DEPARTMENT OF TRANSPORTATION AND COMMUNICATIONS (DOTC)
REPUBLIC OF THE PHILIPPINES

STUDY ON RAILWAY STRATEGY FOR ENHANCEMENT OF RAILWAY NETWORK SYSTEM IN METRO MANILA OF THE REPUBLIC OF THE PHILIPPINES

FINAL REPORT

VOLUME 1

LRT LINE 1 CAVITE EXTENSION PROJECT

JULY 2013

JAPAN INTERNATIONAL COOPERATION AGENCY

ORIENTAL CONSULTANTS CO., LTD.
ALMEC CORPORATION
KATAHIRA & ENGINEERS INTERNATIONAL
TONICHI ENGINEERING CONSULTANTS, INC.

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VOLUME 1

LRT LINE 1 CAVITE EXTENSION PROJECT

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Abbreviation List

Term	English
AASHTO	American Association of State Highway and Transportation Office
AC	Alternate Current
ADB	Asian Development Bank
AFC	Automatic Fare Collection
APS	Audio/Paging System
ASCOM	Army Support Command
ASTM	American Society for Testing and Materials
ATC	Automated Train Control
ATO	Automated Train Operation
ATP	Automated Train Protection
ATS	Automated Train Supervision
AVI	Automatic Vehicle Identification
B/C	Benefit/Cost
BCDA	Base Conversion Development Authority
BIR	Bureau of Internal Revenue
BGC	Bonifacio Global City
BOT	Build-Operate-Transfer
BPO	Business Processing Outsourcing
CAAP	Civil Aviation Authority of the Philippines
CBD	Central Business District
CCTV	Closed-Circuit Television
CDCP	Construction Development Corporation of the Philippines
CDM	Clean Development Mechanism
CER	Certificated Emission Reduction
CIF	Cost, Insurance and Freight
CIIP	Comprehensive and Integrated Infrastructure Program
CNC	Certificate of Non-Coverage
CTMS	Central Traffic Control System
DAO	Department Administrative Order
DBM	Department of Budget and Management
DBP	Development Bank of the Philippines
DC	Direct Current
DED	Detailed Engineering Design
DENR	Department of Environment and Natural Resources
DFS	Detailed Feasibility Study
DILG	Department of Interior and Local Government
DOF	Department of Finance
DOTC	Department of Transportation and Communications
DPWH	Department of Public Works and Highways
DSCR	Debt Service Coverage Ratio
ECA	Environmentally Critical Area

Term	English
ECB	Emergency Call Box
ECC	Environmental Compliance Certificate
ECP	Environmentally Critical Project
EDSA	Epifanio de los Santos Avenue
EIA	Environmental Impact Assessment
EIAD	Environmental Impact Assessment Division
EIARC	Environmental Impact Assessment Review Committee
EIRR	Economic Internal Rate of Return
EIS	Environmental Impact Statement
EMB	Environmental Management Bureau
EMP	Environment Management Plan
EO	Executive Order
EPABX	Electronic Private Automatic Branch Exchange
EPRMP	Environmental Performance Report and Management Plan
ETC	Electronic Toll Collection
FACE	JBIC Facility for Asia Cooperation and Environment
FIRR	Financial Internal Rate of Return
FMB	Forest Management Bureau
FOB	Free on Board
FOE	Fixed Operational Equipment
FOTL	Fiber Optic Transmission Line
FWD	Falling Weight Deflection Meter
GDP	Gross Domestic Product
GEH	Geoffrey E. Havers (Modeling statistics)
GFI	Government Financial Institutions
GOP	Government of The Philippines
HCP	Hollow Core Plank
HGC	Home Guarantee Corporation
HOV	High Capacity Vehicle
HUDCC	Housing and Urban Development Coordinating Council
ICC	Investment Coordination Committee
ISO	International Organization for Standardization
ISM	International School of Manila
ITS	Intelligent Transport Systems
JBIC	Japan Bank International Cooperation
JETRO	Japan International Cooperation Agency
JICA	Japan International Cooperation Agency
KOICA	Korean International Cooperation Agency
LCC	Life Cycle Cost
LCX	Leaky Coaxial Cable
LGU	Local Government Unit
LLDA	Laguna Lake Development Authority
LRT	Light Rail Transit System (Manila)

Term	English
LRTA	Light Rail Transit Authority
MERALCO	Manila Electric Company
METI	Ministry of Economy, Trade and Industry
MIAA	Manila International Airport Authority
MIS	Management Information System
MMDA	Metropolitan Manila Development Authority
MMSW	Metro Manila Skyway
MMUTIS	Metro Manila Urban Transportation Integration Study
MNTC	Manila North Tollways Corporation
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MPIC	Metro Pacific Investment Corporation
MPTC	Metro Pacific Tollways Corporation
MRT	Metro Rail Transit System (Manila)
NAIA	Ninoy Aquino International Airport
NAMRIA	National Mapping and Resource Information Authority
NCR	National Capital Region
NEDA	National Economic Development Authority
NEPC	National Environmental Protection Council
NEXCO	Nippon Expressway Company Limited
C NEXCO	Central Nippon Expressway Company Limited
W NEXCO	West Nippon Expressway Company Limited
NHA	National Housing Authority
Ni-Cd	Nickel-Cadmium
NLEX	North Luzon Expressway
NOE	Non-Operational Equipment
NPCC	National Pollution Control Commission
NPV	Net Present Value
O&M	Operation and Maintenance
OCC	Operational Control Center
OCS	Overhead Contact System
OD	Origin-Destination
ODA	Official Development Assistance
OEM	Original Equipment Manufacturer
OMA	Operation Management Agreement
PABX	Private Automatic Branch exchange
PAGCOR	Philippine Amusement and Gaming Corporation
PC	Prestressed Concrete
PCU	Passenger Car Unit
PCUP	Presidential Commission on Urban Poor
PD	President Decree
PDR	Project Description Report
PFI	Private Finance Initiative

Term	English
PMO	Project Management Office
PNCC	Philippine National Construction Corporation
PNP	Philippine National Police
PNR	Philippines National Railroad
POS	Point of Sales
PPA	Philippine Ports Authority
PPHPD	Peak passengers per hour per direction at maximum load point
PPP	Public Private Partnership
PSSD	The Philippine Strategy for Sustainable Development
RA	Republic Act
RAP	Resettlement Action Plan
RC	Reinforced Concrete
RIMS	Road Maintenance Information Management System
RORO	Roll-on, roll-off
ROW	Right of Way
RSS	Rectifier SubStation
RSU	Road Safety Unit
SCADA	Supervisory Control and Data Acquisition
SCTEX	Subic-Clark-Tarlac Expressway
SDH	Synchronous Digital Hierarchy
SFEX	The Subic Freeport Expressway
SLEX	South Luzon Expressway
SNC	Ernst & Young ShinNihon LLC
SPC	Special Purpose Company
STOA	Supplemental Toll Operation Agreement
STRADA	System for Traffic Demand Analysis
TCS	Traffic Control System
TDM	Traffic Demand Management
TEG-NCRPO	Traffic Enforcement Group under National Capital Regional Police Office
TMP	Traffic Management Plan
TOA	Toll Operation Agreement
TPCS	Toll Plaza Computer System
TRB	Toll Regulatory Board
TSP	Total Suspended Particulate
TTC	Travel Time Cost
VCR	Vehicle Capacity Ratio
VICS	Vehicle Information and Communication System
VOC	Vehicle Operation Cost
UIC	Union Internationale des Chemins de fer
UMAK	University of Makati
UPS	Uninterruptible Power Supply
URPO	Urban Roads Project Office
VMS	Variable Message Sign

Term	English
VOC	Vehicle Operation Cost
VRS	Voice Recording System
VVVF	Variable Voltage Variable Frequency
WACC	Weighted Average Cost of Capital
WB	World Bank

CHAPTER 1
INTRODUCTION

CHAPTER 1 INTRODUCTION

1.1 Background

The LRT Line 1 South Extension Project, also known as Line 6 or Line 1 Cavite Extension, involves the extension of LRT services of the existing 20-kilometer LRT Line 1 system southward from Baclaran through the cities of Parañaque and Las Piñas in Metro Manila, up to the municipality of Bacoor in the Province of Cavite. The project involves the extension of the existing line by another 11.7-kilometers, adding eight (8) new stations with a provision for a further two future stations. Approximately 10.5 km of the Extension will be elevated and 1.2 km will be at grade. Three (3) of the 8 stations (Niyog, Zapote and Dr. Santos) will be designed as intermodal facilities to promote smooth transfer of passengers to/from other road-based transport services. This component will likewise include expansion of the existing depot in Pasay (Baclaran depot) to accommodate additional 21 trains that need to be added to the system with the expanded services, and the construction of a new satellite depot in Zapote, approximately about 4 hectares to accommodate about another 18 trains and provide light maintenance works. The project also includes the refurbishment of 52 of LRTA's existing light rail vehicles (LRVs).

The LRT Line 1 South Extension project has been identified as a priority infrastructure project of the Government of the Philippines (GOP) since the late 1990s. The Project was initially cleared for implementation by NEDA-ICC under an unsolicited joint venture arrangement between LRTA and SNC Lavalin, a Canadian company. The unsolicited proposal however did not flourish as the parties failed to reach agreement on key contractual points. In 2004, LRTA decided to pursue the Project through the solicited PPP mode. Unfortunately, the Project failed to get implemented due a wavering on the PPP policy and consequently government's failure to provide the required budget cover corresponding to the capital grant subsidy required to make the Project bankable. About this time, other unsolicited proposals were received and entertained by LRTA and the PPP approach was abandoned.

The current administration has again identified the Project as a priority strategic transport investment for decongesting traffic and promoting growth of other urban centers outside Metro Manila. The Project is deemed consistent with the current Philippine Development Plan (2011-2016) that highlights the strategy for expanding mass transit systems for urban centers to promote transport efficiencies, promoting users-pay principles to promote operational service sustainability, and broadening the role of the private sector particularly for the operation and management of these services.

Current LRT 1 operations cover approximately 20 kms of service line with a total of 21 stations from Roosevelt Avenue to Baclaran. The 5.7-km North Extension Project was opened for commercial operations in 2010. A Common Station connecting LRT-1, MRT-3, and possibly MRT-7 in North Avenue corner EDSA Boulevard is currently being studied for implementation. An 11 hectare area within the LRTA compound in Pasay City serves as the line's depot accommodating its current fleet of 139 LRVs and various buildings of LRTA. Patronage on the line is significant, about half a million passengers ride Line 1 everyday.

Urban rail services provide a more efficient alternative to road-based services. The current LRT network however needs to be expanded in reach and capacity in order to significantly increase daily passenger volumes. Currently, the 3 urban lines collectively carry a little over 1 million passengers per day which accounts for just 7.6% of person trips in Metro Manila.

The government's current strategy is now to expand, integrate and increase the capacity of LRT services. An integrated transport system is likewise envisaged with seamless transfers, i.e., unified ticketing system allowing efficient movement between lines and more intermodal stations facilitating access between the different lines and road-based transport services. Moreover, the seamless interoperation of Line 1 and 3 could be achieved within few years.

LRTA has already advertised for public procurement, rehabilitation works on LRT 1 amounting to around Php1.51 billions to be completed by 2015 that involves the rehabilitation of about 23 km. of tracks, rehabilitation of the entire 1st Generation fleet (21 BN LRVs), and restoration of 14 LRVs and other safety restoration works. The Railway Unified Ticketing System Project is currently under study for implementation also within 2012. Extensions of services of LRT 2 are likewise identified as part of the pipeline while system capacity upgrades are planned for MRT 3. LRT 1 service expansion to Cavite is consistent with DOTC's rail transport expansion strategy over the medium-term.

1.2 Implementation Scheme

Several PPP options were studied, including the operation and maintenance of the expanded LRT 1 line, and the selected scheme, which has been approved by NEDA early 2012, is a Hybrid scheme (PPP-ODA), where components of rolling stock, depot development, consultancy services of the Project are financed and implemented by government under a traditional ODA procurement process and upon completion it transfers the completed assets for O&M management to the private investor. The public sector, apart from financing, takes on the procurement, completion, and delivery risks for the public component, while the responsibility for financing, procuring and constructing/installing the rest of the components not implemented by government is lodged with the private investor, i.e. CW, E&M subsystems, and O&M. The ODA component, to be funded from JICA, is composed by the procurement of rolling stock, development of the two depot, and consultancy services. This concession will be awarded to the bidder that offers the best concession conditions to the government.

1.3 Objective of Study

The objectives of this study are as follows:

- Review of existing data and previous project evaluations and project parameters for further JICA appraisal
- Review of demand forecast to confirm future train operation plan and fleet requirements
- Close integration and monitoring of the preparation of private sector bid documents and future interface
- Define scope of works of Public sector (ODA) and private sector with in the construction of the depots
- Cost estimation

1.4 Content of this Report

This Final Report includes bellows.

- Demand forecast / Surveys
- Operation Plan/Rolling Stock
- Depot Facilities Plan
- Cost Estimation
- Environmental and Social Considerations
- Project Effects
- AFC（Automatic Fare Collection）
- Implementation Plan
- Institutional Issues to Implement The Project
- Performance specifications for Rolling Stock
- Recommendation for Railway Implementation in The Philippines

CHAPTER 2
DEMAND FORECAST

CHAPTER 2 DEMAND FORECAST

2.1 Line-1 Current Patronage and Review of Past Studies

2.1.1 Introduction

A number of Feasibility Studies and reviews have been conducted for the LRT Line-1 Extension from Baclaran to Niyog, since 1998, when the extension of the line was originally proposed by the comprehensive study of Metro Manila (MM) transport system, namely MMUTIS. The proposed southward extension would extend the current 18km Line-1 by an additional 11.8km with 10 new stations. The proposed alignment would extend the MM transit system to serve the National Capital Region (NC) southern cities of Pasay, Paranaque, and Las Pinas; terminating at Niyog, in Bacoor City of Cavite province. This alignment would serve the areas where growth in residential development has been fast and above average for over the last two decades. The need for the extension was justifiable even in 1998, and its realisation is long overdue.

The studies reviewed for this project are listed at the end of this Chapter. The last major study was conducted in 2006 [*Refrence-4*]. Since then there have been a number of reviews of past studies, most recently by the International Finance Corporation (IFC) in early 2012.

For this JICA study the scope of the review was to prepare 'preliminary' patronage demand estimate based on previous studies and relevant existing data. These demand estimates have been further studied and revised on the basis of traffic and passenger interview surveys conducted in June and July 2012, specifically for this project, to confirm the underlying assumptions and reasonableness of the forecast patronage. This Chapter presents the patronage demand estimate for the whole of Line-1for the next 30 years, based on the analysis of most recent (up to July 2012) data of the existing Line-1, supplied by the LRTA.

This Chapter focuses on the review and patronage forecast for LRT Line-1 South Extension Project only, where necessary reference has been made to the LRT Line-2 studies or data. Draft Final Report Volume 2, Chapter 2 provides the current and forecast patronage for Line-2.

2.1.2 Review of Past Studies

Most recent of the reviews of LRT-1 south extension has been conducted by the DOTC/ LRTA dated 27th February 2012 (*Reference 1*). This review is mostly based on the "LRT1 South Extension Project, Updating of the Feasibility Study / Project Implementation Program", January 2012 (*Reference 2*). Initial work for this update was done by DBP/IFC and its consultants in 2008, and reported in August 2008, (*Reference 3*).

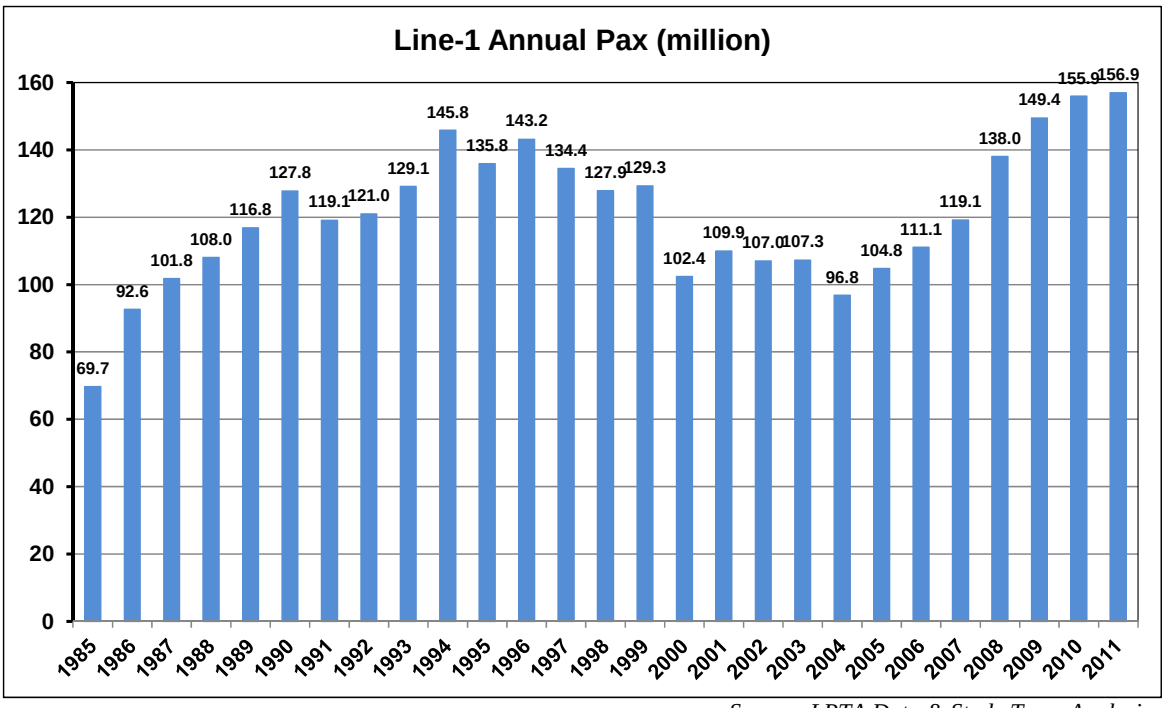
The estimate presented here has also relied upon the "Manila LRT Line 1 Extension Feasibility Study", Draft Report by Halcrow, August 2006 (*Reference 4*). In addition, the detailed work undertaken in the very 1st detailed study of Line-1 extension project completed by SNC-Lavalin in 1998 (*Reference 5*) has also been considered and the results have been used at aggregate level, and where appropriate, modified in the light of recent survey data. The underlying assumptions on which the demand forecast were based upon, like growth in population and socio-economic changes have been within the growth achieved to-date since the forecasts were prepared.

2.1.3 Current Line-1 Patronage and Comparison of Demand Forecasts of Past Studies

Line-1 from Monumento in the north to Baclaran in the south opened for revenue service in December 1984. In 1985, the 1st full year of operation, the patronage of Line-1 was 69.7 million passengers (Pax). The growth in demand was steady and it reached 127.8m by 1990, and increased to a peak of 145.8m Pax

by 1994 (an average growth rate of about 8.5% p.a. from 1985 to 1994). Then the ridership started to decline due to various technical reasons. The decline in patronage continued until 2004 (further exacerbated by the 20% increase in LRT fares in December 2003) and it was 96.8 million Pax in 2004, almost 40% less than it was a decade before that.

However, the declining patronage trend was reversed in 2005, and since 2005 it has been increasing steadily. In 2011 patronage of 156.9 million Pax were recorded on Line-1 with two new northern extension stations (Balintawak & Roosevelt), which opened in 2010. This gives an annual average growth rate for the decade: 2001 to 2011 of 3.62% per annum. Annual patronage of Line-1 since opening is shown below in **Figure 2.1-1**. It can be seen that the drop in patronage from 145 million annual Pax to around 100~110 million Pax annually throughout the 1st half of the last decade was mostly related to the available capacity of the rolling stock (LRV's). With the provision of the additional rolling stock, growth in population and economy, and ever increasing road congestion, Line-1 was able get its patronage back to the peak of 145+ million Pax per annum by 2009 and is able to sustain the patronage increase albeit at a lower growth rate. Line-1 still has capacity to carry more passengers, if the capacity expansion is carried out systematically and with the '*vision*' to provide accessibility and mobility to its '*Customers*', and not just as a means of transport from A to B.



Source: LRTA Data & Study Team Analysis

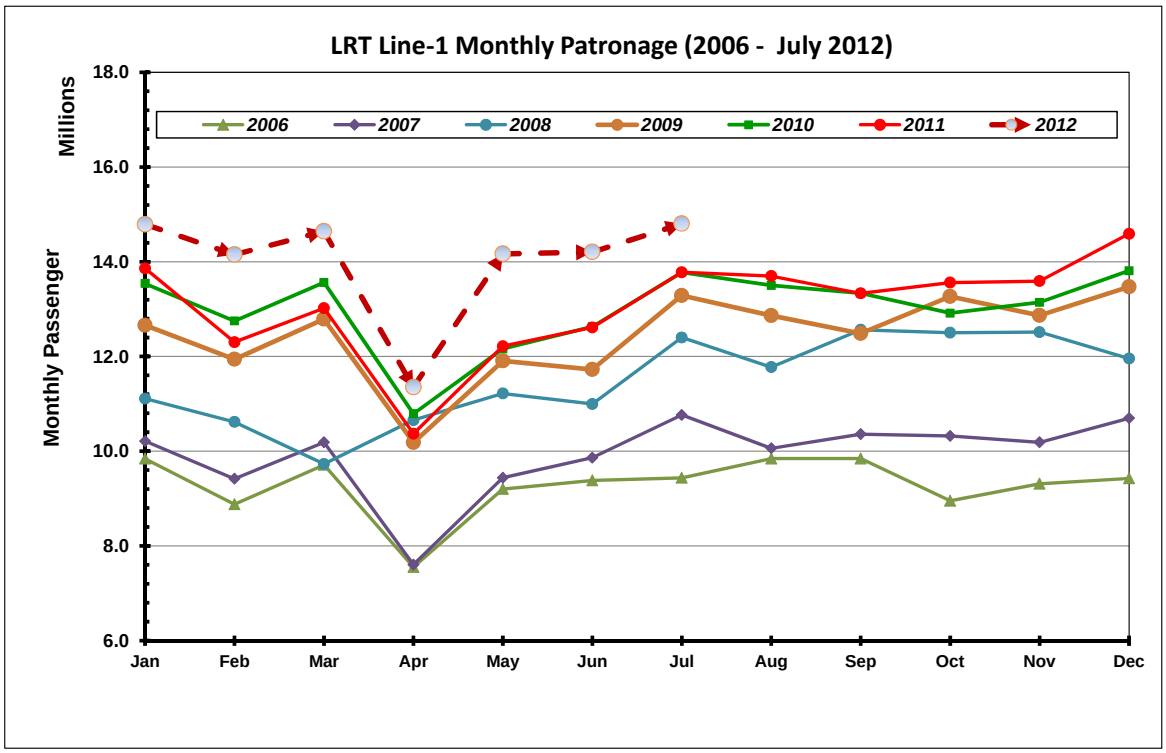
Figure 2.1-1 Line-1 Patronage 1984-2011

Analysis of the recent patronage data up to July 2012, shows a much higher than average growth since 2005-06 period. The monthly patronage for the last six years is depicted in **Figure 2.1-2**. It can be seen that patronage in every month of 2012 is higher than the corresponding month in the past. The demand in July 2012 reached 14.8million Pax, over one million more than the same month previous year. This is a healthy trend, and has been reflected in the preparation of the forecasts for Line-1. However, the demand forecasts prepared by the referenced studies varied due to a number of reasons, some of these are:

- The validity and correctness of data, its availability had effects on the study outcome. e.g. The 1st study by SNC-Lavalin was conducted soon after the MMUTIS project, hence it had a comprehensive transport database available to study Line-1 extension, and it was used to prepare demand forecast. As patronage of Line-1 at that time was almost 140+million Pax, The forecast

estimates reflected above average growth in demand not realising the Line-1 system capacity restraints. Hence produced high demand forecast estimates which was not attainable.

- The scope of any such study, time and resources available affect its outcome, as demand forecasting is a complex process; it takes time, and for reasonably reliable demand forecast considerable data, professional skills and resources are required. In this regard, the Halcrow study for Line-1 extension completed in 2006 appears to have been comprehensive in preparing and documenting the projected patronage demand and revenue estimates.
- The trend forecast approach (used by recent studies) introduced higher unreliability to the patronage demand forecast. Hence the revenue estimates produced by these studies would need to be checked against similar other sources ('bench marking') and sensitivity analysis would need to be undertaken to ensure reliability reasonableness of the demand forecast.



Source: LRTA Data & Study Team Analysis

Figure 2.1-2 Line-1 Monthly Patronage 2006 to July 2012

Table 2.1-1 below summarises the average weekday patronage demand forecasts prepared by the referenced studies and comments explain the underlying reasons as to the reliability of these forecasts.

Table 2.1-1 Average Daily Patronage (Pax ,000) Forecast by Previous Studies

Source	Study Description & (Comments)	2005	2010	2015	2020	2025	2030	2035
5	SNC-Lavalin – Initial (***of Extension Only No Forecast for Existing Line-1 was reported***)	550	–	638	–	722	–	–
	SNC-Lavalin – Revised forecast reduced to 60% of initial forecast to take account of system capacity.	330	–	445	–	469	–	–
5-H	Halcrow forecast at SNC-Lavalin fare level – Completed in 2006	–	–	417	461	475	489	–
4	Halcrow Base Case Demand (***2005 fare level***)	***348***	436	**667**	**738**	**–**	**794**	–
	Halcrow Demand Forecast at Optimum Fare Level		435	640	707	–	760	–
1,2 & 3	Forecast **Without** South Extension, Including North Extension	–	–	567	657	762	883	1,024
	Forecast **With** South Extension, Including North Extension	**–**	**–**	**820**	**953**	**1,104**	**1,281**	**1,481**
	Increase i.e. Line-1 South Extension Patronage	–	–	253	296	342	398	457
JICA June 2012	Line-1, Includes North Extension Actual Patronage (LRTA Data)	**317.5**	**472.4**	–	–	–	–	–
	Forecast **With** South Extension, Including North Extension			**650.7**	**831.2**	**899.9**	**950.3**	**990.7**

a. For Sources: Refer to the reference list given at the end of this Chapter, Section 2.5.

b. Refernce-5, Study conducted in 1998, with 2000 as base year. Growth factors of 3% p.a. from 2005-15, and 2.5% form 2015-25 were used. For other years, forecast were by made interpolation or by extrapolation, but capped at 750,000 Pax/day for Line-1 Extension Only; Excluding the Existing Line patronage.

c. Reference-4, Halcrow study was conducted in 2006. 2005 data is just for the existing LRT Line-1. Forecast years data is for the Total Line-1.

d. References 1,2 and 3 are based on the same demand forecast.

e. JICA Study Team June 2012 Interim daily patronage forecast for Line-1 with South Extension.

Table 2.1-1 above also includes the JICA Study Team recent demand forecast based on the past trends, previous study estimates and study team own assumptions derived from recent survey data and other sources. The following sections explain the forecast methodology and present the results of JICA Study Team patronage demand forecasts.

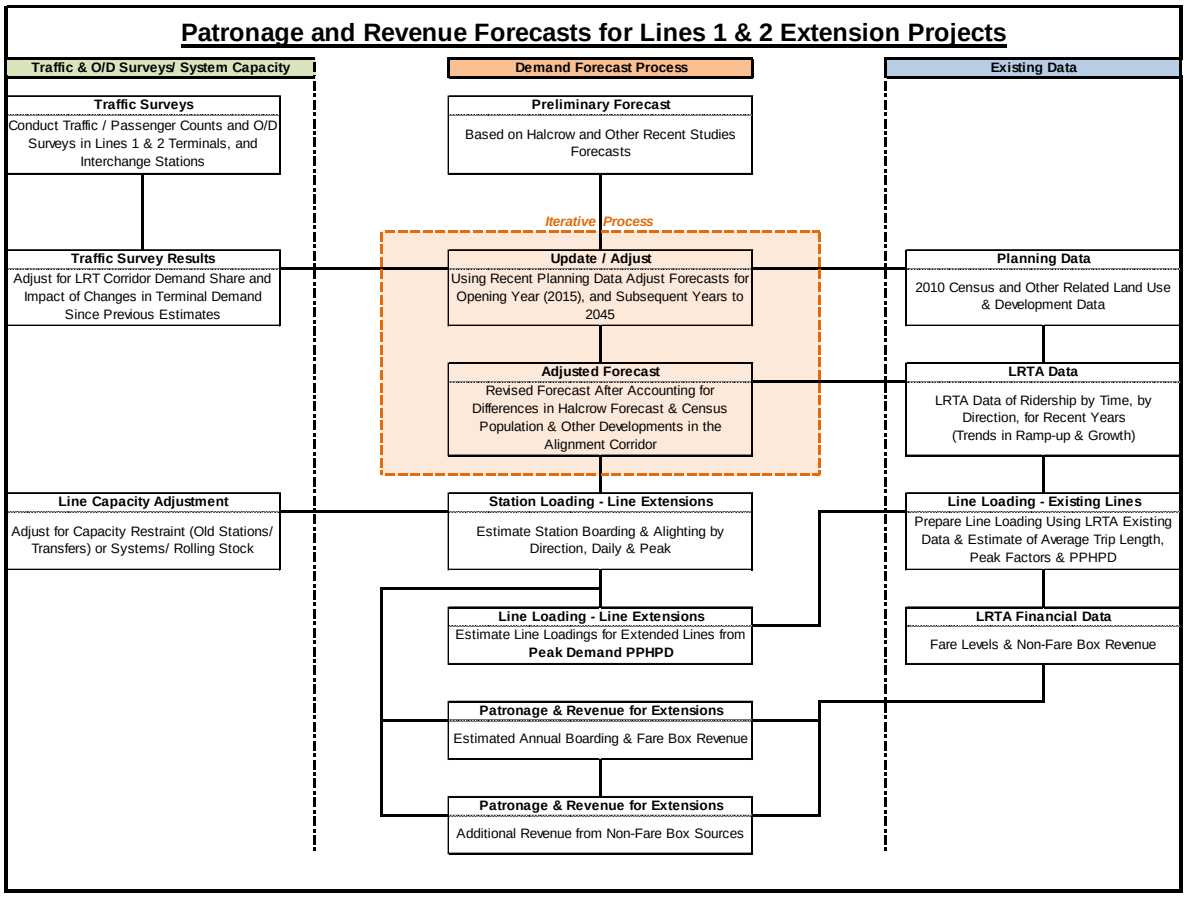
2.2 Demand Forecast Methodology

2.2.1 Introduction

As discussed above, a number of Feasibility Studies and reviews have been conducted for the LRT Line-1 South Extension Project. These studies have been reviewed by the study team of this project, and are listed at the end of this Chapter. In each case the patronage/ demand forecasts have been based on detailed travel demand modelling for the opening year of Line-1 extension; whereas future year forecasts have been based on simple growth factor techniques. However Halcrow [*Reference 4*] forecasts for Line-1 south extension are based on the travel demand model forecasts for the partial opening of extension to Dr. Santos in year 2011, full opening to Niyog by 2012; and also for the forecast years of 2015, 2020 and 2030.

Considerable work has already been done in the past on travel demand estimates through modelling. For this study, it is felt that a full-scale modelling approach is not realistic. A simplified approach of validation of previous forecasts (for the year's to-date) against current LRTA Line-1 patronage data, and projection of future ridership estimates for this project would generally draw on the previous study's modelled results, and adjusted/ updated as appropriate based on latest existing line data and recent survey data.

The proposed patronage and revenue estimate methodology adopted for both lines is outlined in **Figure 2.2-1**. The methodology is further described briefly in the following sections. The complete methodology initially relied on the judgement and extensive experience of the JICA study team, in the preparation of the patronage and revenue estimates for both Lines 1&2 extensions; and finally has been based on the recent (June & July 2012) traffic and travel demand survey data.



Source: JICA Study Team

Figure 2.2-1 Patronage and Revenue Forecasts - A Simple Methodology

2.2.2 Lines 1&2 Demand Forecast Methodology

For Line-1 initial assessment has been prepared and reported next in Section 2.3 as 'Demand Forecast'. The methodology adopted was based on the Halcrow demand forecasts as documented in Refernce-4. The Halcrow demand estimates were initially compared against the LRT Line-1 actual patronage, for the period from 2005 to 2011. The Halcrow base case forecast was then updated according to the '*trends*' in patronage on the Existing Line-1 up to the year 2011. In estimating the demand account has also been taken of the fact that Line-1 has been extended to the north-east for 5.7km, with two stations: Balintawak & Roosevelt. The Halcrow study did not consider/ include this extension in the demand forecast of Line-1; however, it was included in the demand modelling process as an MRT Line-3 extension to the West to Monumento. This impact has been reflected when refining the demand forecast for this project.

Similarly for the patronage forecast of Line-2 the recent studies of Line-2 has been referred and used to prepare initial assessment, preliminary, and now final demand forecasts have been based on these studies, and using the most recent, current patronage data of Line-2 provided by the LRTA.

The latest (2010) census data is available to the JICA study team. The previous population forecasts for the Lines 1&2 corridors would be compared against the actual (Census 2007) and patronage forecasts were checked and it was not necessary to adjust for any changes in population. In addition, future population growth estimates have also be compared with previous forecast and were found to be with the recent trends, and no further adjusted to the 2010 base case demand was necessary.

LRTA has supplied a vast amount of LRT Lines 1&2 data: hourly, daily, monthly and annual patronage. This data has been analysed and results applied, where necessary, to adjust initial forecasts as described above, for peak, daily and annual patronage estimates. The provision of LRTA station loadings by direction of travel yielded passenger-km (Pax-km) travelled, and the essential value of PPHPD (Passengers Per Hour Per Direction) required to estimate the operational headway and related rolling stock requirements.

The Pax-km derived from directional passenger boarding/ alighting and also from station-to-station matrix of passenger travel has been used to derive travel patterns and Pax-km, previously forecast using constant factors. The current demand forecast is based on the above stated data and it yielded more accurate estimate of average trip-length and hence more reliable fare-box revenue. Halcrow forecast average trip-length had be checked and validated against the LRTA data for 2005 and 2010, and forecasts are now based on the base case station-to-station matrix.

Similarly, the trends in patronage growth on Lines 1 & 2 would be used to estimate the patronage on the existing sections of both lines, and particularly for the periods before the opening of the extensions and the '*important*' early years after opening of the extensions.

2.2.3 Traffic and LRT User Interview Surveys

A limited set of traffic volume, vehicle occupancy, and origin/destination (O/D) surveys at key points along the Lines 1 & 2 corridors have been undertaken, and the data is analysed. Survey results have been summarised in the next section and fully reported in Volume 1, Chapter 9 of this report. The occupancy surveys would assist in driving the total person-trip demand along the existing and proposed alignment corridors; and data would assist in determining the LRT share of demand in the corridors of line extensions. This would then be compared with the forecast demand in the corridor, to examine the likely split of the current public and private transport trips and the share of the LRT lines.

LRT passenger interview surveys have being conducted to establish, the LRT user profile, their trip characteristics, including: Origin/ Destination, and number of transfers they make for the complete journey. These surveys were conducted at Lines 1 & 2 terminal stations and key LRT/LRT & LRT/MRT interchange stations. The surveys established the potential patronage which could be realized at the terminal and intermodal transfer terminals of Lines 1 & 2 extensions.

1) *LRT Passenger Interview Surveys*

LRT passenger interview surveys were conducted at:

1. Line-1 Roosevelt Station,
2. Line-1 EDSA Station,
3. Line-1 Baclaran Station,
4. MRT Line-3 Taft Station; and
5. Line-2 Santolan Station (Discussed in Volume 2).

A sample of 400 (200 Boarding and 200 Alighting) passenger at Baclaran (station from which the extension line would start was collected. Whereas at the other three stations sample of 200 Pax per station was collected. In all cases data was expanded to the total daily demand at that station. Survey sample was

representative of age, sex and income level of Pax (details in Chapter 9). The min use of the analysis was to study the O/D patterns of the passengers, and the likely shift to the future extension of Line-1.

Passenger Interviews at Roosevelt station are summarised in **Table 2.2-1**. The table shows the generation, attraction and home zone of all passengers using the station. About 60% of the passengers lived near the mass transit station areas. Of the remainder 32% lived in the MM area and only fewer than 2% lived in the Line-1 extension areas. Therefore no further analysis of Roosevelt data was necessary as it is unlikely to have any impact on the patronage of Line-1extension.

Table 2.2-1 LRT Passenger by Home Location at Line-1 Roosevelt Station

Area of Home Zone	Generation Zone	Attraction Zone	Home Zone	% of Home Zone
Line-1 Existing Station Areas	30,320	30,500	26,680	51%
Line-1_Extension Station Areas	-	-	-	0%
Line-2_ All Station Areas	770	320	580	1%
Line-3 Station Areas	4,350	4,380	3,870	7%
North of Metro Manila (NCR)	3,530	370	3,950	8%
Metro Manila	13,590	15,590	16,750	32%
Las Pinas	-	180	180	0%
Cavite	-	1,040	360	1%
Rizal & Other Areas	-	180	180	0%
Total Person Trips	52,560	52,560	52,560	100%

Survey by TTPI & JICA Study Team Analysis

In depth analysis of the data of other three stations (Baclaran, EDSA and Taft) which lie with a km of each other involved processing of some 373,000 passenger boarding and alighting. Of these passenger trips about 20% per cent of passengers are residents of Las Pinas and Cavite areas. Baclaran station attracted most residents. However, of the 178,000 boarding & alighting at Taft station 33% (58,000) trips had O/D in Las Pinas or Cavite area, compared with 19,000 trips at Baclaran and 46,000 at EDSA were to or from Cavite areas. This adds up to about 123,000 (33%) of the trips at these three stations had origin or destination in the Cavite area. About 40~45% of these passengers travelled by Jeepney to these stations, and those who used the bus was in similar proportion, albeit higher proportions to/from Taft and EDSA than to/from Baclaran. This goes to show that there are a considerable number of current LRT&MRT passengers who use other public transport modes to travel to these stations and then use the mass transit lines to complete their daily journey mostly in the vicinity of Line-1 and other mass transit station areas or within MM.

The total passenger O/D combined for these three stations are summarised in **Table 2.2-2** below. Once the LRT extension to the south is built, it is highly likely that these passengers would use the LRT extension directly to reach their destination. Those using the MRT-3 (at Taft) would also switch to the Line-1 extension and transfer at EDSA. In order to make this routing more desirable and maximise the patronage on the extension, it is pertinent that the extension stations are well planned, and transfer to other lines/ modes in the MM area is improved.

Table 2.2-2 Passenger @ Baclaran, EDSA and Taft Stations by Trip O/D and Home Locations

Area of Home Zone	Generation Zone	Attraction Zone	Home Zone	% of Home Zone
Line-1 Existing Station Areas	121,000	132,600	91,700	25%
Line-1_Extension Station Areas	16,200	-	13,000	3%
Line-2_ All Station Areas	1,700	35,000	17,300	5%
Line-3 Station Areas	21,300	74,300	30,600	8%
North of Metro Manila (NCR)	-	7,200	7,100	2%
Metro Manila	89,000	118,600	141,100	38%
Las Pinas	6,000	-	3,600	1%
Cavite	117,800	-	62,700	17%
Rizal & Other Areas	-	5,300	5,900	2%
Total Person Trips	373,000	373,000	373,000	100%

Survey by TTPI & JICA Study Team Analysis

2) ***Road Traffic Count, Vehicle Occupancy and Passenger Interview Surveys***

The road traffic surveys involving 100% sample of Manual Classified Counts (MCC) and sample of vehicle occupancy counts were conducted at nine (9) locations in both direction of travel. In addition, passenger O/D surveys were also conducted at one location (Station 11). The survey locations were selected to understand the likely demand that would transfer from road to the potential extension along Line-1 extension corridor. Stations 1, 2 &3 data analysis has been described in Line-2 report. Here results of Stations 4-12 are discussed. All survey locations are listed below in **Table 2.2-3.** All vehicles were counted under 11 categories and are listed in **Table 2.2-4**, along with Types of surveys which excluded unnecessary data collection.

Table 2.2-3 Traffic Volume, vehicle occupancy and Passenger O/D Survey Locations

Station No.	Location Description
1	Marcos Highway (West of Sumulong Highway Junction) – ***Also O/D Surveys***
2	Marcos Highway (Between F. Mariano Av. & A. Rodriguez)
3	Marcos Highway (West of Santolan LRT Station on Footbridge)
4	Rizal Avenue (Between Tyumen Rd and Francis P Yuseco Rd)
5	Taft Avenue (Between Vito Cruz and Sen. Gil Puyat Avenue)
6	Roxas Blvd (Between Airport Rd and NAIA Rd – Opposite Aseana Avenue)
7	Cavite Expressway @ Tambo Bridge
8	Quirino Avenue @ Dongalo Bridge
9	Ninoy Aquino Avenue @ Imelda Bridge
10	Evangelista St. Just west of Niog Rd Junction
11	Aguinaldo Highway (Between Niog St and Molino Blvd) – ***Also O/D Surveys***
12	Molino Blvd – North of Ilang-Ilang

Table 2.2-4 Vehicle Categories by Vehicle Type and Survey Details

No.	Vehicle Type Description	Vehicle Occupancy	O/D Surveys
1	Cyclo/ Motorcycle/ Tricycle	All Occupants	No
2	Private Car/ Sedan/ Open Back	All Occupants	Yes
3	SUV	All Occupants	Yes
4	Public Taxi	All Occupants	Yes
5	AUV – Public FX	All Occupants	Yes
6	Jeepney	All Occupants	Yes
7	Mini-Bus	All Occupants	Yes
8	Local Public Bus (Air Con or Other)	All Occupants	Yes
9	Long Distance (Provincial) Bus	All Occupants	Yes
10	Delivery vehicles, 2-axle trucks, Other 2-Axle vehicles (No Occupancy & O/D)		
11	Trucks or Other Goods Vehicles with 3 or more axles (No Occupancy & O/D)		

The goods vehicle volumes were recorded to get estimate of total traffic on the road. The reason for not including the 2/3 wheel vehicles in the O/D surveys was that most of the trips are of very short distance and usually involve using another mode at the end. Such surveys do help to provide insight into feeder Pax volumes, but not to provide estimate of future patronage of mode in a new area. However, when estimating total passenger volume at any location, account was taken of the Pax volumes using 2/3 wheel vehicles, private or public. Surveys at Station 4 & 5 were conducted to ascertain current mode share of LRT Line-1 at these locations. This analysis is summarised in **Table 2.2-5** below. In both cases, in this inner city area the traffic volume is mostly of public transport vehicles with limited number of private vehicles. The person trip analysis shows that the LRT patronage commands over 60% of passengers in the corridor. A very high level of public transport usage, however the percentage is not fully reflective of all traffic in the north/south corridor as traffic from other parallel routes is not included.

Table 2.2-5 Traffic Volume (Person & Vehicle Trips) at 2 Survey Stations, June 2012

Person Trips by Mode	STATION 04 Rizal Av. (2-Way)		STATION 05 Taft Av. (2-Way)	
Private (Incl. 2/3 Wheel)	18,400	5%	10,900	3%
Taxi & FX	900	0%	8,600	2%
Jeepney	113,600	30%	56,400	15%
Bus	-	0%	64,100	17%
Sub-total Public	114,500	30%	129,100	34%
LRT (2012)	**246,700**	**65%**	**243,900**	**64%**
Public + LRT	361,200	95%	373,000	97%
Total (Private + Public)	**379,600**	**100%**	383,900	100%
Note: Station-04 LRT Daily Line Pax are between: Bluementrit - Tayuman Stations & Station-05 LRT Daily Line Pax are between Gil Puyat - Vito Cruz Stations (Average Weekday Volume in Mar-2012)				
Vehicle Trips by Mode	**STATION 04 Rizal Av. (2-Way)**		**STATION 05 Taft Av. (2-Way)**	
Private (Incl. 2/3 Wheel)	10,900	51%	5,800	36%
Taxi & FX	500	2%	2,900	18%
Jeepney	10,100	47%	5,100	32%
Bus	-	0%	2,100	13%
Sub-total Public	10,600	49%	10,100	64%
Total (Private + Public)	**21,500**	**100%**	**15,900**	**100%**

Survey by TTPI & JICA Study Team Analysis

Similar analysis was also carried out at three locations along the Line-1 extension corridor. Starting from the south survey stations 10, 11 & 12 formed a complete screenline just north of the proposed Niyog

station (Last station on the Line-1 extension) location. Stations 7, 8 &9 also formed a screenline (by the river) across the three major highways from the south (all survey locations are depicted in the Survey Report). The 2012 traffic along these highways was recorded. For a like-with-like comparison traffic was factored up to 2016 (the 1st full year of the Line-1 Extension operation) by assuming a modest (*traffic in the south has been increasing at much higher rates, however as the roads are reaching capacity – limited growth is assumed*) 3% per annum growth to the 2016 LRT extension forecast along the same section of the highway. However for comparison with the LRT person trip volume the highway person trips have been reduced by 90% of the corresponding LRT demand (assuming 10% of the LRT volume would be generated walk-in demand not part of the highway demand.

Similarly the vehicle volumes have also been reduced to reflect the diversion to the LRT. The mode share assumed was based on the Line-1 & Line-2 existing mode share at other location, and was estimated to be about 5% from private mode, 10~15% from Taxi & FX, 25~30% from Jeepney and buses at Stations 07-12, depending upon the location and volume of each mode using that route. At Station-06 the mode shift from Jeepney & buses was estimated to be much higher around 45~55% as in the inner city area the LRT speed would be much more attractive and the additional time savings would attract more passengers. These mode share figures compare favourably also with the mode share observed at station 4 & 5 along Line-1 and at Statio-03 along Marcos Highway when compared with the current Line-2 volumes north of Santolan station.

The LRT Line-1 Extension demand has been presented in full in the following section. Similarly the demand is also compared farther north and closer to Baclaran with the traffic volume along Roxas Boulevard, where the demand is highest along the extension section of Line-1. The comparison and mode share of LRT Line-1 extension at these locations as summarised in **Table 2.2-6** demonstrates that the 2016 forecast patronage at these sections is a reasonable estimate, which is based on the increase of 222,000 Pax (Boarding) on an average weekday day, after the full opening of Line-1 Extension and enhanced available capacity on the existing section of Line-1.

Table 2.2-6 Forecast (2016) Traffic Volume (Person & Vehicle Trips) at 3 Locations

Person Trips by Mode (2-way)	**STN. 10-12** North of Niyog		**STN. 07-09** Across River		**STN. 06** Roxas Bulvd.	
Private (Incl. 2/3 Wheel)	121,700	27%	221,500	34%	94,800	19%
Taxi & FX	14,500	3%	54,000	8%	41,500	9%
Jeepney	88,700	20%	95,000	14%	37,700	8%
Bus	133,700	30%	172,200	26%	90,900	19%
Sub-total Public	236,900	53%	321,200	49%	170,100	35%
LRT (26-Jun-12)	**89,400**	**20%**	**118,200**	**18%**	**222,600**	**46%**
Public + LRT	326,300	73%	439,400	66%	392,700	81%
Total (Priv.+Pub.)	**448,000**	**100%**	**660,900**	**100%**	**487,500**	**100%**
Note: The LRT Line-1 Extension 2016 demand for Stations 10-12 is forecast between Niyog and Talaba Station; For Stations 7-9 is compared with LRT demand between Ninoy Aquino and Asia World Stations, whereas at the Station 06 demand is between Redemptorist and Baclaran Station						
Vehicle Trips by Mode (2-Way)	**STN. 10-12** North of Niyog		**STN. 07-09** Across River		**STN. 06** Roxas Bulvd.	
Private (Incl. 2/3 Wheel)	64,240	81%	104,800	78%	41,990	71%
Taxi & FX	3,110	4%	13,160	10%	10,490	18%
Jeepney	8,310	10%	12,350	9%	3,900	7%
Bus	3,670	5%	3,280	2%	2,790	5%
Sub-total Public	15,090	19%	28,790	22%	17,180	29%
Total (Priv+Pub)	**79,330**	**100%**	**133,590**	**100%**	**59,170**	**100%**

Survey by TTPI & JICA Study Team Analysis

2.2.4 The Patronage and Revenue Stream Forecasts for 30 Years

The peak, average weekday, and annual patronage forecasts would be prepared for both Line-1 extension to the south (10 stations) to Niyog, and Line-2 extension to the east (2-stations) to Masinag. The patronage demand will be for each station boarding and alighting by direction of travel (see Volume 1 & 2, Appendix C for details of lines 1 & 2 patronage forecasts respectively). This would also provide the PPHPD volume for each section of the line – peak values would be used to determine the future operational headways and related rolling stock requirements.

This method also yielded Pax-km travelled on the line. The previous work on the estimation of fare-box revenue is on distance based fares. Hence this approach would provide a direct estimate of fare-box revenue from the patronage and the Pax-km travelled.

The annual revenue estimate would be based on the analysis of LRTA daily and annual ridership data of previous years. Previous studies have used different annualisation factors ranging from 300 to 330 equivalent average weekdays. The analysis of the latest LRTA daily ridership data of 2011 has been used for the estimation of more reliable annualisation factor and hence better estimate of future revenue stream.

2.2.5 The Limitations and Advantages of this Simplified Approach

It is clearly understood by the JICA study team that the approach has limitations, such as that full scale demand modelling is not used for demand forecast purposes. However, as explained above, a considerable work has been done, documented and reported using such models. Therefore, in this study, full and extensive use has been made of the past work, and it is felt that repeating the same exercise would not necessarily provide better/ more reliable patronage forecast.

Furthermore, full scale demand modelling is very data hungry; particularly database like that collected by the MMUTIS study during late 1990's would be required. However, it is best to rely on the latest modelled results, which in any case are mostly based on the MMUTIS database, but have been validated/ updated using as recent as 2010/ 2011 & now with the JICA 2012 survey data.

The use of previously forecast result as a base case would also provide resources to be more focused on updating the 'preliminary' forecasts, prepared earlier for this project rather than start afresh. It is also proposed that 'bench-marking' of patronage and revenue forecasts would be made by comparing the previous forecasts and actual patronage, like on Line-1 north-east extension to Roosevelt. This would provide the added confidence in the reasonableness and reliability of the forecasts prepared for the Lines 1 & 2 extension projects.

2.3 Demand Forecast

2.3.1 Total Daily (Average Weekday) Passenger Demand

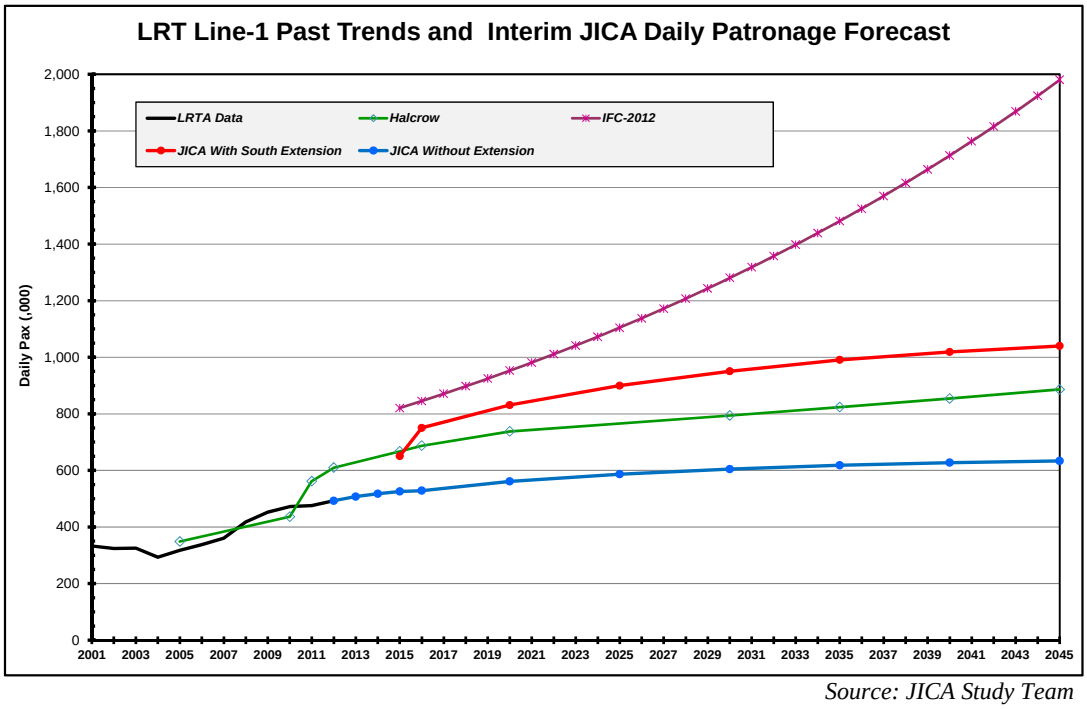
The average weekday demand forecast prepared by the study team is compared below in **Figure 2.3-1** and presented in **Table 2.3-1**. It can be seen that the Halcrow 'Base Case' forecasts are much lower than that of JICA Study Team, because the Halcrow demand model is based on the calibration of the demand model to the 2000-2004 patronage. At that time the Line-1 patronage was suppressed due to lack of capacity, and was at its lowest level since early 1980's. Hence the Halcrow demand forecast of the existing Line-1 had been under estimated. The average weekday Halcrow forecast for the existing Line-1 was 376,800 Pax, compared with the actual LRTA reported patronage of 472,400 Pax in 2010. This shows that the Halcrow forecast did not fully take account of the Line-1 increase in demand due to capacity expansion, and therefore Line-1 demand is un-necessarily supressed. It should also be noted that the Halcrow demand estimate does take account of the Line-1 extension to the north-east, albeit it was

included in the demand model as an extension of Line-3 to Monumento, which has further increased the patronage on the existing Line-1.

The JICA Study Team demand forecast is based on the existing Line-1 patronage of 2011 projected to 2015, plus the increase in demand due to full opening of south extension forecast by Halcrow of 220,000 Pax per average weekday. This demand estimate just for the south extension part of Line-1 is about 15% lower than the DBP/IFC-2012 demand forecast for Line-1 extension of 253,674 Pax i.e. an increase from 566,715 to 820,389 Pax (*Source: DBP/IFC Progress Report January 2012, P-62)*. The main reason for adopting the Halcrow forecast growth is that it is more plausible than DBP/IFC forecast, as it is unlikely that DBP/IFC patronage forecast of Line-1 of 566,715 Pax by 2015, an increase of over 19%, in the next four years (2011 to 2015), without extension, could be realised. Whereas it should be noted that the patronage on Line-1 has reached a plateau (**Figure 2.3-1**), and would not continue to grow at the same rate of growth as in the past without further capacity expansion.

The JICA Study Team demand forecast for the earlier years are generally based on Halcrow demand forecast growth rates, but have been adjusted to take account of slower development growth in the south (immediate hinterland in the alignment corridor area is generally less densely populated). The Halcrow forecast of constant growth rate (0.74% p.a.) for the longer term from 2030 and beyond was also adjusted to a declining rate of growth as Line-1 would approach capacity. The demand forecast growth rates and resultant average weekday patronage results are summarised in **Table 2.3-1.**

The DBP/IFC constant growth rate of 3% per annum from 2015 appears to be an overestimate, given that the DBP/IFC forecast for Line-1 south extension patronage is about 15% higher than Halcrow. Hence, the JICA Study Team estimates of average weekday patronage forecast are prudent. Its forecast fully takes account of the latest patronage of Line-1 (including north-east extension), and are based on reasonable assumptions/ adjustments rather than based on a single or a constant growth rate. This has been further confirmed by the comparison of the JICA forecast with the recent survey data. The final patronage demand forecast adopted for system requirements, revenue estimate and project economic and financial evaluation purposes, and are illustrated in **Figure 2.3-1**, and summarised in **Table 2.3-1**.



Source: JICA Study Team

Figure 2.3-1 Average Weekday Patronage (Pax ,000) Forecast by JICA Study Team & Others

Table 2.3-1 Average Weekday Patronage (Pax) Forecast by JICA & Others

Year	Comments & Assumptions	LRTA Data	JICA Without Extension	JICA With South Extension
2001	***LRTA DATA Converted to Average Weekday Patronage Using a Factor of 330 Days per Year (Annual Factor Estimated from the Daily Ridership Data of 2011)***	**333,200**	***Limited Growth in the Existing Section of Line Due to Increase in Capacity***	***Partial Opening in 2015 and Full Extension Opening by 2016***
2002		324,300		
2003		325,000		
2004		293,500		
2005		**317,500**		
2006		337,600		
2007		361,000		
2008		418,300		
2009		452,900		
2010		**472,400**		
2011		**475,500**		
2012	***JICA Projection Using Average of Last 10 Year (2001-2011) Growth of 3.62% p.a. for 2012; and then a Conservative Estimate of 3.0% Declining to 2.0%pa by 2014.***	**492,700**	**492,700**	
2013			**507,500**	
2014			**517,700**	
2015	**Add Halcrow 'Base Case' Growth in Line-1 Demand Due to Full Opening of Extension by 2016 (220,000 Pax). Also Limited Growth on the Existing Section Due to Decline in Demand at Baclaran, which will Shift to the New Stations of the Extension**		**525,500**	***650,700***
2016			**528,600**	***750,600***
2020	**Used Halcrow 'Base Case' Av. Growth Rate of (3.04%) of 3 Years After Opening, and Adjusted for Now Full Opening in 2016, and Applied (2.6%) for the Next 4 Years: 2016 to 2020.**		**561,100**	**831,200**
2025	**Used Halcrow 'Base Case' Av. Growth Rate (2.04%) of Next 5 Years, and Adjusted & Applied (1.6%) for the Next 5 Years: 2020 to 2025.**		**586,800**	**899,900**
2030	**Used Halcrow 'Base Case' Av. Growth Rate of (0.74%) of the Next 5 Years, and Adjusted & Applied (1.1%) for the Next 5 Years: 2025 to 2030.**		**604,600**	**950,300**
2035	**Adjusted Halcrow Constant Growth Rate of (0.74%) of the Next 5 Years, and Estimated & Applied (0.84%) for the Next 5 Years: 2030 to 2035.**		**618,300**	**990,700**
2040	**Adjusted Halcrow Constant Growth Rate of (0.74%) for Following Years, and Estimated & Applied (0.56%), A Modest & Declining Growth Rate for the Next 5 Years: 2035 to 2040.**		**627,600**	**1,019,000**
2045	**Adjusted Halcrow Constant Growth Rate of (0.74%), and Applied (0.40%), A Modest Growth Rate for the 5 Next 5 Years, as Demand Approaches Capacity - 2040 to 2045.**		**633,500**	**1,039,800**

Source: Study Team

2.3.2 Patronage Forecast – Annual and Peak Factors

1) Annualisation Factor

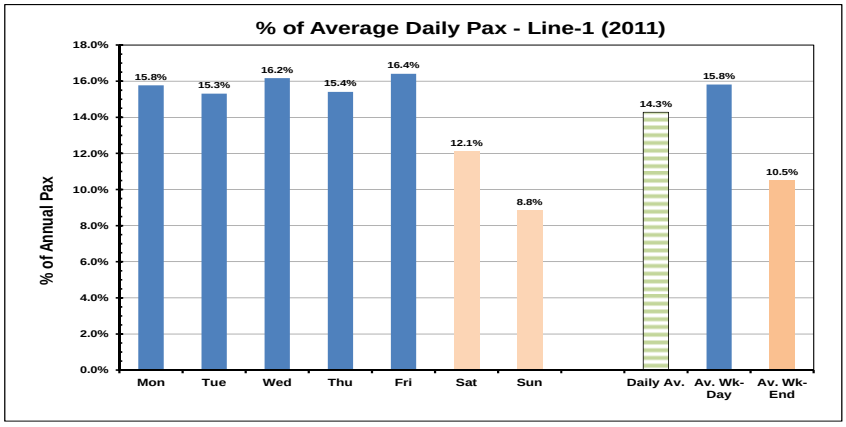
In order to estimate the annual patronage the LRTA 2011 daily data for both lines 1 and 2 was analysed. The data shows a considerable difference in demand during the working days (Monday to Friday) and the weekends (Saturday and Sunday). The 2011 daily passenger boarding for Line-1 are summarised in **Table 2.3-2** below, and the daily variations are depicted in **Figure 2.3-2**. As the demand is estimated for average weekday, a factor is required to convert the daily demand to annual demand and hence the annual revenue. Form Line-1 data analysis the annual factor is calculated to be 329.6, or say 330. Similarly, annual factor form Line-2 data was calculated to be 331.2 or say 330.

It may also be argued that as population gets more prosperous there would be more leisure trips, likely to be in the evenings or over the weekends. This may have impact on the annual factor. However, for simplicity and not to overestimate annual demand a factor of 330 was used for both Lines 1 and 2. In comparison, Halcrow had adopted an annualisation factor of 300, DBP/IFC-2012 forecasts had used a factor of 320, and SNC-Lavalin study used an annual factor of 330.

Table 2.3-2 Calculation of Annual Factor from Line-1 2011 Patronage Data

Day of Week	No of Days	Total Boarding	Average Boarding
Monday	52	24,699,546	474,991
Tuesday	52	23,962,029	460,808
Wednesday	52	25,312,202	486,773
Thursday	52	24,114,267	463,736
Friday	52	25,688,324	494,006
Saturday	53	19,331,506	364,745
Sunday	52	13,819,595	265,761
Total 2011	**365**	**156,927,469**	**429,938**
Week-days (Mon~Fri)	**260**	**123,776,368**	**476,063**
Annual Factor = Total Annual Boarding/ Average Weekday Boarding = 56,927,469/476,063 = **329.64** =**330.**			

Source: LRTA Data, Estimate by JICA Study Team



Source: JICA Study Team

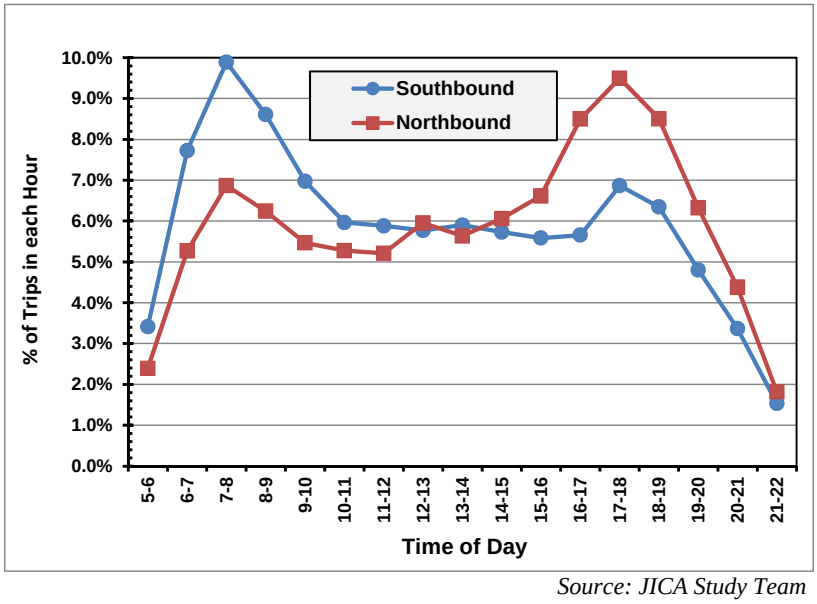
Figure 2.3-2 Daily Variations in Patronage Line-1 (2011)

2) Peek Factors

The peak hour travel demand is used to estimate operational headways and related rolling stock requirement necessary to meet the peak patronage demand. The peak demand in any given system varies by direction of travel, and by time of day. The peak demand tend to be more pronounced in the morning period than the in the evening, whereas in the evening peak demand extends over a longer duration. The peak demand also tends to be directional, and may vary according to the section of the line on a transit system, and depends upon a number of factors such as location of work or school places in relation to homes.

LRTA passenger boarding/ alighting data by direction of travel was analysed for average weekday of March 2012 (most recent data available). **Figure 2.3-3** shows the percentage of trips by time of day in March 2012. It can be seen that the demand is highest (9.9% of total daily trips) in the morning between 07:00 to 08:00 in the southbound direction, and in the evening the peak is 9.5% of daily northbound demand between 17:00 to 18:00. These peak proportions may seem to be on the high side in relation to the road traffic, but in fact in some cities the peak demand on transit systems is even higher and could be as high as 13% of the daily demand.

The demand in the morning peak is the highest between 07:00 to 08:00 therefore the passenger boarding/ alighting, line loading for this hour of the day has been used to calculate peak hour demand for all further analysis. In addition it should be understood that a single peak factor cannot be used, as peak factor may vary by station, section of the line, and direction of travel. Therefore peak factors were computed for the entire travel (station-to-station) matrix for both Lines 1&2. The methodology adopted used the peak hour demand (boarding and alighting by direction of travel) and daily station-to-station matrix to compute peak hour station-to-station matrix. This process used CUBE (*state-of-the-art demand modelling*) software, and matrix '*Furness*' process. The peak hour to daily factors for each station-to-station demand were estimated from the ratio of the two (peak to daily) matrices, and were used to compute future year peak hour matrix, from the daily matrix. The peak hour station and line loadings are then directly derived from the peak hour station-to-station matrix.



Source: JICA Study Team

Figure 2.3-3 Variations in Patronage by Time of Day, Line-1 (Av. Weekday, March 2012)

2.3.3 Total Annual and AM-Peak Hour Passenger Demand

The average weekday demand forecast prepared by the study team has been discussed and presented above in Section 2.3-1. The annual patronage demand used for the revenue estimates has been derived by applying the annual factor to the average weekday demand. The annual demand has been summarised below in **Table 2.3-3** Detailed daily and peak passenger demand by station and peak line loading for each of the forecast years is given in Appendix-C of this report.

Table 2.3-3 Summary of Line-1 Patronage Forecast (2012-2045)

Line-1 Extension to Niyog - Forecast of Passenger and Other Attributes										
Description	Unit	2012	2015	2016	2020	2025	2030	2035	2040	2045
Average Week Day Boarding (Without Extension)	Pax	492,700	525,500	528,600	561,100	586,800	604,600	618,300	627,600	633,500
Increase in Daily Patronage (Av. Week Day)	Pax	-	125,200	222,000	270,100	313,100	345,700	372,400	391,400	406,300
Total Patronage with Extension (Av. Week Day)	Pax	492,700	650,700	750,600	831,200	899,900	950,300	990,700	1,019,000	1,039,800
AM Peak Hour (0700-0800) Boarding Southbound	Pax/Hr	24,200	29,700	32,900	36,100	38,700	40,600	42,200	43,200	44,000
AM Peak Hour (0700-0800) Boarding Northbound	Pax/Hr	13,300	19,700	24,100	27,200	29,700	31,700	33,200	34,300	35,100
Total AM Peak Hour Boarding Both Direction	Pax/Hr	37,400	49,400	57,100	63,200	68,500	72,300	75,400	77,500	79,100
AM-Peak Hour Boarings as %of Daily Boardings	Ratio	7.59%	7.59%	7.60%	7.61%	7.61%	7.61%	7.61%	7.61%	7.61%
Maximum Station Boarding (AM-Peak Hour)	Pax/Hr	7,700	9,100	9,800	10,600	11,300	11,800	12,200	12,400	12,600
Maximum Station Alighting (AM-Peak Hour)	Pax/Hr	4,700	5,600	6,000	6,500	6,900	7,200	7,500	7,600	7,700
Pax/Hr/Per Direction (AM-PK Hr 0700~0800)	PPHPD	19,700	23,800	26,000	28,400	30,500	32,000	33,100	33,900	34,500
Average Week Day Trip Length	km	7.65	9.64	10.72	11.00	11.22	11.37	11.48	11.56	11.62
Annual Factor	Days	330	330	330	330	330	330	330	330	330
Annual Passenger	Pax million	162.59	214.73	247.70	274.30	296.97	313.60	326.93	336.27	343.13
Annual Passenger*km	million*km	1,243.7	2,070.0	2,655.3	3,017.3	3,332.0	3,565.6	3,753.2	3,887.3	3,987.2

Source: JICA Study Team

2.4 Summary and Conclusions

The travel demand presented here is based on thorough analysis of LRTA data of past trends, through analysis of recent traffic and passenger interview data and the current patronage of Line-1. The demand forecasts are mostly based on past studies, with adjustments/ modifications, where possible, through sound judgment and based on the considerable experience of the study team of such projects. These forecasts have been reviewed again for reasonableness and compared against the recently collected traffic and travel demand data.

Extending Line-1 to the south would add ten stations to the existing twenty stations. The exiting Line-1 will be extended by about 12km, increasing its immediate catchment area by more than 60%. The proposed ten stations would be located mostly on brown-field sites, and the surrounding areas are also empty or agriculture land. However, major developments are anticipated in and around the proposed station sites in early years, and further developments in the region as population grows. In addition, the three proposed multi-modal terminals at: Dr. Santos, Zapote, and Niyog would attract passengers from existing road based transport modes, and would also attract suburban commuters from surrounding areas through feeder services.

It is anticipated that this would add about 220,000 (+40%) daily passengers to the existing Line-1 patronage after the 'full' opening of Line-1 by 2016. This estimated patronage increase may appear to be 'high', but given the travel time savings passengers from the south would benefit from is substantial, when compared to the travel times on the congested coastal roads from the south, as shown above in section on survey data. It should also be noted that currently over 123,000 Pax use Line-1 and MRT-3 from Baclaran, EDSA and Taft as estimated from the current passenger surveys. Therefore, the estimated demand in four years with additional catchment area of 12km, is not excessive at all, if the stations are

accessible, well planned, mode-change at stations, mainly at the proposed 3 multi-modal terminals is convenient, and most of all Line-1 current capacity is enhanced for the added comfort of the longer distance travellers.

It is estimated that the patronage would continue to grow as the areas along the Line-1 extension alignment would develop further over time, with increase in population beyond the full opening year of 2016. The development potential in the south is considerable, due to availability of land for high density development. The patronage would also benefit from the integration of Line-1 into the areas south of Metro Manila and extension into Cavite province through feeder services. Further integration of Line-1 with the Metro Manila mass transit network by running through services between Lines 1 & 3; providing convenient transfer to/ from other LRT/MRT lines; and integrated public transport e-ticketing system would further add to the Line-1 patronage.

2.5 References:

1. Project Evaluation Report – LRT Line 1 South Extension Project, – DOTC/ LRTA Comments 27-February 2012.
2. LRT1 South Extension Project, Updating of the FS / Project Implementation Program Study for DBP/IFC – January 2012.
3. International Finance Corporation; LRT Line 1 South Extension Project, Updated Feasibility Study – August 2011.
4. Manila LRT Line 1 Extension Feasibility Study, Draft Report, Halcrow – August 2006
5. Feasibility Study, Manila LRT Line 1 Extension, Final Report, SNC-Lavalin – 1998.
6. JICA, Preparatory Study for LRT Line-2 Extension Project, by Oriental Consultants Co. Ltd; and Others, Final Report – October 2011.
7. Study of Manila LRT Line-2 East-West Extension Project in Philippines, for the Ministry of Economy, Trade and Industry, by Oriental Consultants Co. Ltd; and Others, Final Report – March 2010.
8. Line-2 West & East Extension Ridership Study Final Report, by Oriental Consultants Co. Ltd; and Transport and Traffic Planning, Inc. Final Report – 27th November 2009.

CHAPTER 3
TRAIN OPERATION PLAN

CHAPTER 3 TRAIN OPERATION PLAN

3.1 Route Planning

Cavite extension section of Manila LRT Line1, extend to the south from Baclaran station in Metro Manila Pasay city, which is about 12km route to the Niyog station in the Province of Cavite.

This route passes through the southwest coast of Metro Manila, promotion and development district spread on reclaimed land in coastal area, residential area, and near the district of future large-scale housing development area.

It will become possible to reach Metro Manila from the Southern suburbs near Niyog station. There is little industrial district along the route. Entire route is shown in **Figure 3.1-1.**

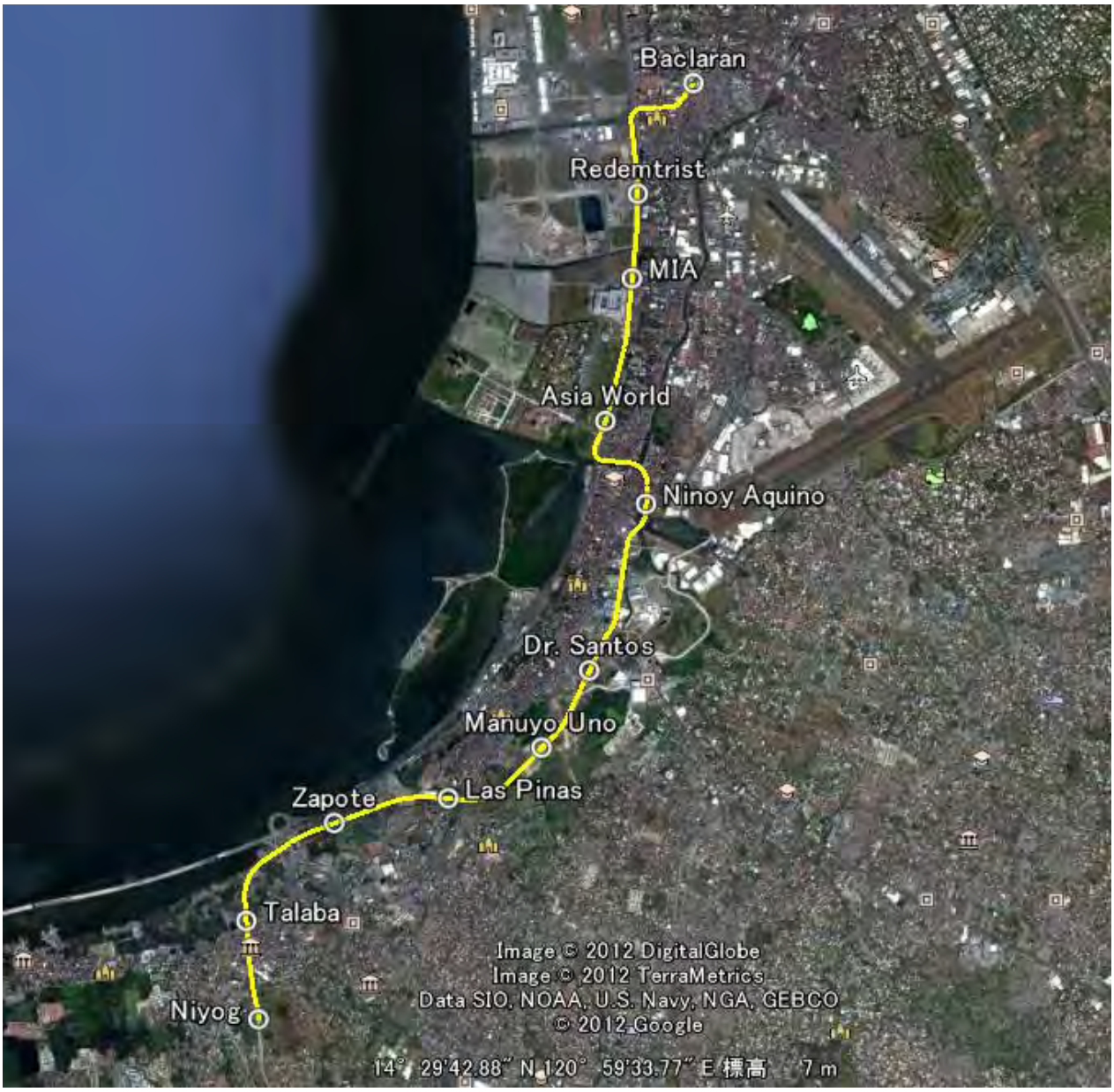


Figure 3.1-1 Entire Alignment of Line 1 Extension

The current status of each station and the main points is shown in **Table 3.1-1.**

Table 3.1-1 Current Status of Stations and the Key Points

Location	Characteristic
Baclaran Station	This station is the terminal station of existing Line-1 and is located in center of Pasay City. Commercial facilities such as street vendors in front of the station area is concentrated and congested with shoppers, jeepneys, and buses. (photo.1)
near 0k＋600m	In the vicinity of this area has a large church and commercial facilities, it is a district within a large number of people gather. Road width is approximately 15m. The bus terminal from the southern Manila regions near the crossing with ROXAS BOULEVARD, and it is very crowded with people or automobile traffic. Orbit on the part of this intersection is a sharp curve of radius 100m.
Redemptrist Station	This station is located in the coastal strip of Paranaque City, facing the ROXAS BOULEVARD and the development area of the along coast. This station is also located at the entrance of the ASEANA BUSINESS PARK currently in development. (photo.3)
near 1k+500m	The route on the waterway is located between the landfill of coastal and ROXAS BOULEVARD. On the route is not particularly large obstacle and the route have a lot of straight line.
MIA Station	This station is located in the front of the UNIWIDE COASTAL MALL, facing the ROXAS BOULEVARD. The station is also close to NINOI AQUINO INTERNATIONAL AIRPORT and that place is the intersection of a great deal of traffic on wide road. (photo.4)
near 3k+000m	The route on the waterway is located between the landfill of coastal and ROXAS BOULEVARD. The route is a straight line mostly and there is no big obstacle in particular.
Asia World Station	This station is located in the coastal strip of Paranaque City, facing the ROXAS BOULEVARD. This station is also located at the entrance of the ASEANA BUSINESS PARK currently in development. (photo.5)
near 3k+800m	The route passes over the ROXAS BOULEVARD and toward the east on the PARANAQUE RIVER. The route passes along the river and the characteristics of the route is that have a s-shaped curve that have two consecutive curves of radius 100m in interval of approximately 900m. (photo.6)
Ninoi Aquino Station	This station is located in the downstream part of a Paranaque river, and is connected to south Ninoy Aquino Avenue from Ninoy Aquino International Airport. The circumference of this station is an area with many traffic and residential sections.
near 5k+000m	The route passes over the Ninoy Aquino Avenue from a Ninoy Aquino station and is extended to south. There is sufficient space for building a LRT structure on a road and the route resembles a straight line. The route passing through the bottom of the road that are planned for the future near the Dr. Santos station is planned. (photo.7)
Dr. Santos Station	This station is located in the southwest part of Paranaque City and is located in the west side of the large-sized supermarket SM CITY SUCAT which faced as C5 EXTENTION. There are plans to collocated bus terminal as intermodal facility in front of the station.
near 7k+000m	The route will be extended to over the C5 Extension street from the Dr. Santos station. This three-lane street is a new road. This street has many straight lines and the visibility is good.
Manuyo Uno Station（Future）	This station is located in the northern end of Las Piñas City and has been planned construction to over the C5 Extension street in the future. There are plans to develop a residential district on the east side of this station.
near 8k+000m	The route turn west along the C5 Extension street and to reach the Las Piñas station. There are two small waterways in the middle but it is considered there is no problem. (photo.9)
Las Pinas Station	This station is located in the northwestern part of Las Piñas City and planed near the QURNO AVENU. Housing, university or church along the road are concentrated in this area.
near 9k+000m	As it approach the coast, the route passes through the district waterways and wetlands often. Some current landfill is progressing well and the route parallel to CAVITE EXPRESSWAY (CAVITEX) at vicinity 500 meters short of the ZAPOTE station.
Zapote Station	This station is located in the northern end of the Bacoor region in CAVITE Province, close to the CAVITE EXPRESSWAY (CAVITEX) .Although the swamp spreads out now, there is a plan to build stations, a depot, and a intermodal facility (bus terminal) there.
near 10k+000m	The route intersects over the interchange of the CAVITE EXPRESSWAY(CAVITEX). Furthermore it passes near the small-scale seaport and toward Talaba region. There are many small-scale rivers and ponds in this area.
Talaba Station（Future）	This station is located at the northern end of Bacoor region in CAVITE Privince.This area is a relay point of the road leading to western Bacoor region from CAVITE EXPRESSWAY(CAVITEX) and there are some old residential area.
near 11k+000m	This route passes over the road leading to the Bacoor region. There is heavy traffic in the street and space is wide.
Niyog Station	This station is located in the northern end of part of Bacoor region In CAVITE Province. The station is a turning point of the road leading to a southern Bacoor region and a Dasmariñas region. Intermodal facility (bus terminal) adjacent to the this station is planned to construct. The residential section and university along a street are near a station.（photo.12）

Current status of vicinity of the point mentioned in **Table 3.1-1** is shown in following figures.

Figure 3.1-2 Current Route Condition (1)

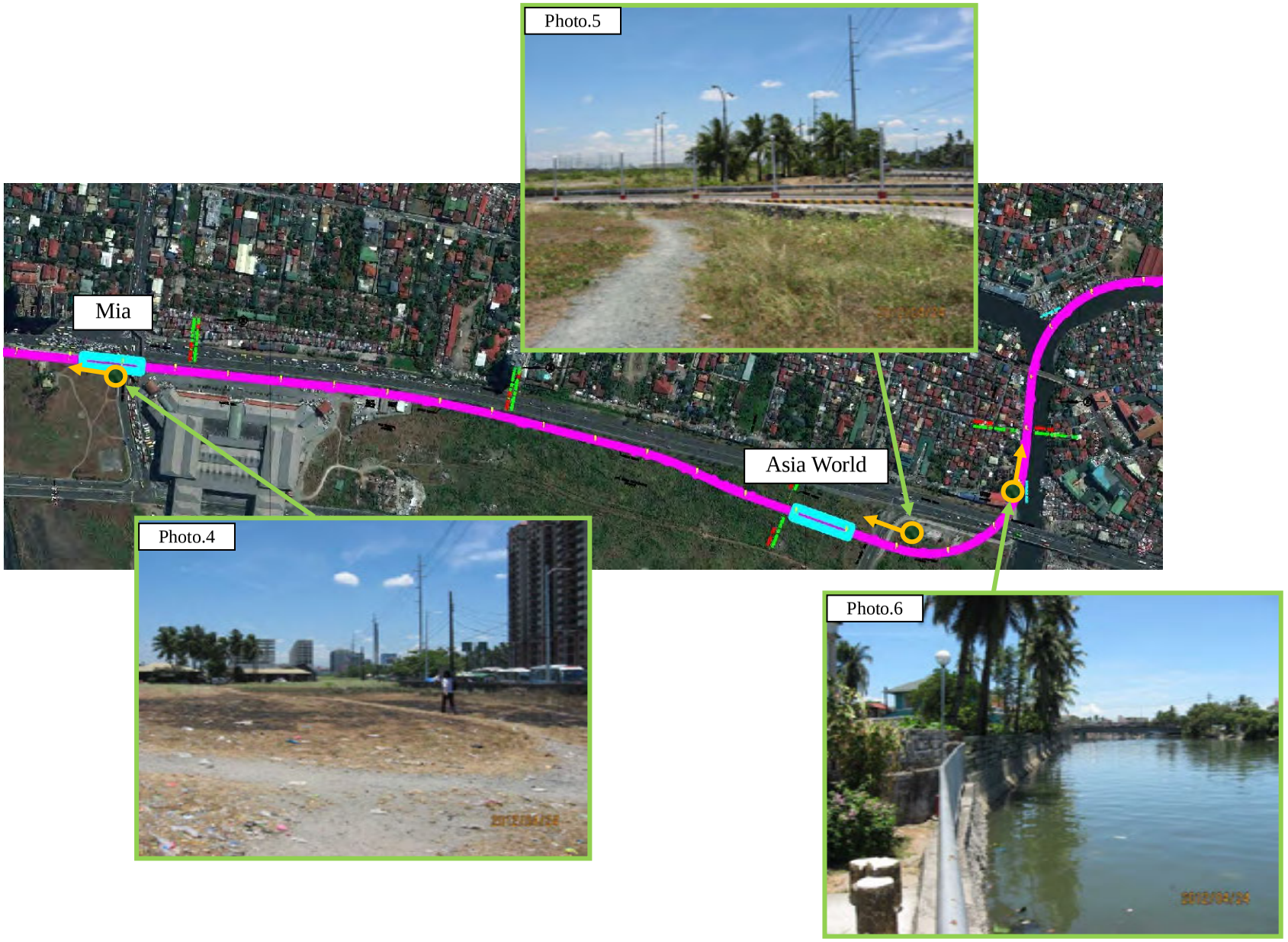


Figure 3.1-3 Current Route Condition (2)

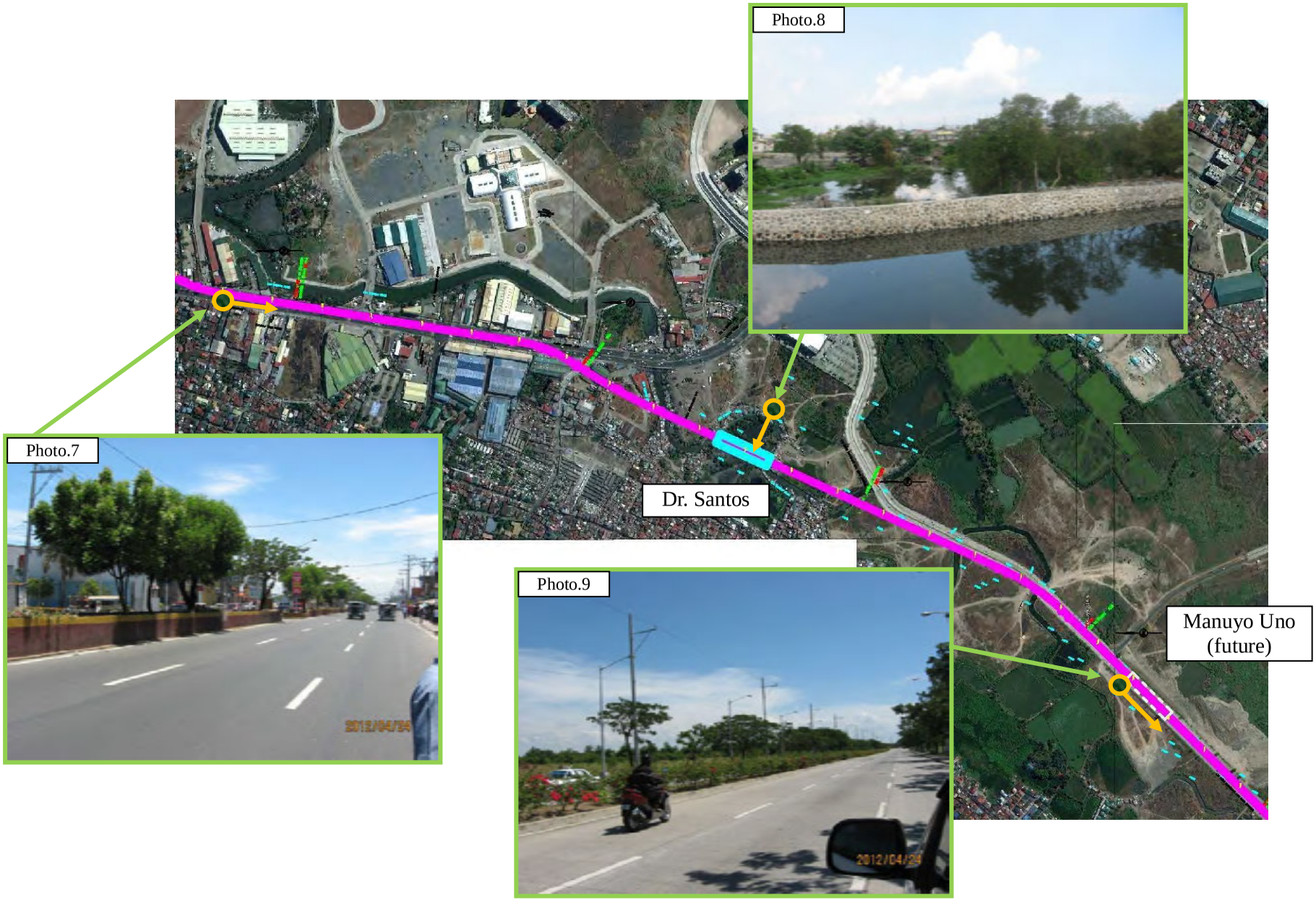


Figure 3.1-4 Current Route Condition (3)

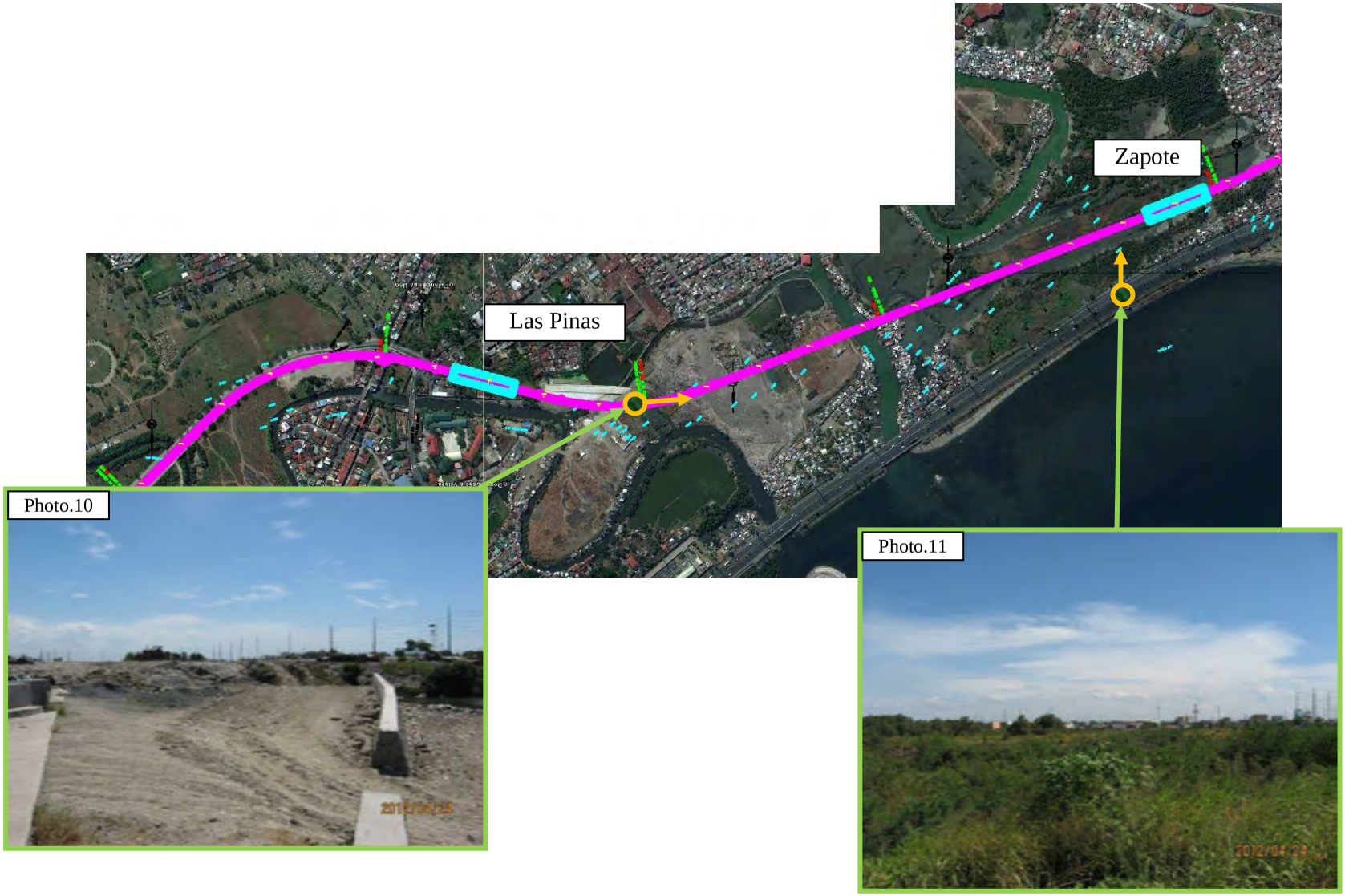


Figure 3.1-5 Current Route Condition (4)

Figure 3.1-6 Current Route Condition (5)

3.1.1 Route Review

In order to review the route alignment, several available documents were taking into consideration, some for its direct description of the originally proposed alignment, others due to the latest specification on track standards. The list of documents reviewed this time is following:

- Manila LRT Line 1 Extension Project Drawings (LAVALIN year 2001)
- LRT Line 1 North Extension Project – Package C Tender document
- Light Rail Transit Authority Tracks and Permanent Ways System.

Beside the above mentioned documents, recent modifications to the route alignment done by the PMO of LRTA were also obtained in the form of individual files. Upon review of all documentation, and based on modifications proposed by LRTA and this Study Team, the following four points have been modified from the original Lavalin report.

1) Location of Redemptorist station

Initially, the Redemptorist Station had been planned before Baclaran Redemptorist Church to face Roxas Boulevard as per the drawings collection of LAVALIN. However, further modification moved it southbound before the district Boulevard 2000 Development, or about 600m from the initial position according to information from LRTA. The original position of the station was proximity 500 mts. from Baclaran station, but around 2km from next station, MIA Station, hence the balance of the distance between the stations was not good.

In addition, a commercial building has already been constructed at the new location, and land development there is ahead than the original location, thus, it is thought that the change of the station location is reasonable. The current location is shown in **Figure 3.1-7**.

Figure 3.1-7 Location of Redemptorist Station

2) Route near Parañaque River

According to the original route plan of LAVALIN, the alignment between Ninoy Aquino stations and the Asia World station, would pass through the central part of the Parañaque River. Generally, as for bridge pier construction, since it is deep water and the central part of the river has the quick flow velocity, it is desirable to avoid the central part of a river. The reasons are shown below:

- Scouring occurs near the basic part of a bridge pier built in underwater.
- The collision power of flotsam is large at the time of a flood.
- A work burden is heavy at the time of construction of a bridge pier.

Thus, it is desirable to avoid the above-mentioned problem if possible here by changing a route into the north-side slippage in a river. A recommended change in route is shown in **Figure 3.1-8**.

3) Location of Niyog station

In the drawings collection of LAVALIN for Cavite extension, the Niyog station was planned at the western side of the Molino Boulevard. Since the bus terminal will be located at the east side of Molino Boulevard, it was necessary to move it eastward to the center of the road (Molino Boulevard) to be side by side with the bus station to facilitate convenience to passengers. This change was done by LRTA, and the changed alignment is shown in **Figure 3.1-9**.

4) Location of Depot

According to the original route plan of LAVALIN, the satellite depot was planned at the sea side (west) of the main line. However, due to the negative impact of sea salt air on the vehicles, the satellite depot would be eventually planned at the mountain side (east) of the main line.

Therefore, as for a Satellite base, it is desirable to build at the west side of the main line based on the site information on LRTA. The change in the location is shown in **Figure 3.1-10**.

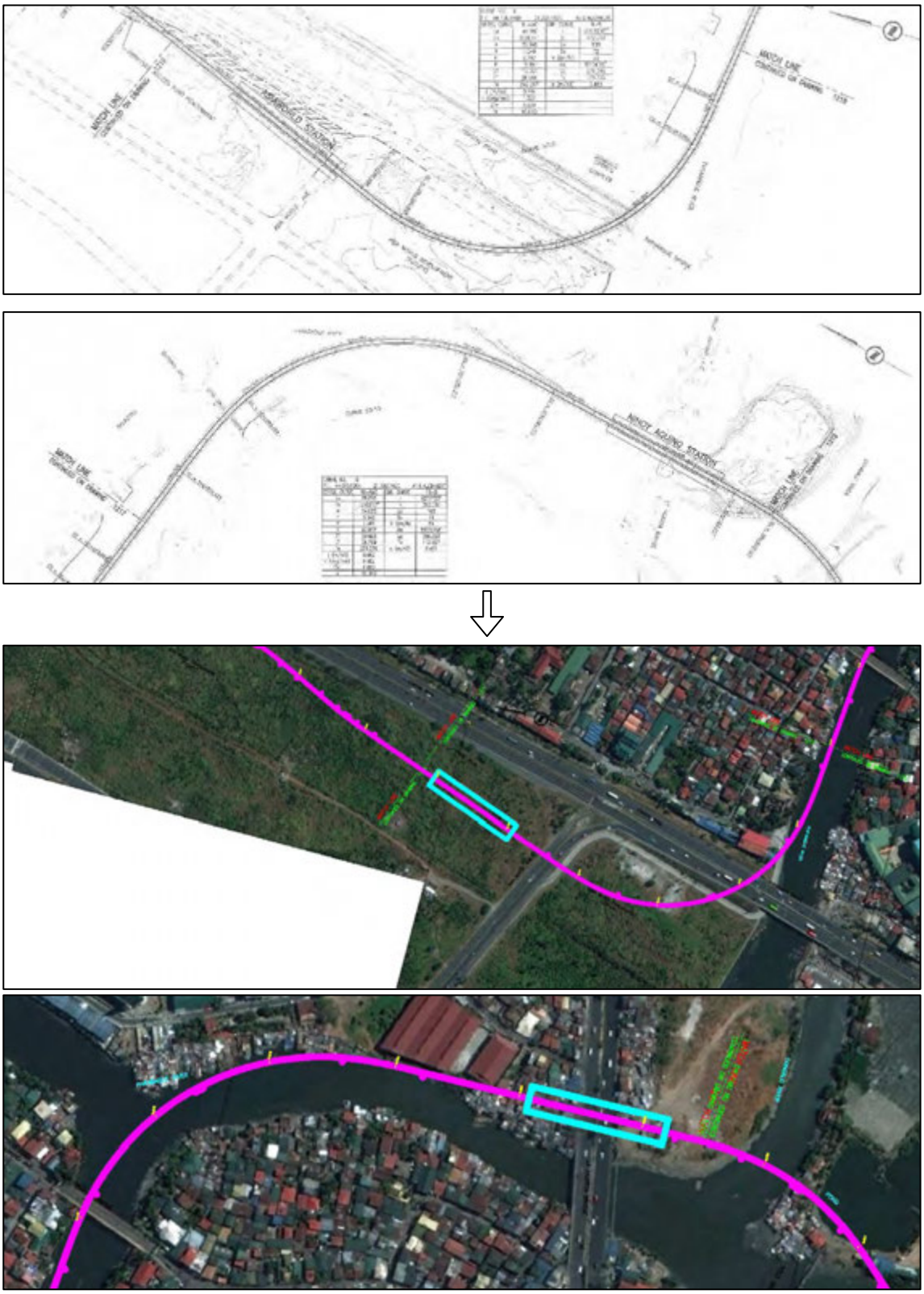


Figure 3.1-8 Alignment near Parañaque River

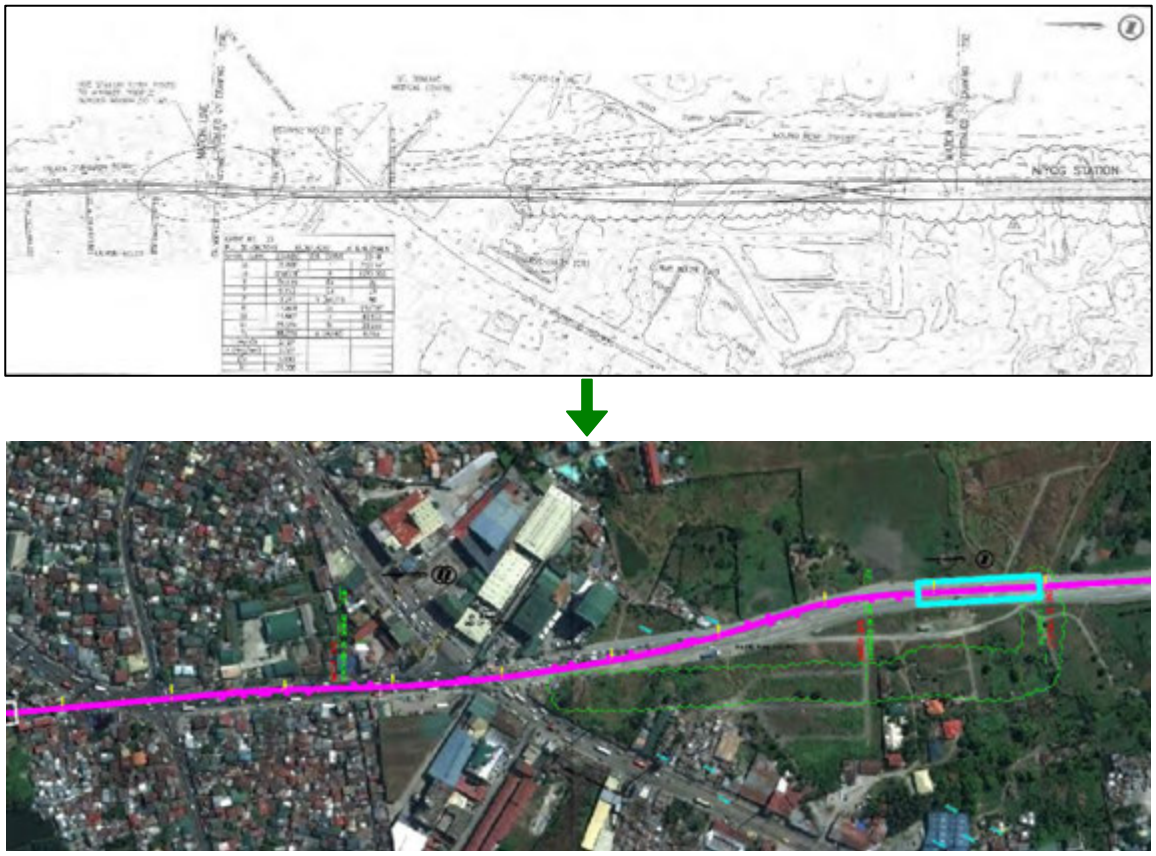


Figure 3.1-9 Location of Niyog station

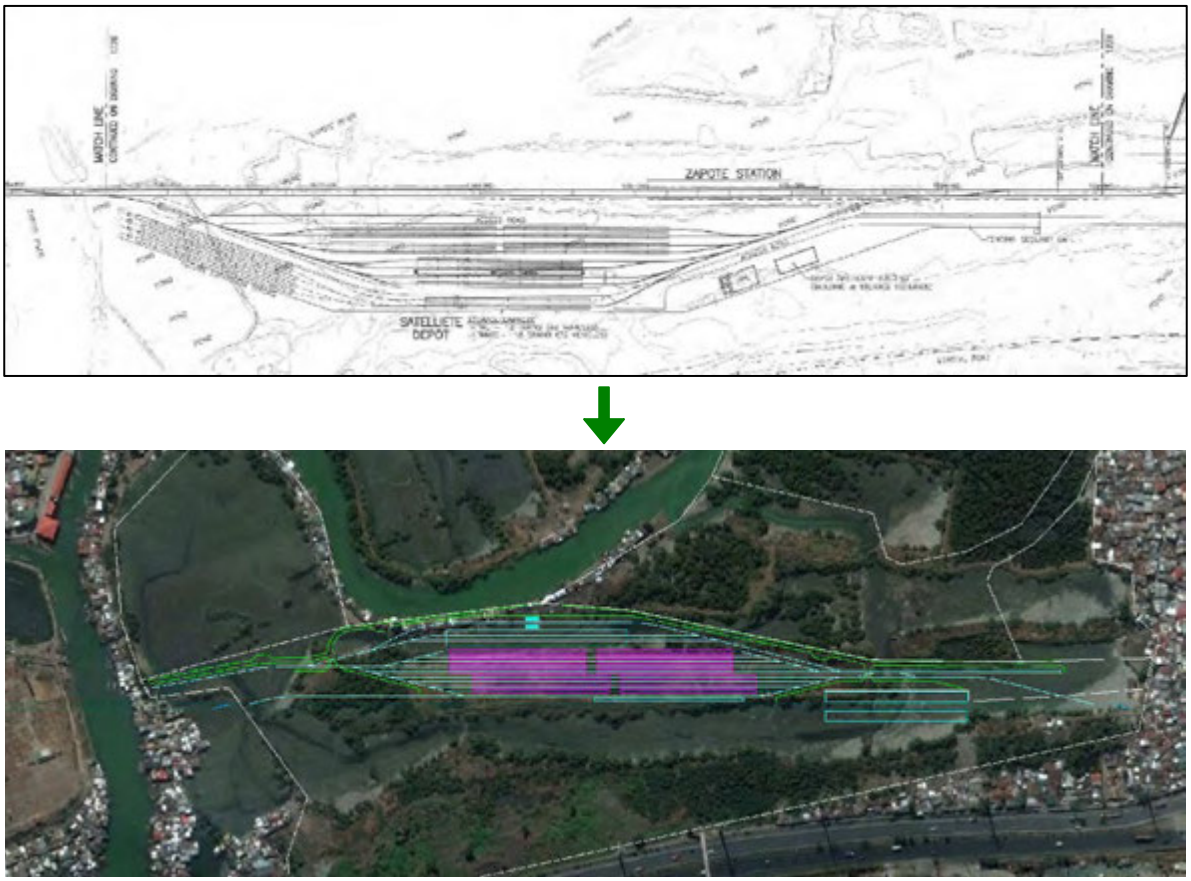


Figure 3.1-10 Location of Satellite Depot

3.2 Train Operation Plan

3.2.1 Demand

The demand for the determination of the train operation plan is defined by the parameter pphpd, defined herewith as the maximal line load during the peak hour per direction. **Table 3.2-1** shows the summary of the pphpd for milestone years, based on demand forecast results from Chapter 2 of this report.

Table 3.2-1 Demand for Line 1

	2015	2016	2020	2025	2030	2035	2040	2045
Daily passengers	650,700	750,600	831,200	899,900	950,300	990,700	1,019,000	1,039,800
PPHPD	23,750	26,000	28,439	30,478	31,955	33,127	33,942	34,524

Source: Study Team, Chapter 2, Table 2.3-3

3.2.2 System Capacity

1) Train Configuration

Figure 3.2-1 shows train configuration of existing Line 1 rolling stock. The First generation train consists of 3 cars and each car has 2 articulation and 3 bodies. The Second and Third generation trains consist of 4 car and each car has 1 articulation and 2 bodies.

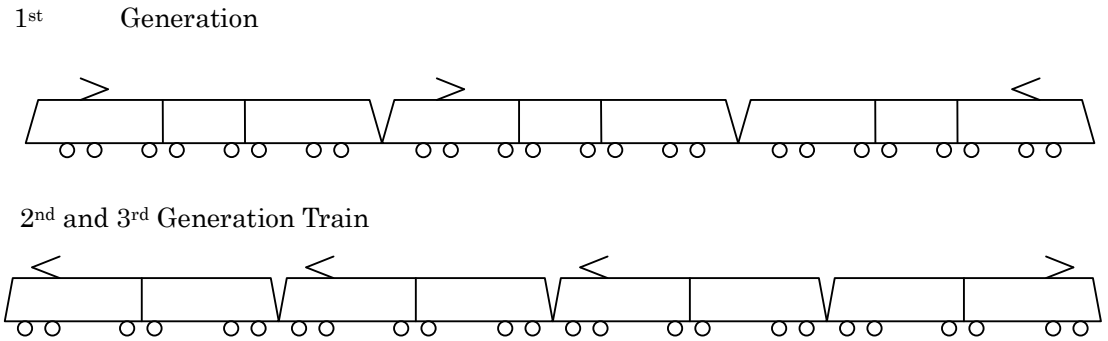


Figure 3.2-1 Existing Rolling Stock Configuration

2) Transportation Capacity

Train capacity of each type of train and number of train sets are as follows.

1st Generation	1,122	21 train sets
2nd Generation	1,358	7 train sets
3rd Generation	1,384	12 train sets

Average train capacity of those trains is 1211 persons.

In the current condition of existing depot it is possible to stable 40 trains because 15 of the 25 tracks can accommodate two (2) 1G trains, but it is not possible to do it with 2nd or 3rd generation trains. Hence, if new trains are replaced with same length (configuration) with 2nd and 3rd generation trains, the number of trains able to be stabled in existing depot will be reduced to only 30 trains in the future. This matter would have to be considered in the future when depot stabling capacity will be a restriction for the required fleet. Meanwhile, it is considered that the 4th Generation fleet can be similar to the 3rd Generation fleet.

Passenger capacity of 3rd generation train is 1,384 so we could assume that the average capacity of trains will be close to 1313. To simplify the calculation 1300 passengers is used for transportation capacity.

Transportation capacity at peak our per each head way becomes as follows.

Table 3.2-2 Transportation Capacity per Headway

Headway	3min	2min30sec	2min15sec	2min
Number of trains per hour	20	24	26.7	30
Passenger capacity	26,000	31,200	34,710	39,000

Based on demand forecast and train capacity, operation headway of peak hour of each year shall be as follows.

Table 3.2-3 Peak-hour Headway at Key Years

	2015	**2016**	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**
PPHPD	23,750	26,000	28,439	30,478	31,955	33,127	33,942	34,524
Headway	3.25min	2.5min	2.5min	2.5min	2.5min	2min	2min	2min
Transportation capacity/hour	24,700	31,200	31,200	31,200	31,200	39,000	39,000	39,000

Source: Study Team

At the first stage operation may start when the construction is completed up to Dr. Santos station. North end is assumed be still at Roosevelt station at this stage. Satellite depot is planed beside Zapote station that is still far from Dr. Santos station therefore expansion of existing depot is required by this stage. At this stage the minimal headway necessary would be 3 minutes.

In the next stage construction will complete up to Niyog but two stations Manuyo Uno station and Talaba station will not constructed in this stage. In the third stage north extension will be extended to common station so that Line 1 will connect with Line3. In future stage two additional stations will be opened and headway will be minimized to 2 minutes. **Table 3.2-4** indicates the condition of each Phase.

Table 3.2-4 Phase and Headway

		Headway	**Description**	**Year**
Opening of South Extension	Phase1	3min15sec	Open the line up to Dr. Santos	2015
	Phase2	2min30sec	Open the line up to Niyog Two stations (Manuyo Uno and Talaba) are not constructed. North extension is connected to common station	2016
Future	Phase1	2min30sec	Replacement of 1st and 2nd Generations' rolling stock Manuyo Uno and Talaba are opened.	2025
	Phase2	2min	Ultimate Stage, additional rolling stock	2035

3.2.3 Operation Schemes

Currently north terminal is Roosevelt station but it is planned to extend to Common Station. Following table indicates the operation pattern of each phase, pattern, and case.

Table 3.2-5 Operation Patterns of Each Phase

Cases		Headway	Operation pattern
Opening of South Extension	Phase1	3min 15sec	Roosevelt — Dr. Santos
	Phase2	2.5min	Common station — Niyog
Future		2min	Common station — Niyog

Currently track of north extension is physically connected to Line 3 but train operation is limited to Roosevelt station. However, this station was not designed to be a terminal station, and its turn back facilities only allow a minimal headway of 3 minutes. It is planned to provide Common Station between Roosevelt and North Avenue so that trains of both line will come to Common Station and passengers can easily transfer from one line to the other, and vice versa.

3.2.4 Travelling Time

Traveling time is calculated by simulation based on the route data indicated in **Figure 3.1-1** and train performance of 3rd generation train.

Regular running time is assumed based on simulated traveling time with adding margin time for contingency and rounded up every 5 seconds. **Table 3.2-6** indicates the regular running time of south bound train and **Table 3.2-7** indicates the regular running time of north bound train. Dwell time at each station is assumed 40 second based on the condition of capacity expansion project. The maximal speed is assumed to be 60kph under the consideration that track rehabilitation would be completed by that time (end of 2015).

Table 3.2-6 Regular Running Time (south bound)

Station	Dwell Time	Running Time	Arrival	Departure
Common Station			––	0:00:00
Rosevelt	40	1:05	0:01:05	0:01:45
Balintawak	40	2:25	0:04:10	0:04:50
Monumento	40	3:00	0:07:50	0:08:30
5th Avenue	40	1:35	0:10:05	0:10:45
R. Papa	40	1:25	0:12:10	0:12:50
Abad Santos	40	1:05	0:13:55	0:14:35
Blummentritt	40	1:35	0:16:10	0:16:50
Tayuman	40	1:05	0:17:55	0:18:35
Bambang	40	1:00	0:19:35	0:20:15
D. Jose	40	1:05	0:21:20	0:22:00
Carriedo	40	1:05	0:23:05	0:23:45
Central	40	1:10	0:24:55	0:25:35
UN Avenue	40	1:40	0:27:15	0:27:55
Pedro Gil	40	1:10	0:29:05	0:29:45
Quirino	40	1:15	0:31:00	0:31:40
Vito Cruz	40	1:15	0:32:55	0:33:35
Gil Puyat	40	1:30	0:35:05	0:35:45
Libertad	40	1:10	0:36:55	0:37:35
EDSA	40	1:30	0:39:05	0:39:45
Baclaran	40	1:00	0:40:45	0:41:25
Redemtrist	40	2:50	0:44:15	0:44:55
MIA	40	1:15	0:46:10	0:46:50
Asia World	40	1:50	0:48:40	0:49:20
Ninoy Aquino	40	2:25	0:51:45	0:52:25
Dr. Santos	40	2:15	0:54:40	0:55:20
Manuyo Uno	40	1:20	0:56:40	0:57:20
Las Pinas	40	1:30	0:58:50	0:59:30
Zapote	40	1:35	1:01:05	1:01:45
Talaba	40	1:50	1:03:35	1:04:15
Niyog		1:25	1:05:40	––

Source: Study Team

In the initial stage Manuyo Uno and Talaba stations will not be constructed.

In case without 2 stations running time between Dr. Santos and Las Pinas becomes 2min.25sec. and running time between Zapote and Niyog becomes 2min.55sec. for both direction and total running time becomes 1hour3min35sec for south bound and 1hour3min.50sec. for north bound. The turnaround time at terminals is estimated at 5 minutes, and then the total loop time of one single train would be 132 minutes between Niyog and Common Station, without the Talaba and Manuyo Uno stations.

Table 3.2-7 Regular Running Time (north bound)

Station	Dwell Time	Running Time	Arrival	Departure
Niyog			––	0:00:00
Talaba	40	1:20	0:01:20	0:02:00
Zapote	40	1:50	0:03:50	0:04:30
Las Pinas	40	1:35	0:06:05	0:06:45
Manuyo Uno	40	1:30	0:08:15	0:08:55
Dr. Santos	40	1:20	0:10:15	0:10:55
Ninoy Aquino	40	2:20	0:13:15	0:13:55
Asia World	40	2:05	0:16:00	0:16:40
MIA	40	1:50	0:18:30	0:19:10
Redemtrist	40	1:15	0:20:25	0:21:05
Baclaran	40	2:40	0:23:45	0:24:25
EDSA	40	1:00	0:25:25	0:26:05
Libertad	40	1:30	0:27:35	0:28:15
Gil Puyat	40	1:10	0:29:25	0:30:05
Vito Cruz	40	1:30	0:31:35	0:32:15
Quirino	40	1:15	0:33:30	0:34:10
Pedro Gil	40	1:15	0:35:25	0:36:05
UN Avenue	40	1:10	0:37:15	0:37:55
Central	40	1:50	0:39:45	0:40:25
Carriedo	40	1:10	0:41:35	0:42:15
D. Jose	40	1:05	0:43:20	0:44:00
Bambang	40	1:05	0:45:05	0:45:45
Tayuman	40	1:05	0:46:50	0:47:30
Blummentritt	40	1:05	0:48:35	0:49:15
Abad Santos	40	1:25	0:50:40	0:51:20
R. Papa	40	1:05	0:52:25	0:53:05
5th Avenue	40	1:25	0:54:30	0:55:10
Monumento	40	1:35	0:56:45	0:57:25
Balintawak	40	3:30	1:00:55	1:01:35
Rosevelt	40	2:25	1:04:00	1:04:40
Common Station		1:10	1:05:50	––

3.2.5 Track Layout at the Terminal

In the train operation plan track layout of terminal is considered as follows.

a) North Terminal

At initial stage Roosevelt station will be the north terminal. The train will go about 700 m to east after evacuating the passengers at the station to turn back. This station and the track layout were not designed for terminal station, and severe limitation of shorter headways is present for this station

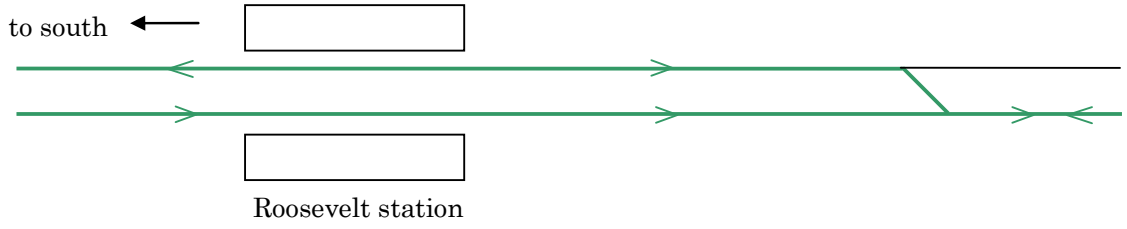


Figure 3.2-2 Track Layout of North terminal (Roosevelt)

The Common Station is planned for exchange of passengers with Line 3. **Figure 3.2-3** indicates the location of common station. As there is a prominent slope from Roosevelt station to west of common station, and to the east of the proposed location of the Common Station there is tight curve, the proposed site is the only location to construct said station.

Figure 3.2-3 Location of Common Station

Figure 3.2-4 indicates the planned track layout of common station.

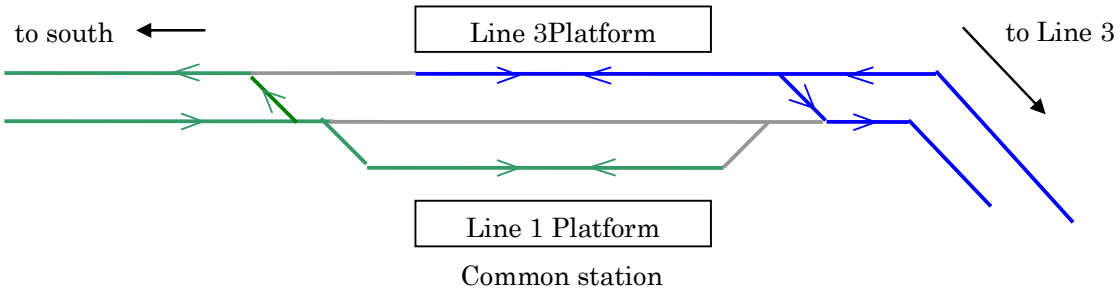


Figure 3.2-4 Planned Track Layout of North terminal (Common Station)

Considering the operation and frequency track layout is not suitable. Recommended track layout of common station is indicated in following figure. There is no enough space for constructing pocket tracks for stabling but siding track is extended so that one train can be stabled.

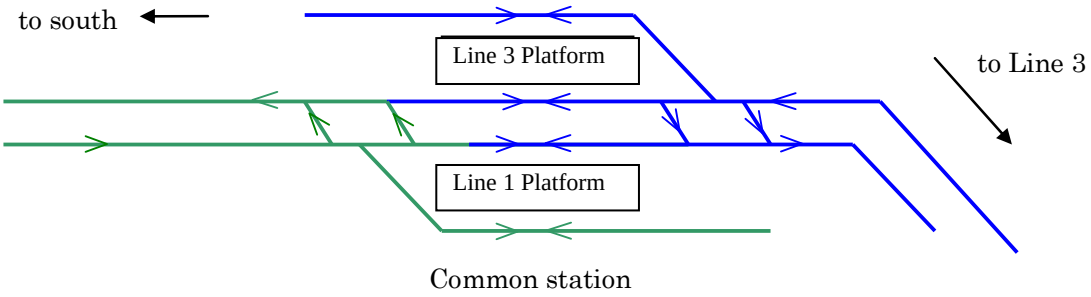


Figure 3.2-5 Recommended Track Layout of North terminal (Common Station)

b) South Terminal (Niyog)

To make the operation more flexible draw out track is recommended to install behind the terminal station. Draw out track will be used as main line when the line is extended to south.

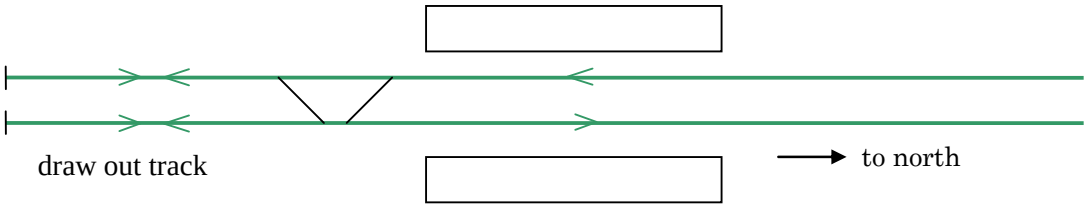


Figure 3.2-6 Track Layout of South Terminal

Track layout of entire line of Line 1 combined with existing and extension is indicated in **Figure 3.2-7**

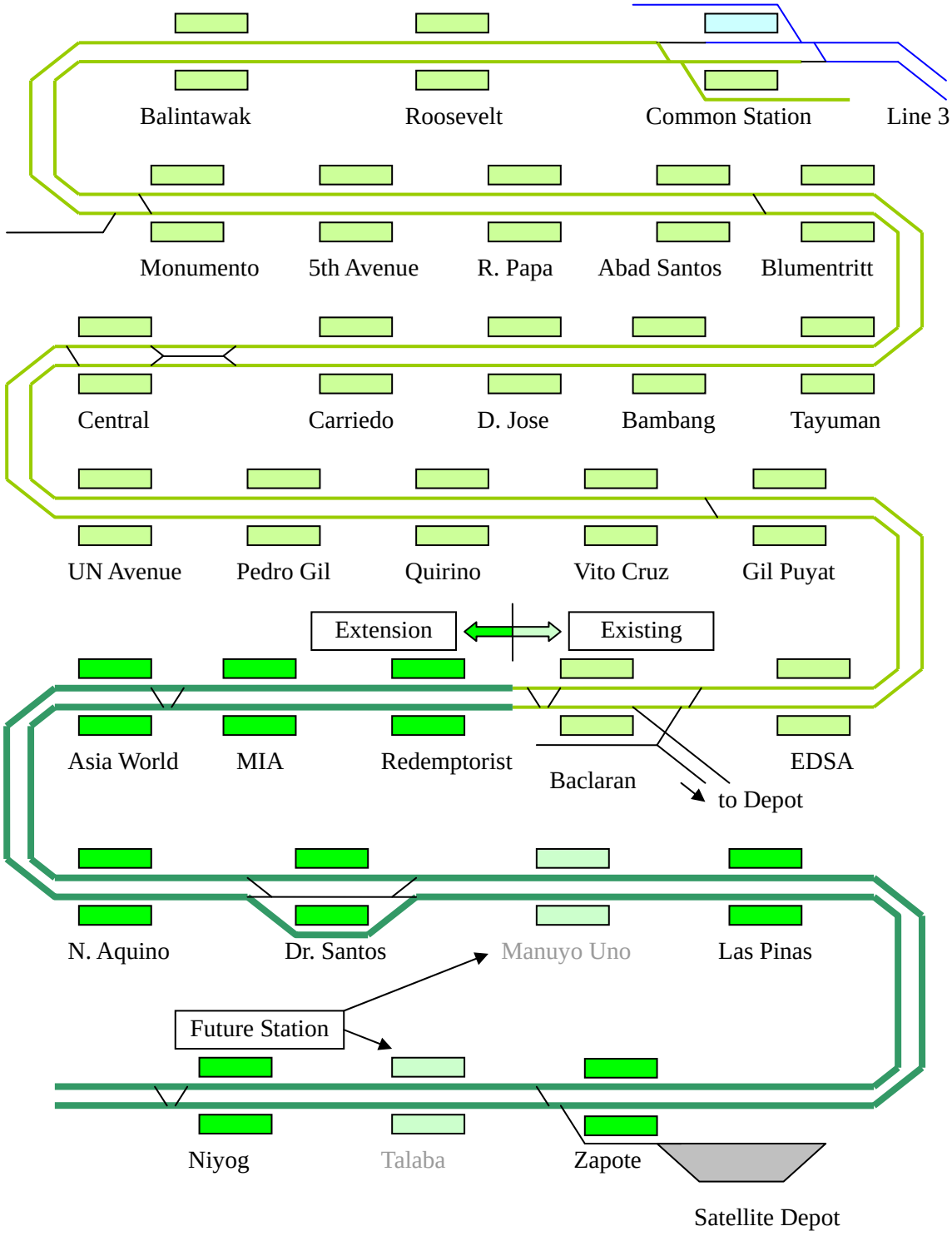
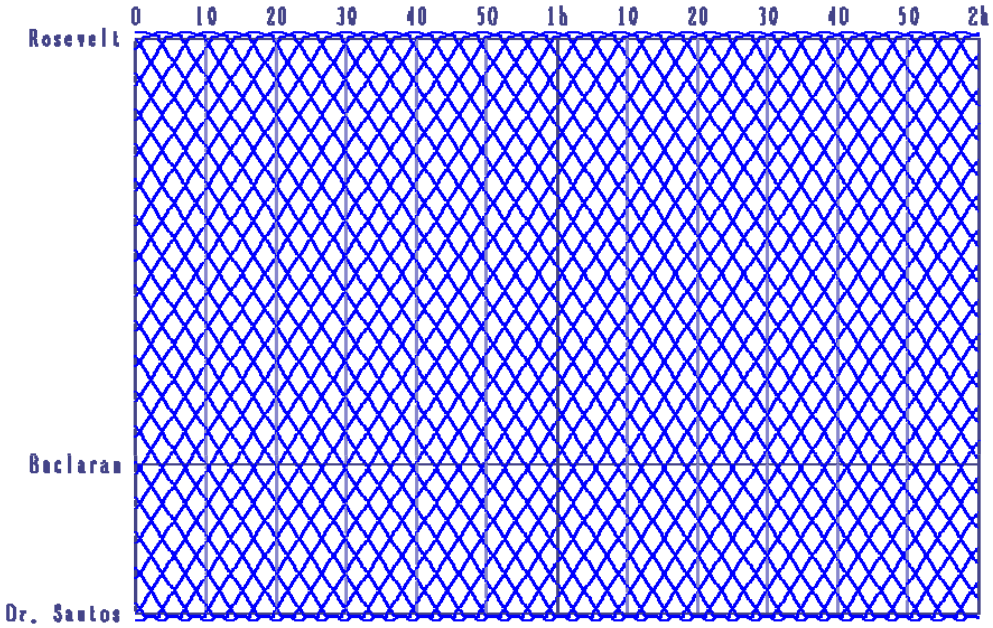


Figure 3.2-7 Track Layout of Line 1

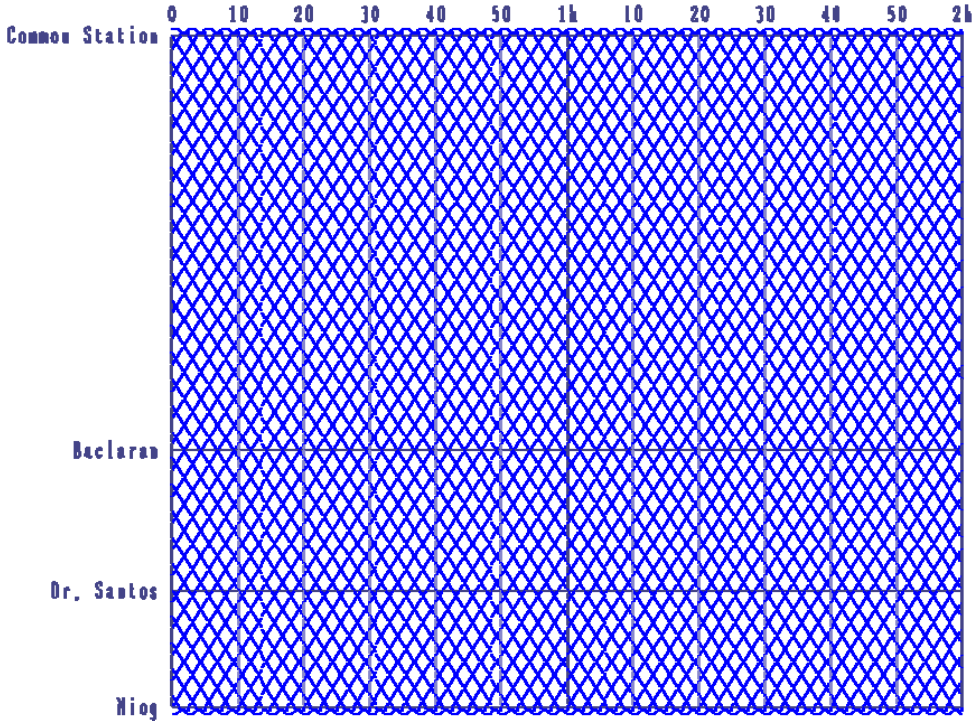
3.2.6 Train Diagrams

Train diagram at peak hour is made to assume necessary number of trains. **Figure 3.2-8** to **Figure 3.2-10** indicate the example of train diagram at peak hour of phases and cases.



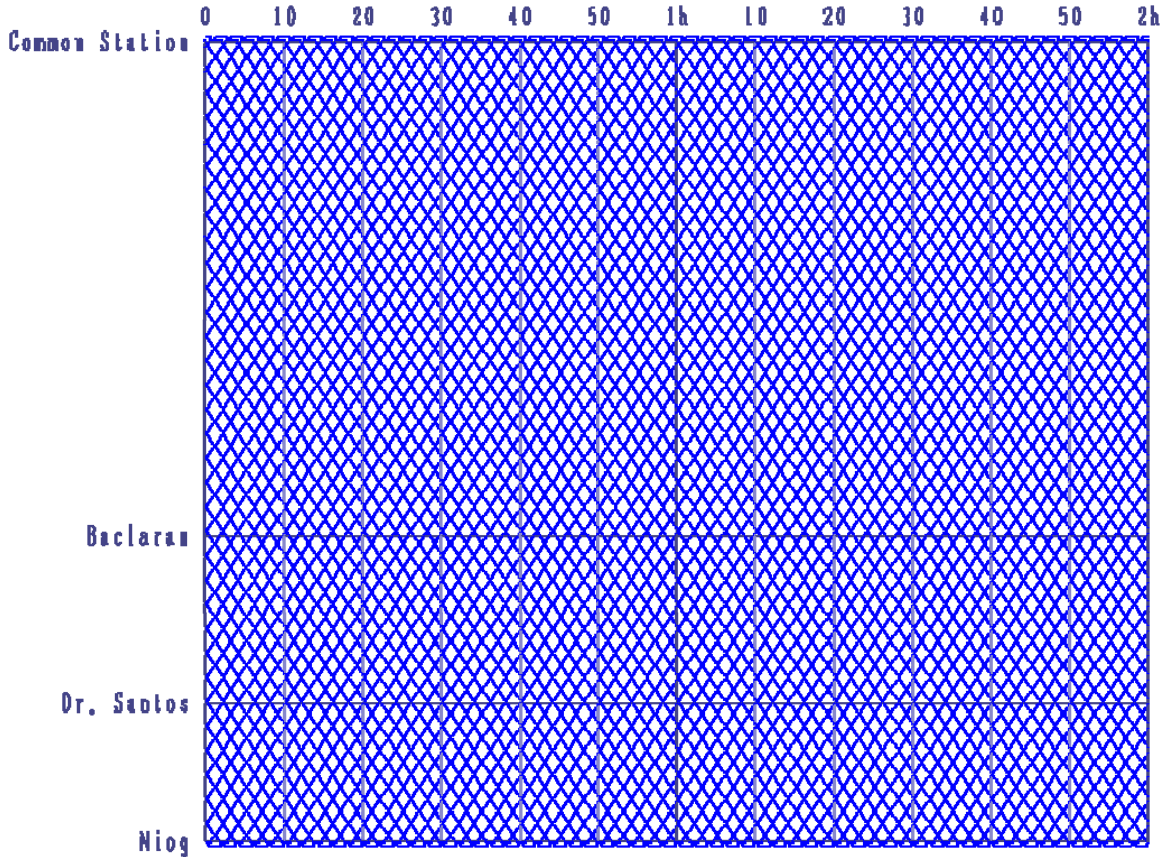
Headway: 3min 15 sec ➔ Number of trains in operation: 35 trains

Figure 3.2-8 Track Diagram (Phase 1)



Headway: 2min 30sec ➔ Number of trains in operation: 54 trains

Figure 3.2-9 Track Diagram (Phase 2)



Headway: 2min ➔ Number of trains in operation: 68 trains

Figure 3.2-10 Track Diagram (Future)

3.3 Required Number of Rolling Stock

3.3.1 Fleet Requirement

Required number of trains is assumed by counting the line in train diagram. **Table 3.3-1** indicates the number of trains in each pattern and case.

Table 3.3-1 Required Number of Trains

		Headway	Trains in operation	Spare trains	Total number of trains
Opening	Phase1	3min 15sec	35	4	39
	Phase2	2min 30sec	54	7	61
Future	Phase1	2min 30sec	55	7	62
	Phase2	2min	68	9	77

Source: Study Team

3.3.2 Rolling Stock Procurement Plan

Based on the number of trains in above data future train procurement plan are indicated as follows. A total of 30 trains are required to be procured at the opening of south extension.

Table 3.3-2 Rolling Stock Procurement Plan

Units: Train sets

		Opening of South Extension		Future	
		Phase1	**Phase2**	**Phase1**	**Phase2**
Year		2015(2/4)	2016	2025	2035
1st Generation Train		16	16		
2nd Generation Train		3	3		
3rd Generation Train		12	12 **+1**	12	12
4th Gen Train	1st batch	**8**	8		
	2nd batch		**22**	**30**	30
5th Generation Train				**20**	20
6th Generation Train					**15**
Total		39	61	62	77
Required number of trains		39	61	62	77

Source: Study Team

3.3.3 Stabling Facilities

Stabling during the night will be done only at depot stabling tracks and some trains at siding tracks of the revenue line so that maintenance activities will not be disrupted. There are 25 stabling tracks in current Pasay depot. Of that total, 15 tracks are good for 2 trains in series when a 1st Generation train is included, while others are good for stabling only one train. However, after replacement of 1st generation trains, only one train could be stabled in a single track. Thus, a total of only 30 trains could be stabled in the existing depot in the future.

By the end of Phase 1 of the project, the expansion of existing Pasay Depot should be completed. There will be constructed 13 additional stabling tracks, increasing the total availability of stabling tracks to 53 trains. However, if some tracks in the light maintenance hall and some particular stations are included for stabling, the total number of stabling tracks becomes 66 trains. Since only 39 trains are required at this phase, there are enough tracks for stabling.

By completion of Phase 2, satellite depot will be constructed and stabling capacity will be 87 including inspection tracks and stabling at stations. Number of trains would be 61, then, stabling capacity is enough in this phase.

In the future headway will be minimized to 2 minutes as ridership will increase. Required number of trains would be 77 at this stage, however the stabling capacity of entire facilities would be reduced to 77 as total replacement of first generation and second generation will occur, being exactly the amount of trains needed. Therefore, this matter must be taken into consideration when implementing the future capacity expansion in 20 years-time if the number of needed trains would be increased from the planned amount.

Table 3.3-3 Stabling Facilities Plan

Units: Train sets

	Opening of South Extension		Future	
	Phase1	**Phase2**	**Phase1**	**Phase2**
	2015	**2016**	**2025**	**2035**
Existing Depot				
Existing Stabling Track	40	40	30	30
Existing Inspection Track	5	5	5	5
Stabling Track in Expansion	13	13	13	13
Inspection Track in Expansion	3	3	3	3
Satellite Depot				
Stabling Track	-	18	18	18
Inspection Track	-	2	2	2
Station				
Common Station	-	1	1	1
Monumento	1	1	1	1
Central	1	1	1	1
Baclaran	2	-	-	-
Dr. Santos	1	1	1	1
Niyog	-	2	2	2
Total	66	87	77	77
Number of trains	39	61	62	77

Source: Study Team

CHAPTER 4
DEPOT PLAN

CHAPTER 4 DEPOT PLAN

4.1 Number of Required Facilities and Stabling Track

4.1.1 Light Maintenance Track

- The light maintenance plan and required number of tracks for LRT Line1 is shown in **Table 4.1-1.**
- Currently, there are 5 light maintenance tracks. 6 tracks are necessary to comply with maintenance standards. However, since there are some trains under failure, the present 5 tracks are sufficient for the light maintenance.
- The required number of tracks for the light maintenance will be 11 when opening of Line 1 Cavite Extension Project assuming that the maintenance method of new train sets is the same as maintenance method of 3rd generation trains. **(Table 4.1-2)**
- According to typical maintenance standard of Japan, the total number of maintenance track and repair track are expected 11 tracks for 87 train sets. **(Table 4.1-3)**
- In this project, the number of light maintenance track for Cavite extension is 11 tracks by reference to existing maintenance condition and Japanese standard.
- In Baclaran depot which is the existing depot, 5 tracks are currently installed and 3 tracks will be newly installed for the expansion depot.
- 3 tracks will be newly installed for Satellite depot.
- All the area for the light maintenance shed should be completed ahead of the delivery of the new rolling stock.

Table 4.1-1 Required Number of Light Maintenance Track

Existing Maintenance Plan

		1G		2G				3G					
		LEVEL1	LEVEL2	I-II	IA-IIA	IB-IIB	IC-IIC	5k-15D	10k-1M	15k-45D	30k-3M	60k-6M	120k-12M
Inspection period	c	1 month	1 month	1 month	4 months	6 months	1 year	15 days	1 month	45 days	3 months	6 months	12 months
Daily conversion		28 days	28 days	28 days	112 days	168 days	336 days	15 days	30 days	45 days	90 days	180 days	360 days
Overlaped coefficient with superior inspection	a	1.0	1.0	84 / 112 = 0.75	56 / 168 = 0.33	168 / 336 = 0.50	1.0	15 / 30 = 0.50	15 / 45 = 0.33	45 / 90 = 0.50	90 / 180 = 0.50	180 / 360 = 0.50	1.0
Number of workdays	b	365 days	365 days	365 days	365 days	365 days	365 days	293 days	293 days	293 days	293 days	293 days	293 days
Workday coefficient		1.00	1.00	1.00	1.00	1.00	1.00	1.25	1.25	1.25	1.25	1.25	1.25
Inspection time	d	1 day	1 day	2 days	2 days	2 days	2 days	1 days	1 days	1 days	1 days	1 days	1 days
Number of trainset	t	21 trainsets		7 trainsets				12 trainsets					
Number of necessary line of each inspection w=t*a*b*d/c	w	0.75 tracks	0.75 tracks	0.38 tracks	0.04 tracks	0.04 tracks	0.04 tracks	0.50 tracks	0.17 tracks	0.17 tracks	0.08 tracks	0.04 tracks	0.04 tracks
Number of necessary line		**2.00 tracks**						**1.00 tracks**					

Phase 3

		1G		2G				3G(12)+4G(32)					
		LEVEL1	LEVEL2	I-II	IA-IIA	IB-IIB	IC-IIC	5k-15D	10k-1M	15k-45D	30k-3M	60k-6M	120k-12M
Inspection period	c	1 month	1 month	1 month	4 months	6 months	1 year	15 days	1 month	45 days	3 months	6 months	12 months
Daily conversion		28 days	28 days	28 days	112 days	168 days	336 days	15 days	30 days	45 days	90 days	180 days	360 days
Overlaped coefficient with superior inspection	a	1.0	1.0	84 / 112 = 0.75	56 / 168 = 0.33	168 / 336 = 0.50	1.0	15 / 30 = 0.50	15 / 45 = 0.33	45 / 90 = 0.50	90 / 180 = 0.50	180 / 360 = 0.50	1.0
Number of workdays	b	365 days	365 days	365 days	365 days	365 days	365 days	365 days	365 days	365 days	365 days	365 days	365 days
Workday coefficient		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Inspection time	d	1 day	1 day	2 days	2 days	2 days	2 days	1 days	1 days	1 days	1 days	1 days	1 days
Number of trainset	t	20 trainsets		7 trainsets				44 trainsets					
Number of necessary line of each inspection w=t*a*b*d/c	w	0.71 tracks	0.71 tracks	0.38 tracks	0.04 tracks	0.04 tracks	0.04 tracks	1.47 tracks	0.49 tracks	0.49 tracks	0.24 tracks	0.12 tracks	0.12 tracks
Number of necessary line		**1.93 tracks**						**2.93 tracks**					

Future

		1G		2G				3G(12)+4G(32)+5G(43)					
		LEVEL1	LEVEL2	I-II	IA-IIA	IB-IIB	IC-IIC	5k-15D	10k-1M	15k-45D	30k-3M	60k-6M	120k-12M
Inspection period	c							15 days	1 month	45 days	3 months	6 months	12 months
Daily conversion								15 days	30 days	45 days	90 days	180 days	360 days
Overlaped coefficient with superior inspection	a							15 / 30 = 0.50	15 / 45 = 0.33	45 / 90 = 0.50	90 / 180 = 0.50	180 / 360 = 0.50	1.0
Number of workdays	b							365 days	365 days	365 days	365 days	365 days	365 days
Workday coefficient								1.00	1.00	1.00	1.00	1.00	1.00
Inspection time	d							1 days	1 days	1 days	1 days	1 days	1 days
Number of trainset	t							87 trainsets					
Number of necessary line of each inspection w=t*a*b*d/c	w							2.90 tracks	0.97 tracks	0.97 tracks	0.48 tracks	0.24 tracks	0.24 tracks
Number of necessary line								**5.80 tracks**					

Table 4.1-2 Required Number of Tracks

Light maintenance track plan	at Present	Future			
	Existing Depot	Existing Depot	Expansion Depot	Satellite Depot	Total
Daily Inspection	1	2		1	3
1G, 2G Inspection	2				
3~5 G Inspection	1	2	2	2	6
Unscheduled Inspection	1	1	1		2
Total	5	5	3	3	11

Table 4.1-3 Required Number of Tracks Derived from Typical Maintenance Standard of Japan

Number of trainset	12+32+43=			87
Type of maintenance	Daily	Monthly	Important part	General
Cycle days	3 days	3 month 90 days	4 years 1,460 days	8 years 2,920 days
Overlapping Ratio of inspection	0.97	0.91	0.5	1
Annual effective working days	365(1)	312(1.17)	312(1.17)	312(1.17)
Work hours	1.5 hours 0.19 day	2 days	18 days	25 days
Capacity /1 track	5.34	2.06	0.63	0.87
Number of track	6	3	2	

4.1.2 Heavy (Amended) Maintenance Tracks

- The train maintenance of LRT Line1 doesn't correspond to the typical heavy maintenance and general maintenance of Japan. The disabled vehicle is replaced and repaired by the cyclic maintenance plan.
- The heavy maintenance plan of LRT Line1 is shown in **Table 4.1-4**.
- The current rate of disabled vehicles is 14% of vehicles for 40 train sets. The required number of heavy maintenance track is still 1 track, even if the rate of those is 20%.
- One more new heavy maintenance track is required for new train sets in 2015.
- For the existing heavy maintenance track, the vehicle separated by every one unit access to the track. For the new heavy maintenance track, the vehicle separated by every two unit access to the track due to the land limitation.

Table 4.1-4 Heavy Maintenance Plan of LRT Line1

Generation	1G (BN/ACEC)	2G (Adtranz)	3G (KN/NS)	**4G**
Number of trainset (cars)	21 (63)	7 (28)	12 (48)	**47 (188)**
Number of maintenance unit	1 car	1 to 2 cars	1 to 2 cars	**1 to 2 cars**
Cycle days	14 days	1 month 30 days	15 days	**15 days**
Overlapping Ratio of inspection	1	1	1	**1**
Annual effective working days	312(1.17)	312(1.17)	312(1.17)	**312(1.17)**
Work hours	1 day	1 day	1 day	**1 day**
Assumed ratio of down	20% (Latest data:19 down / 139 cars = 14%)			
Capacity /1 track	0.35	0.05	0.19	**0.73**
Number of existing track	1 track (0.59)			1 track
Number of track for south extension	**2 tracks**			
Baclaran depot	**1car length * 4tracks (Existing track) 2car length * 2tracks (New)**			

4.1.3 Automatic Car Body Washing Track

- The plan of car body washing is shown in **Table 4.1-5**.
- Exterior cleaning is implemented by using the automatic washing machine for about 20 vehicles per day and twice in a week.
- The existing washing tracks support for 40 train sets. Therefore, one more track is needed for 47 train sets which are procurement vehicles.
- New automatic washing machine will be installed in Satellite depot.

Table 4.1-5 Plan of Car Body Washing of LRT Line1

Generation	1G (BN/ACEC)	2G (Adtranz)	3G (KN/NS)	**4G**
Number of trainset	21	7	12	**47**
Washing days	Monday Friday	Tuesday Staturday		**4 days/week**
Washing capacity /1 track	40			**48**
Number of existing track	1 track			**—**
Number of track for south extension	**2 tracks**			
Baclaran depot	**1 track (Existing)**			
Satellite depot	**1 track (New)**			

4.1.4 Stabling Track

Stabling during the night will be done only at depot stabling tracks and some trains at siding tracks of the revenue line so that maintenance activities will not be disrupted. There are 25 stabling tracks in current Pasay depot. Of that total, 15 tracks are good for 2 trains in series when a 1st Generation train is included, while others are good for stabling only one train. However, after replacement of 1st generation trains, only one train could be stabled in a single track. Thus, a total of only 30 trains could be stabled in the existing depot in the future.

By the end of Phase 1 of the project, the expansion of existing Pasay Depot should be completed. There will be constructed 13 additional stabling tracks, increasing the total availability of stabling tracks to 53 trains. However, if some tracks in the light maintenance hall and some particular stations are included for stabling, the total number of stabling tracks becomes 66 trains. Since only 39 trains are required at this phase, there are enough tracks for stabling.

By completion of Phase 2, satellite depot will be constructed and stabling capacity will be 87 including inspection tracks and stabling at stations. Number of trains would be 61, then, stabling capacity is enough in this phase.

In the future headway will be minimized to 2 minutes as ridership will increase. Required number of trains would be 77 at this stage, however the stabling capacity of entire facilities would be reduced to 77 as total replacement of first generation and second generation will occur, being exactly the amount of trains needed. Therefore, this matter must be taken into consideration when implementing the future capacity expansion in 20 years-time if the number of needed trains would be increased from the planned amount.

The stabling plan corresponding to 77 train sets is shown in **Table 4.1-6**.

Table 4.1-6 Stabling Plan of LRT Line1

Units: Train sets

	Opening of South Extension		**Future**	
	Phase1	**Phase2**	**Phase1**	**Phase2**
	2015	**2016**	**2025**	**2035**
Existing Depot				
Existing Stabling Track	40	40	30	30
Existing Inspection Track	5	5	5	5
Stabling Track in Expansion	13	13	13	13
Inspection Track in Expansion	3	3	3	3
Satellite Depot				
Stabling Track	-	18	18	18
Inspection Track	-	2	2	2
Station				
Common Station	-	1	1	1
Monumento	1	1	1	1
Central	1	1	1	1
Baclaran	2	-	-	-
Dr. Santos	1	1	1	1
Niyog	-	2	2	2
Total	66	87	77	77
Number of trains	39	61	62	77

Source: Study Team

4.2 Existing Baclaran Depot Expansion Plan

Depot expansion plan of existing Baclaran depot is shown as below.

a) Number of stabling track : 13 tracks (1 train set /each track)
b) Number of light maintenance track : 2 tracks (in light maintenance shed)
c) Number of unscheduled inspection track : 1 track (in light maintenance shed)
d) Number of heavy maintenance track : 2 tracks (in heavy maintenance workshop for 1 train set)
e) Number of wheel re-profiling track : 1 track (with wheel re-profiling shed)
f) Buildings and facilities :
    - Heavy maintenance workshop
    - Light maintenance shed
    - Wheel re-profiling shed
    - Office building
    - OCC building
    - Substation
    - Waste water treatment plant
    - Material store
    - Motor pool

Figure 4.2-1 Existing depot expansion plan

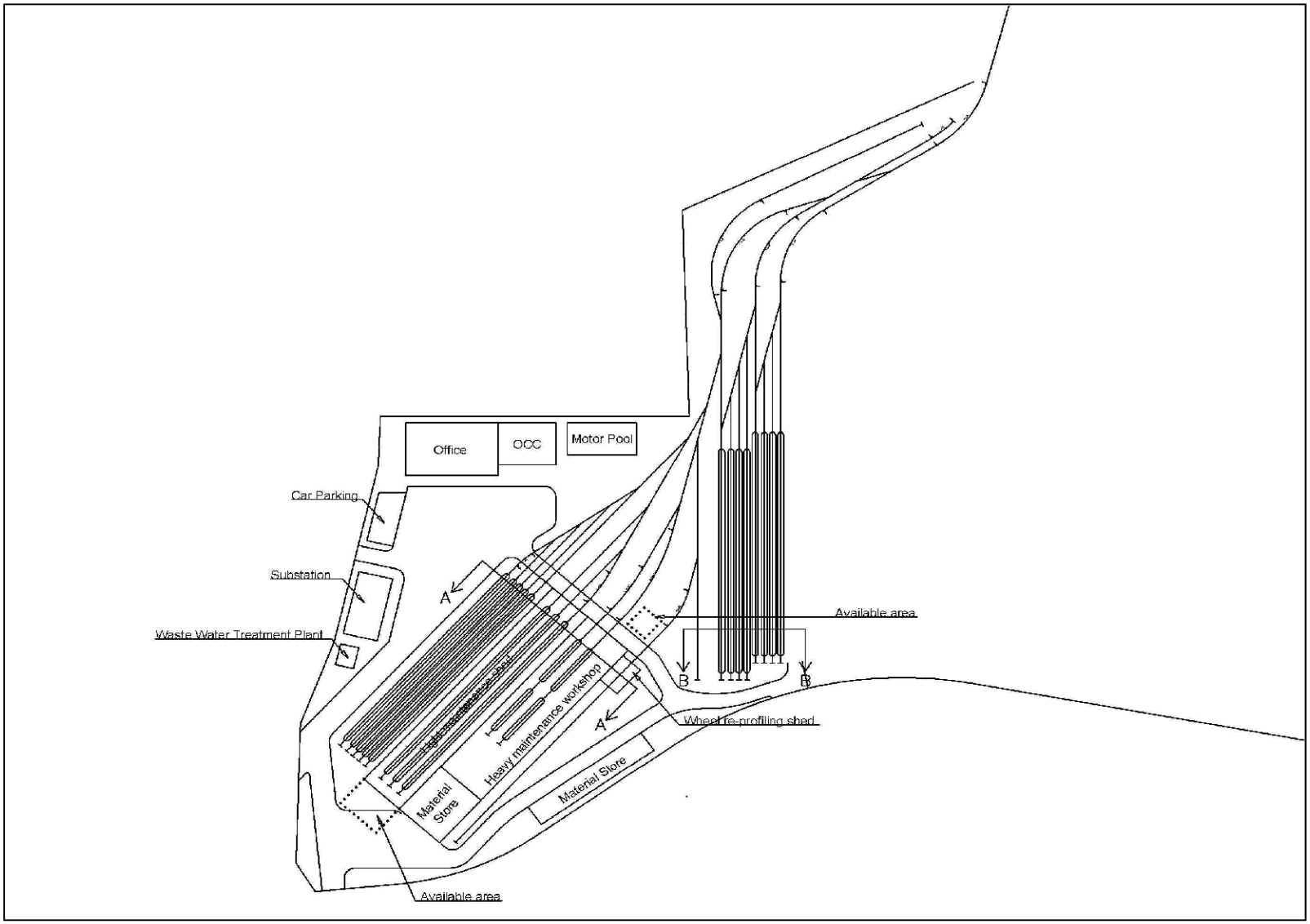


Figure 4.2-2 Expanded track alignment

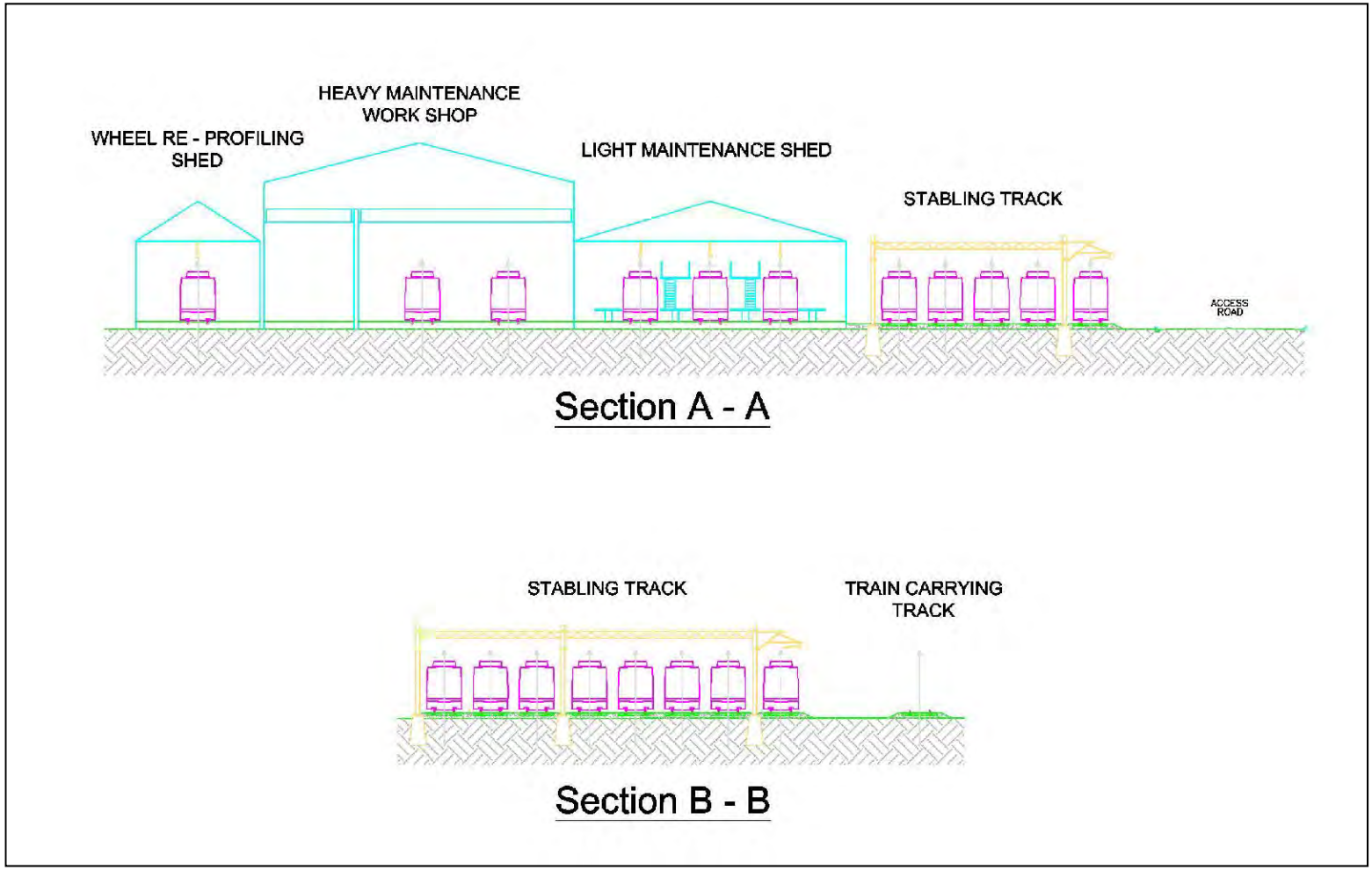


Figure 4.2-3 Section plan of expansion plan

4.3 Satellite Depot Plan

Satellite depot plan at Zapote is shown as below.

a) Number of stabling track : 9 tracks (2 train set /each track)
b) Number of light maintenance track : 2 tracks (in light maintenance shed)
c) Number of daily inspection track : 1 track
d) Number of automatic train wash track : 1 track
e) Buildings and facilities :
    - Light maintenance shed
    - Automatic train wash plant
    - Working deck

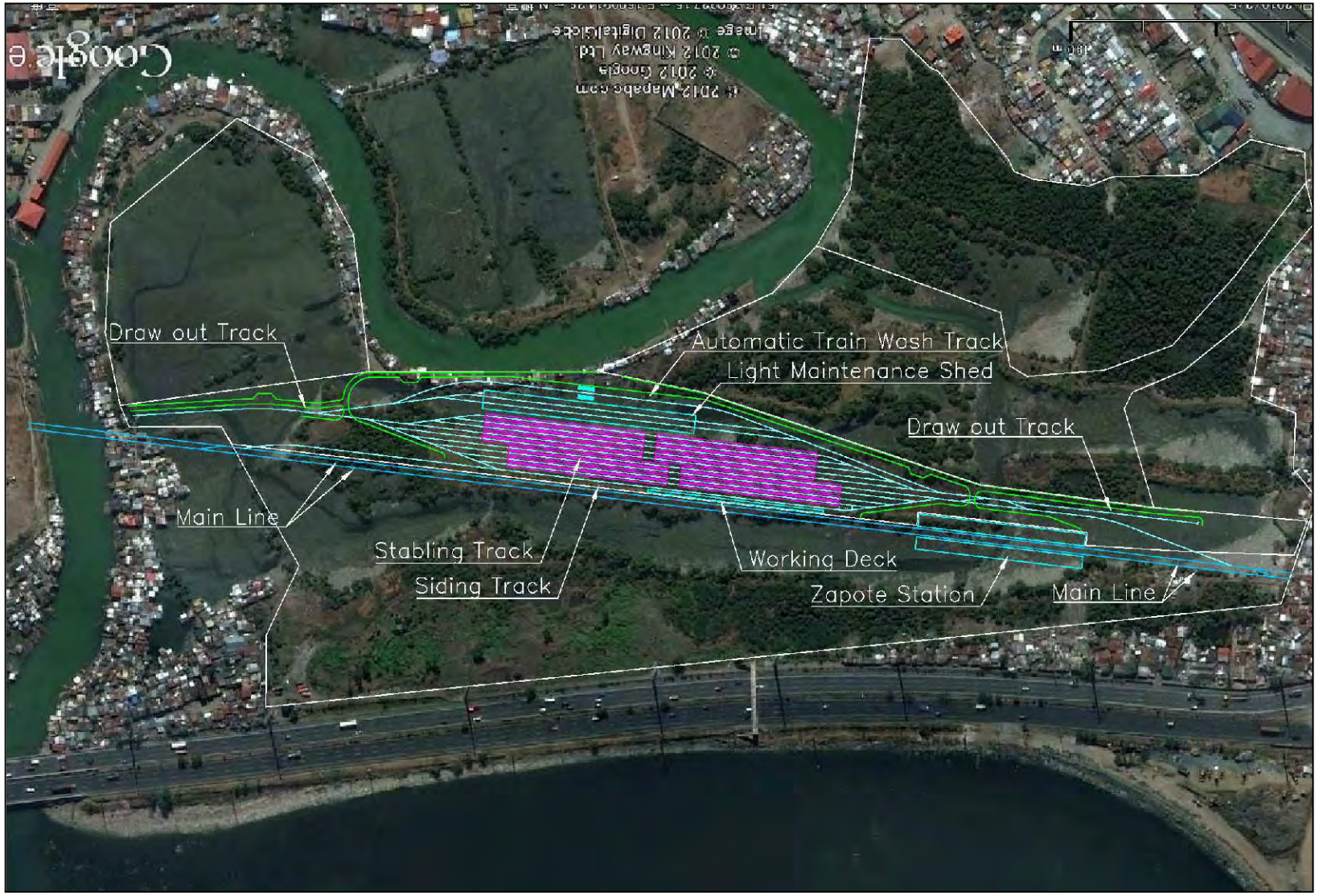


Figure 4.3-1 Satellite depot plan

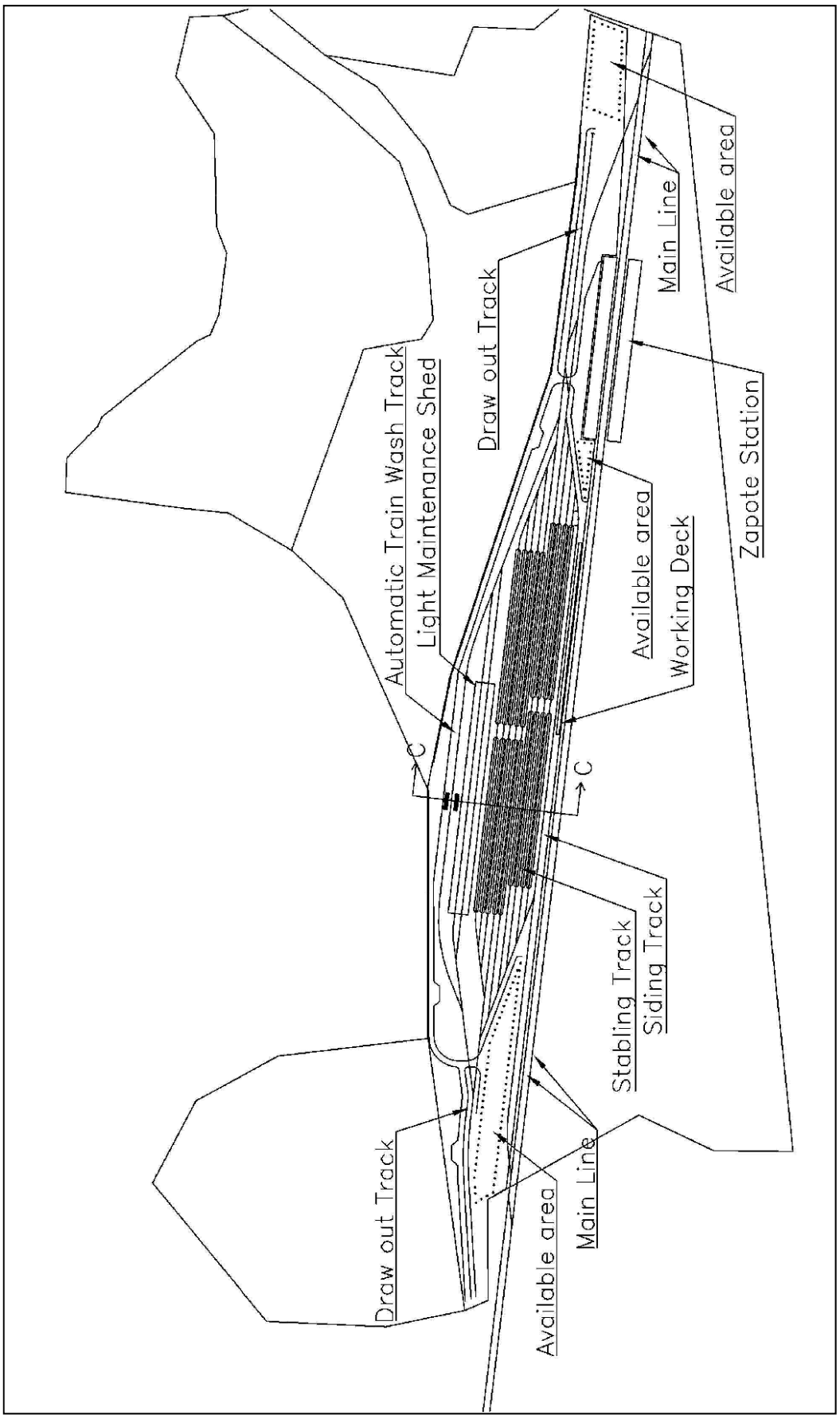


Figure 4.3-2 Track alignment in Satellite depot

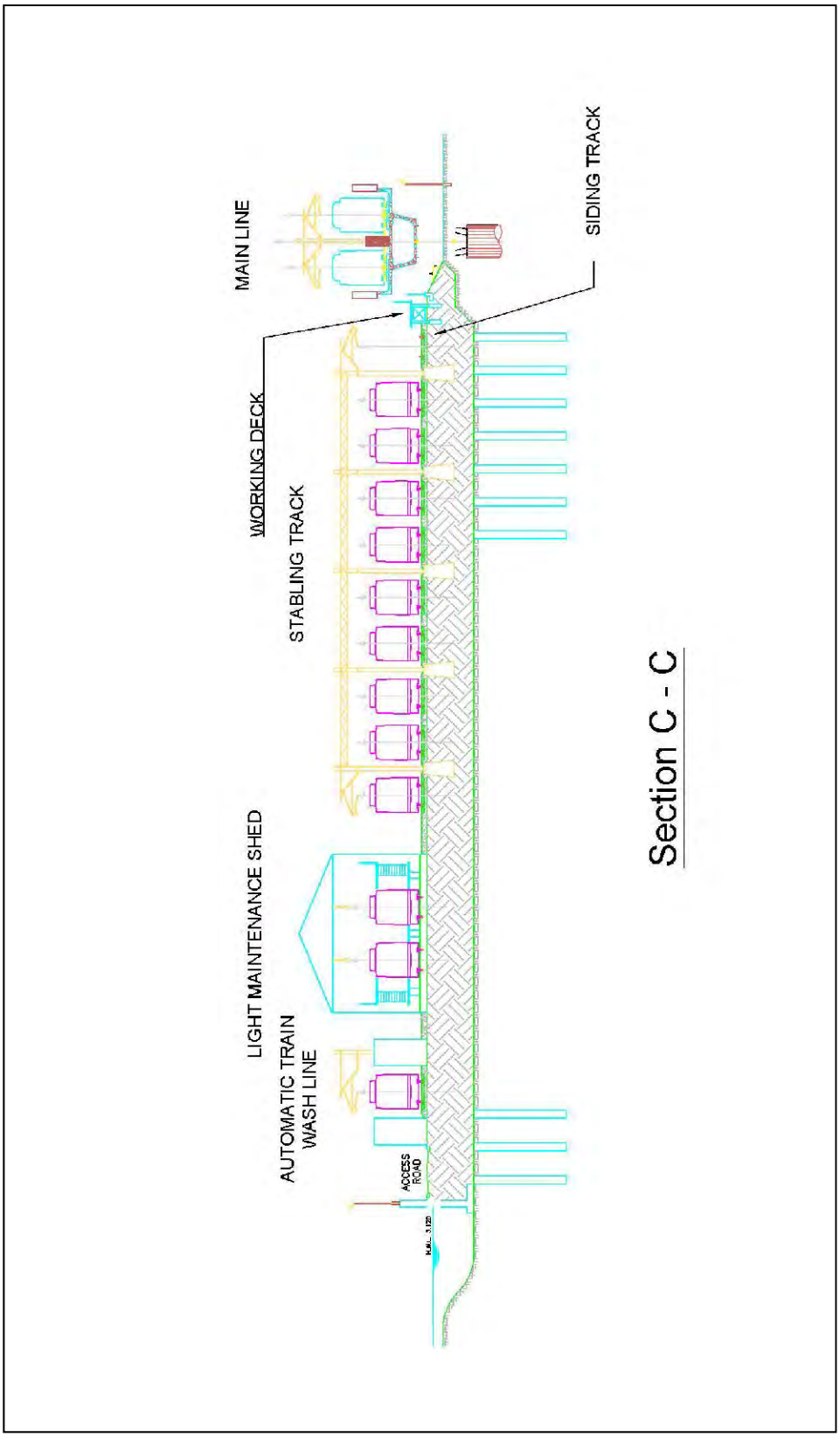


Figure 4.3-3 Section plan of satellite depot

4.4 SOW of JICA ODA on Depot

After exchange of opinions with the consultant for the financial advisor of DOTC for the private sector portion of the project, an agreement of the demarcation of tasks within the two depot areas has been achieved.

Basically, all E&M items within the depot area will be implemented by the private sector (Concessionaire) with close interface with construction of other facilities being implemented by public sector.

The summary of the breakdown of the SOW is shown in **Table 4.4-1**.

Table 4.4-1 SOW of JICA Loan in Depot

Area	Item	JICA Loan	Others	
			PPP	DOTC
Satellite	Land acquisition			*
	Soil improvement	*		
	Land reclamation (Embankment、Track bed、Retaining wall, Drainage, etc)	*		
	Track work (include Access line, Stabling line, inside Workshop, etc)		*	
	Overhead Catenary System (include Access line, Stabling line, inside Workshop, etc)		*	
	Signalling System		*	
	Telecommunication System (Train radio, Dispatcher telephone, Optical transmission, etc)		*	
	Substation (Traction power, Depot power)		*	
	Power distribution (High/Low tension)		*	
	Building for DCC		*	
	Building for Administration (Concessionaire)		*	
	Building for workshop or other maintenance activities, or administration of LRTA (if required)	*		
	Road inside the Depot	*		
	Train maintenance equipment	*		
	Infrastructure maintenance equipment	*		
	E&M system maintenance equipment	*		
	Drainage (Domestic sewage, Industrial waste water, Recycle water)	*		
	Water supply (City water)	*		
	Industrial waste storage (from maintenance Oil/|Grease etc)	*		
	Fire prevention	*		
	Illumination towers inside the Depot	*		

Source: Study Team

Table 4.4-2 SOW of JICA Loan in Depot

Area		Item	JICA Loan	Others	
				PPP	DOTC
Baclaran	New	Land acquisition (if necessary)			*
		Soil improvement	*		
		Land reclamation (Embankment、Track bed、Retaining wall, Drainage, etc)	*		
		Track work (include Access line, Stabling line, inside Workshop, etc)		*	
		Overhead Catenary System (include Access line, Stabling line, inside Workshop, etc)		*	
		Signalling System		*	
		Telecommunication System (Train radio, Dispatcher telephone, Optical transmission, etc)		*	
		Substation (Traction power, Depot power)		*	
		Power distribution (High/Low tension)		*	
		Building for New OCC (If equired)		*	
		Building for Administration (Concessionaire)		*	
		Building for workshop or other maintenance activities, or administration of LRTA (if required)	*		
		Road inside the Depot	*		
		Train maintenance equipment	*		
		Infrastructure maintenance equipment	*		
		E&M system maintenance equipment	*		
		Drainage (Domestic sewage, Industrial waste water, Recycle water)	*		
		Water supply (City water)	*		
		Industrial waste storage (from maintenance Oil/|Grease waste from wheel turning etc)	*		
		Fire prevention	*		
		Illumination towers inside the Depot	*		
	Existing modification	Track changeover		*	
		Overhead Catenary System		*	
		Relocation of public utility	*		

Source: Study Team

CHAPTER 5
ROLLING STOCK

CHAPTER 5 ROLLING STOCK

5.1 Current Condition of Rolling Stock

5.1.1 General

There are three types of rolling stock in Line 1:

First generation trains are introduced in 1984 at the opening of Line 1 and 64 vehicles are installed. Vehicle is double articulated and one train set consists of two cars. After Capacity Expansion Project, first generation trains changed to 3-car train in order bring the passenger capacity of the train almost same as second generation. Thus, 21 vehicles are converted to intermediate car by installing coupler at front end. Consequently, the 1G fleet becomes a 21 3-car trains fleet, from the original 32 2-car trains, plus one car remained.

Second generation train is introduced in 1999 at Phase 1 of Capacity Expansion Project. The train consists of 4 vehicles and the vehicle is single articulated.

Third generation trains are introduced in 2007 at Phase 2 of Capacity Expansion Project. Train configuration is same as second generation train.

5.1.2 Current Condition

Table 5.1-1 shows the condition of each LRV and **Table 5.1-2** shows the summary of the condition of the rolling stock of Line 1. It shows that 33 cars out of 140 cars are not operational; 7 cars are defective because of collision, one car was bombed and 25 cars are because of lack of some parts.

Table 5.1-1 Current Condition of Rolling Stocks

Car No.	operational	cause	Car No.	operational	cause	Car No.	operational	cause	Car No.	operational	cause
First Generation			1041	×	missing parts	Second Generation			1211	○	
1001	○		1042	×	missing parts	1101	○		1212	○	
1002	×	missing parts	1043	○		1102	×	missing parts	1213	○	
1003	×	missing parts	1044	○		1103	○		1214	○	
1004	×	missing parts	1045	○		1104	○		1215	○	
1005	×	missing parts	1046	○		1105	×	missing parts	1216	○	
1006	×	missing parts	1047	○		1106	○		1217	○	
1007	×	missing parts	1048	○		1107	×	collided	1218	○	
1008	○		1049	○		1108	○		1219	○	
1009	×	missing parts	1050	○		1109	○		1220	○	
1010	○		1051	○		1110	○		1221	○	
1011	○		1052	○		1111	○		1222	○	
1012	×	missing parts	1053	○		1112	○		1223	○	
1013	×	collided	1054	×	missing parts	1113	○		1224	○	
1014	○		1055	○		1114	○		1225	○	
1015	○		1056	○		1115	○		1226	○	
1016	○		1057	○		1116	×	missing parts	1227	○	
1017	○		1058	○		1117	×	missing parts	1228	○	
1018	○		1059	○		1118	×	missing parts	1229	○	
1019	○		1060	○		1119	×	missing parts	1230	○	
1020	○		1061	○		1120	×	collided	1231	○	
1021	○		1062	○		1121	×	missing parts	1232	○	
1022	○		1063	○		1122	×	missing parts	1233	○	
1023	○		1064	○		1123	×	missing parts	1234	○	
1024	○					1124	×	missing parts	1235	○	
1025	○					1125	×	missing parts	1236	×	collided
1026	○					1126	×	missing parts	1237	○	
1027	×	collided				1127	×	missing parts	1238	○	
1028	○					1128	×	missing parts	1239	○	
1029	○								1240	○	
1030	○					Third Generation			1241	○	
1031	○					1201	○		1242	○	
1032	○					1202	○		1243	○	
1033	○					1203	○		1244	○	
1034	○					1204	○		1245	○	
1035	○					1205	○		1246	○	
1036	○					1206	○		1247	×	collided
1037	×	bombed				1207	○		1248	×	collided
1038	○					1208	○				
1039	○					1209	○				
1040	○					1210	○				

○: operational ×: not operational

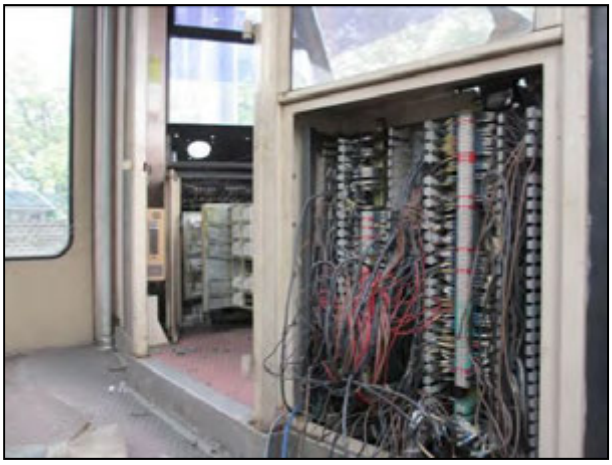
Table 5.2-2 Summary of Rolling Stock Condition

	1st Gen.	2nd Gen.	3rd Gen.	Total
Operational	50	12	45	107
Not Operational	14	16	3	33
Bombed car	(1)			(1)
Collided car	(2)	(2)	(3)	(7)
Missing Parts	(11)	(14)		(25)
Total	64	28	48	140

1) First Generation Rolling Stock

3 cars are totally destroyed by collision and bomb. 11 cars are not operational because of lack of spare parts. 4 cars among 11 are not operated for long time and they are already cannibalized. Car body is also damaged by exposing weather and no maintenance.

Headlight and bumper are missing (1006)



Equipments in the cab is missing (1006)

Figure 5.1-1 First Generation Rolling Stock

2) Second Generation Rolling Stocks

A total of 16 cars are not operational. LRV 1107 and 1120 are down because of collision. Other down trains are not damaged in appearance and missing parts are reported.

Figure 5.1-2 2G Rolling Stock: Body is deformed by collision (1107)

3) Third Generation Rolling Stock

There are three (3) vehicles damaged by collision. LRV # 1247 and 1248 are damaged by same accident. Bolster of articulation was deformed severely. In car 1236 lower portion of car body is damaged and some parts and supports of the equipments are broken.

Figure 5.1-3 3G Train: Body shell is turned outward (1236)

5.2 Restoration Plan

5.2.1 First Generation Rolling Stock

One bombed car and two collided cars are heavily damaged, and considering the lifetime it is not worth repairing due to high cost, instead it is suggested to scrap them and keep the parts for repairing other trains. Twenty one (21) cars are planned in stimulus package project to improve the comfort ability. It is considered that purchasing 4 new train sets to replace the down trains would be economically more efficient. Therefore, the first generation rolling stock would remain operating with only 48 cars (16 trains), and only until 2025.

5.2.2 Second Generation Rolling Stock

Four (4) out of the total seven (7) trains are not operational because of lack of spare parts. Two (2) cars of one of the four (4) trains are also damaged due to collision. Similarly to the first generation, it is considered that purchasing 4 new train sets to replace the down trains (16 cars) would be economically more efficient. Therefore, the second generation rolling stock would remain operating with only 12 cars (3 trains), and only until 2025.

5.2.3 Third Generation Rolling Stock

There are three (3) cars damaged by collision and all of them should be restored by LRTA, either by stimulus package project No. 5, or by other sources of funding.

5.3 Fourth Generation Rolling Stock

According to train operation plan, the required number of trains for Cavite Extension 2017 is 61 trains and 31 existing trains will be available including restored trains. Therefore, 30 trains shall be procured as fourth generation train for this project. Train configuration should be same as 3rd generation train to simplify the maintenance.

Rolling Stocks for Manila LRT line should apply the following design criteria in order to keep compatibility with existing railway system. These criteria shall not be changed in the future unless there is big system change on the line.

1.	Track Gauge	1,435mm
2.	Dimensions	
(1)	Train Length	Max. 106m
(2)	Body width	2,590mm–2,600mm
(3)	Overall height	Max. 3,900mm
(4)	Pantograph working height	Less than 4,300mm – more than 6,000mm
(5)	Pantograph lockdown height	Max. 3,950mm
(6)	Floor height	920mm
(7)	Height of anti-climber	750mm
(8)	Wheel diameter	660mm(new) – 600mm(worn)
(9)	Wheel base	Max. 2,100mm
(10)	Distance between bogie center	Max. 10,000mm
(11)	Door height	1,900mm
3.	Traction Power	
(1)	Nominal Voltage	750V
(2)	Working Range	525V – 900V
4.	Train Performance	
(1)	Maximum speed	60km/h
(2)	Maximum acceleration	1.0m/s^2
(3)	Maximum deceleration of service brake	1.3m/s^2
(4)	Deceleration of emergency brake	1.3m/s^2
5.	Running performance	
(1)	Minimum curve radius	25m
(2)	Maximum gradient	4%
6.	Maximum axle load	12t
7.	Brake system	Emergency brake will be applied in case of train separation
8.	Door system	Door shall not open when train is running Train shall not accelerate when door is open Doors can be opened manually in case of power failure

Preferable Specification for South Extension

Following items are the specification preferable for the rolling stocks for South Extension of Manila LRT Line 1. Specification will be changed depending on development of technology, changing of environmental, etc.

1.	Expected service line	30 years
2.	Train configuration	Mc-M-M-Mc
3.	Vehicle configuration	2 bodies with single articulation 3 bogies
4.	Vehicle length	
(1)	Body length	26,000mm
(2)	Overall length (end car)	26,350mm (anti-climber – coupler)
(3)	Overall length (intermediate car)	26,500mm (coupler – coupler)
5.	Passenger capacity	More than 1,350/train at 7 passengers/sqm
6.	Vehicle body	
(1)	Material	Stainless steel
(2)	Compressive strength	400kN
7.	Passenger door	
(1)	Number per side	4 per car

(2)	Door type	Bi-parting slide door
(3)	Door width	1,500mm
(4)	Door pitch	6,000mm-5,700mm-6,000mm
(5)	Door opening time	2.5 sec ±0.5 sec
(6)	Door closing time	3 sec ±0.5 sec
8.	Passenger seat	
(1)	Seating arrangement	longitudinal
(2)	Configuration	Cantilever type
9.	Wheel chair space	At least one space per car
10.	Jerk limit	1.1 m/s^3 (Except under emergency brake)
11.	Accuracy of speedometer	Within ±2km/h of actual speed
12.	Noise level	
	Interior noise lat stand still	65dB
	Exterior noise at stand still	69dB
	Interior noise at running	65dB
	Exterior noise at running	83dB
13.	Minimum interval of overhaul	600,000km
14.	Loading balance	
	Loading difference between axles	Max 1 ton
	Loading difference between wheels	Less than 10%
15.	Wheel profile	Compatible with existing train (refer appendix)
16.	Propulsion system	
(1)	Traction motor	AC induction motor
(2)	Traction control	VVVF inverter with automatic load compensation control and slip/slide control
17.	Brake system	
(1)	Type	Regenerative brake, pneumatic brake, spring applied parking brake
(2)	Brake control	Electric command pneumatic brake with load compensation and slip/slide control
(3)	Emergency brake reaction time	Max. 1.5 sec.
(4)	Service brake reaction time	Max. 2 sec.
18.	Auxiliary power supply system	
(1)	Type	Static Inverter
(2)	Output	AC 440V 3 phase 60 Hz AC 220V 1 phase 60 Hz DC 110V DC 24V
19.	Air supply system	
(1)	Type	Screw type or rotary type
(2)	Pressure range	8.5 bar – 10 bar
20.	Air conditioning system	
(1)	Configuration	Roof mount
(2)	Compressor	Full hermetic type rotary compressor
(3)	Refrigerant	Environmental friendly type
(4)	Ventilation	2,000m^3/h per vehicle

CHAPTER 6
COST ESTIMATION

CHAPTER 6 COST ESTIMATION

6.1 Basis

This section focuses on the preliminary cost estimation of the ODA JICA portion of the LRT Line 1 South Extension Project only. The estimation is based on revisions on proposed operation plan and depot layout, as well as information regarding rehabilitation of the existing Line 1.

1. Preconditions

Preconditions are set according to information provided by JICA.

- The Rate of fund: JICA 100% and Philippine 0%
- Exchange Rate of Currency: US$1=Yen 82.43, US$1=PHP 43.6 , PHP1=Yen1.89
- Price Escalation: FC=2.1%, LC=2.5%
- Physical Contingency: Construction 5%, Consultant 5%
- Billing Rate of Consultant Expert (referred information from JICA)
- Rate of Tax (VAT 12%, Import Tax 0% (paid by GOP)
- Rate of Administration Cost : 5% (following information from JICA)
- Rate of Interest during Construction: Construction 0.2%, Consultant 0.01%
- Rate of Commitment Charges: 0.1%

2. Pending items

The following item has not yet being estimated with a certain level of accuracy:

- Consultancy Services. Currently at same level as approved by NEDA

6.2 Implementation Plan

The implementation plan presented herein is only for portion covered by JICA Loan, i.e., construction of two depots, rehabilitation of existing rolling stock, and procurement of new rolling stock.

The schedule has been divided into two (2) milestone phases, as explained in the Operation Plan Chapter, which are:

- **Phase 1**: Partial opening of south extension at Dr. Santos station, completion of expansion of Baclaran depot; rehabilitation of 3 3G LRVs (by LRTA); delivery of 8 new trains. **May 2015**.
- **Phase 2**: Total completion of project up to Niyog Station; completion of Zapote satellite depot; Increase frequency of trains by decreasing minimal headway to 2.5 min. This implies completion of Common Station; and delivery of last 22 trains. **May 2016**.

Close coordination with the Civil and E&M works' portion is paramount for the success of the project. Furthermore, the completion of related projects, such as the construction of the Common Station in between Roosevelt and North Avenue stations, and the implementation of the Common Ticketing System are crucial as well for the proper implementation of the Line 1 CEP.

The schedule of these projects is not covered by this report.

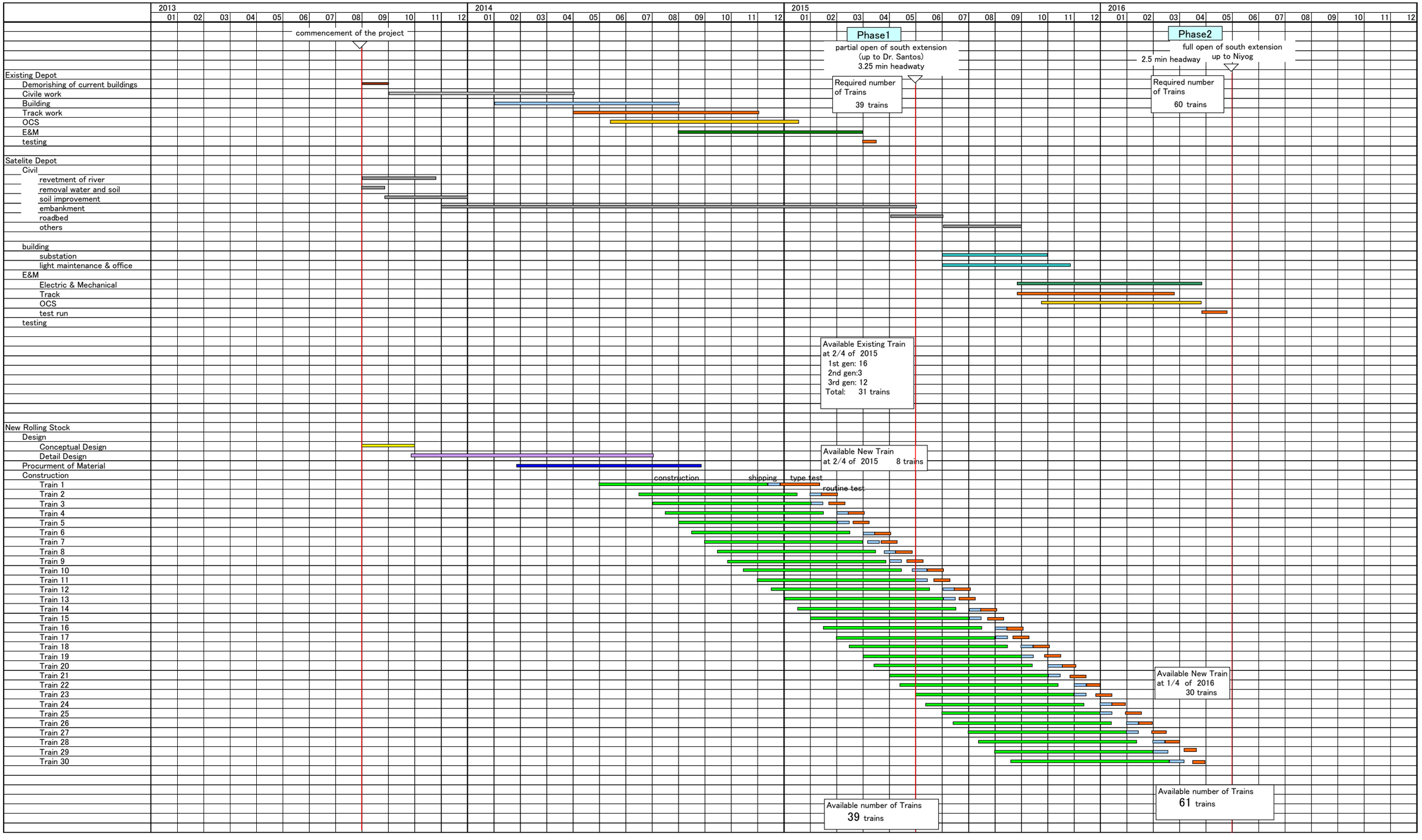


Figure 6.2-1 Implementation Schedule

6.3 Cost of JICA ODA Portion

The summary of the cost for the JICA portion is shown in **Table 6.3-1**. The figures are shown in foreign (JpY) and local (PhP) portions, and summarized in US$.

Table 6.3-1 Total Cost of JICA Loan

Breakdown of Cost	Jpn Yen ('M)			Phi Peso ('M)			Total (Jpn Yen)('M)			Total (US$ M)		
	Total	JICA Portion	Others	Total	JICA Portion	Others	Total	JICA Portion	Others	Total	JICA Portion	Others
Rolling Stock	25,249	25,249	0	0	0	0	25,249	25,249	0	306.31	306.31	0.00
Depot	3,553	3,553	0	770	770	0	5,009	5,009	0	60.77	60.77	0.00
Refurbishment	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00
SubTotal Direct ODA	*28,802*	*28,802*	*0*	*770*	*770*	*0*	*30,259*	*30,259*	*0*	***367.08***	*367.08*	*0.00*
Consulting Services	1,882	1,882	0	612	612	0	3,039	3,039	0	36.87	36.87	0.00
SubTotal Direct Loan	*30,685*	*30,685*	*0*	*1,382*	*1,382*	*0*	*33,298*	*33,298*	*0*	***403.95***	*403.95*	*0.00*
Price Escalation	1,755	1,755	0	39	39	0	1,829	1,829	0	22.19	22.19	0.00
Physical Contingency	1,528	1,528	0	40	40	0	1,604	1,604	0	19.46	19.46	0.00
Land Acquisition	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00
Administration Cost	0	0	0	971	0	971	1,837	0	1,837	22.28	0.00	22.28
VAT	0	0	0	175	0	175	332	0	332	4.02	0.00	4.02
Import Tax	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00
Interest during construction	148	148	0	0	0	0	148	148	0	1.80	1.80	0.00
Commitment Charge	148	148	0	0	0	0	148	148	0	1.79	1.79	0.00
SubTotal Indirect Cost	*3,579*	*3,579*	*0*	*1,226*	*80*	*1,147*	*5,898*	*3,730*	*2,168*	***71.55***	*45.25*	*26.30*
Total	**34,264**	**34,264**	**0**	**2,609**	**1,462**	**1,147**	**39,196**	**37,027**	**2,168**	**475.50**	**449.20**	**26.30**

Source: Study Team

Breakdown of the cost for the JICA portion of the Depot Development is shown in **Table 6.3-2**. The breakdown of the cost for LRT Line 1 new rolling stock is shown in **Table 6.3-3**. Finally, the disbursement schedule for the JICA Loan portion is shown in **Table 6.3-4**.

Table 6.3-2 Breakdown of Cost for Depot Development

Cost Estimation for New Satellite Depot and Expansion of Existing Baclaran Depot

Description			Spec.	Unit	Quantity	Unit price (without VAT)		Amount ('000)	
						Yen	Peso	Yen	Peso
Satellite depot	Civil work	Soil improvement work (Paper drain, Replace)		m2	43,000		2,100	0.00	90,300.00
		Depot embankment	h3.3m*35,000m2	m3	115,500		1,250	0.00	144,375.00
		River wall along Paranaque river		m	250		5,000	0.00	1,250.00
		Bed for railway track	h0.5m*35,000m2	m3	17,500		1,200	0.00	21,000.00
		Rain water drainage in track yard		m2	35,000		143	0.00	4,991.70
		Road and Parking in depot	w4.0m	m	800		2,500	0.00	2,000.00
		Fence around depot	h2.5m	m	1,600		10,750	0.00	17,200.00
		Subtotal Civil Works						**0.00**	**281,116.70**
	Building and Facilities	Light maintenance shed (ground floor) DCC, Staff room (2nd floor)	Steel-2 floor 140*12m	m2	2,040.0	120,000	21,157	244,800.00	43,160.99
		Sub-station	RC-1floor 20*25m	m2	500.0	0	37,025	0.00	18,512.68
		Tank of industrial waste water treatment	RC 8*10*4m	m2	80.0	0	26,447	0.00	2,115.73
		Pit of car body washing	RC 4*40m	m2	120.0	0	10,579	0.00	1,269.44
		Oil storage	RC-1floor 3*3m	m2	9.0	0	31,736	0.00	285.62
		Hazardous material storage	RC-1floor 3*3m	m2	9.0	0	31,736	0.00	285.62
		Waste material storage space	RC 5*15m	m2	45.0	0	15,868	0.00	714.06
		Gatehouse	RC-1floor 3*4m*2, 3*8m*1	m2	48.0	0	31,736	0.00	1,523.33
		Material storage	RC-1floor 10*20m	m2	200.0	0	31,736	0.00	6,347.20
	Building facilities (Water supply, Air ventilation, Fire protection)	Light maintenance shed		lot	1	81,600,000	43,160,985	81,600.00	43,160.99
		Sub-station		lot	1	7,000,000	3,702,535	7,000.00	3,702.54
		Subtotal Civil Works Building and Facilities						**333,400.00**	**121,078.20**
	E&M facilities	Cable trough	total 4,300m	100m	43	0	52,893	0.00	2,274.41
		Illuminating tower	pitch 75m	nos	12	0	528,934	0.00	6,347.20
		Industrial waste water treatment equipment		nos	1	33,000,000	1,057,867	33,000.00	1,057.87
		Security camera system	A 35,000m2	lot	1	8,000,000	1,057,867	8,000.00	1,057.87
		Rolling stock light maintenance facilities		lot	1	210,000,000	5,289,336	210,000.00	5,289.34
		Car body washing machine		track	1	38,000,000	1,057,867	38,000.00	1,057.87
		Subtotal E&M Facilities						**289,000.00**	**17,084.56**
		Sub total for Zapote Satellite Depot						**622,400.00**	**419,279.46**
Baclaran depot	Civil work	Bed for railway track	h0.5m*16,000m2	m3	8,000		1,200	0	9,600.00
		Rain water drainage in track yard		m2	14,000		143	0	1,996.68
		Road and Parking in depot	w4.0m	m	470		2,500	0	1,175.00
		Subtotal Civil Works						**0.00**	**12,771.68**
	Building and Facilities	Workshop (Heavy maintenance)	Steel-1floor 25*95m	m2	2,375.0	120,000	21,157	285,000.00	50,248.70
		Light maintenance shed	Steel-1floor 125*21m	m2	2,625.0	120,000	21,157	315,000.00	55,537.13
		Sub-station	RC-1floor 20*25m	m2	500.0	0	37,025	0.00	18,512.68
		Construction of Guardhouses at Depot and Connecting Line		lot	1	0	**5,000,000**	0.00	5,000.00
		Provision for renovation of Administrative Building and Other Facilities/Structure		lot	1	0	**77,760,000**	0.00	77,760.00
		Tank of industrial waste water treatment	RC-1floor 8*10*4m	m2	80.0	0	26,447	0.00	2,115.73
		Material storage	RC-1floor 30*20m	m2	600.0	120,000	31,736	72,000.00	19,041.61
	Building facilities (Water supply, Air ventilation, Fire protection)	Workshop		lot	1	95,000,000	50,248,696	95,000.00	50,248.70
		Sub-station		lot	1	7,000,000	3,702,535	7,000.00	3,702.54
		Material storage		lot	1	21,600,000	11,424,967	21,600.00	11,424.97
		Subtotal Civil Works Building and Facilities						**795,600.00**	**293,592.04**
	E&M facilities	Cable trough	total 1,000m	100m	10	0	52,893	0.00	528.93
		Illuminating tower	pitch 75m	nos	6	0	528,934	0.00	3,173.60
		Construction of Motor pool Building		lot	1	0	**6,000,000**	0.00	6,000.00
		Industrial waste water treatment equipment		nos	1	33,000,000	1,057,867	33,000.00	1,057.87
		Rolling stock heavy maintenance facilities		lot	1	600,000,000	12,694,407	600,000.00	12,694.41
		Rolling stock light maintenance facilities		3-track	1	340,000,000	10,578,673	340,000.00	10,578.67
		Subtotal E&M Facilities						**973,000.00**	**34,033.48**
		Sub total for Baclaran Depot						**1,768,600.00**	**340,397.20**
To be used in both depot sites	Non-RS Maintenance Equipment	Tracks		lot	1	1,053,000,000	5,289,336	1,053,000.00	5,289.34
		Power supply		lot	1	8,000,000	0	8,000.00	0.00
		Overhead Catenary		lot	1	50,000,000	0	50,000.00	0.00
		Signalling		lot	1	4,000,000	5,289,336	4,000.00	5,289.34
		Telecommunication		lot	1	39,000,000	0	39,000.00	0.00
		Buildings Facilities		lot	1	8,000,000	0	8,000.00	0.00
		Sub total non Rolling Stock Equipment						**1,162,000.00**	**10,578.67**
		Total amount						**3,553,000**	**770,255**
							Grand total ('000)	**¥5,009,242**	
								2,649,557	
								$60,770	

Source: Study Team

Table 6.3-3 Breakdown of New Rolling Stock Cost

	Unit Price	Quantity	Price
Design	400,000,000	1	400,000,000
Construction (MC)	199,500,000	60	11,970,000,000
Construction (M)	185,000,000	60	11,100,000,000
Transportation	6,000,000	120	720,000,000
Commissioning	320,000,000	1	320,000,000
Spare Parts Special Tools	589,400,000	1	589,400,000
Training and Manuals	150,000,000	1	150,000,000
Total			**25,249,400,000**

Source: Study Team

Average cost for 1 car: 210,411,666.7 JPY

Table 6.3-4 Cost Disbursement Schedule for JICA Loan

Breakdown of Cost	Annual Disbursement (Million Jp Yen)				
	2013	2014	2015	2016	Total
Rolling Stock	504.99	4,797.39	16,412.11	3,534.92	25,249.40
Depot	422.31	2,935.63	1,601.20	50.09	5,009.24
Refurbishment	0.00	0.00	0.00	0.00	0.00
SubTotal Direct ODA	*927.30*	*7,733.02*	*18,013.31*	*3,585.01*	*30,258.64*
Consulting Services	569.01	814.26	829.71	826.16	3,039.14
SubTotal Direct Loan	*1,496.31*	*8,547.27*	*18,843.02*	*4,411.17*	*33,297.77*
Price Escalation	21.16	333.32	1,163.77	311.01	1,829.27
Physical Contingency	47.42	403.32	958.85	194.80	1,604.40
Land Acquisition	0.00	0.00	0.00	0.00	0.00
Administration Cost	78.24	464.20	1,048.28	245.85	1,836.57
VAT	80.88	119.54	90.92	40.28	331.62
Import Tax	0.00	0.00	0.00	0.00	0.00
Interest during construction	2.05	19.07	59.47	67.85	148.44
Commitment Charge	36.88	36.88	36.88	36.88	147.52
SubTotal Indirect Loan	*266.64*	*1,376.32*	*3,358.18*	*896.67*	*5,897.81*
Total	***1,762.95***	***9,923.60***	***22,201.20***	***5,307.84***	***39,195.58***

CHAPTER 7

ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

CHAPTER 7 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

7.1 Methodology

The study on the environmental and social considerations is conducted by the following steps:

(i) Review the existing documents such as Environmental Impact Assessment (EIA) Report, Resettlement Action Plan (RAP) and Environmental Compliance Certificate (ECC);
(ii) Field Reconnaissance;
(iii) Study of the supplementary items to be improved of the existing EIA and RAP, in accordance with "JICA Guidelines for Environmental and Social Considerations (April, 2010)" (herein referred to as JICA Guidelines)
(iv) Conduct the surveys on the supplementary EIA and RAP reports by entrusting reliable and experienced local consultants, if necessary; and
(v) Assist DOTC/LRTA to prepare the supplementary EIA and RAP reports.

For the LRT Line 1, although the review of the existing documents was conducted for the whole components of the extension project covered by the EIA and RAP reports, the supplemental EIA and RAP studies by the JICA Study Team focused on the depot, i.e., existing and satellite depots.

7.2 Legal and Institutional Framework for Social and Environmental Considerations in the Philippines

7.2.1 EIA procedure and EIA related Laws and Regulations

1) Laws and Regulations of Environmental Impact Assessment (EIA)

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). Aware of the potential negative impacts of implementation of industrial and other activities, the Philippine government has instituted the measures to encourage the use of EIA as a planning and decision making tool. PEISS is the set of laws, regulations, administrative orders and guidelines concerned EIA. Among them some of the most important laws and guidelines are the followings:

a) **Environmental Impact Statement (EIS) System, Presidential Decree No. 1586 (1978)**
An act establishing and centralizing the Environmental Impact Statement (EIS) System under the National Environmental Protection Council, which emerged with the National Pollution Control Commission in June 1987 to become the Environmental Management Bureau (EMB).

b) **Presidential Proclamation No. 2146 (1981) and No. 803 (1996)**
This proclaims Environmentally Critical Projects (ECPs) to have significant impacts on the quality of the environment and Environmentally Critical Areas (ECAs) as environmentally fragile areas within the scope of the EIS System.

c) **DENR Administrative Order No. 30 Series of 2003 (DAO 03-30), Revised Procedural Manual (2007)**
This provides implementing rules and regulations of Presidential Decree No. 1586, establishing the Philippine Environmental Impact Statement System (PEISS). Also, detailed information in definitions of technical terms, procedures, related laws and regulations are described.

2) Responsible Government Authorities

The review and supervision of PEISS are conducted by the Environmental Management Bureau, Department of Environment and Natural Resources (DENR-EMB). The Department of Environment and Natural Resources (DENR) is the government entity which is mandated to handle issues related to following five tasks as described in the legislations concerned.

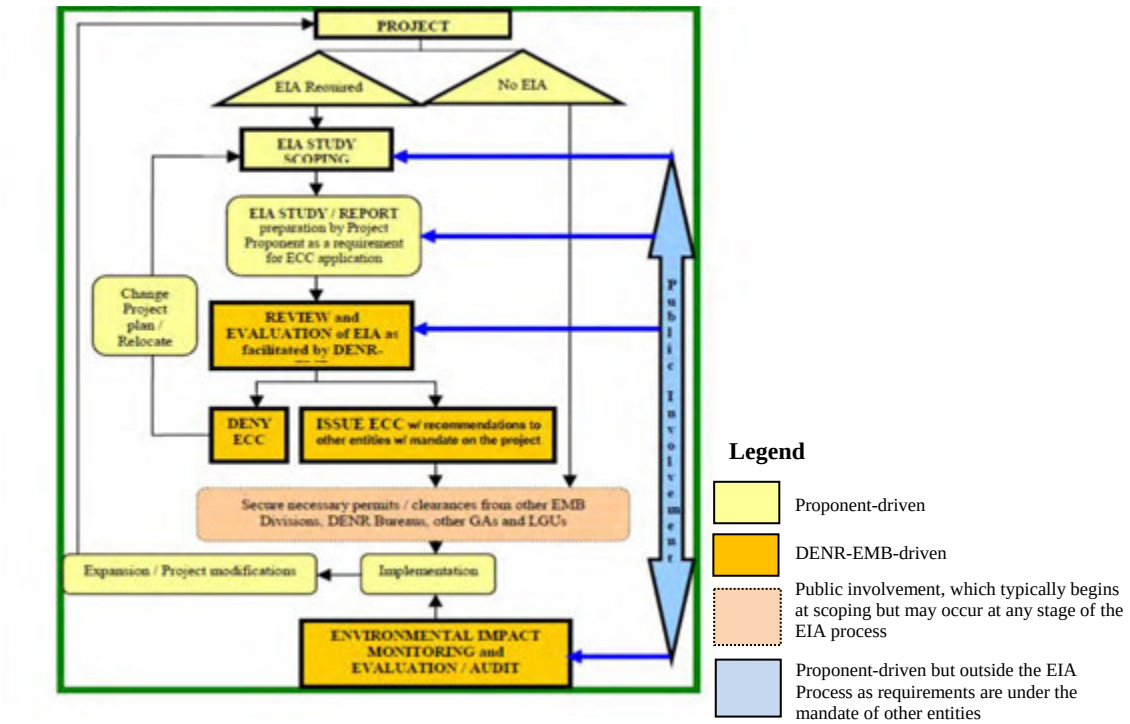
- Assure the availability and sustainability of the country's natural resources through judicious use and systematic restoration or replacement, whenever possible;
- Increase the productivity of natural resources in order to meet the demands for forest, mineral, and land resources of a growing population;
- Enhance the contribution of natural resources for achieving national economic and social development;
- Promote equitable access to natural resources by the different sectors of the population;
- Conserve specific terrestrial and marine areas representative of the Philippine natural and cultural heritage for present and future generations.

EMB is responsible for the issuance of decision making documents such as the 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.

3) Process of PEISS

Application into the EIS System requires compliance with certain stages of the EIA Process. Requirements per EIA stage vary depending on the project group/type being applied for. A summary flowchart of the complete process is presented in **Figure 7.2-1.**

The Philippine EIA Process has six sequential stages: Screening; Scoping; EIA Study and Report Preparation; EIA Review and Evaluation; Decision Making and Post-ECC Monitoring; Validation and Evaluation/Audit stage. The first five stages are those involved when a Proponent applies for ECC or CNC. In particular, for the stages of EIA Review and Evaluation driven by DENR-EMB, the maximum workdays are summarized in **Table 7.2-1.**



Source: DENR Administrative Order No. 30 Series of 2003 (DAO 03-30), Revised Procedural Manual (2007)

Figure 7.2-1 Flow Chart of EIA Process in the Philippines

Table 7.2-1 EIS Review Duration in DENR-EMB

Review and Evaluation Steps	Estimated/Maximum Workdays in DENR-EMB
EMB-Controlled Review Process	90 days
Endorsement of Recommendation	15 days
Sign-off/ Issuance of Decision Document	15 days

Source: DENR Administrative Order No. 30 Series of 2003 (DAO 03-30), Revised Procedural Manual (2007)

4) Covered PEISS Projects

Covered PEISS Projects are projects which have been originally declared as Environmentally Critical Projects (ECPs) or projects in Environmentally Critical Areas (ECAs) presumed to have significant impacts on the quality of the environment, and to be subjects of PEISS. The four ECP project types and twelve ECA categories have been declared through Proclamation No. 2146 (1981) and Proclamation No. 803 (1996), as shown in **Table 7.2-2** and **Table 7.2-3.**

Table 7.2-2 Summary of Environmentally Critical Projects (ECPs)

Main Category	Sub-Category
A. Heavy Industries	• Non-Ferrous Metal Industries • Iron and Steel Mills • Petroleum and Petrochemical Industries • Smelting Plants
B. Resource Extractive Industries	• Major Mining and Quarrying Projects • Forestry Projects • Dikes for/and Fishpond Development Projects
C. Infrastructures	• Major Dams • Major Power Plants • Major Reclamation Projects • Major Roads and Bridges
D. Golf Courses	-

Source: DENR Administrative Order No. 30 Series of 2003 (DAO 03-30), Revised Procedural Manual (2007)

Table 7.2-3 Summary of Environmentally Critical Areas (ECAs)

ECA Categories	Examples
A. Areas declared by law as national parks, watershed reserves, wildlife preserves, and sanctuaries	• Areas of the National Integrated Protected Areas System Act
B. Areas set aside as aesthetic, potential tourist spots	• Areas declared and reserved by the Department of Tourism or other authorities for tourism development
C. Areas which constitute the habitat for any endangered or threatened species of indigenous Philippine wildlife (flora and fauna)	• Areas inhabited by indeterminate species, threatened species, rare species, endangered species
D. Areas of unique historic, archeological, geological, or scientific interests	• National historical landmarks, geological monuments, paleontological and anthropological reservations as designated or determined by the National Historical Institute, National Museum, National Commission for Culture and the Arts, National Commission on Geological Sciences, and other authorities
E. Areas which are traditionally occupied by cultural communities or tribes	• Ancestral lands maintained by the PANAMIN for national minorities • Areas that are occupied or claimed as ancestral lands or ancestral domains by indigenous communities
F. Areas frequently visited and or hard-hit by natural calamities (geologic hazards, floods, typhoons, volcanic activity, etc.	• Areas frequently visited or hard-hit by typhoons • Areas frequently visited or hard-hit by tsunamis • Areas frequently visited or hard hit by earthquakes • Storm surge-prone areas • Flood-prone areas • Areas prone to volcanic activities • Areas located along fault lines or within fault zones • Drought-prone areas
G. Areas with critical slope	• Lands with slope of 50% or more • Alienable and disposable forest lands and unclassified forests
H. Areas classified as prime agricultural lands	• Irrigated and irrigable areas and other areas mapped under the Network of Protected Areas for Agriculture of the Bureau of Soils and Water Management
I. Recharged areas of aquifers	• Areas of sources of water replenishment
J. Water bodies	• Areas that are tapped for domestic purposes • Areas which support wildlife and fishery activities
K. Mangrove Areas	• Tidal areas covered by salt-tolerant, intertidal tree species • Areas declared as mangrove swamp forest reserves
L. Coral Reefs	• Areas characterized by the assemblage of different types of marine plants and organisms • Areas identified by local sources such as the UP-Marine Sciences Institute, DENR-Coastal Environment Program to be rich in corals.

Source: DENR Administrative Order No. 30 Series of 2003 (DAO 03-30), Revised Procedural Manual (2007)

To help identifying required documents under PEISS for consultation and decision making by EMB - DENR, projects are classified into five major groups as described in **Table 7.2-4.**

Table 7.2-4 Project Groups for EIA under PEISS

Group I	ECPs in either ECAs or NECAs (Environmentally Critical Projects in either Environmentally Critical Areas or Non-Environmentally Critical Areas)
Group II	NECPs in ECAs (Non-Environmentally Critical Projects in Environmentally Critical Areas)
Group III	NECPs in NECAs (Non-Environmentally Critical Projects in Non-Environmentally Critical Areas)
Group IV	Co-located Projects in either ECA or NECA
Group V	Unclassified Projects

Source: DENR Administrative Order No. 30 Series of 2003 (DAO 03-30), Revised Procedural Manual (2007)

EIA-covered projects in Groups I, II and IV require either of the following depending on project type, location, magnitude of potential impacts and project threshold. For non-covered projects in Groups II and III, the Project Description Report is required.

i) Environmental Impact Statement (EIS)
ii) Programmatic EIS (PEIS)
iii) Initial Environmental Examination Report (IEER), or
iv) IEE Checklist (IEEC)
v) Project Description Report (PDR)

All documents should be prepared by the project proponent to be submitted to the EMB Central Office or the Environmental Impact Assessment Division in the respective EMB Regional Office. The outcome of the EIA Process within PEISS administered by the EMB-DENR is the issuance of decision documents. Decision documents may either be an ECC, CNC or a Denial Letter, described as follows:

i) An ECC is issued as a certificate of Environmental Compliance Commitment to which the Proponent conforms, after DENR-EMB explains the ECC conditions.
ii) A Certificate of Non-Coverage (CNC) certifies that, based on the submitted Project Description Report (PDR), the project is not covered by the EIS System and is not required to secure an ECC.
iii) A Denial Letter shall contain an explanation for the disapproval of the application and guidance on how the application can be improved to a level of acceptability in the next EIA process.

For Group I projects, ECC application documents need to be submitted to the EMB central office to receive a decision from the EMB Director or DENR Secretary. While an ECC application for Group II needs to be submitted to the EMB Regional Office to receive a decision from the EMB Regional Director. **Table 7.2-5** summarizes Project Groups, EIA Report Types, Decision Documents, Deciding Authorities and Processing Duration.

Table 7.2-5 Summary of Project Groups, EIA Report Types, Decision Documents, Deciding Authorities and Processing Duration

Project Groups	Documents Required For ECC/CNC Application	Decision Document	Deciding Authority	Max Processing Duration
I: Environmentally Critical Projects (ECPs) in either an Environmentally Critical Area (ECA) or Non-Environmentally Critical Area (NECA)	Environmental Impact Statement (EIS)	ECC	EMB Director / DENR Secretary	120 days (Working Days)
II: Non- Environmentally Critical Projects (NECPs) in an Environmentally Critical Area (ECA)	Environmental Impact Statement (EIS) / Initial Environmental Examination Report (IEER) /Initial Environmental Examination Checklist (IEEC) /Project Description Report (PDR)	ECC	EMB RO Director	15-60 days (Working Days)
III: Non-Environmentally Critical Projects (NECPs) in a Non- Environmentally Critical Area (NECA)	Project Description Report (PDR)	CNC	EMB Director / EMB RO Director	15 days (Working Days)
IV: Co-located Projects	Programmatic Environmental Impact Statement (PEIS)	ECC	DENR Secretary	180 days (Working Days)
V: Unclassified Projects	Project Description Report (PDR)	CNC or Recommendation on Final Grouping and EIA Report Type	EMB Director /DENR Secretary/EMB RO Director	15 days (Working Days)

Source: DENR Administrative Order No. 30 Series of 2003 (DAO 03-30), Revised Procedural Manual (2007)

5) Scope of Items to be Examined and Contents to be Assessed in the EIA/IEER reports

As previously discussed, depending on project type, location, magnitude of potential impacts and project threshold, an EIS, IEER or PDR will be required. According to 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), the outline for EIA Reports for proposed new single projects is shown in **Table 7.2-6.**

Table 7.2-6 Outline of EIA Reports for Proposed (New) Single Projects

Project Fact Sheet
Table of Contents
Executive Summary

I. Project Description
- 1.1 Project Location and Area
- 1.2 Project Rationale
- 1.3 Project Alternatives
- 1.4 Project Components
- 1.5 Process/Technology Options
- 1.6 Project Size
- 1.7 Development Plan, Description of Project Phase and Corresponding Timeframes
- 1.8 Manpower
- 1.9 Indicative Project Investment Cost

II. Analysis of Key Environmental Impacts
- 2.1 Land
  - 2.1.1 Land Use and Classification
  - 2.1.2 Geology and Geomorphology
  - 2.1.3 Pedology
  - 2.1.4 Terrestrial Biology
- 2.2 Water
  - 2.2.1 Hydrology & Hydrogeology
  - 2.2.2 Oceanography
  - 2.2.3 Water Quality
  - 2.2.4 Freshwater or Marine Biology
- 2.3 Air
  - 2.3.1 Meteorology/Climatology
  - 2.3.2 Air Quality (and Noise)
- 2.4 People
  - 2.4.1 Identify settlers that will be displaced from among the existing settlers
  - 2.4.2 Discuss the in-migration patterns impact as a result of project implementation
  - 2.4.3 Discuss the impacts on IPs and Culture/Lifestyle (if any)
  - 2.4.4 Discuss the project implementation's threat to public health vis-a-vis the baseline health conditions in the area
  - 2.4.5 Discuss local benefits expected from project implementation
  - 2.4.6 Discuss how the project would affect the delivery of basic services and resource competition in the area
  - 2.4.7 Discuss how the project would affect traffic situation in the area
  - 2.4.8 Identify the entity to be accountable for environmental management in the area
  - 2.4.9 Discuss how the project would affect existing properties in the area in terms of relocation and devaluation
  - 2.4.10 Identify affected properties

III. Environmental/Ecological Risk Assessment
IV. Impact Management Plan
V. Social Development Framework and IEC Framework
VI. Environmental Compliance Monitoring
VII. Emergency Response Policy and Generic Guidelines
VIII. Abandonment/ Decommissioning/Rehabilitation Policies and Generic Guidelines
IX. Institutional Plan for EMP Implementation

Bibliography/References
Annexes

Source: DENR Memorandum Circular NO. 2010-14, Annex 1-A, June 2010

6) Public Participation, Public Consultation and Information Disclosure

The PEISS places importance on public participation. According to DENR Administrative Order No. 30 Series of 2003 (DAO 03-30), Revised Procedural Manual (2007), public participation shall be demonstrated through the following activities:

a) As part of the social preparation process at pre-Scoping, Information, Education and Communication (IEC) of Local Government Units (LGUs) is now explicitly required at the minimum of PEIS/EIS based applications for new or modification proposals 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.

b) Public Scoping for PEIS/EIS-based new projects is now more meaningful as community inputs will precede the Technical Scoping of the EIA Review Team with the proponent, and will be formally considered before the sign-off of the Scoping Checklist that comprises the final TOR of the EIA Study. Key stakeholder representatives, EMB personnel, EIA Review Committee and the Proponent/Preparer representatives will also sign off the List of Issues raised during the Public Scoping.

c) 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, or as interviewers/ interviewees in the socio-economic/perception surveys which shall be used as the basis for the subsequent formulation of social development plans, IEC, monitoring plans and other components of the environmental management plans.

d) As a form of disclosure of the EIA findings, a Public Hearing is required for all new ECPs for which Public Scoping was undertaken and for PEIS-based applications. A waiver of the Public Hearing requested by the Proponent may be granted by the DENR-EMB subject to the absence of mounting opposition or written request for one with valid basis and Public Consultation may be conducted instead of a Public Hearing. The Notice of a Public Hearing provides explicit instructions on registration, access to the EIA Report (with Project Fact Sheet written in the local dialect or mixed with the popularly known language of the host communities), preparation of position papers, and on the mechanics of how issues may be received before or during the hearing. Prior to Public Hearings or Public Consultations, the Proponent is required to give copies of the full EIA Report to the EMB Regional Offices and host municipalities; copies of the Executive Summary to the host barangays; and copies of Project Fact Sheets to other stakeholders for well-informed participation in the hearing/consultation process.

e) Once an ECC/CNC is issued, the EIA recommendations are transmitted by the DENR-EMB to the concerned LGUs and government agencies to be considered in their decision-making process. This resultsin a more integrated, coordinated and participative safeguarding of environmental concerns.

7) Environmental Monitoring and Audit

a) Objectives of Compliance Monitoring and Evaluation

Under the Philippine EIS System, the primary purpose of the monitoring, validation and evaluation/audit is to ensure the judicious implementation of sound environmental management within a company / corporation and its areas of operation 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;
- Effectiveness of environmental measures on prevention or mitigation of actual project impacts vis-a-vis the predicted impacts used as basis for the EMP design; and
- Continuous updating of the EMP for sustained responsiveness in addressing the environmental impacts of undertakings.

b) Role and Responsibilities

i) Project Proponent/Company

Proponents that have been issued ECCs are primarily responsible for monitoring their projects. A proponent is required to submit an ECC Compliance Monitoring Report (CMR) to the designated monitoring EMB office on a semi-annual frequency. The detailed report on compliance to environmental standards specific to environmental laws shall be submitted through the Self-Monitoring Report (SMR) on a quarterly basis to the concerned EMB office.

ii) Multi-partite Monitoring Team (MMT)

The MMT is recommendatory to EMB and has the primary responsibility of validating the proponent's environmental performance.

MMTs are organized, if required, in the ECC especially for ECPs to encourage public participation, to promote greater stakeholder vigilance and to provide appropriate check and balance mechanisms in the monitoring of the environmental impacts of project implementation. MMTs have the primary responsibility of validating the proponent's environmental performance, with the following specific functions:

i. Validate project compliance with the conditions stipulated in the ECC and the EMP;
ii. Validate the Proponent's conduct of self-monitoring;
iii. Receive complaints, gather relevant information to facilitate determination of the validity of complaints or concerns about the project and timely transmit to the Proponent and EMB recommended measures to address the complaint;
iv. Prepare, integrate and disseminate simplified validation reports to community stakeholders;
v. Make regular and timely submission of MMT Reports based on the EMB-prescribed format.

The Compliance Monitoring and Validation Report (CMVR) shall be submitted semi-annually to the concerned EMB Regional Office, with the Proponent's CMR/SMR as an attachment. Moreover, the second CMVR shall preferably present a qualitative desk validation of the trend analysis report and cumulative environmental performance of the Proponent.

iii) EMB

The Environmental Management Bureau shall be primarily responsible for the over-all evaluation/audit of the Proponent's monitoring and the MMT's validation.

Table 7.2-7 summarizes the monitoring, validation and evaluation/audit schemes undertaken by the monitoring entities above.

Table 7.2-7 Monitoring, Validation and Evaluation/Audit Schemes

Monitoring Aspects		Frequency / Timing		
		Proponent Self-Monitoring	MMT Validation of Proponent's Performance	EMB Evaluation/Audit
A. Compliance Reporting	ECC	Semi-annual in CMR	Semi-annual in CMVR	Semi-annual in CER
	EMP[1]	Semi-annual in CMR	Semi-annual in CMVR	Semi-annual in CER
	Environmental Standards (under specific environmental laws)	Detailed report in Quarterly SMR; Summary of compliance in semi-annual CMR	Semi-annual in CMVR	Semi-annual in CER
B. Field Validation		-	Semi-annual	Semi-annual, or whenever there are complaints, failure to comply with standards, or suspicious data
C. Effectiveness of Environmental Management Measures	Sampling and Measurement	Monthly/ Continuous as committed to in the Environmental Monitoring Plan within the EMP	Only in cases of complaints, failure to comply with standards or suspicious data	As the need arises in coordination with the MMT
	Trend Analysis/ Cumulative Performance Report	2nd semi-annual CMR; 4th Quarter SMR	2nd semi-annual CMVR	2nd semi-annual CER

Source: DENR Administrative Order No. 30 Series of 2003 (DAO 03-30), Revised Procedural Manual (2007)

Note:

a) The EMP (Environmental Management Plan) is composed of the Impacts Management Plan, the Social Development Plan, Information Education and Communication (IEC) Plan,
b) CMVR has the Proponent's CMR/SMR as an attachment
c) The Compliance Evaluation Report (CER) is prepared by the EMB Case Handler/staff and shall be attached to the Proponent's CMR/SMR and MMT's CMVR
d) The composite EMB Team (if project has no MMT) conducts validation, or if the Proponent has an existing MMT, the EMB personnel undertake validation as a member of the MMT. Should a composite team be needed to address a mix of issues within the respective mandate of the EMB divisions/units, the EMB composite team shall join the particular MMT validation activity so that there is only one integrated group validating the issues.
e) Trend Analysis is undertaken on key significant environmental parameters in relation to standards while Cumulative Performance Report is done on applicable key significant impacts and measures.

8) Comparison of PEISS and JICA Guidelines/World Bank (WB) Safeguard Policies

In comparison to the JICA Guidelines and World Bank Operational Policy 4.01 - Environmental Assessment (hereafter referred to as WB OP 4.01), there are no variances in terms of the objectives of the JICA Guidelines/WB OP 4.01 and the Philippines' goal as provided in its constitution, environmental policies, EIS system law, and local government code.

7.2.2 Other Environmental Laws and Regulations Concerning the Project

Major environmental laws and regulations, which may be relevant to the interchange projects, must be observed. The PEISS states obligations to strictly comply with the environmental laws, regulations and standards, which have been established by the Philippine government. When project type, location, scale,

and magnitude of potential impacts are clarified, all concerning laws and regulations should be identified to examine the requirements.

1) Environment Code, Presidential Decree No. 1152

Known as the Philippine Environment Code, it launches a comprehensive program on environmental protection and management. It also provides for air, water quality, land use, natural resources and waste management for fisheries and aquatic resources; wildlife; forestry and soil conservation; flood control and natural calamities; energy development; conservation and utilization of surface and ground water and mineral resources.

2) Water Code, Presidential Decree No. 1067

This is a decree instituting a water code which revised and consolidated the laws governing the ownership, appropriation, utilization, exploitation, development, conservation and protection of water resources.

3) Clean Water Act, Republic Act 9275

An Act which aims to protect the country's water bodies from pollution from all possible sources (industrial, commercial, agricultural and household activities). It provides for a comprehensive and integrated strategy to prevent and minimize pollution through a multi-sectoral and participatory approach involving all the stakeholders.

4) Clean Air Act of 1999, Republic Act No. 8749

This is an Act which lays down policies to prevent and control air pollution. The act sets standards forexhaust gas from vehicles, manufacturing plants and so on to follow. All potential source of air pollution must comply with the provisions of the Act. As such, all emissions must be with in the air quality standards set under the law. It also imposes appropriate punishments for violators of the law.

5) Ecological Solid Waste Management Act, Republic Act No. 9003 (2000)

This is an Act providing for an ecological solid waste management program, creating the necessary institutional mechanisms and incentives, declaring certain acts that are prohibited and providing penalties, appropriating funds therefore, and for other purposes.

6) Pollution Control Law, Presidential Decree No. 984

This is an Act that serves as the foundation for managing industrial activities which create impacts on air and water quality. It empowers the DENR to impose ex-parte cease and desist orders on the grounds of immediate threat to life, public health, safety or welfare, or to animal or plant life when wastes or discharges exceed the normal.

7) Forestry Reform Code, Presidential Decree No. 705

The Forestry Reform Code of the Philippines recognizes that there is an urgent need for proper classification; management and utilization of the lands of the public domain to maximize their productivity to meet the demands of the increasing population of the Philippines. It surmises that to achieve the above purpose, it is necessary to reassess the multiple uses of forest lands and resources before allowing any utilization to optimize the benefits that can be derived. It also emphasizes not only the utilization but more so the protection, rehabilitation and development of forest lands to ensure the continuity of their productive condition.

7.2.3 Legal and Institutional Framework for Social Considerations

1) Laws and Regulations on Social Considerations

The policy framework governing Resettlement Action Plans for Structures and Land is derived from the Philippine Constitution, Republic Act (RA) 8974, RA 8371 or the Indigenous Peoples' Rights Act, Environmental and Social Safeguards Policies of the financing institutions and other applicable laws.
Various provisions and prescriptions of laws, policies and guidelines governing the operation and implementation of resettlement action plans and safeguards for indigenous peoples are listed below.

a) 1987 Constitution of the Republic of the Philippines

The national basic policy on land acquisition and involuntary resettlement is based on the following articles. Article III, Bill of Rights, Section 1: "No person shall be deprived of life, liberty, or property without due process of law, nor shall any person be denied the equal protection of the laws". Article III, Bill of Rights, Section 9: "Private property shall not be taken for public use without just compensation."

Article XIII, Urban Land Reform and Hosing, Section 9: "The State shall, by law, and for the common good, undertake, in cooperation with the private sector, a continuing program of urban land reform and housing which will make available at affordable cost, decent housing and basic services to under-privileged and homeless citizens in urban centers and resettlement areas. It shall also promote adequate employment opportunities to such citizens. In the implementation of such program the State shall respect the rights of small property owners."

Article XIII, Urban Land Reform and Hosing, Section 10: "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."

b) RA 7167- Local Government Code of 1991

According to Section 19, the power of eminent domain may not be exercised unless a valid and definite offer has been previously made to the owner, and such offer was not accepted. The local government unit may immediately take possession of the property upon the filing of the expropriation proceedings and upon making a deposit with the proper court of at least fifteen percent (15%) of the fair market value of the property based on the current tax declaration of the property to be expropriated, and further the amount to be paid for the expropriated property shall be determined by the proper court, based on the fair market value at the time of the taking of the property.

c) RA 7279- Urban Development and Housing Act of 1992

The mandate of RA 7279 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. Also the act provides for an equitable land tenure system that shall guarantee security of tenure to Program beneficiaries but shall respect the rights of small property owners and ensure the payment of just compensation.

Eviction or demolition may be allowed under the following situations:

- When persons or entities occupy dangerous areas such as esteros, railroad tracks, garbage dumps, riverbanks, shorelines, waterways, and other public places such as sidewalks, roads, parks, and playgrounds.

- When government infrastructure projects with available funding are about to be implemented.
- When there is a court order for eviction and demolition.

Section 21: Basic Services. Socialized housing or resettlement areas shall be provided by the LGUs or the National Housing Authority (NHA) in cooperation with the private developers and concerned agencies with the following basic services and facilities: (a) Potable water; (b) Power and electricity and an adequate power distribution system; (c) Sewerage facilities and an efficient and adequate solid waste disposal system; and (d) Access to primary roads and transportation facilities.

The provision of other basic services and facilities such as health, education, communication, security, recreation, relief and welfare shall be planned and shall be given priority for implementation by the local government unit and concerned agencies in cooperation with the private sector and the beneficiaries themselves.

d) RA 8974: An Act to Facilitate the Acquisition of Right-of-Way, Site, or Location for National Government Infrastructure Projects and for Other Purposes

RA 8974 establishes a uniform basis for determining just compensation for immediate possession of the property involved in eminent domain proceedings. Section 4 Guidelines for Expropriation Proceedings: Whenever it is necessary to acquire real property for the ROW or location for any national government infrastructure project through expropriation, the appropriate implementing agency shall initiate the expropriation proceedings before the proper court under the following guidelines:

i) the agency shall immediately pay the owner of the property the amount equivalent to the sum of one hundred percent (100%) of the value of the property based on the current relevant zonal valuation of the Bureau of Internal Revenue (BIR); and the value of the improvements and/or structures;
ii) where there is no zonal valuation, the BIR is mandated within the period of 60 days from the date of the expropriation case to come up with the zonal valuation of the area;
iii) if there is no existing valuation, the implement agency shall immediately pay the owner its proffered value based on standards as follows:

Section 5: Standards for the Assessment of the Value of the Land Subject of Expropriation Proceedings or Negotiated Sale:

i) Classification and use for which property is suited;
ii) The development costs for improving the land;
iii) The value declared by the owners;
iv) The current selling price of similar lands in the vicinity;
v) The reasonable disturbance compensation for the removal or demolition of certain improvements on the land and for the value of improvements;
vi) The size, shape or location, tax declaration and zonal valuation of the land.

Section 9, Squatter Relocation: The government through the NHA, in coordination with the LGUs and implementing agencies concerned, shall establish and develop squatter relocation sites, including the provision of adequate utilities and services, in anticipation of squatters that have to be removed from the right-of-way or site of future infrastructure projects. Whenever applicable, the concerned local government units shall provide and administer the relocation sites.

e) Indigenous Peoples' Rights Act (IPRA) of 1997

The IPRA sets conditions, requirements, and safeguards for plans, programs, and projects affecting Indigenous Peoples (IPs). It spells out and protects the rights of IPs. The important provisions of the IPRA are:

i) The right to their ancestral domains (Chapter III, Section 11);
ii) The right to an informed and intelligent participation in the formulation and implementation of any project, government or private, that will impact upon their ancestral domains (Chapter III, Section 7b);
iii) The right to participate fully, if they so choose, at all levels of decision-making in matters which may affect their rights, lives and destinies through procedures determined by them (Chapter IV, Section 16);
iv) The right to receive just and fair compensation for any damages inflicted by or as a result of any project, government or private (Chapter III, Section 7b);
v) The right to stay in their territory and not to be removed from that territory. If relocation is necessary as an exceptional measure, it can only take place with free and prior informed consent of the IPs and Indigenous Cultural Communities (ICCs) concerned (Chapter III, Section 7c);
vi) The right to be secure in the lands to which they have been resettled (Chapter III, Section 7d);
vii) The right to determine and decide their own priorities for the lands they own, occupy, or use (Chapter IV, Section 17);
viii) The right to maintain, protect, and have access to their religious and cultural sites (Chapter IV, Section 33);
ix) The IPRA also created the National Commission on Indigenous Peoples (NCIP) to carry out the policies set forth in the IPRA. The NCIP has issued a number of orders that puts into operation the provisions of the IPRA; the most important for the purposes of this policy is NCIP Administrative Order No. 1 or the Free and Prior Informed Consent Guidelines of 2006.

2) Responsible Government Authorities

There is no government authority in charge to specialize in the land acquisition and resettlement in the Philippines. Therefore, the project competent authorities independently handle the land acquisition and resettlement. In addition to DPWH, the following authorities have the opportunity to implement the ROW acquisition. However, only DPWH has developed its own guidelines and manuals. Other authorities are said to just follow the DPWH procedures and international donors' safeguard policies.

- National Housing Authority
- National Power Corporation
- Transmission Corporation
- National Irrigation Administration
- Department of Agrarian Reform

3) Comparison of Philippines Policies and JICA Guidelines/WB Safeguard Policies on Involuntary Resettlement

A comparison of Philippine and JICA Guidelines/ WB Safeguard Policies on resettlement and compensation was undertaken. The principles of the JICA Guidelines are fundamentally harmonized with WB Safeguard Policies. **Table 7.2-8** summarizes the comparison of relevant regulations in the Philippines and the JICA Guideline/WB Policies on involuntary resettlement.

Table 7.2-8 Comparison of Relevant Regulations in the Philippines and the JICA Guideline/World Bank Policies on Resettlement

JICA Guidelines/World Bank OP4.12	Laws of the Philippines	Comparison/Gaps	Policy and/or Recommendations to bridge the Gaps
Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives. When, after such an examination, avoidance is proved unfeasible, effective measures to minimize impact and to compensate for losses must be agreed upon with the people who will be affected.	No person shall be deprived of life, liberty, or property without due process of law, nor shall any person be denied the equal protection of the laws (Constitution of the Republic of the Philippines, Article III, Section 1). The right to stay in their territory and not to be removed from that territory is to be protected. If relocation is necessary as an exceptional measure, it can only take place with free and prior informed consent of the IPs and ICCs concerned (IPRA of 1997, Chapter III, Section 7c)	There are no directly corresponding provisions in laws and regulations of the Philippines, but no significant deviations are observed in the Philippines' policies on involuntary resettlement.	-
For projects that will result in large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. 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.	A Land Acquisition Plan and Resettlement Action Plan (LAPRAP) shall be prepared for all projects, whether local or foreign funded, that will require ROW acquisitions, using a standardized compensation package (Department Order No.5, 2003). The LAPRAP document shall describe the project, expected impacts and mitigating measures, socio-economic profile of APs, compensation package, timetable of implementation, institutional arrangements, participation, consultation and grievance procedures (Infrastructure Right of Way Procedural Manual, 2003).	There are no government laws or regulations to stipulate preparation of RAP in the Philippines.	The Project Resettlement Policy is in line with WB OP4.12 and JICA guidelines.
Compensation must be based on the full replacement cost as much as possible.	Zonal value as the first offer: Ifthe mode of acquisition is through a negotiated sale, the first offer shall be the zonal value of the particular land where the property is located, as determined by the BIR. If the owner rejects the first offer, the DPWH shall renegotiate using the values recommended by the Appraisal Committee or Independent Land Appraiser as a guide for negotiation (RA 8974)	The BIR zonal valuation is determined based on the past records of land sales and so differs from ILA valuation.	The Project Policy on compensation is based on the full replacement cost in line with WB OP4.12 and JICA guidelines.

JICA Guidelines/World Bank OP4.12	Laws of the Philippines	Comparison/Gaps	Policy and/or Recommendations to bridge the Gaps
Appropriate participation by affected people and their communities must be promoted in the planning, implementation and monitoring of resettlement action plans and measures to prevent the loss of their means of livelihood. 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.	The information campaign will also convey to the PAPs the available channels for complaints and grievances and related procedures. In this respect the PAPs will be informed that grievances from the PAPs related to LARRIPP implementation or any aspect of the project will be handled through negotiations and are aimed at achieving consensus (LARRIPP, 2007). The women, children, and elderly who are among the PAPs shall likewise be consulted and mobilized to participate in the consultation meeting and discuss with them the socio-cultural implication of the Resettlement Action Plan (LARRIPP, 2007).	There are no government laws or regulations on public participation in the Philippines.	The Project Resettlement Policy is in line with WB OP4.12 and JICA guidelines.
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.	Other types of assistance and entitlements other than compensation for land and lost assets include disturbance compensation, income loss, inconvenience allowance, rehabilitation assistance, rental subsidy and transportation allowance or assistance (LARRIPP, 2007).	There are no government laws orregulations on livelihood recovery in the Philippines.	The Project Resettlement Policy is in line with WB OP4.12 and JICA guidelines.
After projects begin, project proponents etc. monitor whether any unforeseeable situations occur and whether the performance and effectiveness of mitigation measures are consistent with the assessment's prediction. Project proponents etc. should make efforts to make the results of the monitoring process available to local project stakeholders.	The main objective of monitoring the implementation of the RAPs is to see whether or not the RAPs are being carried out in accordance with the LARRIPP. This involves the monitoring of land acquisition, payment of compensation for lost assets, and resettlement of persons severely affected by the project. Internal and external monitoring shall be conducted regularly. The External Monitoring Agent shall include during the monitoring, the results of the disclosure of the LARRIPP, RAP to the PAPs during the public consultation conducted for each project contract packages (LARRIPP, 2007).	There are no government laws or regulations on monitoring and evaluation in the Philippines.	The Project Resettlement Policy is in line with WB OP4.12 and JICA guidelines.

Source: Study Team based on the information provided by JICA

7.3 Review of EIA Reports

The Study Team reviewed the following documents of the LRT Line 1Cavite Extension Project.

7.3.1 ECC and EIS in 2002

In 1999, an EIA study for LRT Line 1 Extension Project was conducted to draw up the EIS and submit DENR-EMB. The ECC for the Extension Project was granted by the DENR on December 11, 2002. However, the ECC was automatically cancelled in 2005 after 3 years of the project non-implementation. LRTA sought for an extension of the ECC which was granted but eventually expired in 2007.

The ECC was issued subject to the following conditions:

- To complete the relocation area for affected families in coordination with Local Government Units (LGUs) and other concerned agencies and implement relocation activities;
- To implement all necessary mitigation measures and environmental monitoring and management plans contained in EIS;
- To implement an Integrate Solid Waste Management Program, a workable Traffic Management Program and a Social Development Program
- To design and undertake an effective continuing Information, Education and Communication Program throughout the pre-construction, construction and operational phases of the project;
- To set up the following:
    - Environment Guarantee Fund to cover expenses for compensation of damages to life and property that may be caused by the project, for restoration of areas affected by the project's construction and operation, for compensation of parties and communities affected by possible negative impacts and as a source of fund for contingency;
    - A Multi-partite Monitoring Team (MMT) composed of representatives from the proponent, DENR, a local environmental Non-Government Organization or People's Organization, LGUs, affected communities, and municipal/rural health centers; and
    - An Environmental Monitoring Fund to cover all cost attendant to the operation of the MMT such as meetings, trainings, sampling and analysis, hiring of technical experts, meals, accommodations and transportation.

7.3.2 ECC and EIS in 2012

In early 2012, the EIA study for LRT Line 1 Cavite Extension Project was conducted again for LRTA by Berkman International, Inc. The required EIA documents for ECC application were drew up and submitted to DENR-EMB.

The progress of ECC application is shown in **Table 7.3-1**. The EIS has been reviewed by the EIA Review Committee of DENR-EMB. According to LRTA, the ECC will be issued in the end of September 2012.

Table 7.3-1 Timetable of ECC Application

April 13, 2012	• EPRPM was submitted to DENR-EMB from LRTA to obtain the ECC.
May 8, 2012	• The EIA Review Committee was held at the central DENR/EMB office and requested LRTA to hold another round of public consultations. • DENR/EMB also requested LRTA to submit the EIS instead of the EPRPM.
May22, 2012	• LRTA sent a request letter for reconsideration not to hold another public consultation.
June 12, 2012	• Although LRTA has not received the official letter from DENR-EMB, LRTA's request not to conduct another public consultation was approved.
June 20, 2012	• LRTA submitted the EIS to EMB.
-	(The EIS has been reviewed by the EIA Review Committee of the DENR-EMB.)
September, 2012	• The ECC will be issued when LRTA pays for the Environment Guarantee Fund.

Source: Study Team

7.3.3 Review of the EIS for LRT Line 1Cavite Extension Project (2012)

The JICA Survey Team received the copies of EPRMP and draft EIS. The EIS remained the same contents as the EPRMP. The JICA Study Team has closely examined the EIS report with respect to the items in accordance with the JICA Guidelines.

The comparative study of EIS and recommendations for mitigation measures are summarized in **Table 7.3-2** for pre-construction and construction phase and in **Table 7.3-3** for operational phase.

The comparative study of EIS and recommendations for the Environmental Monitoring Plan are summarized in **Table 7.3-4** for pre-construction and construction phase and in **Table 7.3-5** for operational phase.

The results of monitoring will be provided to JICA on a quarterly basis as a part of the progress reports during construction and biannually until two years after completion of the Project by filling the Monitoring Form. The draft Monitoring Form is attached to **Appendix D-1**.

Table 7.3-2 Comparative Study of EIS and JICA Guidelines and Recommendations on Additional Mitigation Measures Pre-Construction and Construction Phase

JICA Guidelines		Impact Management Plan in EIS 2012		Recommendations on Additional Mitigation Measures
Check Items	Necessity ○:Yes/ X: No	Considered ○:Yes/ X: No	Mitigation Measures	
Anti-pollution measures				
Air quality	○	○	•TSP Control: Water Sprinkling •TSP monitoring	•Vehicles transporting sands and soils shall be covered with tarpaulin, canvass or sack materials to prevent re-suspension of particulate matters •Stockpiled sands and soils shall be wetted, particularly in windy conditions. •Locate plants and stockyard away from residential and sensitive areas. •Reduce the emission of air pollutants by utilizing low-emission construction machines and vehicles. •Regular tune-up and maintenance of construction equipment and machinery properly. •Stop unnecessary idling.
Water quality	○	○	•Surface water: Proper control of SS and siltation, contamination due to leachate from landfill areas •Groundwater: Prevention from contamination due to leachate from landfill areas	•Provision of portable toilets and garbage bins at the construction areas •Avoid the improper land mound to prevent soil erosion from the construction sites, especially during rainy season. •Install a protector and drainage facilities to prevent soil erosion caused by surface runoff during a storm. •For pavement construction, there will be no work during rainy days. •Sediment tanks will be installed for the effluents from the facilities such as crushing plant, quarry, batching plant and other related facilities. •Provide proper construction machines and heavy vehicles and maintain them properly. •Oil and grease traps in drainage system from workshops, vehicles and plant washing facilities and service and fueling areas will be established to prevent contamination of water.
Waste	○	○	•Proper disposal of excavated garbage from the landfill areas •Avoid pollution of water bodies and soil due to leachate	•Proper waste management plan to minimize waste generated from construction works shall be included in the construction plan. •Waste disposal sites shall be identified during detailed design stage. •Implement proper management and disposal of construction waste. •Contractor shall be adequately educated on applicable methods for a) restraint of generation; b) classified collection; c) storage; d) transportation; e) proper maintenance of disposal areas. •Re-use and disposal of excess excavated materials on selected areas. •Excavated waste soil, sand and sediment shall be properly disposed or treated

JICA Guidelines		Impact Management Plan in EIS 2012		Recommendations on Additional Mitigation Measures
Check Items	Necessity ○:Yes/ X: No	Considered ○:Yes/ X: No	Mitigation Measures	
				based on the contaminated levels of toxic substances such as heavy metals and pesticides. Monitoring shall be conducted during the pre-construction phase .
Soil contamination	○	X	-	•Avoid pollution of water bodies and soil due to leachate •Provide proper construction machines and heavy vehicles and maintain them properly. •Treat properly wastewater from asphalt wearing and concrete pavement work. •Oil and grease traps in a drainage system from workshops, vehicles washing facilities, and service and fuelling areas shall be established to prevent contamination of water.
Noise and vibration	○	○	•Proper scheduling of high noise generating construction activities during daytime •Temporary noise barriers particularly in noise-sensitive areas •Construction worker will be provided with earmuffs. •Mufflers and noise suppressors and regular maintenance of heavy equipment, construction machinery	•Inform construction schedule to residents in advance. •Limit construction works at night. •Use low-noise construction machines and heavy vehicles.
Subsidence	X	X	•Refer to 'Topography and geology'	-
Odor	X	X	-	-
Sediment	○	X	-	•Same measures for 'water quality' will be able to be taken into account, in order to avoid sediment in rivers and creeks.
Natural environment				
Protected areas	X	X	-	-
Ecosystem	○	○	•Minimal loss of the natural and cultivated vegetative cover (e.g. mangroves) •Minimize the impacts on aquatic fauna	•"Permit to Cut" trees (including mangroves) will be secured from the DENR-EMB. •Careful balling out and relocation of saplings, juvenile and medium-sized trees •Aesthetical restoration of affected vegetated areas through landscaping
Hydrology	○	○	• Provide enough capacity of drainage system • No stockpiling to avoid flooding	•Study for flood protection measures at Satellite Depot in the Detailed Design, since one of the flood flow routes in the swamp might be reclaimed.
Topography and geology	○	○	•Seismic risk, liquefaction and ground settlement shall be considered in the Detailed Design	-

JICA Guidelines		Impact Management Plan in EIS 2012		Recommendations on Additional Mitigation Measures
Check Items	Necessity ○:Yes/ X: No	Considered ○:Yes/ X: No	Mitigation Measures	
Management of abandoned sites	○	X	-	Decommissioning and abandonment of auxiliary facilities (e.g. work camp): •All temporary structures, including sleeping quarters, cooking and food storage structures and latrines shall be removed to prevent encroachment into the road right of way. •The site shall be restored to the near natural or stable conditions. •Exposed areas shall be planted with suitable vegetation. •Site restoration work shall be ensured before the equipment is allowed to leave. •Conduct a joint site inspection at the work site to ensure that construction spoils/debris, solid and domestic wastes are properly disposed to the approved disposal sites and not abandoned in the construction areas. •Work camp may be turned over or donated to local government units.
Social environment				
Resettlement	○	○	•RAP: Different resettlement packages for the types of PAPs shall be prepared and implemented.	•Informal settlers in the proposed Satellite Depot shall be included in Relocation Action Plan (2012).
Living and livelihood	○	○	• Local employment(+) •Protection on activities several religious organizations •Measures for minimizing impacts on local small business activities •Temporary noise barriers •Traffic Management Plan, including construction vehicles •Transportation of guideway beams during night-time •Close coordination with utility companies and measures for minimizing possible interruption of the service utilities (water, electricity)	•Disseminate information on a construction plan (schedule, traffic restriction section, and etc.) through the media such as radio and paper. •Deploy the traffic enforcers and flagmen at critical construction points to ensure safety of residents. •Perimeter fence shall be installed within the construction area, especially around excavation areas. •Adequate lighting shall be installed within the construction area to provide illumination during night time. •Provide temporal pedestrian accesses where necessary though the meeting with LGUs.
Heritage	X	X	-	-
Landscape	X	X	-	-
Ethnic minorities and indigenous peoples	X	X	-	-
Working conditions (including	○	X	-	Construction Camp Management Plan •The Contractor will construct and maintain all workers' accommodation in such a

JICA Guidelines		Impact Management Plan in EIS 2012		Recommendations on Additional Mitigation Measures
Check Items	Necessity ○:Yes/ X: No	Considered ○:Yes/ X: No	Mitigation Measures	
occupational safety)				fashion that uncontaminated water is available for drinking, cooking and washing. •The Contractor will also provide potable water facilities within the precincts of every workplace in an accessible place, as per standards set by the Philippines Occupational Safety and Health Standards (As Amended), 1992. •The contractor will also guarantee the following: i) Supply of sufficient quantity of potable water in every workplace/ camp site at suitable and easily accessible places and regular maintenance of such facilities. ii) If any water storage tank is provided that will be kept such that the bottom of the tank at least 1m from the surrounding ground level. iii) If water is drawn from any existing well, the contractor shall ensure that sharing water will not cause any shortage in the local community. iv) Testing of water will be done every month as per parameters prescribed in the Philippine National Standards for Drinking Water 2007. •The sewage system for the camp are designed, built and operated in such a fashion that no health hazards occurs and no pollution to the air, ground water or adjacent water courses take place. •Separate toilets/bathrooms, wherever required, screened from those from men (marked in vernacular) are to be provided for women. •Adequate water supply is to be provided in all toilets and urinals. •Provide hand washing facilities at all cooking and eating areas. •Provide good mobile toilets for each construction site. Alternatively, install two chamber septic tanks toilets for each construction team of 50 - 100 workers •The contractor shall provide segregated rubbish bins in the camps and ensure that these are regularly emptied and disposed off as per the Waste Management Plan. •Provide many rubbish bins around camp. Discourage throwing of garbage, waste food, cigarettes, drinks cans on ground. Empty bins to skips regularly and transfer to landfill when full or at least weekly. •Arrangements for disposal of night soils (human excreta) approved by the MMDA/LGUs or as directed by the SC will have to be provided by the contractor. •Improve awareness of infectious diseases prevention, particularly HIV/AIDS and flu for workers. •Set up a medical facility for large-size construction camps for first aid and health care for workers. •Install sign boards, lighting system at the construction sites, borrow pits, or places

JICA Guidelines		Impact Management Plan in EIS 2012		Recommendations on Additional Mitigation Measures
Check Items	Necessity ○:Yes/ X: No	Considered ○:Yes/ X: No	Mitigation Measures	
				which may cause accidents for people and workers. •Fill up holes, ponds created by filling, cutting and earthworks to prevent health risk and remove vector growth places. •Fill up ponds at worker sites and kill rats, bugs, flies and mosquitoes. •Ensure the abandonment of construction camp after the completion of the project •Donate the camp buildings as a public facility such as a barangay center.
Accident prevention measures	○	○	•Traffic Management Plan, including construction vehicles •Transportation of guideway beams during night-time •Measures for securing the safety of pedestrians and residents in the vicinity	•The routes for construction vehicles shall be determined through the meeting with stakeholders, MMDA and LGUs. •Disseminate information on a construction plan (schedule, traffic restriction section, and etc.) through the media such as radio and paper. •Provide adequate education and training to construction workers regarding traffic safety. •Deploy the traffic enforcers and flagmen at critical construction points to ensure safety of motorists. •Illuminated warning signs and barricades shall be installed along the construction area to prevent untoward accidents. •Adequate lighting shall be installed within the construction area to provide illumination during night-time. •Perimeter fence shall be installed within the construction area, especially around excavation areas to prevent untoward accidents. •Personnel will be assigned at every detour road's points of entry and exit to regulate traffic flow.

Source: Study Team

Table 7.3-3 Comparative Study of EIS and JICA Guidelines and Recommendations on Additional Mitigation Measures
Operational Phase

JICA Guidelines		Impact Management Plan in EIS 2012		Recommendations on Additional Mitigation Measures
Check Items	Necessity ○:Yes/ X: No	Considered ○:Yes/ X: No	Mitigation Measures	
Anti-pollution measures				
Air quality	○	○	•Positive effects on air pollutants reduction	-
Water quality	○	X	-	•Proper operation and maintenance of wastewater treatment facilities at the stations and depots •Regular monitoring of effluent water quality (pH, TSS, BOD, COD, Oil/Grease, Phenol, Fiscal Coliforms) from wastewater treatment facilities at stations and depot sites (in accordance with the Revised Effluent Regulations of 1990, Revising and Amending the Effluent Regulations of 1992)
Waste	○	X	-	•Regular monitoring in accordance with the Solid Waste Management Plan
Soil contamination	○	X	-	•Proper handling of hazardous substances to avoid spill and leakage on soils
Noise and vibration	○	○	•Expected to be insignificant •Noise and vibration attenuation measures: installation of noise barriers or shock absorber pads and ballast	•Trees should be planted beneath the guide ways and stations where possible •Regular monitoring of noise levels •Regular maintenance to keep railways in good conditions •Develop a mechanism to record and respond to monitoring results and complaints
Subsidence	○	X	-	•Regular monitoring of ground settlement at reclaimed areas
Odor	X	X	-	-
Sediment	X	X	-	-
Natural environment				
Protected areas	X	X	-	-
Ecosystem	○	X	-	•Regular monitoring of replanted trees
Hydrology	○	X	-	•Monitoring of flood levels of rivers and creeks during heavy rains
Topography and geology	○	X	-	•Regular maintenance of revegetation areas
Management of abandoned sites	X	X	-	-
Social environment				
Resettlement	○	X	-	•Regular monitoring on living and livelihood conditions of relocated families at the relocated sites in accordance with RAP.

JICA Guidelines		Impact Management Plan in EIS 2012		Recommendations on Additional Mitigation Measures
Check Items	Necessity ○:Yes/ X: No	Considered ○:Yes/ X: No	Mitigation Measures	
Living and livelihood	○	○	Improvement on: • Quality of life • Social acceptability • Mobility • Traffic and travel time • Business and economy	•Regular monitoring on living and livelihood conditions of relocated families at the relocated sites in accordance with RAP.
Heritage	X	X	-	-
Landscape	X	X	-	-
Ethnic minorities and indigenous peoples	X	X	-	-
Working conditions (including occupational safety)	X	X	-	-
Accident prevention measures	○	X	-	•Regular monitoring on safeness of pedestrians •Regular monitoring in smoothness of traffic flow

Source: Study Team

Table 7.3-4 Comparative Study of EIS and JICA Guidelines and Recommendations on Additional Monitoring Items Pre-Construction and Construction Phase

JICA Guidelines		Environmental Monitoring Plan in EIS 2012		Recommendations on Additional Monitoring Items
Monitoring Items	Necessity ○:Yes/ X: No	Considered ○:Yes/ X: No	Monitoring Plan	
Anti-pollution measures				
Air quality	○	○	• TSP	•Add NO_2 and SO_2
Water quality	○	○	•Surface water: BOD, TSS, Oil/Grease •Groundwater: Bacteriological contents	-
Waste	○	○	•Waste management and disposal	•Construction site conditions and cleanliness •Practice of 3R activities
Soil contamination	○	X	-	•Quality survey of waste soil/sand and sediment from piling and excavation to check whether the toxic substances are exist or not.
Noise and vibration	○	○	• Noise Level	-
Subsidence	○	X	-	•Ground settlement levels
Odor	X	X	-	-
Sediment	○	X	-	•Quality survey of waste soil/sand and sediment from piling and excavation to check whether the toxic substances are exist or not.
Natural environment				
Ecosystem	○	X	• Tree cutting	-
Protected species	X	X	-	-
Social environment				
Resettlement	○	X	-	•Progress of RAP implementation •Reports of grievance
Living and livelihood	○	○	• Effectiveness of traffic management plan • Compliance of Contractors to occupational health and safety rules and regulation	•Regular monitoring of local employment rates

Source: Study Team

Table 7.3-5 Comparative Study of EIS and JICA Guidelines and Recommendations on Additional Monitoring Items
Operational Phase

JICA Guidelines		Environmental Monitoring Plan in EIS 2012		Recommendations on Additional Monitoring Items
Monitoring Items	Necessity ○:Yes/ X: No	Considered ○:Yes/ X: No	Monitoring Plan	
Anti-pollution measures				
Air quality	X	X	-	-
Water quality	○	X	-	•Regular monitoring of effluent water quality (pH, TSS, BOD, COD, Oil/Grease, Phenol, Fiscal Coliforms) from wastewater treatment facilities at stations and depot sites (in accordance with the Revised Effluent Regulations of 1990, Revising and Amending the Effluent Regulations of 1992)
Waste	○	X	-	•Proper implementation of separate collection and disposal
Soil contamination	X	X	-	-
Noise and vibration	○	X	-	•Regular monitoring of noise and vibration
Subsidence	○	○	•Ground settlement at the station locations	•Include the Satellite Depot at Zapote.
Odor	X	X	-	-
Sediment	X	X	-	-
Natural environment				
Ecosystem	○	○	• Tree cutting	•Regular monitoring of tree growth
Protected species	X	X	-	-
	-	○	•Aggravation of flooding (if any)	-
Social environment				
Resettlement	○	X	-	•Regular monitoring on living and livelihood conditions of relocated families at the relocated sites in accordance with RAP.
Living and livelihood	○	○	•Efficiency of traffic management measures and parking restrictions •Efficiency of public and private transit operations •Maintenance of peace and order •Cleanliness and aesthetic appeal	•Regular monitoring on living and livelihood conditions of relocated families at the relocated sites in accordance with RAP.

Source: Study Team

7.4 Supplementary EIA Study

The scope of work of JICA loan includes development of two depots, namely, the existing depot at Baclaran and the satellite depot at Zapote.

7.4.1 Existing Depot at Baclaran

Because all of the development works in the existing depot will be implemented within the ROW of LRTA, there will be no additional land acquisition. Furthermore, the expansion area of the existing depot is already developed and utilized for the administrative facilities and open space for future use. Therefore any supplementary EIA survey will not be needed to grasp the current environmental and social conditions.

7.4.2 Satellite Depot at Zapote

The site for the Satellite Depot is a flood plain swamp located in the river mouth of Zapote River. Informal settlers have settled along the perimeter of the swamp and the bank of Zapote River. They have used large mangroves trees for houses and charcoals, and polluted the swamp with waste and wastewater for a long time. However, a few small mangrove trees are still remaining in the swamp and creek. Therefore the JICA Study Team is carrying out the following environmental surveys by entrusting by reliable and experienced local consultants.

1) Flora and Fauna Survey

a) **Survey Method**

The objective of flora and fauna survey is to investigate the existence of protected species in and around the proposed Satellite Depot, especially mangrove swamp shown in **Figure 7.4-1**. The obtained information will be used as the baseline conditions for the supplemental EIA study, in order to assess the impacts on those species and elaborate the mitigation measures.

Survey sites

Figure 7.4-1 Location of the Flora and Fauna Survey

Table 7.4-1 summarizes target species to be surveyed, survey method and survey period.

Table 7.4-1 Flora and Fauna Survey Specification

Items	• Protected species declared as endangered or threatened species under DAO No. 2004-15 and DAO No. 2007-01, RA No.9147 the Wildlife Resources Conservation and Protection Act of 2001; • Threatened species (grouped as EN, CR, VU) in the IUCN Red List and Philippine Red Data Book; • Avian species, which are included in the list of the Convention on the Conservation of Migratory Species of Wild Animals; and • Locally important species for the livelihood of local residents		
Survey location	Swamp and Creek (Figure 7.4-1)		
Survey method	Mangroves and terrestrial vegetation		Visual observation, transect method
	Coastal swamp animals and fish	Mammals	Tracks and Scats, Traps
		Birds	Visual, call census and transect method
		Amphibian	Active searches
		Reptilian	Active searches
		Insects	Active searches, Traps
		Fish	Active searches, Fish net
Period/schedule	One week in the middle of June 2012		

Source: Study Team

b) **Results of Flora and Fauna Survey**

Flora

The tree species as well as shrub, herb, and other non-woody plant species that were identified in the study sites are shown in **Appendix D-2**.

None of the species reported in our results are classified as threatened or endangered.
The most abundant tree species surveyed was a mangrove tree called Api-api (*Avicennia marina*). This is expected, since the entire Manila Bay was historically covered with large tracts of the mangrove ecosystem. Unfortunately, what used to be a lush and diverse biome has now been decimated to only a handful of species.

Furthermore, most of the tree and plant species surveyed were fruit trees or ornamentals, such as Atis (*Annona squamosa*), Sampaloc (*Tamarindus indicus*) and Talisay (*Terminalia catappa*), that were probably planted by the residents in the settlements. In addition, some residents also practice subsistence farming, wherein they plant cassava (*Manihot esculenta*), camote (*Ipomoea batatas*), etc. The other plants are weeds or grassland species typical of highly disturbed habitats.

Fauna

There were no fauna species listed as threatened under international and national lists specifically from published list of the International Union for Conservation of Nature (2012), Convention on International Trade in Endangered Species of Wild Fauna and Flora (2011; Appendices I-III) and Convention on the Conservation of Migratory Species of Wild Animals (2012; Appendices I & II).

i) Birds: A total of fourteen species of birds were observed in all areas of the proposed project site in Las Piñas, Cavite. Majority of the species were resident breeding or those that can be found in the Philippine islands as well as in other areas of Southeast Asia. This type of species is also considered geographically widespread. Three species were migratory or those that do not breed in the Philippines. The migrants include the most abundant species in the area which was the Little Egret numbering to at least fifty individuals.

The bird profile was typical of muddy shoreline areas as it was composed of wading species (shorebirds) such as the egret, a heron, night herons and watermen. These types of birds still persisted in the undeveloped muddy intertidal areas which were surrounded by human settlements and engulfed by solid garbage (refer to **Appendix D-2**).

ii) Other wildlife inventory: Opportunistic observations lead to documentation of small mammals such as the remains of the Asian house shrew *Suncus murinus*. This small mammal is a close relative of true rodents. Based on literature reviews, abundance of garbage and dense human settlements should pave way for rats to occur which is likely the Oriental house rat *Rattus tanezumi*. As for cold-bloodied animals, even though it was not observed the Marine Toad *Rhinella marina* is likely to occur in the area as this species is globally widespread and have become associated with human communities.

2) Sediment Quality Survey

a) Survey Method

In order to develop the Satellite Depot in the swamp, excavation of soil and sediments, and ground improvement work will be required before grading. The JICA Study Team is carrying out sediment quality survey in the middle of June, in order to investigate the present concentration of hazardous chemicals and heavy metals in sediment of the swamp and consider the adequate disposal methods.

The sampling location is shown in **Figure 7.4-2**. The obtained data will be used to evaluate the pollution levels of sediment and elaborate the mitigation measures in the supplemental EIA study. **Table 7.4-2** summarized measurement parameters, sampling period and survey method.

Table 7.4-2 Sediment Quality Survey Specification

Parameters	Physical parameters	Particle size distribution, Moisture content
	Nutrients	Total Organic Carbon, Total Nitrogen, Total Phosphorus
	Heavy Metals	As, Cd, Cr, Cu, Pb, Hg, Ni and Zn;
	Persistent Organic Pollutants (POPs)	HCB, DDT, Chlordane, Aldrin, Dieldrin, Endrin and total PCB
	Polycyclic Aromatic Hydrocarbons	Total PAHs
Survey location	2 sites (Figure 7.4-2)	
Survey method	Sediment soil samples were collected and analyzed at the qualified lab.	
Period/schedule	Field sampling in one day (June 2012)	

Source: Study Team

Source: Study Team

Yellow dot: Sediment Sampling Site

Figure 7.4-2 Location of Sediment Quality Survey

b) **Results of Sediment Survey**

The concentrations of heavy metals and chemical compounds such as Persistent Organic Pollutants (POPs) and Polycyclic Aromatic Hydrocarbons (PAHs) in the sediments of two sites were compared with the Canadian Sediment Quality Guidelines for the Protection of Aquatic Life. Refer to **Appendix D-2** for details.

The Canadian Interim Sediment Quality Guidelines include threshold effect levels (TELs) and probable effect levels (PELs) for freshwater and marine (including estuarine). The levels are used to identify the three ranges of chemical concentrations with regards to biological effects. If below TEL, the minimal effect range within which adverse effects rarely occur; if between TEL and PEL, the possible effect range within which adverse effects occasionally occur; and if above PEL, the probable effect range within which adverse effects frequently occur.

The following observations can be made on the present pollution conditions.

i) Heavy Metals:
As and Cr are below TEL; Cu, Hg and Pb are between TEL and PEL; and Zn is above PEL. The value of Cd is inconclusive as its quantification limit is above TEL, though it is definitely below PEL. There are no TEL and PEL values for Ni.

ii) POPs and PAHs:
Although the results of all organic compounds are lower than the quantification limits, this does not mean their concentrations are below the TEL and/or PEL. Some of POPs and PAHs might be exist at TEL and/or PEL.

Some heavy metals are observed at TEL and even PEL. This is because the areas of Wawa 1 and Wawa 2 are near the dump sites, and there are numerous households around them who contribute to waste accretion. Therefore, more sediment samples shall be collected and rigorously analyzed to investigate the extent of pollutant levels during the pre-construction phase.

7.5 Review of RAP

7.5.1 RAP Documents

In 2002 a Resettlement Action Plan (RAP) was once prepared for LRTA by Test Consultants, Inc. However, the LRT Line 1 Extension Project was not implemented.

In November 2008, based on a series of consultations with affected households, "Social Preparation, Community Relations, and Other Pre-Relocation and Post-Relocation Activities for All Affected Informal Settlers along the Alignment of the Proposed LRT Line-1 South Extension Project" was made, which focused on the Relocation Action Plan (RLAP) for informal settlers.

The RLAP was revised by LRTA in 2012 to update the relocation work schedule started from April 2012. However, due to the delay of the project, the relocation work has not been implemented yet.

7.5.2 Current Situation of Affected Informal Settlers

1) Extension Line

Table 7.5-1 shows the summary of qualified beneficiaries of informal settlers as per census and tagging operation, according to RLAP (2008). The documented number of households to be relocated was 1,714 in 2008.

Table 7.5-1 Qualify Prospective Beneficiaries

	Parañaque City	Las Piñas City	Bacoor, Cavite
Structure Owner	589	65	685
Renter	119	9	167
Rent-free Occupants	26	8	32
Care Taker	0	0	4
Absent House Owner	2	0	8
Total	736	82	896

Source: LRTA/ Test Consultants, Inc.

2) Existing Depot at Baclaran

There will be no involuntary resettlement in the existing depot at Baclaran since the lots are owned by LRTA.

3) Satellite Depot at Zapote

The lots for the proposed Satellite Depot have been acquired by LRTA. The areas of informal settlers in the proposed Satellite Depot are called Wawa 1and Wawa 2 of Longos shown in **Figure 7.5-1.**

LRTA started the re-tagging and re-census survey in the middle of July 2012. According to the survey result, the number of Project Affected Persons (PAPs) within the proposed Satellite Depot is 194. The list of potential affected households is presented in **Appendix D-3**. The Study Team requested LRTA to confirm that the affected families in Wawa 1 and Wawa 2 be surely on the list of the beneficiaries of the RAP.

Source: Study Team

Satellite Depot LOT 2 (LRTA)

Structures of informal settlers to be relocated in Satellite Depot

Figure 7.5-1 Proposed Satellite Depot Site

4) Relocation Site

In accordance with the Memorandum of Agreement between LRTA and the province of Cavite, the provincial government of Cavite has responsible for the identification, acquisition and development of a relocation site. The province of Cavite will support the livelihood recover program at the relocation site such as education assistance, job placement and training.

The provincial government has considered as a potential site at Amadeo and also two sites at General Trias in Cavite. Site selection criteria are as follows:

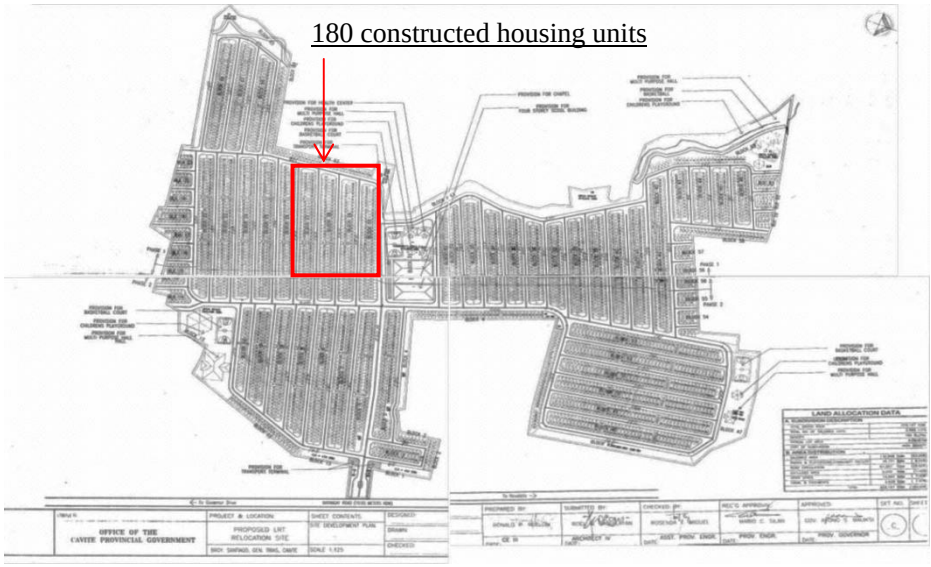
- Feasibility of employment opportunities for informal settles in nearby areas;
- Availability of basic services and facilities such as electricity and water supply already existing;
- Transportation cost to work place is affordable;
- The site does not require excessive leveling cutting and filling:
- Environmentally friendly areas that are no flooding and no earthquake zones
- Financial feasibility and viability where land valuation offer is less; and
- Comparability of existing zoning.

The relocation site was selected in General Trias, Cavite based on the survey results, consultation meetings, and internationally-accepted guidelines on relocation of informal settlers, who opted for relocation within the Province of Cavite (**Figure 7.5-2**). The land acquisition process is in accordance with RA 8974 and RA 7279. Acquisition cost was Php125,488,200 to purchase 14 parcels of land, 1 residential and 13 agricultural lands totaling to 20 hectares. Total cost including land acquisition, development for relocation site and construction of housing units was estimated Php 554,034,000.

The provincial government of Cavite obtained the ECC for the Cavite-LRTA Housing Project from DENR-EMB in March 2010 with the Initial Environmental Examination Report.
Horizontal development of the resettlement site has been substantially completed in November 2010, and about 180 housing units have been constructed. The construction of the remaining 1,820 housing units will be started as soon as LRTA has transferred the additional budget, and take 300 calendar days for construction (**Figure 7.5-3**).

Source: Study Team

Figure 7.5-2 Location of Resettlement Site, General Trias, Cavite



Source: Office of the Cavite Provincial Government

Figure 7.5-3 Site Development Plan at General Trias, Cavite

7.5.3 Review of RLAP

Table 7.5-2 summarized the review results and recommendations based on the JICA Guidelines and World Bank OP 4.12. As reviewed in Section 7.2, the RLAP was prepared in accordance with the 1987 Philippines Constitution and the Urban Development and Housing Act of 1992.

Table 7.5-2 Review Results and Recommendations on RAP Documents

<table>
<tr><th rowspan="2">JICA Guidelines/
World Bank OP 4.12</th><th colspan="2">Resettlement Action Plan / Relocation Action Plan</th><th rowspan="2">Recommendations</th></tr>
<tr><th>Considered
○:Yes/ X: No</th><th>Description/Contents</th></tr>
<tr><td>Necessity of resettlement</td><td>○</td><td>The section “Project Back Ground” explains the project outline and project site.</td><td>The following issues should be addressed in the RAP:
• A map of the project site
• Initial alternative proposals examined to avoid or minimize the land acquisition and resettlement</td></tr>
<tr><td>Legal framework</td><td>○</td><td>Summary of Relevant Policies on Relocation
<table>
<tr><th>Subject</th><th>Policy</th><th>Description</th></tr>
<tr><td>Environmental</td><td>1987 Philippine Constitution Art. 11, Sec. 16 PD 11515 and 1152</td><td>Protection of people and environment</td></tr>
<tr><td>Right of Way</td><td>LOI 19 and 19-A</td><td>Prohibits squatting or Encroachment of any Right of Way, public Domain</td></tr>
<tr><td>Relocation</td><td>UDHA RA 7279</td><td>Just and humane manner in eviction & demolition</td></tr>
<tr><td>Gender and Development</td><td>1987 Philippines Constitution RA 7192</td><td>Mainstreaming gender concerns in Development project</td></tr>
<tr><td>Community Participation</td><td>1987 Philippine Constitution Art. 111 Sec. 10</td><td>Encouraging community Participation in development initiatives</td></tr>
<tr><td>Livelihood Projects</td><td>Administrative Order No. 142</td><td>Guidelines for livelihood program</td></tr>
</table></td><td>The following issues should be addressed in the RAP as shown in Table 7.2-8:
• The laws and regulations on the land acquisition and resettlement in the Philippines and the gaps between JICA Guidelines/WB OP 4.12
• The proposed legal framework to bridge the gaps</td></tr>
<tr><td>Socioeconomic studies
1) Census survey
2) Assets & land survey
3) Livelihood & living survey</td><td>○</td><td>1) Census survey
• Resettlement Action Plan (2001) reported that, in the alignment plan, at least 645 informal settlers and 271 vendors in the Baclaran area are affected.
• Relocation Action Plan (2008) reported that the result of the census registered 1714 affected families in all the areas and 1941 structures to be demolished. The results of social assessment, census survey and tagging operations were attached in the annexes.</td><td>1) Census survey
• The validation of beneficiary list of informal settlers in RLAP (2008) has been undertaken from late July 2012 by retagging operation and re-census survey. The validation survey will be completed in three months.
• If discrepancy is found to be large due to encroachment or moving-out, reevaluation by the Beneficiary Selection, Awards and Arbitration Committee should be considered.</td></tr>
</table>

JICA Guidelines/ World Bank OP 4.12	Resettlement Action Plan / Relocation Action Plan		Recommendations
	Considered ○:Yes/ X: No	Description/Contents	
		• The cut-off date was informed through public consultation meetings in October 2008. Cut-off date was Oct. 29, 2008. • Relocation Action Plan (2012) said that "Resumption of works of Consultancy for Social Preparation and Pre-Relocation" schedule in 2012 for the re-validation of actual number of more or less 2,000 affected families and more or less 1,914 structures that need to be demolished. 2) Assets & land survey Not addressed in the existing RLAP since RLAP has been prepared for informal settlers. According to LRTA, about 81% of ROW has been acquires so far, and assets (land and structures) have been evaluated and compensated according to the procedure of RA 8974. 3) Livelihood and living survey Only reported for affected informal settlers based on the survey conducted 2008.	• Add statement of the cut-off date in the RAP. 2) Assets & land survey • As for the RAP in accordance with JICA and WB safeguard policy, an inventory based on the results of the socio-economic studies should be reported. For instance, land to be acquired (area and current land use), the number of affected households (including land owners, and business owners), affected assets and facilities. 3) Livelihood and living survey • Based on the results of re-census and re-tagging operations, update the data of 2008. The following data of households will be obtained through the re-census survey: head/spouse; size; members; age; civil status; educational attainment; length of residency; employment; occupation; monthly income; structures.
Eligibility/ Entitlement	○	The code of policy on beneficiary selection, award and relocation of affected families was formulated. 1) The official tagging and census masterlist of 2008 shall serve as one of the primary basis for the qualification of families with reference to pertinent provisions of RA 7279. 2) All qualified household/beneficiary shall be given allocation in the Resettlement Site. 3) Specifically, allocation of resettlement for beneficiaries shall be prioritized as follows: Priority I - Qualified Structure Owners Priority II - Qualified Non-Structure Owners – this refers to renters and rent-free occupants. 4) Multiple Structure Owner shall qualify for one program package only. 5) Qualified awardees may opt to avail of either relocation or	Eligibility and entitlement matrix should also be presented for the following type of loss and affected parsons and compensation must be based on the full replacement cost as much as possible. • Loss of agriculture land, pond, and orchards • Loss of homestead/residential/commercial (legal land owners) • Loss of residential/commercial structures and improvements • Loss of trees/ perennials/fish stocks • Loss of access to residential houses/ commercial structures/ cultivable land • Loss of business due to dislocation • Loss of income and work days due to displacement • Displacement of community structure • Temporary impact during construction Informal settlers in the proposed Satellite Depot shall be included in the

JICA Guidelines/ World Bank OP 4.12	Resettlement Action Plan / Relocation Action Plan		Recommendations
	Considered ○:Yes/ X: No	Description/Contents	
		financial assistance. 6) All accommodation/allocations shall be subject to pre- and post-qualification of awardees in order for the award to be confirmed. Qualified households for formal unit award must satisfy all the following: • The household has not availed of any government housing assistance. • The household shall have agreed to dismantle his/her structure from the affected areas of the project. • The household must be included in the Census Masterlist of 2008.	list of beneficiary in Relocation Action Plan (2012).
Valuation of compensation for losses and other resettlement assistance measures	○	The housing package option would be a compromise of a house and lot package at fully developed and serviced sites at General Trias, Cavite or financial assistance equivalent to minimum wage multiplies by 60 days (UDHA). In addition to housing, other benefits covering transportation, livelihood development, food and education assistance are offered to help relocates to make a smooth transition from informal settlements to their new homes.	Refer to comments on eligibility/entitlement above. • Criteria for the eligibility of compensation and resettlement assistance measures (including land owners, tenants, business owners, employees, and informal settlers) shall be formulated in the entitlement matrix (Refer to **Appendix D-4**). • Compensation shall be stated in accordance with the full replacement cost. • Compensation for the eligible people who make livings with land based activities will be prioritized the provision of alternative lands with equivalent site location and potential productivity over the pecuniary compensation. Vendors in the Baclaran area reported in Resettlement Action Plan (2001) had not been reported Relocation Action Plan (2008). Those vendors shall also be re-censused and reported in the updated Resettlement Action Plan (2012).
Resettlement Site Development Plan	○	Refer to **Section 7.5.2**, **4) Relocation site**.	LRTA shall determine the relocation and resettlement schedules, which will be based on its rail construction timetable and will take into consideration the availability of resettlement site by concerned agencies. The progress of development of the remaining 1820 housing units should be observed.

JICA Guidelines/ World Bank OP 4.12	Resettlement Action Plan / Relocation Action Plan		Recommendations
	Considered ○:Yes/ X: No	Description/Contents	
Community participation	○	The essential elements of community participation have been built into the structure of LRTA's Resettlement program. • The inter-agency committee has been formed composed of various agencies, sending and receiving LGUs and people's organization to address issues and concerns of the affected families. • Among the tools to be used to ensure that communities are adequately informed and are fully involved in the resettlement program are: - Community meetings - Focus group discussions - Census survey of the affected families - Publicity through newsletter, bulletins and flyers - Home visits to the affected families • Framework for Community Participation Process in Relocation was presented. • A series of public consultations were held in October to November 2008: - Bacoor, Cavite (5 locations) - Las PinasCity (2 locations) - Paranaque (3 locations)	According to the records of Public Consultation Meetings held in October to November 2008, the following issues and concerns were raised: • Construction and relocation schedule (when will the relocation start?) • Relocation site (where? Transfer assistance) • Financial compensation option • Livelihood restoration /rehabilitation assistance measures • Employment opportunity and source of income at the relocation site • Community public facilities (chapel, day care center) These public opinions shall be reflected in the compensation and resettlement assistant measures and addressed in the RAP. Relocation work schedule shall be revised based on the construction schedule and disseminated to the affected communities and relevant LGUs.
Measures for vulnerable groups	○	Gender Planning: • The participation of women is crucial in the resettlement program. They have as much right as men to participate in projects which profoundly affect their lives. • Within the frame work of the RAP, women's participation will be achieved through the approaches outlined below: - Representation of women in all the resettlement activities. - Support for viable and sustainable income generating projects that will build upon women's activities and social network, focusing on the most vulnerable and disadvantaged. - Development of women's potential through training and education - Women in partnership with men doing advocacy work.	-

JICA Guidelines/ World Bank OP 4.12	Resettlement Action Plan / Relocation Action Plan		Recommendations
	Considered ○:Yes/ X: No	Description/Contents	
Grievance procedures	○	The LRTA has created an Award and Arbitration Committee (AAC) in each sending LGU to determine qualified beneficiaries for relocation, arbitrate in matters of claims and disputes and safeguard of the affected families. The AAC is composed of NHA as chair, LRTA as co-chair, concerned LGU, Presidential Commission for the Urban Poor, (PCUP), Barangay Officials, and community representative of the area concern.	Local accessible grievance mechanisms must be established for the affected people and their communities. The step-by-step procedure should be presented with a flowchart to the affected communities.
Organizational responsibility	○	To facilitate the smooth implementation of the relocation program and to ensure that basic services needed are provided, an inter-agency committee was organized as mandated by existing laws. The Inter-Agency committee is composed of representatives coming from LRTA, NHA, PCUP, Housing and Urban Development Coordinating Council, MMDA, LGUs of Paranaque, Las Piñas, Bacoor Cavite and the Provincial government of Cavite.	The following issues should be addressed in the RAP: • Responsibilities of implementing organizations: organization structure, roles of organization, departments and staff , • Capacity of responsible organizations and its enhancement measures.
Implementation Schedule	○	LRTA shall determine the relocation and resettlement schedules, which will be based on its construction timetable and will take into consideration the availability of resettlement site by concerned agency/ies. • Relocation Work Schedule (2012) - Phase I : 270 families in 2012 - Phase II : 500 families in 2013 - Phase III : 500 families in 2014 - Phase II : 730 families: 2015 • Prioritization and phasing of informal settlers relocation shall be undertaken with close coordination among the communities concerned and the Inter-agency committee. • The relocation work schedule was drawn up for relocation and post-relocation activities for all affected informal settlers along the alignment of the Line 1 Cavite Extension Project.	Implementation of the relocation work has been behind schedule due the delay of the extension project. Relocation work schedule shall be revised and presented to the affected communities and relevant LGUs. • Show the updated project schedule which coincide with the development of relocation site, housing units, basic utilities and services. • Relocation shall be started after completing compensation and relocation arrangement.

<table>
<tr><th rowspan="2">JICA Guidelines/
World Bank OP 4.12</th><th colspan="2">Resettlement Action Plan / Relocation Action Plan</th><th rowspan="2">Recommendations</th></tr>
<tr><th>Considered
○:Yes/ X: No</th><th>Description/Contents</th></tr>
<tr><td>Costs and budget</td><td>○</td><td>According to LRTA, the Sub Allotment Release Order to be released from DOTC to Department of Budget and Management as of 31 July 2012 is as follows.

<table><tr><th>Item</th><th>Cost [Php]</th></tr><tr><td>Negotiated (Land Acquisition)</td><td>2,760,732,915.23</td></tr><tr><td>Expropriated (Land Acquisition)</td><td>340,822,434.25</td></tr><tr><td>Relocation of Informal Settlers</td><td>1,533,870,916.00</td></tr><tr><td>Test Consultancy</td><td>23,543,688.00</td></tr><tr><td>EIA Study Renewal</td><td>3,282,400.00</td></tr><tr><td>Parcellary Survey</td><td>8,185,750.00</td></tr><tr><td>Perimeter Fencing</td><td>56,452,020.52</td></tr><tr><td>Cost of Utility Relocation</td><td>475,192,876.00</td></tr><tr><td>Cost of Improvement</td><td>116,480,000.00</td></tr><tr><td>Total</td><td>5,318,563,000.00</td></tr></table></td><td>A schedule of the entire expenditure shall be prepared by cost and by item, including compensation, development cost for resettlement sites, cost for resettlement assistance measures, and administration fees. The funding sources shall be also addressed in the RAP.</td></tr>
<tr><td>Monitoring and evaluation</td><td>○</td><td>• Monitoring and evaluation of all assistance packages will be undertaken by the Community Relations Office of LRTA.
• All families receiving any type of assistance will be monitored monthly by the estate management office of the Governor.
• The scope of monitoring shall include implementation schedule, assistance package, community participation, and grievance resolution.
• Monitoring indicators:
- Implementations
- Delivery of entitlement
- Consultation and grievance
- Benefit monitoring</td><td>Detailed internal monitoring mechanism and monitoring form shall be drawn up. In addition to the internal monitoring mechanism, an external independent monitoring mechanism shall also be developed.</td></tr>
</table>

Source: Study Team

7.6 Supplementary RAP Study

LRTA has started the re-census survey and retagging operation from late July 2012 for three months, to review the present status informal settles in the project area and validate the masterlist of the RLAP 2008, including the Satellite Depot. Then LRTA will make an updated list of beneficiaries. Therefore the JICA Study Team considers that it is not necessary to conduct the supplementary RAP survey.

However, as indicated in **Table 7.5-3**, the RLAPs (2008 and 2012) have only covered the affected households of the informal settlers. Therefore, LRTA should draw up the RAP to cover not only the informal settlers but also the legal land owners and business owners. The entitlement matrix which covers both informal settlers and legal asset owners (refer to **Appendix D-4**) has been discussed with LRTA to be included in the RAP.

7.7 Review by JICA Environmental Checklist

The JICA Survey Team assisted LRTA with elaborating the JICA Environment Checklist to comply with the JICA Guidelines.

The draft JICA Environment Checklist is shown in **Appendix D-5**.

CHAPTER 8
CONSIDERATION ON PROJECT EFFECTS

CHAPTER 8 CONSIDERATION ON PROJECT EFFECTS

8.1 Methodology

This chapter shows items as follows about Line 1 South Extension Project, referring to existing study.

8.1.1 Operation / Effect Indicators

Table 8.1-1 shows the indicators selected for the estimation of project effects with reason for selection.

Table 8.1-1 Reason for selection of operation/effect indicators

No.	Operation or effect indicators	Reason for selection
1.	Passenger-km	Shows railway productivity
2.	The number of trains in operation	Shows service ability of train operation
3.	Workable car ratio	Shows car operation efficiency
4.	Train-km	Shows train service efficiency
5.	Fare revenue	Shows commercial merit of the project
6.	Fare Box Ratio	Shows profitability of the project
7.	Non-railway revenue	Shows potential of auxiliary business field
8.	Load factor	Shows profitability of the project

Source; Study Team

8.1.2 Qualitative effects for surrounding area of new stations and along the new line

Qualitative effects for surrounding area of new stations and along the new line are estimated as 4 items shown as follows:

- Elimination of inconvenient area for using railway
- Improvement of daily life conveniences
- Change of land use
- Traffic accident reduction

8.1.3 Estimating Greenhouse Gas Reduction

Study team calculates the benefit with reduction of CO_2 emission, referring to "Climate Finance Impact Tool for Mitigation and Adaptation (Summary) Ver. 1.0, JICA, 2011". Conversion from auto transportation is assumed following items.

- Reduction of CO_2 emission in vehicle
- CO_2 emission by rail
- Benefit of CO_2 emission reduction balance

8.2 Operation / Effect Indicators

The calculation of indexes is done for whole section including existing section and extension section. The results of operation/effect indicators are shown in **Table 8.2-1.**

Table 8.2-1 Calculation result of operation or effect indicators

No.	Operation or effect indicators	Actual in 2011	Desired in 2018 (2 years after opening)
1.	Passenger-km	3,791	5,922
2.	The number of trains in operation	222	258
3.	Workable car ratio	76.4	95%
4.	Train-km	2,787,615	5,413,006
5.	Fare revenue	2,285.61	-
6.	Fare Box Ratio	1.09	-
7.	Non-railway revenue	157.83	-
8.	Load factor	77.32	-

8.3 Qualitative Effects for Surrounding Area of New Stations Along the New Line

The existing study of Line 1 South Extension Project was reviewed in this study. CONSIDERATION ON PROJECT EFFECT shows items as follows about Line 1 Extension Project, referring to existing study[1]. Proposed Land Use of Parañaque City and Existing Land Use of Las Piñas City are shown as below.

Source; Existing Study

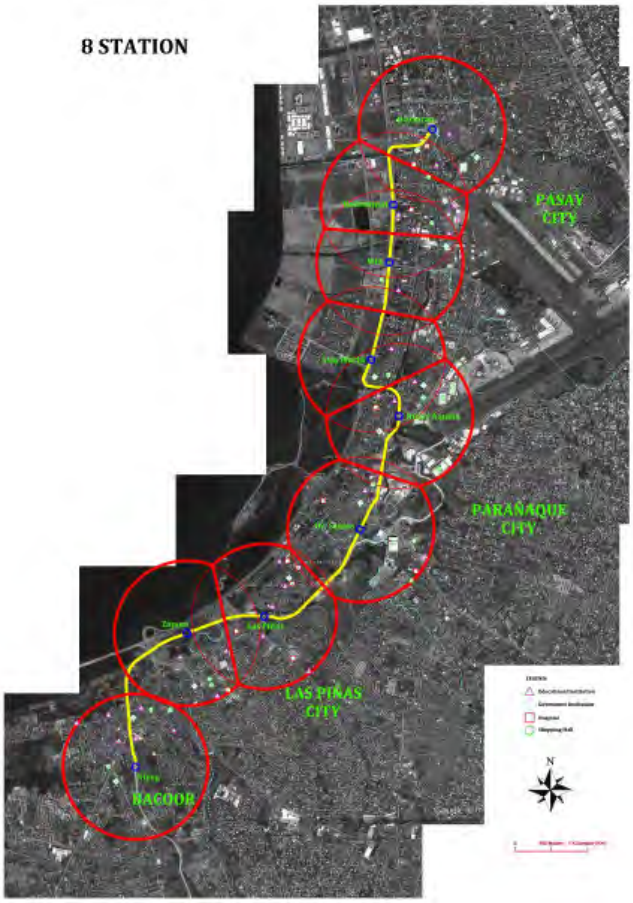
Figure 8.3-1 Proposed Land Use of Parañaque City

[1] Environmental Performance Report and Management Plan (EPRMP) / Light Rail Transit Line 1 Cavite Extension Project (Baclaran to Cavite) / 27 March 2012 / Submitted to: Environmental Management Bureau, Submitted by: Light Rail Transit Authority, Prepared by: Berkaman International Inc.

Source; Existing Study

Figure 8.3-2 Existing Land Use of Las Piñas City

The alignment of Line 1 South Extension is planned at the end of north western part of these cities. There is a room to develop around the new station area and trunk roads connect to the line. Ridership from inland are expected.



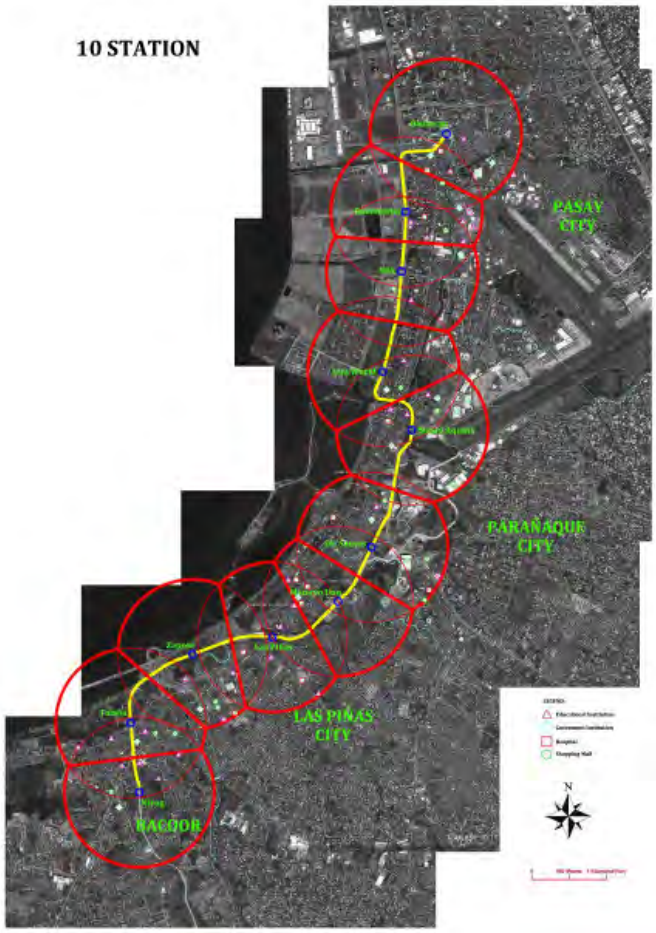
Source; Study Team

Figure 8.3-3 Distribution of facilities with rail accessibility improvement (New 8 Stations)

Table 8.3-1 The facilities with accessibility improvement (New 8 Stations)

		Educational Institution △	Government Institution ◇	Hospital □	Shopping Mall ○
	Area (km²)				
1. Redemptorist	1.867	1. The Growing Place Pre-School 2. Centro Escolar University 3. PATTS College of Aeronautics 4. Metropolitan Aviation School 5. Airlink International Aviation School 6. Flight School International	1. D. Velayo Sports Center	1. D.T. Protacio Hospital	1. Aristocrat Department Store 2. Pearl Plaza
2. MIA	2.022	1. Tambo Elementary School	1. Air Mail Distribution Center		1. Uniwide Coastal Mall
3. Aala World	2.088	1. Don Galo Elementary School	1. PNP Maritime Group		1. AC Store
4. Ninoy Aquino	2.278	1. Sto. Niño Elementary School 2. St. Paul Academy 3. St Andrew Academy	1. Sto. Niño Barangay Hall 2. La Huerta Day Care	1. Community Hospitals	1. Puregold 2. Duty Free Fiesta Mall 3. Duty Free Center 4. SM Warehouse
5. Dr. Santos	2.942	1. Parañaque Municipal Highschool 2. Datamex Institute of Computer Technology	1. Sauloq Transit Terminal	1. Our Lady of Peace Hospital 2. Olivarez General Hospital	1. Airport CitiMall 2. Sm SuperCenter Sucat 3. Vilra Mall Sucat 4. Public Market
7. Las Piñas	2.539	1. St. Joseph Academy 2. Ilaya Elementary School 3. Las Piñas Central School 4. Puanlupa Elementary School 5. Immaculate Mary Montessori School	1. Barangay Hall	1. Lying in Clinic Center 2. Las Piñas District Hospital 3. Health Center 4. Las Piñas District Hospital 5. A. Zarate General Hospital	
8. Zapote	2.599	1. Bernardo College 2. Divine Grace Institute of Technology 3. Zapote Elementary School	1. Zapote Barangay Hall	1. Jasmin Emergency Hospital	1. Las Piñas Public Market 2. New Zapote Market
10. Niyog	3.135	1. Britanny School of Las Piñas 2. Bacoor Evangelical School 3. St. Mathew Academy of Cavite 4. Aniban Central School 5. St. Dominic College of Arts and Science 6. Jubileum Academy of Bacoor 7. Malksi Elementary School	1. Talaba IV Barangay Hall 2. Niyog II Barangay Hall		1. FRC Mall 2. Bacoor Public Market 3. Conrado Commercial Complex

Source; Study Team



Source; Study Team

Figure 8.3-4 Distribution of facilities with rail accessibility improvement (New 10 Stations)

Table 8.3-2 The facilities with accessibility improvement (New 10 Stations)

		Educational Institution △	Government Institution ○	Hospital □	Shopping Mall ○
	Area (km²)				
1 Redemptorist	1.867	1. The Growing Place Pre-School 2. Centro Escolar University 3. PATTS College of Aeronautics 4. Metropolitan Aviation School 5. Airlink International Aviation School 6. Flight School International	1. D. Velayo Sports Center	1. D.T. Protacio Hospital	1. Aristocrat Department Store 2. Pearl Plaza
2 MIA	2.021	1. Tambo Elementary School	1. Air Mail Distribution Center		1. Uniwide Coastal Mall
3 Asia World	2.086	1. Don Galo Elementary School	1. PNP Maritime Group		1. AC Store
4 Ninoy Aquino	2.276	1. Sto. Niño Elementary School 2. St. Paul Academy 3. St Andrew Academy	1. Sto. Niño Barangay Hall 2. La Huerta Day Care	1. Community Hospitals	1. Puregold 2. Duty Free Fiesta Mall 3. Duty Free Center 4. SM Warehouse
5 Dr. Santos	2.260	1. Parañaque Municipal Highschool 2. Datamex Institute of Computer Technology	1. Saulog Transit Terminal	1. Our Lady of Peace Hospital 2. Olivarez General Hospital	1. Airport CitiMall 2. Sm SuperCenter Sucat 3. Virra Mall Sucat 4. Public Market
6. Manuyo Uno	D. Santos = 0.748 Las Piñas = 0.618 New = 0.542 Total = 1.908	1. St. Joseph Academy	1. Barangay Hall	1. Lying in Clinic Center 2. Las Piñas District Hospital 3. Health Center	
7 Las Piñas	1.986	1. Ilaya Elementary School 2. Las Piñas Central School 3. Pulanlupa Elementary School 4. Immaculate Mary Montessori School		1. Las Piñas District Hospital 2. A. Zarate General Hospital	
8. Zapote	2.184	1. Bernardo College 2. Divine Grace Institute of Technology 3. Zapote Elementary School	1. Zapote Barangay Hall	1. Jasmin Emergency Hospital	1. Las Piñas Public Market 2. New Zapote Market
9. Talaba	Zapote = 0.422 Niyog = 0.677 New = 0.961 Total = 2.,050	1. Britanny School of Las Piñas 2. Bacoor Evangelical School 3. St. Mathew Academy of Cavite	1. Talaba IV Barangay Hall		1. FRC Mall 2. Bacoor Public Market
10. Niyog	2.465	1. Aniban Central School 2. St. Dominic College of Arts and Science 3. Jubileum Academy of Bacoor 4. Malliksi Elementary School	1. Niyog II Barangay Hall		1. Conrado Commercial Complex

Source; Study Team

And the elimination effect of train use inconvenient area, new 10 stations, is shown in **Table 8.3-3.** More than 300 thousand population of beneficiaries are expected along the extension section.

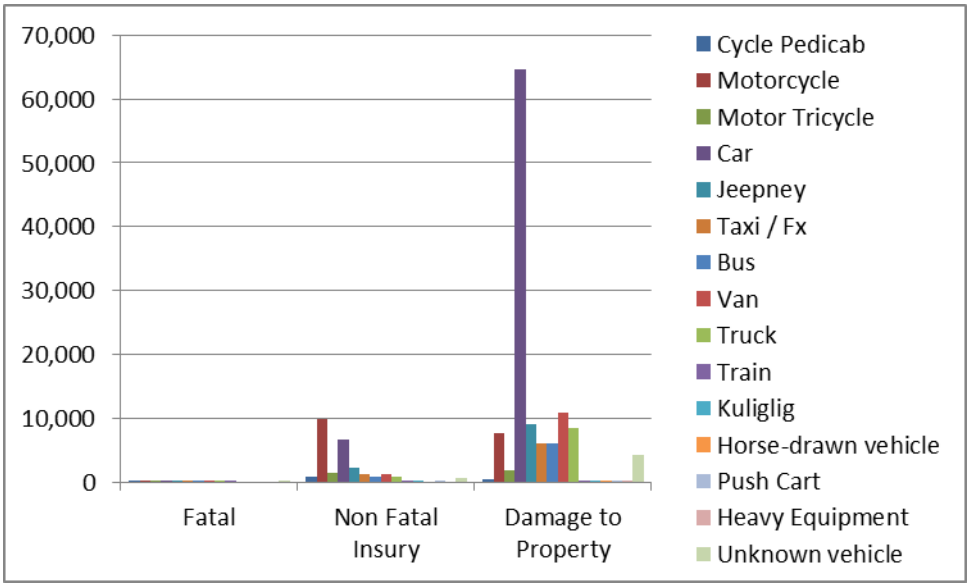
Table 8.3-3 Effect of eliminating inconvenient area for rail use area (New 10 Stations)

No.	Station	Population of Beneficiaries (Pop.)
1	Redemptorist	10,666
2	MIA	13,105
3	Asia World	38,049
4	Ninoy Aquino	18,512
5	Dr. Santos	37,324
6	Manuyo Uno	21,415
7	Las Pinas	42,345
8	Zapote	36,913
9	Talaba	52,059
10	Niyog	32,712
Total		303,097

Source: Study team referring "The Philippines2010 Census"

LRT Line 1, applying two-level crossing through whole section, is safer than typical land transport mode. The extension section is including traffic congested area. Public utility vehicles, especially jeepney, stop wherever and whenever the driver and passenger want by preference. Therefore modal shift is expected to reduce the traffic accident.

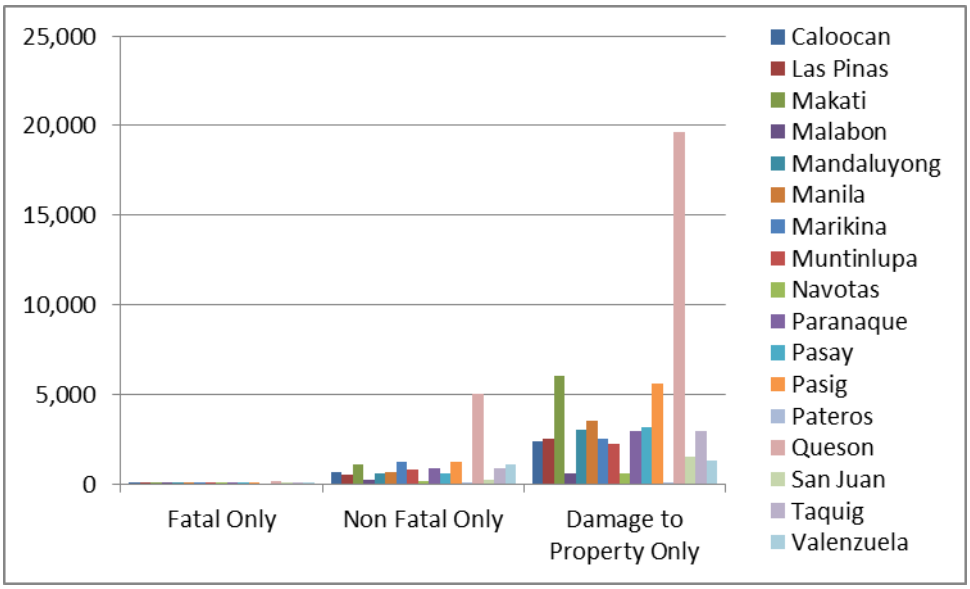
Figure 8.3-5 shows the number of accident on road in Metro Manila marked up by car type. Car and motorcycle stand out and Jeepney occupies 10% in fatal accident, 9% in non fatal injury, and 8% in damage to property.



Source: Study team referring as "Metro Manila Accident Recording and Analysis System (MMRAS) Traffic Accident Report January to December 2011, Produced by the Road Safety Unit (RSU), Traffic and Transport Management Office (TTMO), and Metropolitan Manila development Authority (MMDA)"

Figure 8.3-5 The number of accident on road in Metro Manila <Type>

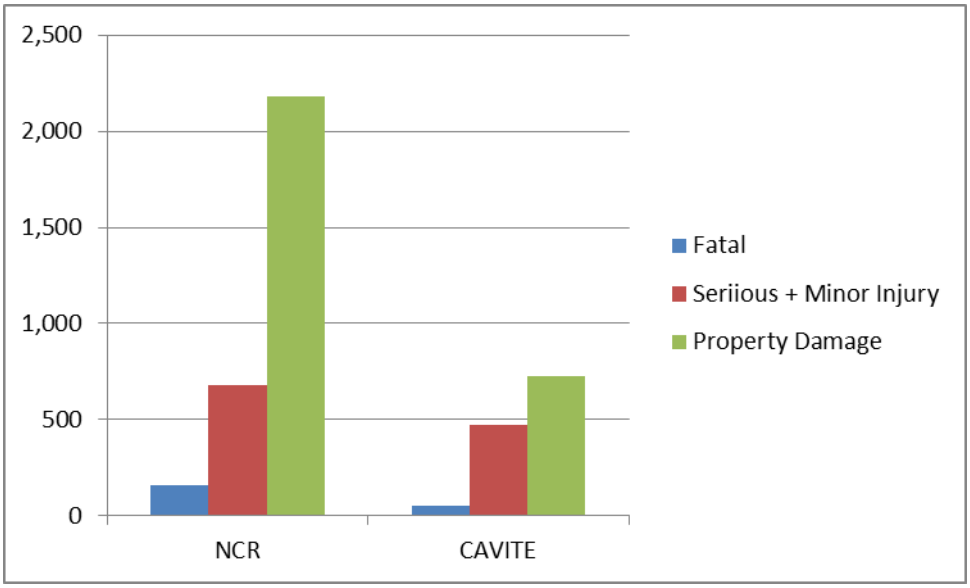
Figure 8.3-6 shows the number of accident on road in Metro Manila maked up by area. Quezon stand out and Las Piñas occupies 2% in fatal accident, 3% in non-fatal injury, and 4% in damage to property. Also Parañaque occupies 5% in fatal accident, 6% in non-fatal injury, and 5% in damage to property.



Source: Study team referring as "Metro Manila Accident Recording and Analysis System (MMRAS) Traffic Accident Report January to December 2011, Produced by the Road Safety Unit (RSU), Traffic and Transport Management Office (TTMO), and Metropolitan Manila development Authority (MMDA)"

Figure 8.3-6 The number of accident on road in Metro Manila <Area>

Figure 8.3-7 shows the comparison of number of traffic accident between NCR and Cavite. Cavite's Serious + Minor Injury ratio is higher than NCR. There is no data of accident divided by car type concerning about Cavite.



Source:" Annual Statistics data for disaster, accident and incident on trunk roads, DPWH Planning Services"

Figure 8.3-7 The number of accident on road comparing NCR and Cavite 2005 - 2011

These three graphs show that there are traffic accidents universally in south extension section, Las Pinas and Paranaque in NCR, and Cavite. But the number of them is not crucial as Quezon. And the number of motorcycle and car will not decrease by the Line 1 extension impact. The effect by decreasing Jeepney will be limited.

Table 8.3-4 shows the train incident / accident for Line 1 recent 4 years. There were damages to property, but there was not serious fatal and injury in commercial operation.

Table 8.3-4 Train Incident / Accident Report for Line 1 2008 - 2011

2011		
9-May	Damaged door at LRV 1053 during depot maneuvering	Incident occurred while a 1st generation train set being towed by unimog from depot track 4 on its route to the washing plant.
28-Mar	No traction of index # 14 at UN Ave. Station (Southbound)	Commotion of passengers at platform of UN Ave. station southbound during the unloading process, thus making it difficult for the High Speed Line (HSL) technician in detecting thee activated doors in LRV 1017.
18-Feb	Incident Crossover # 17 at Roosevelt Station	LRV 1236 which was on the way to the reversing track from platform #2 of Roosevelt Station came into contact and side swept LRV 1015 (which was leaving the reversing area and going to Platform # 1 of Roosevelt Station southbound.
2010		
24-Jun	Accident at Balintawak Station	Train index 10 which was proceeding from the temporary reversing track 2 of Balintawak bumped train index 25 which was then parked at platform 1 of Balintawak Station.
15-Feb	Overhead catenary messenger wire detached between Gil Puyat - Libertad track 1.	Sparking of a portion of the overhead catenary wire between G. Puyat and Libertad Stations Southbound direction (track 1).
2008		
1-Sep	Forceably opening of flap window	Flap window was forcibly opened at Vito Cruz northbound by a certain Ronaldo Romero of Caloocan City.

Source: LRTA

So the effect of traffic accident reduction by Line 1 south extension project is expected, but the impact will be estimated limited.

8.4 Estimating Greenhouse Gas Reduction

The effect of reduction of CO_2 emission is shown referring to "Climate Finance Impact Tool for Mitigation and Adaptation (Summary) Ver. 1.0, JICA, 2011". **Table 8.4-1** shows the result of the estimation of reduction of greenhouse gas. The Project is effective for the reduction of greenhouse gas. The balance for reduction of CO_2 emission will be increasing gradually.

Table 8.4-1 Result of the estimation of reduction of greenhouse gas

Unit: tCO_2 /year

Items		2015	2020	2025	2030	2035
Base Line		16,988,561	18,139,451	18,970,290	19,545,735	19,988,634
Project	Conversion from PUJ	1,578,816	1,685,773	1,762,987	1,816,465	1,857,626
	Increasing	376,152	811,491	940,680	1,038,624	1,118,842
Reduction of CO_2 emission		15,033,593	15,642,187	16,266,623	16,690,646	17,012,167

Source: Study team referring "Climate Finance Impact Tool for Mitigation and Adaptation (Summary) Ver. 1.0, JICA, 2011"

8.5 EIRR & FIRR (Economic & Financial Evaluation)

8.5.1 Economic Analysis

The project is evaluated to determine its economic viability based on the EIRR estimate by comparing the economic costs and benefits over the life of the Project, which is normally assumed to be 30 years after opening.

1) Methodology and Assumptions

a. Methodology

The Project is evaluated from the economic perspective, following a prevailing method of cost-benefit analysis, in which the project cost and benefit are measured in economic price and compared through the project life. Economic cost is the initial investment cost, rolling stock cost and O&M cost of the Project.

b. Economic Benefit Items to be analysed

Economic benefit of the Project is defined as the savings in VOC (Vehicle Operation Costs) and TTC (Travel Time Costs) attributable to the Project. The benefit is the most direct one and comparatively easy to quantity. The benefit is estimated through "with and without" comparison of traffic demand analysis.

- LRT User's Benefit: Reduction in vehicle operating cost (VOC) and savings in travel time cost (TTC) due to usage of LRT extension section (due to shift from private/public transport on road to LRT)
- Road User's Benefit along LRT Line 1 Corridor: Reduction in traffic congestion on the existing road (along LRT Line 1 corridor), as can be seen in increases in travel speeds and reduction in VOCs
- Benefit by CO_2 Reduction: CO_2 reduction by decrease of traffic volume on the existing road (along LRT Line 1 corridor), as can be seen in shifting from road transport to LRT.

The Project would generate other economic benefits such as decrease of traffic accidents, improvement in passengers' comfort ability and contribution to regional development in the long run. However, these benefits are difficult to measure and tend to be an arbitrary estimate, even they can be measured. For that reason, economic benefit is limited to the most direct ones to make the analysis safer.

c. Economic Cost Items to be analyzed

Economic cost is defined as a net consumption of goods and service for implementation of the project. In order to estimate this economic cost of the Project, the initial cost, rolling stock cost and the O&M cost stated in this Report, which is measured in financial cost, need to be converted to costs in economic price. According to various feasibility studies conducted in the Philippines, NEDA has seemingly suggested the following methods for this conversion;

- Application of Standard Conversion Factor (SCF): Economic cost is simply estimated by multiplying SCF to financial cost. The previous projects by JICA or ADB, adopted this method using 0.83 as the value of SCF. The project costs excluding land acquisition are converted using SCF.

d. Other Assumptions

- Project Life: Durable life of a transportation project is usually very long, that is, 50 to 60 years if it is properly maintained. On the other hand, economic project life is considered much shorter than the physical life, that is, around 30 years because the facility soon becomes outdated and uneconomical due to rapid innovation. This project life is defined as 32 years including 4 year of construction period, namely, 2013 to 2046.
- Social Discount Ratio: As the opportunity cost of capital, 15% per annum is assumed as the social discount rate.
- Exchange Rate: USD 1 = Pesos 43, Peso 1 = 1.81 Japanese Yen (Same as Preparatory Study for LRT LINE2 Extension Project)

2) Economic Cost

a. Capital Cost (Initial Cost & Rolling Stock Cost)

An initial estimate of project cost is discussed in this Report. This is summarized in **Tables 8.5-1** and broken down into financial and economic costs. Total economic cost is 211,188.82 Million Peso, 83% of the financial cost.

Table 8.5-1 Project Cost in Financial and Economic Terms

Unit Million Peso

Year	Financial Costs	Economic Costs
2013	25,918.05	21,511.98
2014	31,263.39	25,948.61
2015	29,203.94	24,239.27
2016	29,189.70	24,227.45
2025	23,721.47	19,688.82
2026	31,821.91	26,412.19
2027	43,148.42	35,813.19
2035	2,722.94	2,260.04
2036	11,886.84	9,866.08
2037	25,013.24	20,760.99
2038	554.47	460.21
Total	254,444.37	211,188.82

Source : Study Team

b. O&M Expenses

The O&M costs for LRT Line 1 extension section are shown in the following table. Detail estimate of
O&M work is discussed in this Report

Table 8.5-2 O&M Expenses for LRT Line 1 Extension Section in Benchmark Years

Unit Million Peso

Year	Financial Costs	Economic Costs
2015	1,604.65	1,331.86
2020	4,942.23	4,102.05
2025	6,533.00	5,422.39
2030	7,759.16	6,440.10
2035	10,118.41	8,398.28

Source : Study Team

3) Economic Benefit

a. Vehicle Operating Cost (VOC)

The saving in VOC is one of the major sources of economic benefits in transport projects. **Table 8.5-3** shows the VOCs. The most important is that the VOC should be a function of vehicle speed so that the improvement of road condition would be duly reflected as economic benefit.

Table 8.5-3 Vehicle Operation Cost, 2010

*Unit: Peso/ Vehicle (Train)*km*

Ave. Speed (km/h)	LRT	Jeepney	Private Car
20	-	10.91	12.01
25	-	10.36	11.41
30	-	9.38	10.45
32.8	1.57	-	-
40	-	8.29	9.25
50	-	7.85	8.65
60	-	7.74	8.29

Source : Preparatory Study for LRT LINE2 Extension Project

b. Value of Time (VOT)

The saving in passenger time cost is another major source of economic benefit of transport projects. The following table presents the unit value of time assumed by the result of SP survey. VOT of LRT user is higher than that of Jeepney.

Table 8.5-4 Unit Value of Time (VOT), 2013

Mode	LRT	Private Car	Jeepney
Peso/Min.	1.61	1.85	1.09
Peso/Hour	96.7	111.1	65.5

Source : Study Team

c. Carbon Price

The price of CO_2 emission seems to be depending heavily on economic market. The carbon price is set as 829 Peso1 in 2010 price in this analysis, same as "Preparatory Study for LRT LINE2 Extension Project".

d. Estimation of Economic Benefits

By applying above unit costs to the result of traffic demand and summing VOC, TTC and CO_2 reduction, aggregated transportation cost was estimated. Economic benefit is the difference of the aggregate costs between "with project" case and "without project" case. The following table shows the economic benefit in benchmark years. In 2030, about 60% of benefit will be travel time cost saving.

Table 8.5-5 Economic Benefit in Benchmark Years

Unit: Million Peso/ Year

Year	Economic Benefit			
	VOC Saving	TTC Saving	CO_2 Reduction	Total
2020	3,912.88	13,716.31	22,172.80	39,801.99
2025	4,454.50	31,958.57	23,057.94	59,471.01
2030	5,496.95	38,971.35	23,658.99	68,127.29

Source : Study Team

4) Cost Benefit Flow and EIRR

The following table shows the economic cash flow over the project period for calculating economic internal rate of return (EIRR). According to NEDA's criteria, the threshold value to judge the economic feasibility of a project is 15% in the Philippines. EIRR is 30.9%, which proved to be a feasible from the economic viewpoint.

Table 8.5-6 Cash Flow of Economic Cost and Benefit

Unit: Million Peso

	Year	Capital Cost	O&M Cost	Economic Benefit	Net Cash Flow
1	2013	21,511.98		0.00	-21,511.98
2	2014	25,948.61		0.00	-25,948.61
3	2015	24,239.27	1,331.86	6,121.48	-19,449.65
4	2016	24,227.45	2,939.73	30,804.49	3,637.31
5	2017	0.00	3,230.31	32,254.04	29,023.73
6	2018	0.00	3,520.89	34,024.38	30,503.48
7	2019	0.00	3,811.47	36,209.23	32,397.76
8	2020	0.00	4,102.05	39,801.99	35,699.94
9	2021	0.00	4,366.12	43,050.10	38,683.98
10	2022	0.00	4,630.19	47,222.08	42,591.89
11	2023	0.00	4,894.26	52,709.46	47,815.21
12	2024	0.00	5,158.32	56,923.19	51,764.86
13	2025	19,688.82	5,422.39	59,471.01	34,359.80
14	2026	26,412.19	5,625.93	60,982.33	28,944.20
15	2027	35,813.19	5,829.48	62,544.28	20,901.61
16	2028	0.00	6,033.02	64,156.44	58,123.42
17	2029	0.00	6,236.56	65,817.74	59,581.18
18	2030	0.00	6,440.10	68,127.29	61,687.19
19	2031	0.00	6,831.74	69,730.03	62,898.30
20	2032	0.00	7,223.37	71,358.53	64,135.16
21	2033	0.00	7,615.01	73,003.81	65,388.80
22	2034	0.00	8,006.64	74,653.10	66,646.46
23	2035	2,260.04	8,398.28	76,743.88	66,085.56
24	2036	9,866.08	8,713.53	78,126.42	59,546.82
25	2037	20,760.99	9,028.77	79,395.30	49,605.54
26	2038	460.21	9,344.02	80,476.98	70,672.75
27	2039	0.00	9,659.27	81,253.28	71,594.01
28	2040	0.00	9,974.52	81,523.29	71,548.77
29	2041	0.00	10,348.94	81,322.21	70,973.28
30	2042	0.00	10,723.35	83,316.41	72,593.05
31	2043	0.00	11,097.77	85,380.66	74,282.89
32	2044	0.00	11,472.18	87,517.41	76,045.22
		211,188.82	202,010.08	1,864,020.82	30.92%

Source : Study Team

5) Sensitivity Analysis

Sensitivity analysis was made by changing the projected cost upward and benefit downward. This analysis was done using following scenarios by "ICC Project Evaluation Procedures and Guidelines" of NEDA.

- Scenario I: Increase in projected costs by 10% or 20%
- Scenario II: Decrease in benefit by 10% or 20%
- Scenario III: Combination of Scenario I and II

The following table shows the result of sensitive analysis by changing cost and benefit.

Table 8.5-7 Sensitive Analysis by Changing Cost and Benefit

Changing in Cost &Benefit		Cost Increase		
		Base (0%)	10% Up	20% Up
Benefit Decrease	Base (0%)	30.92%	28.38%	26.19%
	10% Down	28.12%	25.74%	23.67%
	20% Down	25.19%	22.96%	21.02%

Source : Study Team

8.5.2 Financial Analysis

Conducting a financial evaluation of LRT extension project is very important to assess possible PPP schemes. The FIRR will be estimated by comparing project costs and fare revenues as well as other revenues (Miscellaneous Revenues) over the LRT's life. Depending upon the level of FIRR, cost-sharing between public and private sectors will differ. Cash flow analysis also is made.

1) Assumptions

a. Revenue

Total revenue is composed of fare box revenue and miscellaneous revenue, as shown below;

- Fare box Revenue: The fare box revenue is estimated using the result of demand forecast.
- Miscellaneous Revenue: The miscellaneous revenue is assumed as 5% of fare box revenue, based on the existing financial situation and the experience of other countries.

Table 8.5-8 Revenue in Benchmark Years

Unit: Million Peso

Year	Revenue
2020	8,456.55
2025	11,787.04
2030	16,010.58
2035	21,412.02

Source : Study Team

b. Expense

The expense is composed of the construction cost and O&M cost, as shown in the following table.

Table 8.5-9 Expense on Construction Stage

Unit Million Peso

Year	Expense
2013	25,918.05
2014	31,263.39
2015	29,203.94
2016	29,189.70
2025	23,721.47
2026	31,821.91
2027	43,148.42
2035	2,722.94
2036	11,886.84
2037	25,013.24
2038	554.47
Total	254,444.37

Source : Study Team

Table 8.5-10 Expense on O&M in Benchmark Years

Unit: Million Peso

Year	Revenue
2020	4,942.23
2025	6,533.00
2030	7,759.16
2035	10,118.41

Source : Study Team

c. Other Assumptions

- Project Life: The project life is defined as 32 years including 4 year of construction period, namely, 2013 to 2046, same as setting for economic analysis.
- Exchange Rate: USD 1 = Pesos 43, Peso 1 = 1.81 Japanese Yen (Same as "Preparatory Study for LRT LINE2 Extension Project")
- Taxes: 12% of value-added tax (VAT) in Philippines should be considered for both of foreign and domestic currency portion. The import tax for foreign currency portion is excluded from this analysis.
- Inflation: Inflation is excluded from this analysis.

2) Financial Evaluation

a. In the estimation of Equity-IRR, reported to JICA before, increasing ratio of fare was assumed as 5.0 % / year. But it should be modified to 0.5% / year recognized by NEDA, excluding 4.5 % inflation.

b. The assumption of estimation of Equity- IRR is changed as follows, with the modification above.

b.1. The source of funding should be decided, which invested by private sector, the amount is estimated total cost of previous version excluding investment from GOP (JICA-ODA and external GOP portion). So debt - equity ratio is assumed as 65% - 35%. (Same assumption as before)

b.2. It is not clear the condition for remission for corporate tax in PPP project. So it is assumed that 30% of profit, after depreciation and repayment of interests, is taxable. (Same assumption as before)

b.3. Base case is considering 4.5% / year inflation. Because GOP studies various project based on nominal IRR, which stands on IFC report considering 4.5% / year inflation.

b.4. Fare of LRT in first year is assumed (11.0 + 1.0 x Distance (km)) Pesos. The raising ratio is 0.5% / year, same as IFC assumption.

b.5. Concession fee is assumed as 2.05% of fare box (Same as before). Implementation body depreciates properties and transfer to GOP at the end of the period of concession.

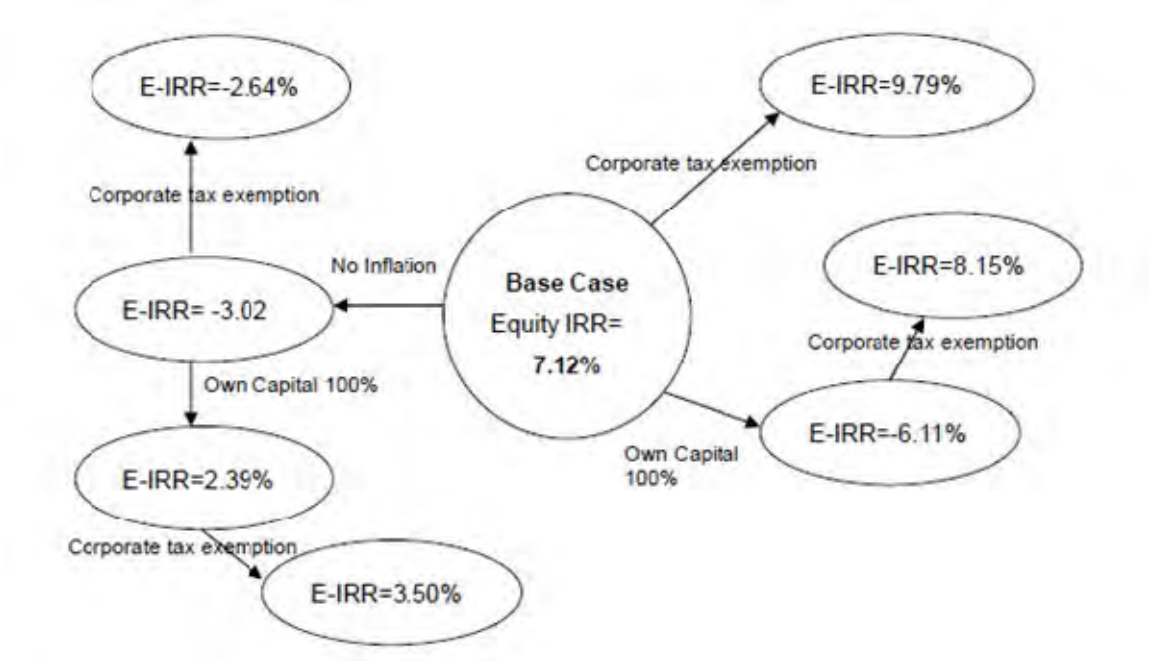
b.6. Regarding previous assumption of the calculation of Equity- IRR, the profit of each year is assumed to be presumed as distribution to keep cash flow security, and cumulative internal reserves are clearing at the final stage. But in this study, Equity-IRR is computed referring equity and after tax profit, as internal reserves was owned by stock holders.

c. Equity- IRR is calculated as 7.12% above mentioned condition as base case. Equity- IRR is changed as above mentioned condition changing as follows.

c.1. Equity- IRR is 9.79%, corporate tax exempted.

c.2. Real Equity- IRR, not considering inflation, is -3.02%. Considering corporate tax, the figure changes to -2.64%.

c.3. In the case of capital adequacy ratio 100%, considering loans presumed as capital in nominalbase, Equity- IRR is 6.11%. Also exemption of corporate tax case, Equity-IRR is 8.15%. So they are lower than the case of capital adequacy ratio 35%. But not considering inflation,Equity-IRR is 2.39% and exemption of corporate tax case is 3.50%.



d. Conclusion

Regarding the result above mentioned, Equity-IRR is low and it is not attractive for investors. The items, rolling stock, E&M and depot, are not enough to bear by GOP. It should be considered to review PPP scheme, for example providing the developing property rights of surrounding area of stations.

CHAPTER 9
AUTOMATIC FARE COLLECTION SYSTEM

CHAPTER 9 AUTOMATIC FARE COLLECTION SYSTEM

This chapter outlines investment needs on AFC system, market soundings with Japanese companies, and proposed financing scheme with STEP loans. Since DOTC has been considering PPP procurement for AFC System, the team discussed with DOTC on advantages of utilizing STEP loans. However, the final feasibility study of DOTC was recently completed with the support of PPP Center and it was informed that the report recommends PPP procurement for AFC System. DOTC is currently preparing the procurement on AFC under PPP mode, although the schedule has not been identified.

9.1 The outline of the AFC System

Magnetic-based ticketing systems at LRT Line-1, -2, and MRT Line 3 are outdated. Certain numbers of gate machines remain malfunctioned at every station because of the lack of spare parts. Commuters are suffering from considerable inconvenience.

Study Team proposed a comprehensive plan for the replacement of the old ticketing system. This plan includes; (i) contactless IC card technology instead of magnetic-stripe based card systems, (ii) the introduction of a central Clearing House System for Railway that will perform apportionment for revenues among the operators, and (iii) PPP scheme using STEP finance.

9.1.1 Assumptions for the introduction of Automatic Fare Collection (AFC) System

AFC System covers fifty seven stations (44 stations at Line-1 and Line-2 which include 13 stations for the expected extension and 13 stations at Line-3) in total.

The comprehensive plan consists of three layers, i.e., Station Computer System, Line Computer System, and the Central Clearing House System. The configuration is as the **Figure 9.1-1.**

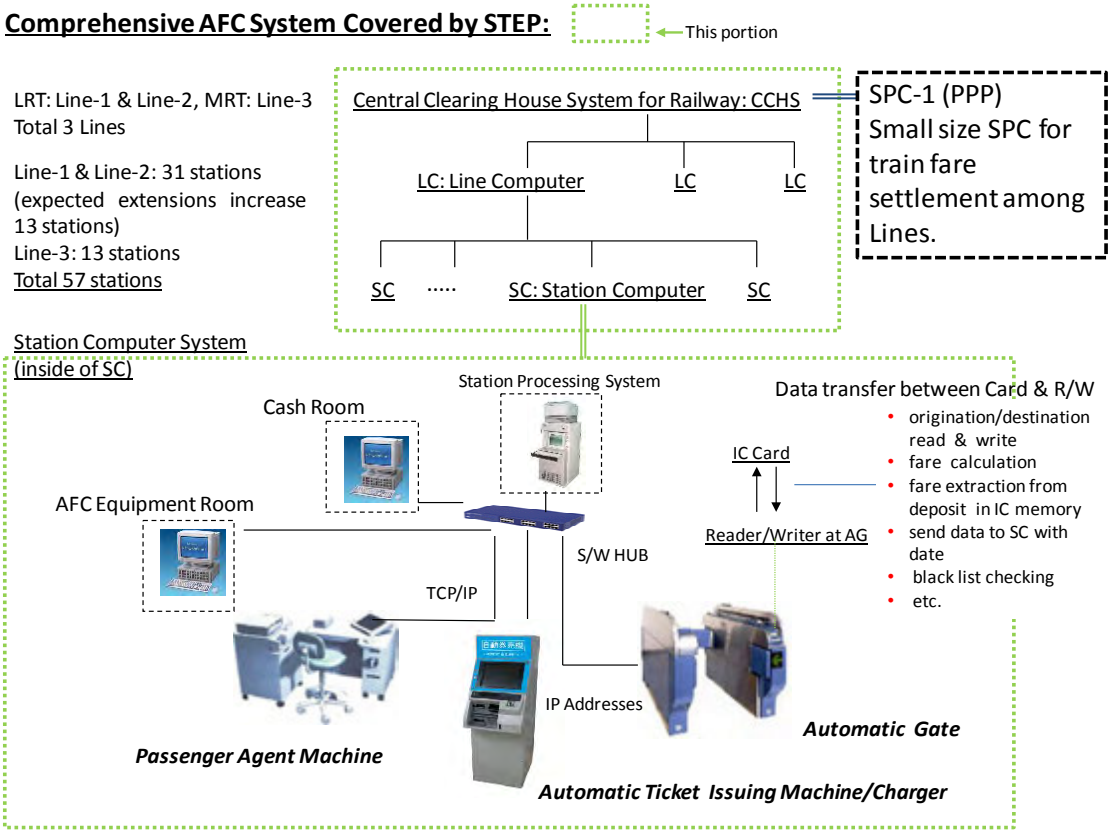


Figure 9.1-1 Comprehensive AFC System

9.1.2 Business Model of Manila Metro AFC System

Study team proposed DOTC to build the Manila Metro AFC system at the Line-1, -2, and -3 by using the JICA's STEP (Special Term for Economic Partnership) loan scheme. Integrated Clearing House system for the fare transactions is desirable considering that the operators of the Lines differ.

Introduction of AFC system into the congested transportation networks is challenging, while Japanese vendors are well experienced for the introduction of the AFC system to the railway stations under heavy traffics.

JICA team envisages the premise that the prepaid IC card system for metro commuters should be a good starting point to let the non-cash payment system spread among the Philippine Society. (**Figure 9.1-2**)

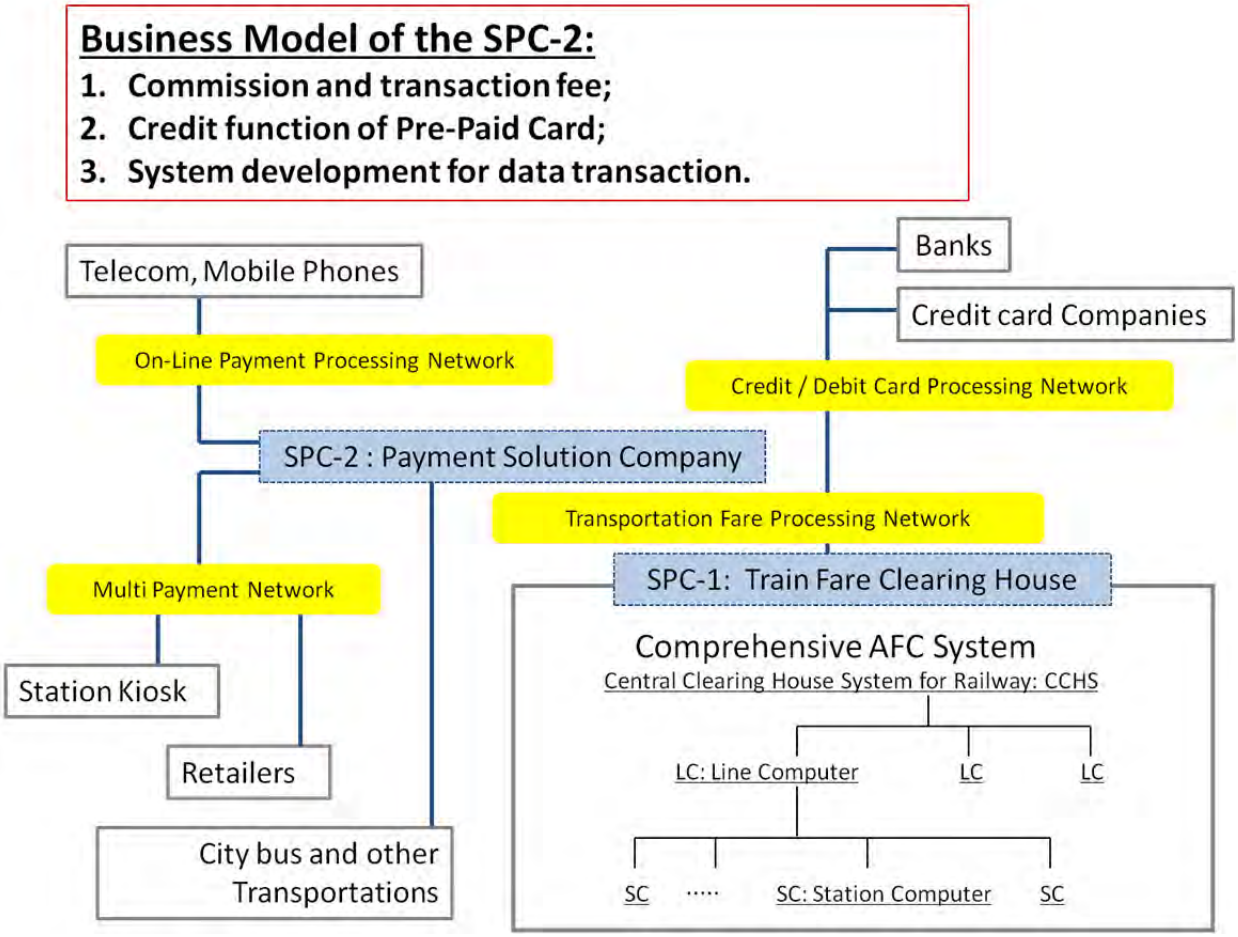


Figure 9.1-2 Business model for IC Card payments

9.1.3 Required Numbers of Automatic Gate based on the Estimated Numbers of Passengers

JICA team estimated the necessary numbers of Automatic Gate (AG) based on the estimated numbers of passengers.(**Table 9.1-1**) We used the maximum numbers of passenger base on the expected peaks at Line 1 stations, north and south bound, per one hour, passengers getting on and off at each station. The present numbers of AG (magnetic type) are 328 in Line-1, 229 in Line-2, 171in Line-3, 728 gates in total.

Table 9.1-1 Required numbers of AG based on the estimated numbers of passengers

Differences of the Required Numbers of Automatic Gate, based on the Passenger's Maximum Numbers per Hour

				Turnstile		Paddle		Flipper		Magnetic	
numbers of reserved gate				Northbound	Southbound	North	South	North	South	North(estimated)	South(estimated)
	2	North Max	South Max	Turnstile=1200PA	Turnstile=1200PA	Paddle=1800PA	Paddle=1800PA	Flipper=3600PA	Flipper=3600PA	Magnetic Tkt=600P	Magnetic Tkt=600PAX/h
				1200	1200	1800	1800	3600	3600	600	600
1	Baclaran	2868	2527	5	5	4	4	3	3	7	7
2	EDSA	6104	4579	8	6	6	5	4	4	13	10
3	Libertad	813	1385	3	4	3	3	3	3	4	5
4	Gil Puyat	2805	4441	5	6	4	5	3	4	7	10
5	Vito Cruz	1713	2083	4	4	3	4	3	3	5	6
6	Quirino	952	1365	3	4	3	3	3	3	4	5
7	Pedro Gil	2411	1491	5	4	4	3	3	3	7	5
8	UN Avenue	2182	3018	4	5	4	4	3	3	6	8
9	Central	1756	1551	4	4	3	3	3	3	5	5
10	Carriedo	2188	1847	4	4	4	4	3	3	6	6
11	D Jose	1837	1533	4	4	4	3	3	3	6	5
12	Bambang	400	451	3	3	3	3	3	3	3	3
13	Tayuman	900	1588	3	4	3	3	3	3	4	5
14	Blumentritt	1237	1487	4	4	3	3	3	3	5	5
15	A Santos	462	819	3	3	3	3	3	3	3	4
16	R Papa	1048	764	3	3	3	3	3	3	4	4
17	5th Avenue	1493	2834	4	5	3	4	3	3	5	7
18	Monumento	11404	5331	12	7	9	5	6	4	22	11
19	Balintawak	969	2735	3	5	3	4	3	3	4	7
20	Roosevelt	2702	4153	5	6	4	5	3	4	7	9
				89	90	76	74	64	64	127	127
					Line-1 AG total estimated		Line-1 AG total estimated		L-1AG Nr÷20×57 Stations		Line-1 AG total estimated
					179		150		128		254
					L-1AG Nr÷20×57 Stations		L-1AG Nr÷20×57 Stations		L-1AG Nr÷20×57 Stations		L-1AG Nr÷20×57 Stations
	Point advance				511		428		365		724
					L-1AG Nr÷20×44 Stations		L-1AG Nr÷20×44 Stations		L-1AG Nr÷20×44 Stations		L-1AG Nr÷20×44 Stations
					394		330		282		559

Calculation method for the numbers of AG: (Passenger's Maximum number ÷passage) point advance +number of reserve gate
Numbers of passage at the gate per minutes=Flipper type:60 person、Paddle type:45 person、Turnstile type: 30 person

9.1.4 Cost Estimates for the Introduction of AFC System

Using the estimated number at **Table 9.1-1**, the cost for the introduction of AFC system is calculated as the follows. (**Table 9.1-2**)

- The numbers used for the cost estimation is present ones and not multiplied by the expected increase of passengers in future. 511 gates are for Turnstile. Unit price of Paddle and Flipper Type is expected to be slightly expensive.
- The numbers of AG based solely on the expected peaks of passengers. The configuration of each station is not considered. The numbers of AG differs, for example, how many tickets that station operates.

Table 9.1-2 Estimation for the cost for the introduction of AFC System

	57 Stations		rounded		44 Stations
AG	Turnstile Type 511gates procuring by the proportion of Entry Type× 5/13+Exit Type × 5/13 +ReversibleType × 3/13				
	2004692308		2,010,000,000		1,545,692,308
TOM	4equipments／1stations	228		176	
	570000000		570,000,000		440,000,000
SCS	57 Stations				
	330600000		330,000,000		255,200,000
LCS	3 Lines				
	17400000		20,000,000		17,400,000
CCHS	1 system for 3 lines				
	400000000		400,000,000		400,000,000
			3,330,000,000		2,658,292,308

Equipment Breakdown	Yen	remarks
Equipment Cost	3,330,000,000	
		AG、TOM、SCS、LCS、CCHC ※ TIM is NOT included supposing the manual sales of the ticket.
Initial Contactless Card	195,000,000	SVC:150 yen × 500000 cards ・ SJT:80 yen × 1500000 cards
Spare	154,000,000	
Warranty's Cost	87,000,000	
Training Cost	100,000,000	
Testing and Commissioning	285,000,000	
System Design and Software Dev't	450,000,000	CCHC、SCS、LCS
Project Management Cost	100,000,000	
Marketing and Documentation	50,000,000	
Installation	285,000,000	
total	5,036,000,000	

AG: Automatic Gate
TOM: Ticket Office Machine
SCS: Station Computer System
LCS: Line Computer
CCHS: Central Clearing House System
SVC: Stored Value Card
SJT: Single Journey Ticket

9.2 Market Sounding on Japanese Investors

9.2.1 Japanese Automatic Fare Collection System Investors

In Japan, automatic fare collection (AFC) systems in most of urban transportation have been well-developed since 1970's. Japanese vendors have accumulated their experience in AFC, and some of them have overseas track records. Japanese system integrators have also experience of developing the AFC system in other countries. Tables below show the list of Japanese AFC investors and their track records overseas.

Table 9.2-1 Japanese Investors on Automatic Fare Collection

AFC Vendor	System Integrator	Clearinghouse Operator
NIPPON SIGNAL OMRON TOSHIBA	NTT DATA HITACHI TOSHIBA etc.	PASMO JR EAST etc.

Table 9.2-2 Examples of Oversea AFC Experience of Japanese Investors

Company	Track record
NIPPON SIGNAL	Chennai (India), etc.
OMRON	Kaoshiung (Taiwan) Beijing (China), etc.
NTT DATA	Vietnam Melbourne (Australia), etc.
TOSHIBA	Daegu (South Korea)

9.2.2 Interview to Japanese AFC Investors

The study team conducted interviews to some of AFC venders and system integrators. Issues identified during the interviews are 1) Possible segregation of AFC system development, 2) Advantageous technology of Japanese AFC investors, 3) Retrofit of automatic fare collection gate and 4) Interest to the AFC System Investment in Manila.

1) Possible Segregation of AFC System Development

AFC development can be divided into 4 categories:

a. Automatic Fare Collection System
   - Hardware Development
   - Software Development

b. Clearinghouse System
   - Hardware Development
   - Software Development

When trying to develop AFC system under PPP scheme combined with JICA loan, development has to be segregated into two parts. Possible segregation needs to be identified, and its possibility is described below.

AFC system development and clearinghouse development can be easily developed independently as clearinghouse system just collect transaction record through each AFC system.

Clearinghouse development can also be divided into hardware development and software development as hardware of clearinghouse is composed of servers and terminals.

On the other hand, AFC hardware development and software development needs to be integral as software development is highly dependent on AFC hardware.

Considering above, there could be 3 kinds of segregations.

- *Alternative 1*
  JICA Loan: Automatic Fare Collection System Development
  PPP: Clearinghouse Development
- *Alternative 2*
  JICA Loan: Automatic Fare Collection System Development and Software Development of Clearinghouse System
  PPP: Hardware Development of Clearinghouse System
- *Alternative 3*
  JICA Loan: Automatic Fare Collection System Development and Hardware Development of Clearinghouse System
  PPP: Software Development of Clearinghouse System

2) Advantageous Technology of Japanese AFC Investors

Three major contactless IC read/write standards are Type A (Mifare), Type B, and Felica. Mifare is developed by Philips, authorized as an international standard (ISO/IEC 14443), and most widely spread contactless IC card. Type B is developed by Motorola, and also authorized as an international standard (ISO/IEC 14443). On the other hand, Felica is developed by Sony and Felica-type contactless IC cards are used in Asian countries, Japan, Hong Kong, etc.

Although those standards are going to be integrated into Near Field Communication (NFC), Felica is the fastest in processing so that AFC system can handle many commuters in rush hours. Transmission speed of Mifare is 106kbps whilst that of Felica is 212kbps[2]. This is the reason why many Japanese subways and Hong Kong MTR which have to make many passengers pass through gates at small place in a station smoothly have applied Felica.

In addition, Felica is developed for multipurpose functions. Felica IC tip has OS and CPU in itself while Mifare does not. Many application softwares can be installed to Felica IC tip and Felica card is able to function as SUICA, Edy, etc. In addition, Felica can control each application without leaking information in one application to others.

3) Retrofit of Automatic Fare Collection Gate

If retrofitting of automatic fare collection gate to contactless IC card gate is required, it is suggested that the control unit has to be replaced. Although original chassis and turnstiles can remain in the gate, it is required to design the connection between existing equipment and contactless IC card control unit and assure connectivity. Since chassis and turnstile are not expensive, it could be cost effective to replace whole system to Contactless IC card gate.

4) Interest to the AFC System Investment in Manila

The interest to invest in AFC system in Manila seems to be strong. Although applied standard, Type A, B or Felica, will be indifferent to the private sector's appetite, downsizing the investment to only installing IC card reader/writer on the current gates or price-driven bidding will affect the private sector's interest in investing the AFC System.

[2] http://developers.orangetags.jp/

9.3 Proposed AFC System Procurement with STEP Loan

The study team proposed a financing scheme for AFC system applying STEP loan. Since DOTC has been considering PPP procurement together with PPP Center and preparing the feasibility study on it, the team focused on analyzing how to coordinate STEP loan with PPP procurement. The study team conducted several discussions with DOTC.

9.3.1 Possible Financing Structure

It is considered how the roles can be divided between the public (STEP loan) and the private (PPP). Based on the interviews with the private sector and technical consideration, the following two assumptions were made on project structuring.

- ✓ Hardware and software development of AG cannot be separated.
- ✓ Hardware and software development of Clearing House (CH) can be procured respectively.

Four options (in **Figure 9.3-1**) were discussed with DOTC.

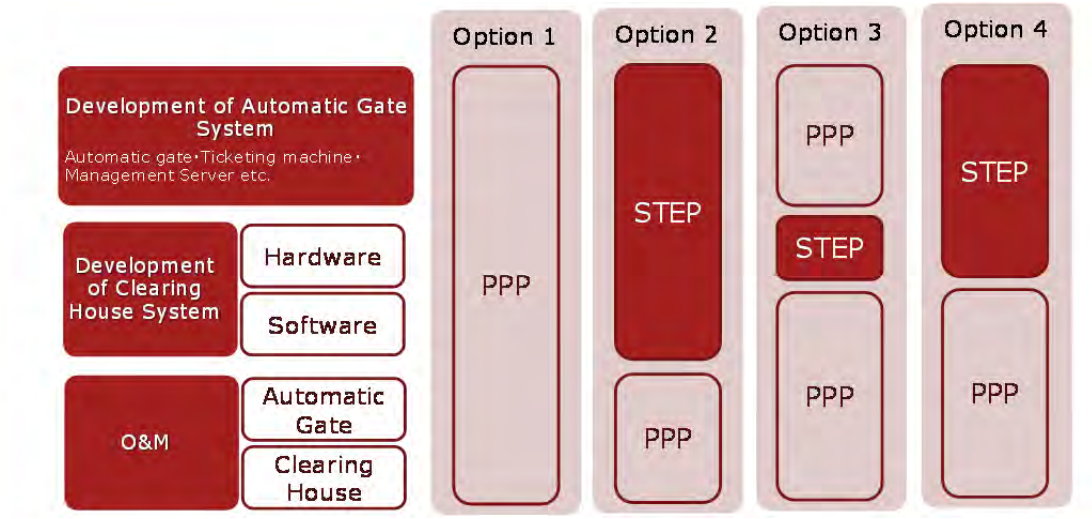


Figure 9.3-1 Possible Financing Options

Option 1: All parts from design and construction to O&M are procured under PPP scheme.
Option 2: All hardware and software are procured under STEP loan and O&M is conducted by the Private Sector
Option 3: Hardware of Clearing House System is procured under STEP loan and Automatic Gate System, software of Clearing House system, and O&M are procured under PPP
Option 4: Automatic Gate System and hardware of Clearing House System are procured under STEP loan and software of Clearing House system and O&M are procured under PPP

It is assumed that the ownership of the system developed under STEP loan will remain under DOTC, and a PPP company will be provided the right to use.
In Option3, STEP portion is relatively small. However, it is assumed to be a part of STEP loan package for Line1, resulting in an efficient implementation.

9.3.2 Illustrative Project Cost Comparison

Project costs of each option are compared in the table below. The table shows that utilizing STEP loan will reduce interest burden compared to procurement solely under PPP, Option 1. In addition, it is noted

that PPP scheme with the availability payment by the government will not eliminate government contribution during the project period.

It is also estimated that utilizing Japanese technology funded by STEP loan will assure the development of a high quality system and stable operation, while well-structured PPP procurement will be required to assure appropriate service requirement on the technical level of development and operation of a system.

Table 9.3-1 Illustrative Project Cost Comparison

Project Costs			Option1 PPP	Option2 STEP +PPP(O&M)	Option3 STEP(HWofCH) +PPP	Option4 STEP(AG, HWofCH) +PPP
STEP Cost	Investment Cost		-	$18.31M	$ 0.80M	$15.11M
	Interest		-	$ 16.31M	$ 0.71M	$13.46M
	Commitment Charge		-	$ 0.03M	$ 0.00M	$0.02M
	TTL		**-**	**$34.65M**	**$1.51M**	**$28.59M**
PPP Cost	Availability Payment	Investment Cost	$ 18.31M	-	$ 17.51M	$3.20M
		PPP Start-up Cost	$ 3.23M	$2.50M	$ 3.20M	$2.63M
		Interest, Dividend, etc.	$ 19.82M	$2.30M	$19.05M	$.5.36
	O&M costs		$ 27.75M	$ 27.75M	$ 27.75M	$ 27.75M
	PPP Operating costs		$ 1.90M	$ 1.90M	$ 1.90M	$ 1.90M
	TTL		**$71.01M**	**$34.45M**	**$69.41M**	**$40.84M**
Total Government Contribution for Project period			**$ 71.01M**	**$ 69.10M**	**$ 70.93M**	**$69.43M**

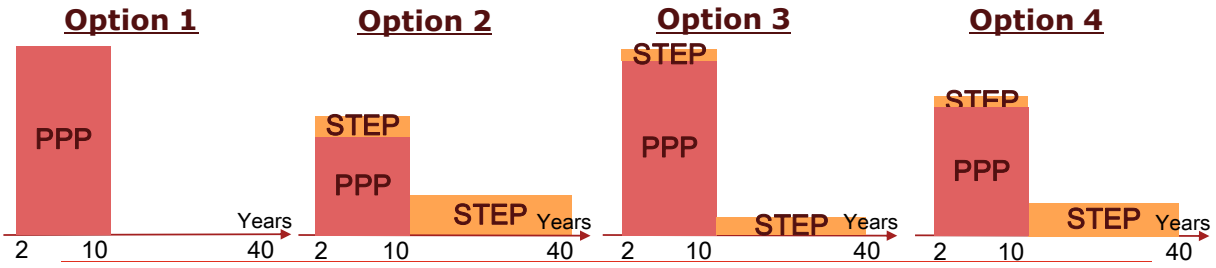
Note:

- Total Government contribution during a project period is borne by a public transportation operator such as LRTA. A part of the contribution is reimbursed through ticket sales, while the other part of contribution is reimbursed through government support, such as subsidy, etc.
- All costs (without inflation) are assumed based on DOTC Draft Feasibility Study (REBEL Report) except funding costs.
- Fee revenues from transaction and maintenance and renewal costs are not considered.
- The amount will be changed depending on the scope of work, possibility of fee revenue, etc.
- HW stands for Hardware.

STEP loan is assumed to be a 40 year-loan with the interest of 0.2%. This will lower annual payments from the government under the scheme utilizing STEP loan than those under Option 1, whole PPP scheme, as shown in the following table and diagram.

Table 9.3-2 Comparison of Annual Payments

Annual Payment		Option1 PPP	Option2 STEP +PPP(O&M)	Option3 STEP(HWofCH) +PPP	Option4 STEP(AG, HWofCH) +PPP
1-10 year	STEP Loan repayment	-	$586K	$26K	$483K
	PPP Payment	$7,101K	$3,445K	$6,941K	$4,084K
11-40 year	STEP Loan repayment	-	$959K	$42K	$791K
	PPP Payment	-	-	-	-



9.4 Assumptions for the Calculation

9.4.1 Capital Investment Cost

Capital investment costs for AFC are identified based on the draft feasibility study of the Rebel report. Costs under each option are allocated to STEP and PPP as follows:

Table 9.4-1 Cost allocation to STEP and PPP

Option	STEP	PPP
Option 1 PPP	$0	$18,312,675
Option 2 STEP+PPP (O&M)	$18,312,675	$0
Oprion 3 STEP (HW of CH)+PPP	$800,000	$17,512,675
Option 4 STEP (AG,HW of CH)+PPP	$15,112,675	$3,200,000

Note:

- All costs (without inflation) are assumed based on DOTC Draft Feasibility Study (REBEL Report) except funding costs.
- In Option 3 and 4, hardware costs for clearinghouse development are assumed to account for a fifth of clearinghouse development cost. The ratio is based on the one acquired through interviews to Japanese investors.

1) STEP Conditions

Repayment Period	40 years
Grace Period	10 years
Repayment Schedule	Level Payment
Interest Rate	0.20%
Commitment Charge	0.10%
Construction Period	1.5 years
Foreign Exchange Margin	3.00%

2) PPP Conditions

Financial conditions and costs for PPP are based on the draft feasibility study of Rebel.

Debt/Equity Ratio	80%
Interest Rate for Senior Loan	6.5%
Interest Rate for Subordinate Loan	9.0%
Equity IRR	20.0%
Start-up Cost	$2,500,000
O&M Cost	$2,774,668 p.a.
PPP Operating Cost	$190,000 p.a.
Operation Period	10 years

CHAPTER 10
PROJECT IMPLEMENTATION

CHAPTER 10 PROJECT IMPLEMENTATION

10.1 Local Capacity for Railway Construction

Local construction entities have been exposed to construction of elevated track infrastructure since the 15-km LRT 1 was built from 1980-84. Then Construction and Development Corporation of the Philippines (now known as Philippine National Construction Corporation) was the prime contractor. When Line 2 was built with JICA (then known as OECF) financing, the winning bidder for the substructure and superstructure was a Korean firm (Hanjin) with Filipino sub-contractors.

The business arrangement (foreign with local partners, and vice-versa) that is typified by the Line 2 construction appears to be prevalent with large and ODA-financed projects. Another rail project that exhibited the same model was the North-South Linkage project of the Philippine National Railways (which involved rehabilitation of tracks and stations, as well as supply of DMUs at a cost of about USD60million) sometime in 2008-2010.

The same firm rehabilitated the PNR Commuter rail tracks sometime in 2008-2010. When LRTA tendered the north loop (5-km extension of Line 1) in 2007, a Philippine contractor was awarded the contract. It hired a German firm to support their signaling system works. This same contractor had a similar job in the building of the civil works of the Dubai monorail system. Moreover, nothing in local laws prevent any other local firm from entering into joint venture with foreign firms with extensive railway construction experience.

For example, it is known that several foreign firms have submitted expression of interests for Line 1 CEP. The DOTC has reported that among the 32 firms that have purchased bid documents for the project include: San Miguel Infrastructure, Macquarie Group, Mitsubishi Corp., DMCI, Hanjin, Sumitomo, Leighton, the Metro Pacific Group, FSG Capital, EFC Enterprises, FF Cruz, Marubeni Corp., BPI Capital, ING Bank and Jorgman Planning. Korean contractors have been reported as particularly aggressive or bold in participating in the tender.

The joint-venture of Marubeni and DMCI was awarded the contract to build the MRT-7 project. The joint-venture of Marubeni and DMCI was awarded the contract by the private proponent to build the MRT-7 project. Typically, the project finance market needs assurance about capability to complete a project before it agrees to finance a PPP deal. It can therefore be concluded that “domestic” capacity exists for all the civil and electromechanical components of LRT 1 CEP. The prequalification requirements imposed by the government PBAC would screen out prospective bidders without the necessary experience.

10.2 Bidding System and Evaluation of Proposals

10.2.1 Tendering Framework

The bidding system in the Philippines is well-structured and formalized, having been applied by the Government over several years. As a consequence, a substantial body of experiences and precedents have been accumulated. For ODA-funded projects, the tendering procedure is subject to review and oversight by the funder; with the results open to veto (as what happened in the case of package 1 for the LRT-2 project sometime in 1997).

For government-funded projects, or those relying entirely on the General Appropriations Act, the procedure is laid out in Republic Act No.9184 (otherwise known as the Government Procurement Reform Act of 2003). This was elaborated further by its Implementing Rules and Regulations.

For PPP projects, the governing law on tendering and evaluation is Republic Act No. 7718 (enacted in 1993, and often referred to as the BOT Law). The Implementing Rules and Regulations for the BOT Law was recently amended (July 2012) to streamline the process and address some problems encountered in the past – mainly on unsolicited proposals that skirted the transparency inherent in an open-tender.

For the LRT-1 CEP, the bidding for the civil works component is within the framework of the BOT Law. On the other hand, the bidding for the electromechanical components – which will be funded by JICA – will follow the Government Procurement Reform Act. There have been problems encountered in the past, when the rules of the ODA funder differed somewhat from the local ones. These have been ironed out, and the lessons provide precedents for resolution of future conflicts.

Traditional procurement entails detailed engineering design by the government prior to bidding, although the North Loop project deviated from this model. In the case of PPP deals, the usual scheme is a design-build arrangement in consonance with the full responsibility of the concessionaire. The LRT 1-CEP will be on design-build scheme.

10.2.2 Pre-qualification

The pre-qualification and evaluation of bids are nearly identical in the two aforementioned laws. For large-ticket projects, the pre-qualification stage precedes the submission of technical proposals. The financial proposal is submitted simultaneously with the technical proposal on the deadline stipulated by the PBAC (Prequalification, Bid and Awards Committee), but is opened only after the technical proposals have been evaluated and only for those bidders whose proposals are deemed complying or satisfactory.

Prequalification revolve on 3 criteria: Legal, Track Record, and Financial. The first deals with the bidder's business registration, including license or accreditation to engage in construction activities. The second deals with the accumulated experience of the bidder in undertaking similar projects, while the third examines the prospective bidder's equity and borrowing capacity.

The tendering for the civil works component of the LRT-1 CEP has commenced, when the DOTC issued invitation (sometime April 2012) to interested parties to submit pre-qualification documents. Originally, the deadline for submission was 22-August. DOTC extended the deadline to 28-September. Apparently, the financial hurdle was also lowered – presumably in response to comments of prospective bidders. The threshold values for each of the 3 major criteria will only be known when the Terms of Reference are issued to the prequalified bidders sometime in late October 2012 or early November (assuming the 28-Sept deadline on prequalification holds).

What is causing statics in the prequalification stage is the track record or experience. It should have been issued immediately after the issuance of invitation – rather than near the deadline. Since the winning bidder will operate and maintain the system, it is but natural to evidence its capability in this area. However, given the shallow rail sector in the Philippines, there are no private local entities who can claim such experience.

The prospective bidder is thus constrained to partner with a foreign entity. But apparently, the threshold value for the latter entity is focusing on minimum volume of passengers that it had handled, rather than scale of the network operated. The initial requirement was 50 million passengers annually; a reduction to 30 million (~80 thousand/day). In many developed countries, LRT systems tend to attract smaller traffic than those of Metro Manila even if they are of the same or larger scale. **Table 10.2-1** provides some comparison of selected LRT systems worldwide. The indicator is "Annual traffic density" which is defined as the number of passengers who, on average, travel over each kilometer (or mile) of system length during the calendar (or fiscal) year. It is the product of annual ridership and average distance travelled by each passenger (ATD), divided by system length.

Following the preceding logic, the operator of the Nagoya LRT will not be qualify, even if its network is larger than the 3 lines of Metro Manila combined.

Table 10.2-1 Rail Traffic Densities in Selected Cities

City/System	Annual Pax (millions)	Traffic Density (million/km)	Length (km)	Year
Nagoya, Japan (LRT/Tram)	112.7	5.8	77.4	1970
Fukuoka JR (Metro)	103.1	14.8	115.9	2005
Lyon, France (LRT Line 1)	14.3	4.9	8.7	2007
Ludwigshafen, Germany (LRT)	2.0	1.0	16.3	2002
Oslo, Norway (LRT)	30.4	2.0	38.3	2006
Ottawa, Canada (LRT)	13.0	3.5	29.4	2009
Manila LRT 1	156	10.1	15.3	2010

Source: compiled by the Study Team from internet, www.publictransit.us/ptlibrary

In addition, the technical committee working on the prequalification is entertaining the idea of requiring ISO-certification – which, by itself, looks good but maybe impractical as the certification cannot automatically be conveyed by a parent foreign firm to a newly-formed subsidiary in the Philippines.

The DOTC has tapped the International Finance Corp. through the state-owned Development Bank of the Philippines as Transaction Advisors. Their main remit is to ensure a successful and open tendering process that will be also be bankable.

The Government expects to complete the bidding process by early next year, and award by June 2013. This is 6 months behind its earlier indicative timetable. Assuming an optimistic 6-month period for financial closing, the construction can commence in the 1st quarter 2014. With the presidential pronouncement of completion by 2015, the construction period is effectively shortened to 24 months.

10.2.3 Evaluation

The criterion for the winning bidder is highest concession fee to the government. The fee can be construed as rental payments for existing assets (LRT 1 system from Baclaran to North Avenue).

Since the market risk will be assumed by the winning bidder, it behooves the Government to grant the latter freedom to set fares. The initial information memorandum for prospective bidders is somewhat re-assuring in that it obligates DOTC and LRTA to “ensure the application of the fare adjustment formula prescribed in the Concession Agreement and provide compensation in the event of disallowances of authorized computed tolls.”

10.3 Special Conditions on Contract

The draft contract or concession agreement is not yet available. It may be issued simultaneously with the release of the Terms of Reference or shortly thereafter. It is therefore difficult to speculate on what the special conditions would be.

However, the delicate portion will likely hinge on periodic evaluation of the concessionaire’s performance during the life (>30 years is contemplated) of the contract. As stated in the information memorandum to prospective bidders “A performance regime related to system reliability and availability, customer care and security, among others, will be defined in the Concession Agreement and payment will be varied based on performance measured under a variety of Key Performance Indicators, under the pain/gain philosophy of a PPP contract.”

Requiring a minimum level of fleet availability looks reasonable, if the rolling stocks and equipment had been supplied at the same time by the concessionaire. Considering that there are 3 generations of incompatible rolling stocks, the operational conditions of which are uncertain, it may turn out to be unreasonable at the beginning. It becomes problematic in the absence of historical records of inventory and maintenance logs for each of the 139 or so LRVs in its fleet. In short, the new operator will be coming in partly blind about the conditions of the fleet that it would assume control from day one. Fortunately, this is recognized in the Information Memorandum which provides for a KPI (key performance indicators) holiday of an indeterminate period.

Several pieces of rehabilitation works have also been commenced, separate from the LRT 1 CEP. This includes the 2nd cycle of rehabilitation of the 1st generation LRVs, as well rail replacement, replacement of high voltage switchgear of Rectifier Substations 1-9, replacement of parapet walls and repair of gantry anchor bolts. The concessionaire will become responsible for the eventual performance of these assets for which it has no prior involvement. The only obligation of LRTA is to "ensure timely delivery of the rehabilitation works on the Existing System under the LRT Safety, Reliability and Capacity Improvement Program." As of September 2012, delays have already been observed on these sub-projects.

A good transit operator would take the effort to standardize its rolling stocks, so as to minimize inventory and improve fleet availability. Therefore, it is expected to retrofit or modify its inherited fleet of LRVs as the years pass by. The three generations of LRVs are incompatible, with very few spare parts that are swappable or interchangeable. This project will add a 4th generation LRVs, which hopefully will be compatible with the earlier ones. The problem, however, is which of the earlier ones will it share commonality. It maybe turn out to be more economical to replace completely some of the old LRVs, due to absence of original equipment suppliers of parts. This project does not have the time nor mandate to examine this issue. A practical solution is to consult the long-term operator or concessionaire in crafting the final specifications for the 4th generation LRVs and which of the old LRVs can be junked.

And when the concessionaire opts to modify the old units in the future, will this require prior permission by LRTA (as owner) or the original equipment supplier? It would be desirable if the operator is granted more degrees of freedom in such a decision.

10.4 Comments on the O&M Scheme

In imposing a requirement to prospective bidders of prior experience in operating a similar urban rail transit system, the Government has recognized the need to professionalize the O&M of Line 1. It has stated years of experience for the personnel to be assigned by the winning bidder. It is ironic that it has not imposed these strict conditions on itself.

Considering the institutional weakness in the public sector, transferring the operations and maintenance of a highly-demanding and technically-complex enterprise to the private sector is a step in the right direction. This was done at the outset, when LRT Line 1 was built and completed in 1983. It was not followed in subsequent lines (Line 2 and 3). Thus, a corps of qualified rail personnel has not been developed or nurtured over the years. To date, the few qualified ones can be traced to the early O&M entity (Metro Transit Organization) for LRT 1.

Because of the inherent financial non-viability of urban transit, a purely private endeavor would fail (e.g., the Bangkok Skytrain, KL's LRT lines, the English Channel Tunnel). Therefore, a major cost of the project has to be borne and paid for by the Government. This split is being followed in the LRT 1 CEP – except for the reversal of roles. Best practices in rail concession suggest that the rolling stock be under private sector responsibility and the track infrastructure assumed by the public sector. The government has opted to fund the electromechanical components via JICA for two reasons: (a) the long tenor and low interest rate that would apply, and (b) most, if not all, of these items are imported anyway and therefore

ideal for foreign funding. To mitigate the downsides of this kind of split, it is recommended that the private concessionaire be consulted in the specification and eventual procurement of these items.

Under an O&M structure, the incentive for the concessionaire is to maximize profits – balancing fare levels against demand elasticity and on-street competition. This minimizes the need for tighter audit and regulation by LRTA/DOTC. However, the Government must resist prescribing very detailed indicators of performance (KPIs) that equates to having a “back seat” driver. This was the case with the 1980s O&M contract for LRT 1.

CHAPTER 11

INSTITUTIONAL ISSUES TO IMPLEMENT THE PROJECT

CHAPTER 11 INSTITUTIONAL ISSUES TO IMPLEMENT THE PROJECT

11.1 Institutional Issues from the Viewpoints of Construction, O&M, Safety, Personnel and Financial Matters

11.1.1 Project Management

The unanswered question is: who will be responsible for Project Management? In the past, this has not arisen because LRTA was always given the benefit of the doubt. It has organized the project management team, with considerable assist from international Consultants. DOTC has expressed a preference to centralize implementation and to assume lead responsibility. If it takes this path, then it must designate a point man as early as possible, and to commence the tendering process for Consultants to support the separate execution of the civil works and electromechanical components. It has not yet done so. If there would be two sets of consultants, project coordination becomes messy and inherently problematic. Clearly, the integration challenge for this project – with hybrid PPP - is more formidable than what LRTA or DOTC has ever faced in the past.

A suggested project structure is illustrated in Figure 11.1-1. It draws on successful infrastructure project implementation in the past, where an Inter-Agency Committee is set up (to function like an ad hoc Board of Directors) that guides the Project Manager. It is proposed that the Committee consists of 5 persons, to be chaired by DOTC, to include LRTA Administrator, a DPWH representative, a MMDA representative, and a civil society/private sector representative.

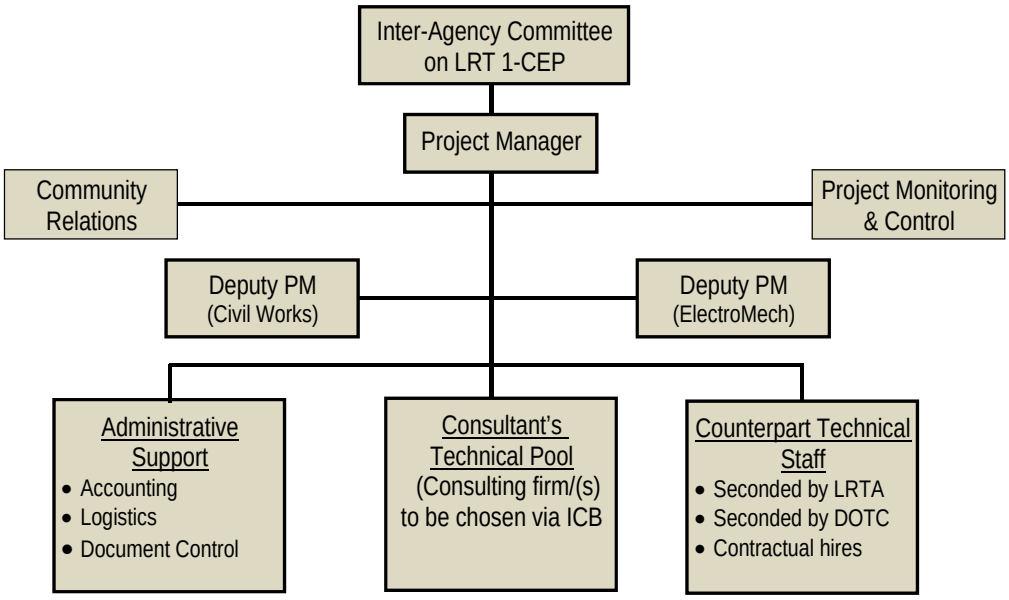


Figure 11.1-1 Suggested Organizational Structure of Manila LRT Project

To minimize conflicts within the project organization, there should only be one Consulting group to be hired – rather than separately for the Civil Works (PPP component) and for the Electromechanical (ODA component). The funding for this common project management support team should be sourced from JICA. It shall be headed by a Team Leader with deep experience in light rail transit construction. Selection of the consulting firm should be commenced as soon as possible, so that it gets mobilized as early as the bid award. In past infrastructure projects, the Consultant was part of the technical evaluation of bids. For unknown reason, neither DOTC nor LRTA has started the process.

The preceding structure is predicated on the fact that financing of the capital cost will be borne by the private sector (in so far as the civil works component is concerned), while JICA is financing the other component. The ROW acquisition is funded by LRTA. It is still unclear as to who will provide the budget for Project Management and its consultants. This should, preferably, be funded by JICA and LRTA.

It can be presumed that the PM Consultant will be responsible for the formulation of technical and performance specifications, as well as preparation of tender documents, for the different packages of the Electro-mechanical component. Although still unclear, preferably it should also be tasked to review the design and construction plan of the civil works component. This would obviate interface problems and buck-passing, in the event of defects or failures during system integration test.

One of the critical responsibilities of the PM consultant is the setting of criteria and procedures to be used for testing the operational system or its major components. The Testing Phase ends with the acceptance of an operational transport system in accordance with predetermined criteria, and based on the satisfactory completion of the construction and installation and test of all subsystems and components, and their integration into a system. Tests include plant and on-site performance testing of major systems, and integration testing of the entire system in its operating environment. Since the concessionaire will be on-board at that time, acceptance of the system may have to be performed by the operator, rather than LRTA or the PM consultant. This needs to be resolved also.

11.1.2 Post-Construction Turnover

This phase of the project is often ignored or undervalued in importance, after the excitement of project completion and inauguration has subsided. They are, however, important in the long-term operation and maintenance of the system.

Of prime importance are the as-built drawings to be handed over to LRTA, as well as any warranty provided by the suppliers of Electro-mechanical components. The equipment manual and parts identification will be useful in subsequent maintenance works. Any lingering claims should be settled during the winding down phase of the project.

11.1.3 Safety Concerns

The O&M, Safety, Personnel and Financial matters are spelled out in the draft Concession Agreement. The first two topics would be transferred from LRTA to the Concessionaire. Affected LRTA personnel (approximately numbering 940) shall be initially absorbed by the winning Bidder, subject to termination or replacement after a 6-month review. Presumably, the operator would (or should) also assume the responsibility of a common carrier (particularly on its liability to passengers and potential tort claims in case of accidents).

Industrial and operational safety was the traditional concerns of transit authorities, aside from petty crimes like vandalism and snatching. Of late, the threat of terrorist attacks on transport assets have emerged as a primary security concern – especially after a number of incidents involving a bus in the metropolis, an LRV car, and an inter-island vessel. This has increased delays at stations, as the same could not be left to police authorities alone. LRTA and the concessionaire would need to assume joint responsibility for this issue, with the latter as primary implementer of a sound Safety and Security Management Plan.

It may be worthwhile to consider safety pre-emptively, by subjecting the facility designs to preliminary Hazard Analysis and Threat and Vulnerability Analysis.

Financing of the capital cost will be borne by the private sector (in so far as the civil works component is concerned) and by DOTC (for the electromechanical component). Latter, in turn, will source most of the

amount from JICA. The ROW acquisition is funded by LRTA from its corporate funds and probably with additional support from the national budget.

Fare collection becomes the responsibility of the concessionaire. However, its ticketing system maybe carved out in the light of DOTC's plan to introduce a new common ticketing system for the 3 rail lines. The tendering for the common ticketing system is yet to start, although the transaction study has already been completed in April 2012. Based on the timetable, the new AFCS provider - which would be a party different from LRTA or the LRT 1 concessionaire – would only come in by 3rd quarter 2013 and cut-over to the new ticketing would start only in January 2015 (at the earliest). Accountability and cut-off points, in the shift to a new system as well as shift of responsibilities need to be managed properly. As this is likely to occur during the period of construction (rather than upon completion of the civil works), it is suggested that responsibility for managing the transition and turnover to the new operator be assigned to somebody else within LRTA, rather than included in the project team's brief. Coordination works – more with the Concessionaire and to a lesser degree with the Project Team, would be required.

11.1.4 Long-Term Structure

The institutional framework in the long term is unclear. Formation of a Strategic Railway Authority within DOTC is stipulated in the Philippine Development Plan 2011-2016. If the Railway Authority is established either within DOTC or as a new entity, and the rail services are concession out to private entities, it would render LRTA superfluous. But nothing is being proffered on the future role of LRTA. The implementation of LRT 1-CEP will trigger the privatization thrust and move the rail sector one step closer to this long term direction. However, no similar effort is underway for Line 2 and Line 3, although there were some announcements that the O&M for Line 2 would also be privatized. Given the situation today and the public sector rigidities, it is reasonable to expect (up to the end of 2016 and the completion of Line 1 CEP), that the LRTA would likely remain as the operator of Line 2, the DOTC as operator of Line 3, and the private sector for the extended Line 1. In the event MRT-7 gets implemented, its contractual structure – and risk allocation - would be different from that of Line 1. The government will then be cast in an awkward position of applying different metrics of performance for four lines and creating a highly uneven playing field. Furthermore, the LRTA or DOTC will be a regulator and operator at the same time – the kind of combination that is considered unsound. The regulator can impose high performance standards from the Line 1 concessionaire, but cannot exact the same from itself.

Another issue that is being sidestepped, or deferred, is the long overdue financial restructuring of LRTA. It was proposed in 1996; and updated in 2007 under a JICA-funded study. Its main recommendation is to write off the unpaid debts of LRTA – debts in the form of advances made by the Treasury in payment of foreign loans incurred in the construction and expansion of Lines 1 and 2. The advances totaled Php6billion of its total liabilities estimated at PhP45 billion in 2005, and could not be repaid even under the most favourable assumptions. Recommended amount to be taken out of the books of LRTA was Php30 billion.

Ideally, the re-structuring of the railway sector should precede the expansion of the system and establish a sustainable foundation for the four rail lines. These lines will continue to entail subsidies of varying amounts – even if all of them get privatized. There is no policy on how to allocate this subsidy among the four rail operators, or where to source them.

In the case of LRT 1 system as extended to Cavite, the subsidy is upfront in the form of government-owned assets whose debt servicing will remain with LRTA. Under the concession contract, there is no other subsidy to call, unless the Government reneges on its obligation to adjust fares in a timely fashion.

In the case of MRT-3 system, the subsidy is opaque as it varies year to year – depending on the gap between fare collections and fixed lease payments. And because it is sourced from the General Appropriations Act, the amount needs to be negotiated with Congress every year.

The subsidy for Line 2 will be operational (as opposed to capital) in nature, as it would vary every year depending on actual fare collections and management efficiency of LRTA. Debt servicing for the Line 2 assets will likely fall on the Department of Finance – which guaranteed the loans and has picked up the tab in the past due to failure of LRTA to repay them.

Table 11.1-1 shows the level of subsidy to the three rail lines.

Line	2010		2011 (Forecast)		Average
	Full-cost Fare	Gov't Subsidy	Full-cost Fare	Gov't Subsidy	Fare/Pax
LRT 1 (Taft-Rizal, Yellow)	35.77	21.57	47.36	33.16	14.20
LRT 2 (Aurora, Purple	60.75	47.24	59.08	45.57	13.51
MRT 3 (Edsa, Blue)	60.03	47.73	64.38	52.08	12.30

Source: DOTC, LRT/MRT Fare Restructuring (Oct 2010)

Because the national treasury is seen as the default payer – for Line 2 and Line 3, there is no incentive to run the system more efficiently and achieve profitability. A suitable structure that will address the preceding infirmities and create a sustainable framework for urban rail transit should have the following elements:

- Privatize (O&M) Line 2 and 3, following turnover of Line 1 to the winning bidder;
- Transfer ownership of the fixed assets (i.e., track infrastructure) to the government with corresponding assumption of loan obligations;
- Transfer ownership of the rolling stocks to the private operator, or in the interim to LRTA;
- Transform LRTA into a rail strategic authority, that focuses on network planning and regulation of the 3 (and additional lines in the future) privatized lines;
- Withdrawal of DOTC from operational activities, in order to focus on its rightful role as a 'holding firm' and rail franchiser under its charter.

A short explanation for the above recommendation can be found in the ADB study on "Best Practices for Private Sector Investment in Railways" (July 2006). One of its findings was: "direct government involvement in running rail transportation services may reduce both technical and allocative efficiency. The closer government is to management, the more that decisions which affect technical efficiency (for example, staffing or investment decisions) become influenced by political patronage. In such a situation, managers cannot be held commercially accountable and incentives for technical efficiency are further weakened. Allocative efficiency may be adversely affected because prices may be set to reflect political objectives rather than costs."

11.2 Risk Analysis on the Hybrid Type PPP for LRT Extension

The Transaction Advisor for the project has provided an initial Risk Allocation matrix shown on **Table 11.2-1** below.

Table 11.2-1 Risk Allocation Matrix

Risk/Responsibility	Allocation	Remarks
Transfer of existing LRT assets	DOTC	Handed over at Financial Close, with a KPI holiday of indeterminate duration.
Traffic/Ridership	Concessionaire	No minimum traffic/ridership guarantee
Fare Adjustment Implementation	DOTC	Compensation provided for disallowance of adjustment based on agreed formula
Project Financing	Concessionaire	Private financing
Inflation & Foreign Exchange	Concessionaire	Relief provided for domestic inflation through Fare Adjust formula
ROW Acquisition & Delivery	DOTC	Free and clear, delivered by pre-agreed timeline
Design/Construction	Concessionaire	Performance Security for Construction posted in favor of the DOTC
Integration of existing Line 1 and the Southern Extension	Concessionaire	Commissioning tests to be carried into existing service provision
Delivery of Rolling Stock	DOTC	Concessionaire shall be allowed to provide inputs on the specifications required for the rolling stock
Depot Development / Satellite Depot Construction	DOTC	Concessionaire shall be allowed to provide inputs on the design/development of the depot
Operation/ Maintenance	Concessionaire	KPIs set with corresponding penalties / benefits for non-compliance/ compliance-betterment, Performance Security for Operations posted in favor of DOTC
Political Risks	DOTC	Limited events
Force Majeure (FM)	Concessionaire and DOTC	Relief provided to Concessionaire on O&M performance of obligations, procedure and mechanism for addressing impact of FM events to be provided in the Concession Agreement
Turn-over at the end of Concession	Concessionaire	At pre-agreed conditions, testing & acceptance regime included in Concession Agreement

Source: DOTC, Manila LRT 1 Project: Preliminary Information Memorandum (April 2012)

11.2.1 Risks before Construction

Before construction can commence, the winning bidder must be able to raise project financing. An event of financial closing must occur. A delay will cascade into delays in construction. Hence, it is possible for the rolling stocks to be delivered before they are needed. Conversely, there could be delays in the procurement of the latter. Similarly, the delivery of the 'rehabilitated items' which LRTA is procuring via RA#9184 could be delayed.

It is advantageous to have the winning bidder assume O&M responsibility immediately after contract signing as stated in the initial instructions to Bidders. However, if financial closing is delayed or fails,

there could be a problem of disruption considering that a new organization (with new employees and payment of separation benefits) has already been in place. Apparently, this was foreseen as the Information Memorandum now states that turnover occurs only after financial closure.

The transition from award to assumption of O&M responsibility could also be disrupted by labour actions, as what happened in previous instances of privatization. Existing employees appear to be demanding a golden parachute, the cost of which may exceed what the winning bidder had budgeted for. Probably, the amount will be fixed, so that the same can be factored into the financial equation of the prospective bidders.

11.2.2 Risks during Construction

During construction, the biggest risk in the above-mentioned project structure is the high probability of a mismatched in the timing and delivery of project components.

For the civil works, the right of way issue is on top of the list. In 2011, LRTA has stated that it would be able to complete 100% the ROW acquisition before end-2012. The acquisition of relocation sites by the Cavite provincial government has elicited adverse opinions from the Commission on Audit.

During project construction, the division of responsibility between LRTA and DOTC is still unclear. As currently structured, the tendering and contract signing will be with DOTC – which may be justified on grounds that it has the budget for it. On the other hand, LRTA is a chartered GOCC that owns the assets to be 'rented out' to the private concessionaire. It has also prior experience in project implementation of Line 2 and the Line 1 North Loop. The separate execution of the civil works components and electromechanical will add another layer of complexity into the organizational project management of LRT 1- CEP.

11.2.3 Risks after Completion

The legal character of the concessionaire vis-à-vis LRTA is a major risk. If construed as a public utility operator, then it needs a franchise. The initial information to prospective bidders considers the same as a public utility entity. However, it also takes pain in justifying that such a franchise will not be required nor granted; the concessionaire becoming merely an agent or contractor of LRTA. This could open the door to legal challenges, or stall project financing (as what happened in the case of new SLEX toll road project). It also creates some possible contradiction as the concession is supposed to be signed by DOTC, and not LRTA. In such a situation, the concessionaire becomes an agent of DOTC and not LRTA as the two government bodies are deemed two separate legal entities. A practical compromise, although not ideal, is for the two to become joint signatories into the concession agreement. Ideally, DOTC should grant the 'franchise' via a certificate of public convenience and the LRTA as owner of the assets granting beneficial use thereof to the concessionaire. Payments for the lease of such assets – which will be the bidding criterion – should accrue to LRTA (and not DOTC).

The laws governing public utilities are the following:

1) Constitution – Article XII, section 11 states: "No franchise, certificate, or any other form of authorization for the operation of a public utility shall be granted except to citizens of the Philippines or to corporations or associations organized under the laws of the Philippines, at least sixty per centum of whose capital is owned by such citizens; nor shall such franchise, certificate, or authorization be exclusive in character or for a longer period than fifty years. Neither shall any such franchise or right be granted except under the condition that it shall be subject to amendment, alteration, or repeal by the Congress when the common good so requires. The State shall encourage equity participation in public utilities by the general public. The participation of foreign investors in the governing body of any public utility enterprise shall be limited to their proportionate share in its

capital, and all the executive and managing officers of such corporation or association must be citizens of the Philippines."

2) Executive Order No. 603 (charter of LRTA) – Section 4 lays down the powers of LRTA; one of which states "to contract any obligation or enter into, assign or accept the assignment of, and vary or rescind any agreement, contract of obligation, necessary or incidental to the proper management of the Authority".

3) The implementing rules and regulations of the BOT Law, Section 12.2 of which states: "Grant of Franchise. - In case of a project requiring a utility franchise, the winning project proponent shall automatically be granted by the appropriate Agency/LGU the franchise to operate and maintain the facility, including the collection of tolls, fees, rentals, and other charges in accordance with the schedules stipulated in the approved contract. The original franchise period as stipulated in the contract agreement may be extended, as may be authorized by the concerned authority, provided that the total franchise period shall not exceed fifty (50) years. Provided further that the extension and the new terms and conditions of the contract will be subject to ICC's no objection clearance."

4) Executive Order No. 125, s1987 (charter of DOTC) stipulates that one of the powers of the Department, under section 5 (g) is: "issue certificates of public convenience for the operation of public land and rail transportation utilities and services."

5) The Public Service Act (CA no. 146 as amended) clearly includes railways as a public utility.

11.2.4 The Fare Issue

The biggest risk during operation is the inability of LRTA and DOTC to allow periodic fare adjustments. On several occasions since 1983, it has turned timid in raising fares. The most recent attempt (in 4th quarter 2010) was junked by Malacañang. Legally, the LRTA Board has the power to adjust fares. As stated in its charter, the LRTA has the power "To determine the fares payable by persons travelling on the light rail system, in consultation with the Board of Transportation" (which was replaced by LTFRB). In practice, it is decided or approved by the President – thus making the fare-setting process a political exercise. There is public pronouncement again that it would be adjusted in early 2013. Next year is not opportune, because it precedes and is too near the local elections in May 2013. Under the terms of the draft concession agreement, the government will compensate the private operator for the un-earned revenues - in case of delays or deferment in the fare adjustment. The mechanism for this compensation should be clarified, as it could be contentious – especially, if the private operator is merely an agent of LRTA. An equitable arrangement is for the operator to have the option to offset the amounts from his periodic lease payments.

The fare adjustment formula has the advantage of simplicity – indexed to domestic inflation. It disregards foreign exchange fluctuation. The latter is favourable to the concessionaire under present climate of peso appreciation, but becomes adverse when the peso depreciates. Nearly all the spare parts – especially, the big ticket items - of the system are imported. It is also unclear how the domestic inflation correlates with the price of electricity, which comprises about 25% of direct operating expenses. Electricity is outside the control of the transit operator.

The Concessionaire will be responsible for operation and maintenance for 25 years or more, and is, therefore, incentivized to optimize capital expenditure decisions with the knowledge that many design decisions will affect operations. However, it is DOTC who will be responsible for the acquisition of the Light Rail Vehicles (LRVs); the operator will therefore confront a significant risk. For the existing LRVs, it is LRTA who will convey the equipment – in varying conditions - to the operator.

The risk allocation matrix is silent on the ownership of the civil works components built by the concessionaire with private funding. It is proposed that this be transferred to DOTC, upon completion, to be consistent with the long-term urban rail structure intimated earlier. Also, this is to obviate taxation of these assets by local government units – as what transpired in the case of MRT 3. Accordingly, the obligation for property insurance will have to be assumed by DOTC in accordance with government policies. The amount is not insignificant, but minimal in comparison to the avoided tax impositions.

CHAPTER 12

RECOMMENDATION FOR RAILWAY DEVELOPMENT IN THE PHILIPPINES

CHAPTER 12 RECOMMENDATION FOR RAILWAY DEVELOPMENT IN THE PHILIPPINES

From the following 3 view points, we would like to recommend about the future railway development in Philippines. The recommendations were accepted by DOTC of our counterpart, and the letter is attached in next page.

(1) Review of tender documents (draft)

In Private portion of LRT Line 1 extension project, the extension section is planed through weak ground along the coast, and the measures to earthquake-proof, flood control, etc. are essential. We advised to the Ministry of Transportation about appropriately preparation of tender documents, and recommended with Japanese technologies and experiences.

(2) Assistance for preparation of railway technical standard (draft)

In Metro Manila, further development of urban railway network is required. On the other hand, a railway technical standard has not been established including the viewpoint of earthquake resistance, etc., so we recommended preparation of railway technical standard (draft).

(3) Networking of urban railway

To promote the urban railway network in Manila metropolitan area, we examined and proposed especially focusing the urban railway from the technical viewpoints.

Republic of the Philippines
DEPARTMENT OF TRANSPORTATION AND COMMUNICATIONS

27 June 2013

MR. SHINYA NAKAMURA
General Manager
Oriental Consultants Co., Ltd.
Railway & Mass Transit Department
Global Consulting H.Q.

Dear Mr. Nakamura:

This refers to the **JICA Study for Enhancement of Railway System in Metro Manila** wherein the Technical Recommendation for Technical Standard in the Philippines and the Concession Agreement of LRT Line 1 was presented to the Department.

We are glad to note that the railway technical standard which you prepared and presented as part of the aforesaid study is significant to the development of the railways in the Philippines. We would like to discuss how to utilize the proposed standard with the agencies concerned to serve as reference in our future railway projects.

Thank you and more power.

Very truly yours,

JOEL R. MAGBANUA
Chief, Rail Transport Division

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12.1 Technical Recommendation for the Concession Agreement of LRT Line1

1. Background

We would like to recommend the detail of standard for the following viewpoints.
- To secure compatibility with the existing railway.
- To ensure the safety of railway facilities to the natural disaster of the Metro Manila coastal.

2. Recommendation to secure compatibility with the existing railway.

2.1 Horizontal Curve

In the main line bigger curve radius is more preferable so that train will not reduce the speed and ride quality is better. In the depot operating speed is slow and there are no passengers inside the train curve radius can be much smaller. Minimum radius of the curve shall be defined in the main line and in the depot individually and rolling stocks shall be designed to pass the minimum radius of the curve in depot.
Actual curve radius of Baclaran Depot (existing depot) is less than 30m.
In Line 1 minimum radius of curve is defined 100m in main line and 25m in the depot.
Rolling stocks of Line 1 is required to have the capability to pass 25m radius curve without problem.

2.2 Gradient

Considering the smooth train operation gradient of the line is the smaller the better. However steep slope is often required because of landscape or grade separation with other traffic mode. When grade is too high train will be stocked on the slope. Maximum gradient shall be determined by the train performance.
When a train becomes defective on the slope it will be rescued by other train. Train shall be capable to push other train at maximum gradient. When it is main line defective train is possibly full loaded. When it is side track such as connecting line of depot to main line train are supposed to be empty therefore maximum gradient at side track can be higher than main line.
In Line 1 maximum gradient at existing line is 2.5 % for main line and 4% for connecting line. It is recommended to define these values as maximum gradient for Line 1 because performances of rolling stocks are only verified with these values. However 2.5% is rather low for urban railway and when there is necessity to construct higher gradient due to land condition performances of rolling stock shall be recalculated to confirm that rolling stocks is capable to climb higher gradient.

3. Recommendation to ensure the safety of railway facilities for the natural disaster of the Metro Manila coastal.

We submitted the following document to DOTC, “Technical recommendation for the Concession Agreement”, “Seismic Design Procedure” and “Design Standards for Railway Structure and Commentary (Seismic Design)” are shown from next page.

Technical recommendation for the Concession Agreement

1 Earthquake

1.1 Large displacement and deformation of structures

Massive damage such as destruction and collapse of a bridge caused by large displacement and deformation of structures are occurred. Additionally, there is a possibility of derailment of running train caused by earthquake motion.

Issues to Avoid or Reduce Damage

1) Understand earthquake motion

2) Implement railway facility plan to satisfy required seismic performance

3) Compute behavior of railway structures caused by earthquake motion, and confirm required safety and performance

4) Secure running safety during earthquakes against level 1 earthquake motion

Solution and Procedure for Issues

1) Carry out earthquake-resistant design with applying predictable earthquake force, and then check earthquake-resistant performance of each part, and secure the proof strength at last.

a) There are two types of seismic motions: oceanic seismic ground motion; and terrestrial near-fault earthquake.

A design of seismic ground motion is set based on the type of seismic ground motion. Yet, numerical analyses are conducted to determine a design for both oceanic seismic ground motion and terrestrial near-fault earthquake.

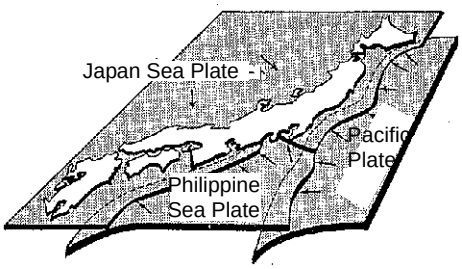


Figure: Plate boundary where oceanic earthquakes occur

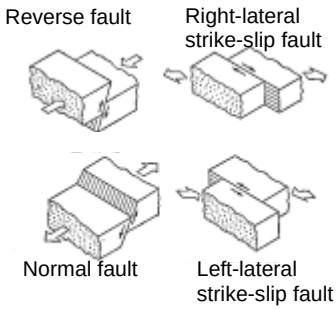


Figure: Types of earthquake fault

b) As the design systems are transitioning to a performance examination type in the recent years, there is a trend to categorize design seismic ground motion into two levels depending of its scale. This trend is especially apparent in Japan and the United States.

The railway standard in Japan specifies two types of seismic ground motion, L2 seismic ground motion and L1 seismic ground motion depending on the scale and frequency of seismic ground motions. That is, L2 seismic ground motion includes two types of seismic ground motions, “oceanic seismic ground motion: spectrum I” and “terrestrial near-fault earthquake: spectrum II”. Meanwhile, L1 seismic ground motion includes “oceanic seismic ground motion”.

c) The design system of performance examination type needs to designate necessary performances for a structure. Earthquake resistance performances can be easily understood when performances are designated based on levels of damages and difficulties in repairing or reinforcing the damages. Design systems in the U.S. and Japan are based on such aspects.

The figure below describes an example of earthquake resistance performance of the railway standards in Japan.

Earthquake resistance performance of structures

Earthquake resistance performance I:
A structure can retain its functions without repairing damages after an earthquake, and no major displacement is generated in an earthquake.

Earthquake resistance performance II:
A structure requires repairs after an earthquake, but the damages can be quickly repaired.

Earthquake resistance performance III:
The overall structure does not collapse in an earthquake.

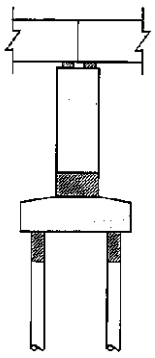
Damages to structural members

Damage level 1:
No damage
Damage level 2:
Repairs are necessary in some cases.
Damage level 3:
Repairs are necessary.
Damage level 4:
Repairs are necessary, and replacement of members is necessary

Stabilization of foundations

Stabilization level 1:
No damage (Applied load is less than a bearing capacity.)
Stabilization level 2:
Repairs are required in some cases.
Stabilization level 3:
Repairs are necessary. Reinforcement or realignment of structures is also required in some cases.

Figure: Earthquake resistance performance of bridge supports and elevated bridges



: Damaged sections

Figure: Image of damaged sections of a bridge support

Table: Repair methods for damage levels

	Damage level	Repair method
Damage level 1	No damage	No repair (measures to improve durability if necessary)
Damage level 2	Repairs are necessary in some cases.	Crack injection or repairs of cross sections if necessary
Damage level 3	Repairs are necessary.	Crack injection, repairs of cross sections, correction of hoop reinforcement if necessary
Damage level 4	Repairs are necessary, and replacement of members is necessary in some cases.	-Crack injection, repairs of cross section, correction of hoop reinforcement -Replacement of structural members if axial reinforcements or steel frames are significantly distorted.

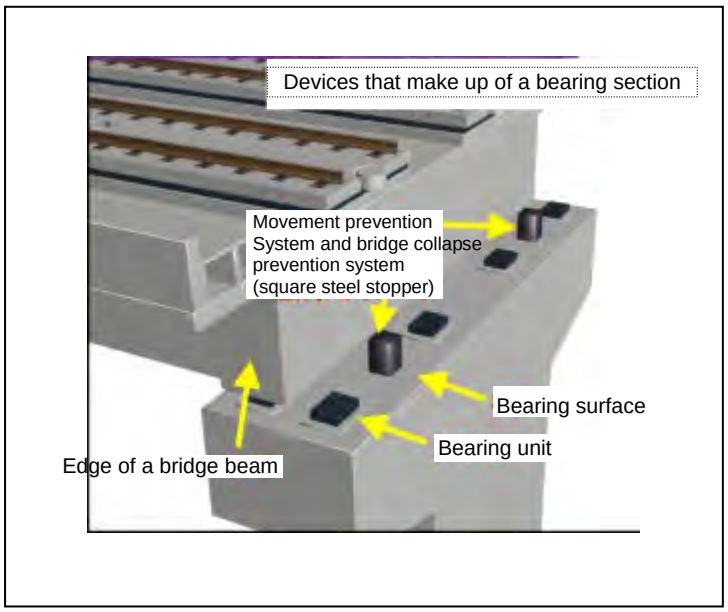
Table: Earthquake resistant performances of bridge supports, level of damage to members, and foundation stabilization level

Structure	Earthquake resistant performance I	Earthquake resistant performance II	Earthquake resistant performance III
Level of damage to members	1	3	3
Foundation stabilization level	1	2	3

d) Japan is a country with frequent earthquakes, and earthquakes have hit trains during service hours. Thus, the railway standards in Japan provide limits to displacement of railway tracks to ensure the safety of driving trains during an earthquake.

2) Secure the anti-collapse device or frame, even when sub-structure or bearing part of bridges are destructed/or deformed severely

Ideally, railway facilities are capable of securing the safety during an earthquake and immediately resume train services after an earthquake. Quick restoration of train services requires measures to prevent fatal damages such as collapse of bridges. Bridge collapse prevention system is a measure to have devices to prevent bridges from falling in advance. An example of a bridge collapse prevention system used in Japan is shown in the figure below.



1.2 Ground liquefaction

Damage such as subsidence, inclination and destruction of railway structures, or damage of roadbed are caused by ground liquefaction. Also, settlement of ground surface after ground liquefaction is occurred.

Issues to Avoid or Reduce Damage

1) Understand earthquake motion and liquefaction damage caused by earthquake motion

2) Implement railway facility plan including foundation works considering impact on railway facilities

Solution and Procedure for Issues

1) Assessment of ground liquefaction

Assessments of ground liquefaction are compared by calculating “the force that causes ground liquefaction” and “resistance to ground liquefaction” which are obtained based on terrain conditions and soil conditions. Preventive measures are necessary if the force is higher than the resistance as a result of a comparison.

2) Foundation types and soil improvement according to soil characteristics

Major examples of measures to prevent ground liquefactions depending on conditions of a target ground are listed below:

Increased density: Sand compaction piling method
Increased resistance against ground liquefaction: Pre-loading method
Ground coagulation: Ground improvement method
Decreased saturation level and increased effective stress: Deep well method
Reduction and dispersion of excess hydrostatic pressure: Drain method

2 Typhoon, Cloudburst

2.1 Flood

Frequent occurrence of high-water floods submerging houses are caused by flooding.

Issues to Avoid or Reduce Damage

1) Set location and specification of bridge, pier and abutment on river

2) Implement plan for railway structures understanding and considering effect of water pressure, collision with driftwood, and scouring of foundation

Solution and Procedure for Issues

1) Investigate high-water level of each river, and secure overhead sufficient clearance between girders and high water flow level

Girders of a bridge should be located higher than a high-water level (HWL).

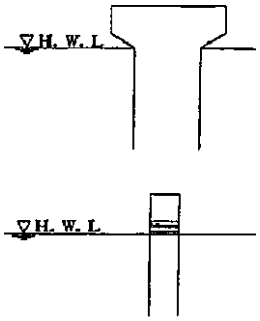
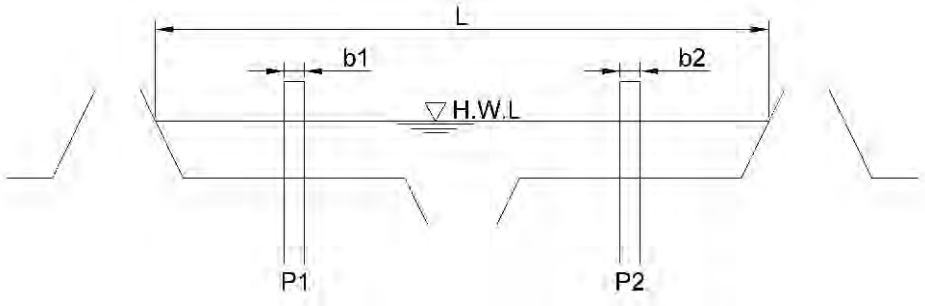


Figure: Shape of a bridge support and a position of high-water level

2) Arrange a bridge to meet a river at right angles not to obstruct water flow

Bridges should be placed at a right angle to a river flow based on the perspective that a bridge crossing a river shall not impede the river flow.

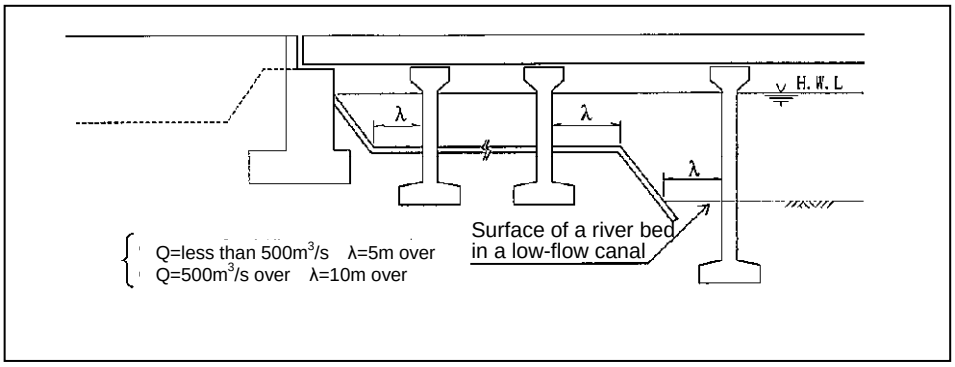
Also, the width of bridge supports to the width of a river (river width blocking rate) is reduced to decrease obstruction to the flow.



$$\text{River width blocking rate} = \frac{b1+b2}{L} \times 100 \quad \cdots\cdots (\%)$$

3) Locate a bridge in high place where high-water flow is not discharged

Positions to install bridge supports are examined so that the river flow would not be impeded. The figure below describes the standard installation positions in Japan.



4) Cross section of substructure shall be less water resistance

The horizontal cross-section of bridge supports installed in a river should be oval which is as narrow as possible or similar shapes. In addition, the direction of the longer diameter should be the same as the flow of a river. The figures below describe the above concept and an example of an actual bridge.

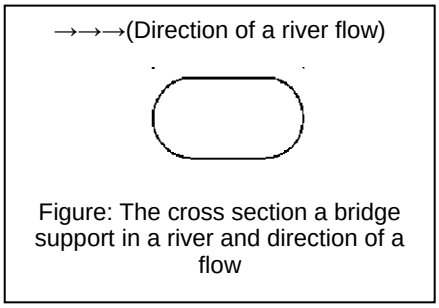


Figure: The cross section a bridge support in a river and direction of a flow

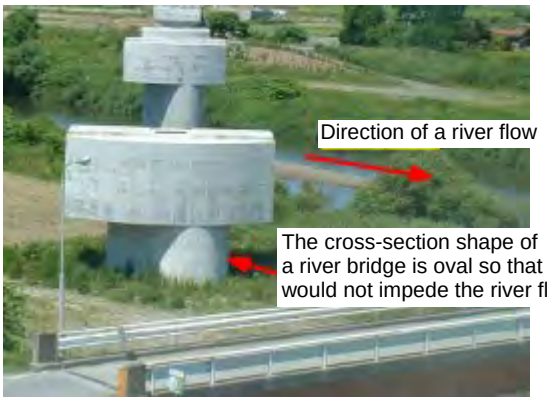


Figure: Actual example of a bridge support in a river (skew bridge)

5) Footing of bridge shall be resistant against scouring

The foundation of a river support installed in a river should be placed to a sufficient depth so that it would not be scoured by the river flow. The figure below describes standards in Japan.

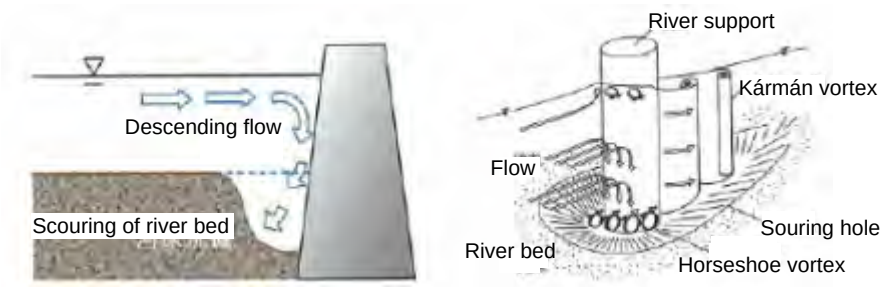
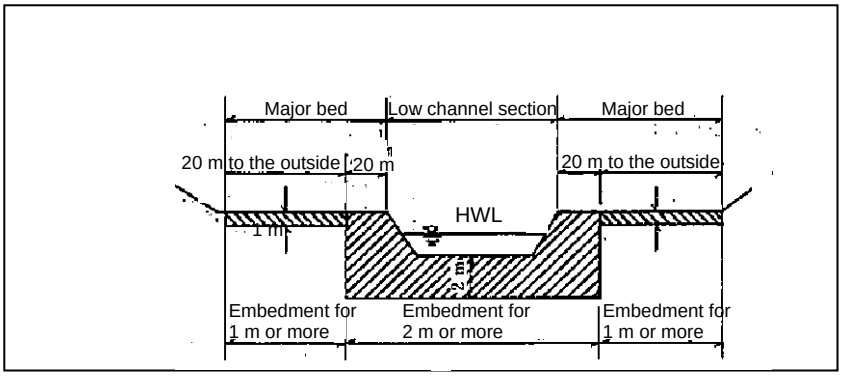


Figure: Flows at the front of a structure and surrounding flows around a pillar-shaped structure



Issues to Avoid or Reduce Damage

Implement railway facility (station, depot, and substation, etc.) plan considering measures to prevent submergence

Solution and Procedure for Issues

1) The most suitable location for railway structures

To avoid the cost increase caused by flood damage and land preparation, examine the most suitable location considering historical records of flood and ground information.

2) Secure the sufficient height of formation level against submergence in planning of land preparation or embankment

To avoid the submergence damage caused by flood, understanding the flood height from the historical records and set the height of formation level securing the sufficient height.

3) Examine the most suitable structure type for railway facility considering the locational conditions;

a) Selection of structure type

Select the most suitable structure type to avoid the submergence damage caused by flood considering the economical efficiency. Reinforced embankment retaining wall containing the planar reinforcement is suitable for high water level by flood, and is also high shockproof and high safety level rather than existing structure.

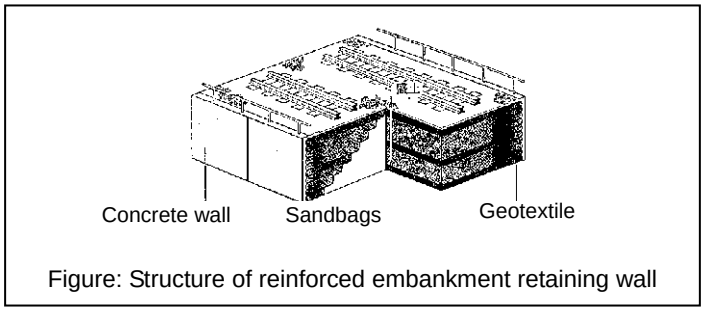


Figure: Structure of reinforced embankment retaining wall

b) Implement a geographical survey and appropriate soil improvement, if bearing capacity is weak because of wetland

To avoid the risks such as destruction and subsidence of structure owing to weak ground, implement a geographical survey and the necessary measures.

Table: Geographical survey for weak ground

Item	Survey / Test
Stratum structure, Ground water level	Boring survey
Particle size distribution	Particle size test
Unit volume weight	Unit volume weight test
Consolidation degree	Consolidation degree test
Cohesion, internal friction angle	Uniaxial compression test, triaxial compression test

Table: Measures for weak ground

Method	Typical method name
Accelerating consolidation	Presser embankment, Preload
Compaction, tamping	Sand compaction pile
Surface stability	Substitution, surface ground improvement, insole network, chemical grouting
Deep mixing process	Mechanical stirring improvement, high-pressure jet stirring improvement

Following figure shows the typical measure for weak ground of “ensuring the bearing capacity using the sand compaction pile method”.

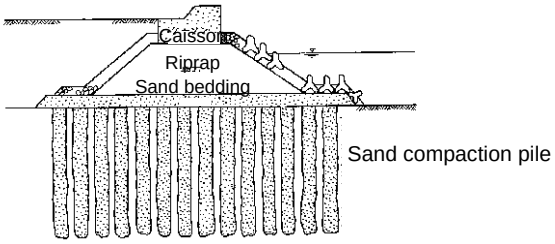


Figure: Ensuring the bearing capacity using the sand compaction pile method

c) Consider strengthening embankment slope based on the assumption of damage due to a river or sea flooding nearby

The grid cribwork is the typical method for protection of slope.

d) If the above mentioned solutions are not sufficient to prevent the damage, consider establishment of cut-off wall/door

Following figures show the example of cut-off wall.

Figure: Example of cut-off wall (electrical facility)

2.2 High level tide

Destruction of shore protection and road/house submergence are caused by high level tide.

Issues to Avoid or Reduce Damage

Predict high level tide, and implement railway facility plan considering effect of shore protection and coastal bank

Solution and Procedure for Issues

1) Estimate highest tidal level based on previous data

The highest tidal level is estimated based on storm surge data from the past.

2) Railway structures shall be resistant to storm surges.

Reinforced retaining walls in which a sheet-like reinforcement is installed have high earthquake resistance and safer than conventional soil structures. The photographs below show an example in which a sea wall that was damaged by a typhoon was restored with a reinforced retaining wall. The restored wall satisfies required performances against flooding, of course, and wave forces and oceanic waves.

Figure: Seawall damaged by a typhoon

Figure: Restoration of seawall damaged by a typhoon using reinforced retaining wall

3) Secure the sufficient height of formation level which is higher than highest tidal level

The height of an installation surface should be higher than the highest tidal level to prevent railway facilities from flooding.

4) Consider strengthening embankment slope and establishment of cut-off wall, in case that damaging and submerging railway facilities are predictable

Photographs below describe examples of tidal gates installed at areas with risks of flooding caused by high tides.

Figure: Example of a tidal gate (railway)

Figure: Example of a tidal gate (railway)

2.3 Landslide, Falling rock

Destruction, deformation of railway structures, and derailment and overturn accidents, etc. are caused by landslide and falling rock.

Issues to Avoid or Reduce Damage

1) Predict peak rainfall considering abnormal weather, and scale and frequency of landslide, falling rock around railway facilities

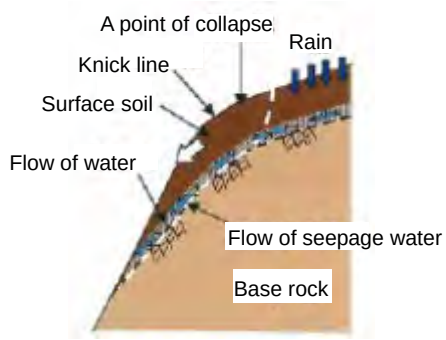
2) Method of confirmation to take measures for preventing the occurrence of landslide and falling rock

Solution and Procedure for Issues

1) Investigations at areas with risks of landslide and falling rocks are conducted to forecast damages.

Landslides occur at areas where seepage water is flowing in the ground. Weathering of the ground gradually progresses as the seepage water passes through the ground, decreasing the cohesive force of the ground and lowering the searing strength, resulting in collapses of the ground. Landslides can be forecasted by calculating rotational slips based on ground investigations. Meanwhile, falling rocks are assessed by conducting on-site investigations.

Figures below describe conditions which are prone to landslides and falling rocks.



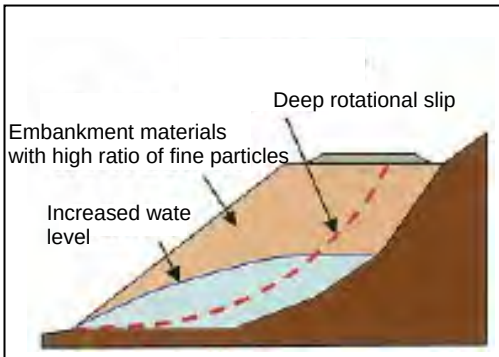


Figure: Example of a collapse of a slope

2) Take measures to prevent landslide and falling rock in a hazardous area

One of the measures to prevent landslide is to install piles as if skewering into a rotational slip to reduce the movement of soil using the bending rigidity of the piles.

Preventive measures applied on the source of falling rocks are as follows:

a) Cut slope
b) Removal of loose rocks
c) Foot protection
d) Rock anchoring
e) Covering of surfaces
f) Installation of wire roles

The photograph below describes an actual example of embedding method and installation of wire ropes.

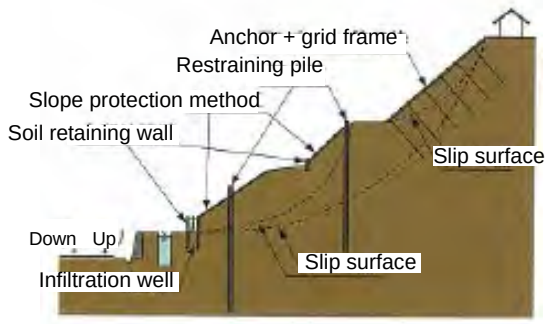


Figure: Landslide prevention measures using restraining piles

Figure: Foot protection and installation of wire ropes

3) Construct protection equipment to minimize damage

There are the following five types of measures applied on slopes and at the edge of railways.

a) Protective mesh from falling rocks
b) Protective fence from falling rocks
c) Protective wall from falling rocks
d) Covering of falling rocks
e) High energy absorption fence

Examples of b) and d) are shown below.

Figure: Protective fence from falling rocks

Figure: Covering of falling rocks

Falling rock detection system notifies an onset of falling rocks to trains to secure the safety of train operations.

Figure: Falling rock detection system

3 Others

3.1 Subsidence caused by groundwater level drawdown

Settlement and deformation of rail level, and damage to foundation are occurred.

Issues to Avoid or Reduce Damage

1) Predict future ground settlement and deformation of rail level

2) Confirm availability of measures for ground settlement

Solution and Procedure for Issues

1) Implement a geographical survey

The table blow describes categories of soil investigations and testing method on soft grounds.

Table: Soil investigations on soft rocks

Investigation category	Investigations and tests
Soil layer formations, ground water levels	Boring
Particle size distribution	Particle size test
Unit weight	Test of unit weight
Density	Density test
Cohesive force, the angle of internal friction	unconfined compression test, triaxial compression test

2) Estimate a degree of subsidence from groundwater level, N-value and soil characteristics

Submerged water layers are located beneath a soft clay surface, and the water pressure is decreased when the submerged water is pumped up. The pressure among the sol particles in the clay surface increases as the water pressure is decreased and triggers consolidation. The ground lowers when the degree of consolidation increases.

The degree of ground subsidence caused by decreased groundwater level can be obtained by a one-dimensional consolidation settlement analysis using consolidation coefficient obtained in an indoor soil tests.

3) Foundation in places where subsidence is predictable shall be constructed to be resistant to subsidence

When the ground surrounding a foundation lowers as the ground water level lowers, the vertical friction force works on the sides of the foundation. The friction force sometimes damages the foundation by compression when it exceeds the durability of the foundation. Reduction of the friction is effective in avoiding such situation. Possible measures include the adoption of steel piles with smooth surfaces and application of resin on concrete piles.

3.2 Salt damage caused by splashing seawater

Salt damage and aging of rolling stock, concrete, and steel structure are caused by splashing seawater.

Issues to Avoid or Reduce Damage

1) Understand and predict salt spray and salt damage

2) Confirm availability of measures depending on intensity and characteristic of salt damage

Solution and Procedure for Issues

1) Treatment of structure against rust prevention to rolling stocks and railway facilities

Structures and materials must be carefully selected for vehicles and facilities in areas where salt damages are expected to prevent corrosions and oxidations on vehicles and facilities. For example, aluminum alloys or stainless vehicles are used in such cases.

2) Review concrete covering to reduce decaying a reinforced concrete structures

A key to retain the durability of reinforced concrete is to retain neutrality of the concrete and prevent the steel reinforcement from rusting for a long time.

a) Installation of hard concrete

When the covering depth is 4 cm and the water-concrete ratio is 60%, the concrete retains its neutrality for about 80 years. Yet, if the concrete is made harder by making the water-concrete ratio to 55%, the neutrality can be retained up to about 110 years.

b) Securing the covering depth

When the water-concrete ratio is 65% and the covering depth is 2 cm due to defective installation, the inside the concrete can be kept neutral only for less than 20 years, and the steel reinforcement inside the concrete starts to rust after that. The rust on steel reinforcement increases the volume around the steel, expanding the concrete and resulting in cracks, damages, and collapses.

c) Steel reinforcement with epoxy resin application

Uses of steel reinforcement on which epoxy resin is applied enables high durability, because the structure does not become close to a corrosion limit at all even after 50 years from the construction. The additional cost compared to the use of normal steel reinforcement is about 1 to 2 % in the overall construction cost. Japan Society of Civil Engineering has prepared design standards.

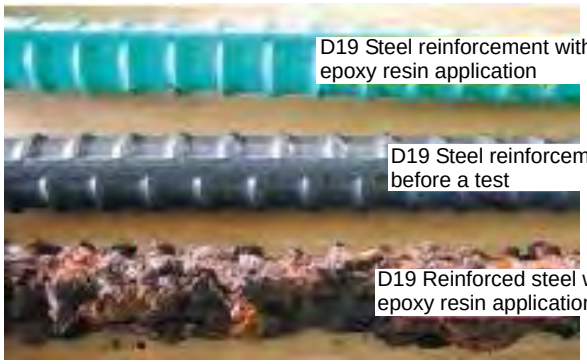


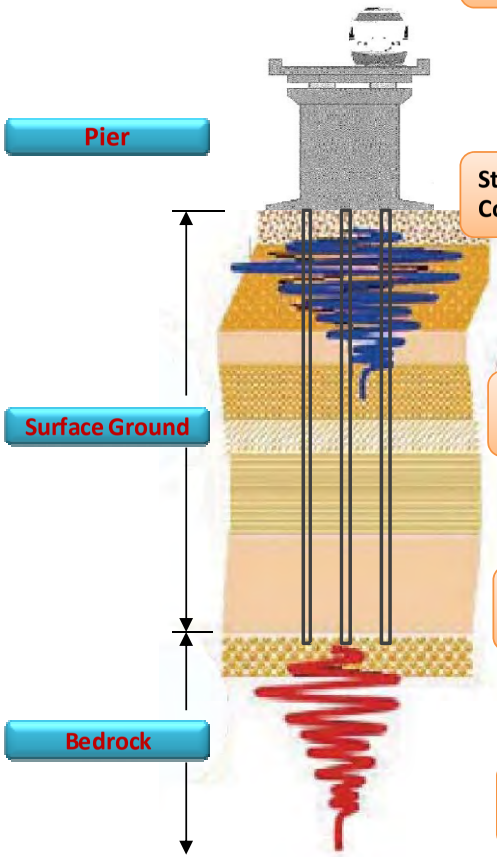
Figure: Overview of reinforced steels with epoxy resin application

3) With regard to seaside structure, adopting weather resistant steel, painting material, painting interval, etc

A common measure to prevent salt damages on steel structures is to use weather resistant steels. Weather resistant steels prevent progress of oxidation and rusting by forming “generated rust” at the beginning. Generated rust is red brown as shown below which is similar to the color of rust, giving a “heavy” impression.

Figure: Bridge support with weather resistant steel
(No paint application is planned for the future.)

Seismic Design Procedure



Step5:
Verification of Seismic Performance

Repeated Computations

Step4:
Computation of Structural Response Values

Step3:
Setting Seismic Performance

Step2:
Evaluation of Surface Ground

Step1:
Setting Input Earthquake Motions

For required seismic performance, damage level of members and stability level of foundation are verified by repeated computations, not to exceed the following limit values.

	Seismic Performance Ⅰ	Seismic Performance Ⅱ	Seismic Performance Ⅲ
Members	Damage Level 1	Damage Level 3	Damage Level 3
Foundation	Stability Level 1	Stability Level 2	Stability Level 3

Damage Level 1	No damage	(Photo 1)
Damage Level 2	Damage that may require repair depending on situation	(Photo 2)
Damage Level 3	Damage requiring repair	(Photo 3)
Damage Level 4	Damage requiring repair and replacement of members depending on situation	(Photo 4)

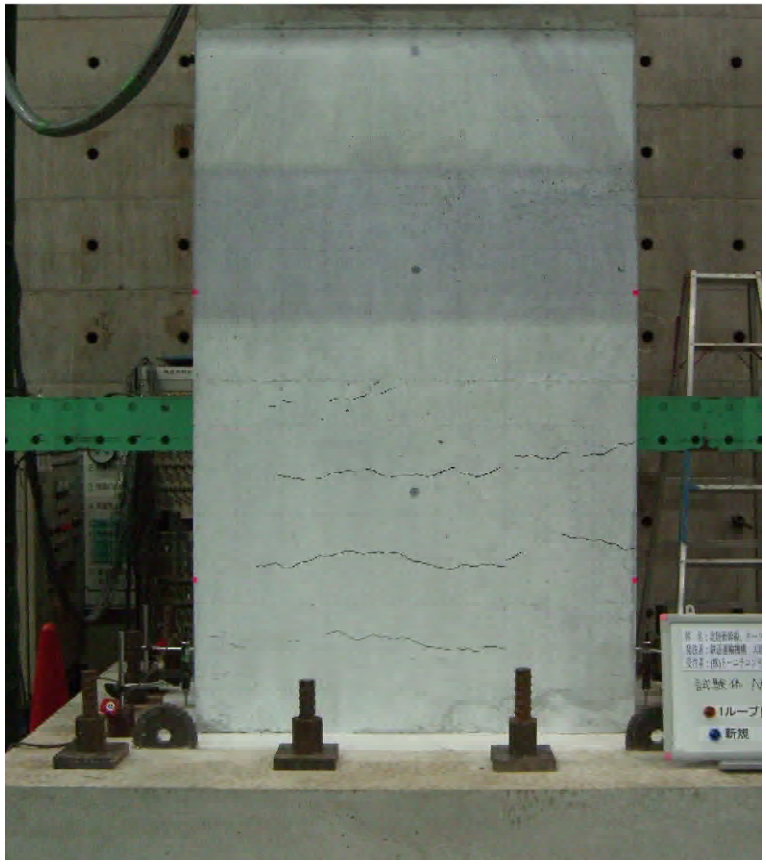
	Earthquake Scale	Extent of Repair
Seismic Performance Ⅰ	Medium Scale Earthquake	Function of structure is retained without conducting repair after an earthquake, and no excessive displacement occurs.
Seismic Performance Ⅱ	Large Scale Earthquake	Repair may be required after an earthquake, but function of structure can be restored within a short period.
Seismic Performance Ⅲ	Large Scale Earthquake	The entire structure does not collapse because of an earthquake.

Seismic Performance Ⅰ is applied to all railways,
Seismic Performance Ⅱ is applied to Shinkansen and urban railway,
Seismic Performance Ⅲ is applied to other railways.

(Photo 1)

Damage Level 1

No damage



(Photo 2)

Damage Level 2

Damage that may require repair depending on situation

(Photo 3)

Damage Level 3

Damage requiring repair

(Photo 4)

Damage Level 4

Damage requiring repair and replacement of members depending on situation

2007.03

Design Standards for Railway Structures and Commentary (Seismic Design)

Editorial Supervisor, Railway Bureau of the Ministry of Land, Infrastructure and Transport Government of Japan

RAILWAY TECHNICAL RESEARCH INSTITUTE

CONTENTS

OUTLINE OF DESIGN STANDARDS FOR RAILWAY STRUCTURES AND COMMENTARY (SEISMIC DESIGN)

I DESCRIPTION OF THE SEISMIC STANDARD

The code provisions of "Design Standards for Railway Structures (Seismic Design)," that have been used generally for seismic design of railway structures in Japan, was issued as a notice by the Ministry of Transport (currently the Ministry of Land, Infrastructure and Transport) in December 1998. Commentaries and appendices were added and published in November 1999 as the "Design Standards for Railway Structures and Commentary (Seismic Design)," hereinafter referred to as the "seismic standard."

The seismic standard is the result of a drastic revision of conventional seismic design based on the lessons learned from the damage to railway, road and other important facilities caused by the Hyogoken-Nanbu Earthquake which occurred on January 17, 1995. The seismic standard is applied to the design of bridges, viaducts, foundation structures, retaining structures (retaining walls, abutments, etc.), cut and cover tunnels and embankments. As for the embankments, however, the seismic standard is applied only when seismic design is necessary, for example, in cases where designing highly important embankments when the geographical features of the site are susceptible to the effect of earthquakes, or when recovery is difficult.

The seismic standard is composed of fifteen chapters as shown in Table 1. Technical documents, required when performing sophisticated design, are attached at the end of this standard as Appendices.

Table 1 Contents of the Seismic Standard

Chapter No.	Title	Chapter No.	Title
1	General	9	Abutments
2	Basis of Seismic Design	10	Rigid Frame Structures
3	Design Earthquake Motions and Loads	11	Bearings
4	Materials and Design Values	12	Foundation Structures
5	Evaluation of Surface Ground and Computation of Behavior	13	Retaining Walls
6	Computation of Response Values of Structure	14	Embankments
7	Verification of Seismic Performance	15	Cut and Cover Tunnels
8	Bridge Piers		Appendices

II A BRIEF HISTORY OF THE ISSUE OF THE SEISMIC STANDARD AND ITS CHARACTERISTICS

1. History of the Issue of the Seismic Standard

Many railway facilities suffered severe damages in the Hyogoken-Nanbu Earthquake that occurred on January 17, 1995. A fundamental philosophy for seismic design was proposed by the "Study Committee for the Seismic Structure of Railway Facilities" set up by the Ministry of Transport (currently the Ministry of Land, Infrastructure and Transport) after the earthquake. Following the proposal, the "Study Sub-committee for Seismic Standard" was set up by the Railway Technical Research Institute performing as a secretariat under the guidance of the Ministry of Transport. This sub-committee consisted of academics and engineers from railway operators specializing in seismic design. The seismic standard is the result of discussions conducted over three years by this sub-committee.

The study committee presumed the principal causes of damage to railway structures due to 1995 Hyogoken-Nanbu Earthquake, which are described below based on damage investigation and the results of analyses.

a) All of the structures at the site possessed the required capacity corresponding to a design horizontal seismic coefficient of 0.2 specified in the design standard at the time of their design. However, this value was grossly exceeded by acceleration induced by the earthquake. For this

reason, many structures suffered damage.

b) The Shinkansen viaducts that suffered severe damage, such as collapse, had less safety against shear than against flexure, which caused considerable structural damage. One of the reasons for this was that, according to the standards at the time of their design, the allowable shear stress of concrete was larger than that of current standards.

c) The main reason for the large difference in the degree of damage between adjacent viaducts (some collapsed while others suffered only cracks in columns) was the difference in surface ground.

As a result, we learned that the following should be included in the new seismic standard: a) inland earthquake motions must be considered, b) the failure mode must be considered in evaluating the safety of members, and c) the dynamic properties of surface ground must be fully taken into consideration when computing the response values of structures.

On the other hand, though foundation damage was relatively light, of particular note was the damage caused by the lateral flow of soil accompanying the liquefaction of the ground. The large motion of the ground caused piles to break, thus indicating the importance of design methods against the lateral flow of soil.

2. Characteristics of the Seismic Standard

The following are the main characteristics of the new seismic standard.

(1) Consideration of 1995 Hyogoken-Nanbu Earthquake-class earthquake motion

In light of the damage caused by the 1995 Hyogoken-Nanbu Earthquake, structures must be designed to withstand this kind of strong earthquake motion. For this reason, two levels of design earthquake motion (earthquake motion to be considered in design), Level-1 and Level-2, were adopted. Level-1 earthquake motion has a probability of occurring several times within the service period of the structure and that is of a level that has been already considered in conventional seismic design. Level-2 earthquake motion is strong earthquake motion that has a low probability of occurring within the service period, such as earthquake motion caused by a near-land-large-scale interplate earthquake or by an inland near-field earthquake.

(2) Use of structural ductility

When inland earthquake motion with a return period of several hundred years is taken as design earthquake motion, the effect on structures will increase dramatically. Therefore, it is rational to design structures adopting the concept of allowing damage but preventing collapse, which is available through the appropriate evaluation of the ductility of members and foundations. So, the endurable extent of damage is prescribed and represented by "seismic performance" based on the viewpoint of damage control.

Figure 1 shows the defined three criteria of seismic performances of structures corresponding to the extent of repair and retrofitting that will be required after an earthquake. The seismic standard prescribes verifying that structures satisfy those performances with respect to design earthquake motions. Which seismic performance is to be assigned to a structure is determined according to the importance of the structure. Also, the damage level corresponding to the seismic performance of a structure must be set for members and foundations.

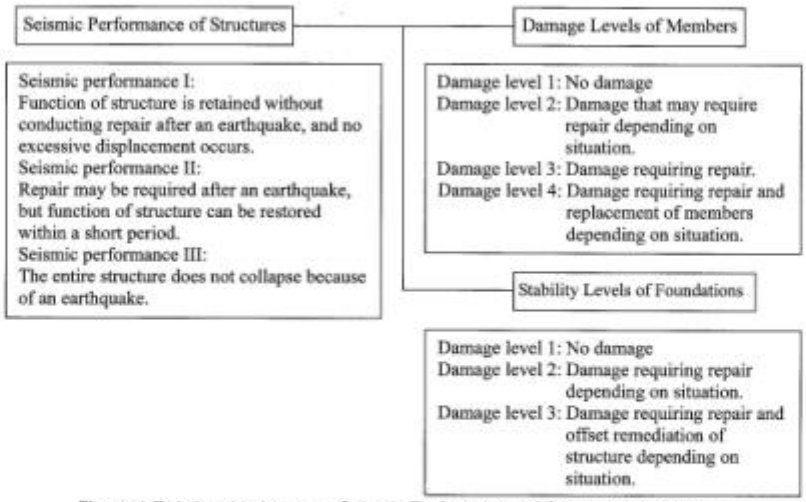


Figure 1 Relationship between Seismic Performance of Bridges and Viaducts, Damage Level of Members and Stability Level of Foundations

(3) Use of dynamic analysis

Dynamic analysis that completely models the foundation and the superstructure are mainly used to compute the response values of structures. This is because the effect of an earthquake is fundamentally dynamic, and because the dynamic effect of the surface ground is significant when subjected to strong earthquake motion such as that experienced in the 1995 Hyogoken-Nanbu Earthquake. The nonlinear response spectrum method, however, is regarded as an alternative to be applied to some types of structures.

III SEISMIC DESIGN PROCEDURE

Figure 2 illustrates the procedure for seismic design for bridges and viaducts.

In the seismic design of the new seismic standard, the input earthquake motion is set first. Then, the surface ground is classified based on a soil exploration. In the time history dynamic response analysis, ground and structures are appropriately modeled to obtain the response values of the structure. On the other hand with the nonlinear spectrum method, the response values of the structure are computed using nonlinear response spectra (also called "demand yield seismic coefficient spectra") that are prepared using the design earthquake motion preset for each ground classification. In the general verification of seismic performance, these response values and the limit values of the structure are used.

The nonlinear response spectrum method may be used for structures that can generally be modeled by single degree of freedom system to express the behavior against earthquakes. However, for complex structures, the time history dynamic analysis method should be used.

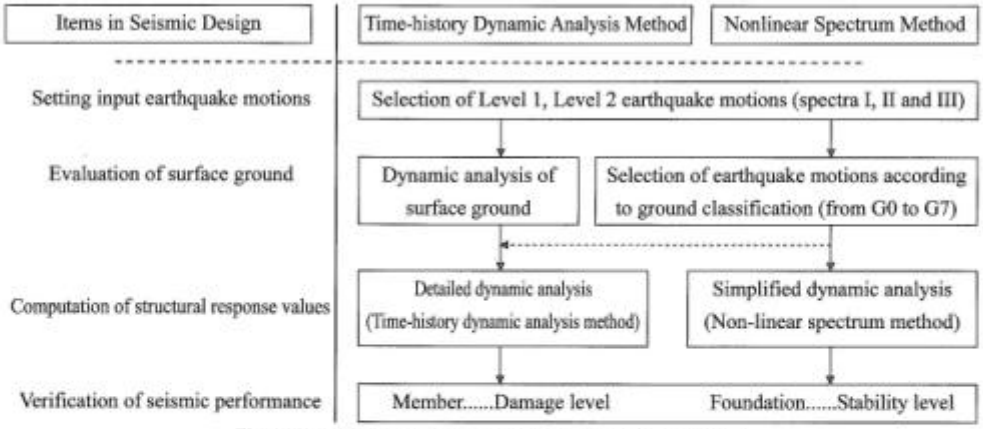


Figure 2 Seismic Design Procedure for Bridges and Viaducts

IV SUMMARY OF THE SEISMIC STANDARD

1. Design Earthquake Motions

(1) Bedrock earthquake motions

The seismic standard prescribes Level-1 and Level-2 earthquake motions as design earthquake motions. These Level-1 and Level-2 earthquake motions are set at the bedrock and their properties are represented by acceleration response spectra. For bedrock, it is desirable to take the hardpan of which shear wave velocity is large. In actual design, however, the bedrock is generally taken to be the top surface of a hard stratum that can bear the foundations.

a) Level-1 earthquake motion

This level of earthquake motion has been used in combination with the elastic design method. As well as being presented as static loads (for the seismic coefficient method), it also is provided as a seismic wave form for dynamic analysis.

The intensity of Level-1 earthquake motion is prescribed based on the acceleration response spectrum determined for firm ground classified in the conventional allowable stress design method, and is determined referring to an earthquake risk analysis of the return period of 50 years. The maximum value is taken as 250 gal (damping ratio 5%).

b) Level-2 earthquake motions

A design earthquake motion with a maximum elastic response acceleration of 1G has been taken into consideration in the conventional design of structures on standard ground. However, as for the intensity of Level-2 earthquake motion, it was necessary to consider earthquake motion that occurred in regions near the fault including hypocenter as severe as the strong earthquake motions experienced during the 1995 Hyogoken-Nanbu Earthquake.

To set this kind of earthquake motion, the positions of active faults that will be a threat must be specified in each area by comprehensively taking into consideration geological information relating to active faults, geodesic information related to movement of the earth's crust, and seismological information relating to seismic activity. Although it is ideal to prescribe the intensity of earthquake motion based on these active faults, the accuracy of a return period of an earthquake generated by inland active faults, the magnitude and the properties of earthquake motion are often insufficient to be used in the basis of seismic design. In the seismic standard, standard earthquake motion for the area near the faults was prescribed based on analyses and records of strong earthquake motions near faults

that have caused major disasters in the past, such as the 1995 Hyogoken-Nanbu Earthquake.

The acceleration response spectra of Level-2 earthquake motion as standard earthquake motion considers the following:

(i) Acceleration response spectrum (Spectrum I) targeting near-land interplate earthquakes (Magnitude 8 level, distance to epicenter of 30 to 40 km) that has been considered in conventional design.

(ii) Acceleration response spectrum (Spectrum II) determined according to statistical analysis based on past earthquake observation records targeting earthquakes produced by inland active faults.

Furthermore, when the rupture mechanism of faults can be specified, the acceleration response spectrum (Spectrum III) computed by analysis based on that mechanism may be used instead of Spectrum II.

Spectrum II was set taking into consideration a non-exceedance probability of 90% for the response spectrum of past earthquake motions observed on firm ground. The maximum value of spectrum II determined according to this method is 1700 gal (damping ratio 5%) for G1 ground classification (bedrock).

Figure 3 shows the procedure for setting Level-2 earthquake motions.

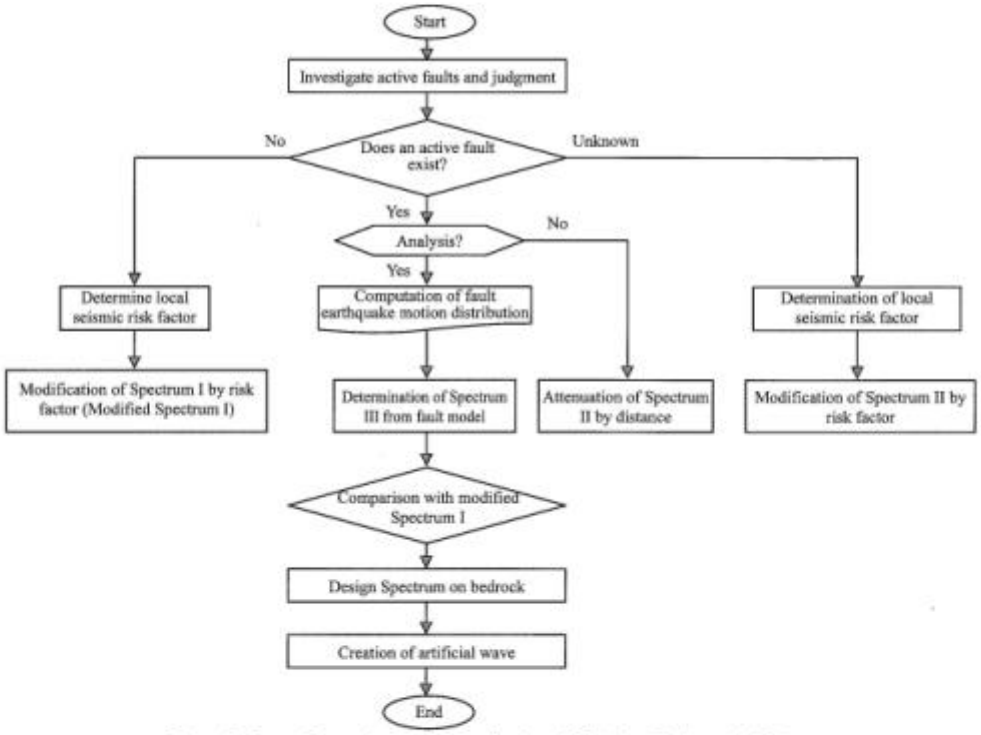


Figure 3 General Procedure to Determine Level-2 Design Earthquake Motion

(2) Ground surface design earthquake motion

The seismic standard prescribes the ground surface design earthquake motion for each ground classification, and the characteristics of that earthquake motion are outlined by the acceleration response spectra.

Since the characteristics of the surface ground must be expressed as accurately as possible, ground is

classified into eight types. The classification corresponds to the natural period of ground computed based on the initial velocity of shear wave of the surface ground.

Ground surface design earthquake motions are determined to Level-1, and Spectra I and II of Level-2 earthquake motions. Figures 4 to 6 show the elastic acceleration response spectrum of the respective ground surface design earthquake motions, and Figures 7 and 8 show the time-history waveforms (Spectra I and II) of ground surface design earthquake motions (Level-2 earthquake motions).

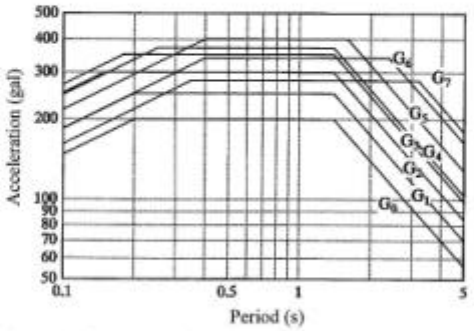


Figure 4 Elastic Acceleration Response Spectra of Ground Surface Design Earthquake Motions
(Level-1 earthquake motion)

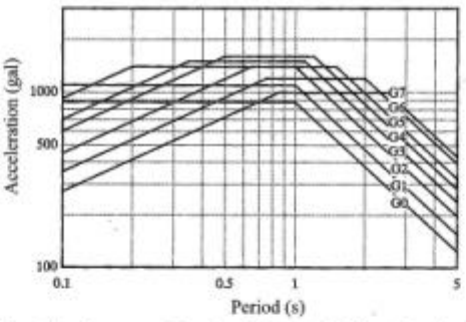


Figure 5 Elastic Acceleration Response Spectra of Ground Surface Design Earthquake Motions
(Spectrum I of Level-2 earthquake motion)

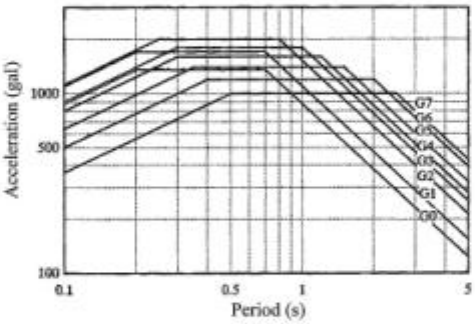


Figure 6 Elastic Acceleration Response Spectra of Ground Surface Design Earthquake Motions
(Spectrum II of Level-2 earthquake motion)

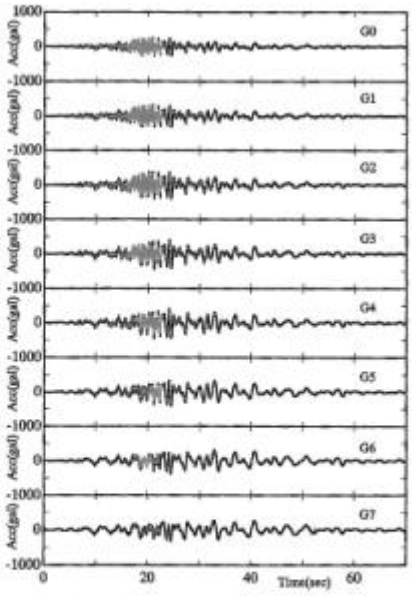


Figure 7 Time-history Waveforms of Ground Surface Design Earthquake Motion (Spectrum I)

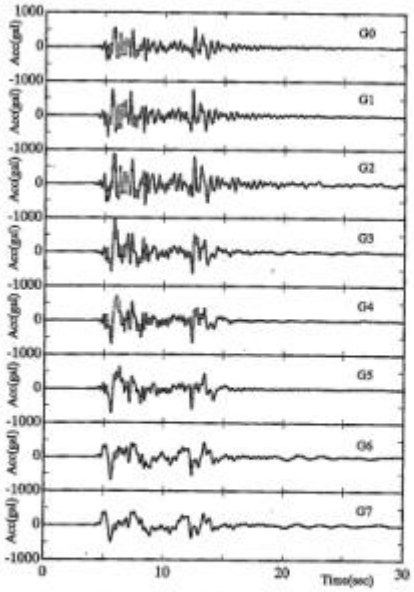


Figure 8 Time-history Waveforms of Ground Surface Design Earthquake Motion (Spectrum II)

2. Evaluation of Surface Ground

(1) Property Survey and Testing of Ground

Since Level-2 earthquake motion is considerably intense, the nonlinear characteristics of ground as much as those of structures have to be adequately evaluated. For this reason, appropriate property surveys and testing of the ground must be performed.

Table 2 shows ground survey items in seismic design and their purpose.

Table 2 Relation Between Survey Items in Ground Surveys for Seismic Design and Their Purposes

Survey Item	Description	Primary Purpose of Survey			
		Setting of bedrock surface and ground surface in seismic design	Judgment of liquefaction/ lateral flow of soil, judgment of soft clayish soil	Setting of ground classification in seismic design	Setting of parameters when performing dynamic analysis of ground
Document surveys	Earthquake damage records		○		
	Dynamic properties of soil				○
Site surveys In-situ tests	Geographic features/geological survey	○	○	○	○
	Boring	○	○	○	○
	Ground-water level measurement	○	○	○	○
	Standard-penetration test	○	○	○	○
	Seismic velocity logging (PS well logging)	△		△	○
	Elastic wave exploration	△		△	△
	In-situ strength test	△	△	△	△
	Undisturbed sampling	△	△	△	△
Laboratory soil test	Particle-size analysis	△	○	△	○
	Wet density test of soil	△	△	△	△
	Unconfined compression test of soil	△	△	△	△
	Undrained cyclic triaxial compression test of soil		△		△
	Cyclic triaxial compression test for obtaining dynamic deformation characteristics of soil				△

○: In principle, must be performed △: Required according to situation

For ground which might possibly liquefy, it is recommended to conduct a cyclic loading triaxial compression test and to ascertain the shear strength ratio. Figure 9 shows the procedure to judge the possibility of liquefaction.

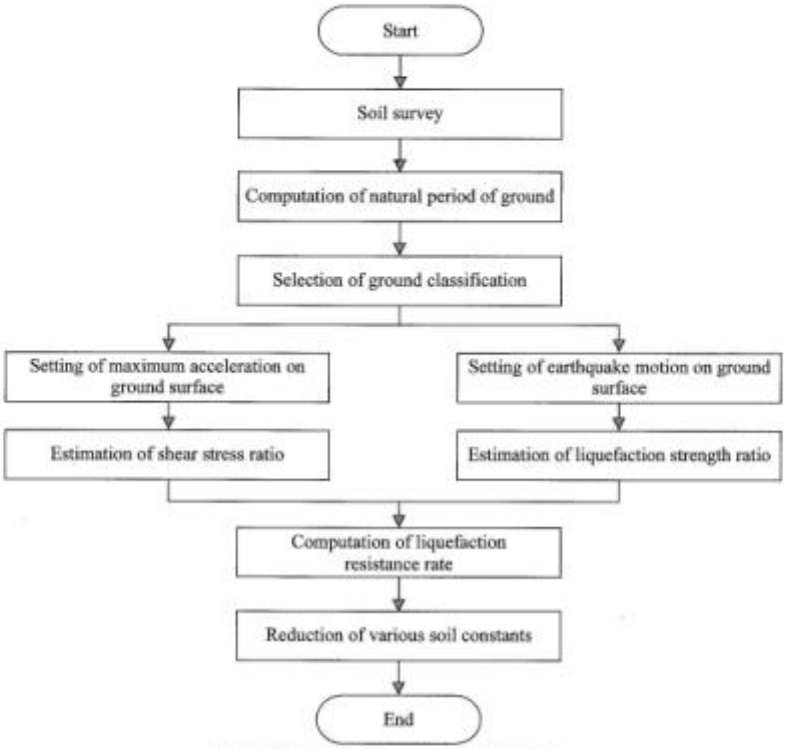


Figure 9 Liquefaction Judgment Procedure

(2) Ground Classification

The surface ground is classified to eight profiles, from G0 to G7, for seismic design as shown in Table 3.

Table 3 Ground Classification for Seismic Design

Ground Classification	Natural Period T_g	Description
G0	—	Hard rock
G1	—	Bedrock
G2	0.25 and shorter	Diluvium
G3	0.25 to 0.5	Dense soil
G4	0.5 to 0.75	Dense to soft soil
G5	0.75 to 1.0	Soft soil
G6	1.0 to 1.5	Very soft soil
G7	1.5 and longer	Extremely soft soil

The following shows the formula for computing the natural period shown in Table 3:

$$T_g = 4 \times \sum_{i=1}^{N} \left(\frac{h_i}{V_{s0i}} \right) \qquad \text{(Eq. 1)}$$

where,

h_i: layer thickness (m) of each soil layer (i^{th} layer) (i = 1 to N layers)

V_{sdi}: design initial velocity of shear wave (m/s) of each soil layer (i^{th} layer)

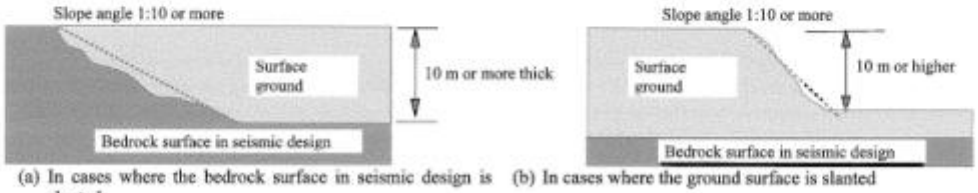
(3) Evaluation of Surface Ground

The characteristics of surface ground must be fully assessed as they greatly affect on the seismic performance of structures that are built on the ground. The following shows evaluation methods for some typical grounds requiring attention:

a) Geologically Irregular Ground

At geologically irregular ground, the earthquake motion is amplified and has caused considerable damage in past earthquakes. The evaluation of the amplification effect of geologically irregular ground should be conducted using the finite element analysis method. This method is, however, not popularly used at the design stage, so the amplification factor of earthquake motion based on seismic response analysis of geologically irregular ground is plotted and shown in the seismic standard.

Figure 10 shows the ground conditions for which the effect of geologically irregular ground should be considered.



(a) In cases where the bedrock surface in seismic design is slanted (b) In cases where the ground surface is slanted

Figure 10 Conditions in which the Effect of Geologically Irregular Ground Must Be Considered

b) Liquefied Ground

Liquefaction is a considerable problem in seismic design and it has caused many disasters on structures in the past earthquakes. Countermeasures should be devised when the occurrence of liquefaction can be prevented economically by soil improvement. If it is difficult, other measures must be devised to prevent the collapse of the structure or major damage caused by the excessive response of structure due to liquefaction or excessive displacement of the foundation due to land settlement and lateral flow of soil.

In the 1995 Hyogoken-Nanbu Earthquake, considerable damage was caused to structures due to the lateral flow of soil accompanying liquefaction. To assess this, the seismic standard adopted the same approach as the response displacement method, which computes the amount of ground displacement that causes lateral flow of soil, and acts on structures via the subgrade reaction (see Figure 11).

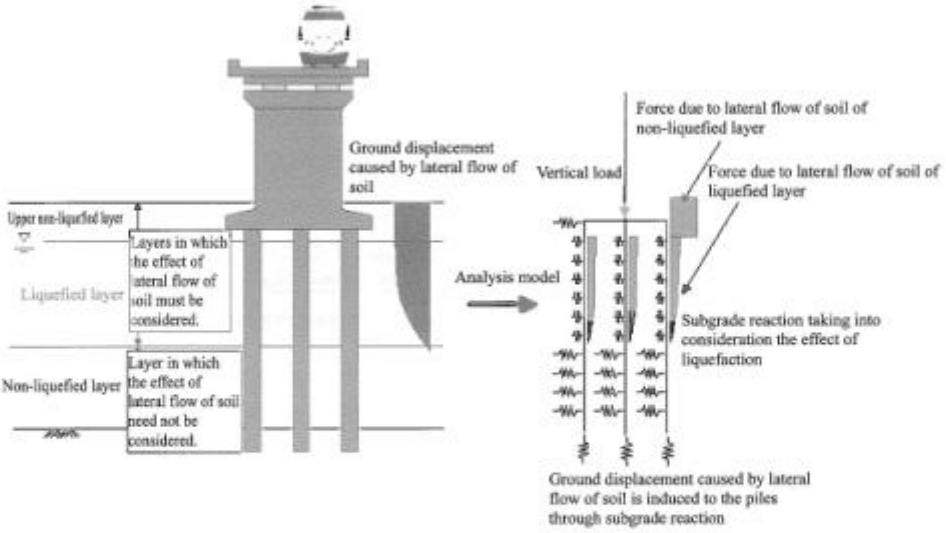


Figure 11 Consideration of Ground Displacement Caused by Lateral Flow of Soil

c) Soft Ground

At soft ground, earthquake motion is amplified in the weak surface layer, resulting in considerable displacement that damages the pile foundation. Therefore, this phenomenon must be taken into consideration for foundations on ground where large displacement might occur. The amount of displacement in this case should be computed by seismic response analysis of surface ground. The seismic standard, however, provides a simple method, for the sake of practical design, to obtain the displacement using the natural period of the ground for each level of earthquake motion.

3. Computation of Structural Response Values

(1) Nonlinear Spectrum Method

Dynamic analysis methods are primarily used in the design of bridges and other structures in seismic design. It is necessary to use the dynamic analysis model of multi-degree of freedom system for structures, such as multi-span continuous bridges, long-period structures or new-type bridges whose behavior cannot be expressed by the single-degree of freedom system. For general structures, however, response values may be obtained by nonlinear response spectra computed using dynamic analysis which take into consideration the hysteresis characteristics of structures.

In the seismic standard, this method is called the "nonlinear spectral method." The demand yield seismic coefficient spectrum is a nonlinear response spectrum that illustrates the relationship between the yield seismic coefficient and natural period of the structure for each ductility factor. The ductility factor (response displacement) of a structure subjected to a design earthquake can be simply obtained if the yield seismic coefficient and equivalent natural period of the structure are known.

Figure 12 shows the method to create the demand yield seismic coefficient spectrum. Figure 13 shows the method to obtain the ductility factor from the equivalent natural period and yield seismic coefficient.

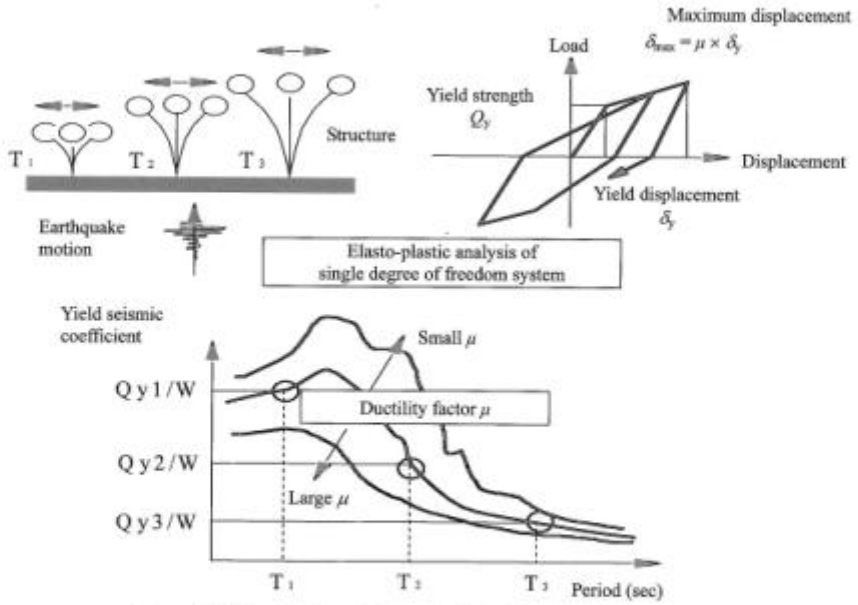


Figure 12 Method to Create Demand Yield Seismic Coefficient Spectrum

The process to compute the ductility factor of a structure using the demand yield seismic coefficient spectrum shown in Figure 13 is as follows: a) obtain the yield seismic coefficient K_{hy} using nonlinear analysis of the structure, b) obtain the equivalent natural period of the structure, and c) the point of intersection between a) and b) is determined using the demand yield seismic coefficient spectrum diagram, and the ductility factor is read from the diagram.

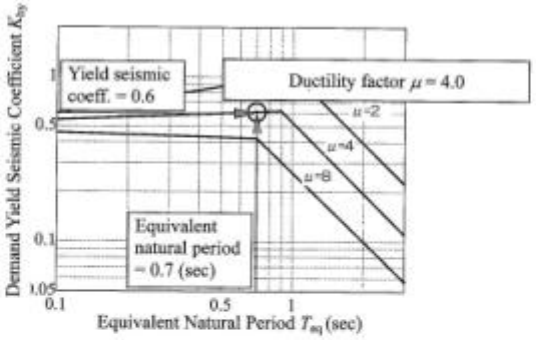


Figure 13 Method to Compute Ductility Factor from Equivalent Natural Period T_{eq} and Yield Seismic Coefficient K_{hy}

(2) Time-history Dynamic Analysis

The time-history dynamic analysis can rationally express the behavior of a structure subjected to an earthquake. There is, however, still many uncertainties. Modeling methods must be fully assessed when applying this method of analysis.

There are various kinds of time-history dynamic analysis methods. It is important to select an appropriate method after a full understanding of their differences, for instance on the convenience of modeling, easiness of setting various analysis constants, adaptability to nonlinearity, applicability to complex

structures, and applicability to liquefaction and geologically irregular ground.

(3) Evaluation of Dynamic Interaction Between Soil and Structures

During an earthquake, dynamic interaction occurs between soil and structures. The interaction is greatly influenced by their frequencies and masses. The effect of dynamic interaction must be taken into consideration when the behavior of structures subjected to an earthquake is strongly affected by this phenomenon.

There are two types of dynamic interaction: interaction caused by the inertia force of the structure (inertial interaction), and interaction caused by the rigidity of the foundation and positional fluctuations of earthquake motion (kinematic interaction). For highly rigid foundations in the ground, the latter (kinematic interaction) must be considered.

4. Verification of Seismic Performance

(1) Seismic Performance of Structures

The seismic standard adopts the performance-based design method which clearly sets and verifies the damage states of structures (i.e. seismic performance) when they are subjected to design earthquake motion. These provisions can also be called the "damage control design method."

As shown in Figure 1, the seismic performance of a structure is related to the difficulty of recovery after an earthquake. For relationships between design earthquake motion and required seismic performance, Seismic performance I is applied to Level-1 earthquake motion. Seismic performance II is applied to Level-2 earthquake motion for important structures, and Seismic performance III is applied to other structures.

To ensure the seismic performance of structures, the damage level of component members of a structure and the stability level of the foundation must be set appropriately. The damage level of each member has to be set taking into consideration the seismic role of the corresponding member. As the stability level of foundations affect the deformation of a structure, it is set taking into consideration the bearing capacity and displacement since this greatly influences deformation.

(2) Member Damage Levels and Foundation Stability Levels

The member damage levels are associated with the extent of displacement, that are represented on the envelop curve of load-displacement relationship and taking into consideration the importance of the structure, member characteristics, the relation between damage and repair methods for the member.

For example, for reinforced concrete members being subjected to moderate axial compressive force and having the precedent failure mode of flexure, the envelope curve of the load-displacement relationship of the member is expressed as shown in Figure 14. Then, each damage level may be set corresponding to the points of gradient change on the envelop curve of the load-displacement relationship.

In Figure 14, damage level 1 is set within the displacement to make the longitudinal reinforcement yield (point B); the damage level 2 is set within the displacement at maximum capacity (point C); the damage level 3 is set within the displacement at which the yield capacity can be sustained (point D); and the damage level 4 is set for the displacement beyond the point D.

When the relationship between the damage level and the displacement of member is set in this way, the displacement of a member can be taken as a verification index. Table 4 shows the guidelines of repair methods corresponding to each of these damage levels.

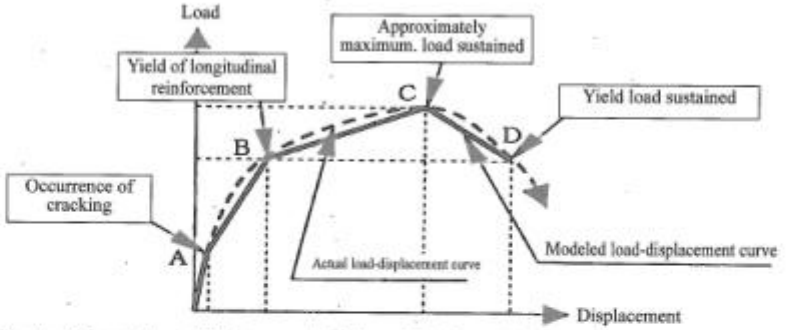


Figure 14 Envelop Curve of Load-Displacement Relation of Reinforced Concrete Members (under low axial force)

Table 4 Summary of Repair Methods for Corresponding Damage Levels of Reinforced Concrete Members

	Damage Level	Guideline of Repair Method
Damage level 1	No damage	• No repair (Durability considered as necessary)
Damage level 2	Damage that may require repair depending on situation	• Injection into crack / patching, if necessary
Damage level 3	Damage requiring repair	• Injection into crack / patching. Remediation of ties, if necessary
Damage level 4	Damage requiring repair, and replacement of members depending on situation	• Injection into crack / patching /remediation of ties. • Replacement of members when buckling of longitudinal reinforcements or structural steel frame is conspicuous.

It is prescribed that the stability level of foundations is set with emphasis principally on bearing capacity and displacement. The residual displacement and ductility factor of a foundation are used as indices of this. The ductility factor is the ratio between the response displacement of a foundation subjected to earthquake and its yield displacement. Figure 15 illustrates the relation between the stability level and load-displacement curve of the foundation.

The yield point of the foundation is defined by the yield of either supporting ground or members. Both are referred to as "stability level."

The stability levels of foundation are defined as follows:

Stability level 1: In principle, the load acting on the foundation is smaller than the yield bearing capacity of the foundation, and large displacement does not occur. Also, the section forces of component members of the foundation do not exceed the yield bearing capacity.

Stability level 2: Either or both of the supporting subgrade or members may yield but have sufficient bearing capacity. Also, harmful displacement and residual displacement, which spoil the function of structure after earthquake, have not occurred.

Stability level 3: The structure retains the required bearing capacity to prevent it from collapsing due to failure of the supporting subgrade and damage to members.

Table 5 summarizes repair methods corresponding to the stability levels of the foundation. Figure 16 illustrates the potential damage regions of piers. Table 6 summarizes the relations between the seismic performance of pier members, and the limit values for member damage levels and foundation stability levels.

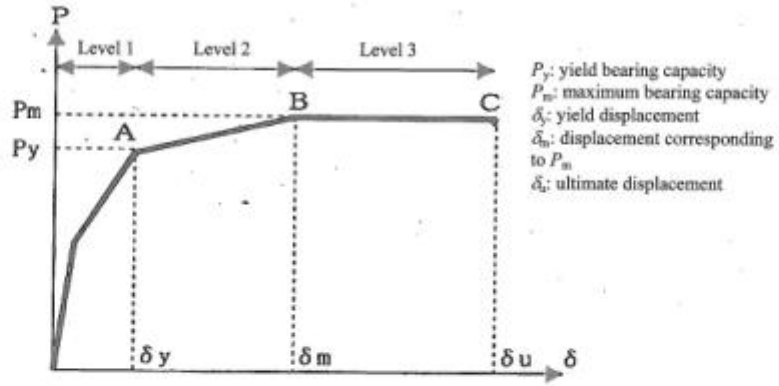
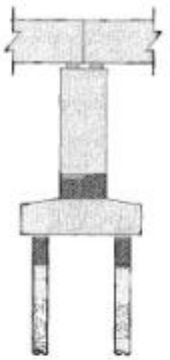


Figure 15 Load-Displacement Curve and Stability Levels of Foundation Structures

Table 5 Scheme of Repair Methods for Corresponding Stability Levels

	Damage Level	Summary of Repair Method
Stability level 1	• No damage • Acting load is smaller than yield bearing capacity.	• No repair
Stability level 2	• Damage that may require repair depending on situation.	• Injection of voids in footings and around foundations may be required depending on situation
Stability level 3	• Damage that may require strengthening or remediation of the structure	• Soil-improvement • Strengthening of foundation by expanding footing and/or additional piles.



: Potential damage region

Figure 16 Schematics of Potential Damage Region of Pier

Table 6 Seismic Performance of Pier Members, and Limit Values for Member Damage and Foundation Stability Levels

Structure	Seismic Performance I	Seismic Performance II	Seismic Performance III
Damage level of member	1	3	3
Stability level of foundation	1	2	3

*Of the member damage levels, bearing damage level is in accordance with "7.11 Bearings."

(3) Concept of Importance

The importance of structures is set according to the extent that structural damage will affect human life, the degree of influence on society and surroundings the operating speed and number of trains and the difficulty

of recovery in the event of damage to the structure, and other factors.

Structures as follows are judged to be important structures: a) structures for the Shinkansen railway network and metropolitan passenger railway networks, and b) cut and cover tunnels, that are difficult to recover in the event of structural damage.

5. Seismic Design of Structures

(1) Seismic Design of Bridges

a) Computation of Response Values of Piers

In the computation of response values of bridge piers using the time-history dynamic analysis, the structure is divided into the design vibration unit and modeled to either an overall detailed model composed of super- and sub-structures or a model in which support springs represent the foundation as shown in Figure 17.

Though superstructures and foundations behave monolithically during an earthquake, it is intricate to use the overall detailed model composed of super- and sub-structures when time-history dynamic analysis methods are used in the practical design process. Also, detailed assessment is required for the modeling of the ground in this case. Generally, modeling may be performed with the superstructure and foundation as separate.

In the modeling of members, beams and columns are modeled as linear members and nonlinearity is taken into consideration. To express the nonlinearity of reinforced concrete members, a model must be used that can take into consideration the influence of the cracking of members, yield of longitudinal reinforcement, spalling of cover concrete, and buckling of longitudinal reinforcement. Generally, either a tri-linear model or a tetra-linear model, which can take into consideration the decrease of flexural moment capacity beyond the maximum flexural moment capacity, is used to express the M-θ relationship as shown in Figure 18 (a). If the tetra-linear model is used, the behavior of a structure can be traced even after some of its members have reached the capacity decreasing region, thus can provide very accurate analysis. A degrading rigidity model is used for unloading rigidity.

Figures 18 (b) and 18 (c) show the M-θ relationship models for concrete-filled steel tube members (with a circular section) and of steel members, respectively.

The rigidity change points of models for each member and hysteresis rules shown in Figure 18 have been newly prescribed based on member test results.

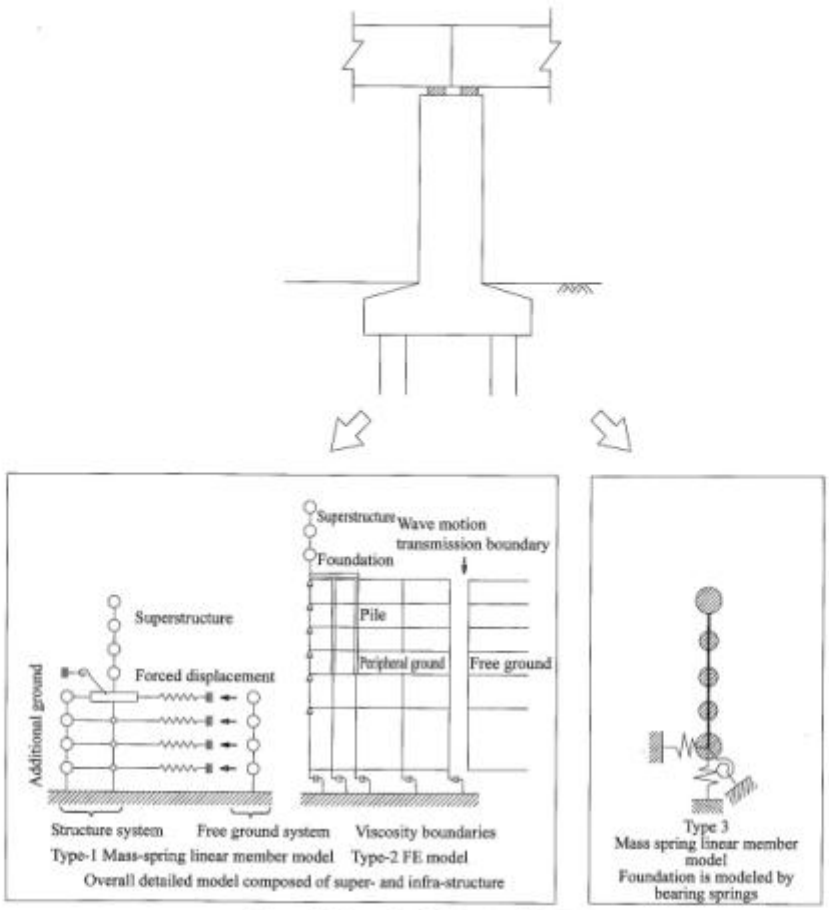


Figure 17 Example of Structural Modeling

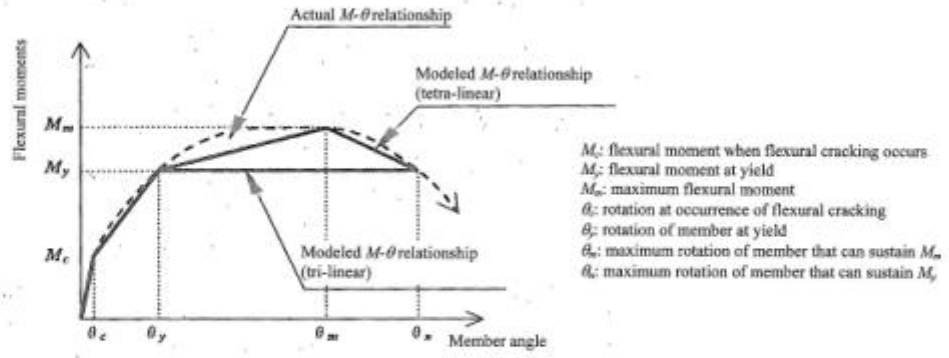


Figure 18 (a) Concrete Members

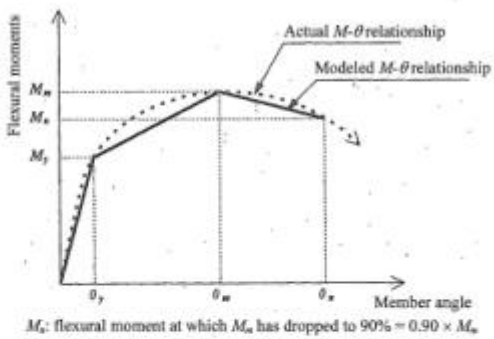


Figure 18 (b) Concrete-filled Steel Tube Members

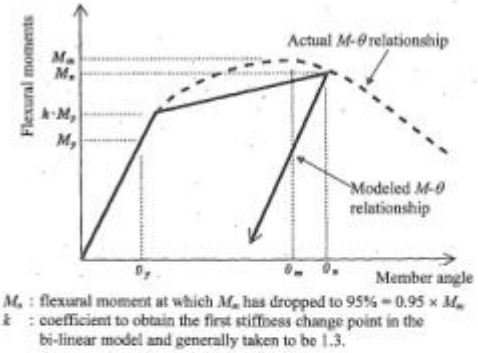


Figure 18 (c) Steel Members

Figure 18 Modeling of Nonlinearity of Members

b) Verification of Seismic Performance

Verification of seismic performance is conducted by verifying that the damage level of component members of a structure is satisfied when subjected to the design earthquake motion.

The damage level of members is verified by the following formula:

$$\gamma_i \cdot S_d / R_d \leqq 1.0 \qquad \text{(Eq. 2)}$$

where,

S_d: design response value

$S_d = \gamma_a \cdot S(F_d)$

R_d: design member performance corresponding to the damage level of the member

$R_d = R(f_d)/\gamma_b$

$S(F_d)$: response value with respect to the design load F_d

$R(f_d)$: member performance corresponding to the design materials strength f_d

γ_i: structure factor

γ_a: structural analysis factor

γ_b: member factor

The limit values of member damage levels are set taking into consideration the guideline of retrofit methods shown in Table 4, member characteristics and loading conditions.

Verification is conducted by confirming that the response values, obtained using the nonlinear model shown in Figure 17, do not exceed the evaluation index (displacement) corresponding to the damage level of the members shown in Figure 14. For members such as columns whose flexural moment distribution varies linearly, the rotation θ shown in Figure 18 is used as the evaluation index. On the other hand, for members such as beams whose flexural moment distribution varies in a curved manner, the curvature φ of the member section is used.

The damage levels of bearings are set based on Tables 7 and 8. The damage level of bearings corresponding to the seismic performance II of structure is basically set as level 2. However, up to damage level 3 is allowed when the capacity of infrastructure is large like that of the transverse direction of a wall shape pier.

Table 7 Seismic Performance and Damage Level Limits

Seismic performance of structures	I	II	III
Damage level of bearings	1	2 (3)	3

Table 8 Damage Level of Bearings

Damage Level	Extent of Damage	Extent of Repair
1	Sound and no damage	No repair
2	Relatively slight damage without unseating of girder	Repair as necessary.
3	Damage includes unseating of girder and failure of some bearing apparatus, but bridges do not fall off.	Repair or replacement is necessary.

(2) Seismic Design of Foundations

a) Basic Concepts

Foundations must transfer inertia forces that are applied from the superstructure safely to the subgrade, and must also satisfy the design conditions (displacement limits, etc.) that are required from the superstructure. For this reason, the type of foundation must be selected to suit the type of the superstructure. As the seismic design of foundations can not be considered separate from that of superstructures, the safety of the overall structure must be well bewared through the analysis with a detailed model composed of superstructure and foundation.

Furthermore, foundations generally are difficult to repair, requiring significant time and money for the repair work. For this reason, the seismic performance of foundations must be determined taking into consideration economic factors and its relationship with the capacity of the superstructure.

It is difficult to use a method which merely allocates large capacity to foundation members to not only provide sufficient seismic performance of a structure subjected to a severe earthquake while designing it economically. Accordingly, the seismic standard allows plastic deformation of the foundation, and prescribes verifying that the foundation possesses sufficient deformability.

b) General Seismic Design Methods for Foundations

Appropriate seismic performance must be set for foundations, and indices for evaluating the performance are also required.

For the seismic performance of foundations, the stability level is categorized in to three levels as shown with the load-displacement curve obtained by a pushover analysis in Figure 15. Evaluation indices include the damage (plasticization) of surrounding soil that supports the foundation and damage to component members. Member damage levels are set based on the methodology shown in Figure 14 and Table 4. On the other hand, the damage level of the subgrade (extent of plasticization) must basically be set based on loading test results obtained using scale model foundations tested for large displacement region or actual structures, because the damage level varies according to the type of foundation.

Further, in the computation of response values of foundations using dynamic analysis, the hysteresis characteristics of the foundation based on plastic deformation of the ground must be modeled appropriately. These are set based on vibration test results obtained using scale model foundations tested for large displacement region.

Generally, foundations should be designed to exceed the capacity of the superstructure since it is difficult to discover damages in foundations after an earthquake and extremely expensive to perform repair or strengthening. However, in the case of foundations for wall type piers that have considerably large capacity in the transverse direction, the foundations should be designed so that seismic energy is absorbed by plastic deformation of the foundation since it is not always rational to design foundations to exceed the capacity of the superstructure. But, since it is not desirable to increase the plastic deformation of foundations, limit values are determined for the ductility factor of the foundation as shown in Table 9, in order to prevent excessive residual deformation from occurring.

Table 9 Ductility Factor Limit Values for Foundations

Foundation Stability Level	Ductility Factor Limit Values for Foundations	
	Spread Foundation	Pile Foundation
Stability level 1	1	1
Stability level 2	3	2.5
Stability level 3	6	4

c) Seismic Deformation Method

In the seismic design of foundations, the foundations are generally designed to support the inertia force of the superstructure. In cases where, however, the ground is soft, a large displacement occurs in the ground that sometimes considerably affects piles. The seismic deformation method has been traditionally adopted to consider this influence.

With the seismic deformation method, the ground displacement and the inertia force from the superstructure acts on the foundation to check its safety. With the allowable stress design method, however, the horizontal force obtained by multiplying the design seismic coefficient with the weight of superstructure acts as the inertia force, and then the ground displacement is added. However, since i) the response acceleration of structures varies depending on the relationship between the natural periods of the ground and structure and ii) a time difference exists in the occurrence of the maximum values of ground displacement and response acceleration of the structure, they must be appropriately assessed so that foundations are rationally designed. Figure 19 shows the procedure for computing response values by the seismic deformation method used in the seismic standard.

When the design natural period of surface ground T_g is longer than 0.5 seconds, or the standard penetration resistance (N value) and the layer thickness matches specified conditions, the amount of horizontal displacement of the ground during an earthquake is considerable. The influence of not only inertia force but also ground displacement increases in deeply embedded foundations (excluding spread foundations). So, the influence of both inertia force and ground displacement must be considered as an effect of earthquakes.

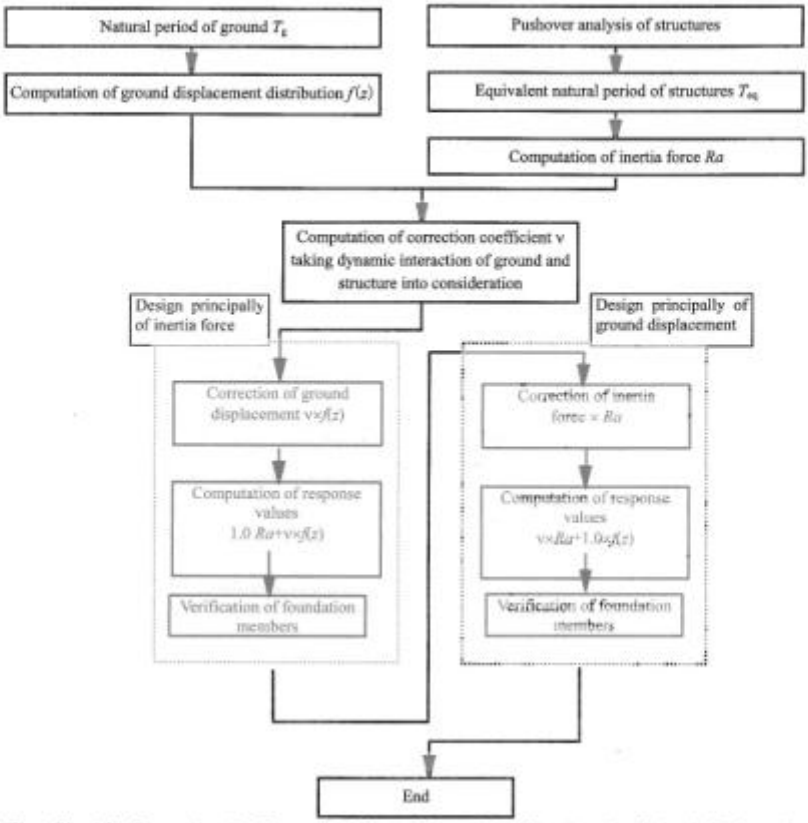


Figure 19 Flow Chart for Computing the Response Value of Foundation Structures by Seismic Deformation Method

(3) Seismic Design of Embankment Structures

a) Basic Concepts

Until the 1995 Hyogoken-Nanbu Earthquake, embankments were constructed without implementing seismic design since recovery after a disaster was simple. However, this earthquake prompted the application of seismic design to embankments. This is because linear structures such as railways remain unusable if the safety of all structures is not continuously maintained. Thus required seismic performance must be maintained for earth structures as well.

General embankments are basically constructed based on "Design Standards for Railway Structures and Commentary (Earth Structures)," and seismic performance is accounted for according to the structural details in the standard. However, seismic design is now conducted on important embankments at i) locations where severe damage in an earthquake is anticipated judging from embankment shape, geographical features, geological conditions, history of past disasters, and ii) locations where high seismic performance must be provided. Figure 20 shows the flow for the seismic design of embankments.

The main embankments that are likely to be damaged judging from the experiences of past disasters are as follows: a) embankments on soft ground, b) embankments on slopes, c) embankments at boundaries between cutting and embankment, d) embankments on ground with sloped bedrock, and e) particularly high embankments.

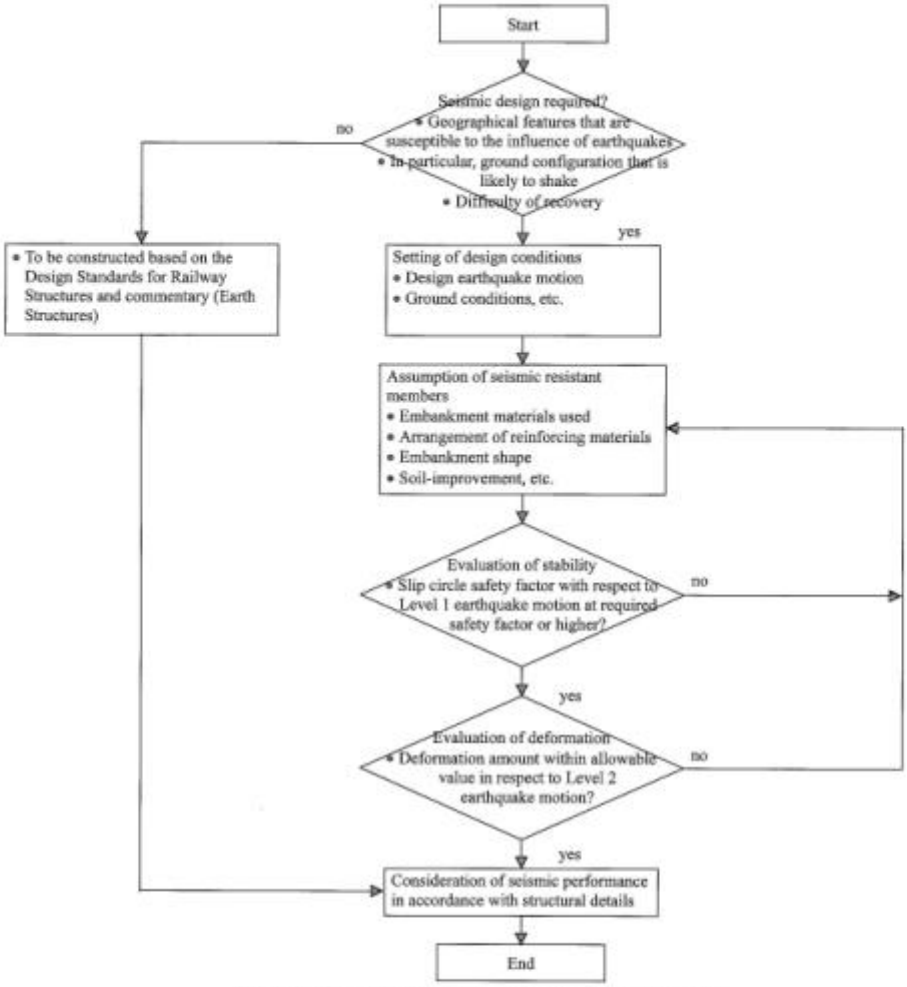
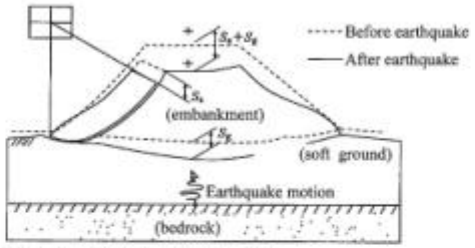


Figure 20 Flow Chart for Seismic Design of Embankments

b) Computing Embankment Response Values

In computing embankments response values, the safety factor with respect to Level-1 earthquake motion is obtained by the circular arc slip method. For Level-2 earthquake motion, however, a required safety factor of more than 1.0 cannot be ensured by the circular arc slip method. Instead, the amount of residual embankment deformation is computed by adding, i) the amount of residual deformation caused by deterioration of the deformation coefficient, and ii) the amount of deformation caused by liquefaction of soft ground as necessary, to the amount of sliding deformation, which is computed by the Newmark method. However, the amount of deformation computed by this method is fairly unreliable because of the low-level of accuracy when accounting for the heterogeneity of the ground and embankments.

Figure 21 illustrates the amount of embankment settlement during an earthquake.



(Schematics of embankment settlement)
$S_T=S_s+S_e+S_g<S_a$
where,
S_s: settlement causing by sliding of slipping clods of earth
S_e: slide-in settlement of embankment
S_g: slide-in settlement of ground
S_a: allowable settlement amount

Figure 21 Amount of Embankment Settlement During an Earthquake

c) Verification of Seismic Performance of Embankments

The seismic performance of embankments is set based on the difficulty of recovery of a structure after an earthquake. The amount of settlement is used as the evaluation index in considering computational accuracy.

The seismic performance levels of embankments are defined as follows.

Deformation level 1: No damage due to slipping failure and almost no residual displacement occurs.

Deformation level 2: Damage where slipping failure occurs, accompanied by small or slight residual displacement.

Deformation level 3: Damage where considerable residual deformation of embankment and the ground occurs, and where partial reconstruction of embankments is required.

Deformation level 4: Damage where destructive failure of embankments is caused by the liquefaction of the ground, and where total reconstruction is required.

Deformation levels 1, 2 and 3 correspond to Seismic performance I, II and III of structures, respectively. Therefore, Level-1 earthquake motion must be verified to satisfy deformation level 1, and Level-2 earthquake motion must be verified to satisfy deformation level 2 or 3 according to the importance of the embankments.

Tables 11 and 12 show extent of damage and standard settlement amounts for embankments and abutments.

Table 11 Degree of Damage and Standard Settlement Amounts for Embankments

Deformation Level	Degree of Damage	Extent of Settlement Amount
1	No damage	No damage
2	Slight damage	Settlement amount less than 20 cm
3	Recovery possible by temporary measures	Settlement amount more than 20 cm and less than 50 cm
4	Long time required for recovery	Settlement amount more than 50 cm

Table 12 Degree of Damage and Standard Settlement Amounts for Abutments

Deformation Level	Extent of Damage	Extent of Settlement Amount
1	No damage	No damage
2	Slight damage	Differential settlement at abutment back less than 10 cm
3	Recovery possible by temporary measures	Differential settlement at abutment back less than 20 cm
4	Long time required for recovery	Settlement amount more than 20 cm

(4) Seismic Design of Retaining Walls and Abutments

If the overturning or tilting of the main body or the failure of a concrete wall body at retaining walls and abutments occurs, it would become a large problem because time-consuming repair work is required. Since the major function of retaining walls and abutments is to bear earth pressure, its deformation during an earthquake has a high possibility to be cumulated in one direction. This phenomenon should be considered in seismic design. The following describes seismic design mainly for retaining walls.

a) Loads to be Considered

Earth pressure and the inertia force are typical loads that act in wall bodies during an earthquake. These loads are strongly influenced by the characteristics of earthquake motion at the ground surface.

The earth pressure during an earthquake is determined by the behavior of the backwall soil and the retaining wall bodies. The pressure varies because of phase differences between them due to the yielding of the wall and plasticization of backwall soil. However, since the various soil constants of backwall soil cannot be accurately ascertained and phenomena, such as the rubbing-in of soil into the gap between the back ground and wall body by vibration, occur, the structure and back ground are considered, in design, to behave in the same phase. In other words, the behavior of a structure is assumed to be mainly governed by that of back ground, and, in practical terms, the acceleration of earthquake motion of the ground surface may be used to compute the pressure.

In the seismic standard, a new method is prescribed to provide an appropriate active earth pressure when subjected to large earthquake motion based on the experiences of disasters and model vibration test results.

b) Computing Response Values of Retaining Walls

The dynamic analysis methods should be basically used in the computation of the response values of retaining walls. However, the deformation during an earthquake has a high possibility to be cumulated in one direction at retaining walls, so it makes difficult to model the structure and back ground properly. For this reason, the load-displacement relationship is computed by static nonlinear analysis (pushover analysis) to determine the yield point, and the Newmark's equal energy criterion shown in Figure 22 is introduced to compute the response values.

Figure 23 shows an example of a structural analysis procedure for Level-2 earthquake motion.

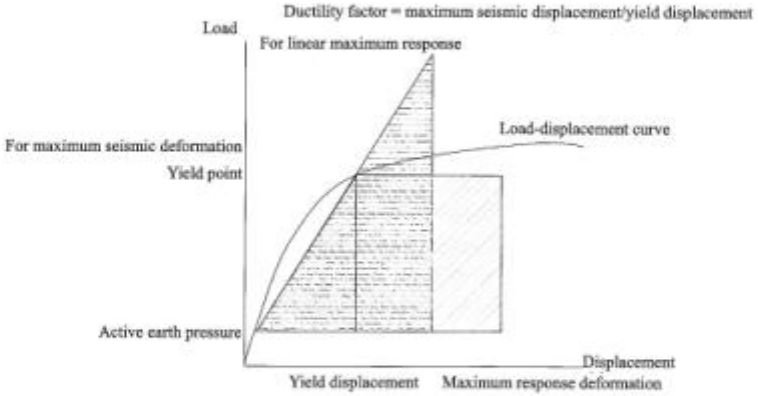


Figure 22 Newmark's Equal Energy Criterion

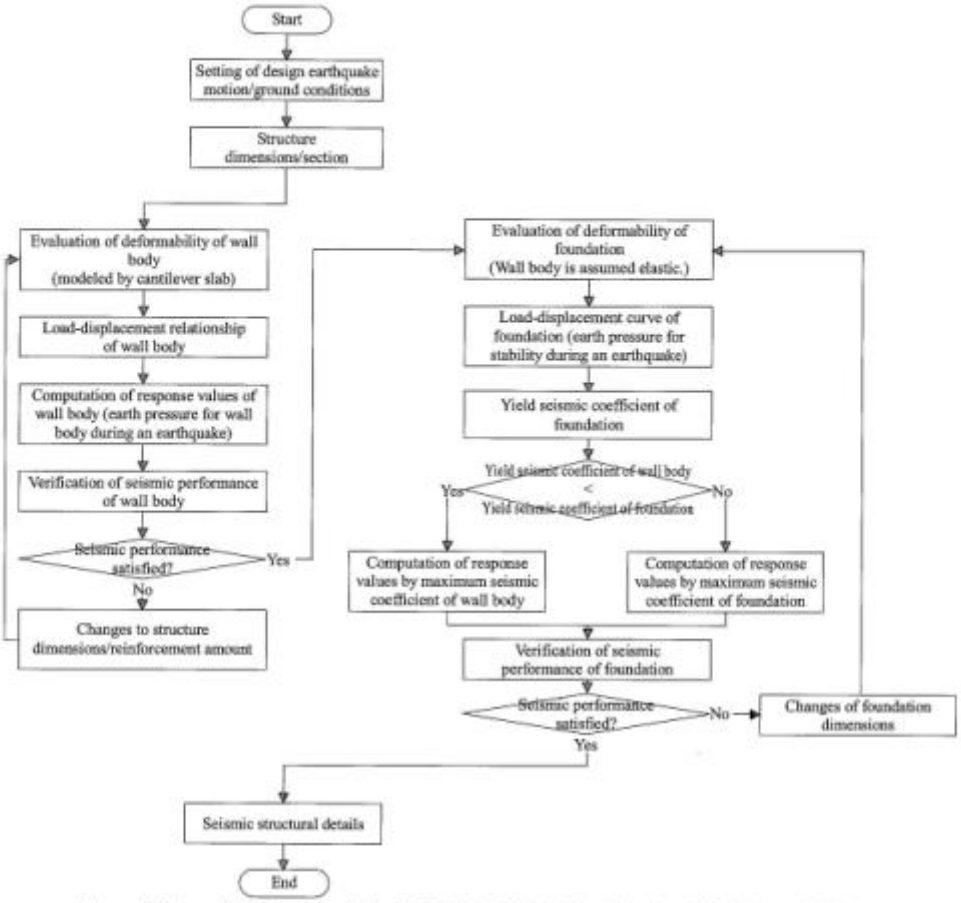


Figure 23 Flow of Structural Analysis for Retaining Wall subjected to Level-2 Earthquake Motion

c) Verification of Seismic Performance of Retaining Walls

Three indices a) stability level of the foundation, b) damage level of wall bodies and c) residual displacement (maximum displacement) are used to express the seismic performance of retaining walls.

Slightly severer limit values are set for the retaining wall because the stability level limit values prescribed for pier foundation give unsafe judgment for the retaining wall of which deformation cumulates in one direction. The damage level of wall bodies, on the other hand, is following that of members. The residual displacement is difficult to evaluate, so it is merely recommended to restrict the settlement of backwall soil of abutments within a range that permits slow-speed running after an earthquake.

(5) Seismic Design of Underground Structures, Such as Cut and Cover Tunnels

As the cut and cover tunnels are located in the ground, it had been considered generally to be safe with respect to earthquakes. For this reason, there were no clear seismic design provisions. However, the following is now prescribed in the seismic standard because the cut and cover tunnels suffered severe damages due to shear failure of the center columns in the 1995 Hyogoken-Nanbu Earthquake:

a) Basic Concepts

The behavior of underground structures like cut and cover tunnels subjected to earthquake motion is strongly influenced by the behavior of the surrounding soil. For this reason, it is important in the seismic design to precisely understand the behavior of the soil during an earthquake and to consider the dynamic interaction between the structure and the ground. The nonlinearities of the soil and component members of the structure also must be taken into consideration as they become considerable during severe earthquake motion.

Therefore, in the seismic design, verification of the safety of structural members is generally conducted computing the behavior of the ground during an earthquake and the response of structures (deformation and stress) subjected to ground displacement.

b) Computing Response Values of Cut and Cover Tunnels

When computing response values of cut and cover tunnels, it is important to adopt the evaluation method taking into consideration the dynamic interaction between the soil and the structure. For this computation, it is ideal to use the finite element method that can evaluate dynamic interaction behavior by modeling both the soil and structure simultaneously. However, for the practical design, the seismic deformation method which computes the dynamic behavior of surrounding soil and then applies statically the outcome displacement to the structure through the subgrade reaction is used. In this case it is important to evaluate appropriate soil constants and compute the subgrade reaction.

Figure 24 shows schematics of the method to apply loads in the seismic deformation method.

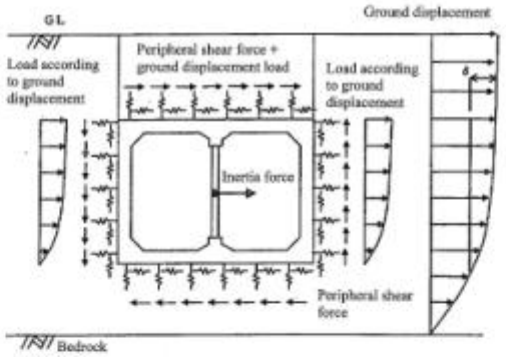


Figure 24 Schematics of Loads According to Seismic Deformation Method

c) Verifying the Seismic Performance of Cut and Cover Tunnels

The member damage level and stability level are taken as indices for evaluating the seismic performance of cut and cover tunnels.

Member damage level 1 should be satisfied for each of the members to ensure seismic performance I against Level-1 earthquakes. On the other hand, seismic performance II should be ensured for Level-2 earthquakes based on the importance of cut and cover tunnels and difficulty of repair after an earthquake. In accordance with this, damage level 2 should be satisfied for members that support trains and members (e.g. floor slabs and sidewalls) that are difficult to repair due to contact with peripheral ground, while damage level 3 should be satisfied for other members.

Though the stability level generally does not need to be verified in general, the stability (settlement or uplift) of the structure should be verified when ground liquefaction occurs.

V DESIGN GUIDEBOOK, DESIGN EXAMPLES, AND DESIGN SOFTWARE

A design guidebook, design examples and design software are available so that new design methods prescribed in the seismic standard can be used smoothly in the practical design.

1. Design Guidebook and Design Examples

The following are available as the design guidebook and design examples of the seismic design.

a) Design Guidebook for Verification of Bridges and Viaducts
b) Design Example for Reinforced Concrete Piers (Spread Foundations)
c) Design Example for Reinforced Concrete Piers (Pile Foundations)
d) Design Example for Caisson Foundations
e) Design Example for Pile Foundations (Influence of Liquefaction/Lateral Flow of Soil)
f) Design Example for Pile Foundations (Seismic Deformation Method)
g) Design Example for Abutments
h) Design Example for Cut and Cover Tunnels (Seismic Design)

2. Design Software

(1) Seismic Design Software Package: SNAP

A design software compliant with the seismic standard and essential for practical design is available. The seismic design software package including the core program SNAP (Static Nonlinear Analysis with Pushover-analysis) covers bridges, rigid frame viaducts, cut and cover tunnels, retaining wall/abutment structures, steel pipe sheet foundations, caisson foundations, and various other structures.

Also available is a ground liquefaction judgment program based on a cumulative damage theory with respect to Level-2 earthquake motion.

(2) ASCARS (Assessment Program for Seismic Capacity of Railway Structures)

A program that can take into consideration entire structural systems as a frame analysis model in compliance with the seismic standard, and that computes response values according to design earthquake motion and verifies seismic performance, is available.

a) Types of structures covered by this software
   - A bridge pier, rigid frame viaduct, arbitrarily shaped structures
   - Pile foundation, spread foundation and foundation modeled by springs.

   The arrangement of the members and foundation shape are arbitrary. They are directly modeled using nodal point coordinates.

b) Members covered by this software
   - RC (Section shapes with rectangular, circular, T, oval and arbitrary), SRC (Section shapes with rectangular, circular, and T), Steel (Section shapes with rectangular and circular), CFT (Section shape with circular)
   - Other: nonlinear characteristics can be directly modeled.

• Interactive mode and display mode

Data is input in interactive mode and the data can be checked on screen as it is input. Together with the complete data check function, this prevents omissions and typos.

• Automatic generation in the analysis model

Consistent results are produced by automatically generating an analysis model and data based on information input from design drawings for standard bridge beams and viaducts.

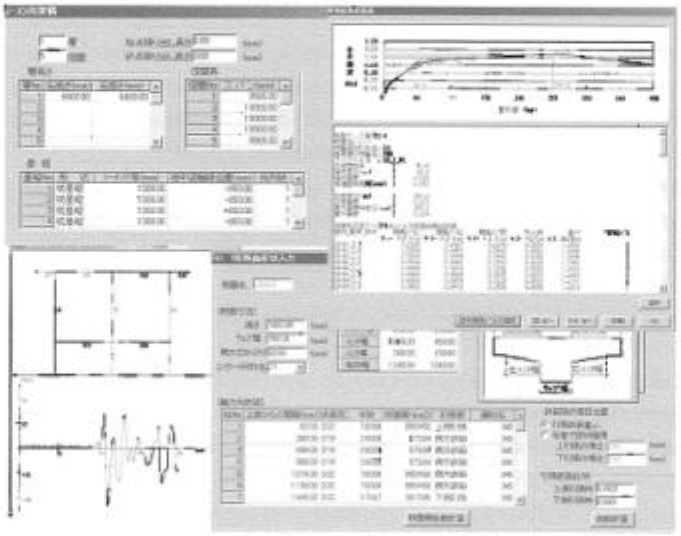


Figure 28 Example of ASCARS Interface

Outline of Design Standards for Railway Structures and Commentary (Seismic Design)

The English edition of the outline of the "Design Standards for Railway Structures and Commentary (Seismic Design)" was produced by the Railway Technical Research Institute (RTRI) to introduce one of the advanced railway technologies established in Japan.
The provisions of the original standard, written in Japanese, are the fruits of discussions in the working committees composed of academics and engineering specialists from railway companies. They are based on the investigation and research of RTRI, as directed by Japan's Ministry of Land, Infrastructure and Transport as a part of ministerial policy to establish railway technical standards.
This document is an English translation summarizing the original standard.
It is our hope that this document helps overseas railway engineers to understand the railway technologies currently being used in Japan.

March 2007

Contact directory

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12.2 Recommendation for Railway Technical Standard in Philippines

1. Standardization of Railway Transport

(1) Obstacles to Railway Development

Essential characteristics of rail transport include: 1) alleviation of road congestion by mass transit, 2) ensuring safety and stable operation, 3) environment-friendly and energy efficient.
On the minus side are the huge initial investment costs, relatively expensive operation and maintenance costs, aside from low financial viability.
In the Metro Manila case, the advantages have often been negated by fragmented developments of the railway lines, sparseness of the railway network, and disregard of users' convenience. As a result, low railway-share and low profitability have being occurred.
In the absence of an explicit technical standard on railways in the Philippines, compatibility of the railway facilities and equipment—tracks, rolling stocks, signal/telecommunication and operation aspects—among the various railway lines cannot be assured. In such a situation, high procurement cost and inefficiency of operation and maintenance are not surprising.

(2) Establishment Strategy for Railway Technical Standard

To formulate the contents of mandatory technical standards, it is necessary to define the rules—from the early stage of design concerning the strength of materials of facilities and rolling stock, safety level of structures, and so forth. If the design and construction are carried out on the basis of these rules (design standards), consistently good structures can be realized automatically.

2. Purposes of Establishing Railway Technical Standards

Specific rules and standards are necessary for railways to carry out safe, high-speed, punctual, and efficient train operation. Therefore, it is essential for the national government to clearly indicate standards on safety conditions and so forth so that railway operators can satisfy a specific level of social requirements by meeting the standards.
Furthermore, various railway operators with different technological power, past achievements and so forth will become able to observe the standards and secure safety conditions and so forth higher than a specific level.
The governments and national railways of individual countries have established compulsory technical standards on railway construction and operation, for such purposes as ensuring of railway safety and maintaining of railway networks.

3. Drawing Up of Railway Technical Standards in Metro Manila

Numerical value regulations can become a factor which hampers development and introduction of new technologies, and also can nullify peculiarities of individual railway organizations or routes, eventually leading to the increase in railway operation costs. Furthermore, there is a possibility that technologies of a specific country (or countries) will become advantageous.
Therefore, in drafting the Technical Standards for the Philippines, the so-called “performance regulations” stipulating performance essential for railways have been adopted, in order to expand the scope of technological freedom of respective railways.
However, since it might be difficult to make technical judgment according to the performance standards alone, such items as “the principles and interpretation of the technical standards” and “the concrete numerical values for reference” are described in Appendix as the interpretation standards (explanation).
The Technical Standards in the main text have been drawn up, based on the assumption that official standards should be established and put in forth by the Government. The interpretation standards

(explanation) have been prepared for the reference of individual railway organizations in making judgment for establishing their technical by-standards.

4. Legislation of Railway Technical Standards

Compulsory standards must be adhered to in each railway company. For this reason, it is necessary for these technical standards to be clearly prescribed in the legal system of the Philippine Government.
Confirmation of compliance with standards can either be carried out by the railway companies themselves, or by the public administration sector. As the basic philosophy, the weight applied to the self responsibility of railway companies shall be raised, the degree of freedom of companies including makers shall be expanded, and administrative involvement shall be held to a minimum.

5. Organization in Charge of Railway Technical Standards

Railway technical standards state regulations which are necessary for securing railway safety, maintaining networks, displaying railway characteristics, securing convenience for users, and taking environmental countermeasures; however, in order to newly establish or revise standards, it is necessary to assign experts in technical standards who are well versed in railway work affairs.

We submitted the following document to DOTC, “Railway Technical Standard in the Philippines” and “Interpretation Guidelines for Technical Standard” are shown from next page.

Railway Technical Standard in the Philippines

Chapter 1 General

1.1 Definition of Terminology

The main technical terms are defined below.

(1) Track gauge : shortest distance between inner side surfaces of two rail heads of a track measured
(2) Main line : track constantly used for train operation
(3) Siding : track other than a main line
(4) Station : place used by passengers to get in and out of trains or for the loading and unloading of cargo
(5) Signaling yard : place mainly used for mutual passing or waiting for a train
(6) Shunting yard : place mainly used for the shunting of rolling stock or the composition of a train
(7) Station, etc. : inclusive term for a station, signaling yard and shunting yard
(8) Depot : place mainly used to accommodate and maintain rolling stock
(9) Rolling stock : locomotives, passenger cars, freight cars and special-purpose cars (rolling stock with special structure and equipment, including a track tester and accident relief car, etc.) used for railway business
(10) Train : a group of rolling stock composed for operation on track outside a station, etc.
(11) Motive power units : electric or internal combustion rolling stock
(12) Block : Simultaneous operation of two or more trains is not allowed in this section
(13) Operation safety devices: signaling safety devices, level crossing safety devices and safety communication devices
(14) Railway signals : signals, signs and markers
(15) Signals : objects indicating the operating conditions of a train, etc. to railway staff
(16) Signaling safety devices: devices to display railway signals and devices to automatically reduce the train speed or stop a train, etc. in accordance with the signal indication in order to ensure the safe operation of a train, etc.
(17) Signs : physical movement and so forth to mutually indicate intentions between railway staff
(18) Markers : objects indicating the position, direction and conditions, etc. of specific items to railway staff
(19) Disabled persons: persons who find it difficult to travel by rail without help due to a physical reason(s)

1.2 Preparation of Implementation Standards

1.2.1 A railway proponent shall prepare “Implementation Standards” based on the Technical Standards prior to the construction of a railway line and shall submit them to the Department of Transport and Telecommunications.

1.2.2 The DOTC shall be entitled to issue an order to alter the “Implementation Standards”.

1.3 Prevention of Construction Accident

Slope, cut, excavation, embankment, piling, etc. of railway facilities shall be constructed so as not to cause any harm to persons.

1.4 Prevention of Loud Noise

Railway operator shall strive to prevent loud noise due to train operation.

1.5 Act on Promotion of Smooth Transportation, etc.

Railway operator shall provide facilities for smooth transportation, etc. of elderly persons, disabled

persons, etc.

Chapter 2 Personnel

2.1 Security of safe operation

Railway operator should strive to ensure the security of train operation, etc. by use of railway employees' knowledge, their skill and operation-related equipment.

2.2 Education and Training of Railway Employees

2.2.1 Railway operator shall provide the necessary education and training for those railway employees directly related to train operation.

2.2.2 Qualification of Railway Employees (Obtaining of Certificate) Motive power units (electric rolling stock; internal combustion rolling stock) shall only be operated by those who have obtained the certificate for train drivers published by DOTC or official agencies.

Chapter 3 Tracks

3.1 Gauge and Slack

The gauge shall be decided to ensure the smooth running of rolling stock, taking the structure of vehicles and others into consideration. At curves, appropriate slack shall be provided in accordance with the curve passing performance of rolling stock.

3.2 Railway Alignment

A curve radius and a grade shall be decided to ensure the high-speed and mass transport, taking the maximum speed and the traction load, etc. into consideration.

3.3 Curve Radius

3.3.1 An appropriate curve radius shall be adopted based on the standard minimum curve radius to ensure the smooth running of rolling stock, taking the curve passing performance and running speed of vehicles and the cant, etc. into consideration.

3.3.2 In the case of a curve along a platform, its radius shall be as large as possible to ensure the smooth boarding/alighting and safety of passengers.

3.4 Cant

A circular curve shall be provided with cant in accordance with the gauge, radius of curve and speed of rolling stock, etc. It must be ensured that the largest value of the cant will not adversely affect the stability, etc. of rolling stock which is either travelling at a low speed or which is stationary.

3.5 Transition Curve

A transition curve shall be provided between a straight line and a circular curve or between two circular curves depending on the structure, degree of cant and travelling speed of rolling stock, etc.

3.6 Grade

The grade of the track shall be determined in consideration of the power performance, braking performance and speed of operation, etc. of rolling stock and the standard steepest grade for main lines is given below. A grade as gentle as possible shall be introduced on a main line along a platform and storage siding, etc., taking the rolling motion, etc. of rolling stock into consideration.

3.7 Vertical Curve

In places where the grade changes, a vertical curve shall be introduced to prevent the derailing of rolling stock and to prevent any unpleasant feeling on the part of passengers, taking the speed of train operation and rolling stock performance, etc. into consideration.

3.8 Construction Gauge

The construction gauge shall be determined to ensure the safety of rolling stock and passengers, etc. vis-a-vis the pitching or rolling, etc. of travelling rolling stock and no structure shall be introduced within the construction gauge.

3.9 Width of Formation Level

The width of the formation level shall be determined to ensure the safety of passengers and workers, etc. in consideration of the pitching motion of travelling rolling stock and the track structure, etc.

3.10 Center-to-Center Distance of Adjacent Tracks

3.10.1 The center-to-center distance of adjacent tracks shall be determined by adding a margin to the width of rolling stock in consideration of pitching motion to ensure its safety and of the passengers.

3.10.2 This distance shall be widened at curves, etc. in response to the expected swaying, etc. of rolling stock.

3.11 Track and Civil Engineering Structures

Track and civil engineering structure shall be determined to ensure the safety and security of the rolling stock and railway facilities in consideration of the structure of rolling stock, train weight and sub-grade conditions, etc.

3.12 Building Construction

Buildings shall be constructed so as not to compromise the safety of the rolling stock and passengers.

3.13 Disaster Prevention Devices, Safety Devices and Evacuation Devices

Disaster prevention and safety devices shall be installed to avoid entry of unwanted persons and of falling objects onto the tracks. Similarly, measures shall be applied to prevent damage to the facilities which may be brought about by accidents or any untoward incidents happening in the perimeter area. In addition, evacuation devices designed to safely guide passengers at the time of an accident or an emergency will be set up.

3.14 Underground Station Facilities

Underground Station, tunnel connected to this station and long tunnel shall be equipped with ventilation facilities to meet its specified capacity.

Chapter 4 Station Facilities

4.1 Track Layout of Station

4.1 Specifications for station facilities such as effective track length, platform length/width, etc. shall be determined so as to ensure smooth train operation with consideration for passenger safety.

4.2 Smooth transfers between railway line

Railway proponents shall plan through train services by constructing or improving railway facilities in cooperation with other railway proponent, or, shall plan the stations in the same location with or adjacent to the stations of other railway lines to facilitate transfers between railway lines by proponents.

4.3 Smooth transfers between railway and road-based and other modes of transport

Railway proponents shall plan appropriate type of station plazas in cooperation with relevant road management agencies/operators prior to the construction or improvement of railway facilities to allow smooth transfers from road-based and other modes of transport.

4.4 Depot

Depot shall be capable of sufficient capacity of stabling area in accordance with rolling stock to introduce.

Chapter 5 Power Facilities

5.1 Contact Line

5.1.1 A contact line, a feeder line, its attached equipment and electric wire, and protection facilities shall be installed according to a situation of installation place, a method of installation and a standard voltage so as not to cause any electric shock and/or fire.

5.1.2 Contact lines shall be capable of collecting power evenly and continuously in accordance with the speed of the train and the power collection method of the rolling stock.

5.1.3 The voltage of contact lines shall be maintained at a stable level sufficient to ensure smooth train operation.

5.1.4 Return rail shall be designed in such a way that the leakage current from rail to ground is minimized.

5.2 Substations

5.2.1 Substations shall be constructed in such a way that their safety and security are ensured.

5.2.2 Substation equipment shall have the capacity to meet its specified load as well as withstand specified overloading conditions.

5.2.3 Substations shall have a power control center, and shall be equipped to cope with failures.

5.2.4 Substations shall be designed such that other substations can provide the power required for train operation even when one of the substations is down.

5.3 Electrical Facilities

An electrical equipment, a distribution board and same others shall be installed so as not to cause any electric shock and/or fire.

5.4 Lighting Facilities

Lighting facilities shall be provided inside and under the stations and tunnels to facilitate the boarding/alighting of passengers and to guide passengers to safety in case of emergency.

Chapter 6 Operation Safety Devices

6.1 Installation of Operation Safety Devices

6.1.1 Railway lines shall be equipped with operation safety devices.

6.1.2 Operation safety devices shall be installed so as not to cause any harm to the safe operation of a train, etc. even if they experience a malfunction.

6.2 Devices to Ensure Safety between Trains

6.2.1 A device to ensure a block section shall conform to the following criteria. It must make the signal indication corresponding to the conditions of the block section on the route or guarantee the block section.

6.2.2 A device to control the distance between trains shall conform to the following criteria.

a. It shall be capable of indicating the signal in accordance with the distance to a train, etc. on the route.

b. It shall automatically reduce the train speed or stop the train at a position to prevent a collision or derailing in accordance with the distance between trains or the track conditions.

6.2.3 A device to ensure safety between trains in a single track section shall be capable of preventing the simultaneous operation of trains running in opposite directions.

6.3 Indicating Device of Railway Signals

6.3.1 The structure, indication method and installation method of an indicating device for railway signals shall be capable of making the correct signal indication to prevent the erroneous recognition of a signal.

6.3.2 A signal device shall be installed at the starting point of a block section, and a corresponding signal indication device shall be installed at a point in rear which enables a train to reduce its speed in accordance with the signal indication or to stop.

6.3.3 At a crossing or branching site, a signal indicating device shall be installed in a suitable position to prevent derailing or the disruption of a route by another train, etc.

6.3.4 In the case of a cab signal, the starting point of the block section shall be indicated depending upon the need.

6.4 Interlocking Device

6.4.1 An interlocking device shall be installed at a crossing or branching site.

6.4.2 An interlocking device shall be capable of mutually interlocking a signaled route and other signals and points which may disrupt operation on the signaled route.

6.5 Remote Control Device

6.5.1 A device which remotely or automatically controls an interlocking device shall not disrupt the locking function of the interlocking device.

6.5.2 When the manual control of a remote or automatically controlled interlocking device is intended, there must be a system at the control station to display the presence of a train, etc. on the track and other information.

6.6 Automatic train stop of decelerating device

When trains are operated in block system equipment capable of automatically stopping train or decelerating its speed according to train conditions as well as signal indication shall be installed, except train can be safely depending on the status of train operations as well as the condition of tracks.

6.7 Automatic Train Operation Device

6.7.1 Automatic Train Operation device on driverless train shall conform to the following requirement.

a. It must not make a train leave until safety of passengers is guaranteed.

b. It shall be capable of making target speed lower than speed directed by control information based on device to control the distance between trains. In addition, required functions on operation safety will be set up, such as smoothly running speed, etc.

c. It shall automatically stop the train at the place not to compromise the safety of passengers.

6.8 Train Detection Device

A train detection device used for the operation safety system shall be capable of detecting a train, etc. without fail while preventing any disruption of its function by induction, etc.

6.9 Communication System for Safety Purposes

A communication system for safety shall be installed between such facilities as stations and so forth, substations, operation command centre and power command office, etc. for safety and operational purposes.

6.10 Installation of Communication Cables

Overhead communication cables shall be installed at a sufficient clearance/distance so as not to disrupt other means of transport and shall not contact power cables in order to avoid any physical harm to persons.

6.7 Railway Crossing Safety Facilities

6.7.1 Railway crossing safety facilities shall be provided at railway crossing.

6.7.2 Railway crossing safety facilities shall be capable of informing the approach of a train to persons using the crossing road and of shutting down traffic on such a road with the approach of a train. They must be at least capable of informing that a train is approaching even if other operations are impossible due to the specific circumstances of the facilities.

6.7.3 Railway crossing safety facilities shall have an additional device to inform of an obstruction on a crossing road by an automobile if such an additional device is deemed to be necessary considering the train speed, traffic volume on the road and railway track and types of passing automobiles, etc.

Chapter 7 Rolling Stock

7.1 Size Limits of Rolling Stock

7.1.1 Rolling stock shall not exceed the specified size limits of rolling stock.

7.1.2 Height of anti climber shall be identical.

7.2 Constrains with respect to Tracks and Structures
Rolling stock shall not impose a heavier burden than that bearable by tracks and structures.

7.3 Stability
Rolling stock shall be capable of providing a stable running performance under the anticipated conditions.

7.4 Running Gear

7.4.1 Running gear shall be solid with sufficient strength, shall be capable of ensuring the safe as well as stable running of rolling stock and shall not damage the track.

7.4.2 The distribution of the axles of a car shall allow passing of the minimum radius of the running line without any problems.

7.4.3 The suspension mechanism shall have a sufficient buffer capacity and should be capable of securing stable shock absorbing movement against shock from the track.

7.5 Motive Power Apparatuses

7.5.1 Electric equipment of electric circuits of rolling stock shall conform to the following criteria.

a. Electric equipment shall not cause electric shocks and/or fire accidents when thebreakage of electric insulation takes place.

b. Electrical equipment shall not cause any inductive disturbance to other electric circuits.

c. Current collecting device shall be that which can ensure electric insulation against the car body and which can smoothly follow contact wires while running.
d. Pantographs of a train shall be able to be simultaneously folded from crew cabin.

7.5.2 A motive power apparatuses shall be installed so as to prevent the floor and walls from generating heat or causing a fire.

7.6 Brake Equipment

7.6.1 The brake equipment of rolling stock shall conform to the following criteria.

a. The brake equipment shall be capable of reducing the speed or stopping rolling stock in motion without failure in accordance with specified conditions.

b. Brake equipment shall be controlled throughout all cars in formation when operated from the crew section.

c. Brake equipment shall automatically produce braking force in case any of cars in formation is disconnected.

7.6.2 Rolling stock shall be equipped with an independent braking function depending on the type of rolling stock in case of failure of the normal brake equipment.

7.7 Car Body Structure
The body of rolling stock shall be solid with sufficient strength and shall be able to withstand operation under the anticipated usage.

7.8 Structure to Mitigate Excessive Noise

Rolling stock shall have a structure which mitigates excessive noise generated by the running train.

7.9 Structure of Crew Cabin

7.9.1 The crew Cabin shall have a doorway for the crew and shall be so structured to protect the operation of the crew from passenger interference. Devices and equipment required for train operation shall be protected so that they cannot be touched by passengers.

7.9.2 The front and sides of the crew section shall provide the view required for operation by the crew in accordance with the operating conditions.

7.10 Structure of Passenger Cabin

The structure of passenger cabin shall conform to the following requirement.

a. Windows shall have sufficient strength and shall not touch any wayside structures at open condition and there shall no possibility for passengers to fall down from windows.

b. The passenger room shall have lighting equipment required at night or when running through tunnels, and shall be maintained enough brightness inc calse of emergency.

c. Toilets shall be provided depending on the usage and operation distance of rolling stock.

d. At least one car of the passenger train shall be provided with a space to accommodate wheelchairs.

7.11 Structure of Passenger Door

7.11.1 Passenger door will have a structure which ensures the safe and smooth boarding and alighting of passengers and there shall be no danger of passengers stumbling.

7.11.2 The level difference between the doorway and the platform shall be as small as possible.

7.12 Automatic Door Control Device

7.12.1 The automatic door control device installed at the doors of passenger doorway shall be capable of securing the safety of passengers while the rolling stock is running and shall allow the simultaneous opening or closing of all doors and shall be able to confirmation of the door status by the crew.

7.12.2 The doors equipped with an automatic door control device shall allow their manual opening in case of an emergency.

7.13 Structure of Gangway

A gangway shall have a structure which allows the safe and smooth passage of passengers.

7.14 Structure of Emergency Exit

When arrangement of door is not easy for the passengers to escape in emergency rolling stock shall have emergency exit and such emergency exit should be easy for train crew to confirm the whether it is open or close.

7.15 Coupling Device

The device required to connect rolling stock shall be solid with sufficient strength and shall be capable of connecting the cars securely withstanding vibrations and impacts.

7.16 Structure of Rolling Stock for Transport of Special Cargo

Tankers and other freight cars for the transportation of special cargo shall have a structure to prevent disasters originating from the said cargo.

7.17 Equipment of Driver's Cabin

The crew cabin which is used to operate rolling stock shall be equipped with such devices and equipment as acceleration and deceleration control and others required for operation in accordance with the usage of rolling stock.

7.18 Air Compressor and Accessories

The air compressor (source of compressed air) shall be capable of preventing abnormal rise of the compression pressure and functional decline due to the water produced by air compression.

7.19 On-Board Devices

On-board devices shall conform to the following criteria.

a. Rolling stock shall be equipped with device which allow verbal communication or the exchange of signs between crew members or between a crew member and ground staff, depending on the facility conditions.

b. The car at the front end of the train shall have a device capable of warning of danger by means of a whistle at its front end.

7.20 Marking on Rolling Stock

Rolling stock shall have a marking which allows the identification of individual cars.

7.21 Fire Prevention for Rolling Stock

7.21.1 Onboard wires shall not cause fire or spreading of fire even in the presence of anticipated heat generating sources.

7.21.2 On-board heat generating equipment shall not adversely affect other sections of rolling stock.

7.21.3 Vehicle body shall be composed of construction and materials which can prevent breaking out and spreading of fire

7.22 Continued Functioning of Devices during Power Interruption.

Devices designed to ensure the safety of train operation and passengers, and devices required for passenger evacuation shall be capable of continuing their function for a specific period of time when their main power supply is cut off.

Chapter 8 Maintenance of Facilities and Rolling Stock

8.1 Maintenance of Railway Facilities and Rolling Stock

8.1.1 Railway facilities shall be regularly maintained and inspected in a condition which permits the safe operation of trains, etc.

8.1.2 Operation safety devices shall be maintained in a state which permits their accurate functioning.

8.1.3 Rolling stock shall not be used unless its condition allows safe operation.

8.2 Inspection and Trial Operation of New Facilities and Rolling Stock, etc.

8.2.1 Newly constructed/installed, improved, modified or repaired tracks and electric power equipment and newly built, procured or modified rolling stock shall only be used after satisfactory inspection and trial operation.

8.2.2 Newly installed, modified or repaired operation safety devices shall only be used after satisfactory inspection and trial operation.

8.2.3 When train operation is resumed after disaster or incident or suspended tracks and power supply systems such tracks and power supply systems shall be inspected and if necessary trial operation shall be conducted before resumption of the facilities.

8.2.4 Wen rolling stocks are procured, modified or repaired such rolling stocks shall not be provided for revenue operation before inspection and running test however modification or repair is minor inspection and running test can be omitted

8.3 Patrolling of Facilities

8.3.1 Tracks and contact lines shall be patrolled in accordance with the condition of the line and operation.

8.3.2 When there is a prospect of a natural disaster adversely affecting train operation, the relevant tracks shall be monitored. If necessary, the operating speed of the said track shall be restricted or operation itself shall be suspended.

8.4 Regular Inspection of Railway Facilities and Rolling Stock

8.4.1 In regard to the regular inspection of railway facilities and rolling stock, the interval, subject sections and method of inspection shall be stipulated in correspondence with the type, structure and conditions of use, etc. of such railway facilities and rolling stock.

8.5 Recording of Inspection Data

When the regular inspection of railway facilities and rolling stock is conducted, the inspection data, location and contents shall be recorded and stored.

Chapter 9 Train Operation

9.1 Train Composition

The maximum number of connected cars of a train shall be determined based on the facility conditions and the performance, structure and strength of the cars.

9.2 Brake Force

9.2.1 The integrated braking force of a train shall be that which is suitable for the track conditions and operating speed.

9.2.2 The details of the brake test for a train and the method of verifying its operation status shall be stipulated separately.

9.3 Boundary of Station

The boundary of a station shall be the position at which the home signal or home marker is located.

9.4 Emergency Braking Distance, etc. of Trains

9.4.1 The emergency braking distance shall be stipulated separately.

9.4.2 The braking mechanism of a train shall be continuous braking.

9.4.3 The ratio of brake axles to the total number of axles of the train shall be stipulated separately.

9.5 Train Operation

9.5.1 A main line outside a station shall only be used for train operation.

9.5.2 Departure, passing and/or arrival times at a station shall be pre-determined for train operation.

9.5.3 “Keep-right” or “Keep-left” shall be stipulated separately for the double-track sections where trains are operated.

9.6 To Ensure Safety between Trains
The train should be driven by either one of the following methods to ensure safety between trains.

a. By means of block section

b. By means of device to ensure safety between trains

c. By means of operation by sight of motive power unit’s driver and taking conditions required for safety operation of train into consideration

9.7 Backward Operation
In principle, a train shall not engage in backward operation, etc. However, this does not apply to trains engaged in the repair work of tracks and other facilities, relief trains and trains in trial operation.

9.8 Train Protection
When an abnormality occurs during train operation, the train shall be immediately stopped, and measures for train protection shall be taken.

9.9 Track Closure

9.9.1 In principle, works on track facilities and electrical equipment shall be conducted while track is closed and isolated from running trains.

9.9.2 The procedure for the designation, commencement and ending of track closure shall be stipulated separately.

9.10 Shunting of Rolling Stock
That the shunting of rolling stock shall be conducted using cab signals, shunting signals, guiding signals and/or shunting markers, etc. and other requirements shall be stipulated separately.

9.11 Operation Speed

9.11.1 The maximum operation speed of a train shall be determined taking the tracks, electrical lines and

structure of the rolling stock into consideration.

9.11.2 Should reverse operation be required, the speed of operation shall be stipulated separately.

9.11.3 Speed limit, shunting speed, etc. which are indicated by signals shall be stipulated separately.

9.12 Safety between Trains

9.12.1 A train shall be operated by means of employment of the block system.

9.12.2 The substitute block system shall be stipulated separately.

9.12.3 The method of operation solely relying on the driver's judgement shall be stipulated separately.

9.13 Railway Signals and Operation

A train or rolling stock shall be operated in accordance with the conditions indicated by the railway signals.

9.11 Response to Natural Disaster

The procedure to be taken when there is a hazard vis-a-vis train safety due to meteorological conditions (rain, wind or earthquake, etc.) shall be stipulated separately.

Chapter 10 Reporting of Railway Accidents

10.1 Objective

The objective of the provisions of Chapter 10 is the prompt reporting and dealing with railway operation accidents and incidents which impede railway operation in an assured manner.

10.2 Scope of Application

The method to report and deal with a railway operation accident of one's own company or such an accident of another company which is related to the staff and/or rolling stock of one's own company shall be stipulated separately.

10.3 Terminology

Such terms as "a killed person" and "an injured person", etc. shall be stipulated separately.

10.4 Stipulations Regarding Railway Operation Accidents, etc.

10.4.1 Accidents shall be classified into railway operation accidents and incidents disrupting railway operation.

10.4.2 A railway operation accident shall be an accident which entails casualties and/or material damage resulting from the operation of a train, etc.

10.4.3 An incident which disrupts railway operation shall be a minor accident which involves casualties and/or material damage due to the operation of a train, etc. and which does not fall in the category of a train operation accident. The scope of such an incident shall be stipulated separately.

Interpretation Guidelines for Technical Standard

1. Track Gauge

Track gauge is the most basic item to be identical for compatibility with rolling stock and track.
Track gauge is distance of inner side of two rails. It shall be measured 14mm below the level of rail top.

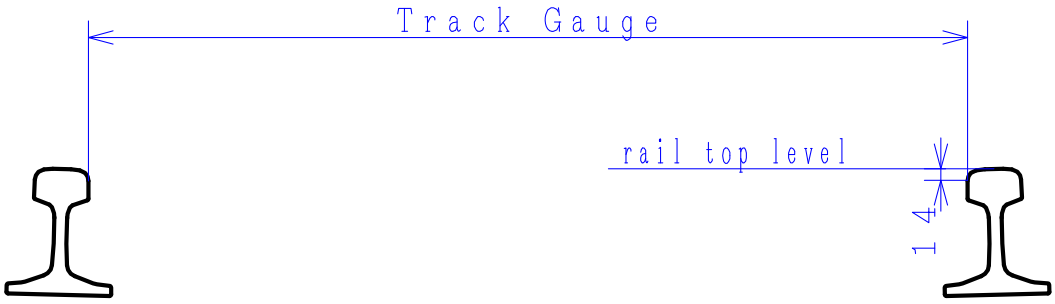


Figure *.1.1 Track Gauge

In the Philippines 2 types are applied for public transportation.

1,435mm :	Line1, Line2, Line3
1,067mm:	PNR

1,435mm is called as standard gauge and it is applied in many countries all over the world.
1,067mm is applied in the Philippines, Japan, Taiwan, Indonesia, New Zealand and some countries in Southern Africa. Considering the compatibility of railway network no other gauge shall be applied in the Philippines.

2. Wheel Profile

Even the track gauge is identical it dose not mean that any train can run on the line even the structure gauge is cleared. Wheel type is classified roughly into two groups, one is for heavy rail and the other is for light rail like tram line.
Figure *.2.1 shows the wheel profile of Line 1.

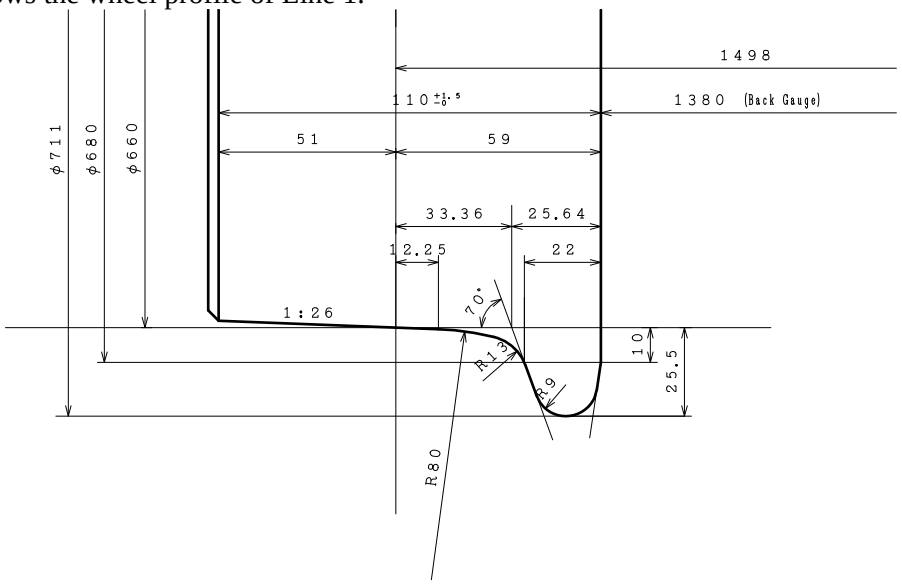


Figure *.2.1 Wheel Profile of Line 1

Figure *.2.2 shows the wheel of light rail and wheel of heavy rail putting at track center. Back gauge heavy rail is smaller than that of light rail and flange width of heavy rail is bigger than that of light rail.

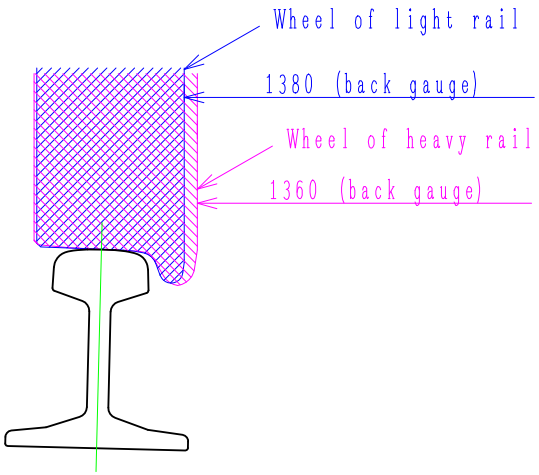


Figure *.2.2 Wheel for Light Rail and Heavy Rail

Clearance of flange way at switch is highly related to the back gauge. Flange way of light rail is narrower than heavy rail.

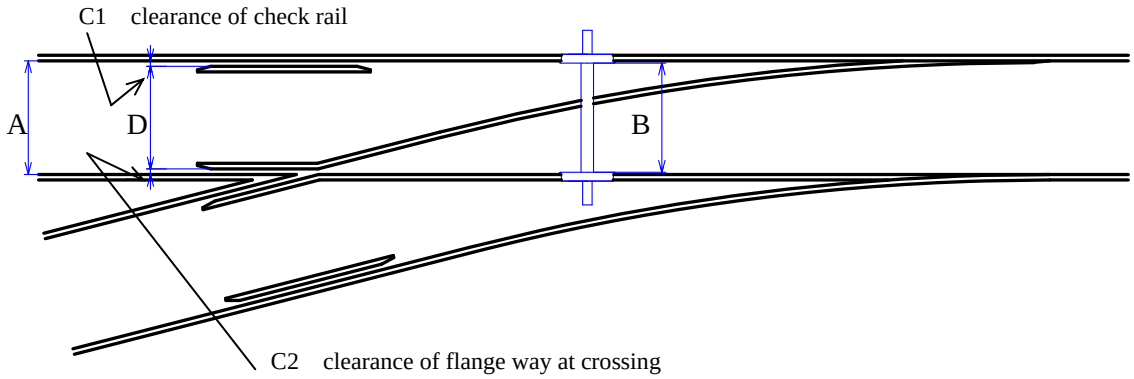


Figure *.2.3 Wheel Set at Turnout

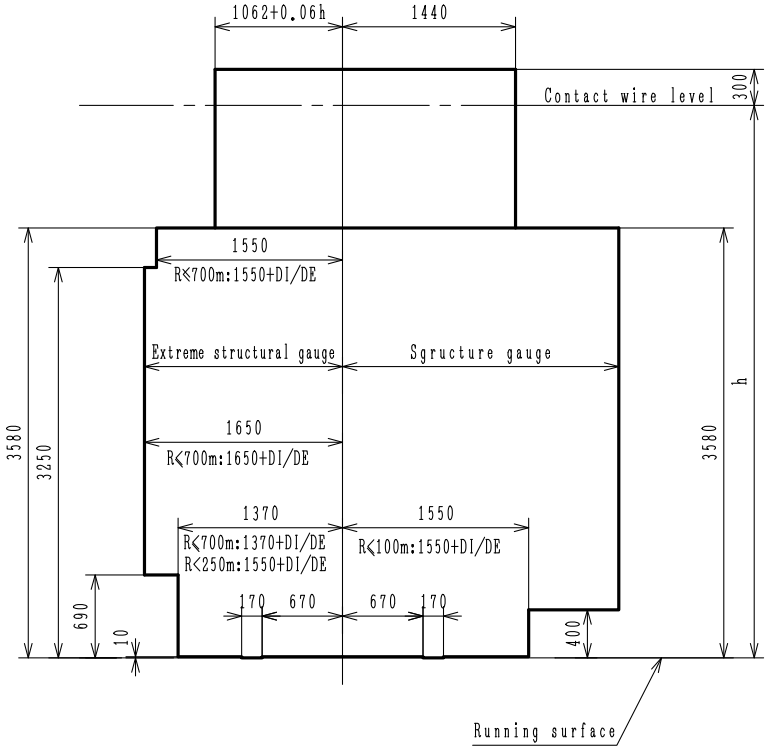
In figure *.2.3 when back gauge of wheel (B) is smaller than dimension D wheel will be stacked at crossing. Dimension D can be calculated by subtracting C1 and C2 from track gauge (A). C1 is clearance between check rail and main rail and C2 is clearance of flange way at crossing rail.
In the projects of Line 1 C1 is specified 31mm and C2 is specified 37mm. Dimension B becomes 1367mm. Wheel of heavy rail cannot pass the switch of light way. Also there will be a risk of derailment for the wheel of light rail passing the switch of heavy rail.
Wheel profile shall be identical for the railway line.

3. Construction Gauge and Rolling Stock Gauge

Construction Gauge and Rolling Stock Gauge shall be defined so that trains can run safely on the line without confliction with wayside structures or other trains. However such gauges are not clearly established in the rules or regulations.
In case of capacity expansion of Line 1 only construction gauge and rolling stock shall be designed not to hit to construction gauge in any case of operation. Rolling Stock supplier has to confirm by drawing

kinematic envelope of rolling stock. Figure *.3.1 shows the construction gauge of Line 1 in tender document and Figure *.3.2 shows kinematic envelop of third generation train submitted by rolling stock manufacturer.

h : 4.6m in open line (recommended value)
h : 5.8m in Light maintenance hall
h min. : 4.3m
h max, : 6.0m



DI/DE : Vehicle´s overthrow in curve

DI (mm) : (inside overthrow of curve) 12600/R
DE (mm) : (outside overthrow of curve) 13500/R
R (m) : Radius of curve

Figure *.3.1 Construction Gauge of Line 1

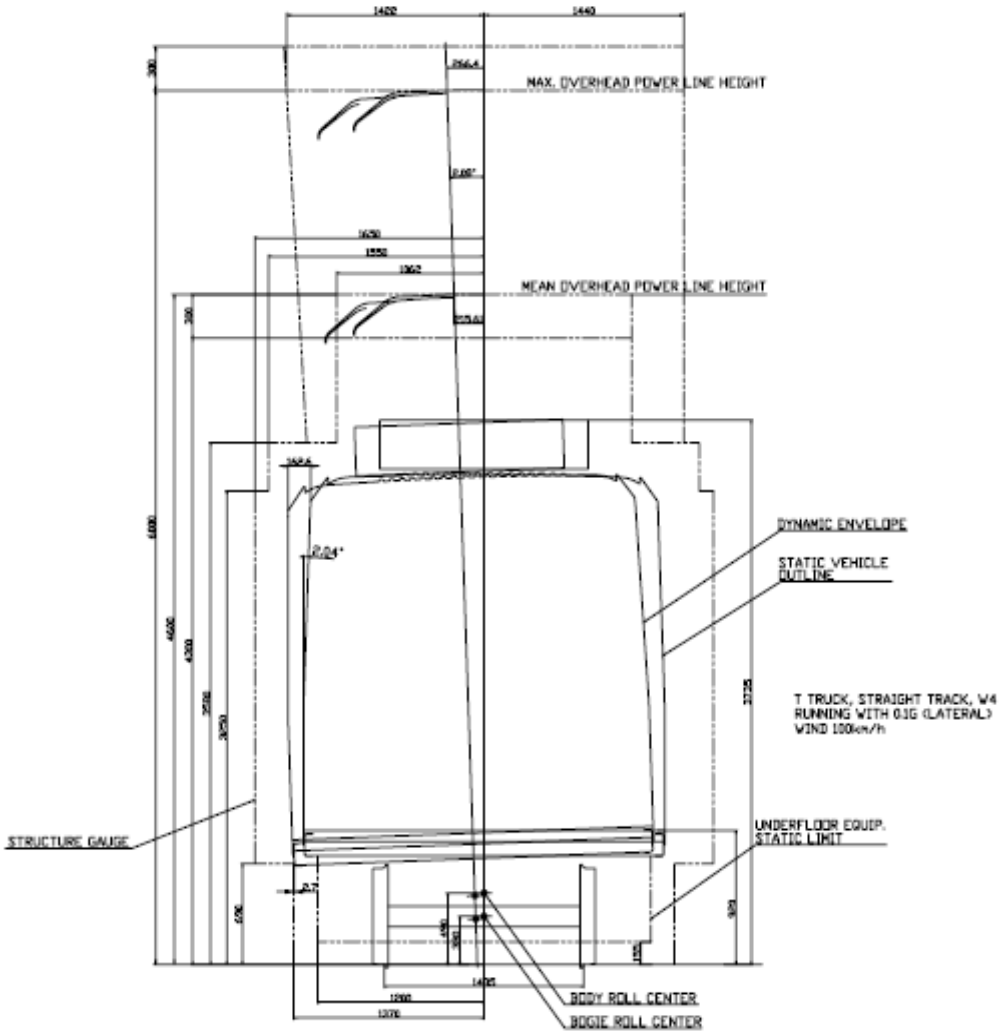
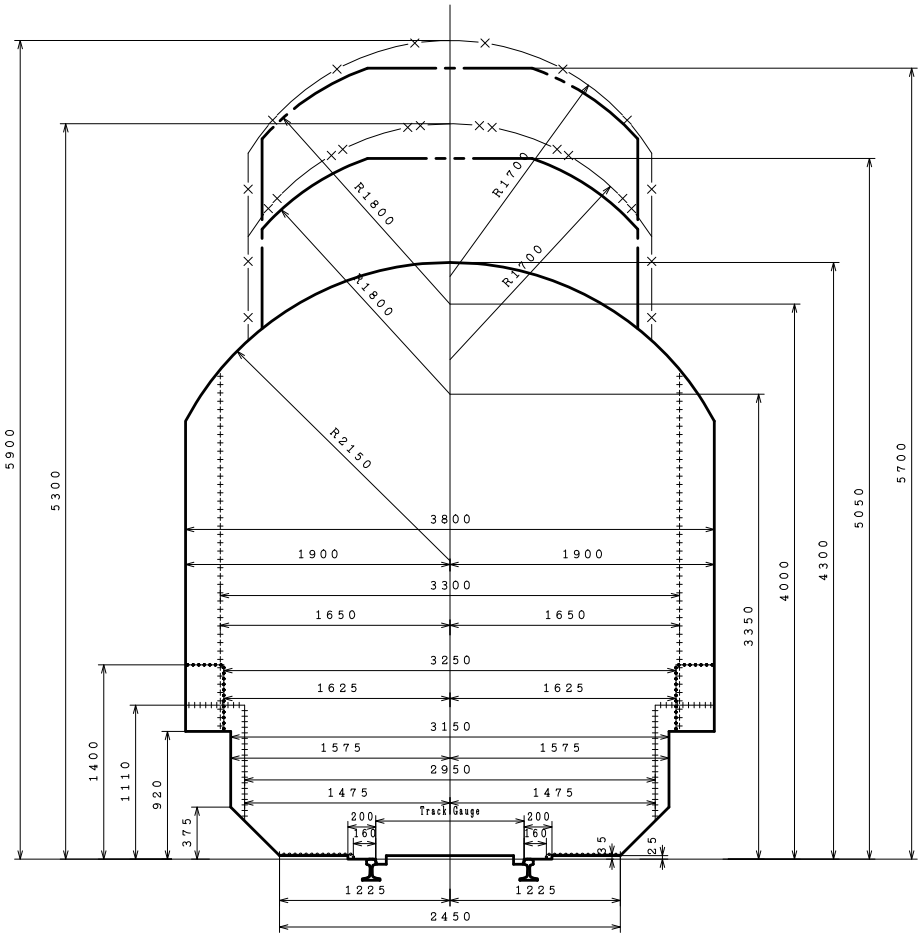


Figure *.3.2 Kinematic Envelop of Third Generation Train (at tangent track)

In Japanese railway rolling stock gauge is defined and rolling stock supplier shall confirm that every part of rolling stock is within the rolling stock gauge at static condition. It is simple and easier than drawing kinematic envelope. Figure *.3.3 and Figure *.3.4 show the construction gauge of Japanese railway applied for JR group.



Structure gauge (base line)

Applied for DC electrified section except contact wire and hanging device

Applied for tunnel, bridge, overbridge, show shelter and roof of platform at DC electrified section except contact wire and hanging device

Applied for AC electrified section except contact wire and hanging device

Applied for tunnel, bridge, overbridge, show shelter and roof of platform at AC electrified section except contact wire and hanging device

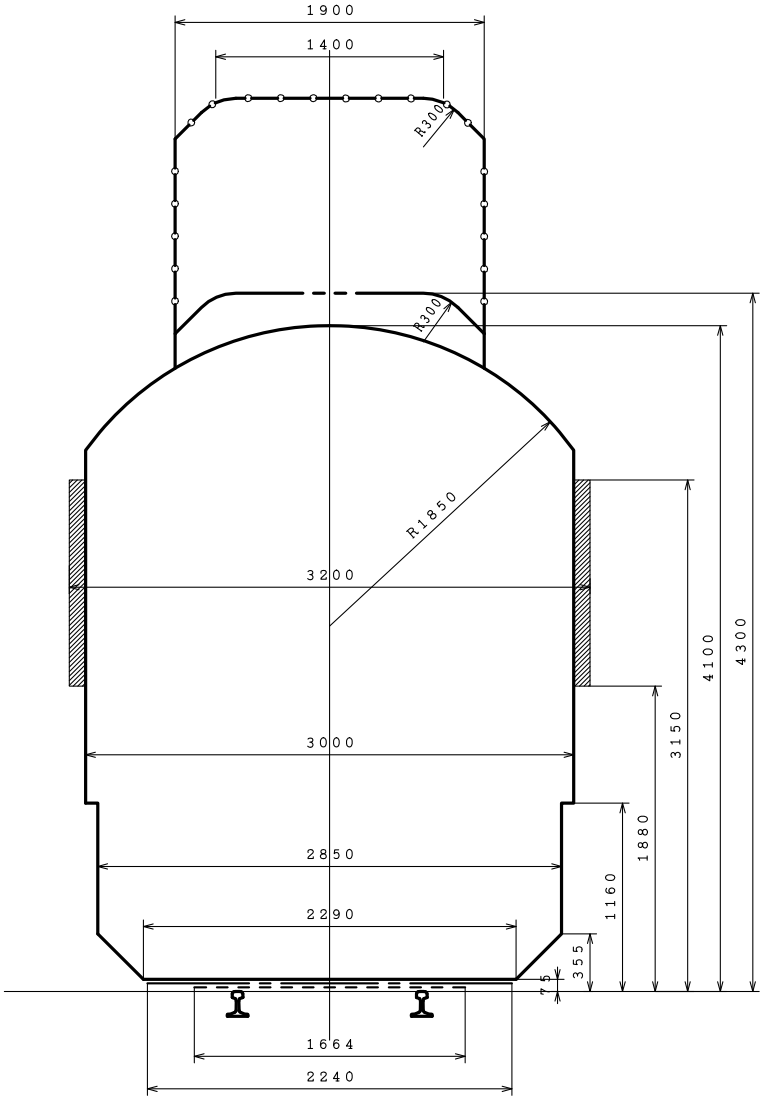
Applied for signals, markers, sign device and special tunnel and bridge

Applied for run-over type turnout

Applied for platform

Applied for fueling device, water supplying device and column of signal at the section where only freight trains are operated and turntable, weighing device, car washing facilities, entrance of inspection shed and equipment for inspection at side track and column of roof for platform of freight station

Figure *.3.3 Structure Gauge of Japanese Railway



Rolling Stock gauge (base line)

Applied for pantograph at locked down position

Applied for pantograph at working positon

Applied for marks and indicator lump

Applied for unsuspended equipment

Applied for sanding device, rail guard, brake shoe and other equipment within the width of rim

Figure *.3.4 Rolling Stock Gauge of Japanese Railway

Figure *.3.5 shows combined figure with construction gauge, rolling stock gauge and body contour of typical rolling stock. When the rolling stocks are constructed within the rolling stock gauge it is guaranteed that rolling stock will not hit the structure gauge.

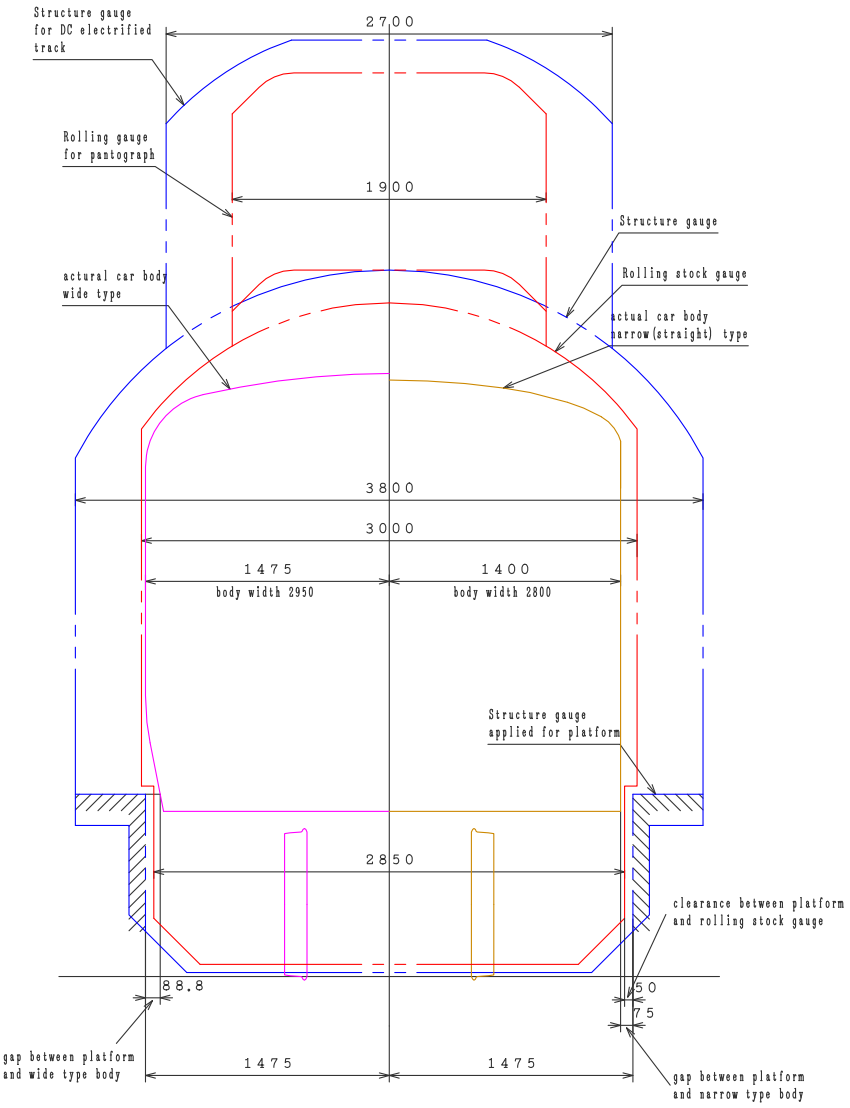


Figure *.3.5 Construction Gauge and Rollins Stock Gauge of Japanese Railway

It is strongly recommended that rolling stock gauge is defined. It is not only for convenience for rolling stock manufacturer but also it makes easier for engineers to confirm that rolling stocks are properly assembled after maintenance work or modification. Figure *.3.6 indicates recommended rolling stock gauge for Line 1.

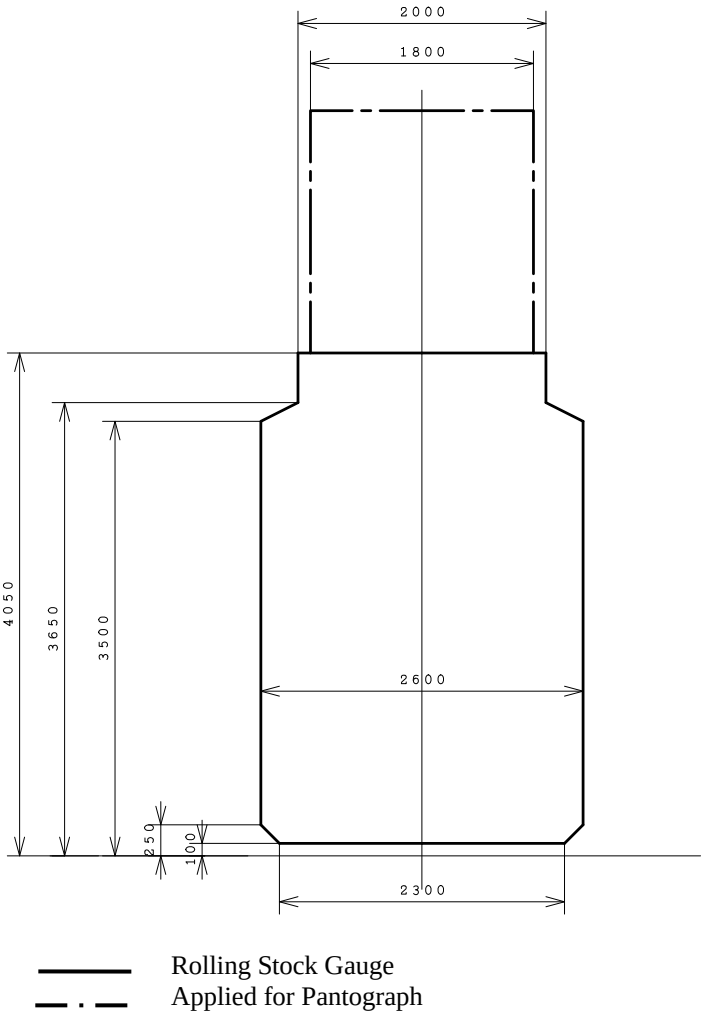


Figure *.3.6 Recommended Rolling Stock Gauge for Line 1.

Combined figure with construction gauge, rolling stock gauge and contour of existing rolling stocks are indicated in Figure *.3.7 Existing rolling stocks are all within the rolling stock gauge. Rolling stock gauge are shifted and tiled in the figure to confirm it will not touch with construction gauge.
Thus if the rolling stock are constructed within the rolling stock gauge it can be confirmed that rolling stock will not hit the structures without drawing kinematic envelope.

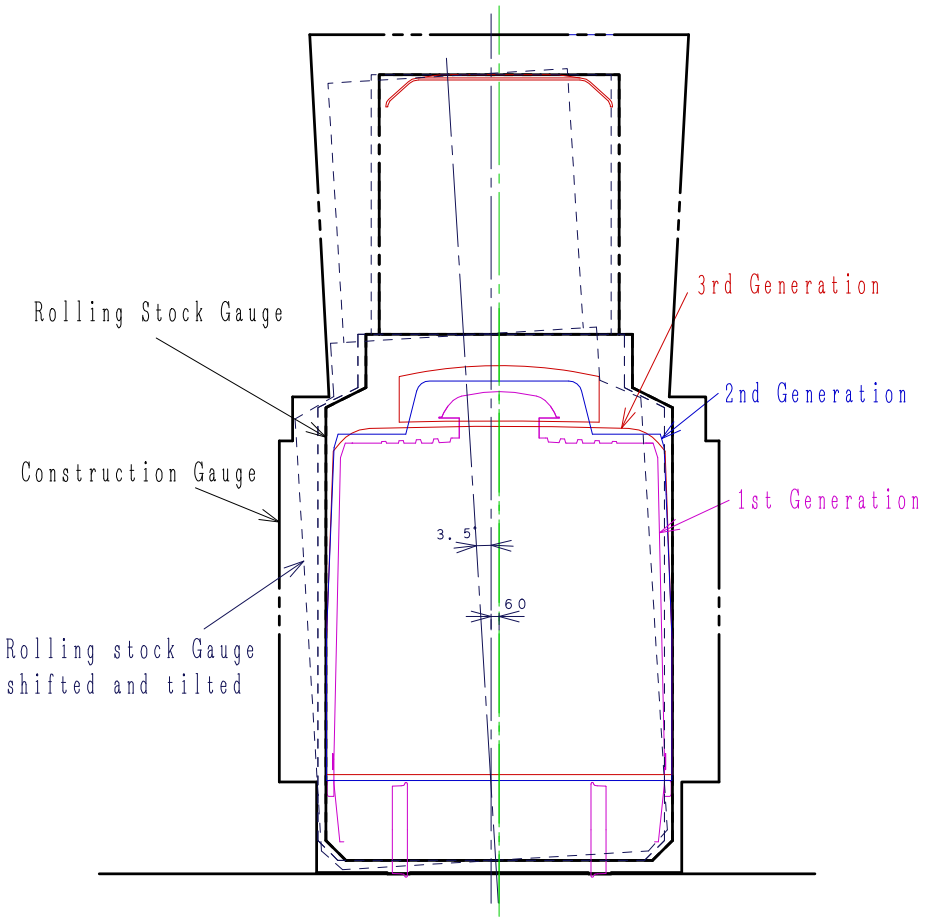


Figure *.3.7 Construction Gauge and Rolling Stock Gauge Recommended for Line 1

4. Widening of Structure Gauge at Curvature

When train is on the curved track there is overthrow of car body end at outside of the curve and overthrow of middle of the car body at inside of the curve. Construction gauge should be widened at curve and in the construction gauge of Line 1 it is defined DI for inside and DE for outside.

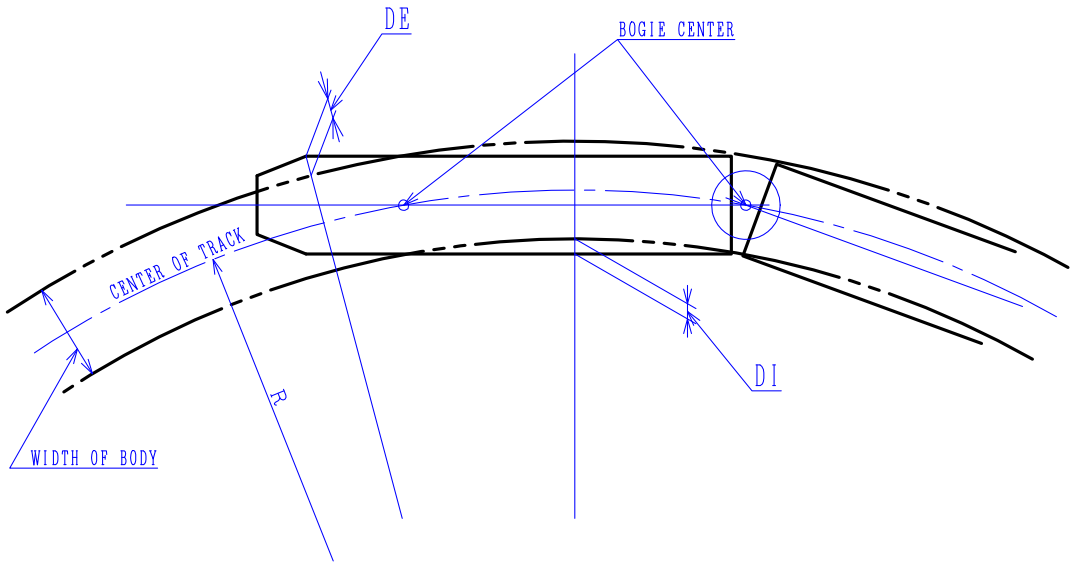


Figure *.4.1 Vehicle Overthrow at Curve

DI and DE can be calculated as follows.
Bogie Center is shifted to inside from track center.

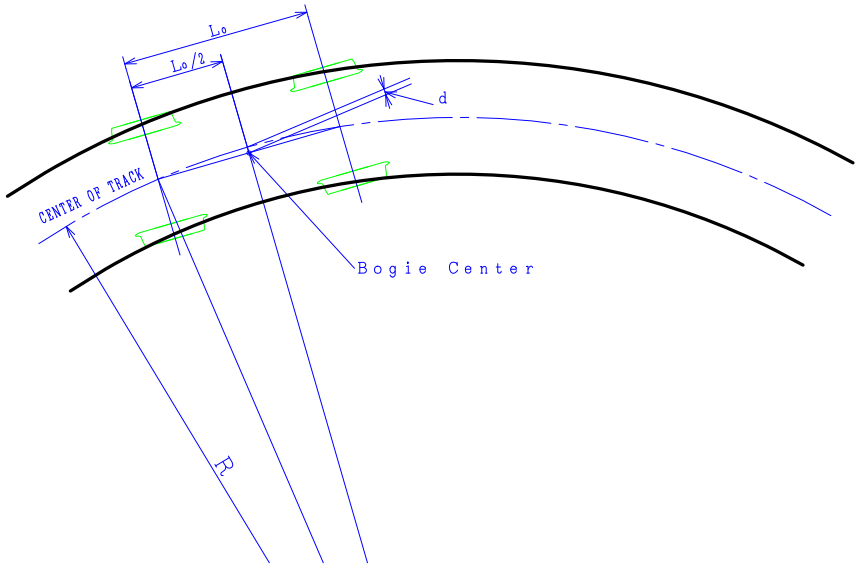


Figure *.4.2 Overthrow of Bogie Center

Overthrow of bogie center is calculated by following formula.

$$d = R - \sqrt{\{ R^2 - (L_0 / 2)^2 \}}$$

Where d: overthrow of bogie center (mm)
R: Radius of Curve (track center) (mm)
L0: Wheel base (mm)

Overthrow to inside is calculated by following formula.

$$DI = R - \sqrt{\{(R - d)^2 - (L_1 / 2)^2\}}$$

Where DI: overthrow to inside (mm)
L_1: distance between bogie center (mm)

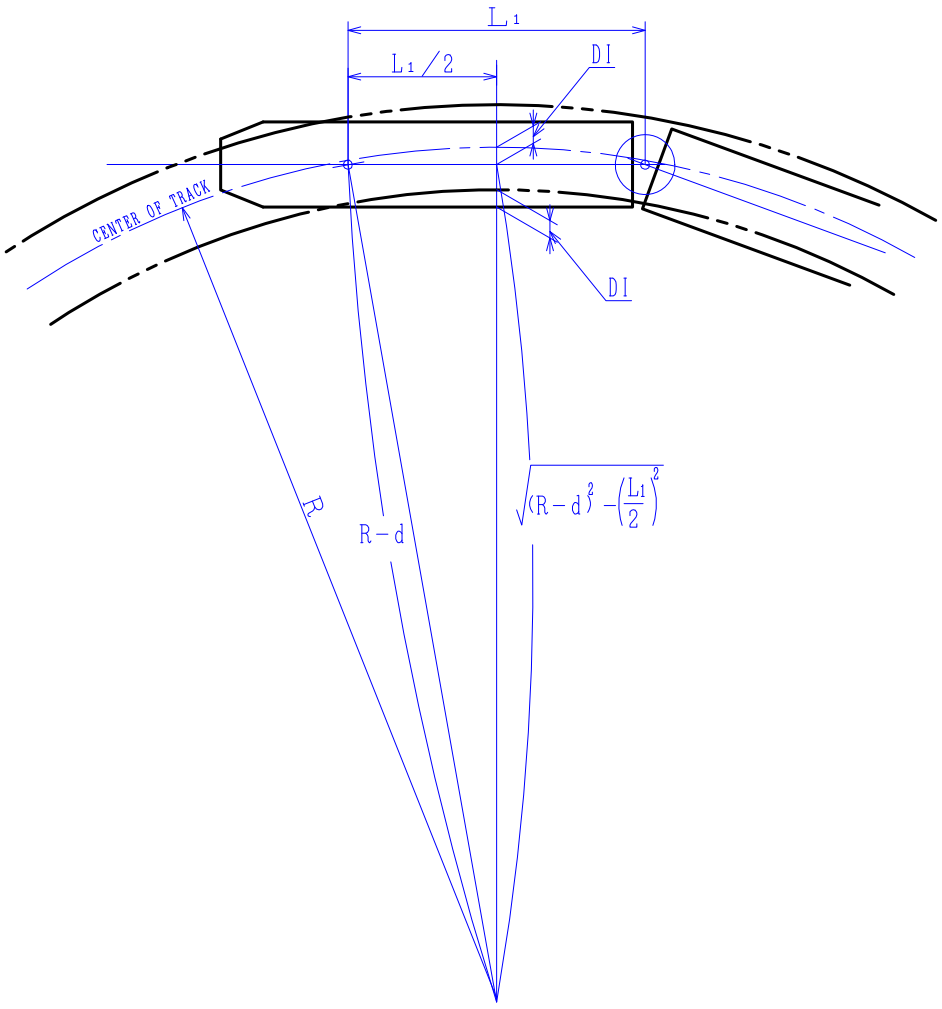


Figure *.4.3 Vehicle Overthrow to Inside of the Curve

To calculate overthrow to outside following formula is applied in general.

$DE = \sqrt{\{(R - B/2 - DI)^2 + (L_2/2)^2\}} - R - B/2$

Where DE: Overthrow to outside (mm)
B: Body width (mm)
L_2: length of car body (mm)

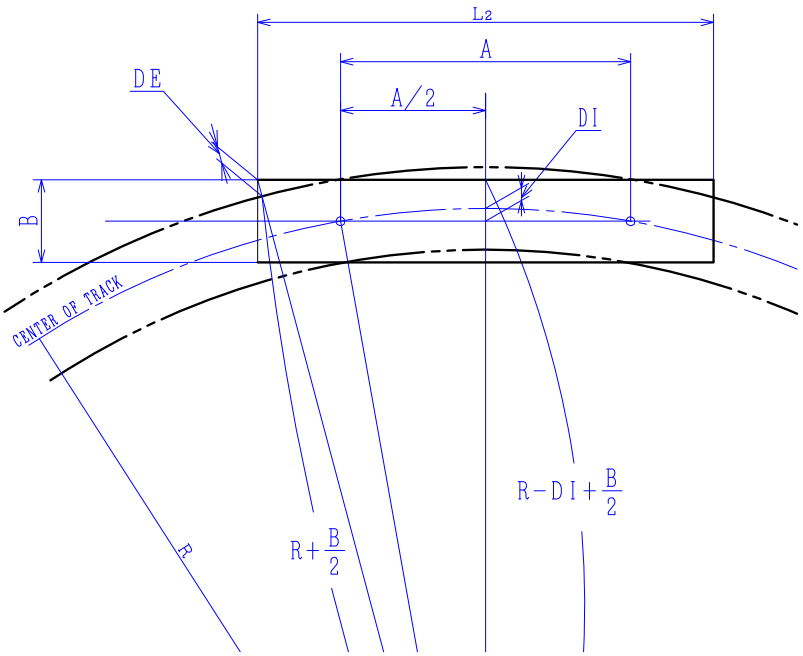


Figure *.4.4 Vehicle Overthrow to Outside

This formula can be applied for the rolling stock without articulation such as Line 2 rolling stock.

Overthrow to outside for the rolling stock with articulation is calculated as follows.
$DE = \sqrt{\{(R - B/2 - DI)^2 + (L_1/2 + C)^2\}} - R - B/2$
Where DE: Overthrow to outside (mm)
B: Body width (mm)
C: longitudinal dimension from bogie center to the edge of the body (mm)

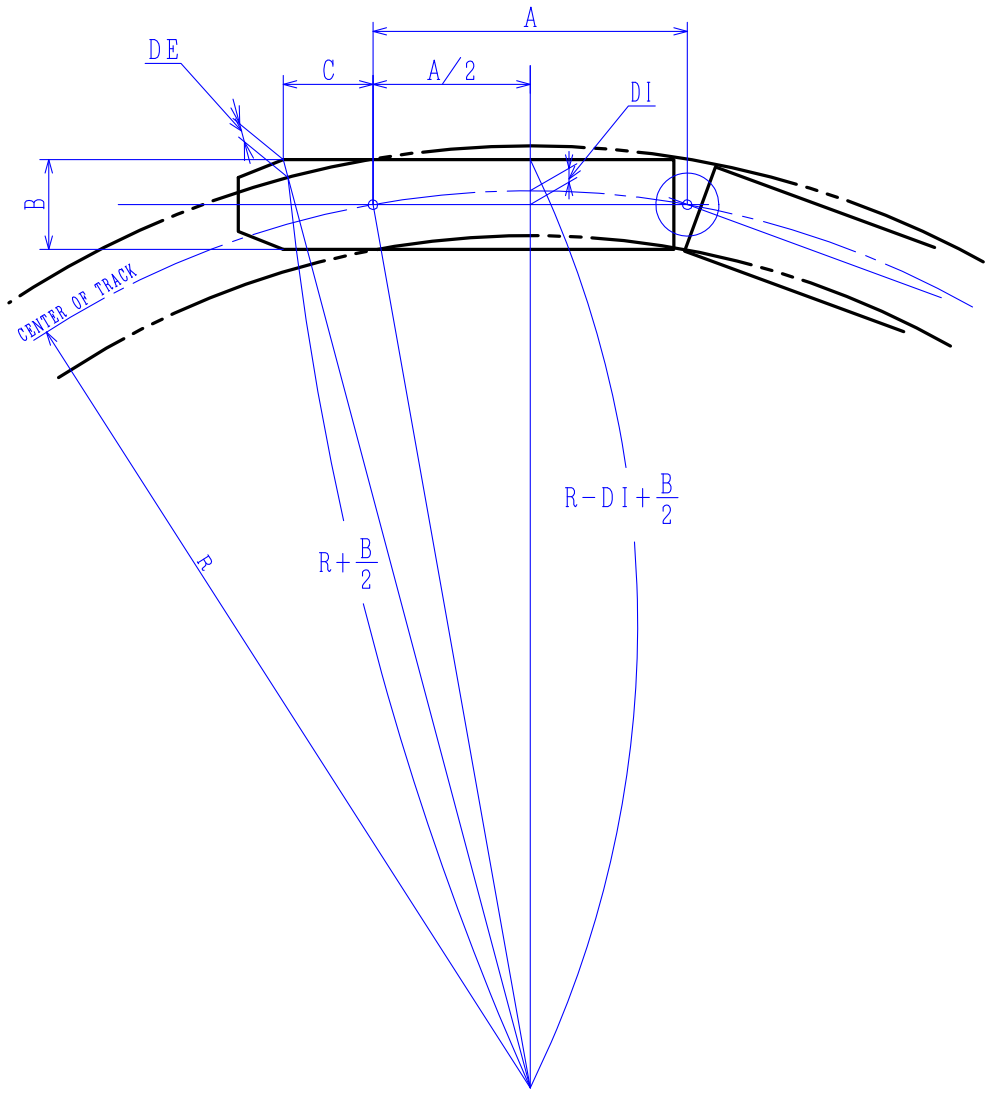


Figure *.4.5 Overthrow to Outside for Articulated Vehicle

Construction gauge should be widened at curved section according to those values.
At first phase of Line 1 DI and DE are defined based on first generation train and value is give by graph. Figure *.4.6 shows the graph to obtain the value of DI and DE. However to read the value from the graph is not accurate.
In Phase 1 of the capacity expansion project overthrow of the body was ignored. Both L1 (distance between bogie center) and B (body width) of rolling stock introduce in the project (second generation train) was longer than first generation train. Actually second generation train hit the platform and platforms of some stations were grinded.

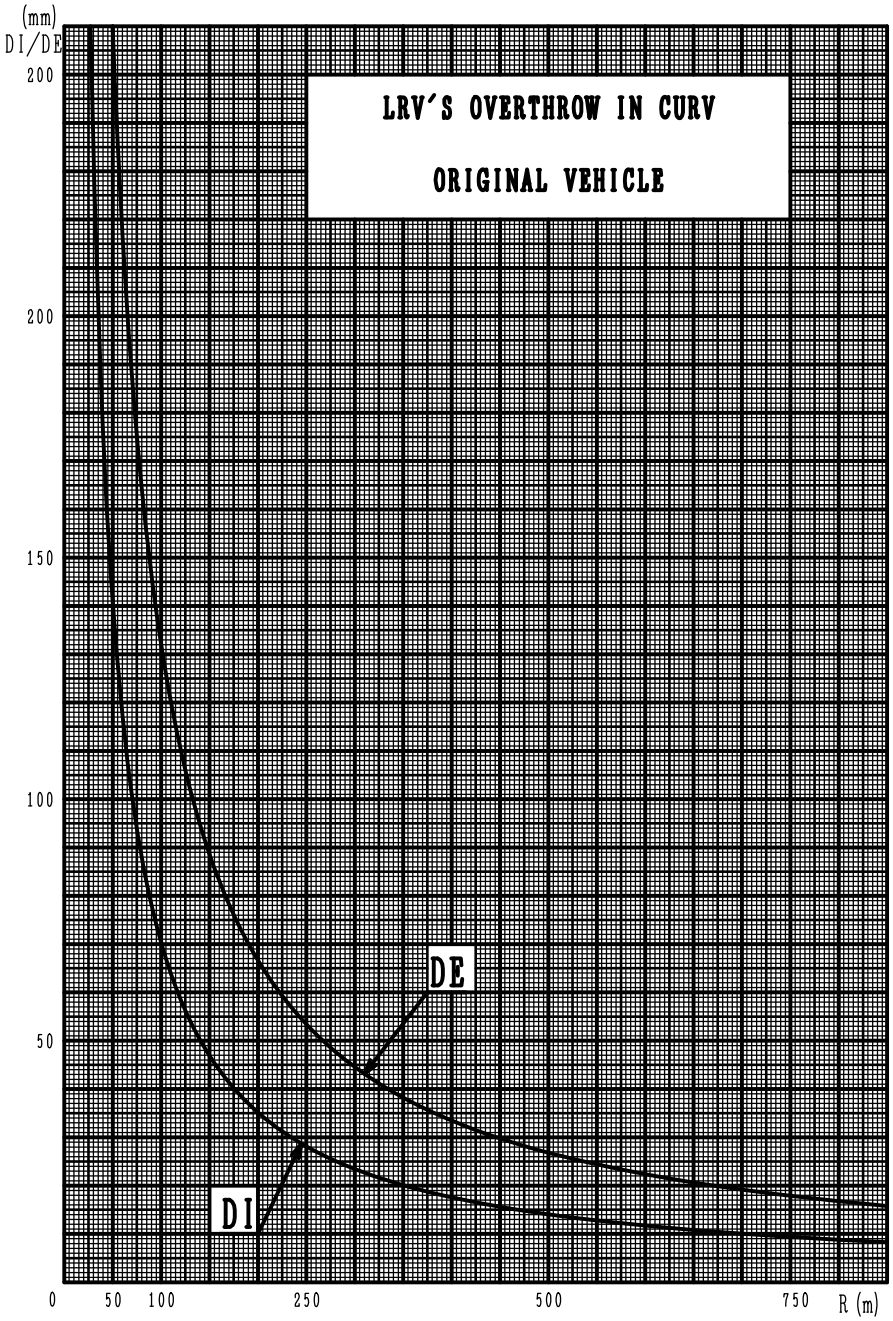


Figure *.4.6 Graph of Over Throw used in Initial Phase

Formula to calculate DI and DE is very complicated and graph is not accurate. Calculation of DI and DE can be approximate into following formula to simplify the calculation.

$DI = A_1/R$

$DE=A_2/R$

In the Phase 2 of Capacity Expansion Project following formula was applied.

$DI=12600/R_M$

$DE=13500/R_M$

Where RM: radius of curve in meter ($R_M=R/1000$)

Contractor of infrastructure should consider that border of side of the construction gauge must be shifted to outside from track center depend of the curve radius.
Also rolling stock gauge can be widened at curved section.

5. Distance Between Track Centers

When the two tracks are constructed in parallel distance between track centers shall be considered so that train can pass safely. 200mm is considered for rolling of the vehicle and 200mm is considered for safety clearance and totally 600mm shall be considered between rolling stock gauges. In case of Line 1 3200mm is the appropriate value for distance of track centers at tangent track.
At the curved track DI and DE mentioned in previous section shall be considered.

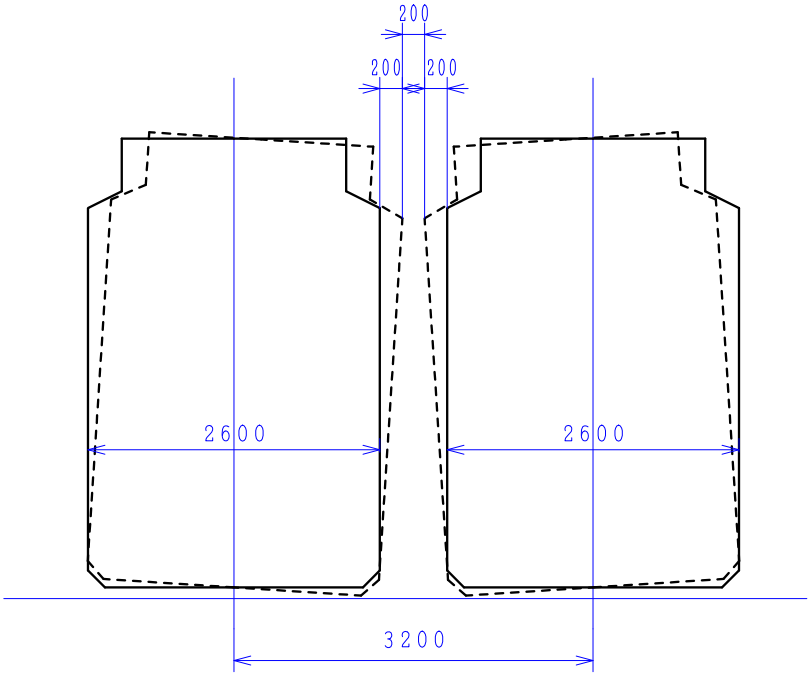


Figure *.5.1 Distance Between Track Centers

6. Height of Contact Wire and Pantograph Working Height

When height of contact wire is too high pantograph cannot touch the wire. When contact wire is too low there will be the risk of earth fault of electrification. Maximum height and minimum height shall be specified and working range of pantograph height must cover these heights. When electric system is DC rolling stock will lower the pantograph in case of emergency. In that case there must be enough clearance between contact wire and pantograph for arc extinction.

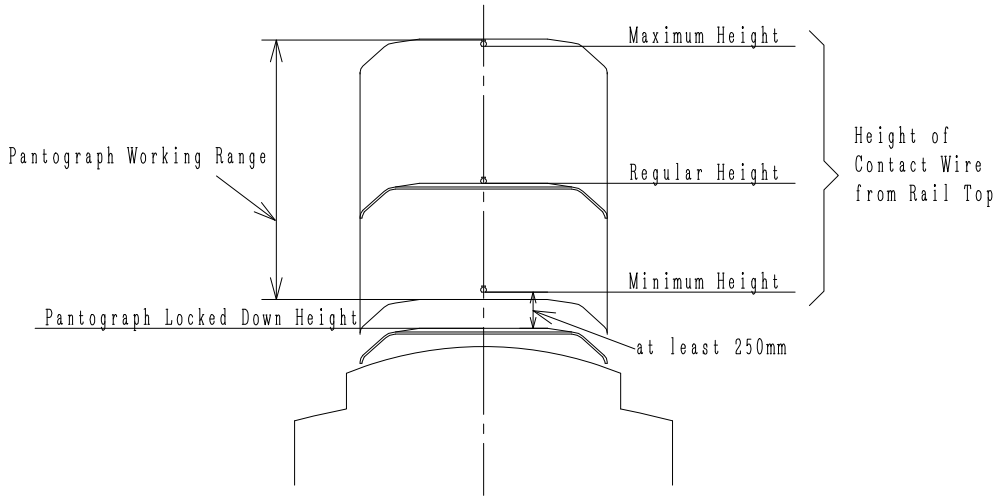


Figure *.6.1 Height of Contact Wire and Pantograph Working Height

In Line 1 initial phase heights of contact wire from top of rail is specified as follows.

Nominal (Regular) Height: 4600mm
Maximum Height: 6000mm
Minimum Height: 4300mm

Pantograph height of rolling stocks for Line 1 shall be specified as follows.

Pantograph working range: less than 4300mm to more than 6000mm
Lock down height of pantograph: less than 4050mm

7. Horizontal Curve

In the main line bigger curve radius is more preferable so that train will not reduce the speed and ride quality is better. In the depot operating speed is slow and there are no passengers inside the train curve radius can be much smaller. Minimum radius of the curve shall be defined in the main line and in the depot individually and rolling stocks shall be designed to pass the minimum radius of the curve in depot.
In Line 1 minimum radius of curve is defined 100m in main line and 25m in the depot.
Rolling stocks of Line 1 is required to have the capability to pass 25m radius curve without problem.

8. Horizontal Curve at Station

It is preferable that track along the platform is tangent because driver can view the side of entire train to secure the safety and gap between platform and door edge is minimized.
When a train is at the station in curved section and platform is outside of curve middle of train body will overthrow to inside and platform edge is shifted to out side because of widening of construction gauge. There will be big gap between platform and vehicle body. Also when platform is inside of the curve end of vehicle body will overthrow to inside of the curve and platform edge is shifted to outside.

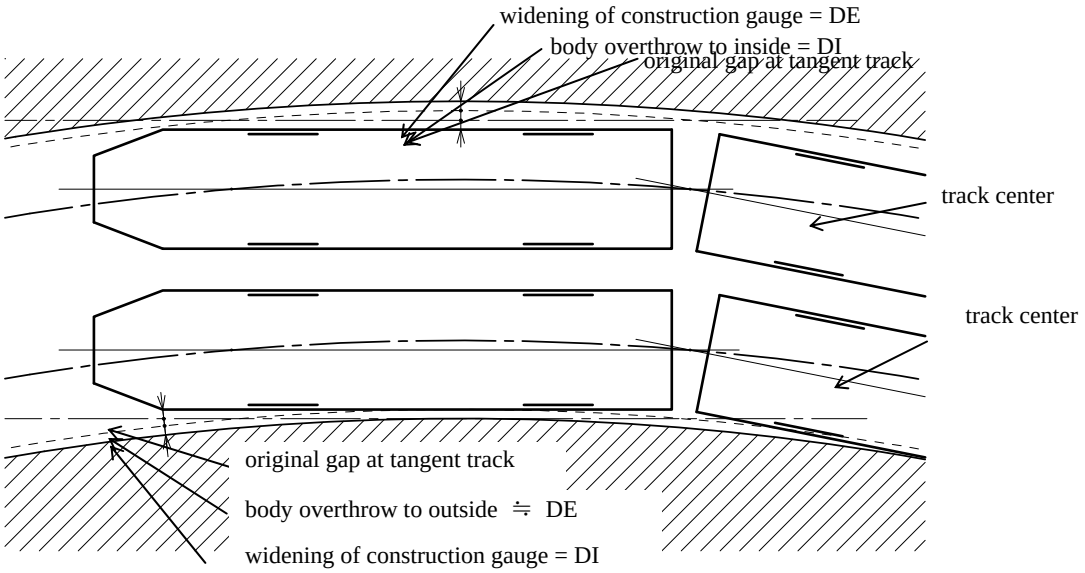


Figure *.8.1 Gap Between Vehicle Body and Platform at Curve

In the structure gauge of Line 1 distance between platform edge and track center is defined as 1370mm at tangent track. At curved section 1370mm+DI/DE is applied when curve radius is less than 700m and grater than 250m. That means minimum curve radius should be 250mm. At tangent track gap between door edge and platform is 75mm (2^{nd} generation and 3^{rd} generation train) and when at 250m radius track approximately 100mm bigger than the gap at tangent track. Much smaller curve at station shall not be allowed by safety reason.

9. Cant or Super Elevation

Outer rail of the curve shall be raised to cancel the centrifugal force of the train running on the curve. Value of super elevation is calculated by track gauge, curve radius and train speed.

When train is on the curved track and resultant force or centrifugal force and gravity is perpendicularly to the vehicle floor passengers will not feel centrifugal force. In such condition following equality holds.

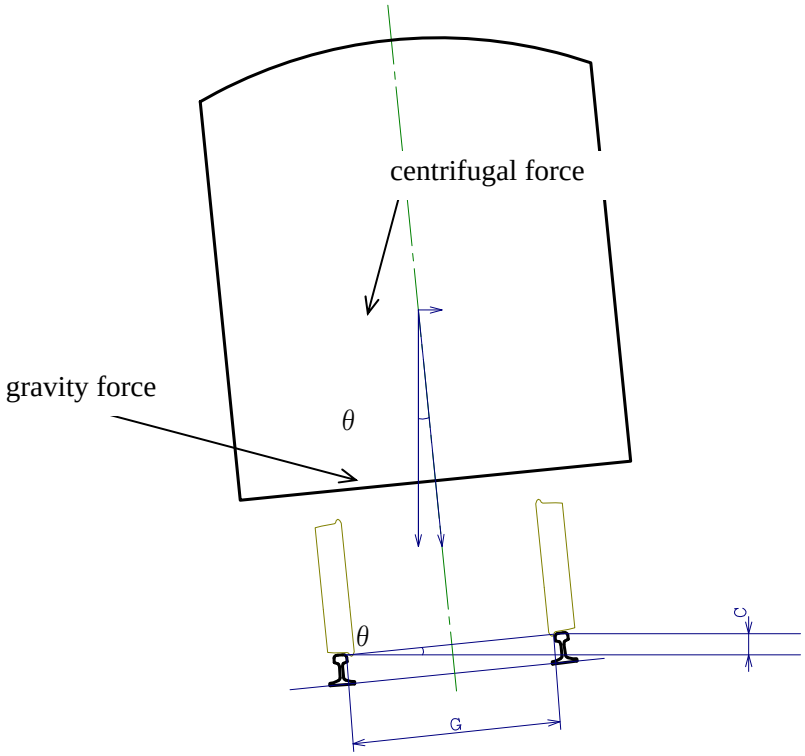


Figure *.9.1 Balancing Cant

$$M \times g \times \tan\theta = M \times \upsilon^2 / R$$

Where

M: mass of rolling stock (kg)

υ : train speed (m/s^2) υ =V(km/h)／3.6

R: radius of curve (m)

While θis small tanθcan be calculated as follows

$\tan\theta \fallingdotseq \sin\theta = C/G$

Where

G: track gauge (mm)

C_b: balancing cant (super elevation) (mm)

Therefore balancing cant can be calculated as follows

$$C_b = G \times g \times \upsilon^2 R$$

Substituting following equation cant can be obtained below.

g=9.8(m/s)

υ =V(km/h)／3.6

$C_b = G \times V^2 / (127 \times R)$

However train speed is not constant and sometimes train will stop on the curve. Super elevation shall be limited so that train can stand still safely on the curve and passenger will not feel uncomfortable in the train when train stops on the curve. Maximum super elevation can be defined that gravity center deviation of the rolling stock will not exceed one-sixth of track gauge from center of track.

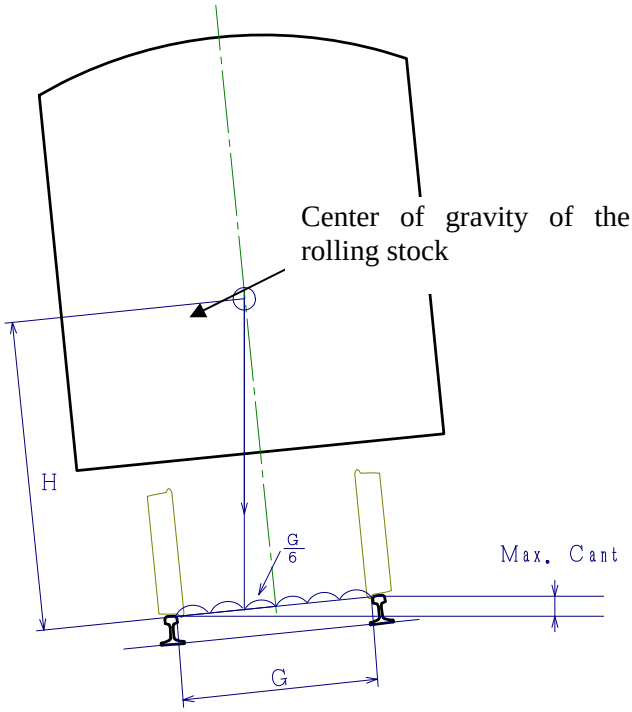


Figure *.9.2 Maximum Cant

Maximum cant can be obtained by following formula.

$C_{max}=G／6×G／H=G^2／(6×H)$

Where

C_{max}: Maximum cant (mm)
G: track gauge (mm)
H: height of gravity center or rolling stock (mm)

Gravity center height of rolling stock is depend on the design of rolling stock. Usually it is about 1.3m to 1.4m from top of rail at tare condition but it will be higher at loaded condition.
In Line 1 maximum super elevation is defined 150mm.

As cant is limited above reason train cannot run fast at the section where cant is already maximum value. However small excess of speed can be allowed so that train can run faster. Allowable cant deficiency is defined and limited speed at curved section is calculated based on it.
Allowable cant deficiency should be determined in consideration of rollover outward of the curve by beam wind and passengers riding comfort, etc.
Limited speed at curved track can be calculated by following formula.

$V \leq \sqrt{(127×(C_m + C_d) / G)}$

Where
V : Train speed (km/h)
R : Radius of curve (m)
C_m : Actual cant (mm)
C_d : Cant deficiency (mm)
G : Gauge (mm)

10. Transition Curve

When curved track connected with tangent track directly centrifugal force appears immediately into full range when train is running from tangent track to curved track and it will make ride comfort worse. Also cant cannot be applied appropriately of its required value. On main tracks, all curves (except those in

turnouts and those with a large radius) are connected to straight section through transition curves so that it will provide better ride quality and super elevation can be changed gradually within the transition curve. In the transition curve the radius is inversely proportional to the distance along the curve.

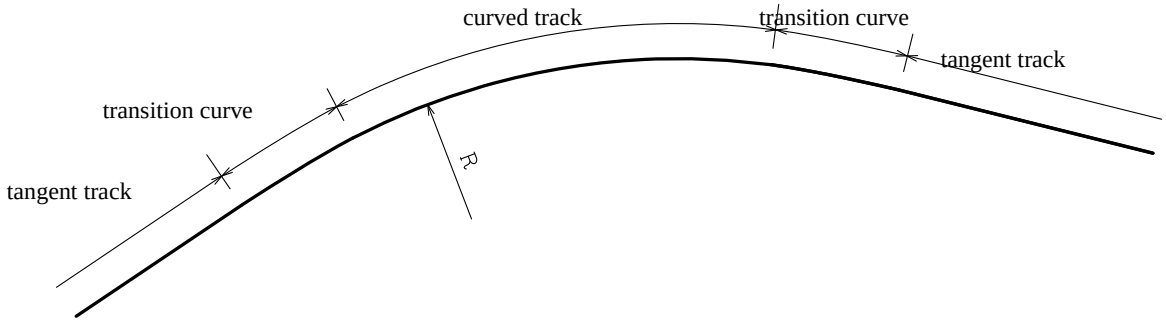


Fig *.10.1 Transition Curve

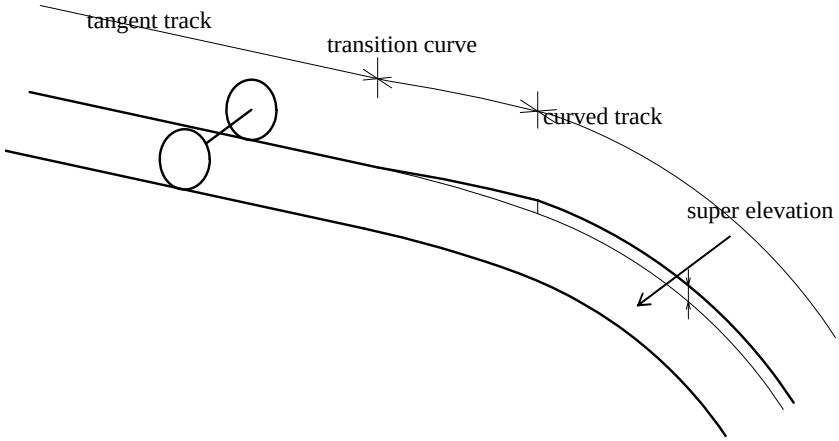


Fig *.10.2 Transition Curve and Super Elevation

The commonly-used shape of transition curve on railway is “clothoid curve”, “cubic parabola curve”, and “sign half wavelength curve”.
The length of transition curves may be determined in one of three methods. The method which indicates the greatest length shall be used.
The transition curve shall also be where the cant is developed, in order to combine the effect of the increasing curvature with the increasing cant.
The following formulas are shown as reference for design.

1) Length to avoid derailments by cant-over (L_1)

$L_1 = 400 \times C_m / 1000$ (m)

2) Length which be derived from the comfort for passengers to which the speed of increasing cant acts (L_2)

$L_2 = V / 3.6 \times C_m / C_{mo}$ (m)

3) Length which be derived from the comfort for passengers to which the increasing centrifugal force acts (L_3)

$L_3 = V / 3.6 \times (C_d \times g) / (G \times P_o)$ (m)

Where,

V : Maximum speed in the curve (km/h)
C_m : Cant (mm)
C_{mo} : Limit speed of increasing cant (mm/sec) (for example 29~35 mm/sec)
C_d : Maximum cant deficiency (mm)
g : Gravitational acceleration
G : Gauge (mm)

P_o : Limit g of increasing centrifugal force (g/sec) (for example 0.03~0.04 g/sec)

11. Gradient

Considering the smooth train operation gradient of the line is the smaller the better. However steep slope is often required because of landscape or grade separation with other traffic mode. When grade is too high train will be stocked on the slope. Maximum gradient shall be determined by the train performance.

When a train becomes defective on the slope it will be rescued by other train. Train shall be capable to push other train at maximum gradient. When it is main line defective train is possibly full loaded. When it is side track such as connecting line of depot to main line train are supposed to be empty therefore maximum gradient at side track can be higher than main line.

In Line 1 maximum gradient at existing line is 2.5 % for main line and 4% for connecting line. It is recommended to define these values as maximum gradient for Line 1 because performances of rolling stocks are only verified with these values. However 2.5% is rather low for urban railway and when there is necessity to construct higher gradient due to land condition performances of rolling stock shall be recalculated to confirm that rolling stocks is capable to climb higher gradient.

When there is curve in gradient train resistance in curve shall be added to determine the maximum gradient. Equivalent grade in curve is calculated by following formula.

Ge=800／R (standard gauge)

Ge=600／R (1,067mm)

Where

Ge: Equivalent grade (‰)

R: radius of curve (m)

For example defined maximum gradient is 4% (=40‰) and curve radius is 400m, 800／400=2(‰) shall be added to gradient as equivalent grade. Therefore 3.8% is the maximum gradient of this section.

12. Platform Height and Floor Height

Difference of platform height and floor height of the train should be minimized to enable smooth transition from platform to train.

In Line 1 platform height is 690mm from top of rail and floor height of the train is 900mm for first generation train and 920mm for second generation and third generation train. Height difference is little bit big because platform height is limited by plug door of first generation train.

When doors of first generation train open door leaves swing out above the platform. Platform height is maintained lower so that door leaves will not hit the platform.

Second generation train and third generation train apply slide door and there a no issue of confliction of door leaves and platform. Currently difference of height for second and third generation trains are 230mm and it should not be bigger. Floor height of rolling stock shall be maintained 920mm in maximum.

Figure *.12.1 Plug Door of First Generation Train

13. Height of coupler

In emergency case train will be towed or pushed by other train by coupling together. When height is

different it will be difficult to couple or connected incline. It will make vertical component at coupler and this might cause the vertical buckling of the train. Coupler height shall be same with two trains and it shall be identical in the same line.
In Line 1 train coupler is not installed at front end however bracket and pin for towing bar is installed. Towing bar can be attach to the end of car easily even the height of other car is different and towing bar has enough length so that vertical component will not grow high therefore height of bracket may not severely controlled.

14. Height of Anti-climber

In case of collision of the train damage is minimized when under frame hit the under frame of other train because this is the most strong part in the rolling stock structure. However when one body rise higher than other body and it will sometimes happen at the shock of collision car body will make damage on other car.

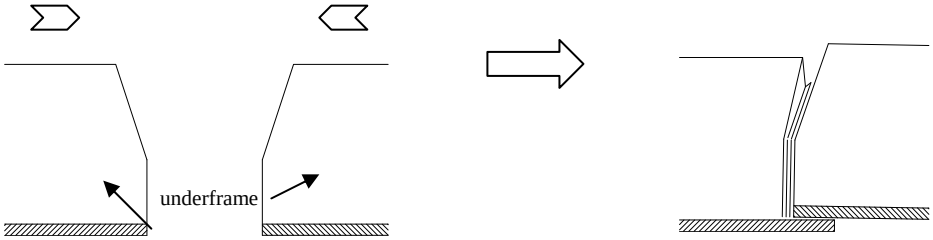


Figure *.14.1 Collision without Anti-Climber

Anti-climber is installed at end car of Line 1 and Line 2. Role of anti-climber is to engage with anti-climber of other the car in case of collision so that car will not climb on the other car to minimize the damage. Therefore height of anti-climber shall be identical.

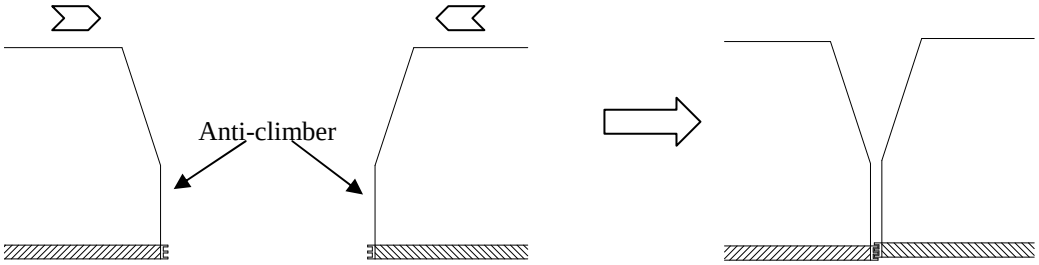


Figure *.14.2 Collision with Anti-Climber

Line 1 Train (3rd Generation) **Line 2 Train**

Figure *.14.3 Coupler and Aiti-Climber

Height of anti-climber of current vehicle in Line 1 is 750mm.

14. Distance Between Bogie Center

Formula to calculate widening of structure gauge is based on the dimension of rolling stock. When increasing the distance of bogie center it will increase overthrow to inside and when decreasing of distance of bogie center it will increase overthrow to outside. Overthrow to outside can be limited by cutting the body however overthrow to inside cannot be avoided unless reducing the width of body and it dose not make sense. In case of Line 1 calculation of overthrow to inside is under condition of 10m for distance between bogie center that is dimension for 2nd generation and 3rd generation trains. Maximum distance between bogie centers shall be defined to keep clearance with structure at curved section.

15. Maximum Speed and Deceleration

In recent railway system trains are secured to operate safely by onboard signaling system such as ATP. Function of ATP is to stop the train before stop signal by emergency brake when driver overlook the signal. Location to apply the brake is calculated from train speed and deceleration. Function of ATP is programmed based on train performance such as train speed and deceleration. Also tracks are designed based on maximum speed. Maximum speed and minimum deceleration at emergency brake shall be defined.

16. Train Load

Maximum axle load can be calculated by adding passenger weight to the axle load at tare condition of rolling stock that was calculated or measured by rolling stock manufacturer. Following figure indicate the axle load and loading point of Line 1 trains.

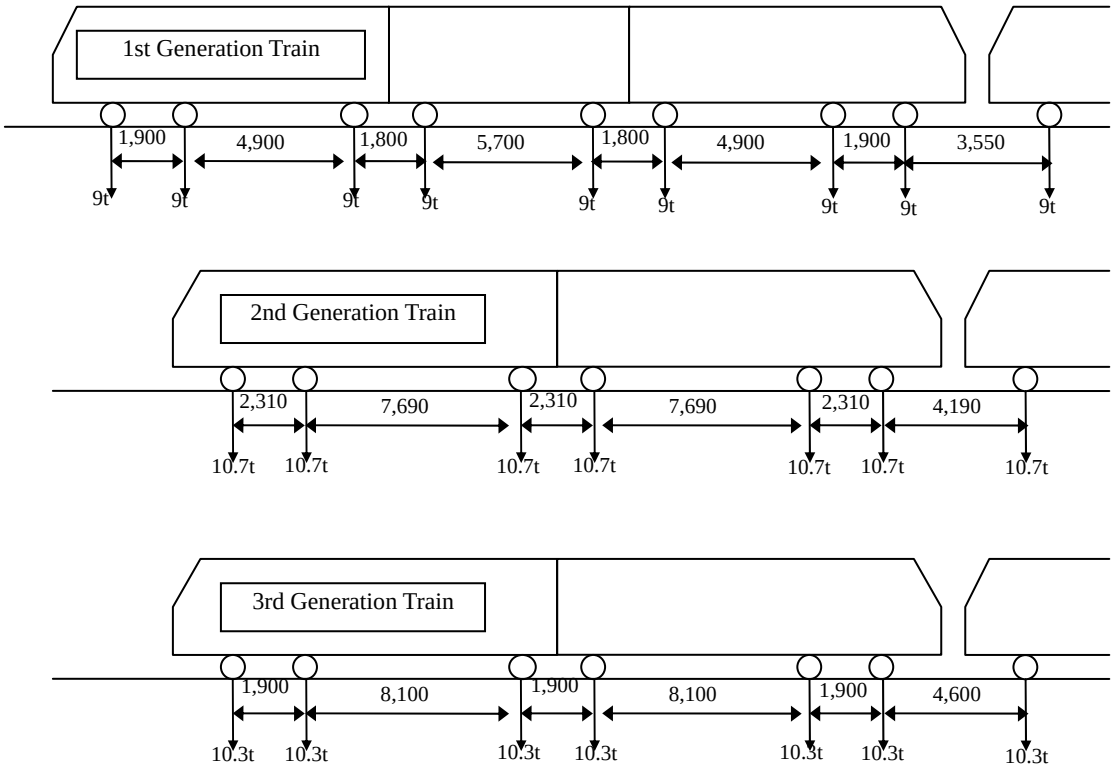


Figure *.16.1 Load Case of Line 1 Trains

Civil structure and tracks shall be constructed to withstand the loading condition of those rolling stocks.
In Line 1 while at initial phase loading condition to consider is only 1st generation train. Axle load of 2nd generation train is almost 20% higher than first generation train. Therefore it accelerated the deterioration of the track. Currently train speed of Line 1 is restricted because of track condition except north extension.
Normally structures are designed and constructed based on the loading condition of rolling stocks those supposed to run on the tracks. Also maximum axle load of rolling stock shall be defined. It is preferable to have margin between the axle load to consider for civil structure and maximum axle load for rolling stock. It is recommended to define axle load to consider for civil structure is 11t and maximum axle load of rolling stock is 10.5t.

17. Facilities for Underground Railway

Currently there are no underground railways in the Philippines except short section in Line 3.
Several facilities are required for the underground railway to secure the safety.

(Ventilation)

- Air and smoke ventilation equipments should be equipped at underground stations.
- Smoke barrier should be installed between platforms and tracks and at staircases and or escalators at stations.
- In case temperature at underground stations is raised, air conditioning facilities should be equipped.

(Water)

- Water supply and drainage facilities should be equipped.
- Water supply is used for drinking water for passengers and station staff and fire fighting.
- Sewage should be treated according to the sewage treatment standard of municipalities.
- In tunnels and at stations in underground sections, Drain pump is installed appropriate for the track gradient.

(Flood)

- Cut-off panels of flooded water should be installed at the entry and exit of underground stations and tunnels.
- Iron cut-off doors should be installed at the entrance of tunnels if needed.

(Power)

- Power supply system is duplicated to prevent all shutdown of power supply.
- Power supply is used for emergency lighting system, automatic fire extinguishing system, fire prevention system, evacuation guidance for passengers, Air and smoke ventilation equipment, public address system, signal/telecommunication system, iron cut-off doors and drainage pumps, etc.
- Emergency power generator should be equipped at underground stations if needed.

(Fire Prevention)

- In principle, underground structures should be built with non-combustible materials.
- Fire prevention control center should be provided at stations in order to monitor and control fire prevention facilities.
- The following facilities should be provided at stations.
  Fire detection system, evacuation guidance system, two or more evacuation routes and emergency lighting system and fire prevention doors
- Fire fighting facilities such as extinguishers, indoor fire hydrants, sprinklers, water pumping pipes for fire department, etc. should be equipped at underground stations.

18. Rolling Stock for Underground Railway

In Japanese railway passenger cars shall be connected with gangway so that passengers can move from car to other car. It is not for passengers' convenience but also in case of emergency such as fire in the train passengers can escape from the car. It is mandatory for the trains running on underground railway or long tunnel to be connected all the passenger cars with gangway. In case of fire in the tunnel driver should not stop the train but should drive the train to safety place such as outside of the tunnel or station so that passengers can evacuate from side door. If driver stops the train in the tunnel there will be much risk for the passengers breathing the smoke to die. When train with fire is running in the tunnel passengers will escape from the car in the fire to the other car by passing gangway.

In Line 1 trains and Line 3 there are gangways at articulation section however it is impossible to install gangway between two cars because there are sharp curves in the depot. When train passes sharp curve especially at the connection point of tangent track with sharp curve declination of body center of adjacent car is very big and if gangway is installed bellows of gangway will be broken.

When the Line 1 or Lin 3 is extended underground railway or long tunnel should not be planned otherwise trains shall be replaced or modified with the cars fully connected with gangway.

12.3 Recommendation for a Harmonious Network of Railway in the Philippines

1. General

Generally speaking railway is safe, punctual, low energy consumption and environmental friendly compare with other traffic mode. It is recommended that urban transportation should be shifted to railway otherwise road will be much congested and air pollution cannot be mitigated. A harmonious network of railway is required to promote the railway transportation.

2. Interoperability with Other Line

(1) Compatibility of Railway System

It is important to consider convenience of passengers for creating railway network in Metro Manila. It is preferable that stations to connect with other railway line are close together and it will be better that passenger can change the train at the same platform without walking far. More preferable thing is trains can provide through operation with other line and passengers do not need changing the train.
To provide through operation systems of both lines shall be compatible.
Currently there are 4 railway systems in the Philippines Line 1, Line 2, Line 3 and PNR. Those can be classified to 3 groups.

Line1,Line3 :	Standard gauge(1435mm), DC 750V electrified, Light Rail
Line2:	Standard gauge(1435mm), DC 1500V electrified, Heavy Rail
PNR:	Narrow gauge (1067mm), non electrification, Heavy Rail

When constructing new railway it should be able to belong to one of 3 groups so that there will be the possibility of through operation. Even stations are not connected to other line and through operation is not provided at first time there will be the possibility that line will be extend to connect to other line or another line will be constructed and will be connected to the line.

(2) Technical considerations for through operation

To provide through operation there are still many items to consider. Following items are technical considered for through operation.

Table 12.3-1 Technical Consideration for Through Operation

Category	Item	Criteria
Dimensions	Track gauge	Identical
	Wheel profile	Compatible with rail including turnout
	Rolling stock gauge (or kinematic envelope of rolling stock) and construction gauge	No confliction
	Door and platform	There shall be no big gap with platform. There shall be no big difference with car floor and platform.
	Pantograph working height and contact wire height	Pantograph working height shall cover the range of contact wire height
Performance	Maximum speed	Same or adjustable
	Emergency brake deceleration	Same or adjustable
	Curve radius	Rolling stock can pass the minimum radius curve on the line
	Gradient	Trains have capability to start at maximum gradient on the line. Trains have capability to tow/push down train at maximum gradient in emergency case.
Train load	Train load	Tracks and structures are capable of train at clash load.
Subsystems	Power supply voltage	Working voltage of rolling stock shall cover the voltage range of power supply
	Capacity of substation	Total consumption of power will not exceed the capacity of substation Peak current of train shall not exceed the current limiter of substation
	Signaling system	Interface between onboard system and wayside system shall be compatible.
	Telecommunication system	Onboard system shall be compatible with wayside system.

When trains are stabled or inspected in the depot of other line, compatibility of depot facilities shall be confirmed.

(3) Signaling System Issue

Signaling system is always the problem for through operation. In conventional signaling system equipment of the system is only wayside signal lamps and control boxes for them and there are no on board equipment. Trains are controlled manually by the driver who watches the wayside signal. In modernized railway onboard equipment is installed on the train to avoid the collision even driver violates the signal so called ATP. Onboard equipment exchanges data with wayside signaling equipment with particular protocol and deferent type of onboard and wayside equipment will not work.
In the railways of the Philippines ATP is applied in Line 1, Line 2 and Line 3 but each system is different and have no compatibility with other lines.
When there are two lines with different signaling system and providing through operation there are some options to prove this problem also there are two cases for through operation.

Case1 is trains of one line to provide through operation, trains of other line run only there own line.
Case2 is trains of both lines to provide through operation.
Options for each case are indicated in the tables below.

Table 12.3-2 Measures for Through Operation for Case 1

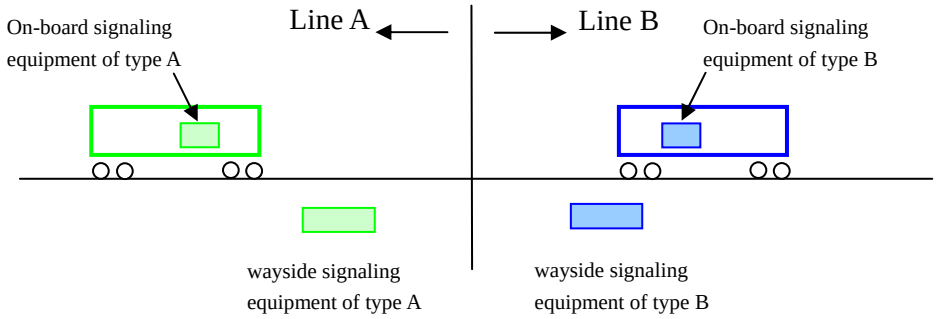
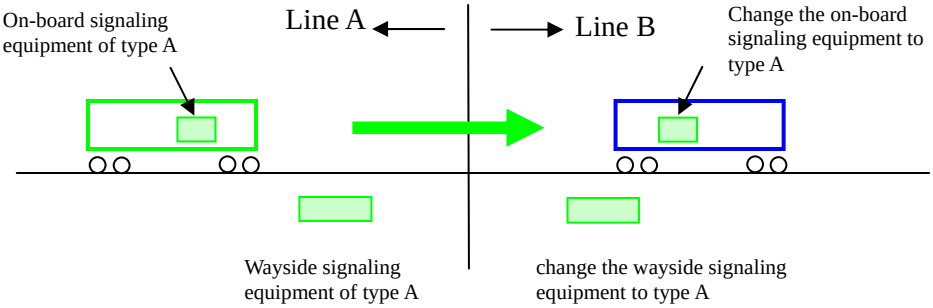
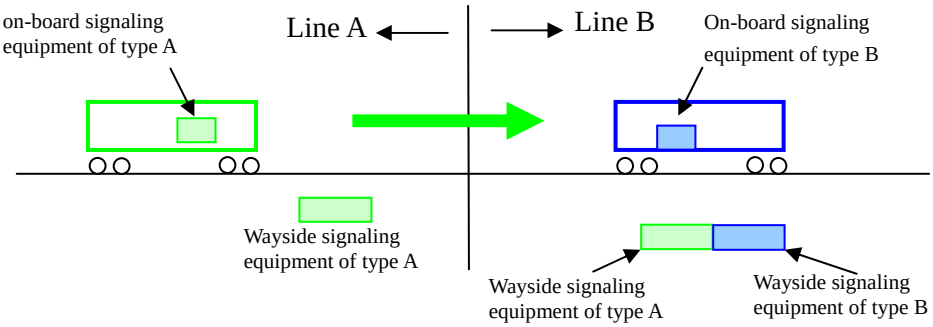
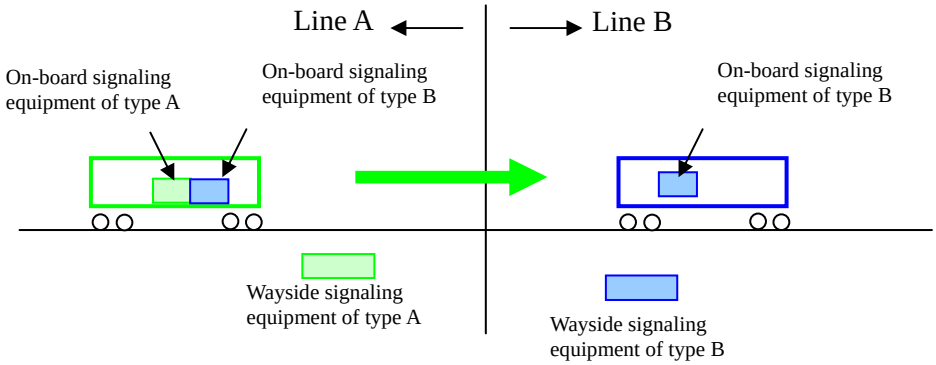
<table>
<tr><td>Before
Through
Operation</td><td>It is not possible to conduct through operation
 
</td></tr>
<tr><td>Option 1</td><td>change the signaling system of one line to same as other line
 
</td></tr>
<tr><td>Option 2</td><td>install 2 types of wayside signaling system in one line
 
</td></tr>
<tr><td>Option 3</td><td>install 2 types of on-board signaling system on the trains of one line
 
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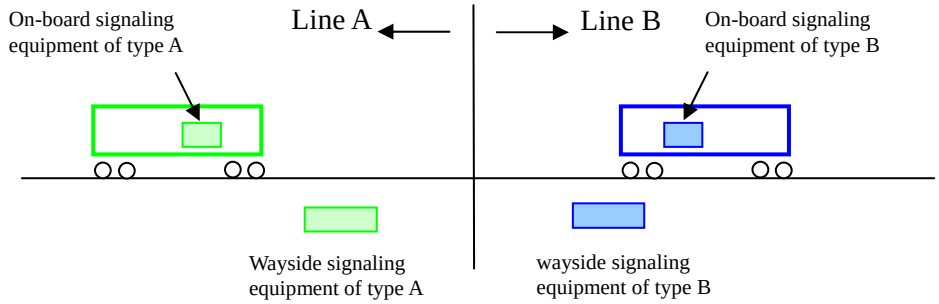
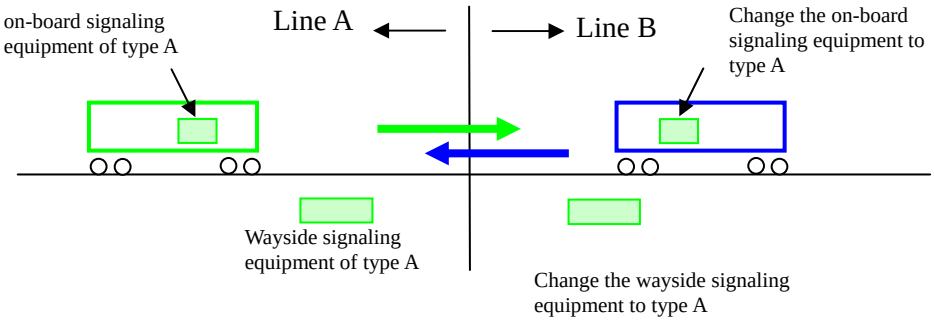
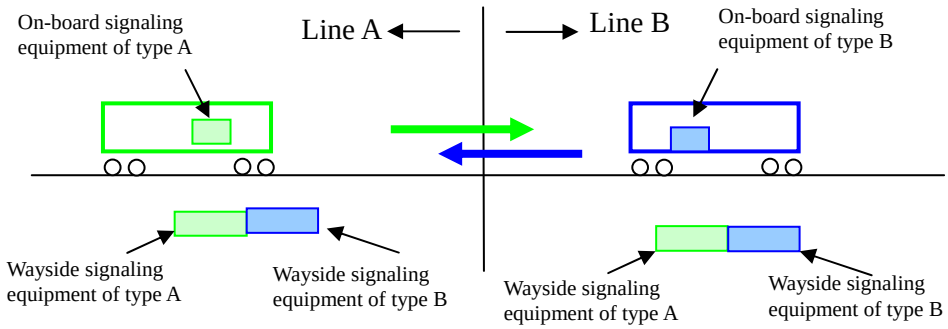
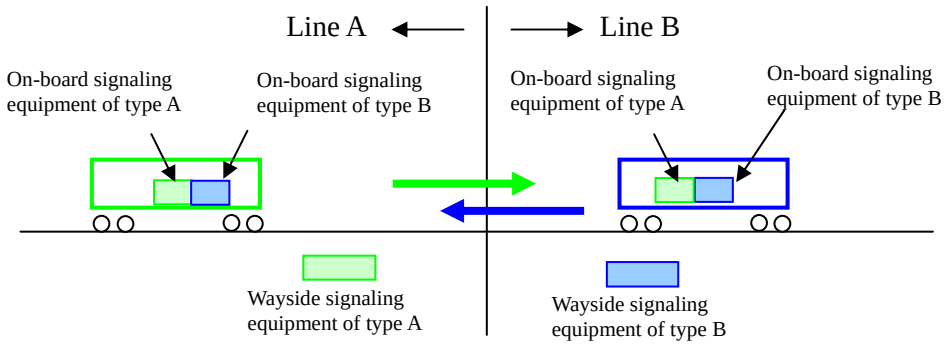
Table 12.3-3 Measures for Through Operation for Case 2

Before Through Operation	It is not possible to conduct through operation 
Option 1	change the signaling system with one type in entire line 
Option 2	install 2 types of wayside signaling system in both lines 
Option 3	provide 2 types of on-board signaling system on the train 

In case 1 option 3 will be better than other options and in case 2 option 1 will be better in general however it depends on the condition of rolling stocks and signaling systems.

(4) Procedure for Through Operation

Rolling stock owner shall submit necessary data of rolling stock to the operator of the line where the rolling stock is planned to operate.
Operator shall confirm data of rolling stock data that rolling stock is comfort to the criteria for operating the line.
Items for confirm are as follows.

a. Rolling stock is within the construction gauge of the line at any condition.
b. Track gauge is same and wheel profile is compatible with the track to run safely
c. Floor height and gap between door edge and platform is appropriate for passengers to get on and to get off safely
d. Voltage range of the rolling stock is compatible with the voltage range of the line
e. Working range of pantograph height covers minimum and maximum height of contact wire
f. Onboard equipment of signaling system and telecommunication system are compatible with the line

(5) Other Consideration for Through Operation

Besides the technical matter described above following items shall be solved before providing through operation.

A. Train Driver which driver operates the train (track owner or train owner)
B. Common ticketing system
C. How to share the revenue
D. Operation Control
E. Procedure for Emergency Case
F. Rolling stock rental fee
G. Operation planning (how to make train schedule)
H. Responsibility in case of accident
I. Training for operational personnel

3. Interconnectivity with Other Line

(1) Station Location

To stimulate the use of mass transit it is necessary to minimize the obstruction. Existing railway network there are some stations to exchanging train to other line.

Line 1 EDSA – Line 3 Taft
Line 2 Alaneta Cener – Line 3 Cubao
Line 1 Doroteo Jose – Line 2 Recto

Figure 12.3-1 to **Figure 12.3-3** indicate satellite image of interconnecting stations in Metro Manila urban railways.

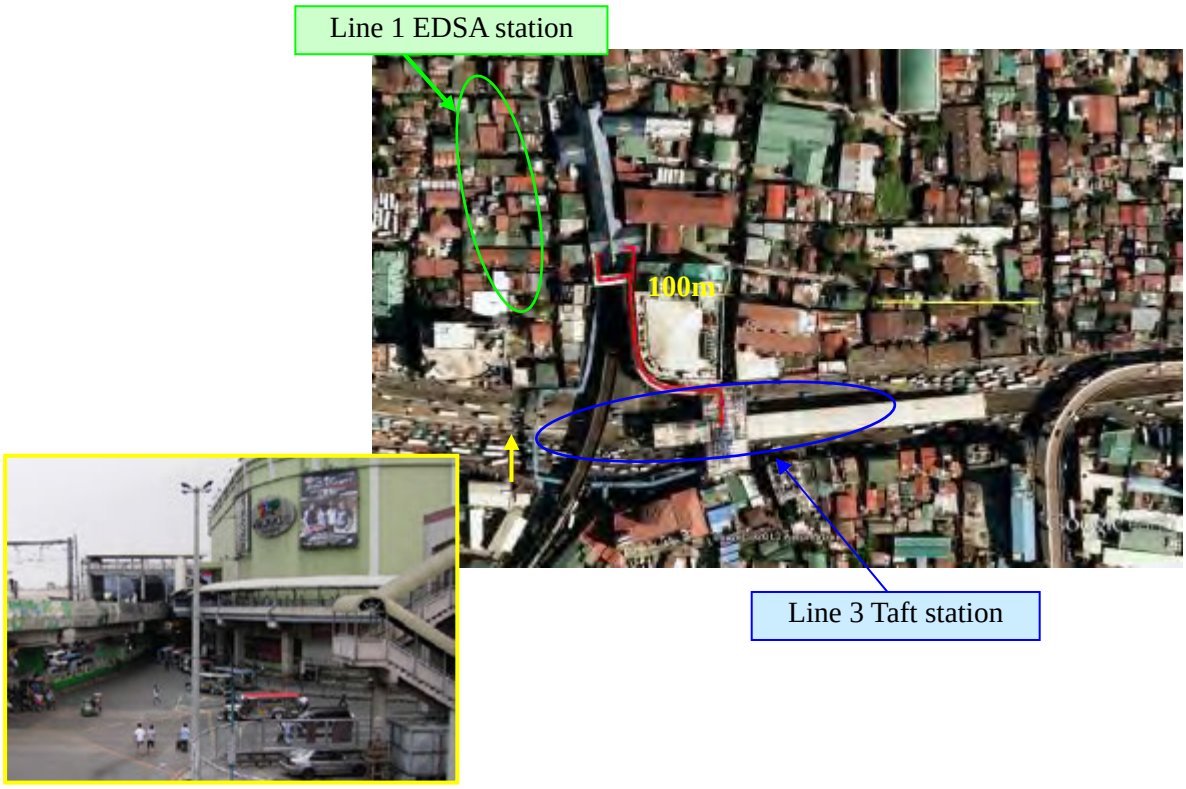


Figure 12.3-1 Interconnection with Line 1 and Line 3

Figure 12.3-2 Interconnection with Line 2 and Line 3

Figure 12.3-3 Interconnection with Line 1 and Line 2

Location of the station is not good at the point of view for convenience of transfer. At first moment there are no designated paths for transfer. Paths were constructed later for passengers to transfer without suffering the rain or sun however passengers have to walk long way.

Passengers have to pass a lot of obstacles until transferring the train.
Following items are considered as obstacle for interconnection of the station.

Approach between two stations
Security check
Ticket counter
Ticket gate
Stairs

Figure 4 indicates the passenger flow to transfer the train. Each circle is supped to be the obstacle.
It will take a lot of time and effort for passengers to transfer the train.

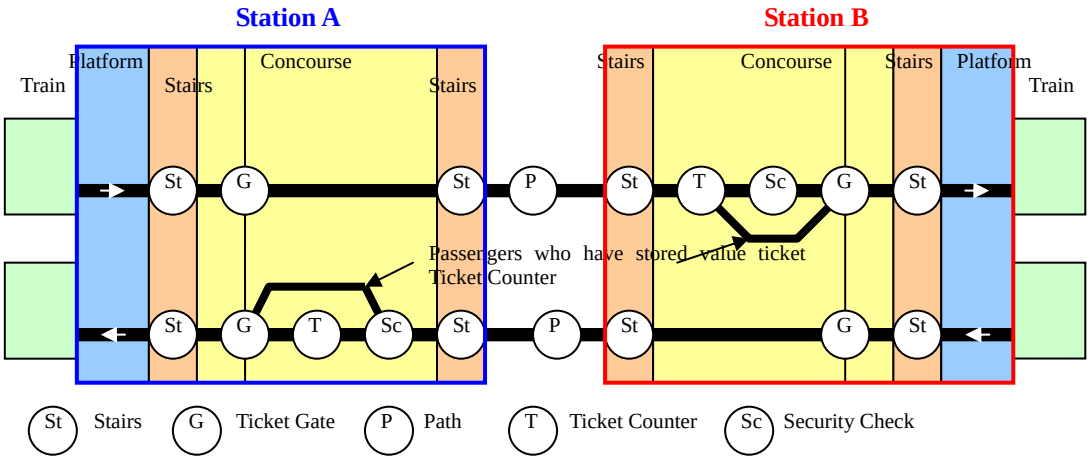


Figure 12.3-4 Passenger Flow to Transfer the Train

Figure 12.3-5 shows the example of interconnecting station in Japan.

Figure 12.3-5 Example of Interconnecting Station in Japan
(Tsuruhashi Station of JR West and Kintetsu)

Two stations of different operator are constructed in same place. There are transfer gate at the side of upper platform and there are stares connected to lower platform. When passenger get off from train of upper level will pass the gate and go down the stares it is already the platform of lower level.

It is recommended to construct interconnecting station as near as possible with other line.

Following figure indicates passenger flow of transferring the train at this station. Compare to figure 4 it is very simple and passenger can transfer the train easily and immediately.

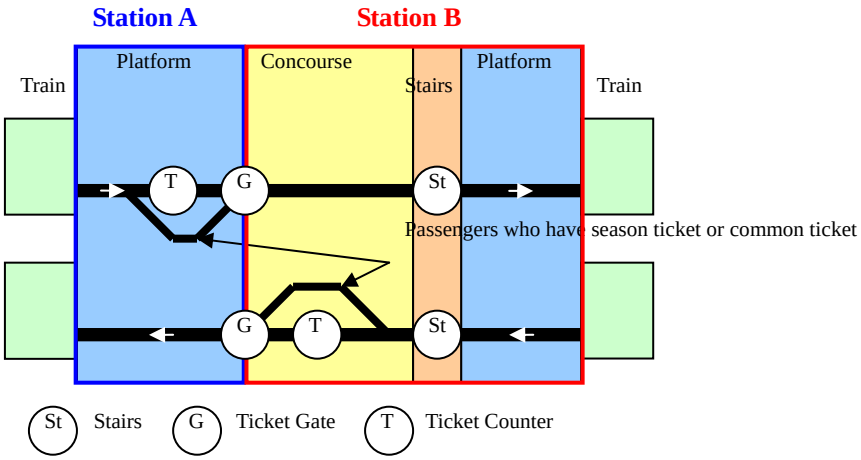


Figure 12.3-6 Passenger Flow to Transfer the Train

It is preferable to reduce the number of obstacles however it is difficult to reduce the number when station location is far from other line. Followings are measures to lower the level of obstacles.

(2) Ticketing Counter

There are always long lines at ticketing counter. It is because most of the passengers buy the ticket every time they ride on the train even railway operator provide stored value ticket.

Figure 12.3-7 Lines of Passengers Before Ticket Counter (Line 3 Taft Station)

In Japan advantage of season ticket is about 50% discount when using railway with one roundtrip every day and much more discount for season ticket for students. Therefore almost every workers and students has season ticket and it can prevent the congestion of ticket counter at peak hour.

Advantage of current stored value ticket is for the last ride. Ticked is valid for one more ride even if the remaining balance is less than minimum fare. When the fare of last ride is same as balance there are no advantage. It is not very attractive for the passengers.

It is recommended to give more advantage for the passengers and it will not only mitigate the congestion at ticket counter but also it will increase the ridership of the train.

Another solution for mitigate the congestion at ticket counter is to provide ticket vending machine. Figure 8 indicates ticket vending machine in Japan.

Figure 12.3-8 Ticket Vending Machine in Japan

(3) Ticket Gate

Currently bottle neck of passenger flow in station is ticket counter therefore long line before the ticket gate is not happen. However in case that there are not much space for ticket gate there is possibility that long line will occur before the ticket gate.

Figure 12.3-9 Ticket Gate (Line 3 Taft Station)

Ticket gate commonly used in the Philippines is rotating bar type. Passenger has to stop before the gate and insert the ticket and push the bar to pass the gate.

In Japan frap door type ticket gate is commonly used. Passenger inserts the ticket and machine will accept the ticket any direction or any side is up. Frap door keeps open unless passenger tries to pass without ticket or with wrong ticket or there is long interval after last passenger passed. Processing speed of frap door type is approximately twice as much as that of rotating bar type.

Currently ticket media is changing to smart card and passenger does not need to insert the ticket into the machine but just put the ticket over the sensor of the machine that is either in the case such as wallet or not. Passenger can pass the gate without stopping.

Figure 12.3-10 indicates ticket gate in Japan.

Figure 12.3-10 Ticket Gate in Japanese Railway

4. Interconnect with Other Transportation Mode

Railway shall not compete with other transportation modes but get together with others. Railway service is provided only from station to station. Usually distance of station is longer than other traffic mode. Station to the destination shall be covered with other traffic mode those are bus, taxi, jeepney, tricle or private cars as feeder service. Station location and circumstances shall be convenient for transferring other transportation mode. When constructing new line it is recommended to select the station location near the terminal of other transportation mode or constructing terminal of other transportation together to make transportation hub.

Currently car park of shopping mall in Magallanes is already full in the morning because peoples from South Luzon Highway park the car and ride the train. When there is car park near the station it will promote the people to use the railway and mitigate the road congestion in city center. When car park is operated by railway operator parking fee will become additional income for the operator.

5. Conclusion

To provide harmonious network of railway in the Philippines following matters are recommended.

1. standardize the railway system to prepare for through operation
2. plan the interconnecting to provide easy transfer for passengers
3. modernize the station facilities to utilize smooth passenger flow
4. promote prepaid ticked to mitigate the congestion at ticket counter
5. plan the station to combine with other transportation mode

CHAPTER 13
SUMMARY OF FINDINGS

CHAPTER 13 SUMMARY OF FINDINGS

This chapter summarizes the major findings of this study.

13.1 Ridership

For this study '*preliminary*' patronage demand estimate were based on previous studies and relevant existing data. These demand estimates have been further studied and revised, based on the analysis of most recent (up to July 2012) LRTA data of the existing Line-1. Additionally the forecast patronage has been updated based on the traffic and passenger interview surveys conducted in June and July 2012, to confirm the underlying assumptions and reasonableness of the forecast patronage. This section summarizes the patronage demand estimate for the whole of Line-1, for the next 30 years.

A comparison between previous studies and the latest JICA estimations was done, and the results are illustrated in **Figure 13.1-1**. It shows that the earlier estimates made by Halcrow had produced a low demand forecast, while the recent ICF forecast show almost an exponential growth in demand irrespective of the Line-1 capacity constraints. Our estimate has been checked against possible line capacity, and is prudent.

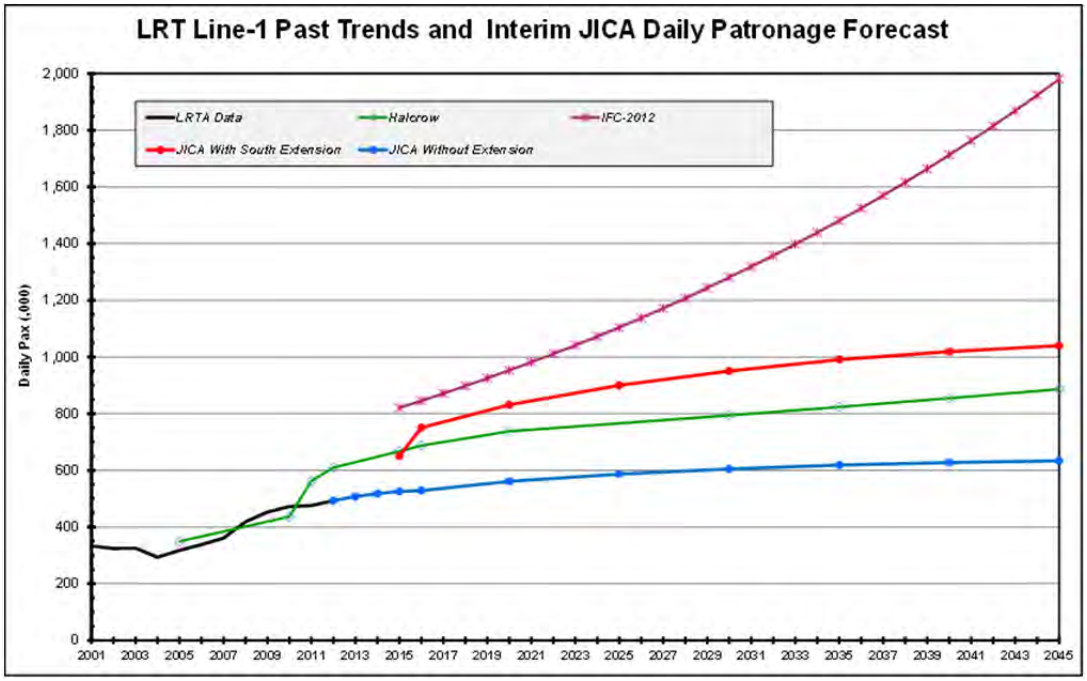


Figure 13.1-1 Average Weekday Patronage Forecast by JICA & Others

The average weekday demand forecast prepared by the study team has been discussed and presented in Section 2.3.1. The annual patronage demand used for the revenue estimates has been derived by applying the annual factor to the average weekday demand. The annual demand has been summarized below in **Table 13.1-1**. Detailed daily and peak passenger demand by station and peak line loading for each of the forecast years is given in Appendix-C of this report.

Table 13.1-1 Summary of Patronage Forecast for Line-1

Line-1 Extension to Niyog - Forecast of Passenger and Other Attributes										
Description	Unit	2012	2015	2016	2020	2025	2030	2035	2040	2045
Average Week Day Boarding (Without Extension)	Pax	492,700	525,500	528,600	561,100	586,800	604,600	618,300	627,600	633,500
Increase in Daily Patronage (Av. Week Day)	Pax	-	125,200	222,000	270,100	313,100	345,700	372,400	391,400	406,300
Total Patronage with Extension (Av. Week Day)	Pax	492,700	650,700	750,600	831,200	899,900	950,300	990,700	1,019,000	1,039,800
AM Peak Hour (0700-0800) Boarding Southbound	Pax/Hr	24,200	29,700	32,900	36,100	38,700	40,600	42,200	43,200	44,000
AM Peak Hour (0700-0800) Boarding Northbound	Pax/Hr	13,300	19,700	24,100	27,200	29,700	31,700	33,200	34,300	35,100
Total AM Peak Hour Boarding Both Direction	Pax/Hr	37,400	49,400	57,100	63,200	68,500	72,300	75,400	77,500	79,100
AM-Peak Hour Boarings as % of Daily Boardings	Ratio	7.59%	7.59%	7.60%	7.61%	7.61%	7.61%	7.61%	7.61%	7.61%
Maximum Station Boarding (AM-Peak Hour)	Pax/Hr	7,700	9,100	9,800	10,600	11,300	11,800	12,200	12,400	12,600
Maximum Station Alighting (AM-Peak Hour)	Pax/Hr	4,700	5,600	6,000	6,500	6,900	7,200	7,500	7,600	7,700
Pax/Hr/Per Direction (AM-PK Hr 0700~0800)	PPHPD	19,700	23,800	26,000	28,400	30,500	32,000	33,100	33,900	34,500
Average Week Day Trip Length	km	7.65	9.64	10.72	11.00	11.22	11.37	11.48	11.56	11.62
Annual Factor	Days	330	330	330	330	330	330	330	330	330
Annual Passenger	Pax million	162.59	214.73	247.70	274.30	296.97	313.60	326.93	336.27	343.13
Annual Passenger*km	million*km	1,243.7	2,070.0	2,655.3	3,017.3	3,332.0	3,565.6	3,753.2	3,887.3	3,987.2

Extending Line-1 to the south would add ten stations to the existing twenty stations. The exiting Line-1 will be extended by about 12km, increasing its immediate catchment area by more than 60%. The proposed ten stations would be located mostly on brown-field sites, and the surrounding areas are also empty or agriculture land. However, major developments are anticipated in and around the proposed station sites in early years, and further developments in the region as population grows. In addition, the three proposed multi-modal terminals at: Dr. Santos, Zapote, and Niyog would attract passengers from existing road based transport modes, and would also attract suburban commuters from surrounding areas through feeder services.

It is anticipated that this would add about 220,000 (+40%) daily passengers to the existing Line-1 patronage after the 'full' opening of Line-1 by 2016. This estimated patronage increase may appear to be 'high', but given the travel time savings passengers from the south would benefit from is substantial, when compared to the travel times on the congested coastal roads from the south, as shown above in section on survey data. It should also be noted that currently over 123,000 Pax use Line-1 and MRT-3 from Baclaran, EDSA and Taft as estimated from the current passenger surveys. Therefore, the estimated demand in four years with additional catchment area of 12km, is not excessive at all, if the stations are accessible, well planned, mode-change at stations, mainly at the proposed 3 multi-modal terminals is convenient, and most of all Line-1 current capacity is enhanced for the added comfort of the longer distance travellers.

It is estimated that the patronage would continue to grow as the areas along the Line-1 extension alignment would develop further over time, with increase in population beyond the full opening year of 2016. The development potential in the south is considerable, due to availability of land for high density development. The patronage would also benefit from the integration of Line-1 into the areas south of Metro Manila and extension into Cavite province through feeder services. Further integration of Line-1 with the Metro Manila mass transit network by running through services between Lines 1 & 3; providing convenient transfer to/ from other LRT/MRT lines; and integrated public transport e-ticketing system would further add to the Line-1 patronage.

13.2 Route Review

1) Location of Redemptorist station

Initially, the Redemptorist Station had been planned before Baclaran Redemptorist Church to face Roxas Boulevard as per the drawings collection of LAVALIN. However, further modification moved it southbound before the district Boulevard 2000 Development, or about 600m from the initial position according to information from LRTA. The original position of the station was proximity 500 mts. from Baclaran station, but around 2km from next station, MIA Station, hence the balance of the distance between the stations was not suitable.

In addition, a commercial building has already been constructed at new location, and land development at the new proposed location is ahead than the original location. Thus, it is considered that the change of the station location is reasonable.

2) Route near Parañaque River

According to the original route plan of LAVALIN, the alignment between Ninoy Aquino stations and the Asia World station would pass through the central part of the Parañaque River. Generally, as for bridge pier construction, since it is deep water and the central part of the river has the quick flow velocity, it is desirable to avoid the central part of a river. The reasons are shown below:

- Scouring occurs near the basic part of a bridge pier built in underwater.
- The collision power of flotsam is large at the time of a flood.
- A work burden is heavy at the time of construction of a bridge pier.

Thus, it is desirable to avoid the above-mentioned problem if possible here by changing a route into the north-side slippage in a river.

3) Location of Niyog station

In the drawings collection of LAVALIN for Cavite extension, the Niyog station was planned at the western side of the Molino Boulevard. Since the bus terminal will be located at the east side of Molino Boulevard, it was necessary to move it eastward to the center of the road (Molino Boulevard) to be side by side with the bus station to facilitate convenience to passengers. This change was done by LRTA.

4) Location of Depot

According to the original route plan of Lavalin, the satellite depot was planned at the sea side (west) of the main line. However, due to the negative impact of sea salt air on the vehicles, the satellite depot would be eventually planned at the mountain side (east) of the main line.

Therefore, as for a Satellite base, it is desirable to build at the west side of the main line based on the site information on LRTA.

13.3 Operation Plan

1) Operation Schemes

Currently north terminal is Roosevelt station but it is planned to extend to Common Station. Following table indicates the operation pattern of each phase, pattern, and case.

Table 13.3-1 Operation Patterns of Each Phase

Cases		Headway	Operation pattern
Opening of South Extension	Phase1	3min 15sec	Roosevelt — Dr. Santos
	Phase2	2.5min	Common station — Niyog
Future		2min	Common station — Niyog

Currently track of north extension is physically connected to Line 3 but train operation is limited to Roosevelt station. However, this station was not designed to be a terminal station, and its turn back facilities only allow a minimal headway of 3 minutes. It is planned to provide Common Station between Roosevelt and North Avenue so that trains of both line will come to Common Station and passengers can easily transfer from one line to the other, and vice versa.

2) Operation at North Terminal

At initial stage Roosevelt station will be the north terminal. The train will go about 700 m to east after evacuating the passengers at the station to turn back. This station and the track layout were not designed for terminal station, and severe limitation of shorter headways is present for this station.

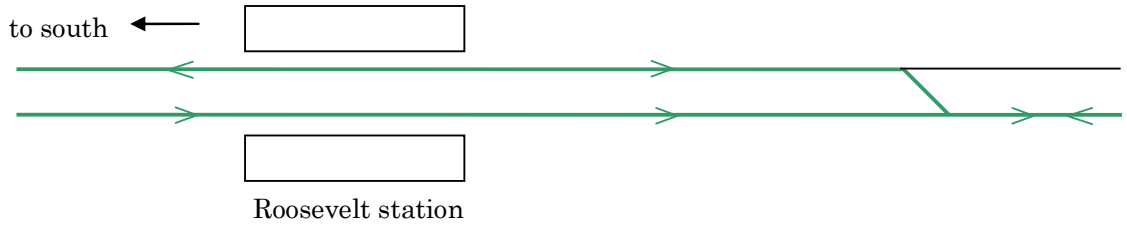


Figure 13.3-2 Track Layout of North terminal (Roosevelt)

Considering the through operation and frequency, the recommended track layout of the Common Station is indicated in figure below. There is no enough space for constructing pocket tracks for stabling but siding track is extended so that one train can be stabled.

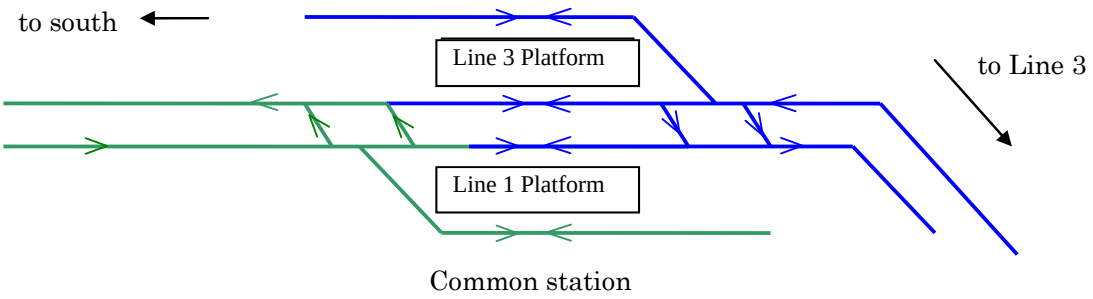


Figure 13-3-3 Recommended Track Layout of North terminal (Common Station)

3) Fleet Requirement

Required number of trains is assumed by counting the line in train diagram. Based on the number of trains shown in **Table 13.3-2**, future train procurement plan are indicated as follows. A total of 30 trains are required to be procured at the opening of south extension.

Table 13.3-2 Rolling Stock Procurement Plan

Units: Train sets

		Opening of South Extension		Future	
		Phase1	**Phase2**	**Phase1**	**Phase2**
Year		2015(2/4)	2016	2025	2035
1st Generation Train		16	16		
2nd Generation Train		3	3		
3rd Generation Train		12	12	12	12
4th Gen Train	1st batch	**8**	8		
	2nd batch		**22**	**30**	30
5th Generation Train				**20**	20
6th Generation Train					**15**
Total		39	61	62	77
Required number of trains		39	61	62	77

Source: Study Team

13.4 Depot Plan

1) Existing Baclaran depot expansion plan

Depot expansion plan of existing Baclaran depot is shown as below:

- No. of stabling tracks: 13 tracks (1 train set /each track)
- No. of light maintenance tracks: 2 tracks (in light maintenance shed)
- No. of unscheduled inspection tracks: 1 track (in light maintenance shed)
- No. of heavy maintenance tracks: 2 tracks (in heavy maintenance workshop for 1 train set)
- No. of wheel re-profiling tracks: 1 track (with wheel re-profiling shed)
- Buildings and facilities :
  - Administration building for LRTA
  - OCC building
  - Substation
  - Waste water treatment plant
  - Material storage
  - Motor pool

Figure 13.4-1 shows scheme of Baclaran Depot Layout

2) New Zapote Satellite depot plan

Depot expansion plan of existing Baclaran depot is shown as below:

- No. of stabling tracks: 9 tracks (2 train set /each track)
- No. of light maintenance tracks: 2 tracks (in light maintenance shed)
- No. of daily inspection tracks: 1 track
- No. of automatic train wash track: 1 track

Figure 13.4-2 shows scheme of Zapote Satellite Depot Layout

Figure 13.4-1 Baclaran Depot Expansion Plan

Figure 13.4-2 Zapote Satellite Depot Plan

3) Stabling Facilities Plan

Stabling during the night will be done only at depot stabling tracks and some trains at siding tracks of the revenue line so that maintenance activities will not be disrupted. There are 25 stabling tracks in current Pasay depot. Of that total, 15 tracks are good for 2 trains in series when a 1st Generation train is included, while others are good for stabling only one train. However, after replacement of 1st generation trains, only one train could be stabled in a single track. Thus, a total of only 30 trains could be stabled in the existing depot in the future.

By the end of Phase 1 of the project, the expansion of existing Pasay Depot should be completed. There will be constructed 13 additional stabling tracks, increasing the total availability of stabling tracks to 53 trains. However, if some tracks in the light maintenance hall and some particular stations are included for stabling, the total number of stabling tracks becomes 66 trains. Since only 39 trains are required at this phase, there are enough tracks for stabling.

By completion of Phase 2, satellite depot will be constructed and stabling capacity will be 87 including inspection tracks and stabling at stations. Number of trains would be 61, then, stabling capacity is enough in this phase.

In the future headway will be minimized to 2 minutes as ridership will increase. Required number of trains would be 77 at this stage, however the stabling capacity of entire facilities would be reduced to 77 as total replacement of first generation and second generation will occur, being exactly the amount of trains needed. Therefore, this matter must be taken into consideration when implementing the future capacity expansion in 20 years-time if the number of needed trains would be increased from the planned amount.

Table 13.4-1 Stabling Plan of LRT Line1

Units: Train sets

	Opening of South Extension		**Future**	
	Phase1	**Phase2**	**Phase1**	**Phase2**
	2015	**2016**	**2025**	**2035**
Existing Depot				
Existing Stabling Track	40	40	30	30
Existing Inspection Track	5	5	5	5
Stabling Track in Expansion	13	13	13	13
Inspection Track in Expansion	3	3	3	3
Satellite Depot				
Stabling Track	-	18	18	18
Inspection Track	-	2	2	2
Station				
Common Station	-	1	1	1
Monumento	1	1	1	1
Central	1	1	1	1
Baclaran	2	-	-	-
Dr. Santos	1	1	1	1
Niyog	-	2	2	2
Total	66	87	77	77
Number of trains	39	61	62	77

Source: Study Team

13.5 Rolling Stock

1) Existing Fleet

There are three types of rolling stock in Line 1:

First generation trains are introduced in 1984 at the opening of Line 1 and 64 vehicles are installed. Vehicle is double articulated and one train set consists of two cars. After Capacity Expansion Project, first generation trains changed to 3-car train in order bring the passenger capacity of the train almost same as second generation. Thus, 21 vehicles are converted to intermediate car by installing coupler at front end. Consequently, the 1G fleet becomes a 21 3-car trains fleet, from the original 32 2-car trains, plus one car remained.

Second generation train is introduced in 1999 at Phase 1 of Capacity Expansion Project. The train consists of 4 vehicles and the vehicle is single articulated.

Third generation trains are introduced in 2007 at Phase 2 of Capacity Expansion Project. Train configuration is same as second generation train.

Table 13.5-1 shows the summary of the condition of the rolling stock of Line 1. It shows that 33 cars out of 140 cars are not operational; 7 cars are defective because of collision, one car was bombed and 25 cars are because of lack of some parts.

Table 13.5-1 Summary of Rolling Stock Condition

	1st Gen.	2nd Gen.	3rd Gen.	Total
Operational	50	12	45	107
Not Operational	14	16	3	33
Bombed car	(1)			(1)
Collided car	(2)	(2)	(3)	(7)
Missing Parts	(11)	(14)		(25)
Total	**64**	**28**	**48**	**140**

2) Fourth Generation Rolling Stock

According to train operation plan, the required number of trains for Cavite Extension 2017 is 61 trains and 31 existing trains will be available including restored trains. Therefore, 30 trains shall be procured as fourth generation train for this project. Train configuration should be same as 3rd generation train to simplify the maintenance.

13.6 Implementation Plan

The implementation plan presented herein is only for portion covered by JICA Loan, i.e., construction of two depots, rehabilitation of existing rolling stock, and procurement of new rolling stock.

The schedule has been divided into two (2) milestone phases, as explained in the Operation Plan Chapter, which are:

- **Phase 1**: Partial opening of south extension at Dr. Santos station, completion of expansion of Baclaran depot; rehabilitation of 3 3G LRVs (by LRTA); delivery of 8 new trains. **May 2015**.

- **Phase 2**: Total completion of project up to Niyog Station; completion of Zapote satellite depot; Increase frequency of trains by decreasing minimal headway to 2.5 min. This implies completion of Common Station; and delivery of last 22 trains. **May 2016**.

Close coordination with the Civil and E&M works' portion is paramount for the success of the project. Furthermore, the completion of related projects, such as the construction of the Common Station in between Roosevelt and North Avenue stations, and the implementation of the Common Ticketing System are crucial as well for the proper implementation of the Line 1 CEP.

The schedule of these projects is not mentioned in this report.

13.7 Cost of JICA ODA Portion

The summary of the cost for the JICA portion is shown in **Table 13.7-1**. The figures are shown in foreign (JpY) and local (PhP) portions, and summarized in US$. The disbursement schedule for the JICA Loan portion is shown in **Table 13.7-2**.

Table 13.7-1 Total Cost of JICA Loan

Breakdown of Cost	Jpn Yen ('M)			Phi Peso ('M)			Total (Jpn Yen)('M)			Total (US$ M)		
	Total	JICA Portion	Others	Total	JICA Portion	Others	Total	JICA Portion	Others	Total	JICA Portion	Others
Rolling Stock	25,249	25,249	0	0	0	0	25,249	25,249	0	306.31	306.31	0.00
Depot	3,553	3,553	0	770	770	0	5,009	5,009	0	60.77	60.77	0.00
Refurbishment	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00
SubTotal Direct ODA	*28,802*	*28,802*	*0*	*770*	*770*	*0*	*30,259*	*30,259*	*0*	***367.08***	*367.08*	*0.00*
Consulting Services	1,882	1,882	0	612	612	0	3,039	3,039	0	36.87	36.87	0.00
SubTotal Direct Loan	*30,685*	*30,685*	*0*	*1,382*	*1,382*	*0*	*33,298*	*33,298*	*0*	***403.95***	*403.95*	*0.00*
Price Escalation	1,755	1,755	0	39	39	0	1,829	1,829	0	22.19	22.19	0.00
Physical Contingency	1,528	1,528	0	40	40	0	1,604	1,604	0	19.46	19.46	0.00
Land Acquisition	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00
Administration Cost	0	0	0	971	0	971	1,837	0	1,837	22.28	0.00	22.28
VAT	0	0	0	175	0	175	332	0	332	4.02	0.00	4.02
Import Tax	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00
Interest during construction	148	148	0	0	0	0	148	148	0	1.80	1.80	0.00
Commitment Charge	148	148	0	0	0	0	148	148	0	1.79	1.79	0.00
SubTotal Indirect Cost	*3,579*	*3,579*	*0*	*1,226*	*80*	*1,147*	*5,898*	*3,730*	*2,168*	***71.55***	*45.25*	*26.30*
Total	**34,264**	**34,264**	**0**	**2,609**	**1,462**	**1,147**	**39,196**	**37,027**	**2,168**	**475.50**	**449.20**	**26.30**

Source: Study Team

Table 13.7-2 Cost Disbursement Schedule for JICA Loan

Breakdown of Cost	Annual Disbursement (Million Jp Yen)				
	2013	2014	2015	2016	Total
Rolling Stock	504.99	4,797.39	16,412.11	3,534.92	25,249.40
Depot	422.31	2,935.63	1,601.20	50.09	5,009.24
Refurbishment	0.00	0.00	0.00	0.00	0.00
SubTotal Direct ODA	*927.30*	*7,733.02*	*18,013.31*	*3,585.01*	*30,258.64*
Consulting Services	569.01	814.26	829.71	826.16	3,039.14
SubTotal Direct Loan	*1,496.31*	*8,547.27*	*18,843.02*	*4,411.17*	*33,297.77*
Price Escalation	21.16	333.32	1,163.77	311.01	1,829.27
Physical Contingency	47.42	403.32	958.85	194.80	1,604.40
Land Acquisition	0.00	0.00	0.00	0.00	0.00
Administration Cost	78.24	464.20	1,048.28	245.85	1,836.57
VAT	80.88	119.54	90.92	40.28	331.62
Import Tax	0.00	0.00	0.00	0.00	0.00
Interest during construction	2.05	19.07	59.47	67.85	148.44
Commitment Charge	36.88	36.88	36.88	36.88	147.52
SubTotal Indirect Loan	*266.64*	*1,376.32*	*3,358.18*	*896.67*	*5,897.81*
Total	***1,762.95***	***9,923.60***	***22,201.20***	***5,307.84***	***39,195.58***

13.8 Environmental and Social Considerations

1) Review of EIA Report

For the LRT Line 1 Cavite Extension Project, the review of the existing documents was conducted for the whole components of the extension project covered by the Environmental Impact Assessment (EIA) report.

The Study Team has made recommendations on mitigation measures and monitoring plans in accordance with the JICA Guidelines

The scope of work (SOW) of JICA loan includes development of two depots, namely, the existing depot at Baclaran and the satellite depot at Zapote. Therefore, the supplemental EIA study focused on the existing depot and new satellite depot.

2) Supplemental EIA Study

The site for the Satellite Depot is a flood plain swamp located in the river mouth of Zapote River. Informal settlers have settled along the perimeter of the swamp and the bank of Zapote River. They have used large mangroves trees for houses and charcoals, and polluted the swamp with waste and wastewater

for a long time. However, a few small mangrove trees are still remaining in the swamp and creek. Therefore the Study Team carried out the supplemental environmental surveys.

The result of flora and fauna survey shows that none of species listed as threatened under international and national lists were found in the Satellite Depot. The result of the sediment quality analysis shows that the site for Satellite Depot might be contaminated by dumping waste. More sediment samples shall be collected and rigorously analyzed to investigate the extent of pollutant levels during the pre-construction phase.

3) Review of RAP

In November 2008 the Relocation Action Plan (RAP) was made based on a series of consultations with households, giving attention to the informal settlers, who would be directly affected within the ROW of the proposed alignment. According to RAP (2008), the documented number of informal settler households to be relocated was 1,714 in 2008.

The RAP was revised by LRTA in 2012 to update the relocation work schedule. LRTA started the re-tagging and re-census survey in late July 2012. The number of potential Project Affected Persons (PAPs) in proposed Satellite Depot site is about 190. The Study Team requested LRTA to confirm that the affected families in the Satellite Depot be surely on the list of the beneficiaries of the revised RAP. Furthermore, the entitlement shall meet the requirement of JICA Guidelines.

The selected resettlement site located in General Trias, Cavite with approximately 20-hectare area has been acquired. Horizontal development of the resettlement site has been substantially completed, and about 180 housing units have been constructed. The construction of the remaining 1,820 housing units will be started as soon as LRTA has transferred the additional budget.

RAP (2008 &2012) had been prepared only for the relocation of informal settlers. However, in accordance with JICA Guidelines and World Bank OP 4.12, the RAP shall also prepare for the legal PAPs such as land owners and title holders of structures, business owners and operators and so on.

13.9 Considerations of Project Effects

The calculation of indexes is done for whole section including existing section and extension section. The results of operation/effect indicators are shown in **Table 13.9-1**.

Table 13.9-1 Calculation result of operation or effect indicators

No.	Operation or effect indicators	Actual in 2011	Desired in 2018 (2 years after opening)
1.	Passenger-km	3,791	5,922
2.	The number of trains in operation	222	258
3.	Workable car ratio	76.4	95%
4.	Train-km	9,818,243	19,374,842
5.	Fare revenue	2,285.61	-
6.	Fare Box Ratio	1.09	-
7.	Non-railway revenue	157.83	-
8.	Load factor	77.32	-

And the elimination effect of train use inconvenient area, new 10 stations, is shown in **Table 13.9-2**. More than 300 thousand populations of beneficiaries are expected along the extension section.

Table 13.9-2 Effect of eliminating inconvenient area for rail use area (New 10 Stations)

No.	Station	Population of Beneficiaries (Pop.)
1	Redemptorist	10,666
2	MIA	13,105
3	Asia World	38,049
4	Ninoy Aquino	18,512
5	Dr. Santos	37,324
6	Manuyo Uno	21,415
7	Las Pinas	42,345
8	Zapote	36,913
9	Talaba	52,059
10	Niyog	32,712
Total		303,097

Source: Study Team The Philippines 2010 Census"

The effect of reduction of CO_2 emission is shown referring to "Climate Finance Impact Tool for Mitigation and Adaptation (Summary) Ver. 1.0, JICA, 2011". **Table 13.9-3** shows the result of the estimation of reduction of greenhouse gas. The project is effective for the reduction of greenhouse gas. The balance for reduction of CO_2 emission will be increasing gradually.

Table 13.9-3 Result of the estimation of reduction of greenhouse gas

Unit: tCO_2 /year

Items		2015	2020	2025	2030	2035
Base Line		55	58	61	63	64
Project	Conversion from PUJ	4	4	4	5	5
	Increasing	1	2	2	3	3
Reduction of CO_2 emission		50	52	55	55	56

13.10 Automatic Fare Collection System

Study Team proposed a comprehensive plan for the replacement of the old ticketing system. This plan includes; (i) the contactless IC card technology instead of magnetic-stripe based card systems, (ii) the introduction of a central Clearing House System for Railway that will perform the apportionment for revenues among the operators, and (iii) PPP scheme using STEP finance.

Japanese Automatic Fare Collection (AFC) vendors have ample track records of developing Felica type card which can transmit data much faster than Type A and B of IC card. Felica is proved to be suitable for city transportation with heavy traffic such as transportation at Tokyo and Hong Kong. Felica has OS and CPU built in, which makes it easier to be applied for multi-purpose use such as e-money, etc.

Considering market soundings with Japanese investors, Study Team identified four options: (i) AFC system and Clearing House development and operation and maintenance (O&M) under PPP mode; (ii) AFC system and Clearing House development under JICA STEP loan with O&M under PPP mode; (iii) hardware development of Clearing House system under JICA STEP loan with AFC system development, software development of Clearing House and O&M under PPP; and (iv) AFC system development and hardware development of Clearing House under JICA STEP loan with software development of Clearing House and O&M under PPP.

Total estimated government contributions for above mentioned options of the project are as follows: (i) $71.01M, (ii) $69.10M, (iii) $70.93M and (iv) $69.43M, respectively. The results show that utilizing

STEP loan will reduce interest burden compared to procurement solely under PPP, Option (i). It is noted that PPP scheme with the availability payment by the government will not eliminate government contribution during the project period. STEP loan is assumed to be a 40 year-loan with interests of 0.2%. This could lower annual government payments under scheme utilizing STEP loan than those of Option (i), procurement solely under PPP.

13.11 Project Implementation Scheme

1) Railway Construction Capacity

Local construction entities have experienced construction of elevated track infrastructure since the 15-km LRT L1 was built in 1980 – 84. The prime contractor was Philippine National Construction Corporation. Since then, Construction of Line 2, extension of LRT 1 and MRT 7 as well as PNR rehabilitation works followed and was contracted with domestic contractors or joint ventures of foreign and local contractors. As the project finance market needs assurance of capacity enough for the project implementation, it can be judged that "domestic" capacity exists for all the civil and electromechanical components of LRT 1 CEP.

2) Bidding System

The bidding system in the Philippines is well-structured and formalized which has been applied by the Government over a decade. As a consequence, substantial experiences and precedents have been accumulated. For ODA-funded projects, however, the tender procedure is subject to review and oversight by the funder. There have been problems encountered in the past, when the rules of the ODA funder differed from somewhat from the local ones. Projects with an ODA loan entails detail design prior to bidding, while PPP usually adopts a design-build scheme.

As for tendering, DOTC has tapped the International Finance Corp. as Transport Advisors. Their main merit is to ensure a successful and open tendering process that will be also bankable. The main criterion for the winning bidder is highest concession fee to the Government, which is construed as rental payment for existing assets in case of LRT 1 (from Baclaran to North Avenue).

3) Contract

Delicate portions of contract or concession agreement will hinge on periodic review of the concessionaire's performance referring to key performance indicators (KPIs), during the contract period (30 years) and rehabilitation works, especially of rolling stock which has no historical records.

4) O&M

Considering the institutional weakness in the public sector, transferring the operation and maintenance of a highly demanding and technically complex enterprise to the private sector is a step in the right direction. The incentive for the concessionaire is to maximize profits, balancing fare levels against demand elasticity and on-street competition. This is minimizes the needs for tighter audit and regulation by LRTA/ DOTC.

13.12 Institutional Issues to Implement the Project

1) Institutional issues from the viewpoints of Construction, O&M, Safety, Personnel and Financial Matters

Structure of the Project Management is still unclear. It is suggested by the JICA Study Team to compose an Inter-Agency Committee consisting of representatives of DOTC, LRTA, DPWH, MMDA and a civil

society/ Private sector. The Committee should appoint a project manager (PM) and two deputy managers in charge of civil works of PPP component and electromechanical components, respectively. The PM and deputy PMs shall organize three supportive groups of: (1) Administrative Support, (2) Consultant's Technical Pool and (3) Counterpart Technical Staff. To minimize conflicts within the organization, there should be only one Consulting group to be hired , rather than separately for the Civil Works (PPP Component) and for the electro- mechanical (ODA Component), preferably funded by JICA and LRTA.

It can be presumed that the PM Consultant will be responsible for the formulation of technical and performance specifications as well as presentation of tender documents, for the different packages of the Electro-mechanical components, possibly as well as the civil work component. The PM Consultant is also responsible to set of criteria and procedures to be used for testing the operational system or its major components.

2) Risks analysis on the hybrid type PPP for LRT Extension

According to the Preliminary Information of Memorandum (April 2012), DOTC shoulders such risks as (a) Transfer of Existing LRT assets (b) Fare Adjustment Implementation (c) ROW Acquisition and Delivery (d) Delivery of Rolling Stock (e) Depot Development/ Satellite Depot Construction and (f) Political Risks, while the concessionaire shoulders the risks of (g) Traffic/ Ridership (h) Project Financing (i) Inflation & Foreign Exchange (j) Design/ Construction (k) Integration of Existing Line 1 and the Southern Extension (l) Operation/ Maintenance and (m) Turnover at the end of Concession. The risk of Force Majeure is shouldered by both sides.

Before starting construction, financial closing may be the highest risk in general. In case of a PPP scheme, the most important issue during construction is to keep the schedule. Both sides have to fulfill their own responsibility in time, especially for such events as land procurement, construction and rolling stock delivery. During operation, the biggest risk is failure of periodic fare adjustment. Legally, LRTA Board has the power to adjust fares. In practice, however, it is decided by the President, thus, making the fare-setting process a political exercise.

13.13 Recommendation for Railway Development in the Philippines

From the following 3 view points, we would like to recommend about the future railway development in Philippines. The recommendations were accepted by DOTC of our counterpart.

1) Review of tender documents (draft)

In Private portion of LRT Line 1 extension project, the extension section is planed through weak ground along the coast, and the measures to earthquake-proof, flood control, etc. are essential. We advised to the Ministry of Transportation about appropriately preparation of tender documents, and recommended with Japanese technologies and experiences.

2) Assistance for preparation of railway technical standard (draft)

In Metro Manila, further development of urban railway network is required. On the other hand, a railway technical standard has not been established including the viewpoint of earthquake resistance, etc., so we recommended preparation of railway technical standard (draft).

3) Networking of urban railway

To promote the urban railway network in Manila metropolitan area, we examined and proposed especially focusing the urban railway from the technical viewpoints.