	QUEBIAUAN	February 22, 2018
	MAIMPIS	March 13, 2018
	SINDALAN	March 08, 2018
	MALPITIC	March 08, 2018
	CALULUT	March 08, 2018
	BALITI	February 23, 2018
	PANIPUAN	March 08, 2018
	PULUNG BULU	February 24, 2018

PROVINCE/ CITY/MUNICIPALITY	BARANGAY	CUT-OFF DATE (First day of census tagging)
ANGELES CITY	SANTO CRISTO	March 02, 2018
	LOUDRES SUR	March 02, 2018
	LOURDES SUR EAST	March 02, 2018
	AGAPITO DEL ROSARIO	March 04, 2018
	CLARO M. RECTO	March 02, 2018
	VIRGEN DELOS REMEDIOS	March 04, 2018
	SANTA TERESITA	March 05, 2018
	MALABANAS	March 03, 2018
	BALIBAGO	March 03, 2018
MABALACAT	DAU	March 05, 2018
	CAMACHILES	March 05, 2018
	MABIGA	March 05, 2018
	MAMATITANG	March 05, 2018
	SAN JOAQUIN	March 05, 2018
	DOLORES	March 05, 2018
	LAKANDULA	March 05, 2018
	SAN FRANCISCO	March 05, 2018
	TABUN	March 05, 2018
	POBLACION	March 05, 2018
	SAN JOAQUIN	SEPT 7, 2018

Source: JICA Design Team

9.2.4.3 Principle of Replacement Cost

All land and non-land assets owned by households/shop owners who meet the cut-off date will be compensated based on the principle of replacement cost. Replacement cost is the amount calculated before displacement which is needed to replace affected asset without depreciation and without deduction for taxes and/or costs of transaction.

9.2.5 Socioeconomic Characteristics of PAHs

The socio-economic survey was carried out to identify all PAPs and their assets to be affected (land, structures, improvements, and crops) as well as establish baseline of their social and economic conditions. It is comprised of three main components namely the: (i) Census survey, (ii) Asset and land survey, (iii) Livelihood and living survey. Further, questions seeking to the following information from the PAPs were made: ‘project awareness, perceptions, issues and concerns, suggested livelihood rehabilitation measures, information on railway access/use, previous relocations, and relocation preferences. All these information are essential inputs to the development of a robust RAP.

9.2.5.1 The Census Survey

The main purpose for conducting the census survey and tagging are:

- To determine the number of persons and households (including landowners, tenants, business owners, employees and informal settlers) and those more vulnerable among them that will be affected by the project;
- To determine the profile of the PAPs including their socio-demographic profile, livelihood sources, economic status and/or living standards, and their access to basic services and facilities which are essential to meet compensation and resettlement assistance requirements.
- To gauge PAPs' perceptions about the project, anticipated project benefits, concerns, issues, recommendations for addressing these issues, and suggested livelihood rehabilitation measures;
- To quantify all affected assets (land, structures, improvements, crops, etc.) within the project area as input to establishing full and fair compensation; and,
- To provide a baseline for measuring the impact and social performance of the Project.

9.2.5.2 Profile of Affected Households

Households occupying structures were categorized as residential or residential/commercial purposes and surveyed to establish their number, profiles and socio-economic conditions which are vital inputs to this plan. Household, for this plan is defined as "…*one or more people who live in the same dwelling and also share meals or living accommodation and may consist of a single family or some other grouping of people. A single dwelling will be considered to contain multiple households if either meals or living space are not shared*".

A total of 1,416 potentially affected households to be displaced were surveyed as shown in Table 9.2.7**,** with the Gender Distribution of Household Heads summarized in Table 9.2.8.

Table 9.2.7 Number of Affected Households

City/ Municipality	Formal Settler Families/ Households	Informal Settler Families/Households (ISFs)	Total No of Affected Households	%
Malolos	3	3	6	0.42
Calumpit	42	286	328	23.16
Apalit	1	2	3	0.21
Sto. Tomas	11	13	24	1.69
San Fernando	159	664	823	58.12
Angeles	21	176	197	13.91
Mabalacat	6	29	35	2.47
Total	**243**	**1,173**	**1,416**	**100.00**
%	17.16	82.84	100.00	

Source: JICA Design Team

Table 9.2.8 Gender Distribution of Household Heads

City/Municipality	Male		Female		Total	
	no.	%	no.	%	no.	%
Malolos	17	51.52	16	48.48	33	100.00
Calumpit	666	50.53	652	49.47	1,318	100.00
Apalit	12	66.67	6	33.33	18	100.00
Sto Tomas	50	47.62	55	52.38	105	100.00
San Fernando	1,734	50.64	1,690	49.36	3,424	100.00
Angeles	388	50.32	383	49.68	771	100.00
Mabalacat	72	54.96	59	45.04	131	100.00
Total	**2,939**	**50.67**	**2861**	**49.33**	**5,800**	100.00

Source: JICA Design Team

(1) Type of residence

Residential structures are considered *primary residences* if the occupant households consider it as their permanent living accommodation while some residential structures are considered *secondary residence* if the household occupants have a primary residence elsewhere. In most cases, secondary residences serve as temporary accommodations for individuals or households who want to be near schools or workplace during weekdays or for an extended period with the intention to return to their primary residence during weekends, school/work holidays/vacations and or during school breaks. The type of residence summarized in Table 9.2.9.

Table 9.2.9 Type of Residence

City/ Municipality	Primary Residence		Secondary Residence		No Response		N/A		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Malolos	5	83.33	0	0.00	1	16.67	0	0.00	6	100.00
Calumpit	303	92.38	17	5.18	4	1.22	4	1.22	328	100.00
Apalit	3	100.00	0	0.00	0	0.00	0	0.00	3	100.00
Sto. Tomas	22	91.67	2	8.33	0	0.00	0	0.00	24	100.00
San Fernando	804	97.69	19	2.31	0	0.00	0	0.00	823	100.00
Angeles	186	94.42	6	3.05	5	2.54	0	0.00	197	100.00
Mabalacat	31	88.57	4	11.43	0	0.00	0	0.00	35	100.00
Total	**1,354**	**95.62**	**48**	**3.39**	**10**	**0.71**	**4**	**0.28**	**1,416**	**100.00**

Source: JICA Design Team

(2) Reason for Establishing Residence in Present Location

Multiple responses were generated from potentially affected households when asked about the reasons for choosing to reside in their present location. The results are summarized in Table 9.2.10.

Table 9.2.10 Reasons for Establishing Residence in the Current Location

City/ Municipality	A	B	C	D	E	F	G	Total
Malolos	5	0	1	5	0	1	0	12
Calumpit	184	48	10	190	23	46	8	509
Apalit	1	1	0	2	0	0	0	4
Sto. Tomas	7	3	6	7	3	6	0	32
San Fernando	478	113	37	505	66	89	28	1,316
Angeles	76	28	10	121	11	18	1	265
Mabalacat	28	1	3	20	1	2	2	57
Total	**703**	**166**	**57**	**729**	**93**	**144**	**38**	**1,930**
%	36.42	8.60	2.95	37.77	4.82	7.46	1.97	100.00
Note: A - Proximity to workplace, B - Family ties, C - Proximity to livelihood & family ties, D - Near Church, E - Family ties & got married, F - Family ties & near school, G - Got married								

Source: JICA Design Team

(3) Household Size or Number of Household Members

The average household size is summarized in Table 9.2.11.

Table 9.2.11 Household Size

City/Municipality	1-2	2-4	5-6	7-8	9-10	10 <	NR	Total	Ave.
Malolos	0	3	1	1	1	0	0	6	6
Calumpit	72	134	87	26	8	1	0	328	4
Apalit	0	0	2	1	0	0	0	3	6
Sto. Tomas	5	11	4	1	2	1	0	24	4
San Fernando	167	337	219	68	21	9	2	823	4
Angeles	51	77	51	13	3	2	0	197	4
Mabalacat	10	12	11	1	1	0	0	35	4
Total	**305**	**574**	**375**	**111**	**36**	**13**	**2**	1,416	**4**
%	21.54	40.54	26.48	7.84	2.54	0.92	0.14	100.0	

Source: JICA Design Team

(4) Educational Attainment of Household Members

The educational attainment of the surveyed household members is summarized in Table 9.2.12.

Table 9.2.12 Educational Achievement of Household Members

City/ Municipality	A	B	C	D	E	F	G	H	I	Total
Education, FEMALE										
Malolos	1	3	0	2	4	0	2	2	0	14
Calumpit	21	91	35	112	102	38	78	119	0	596
Apalit	0	1	1	1	0	0	0	1	0	4
Sto. Tomas	0	6	3	11	17	1	2	11	0	51
San Fernando	55	259	112	317	305	44	183	211	16	1,502
Angeles	7	68	27	86	79	7	40	37	3	354
Mabalacat	5	11	7	15	7	4	2	0	0	51
Sub Total, Female	89	439	185	544	514	94	307	381	19	2,572
%	3.46	17.07	7.19	21.15	19.98	3.65	11.94	14.81	0.74	100.00

City/ Municipality	A	B	C	D	E	F	G	H	I	Total
Education, MALE										
Malolos	2	1	1	6	2	2	1	1	0	16
Calumpit	24	101	42	121	108	46	70	95	0	607
Apalit	1	4	0	1	0	0	1	0	0	7
Sto. Tomas	2	9	3	5	15	1	4	4	0	43
San Fernando	64	264	122	317	302	57	176	186	12	1,500
Angeles	13	76	25	80	64	13	42	26	1	340
Mabalacat	1	9	13	15	13	3	4	1	0	59
Sub Total, Male	107	464	206	545	504	122	298	313	13	2,572
%	4.16	18.04	8.01	21.19	19.60	4.74	11.59	12.17	0.51	100.00
Total	196	903	391	1,089	1,018	216	605	694	32	5,144
%	3.81	17.55	7.60	21.17	19.79	4.20	11.76	13.49	0.62	100.00

A – Preschool; B – Elementary Level; C – Elementary Graduate; D – High School Level; E – High School Graduate; F – Vocational/Technical; G – College Level; H – College Graduate; I – Advance Degree

Source: JICA Design Team

9.2.5.3 Assets and Land Survey

Assets can be classified as either fixed and movable. Fixed assets refer to structures and perennial crops which are attached to the ground while movable assets are those that PAPs can still bring with them when relocated. The asset survey focused on the fixed structures since these will be impacted by the project. Asset and land surveys involved gathering information on their ownership status and type of the use.

Table 9.2.13 Number of Affected Residential Structures and Survey Respondents

City/ Municipality	No. of Occupied Structures		No. of Surveyed Persons		
	No.	%	Formal Settler Families/ Households	Informal Settler Families/Households (ISFs)	Total
Malolos	11	1.01	3	3	6
Calumpit	319	29.29	42	286	328
Apalit	2	0.18	1	2	3
Sto. Tomas	24	2.20	11	13	24
San Fernando	566	51.97	159	664	823
Angeles	141	12.95	21	176	197
Mabalacat	26	2.39	6	29	35
Total	**1,089**	**100.00**	**243**	**1,173**	**1,416**

Table 9.2.14 Number of Structures by Type of Use

City/ Municipality	Total No. of Structures		Structure Usage							
	No.	%	Residential	Commercial	Commercial-Residential	Industrial	Industrial-Residential	Institutional	Residential/ Institutional	Others
Malolos	11	1.01	2	4	0	5	0	0	0	0
Calumpit	319	29.29	169	85	0	62	1	0	1	1
Apalit	2	0.18	1	1	0	0	0	0	0	0
Sto. Tomas	24	2.20	23	0	0	0	1	0	0	0
San Fernando	566	51.97	489	57	1	17	1	0	1	0
Angeles	141	12.95	75	51	0	13	0	2	0	0
Mabalacat	26	2.39	25	1	0	0	0	0	0	0
Total	**1,089**	**100.00**	**784**	**199**	**1**	**97**	**3**	**2**	**2**	**1**
%		100.00	71.99	18.27	0.09	8.91	0.28	0.18	0.18	0.09

Source: JICA Design Team

(1) Land Ownership Status

Land ownership can be a form of economic security among the affected households, business owners and land owner/claimants. As part of the census survey, respondents were asked whether they own the lands they occupy and/or claim. The results are summarized in Table 9.2.15.

Table 9.2.15 Ownership of Lands

City/Municipality	Do you own the land you occupy/ claim?			Total	
	Yes	No	N/R	Number	%
Malolos	5	13	0	18	1.00
Calumpit	60	438	2	500	27.90
Apalit	1	2	0	3	0.17
Sto. Tomas	23	14	0	37	2.06
San Fernando	217	692	1	910	50.78
Angeles	54	231	2	287	16.02
Mabalacat	6	31	0	37	2.06
Total	**366**	**1,421**	**5**	**1,792**	**100.00**
%	20.42	79.30	0.28	100.00	

Source: JICA Design Team

(2) Structure Ownership and Occupancy

Potentially affected residential or business structure occupants were asked if they own the structures they occupy. Survey responses as presented in Table 9.2.16.

Table 9.2.16 Ownership of Structures

City/ Municipality	Yes		No		N/R		Total	
	No.	%	No.	%	No.	%	No.	%
Malolos	11	61.11	7	38.89	0	0.00	18	100.00
Calumpit	323	65.38	171	34.62	0	0.00	494	100.00
Apalit	2	66.67	1	33.33	0	0.00	3	100.00
Sto. Tomas	11	44.00	14	56.00	0	0.00	25	100.00
San Fernando	524	59.48	352	39.95	5	0.57	881	100.00
Angeles	99	36.94	169	63.06	0	0.00	268	100.00
Mabalacat	30	81.08	7	18.92	0	0.00	37	100.00
Total	**1,000**	**57.94**	**721**	**41.77**	**5**	**0.29**	**1,726**	**100.00**

Source: JICA Design Team

9.2.5.4 Livelihood and Living Survey

This section provides details necessary to understand the affected households' livelihoods and living standards as well as vulnerabilities.

(1) Sources of Household Income

The survey also sought information on the households' primary sources of income by categorizing either as land-based, wage-based, enterprise-based and remittance based. Land-based sources are those income generating activities largely dependent on the productive potential of land, such as crop production, fish or aquaculture, livestock raising/production etc. Wage-based incomes are cash payments paid to individuals in return for services rendered while enterprise-based sources are those income earning activities that the household or household members engage into that is not land-based nor wage-based. Remittance based sources are those incomes sent to the household or household member/s from another location as a means to support household needs or expenses. The result of the survey is summarized in Table 9.2.17.

Table 9.2.17 Primary Source of Household Income

City/ Municipality	Land Based	Wage Based	Enterprise Based	Remittance Based	Others	Total
Malolos	0	3	5	1	0	9
Calumpit	24	345	184	30	20	603
Apalit	0	1	3	0	1	5
Sto. Tomas	2	30	14	0	1	47
San Fernando	5	953	343	43	31	1,375
Angeles	0	248	88	8	13	357
Mabalacat	0	42	8	0	0	50
Total	**31**	**1,622**	**645**	**82**	**66**	**2,446**
%	1.27	66.31	26.37	3.35	2.70	100.00

Source: JICA Design Team

The location of the primary source of income is summarized in Table 9.2.18.

Table 9.2.18 Location of Primary Source of Income

City/ Municipality	Own Residence/ House	Within Neighborhood/ Brgy	Near Barangay	Other City/ Municipality	Overseas	No Definite Area	Others	Total
Malolos	6	0	0	1	2	0	0	9
Calumpit	177	106	71	152	35	52	7	600
Apalit	0	1	2	1	0	1	0	5
Sto. Tomas	0	18	9	16	1	0	0	44
San Fernando	208	287	406	274	89	77	12	1,353
Angeles	65	59	78	129	9	11	2	353
Mabalacat	4	14	9	15	0	6	2	50
Total	**460**	**485**	**575**	**588**	**136**	**147**	**23**	**2,414**
%	19.06	20.09	23.82	24.36	5.63	6.09	0.95	100.00

Source: JICA Design Team

Table 9.2.19 presents the different types of enterprises found on the different locations surveyed.

Table 9.2.19 Types of Enterprise-Based Livelihoods

City/ Municipality	Sari-Sari Store	Food/ Catering	Hair/ Nails/ Beauty Salon	Tailoring/ Dress-structuremaking	Transportation	Construction	Vulcanizing Shop	Vending	Others	Total
Malolos	1	0	0	0	0	0	0	1	1	3
Calumpit	37	29	5	6	11	4	4	24	62	182
Apalit	0	0	0	0	1	0	0	2	0	3
Sto. Tomas	2	0	0	0	0	0	0	0	12	14
San Fernando	67	35	7	3	65	2	4	35	68	286
Angeles	22	9	6	1	7	0	1	12	30	88
Mabalacat	2	0	1	0	2	0	0	2	1	8
Total	**131**	**73**	**19**	**10**	**86**	**6**	**9**	**76**	**174**	**584**
%	22.43	12.50	3.25	1.71	14.73	1.03	1.54	13.01	29.79	100.00

Source: JICA Design Team

(2) Monthly Household Income

The survey results for monthly household income is summarized in Table 9.2.20.

Table 9.2.20 Monthly Household Income (All Sources)

Income Bracket	Total	%
Php 0-999	3	0.21
Php 999-1,999	7	0.49
Php 2,000-Php3,999	30	2.12
Php4,000- Php5,999	52	3.67
Php 6,000-Php7,999	97	6.85
Php8,000-Php 9,999	150	10.59
Php 10,000-Php11,999	133	9.39
Php12,000-Php 15,999	240	16.95
Php 16,000-Php 19,999	140	9.89
Php 20,000-Php24,999	138	9.75
Php25,000-Php29,999	88	6.21
Php30,000 -Php 49,999	184	12.99
Php50,000-& Above	114	8.05
No answer	40	2.82
Total	**1,416**	**100.00**

Source: JICA Design Team

(3) Monthly Expenditures

The average monthly expense among affected households is summarized in Table 9.2.21.

Table 9.2.21 Monthly Household Expenditures

Average Monthly Expense	No. of Resp. Reporting	Monthly Average Expense	%
Rent (Land)	28	3,178	7.74
Rent (House/Room)	456	2,424	5.91
Tax	188	2,032	4.95
Food	2,451	7,846	19.12
Light	2,242	1,334	3.25
Water	2,023	506	1.23
Education	1,169	3,172	7.73
Communications (Telephone, CP, etc.)	1,881	622	1.52
Transportation	1,620	1,605	3.91
Recreation	599	1,954	4.76
Gas/groceries/medicine, etc.	2,749	8,648	21.07
Average, Total Expense		**41,038**	**100.00**
Note: Percent against average monthly household income of PhP30,204.49 (Detailed Census and Survey 2018)			

Source: JICA Design Team

(4) Vulnerability

Vulnerable persons will most likely experience more difficulty when physically or economically displaced and coping with transition at relocation site without appropriate support and assistance. The census survey recorded the following vulnerabilities:

Table 9.2.22 Summary of Vulnerabilities among PAPs

Vulnerabilities	Male		Female		Total	
	no.	%	no.	%	no.	%
Baby/Toddler	228	54.81	188	45.19	416	62.65
Pregnant	0	0.00	19	100.00	19	2.86
Elderly	66	40.74	96	59.26	162	24.40
Mental Disorder	6	50.00	6	50.00	12	1.81
Needs Assistance in Walking/ Cannot Walk	12	54.55	10	45.45	22	3.31
Seriously Ill	1	14.29	6	85.71	7	1.05
Blind	1	25.00	3	75.00	4	0.60
Mute/Deaf	1	33.33	2	66.67	3	0.45
Other illnesses and disabilities	10	52.63	9	47.37	19	2.86
Total	**325**	**48.95**	**339**	**51.05**	**664**	**100.00**

Source: JICA Design Team

9.2.5.5 Profile of Affected Businesses

(1) Type of Business Ownership

The type of business ownership is summarized in Table 9.2.23.

Table 9.2.23 Type of Business Ownership

City/ Municipality	Single Proprietorship				Partnership				Corporation				Cooperative				Others				Total			
	M	**F**	**N/R**	**ST**	**M**	**F**	**N/R**	**ST**	**M**	**F**	**N/R**	**ST**	**M**	**F**	**N/R**	**ST**	**M**	**F**	**N/R**	**ST**	**M**	**F**	**N/R**	**Total**
Malolos	7	4	0	11	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	7	4	1	12
Calumpit	76	85	0	161	0	2	0	2	0	0	2	2	0	0	0	0	0	0	1	1	76	87	3	166
Apalit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sto Tomas	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
San Fernando	25	30	0	55	0	0	0	0	2	0	0	2	0	0	0	0	0	0	1	1	27	30	1	58
Angeles	33	35	1	69	0	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	35	35	1	71
Mabalacat	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2
Total	**141**	**157**	**1**	**299**	**0**	**2**	**0**	**2**	**4**	**0**	**3**	**7**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**2**	**145**	**159**	**6**	**310**
%	97.24	98.74	16.67	96.45	0.00	1.26	0.00	0.65	2.76	0.00	50.00	2.26	0.00	0.00	0.00	0.00	0.00	0.00	33.33	0.65	100.00	100.00	100.00	100.00

Source: JICA Design Team

(2) Average income of Employees

The average income of employees is summarized in Table 9.2.24.

Table 9.2.24 Average Monthly Income – Employee

City/ Municipality	Average Income (Monthly)			Total Average Income (Monthly)	No. of Businesses Disclosing
	Rank and File	Mid-Level Management	Senior Management		
Malolos	5,436	1,458	1,250	8,145	10
Calumpit	33,098	39740	29,000	96,338	59
Apait	0	0	0	0	0
Sto. Tomas	8,200	0	0	8,200	1
San Fernando	19,857	7,975	14,125	33,124	24
Angeles	23,967	26,500	20,111	70,578	26
Mabalacat	37,461	10,478	36,276	80,913	6
Average	**21,337**	**17,230**	**20,152**	**49,550**	**126**

Source: JICA Design Team

9.2.5.6 Project Awareness

The awareness about the Project is summarized in Table 9.2.25 for Land Owners/Claimants, and in Table 9.2.26 for Affected Households.

Table 9.2.25 Project Awareness among Land Owners/Claimants

City/ Municipality	Have you heard about the North-South Railway Project?							
	Yes	%	No	%	N/R	%	Total	%
Malolos	0	0.00	0	0.00	0	0.00	0	0.00
Calumpit	8	100.00	0	0.00	0	0.00	8	100.00
Apalit	0	0.00	0	0.00	0	0.00	0	0.00
Sto. Tomas	6	85.71	1	14.29	0	0.00	7	100.00
San Fernando	21	91.30	2	8.70	0	0.00	23	100.00
Angeles	13	81.25	3	18.75	0	0.00	16	100.00
Mabalacat	0	0.00	0	0.00	0	0.00	0	0.00
Total	**48**	**88.89**	**6**	**11.11**	**0**	**0.00**	**54**	**100.00**

Source: JICA Design Team

Table 9.2.26 Project Awareness Among Households

City/ Municipality	Have you heard of Malolos-Clark Railway Project?							
	Yes	%	No	%	N/R	%	Total	%
Malolos	5	83.33	1	16.67	0	0.00	6	100.00
Calumpit	316	96.34	12	3.66	0	0.00	328	100.00
Apalit	1	33.33	2	66.67	0	0.00	3	100.00
Sto. Tomas	23	95.83	1	4.17	0	0.00	24	100.00
San Fernando	743	90.28	70	8.51	10	1.22	823	100.00
Angeles	159	80.71	36	18.27	2	1.02	197	100.00
Mabalacat	18	51.43	17	48.57	0	0.00	35	100.00
Total	**1265**	**89.34**	**139**	**9.82**	**12**	**0.85**	**1416**	**100.00**

Source: JICA Design Team

9.2.5.7 Issues and Concerns

The issues and concerns about the Project are summarized in Table 9.2.27 for Land Owners/Claimants, and in Table 9.2.28 for Affected Households.

Table 9.2.27 Issues and Concerns Among Land Owners/Claimants

City/Municipality	A	B	C	D	Total
Malolos	0	0	0	0	0
Calumpit	2	0	1	3	6
Apalit	0	0	0	0	0
Sto. Tomas	1	1	1	2	5
San Fernando	17	5	6	2	30
Angeles	13	5	5	1	24
Mabalacat	0	0	0	0	0
Total	**20**	**6**	**8**	**7**	**41**
%	48.78	14.63	19.51	17.07	100.00
Note: A-May not get the fair market price of the land, B- Payment may be delayed, knowing government procedures, C-Only asset I have, may not be able to buy the same quality and location at the price paid					

Source: JICA Design Team

Table 9.2.28 Issues and Concerns Among Affected Households

City/ Municipality	A	B	C	D	E	Others	N/R	Total
Malolos	5	1	0	0	0	0	1	7
Calumpit	280	26	29	7	6	10	23	381
Apalit	1	0	0	0	0	0	1	2
Sto. Tomas	11	0	0	3	0	5	0	19
San Fernando	665	17	52	58	13	38	69	912
Angeles	140	5	26	15	0	14	20	220
Mabalacat	22	0	1	0	1	5	5	34
Total	**1,124**	**49**	**108**	**83**	**20**	**72**	**119**	**1,575**
%	71.37	3.11	6.86	5.27	1.27	4.57	7.56	100.00
Note: A- My house will be demolished/we will be relocated to another area, B- My shop will be relocated, C- My business will be negatively affected, D-Living environment in the area will get worse because of noise and vibration, E. Value of commercial and residential properties will be decreased.								

Source: JICA Design Team

9.2.5.8 Recommendations to Address Issues and Concerns

As part of the survey, respondents were asked of their thoughts on how they think the issues and concerns they have raised can be addressed. The recommendations/suggestions generated from the respondents are summarized in Table 9.2.29.

Table 9.2.29 Recommendations/suggestions generated from the respondents

Issues/Concerns	Households	Business	Land Owners/Claimants
Project Design	Reduce the required area so that they will be spared		Provide alternative access for those who will still have remaining properties that will be cut -off by the project
Compensation	Compensation for affected assets	Compensation for affected assets (business and structure Cash compensation should be given directly to the rightful recipient	Appropriate (just and fair) cash compensation for the affected land Timely payment of affected lands Replacement land
Financial Assistance	Financial assistance to go back to the province	Financial assistance to help re-establish business	
Livelihood	Extend livelihood assistance		
Relocation Site	Be properly relocated in an area near current residence/ workplace/livelihoods Near basic social services (schools, market, hospitals, etc.) Relocation site where they can live permanently Must be safe and free from hazards Within the same barangay/city Keep the same neighborhood at relocation site	Relocation near populated area/business centers	
Relocation House/Structure	Provision of affordable replacement housing Provision of power and water supply at the relocation site	Provision of relocation structure Replacement house for the affected rental apartment	

Source: JICA Design Team

9.2.5.9 Proposed Livelihood Restoration and Improvement Measures

The respondents from the affected household and business owners indicated various types of livelihood assistance when asked what they think would be the appropriate livelihood assistance in case they lose their livelihoods, jobs or businesses. The results are summarized in Table 9.2.30.

Table 9.2.30 Types of Proposed Livelihood Assistance Among Affected Households

City/ Municipality	A	B	C	D	E	F	G	H	I	Total
Malolos	1	1	1	0	0	0	3	0	1	7
Calumpit	55	18	21	13	11	10	203	6	21	358
Apalit	0	0	1	0	0	0	1	0	0	2
Sto. Tomas	1	3	0	0	2	0	5	0	12	23
San Fernando	206	45	39	83	89	24	322	39	78	925
Angeles	52	16	25	21	7	6	87	1	9	224
Mabalacat	11	3	2	3	3	3	18	2	1	46
Total	**326**	**86**	**89**	**120**	**112**	**43**	**639**	**48**	**122**	**1,585**
%	20.57	5.43	5.62	7.57	7.07	2.71	40.32	3.03	7.70	100.00

Note: A- Job/Employment within the current sector and within the same Barangay, B- Any job/employment within the same Barangay, C- Job/Employment within the current sector near the relocation site, D-Any job/employment near the relocation site, E-Job/Employment with the same occupation in the same city, F- Any Job/Employment in the same city, G- Business capital/funds to re-start the same business, H- Business capital/funds to set-up new business, I- Vocational training/other livelihood skills

Source: JICA Design Team

9.2.6 Compensation and Entitlement

PAPs' eligibility for compensation and entitlements is in accordance with the policy and legal framework for land acquisition and resettlement policy of the Project. Identification of PAPs' eligibility was carried through the socio-economic survey.

For areas requiring land acquisition, negotiated sale will be the preferred mode of acquisition. Compensation for the structures and improvements will be based on full replacement cost.

9.2.6.1 Eligibility Criteria

PAPs are eligible for compensation of their affected assets in accordance to Section 5 of R.A. 10752. As described in Chapter 4, there are two main modes of acquisition prescribed by law namely, (i) Negotiated Sale and (ii) Expropriation.

(1) Negotiated Sale

Under negotiated sale, the following two eligibility criteria will be observed.

a. PAPs who meet the following criteria will be entitled to cash compensation for the loss of land, crops and trees (if any) based on current market value, and full replacement cost for structures and improvements, free from taxes, including capital gains tax, documentary stamp tax, transfer tax and registration fees, except Real Property Tax (RPT) arrears and estate tax in case of Extra-Judicial Settlement (EJS).
    - PAPs who have full title, such as Original Certificate of Title (OCT) or Transfer Certificate of Title (TCT) or Emancipation Patents (EP) or Certificate of Land Ownership Award (CLOA)

- PAPs who are not original patent holders of lands granted under C.A. 141 and where any previous acquisition is not through a gratuitous title (e.g., donation, succession)
- PAPs who can present (i) a Tax Declaration showing his/ her and his/her predecessors' open and continuous possession of the property for at least 30 years, (ii) a certification from the Department of Environment and Natural Resources (DENR) that the land is alienable and disposable, or (iii) other documents that may show proof of ownership;
- PAPs who are holders of (i) Emancipation Patent (EP) granted under Presidential Decree No. 27 or (ii) CLOA granted under the Comprehensive Agrarian Reform Act (R.A. 6657)
- PAPs who were former ISFs but who now hold a title of land as beneficiaries of government socialized housing programs. In addition, they will be eligible to become beneficiary of other CMP programs in accordance with the Social Housing Finance Corporation (SHFC) Board Resolution No. 528 and Corporate Circular 16-047 Series of 2016.

If losing 10% or more of agricultural land, PAPs are entitled to participate in the Livelihood Restoration and Improvement Program.

b. PAPs who are original patent holders of lands granted under CA 141 and whose land has not been subjected to previous government exercise of its lien will not receive compensation for land but will be provided with:
    - Cash compensation for structure, improvements, crops and trees, computed at full replacement cost;
    - No compensation for land up to 20 m width if patent was granted prior to 1975, and up to 60m width for patents granted thereafter. In excess of government lien, follow other entitlements for PAPs who have full title or if feasible, land for land will be provided in terms of a new parcel of land of equivalent productivity, at a location acceptable to PAP;
    - For PAPs directly engaged in farming, a disturbance compensation equivalent to five times the average gross harvest for the last five years on the principal and secondary crops of the area acquired (as adopted from RA 6389);
    - If losing 10% or more of agricultural land, PAPs are entitled to participate in the Livelihood Restoration and Improvement Program; and
    - Financial assistance, particularly to displaced tenants/occupants of agricultural lands, cultural minorities and settlers who are duly accredited by the Ministry of Agrarian Reform/Bureau of Forest Development/Office of Muslim Affairs and Cultural Communities in accordance with Section 18 of EO No.1035 series of 1985.

c. PAPs who own the structures but do not own the land are entitled to the following:
    - Cash compensation for the entire or, affected portion of the structure or improvement without depreciation, upon presentation of proof of ownership (e.g., certification from the concerned barangay in accordance with the IRR for R.A. 10752);
    - If low income and homeless, option to avail of tenured land, or socialized housing package either through the LGUs or CMP through the SHFC; and

- Have the option to keep salvaged materials from demolished structures without deduction from compensation due him.

d. PAHs who will incur temporary impacts during construction (for use as access road, for soil dumping, borrow sites and contractor's camps, etc.) and who have legal rights to the land will be entitled to the following from the construction Contractor:
   - Lease amount equivalent to prevailing rental rates in the location of the property
   - Compensation for affected non-land assets based on replacement cost and
   - Restoration of land to pre-construction state

(2) Expropriation Proceedings

In the event that a PAP refuses or fails to accept the compensation in the negotiated sale, or fails or refuses to submit the documents necessary for the payment, DOTr will initiate expropriation proceedings.

For expropriation cases, a check will be deposited to the court upon the filing of complaint by the DOTr through the Office of the Solicitor General (OSG). For land, the amount of compensation will be computed based on the latest Bureau of Internal Revenue (BIR) Zonal value. For structures and improvements, basis of computation will be in terms of full replacement cost as defined in R.A. 10752 and its IRR. Crops and trees will be compensated based on its current market value.

The Court will immediately issue an order to take possession of the property and start implementation of the project as provided in Section 6(a) of R.A. 10752. While the court adjudicates the compensation to be paid, the PAP may, at any time request the court to release such deposit upon presentation of proof of ownership (Section 6(a) R.A. 10752).

After the case has been heard by the court, the court will order DOTr to pay the difference, if any, between the initial compensation and the just compensation as determined by the Commissioners assigned by said court. DOTr will pay the necessary documentary stamp tax and registration fee.

Based on Rule 16 Section 1(h) of the 1997 Rules of Court on Civil Procedures, the plaintiff (DOTr in this Project) can withdraw the case any time before the filing of the answer by the defendant (PAPs). If the answer has been filed there has to be a joint filing by DOTr and the owner to withdraw the case (Section 2, Rule 17 of the 1997 Rules of Court on Civil Procedures).

In both cases, the acquisition mode would revert back to Negotiated Sale, which will entitle the owner to payment at current market value for land (as indicated in DOTr's letter offer), free of taxes, including CGT, and registration fees, replacement cost for structures and improvements, and market value for crops and trees.

If no motion to dismiss as above described is filed, expropriation proceeding will continue. Once the court decision becomes final and executory acquisition mode (expropriation) cannot revert back to any other mode.

Where the PAP agreed to the negotiated sale, but was unable to gain the necessary documents to show proof of the ownership, DOTr may pursue a joint motion in the court for a compromised judgement reflecting the agreed amount - on a case-by-case basis and in good faith. DOTr will provide assistance to PAPs whose lands will be subjected to EJS. This will be done through the Help Desk that will be established at each LGU prior to the issuance of the NoT. Early issuance of the NoT is highly recommended for PAPs to have enough time to complete/progress EJS process prior to the issuance of the Letter Offer to Buy, which only gives them 30 days to accept the offer, after which the expropriation proceedings can commence.

9.2.6.2 Special Assistance for Vulnerable Groups

PAPs who belong to any of the following vulnerable groups will be regarded as vulnerable.

- Baby/Toddler
- Pregnant women
- Poor based on the poverty threshold
- Elderly
- Persons with disabilities (PWDs)
- Single women-headed households

Those may be worsened off after the displacement will be provided with:

- Inconvenience allowance in the amount of PhP 10,000 per household;
- Rehabilitation assistance in the form of skills training and other development activities with the value of up to PhP 15,000 per household in coordination with other government agencies;
- Support to access/maintain government welfare programs;
- Inclusion in the Livelihood Restoration and Improvement Program as prescribed in the RAP.

For families with persons needing special assistance and/or medical care, respective LGUs will provide nurses or social workers to help them before and during the resettlement activities.

9.2.6.3 Severity of Project Impacts

PAPs will be compensated in accordance with the severity of the impact (severe or marginal) on the affected properties, as defined in the ADB SPS (2009).

There are two levels of impacts that are expected from the ROW acquisition:

1. **Severe** (severely-affected) – for properties (land and structures / improvements) that are acquired for the Project covering more than 20% (for residential land) or 10% (for agricultural land); or if less than 20% (for residential land) or 10% (for agricultural land) but the remaining area is no longer economically viable or will no longer serve intended function.

2. **Marginal** (marginally-affected) – for properties (land and structures / improvements) that are acquired for the Project covering less than 20% (for residential land) or 10% (for agricultural land) and the remaining area is still viable for continued use.

Properties to be acquired may include the entire area, or a portion of the properties. For severely affected properties, the entire land and or structure including improvements, crops and trees will be compensated at replacement cost. Whereas for marginally affected properties, only the portion affected, including the improvements, crops and trees contained in the affected portions will be compensated as replacement cost.

9.2.6.4 Payment Schedule

The mode of the payment to the PAPs is summarized in Table 9.2.31.

Table 9.2.31 Payment Arrangements for Legal Property Owners

PAP Category	Estimated time for validation and overall land acquisition	Payment
Case 1. PAP with complete documents which have been verified by DOTr and authenticated by authorized agencies	15 to 30 working days	(i) DOTr to pay 100% of compensation prior to issuance of a new title in favor of DOTr and before relocation/construction can begin. (ii) DOTr to notify property owners early to enable time to gather necessary paperwork as proof of ownership.
Case 2. PAPs with complete documents except Tax Clearance (due to the landowner's incapacity to pay their RPT arrears)	30 to 45 days	(i) DOTr to pay 100% of compensation prior to issuance of a new title in favor of DOTr and before relocation/construction can begin. (ii) DOTr to notify property owners early to enable time to gather necessary paperwork as proof of ownership.
Case 3. PAPs/cases would require extra-judicial settlements (i.e. missing documents due to death of land owner, etc.)	6 months-1 year	(i) An initial compensation at an amount computed at 100% of lot price based on latest Bureau of Internal Revenue (BIR) zonal value for land, replacement cost for structure and improvements, and market value for crops and trees. A check will be deposited to the court in favor of the owner upon filing of expropriation case by DOTr. (ii) While the court adjudicates the compensation to be paid, the PAPs may, at any time request the court to release such deposit upon presentation of proof of ownership; (iii) After the case has been heard by the court, the Court will order DOTr to pay difference, if any, between initial compensation and the just compensation as determined by the court.

Source: JICA Design Team

9.2.6.5 Entitlement Matrix

The Entitlement Matrix of the Project describes the compensation and entitlements for the PAPs as shown in Table 9.2.32.

Table 9.2.32 Entitlement Matrix for MCRP

Type of Impact		Loss of Land	
Entitled Person		(Severe/Full)	(Marginal/Partial)
1a	PAPs who have full title being Original Certificate of Title (OCT) or Transfer Certificate of Title (TCT) or emancipation patents (EP) or Certificates of Land Ownership Award (CLOA).	**Entitlements:** Cash compensation for loss of land at full replacement cost computed at current market value, free of taxes, including capital gains tax (CGT), documentary stamps tax (DST), transfer tax, and registration fees, except Real Property Tax (RPT) arrears. **OR** If feasible, land for land will be provided in terms of a new parcel of land of equivalent productivity, at a location acceptable to PAPs.	**Entitlements:** Cash compensation for portion of land at full replacement cost computed at current market value, free of taxes, including CGT, DST, transfer tax, and registration fees, except RPT arrears. **Easement Agreement:** If the portion of a lot required for a ROW is minimal, such that the expenses for surveying or segregating that portion from the main lot would be more than the value of the part of the lot needed, the DOTr may, if the owner agrees, resort to the mode of easement of ROW (Title VII, Chapters 1 and 2 Civil Code of the Philippines). In this case, cash compensation for the value of the portion of the land subjected to easement agreement computed at latest BIR zonal value, with owner retaining ownership of said portion of land (Article 630, Chapter 1, R.A. 386/ Civil Code of the Philippines).
1b	PAPs who are not original patent holders of lands granted through C.A. 141 (i.e. those who have bought the patent for the land previously granted through C.A. 141) and where any previous acquisition is not through a gratuitous title (e.g., donation or succession) (C.A. 141, Chapter 7).		
1c	For untitled land, PAPs who can present: (a) Tax Declaration showing his and his predecessors' open and continuous possession of the property for at least 30 years, (b) a certification from the DENR that the land is alienable and disposable, and (c) other documents that may show proof of ownership (RA 10752).		
1d	PAPs who were former ISFs but now hold title of land as a result of a government socialized housing program.		
1e	PAPs who were former ISFs and government socialized housing program beneficiaries whose titles are still under the name of the organization.	**Entitlements:** Same as above, with less any amount still owing to the title.	**Entitlements:** Same as above.
1f	PAPs who are original patent holders of lands granted through Commonwealth Act (C.A.) No. 141 and the land has not been subjected to previous government exercise of its lien.	**Entitlements:** No compensation for land up to 20 meters width if patent was granted prior to 1975, and up to 60 meters width for patents granted thereafter[15]. In excess of government lien, follow other entitlements for 1a.	**Entitlements:** No compensation for the affected portion of land within 20 meters width if patent was granted prior to 1975 and up to 60 meters width for patents granted thereafter. In excess of government lien, follow other entitlements for marginal/partial impacted 1a PAPs.

[15] For example, if the affected land was granted through CA 141 prior to 1975 and the land to be acquired for the right of way was a strip of land up to 20m then the PAP would not be entitled to compensation for the land. If, however, the land to be acquired from the same land was wider than 20m (say 50m) then the PAP would be entitled to compensation for any area over the 20m width (in this case 30m) provided other required conditions are met. For land granted through CA 141 from 1975, then the any land acquired up to a width of 60m would not be compensated and same principle would apply as to the 20m example.

<table>
<tr><th colspan="2">Type of Impact</th><th colspan="2">Loss of Land</th></tr>
<tr><th colspan="2">Entitled Person</th><th>(Severe/Full)</th><th>(Marginal/Partial)</th></tr>
<tr><td>1g</td><td>PAPs whose properties are mortgaged</td><td>Entitlements:
Same as above, but check payment will be split into as follows:
For mortgagee PAPs – Full replacement cost as defined above, less remaining amortization;
For Mortgagor – Remaining amortization amount, computed based on original amount of principal, less interests for remaining amortization period</td><td>Entitlements:
DOTr to request Mortgagor to segregate the portion of the property to be acquired for ROW from the rest of the property.
Full replacement cost for portion of the mortgaged property to be acquired, less remaining amortization;
Pay Mortgagee the remaining amortization amount needed to release portion of mortgaged property</td></tr>
<tr><td colspan="4">Implementation Considerations:
DOTr to pay 50% of compensation upon execution of the Deed of absolute Sale, and the remaining 50% at the time of issuance of a new title in favor of DOTr but before displacement/clearing can begin.
DOTr to notify property owners early to enable time to gather necessary paperwork as proof of ownership.
If the original patent granted under CA 141 has been subject to Government exercise or lien, it cannot be subject to lien a subsequent time.
PAPs can request DOTr to pay the RPT arrears in advance to the LGU. This amount will be deducted from the compensation payment, except when the arrears is higher than the total compensation amount.
The land for land option will be considered on a case by case basis considering the potential complexities in transferring titles, in order to ensure that there is not a large gap between acquisitions of land and providing the new parcel of land to the PAP.</td></tr>
</table>

<table>
<tr><th colspan="2">Type of Impact</th><th colspan="2">Loss of Structure</th></tr>
<tr><th colspan="2">Entitled Person</th><th>(Severe/Full)</th><th>(Marginal/Partial)</th></tr>
<tr><td>2a</td><td>PAPs who own structures and also own the land where the structure is located.</td><td rowspan="2">Entitlements:
Cash compensation for entire structure equivalent to full replacement cost without deduction for depreciation or salvaged materials.

In cases where the affected structures are being used as a dwelling by the structure owner and their family residing there, self-relocation or assisted resettlement as follows:

1. Self-relocation assistance:
(i) Rental subsidy equivalent to 5 months of rental payment for an alternative dwelling;
(ii) Cash compensation to cover the cost of reconnecting utilities such as water and power;
(iii) Transportation to new dwelling inclusive of transportation of materials; and
(iv) Food allowance of 150p per person relocated or a food parcel of equal or greater amount (as determined by DOTr).

OR</td><td rowspan="2">Entitlements:
Cash compensation for the affected portion of the structure to full replacement cost without deduction for depreciation or salvaged materials.</td></tr>
<tr><td>2b</td><td>PAPs who own structures but do not own the land where the structure is located on and are <u>not a low-income</u> household and/or they own a dwelling elsewhere.</td></tr>
</table>

<table>
<tr><th colspan="2">Type of Impact</th><th colspan="2">Loss of Structure</th></tr>
<tr><th colspan="2">Entitled Person</th><th>(Severe/Full)</th><th>(Marginal/Partial)</th></tr>
<tr><td></td><td></td><td>2. Assisted-resettlement:
(i) Option to avail of government economic and medium cost housing program under the Home Development Mutual Fund otherwise known as Pag-IBIG Fund. The Pag-IBIG housing loan may be used to finance any one or a combination of the following:
- Purchase of a fully-developed residential lot or adjoining residential lots not exceeding 1,000 m^2;
- Purchase of a residential house and lot, townhouse or condominium unit;
- Construction or completion of a residential unit on a residential lot owned by the member;
- Home Improvement; and/or
- Refinancing of an existing housing loan.
(ii) Cash compensation to cover the cost of reconnecting utilities such as water and power;
(iii) Transportation to new dwelling inclusive of transportation of materials; and
(iv) Food allowance of 150p per person relocated or a food parcel of equal or greater amount (as determined by DOTr).</td><td></td></tr>
<tr><td colspan="4">Implementation Considerations:
The amount of the rental subsidy by locality will be determined by DOTr through the replacement cost study.
The DOTr will enter into an agreement with Pag-IBIG so that available housing programs can be made accessible to eligible PAPs through their respective LGUs. PAPs that do not meet Pag-IBIG program eligibility criteria, such as the elderly, may have the option to avail of affordable public rental accommodation in socialized housing arranged by DOTr. Rental allowance subsidy equivalent to five (5) months will be provided while awaiting availability of public rental accommodation.
PAPs may be allowed to self-demolish their structures to enable them to preserve materials that still have salvage value. In such cases PAPs will be entitled to keep salvageable materials without deduction from compensation.
Eligibility requirements for Pag-IBIG Loan: (i) active member of Pag-IBIG Fund; (ii) have made at least 24 monthly savings (the lump sum payment of the required 24 monthly savings is allowed); (iii) have the legal capacity to acquire and encumber real property; (iv) have passed satisfactorily background credit/ and employment/business checks of Pag-IBIG Fund; (v) have no outstanding Pag-IBIG short-term loan in arrears at the time of loan application; (vi) have no Pag-IBIG housing loan that was foreclosed, cancelled, bought back due to default, or subjected to dacion en pago; and (vii) if with existing Pag-IBIG housing loan, either as principal or co-buyer/borrower, it must be updated.
The maximum loanable amount is PhP6M based on the lowest of the following: (i) member’s actual need; (ii) desired loan amount (iii) loan entitlement based on capacity to pay; and (iv) loan-to-appraised value ratio.
Loan term or maximum repayment period is 30 years.
Normal loan application may either be through on-line scheduling of appointment or walk-in at any Pag-IBIG branches. In the case of PAPs, DOTr will make necessary agreement with the Housing and Urban Development Coordinating Council (HUDCC) so that the PAPs can be assigned a priority lane or similar arrangement for faster processing of their loan.
With regards to marginally/partially affected structures, if the affected portion results in the structure no longer being suitable for a dwelling for the structure owner and residents, then self-relocation or assisted resettlement options apply.</td></tr>
</table>

Type of Impact		Loss of Structure	
Entitled Person		(Severe/Full)	(Marginal/Partial)
2c	PAPs who are renting, leasing or sharing the structure, and do not have a low-income.[16]	**Entitlements:** No compensation for land or structures. In cases where the structures are being used as residential dwellings, self-relocation or assisted resettlement as follows: 1. Self-relocation assistance: (i) Rental subsidy equivalent to 5 months of rental payment for an alternative dwelling; (ii) Cash compensation to cover the cost of reconnecting utilities such as water and power; (iii) Transportation to new dwelling inclusive of transportation of materials; and (iv) Food allowance of 150p per person relocated or a food parcel of equal or greater amount (as determined by DOTr). OR 2. Assisted resettlement: (i) Option to avail of government economic and medium cost housing program under the Home Development Mutual Fund otherwise known as Pag-IBIG Fund. The Pag-IBIG housing loan may be used to finance any one or a combination of the following: - Purchase of a fully-developed residential lot or adjoining residential lots not exceeding 1,000 m^2; - Purchase of a residential house and lot, townhouse or condominium unit; - Construction or completion of a residential unit on a residential lot owned by the member; - Home improvement; and/or - Refinancing of an existing housing loan. (ii) Cash compensation to cover the cost of reconnecting utilities such as water and power; (iii) Transportation to new dwelling inclusive of transportation of materials; and (iv) Food allowance of 150p per person relocated or a food parcel of equal or greater amount (as determined by DOTr).	No compensation. In the case of residential dwellings, if the affected portion results in the structure no longer being suitable for a dwelling, then self-relocation or assisted resettlement options apply.

[16] Refer to footnote 5.

<table>
<tr><th colspan="2">Type of Impact</th><th colspan="2">Loss of Structure</th></tr>
<tr><th colspan="2">Entitled Person</th><th>(Severe/Full)</th><th>(Marginal/Partial)</th></tr>
<tr><td>2d</td><td>PAPs who own structures but do not own the land where the structure is located on, and are a low-income household.[17]</td><td rowspan="2">Entitlements:
Cash compensation for entire structure equivalent to full replacement cost without deduction for depreciation or salvaged materials.
In cases where the structures are being used as dwellings, self-relocation or assisted resettlement as follows:

1. Self-relocation assistance:
(i) If PAP opts to move to an existing property (verified by the receiving LGU), transportation to be provided (e.g. bus tickets) inclusive of transportation of belongings; and
(ii) Cash compensation to cover the cost of reconnecting utilities such as water and power;
(iii) Food allowance of 150p per person relocated or a food parcel of equal or greater amount (as determined by DOTr).

OR

2. Assisted resettlement:
(i) Option to avail of government socialized housing program of a partner government key shelter agency (KSA) (if qualified);
(ii) Cash compensation to cover the cost of reconnecting utilities such as water and power (if not provided by KSA/LGU);
(iii) Transportation to new dwelling inclusive of transportation of materials; and
(iv) Food allowance of 150p per person relocated or a food parcel of equal or greater amount (as determined by DOTr).

If completion of the socialized housing accommodation will not be ready in time, temporary accommodation or a rental allowance will be provided.</td><td rowspan="3">Entitlements:
Cash compensation for affected portion of the structure equivalent to full replacement cost without deduction for depreciation or salvaged materials.</td></tr>
<tr><td>2e</td><td>PAPs who own structures and were former ISFs but now hold title of land through government socialized housing programs.</td></tr>
<tr><td>2f</td><td>PAPs who were former ISFs and CMP/NHA beneficiaries whose titles are still under the name of the organization.</td><td>Same as above minus any amount still owed to the housing agency.</td></tr>
</table>

[17] Includes PAPs who previously participated in a government socialized housing program but who no longer have it, but did not sell it or rent it out (e.g. those who abandoned the housing unit).

Type of Impact		Loss of Structure	
Entitled Person		(Severe/Full)	(Marginal/Partial)
2g	PAPs who own structures but do not own the land where the structure is located, and who have previously availed of government socialized housing program (returnees) and are deemed ineligible by the key shelter agency (KSA) to participate in the socialized housing program	**Entitlements:** Cash compensation for entire structure equivalent to full replacement cost without deduction for depreciation or salvaged materials. In cases where the structures are being used as dwellings by the structure owner and their family residing there, self-relocation or assisted resettlement as follows: 1. Self-relocation assistance: (i) If PAP opts to move to an existing property (verified by the receiving LGU), transportation to be provided (e.g. bus tickets) inclusive of transportation of belongings; (ii) Cash compensation to cover the cost of reconnecting utilities such as water and power; and (iii) Food allowance of 150p per person relocated or a food parcel of equal or greater amount (as determined by DOTr). OR 2. Assisted resettlement: (i) Option to avail of affordable public rental housing accommodation by DOTr in partnership with KSA or LGUs; (ii) Cash compensation to cover the cost of reconnecting utilities such as water and power (if not provided by KSA/LGU); (iii) Transportation to new dwelling inclusive of transportation of materials; and (iv) Food allowance of 150p per person relocated or a food parcel of equal or greater amount (as determined by DOTr). If completion of the public rental housing accommodation will not be ready in time, temporary accommodation or a rental allowance will be provided.	
Implementation Considerations: PAPs will not be responsible for demolition of structures. PAPs are entitled to salvageable materials. Payment of compensation for structures and improvements may be held in abeyance or used as an advance payment on their amortizations at the PAPs request until the relocation site and socialized housing accommodation becomes available. For PAPs who own untitled condominium units, DOTr shall oblige developers, particularly if these were engaged by key shelter agencies, to make the necessary arrangements to effect release of Certificate of Condominium Title to PAPs who have duly paid full amount in consideration. Any fees required to be paid to community organizers to set up communities to borrow for socialized housing will be paid by DOTr.			

Type of Impact		Loss of Structure	
Entitled Person		(Severe/Full)	(Marginal/Partial)
2h	PAPs who occupy temporary dwellings.	Provision of Assisted Resettlement options as detailed for 2d provided that they present a Certification from their respective Barangay Captains and Head of LGU's Urban Poor Affairs Office stating that they are bona fide residents and have occupied the project affected-area prior to the applicable cut-off date. PAPs that do not meet the socialized housing program eligibility criteria but are able to present Certification may have the option to avail of affordable public rental housing accommodation through partnership with KSA and LGUs. If completion of the public rental housing accommodation will not be ready in time, temporary accommodation or a rental allowance will be provided.	No compensation for structure.
2i	PAPs who are renting, leasing or sharing the structure, and have a low-income.[18]	No compensation for land or structures. In cases where the structures are being used as residential dwellings, self-relocation or assisted resettlement as follows: 1. Self-relocation assistance: (i) Rental subsidy equivalent to 5 months of rental payment for an alternative dwelling; (ii) Cash compensation to cover the cost of reconnecting utilities such as water and power; (iii) Transportation to new dwelling inclusive of transportation of materials; and (iv) Food allowance of 150p per person relocated or a food parcel of equal or greater amount (as determined by DOTr). OR 2. Assisted resettlement: (i) Option to avail of government socialized housing (if qualified); (ii) Cash compensation to cover the cost of reconnecting utilities such as water and power (if not provided by KSA/LGU); (iii) Transportation to new dwelling inclusive of transportation of materials; and (iv) Food allowance of 150p per person relocated or a food parcel of equal or greater amount (as determined by DOTr).	

[18] Refer to footnote 5.

Type of Impact		Loss of Structure	
Entitled Person		**(Severe/Full)**	**(Marginal/Partial)**
		If completion of the socialized housing at the relocation site will not be ready in time, temporary accommodation or a rental allowance will be provided.	
Implementation Considerations: Any fees required to be paid to community organizers to set up communities to borrow for socialized housing will be paid by DOTr. The amount of the rental subsidy by locality will be determined by DOTr through the replacement cost study.			

Entitled Person		Loss of income/Livelihood
3a	PAPs who own fixed micro businesses (e.g. small shops, sari-sari store, carinderia, food stand, repair shop, etc.) with or without permits from the LGU concerned.	**Entitlements:** Cash compensation for income losses during transition period corresponding to stoppage of business activities, not to exceed six months.[19] Cash compensation to cover transactional (e.g., permitting) cost of re-establishing the business elsewhere. Assistance in securing soft loan to enable self-rehabilitation for those restarting business elsewhere. Participation in the Livelihood Restoration and Improvement Program. For PAPs who are leasing space from property owners: (i) For those who will continue with their micro-small business activities elsewhere, rental subsidy for three (3) months based on prevailing average monthly rental for a similar structure of equal type and dimension to the property being leased. Not applicable to lease contracts that will expire at the time of taking.
3b	PAPs who own small, medium and large business establishments[20] and own the affected property.	**Entitlements:** Cash compensation for income losses during transition period corresponding to stoppage of business activities, not to exceed six months.[21] Cash compensation to cover transactional (e.g., permitting) cost of re-establishing the business elsewhere. Assistance in securing soft loan to enable self-rehabilitation for those restarting business elsewhere. For PAPs who are owners of medium to large commercial establishments built inside own affected property: (i) Acquire the property but allow the owner of the structure and business use of the land for a defined period to give the owner time to transfer, subject to agreement on a case to case basis; For PAPs who are owners of commercial/business entities and are leasing affected space/property: (i) For those who will continue with their commercial and business activities elsewhere, rental subsidy for three (3) months based on
3c	PAPs who own medium and large business establishments and are leasing/renting space from property owners.	

[19] Preferred mode of business transition is to help set up affected persons with an alternative but similar business with minimal transition period. Options have to be considered by the PAPs with no delay.
[20] Categories of businesses are based on capitalization and number of employees, with (1) Php 15,000,000-100,000,000 capitalization and 100-199 employees for medium businesses, and (2) More than PhP 100,000,000 capitalization and over 200 employees for large businesses. In this project, affected enterprises are expected to be only micro and small as defined under Small and Medium Enterprise Development (SMED) Council Resolution No. 01 Series of 2003 dated 16 January 2003.
[21] Preferred mode of business transition is to help set up affected persons with an alternative but similar business with minimal transition period. Options have to be considered by the PAPs with no delay.

Entitled Person		Loss of income/Livelihood
		prevailing average monthly rental for a similar structure of equal type and dimension to the property being leased. Not applicable to lease contracts that will expire at the time of taking.
3d	Vendors with no stalls / ambulant vendors/ hawkers.[22]	Assistance in identification of, and transportation to, an alternative site to continue economic activity, e.g. assistance in (a) shifting to areas within the same LGU where there is no construction and/or (b) identify alternative sites to sell.
3e	PAPs who are employed in a displaced commercial or industrial establishment and lose their job due to closure of business or laying off as a result of minimized operation.	**Entitlements:** Cash compensation for net salary for two (2) months based on minimum wage. Participation in the Livelihood Restoration and Improvement Program. Provision of skills training in anticipation of available job positions during construction and operation of the project. Priority in employment during construction and operation stage of the project.
3f	PAPs who permanently relocate to a place that makes former wage-based livelihood opportunities inaccessible and as a result need to find new employment or source of livelihood.	
3g	PAPs who permanently relocate to a place that makes it more expensive to commute to their place of work and they retain their employment.	Commuting allowance of an amount based on additional costs, but not exceeding Php 5,000 per household per month for three months (not entitled to 3e or 3f).
3h	PAPs who are agricultural tenants and sharecroppers.	**Entitlements:** Financial assistance equivalent to the average gross harvest for the last three (3) years and not less than P 15,000 per hectare (EO 1035). Crop compensation will be made between the owner and sharecropper as per terms of the sharecropper in case of privately-owned land / publicly-owned land. In case of dispute over verbal agreement with sharecropper, certification from elected representatives will be considered as legal document. Participation in the Livelihood Restoration and Improvement Program.
3i	PAPs who are landowners or lessee who are directly engaged in farming.	A disturbance compensation equivalent to five times the average gross harvest for the last five years on the principal and secondary crops of the area acquired (as adopted from RA.6389). Participation in the Livelihood Restoration and Improvement Program.
Implementation Considerations: Income losses as based on evidence such as tax receipts or otherwise as per estimated values of monthly income losses for various categories of micro-businesses to be determined by replacement cost study.		

Entitled Person		Loss of Public Land and Structure (Severe/Full)
4a	Government Agency/ Local Government Unit (LGU) owners of affected public structures and areas on public land.	**Entitlements:** Compensation between agencies based on mutual agreement.
4b	Government Agency/ Local Government	**Entitlements:**

[22] Pertains to itinerant vendors who move from place to place to sell goods/services.

Entitled Person		Loss of Public Land and Structure (Severe/Full)
	Unit (LGU) owners of affected public structures and areas on private land.	Cash compensation for structures at full replacement cost. Reconstruction of the social infrastructure within easy reach of all users. Transportation to be provided inclusive of transportation of materials.

Entitled Person		Loss of Non-Land Assets and Improvements
5a	Owners of fruit and timber trees (regardless of ownership status of affected land).	**Entitlements:** Cash compensation at replacement cost for affected fruit and timber trees.
5b	Owners of crops (regardless of ownership status of affected land).	**Entitlements:** Compensation for the affected crop at market value of the crop at full-term harvest time.
5c	Owners of aquaculture produce (regardless of ownership status of affected land).	**Entitlements:** Allowance for costs associated with moving aquaculture stock[23]
5d	Owners of other affected non-land assets and improvements (not mentioned in 5a, 5b or 5c).	**Entitlements:** Compensation at replacement cost for affected non-land assets and improvements (not mentioned in 5a, 5b, 5c).
Implementation Considerations: Determination of replacement cost of trees will take in to account age and productivity of the tree. Compensation rates determined by the replacement cost study and informed by values prescribed by the Department of Agriculture (for fruit trees) or Department of Environment and Natural Resources (DENR) for timber trees. Coordination with land owners and/or fishpond operators to advise them regarding the schedule of clearing.		

Entitled Person		Additional Hardship Due to Vulnerability
6a	PAPs who are classified as any of the following vulnerable groups: poor (based on the poverty income threshold), elderly and single women-headed households, and persons with disabilities.	**Entitlements:** In addition to applicable compensation: Inconvenience allowance in the amount equivalent to Php 10,000 per household. For the families with persons who need special assistance and/or medical care, respective LGUs to provide nurses or social workers to help them before and during the resettlement activity. Rehabilitation assistance in the form of skills training and other development activities with the value of up to Php 15,000 will be provided in coordination with other government agencies. Support and/or maintain access to government welfare programs. Inclusion in the Livelihood Restoration and Improvement Program.

[23] PAPs will receive compensation for land and compensation for improvements. If the remaining area (remaining fish pond area) is no longer viable, PAPs will be compensated for entire area.

Entitled Person		Temporary Impacts due to Construction
7a	PAPs who have legal rights to the land.	**Entitlements:** Restoration of land within 3 months of completion of use. Compensation for affected non-land assets at full replacement cost. Cash payment for rent of the affected land at prevailing rental rates in the location of the property until the property is restored.
7b	PAPs without legal rights to affected land but owners of affected non-land assets.	
7c	Severance impacts/ barrier effect during construction disrupting lateral movement (access).	The project will provide for crossings and continued access.
Implementation Considerations: Contractors will be responsible for the arrangement and payment of land rent, restoration of land and compensation for non-land assets. Contractors will also be responsible for restoration of land and compensation for non-land assets.		
Entitled Person		**Unanticipated Involuntary Resettlement Impacts**
8a	Eligible affected persons.	Entitlements will be prepared in accordance with the ADB Safeguard Policy Statement and applicable national laws and regulations (including requirements for preparation of corrective action plan and other related documents for ADB and JICA to review and approve).
Implementation Considerations: Entitlements to be prepared in such circumstances are subject to approval of the DOTr and concurrence by ADB and JICA.		

Expropriation Proceeding
1. An initial compensation at an amount computed at 100% of lot price based on latest Bureau of Internal Revenue (BIR) zonal value for land, replacement cost for structures and improvements, and market value for crops and trees in the form of a check will be deposited to the court in favor of the owner upon filing of expropriation case by DOTr. The Court will immediately issue an order to take possession of the property and start implementation of the project (Section 6(a) R.A. 10752). 2. While the court adjudicates the compensation to be paid, the PAPs may, at any time request the court to release such deposit upon presentation of proof of ownership (Section 6(a) R.A. 10752). 3. After the case has been heard by the court, the Court will order DOTr to pay the difference, if any, between initial compensation and the just compensation as determined by the court. 4. At this time, DOTr will also pay any required taxes with the exception of CGT (as detailed in RA10752) and any unpaid RPT.
Implementation Considerations: Based on Rule 16 Section 1(h) of the 1997 Rules of Court on Civil Procedures, the plaintiff (DOTr) can withdraw the case any time before the filing of the answer by the defendant (owners). If the answer has been filed there has to be a joint filing by DOTr and owner to withdraw the case (Section 2, Rule 17 of the 1997 Rules of Court on Civil Procedures). In both cases, the acquisition mode would revert back to negotiated sale, which will entitle the owner to payment at current market value for land (as indicated in DOTr's letter offer), free of taxes, including CGT, and registration fees, replacement cost for structures and improvements, and market value for crops and trees. If no motion to dismiss as above described is filed, expropriation proceeding will continue. Once the court decision becomes final and executory acquisition mode (expropriation) cannot revert back to any other mode. Where the PAP agreed to the negotiated sale, but was unable to gain the necessary documents to show proof of ownership, DOTr may pursue a joint motion in the court for a compromised judgement reflecting the agreed amount – on a case-by-case basis and in good faith. DOTr will provide assistance to PAPs whose lands will be subjected to Extra Judicial Settlement (EJS). This will be done through the Help Desk that will be established at each LGU prior to the issuance of the Notice of Taking (NoT). Early issuance of the NoT is highly recommended for PAPs to have enough time to complete/progress EJS process prior to issuance of the Letter Offer to Buy, which only gives them 30 days to accept offer, after which expropriation proceedings can commence. If PAPs are unable to complete the EJS before the expropriation proceedings are heard by a court, DOTr will pay the just compensation as determined by the court, as well as any required taxes including CGT, except for any unpaid RPT.

9.2.7 Relocation Sites

As part of the project policy, resettlement assistance will be provided for immediate loss (i.e. for a transition period needed to restore the livelihood and standards of living of PAH and for permanent loss of structure for ISFs. In particular, ISFs, as defined under R.A. 7279 and in accordance with the IRR of R.A. 10752, are entitled to relocation.

Prior to the relocation, ample consultations will be provided to PAPs to ensure that their needs are addressed and relocation site options to be presented. In coordination with the key shelter agencies, host and sending LGUs, and PAPs, DOTr as the implementing agency, is tasked to ensure that no PAP will be forcibly evicted or a structure demolished without prior notice and consultation.

In-city relocation should be prioritized as much as possible to ensure minimal displacement of PAHs from their source of livelihood. During Detailed Engineering Design Stage, PAPs will be asked to select their preferred relocation site, based on the information on available relocation sites.

The comparison of the housing packages is summarized in Table 9.2.33

Table 9.2.33 Housing Packages

Options	Housing Modality		
	NHA Relocation	**Pag-IBIG Housing Loan**	**Public Rental**
Housing Package inclusions	• House and lot package (inclusive of cost for housing construction and social preparation activities and exclusive of land acquisition cost for in-city relocation); • Socioeconomic component (inclusive of relocation and social preparation and community development); • Community facilities; and Livelihood development • In addition to the above listed, for in-city relocation sites, land acquisition cost and administration cost (3%) are added.	• Any or a combination of the following: • Purchase of a fully-developed residential lot or adjoining residential lots not exceeding 1,000 m^2 • Purchase of a residential house and lot, townhouse or condominium unit; • Construction or completion of a residential unit on a residential lot owned by the member • Home Improvement; • Refinancing of an existing housing loan	• For those who do not qualify for socialized housing program or housing loans, Public Rental option at an affordable rate shall be provided through DOTr.

Source: JICA Design Team

The specific arrangements for the PAHs for each relocation site option would be discussed in detail in a Memorandum of Agreement (MOA) between DOTr and NHA.

9.2.7.1 Identification of Relocation Sites for ISFs

As a new approach adopted by NHA Memorandum Circular No. 014, Series of 2018, NHA uses the Community Based Initiative Approach (CBIA) to select the relocation sites. NHA will partner with private developers through advertisement to provide a list of land or projects suitable for resettlement sites or housing units in developed sites and bid out the development of the site.

PAPs will identify their preferred relocation sites through the CBIA. In this approach, the community selects the site and executes a formal agreement with the developer upon the proper endorsement of the Local Inter-Agency Committee (LIAC) and the NHA. CBIA is an implementation strategy of NHA which is designed to build on the community's initiative and promote participation of PAPs through their Community Associations (CA) in the relocation and resettlement decision-making process.

The CBIA key components are:

- Selection and endorsement by project beneficiaries of their preferred project sites;
- Development of project sites including the construction of housing units by the participating landowner/developer/contractor;
- Acquisition of house and lot units through the existing financing scheme for beneficiaries; and
- Participation of the project beneficiaries in the identified aspects of the relocation and resettlement program, as well as in project implementation.

Land acquisition, under CBIA financing scheme, include lands owned by NHA under its inventory of resettlement sites, including its properties, other government properties owned by non-government agencies, LGUs, and privately developed sites offered by landowners/developers/contractors under a specific NHA housing program.

9.2.7.2 NHA Verified Candidate Relocation Sites

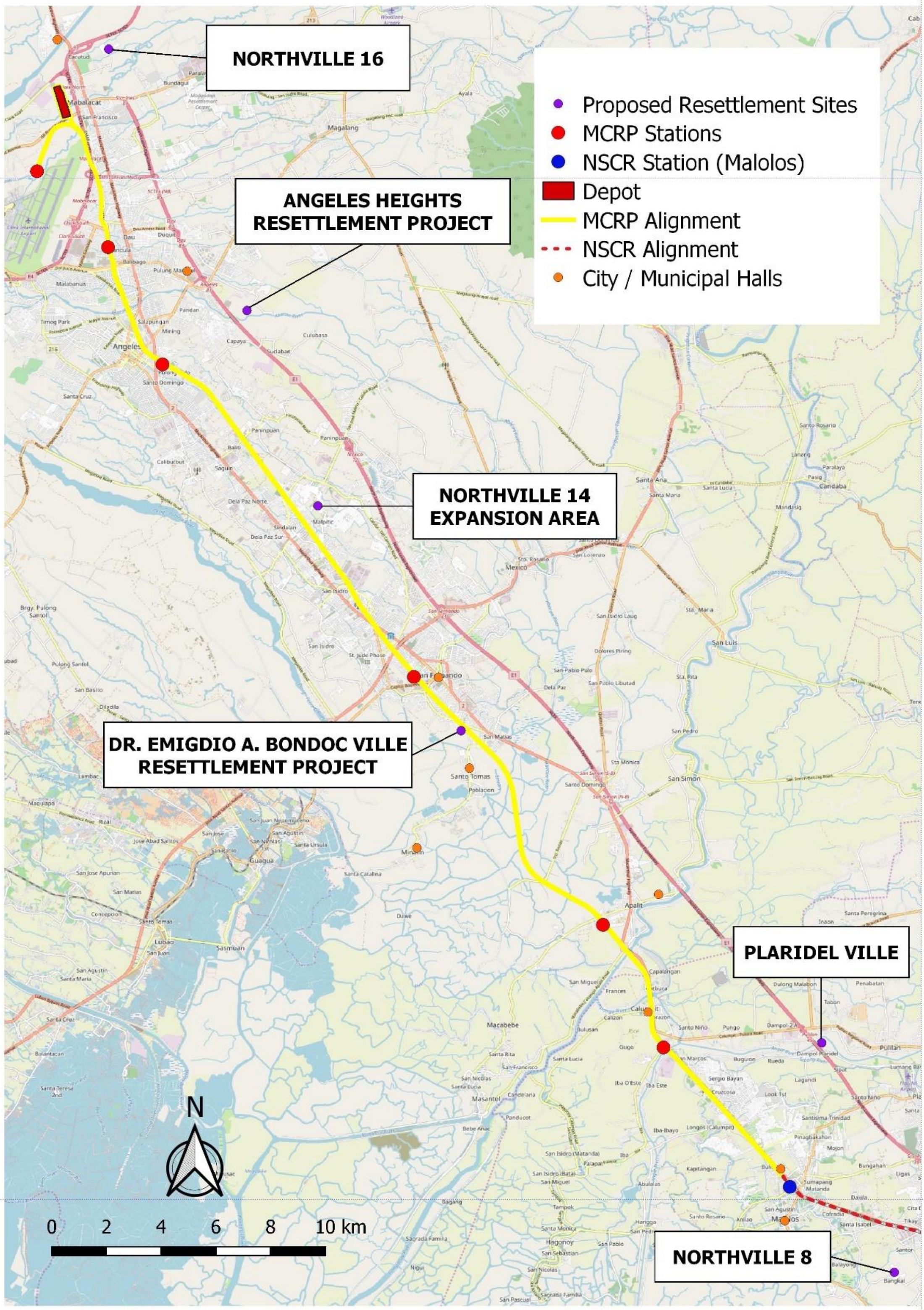
Based on the initial verification of available lots conducted by NHA for the proposed resettlement sites for in-city sites, Table 9.2.34 indicates a summary of the available existing NHA in-city relocation sites for MCRP, for Angeles new in-city relocation site will be development through CBIA process.

Table 9.2.34 Summary of Option for Candidate Relocation Sites

No.	LGU	ISFs	Proposed Relocation Site	
			Location	No. of Available lot
1	Malolos	3	Northville 8 Brgy. Bangkal, Malolos, Bulacan	33
2	Calumpit	286	Plaridel Ville Brgy. Sipat, Calumpit, Bulacan	394
3	Apalit	2	Dr. Emigdio A. Bondoc Ville Resettlement Project Brgy. Sto Nino, Sto. Tomas, Pampanga	3
4	Santo Tomas	13	Dr. Emigdio A. Bondoc Ville Resettlement Project Brgy. Sto Nino, Sto. Tomas, Pampanga	33
5	San Fernando	664	Northville 14 Expansion Area Brgy. Calolot, San Fernando, Pampanga	1,700
6	Angeles	176	Angeles Heights Resettlement Project Brgy. Sapa-Libutad, Angeles, Pampanga	16
7	Mabalacat	29	Northville 16 Brgy. Atlu-Bola, Mabalacat, Pampanga	3,374 Developed lots

Source: NHA

ISFs will be informed of the resettlement options during the succeeding Stakeholder Consultations accordingly. They will also be involved in preparing their own Community Resettlement Plan.



Source: JICA Design Team

Figure 9.2.4 Location Map of Existing NHA Relocation Sites for MCRP

9.2.7.3 Amortization

As in all other government socialized housing projects, the relocated PAHs will also be required to pay monthly amortization costs.

Based on the discussion with DOTr and NHA, it is agreed that the affordable rate will be set as flat rate for maximum 30 years loan based on the income of PAHs, government policies and in line with the housing package, minus compensation for affected assets as indicated in the Entitlement Matrix.

9.2.7.4 Temporary Accommodation

In case the Resettlement site construction are not yet ready in time for the clearing of ROW, rental subsidy will be provided to the PAHs, for a maximum period of six months.

Rental subsidies will be paid directly to the PAPs on a monthly basis. DOTr will provide support to PAFs to set up a bank account with Landbank, so that monthly rental subsidies will be paid. The initial payment of the rental subsidy will also include a deposit amount of two months. This will facilitate financial literacy, and can be support by financial literacy training under the LRIP.

9.2.7.5 Relocation Under Northrail Project

(1) Number of Relocatees Under Northrail

Previous relocation for the Northrail Project was conducted by North Luzon Railways Corporation (Northrail) Authority in two phases: (1) Bulacan Segment from Caloocan to Malolos, Bulacan and (2) Malolos, Bulacan to Mabalacat, Pampanga. Table 9.2.35 summarizes the indicative number of relocatees.

Table 9.2.35 Northrail Phase 1 Number of Relocatees

No.	Segment	Location	Number of ISFs relocated	Location of Relocation Sites	Inclusive Dates
1	Bulacan	Caloocan to Malolos	12,800	Northville 3-9	May 2005 – December 2006
2	Pampanga	Malolos, Bulacan to Mabalacat, Pampanga	23,000	Northville 10-16	
TOTAL			37,800		

Source: NHA

(2) Relocation Options

During the Northrail Project, the ISFs were provided with two options, as summarized in Table 9.2.36.

Table 9.2.36 Northrail Phase 1 Relocation Options

No.	Option	Inclusions	Remarks
1	Relocation package	House and lot package inclusive of basic services (e.g. water and electricity connection) and facilities (e.g. educational and health facilities) in compliance with *Section 21 of RA 7279*	• No livelihood assistance provided by NHA under the relocation package (In selected areas, the following support were provided: (1) trainings and seminars under TESDA and (2) DSWD, and (2) coordinate with prospective employers) • NHA responsibilities include: (1) social preparation activities, (2) estate management, (3) awarding of units and (4) collection of monthly amortizations
2	Balik-Probinsya	ISFs who opt for *Balik-Probinsya* were provided with financial assistance equivalent to the prevailing minimum wage multiplied by 60 days (in compliance with Section 20 (8) of RA 7279.	Transportation allowance was deducted from the amount provided to the ISFs.

Source: NHA

(3) Ongoing/Unresolved Issues

Through an interview, NHA mentioned the following unsolved issues concerning the Northrail Relocation:

- **Low Collection Efficiency Rate (CER):** NHA mentioned that on the average, the collection efficiency rate is 38%, with some beneficiaries still unable to pay for the monthly amortization.
- **Returnees:** NHA has an Alpha List containing ISFs who opted for relocation or the *Balik-Probinsya Program.* They estimate that majority of the returnees may be those who availed of the latter (*Balik-Probinsya),* but also mentioned that the beneficiaries often return due to lack of livelihood in the relocation site.
- **Issues on Livelihood:** During the Northrail Project, the relocation package did not include livelihood. However, NHA provided assistance in the form of (1) trainings and seminars provided by TESDA and DSWD, and (2) employment assistance in coordination with other stakeholders to select ISFs, subject to internal arrangements with the said stakeholders. In addition, only select LGUs have a Public Employment Service Office (PESO) which may help facilitate the exchange of labor market information and provide assistance in the selection, matching and coordination with prospective employers and/or industries.

9.2.8 Livelihood Restoration and Improvement Plan

The objective of the Livelihood Restoration and Improvement Program (LRIP) is to assist PAPs whose livelihoods are directly adversely affected by the Project for restoring their income generating capacity to at least pre-project levels. For vulnerable PAPs including ISFs, the LRIP is also aimed at improving their living standards. The livelihood restoration measures are to be planned to take account of each individual situation. Sufficient time for planning and substantial interaction with the PAPs is deemed essential requisites to developing a more robust plan that will promote both immediate and long-term self-sufficiency.

As such, while this plan outlines the necessary livelihood restoration measures, further consultations with the PAPs to plan specific livelihood restoration and improvement measures in accordance with the following hierarchy of preference:

Preference 1 Restoration of current livelihoods:

Where the PAPs have existing viable livelihoods, the preferred approach is to restore these livelihoods where feasible. This is considered a lower-risk approach considering that the likelihood of success is high if the PAPs will be able to continue doing what they know best and what is proven to workable in the local situations. While opportunities for the livelihood improvement may be introduced, the emphasis should be on replacing enabling conditions and livelihood assets with new assets of at least equal quality and quantity. This represents a lower risk of failure due to technical, economic, or social factors. The many PAPs with affected livelihoods are expected to be able to restore their income generating capacity with transitional assistance without additional LRIP interventions. However, some will require additional support to enable them to readjust their existing livelihood to a new operating environment, more particularly if their previous livelihood involves engaging in service activities. This finds more applicability to women as engagement in service activities ranked 3rd among the major industries participated by them.[24]

Preference 2 Introduction of Alternative Livelihoods.:

Opportunities for alternative livelihoods will be provided to the PAPs when restoration of their previous livelihood is not feasible or preferred by the PAP, or as a means to improve the households' income earning capacity. The promotion of alternative livelihoods should be geared towards providing the PAPs opportunity for diversifying livelihoods and improving household incomes (e.g. seasonal workers, minimum wage-earning households) interest of the based on PAP current skills set and/or capacities, and taking account of market needs/demands. Livelihood activities traditionally engaged in by women should be supported; but at the same time, livelihood programs that encourage men and women's participation in non-traditional undertakings should likewise be promoted. Moreover, care should be taken that unpaid care and domestic work are equally redistributed within the household, especially between the husband and wife, to avoid exacerbating women's burden of unpaid work as a result of additional hours spent on alternative livelihoods.

9.2.8.1 Livelihood Restoration for the Affected Businesses

In the Philippines' legal framework, compensation for income losses is not provided except for agricultural tenants, lessees, and free patent holders. While JICA Guidelines (2010)[25] and ADB SPS

[24] 2016 Gender Statistics
[25] In reference to World Bank's O.P. 4.12

(2009) prescribe payment for loss of income, it would render the Project financially unviable if the acquisition of the ROW becomes very expensive. Thus, a combination of assistance in various forms are carefully crafted to assist the PAPs based on their (i) tenurial status and (ii) size of their business.

(1) Tenurial Status of the Business Owner

The set of the assistance has been formed according to the tenurial status of the business owner, as presented in Table 9.2.37.

Table 9.2.37 Assistance by Tenurial Status of the Business Owner

Tenurial Status	Assistance
PAPs who Own the Land on which their Business Operated	• Assistance in seeking replacement land, of the same size or of a size that permits relocation of the affected business, possibly within the same barangay or City/Municipality; • Cash compensation to cover transactional (e.g., permitting) cost of re-establishing the business in the replacement land; • Assistance in securing government soft loans that offer lower transaction costs and interest rates, and long term and flexible payment schedules, to enable self-rehabilitation; • Project benefit-sharing agreement with DOTr such as, but not limited to Right of First Offer (RFO) or Right of First Refusal (RFR) in locating at commercially developed areas during the project operation. This option is deemed more practicable for commercial rather than industrial establishments.
PAPs who Lease Land and/or Structures for Operating Their Businesses	• Assistance in seeking alternative rental space to reestablish business, preferably within the same barangay or City/Municipality; • Rental subsidy for three months based on prevailing average monthly rental for a similar structure of equal type and dimension to the property being leased. Not applicable to lease contracts that will expire within three months at the time of taking; • Cash compensation to cover transactional (e.g., permitting) cost of reestablishing the business elsewhere.
PAPs whose Affected Businesses are within the PNR Row and are not Paying Any Rent	• Assistance in securing government soft loans that offer lower transaction costs and interest rates, and long term and flexible payment schedules, to enable self-rehabilitation; • Assistance in seeking alternative rental space to reestablish business, preferably within the same barangay or City/Municipality; • Cash compensation to cover transactional (e.g., permitting) cost of reestablishing the business elsewhere.

Source: JICA Design Team

In any case, the affected businesses should be given preference for availing of rental commercial spaces that may be established at the railway stations on a first-come-first-serve basis subject to screening procedures aimed at ensuring business appropriateness.

(2) Size of the Business

The set of the assistance formed according to the Size of the Business is as presented in Table 9.2.38.

Table 9.2.38 Assistance by the Size of Business

Tenurial Status	Assistance
PAPs who own fixed micro businesses regardless of tenurial status and with or without permits from the LGU concerned (e.g. Small shops, sari-sari store, carinderia, food stand, repair shop, etc.)	• Cash compensation for income losses during transition period corresponding to stoppage of business activities, not to exceed six months. • Cash compensation to cover transactional (e.g., permitting) cost of reestablishing the business elsewhere: • Assistance in securing soft loan that offer lower transaction costs and interest rates, and long term and flexible payment schedules to enable self-rehabilitation for those restarting business elsewhere.
Vendors with no stalls/ ambulant vendors/ hawkers	• Assistance in identification of alternative temporary sites to continue economic activity. (e.g. assistance in (a) shifting to areas within the same LGU where there is no construction and/or (b) identify alternative sites to sell). LGU assistance will be sought to reorganize their places operating outside the acquired areas.
PAPs who own medium and large business establishments (including apartments for rent and those who own the land)	• Cash compensation for income losses during transition period corresponding to stoppage of business activities, not to exceed six months. • For PAPs who are owners of medium to large commercial establishments built inside own affected property - Acquire the property but allow the owner of the structure and business use of the land for a defined period to give the owner time to transfer, subject to agreement on a case to case basis; - Cash compensation to cover transactional (e.g., permitting) cost of reestablishing the business; - Assistance in securing soft loan that offer lower transaction costs and interest rates, and long term and flexible payment schedules to enable self-rehabilitation for those restarting business elsewhere. Transitional support during the period while PAPs are resettling and re-establishing their livelihoods will be provided aimed at stabilizing their living standards.
PAPs who are owners of medium to large commercial establishments built inside own affected property:	• Acquire the property but allow the owner of the structure and business use of the land for a defined period to give the owner time to transfer, subject to agreement on a case to case basis; • Cash compensation to cover transactional (e.g., permitting) cost of reestablishing the business • Assistance in securing soft loan to enable self-rehabilitation for those restarting business elsewhere. Transitional support during the period while PAPs are resettling and re-establishing their livelihoods will be provided aimed at stabilizing their living standards.
Note: Preferred mode of business transition is to set up affected persons with an alternative but similar business. Options have to be considered by the PAPs with no delay.	

Source: JICA Design Team

Income losses to be paid shall be based on evidence such as tax receipts or otherwise as per estimated values of monthly income losses for various categories of microbusinesses as determined by the SES and validated by DOTr during RAP implementation.

(3) Livelihood Restoration for Affected Employees and/or Wage-Based Earners

For Affected Employees and/or Wage-Based Earners, the assistance is described in Table 9.2.39.

Table 9.2.39 Assistance by Tenurial Status of the Affected Employees and/or Wage-Based Earners

Tenurial Status	Assistance
For employees of commercial and industrial enterprises who will lose their jobs either due to closure or minimized operations	• Cash compensation for net salary for two months based on minimum wage • Provision of skills training in anticipation of available job positions during construction and operation • Priority in employment during construction and operation stage of the project or provision of alternative livelihood opportunity as outlined in this chapter.
PAPs who are relocated in an off-city site and continue working in the same company/location after being relocated	• Commuting allowance going to the original place of work with an amount not exceeding Php 5,000 per household/ per month for three months • Provision of skills training to qualify for job/livelihood opportunities near the relocation site • Endorsement to the receiving LGU to be prioritized for employment opportunities of equal salary or to be provided initial inputs to start a business, including provision of commercial space/stalls to be rented/owned, capitalization and access to soft loan, and assistance in marketing their products. As women build on their existing traditional skills, LGUs must ensure that business skills training on non-traditional skills shall also be provided to them to prevent over competition and market saturation within communities
PAPs who permanently relocate to a place that makes former wage-based livelihood opportunities inaccessible and as a result need to find new employment or source of livelihood	• Cash compensation for net salary for 2 months based on minimum wage AND • Provision of skills training in anticipation of available job positions during construction and operation, and • Priority in employment during construction and operation stage of the project OR • Provision of skills training to qualify for job/livelihood opportunities near the relocation site; and • Endorsement to the receiving LGU to be prioritized for employment opportunities of equal salary or to be provided initial inputs to start a business, including provision of commercial space/stalls to be rented/owned, capitalization and access to soft loan, and assistance in marketing their products, taking into account the prevention of over competition and market saturation in communities, particularly in the business enterprises participated by women.
Note: Preferred mode of business transition is to set up affected persons with an alternative but similar business. Options have to be considered by the PAPs with no delay.	

Source: JICA Design Team

9.2.8.2 Livelihood Restoration for Land Based Income Earners (Replacement Farm Land)

It is recommended that privately owned farms be assisted in finding replacement farmlands where possible. For farming households within PNR ROW, replacement land at resettlement sites is also suggested, however, the viability of this option needs to be studied further during the detailed planning stage. Through an appropriate government program outlined in the subsequent section, technical support to assist farmers adapt their farming practices to the changed conditions should be extended. Technical support should include women-friendly and sustainable agriculture technology designed based on accessibility and viability, in consultation with women’s organizations (Sec. 21, Republic Act 9710). Inputs (fertilizer, chemicals and crop varieties) should also be provided to bring the land into full productive potential.

Alternative non-land-based livelihood opportunities should be extended where sufficient replacement land is not available. This will include skills training and consideration for the project employment to assist PAPs depending on the land-based income supplement their livelihoods at resettlement sites.

Additionally, immediate traditional support shall be provided as described in Table 9.2.40:

Table 9.2.40 Assistance by Tenurial Status of the Land Based Income Earners

Tenurial Status	Assistance
Agricultural land owners who are directly engaged in farming	• If feasible, land for land will be provided in terms of a new parcel of land of equivalent productivity, at a location acceptable to PAPs; Consultations with both women and men shall be held to guarantee same rights to both spouses or common law spouses in respect to resources and property ownership and management, whether titled or not (Sec. 19(f), RA 9710) • A disturbance compensation equivalent to five times the average gross harvest for the last five years on the principal and secondary crops of the area acquired. (as adopted from RA 6389)
Agricultural lessee	• Entitled to disturbance compensation equivalent to five times the average gross harvests on his/her landholding during the last five preceding calendar years
Agricultural tenants and Share croppers	• Financial assistance equivalent to the average gross harvest for the last three (3) years and not less than P15,000 per hectare (EO 1035); • Rehabilitation assistance in the form of skills training and other development activities to be provided in coordination with other government agencies to be designed in consultation with eligible PAPs, including and women's organizations groups to ensure development of women-friendly and sustainable agriculture technologies; and • Assistance in securing soft loan to enable self-rehabilitation.

Source: JICA Design Team

Crop compensation will be made between the owner and sharecropper as per terms of the sharecropper in case of privately-owned land/publicly-owned land. In case of dispute over verbal agreement with sharecropper, certification from elected representatives will be considered as legal document.

9.2.8.3 Programs and Services

The LRIP activities to improve livelihoods will be based primarily on existing relevant programs at the national, regional, provincial and LGU levels with the last being an active partner in program implementation in order to ensure maximum project benefits. This approach ensures the LRIP alignment to broader community investment programs, synergies in achieving cost efficiencies and development outcomes, and sustained LGU support once the LRIP ends. To ensure social inclusion, development outcomes should consider integration of the different needs and concerns of women and men, people with disability, and the elderly people as agents and beneficiaries of programs and services, in all local plans and agenda including the LGUs investment plan and programs. This will guarantee the gender responsiveness and sustainability of the livelihood programs to be accessed by the PAPs (Sec 36(a)(3), RA 9710).

(1) Vocational Training

Vocational training will be provided by the Technical Education and Skill Development Authority (TESDA). TESDA is the government agency tasked to manage and supervise technical education and skills development in the Philippines. Training activities will be delivered through the following three modes.

TESDA run training centers: TESDA provides certificates of completion after each training course. The certificates of the completion are presented to would-be employers who will provide permanent employment and a regular stream of income. Trainings cost an average of Php

10,000/course, but may be as high as Php 15,000. TESDA, in collaboration with various LGUs, industries/sectors who provide funds, implement the Training for Work Scholarship Program (TWSP) where successful scholars are chosen to undergo training based on industry requirements. The scholars, before being chosen, undergo a rigid selection process. PAFs and/or vulnerable groups may avail of this program, after they pass the tests or assessments provided. Centres in the project areas are located in Culumpit, Bulacan and San Luis, Pampanga.

Private – run: private institutions/schools: Vouchers are allocated by TESDA at least 3-4 times a year to accredited training centers. The number of vouchers is demand-based; it is usually determined through surveys on the training courses needed per barangay.

Community Based Programs: Community-based Training for Enterprise Development Program is primarily addressed to the poor and marginal groups, those who cannot access, or are not accessible by formal training provisions. They may have low skills, limited management abilities, and have few economic options. They may have no access to capital – most of them are unqualified for formal credit programs. The program goes further than just mere skills training provision. It is purposively designed to catalyzed the creation of livelihood enterprises that shall be implemented by the trainees, immediately after the training. Likewise, it is designed to assist partner agencies such as LGUs, NGOs, people organizations and other agencies and organizations with mission to help the poor get into productive undertakings to help themselves and their communities.

Vocational Training(s), in particular, those provided by TESDA, should ensure enrollment of women in non-traditional skills training (e.g. welding, carpentry, plumbing) as it offers higher income compared to engagement in traditional livelihood activities (Sec. 13, RA 9710). TESDA should ensure the full implementation of the gender sensitive TVET curriculum in all training courses, regardless of the mode of delivery of these trainings.

(2) Mainstream Employment Information and Referral

Mainstream employment opportunities will be explored and interventions carried out to assist PAPs for potential employment. A labor market assessment will be carried out in areas were groups of PAHs are relocated for program implementers to understand the dynamic market conditions (i.e. available jobs, volume of human resource demand, skills required, job hiring seasons/cycles etc.) and sources of potential employment and entrepreneurship opportunities among PAPs. Labor market assessment should consider the gender needs of women and men, as gender segregation characterizes employment in the Country (WEDGE Plan). By Looking into the type of employment women and men are traditionally engaged in, a gender responsive employment plan could be devised by the project implementers, and improve chances of women to better jobs, with higher income. The result of the assessment will help define specific interventions to improve chances of PAPs for employment.

(3) Project Employment Opportunities

Based on the outcomes of the survey and FGDs, there are wage-based earning PAPs who expressed that they be given opportunity to be employed near resettlement sites while enterprise-based earning PAPs saw employment opportunities as an alternative to their lost enterprises. Additionally, there are a number of PAPs who are in their working age but are currently unemployed due to a lack of opportunities. Other PAPs stressed that being directly impacted by the project, they should be given priority in availing job opportunities during construction and operations.

(4) Financial Management and Entrepreneurial Training

Resettlement processes are complex, particularly as they relate to valuation, compensation and assistance packages. Limited exposure to the cash economy and low levels of financial literacy, in light of future payment of compensation funds, highlights the need to provide PAPs with access to financial advice, as part of this program. Financial advice will help to improve their capabilities on money management matters, including financial planning; investment options; training, employment and business development. The nature of financial advice varies and will have to be undertaken at different stages to coincide with the various financial activities during the RAP implementation (i.e. compensation payment, release of livelihood support, livelihood implementation/enterprise operations etc.).

(5) Additional Support for Vulnerable Persons

The detailed LRIP will be identified by HUDCC, SHFC and DOTr PMO, with the need to provide additional support to vulnerable persons, including extremely underprivileged persons, Persons With Disabilities (PWD), elderly people. Depending on the number of vulnerable persons, DOTr will engage special interest Civil Society Organizations (CSOs) or Non-Government Organizations (NGOs) to provide support to each vulnerable group.

9.2.9 Grievance Redress Mechanism

Grievance refers to any concern, issue or conflict resulting from the varying interpretations of involuntary resettlement and implementation of the RAP for the MCRP. This may include issues on the compensation for various types of PAPs, application of the eligibility criteria, relocation of the informal settlers, reduced income, and the quality of services.

9.2.9.1 Levels of Grievance Redress Mechanism

There are four levels of Grievance Redress Mechanism (GRM), while an assigned Grievance Officer from Office of the Undersecretary for Railways, the DOTr serves as the first contact point for PAPs. Table 9.2.41 summarizes the levels of grievances for ISFs and legal PAFs.

Table 9.2.41 Levels of Grievance Redress Mechanism

	For Legal Project-Affected Families	For Informal Settler Families (ISFs)
1st Level	Help Desk/Grievance Desk	
2nd Level	RAP Implementation and Management Committee (RIMC) • To be headed by the MCRP Project Management Office (MCRP PMO) • Will convene once the ROW Acquisition (ROWA) starts	Local Housing Office (LHO) / Local Inter-Agency Committee (LIAC)
3rd Level	Project Inter-Agency Committee (PIAC)	
4th Level	Court	

Source: JICA Design Team

9.2.9.2 Roles and Responsibilities of Officers and Offices concerning the GRM

(1) Help Desk/Grievance Desk

The Help Desk/Grievance Desk is the first contact point for legal PAPs and ISFs in the GRM. It will receive all complaints and determine whether such complaints are project related or not. The Help Desk/Grievance Desk will be established in each LGU and in the DOTr Railway Office. The following are outline of the roles and responsibilities of the Help Desk/Grievance Desk under the abovementioned office:

- Acknowledge receipt of the complaint either the written or verbal complaint from the PAPs and explaining the grievance redress process including contact details where complaint will be forwarded and who is responsible for acting complaint to PAP. If it is a verbal complaint, the PMO will write down the complaint for the PAP and ask him/her to sign the complaint.
- Assign a coded reference number for all complaints received via phone call, text message, letter, or verbal that will be easily identified and traced for follow up purposes.
- Clarify the nature of the complaint whether it is project related or not.
- If the concern is beyond the Grievance Desk Officers' capacity to decide, forward the complaint to the respective LHO/LIAC designated office for ISFs or RIMC for legal PAHs if it is project related.
- Advise the complainant if the complaint is not project-related, and assists him/her by forwarding the complaint to the appropriate agency or LGUs who could act on the complaint.
- Follow up with the LHO/LIAC/RIMC on their action on the complaint.
- Provide feedback to the PAP on the status of complaint - and the decision of the LHO/ LIAC/RIMC.
- Maintain a database for all complaints and the corresponding actions and decisions on the complaints received. Prepare quarterly Monitoring Reports on Grievance Redress with accomplishments and status of unresolved grievance to the PIAC, and semi-annual monitoring reports to JICA and ADB.

(2) RAP Implementation and Management Committee (RIMC) / MCRP Project Management Office (MCRP PMO)

Grievances unresolved under the Help deck/Grievance Desk at the first level of GRM will be turned over to the RAP Implementation and Management Committee (RIMC) / MCRP PMO. They will receive the complaints made by a legal PAHs and seek to resolved it.

As the second level of grievance, the RIMC will have the following roles and responsibilities:

- Act and decide on each complaint within 15 working days on the complaint filed by PAP
- Provide feedback to the PAP on the status of complaint - and the decision of the RIMC through the MCRP PMO.

(3) Local Housing Office (LHO) or Local Inter-Agency Committee (LIAC)

As the second level of GRM for the ISFs, they will decide on the merits of the complaints elevated or forwarded by the Help/Grievance Desk. In particular, the LIAC/LHO will:

- Supervise and coordinate all concerns in relation to relocation;
- Facilitate and expedite activities of the beneficiary validation committee in the stages;
- Act and decide on the complaint within 15 working days from receipt of complaint from the Help Desk and informing the PAP on the action and decision;
- Inform the MCRP PMO of the action and decision on the PAP's complaint; and
- Create subcommittees to support various activities identified, such as: pre-relocation stage, actual relocation stage and post-relocation.

(4) Project Inter-Agency Committee (PIAC)

The PIAC will serve as the third level of grievance for legal PAFs and ISFs. The PIAC will receive all complaints and determine complaints forwarded from the LHO/LIAC, or the RIMC.

As the third level of grievance, the PIAC will have the following roles and responsibilities:

- Act and decide on each complaint within 15 working days on the complaint filed to the PIAC by MCRP PMO or the LHO/LIAC.
- Provide feedback to the PAP on the status of complaint - and the decision of the PIAC through the MCRP PMO or the LHO/LIAC.

9.2.9.3 Grievance Redress Mechanism Procedures

Grievances from the PAPs related to the resettlement implementation or any related issues with regards to the project will be handled, free of monetary charge, through a process of negotiations aimed at arriving at a consensus decision. The procedures for ISFs and legal PAP are described in Table 9.2.42.

Table 9.2.42 Grievance Redress Mechanism Procedure

<table>
<tr><th>Steps</th><th>By</th><th colspan="2">Actions</th></tr>
<tr><td>1</td><td>Aggrieved Stakeholder</td><td colspan="2">• Any aggrieved stakeholder will lodge his/her grievance in person to the Help/Grievance Desk, or in writing, verbally or electronically transmitted to the Grievance Officers within the MCRP PMO for immediate action.</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">1st Level
Help Desk established at each LGU</td><td colspan="2">• When received in person, the grievance may be written down by the staff of the Help/Grievance Desk on behalf of the aggrieved stakeholder, who will sign the written complaint for official submission.
• Explain process to the aggrieved stakeholder and give contact details of where the complaint will be forwarded and who is responsible for acting on complaint.
• Review the complaint to determine whether it is project related or not.
• If the concern is beyond the Grievance Desk Officers' capacity to decide, forward the complaint to the 2nd level.</td></tr>
<tr><td>a) If the complaint is project- related, the Help/Grievance Desk will forward the complaint to the RIMC for concerns pertaining to legal PAPs, and LHO/LIAC for ISFs' within 15 working days from receipt of complaint.</td><td>b) If it is not project related, the Help/Grievance Desk will assist the PAP by referring the complaint to the appropriate agency or LGU who may be able to act on the complaint.</td></tr>
<tr><td>3</td><td>Aggrieved Stakeholder</td><td rowspan="2"></td><td>If the aggrieved stakeholder is not satisfied with the decision of the Help/Grievance Desk that the complaint is not project related, the aggrieved stakeholder may elevate his/her complaint to the RIMC or LHO/LIAC.</td></tr>
<tr><td>4</td><td>Help/Grievance Desk</td><td>• Receive request from the aggrieved stakeholder to elevate his/her complaint to RIMC or LHO/LIAC.
• Record the status of the aggrieved stakeholder complaint.</td></tr>
<tr><td>5</td><td>2nd Level
RIMC (Legal PAPs) or LHO/LIAC (ISFs)</td><td colspan="2">• Receives complaint from the Help/Grievance Desk.
• Act and decide on the complaint within 15 working days reckoning from the day it is received from Help/Grievance Desk
• Inform the Help/Grievance Desk the action and/or decision on the aggrieved stakeholder's complaint.</td></tr>
<tr><td>6</td><td>Help/Grievance Desk</td><td colspan="2">• Receive and record decision of 2nd level decision maker.
• Inform to the aggrieved stakeholder.</td></tr>
<tr><td>7</td><td>Aggrieved Stakeholder</td><td colspan="2">• Receives action of the 2nd level through the Grievance officer
• If satisfied, the complaint is resolved and recorded accordingly.
• If not satisfied with the decision of the 2nd level or if his/her complaint has not been acted upon within a period of 15 working day and has not received any response from the 2nd level decision maker, the aggrieved stakeholder can forward the complaint, or file an appeal, to the PIAC.</td></tr>
<tr><td>8</td><td>Help/Grievance Desk</td><td colspan="2">• Receive request from the aggrieved stakeholder to elevate his/her complaint to the PIAC
• Record the status of the aggrieved stakeholder complaint.
• Forward the complaint to the 3rd Level within 15 working days from receipt of complaint.</td></tr>
<tr><td>9</td><td>3rd Level
PIAC</td><td colspan="2">• Receives complaint from the Help/Grievance Desk
• Act and decide on the complaint within 15 working days and inform the decision to the aggrieved stakeholder on the decision accordingly.
• Inform the Help/Grievance Desk the action and/or decision on the aggrieved stakeholder's complaint.</td></tr>
<tr><td>10</td><td>Help/Grievance Desk</td><td colspan="2">• Receive and record decision of PIAC
• Inform to the aggrieved stakeholder.</td></tr>
</table>

Steps	By	Actions
11	Aggrieved Stakeholder	• Receives action of the 3rd Level through the Help/Grievance Desk • If satisfied, the complaint is resolved and recorded accordingly. • If not satisfied with the decision of the 3rd Level or if his/her complaint has not been acted upon within a period of 15 working day and has not received any response from the 3rd Level, the aggrieved stakeholder can forward the complaint, or file an appeal, to the 4th Level (Court).
12	Help/Grievance Desk	• Receive request from the aggrieved stakeholder to elevate his/her complaint to the 4th Level. • Record the status of the aggrieved stakeholder complaint.
13	**4th Level** Court	• Receives complaint from aggrieved stakeholder. • Once the complaint is filed in the Court, the judicial procedures for the trial on the case will be followed.

Source: JICA Design Team

9.2.10 RAP Implementation Institution

DOTr is the Implementing Agency (IA) of the Project. It is headed by the Department Secretary to whom several Undersecretaries report directly. For this Project, the Undersecretary for Railways will directly supervise the implementation of the project through the Project Management Office (PMO).

9.2.10.1 The DOTr Technical Working Committee for the Acquisition of Sites/Rights-of-Way for the Department's Infrastructure Projects (DOTr TWC)

The Department Order No. 2013-05 specifies the composition of the TWC for the acquisition of sites/ROW. "The DOTr Technical Working Committee for the Acquisition of Sites/ROW for the Department's Infrastructure Projects" (DOTr TWC) will provide supports to all project management office under DOTr including MCRP PMO.

The following are the roles and responsibilities of the DOTr TWC:

- Provide overall supervision and coordination in the planning, implementation, monitoring and evaluation of land/site acquisition activities;
- Evaluate and examine all documents pertaining to the property to be acquired;
- Certify that at least 50% of required ROW had been acquired on the date of bidding in case a project would take more than one year to complete before the project is advertised and bid out, or the necessary complaint for expropriation had been filed and the corresponding writ of possession had been issued by the court;
- Study and approve the acquisition price of the real property to be acquired, including improvements thereon, as recommended by an Independent Property Appraiser (IPA)/Government Financing Institution (GFI), in accordance with R.A. 10752 and its IRR;
- Approve payment of resettlement benefits to project affected property owners.

9.2.10.2 Right of Way Project Management Office (ROW PMO)

While the MCRP PMO will be exclusive for the Project, the ROW-PMO will be responsible for all railway projects under the support of the TWC. The ROW PMO is focused on the ROW acquisition, relocation of PAPs including the ISFs and indigenous people, in compliance with laws on environment protection and preservation with an effective performance monitoring and auditing mechanism. The ROW PMO is responsible for the following tasks:

- Execute DOTr's duties and responsibilities in ROW acquisitions;
- Read, know and understand the provisions of this RAP particularly the Entitlement Matrix;
- Ensure timely procurement of GFI services and monitor appraisal of affected properties, thereafter;
- Issue Notice of Taking (NoT) and Letter Offer (LO) duly approved and signed by proper authorities;
- Offer step-by-step guide to PAPs in securing required documents, particularly in extra-judicial settlement (EJS) cases;
- Carry-out timely payment of compensation to PAPs; and
- Monitor and ensure timely clearing of the ROW and relocation of PAPs.

9.2.10.3 MCRP Project Management Office (MCRP PMO)

The MCRP PMO will be the implementing office of the MCRP Project in accordance with JICA and ADB policies on involuntary resettlement.

- Provide technical assistance on day-to-day activities and management monitoring of the Project;
- Secure necessary approval and permit from concerned government agencies, LGUs, and other stakeholders, including relocation of utilities;
- Supervise the general consultant undertaking the detailed engineering design review, tendering and construction;
- Monitor the progress of the Project to ensure that compliance with the conditions of the contract are carried out by the general consultant and general contractor;
- Conduct internal monitoring of RAP implementation; and
- Submit periodically (monthly basis) all necessary reports to DOTr and act under the overall direction of the Undersecretary for Railways.

9.2.10.4 The Project Inter-Agency Committee (PIAC)

The Project Inter-Agency Committee (PIAC) will be responsible in creating inter-agency policies or agreements regarding sharing of resources, exchange of information and linking of programs for the effective and unhampered implementation of the RAP, in accordance with the laws of the Philippines, the JICA Guidelines (2010) and ADB SPS (2009). It will provide a high-level coordination to make resources, programs and information available and accessible to the lower level units of each Department and LGUs where the actual work of RAP implementation happens.

The following are the roles and responsibilities of the PIAC:

- Craft and approve project specific policies that are not in contrary to, and may have not been covered by the provisions of the approved RAP;

- Perform oversight function in the planning, implementation, monitoring and evaluation of the resettlement activities including site selection, site development, actual relocation and integration of the PAPs to the host community;
- Establish and maintain high level coordination to support the TWG and MCRP PMO in the actual execution of plans and programs for the resettlement, livelihood restoration, and provision of social safety nets;
- Consolidate and mobilize resources to hasten the efficient implementation of the RAP; and
- Review, deliberate and provide resolution/action on the grievance complaints elevated at their level.

9.2.10.5 The Technical Working Group (TWG)

Under PIAC is a Technical Working Group (TWG) composed of representatives from the concerned division and attached agencies of partner Departments, and representatives from the LGUs for housing and livelihood. The TWG will be responsible in implementing all the programs related to livelihood and relocation envisioned in this RAP from the community down to the household level.

9.2.10.6 RAP Implementation and Management Committee (RIMC)

The RAP Implementation and Management Committee (RIMC) will be created through a Memorandum of Understanding between the MCRP PMO and the concerned LGUs. Its main role, as its name connotes, is to implement the RAP. Other important functions include:

- Participate in the conduct of information education and communication (IEC) with PAPs, throughout the duration of the RAP implementation;
- Assist DOTr in validating the eligibility of PAPs in relation to their corresponding entitlements; and
- Receive grievances during RAP implementation, related but not limited to project design, parcellary survey, appraisal, compensation, extra-judicial settlement (EJS), etc.

The RIMC will be established after the creation of the MCRP PMO.

9.2.10.7 Philippine National Railways (PNR)

The Philippine National Railways (PNR), as one of the attached agencies of DOTr, owns the legacy of the PNR ROW, and acts as the co-project director. It will be represented in the MCRP PMO**.**

9.2.10.8 Local Government Units (LGUs)

As stipulated in RA 7279, LGUs, in coordination with the National Housing Authority (NHA), “shall provide relocation and resettlement sites with basic services and facilities and access to employment and livelihood opportunities sufficient to meet the basic needs of the affected families”.

9.2.10.9 Local Housing Office (LHO) or Local Inter-Agency Committee (LIAC)

The Local Housing Office (LHO) or Local Inter-Agency Committee (LIAC) is the central decision-making, coordinating and consultative body, a pool of manpower, resources and expertise of concerned local government units and national government agencies, as well as the working group that implements and/or causes the carrying out of the various activities, plans, programs and projects regarding resettlement of ISFs. LIAC members gather as required, attend all open dialogues, and observe all demolition works to secure the rights of the affected families/persons as well as to prevent conflicts.

9.2.10.10 Housing and Urban Development Coordinating Council (HUDCC)

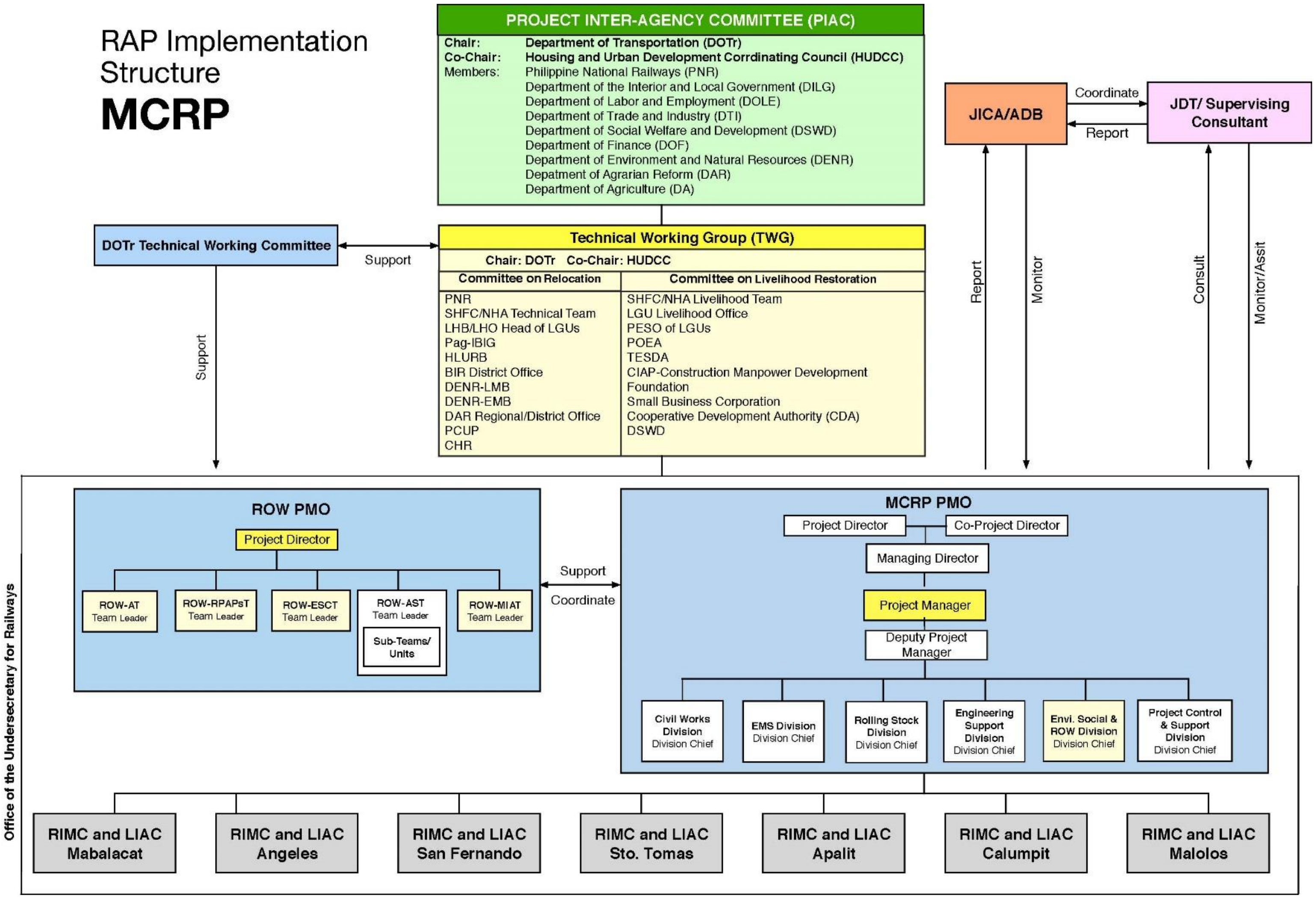
The Housing and Urban Development Coordinating Council (HUDCC), under the immediate control and supervision of the President of the Philippines, is charged with main function of coordinating the activities of the government housing agencies (i.e. NHA and SHFC) to ensure the accomplishment of the National Shelter Program. Based on Section 3 of Executive Order No. 90 Series of 1986.

9.2.10.11 National Housing Authority (NHA)

Under Presidential Decree No. 757series of 1975, NHA has the following mandate:

- Provide and maintain adequate housing for the greatest possible number of people (Section 3)
- Undertake housing, development, resettlement or other activities as would enhance the provision of housing to every Filipino (Section 3)
- Harness and promote private participation in housing ventures in terms of capital expenditures, land, expertise, financing and other facilities for the sustained growth of the housing industry (Section 3)
- Develop and undertake housing development and/or resettlement projects through joint ventures or other arrangements with public and private entities (Section 6 e).

The role and Coordination of MCRP RAP Implementation Institutions / Agencies is as shown in Figure 9.2.5.



Source: JICA Design Team

Figure 9.2.5 Role and Coordination of MCRP RAP Implementation Institutions / Agencies

9.2.11 Implementation Schedule

The construction stage of the Project will commence in May 2019 and will be completed by the end of April 2022. The RAP Implementation Schedule is presented in Table 9.2.43.

Table 9.2.43 RAP Implementation Schedule

	Activity	Responsible Agency	Period (Duration)	2018: 9 10 11 12 / 2019: 1 2 3 4 5 6 7 8 9 10 11 12 / 2020: 1 2 3 4 5 6 7 8 9 10 11 12 / 2021: Q1 Q2 Q3 Q4 / 2022: Q1 Q2 Q3 Q4
A. Project Implementation				
1	Start of Construction	Contractor	May. '19 - Apr.'22	
B. Preparation of RAP Implementation				
1	RAP field surveys (Parcellary, As Built, DMS, SES, RCS)	JDT	Sep. '18 - Dec. '18	
2	Finalization of RAP Report	JDT	Jul. '18- Feb. 19	
3	JICA/ ADB Review and concurrence of RAP	JICA/JDT	Jan. '19 - Feb. '19	
C. RAP Implementing Institution				
1	Creation of PMO, RIMT, LIAC, etc.	DOTr/PNR	Sep. '18 - Oct. '18	
2	Mobilization of LIAC (LGU level)	LGU(Chair) DOTr (Co-chair)	Sep. '18 - Oct. '18	
3	Coordination of sending LGUs, LIAC members regarding resettlement scope and schedule	DOTr/PNR/LIAC	Sep. '18 - Jan. '19 (5M)	
4	Appointment of PAPs representatives to LIAC	LIAC/PMO/RIC/LGUs/NGOs	Oct. '18 (1M)	
5	Set up and Operation of Grievance Redress Mechanism	LIAC/PMO/RIC	Sep. '18 -	
D. Land Acquisition (Depends on schedule of DOTr validation of data)				
2	Validation of RAP survey	DOTr PMO/PNR/LIAC	Dec. '18 - Mar.'19 (4m)	
3	Issuance of Notice of Taking (after Masterlist validated based on parcellary survey)	DOTr PMO	Dec. '18 - Jan.'19 (2m)	
4	Procurement/ Appraisal of Affected Properties	GFI/IPAs	Jan. '20 - Mar. '19 (3m)	Land to be Vacant
6	Issuance of Letter of Offer	DOTr PMO	Mar. '19 (1m)	
7	Payment of Compensation and other forms of assistance	PMO/Contractor	Apr. '19 (1m)	
8	Expropriation Proceedings	DOTr PMO	From Apr. '19	
9	Clearance of ROW by PAPs	Structure owners/PMO/LGU	From Apr. '19	
E.Relocation of Informal settlers				
1	MOA between DOTr and Key Shelter Agencies and transfer of funds	DOTr PMO/ KSAs	Sept. '18	
2	Verification of eligibility of ISFs	DOTr/PNR/LIAC	Jan. '19 - Feb. '19 (2m)	
3	Validation of affected ISFs against Alpha list	LIAC/DOTr PMO	Jan. '19 - Feb. '19 (2m)	
4	Construction of relocation sites (bidding, selection of developer, community organizing, identification of	KSA/DOTr PMO	Oct '18 - Mar. '19 (6m)	
5	Provision of Rental Subsidy if the housing is not ready	KSA/DOTr PMO	Apr. '19 - Sep. '19 (6m)	Land to be Vacant
6	Payment of Compensation and other forms of assistance	LIAC/DOTr PMO	Feb. '19 - Mar. '19 (2m)	
7	Relocation (ISFs)	LIAC/DOTr PMO	Feb. '19 - Apr. '19 (3m)	
F. Provision of Livelihood restoration Program				
1	Formation of Committee on Livelihood	LIAC/DOTr PMO	Sep.'18 - Oct. '18	
2	Coordination and MOA with relevant agencies on provision of Livelihood	LIAC/DOTr PMO	Sep.'18 - Nov. '18	
3	Implementation of Livelihood and Income Restoration Program	HUDCC/NHA/DOTr	Sep '18 -Apr. '19	
4	Implementation of Livelihood and Income Improvement Program	HUDCC/NHA/DOTr	Feb. '19 - Apr. '21	
5	Monitoring of Livelihood and Income Improvement Program	HUDCC/NHA/DOTr	Case to case until Project End	
G. Monitoring of RAP Implementation				
1	Set up Monitoring Agents	DOTr PMO/PNR	Nov. '18 - Dec. '18	
2	Internal Monitoring	DOTr PMO	Jan. '18 - Up to Project Completion	
3	External Monitoring	EMO	Jan. '18 - Up to Project Completion	

Source: JICA Design Team

9.2.12 Costs and Budget

The cost for implementing the RAP for the MCRP is presented in Table 9.2.44.

Table 9.2.44 Estimated RAP Implementation Cost

Activity		Cost Item	Amount (PhP)	Remarks
A. Land and Structures Acquisition		Land	4,685,987,000	Estimated based on the adjusted BIR zonal values. Assumption is that PNR existing ROW is only about 20 m and that there is an additional 10 m to be acquired by the IA.
		Structures	653,947,000	Estimated based on replacement cost as defined in R.A. 10752
		Subtotal for (A)	5,339,934,000	
B. Resettlement Assistance		Livelihood rehabilitation assistance	52,260,000	Maximum amount PhP15,000 per ISF
		Rental Subsidy	5,067,510	Renters of residential structures based on highest average current rental fee x 5 months
		Temporary Shelter	228,735,000	Estimated based on prevailing local price of prefabricated temporary shelters plus 30% associated cost
		Income Loss (business)	102,541,002	Compensation for income loss for CIBE declared incomes
		Income Loss (employee)	190,103,854	Compensation for income loss for employees/workers
		Special Assistance for vulnerable groups	6,640,000	Special Assistance for vulnerable persons such as medical care due to the implementation of relocation
		Transportation Assistance	5,865,000	For transporting PAFs to the relocation site
		Food assistance	2,639,250	For relocating PAPs during relocation schedule (3 days)
		Subtotal for (B)	593,851,616	
C. Development of Relocation Sites		Horizontal/vertical development	527,850,000	Using NHA ceiling price for horizontal and vertical development
		Subtotal for (C)	527,850,000	
D. Crops and Trees		Compensation for Crops and Trees	233,595,048	Market value of potentially affected crops and trees.
		Subtotal for (D)	233,595,048	
E. RAP Implementation and monitoring		LIAC coordination	7,000,000	Organizing and make LIAC functioning through meetings and other related activities
		Internal monitoring cost	8,600,000	RAP Internal monitoring cost for 2019 to 2022
		External monitoring cost	2,700,000	RAP external monitoring cost for 2019 to 2022
		Subtotal for (E)	18,300,000	
Total (A+B+C+D+E)			6,713,530,664	
F	Administrative Cost		335,771,533	5% of Total (A+B+C+D+E)
	Contingency		671,543,066	10% of Total (A+B+C+D+E)
Grand Total (A+B+C+D+E+F)			7,720,560, 264	7,720,560,000 Rounded off

Source: JICA Design Team

9.2.13 Monitoring and Evaluation

The DOTr will put in place a monitoring system that will track whether the: (i) planned resettlement activities for PAHs was delivered (i.e., whether compensation for lost assets were promptly paid); and (ii) planned activities contained in the RAP, such as relocation and livelihood restoration are producing the desired outcomes. Internal monitoring will track the progress in the delivery of physical and financial targets, resettlement assistance and other entitlements, while external monitoring will assess the effects and impact of the RAP implementation.

9.2.13.1 Internal Monitoring

The tasks and obligations of the MCRP PMO on internal monitoring are to:

a. Supervise and monitor the implementation of the RAP, on a regular basis. The findings will be documented in the monthly report to be submitted to the Project Director of MCRP PMO, for subsequent submittal to JICA/ADB.
b. Review if the RAP is implemented as designed and planned and report on any gaps.
c. Verify that funds are released in a timely and the amount is sufficient for each activity and purpose.
d. Validation of compensation paid and verification that 100% compensation was paid prior to relocation;
e. Review how grievances are recorded and addressed.
f. Prepare required monitoring reports based on format prescribed in the RAP.

9.2.13.2 External Monitoring

DOTr will mobilize an External Monitoring Agent (EMA) to undertake independent external monitoring and evaluation to ensure that DOTr is properly implementing the RAP, such that it meets the JICA/ADB policies. The EMA can either be a qualified individual or a consultancy firm with qualified and experienced staff.

The methodology of external monitoring will be of two types namely: 1) random observation visits; and 2) consultation with PAHs, both at their current residence area and at their relocation site. The tasks of the EMA will be the following:

a. Verify results of internal monitoring;
b. Assess the extent to which consultation and disclosure activities are inclusive, accessible and effective in conveying key information from the RAP as well as provide conditions for PAPs to contribute to decision making which affects them such resettlement and livelihood restoration.
c. Verify that compensation and assistance has been provided in accordance with the requirements of the RAP;
d. Assess whether resettlement objectives are likely to be achieved; specifically, whether livelihood and living standards have been restored or enhanced

e. Ascertain whether the social safeguards document/plan entitlements were appropriate to meet the objectives, and whether the objectives were suited to AP conditions;
f. Suggest modification in the implementation procedures of the social safeguard document/plan, if necessary, to achieve the principles and objectives of the RIPPF;
g. Review how compensation rates were evaluated; and
h. Validation of compensation paid and verification that 100% compensation was paid prior to relocation; and
i. Review the effectiveness of the grievance redress mechanism, it's accessibility and responsiveness to resolving complaints.

The detailed monitoring indicators for the IMA and EMA are shown in Table 9.2.45.

Table 9.2.45 Monitoring Indicators for the MCRP RAP

Monitoring Indicators	Basis for Indicators/Check List
For the IMA	
1. Budget and timeframe	• Have all land acquisition and resettlement staff been appointed and mobilized for the field and office work on schedule? • Have capacity building and training activities been completed on schedule? • Are settlement implementation activities being achieved against the agreed implementation plan? • Are funds for resettlement being allocated to resettlement agencies on time? • Have resettlement offices received the scheduled funds? • Have funds been disbursed according to the RAP? • Has the social preparation phase taken place as scheduled? • Have all land been acquired and occupied in time for project implementation?
2. Delivery of Compensation and Entitlements	• Have all PAFs received entitlements according to amounts and categories of loss set out in the entitlement matrix? • Have PAFs received payments for affected structures on time? • Have all received the agreed transport costs, relocation costs, income substitution support and any resettlement allowances, according to schedule? • Have all replacement land plots or contracts been provided? Was the land developed as specified? Are measures in train to provide land titles to PAFs? • How many PAFs resorted to expropriation? • How many PAF households have received land titles? • How many PAFs have received housing as per relocation options in the RAP? • Does house quality meet the standards agreed? • Have relocation sites been selected and developed as per agreed standards? • Are the PAFs occupying the new houses? • Are assistance measures being implemented as planned for host communities? • Is restoration proceeding for social infrastructure and services? • Are the PAFs able to access schools, health services, cultural sites and activities at the level of accessibility prior to resettlement? • Are income and livelihood restoration activities being implemented as set out in income restoration plan? For example, utilizing replacement land, commencement of production, numbers of PAFs trained and provided with jobs, micro-credit disbursed, number of income generating activities assisted? • Have affected businesses received entitlements including transfer and payments for net losses resulting from lost business and stoppage of production?
3. Public Participation and Consultation	• Have consultations taken place as scheduled including meetings, groups, and community activities? Have appropriate resettlement leaflets been prepared and distributed? • How many PAFs know their entitlements? How many know if they have been received? • Have any PAFs used the grievance redress procedures? What were the outcomes? • Have conflicts been resolved? • Was the social preparation phase implemented?

Monitoring Indicators	Basis for Indicators/Check List
4. Benefit monitoring	• What changes have occurred in patterns of occupation, production and resources use compared to the pre-project situation? • What changes have occurred in income and expenditure patterns compared to pre-project situation? What have been the changes in cost of living compared to pre-project situation? Have PAFs' incomes kept pace with these changes? • What changes have taken place in key social and cultural parameters relating Monitoring Indicators Basis for Indicators / Check List to living standards? • What changes have occurred for vulnerable groups?
For the EMA	
5. Delivery of Entitlements	• Entitlements disbursed, compared with number and category of losses set out in the entitlement matrix. • Disbursements against timelines. • Identification of the displaced persons losing land temporarily, e.g. through soil disposal, borrow pits, contractors' camps, been included. • Timely disbursements of the agreed transport costs, relocation costs, income substitution support, and any resettlement allowances, according to schedule. • Provision of replacement land plots. • Quality of new plots and issue of land titles. • Restoration of social infrastructure and services. • Progress on income and livelihood restoration activities being implemented as set out in the income restoration plan, for example, utilizing replacement land, commencement of production, the number of the displaced persons trained in employment with jobs, microcredit disbursed, number of income-generating activities assisted. • Affected businesses receiving entitlements, including transfer and payments for net losses resulting from lost business.
6. Consultation and Grievances	• Consultations organized as scheduled including meetings, groups, and community activities. • Knowledge of entitlements by the displaced persons. • Use of the grievance redress mechanism by the displaced persons. • Information on the resolution of the grievances. • Information on the implementation of the social preparation phase. • Implementation of special measures for Indigenous Peoples.
7. Communications and Participation	• Number of general meetings (for both men and women). • Percentage of women out of total participants. • Number of meetings exclusively with women. • Number of meetings exclusively with vulnerable groups. • Number of meetings at new sites. • Number of meetings between hosts and the displaced persons. • Level of participation in meetings (of women, men, and vulnerable groups). • Level of information communicated—adequate or inadequate. • Information disclosure. • Translation of information disclosure in the local languages.
8. Budget and Time Frame	• Land acquisition and resettlement staff appointed and mobilized on schedule for the field and office work. • Capacity building and training activities completed on schedule. • Achieving resettlement implementation activities against the agreed implementation plan. • Funds allocation for resettlement to resettlement agencies on time. • Receipt of scheduled funds by resettlement offices. • Funds disbursement according to the resettlement action plan. • Social preparation phase as per schedule. • Land acquisition and occupation in time for implementation.
9. Resettlement and Relocation	• ISFs provided adequate information, consulted on preferences and guided on procedures to avail of social housing. • ISFs participation in selection and design of social housing locations and options. • Number and percentage of ISFs provided availing of social housing programs. • Timeliness of provision of social housing to relocating ISFs • Quality of social housing provided to ISFs (suitability of location, utilities, access to social services). • Transitional assistance, such as transportation allowances, provided.

Monitoring Indicators	Basis for Indicators/Check List
	• Rental assistance provided until social housing is available for eligible ISFs. • Percentage of relocating ISFs able to service financial obligations • Percentage of relocating ISFs satisfied with social housing and remaining in social housing. • Adequate management on the part of NHA.
10. Livelihood and Income Restoration	• Number of displaced persons under the rehabilitation programs (women, men, and vulnerable groups). • Number of displaced persons who received vocational training (women, men, and vulnerable groups). • Types of training and number of participants in each. • Number and percentage of displaced persons covered under livelihood programs (women, men, and vulnerable groups). • Number of displaced persons who have restored their income and livelihood patterns (women, men, and vulnerable groups). • Number of new employment activities. • Extent of participation in rehabilitation programs. • Extent of participation in vocational training programs. • Degree of satisfaction with support received for livelihood programs. • Percentage of successful enterprises breaking even (women, men, and vulnerable groups). • Percentage of displaced persons who improved their income (women, men, and vulnerable groups) • Percentage of displaced persons who improved their standard of living (women, men, and vulnerable groups) • Number of displaced persons with replacement agriculture land (women, men, and vulnerable groups) • Quantity of land owned/contracted by displaced persons (women, men and vulnerable groups) • Number. of households with agricultural equipment • Number of households with livestock

Source: JICA Design Team

9.2.13.3 Type of Reports

The monitoring reports to be prepared are summarized in Table 9.2.46.

Table 9.2.46 Monitoring Reports

Type of report	Internal/ External	Frequency	Who to prepare	Submit to whom
Inception and Compliance Report	External Monitoring	1 month after mobilization	EMA	EMA ⇒DOTr, JICA and ADB
Initial Evaluation Report	Internal Monitoring	3 months after the completion of payments of compensation to PAPs	PMO	Project Manager ⇒ JICA and ADB
Quarterly monitoring Report	Internal Monitoring	Quarterly submission	PMO	Project Manager ⇒ JICA and ADB
Semi-Annual Monitoring and Evaluation Report	Internal/ External Monitoring	Every 6 months until the end of the project,	PMO /EMA	Project Manager ⇒ JICA and ADB EMA ⇒DOTr, JICA and ADB
Final Report/ Resettlement audit Report	External Monitoring	Upon loan closing	PMO/EMA	Project Manager ⇒ JICA and ADB EMA ⇒DOTr, JICA and ADB

Source: JICA Design Team

9.2.14 Public Consultation

Information, Education and Communication (IEC) with LGUs was organized to inform the Project, which was based on the project affected area as of December 2017. After the IEC, consultation meeting with the PAPs and FGD for the PAPS with specific characters were carried out. The schedule of the series of those meeting is shown in Table 9.2.47.

Table 9.2.47 Meeting's Schedule, Participants and Topics

Date	Participants	Topics of the discussion and contents
Information, Education and Communication: IEC (Dec. 2017 ~ Jan. 2018)	LGU (City/ Municipalities along the alignment)	• Project outline • Gathering the concerns of the LGUs
1st Stakeholder Consultation Meeting (Jan. 2018)	LGU (City/ Municipalities along the alignment) Stakeholders including the Barangays Captains	• Project Outline • Outline of RAP surveys • Project timeline and Cut -off dates • Collecting PAPs opinion
2nd Stakeholder Consultation Meeting (March 2018)	LGU (City/ Municipalities along the alignment) Stakeholders including the Barangays Captains	• Legal Framework for land acquisition and resettlement • Collecting PAPs opinion
3rd Stakeholder Consultation Meeting (August 2018)	LGU (City/ Municipalities along the alignment) PAPs determined through census survey Barangays Captains	• Results of the SES • Relocation sites and Entitlements • Collecting PAPs opinion
FGD (March 2018)	Vulnerable People (Women, Poor people etc.)	• Collecting PAPs opinion • Consideration of Gender and Poor • Livelihood Improvement Measures

Source: JICA Design Team

9.2.14.1 Information, Education and Communication (IEC)

The Outline of the conducted IEC are shown in Table 9.2.48, the opinion collected from the LGUs and the countermeasures are shown in Table 9.2.48.

Table 9.2.48 IEC dates, Targets and Participants

Date and Time	Place	Participants	Participants
2017/12/11, 10:00~11:30	Malolos Sports and Convention Center, Malolos City, Bulacan	• City Officials • Barangay Chairmen • Municipal officials • Barangay Chairmen	Male: 16 Female:7 Total: 23
2017/12/11, 3:30~4:00	Provincial Capital Residence, Malolos, Bulacan	• Provincial Governor • Provincial Government Staff	Male: 7 Female:5 Total: 12
2017/12/12, 2:00~4:00	Apalit Municipal Hall, Pampanga	• Municipal Mayor • Municipal officials	Male: 13 Female: 5 Total: 18
2017/12/14, 1:00~3:00	Department of Transportation – Central Office, S.Osmena St. Clark Freeport Zone, Angels, Pampanga	• BCDA representative • CDC Representative • CIAC Representative • ADB Representative	Male: 6 Female: 7 Total: 13
2017/12/14, 5:00~6:00	Heroes Hall, Barangay North Tiburcio, San Fernando City, Pampanga	• City Mayor (San Fernando and Santo Tomas) • Barangay Chairmen • Municipal Mayor • Municipal officials	Male: 13 Female: 2 Total: 15

Date and Time	Place	Participants	Participants
2017/12/20, 10:00~11:30	Angels City Hall, Pampanga	• City Officials • Barangay Chairmen	Male: 12 Female: 9 Total: 21
2017/12/22, 10:00~11:30	Office of the Governor, Pampanga	• Provincial Governor • Provincial Government Staff	Male: 6 Female: 4 Total: 10
2018/01/04, 10:00~12:00	Mabalacat City Hall, Pampanga	• City Officials	Male: 13 Female: 1 Total: 14
2018/01/04, 2:00~3:00	Capas Municipal Hall, Tarlac	• Municipality Officials	Male:7 Female:6 Total: 13
2018/01/05, 10:00~11:00	Bamban Municipal Hall, Tarlac	• Municipality Officials	Male: 13 Female: 9 Total: 22
2018/01/10, 10:00~11:00	Minalin Municipal Hall, Pampanga	• Municipality Officials • Barangay Chairmen	Male: 7 Female: 6 Total: 13
2018/1/11, 9:00~10:30	Provincial Gov. Tarlac	• Provincial Government Staff	Male: 5 Female: 7 Total:12
2018/6/11, 9:30~10:30	Mabalacat City Hall, Pampanga	• City Mayor • City Officials • BCDA Representatives • CDC Representatives • Barangay Captain	Male: 10 Female: 4 Total:14
2018/7/9, 14:00~16:00	Mabalacat City Hall, Pampanga	• City Mayor • City Officials	Male: 8 Female: 1 Total:9

Source: JICA Design Team

Table 9.2.49 Summary of Major Issues and Concerns during IEC for MCRP

LGU	Concerns		Answers
	EIA	RAP	
Malolos City, Bulacan	• The City Engineer raised their concern on flooding in their area. • The barangay councilor inquired regarding the construction of fences during construction. • What about the preservation of PNR Old station?		• Drainage Plans for MCRP will match those of NSCR. • As part of DOTr's policy, no access roads will be blocked. There will be approved points of access. A fence will also be put up. • JICA Design Team will discuss the preservation of old PNR stations with NHCP and DOTr.
Calumpit, Bulacan	• There is a garbage pile located near the intersection of Barangay Iba O' Este.		• JICA Design Team will check the location and situation of the garbage pile.
		• Are there remaining ISFs within PNR ROW?	• There are remaining ISFs who will have to be relocated.
		• Northrail Project provided housing for 2000 households, and 1,800 households have relocated to the Northville 9 Relocation site in Calumpit.	• JICA Design Team will gather information concerning relocation to Northville 9.

LGU	Concerns		Answers
	EIA	RAP	
		• There are still some ISFs within PNR non-core properties.	• Noted.
	• What about the preservation of PNR Old station?		• JICA Design Team will discuss the preservation of old PNR stations with NHCP and DOTr.
	• What will be done for the drainage/ water canal along PNR?		• Drainage Plans for MCRP will match those of NSCR.
Office of the Governor, Bulacan	• The Governor requested to coordinate with the Calumpit LGU regarding the Old PNR Station and proposed station location.		• It has already been taken into account.
Apalit, Pampanga		• ISFs have been relocated to a Northville resettlement site, and that the PNR ROW is cleared of structures.	• Noted.
Minalin, Pampanga	• The LGU raised concerns about impact on rivers.		• Noted.
		• The ISFs within PNR ROW were relocated during Northrail Project.	• JICA Design Team requested information concerning the relocation.
San Fernando City, Pampanga		• The ISFs within PNR ROW were relocated during Northrail Project.	• JICA Design Team requested information concerning the relocation.
	• What about the preservation of PNR Old station: (Already registered with NHCP)		• JICA Design Team will discuss the preservation of old PNR stations with NHCP and DOTr.
Sto. Tomas, Pampanga	• What about the preservation of PNR Old station (LGU plans to rehabilitate the station (i.e. museum and park)		• JICA Design Team requested DOTr to provide MOU of NHCP/PNR for preservation of PNR stations.
Angeles City (Pampanga)	• Will the trees near the station be cut down?		• JICA Design Team will check for permission to cut.
Mabalacat City, Pampanga	• Proposed alignment needs to avoid the ancestral land. There is a history of a longstanding agreement being prepared between Clark Development Corporation (CDC) and the Tribung Aeta regarding the development of a 10,684 ha. Ancestral land.		• JICA Design Team and DOTr will confirm the details of Ancestral Domain with NCIP. • If alignment will pass through an ancestral land with indigenous peoples and communities (IPCs) as part of the PAPs, an IP Plan, will be prepared.
Bamban, Tarlac		• The Dapdap relocation site is managed by Pinatubo Committee, as well as NHA.	• DOTr requested that the alignment avoids Dapdap relocation site.

Source: JICA Design Team

Source: JICA Design Team

Photo 9.2.1 IEC in San Fernando (left) and Angeles (right)

9.2.14.2 Stakeholder Consultation Meetings

After the IEC, the Stakeholder Consultation Meetings (SCM) was carried out for total three times. The SCM shall be held considering working hours to maximize the participation of PAPs. During the SCM, explanation of the outline of the Project, proposed alignment and station location, tentative implementation schedule, outline of surveys were conducted in Tagalog to enable all the participants to understand the discussion. To facilitate the participation of poor or vulnerable PAPs, the venue location was selected in the proximity to the PAPs, so they could attend the meeting by walking. For PAPs who need assistance for transportation, respective Barangay Offices were requested, and agreed to provide service vehicles.

(1) 1st Round Stakeholder Meeting

The first public consultation meeting was conducted at the cities with expected PAPs from January 2018 as shown in Table 9.2.50 for the Malolos-Clark Section At the end of each meeting, the PAPs were invited to participate in the open forum to express their views/opinions freely. SCM for Capas and Bamban are on hold until the finalization of the alignment. The main concerns and issues are summarized in Table 9.2.51.

Table 9.2.50 First Round of Public Consultation Meeting for MCRP

Date and Time	Venue	Target Affected Cities and Municipalities	Main Participants	No. of Participants
01/17/2018 (8:30am)	Aldaba Hall, City of Malolos Integrated School, Sto. Rosario, City of Malolos, Bulacan	Malolos	DOTr, LGU, Residents of affected barangays	Male: 28 Female:41 Total: 69
01/17/2018 (8:30am)	Sampaga Covered Court, Brgy. San Vicente, Apalit, Pampanga	Apalit	DOTr, LGU, Residents of affected barangays	Male:55 Female:31 Total: 86
01/17/2018 (1:30pm)	Municipal Covered Court, Calumpit Municipal Hall, Calumpit, Bulacan	Calumpit	DOTr, LGU, Residents of affected barangays	Male: 61 Female:88 Total: 149
01/17/2018 (1:30pm)	Technical Training Center, Minalin Municipal Hall, Minalin	Minalin	DOTr, LGU, Residents of affected barangays	Male: 13 Female:3 Total: 16
01/18/2018 (8:30am)	Municipal Auditorium, Santo Tomas Municipal Hall, Santo Tomas,	Sto. Tomas	DOTr, LGU, Residents of affected barangays	Male: 24 Female:3 Total: 27

Date and Time	Venue	Target Affected Cities and Municipalities	Main Participants	No. of Participants
	Pampanga			
01/18/2018 (8:30am)	New Legislative Building, Angeles City Hall, Angeles City, Pampanga	Angeles City	DOTr, LGU, Residents of affected barangays	Male:45 Female:38 Total: 83
01/18/2018 (1:30pm)	San Fernando, Pampanga	City of San Fernando	DOTr, LGU, Residents of affected barangays	Male: 57 Female:46 Total: 103
01/18/2018 (1:30pm)	Xevera Covered Court, Xevera, Mabalacat, Pampanga	Mabalacat City	DOTr, LGU, Residents of affected barangays	Male: 186 Female: 354 Total: 540

Source JICA Design Team

Source: JICA Design Team

Photo 9.2.2 1st SCM in Mabalacat (left) and Angeles (right)

Table 9.2.51 Main Concerns/Issues at the 1st SCM

Queries/Concerns/Suggestions/Comments	Responses to Queries
Entitlements and Rights of ISFs	
• If recipients of previous relocation program be included in the housing program for this project	• Confirmed that if a person did not avail any relocation program before, it means that the individual is not a recipient of a housing program; • The NHA has a master list of those who were previously awarded with relocation sites; • Those who have already been awarded with relocation sites before will not be qualified for relocation again; • It would be unfair for the government to provide relocation sites for those who abandoned or sold the rights to relocation sites previously awarded to them by the government; • If those previously awarded with relocation sites officially returned the same to the housing agency concerned, then they could have still been qualified for relocation
• Considerations for the Northville relocation program awardees who returned to illegal settling along the tracks in San Vicente	• As part of the RAP study, the Team will gather data of previous housing project awardees from the barangay; • The survey to be undertaken will establish the present status of the PAPs; • The RAP Team could only recommend who are qualified, but it is the partner housing agency of the DOTr who will decide if the PAP is qualified for the relocation program/compensation or not
• If landowners are qualified for relocation	• Private lands to be affected by the project will be compensated
• If structure owners are qualified to the relocation program for the project	• Qualifications of the structure owners to the relocation program will be discussed in detail during the 2nd SCM; • Reminded the stakeholders that the housing is not free and will be amortized monthly

Queries/Concerns/Suggestions/Comments	Responses to Queries
• If the relocation program will be awarded per family or per structure	• Relocation program will be per household; • One household is defined by a separate kitchen and food budget
Issues and Concerns on the Tagging and Survey	
• Before the administration's Build Build Build plan, a tagging and a study were already undertaken in the area	• A new tagging will be implemented for this project
• Structure owners may not be present during the tagging, census and survey due to work schedule, particularly during weekdays	• Permission will be requested from the structure owners prior to tagging; • Suggested to the PAPs to authorize their neighbors to permit the tagging in case the owners are not present; • Schedule of the interview could be arranged with Team on weekends as the enumerators are staying in the area, to accommodate PAPs who are working during weekdays
• If tagging of structures depends on the number of families living in the house	• Clarified that the tagging will be per structure, not per household or per family; • Explained that structures tagged at this stage are considered potentially affected only; • There may be additional structures to be tagged once the parcellary survey is completed; • After the tagging, the enumerators/interviewers will start the survey and census
• Requested that the survey and census be coordinated and verified with the barangay	• Assured the stakeholders that the tagging, survey and census teams will coordinate with the barangay official prior to undertaking of any activities related to the project
Alternative Livelihood and Restoration Program	
• Alternative source of livelihood must be provided to the PAPs who will be resettled	• The socio-economic survey (SES) to be undertaken will establish the present socio-economic status of the PAPs; • A detailed explanation on the livelihood restoration program for the PAPs will be discussed in the next SCM
• Most of the affected area in Minalin are fish ponds and even if only a fraction will be acquired, the fish pond will not be functional; • If the affected fish ponds could still be utilized or will it be fenced, and fishing would be prohibited	• If the remaining part of the fish pond is no longer viable for business, there is a possibility that the whole property will be acquired; • The extent of the areas to be affected cannot determined yet as the exact measurements are. • The policy now is that even if DOTr will build above the land, no structures are allowed to be constructed below; • There is a plan to fence the ROW
Temporary Employment	
• Suggested that out-of-school youths along the tracks be hired during construction stage of the project	• Part of the study is to identify who are these youths and what skills they can offer. This is also why we're coordinating with you and the barangay. • Suggestion is noted
Concerns on the Relocation Site	
• If existing relocation sites be used for those who will be relocated	• Relocation sites will depend on the study of EcosysCorp, the RAP subcontractor (Consultant) of the project; • EcosysCorp will consult the PAPs, LGUs, the DOTr, the PNR, and other concerned agencies; • Coordination with the LGUs and the NHA will be will be undertaken to ascertain the availability of relocation sites within the municipality/city or those near the area; • If there are no relocation site available, DOTr will give the PAPs choices for relocation sites; • If there are many PAPs to be relocated, the concerned LGU or the PAPs could offer a lot where a 2-storey or 3-storey building could be built as your relocation site using the budget allotted for your relocation (People's Plan); • Encouraged the PAPs to provide accurate inputs during the survey, especially about their compensation and entitlements
• Asserted that there are relocation sites without basic utilities such as electricity	• In the JICA guidelines, those relocated should at least have electricity and water

Queries/Concerns/Suggestions/Comments	Responses to Queries
• If there is an identified relocation site for the PAPs affected by Phase 1	• In-city relocation is the priority; • For Phase 1, informal settlers may be relocated in NHA projects such as Bustos, Caloocan, and Harmony Hills in San Jose Del Monte, Bulacan. • According to the NHA, Northville in Malolos is already fully occupied; • Livelihood packages will be included for those who will be relocated; • There will be three (3) SCMs per stage of the project, and the 3rd SCM will tackle the issues concerning the potential relocation sites and the entitlements of the PAPs
Right-Of-Way Issues	
• How wide is the PNR ROW	• The PNR ROW is approximately 30 m wide; • ROW required by the project is 15-15m from the centerline of the PNR ROW, however, it would still depend on the final design of the project
• If the 30-m ROW measures 15 m to the left and 15 m to the right of the centerline • Reckoning point of the 30-meter PNR ROW	• The 30-m ROW means 15 meters to the left plus 15 meters to the right of the centerline; • Explained that the 30-m area as for now will only be used for surveys to determine the current condition of the area and for DOTr to be able to prepare the budget request; • The final Right-Of-Way (ROW) required by the project has not been finalized yet; • Explained that the surveyors are still locating the boundary of the 30 m ROW
• There is an existing list of legitimate occupants of PNR property, and there are delinquent members or informal settlers	• If the property is (within) a public land, DOTr will verify if the government allowed the subject property to be occupied, and look for proof recognized by the concerned government entity who owns the land; • Explained that if it is proven that the government allowed its land to be occupied, then those occupying the said property are not classified as informal settlers, and their compensation will be different; • If any land owner, in general, does not acknowledge whoever is occupying their land, those occupants will be classified as informal settlers.
• If the new railway will be constructed where the old railway is	• Yes, the new railway will utilize the existing PNR ROW
• Possibility that the ROW required would exceed 30 meters, considering the planned cargo/freight train	• The surveys will be undertaken within the 30-meter area; • The alignment of the cargo/freight train is not final yet
• Location of the cargo/freight train along McArthur Highway	• As of now, location of the cargo/freight train is not determined yet as the studies are still on-going; • In Phase 1, the alignment of the cargo/freight train changes: there are areas where the trains are on the right side of the elevated railway, and there are areas where the trains cross to the left side of the elevated railway; • The location of the cargo/freight railway depends on the availability of land, final design, and the over-all ROW.
• Several Barangay Roads in San Fernando City is beside the 15-m PNR ROW	• Barangay Roads and access of the PAPs are considered in the design; • DOTr will find a way for affected areas to be accessible; • There will be an inventory of all affected crossings; • Areas with no viable alternative access routes will be considered in the design of the project
• Basis of compensation for private lands	• A more detailed explanation on compensation of private lands will be discussed in the 2^{nd} SCM; • The latest ROW law, R.A. 10752 will be implemented for the compensation of affected private properties
• Possibility that the areas below the elevated railway could be utilized as alternative roads	• The matter will be referred to DOTr as the agency may have other plans for the areas underneath the elevated guideway

Queries/Concerns/Suggestions/Comments	Responses to Queries
Concern on Access (Vehicles & Residents)	
• If barangay roads crossing the PNR ROW be maintained	• Legitimate public, municipal, and barangay roads will not be closed, but with regards to private roads crossing the PNR ROW, the matter must be discussed with the PNR; • An inventory of private access roads crossing the PNR ROW will be undertaken
• Concern about the subdivision access (Brgy. Cruzcosa, Calumpit) to the other side of the tracks during construction period when the ROW is fenced; • Asked if access to the other side of the railway tracks will be provided once the line is operational	• Existing public and national roads will not be closed during construction; • Subdivisions with access roads crossing the PNR ROW and private property owners or private properties crossing the PNR ROW without the permission of PNR may be closed, unless the subdivisions or private property owners execute an agreement with PNR; • When the required ROW is measured, access to areas with numerous structures that will be blocked will be noted and these will be studied to find ways how to provide access; • Access will most probably be located away from the PNR ROW
• Concern on the possible closure of public roads crossing the tracks, which are major access points to schools in Sta. Isabel, Malolos City	• Major public roads such as those used by the municipalities and barangays will not be blocked/closed; • Operating hours of the future cargo/freight train will only be at night as many intersections will be affected
• Provision of access for residents crossing the tracks	• Clarified that unauthorized access to public will no longer be allowed once operational; • The survey will include questionnaire regarding access, to understand the need of the residents for access to cross over to the other side of the tracks, and the importance of the access that will be lost; • The RAP Preparer could recommend the provision of the access to the other side of the tracks if the purpose for crossing over is valid, such as going to a day care or school
• Concern on the possible closure of existing road crossings and public access points	• All existing legal roads crossed by the alignment such as National Roads, City Roads, and Barangay Roads will be maintained and not closed/blocked; • Provision of alternative access to affected access roads and crossings are being considered in the design; • Assured that the concern is being carefully studied by the traffic engineering design team
Timeline of the Project	
• Target date of relocation or clearing	• The project is currently in the Feasibility Study stage; • The JDT will have to adjust the design of the project based on the results of the study; • DOTr will send out the letter of notice prior to implementation to enable the PAPs to prepare
• Date of clearing in the affected areas; • Expected completion of Phase 1; • Expected start of Phase 2	• For Phase 1, affected areas will be cleared and affected families will be resettled/relocated in April or May 2018; • Less than 10 are affected by Phase 1; • Construction of Phase 1 will start between July to September 2018; • Disclosed that DOTr is currently conducting a supplemental feasibility study for Phase 2; • The basic design for Phase 2 is expected to be completed by August 2018; • The Detailed Engineering Design stage of the project will be from September 2018 to May 2019; • The signing of the loan agreement will be on December 2018; • Essentially, after May 2019, there will be a final RAP containing the final list of project PAPs; • The construction of Phase 2 may start in 2019; • The aim is to connect Manila to Clark Airport by 2022, even if other stations have not been built yet
• Transition period allowed by the DOTr for the PAPs to fully vacate the area	• Assured the PAPs that they will have enough time to prepare before the actual relocation is implemented, as they will be involved in the planning period

Queries/Concerns/Suggestions/Comments	Responses to Queries
• Exact date that the affected area will be determined	• Based on the project's tentative timeline, the DED will be undertaken by August 2018; • The specific areas to be affected will be determined during the DED stage
Engineering Design	
• If the 30-m PNR ROW will be fenced once the railway is operational	• Yes, the ROW will be fenced to limit access to the public to ensure safety; • Unauthorized access to the ROW will be limited
• If the railway project is elevated	• Yes, and there are also some sections on embankment
• Height of the elevation (vertical clearance)	• Explained that the DOTr will follow the guidelines on clearance (vertical) set by the country in designing the project; • The DPWH follows a 5.02-meter clearance for national roads; • Informed the stakeholders that in the design of Phase 1 or the Tutuban to Malolos Line, 5.2 m clearance from ground level is usually used, so that access roads (national roads, public roads, municipal roads, etc.) crossing the Line would still be passable; • Disclosed that the proposed project is funded by the Japan International Cooperation Agency (JICA), and further explained that JICA has guidelines on environmental and social considerations
• Suggested that a station be located in Brgy. Lourdes, Minalin, as there was an old station in the area before, and ridership is relatively high	• Explained that the project is already approved by NEDA; • In case a new station will be built, it will be just an additional station, and maybe not a part of this project but of future projects; • The suggestion was noted and will be related to JDT; • Explained that one of the criteria considered in the station location is the volume of ridership which was absolutely studied by JDT
• If the stations will be elevated	• The guideway and the stations will be elevated • The alignment is a viaduct in principle. The structure of the station is super elevated (in principle)
• Length of the station	• The width of stations is 60 m, while the is approximately 250 m
• If the segment in San Fernando will be on viaducts or embankments	• There will be some areas with embankments, and some areas with viaducts; • The location of viaducts and embankments will depend on ground conditions, and will be finalized in the DED stage
• Requested to include the provision of parking space in the program during the FS stage	• Stated that provision of parking spaces in stations of the railway is already considered
• Requested to consider side streets outside the PNR ROW for tricycles and other vehicles	• In cooperation with the LGU, DOTr will undertake a series of meetings regarding the development of the 7-kilometer radius from the station (transit-oriented development); • The DOTr will help the LGU prepare technical plans for the 7-kilometer radius around the station for the management of traffic to and from the station, for the development of an inter-modal transport system
• Location of the stations	• Old stations may be preserved; • The new stations may be located within the area of the old stations, but studies will still be undertaken; • The location of stations would depend on factors such as accessibility; • The final locations of stations might be available by the time 3rd SCM is held;
• Location of San Fernando Station; • If the suggestions of the LGU on the location of the new station to optimize ridership be considered in the design • If the LGU will be ask for their suggestions on where ridership can be optimized, or on where to place the new station	• DOTr is still in the conceptual design stage of the project; • There is an existing PNR San Fernando Station, but it still has to be determined if it could be incorporated into the design of the new station, or if it will be avoided because it is already a heritage site; • The location of the new San Fernando station could be moved, depending on the DED stage of the project; • Factors considered in determining the location of the new stations include the availability of space and ridership; • New stations will be placed in accessible areas where space is available, and ridership can be optimized; • As of now, there are no final locations for stations; • The practice is to coordinate with concerned LGUs

Queries/Concerns/Suggestions/Comments	Responses to Queries
• Related that the City Mayor of San Fernando is requesting for an additional station in Brgy. Sindalan	• Advised the LGU to write the DOTr regarding the request for additional station in Brgy. Sindalan
• Requested to consider re-aligning the railway route to the open spaces in Brgy. Dolores to minimize the residential structures to be affected	• Explained that the affected area of Brgy. Dolores is still not final; • There is a directive from Sec. Tugade that urges the design team to prioritize areas with minimum affected persons
• Related that there was once a PNR station in Santo Tomas; • Requested to add another station in Santo Tomas as the distance between the proposed Apalit Station and San Fernando Station is too far; • The additional station in Santo Tomas can also cater to western municipalities of Pampanga (i.e. Minalin, Sasmuan, Guagua, Macabebe, Masantol) because a new highway will pass through Lubao, Guagua up to NLEX in Santo Tomas	• DOTr can consider a Santo Tomas station in the design stage; • The request and comments are noted
• If the existing structures built under the Northrail project be retained	• Existing structures from the Northrail project were assessed, and one of the recommendations was to build new structures instead: firstly, the Chinese and the Japanese have different standards, secondly, new technology now exists, and thirdly, the PNR Phase 2 is completely a new project; • The PNR line will be reconstructed completely; • The decision to use structures of the Northrail project will be finalized during the DED stage, because the structures will still be assessed further, considering their current state; • Reusing the Northrail structures will translate to savings, the reliability and safety of the railway will have to be considered
• If there will be sections of the railway on embankments in Santo Tomas	• There will be sections with embankments, and there will be sections with elevated viaducts; • The exact areas of embankments and viaducts will be determined after detailed studies which will start in August
Concern on Flooding	
• Flooding is a problem in Brgy. Caniogan, Malolos City • Propose that the old drainage system be revived	• DOTr is aware of the drainage problem in Brgy. Caniogan; • Disclosed that the drainage in the area was clogged during implementation of the Northrail Project; • The design for Phase 1 has been finalized, and DOTr coordinated with the LGU's engineering division/department regarding the drainage; • Informed the stakeholders that the drainage system along the boundary of the project is the concern of the PNR, since that area is within the PNR property; • Drainage systems for areas along the boundaries of the project were considered in the design of the project, however, DOTr needs to work within its loan agreement with JICA
• Purok 1, Brgy. Gatbuca, Calumpit is a flood prone	• Areas prone to flooding are considered in the design of the railway
• Embankment sections in Santo Tomas might aggravate the existing flooding problem in the area	• Flood levels and the findings of the 2013 flood hazard assessment also incorporated into the design of the project
Other Issues and Concerns, and Suggestions	
• There should be coordination with the PNR	• Coordination with the stakeholders will be continuous; • Requested the stakeholders to cooperate with the team conducting surveys and interviews, and provide them with copies of the relevant documents
• There was a station near Brgy. Pio Cruzcosa aside from the main Calumpit Station	• Clarified that there is no other proposed station aside from the main Calumpit Station, however, it may be considered as a "proposed future station"; • For now, there will be no ROW acquisition for "proposed future stations" because these stations are not part of the budget of the current project

Queries/Concerns/Suggestions/Comments	Responses to Queries
• Concern regarding noise impact	• Informed the stakeholders that the noise impact is considered in the EIA study; • Disclosed that in the design of the project, some areas will be provided with noise barriers; • Explained that the trains are relatively quiet as the design will adopt the Japanese technology

Source JICA Design Team

(2) 2nd Round Stakeholder Meeting

The 2nd round of SCMs involved the (i) presentation of the legal framework that will be the basis for compensation and entitlements along with the corresponding eligibility requisites. As in the 1st SCMs, the invited PAPs were encouraged to participate in the Open Forum at the end of each meeting. The dates and participants number are summarized in Table 9.2.52. The issues, concerns, comments and suggestions raised during the 2nd SCM are summarized in Table 9.2.53.

Table 9.2.52 Second Round of Public Consultation Meeting for MCRP

Date & Time	LGUs	Venue	Main Participants	Number of Participants		
				Male	Female	Total
8:00 A.M. 2 May 2018	City of San Fernando, Pampanga	Covered Court, Brgy. Santo Niño	LGUs, PAPs, BLGUs, DOTr Representatives, JICA Design Team Representatives, EcosysCorp, Inc.	37	36	73
1:30 P.M. 2 May 2018	City of San Fernando, Pampanga	Covered Court, Brgy. Santo Niño	LGUs, PAPs, BLGUs, DOTr Representatives, JICA Design Team Representatives, EcosysCorp, Inc.	54	128	182
8:00 A.M. 3 May 2018	Municipalities of Calumpit and Malolos, Bulacan, and Municipalities of Minalin and Apalit, Pampanga	Covered Court, Calumpit Municipal Hall Compound, Calumpit, Bulacan	LGUs, PAPs, BLGUs, DOTr Representatives, JICA Design Team Representatives, EcosysCorp, Inc.	67	90	157
1:30 P.M. 3 May 2018	Municipality of Santo Tomas, Pampanga	Auditorium, Municipal Hall, Santo Tomas, Pampanga	LGUs, PAPs, BLGUs, DOTr Representatives, JICA Design Team Representatives, EcosysCorp, Inc.	5	17	22
08:00 A.M. 04 May 2018	City of Angeles, Pampanga	Covered Court, Brgy. Mining, Angeles City, Pampanga	PAPs, BLGUs, DOTr Representatives, JICA Design Team Representatives, EcosysCorp, Inc.	70	85	155

Source JICA Design Team

Table 9.2.53 Summary of Issues, Concerns, Comments, and Suggestions Raised during the 2nd SCM

Queries/Concerns/Suggestions/ Comments	Responses to Queries
Compensation and Entitlements	
• What will be the compensation/entitlements for affected property owners? • Who will determine the compensation price for our properties? • How much will be our compensation, and when will we receive it? • Will the government acquire the whole of our property if only a very small portion of it is left unaffected by the project? • How will commercial and residential lots be relocated? • What will be the entitlements of business owners? • If our renters were the only ones interviewed does that mean they are the only ones who have entitlements? • Will we be compensated for a structure we build on land we do not own? • What will happen to properties still being paid off by their occupants? • What are the standards of property valuation? • What if our Deed of Sale indicates an amount lower than what was actually spent for the structure? • A rent-free occupant who was relocated in Northville sold his property and is currently residing in a structure he does not own. What will happen to structure owners who are not residing in their structures and were not interviewed during census activities? Will occupants be paid for the structure? Will the structure owner be given a replacement house? • What is replacement cost? Does it only include the costs of materials? How about labor costs?	• Legal owners of affected private properties with titles and tax declarations will be paid just compensation based on the current market value of the affected land and crops and trees therein; and the replacement cost of affected structures/improvements. The replacement cost is the cost of rebuilding the affected structures today, at current prices. • Government Financial Institutions or Independent Property Appraisers will appraise your property. • Upon the execution of a Deed of Absolute Sale before your structures are demolished, you will already receive 50% of the total compensation price for the affected land plus 70% of the total compensation price for the affected structures/improvements. • If the remaining portion of your property will become unusable or nonviable, the government will acquire your whole property instead. The World Bank says that if 80% of a parcel of land is affected by the project, the whole parcel should be acquired and compensated. For structures, once foundation is affected by the project, the whole structure will be acquired and compensated. • Relocation is only for those who do not own land or for informal settler who meet the criteria set by law. Private property owners have the right to choose wherever they want to transfer. • Livelihood is considered in the Resettlement Action Plan. Business owners will have entitlements. Assistance will be extended to business owners for them to be able to start again. • Everyone affected has entitlements. Each group (i.e. renters, property owners, business owners) will have different entitlements. Even if renters were the ones interviewed, they will not receive the entitlements due to the property owner, because they will be unable to provide any proof of ownership over the property (such as titles and tax declarations). • According to the new law, even if we do not own the land, we have the right to be compensated for our non-land assets. • For properties still being paid off by their occupants, the remaining unpaid balance should be deducted from the compensation payment you will receive. • Compensation and entitlements will be discussed in detail during the next SCM. • Independent Property Appraisers are licensed and are private practitioners. They have experience in real estate. The methodology of the valuation of properties is based on Philippine Valuation Standards which are aligned with International Valuation Standards. • If a structure owner spent for the renovation of his house, it is best if copies of receipts are given to the appraiser. Civil engineers will know how to compute for the replacement cost of the materials. • Regardless of the amount stated in the Deed of Sale, the structure will be paid according to its replacement cost as assessed by appraisers for the project. During the project's FS stage, the RAP Team only did a per square meter valuation of the property for budgetary purposes. During the DED stage, a detailed bill of quantities will be produced. • The rent-free occupant was interviewed. He will be given relocation if he is qualified. Those appearing in the RAP Master List are not automatically qualified for relocation. Housing agencies will validate and identify individuals qualified for relocation. • The replacement cost as defined by the law includes the costs of materials, equipment, and labor, which includes the contractor's profit.

Queries/Concerns/Suggestions/ Comments	Responses to Queries
Issues and Concerns on the Tagging and Survey	
• Our structure was not tagged, and we were not interviewed. Will there be another set of interviews? • Although we built our structures separately, my neighbors and I only have one tag. • When is the schedule of the next tagging activities?	• If your structure has no tag, you will not be interviewed. Tags can only be placed on structures if occupants give their consent to the tagging team. There might have been no one in your structure during the tagging activities, but there is a tag reserved for your structure. For those who were not interviewed, please have your names listed in your Barangay. • One tag is placed on each structure, and not on each person or each household. Interviews are conducted per household. We will ask the tagging team why you and your neighbors only have one tag. • There will be another meeting where the RAP team will inform affected persons of the schedule of the next set of tagging activities. Tagging will start when the parcellary survey is complete and when geodetic engineers have surveyed and demarcated the final area affected by the project.
Concerns on the Relocation Site	
• Do private property owners have an option to reject housing from the housing agencies? • Where will we be relocated? • Relocation must be in an area which is safe and not flood-prone.	• Informal settlers are the only ones who may receive housing, subject to criteria set by law. Private property owners have the right to choose where they would like to transfer. • The Socialized Housing and Finance Corporation (SHFC) encourages Community Mortgage Programs (CMPs). According to Republic Act No. 7279, LGUs should allot land for its landless informal settlers. The location of relocation sites should be indicated in the Comprehensive Land Use Plans (CLUPs) of LGUs. Updates on relocation will be closely monitored by JICA and ADB. Relocation sites must have water supply, electricity connection, drainages, transportation networks, and must be near a school, hospital, and marketplace. There should also be livelihood programs for those relocated.
Right-Of-Way Issues	
• What is the width of the existing PNR right-of-way? • What is the width of the right-of-way needed for the project? • Will the 15 meter or 30-meter measurement starts from the centerline of the PNR right-of-way? • Who gave the NHA relocation beneficiaries authority to sell their lot allocations? Who will be held responsible for relocatees who returned to PNR properties?	• The width of the existing PNR right-of-way is 7.5 + 7.5 meters, on average. • The right-of-way needed by the project's alignment is 15 + 15 meters or 30 meters in total, but its center point changes when there are curves. The right-of-way needed by the project also differs for different areas. • We need to wait for the completion of the Detailed Design before we could determine the exact boundaries of PNR properties and the right-of-way needed for the project. • When the railway alignment curves, the center point of its right-of-way changes. • The right-of-way needed by the project differs for different areas. • The PNR did not give relocatees authority to sell their lot allocations. An in-depth study will be conducted if there is a valid reason why these relocatees chose to go back to PNR. The master list of the RAP Team will be screened by the NHA or SHFC to determine who is qualified for relocation. If there is a valid reason why previous relocatees chose to go back, there is a chance that they will still be qualified for relocation.
Concern on Access (Vehicles & Residents)	
• How will we access our store or our properties if our barangay road is affected by the project? • How will the community access their neighborhoods if the right-of-way will be fenced? • If property owners will be given access roads, will the land come from private owners or the government? • What will happen to the utilities during and after construction?	• No barangay road will be closed. The government will find a way to make your properties accessible. • We have a law that disallows no access. The DOTr will ensure that the community will have an access. The community will be given access. It may be different from the one that community has now but there will be access. • It will be recommended that the right-of-way to be acquired for the project will already include access roads for the community. During the DED stage, the provision of access roads or right-of-way for property owners will be studied. • The provision/location of the infrastructure of utilities will be planned during the DED stage.

Queries/Concerns/Suggestions/ Comments	Responses to Queries
Timeline of the Project	
• When will we need to vacate our properties? • When will the construction start?	• Notices of Taking will be issued after the completion of the parcellary survey. The issuance of notices of taking may start between the end of 2018 and the first quarter of 2019. Land acquisition should have been completed within the third quarter of 2019. Actual construction work is expected to start in 2019. • The target of the construction is May 2019.
Concern on Flooding	
• Drainages will be damaged once the project is implemented.	• The RAP will recommend replacing affected drainages. During the DED stage, engineers will consider drainages to ensure that the community will be protected from flood.
Other Issues and Concerns, and Suggestions	
• Please ensure that all stakeholders are invited to meetings. • How come there is a possibility that titles were issued for properties encroaching PNR properties? • Does project still continue if there are many people who will be affected? • What they should do if in their area, there is an ongoing case of land dispute? • Who will demolish the structure?	• Invitations to our meetings are coursed through the Barangay. For our next meetings, we will also send invitations through texts. • The exact boundaries of PNR properties have yet to be verified, but nevertheless, for cases involving encroachments, the process would be reversion. Titles for government-owned properties cannot be issued to private persons. • The number of affected people will always be considered. There will always be people affected by government infrastructure projects. For the NSRP, there are more than 15,000 affected structures. • Land disputes should already be already resolved before right-of-way acquisition. These disputes can cause delays in project implementation. If the government cannot identify the rightful owner of an affected property because there is an ongoing case, it may proceed with expropriation. The payment for the property will be lodged in the court and it will be released once expropriation proceedings are finished. The payment will not be released up until the case is cleared but DOTr will already be given right to use the property. • If the structure owner is capable of demolishing his property, then he can do so and he can keep salvageable materials. An Agreement to Demolish and Remove Improvements (ADRI) will be executed. The ADRI will indicate the details of the demolition.

Source: JICA Design Team

(3) Additional Round of First and Second Stakeholder Consultation Meetings (SCM)

An additional round of first and second Stakeholder Consultation Meetings (SCMs) were held for the proposed San Fernando City Station, Calumpit Station, and Mabalacat City Depot, as shown in Table 9.2.54**.** In the said SCMs, topics discussed in first and second SCMs were combined. The combined first and second SCMs started with the disclosure of the Project in terms of (i) areas that the Project will traverse, (ii) its components such as the stations, depot, and (iii) other features such as envisioned width of the Right-Of-Way (ROW); then a description of the RAP Study, with particular focus on the following topics: (i) Basic principles of resettlement; (ii) Socio-economic survey activities, and (iii) RAP schedule of activities. This was followed by a discussion on the legal framework of the RAP, which consists of two (2) overarching guidelines, namely the (i) international standards (WB, ADB, JICA), and (ii) the applicable Philippine legislation, particularly R.A. 10752 and R. A. 7279.

At the end of each meeting, the invited PAPs were encouraged to participate in the open forum to express their views/opinions. A summary of the main concerns/issues raised during the first SCMs is provided in Table 9.2.55**.**

Table 9.2.54 Outline of the Additional Round of First and Second Stakeholder Consultation Meetings

Date & Time	LGUs	Venue	Main Participants	Number of Participants		
				Male	Female	Total
8:00 A.M. 17 May 2018	City of San Fernando, Pampanga (Proposed San Fernando Station)	Covered Court, Brgy. Santo Niño, City of San Fernando, Pampanga	LGUs, PAPs, BLGUs, DOTr Representatives, JICA Design Team Representatives, PNR Representative, EcosysCorp, Inc.	20	26	46
8:00 A.M. 30 May 2018	Municipality of Calumpit, Bulacan (Proposed Calumpit Station – Alternative 1)	Covered Court, Calumpit Municipal Hall Compound, Calumpit, Bulacan	LGUs, PAPs, BLGUs, DOTr Representatives, JICA Design Team Representatives, PNR Representative, EcosysCorp, Inc.	32	34	66
8:00 A.M. 18 July 2018	Municipality of Calumpit, Bulacan (Proposed Calumpit Station – Alternative 2)	Covered Court Purok 2, Brgy. Iba O Este, Municipality of Calumpit, Bulacan	LGUs, PAPs, BLGUs, DOTr Representatives, JICA Design Team Representatives, PNR Representative, ADB Representative, EcosysCorp, Inc.	8	15	23
8:00 A.M. 25 July 2018	Municipality of Calumpit, Bulacan (Proposed Calumpit Station – Alternative 3)	Multi-Purpose Hall Creekstone Homes, Brgy. Iba O Este, Municipality of Calumpit, Bulacan	LGUs, PAPs, BLGUs, DOTr Representatives, JICA Design Team Representatives, EcosysCorp, Inc.	19	40	59
08:00 A.M. 02 August 2018	Mabalacat City, Pampanga (Proposed Depot)	Jade Hall Xevera Complex, Brgy. Tabun, Mabalacat City, Pampanga	PAPs, BLGUs, DOTr Representatives, JICA Design Team Representatives, PNR Representative, ADB Representative, EcosysCorp, Inc.	128	163	291
8:00 A.M. 30 August 2018	Yumi Clark Agro Inc. Compound, Gil Puyat Avenue, Brgy. San Joaquin, Mabalacat City, Pampanga	Mabalacat City, Pampanga (Gil Puyat Avenue Depot)	PAP, EcosysCorp, Inc.	0	1	1
11:00 A.M. 06 September 2018	Yumi Clark Agro Inc. Compound, Gil Puyat Avenue, Brgy. San Joaquin, Mabalacat City, Pampanga	Mabalacat City, Pampanga (Gil Puyat Avenue Depot)	PAPs, DOTr Representative, JICA Design Team Representative, EcosysCorp, Inc.	2	3	5
1:00 P.M. 06 September 2018	Covered Court, Barangay Hall Compound, Brgy. Dolores, Mabalacat City, Pampanga	Mabalacat City, Pampanga (Northrail Depot)	PAPs, DOTr Representatives, JICA Design Team Representatives, BLGUs, EcosysCorp, Inc.	23	8	31

Source: JICA Design Team

Table 9.2.55 Summary of Issues, Concerns, Comments, and Suggestions Raised during the Additional Round of First and Second SCMs

Queries/Concerns/Suggestions/Comments	Responses to Queries
Entitlements and Rights	
• Partially affected properties.	• Explained that if the remaining portion of the property would be unviable (e.g. the foundation of a structure needs to be removed/demolished), the whole property will be acquired and compensated instead. Added that if the remaining portion of the property would still be viable, then only the affected portion will be acquired.
• Process of compensation payments.	• Discussed the process for the payment of compensation and the requirements to be prepared by affected persons.
• Asked about relocation.	• Reiterated that only those underprivileged and homeless are qualified for socialized housing.
• Compensation of PAPs who made improvements to the structure they are renting;	• Explained that structures will be compensated according to their replacement cost without depreciation; • Suggested that renters coordinate with property owners
• Asked about the compensation/entitlements of landowners who do not have structures on their land	• Explained that all PAPs will have entitlements, including landowners without structures; • Reiterated that compensation and entitlements will be explained in the 3rd SCM
Issues and Concerns on the Tagging and Survey	
• Asked if the conduct of census and tagging activities mean that the area is surely affected.	• Explained that tagging activities during the Feasibility Study stage are only to determine the budget needed for right-of-way acquisition. It does not necessarily mean that structures tagged during this stage are surely affected by the project. Added that structures tagged during the Detailed Design stage are those surely affected by the project.
• Asked if two households will be interviewed separately even if they live in one structure.	• Explained that interviews are conducted per household, and not per structure.
• Expressed concern on structure owners who are not in their properties when census and tagging activities are conducted	• Advised stakeholders who will not be available during the conduct of tagging activities to inform the Barangay Chairman if they are willing to have their structures tagged or otherwise; • Explained that interviews can also be conducted on weekends
Alternative Livelihood and Restoration Program	
• Expressed concern on the loss of livelihood.	• Mentioned that there will be a livelihood restoration and improvement program for relocatees, in accordance with the law and international guidelines; • Explained that affected businessowners will have the right of first offer.
Concerns on the Relocation Site	
• Expressed concern on the need to pay for relocation.	• Discussed the rationale behind paying for relocation.
• Asserted that relocation should be within the same affected city/municipality.	• Stated that in-city relocation is prioritized.
• Suggested that unused PNR properties be used as relocation sites for project-affected persons.	• Suggestion noted.
• Asserted that relocation sites should be complete with utilities and should not be flood-prone. •	• Stated that proponents are aware of the situation of resettlement sites for previous projects. • Assured stakeholders that JICA and ADB are closely monitoring the project.
• Asked if PAPs will be the ones to choose where they will be relocated.	• Explained that PAPs will be asked where they want to be relocated, but it will still depend on the availability of the site they choose and the capacity of the members of the association.
• Suggested that PAPs from Brgy. Dolores, Mabalacat, Pampanga be relocated within the Barangay;	• Suggestions noted
• Suggested that the open space beside the Sacovia River across the Xevera Compound be the resettlement site for PAPs from Brgy. Dolores	• Suggestions noted

Queries/Concerns/Suggestions/Comments	Responses to Queries
Right-Of-Way Issues	
• Mentioned that structures were built on PNR land because there was a previous agreement with the PNR wherein PNR employees are given rights to occupy/lease PNR land.	• Previous agreements with the PNR will be reviewed to determine the status of the ownership of affected land. • Asserted that expired agreements are no longer valid.
Timeline of the Project	
• Project timeline.	• Stated that the target start of construction is on May 2019 and that the target completion of the project is on 2022. • Informed stakeholders that targets are tentative and may move depending on the progress of the project.
• Asked when will station locations be finalized.	• Informed stakeholders that the final alignment of the project will be presented in the next stakeholder meetings.
Engineering Design	
• Suggested that the proposed Calumpit station be transferred to an area with lesser traffic and lesser affected people, such as the junction behind the old Caltex Station near the Colegio de Calumpit where a number of projects (including a commercial complex and a sports complex) will be built. Stressed that that the proposed alternative location of the Calumpit Station has access to roads leading to Pulilan, Plaridel, Pampanga and Malolos.	• Advised stakeholders to coordinate with their LGU so that comments and suggestions will be conveyed to the DOTr/proper agencies. • Mentioned that a proposal to move the Calumpit Station to a different location was already submitted.
• Asked about the measurement and location of the proposed Calumpit station.	• Stated that the current measurement of the station is 250 meters by 60 meters (around 1.2 hectares).
• Asked about the measurement of the right-of-way required by the project.	• Explained that the centerline and the boundaries of PNR properties are being determined in the ongoing relocation survey. Added that the final right-of-way needed for the project can be determined when the boundaries of PNR properties are established. • Explained that once the centerline is established, 30 meters will be needed for the alignment, and 60 meters will be needed for stations. • Stated that the final right-of-way needed will be presented in the next stakeholder meetings.
• Requests that the station be moved to a vacant lot owned by the Philippine National Railways	• Explained that the exact boundaries of PNR properties have yet to be identified; • Explained that private properties will be acquired if the ROW required by the project goes beyond the boundaries PNR properties
• Asked if there is an alternative location for the MCRP depot	• Explained that alternative sites for the depot are being studied • Explained that in choosing the location or right-of-way of government projects, the government always considers their own properties first
Concern on Flooding	
• Mentioned that the location of the old San Fernando Station and the proposed San Fernando station gets submerged in flood.	• Comment noted.
Other Issues and Concerns, and Suggestions	
• Inquired if there is an office PAPs could go to for concerns and queries regarding the project.	• Stated that there will be a Help Desk for the project. Help Desks are usually located in a barangay hall or a municipal/city hall.
• Stated that disclosing information that is not final causes anxiety.	• Explained that although holding meetings before everything is finalized brings stress and anxiety to potentially affected persons, holding meetings after everything is finalized would leave affected persons with no time to prepare.
• Mentioned that the Brgy. Iba O Este Tricycle Operators and Drivers Association has around 400 members; • Expressed concern on the loss of a tricycle terminal during the construction of the project; • Requested for a provision of a tricycle terminal	• Explained that a tricycle terminal may be considered in the planned transit-oriented development around the station; • Explained that the provision of a temporary tricycle terminal during the construction of the project may be considered

Queries/Concerns/Suggestions/Comments	Responses to Queries
• Explained that most potentially affected properties in Creekstone Homes (Brgy. Iba O Este, Calumpit, Bulacan) are still mortgaged to PAG-IBIG; • Explained that PAG-IBIG transfers titles to those who purchased them after 2 years of payments, even if the properties have not been fully paid yet; • Explained that the original titles are still with PAG-IBIG	• Explained that the government only gives compensation to whoever is listed in the titles of affected properties
• Explained that the potentially affected lands in Brgy. Dolores, Mabalacat, Pampanga are owned by the BCDA, but rights to the said lands were bought by PAPs (transfer of rights);	• Explained that documents such as Tax Declarations will be needed by Project-Affected Persons (PAPs) as proofs of their ownership to their properties; • Explained that PAPs without legal rights to affected lands may still be entitled to relocation

Source: JICA Design Team

(4) 3rd Round Stakeholder Meeting

The 3rd round of Stakeholder Consultation Meetings (SCMs) were held for each affected LGU as shown in Table 9.2.56. The 3rd SCM started with updates on the Project. This was followed by the explanation of the Entitlement Matrix. At the end of each meeting, the invited PAPs were encouraged to participate in the open forum to express their comments/suggestions/opinions. A summary of the main concerns/issues raised during the third SCMs is provided in Table 9.2.57.

Table 9.2.56 Outline of the 3rd Round of Stakeholder Consultation Meetings for MCRP

Date & Time	LGUs	Venue	Main Participants	Number of Participants		
				Male	Female	Total
8:00 A.M. 16 August 2018	Angeles City, Pampanga	Session Hall, Legislative Building, Angeles City Hall Compound, Angeles City, Pampanga	PAPs, BLGUs, DOTr Representatives, NHA Representative, ADB Representative, JICA Design Team Representatives, EcosysCorp, Inc.	80	100	180
2:00 P.M. 16 August 2018	Municipality of Calumpit, Bulacan	Covered Court, Calumpit Municipal Hall Compound, Brgy. Balungao, Calumpit, Bulacan	PAPs, BLGUs, DOTr Representatives, NHA Representative, ADB Representative, JICA Design Team Representatives, EcosysCorp, Inc.	102	167	269
8:00 A.M. 17 August 2018	City of San Fernando, Pampanga (Cluster 1)	Covered Court, Brgy. Santo Niño, City of San Fernando, Pampanga	PAPs, BLGUs, DOTr Representatives, NHA Representative, ADB Representative, JICA Design Team Representatives, EcosysCorp, Inc.	115	185	300
2:00 P.M. 17 August 2018	City of San Fernando, Pampanga (Cluster 2)	Covered Court, Brgy. Santo Niño, City of San Fernando, Pampanga	PAPs, BLGUs, DOTr Representatives, NHA Representative, ADB Representative, JICA Design Team Representatives, EcosysCorp, Inc.	146	244	390

Date & Time	LGUs	Venue	Main Participants	Number of Participants		
				Male	Female	Total
8:00 A.M. 23 August 2018	Municipality of Santo Tomas, Minalin and Apalit, Pampanga, and Malolos City, Bulacan	Santo Tomas Municipal Hall, Brgy. San Vicente, Santo Tomas, Pampanga	PAPs, BLGUs, DOTr Representatives, ADB Representative, JICA Design Team Representatives, EcosysCorp, Inc.	14	18	32
2:00 P.M. 23 August 2018	Mabalacat City, Pampanga	Xevera Lot Only Basketball Court, Brgy. Tabun, Mabalacat City, Pampanga	PAPs, BLGUs, DOTr Representatives, ADB Representative, JICA Design Team Representatives, EcosysCorp, Inc.	122	145	267
8:00 A.M. September 12, 2018	Mabalacat City, Pampanga (Proposed Depot – Alternative 2)	Yumi Clark Agro Inc. Compound, Gil Puyat Avenue, Brgy. San Joaquin, Mabalacat City, Pampanga	PAPs, BLGU, Ecosys Corp, Inc.	2	2	4
8:00 A.M. September 12, 2018	Mabalacat City, Pampanga (Proposed Depot – Alternative 2)	Covered Court, Barangay Hall Compound, Brgy. Dolores, Mabalacat City, Pampanga	PAPs, DOTr Representative, JICA Design Team Representatives, ADB Representatives, NHA Representatives, LGUs, BLGUs, EcosysCorp, Inc.	31	14	45

Source: JICA Design Team

Table 9.2.57 Summary of Issues, Concerns, Comments, and Suggestions Raised during the 3rd SCM

Queries/Concerns/Suggestions/Comments	Responses to Queries
Entitlements and Rights	
• Asked about entitlements of affected employees	• Explained that employees of affected businesses are entitled to 2 months of compensation
• Asked about the entitlements of an affected businesses	• Explained that business owners are entitled to 3 months of rental assistance, assuming their lease agreements are not expired
• Asked about the compensation for partially affected structures	• Explained that if structures become economically non-viable, the whole structure will be acquired instead; • Reiterated that structures will be compensated based on their replacement cost
• Asked if those capable to buy other properties will not be qualified for housing	• Reiterated that those capable may not be qualified to avail of socialized housing; • Reiterated that socialized housing is not just the only option offered by the government
• Asked if affected fences will be compensated	• Explained that fences are improvements, and that all affected improvements will be compensated based on their replacement cost
• Asked if occupants of tagged structures are the ones with entitlements	• Reiterated that structures tagged in the second set of tagging activities to be conducted in the Detailed Design stage are those surely affected by the project; • Stated that surely affected PAPs have entitlements; • Reiterated that all those interviewed are part of the masterlist of PAPs
• Asked if people who bought rights to affected land will be compensated	• Explained that rights to affected land cannot be compensated

Queries/Concerns/Suggestions/Comments	Responses to Queries
• Asked if groups under Community Mortgage Programs (CMPs) will be compensated	• Explained that if the properties are affected by the project, compensation payment will go to its owners; • Advised PAPs to keep all receipts of their payments; • Reiterated that PAPs will still be eligible for another CMP
• Asked if renters will be relocated	• Reiterated that renters may be eligible for relocation
• Asked about the compensation of land and structure owners	• Reiterated that land owners and structure owners will be compensated for their properties; • Briefly discussed other entitlements of property owners
• Asked about entitlements of those who purchased rights to affected land in Brgy. Dolores, Mabalacat City, Pampanga	• Reiterated that property owners with valid proofs of ownership to affected land/structures will be compensated; • Stated that the DOTr and BCDA will discuss the issues/concerns raised by stakeholders;
• Asked about the assurance that entitlements will indeed by given to PAPs	• Explained that the signing of loan agreements for the project will not be possible if international guidelines will not be followed
• Expressed concern on the cost of transferring seedlings and soil	• Explained that the cost of transferring seedlings and soil will be shouldered by the DOTr
• Asked about compensation for affected crops	• Responded that compensation will be based on the full harvestable value of affected grown vegetables
Issues and Concerns on the Tagging and Survey	
• Asked if there will be a second batch of interviews	• Explained that there will be a second round of interviews for those who were not interviewed; • Explained that those with newly built structures will not be interviewed; • Reiterated that all PAPs, even those who were not interviewed, have entitlements
• Expressed concern on properties which were not tagged	• Explained that tags are placed only if consent is given by structure occupants; • Explained that all potentially affected structures have control numbers assigned to them; • Explained that all potentially affected structures were photographed; • Advised stakeholders who will not be available during tagging activities to inform their barangays whether they agree to have their structures tagged or not
• Mentioned that renters were the only ones interviewed and asked if renters will have separate entitlements from property owners	• Reiterated that renters and property owners have different entitlements
• Asked how owners of affected vacant lands will be identified	• Explained that owners of vacant lots will be identified through the parcellary survey
• Asked how the government will identify those who bought rights to the affected land but did not build any structure	• Stated that PAPs who purchased rights to affected land can request a certification from the Barangay Chairman
Alternative Livelihood and Restoration Program	
• Raised concern on the loss of income from the tenants of affected properties	• Explained that studies will be made to determine the entitlements of those who will lose income from rentals; • Explained that stakeholders who have the same concern may possibly be entitled to a maximum of 6 months of income loss compensation
• Requested that the hiring of PAPs be prioritized	• Advised interested PAPs to undergo training as early as now so that they can acquire the skills necessary for them to be hired; • Reiterated that livelihood restoration considers the hiring of PAPs
• Requested for relocation to be single detached housing so that there will be parking spaces for beneficiaries who bought vehicles for their livelihood	• Reiterated that only the underprivileged and homeless can be qualified for socialized housing; • Reiterated that the NHA only caters to low-income earners, and that those who are capable of buying vehicles might not be qualified for socialized housing
• Expressed concern on the possibility of being unable to pay for socialized housing	• Reiterated that livelihood programs will be provided by the government

Queries/Concerns/Suggestions/Comments	Responses to Queries
Concerns on the Relocation Site	
• Asked if subsidy will still be given to relocatees if the relocation site is not yet ready after 5 months	• Explained that rental allowance is given when the relocation site is not yet ready; • Explained that developers will be given a timeline which they should follow
• Expressed concern on the quality and the lack of basic utilities and livelihood in relocation sites	• Stated that JICA and ADB are closely monitoring the project; • Explained that a relocation program is included in the budget of the project; • Explained that the provision of basic social facilities/amenities, utilities, and livelihood in relocation sites is included in the relocation program
• Expressed concern on the amount of amortization to be paid for housing	• Explained that the amount of amortization for housing programs will be based on the capability of the awardees to pay
• Asked about the location of the relocation sites	• Explained that relocation sites have not been identified
Concern on Access (Vehicles & Residents)	
• Expressed concern on the possible loss of access to properties because of the project's fenced ROW	• Explained that access to properties will be considered in the project's design
• Expressed concern on the possible closure of roads because of the project	• Stated that the closure of access roads will be avoided; • Assured stakeholders that if the closure of an access road is unavoidable, an alternative route will be opened
Timeline of the Project	
• Project timeline	• Target start of construction is on May 2019; • Target start of operations is in 2022
• Asked when the final location of the project's depot will be determined	• Exact boundaries of the project's depot, alignment, and stations will be determined after the completion of the parcellary survey during the DD stage towards the end of 2018
Engineering Design	
• Asked about the required Right-Of-Way (ROW) of the project	• Explained that 30 meters of Right-Of-Way (ROW) is needed for the project's alignment; • Explained that the exact boundaries of the Philippine National Railways (PNR) ROW have yet to be determined through a parcellary survey; • Stated that the parcellary survey will be conducted from August 2018 to September 2018; • Reiterated that meetings will be held to present updates on the project
• Asked about the location of the Calumpit station	• Explained that the proposed Calumpit Station was moved to Brgy. Iba O Este
• Asked about the measurement of stations	• Stated that stations measure 50 meters by 250 meters
• Suggested that vacant PNR lands be used for the whole project	• Explained that the design of the project may not be compatible with the existing PNR ROW; • Explained that social, engineering, financial, and safety factors were considered in studies for the project
Other Issues and Concerns, and Suggestions	
• PAP mentioned that he inherited his potentially affected land from his grandparents and that its title is lost	• Advised PAP to execute an extrajudicial settlement with the other heirs of the subject property as soon as possible since the government will only compensate whoever is listed in affected titles; • Advised PAP to approach the Help Desk so that assistance can be given by the DOTr
• Asked what will happen to entitlements if the entitled PAP goes abroad	• Explained that a Special Power of Attorney can be executed by the PAP
• Asked about the appraisal of properties	• Explained that the appraisal of affected properties will be conducted after the second round of tagging activities; • Explained that affected properties will be appraised by Independent Property Appraisers
• Asked if properties that are outside PNR properties but are within the project's required ROW will be acquired by the government	• Explained that properties within the project's required ROW will be acquired and compensated by the government

Queries/Concerns/Suggestions/Comments	Responses to Queries
• Expressed concern on the loss of a tricycle terminal currently located along the PNR ROW	• Assured stakeholders that there will be livelihood restoration planning which will consider affected Tricycle Operators and Drivers Associations
• Raised concern about affected properties in Creekstone (Brgy. Iba O Este, Calumpit, Bulacan) still being paid off to PAGIBIG • Asked if amortizations paid to PAGIBIG will be returned	• Explained that PAPs are entitled to avail of another PAGIBIG housing loan; • Explained that for affected properties, the PAGIBIG loan will be closed, and amortizations will be returned
• Raised concern on PNR land being sold and structures currently being built on PNR properties	• Assured PAP that the PNR will look into PAP's concern
• Asked if PAPs can be assisted when availing PAGIBIG housing loans	• Explained that PAGIBIG housing loans are available to all, and that assistance will be given to PAPs
• Mentioned that property is still mortgaged to a bank	• Stated that the PAP's willingness to enter into a negotiated sale can be expressed at the Help Desk for the project so that assistance can be given; • Explained that it is possible that the remaining balance of the mortgage will just be deducted from the compensation the PAP will receive
• PAP mentioned that she is paying the GSIS for a potentially affected property; • Mentioned that PAP only continued/resumed the payments of the original owner of the said property	• Advised PAP to visit the GSIS and fix the documents for the property she is paying for, and ensure that her payments are transferred under her name
• Expressed concern on buyers of affected PAGIBIG-owned foreclosed properties	• Advised buyers of potentially affected PAGIBIG-owned foreclosed properties to visit PAGIBIG and fix all matters related to their properties
• Expressed concern on safety/livability of properties near the project	• Assured stakeholders that structures outside the project's ROW are safe
• Reiterated request for relocation to be within the same barangay (Brgy. Dolores, Mabalacat City, Pampanga)	• Comment noted
• Asked if the construction of unfinished structures can still continue	• Reiterated that since there is a cut-off date for those with no legally recognizable rights to the affected land, any improvement made after the cut-off date will not be compensated
• Asked if affected properties should be vacated once construction begins	• Explained that PAPs will be given enough time to relocate; • Reiterated that there will be no demolition without relocation; • Reiterated that PAPs will not be asked to vacate affected properties until relocation is available
• Mentioned that he did not receive an invitation to the 1st and 2nd SCMs	• Explained that invitations were sent to affected barangays; • Explained that texts were sent to those who gave their mobile numbers during the interviews/census; • Explained that a parcellary survey that will identify the owners of affected properties is not yet available during the feasibility study stage
• Expressed concern on the budget the government needs to prepare to implement the RAP	• Explained that the Feasibility Study RAP includes the costs needed for its implementation; • Explained that the loan agreement will not be approved if budget for right-of-way acquisition is not available

Source: JICA Design Team

(5) Focus Group Discussion with Affected Vulnerable Sector

This Focus Group Discussion (FGD) was conducted as part of the consultation with the vulnerable sectors affected by the MCRP. The vulnerable sectors in this FGDs will only be limited to the poor, the underprivileged, and the homeless, including socialized housing beneficiaries. Separate FGDs have been designed and conducted for other vulnerable groups such as women, elderly, and children under the Gender Impact Assessment component of the Resettlement Action Plan (RAP).

Table 9.2.58 indicates the dates and locations of the FGDs for each City/Municipality.

Table 9.2.58 Dates and Locations of FGDs

City/Municipality	Date	Time	Venue	Female	Male	Total
Angeles, Pampanga	16 April 2018	2:00 P.M.	Angeles Elementary School, Brgy. Pulungbulu	12	17	29
San Fernando, Pampanga	17 April 2018	9:00 A.M.	City College of San Fernando, San Juan	9	7	16
Calumpit, Bulacan	19 April 2018	9:00 A.M.	F. Mendoza Memorial Elem. School	13	13	26
Malolos, Bulacan	19 April 2018	2:00 P.M.	City of Malolos Integrated School	5	2	7
Santo Tomas, Pampanga	20 April 2018	9:00 A.M.	Santo Tomas Municipal Hall	22	9	31
Total				**61**	**48**	**109**

Source: JICA Design Team

The results of the FGDs are summarize in Table 9.2.59.

Table 9.2.59 Consolidated MCRP FGD Results

Guide Questions	Responses
1. What are your apprehensions /concerns regarding the potential impact of resettlement on your livelihoods?	• Location of relocation site being far from current location resulting to apprehensions over distance from current workplace and livelihoods consequently leading to longer travel time, additional transport cost, and added pressure on income and business capital • Ability to continue current livelihoods at relocation site vis-à-vis loss of regular clients/customers, limited space, existence of similar enterprises (e.g. sari-sari stores, eateries, etc.), reduced capital due to added cost of going to and from product source (market) • • Other Concerns: • Absence of power and water system at relocation site • Concerns over access to basic services/facilities such as hospitals and schools, churches, market, including peace and order situation at relocation site • Current houses are still being amortized with Pag-ibig Housing as part of the previous relocation program. What will happen to payments already made and whether compensation will be provided with consideration to the improvements already made
2. What support programs do you think are necessary to help you cope up with the possible impacts on your livelihoods?	• Financial assistance to augment business/income losses due to physical relocation • Commercial spaces at relocation site for sari-sari store owners, vendors, eateries/carenderia owners, etc. • Agricultural program on livestock and poultry raising • Establishment of 24-hour transport terminal at relocation site so that employees/workers will have access to transport services anytime (e.g. call center employees, etc.) • Creation of a transport operators/drivers association (TODA) at the relocation for affected tricycle/jeepney drivers and operators • Relocation in single-detached housing units to be able to continue mini-food stores / eatery • Relocation near main roads to continue vending/selling products • Government to provide service/shuttle bus to workers whose jobs will be far from the relocation site

Guide Questions	Responses
3. If livelihood restoration is not possible, what alternative livelihood programs can you suggest?	• Financial support to start new businesses/enterprises • Opportunity to enter into small business contracts with the government (i.e. tailors, dressmakers etc.) • Be provided with an area to carry out farming enterprises (i.e. crop and livestock production) • Training on farming technologies • Livelihood skills training programs (e.g. bag-making, slippers-making or handicrafts/decorations-making) • Free access to TESDA courses for affected persons • Relocation near factories or encourage investors near relocation sites to generate jobs • Financial assistance for senior citizens who are no longer able to engage in any other alternative livelihoods
4. What other programs can you suggest to help improve existing livelihoods and consequently help improve household income?	• Skills training program to improve current livelihoods • Trainings on financial literacy and business management • Free training programs to be carried out right at the relocation site so that affected persons will have the opportunity to learn new skills and establish new livelihood enterprises • Assistance to improve products (e.g. improved packaging for ice cream and processed meat, provision of better appliance/machine for ice cream making) • Access to micro-finance or funding institutions • Encourage investors to put up industries near relocation site so that more jobs can be generated • Provide permanent job opportunities • Training on business management and financial management
5. How do you think the project can help you cope better with the livelihood impacts?	• During Construction • Priority in employment opportunities during construction • PAPs to be allowed to put up stores near construction site (i.e. sari-sari stores, eatery) • During Operation • Priority in employment opportunities during operations • No age limit in hiring able and capable employees • Prioritize new graduates from affected households for employment • Employment opportunities during the operation should include benefits like what they are currently enjoying at work (e.g. promotions for good performance, etc.)
6. What is your relocation preference?	• Relocation near current location or current City/Municipality • Housing at relocation site with access to water and power supply • Low-cost housing and affordable payment terms same as HDMF system (25-30 years and amortization to start after a reasonable number of years (i.e. 2 years) to allow for livelihoods to be re-established first • Free Housing • Implement sports program to jobless so that they will be productive and not become a problem to the community • Secure place and near police station • Peace and order at the relocation site • Site should have trees, so it will not be hot • Near schools, hospital, church and market place • Assignment of relocation houses should consider current neighborhood locations to maintain support network and adjustment is easy • Bigger lot area (120sqm) and floor area (at least bigger than the government standard of 40sqm) • Single-detached houses and not multi-storey buildings • To be relocated in the current subdivision (Bondocville) • Sturdy housing materials • Regulated transport fare so that no one will take advantage of the relocatees' situation • Opportunities for employment at relocation site

Guide Questions	Responses
	• Accessible transport terminal and relocation near main roads • Flood-free, peaceful community with clean surroundings and properly maintained and would not look like a squatters' area
7. What are the factors influencing your relocation preference?	• Relocation site of our neighbors who were relocated earlier were not orderly. Location is very hot like a desert that's why most relocatees left and went back to where they came from • Current neighborhood is the source of support in times of need, hence, it's important that they remain neighbors in the relocation site • No peace and order current community (e.g. robbery etc.) • Preferred Bondocville because it is not crowded, with wide streets, house sizes are big with the option to extend upwards (2nd floor) • The Northville relocation experience wasn't good, messy • Some previous government housing projects are not good, not sturdy, design and materials for windows and doors did not consider security of occupants • Water and electricity are essential • Most government housing are substandard • Other relocation sites are prone to flooding • So that the cost of housing is not going to add burden to our household • To be near current workplace/jobs • Government housing are weak. Roofs get blown during heavy winds • To be able to plant within the vicinity of houses as a stress reliever • Too noisy for houses to be too close to each other • To have some privacy if houses are not closely located with each other • Floods are sources of illnesses • People in the squatters' area mostly drink and create trouble in the community
8. Other suggested resettlement support/assistance	• Financial assistance while re-establishing livelihoods at the relocation site to support day-to-day needs and activities • Provide trucks during physical relocation or financial assistance to hire vehicle/trucks • Give enough time for adjustment to let them better understand their situation • Provide relief goods during relocation in the form of food assistance during transition period (e.g. 2-3 months) • Financial assistance for the affected senior citizens • Relocation should be carried out during dry season so that it would be less difficult • Cash compensation for affected properties should be paid early so that it can be used to rebuild their lives • Security during relocation to avoid looting • Food allowance during relocation • Labor assistance during relocation • Ensure that timing of relocation would not affect the schooling of children

Source: JICA Design Team


Photo 9.2.3 FGD in Angeles (left) and San Fernando (right)

(6) Focus Group Discussion (FGD) with Affected Business Sector

Besides the FGD for the affected vulnerable sector, FGD for the Affected Business Sector was held. The notification to the stakeholders was conducted through the sub-consultants who noticed the Barangays, who in turn noticed the concerned stakeholders through phone calls or person to person information. During hearing and collect comments from PAPs, gender balance and gender difference were considered. To encourage and have at least 40% women participation, child-minding services and breastfeeding area were arranged.

Results from the FGDs will be consolidated to substantiate the data gathered from the Socio-Economic Survey and will be analyzed as inputs in the preparation of the LRIP which will be included in the RAP.

The FGDs were conducted in the Cities/Municipalities of Angeles, San Fernando, and Sto. Tomas in Pampanga and Calumpit and Malolos in Bulacan. Table 9.2.60 below indicates the dates and locations of the FGDs for each City/Municipality.

Table 9.2.60 FGD dates, Targets and Participants

City/Municipality	Date	Location	Participants		
			Male	Female	Total
Angeles, Pampanga	April 16, 2018	Angeles Elementary School, Brgy. Pulungbulu	4	3	7
San Fernando, Pampanga	April 17, 2018	City College of San Fernando, San Juan	2	1	3
Calumpit, Bulacan	April 19, 2018	F. Mendoza Memorial Elem. School	0	0	0
Malolos, Bulacan	April 19, 2018	City of Malolos Integrated School	0	1	1
Santo Tomas, Pampanga	April 20, 2018	Santo Tomas Municipal Hall	1	0	1
Minalin, Pampanga	April 20, 2018	Brgy. Hall, Minalin, Pampanga	2	0	2
Total			**9**	**5**	**14**

Source: JICA Design Team

The results of the FGDs are summarized in Table 9.2.61.

Table 9.2.61 FGD Results for the Business Sector

Guide Questions	Responses
1. On the business side - What are your apprehensions/concerns regarding acquisition of your property?	• Loss of property • What will happen to the business? • Loss of access if railway will be fenced • What will happen to the remaining property if not all will be acquired • What will happen to tenants? Will there also be financial assistance to tenants? • Loss of space • Loss of investment • Where to relocate business • Finding a conducive location • Transferring factory equipment and supplies • It will be a new chapter in their lives • Difficulty in setting up/re-establishing business • Distance in new place • Losing customers • Effect on income (product has shelf life) • Space for fishpond will become smaller • Compensation for the expenses incurred in developing fishpond
2. What are your expectations regarding livelihood restoration and improvement?	• Compensation for loss of property • Financial assistance to relocate business/mobilization of tools and equipment • Opportunity to have space to re-establish business • Opportunity to land a job while re-establishing eatery • On-time payment of compensation • Opportunity to find a building/space within the city • Transition allowance • Assistance in transferring equipment • Assistance in finding space for business • Financial assistance in transporting equipment/machinery/products • Additional capital to purchase machinery • Compensation for the portion of affected property so that they can purchase equipment/materials • Assistance to avail of loan with no interest to be able for additional capital to purchase good fingerlings to boost production and ensure steady income
3. What possible project benefit sharing schemes can you suggest?	
During Construction?	• Opportunity to put up eatery
During Operation?	• Opportunity to put up eatery
4. What is your expected timeline for this?	
During Construction?	• No answer
During Operation?	• No answer
5. What do you consider as “deal breakers” for the schemes presented?	• Delays in compensation for property • Unjust compensation

9.3 Gender Impact Assessment

A Gender Impact Assessment has been conducted as a component of the Resettlement Action Plan (RAP) in order to anticipate or identify the likelihood of the project effecting negative consequences for either women or men, which bear on the degree of equality between them.

9.3.1 Legal Framework

The Legal Framework guidelines for Gender Consideration is summarized in Table 9.3.1.

Table 9.3.1 Legal Framework for Gender Considerations

Law and Regulations	Contents
RA 9710, Magna Carta of Women of 2009	• Addresses the gender gaps favoring men, thus paving the way to gender equality and women empowerment. • The law recognizes the economic, political, and sociocultural realities affecting women's current condition. The equality of men and women entails the abolition of the unequal structures and practices that perpetuate discrimination and inequality.
Harmonized Gender and Development Guidelines for Project Development, Implementation, Monitoring and Evaluation (2007)	• Provides Philippine government agencies (including LGUs), ODA donors and development practitioners with a common set of analytical concepts and tools for integrating gender concerns into development programs and projects. The uniform guidelines are supposed to help users in evaluating projects proposed for funding, designing projects, and implementing them – including managing, monitoring and evaluating performance.
DOTr Department Order No. 2012-05	• Requires that "Specific analysis/evaluation and recommendations on gender-related issued shall be incorporated in the locally- and foreign funded transport development studies (master plan studies and feasibility studies), to include service level standards in service-oriented industry."

Source: JICA Design Team

9.3.2 Focus Group Discussion

The FGDs were conducted from April 16, 2018 for each of the host LGUs, namely: Malolos and Calumpit in Bulacan, and Angeles, San Fernando and Sto. Tomas in Pampanga. Fifteen participants were randomly selected from the list of female respondents and female household heads of the SES to participate in the FGDs.

9.3.2.1 Issues on access for potential female users in terms of: travel patterns, modes of transportation, and access to resources for travel

In order to determine the participants' travel patterns, modes of transportation, and access to resources for travel, they were asked the following questions:

a. What regular trips do you take and for what purpose?
b. What is your regular mode of transportation?
c. What is your reason/consideration in choosing this mode?

Majority of the participants are full time housewives with some having homebased livelihood like sari-sari store or carinderia. The very few participants are having regular work outside of the house.

As for the question (a), a regular trip and its purpose, major answers are as follows: (i) Market for daily food consumption, (ii) Market weekly for goods and merchandise for their sari-sari store or carinderia, (ii) Bring and fetch their children to and from school, (iv) Pay the bills, (v) Visit the health center for the vaccination of their children and for free contraceptives, and, (vi) Go to church. All are response form the housewives, which reveals the major role they play are caring for the family and managing the household. The respondents who have regular work take trips to the mall for recreation and eating out during Sundays after church.

Responses also reveal that their common modes of transportation are jeepney and tricycle although majority of them choose to walk whenever possible to save on transportation fare.

As for the question (c) common modes of transportation are jeepney and tricycle.

However, related to the question (d) majority of the respondents choose to walk whenever possible to save on transportation fare.

9.3.2.2 Perceived Threats and Potential Benefits of the project

The second set of questions were to collect the participants' perception on the Project in terms of perceived threats and potential benefits. The questions are:

a. As a woman, what are your apprehensions and concerns about the project?
b. As a woman, what other negative effects do you feel will result from this project?
c. What potential benefits do you think will result from the project for you, your family and the community?

Answers to the question (a) and (b)s are as follows: losing their homes, losing their livelihood, being moved away from work, being moved away from their children's school, and the uncertainty of the kind of life that they will have in the relocation site.

Responses on potential benefits of the Project, the question (c), were few. The participants emphasized that although the railway project will bring development to their city/municipality, it will not benefit them directly because their regular trips do not require the services of a train.

9.3.2.3 Livelihood Opportunities

In order to help the participants identifying livelihood opportunities that the project will open for them; the following questions were asked:

a. What type of job or work do you think you can perform during construction and operation?
b. What other livelihood opportunities do you think will stem from the project?
c. In the light of a possible relocation and loss of livelihood, what types of assistance can help you restore and improve your livelihood?

The participants gave very few answers to the questions above. Most of them held the common conception that jobs especially during construction are mostly for men. The jobs that they identified were related to the work that they currently do as housewives: cooking and selling food, food vending and jobs related to cleaning (utility worker, janitress).

9.3.3 Recommendations

Based on the Gender Analysis of the MCRP, a Gender Action Plan (GAP) was developed to recommend and propose measures to address gender-specific needs of potential female users of the MCRP integrating gender considerations in all the project phases. This GAP was shared within the Study Team for considerations, and gender considerations are applied in the design of stations and train. Even in the preparation of this RAP, child-friendly corners were provided during the SCMs to ensure women's the participation in the planning stage. This GAP will also be applied to the LRIP, to ensure that women are given opportunities to improve their economic status.

Table 9.3.2 Gender Action Plan for MCRP

Project Outcome: Improved Commuter Railway System		
Components and Outputs	**Proposed Gender Mainstreaming Activities**	**Primary Responsibility**
Output 1. Integrate gender-sensitive physical design features		
1.1 Integrate railway safety and accessibility-related physical design features that effectively protect and address specific needs of women	Priority seating, handrails, and waiting spaces for women, elderly, and people with disability in all trains and train stations Ensure that handlebars are suited to average height of Filipino women Ensure that all road safety and IEC materials developed are gender-sensitive and do not promote gender stereotypes (e.g. use appropriate gender sensitive language)	DOTr Project Team, JICA Design Team, Local Consultant
1.2 Reduce gender inequalities and social risks at Railway Stations	Installation of sufficient lighting and CCTVs especially in dark areas, around basic facilities in the stations e.g. walkways, stairs and platforms Provide separate male/female toilets and larger capacity female toilets at railway stations and on trains Increased visibility of security personnel to prevent the occurrence gender-related violence (e.g. sexual harassment) Set up a Complaints Desk for violations to personal safety Train public transport staff and local railway security personnel on proper response, handling and management of sexual harassment cases	DOTr Project Team, JICA Design Team, Local Consultant
Output 2. Increase women's participation in all Project Stages: Planning, Design, Construction, Operation and Maintenance		
2.1 Ensure participation of Women in project-related consultations	Ensure participation of women in all public consultations and consultative meetings and conduct these in local languages Provide for a Child-friendly Corner (child-minding/babysitting services, breastfeeding area) during public consultations and meetings to encourage women to attend and participate Encourage women participation in Grievance Redress Mechanisms (GRM) Committee (at least 1 woman in addition to all members) Female representation in all committees established for the project	DOTr Project Team, JICA Design Team, Local Consultant

Project Outcome: Improved Commuter Railway System		
Components and Outputs	**Proposed Gender Mainstreaming Activities**	**Primary Responsibility**
Output 3. Improve economic opportunities for women		
3.1 Ensure that construction activities abide by labor standards, such as equal opportunities and equal wages of men and women for work of equal value, prohibition of child labor, etc.	Bidding documents and contracts contain provisions on core labor standards Incidents of non-compliance reported Where possible, include provisions in bidding documents to encourage women's participation in labor-based work during the construction, including female hiring to comprise 20% of the total workforce in skilled and unskilled position Ensure equal pay for equal work between male and female workers, and payment for women should be given directly to them	DOTr Project Team, JICA Design Team, Contractors
3.2 Promote women's livelihood and entrepreneurship in railway stations	Allocation of reserved shop spaces for women's businesses inside the railway stations	DOTr Project Team, JICA Design Team, Local Consultant
3.3 Ensure that resettlement activities will deal with both men and women including equal compensation for both	If land is acquired and/or livelihood is affected, ensure that affected females are compensated at the same rate of payment as affected males, and provided with adequate arrangements to restore/maintain livelihoods (replacement of land, financing for micro business opportunities, skills training for income generation projects, cash transfers, etc.)	DOTr Project Team, JICA Design Team, Local Consultant
3.4 Reduce gender inequalities and social risks	Provide separate sanitary facilities and changing rooms and lockers for men and women Organize bi-annual training for railway workers and community members on gender issues and HIV/AIDS awareness Provide Gender-sensitivity trainings for all construction workers and affected community members. 100% of women employed in the MCRP trained in train safety	DOTr Project Team, JICA Design Team, Local Consultant
Output 4. Institutional Strengthening and Capacity Building for Better Project Management		
4.1 Enhanced gender-responsiveness of transport authorities and project management	Recruitment of at least 20% women staff for its project management unit Recruitment of a Gender Specialist to assess, consult, train and help manage the implementation of GAP Inclusion of indicators that measures the implementation of the GAP in the MCRP project monitoring framework Collection, analysis and maintenance of sex-disaggregated data in the baseline, progress and monitoring and evaluation reports	DOTr PMO
4.2 Capacity building for gender mainstreaming	Develop a gender strategy to recruit female staff in various positions and additional capacity building and training for female staff Conduct gender-sensitivity trainings and HIV/AIDS awareness for MCRP project management staff	DOTr PMO
Implementation Arrangements: The GAP implementation will be the primary responsibility of the Gender Specialist under the DOTr PMO. Likewise, GAP implementation progress reports are to be prepared and submitted bi-annually by the PMO Gender Specialist.		

Source: JICA Design Team