The Republic of Panama Secretaría del Metro de Panamá

THE FEASIBILITY STUDY ON PANAMA CITY URBAN TRANSPORTATION LINE-3 PROJECT

Final Report

September 2014

JAPAN INTERNATIONAL COOPERATION AGENCY

NIPPON KOEI CO., LTD. TONICHI ENGINEERING CONSULTANTS, INC. TOSTEMS, INC. NIPPON KOEI LAC CO., LTD.



The Republic of Panama Secretaría del Metro de Panamá

THE FEASIBILITY STUDY ON PANAMA CITY URBAN TRANSPORTATION LINE-3 PROJECT

Final Report

September 2014

JAPAN INTERNATIONAL COOPERATION AGENCY

NIPPON KOEI CO., LTD. TONICHI ENGINEERING CONSULTANTS, INC. TOSTEMS, INC. NIPPON KOEI LAC CO., LTD.

Exchange Rate (October 2013)

- 1 Balboa (B/.)
- 1 Yen 1 US Dollar (US\$)
- 1 US\$

= 99.7 Yen (JPY) = 0.01003 Balboa = 99.7 Yen = 1 Balboa



- •This is an image of a bridge conceptual phase.
- It has possibilities of changing its appearance by future investigation. •This image is the copyright of JICA unless stated.
- This image is the copyright of JICA unless stated.
 All rights reserved.





•This is an image of a bridge conceptual phase. It has possibilities of changing its appearance by future investigation. •This image is the copyright of JICA unless stated. All rights reserved.

This is an image of a bridge conceptual phase.
It has possibilities of changing its appearance by future investigation.
This image is the copyright of JICA unless stated.
All rights reserved.

IN THE REAL PROPERTY AND A REAL PROPERTY OF A REAL PROPERTY OF

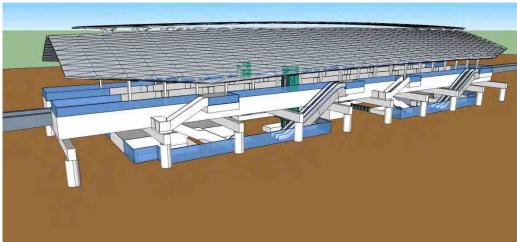
•This is an image of a bridge conceptual phase.

- It has possibilities of changing its appearance by future investigation. •This image is the copyright of JICAunless stated. All rights reserved.

This is an image of a bridge conceptual phase. It has possibilities of changing its appearance by future investigation.
This image is the copyright of JICA unless stated. All rights reserved.

This is an image of a bridge conceptual phase.
It has possibilities of changing its appearance by future investigation.
This image is the copyright of JICA unless stated.

All rights reserved.



Albrook Station



Standard Station



THE FEASIBILITY STUDY ON PANAMA CITY URBAN TRANSPORTATION LINE-3 PROJECT

FINAL REPORT

TABLE OF CONTENTS

Part 1 Project Necessity

Chapter 1	Outline of the Project	1-1
	kground of the Project	1-1
1.2 Pro	ject Scope	1-1
1.3 Stu	dy Purpose	1-2
1.3.1	Urban Transportation Line-3	1-2
1.3.2	4th Panama Canal Bridge	1-2
1.4 Stu	dy Scope	1-2
1.5 Sur	vey Area	1-3
1.6 Wo	rk Schedule	1-5
1.7 Stal	keholder Meeting	1-5
1.8 Stu	dy Tour in Japan	1-6
Chapter 2	Necessity of the Project	2-1
	rent Situation and Issues of Urban Transportation Sector	
2.1.1	Socioeconomic Situation and Urban Development	
2.1.2	Transportation Network	
2.1.2	Public Transport	
2.1.4	Current Situation and Problems of Urban Transportation	
	icies and Plans for the Urban Transportation Sector	
	ernational Assistance in Transportation Sector	
	cessity of the Project	
2.4.1	Necessity of transport infrastructure crossing the canal	
2.4.2	Necessity of the 4 th Bridge	
2.4.3	Necessity of Urban Transportation Line-3	
	luation of Alternatives	
2.5.1	Without Project Case	
2.5.2	Metro Line-3 as a Separate Project	
2.5.3	Tunnel	
	iclusion	
2.0 001		
Chapter 3	Demand Forecast	
	thodology	
3.1.1	Introduction	3-1
3.1.2	Origin and Destination Matrix	3-1
3.1.3	Modifying the SMP 2009 OD	
3.1.4	Transit Assignemnt	
3.2 Der	nand Forecast of ACP's Pre-Feasibility Study	3-4
3.2.1	Result of the Demand Forecast in ACP's Study	
3.2.2	Demand Forecast Method in ACP's Study	
3.3 Tra	ffic Surveys	
3.3.1	Present Traffic	
3.3.2	Passenger OD Survey	3-11
3.3.3	Stated Preference Survey	
3.3.4	Travel Time Survey	3-13

3.4 Soci	ioeconomic Framework	
3.4.1	Economic Growth Rate	
3.4.2	Population Projection	
3.4.3	Car ownership	
3.5 Den	nand Forecasting Model	
3.5.1	Present OD	
3.5.2	Modal Share	
3.5.3	Demand of Panama Pacifico	
3.5.4	Transit Assignment	
3.5.5	Traffic Assignment	
3.6 Futu	re Passenger Demand	
3.6.1	Fare Scenario	
3.6.2	Peak Hour Passenger Demand	
3.6.3	Daily Traffic	
3.6.4	Results of Traffic Assignment	
3.7 Traf	fic Simulation at Omar Torrijos Roundabout	
3.7.1	Traffic Flow at the Roundabout	
3.7.2	Adjustment of the Demand Forecast Model	
3.7.3	Future Traffic	
Chapter 4	Natural Conditions	4-1
•	graphy	
	graphy of Project Site	
	soil Conditions	
	nate	
4.4.1	Temperature	
4.4.2	Humidity	
4.4.3	Rainfall	
4.4.4	Wind	
	Irology (Including Channel Bed Scouring)	
	hquake	
	1	

Part 2 Project Implementation Plan of Metro Line-3

Chapter 5	System Selection	5-1
5.1 Rou	ute Alternatives	
5.1.1	Comparison items	
5.1.2	Comparison method	
5.1.3	Evaluation	
5.1.4	Conclusion	
5.2 Car	ndidate Systems and the First Screening	
5.2.1	Procedures for System Screening	
5.2.2	Candidate Systems	
5.3 Car	ndidate Systems and the First Screening	
5.4 Mu	lti-criteria Analysis	
5.4.1	System Selection Chart	
5.4.2	Conditions and Method of Comparison	
5.4.3	Comparison in a Radar Chart	
5.4.4	Evaluation by Ten Criteria	
5.5 Cor	nclusion	
	Route Plan	
6.1 Rou	ute of Line-3	6-1

6.2	Route Condition	6-2
6.2.1	Topographical Conditions	6-2
6.2.2	Geographical Conditions	6-5
6.2.3	Utilities	6-5
6.2.4	Hydrological Conditions	6-7
6.2.5	Meteorological Condition	6-8
6.3	Station Location	6-10
~		
Chapter 7		
	Alignment	
7.1.1		
7.1.2	8	
7.1.3		
	Rolling Stock	
7.2.1		
7.2.2	1 6	
7.2.3		
7.3 7.3.1	Train Operation Plan	
7.3.1	8,	
7.3.3 7.3.4	0	
	1	
7.4	Civil Structure	
7.4.1	1 2	
7.5.1	Guideway Structures	
7.5.2		
7.5.2		
7.5.4		
7.5.4	•	
7.5.6		
	Station	
7.6.1		
7.6.2		
7.6.3	•	
7.6.4	-	
7.6.5		
7.6.6		
7.6.7		
7.6.8		
	Intermodal Facilities	
7.7.1		
7.7.2	5	
7.7.3		
	Depot	
7.8.1	•	
7.8.2	•	
7.8.2		
	Power Supply	
7.9.1		
7.9.2		
7.9.3	5	
7.9.4		

7.9.5	Utility Power supply	7-88
7.9.6	Lightning Protection	7-91
7.10 Sigr	naling System	7-96
7.10.1	Function of the Signaling System	7-96
7.10.2	Basic Concept of Signaling System	7-97
7.10.3	Automatic train protection system (ATP)	7-98
7.10.4	Train Detection system	7-101
7.10.5	Interlocking System (IL)	
7.10.6	Automatic Traffic Supervision System (ATS)	7-103
7.10.7	Automatic Train Operation System (ATO)	
7.10.8	Signaling system in the Depot	7-105
7.10.9	Design Standards for Signaling System	7-106
7.11 Tele	communication	7-109
7.11.1	Objectives and required telecommunication service	7-109
7.11.2	Requirement of telecommunication system	7-109
7.11.3	Network configuration and protocol	7-110
7.11.4	Type of telecommunication systems	7-112
7.11.5	Design standards and function	7-122
Chapter 8	Project Implementation Plan	
8.1 Eng	ineering Service	
8.1.1	Engineering Services prior to Construction	
8.1.2	Engineering Services during Construction	
8.1.3	Engineering Services after Construction	
8.2 Lan	d Acquisition	
8.3 Proj	ect Cost Estimate	
8.3.1	Cost Estimate Conditions	
8.3.2	Construction Cost Breakdown	
8.3.3	Consultant Fees	
8.3.4	Cost Estimate Results	
8.3.5	Comparison with the METI Study	
	struction Plan	
8.4.1	Substructure	
8.4.2	Superstructure	
8.4.3	Installation of Electric Power, Signal and Communications Systems	
8.4.4	Traffic Management Plans and Safety Management Plans during Construction	
8.4.5	Procurement of Materials and Equipment	
8.4.6	Consulting Services	
8.4.7	Construction Schedule	
	curement Package	
8.5.1	Constract for Construction	
8.5.2	Contract for Design - Build	
8.5.3	EPC/Turnkey	
8.5.4	Procurement Package for Line-3	
	lic-Private Partnership	
8.6.1	Environment for PPPs in Panama	
8.6.2	Applicability of PPP to the Project	
8.6.3	Implications on PPP for Line-3 Project	
8.7 Imp	lementation Schedule	8-36
Chapter 9	Institution and Organization	
9.1 Imp	lementation Structure	9-1
9.1.1	Railway project in Panama	
9.1.2	The items to be considered in the Project	9-5

9.2 Imp	plementation Organization	
9.2.1	Implementation Scheme for the Project	
9.2.2	Finance and Budget Structure	
9.2.3	Technical Standard	9-9
9.3 0&	M Organization	9-9
9.3.1	Concept of O&M Organization	9-9
9.3.2	Concept of Finance, Budget and Technical Level	
9.4 Opt	eration and Maintenance Plan	
9.4.1	Precondition for Operation and Maintenance Plan	
9.4.2	Organization and Personnel Plan	9-14
9.4.3	Maintenance Plan	
9.4.4	Estimation of O&M Cost	

Part 3 Project Implementation Plan of 4th Panama Canal Bridge

Chapter 10	Comparison Study on Bridge Planning	
	eening of Main Bridge Type for 4th Panama Canal Bridge	
10.1.1	Summary	
10.1.2	Selection of Alternative Main Bridge Type	
10.1.3	Screening Method	
10.1.4	Evaluation Results	
10.1.5	Conclusion	
10.2 Stu	dy of Platform Plan for 4th Panama Canal Bridge	
Chapter 11	Preliminary Road Design	
	nmary	
11.1.1	Objective	
11.1.2	Study Items	11-1
11.1.3	Revisions and Proposals based on the Pre-F/S	
11.1.4	Conclusion of Preliminary Road Design	
11.2 Ger	neral Condition of the Route	11-3
11.2.1	General condition of the Route	11-3
11.2.2	Existing Traffic Condition	11-5
11.2.3	Obstacles	11-5
11.3 Col	llection and Review of Existing Material	11-13
11.3.1	Collection of Existing Materials	11-13
11.3.2	Review of Previous Data	11-13
11.3.3	Proposal of Road Alignment	11-16
11.4 Pre	liminary Design	11-20
11.4.1	Scope of Work	11-20
11.4.2	Design Conditions	11-20
11.4.3	Preliminary Design	11-22
11.5 Cor	ncept Design	11-31
11.5.1	Study of the Concept Design	11-31
11.5.2	Micro Simulation	
Chapter 12	Preliminary Bridge Design	12-1
12.1 Sun	nmary of Preliminary Bridge Design	
12.1.1	Objective	
12.1.2	Items included in the Preliminary Design	
12.1.3	Results of Preliminary Design	
12.2 Plan	nning Conditions and Design Criteria	
12.2.1	Planning Conditions	

12.2.2	Design Standards and Criteria	
12.3 Typ	bical Cross Sections	
	liminary Designs of Bridge Structures	
12.4.1	Main Bridge	
12.4.2	Access Bridges to the Bridge of the Americas	
12.4.3	Bridge Ancillary Works	
12.4.4	Drawings of Preliminary Design	
12.4.5	Preliminary Quantities	
12.5 Per	nding Studies for the D/D	
Chanten 12	Durlinsinger, Electrical and Machanical Design	12.1
Chapter 13 13.1 Sur	Preliminary Electrical and Mechanical Design	
13.1 Sui 13.1.1	-	
13.1.1	Objective	
13.1.2	Study Items	
13.1.3	Study Results	
	Conclusion	
-	uipment Plan	
13.2.1	Selection Criteria of Necessary Equipment.	
13.2.2	Coordination with the Metro Line-3 Project	
13.2.3	Electrical Equipment	
13.2.4	Communication Equipment	
13.2.5	Mechanical Equipment	
	liminary Designs	
13.3.1	Design Scope	
13.3.2	Lighting Equipment	
13.3.3	Power Supply Equipment	
13.3.4	Communication Equipment	
	lity Installation Plan (Out of the Scope of the Project)	
13.4.1	Identification of the Utilities to be Installed	
	wings of Preliminary Designs and Estimated Work Quantities	
13.5.1	Drawings of Preliminary Design	
13.5.2	Estimated Work Quantities	
	n for Relocating Existing Utilities	
13.6.1	Identification of Existing Utilities	
13.6.2	Plan for Relocating Existing Utilities and Underground Installations	
13.7 Co	nclusion	
Chapter 14	Preliminary Operation and Maintenance Plan	14-1
	nmary	
14.1.1	Objective	
14.1.1	Study Items	
14.1.2	Survey Results	
14.1.3	Conclusion	
	liminary Operation and Maintenance Plan	
14.2 110	Development Plan	
14.2.1	Division of the Operation and Maintenance Services	
	A	
14.2.3	Operation and Maintenance Entity	
14.2.4	Operation Method	
	tline of the Operation, Maintenance and Management System	
14.4 Pre 14.4.1	liminary Maintenance Plan	
	Civil Structures Electrical and Mechanical Equipment	
14.4.2		
14.4.3 14.5 Cor	Environmental Monitoring	
14.3 CO		14-10

Chapter 15	Preliminary Construction Planning and Project Cost Estimate	15-1
15.1 Prel	iminary Construction Planning	
15.1.1	Summary	15-1
15.1.2	Related Regulation and Standards	15-1
15.1.3	Contract Packaging	15-1
15.1.4	Procurement of Labor, Material and Equipment	15-2
15.1.5	Construction Method	15-4
15.1.6	Temporary Facilities	. 15-25
15.1.7	Construction Schedule	. 15-26
15.1.8	Traffic Management and Safety Management during Construction Period	. 15-29
15.1.9	Conclusion	. 15-30
15.2 Prel	iminary Project Cost Estimate	. 15-30
15.2.1	Summary	. 15-30
15.2.2	Related Laws and Regulations	. 15-31
15.2.3	Conditions of Cost Estimate	. 15-31
15.2.4	Methodology of Cost Estimate	. 15-31
15.2.5	Unit Cost	. 15-33
15.2.6	Preliminary Project Cost	. 15-33
15.3 Prel	iminary Operation and Maintenance Cost	. 15-37
15.3.1	Objective	
15.3.2	Preliminary Operation and Maintenance Cost	. 15-37
15.3.3	Environmental Monitoring Cost	
15.3.4	Conclusion	. 15-37
Chapter 16	Comparison Study between the Pre-F/S Option and the JICA Study Option	16-1
	ective	
16.2 Sun	nmary of Preliminary Design Results	16-1
16.2.1	JICA Study Option	16-1
16.2.2	Pre-F/S Option	16-1
16.3 Con	nparison Study between the Pre-F/S Option and the JICA Study Option	16-4
16.3.1	Study Method	
16.3.2	Study Results	16-7
16.4 Con	clusion	16-7
Chapter 17	Implementation Plan	
17.1 Proj	ect Components	17-1
17.1.1	Scope of Construction Works	
17.1.2	Relocation of Existing Utilities	17-2
17.2 Den	narcation between Metro Line-3 and 4th Panama Canal Bridge	17-2
17.3 Fun	d Procurement Plan	17-2
17.4 Proj	ect Implementation Structure	17-3
17.4.1	Project Implementation Organizations	17-3
17.4.2	Financial and Budgetary Status and Technical Level of the Executing Agency	17-3
17.4.3	Financial and Budgetary Status and Technical Level of the Maintenance Agency	17-5
17.5 Proc	curement Plan	17-6
17.5.1	Procurement of the Consultant	
17.5.2	Procurement of the Construction Contractor(s)	17-8
17.6 Imp	lementation Schedule of the 4th Panama Canal Bridge Project	
	er Items to be Implicated	

Part 4 Project Impact

Chapter 18	Project Impacts	-1
------------	-----------------	----

18.1 Gree	enhouse Gas Emissions Reductions	
18.1.1	Methodology	
18.1.2	Base Line Emissions	
18.1.3	Project Emissions	
18.1.4	Reduction in CO ₂ Emission	18-5
18.2 Ope	ration and Effect Indicators	
18.2.1	Operation Indicators	
18.2.2	Effect Indicators	
	litative Impacts	
	nomic Analysis	
18.4.1	Methodology	
18.4.2	Project Cost	
18.4.3	O&M Cost	
18.4.4	Reinvestment and Additional Investment Cost	
18.4.5	Vehicle Operating Cost	
18.4.6	Travel Time Cost	
18.4.7	Economic Internal Rate of Return (EIRR)	
18.4.8	Sensitivity Analysis	
	incial Analysis	
18.5.1	Objectives	
18.5.2	Methodology	
18.5.2	Assumptions	
18.5.3	Cost Projection	
18.5.4	Revenue Projection	
18.5.6	Funding and Finance	
18.5.0		
	Project FIRR.	
18.5.8	Life Cycle Cost of PublicInvestment and Operation	
		10 25
18.5.9	Value for Money of Project Scheme Alternatives	
18.5.9 18.5.10	Value for Money of Project Scheme Alternatives Implications from Financial Analysis	
18.5.10	Implications from Financial Analysis	18-38
18.5.10 Chapter 19	Implications from Financial Analysis Environmental and Social Considerations	18-38
18.5.10 Chapter 19 19.1 Intro	Implications from Financial Analysis Environmental and Social Considerations	18-38 19-1 19-1
18.5.10 Chapter 19 19.1 Intro 19.2 Lega	Implications from Financial Analysis Environmental and Social Considerations oduction al and Institutional Framework on Environmental and Social Considerations	18-38 19-1 19-1 19-1
18.5.10 Chapter 19 19.1 Intro 19.2 Leg 19.2.1	Implications from Financial Analysis Environmental and Social Considerations oduction al and Institutional Framework on Environmental and Social Considerations Panamamian Legal Framework	18-38 19-1 19-1 19-1 19-1
18.5.10 Chapter 19 19.1 Intro 19.2 Leg 19.2.1 19.2.2	Implications from Financial Analysis Environmental and Social Considerations oduction al and Institutional Framework on Environmental and Social Considerations Panamamian Legal Framework Environmental Resolution	18-38 19-1 19-1 19-1 19-2
18.5.10 Chapter 19 19.1 Intro 19.2 Lega 19.2.1 19.2.2 19.2.3	Implications from Financial Analysis Environmental and Social Considerations oduction al and Institutional Framework on Environmental and Social Considerations Panamamian Legal Framework Environmental Resolution JICA Guidelines for Environmental and Social Considerations (2010)	18-38 19-1 19-1 19-1 19-2 19-3
18.5.10 Chapter 19 19.1 Intro 19.2 Lega 19.2.1 19.2.2 19.2.3 19.2.4	Implications from Financial Analysis Environmental and Social Considerations oduction al and Institutional Framework on Environmental and Social Considerations Panamamian Legal Framework Environmental Resolution JICA Guidelines for Environmental and Social Considerations (2010) Institutional Framework	18-38 19-1 19-1 19-1 19-2 19-3 19-3
18.5.10 Chapter 19 19.1 Intro 19.2 Lega 19.2.1 19.2.2 19.2.3 19.2.4 19.3 Cate	Implications from Financial Analysis Environmental and Social Considerations oduction al and Institutional Framework on Environmental and Social Considerations Panamamian Legal Framework Environmental Resolution JICA Guidelines for Environmental and Social Considerations (2010) Institutional Framework egorization of the Projects	18-38 19-1 19-1 19-1 19-2 19-3 19-3 19-4
18.5.10 Chapter 19 19.1 Intro 19.2 Lega 19.2.1 19.2.2 19.2.3 19.2.4 19.3 Cate 19.3.1	Implications from Financial Analysis Environmental and Social Considerations oduction al and Institutional Framework on Environmental and Social Considerations Panamamian Legal Framework Environmental Resolution JICA Guidelines for Environmental and Social Considerations (2010) Institutional Framework egorization of the Projects Categorization according to the Panamanian legislation	18-38 19-1 19-1 19-1 19-2 19-3 19-3 19-4 19-4
18.5.10 Chapter 19 19.1 Intro 19.2 Lega 19.2.1 19.2.2 19.2.3 19.2.4 19.3 Cate 19.3.1 19.3.2	Implications from Financial Analysis Environmental and Social Considerations oduction al and Institutional Framework on Environmental and Social Considerations Panamamian Legal Framework Environmental Resolution JICA Guidelines for Environmental and Social Considerations (2010) Institutional Framework egorization of the Projects Categorization according to the Panamanian legislation Categorization according to JICA Guidelines	18-38 19-1 19-1 19-1 19-2 19-3 19-3 19-4 19-4 19-4
18.5.10 Chapter 19 19.1 Intro 19.2 Legi 19.2.1 19.2.2 19.2.3 19.2.4 19.3 Cate 19.3.1 19.3.2 19.4 Pub	Implications from Financial Analysis Environmental and Social Considerations oduction al and Institutional Framework on Environmental and Social Considerations Panamamian Legal Framework Environmental Resolution JICA Guidelines for Environmental and Social Considerations (2010) Institutional Framework egorization of the Projects Categorization according to the Panamanian legislation Categorization according to JICA Guidelines lic Participation	18-38 19-1 19-1 19-1 19-2 19-3 19-3 19-4 19-4 19-4 19-4
18.5.10 Chapter 19 19.1 Intro 19.2 Lega 19.2.1 19.2.2 19.2.3 19.2.4 19.3 Cate 19.3.1 19.3.2 19.4 Pub 19.4.1	Implications from Financial Analysis Environmental and Social Considerations oduction al and Institutional Framework on Environmental and Social Considerations Panamamian Legal Framework Environmental Resolution JICA Guidelines for Environmental and Social Considerations (2010) Institutional Framework egorization of the Projects Categorization according to the Panamanian legislation Categorization according to JICA Guidelines lic Participation Resume of the Community Participation Activities	18-38 19-1 19-1 19-1 19-1 19-2 19-3 19-3 19-3 19-4 19-4 19-4 19-4 19-4
18.5.10 Chapter 19 19.1 Intro 19.2 Lega 19.2.1 19.2.2 19.2.3 19.2.4 19.3 Cate 19.3.1 19.3.2 19.4 Pub 19.4.1 19.5 Ana	Implications from Financial Analysis Environmental and Social Considerations oduction al and Institutional Framework on Environmental and Social Considerations Panamamian Legal Framework Environmental Resolution JICA Guidelines for Environmental and Social Considerations (2010) Institutional Framework egorization of the Projects Categorization according to the Panamanian legislation Categorization according to JICA Guidelines lic Participation Resume of the Community Participation Activities lysis of Alternatives	18-38 19-1 19-1 19-1 19-1 19-2 19-3 19-3 19-4 19-4 19-4 19-4 19-5 19-11
18.5.10 Chapter 19 19.1 Intro 19.2 Leg: 19.2.1 19.2.2 19.2.3 19.2.4 19.3 Cate 19.3.1 19.3.2 19.4 Pub 19.4.1 19.5 Ana 19.5.1	Implications from Financial Analysis Environmental and Social Considerations oduction al and Institutional Framework on Environmental and Social Considerations Panamamian Legal Framework Environmental Resolution JICA Guidelines for Environmental and Social Considerations (2010) Institutional Framework egorization of the Projects Categorization according to the Panamanian legislation Categorization according to JICA Guidelines lic Participation Resume of the Community Participation Activities lysis of Alternatives "No Project"	18-38 19-1 19-1 19-1 19-2 19-3 19-3 19-3 19-4 19-4 19-4 19-4 19-1 19-11 19-11
18.5.10 Chapter 19 19.1 Intro 19.2 Lega 19.2.1 19.2.2 19.2.3 19.2.4 19.3 Cate 19.3.1 19.3.2 19.4 Pub 19.4.1 19.5 Ana 19.5.1 19.5.2	Implications from Financial Analysis Environmental and Social Considerations oduction al and Institutional Framework on Environmental and Social Considerations Panamamian Legal Framework Environmental Resolution JICA Guidelines for Environmental and Social Considerations (2010) Institutional Framework egorization of the Projects Categorization according to the Panamanian legislation Categorization according to JICA Guidelines lic Participation Resume of the Community Participation Activities lysis of Alternatives "No Project" Metro Line 3 Project	18-38 19-1 19-1 19-1 19-1 19-2 19-3 19-3 19-3 19-4 19-4 19-4 19-4 19-1 19-11 19-11 19-12
18.5.10 Chapter 19 19.1 Intro 19.2 Lega 19.2.1 19.2.2 19.2.3 19.2.4 19.3 Cate 19.3.1 19.3.2 19.4 Pub 19.4.1 19.5 Ana 19.5.1 19.5.2 19.5.3	Implications from Financial Analysis Environmental and Social Considerations oduction	18-38 19-1 19-1 19-1 19-2 19-2 19-3 19-3 19-4 19-4 19-4 19-4 19-11 19-11 19-12 19-13
18.5.10 Chapter 19 19.1 Intro 19.2 Lega 19.2.1 19.2.2 19.2.3 19.2.4 19.3 Cate 19.3.1 19.3.2 19.4 Pub 19.4.1 19.5 Ana 19.5.1 19.5.2 19.5.3 19.6 Scop	Implications from Financial Analysis Environmental and Social Considerations oduction al and Institutional Framework on Environmental and Social Considerations Panamamian Legal Framework Environmental Resolution JICA Guidelines for Environmental and Social Considerations (2010) Institutional Framework egorization of the Projects Categorization according to the Panamanian legislation Categorization according to JICA Guidelines lic Participation Resume of the Community Participation Activities lysis of Alternatives "No Project" Metro Line 3 Project The 4th Panama Canal Bridge project ping	18-38 19-1 19-1 19-1 19-1 19-2 19-3 19-3 19-4 19-4 19-4 19-4 19-1 19-11 19-11 19-13 19-17
18.5.10 Chapter 19 19.1 Intro 19.2 Leg: 19.2.1 19.2.2 19.2.3 19.2.4 19.3 Cate 19.3.1 19.3.2 19.4 Pub 19.4.1 19.5 Ana 19.5.1 19.5.2 19.5.3 19.6 Scop 19.7 Res	Implications from Financial Analysis Environmental and Social Considerations oduction al and Institutional Framework on Environmental and Social Considerations Panamamian Legal Framework on Environmental and Social Considerations (2010) Institutional Resolution JICA Guidelines for Environmental and Social Considerations (2010) Institutional Framework egorization of the Projects Categorization according to the Panamanian legislation Categorization according to JICA Guidelines lic Participation Resume of the Community Participation Activities lysis of Alternatives "No Project" Metro Line 3 Project The 4th Panama Canal Bridge project ping alts of Environmental Impact Assessments (EIAs)	18-38 19-1 19-1 19-1 19-1 19-2 19-3 19-3 19-4 19-4 19-4 19-4 19-11 19-11 19-11 19-13 19-17 19-17
18.5.10 Chapter 19 19.1 Intro 19.2 Lega 19.2.1 19.2.2 19.2.3 19.2.4 19.3 Cate 19.3.1 19.3.2 19.4 Pub 19.4.1 19.5 Ana 19.5.1 19.5.2 19.5.3 19.6 Scop 19.7 Resu 19.7.1	Implications from Financial Analysis Environmental and Social Considerations oduction	18-38 19-1 19-1 19-1 19-1 19-2 19-3 19-3 19-3 19-4 19-4 19-4 19-4 19-11 19-11 19-11 19-17 19-17 19-17
18.5.10 Chapter 19 19.1 Intro 19.2 Lega 19.2.1 19.2.2 19.2.3 19.2.4 19.3 Cate 19.3.1 19.3.2 19.4 Pub 19.4.1 19.5.2 19.5.3 19.5.3 19.6 Scop 19.7 Rest 19.7.1 19.7.2	Implications from Financial Analysis Environmental and Social Considerations oduction	18-38 19-1 19-1 19-1 19-2 19-2 19-3 19-3 19-4 19-4 19-4 19-4 19-11 19-11 19-11 19-17 19-17 19-17 19-36
18.5.10 Chapter 19 19.1 Intro 19.2 Lega 19.2.1 19.2.2 19.2.3 19.2.4 19.3 Cate 19.3.1 19.3.2 19.4 Pub 19.4.1 19.5 Ana 19.5.1 19.5.2 19.5.3 19.6 Scop 19.7 Resu 19.7.1 19.7.2 19.7.3	Implications from Financial Analysis Environmental and Social Considerations oduction al and Institutional Framework on Environmental and Social Considerations Panamamian Legal Framework on Environmental and Social Considerations (2010) Environmental Resolution JICA Guidelines for Environmental and Social Considerations (2010) Institutional Framework egorization of the Projects Categorization according to the Panamanian legislation Categorization according to JICA Guidelines lic Participation Resume of the Community Participation Activities lysis of Alternatives "No Project" Metro Line 3 Project The 4th Panama Canal Bridge project ping alts of Environmental Impact Assessments (EIAs) Current Conditions of Environmental and Social Aspects in the Study Area Impact Assessment Mitigation Measures	18-38 19-1 19-1 19-1 19-2 19-2 19-3 19-3 19-4 19-4 19-4 19-4 19-4 19-11 19-11 19-12 19-13 19-17 19-17 19-36 19-51
18.5.10 Chapter 19 19.1 Intro 19.2 Lega 19.2.1 19.2.2 19.2.3 19.2.4 19.3 Cate 19.3.1 19.3.2 19.4 Pub 19.4.1 19.5 Ana 19.5.1 19.5.2 19.5.3 19.6 Scop 19.7 Resu 19.7.1 19.7.2 19.7.3 19.7.4	Implications from Financial Analysis Environmental and Social Considerations oduction	18-38 19-1 19-1 19-1 19-1 19-2 19-3 19-3 19-4 19-4 19-4 19-4 19-1 19-11 19-11 19-13 19-17 19-17 19-36 19-51 19-52
18.5.10 Chapter 19 19.1 Intro 19.2 Lega 19.2.1 19.2.2 19.2.3 19.2.4 19.3 Cate 19.3.1 19.3.2 19.4 Pub 19.4.1 19.5 Ana 19.5.1 19.5.2 19.5.3 19.6 Scop 19.7 Resu 19.7.1 19.7.2 19.7.3	Implications from Financial Analysis Environmental and Social Considerations oduction al and Institutional Framework on Environmental and Social Considerations Panamamian Legal Framework on Environmental and Social Considerations (2010) Environmental Resolution JICA Guidelines for Environmental and Social Considerations (2010) Institutional Framework egorization of the Projects Categorization according to the Panamanian legislation Categorization according to JICA Guidelines lic Participation Resume of the Community Participation Activities lysis of Alternatives "No Project" Metro Line 3 Project The 4th Panama Canal Bridge project ping alts of Environmental Impact Assessments (EIAs) Current Conditions of Environmental and Social Aspects in the Study Area Impact Assessment Mitigation Measures	18-38 19-1 19-1 19-1 19-1 19-2 19-3 19-3 19-4 19-4 19-4 19-4 19-11 19-11 19-11 19-17 19-17 19-17 19-52 19-55

19.8 Stra	ategic Resettlement Action Plan (SRAP)	
19.8.1	Necessity of Resettlemnet and Land Acquisition	
19.8.2	Legal Framework related to Resettlement and Land Acquisition	
19.8.3	Scope of Resettlement and Land Acquisition	
19.8.4	Measures for Compensation and Social Assistance	
19.8.5	Grievance Redress Mechanism	
19.8.6	Implementation System	
19.8.7	Implementation Schedule	
19.8.8	Cost	
19.8.9	Monitoring Plan	
19.9 Co	nclusion and Recommendation	
	Introduction of Applicable Japanese Technology	
	neral	
	tro Line-3 Project	
20.2.1	Battery Power System (BPS) for Railway	
20.3 4th	Panama Canal Bridge Construction Project	
20.3.1	Steels for Bridge High Performance Structure (SBHS)	
20.3.2	Advanced Weathering Steel (Nickel Type)	
20.3.3	Steel Pipe Sheet Pile (SPSP)	
20.3.4	Low-position Lighting	
Chapter 21	Conclusions and Recommendations	
21.1 Co	nclusions	
21.2 Red	commendations on Project Implementation Stage	
21.2.1	Urban Transport Line-3	
21.2.2	4th Panama Canal Bridge	
21.3 Red	commendations on Project Operation Stage	
21.3.1	Urban Transportation Line-3	
21.3.2	4th Panama Canal Bridge	

LIST OF TABLES

Table 1.1	Attendance List of Study Tour in Japan.	
Table 1.2	Study Tour Schedule	
Table 2.1	Population breakdown of Panama	
Table 2.2	Contactless IC Card for the Metro bus	
Table 2.3	Line-1 Features	
Table 2.4	Cost Breakdown for Line-1	2-11
Table 2.5	Donor Approval of loans to Panama in the last 5 years (cumulative)	2-13
Table 2.6	Preliminary Construction Cost for Tunnel	
Table 3.1	Traffic Projection in ACP's Study (vehicles per day)	
Table 3.2	AADT of Bridge of Americas (no. of vehicles per day)	
Table 3.3	Traffic Count Survey (2012)	
Table 3.4	Traffic Count Survey (2013)	
Table 3.5	No. of Buses (Monday-Friday) in Traffic Survey by ATTT	
Table 3.6	AADT of Centenario Bridge (no. of vehicles)	
Table 3.7	AADT of Centenario Bridge (no. of vehicles)	
Table 3.8	Traffic Volume between Arraijan and Nuevo Arraijan	
Table 3.9	Traffic Volume between Nuevo Arraijan and La Chorrera	3-10
Table 3.10	Traffic Volume of Autopista (between Arraijan and La Chorrera)	3-11
Table 3.11	Locations of Passenger OD Surveys	3-11
Table 3.12	% of Modal Share of Feeder Transport	3-12
Table 3.13	Mode Preference in the SP Survey	3-12
Table 3.14	Result of Logit Model Analysis	3-13
Table 3.15	Economic Growth Rate Projection from 2013 to 2018 (%)	
Table 3.16	Population Projection	
Table 3.17	No. of Vehicles per 1000 Inhabitants in different countries	
Table 3.18	No. of Vehicles per 1000 inhabitants (Projection)	
Table 3.19	Estimation of Passenger Volume from West to East	
Table 3.20	Estimation of Passenger Volume from East to West	
Table 3.21	Modal Share in SMP 2009 OD (6:00-8:00, 2 hours)	
Table 3.22	Estimation of Modal Share in Araijan and La Chorrera	
Table 3.23	Modal Shift Rate from Car to Line-3	
Table 3.24	Trip Generation and Attraction in Panama Pacifico	
Table 3.25	Intermediate Year Forecast of Public Transport Trips from/to Panama Pacific	
Table 3.26	Transit Lines in Network Model	
Table 3.27	Speed Setting	3-27
Table 3.28	Transit Fare between Albrook and La Chorrera	3-27
Table 3.29	Fare Setting	
Table 3.30	Link Classification with Capacity and Speed	
Table 3.31	BPR Parameters	
Table 3.32	Toll Road Rate	
Table 3.33	Network Scenarios	
Table 3.34	Projection of Future Truck Traffic (No. of Vehicles per Day)	
Table 3.35	Peak Hour Fare Revenue by Fixed Rate (Full development case, 2050)	
Table 3.36	Demand Forecast in Fare Integration and Flat Fare Cases	
Table 3.37		
		3-34
Table 3.38	Forecast of Peak Hour Traffic	
Table 3.39	Station-to-Station Matrix (Full development case)	3-36
Table 3.40	Station-to-Station Matrix (Phase-1 development case: High Growth)	3-37
Table 3.41	Station-to-Station Matrix (Phase-1 development case: Mid Growth)	3-38
Table 3.42	Station-to-Station Matrix (Phase-1 development case: Low Growth)	
Table 3.43	Daily Boarding Passengers by Station (Full Development Case)	3-40

Table 3.44	Daily Boarding and Alighting Passengers by Station (Phase-1 Case)	3-40
Table 3.45	Result of Demand Forecast (Population High Projection)	
Table 3.46	Result of Demand Forecast (Population Medium Projection)	
Table 3.47	Result of Demand Forecast (Population Low Projection)	
Table 3.48	Results of Demand Forecast - 4th Bridge (No. of Vehicles per day)	
Table 3.49	Traffic at Omar Torrijos Roundabout (AM 7:00- AM 8:00)	
Table 3.50	Comparison of Actual Traffic and Traffic Assignment at Omar Torrijos Round	
Table 3.51	Future Traffic at Omar Torrijos Roundabout	
Table 4.1	Channel Flow Velocity of the Panama Canal near the 4th Panama Canal Bridge	
•••••		4-8
Table 5.1	List of Comparison Items	5-2
Table 5.2	Evaluation Grades and Coefficients	5-3
Table 5.3	Route Selection Comparison Table	5-8
Table 5.4	Candidate Systems	5-10
Table 5.5	First System Screening Chart	5-11
Table 5.6	System Comparison Chart	5-12
Table 5.7	Comparison of System Capacity	5-14
Table 5.8	Comparison of Initial Cost of the Systems	5-15
Table 5.9	Comparison of Vertical Alignment Features	5-16
Table 5.10	Comparison of Initial Cost of Infrastructure	
Table 5.11	Comparison of O&M Cost	5-17
Table 5.12	Comparison of Proprietary	
Table 5.13	Comparison of Safety Aspects	
Table 5.14	Comparison of Land Acquisition and Resettlement	
Table 5.15	Comparison of Impacts on Natural Environment	
Table 5.16	Comparison of Impact on Landscape / Cityscape	
Table 5.17	Comparison of Maintainability	
Table 6.1	Bearing Layer Depths Determined Based on Geotechnical Investigation	
Table 6.2	The List of Authorities Related to Public Utilities	
Table 6.3	Yearly Average No. of Days of Lighting (2008-2012)	6-9
Table 6.4	Station Location	
Table 6.5	Outline of Typical Stations	6-12
Table 7.1	Conditions for Horizontal Alignment	7-1
Table 7.2	Conditions for Vertical Alignment	7-2
Table 7.3	Major Control Points	7-3
Table 7.4	Passenger Capacity and Car Weight (Long Seat Type)	
Table 7.5	Passenger Capacity and Car Weight (Semi-cross Seat Type)	
Table 7.6	Principal Specifications	7-8
Table 7.7	Speed in Curve Section	7-11
Table 7.8	Train Configuration and Operation Performance	7-15
Table 7.9	Transport Capacity (PHPDT) of Monorail under Various Combinations	
Table 7.10	Calculation of Assumed Average Standees for 3 Target Passenger Cases	7-16
Table 7.11	Required Train Operation Time and Commercial Speed (After 2025)	7-18
Table 7.12	Calculation of Train Operation Plan at Peak Hour (East and West Section)	
Table 7.13	Calculation Result of the required Number of Train-sets/Cars	7-20
Table 7.14	Train Operation Frequency/Headway of a Whole Day (2020-2050)	
Table 7.15	Design load combinations	
Table 7.16	Axle Loads	
Table 7.17	Comparison of Barrier free standards	
Table 7.18	Comparison of Station platform types	
Table 7.19	Platform width	
Table 7.20	Comparison of Contactless IC cards	
Table 7.21	Requirement of AFC equipment.	7-46

Table 7.22	Installation of AFC gates	7-47
Table 7.22	Case Examples of Intermodal Facilities	
Table 7.24	Assumed modal share	
Table 7.24	Coefficients for calculating Station Plaza Capacity by traffic mode	
Table 7.26	Required Capacity at Peak Hours	
Table 7.20	Required Berth Area for Each Transport Mode	
Table 7.27 Table 7.28	Required Waiting Area for Each Transport Mode	
Table 7.28 Table 7.29	Required Road Space for Vehicles	
Table 7.29 Table 7.30	Required Pedestrian Space	
Table 7.30	Required Parking Space	
Table 7.31 Table 7.32		
Table 7.32 Table 7.33	Required Intermodal Facility in Ciudad de Futuro Station	
	Required Intermodal Facility in Ciudad de Futuro Station	
Table 7.34	Proposed Plan for Intermodal Facility for each Station	
Table 7.35	Proposed Application of Universal Design in the Intermodal Facility	
Table 7.36	Specification of Target Vehicle	
Table 7.37	Assessment of each Candidate Site	
Table 7.38	Roles, Functions and No. of Tracks for each Line Facility	
Table 7.39	Equipment List	
Table 7.40	Transmission Line Voltage Drop Table	
Table 7.41	Power Consumption by Traction	
Table 7.42	Voltage Drop Calculation	
Table 7.43	Study of Contact Line Section	
Table 7.44	Loads in each station and depot	
Table 7.45	Voltage Drop in Distribution Line	
Table 7.46	Protection Level	
Table 7.47	Characteristics and Protection Level	
Table 7.48	Summary of the Basic Concepts of the Project's Signaling System	
Table 7.49	Comparison of Fixed Block and Moving Block Systems	
Table 7.50	Train Detection method	
Table 7.51	Design standards for signaling system	
Table 7.52	Required Telecommunication Functions and Systems	
Table 7.53	Comparison of redundancy method	
Table 7.54	Comparison of network configuration	
Table 7.55	Type of BTN network service	
Table 7.56	Outline of Clock locations	
Table 7.57	General comparison of radio systems	7-122
Table 7.58	Design standards	
Table 8.1	Land Acquisition Summary	
Table 8.2	Cost estimate conditions	
Table 8.3	Consultant fees	
Table 8.4	Construction costs	
Table 8.5	Additional investment costs	
Table 8.6	Comparison of project Cost Estimates	
Table 8.7	Pile and pier construction procedures	8-11
Table 8.8	Procedure for establishing the Traffic Management Plan	
Table 8.9	Procurement of materials and equipment	
Table 8.10	Consulting services	
Table 8.11	Proposed process for civil works	
Table 8.12	Preparation stage preconditions	
Table 8.13	Construction stage preconditions	
Table 8.14	Construction schedule	
Table 8.15	Project Scheme Options (Draft)	
Table 8.16	Comparison of Project Scheme Alternatives	
Table 9.1	The progress of the Metro project	

Table 9.2	Legal framework of SMP	9-2
Table 9.3	The plan for increasing the number of staff for Line-1 operation	
Table 9.4	Construction Sections and Development Plan	
Table 9.5	Concept of Fare Structure for Line-3	
Table 9.6	Type of Profession and Unit Numbers for Estimating Number of Personnel	
Table 9.7	Actual Unit Number of Personnel of Major Japanese Monorail Operators	
Table 9.8	Calculation Results for the Number of Personnel in Line-3 (Phase1)	
Table 9.9	Periodic Inspections of Vehicles	
Table 9.10	Overview of Inspection/Maintenance of Track facilities, Railway structure	es and
Station	equipment	
Table 9.11	Overview of Inspection/Maintenance (Repair) of Electrical Equipment	
Table 9.12	Unit Personnel Cost by Profession	
Table 9.13	Estimated Direct Personnel Cost	9-22
Table 9.14	Cost Items and Unit Cost Estimation for the Cost but Personnel Cost	9-23
Table 9.15	Unit Cost Actual in Monorail Lines in Japan	9-24
Table 9.16	Estimated O&M Cost (Before revising Outsourcing Personnel Cost)	
Table 9.17	Revised O&M Cost	
Table 9.18	Summary of Total O&M Cost	
Table 10.1	Preconditions of Bridge Plan	
Table 10.2	Evaluation Items and Weighting	
Table 10.3	Evaluation Results	
Table 10.4	Preconditions of Bridge Plan	
Table 10.5	Applicable and Maximum Span Lengths for Each Bridge Type	
Table 10.6	Selected Alternatives and Reasons	10-6
Table 10.7	Bridge Elements	
Table 10.8	Evaluation Items and Weighting	
Table 10.9	Evaluation Criteria	
Table 10.10	Evaluation Results (Safety for Channel and Airspace)	
Table 10.11	Evaluation Results (Wind Resistance Stability)	
Table 10.12	Evaluation Results (Seismic Adequacy)	
Table 10.13	Evaluation Results (Rigidity)	
Table 10.14	Evaluation Results (Safety Risk) (Not Using Channel in Erection Works)	
Table 10.15	Evaluation Results (Safety Risk) (Use Channel in Erection Works)	
Table 10.16	• • • • • •	
Works)		
Table 10.17		
Works)		
Table 10.18	Evaluation Results (Availability of Local Materials)	. 10-14
Table 10.19	Evaluation Results (Construction Yard) (Not Using the Channel in Ex	rection
Works)		. 10-15
Table 10.20	Evaluation Results (Construction Yard) (Use of Channel in Erection Works)	10-15
Table 10.21	Evaluation Results (Work Volume)	. 10-16
Table 10.22	Evaluation Results (Workability)	. 10-16
Table 10.23	Evaluation Results (Availability of Procurement)	. 10-17
Table 10.24	Evaluation Results (Harmony with the Bridge of the Americas and Surrour	ndings)
		. 10-18
Table 10.25	Evaluation Results (Landmark)	
Table 10.26	Evaluation Results (Originality)	
Table 10.27	Evaluation Results (Architectural Features)	
Table 10.28	Evaluation Results (View from Deck Surface)	
Table 10.29	Evaluation Results (Cost) (Not Using the Channel in Erection Works)	
Table 10.30	Evaluation Results (Cost) (Using the Channel in Erection Works)	
Table 10.31	Evaluation Results	
Table 10.32	Summary of Study Results of Platform Plan (Main Bridge of 4th Panama	Canal

Bridge)	
Table 11.1	Summary of the Results of Preliminary Design
Table 11.2	Summary of the Results of Concept Design 11-3
Table 11.3	Measures for the obstacles
Table 11.4	Crossing Condition (East Side of 4th Panama Canal Bridge)11-8
Table 11.5	Summary of the Navigation Channel
Table 11.6	Summary of the Civil Aviation Requirements
Table 11.7	List of Collected Materials
Table 11.8	Outline of Condition for Road Planning and Design 11-14
Table 11.9	Horizontal Alignment of the Access Road 11-15
Table 11.10	Vertical Alignment of Approach Road (Pre-F/S) 11-16
Table 11.11	Summary of Running Speed and Grades 11-16
Table 11.12	Proposed Revised Value Corresponding to Pre-F/S 11-19
Table 11.13	Crossing Conditions
Table 11.14	Geometric Design Standard (Preliminary Design) 11-21
Table 11.15	Elements of the Horizontal Alignment of the Approach Road (Preliminary Design)
Table 11.16	Vertical Alignment Elements of Approach Road (Preliminary Design) 11-24
Table 11.17	Elements of the Horizontal Alignment of the East Side Connection Road (On
ramp)	
Table 11.18	Elements of the Vertical Alignment of the East Side Connection Road (On ramp)
	Elements of the Horizontal Alignment of the East Side Connection Road (Off
ramp)	
Table 11.20	Elements of the Vertical Alignment of the East Side Connection Road (Off
ramp)	
Table 11.21	Horizontal Alignment of Access Bridge to the Bridge of Americas (East-bound for
Panama	City)
Table 11.22	Horizontal Alignment of Access Road to the Bridge of Americas (West-bound for
Arraijan)
Table 11.23	Vertical Alignment of the Access Road to the Bridge of the Americas (East-bound
	ma City)
Table 11.24	Cross Section Elements of Approach Roads (Preliminary Design) 11-26
Table 11.25	Earth work Section and Earth work Structure of the Approach Roads 11-27
Table 11.26	Pavement Structure of the Approach Roads 11-27
Table 11.27	List of Drawings of Preliminary Design (Road Design) 11-28
Table 11.28	Main Construction Quantities for Road Works (Preliminary Design) 11-30
Table 11.29	Design Condition of Ramps (Concept Design)
Table 11.30	Travelling Speed of Object Road 11-33
Table 11.31	Description of the Roads of the East Side Concept Design 11-34
Table 11.32	Drawing List for the Concept Design (East Side) 11-34
Table 11.33	Drawing List for the Concept Design (West Side) 11-35
Table 11.34	Main Construction Quantities of the Roads in the Concept Design 11-36
Table 11.35	OD Traffic Volume and Spot Traffic Volume in 2013 (7:00am-8:00am) 11-37
Table 11.36	OD Traffic Volume in 2050 (7:00am-8:00am) 11-37
Table 11.37	Design Speed applied to the Network Models
Table 11.38	Average Simulated Speed of Each Case 11-41
Table 12.1	Summary of Preliminary Bridge Design Results
Table 12.2	Pier Locations and reasons for the Decision
Table 12.3	Designated Points for Stress Calculation
Table 12.4	Summary of Stress Calculation
Table 12.5	External Forces transmitted from the Superstructure (Main Bridge)
Table 12.6	Analysis Conditions
Table 12.7	Structure Types by Span Lengths

Table 12.8	Pier Types	12-39
Table 12.9	Conjunction Points with Metro Line 3	12-40
Table 12.10	Locations of Viaduct Abutments	
Table 12.11	Most Favorable Span Length by Pier Heights	
Table 12.12	Bridge Lengths and Span Arrangements	
Table 12.13	Abutment Locations (Flyover)	
Table 12.14	Bridge Length and Span Arrangements of Flyovers	12-45
Table 12.15	Abutment Locations	12-49
Table 12.16	Summary Table of Expansion Joints	
Table 12.17	Summary of Bearings	
Table 15.1	Main Construction Quantities	
Table 15.2	Procurement Plan for the Main Materials in the Project	
Table 15.3	Superstructure Erection Method (Main Bridge of 4th Panama Canal Bridge	
Table 15.4	Technical Risk Analysis of the Superstructure Erection (Main Bridg	
Panama	Canal Bridge (Arch Rib))	
Table 15.5	Risk Items and Countermeasures	
Table 15.6	Work Schedule of Re-fabrication and Erection of Arch Rib	15-14
Table 15.7	Work Items and Duration (Removal of Arch Rib)	15-15
Table 15.8	List of Labors and Equipment (Removal of Arch Rib)	
Table 15.9	Construction Procedures of Pile Foundation and Substructure	
Table 15.10	Construction Yard Area	
Table 15.11	Construction Schedule (Using the Navigation Channel)	15-27
Table 15.12	Construction Schedule (Without Using the Navigation Channel)	
Table 15.13	Preliminary Project Cost	
Table 15.14	Conditions of Cost Estimate	
Table 15.15	Project Cost Structure	15-32
Table 15.16	Preliminary Construction Cost (2013 price)	15-33
Table 15.17	Preliminary Consultant Fee (2013 price)	15-34
Table 15.18	Preliminary Cost for Environmental Compensation (2013 price)	15-34
Table 15.19	Preliminary Land Acquisition Cost (2013 price)	15-34
Table 15.20		
	l)	
Table 15.21		
Navigat	ion Channel)	
Table 15.22	Preliminary Operation and Maintenance Cost	15-37
Table 16.1	Summary of Preliminary Design Results of Arch Bridge (JICA Study)	
Table 16.2	Summary of Preliminary Design Results of Cable-stayed Bridge (Pre-F/S)	
Table 16.3	Risk Cost (Main Bridge of 4th Panama Canal Bridge)	
Table 16.4	Options after Adjustment of Comparison Conditions	
Table 16.5	Comparison Study Results	
Table 17.1	Scope of Construction Works	
Table 18.1	Fuel Consumption Rate	
Table 18.2	CO ₂ Emission Rate	
Table 18.3	Share of "Diablo Rojo"	
Table 18.4	Passenger-km and Modal Share for Baseline Traffic Calculation	
Table 18.5	Calculation of CO ₂ Emission Factor	
Table 18.6	CO_2 Emission by the Project	
Table 18.7	CO_2 Reduction by the Project	
Table 18.8	Operation Indicators.	
Table 18.9	Relevant Tax and Shadow Pricing Factors	
Table 18.10	Targets of Economic Analysis	18-8
Table 18.11	Cost Classification for Economic Analysis	
Table 18.12	Financial Cost to Economic Cost (Line-3)	
Table 18.13	Financial Cost to Economic Cost (4 th Bridge)	18-11

Table 18.14	Line-3 Cost in 4 th Bridge Project Cost	18-12
Table 18.15	Economic Cost of Initial Investment (4th Bridge & Line-3)	
Table 18.16	Economic Cost of Initial Investment (Line-3)	
Table 18.17	Economic Cost of Initial Investment (4th Bridge)	
Table 18.18	Unit Prices for VOC Calculation	
Table 18.19	Vehicle Utilization	
Table 18.20	Consumption Rate per1000 Vehicle Kilometers	
Table 18.21	VOC per1000 Vehicle Kilometers	
Table 18.22	Value of Time in SMP Study 2011	
Table 18.23	Monthly Income and Value of Time for Business Trips (Car)	
Table 18.24	Monthly Income and Value of Time for Business Trips (Bus)	
Table 18.25	Travel Time Reduction and VOC Saving (4 th Bridge & Line-3)	
Table 18.26	Travel Time Reduction and VOC Saving (Line-3)	
Table 18.27	Travel Time Reduction and VOC Saving (4th Bridge)	
Table 18.28	Cash Flow of Economic Benefit and Cost (4th Bridge & Line-3)	
Table 18.29	Cash Flow of Economic Benefit and Cost (Line-3).	
Table 18.30	Cash Flow of Economic Benefit and Cost (4th Bridge)	
Table 18.31	Sensitivity Analysis of EIRR (4th Bridge & Line-3)	
Table 18.32	Sensitivity Analysis of EIRR (Line-3)	
Table 18.33	Sensitivity Analysis of EIRR (4 th Bridge)	
Table 18.34	Basic Assumptions of Financial Analysis	
Table 18.35	Initial Investment Cost (Constant Price)	
Table 18.36	Initial Investment Cost (Nominal Price)	
Table 18.37	Annual O&M Cost	
Table 18.38	Reinvestment and Additional Investment Cost	
Table 18.39	Revenue Projection	
Table 18.40	Assumptions on Funding and Finance	
Table 18.41	WACC of Public Investment Case	
Table 18.42	Project FIRR and NPV	18-31
Table 18.43	Project Cash Flow Projection (Constant Price)	
Table 18.44	Sensitivity Test (Project FIRR)	
Table 18.45	Life Cycle Cost of Public Investment and Operation Case	
Table 18.46	Cash Flow Projection (Public Investment and Operation)	
Table 18.47	Sensitivity Test (Revenue and Cost Changes)	
Table 18.48	Sensitivity Test (JPY LIBOR Rate and Revenue/Cost)	
Table 18.49	Assumptions on Value for Money Estimation	18-36
Table 18.50	Adjustment Mechanism for Commercial Viability	18-36
Table 18.51	WACC of the Private Concessionaire	
Table 18.52	Value for Money of Project Scheme Alternatives	
Table 18.53	Cash Flow Projection of Concession Scheme (Fare-based)	
Table 18.54	Cash Flow Projection of Concession Scheme (Annuity-based)	
Table 18.55	Cash Flow Projection of BOT/BTO Scheme	18-41
Table 18.56	Cash Flow Projection of Vertical Separation Scheme (Fare-based)	18-42
Table 18.57	Cash Flow Projection of Vertical Separation Scheme (Annuity-based)	18-43
Table 18.58	Cash Flow Projection of Public Operation with Private Investment	18-44
Table 19.1	Legislation on Environmental and Social Considerations in Panama	19-1
Table 19.2	Record of Community Participation Activities	19-5
Table 19.3	Project Stakeholders	
Table 19.4	Main Questions and Answers of Community Meetings	
Table 19.5	Comparison of Tunnel and Bridge Technologies	
Table 19.6	Comparison of Tunnel and Bridge Technologies (Environmental and	Social
Aspects)		
Table 19.7	Land Use in the Metro Line 3 Project Area	
Table 19.8	Land Use in the 4th Panama Canal Bridge Project Area	19-20

Table 19.9	Fauna Diversity according to Species
Table 19.10	Population of Corregimientos in the Project Area 19-33
Table 19.11	HDI of Corregimiento in the Project Area 19-34
Table 19.12	Types of Housing in the Project Area 19-35
Table 19.13	Economic Activities in the Project Influence Area 19-36
Table 19.14	Draft Scoping and Study Results Chart for Metro Line 3 Project 19-38
Table 19.15	Draft Scoping and Study Results Chart for 4th Panama Canal Bridge Project 19-45
Table 19.16	Main EMP for Metro Line 3 and the 4th Panama Canal Bridge Projects 19-52
Table 19.17	Main Legal Framework for Land Acquisition and Resettlement 19-57
Table 19.18	Comparison of JICA Guidelines and the Panamanian Legal Framework 19-59
Table 19.19	Number of project affected units and PAPs (Metro Line 3 Project) 19-65
Table 19.20	Number of project affected units and PAPs (4th Panama canal Bridge Component)
Table 19.21	Area and type of land to be acquired 19-67
Table 19.22	Type and number of structures to be affected (Metro Line 3 Project) 19-68
Table 19.23	Number and Type of Affected Structures (4th Panama Canal Bridge Project) 19-68
Table 19.24	Entitlement Matrix
Table 19.25	Organization for Implementation of RAP19-73
Table 19.26	Implementation Schedule of RAP for the Metro Line 3 Project19-74
Table 19.27	Implementation Schedule of RAP for the 4th Panama Canal Bridge Project. 19-74
Table 19.28	Estimated Cost of RAP for Metro Line 3 Project (*1)19-75
Table 19.29	Estimated Cost of RAP for 4th Panama Canal Bridge (*1)19-75
Table 20.1	Yield Strengths of Conventional Steel and SBHS
Table 21.1	Project Cost

LIST OF FIGURES

Figure 1.1	Survey area for route study	
Figure 2.1	Annual GDP (current USD) of Panama	
Figure 2.2	Map of Urbanized Areas and Main Roads	
Figure 2.3	Master Plan of Panama Pacifico	
Figure 2.4	Metro Plan	
Figure 2.5	Metro Bus Network	
Figure 2.6	Metro Bus (center) with the Fare Collection Gate (right) and Exit (left)	2-6
Figure 2.7	Contactless IC Card charging machines and charging counter	2-7
Figure 2.8	Examples of a typical Pirata (left) and taxi (right)	
Figure 2.9	Congested conditions during morning peak hour on the Pan-American Highw	
Figure 2.10	Fully loaded Metro Bus and a waiting passenger	2-8
Figure 2.11	Difference in walking distance	2-8
Figure 2.12	Number of Registered Vehicles by year	2-9
Figure 2.13	Location of Line-1 Stations	2-10
Figure 2.14	Metro System and interconnection at San Miguelito Station	2-12
Figure 2.15	Entrance gate of the 5 de Mayo Pre-paid Zone for Metro Bus	2-12
Figure 2.16	Layout of Albrook Terminal	2-13
Figure 2.17	IDB Portfolio for the past 5 years in Panama	2-14
Figure 3.1	Zone Divisions west of the Canal	3-2
Figure 3.2	Traffic Zoning System	3-2
Figure 3.3	Flow for making the OD Matrix	3-3
Figure 3.4	Traffic Zoning in ACP's Pre-F/S	3-5
Figure 3.5	Assumption of Economic Growth Rate	3-14
Figure 3.6	Population Forecast (High Case)	3-16
Figure 3.7	Population Forecast (Mid Case)	
Figure 3.8	Population Forecast (Low Case)	3-16
Figure 3.9	No. of Vehicles in Panama	3-17
Figure 3.10	Estimation of Passenger Volume from West to East	3-18
Figure 3.11	Area of Walking Distance for Modal Shift	3-21
Figure 3.12	Transit Network in West Area (1)	3-24
Figure 3.13	Transit Network in West Area (2)	3-25
Figure 3.14	Links in the Network Model	3-26
Figure 3.15	Connection of Zone Centroid and Transit Routes	3-26
Figure 3.16	Zone Division of Arraijan and Vista Alegre	3-28
Figure 3.17	Locations of Stations	
Figure 3.18	Regression Analysis for Cargo Vehicles	3-32
Figure 3.19	Station Locations of Autopista Case	3-34
Figure 3.20	Section Traffic for Peak Direction	
Figure 3.21	Omar Torrijos Roundabout	3-46
Figure 3.22	Correspond of Entering and Exiting Pair and Zoning	3-52
Figure 3.23	Corresponding Alphabet of Entering and Exiting Legs	3-53
Figure 4.1	Map of Panama Canal Area	
Figure 4.2	Geography and Active Fault Distribution of the Study Area	4-2
Figure 4.3	Subsoil Conditions in the Project Site	4-3
Figure 4.4	Annual Average Air Temperature, Balboa	
Figure 4.5	Relative Humidity in the Project Site	4-4
Figure 4.6	Annual Monthly Average Rainfalls, Panama Canal Basin	
Figure 4.7	Wind Rose showing Direction and Velocity, Balboa	
Figure 4.8	Monthly Maximum Wind Speed between 1985 and 2012, Balboa	
Figure 4.9	Wind Velocity Occurrence, Balboa	
Figure 4.10	Distribution of Epicenters of Past Earthquakes since 1997, Panama	
Figure 4.11	Major Tectonic Elements in Central America	

Eigung 5 1		51
Figure 5.1	Route Alternatives System Selection Flow	
Figure 5.2 Figure 5.3	Radar Chart comparison between monorail and MRT	
Figure 5.3 Figure 5.4	Structure of O&M Cost Comparison.	
Figure 5.4	Comparison of Impact on Landscape (Area shaded by Structure)	
Figure 5.5 Figure 6.1	Outline of Line-3 Route	
0		
Figure 6.2	Satellite image, profile outline and photos along the first half of the project ro	
Figure 6.3	Satellite image, profile outline and photos along the last half of the project rou	
Figure 6.4	Typical Colum Diagram from the 4 th Bridge to Arraijan	
Figure 6.5	Location and photo of Fuel Pipelines along the Line-3 Alignment	
Figure 6.6	Location and photo of IDAAN Water Pipes along the Line-3 Alignment	
Figure 6.7	Watershed distribution - Project Area	
Figure 6.8	Monthly Average Rainfall in the Study Area	
Figure 6.9	Locations of Lighting Statistics	
Figure 7.1	Car Dimensions and Seat arrangement of "Long Seat Type"	
Figure 7.2	Seat arrangement of "Semi-cross Seat Type"	
Figure 7.3	Arrangement of Major Equipment	
Figure 7.4	Auxiliary System	
Figure 7.5	Flowchart for Examining Train Operation	
Figure 7.6	Passenger Line Load at Peak Hour in Phase 1	
Figure 7.7	Track Layout Plan at Stations of Line 3 (Phase 1)	
Figure 7.8	Train Run-Curve of Line 3 (Phase 1)	
Figure 7.9	Train Operation Patterns of Line 3 (Phase 1)	
Figure 7.10	Calculation Method of the Required Train-sets at Peak Hour	
Figure 7.11	Selection of superstructure type	
Figure 7.12	Cross Section of pre-stressed concrete girder (L=25m)	
Figure 7.13	Cross Section of Steel Girder Bridge (L=50m)	
Figure 7.14	Typical Cross Section of Monorail Piers	
Figure 7.15	Typical Cross Section of a Monorail Viaduct Portal Type Pier	
Figure 7.16	Profile and Cross Section of a Monorail switch bridge	
Figure 7.17	Bearings and Expansion Joints (Example)	
Figure 7.18	Photo of the stoppers, (Sample: end of Tama Monorail)	
Figure 7.19	Axle arrangement	
Figure 7.20	Center of gravity of the Monorail	7-30
Figure 7.21	Response Spectrum	
Figure 7.22	Standards for Equilibrium Control	7-32
Figure 7.23	Platform screen doors of Tama Monorail station in Japan	7-34
Figure 7.24	Smooth transition between the train and platform	
Figure 7.25	Notification LCD Display in the train	7-35
Figure 7.26	User-friendly elevators and escalators	7-35
Figure 7.27	Station layout map of the facilities for handicapped users	7-36
Figure 7.28	Cross section of Station (Platform)	7-38
Figure 7.29	Road Cross Section at Station	7-39
Figure 7.30	Station Layout	7-39
Figure 7.31	Platform Screen Door System	7-42
Figure 7.32	Entry/Exit Gates	7-45
Figure 7.33	System configuration of AFC (Automatic Fare Collection system)	7-48
Figure 7.34	Traffic Movement	
Figure 7.35	Process for Determining the Required Capacity of a Station Plaza	7-51
Figure 7.36	Image of Station Transfers and Station Plaza Users	
Figure 7.37	Representative example of Major Interchange Station	7-59
Figure 7.38	Representative example of Exchange Station	
Figure 7.39	Representative example of a Park and Ride Station	
Figure 7.40	Target Area for Land Acquisition	7-61

Figure 7.41	Depot Candidate Sites	7-62
Figure 7.42	Depot Layout	7-65
Figure 7.43	Workshop Layout	7-67
Figure 7.44	ETESA Transmission System	7-76
Figure 7.45	Construction Site for Burunga Substation	7-77
Figure 7.46	Transmission Line System Plan	7-79
Figure 7.47	Feeding System Diagram	
Figure 7.48	Standard Substation Connection Diagram	
Figure 7.49	Contact Line Structure	
Figure 7.50	Air Termination System of External Lightning Protection System	
Figure 7.51	Protection Area	
Figure 7.52	Alternative Plans of Overhead Ground Wire and Protection Area	7-94
Figure 7.53	Automatic Train Protection (ATP)	.7-100
Figure 7.54	Schematic Diagram of ATP System	
Figure 7.55	Interlocking System (IL)	
Figure 7.56	Schematic Diagram of ATS system	
Figure 7.57	Schematic Diagram of ATO system	
Figure 7.58	Depot Control Area	
Figure 7.59	Schematic Diagram of Signaling System	
Figure 7.60	Outline of Track Layout for Metro Line-3	.7-108
Figure 7.61	System Configuration for Digital Radio Communication System	. 7-113
Figure 7.62	System Configuration for Telephone System	
Figure 7.63	System Configuration for Closed Circuit Television (CCTV) System	
Figure 7.64	System Configuration for Public Address (PA) System	. 7-117
Figure 7.65	Example of Passenger Information Display Systems (PIDS)	. 7-119
Figure 7.66	System Configuration for Backbone Transmission Network (BTN) System	.7-121
Figure 8.1	Construction sequence in Panamericana road widening section	8-10
Figure 8.2	PC beam erection	8-12
Figure 8.3	Beam transport by cranes and by beam transport and erection machine	8-13
Figure 8.4	Maintenance vehicle	8-14
Figure 8.5	Public Investment and Operation	8-30
Figure 8.6	Concession Scheme (Fare-based)	
Figure 8.7	BOT/BTO Scheme	8-31
Figure 8.8	Vertical Separation Scheme (Fare-based)	
Figure 8.9	Public Operation with Private Investment	
Figure 8.10	Implementation Schedule	
Figure 9.1	Organization chart of SMP (Line-1 construction stage)	9-3
Figure 9.2	Route map and photos of PCRC	
Figure 9.3	Association chart of project executing agency	
Figure 9.4	The ordinary budget/ actual in 2013	
Figure 9.5	The capital budget/ actual in 2013	
Figure 9.6	The ordinary budget actual 2010 - 2013	
Figure 9.7	The capital budget in 2014	
Figure 9.8	Line-1 / SMP Operational Organization Chart	
Figure 9.9	Organizational Structure of Monorail Operator (Recommendation)	
Figure 9.10	Comparison of Number of Personnel between Line-1 and Japanese Monorai	
Figure 9.11	Daily Inspection (Tama Urban Monorail)	
Figure 9.12	Maintenance Using Special Maintenance Vehicles for Monorail	
Figure 9.13	Total O&M Cost and Number of Staffs)	
Figure 10.1	Radar Chart (Evaluation Results)	
Figure 10.2	Evaluation Items and Weighting	
Figure 10.3	The Existing Bridge of the Americas (Photo)	. 10-18
Figure 10.4	Radar Chart (Evaluation Results)	
Figure 11.1	Location Map of the Design Road	11-1

Figure 11.2	Present Condition on the East Side of 4th Panama Canal Bridge	11-4
Figure 11.3	Present Condition on the West Side of 4th Panama Canal Bridge	11-4
Figure 11.4	Locations where the above photos where taken.	11-7
Figure 11.5	Future Canal Expansion (Cross-section)	11-9
Figure 11.6	Future Canal Expansion (Plan)	
Figure 11.7	Horizontal Surfaces of Albrook International (Marcos A. Gelabert) Airpo	
Howard A	Airport	. 11-11
Figure 11.8	Approach Surface and Transition Surface, Albrook International Airpo	rt and
Howard A	Airport	
Figure 11.9	Typical Cross Section of 4th Panama Canal Bridge	. 11-14
Figure 11.10	Speed Performance Curve of Trucks on a 5% Up-grade (From BP to EP)	
Figure 11.11	Speed Performance Curve of Trucks on a 5% Up-grade (From EP to BP)	
Figure 11.12	Speed Performance Curve of Trucks on a 4% Up-grade (From BP to EP)	
Figure 11.13	Speed Performance Curve of Trucks on a 4% Up-grade (From EP to BP)	
Figure 11.14	Clearance of Cross Road	
Figure 11.15	Project Road Plan (Preliminary Design)	
Figure 11.16	Project Road Profile (Preliminary Design)	
Figure 11.17	Typical Cross Section, Earth work (6 lanes) (Preliminary Design)	
Figure 11.18	Typical Cross Section, Retaining Wall (4 lanes) (Preliminary Design)	
Figure 11.19	Typical Cross Sections of Underpass (Concept Design)	
Figure 11.20	Typical Cross Section of 1 way, 1 lane Ramp (Concept Design)	
Figure 11.21	Typical Cross Section of 1 way, 2 lanes Ramp (Concept Design)	
Figure 11.22	Sketches of the Roundabout with/without Concept Design	
Figure 11.23	Layout of the Concept Design (East Side)	
Figure 11.24	Layout of the Concept Design (West Side)	
Figure 11.25	Network Models applied to Micro Simulation (Existing and Future)	
Figure 11.26	Correlation between the Observed Traffic Volume and the Traffic V	
	n the Simulation	
Figure 11.27	Results of Micro Simulation on Existing Network (Simulated Speed)	
Figure 11.28	Results of Micro Simulation on Future Network (Simulated Speed)	
Figure 12.1	Bridge Location Map	
Figure 12.2	Topographic Mapping Data used by the Study	
Figure 12.3	Typical Subsoil Conditions in the Lowlands of the Study Area	
Figure 12.4	Subsoil Profile (4th Panama Canal Bridge)	
Figure 12.5	Bearing Stratum (4th Panama Canal Bridge)	
Figure 12.6	Route of Metro Line 3 and Planned Stations	
Figure 12.7	Loadings of HL-93	
Figure 12.8	Loadings of Monorail	
Figure 12.9	Calculation Formula of Acceleration Response Spectrum	
Figure 12.10	Site Class Definitions	
Figure 12.11	Examples of values of site factor	
Figure 12.12	Reference Graph (Response Acceleration for Natural Period = 0.2 Sec	12 11
Figure 12.13		
•	Acceleration Spectrum adopted in the Study Design Wind Load	
Figure 12.14 Figure 12.15	Typical Cross Sections of Bridge Structures	
Figure 12.15 Figure 12.16	•	
Figure 12.10 Figure 12.17	Scope of application for SBHS500 Typical Cross Sections of Main Bridge (Arch Bridge)	
Figure 12.17 Figure 12.18	Span Arrangement of Main Bridge (Arch Bridge)	
Figure 12.18 Figure 12.19	Skelton Model of Superstructure Analyses	
Figure 12.19 Figure 12.20	Designated Points for Stress Calculation	
Figure 12.20	Designated Forms for Stress Calculation	
Figure 12.21 Figure 12.22	Step-wise Reactions transmitted to the Substructure	
Figure 12.22	Outcomes of the Substructure and Foundation Designs (1)	
0	\mathbf{O}	

	Outcomes of the Substructure and Foundation Designs (2)	12 31
Figure 12.24 Figure 12.25		
U	Outcomes of the Substructure and Foundation Designs (3)	
Figure 12.26	Outcomes of the Substructure and Foundation Designs (4)	
Figure 12.27	Modeling of cross point between the arch-rib and the stiffening girder	
Figure 12.28	Analysis Model	
Figure 12.29	Results of the FEM analysis CASE1	
Figure 12.30	Results of the FEM analysis CASE2	
Figure 12.31	Results of the FEM analysis CASE3	
Figure 12.32	Span arrangement of the West Bank Approach Viaduct No.2	12-41
Figure 12.33	Typical Cross Section of the East Bank Approach Viaduct	
Figure 12.34	Typical Cross Section of the West Bank Approach Viaduct	
Figure 12.35	Portal Rigid Frame for the Combined Section of Metro Line 3 and A	
Viaduct		
Figure 12.36	Cantilever type Piers at the Independent (Separate) Section	
Figure 12.30	Span Arrangement of Flyover No.1	
Figure 12.37	Span Arrangement of Flyover No.2-1	
Figure 12.38 Figure 12.39	Span Arrangement of Flyover No.2-2	
U		
Figure 12.40	Typical Cross Sections of Flyovers	
Figure 12.41	Cross Sections of Cantilever Type Piers for Flyovers	
Figure 12.42	Typical Cross Section of Access Bridges to the Bridge of the Americas	
Figure 12.43	Typical Pier Section of Access Bridges to the Bridge of the Americas	
Figure 12.44	Image of Expansion Joint	
Figure 12.45	Images of Bearings	
Figure 12.46	Area where Sidewalk is to be installed	12-52
Figure 12.47	Typical cross-section of maintenance walkways	12-52
Figure 12.48	Indicative Locations of Maintenance Walkways	
Figure 15.1	Construction Sections	
Figure 15.2		Bridge)
Figure 15.2	Erection Segment of Superstructure (Main Bridge of 4th Panama Canal	
	Erection Segment of Superstructure (Main Bridge of 4th Panama Canal	15-4
Figure 15.3	Erection Segment of Superstructure (Main Bridge of 4th Panama Canal Erection Procedure of Main Bridge of 4th Panama Canal Bridge with	15-4 th Using
Figure 15.3 Navigatio	Erection Segment of Superstructure (Main Bridge of 4th Panama Canal Erection Procedure of Main Bridge of 4th Panama Canal Bridge with on Channel	15-4 th Using 15-5
Figure 15.3 Navigatio Figure 15.4	Erection Segment of Superstructure (Main Bridge of 4th Panama Canal Erection Procedure of Main Bridge of 4th Panama Canal Bridge with on Channel Location of Expected Temporary Yard (Arch Rib and Stiffening Girders)	15-4 th Using 15-5 15-5
Figure 15.3 Navigatio Figure 15.4 Figure 15.5	Erection Segment of Superstructure (Main Bridge of 4th Panama Canal Erection Procedure of Main Bridge of 4th Panama Canal Bridge with on Channel Location of Expected Temporary Yard (Arch Rib and Stiffening Girders) Assembling Plan (Arch Rib: On a Deck Barge)	15-4 th Using 15-5 15-5 15-6
Figure 15.3 Navigatio Figure 15.4 Figure 15.5 Figure 15.6	Erection Segment of Superstructure (Main Bridge of 4th Panama Canal Erection Procedure of Main Bridge of 4th Panama Canal Bridge with on Channel Location of Expected Temporary Yard (Arch Rib and Stiffening Girders) Assembling Plan (Arch Rib: On a Deck Barge) Erection Plan of Arch Rib (Lifting Method)	15-4 th Using 15-5 15-5 15-6 15-7
Figure 15.3 Navigatio Figure 15.4 Figure 15.5 Figure 15.6 Figure 15.7	Erection Segment of Superstructure (Main Bridge of 4th Panama Canal Erection Procedure of Main Bridge of 4th Panama Canal Bridge with on Channel Location of Expected Temporary Yard (Arch Rib and Stiffening Girders) Assembling Plan (Arch Rib: On a Deck Barge) Erection Plan of Arch Rib (Lifting Method) Erection Plan of Stiffening Girder (Median) (Cantilever Erection)	15-4 th Using 15-5 15-5 15-6 15-7 15-9
Figure 15.3 Navigatio Figure 15.4 Figure 15.5 Figure 15.6 Figure 15.7 Figure 15.8	Erection Segment of Superstructure (Main Bridge of 4th Panama Canal Erection Procedure of Main Bridge of 4th Panama Canal Bridge with on Channel Location of Expected Temporary Yard (Arch Rib and Stiffening Girders) Assembling Plan (Arch Rib: On a Deck Barge) Erection Plan of Arch Rib (Lifting Method) Erection Plan of Stiffening Girder (Median) (Cantilever Erection) Erection Plan of Stiffening Girder (Side Bracket) (Cantilever Erection)	15-4 th Using 15-5 15-5 15-6 15-7 15-9 15-10
Figure 15.3 Navigatio Figure 15.4 Figure 15.5 Figure 15.6 Figure 15.7 Figure 15.8 Figure 15.9	Erection Segment of Superstructure (Main Bridge of 4th Panama Canal Erection Procedure of Main Bridge of 4th Panama Canal Bridge with on Channel Location of Expected Temporary Yard (Arch Rib and Stiffening Girders) Assembling Plan (Arch Rib: On a Deck Barge) Erection Plan of Arch Rib (Lifting Method) Erection Plan of Stiffening Girder (Median) (Cantilever Erection) Erection Plan of Stiffening Girder (Side Bracket) (Cantilever Erection) Erection Plan of Arch Rib (Cable Crane with Oblique Hang)	15-4 th Using 15-5 15-5 15-6 15-7 15-9 15-10 15-11
Figure 15.3 Navigatio Figure 15.4 Figure 15.5 Figure 15.6 Figure 15.7 Figure 15.8 Figure 15.9 Figure 15.10	Erection Segment of Superstructure (Main Bridge of 4th Panama Canal Erection Procedure of Main Bridge of 4th Panama Canal Bridge with on Channel Location of Expected Temporary Yard (Arch Rib and Stiffening Girders) Assembling Plan (Arch Rib: On a Deck Barge) Erection Plan of Arch Rib (Lifting Method) Erection Plan of Stiffening Girder (Median) (Cantilever Erection) Erection Plan of Stiffening Girder (Side Bracket) (Cantilever Erection) Erection Plan of Arch Rib (Cable Crane with Oblique Hang) Plan of Test Lifting (Arch Rib)	15-4 th Using 15-5 15-5 15-6 15-7 15-7 15-9 15-10 15-11 15-14
Figure 15.3 Navigatio Figure 15.4 Figure 15.5 Figure 15.6 Figure 15.7 Figure 15.8 Figure 15.8 Figure 15.9 Figure 15.10 Figure 15.11	Erection Segment of Superstructure (Main Bridge of 4th Panama Canal Erection Procedure of Main Bridge of 4th Panama Canal Bridge with on Channel Location of Expected Temporary Yard (Arch Rib and Stiffening Girders) Assembling Plan (Arch Rib: On a Deck Barge) Erection Plan of Arch Rib (Lifting Method) Erection Plan of Stiffening Girder (Median) (Cantilever Erection) Erection Plan of Stiffening Girder (Side Bracket) (Cantilever Erection) Erection Plan of Arch Rib (Cable Crane with Oblique Hang) Plan of Test Lifting (Arch Rib) Construction Plan of Substructure and Foundation (West Side: in the C	15-4 th Using 15-5 15-5 15-6 15-7 15-7 15-10 15-11 15-14 anal) 1/2
Figure 15.3 Navigatio Figure 15.4 Figure 15.5 Figure 15.6 Figure 15.7 Figure 15.8 Figure 15.8 Figure 15.9 Figure 15.10 Figure 15.11	Erection Segment of Superstructure (Main Bridge of 4th Panama Canal Erection Procedure of Main Bridge of 4th Panama Canal Bridge with on Channel Location of Expected Temporary Yard (Arch Rib and Stiffening Girders) Assembling Plan (Arch Rib: On a Deck Barge) Erection Plan of Arch Rib (Lifting Method) Erection Plan of Stiffening Girder (Median) (Cantilever Erection) Erection Plan of Stiffening Girder (Side Bracket) (Cantilever Erection) Erection Plan of Arch Rib (Cable Crane with Oblique Hang) Plan of Test Lifting (Arch Rib) Construction Plan of Substructure and Foundation (West Side: in the C	15-4 th Using 15-5 15-5 15-6 15-7 15-7 15-10 15-11 15-14 anal) 1/2 15-17
Figure 15.3 Navigatio Figure 15.4 Figure 15.5 Figure 15.6 Figure 15.7 Figure 15.8 Figure 15.8 Figure 15.9 Figure 15.10 Figure 15.11	Erection Segment of Superstructure (Main Bridge of 4th Panama Canal Erection Procedure of Main Bridge of 4th Panama Canal Bridge with on Channel Location of Expected Temporary Yard (Arch Rib and Stiffening Girders) Assembling Plan (Arch Rib: On a Deck Barge) Erection Plan of Arch Rib (Lifting Method) Erection Plan of Stiffening Girder (Median) (Cantilever Erection) Erection Plan of Stiffening Girder (Side Bracket) (Cantilever Erection) Erection Plan of Arch Rib (Cable Crane with Oblique Hang) Plan of Test Lifting (Arch Rib) Construction Plan of Substructure and Foundation (West Side: in the C	15-4 th Using 15-5 15-5 15-6 15-7 15-7 15-10 15-11 15-14 anal) 1/2 15-17
Figure 15.3 Navigatio Figure 15.4 Figure 15.5 Figure 15.6 Figure 15.7 Figure 15.8 Figure 15.9 Figure 15.10 Figure 15.11	Erection Segment of Superstructure (Main Bridge of 4th Panama Canal Erection Procedure of Main Bridge of 4th Panama Canal Bridge with on Channel Location of Expected Temporary Yard (Arch Rib and Stiffening Girders) Assembling Plan (Arch Rib: On a Deck Barge) Erection Plan of Arch Rib (Lifting Method) Erection Plan of Stiffening Girder (Median) (Cantilever Erection) Erection Plan of Stiffening Girder (Side Bracket) (Cantilever Erection) Erection Plan of Arch Rib (Cable Crane with Oblique Hang) Plan of Test Lifting (Arch Rib) Construction Plan of Substructure and Foundation (West Side: in the C	15-4 th Using 15-5 15-5 15-6 15-7 15-7 15-10 15-11 15-14 anal) 1/2 15-17 anal) 2/2
Figure 15.3 Navigatio Figure 15.4 Figure 15.5 Figure 15.6 Figure 15.7 Figure 15.8 Figure 15.9 Figure 15.10 Figure 15.11	Erection Segment of Superstructure (Main Bridge of 4th Panama Canal Erection Procedure of Main Bridge of 4th Panama Canal Bridge with on Channel Location of Expected Temporary Yard (Arch Rib and Stiffening Girders) Assembling Plan (Arch Rib: On a Deck Barge) Erection Plan of Arch Rib (Lifting Method) Erection Plan of Stiffening Girder (Median) (Cantilever Erection) Erection Plan of Stiffening Girder (Side Bracket) (Cantilever Erection) Erection Plan of Arch Rib (Cable Crane with Oblique Hang) Plan of Test Lifting (Arch Rib) Construction Plan of Substructure and Foundation (West Side: in the C	15-4 th Using 15-5 15-5 15-6 15-7 15-7 15-10 15-11 15-11 anal) 1/2 15-17 anal) 2/2 15-18
Figure 15.3 Navigatio Figure 15.4 Figure 15.5 Figure 15.6 Figure 15.7 Figure 15.7 Figure 15.8 Figure 15.9 Figure 15.10 Figure 15.11 Figure 15.12	Erection Segment of Superstructure (Main Bridge of 4th Panama Canal Erection Procedure of Main Bridge of 4th Panama Canal Bridge with on Channel Location of Expected Temporary Yard (Arch Rib and Stiffening Girders) Assembling Plan (Arch Rib: On a Deck Barge) Erection Plan of Arch Rib (Lifting Method) Erection Plan of Stiffening Girder (Median) (Cantilever Erection) Erection Plan of Stiffening Girder (Side Bracket) (Cantilever Erection) Erection Plan of Stiffening Girder (Side Bracket) (Cantilever Erection) Erection Plan of Arch Rib (Cable Crane with Oblique Hang) Plan of Test Lifting (Arch Rib) Construction Plan of Substructure and Foundation (West Side: in the C Construction Plan of Substructure and Foundation (Procedure for P32 Pie	15-4 th Using 15-5 15-5 15-6 15-7 15-7 15-10 15-11 15-14 anal) 1/2 15-17 anal) 2/2 15-18 er) 15-19
Figure 15.3 Navigatio Figure 15.4 Figure 15.5 Figure 15.6 Figure 15.7 Figure 15.7 Figure 15.8 Figure 15.9 Figure 15.10 Figure 15.11 Figure 15.12 Figure 15.13 Figure 15.14	Erection Segment of Superstructure (Main Bridge of 4th Panama Canal Erection Procedure of Main Bridge of 4th Panama Canal Bridge with on Channel Location of Expected Temporary Yard (Arch Rib and Stiffening Girders) Assembling Plan (Arch Rib: On a Deck Barge) Erection Plan of Arch Rib (Lifting Method) Erection Plan of Stiffening Girder (Median) (Cantilever Erection) Erection Plan of Stiffening Girder (Side Bracket) (Cantilever Erection) Erection Plan of Arch Rib (Cable Crane with Oblique Hang) Erection Plan of Test Lifting (Arch Rib) Plan of Test Lifting (Arch Rib) Construction Plan of Substructure and Foundation (West Side: in the C Construction Plan of Substructure and Foundation (Procedure for P32 Pic Construction Plan of Substructure and Foundation (Procedure for P33 Pic	15-4 th Using 15-5 15-5 15-6 15-7 15-7 15-10 15-11 15-14 anal) 1/2 15-17 anal) 2/2 15-18 er) 15-19 er) 15-20
Figure 15.3 Navigatio Figure 15.4 Figure 15.5 Figure 15.6 Figure 15.7 Figure 15.7 Figure 15.8 Figure 15.9 Figure 15.10 Figure 15.11 Figure 15.12 Figure 15.13 Figure 15.14 Figure 15.15	Erection Segment of Superstructure (Main Bridge of 4th Panama Canal Erection Procedure of Main Bridge of 4th Panama Canal Bridge with on Channel Location of Expected Temporary Yard (Arch Rib and Stiffening Girders) Assembling Plan (Arch Rib: On a Deck Barge) Erection Plan of Arch Rib (Lifting Method) Erection Plan of Stiffening Girder (Median) (Cantilever Erection) Erection Plan of Stiffening Girder (Side Bracket) (Cantilever Erection) Erection Plan of Arch Rib (Cable Crane with Oblique Hang) Plan of Test Lifting (Arch Rib) Construction Plan of Substructure and Foundation (West Side: in the C Construction Plan of Substructure and Foundation (Procedure for P32 Pic Construction Plan of Substructure and Foundation (Procedure for P33 Pic Precast Segment Method and Truck-crane Erection Method	15-4 th Using 15-5 15-5 15-6 15-7 15-7 15-10 15-11 15-11 anal) 1/2 15-17 anal) 2/2 15-18 er) 15-19 er) 15-20 15-22
Figure 15.3 Navigatio Figure 15.4 Figure 15.5 Figure 15.6 Figure 15.7 Figure 15.8 Figure 15.9 Figure 15.10 Figure 15.11 Figure 15.12 Figure 15.13 Figure 15.14 Figure 15.15 Figure 15.16	Erection Segment of Superstructure (Main Bridge of 4th Panama Canal Erection Procedure of Main Bridge of 4th Panama Canal Bridge with on Channel Location of Expected Temporary Yard (Arch Rib and Stiffening Girders) Assembling Plan (Arch Rib: On a Deck Barge) Erection Plan of Arch Rib (Lifting Method) Erection Plan of Stiffening Girder (Median) (Cantilever Erection) Erection Plan of Stiffening Girder (Side Bracket) (Cantilever Erection) Erection Plan of Arch Rib (Cable Crane with Oblique Hang) Plan of Test Lifting (Arch Rib) Construction Plan of Substructure and Foundation (West Side: in the C Construction Plan of Substructure and Foundation (Procedure for P32 Pic Construction Plan of Substructure and Foundation (Procedure for P33 Pic Precast Segment Method and Truck-crane Erection Method Large Block Erection Method with Winch.	15-4 th Using 15-5 15-5 15-6 15-7 15-7 15-10 15-11 15-11 anal) 1/2 15-17 anal) 2/2 15-18 er) 15-19 er) 15-20 15-22 15-23
Figure 15.3 Navigatio Figure 15.4 Figure 15.5 Figure 15.6 Figure 15.7 Figure 15.7 Figure 15.8 Figure 15.9 Figure 15.10 Figure 15.10 Figure 15.12 Figure 15.13 Figure 15.13 Figure 15.14 Figure 15.15 Figure 15.16 Figure 15.17	Erection Segment of Superstructure (Main Bridge of 4th Panama Canal Erection Procedure of Main Bridge of 4th Panama Canal Bridge with on Channel Location of Expected Temporary Yard (Arch Rib and Stiffening Girders) Assembling Plan (Arch Rib: On a Deck Barge) Erection Plan of Arch Rib (Lifting Method) Erection Plan of Stiffening Girder (Median) (Cantilever Erection) Erection Plan of Stiffening Girder (Side Bracket) (Cantilever Erection) Erection Plan of Arch Rib (Cable Crane with Oblique Hang) Plan of Test Lifting (Arch Rib) Construction Plan of Substructure and Foundation (West Side: in the C Construction Plan of Substructure and Foundation (Procedure for P32 Pic Construction Plan of Substructure and Foundation (Procedure for P33 Pic Precast Segment Method and Truck-crane Erection Method Large Block Erection Method	15-4 th Using 15-5 15-5 15-6 15-7 15-7 15-10 15-11 15-11 anal) 1/2 15-17 anal) 2/2 15-18 er) 15-19 er) 15-20 15-22 15-23 15-24
Figure 15.3 Navigatio Figure 15.4 Figure 15.5 Figure 15.6 Figure 15.7 Figure 15.7 Figure 15.8 Figure 15.9 Figure 15.10 Figure 15.10 Figure 15.12 Figure 15.13 Figure 15.13 Figure 15.14 Figure 15.15 Figure 15.16 Figure 15.17 Figure 15.18	Erection Segment of Superstructure (Main Bridge of 4th Panama Canal Erection Procedure of Main Bridge of 4th Panama Canal Bridge with on Channel Location of Expected Temporary Yard (Arch Rib and Stiffening Girders) Assembling Plan (Arch Rib: On a Deck Barge) Erection Plan of Arch Rib (Lifting Method) Erection Plan of Stiffening Girder (Median) (Cantilever Erection) Erection Plan of Stiffening Girder (Side Bracket) (Cantilever Erection) Erection Plan of Arch Rib (Cable Crane with Oblique Hang) Plan of Test Lifting (Arch Rib) Construction Plan of Substructure and Foundation (West Side: in the C Construction Plan of Substructure and Foundation (Procedure for P32 Pic Construction Plan of Substructure and Foundation (Procedure for P33 Pic Precast Segment Method and Truck-crane Erection Method Large Block Erection Method with Winch Track Crane Erection Method Candidate Locations of Construction Yard	15-4 th Using 15-5 15-5 15-6 15-7 15-7 15-10 15-11 15-14 anal) 1/2 15-17 anal) 2/2 15-18 er) 15-19 er) 15-20 15-23 15-24 15-25
Figure 15.3 Navigatio Figure 15.4 Figure 15.5 Figure 15.6 Figure 15.7 Figure 15.7 Figure 15.8 Figure 15.9 Figure 15.10 Figure 15.11 Figure 15.12 Figure 15.13 Figure 15.13 Figure 15.14 Figure 15.15 Figure 15.16 Figure 15.17 Figure 15.18 Figure 15.19	Erection Segment of Superstructure (Main Bridge of 4th Panama Canal Erection Procedure of Main Bridge of 4th Panama Canal Bridge with on Channel Location of Expected Temporary Yard (Arch Rib and Stiffening Girders) Assembling Plan (Arch Rib: On a Deck Barge) Erection Plan of Arch Rib (Lifting Method) Erection Plan of Stiffening Girder (Median) (Cantilever Erection) Erection Plan of Stiffening Girder (Side Bracket) (Cantilever Erection) Erection Plan of Arch Rib (Cable Crane with Oblique Hang) Plan of Test Lifting (Arch Rib) Construction Plan of Substructure and Foundation (West Side: in the C Construction Plan of Substructure and Foundation (Procedure for P32 Pic Construction Plan of Substructure and Foundation (Procedure for P32 Pic Construction Plan of Substructure and Foundation (Procedure for P32 Pic Construction Plan of Substructure and Foundation (Procedure for P32 Pic Construction Plan of Substructure and Foundation (Procedure for P32 Pic Construction Plan of Substructure and Foundation (Procedure for P33 Pic Precast Segment Method and Truck-crane Erection Method Large Block Erection Method with Winch Track Crane Erection Method Candidate Locations of Construction Yard Traffic Detours during Removal of Existing Flyover	15-4 th Using 15-5 15-5 15-6 15-7 15-7 15-10 15-11 15-14 anal) 1/2 15-17 anal) 2/2 15-18 er) 15-19 er) 15-20 15-22 15-23 15-24 15-25 15-29
Figure 15.3 Navigatio Figure 15.4 Figure 15.5 Figure 15.6 Figure 15.7 Figure 15.8 Figure 15.9 Figure 15.10 Figure 15.10 Figure 15.12 Figure 15.13 Figure 15.13 Figure 15.14 Figure 15.15 Figure 15.16 Figure 15.17 Figure 15.18 Figure 15.19 Figure 17.1	Erection Segment of Superstructure (Main Bridge of 4th Panama Canal Erection Procedure of Main Bridge of 4th Panama Canal Bridge with on Channel Location of Expected Temporary Yard (Arch Rib and Stiffening Girders) Assembling Plan (Arch Rib: On a Deck Barge) Erection Plan of Arch Rib (Lifting Method) Erection Plan of Stiffening Girder (Median) (Cantilever Erection) Erection Plan of Stiffening Girder (Side Bracket) (Cantilever Erection) Erection Plan of Arch Rib (Cable Crane with Oblique Hang) Plan of Test Lifting (Arch Rib) Construction Plan of Substructure and Foundation (West Side: in the C Construction Plan of Substructure and Foundation (West Side: in Ca Construction Plan of Substructure and Foundation (Procedure for P32 Pic Construction Plan of Substructure and Foundation (Procedure for P32 Pic Construction Plan of Substructure and Foundation (Procedure for P33 Pic Precast Segment Method and Truck-crane Erection Method Large Block Erection Method with Winch Track Crane Erection Method Candidate Locations of Construction Yard Traffic Detours during Removal of Existing Flyover Demarcation between the two Projects (Metro Line-3 Project, 4th Panar	15-4 th Using 15-5 15-5 15-6 15-7 15-7 15-10 15-11 15-11 15-14 anal) 1/2 15-17 anal) 2/2 15-18 er) 15-19 er) 15-20 15-22 15-23 15-24 15-29 na Canal
Figure 15.3 Navigatio Figure 15.4 Figure 15.5 Figure 15.6 Figure 15.7 Figure 15.8 Figure 15.9 Figure 15.10 Figure 15.10 Figure 15.11 Figure 15.12 Figure 15.13 Figure 15.13 Figure 15.14 Figure 15.15 Figure 15.16 Figure 15.17 Figure 15.18 Figure 15.19 Figure 17.1 Bridge Pr	Erection Segment of Superstructure (Main Bridge of 4th Panama Canal Erection Procedure of Main Bridge of 4th Panama Canal Bridge with n Channel Location of Expected Temporary Yard (Arch Rib and Stiffening Girders) Assembling Plan (Arch Rib: On a Deck Barge) Erection Plan of Arch Rib (Lifting Method) Erection Plan of Stiffening Girder (Median) (Cantilever Erection) Erection Plan of Stiffening Girder (Side Bracket) (Cantilever Erection) Erection Plan of Arch Rib (Cable Crane with Oblique Hang) Plan of Test Lifting (Arch Rib) Construction Plan of Substructure and Foundation (West Side: in the C Construction Plan of Substructure and Foundation (West Side: in Ca Construction Plan of Substructure and Foundation (Procedure for P32 Pic Construction Plan of Substructure and Foundation (Procedure for P32 Pic Construction Plan of Substructure and Foundation (Procedure for P32 Pic Construction Plan of Substructure and Foundation (Procedure for P32 Pic Construction Plan of Substructure and Foundation (Procedure for P32 Pic Construction Plan of Substructure and Foundation (Procedure for P32 Pic Construction Plan of Substructure and Foundation (Procedure for P32 Pic Construction Plan of Substructure and Foundation (Procedure for P33 Pic Precast Segment Method and Truck-crane Erection Method Large Block Erection Method with Winch. Track Crane Erection Method Candidate Locations of Construction Yard. Traffic Detours during Removal of Existing Flyover Demarcation between the two Projects (Metro Line-3 Project, 4th Panar roject)	15-4 th Using 15-5 15-5 15-6 15-7 15-7 15-10 15-11 15-11 15-14 anal) 1/2 15-17 anal) 2/2 15-18 er) 15-19 er) 15-20 15-22 15-23 15-24 15-29 na Canal 17-2
Figure 15.3 Navigatio Figure 15.4 Figure 15.5 Figure 15.6 Figure 15.7 Figure 15.7 Figure 15.8 Figure 15.9 Figure 15.10 Figure 15.10 Figure 15.12 Figure 15.13 Figure 15.13 Figure 15.14 Figure 15.15 Figure 15.16 Figure 15.17 Figure 15.18 Figure 15.19 Figure 17.1 Bridge Pr	Erection Segment of Superstructure (Main Bridge of 4th Panama Canal Erection Procedure of Main Bridge of 4th Panama Canal Bridge with n Channel Location of Expected Temporary Yard (Arch Rib and Stiffening Girders) Assembling Plan (Arch Rib: On a Deck Barge) Erection Plan of Arch Rib (Lifting Method) Erection Plan of Stiffening Girder (Median) (Cantilever Erection) Erection Plan of Stiffening Girder (Side Bracket) (Cantilever Erection) Erection Plan of Arch Rib (Cable Crane with Oblique Hang) Plan of Test Lifting (Arch Rib) Construction Plan of Substructure and Foundation (West Side: in the C Construction Plan of Substructure and Foundation (West Side: in Ca Construction Plan of Substructure and Foundation (Procedure for P32 Pic Construction Plan of Substructure and Foundation (Procedure for P32 Pic Construction Plan of Substructure and Foundation (Procedure for P32 Pic Construction Plan of Substructure and Foundation (Procedure for P32 Pic Construction Plan of Substructure and Foundation (Procedure for P32 Pic Construction Plan of Substructure and Foundation (Procedure for P32 Pic Construction Plan of Substructure and Foundation (Procedure for P33 Pic Precast Segment Method and Truck-crane Erection Method Large Block Erection Method with Winch Track Crane Erection Method Candidate Locations of Construction Yard. Traffic Detours during Removal of Existing Flyover Demarcation between the two Projects (Metro Line-3 Project, 4th Panar roject) Project Implementation Scheme.	15-4 th Using 15-5 15-5 15-6 15-7 15-7 15-10 15-11 15-14 anal) 1/2 15-14 anal) 2/2 15-17 anal) 2/2 15-18 er) 15-19 er) 15-20 15-23 15-23 15-24 15-29 na Canal 17-2 17-3
Figure 15.3 Navigatio Figure 15.4 Figure 15.5 Figure 15.6 Figure 15.7 Figure 15.8 Figure 15.9 Figure 15.10 Figure 15.10 Figure 15.11 Figure 15.12 Figure 15.13 Figure 15.13 Figure 15.14 Figure 15.15 Figure 15.16 Figure 15.17 Figure 15.18 Figure 15.19 Figure 17.1 Bridge Pr	Erection Segment of Superstructure (Main Bridge of 4th Panama Canal Erection Procedure of Main Bridge of 4th Panama Canal Bridge with n Channel Location of Expected Temporary Yard (Arch Rib and Stiffening Girders) Assembling Plan (Arch Rib: On a Deck Barge) Erection Plan of Arch Rib (Lifting Method) Erection Plan of Stiffening Girder (Median) (Cantilever Erection) Erection Plan of Stiffening Girder (Side Bracket) (Cantilever Erection) Erection Plan of Arch Rib (Cable Crane with Oblique Hang) Plan of Test Lifting (Arch Rib) Construction Plan of Substructure and Foundation (West Side: in the C Construction Plan of Substructure and Foundation (West Side: in Ca Construction Plan of Substructure and Foundation (Procedure for P32 Pic Construction Plan of Substructure and Foundation (Procedure for P32 Pic Construction Plan of Substructure and Foundation (Procedure for P32 Pic Construction Plan of Substructure and Foundation (Procedure for P32 Pic Construction Plan of Substructure and Foundation (Procedure for P32 Pic Construction Plan of Substructure and Foundation (Procedure for P32 Pic Construction Plan of Substructure and Foundation (Procedure for P32 Pic Construction Plan of Substructure and Foundation (Procedure for P33 Pic Precast Segment Method and Truck-crane Erection Method Large Block Erection Method with Winch. Track Crane Erection Method Candidate Locations of Construction Yard. Traffic Detours during Removal of Existing Flyover Demarcation between the two Projects (Metro Line-3 Project, 4th Panar roject)	15-4 th Using 15-5 15-5 15-6 15-7 15-7 15-10 15-11 15-14 anal) 1/2 15-14 anal) 1/2 15-17 anal) 2/2 15-18 er) 15-19 er) 15-20 15-23 15-23 15-24 15-25 15-29 na Canal 17-2 17-3 17-4

Figure 17.5	Example of an ICB Procurement following the JICA Guideline
Figure 17.6	Project Implementation Schedule for the Case of "Using" the Navigation Channel
(Arch-R	ib Lifting Method) 17-9
Figure 17.7	Project Implementation Schedule for the Case of "Without" Using the Navigation
Channel	(Cable Erection Method)
Figure 18.1	Fare Revenue Projection
Figure 18.2	Threshold to Achieve VFM
Figure 19.1	Process to Obtain Environmental Resolution
Figure 19.2	At Arraijan (Super Xtra) March 16, 2014 (L) and Albrook Transportation Terminal,
March 2	2, 2014 (R)
Figure 19.3	Geological Map of the Project Areas 19-19
Figure 19.4	Climate Map for the Project Areas
Figure 19.5	Noise (L) and Vibration (R) Surveys19-23
Figure 19.6	General view of Typical Mature Secondary Forest (L) and Elaeis oleífera (R)19-25
Figure 19.7	Curatella americana (L) and Pithecellobium unguis-cati (R)19-26
Figure 19.8	Rhizophora mangle in the project area (L) and Pellicera rizhophorae (R) 19-29
Figure 19.9	Melongena sp. (L) and Protothaca asperrima (R) 19-29
Figure 19.10	Pacific Crevalle Jack (Caranx caninus) (L) and Longjaw Leatherjacket
	<i>ites altus</i>) (R)19-30
Figure 19.11	Alignment of the Project
Figure 19.12	Typical Landscape in the Project Area 19-33
Figure 19.13	Transportation System in the Project Area 19-35
Figure 19.14	Typical Type of Land to be Affected 19-66
Figure 19.15	Typical Type of Structures to be Affected 19-67
Figure 19.16	Artisanal Fishermen Activities
Figure 19.17	Grievance Redress Mechanism
Figure 20.1	BPS Cabinet
Figure 20.2	Inside of a BPS Cabinet
Figure 20.3	High-capacity nickel-metal hydride battery GIGACELL TM , used for the BPS 20-2
Figure 20.4	Cristal Composition of Conventional Steel and SBHS
Figure 20.5	Charpy Absorbed Energy of Conventional Steel and SBHS 20-4
Figure 20.6	Root Cracking Ratio of SBHS500 and 700 (Y-groove Weld Cracking Test) 20-4
Figure 20.7	Components using SBHS in the Project (Main Bridge of the 4th Panama Canal
Bridge)	
Figure 20.8	Illustrations of Rust Layer of Weathering Steel and Conventional Steel 20-5
Figure 20.9	Example of Estimated Curve of Thickness Reduction
Figure 20.10	Image of SPSP
Figure 20.11	Main Construction Sequence of SPSP20-7
Figure 20.12	Field Welding of Stud at Connecting Part (photo)
Figure 20.13	
Figure 20.14	
Figure 20.15	Light Distribution Photo of LED Lamp
Figure 20.16	
Figure 20.17	Area for Low-position Lighting Installation (4th Panama Canal Bridge) 20-11
Figure 20.18	Locations of Low-position Lighting Installation (4th Panama Canal Bridge)20-11

LIST OF APPENDICES

Appendix-1	Traffic Survey Forms	
Appendix-1 Appendix-2	Topographic Survey (Cross Section)	
Appendix-2 Appendix-3		
Appendix-3 Appendix-4	Drawings (Line-3)	
Appendix-4	4-1 Plan and Profile	
Annondin 5	0	
Appendix-5	Drawings (4th Panama Canal Bridge)	
	5-1 Preliminary Design Drawings	
	5-1-1 Project Location Map	
	5-1-2 Road Drawings	
	5-1-3 Bridge Drawings	
	5-1-4 Electrical and Mechanical Facility Drawings	
	5-2 Concept Design Drawings	
	5-2-1 East Side Area	
	5-2-2 West Side Area	
Appendix 6	Location of Existing Utilities and Relocation Plan (4th Panama Canal Bridge)	
Appendix 7	Breakdown of Preliminary Construction	
	Cost (Preliminary Design Section) (4th Panama Canal Bridge)	
	7-1 Using Navigation Channel during Main Bridge Erection	
	7-2 Without Using Navigation Channel during Main Bridge Erection	
Appendix 8	Preliminary O&M Cost (Preliminary Design Section) (4th Panama Canal Bridge)	
	8-1 O&M Cost for Civil Works	
	8-2 O&M Cost for Electrical and Mechanical Facilities	
Appendix 9	Pre-F/S Review Report (Main Bridge, 4th Panama Canal Bridge)	
Appendix 10	Risk Analysis Report (Main Bridge, 4th Panama Canal Bridge)	
Appendix 11	Environmental and Social Considerations	
	11-1 Summary of Focus Group Discussion	
	11-2 Route Alternatives Analysis - Environmental and Social Considerations	
	11-3 System Alternatives Analysis - Environmental and Social Considerations	
	11-4 Terrestrial Flora Species Identified during the Baseline Surveys	
	11-5 Terrestrial Fauna Species Identified during the Baseline Surveys	
	11-6 Aquatic Species Identified during the Baseline Surveys	
	11-7 Estimated Cost of EMP for the Metro Line 3 Project	
	11-8 Estimated Cost of EMP for the Fourth Panama Canal Bridge Project	
	11-9 Monitoring Plans for Metro Line 3 Project and	
	the Fourth Panama Canal Bridge Projects	
	11-10 Draft of Monitoring format of EMP	
	11-11 Draft of Monitoring format of progress of activities related to RAP	
	11-12 JICA Check list of Environmental and Social Considerations	
	for Metro Line 3 Project and the Fourth Panama Canal Bridge Project	

Abbreviation	Official Term
AASHTO	American Association of State Highway and Transportation Officials
ABEI	Central American Bank for Economic Integration
ACP	Autoridad del Canal de Panama
AFC	Automatic Fare Collection
AGT	Automated Guideway Transit
AMP	Panama Maritime Authority
ANA	National Customs Authority
ANAM	Autoridad Nacional del Ambiente
ANAPYME	Authority of Macro, Small and Medium Enterprises
ANATI	Autoridad Nacional de Administración de Tierras
AP	Autopista
ARAP	Autoridad de Recursos Acuáticos de Panamá
ASCE	American Society of Civil Engineers
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiomete
ATO	Automatic Train Operation
ATP	Automatic Train Protection system
ATS	Automatic Traffic Supervision system
ATTT	Autridad del Transito y Transporte Terrestrede Panama
AVM B/D	Add Value Machine
BBA	Basic Design British Bankers Association
BOT	Build Operate Transfer
BP	Beginning Point
BRT	Bus Rapid Transit
BTN	Backbone Transmission Network
BTO	Build Transfer Operate
CAF	Corporation Andina de Fomento
CAP	Corrective Action Plan
CBTC	Communication Based Train Control
CCR	Central Control Room
CCTV	Closed Circuit Television
CDM	Clean Development Mechanism
CELADE	Latin America Demographic Center
CGP	Panamanian General
CO2	Carbon dioxide
COD	Chemical Oxygen Demand
CPS	Country Partnership Strategy
CTC	Centralized train control
D/D	Detailed Design
DC	Direct Current
DDR	Due Diligence Report
E&M	Electric and Mechanical
EED	Emergency Escape Door
EIA	Environment Impact Assessment
EIB	European Investment Bank
EIRR	Economic Internal Rate of Return
EL	Elevation Level

ABBREVIATIONS

EMP	Environmental Management Plan				
EN	Exchange of Notes				
ENA	Empresa Nacional de Autopistas				
EP	End Point				
ESAL	Equivalent Single Axle Load				
ESIA	Environmental and Social Impact Assessment				
ESMP	Environmental and Social Management Plan				
F/S	Feasibility Study				
FC	Foreign Currency				
FEM	Finite Element Method				
FHWA	Federal Highway Administration				
FIRR	Financial Internal Rate of Return				
FP	Fixed Screens				
GDP	Gross Domestic Product				
GIS	Geographic Information System				
GOP	The Government of Panama				
GPS	Global Positioning System				
HDI	Human Development Index				
HDM	Highway Design and Maintenance Standards Model				
IALA	International Association of Lighthouse Authorities				
IBRD	International Bank for Reconstruction and Development				
IC	Integrated Circuit				
ICB	International Competitive Bidding				
IDB	Inter-American Development Bank				
IDC	Interest During Construction				
IDDAN	Instituto de Acueductos y Alcantarillados Nacionales				
IEC	Integrated Electric Control				
IEE	Initial Environmental Examination				
IL	Interlocking System				
INEC	National Institute of Statistics and Census				
IP	Internet Protocol				
IR	Inductive Radio				
ITBMS	Impuesto a las Transferencias de Bienes Corporales Muebles y la Prestacion de Servicios				
IUCN	International Union for Conservation of Nature				
JICA	Japan International Cooperation Agency				
JIS	Japanese Industrial Standards				
LC	Local Currency				
LCC	Life Cycle Cost				
LCD	Liquid Crystal Display				
LCX	Leakage Coaxial Cable				
LF	Low Frequency				
	London InterBank Offered Rate				
LIBOR	London InterBark Onered Rate				

LRTLight Rail TransitMaglevMagnetic levitationMEFMinistry of Economy and FinanceMETIMinistry of Economy, Trade and IndustryMIDESMinistry of Social DevelopmentMIGAMultilateral Investment Guarantee AgencyMITRADELMinistry of Works and Labor DevelopmentMLWSMean Low Water SpringMOPMinistry of Public WorksMRTMass Rapid TransitMSDManual Secondary DoorNPVNet Present ValueO&MOperation & MaintenanceOCCOperation & MaintenanceOCCOperation Control CenterODOrigin and DestinationOSHAOccupational Safety & Health AdministrationP/QPre QualificationPAPanamericanaPASPublic Addressing SystemPCPre-stressed ConcretePCDPPublic Consultation and Disclosure PlanPCRCPanama Canal Railway CompanyPGAPeak Ground AccelerationPHPDTPeak Hour Peak Direction TrafficPIDSInformation Display System	
MEFMinistry of Economy and FinanceMETIMinistry of Economy, Trade and IndustryMIDESMinistry of Social DevelopmentMIGAMultilateral Investment Guarantee AgencyMITRADELMinistry of Works and Labor DevelopmentMLWSMean Low Water SpringMOPMinistry of Public WorksMRTMass Rapid TransitMSDManual Secondary DoorNPVNet Present ValueO&MOperation & MaintenanceOCCOperation Control CenterODOrigin and DestinationOSHAOccupational Safety & Health AdministrationP/QPre QualificationPAPanamericanaPASPublic Addressing SystemPCPre-stressed ConcretePCDPPublic Consultation and Disclosure PlanPCRCPanama Canal Railway CompanyPGAPeak Ground AccelerationPHPDTPeak Hour Peak Direction Traffic	
METIMinistry of Economy, Trade and IndustryMIDESMinistry of Social DevelopmentMIGAMultilateral Investment Guarantee AgencyMITRADELMinistry of Works and Labor DevelopmentMLWSMean Low Water SpringMOPMinistry of Public WorksMRTMass Rapid TransitMSDManual Secondary DoorNPVNet Present ValueO&MOperation & MaintenanceOCCOperation Control CenterODOrigin and DestinationOSHAOccupational Safety & Health AdministrationP/QPre QualificationPAPanamericanaPASPublic Addressing SystemPCPre-stressed ConcretePCDPPublic Consultation and Disclosure PlanPCRCPanama Canal Railway CompanyPGAPeak Ground AccelerationPHPDTPeak Hour Peak Direction Traffic	
MIDESMinistry of Social DevelopmentMIGAMultilateral Investment Guarantee AgencyMITRADELMinistry of Works and Labor DevelopmentMLWSMean Low Water SpringMOPMinistry of Public WorksMRTMass Rapid TransitMSDManual Secondary DoorNPVNet Present ValueO&MOperation & MaintenanceOCCOperation Control CenterODOrigin and DestinationOSHAOccupational Safety & Health AdministrationP/QPre QualificationPAPanamericanaPASPublic Addressing SystemPCPre-stressed ConcretePCDPPublic Consultation and Disclosure PlanPCRCPanama Canal Railway CompanyPGAPeak Ground AccelerationPHPDTPeak Hour Peak Direction Traffic	
MIGAMultilateral Investment Guarantee AgencyMITRADELMinistry of Works and Labor DevelopmentMLWSMean Low Water SpringMOPMinistry of Public WorksMRTMass Rapid TransitMSDManual Secondary DoorNPVNet Present ValueO&MOperation & MaintenanceOCCOperation Control CenterODOrigin and DestinationOSHAOccupational Safety & Health AdministrationP/QPre QualificationPAPanamericanaPASPublic Addressing SystemPCPre-stressed ConcretePCDPPublic Consultation and Disclosure PlanPCRCPanama Canal Railway CompanyPGAPeak Ground AccelerationPHPDTPeak Hour Peak Direction Traffic	
MITRADELMinistry of Works and Labor DevelopmentMLWSMean Low Water SpringMOPMinistry of Public WorksMRTMass Rapid TransitMSDManual Secondary DoorNPVNet Present ValueO&MOperation & MaintenanceOCCOperation Control CenterODOrigin and DestinationOSHAOccupational Safety & Health AdministrationP/QPre QualificationPAPanamericanaPASPublic Addressing SystemPCPre-stressed ConcretePCDPPublic Consultation and Disclosure PlanPCRCPanama Canal Railway CompanyPGAPeak Ground AccelerationPHPDTPeak Hour Peak Direction Traffic	
MLWSMean Low Water SpringMOPMinistry of Public WorksMRTMass Rapid TransitMSDManual Secondary DoorNPVNet Present ValueO&MOperation & MaintenanceOCCOperation Control CenterODOrigin and DestinationOSHAOccupational Safety & Health AdministrationP/QPre QualificationPAPanamericanaPASPublic Addressing SystemPCPre-stressed ConcretePCDPPublic Consultation and Disclosure PlanPCRCPanama Canal Railway CompanyPGAPeak Ground AccelerationPHPDTPeak Hour Peak Direction Traffic	
MOPMinistry of Public WorksMRTMass Rapid TransitMSDManual Secondary DoorNPVNet Present ValueO&MOperation & MaintenanceOCCOperation Control CenterODOrigin and DestinationOSHAOccupational Safety & Health AdministrationP/QPre QualificationPAPanamericanaPASPublic Addressing SystemPCPre-stressed ConcretePCDPPublic Consultation and Disclosure PlanPCRCPanama Canal Railway CompanyPGAPeak Ground AccelerationPHPDTPeak Hour Peak Direction Traffic	
MRTMass Rapid TransitMSDManual Secondary DoorNPVNet Present ValueO&MOperation & MaintenanceOCCOperation Control CenterODOrigin and DestinationOSHAOccupational Safety & Health AdministrationP/QPre QualificationPAPanamericanaPASPublic Addressing SystemPCPre-stressed ConcretePCDPPublic Consultation and Disclosure PlanPCRCPanama Canal Railway CompanyPGAPeak Ground AccelerationPHPDTPeak Hour Peak Direction Traffic	
MSDManual Secondary DoorNPVNet Present ValueO&MOperation & MaintenanceOCCOperation Control CenterODOrigin and DestinationOSHAOccupational Safety & Health AdministrationP/QPre QualificationPAPanamericanaPASPublic Addressing SystemPCPre-stressed ConcretePCDPPublic Consultation and Disclosure PlanPCRCPanama Canal Railway CompanyPGAPeak Ground AccelerationPHPDTPeak Hour Peak Direction Traffic	
NPVNet Present ValueO&MOperation & MaintenanceOCCOperation Control CenterODOrigin and DestinationOSHAOccupational Safety & Health AdministrationP/QPre QualificationPAPanamericanaPASPublic Addressing SystemPCPre-stressed ConcretePCDPPublic Consultation and Disclosure PlanPCRCPanama Canal Railway CompanyPGAPeak Ground AccelerationPHPDTPeak Hour Peak Direction Traffic	
O&MOperation & MaintenanceOCCOperation Control CenterODOrigin and DestinationOSHAOccupational Safety & Health AdministrationP/QPre QualificationPAPanamericanaPASPublic Addressing SystemPCPre-stressed ConcretePCDPPublic Consultation and Disclosure PlanPCRCPanama Canal Railway CompanyPGAPeak Ground AccelerationPHPDTPeak Hour Peak Direction Traffic	
OCCOperation Control CenterODOrigin and DestinationOSHAOccupational Safety & Health AdministrationP/QPre QualificationPAPanamericanaPASPublic Addressing SystemPCPre-stressed ConcretePCDPPublic Consultation and Disclosure PlanPCRCPanama Canal Railway CompanyPGAPeak Ground AccelerationPHPDTPeak Hour Peak Direction Traffic	
ODOrigin and DestinationOSHAOccupational Safety & Health AdministrationP/QPre QualificationPAPanamericanaPASPublic Addressing SystemPCPre-stressed ConcretePCDPPublic Consultation and Disclosure PlanPCRCPanama Canal Railway CompanyPGAPeak Ground AccelerationPHPDTPeak Hour Peak Direction Traffic	
OSHAOccupational Safety & Health AdministrationP/QPre QualificationPAPanamericanaPASPublic Addressing SystemPCPre-stressed ConcretePCDPPublic Consultation and Disclosure PlanPCRCPanama Canal Railway CompanyPGAPeak Ground AccelerationPHPDTPeak Hour Peak Direction Traffic	
P/QPre QualificationPAPanamericanaPASPublic Addressing SystemPCPre-stressed ConcretePCDPPublic Consultation and Disclosure PlanPCRCPanama Canal Railway CompanyPGAPeak Ground AccelerationPHPDTPeak Hour Peak Direction Traffic	
P/QPre QualificationPAPanamericanaPASPublic Addressing SystemPCPre-stressed ConcretePCDPPublic Consultation and Disclosure PlanPCRCPanama Canal Railway CompanyPGAPeak Ground AccelerationPHPDTPeak Hour Peak Direction Traffic	
PASPublic Addressing SystemPCPre-stressed ConcretePCDPPublic Consultation and Disclosure PlanPCRCPanama Canal Railway CompanyPGAPeak Ground AccelerationPHPDTPeak Hour Peak Direction Traffic	
PCPre-stressed ConcretePCDPPublic Consultation and Disclosure PlanPCRCPanama Canal Railway CompanyPGAPeak Ground AccelerationPHPDTPeak Hour Peak Direction Traffic	
PCDPPublic Consultation and Disclosure PlanPCRCPanama Canal Railway CompanyPGAPeak Ground AccelerationPHPDTPeak Hour Peak Direction Traffic	
PCRCPanama Canal Railway CompanyPGAPeak Ground AccelerationPHPDTPeak Hour Peak Direction Traffic	
PGAPeak Ground AccelerationPHPDTPeak Hour Peak Direction Traffic	
PHPDT Peak Hour Peak Direction Traffic	
PIDS Information Display System	
PIS Passenger Information System	
PPIAF Public-Private Initiative Advisory Facility	
PPP Public Private Partnership	
Pre-F/S Pre-Feasibility Study	
PSC Public Sector Comparator	
PSD Platform Screen Door	
PTS Pentax Total Station	
PVC Polyvinyl Chloride	
PWS Parallel Wire Strand	
RAMS Reliability, Availability, Maintainability and Safety	
RAP Resettlement Action Plan	
RC Reinforced Concrete	
REP Reglamento de la Construccion Panama	
RoW Right of Way	
RQD Rock Quality Designation	
RSS Receiving SubStations	
S&C Signaling and Telecommunication equipment	
SBHS Steel for Bridge High Performance Structures	

SCADA	Supervisory Control and Data Acquisition system			
SCR	Station Control Room			
SDH	Synchronous Digital Hierarchy			
SFRL	Social and Fiscal Responsibility Law			
SIV	Static Inverter			
SMP	Secretaria del Metro de Panama			
SP	Stated Preference			
SPF	Shadow Pricing Factor			
SPT	Standard Penetration Test			
SR	Space Wave Radio			
SRAP	Strategic Resettlement Action Plan			
STM	Synchronous Transport Module			
TD	Train Detection System			
ТОМ	Ticket Office Machine			
ToR	Terms of Reference			
TSS	Transmission SubStation			
TTC	Travel Time Cost			
TVM	Ticket Vending Machine			
UABR	Administrative Unit of Reverted Properties			
UAS	Environmental Sectrial Unit			
UHF	Ultra High Frequency			
UTM	Universal Transverse Mercator			
UTO	Un-attendant train Operation			
VCR	Vertical Curve Radius			
VFM	Value For Money			
VHF	Very High Frequency			
VOC	Vehicle Operating Cost			
VOT	Value of Time			
VVVF	Variable Voltage Valuable Frequency			
WACC	Weighted Average Cost of Capital			
WGS84	World Geodetic System 84 (1984)			

Chapter 1 Outline of the Project

1.1 Background of the Project

Traffic congestion in Panama City, the capital of the Republic of Panama, and surrounding areas has become worse year by year due to the rapid increase in the number of cars following high economic growth of the country. To alleviate this problem, in 2009, the Government of Panama established the "Secretaria del Metro de Panama" (SMP) under the Presidential Office, and SMP has drawn up a metro network plan consisting of four metro lines. Line-1, Line-2 and Line-4 are planned within Panama City, while Line-3 is planned for the west side of the Panama Canal, to connect Panama City and the suburban areas such as Araijan and La Chorrera.

The population of the districts of Arraijan and La Chorrera has been growing rapidly in recent years, and the congestion of the road connecting Panama City with these districts has become a serious problem. In order to solve this problem, the Government of Panama (GOP) is planning to construct Line-3 concurrently with Line-2.

Under such situation, the Ministry of Economy, Trade and Industry (METI) of Japan carried out a study for the Line-3 Project. The METI study proposed a monorail system for Line-3, which would follow the Pan-American and "Autopista" Highways and cover the demand on the west side of the Panama Canal.

The GOP plans to construct a bridge across the canal in parallel with the Bridge of Americas. The Panama Canal Authority (ACP) has been conducting the Pre-F/S for the 4th Panama Canal Bridge since 2012. The GOP plans to provide track space on the 4th Panama Canal Bridge for Line-3.

In March 2013, the Japan International Cooperation Agency (JICA) and the GOP agreed to conduct a feasibility study for the Line-3 Project, and the study started in July 2013. The study on the section of the 4th Panama Canal Bridge was not included in the study scope in the beginning because the 4th Panama Canal Bridge had been studied by ACP as mentioned above. Meanwhile, GOP expressed its interest to fund the 4th Panama Canal Bridge Construction Project - with a Japanese Yen Loan. Therefore, GOP and Government of Japan (GOP) held a meeting on July 12, 2013 and agreed that GOJ will conduct its study. As a result, the Study for the 4th Panama Canal Bridge Construction Project was commenced under JICA's technical assistance from September, 2013.

1.2 Project Scope

JICA and GOP agreed on the scope of the "Panama City Urban Transportation Line-3 Project" (hereinafter referred to as the "Project"). The Project will introduce an urban transit system connecting Nuevo Arraijan and Albrook via the planned 4th Panama Canal Bridge, and consists of the following components;

- Civil Works (including Stations, Track works, a Depot, Workshops, and Intermodal Facilities)
- E&M (Power Supply, Signal & Telecommunication, Operation Control, etc.)
- Rolling Stock
- Consulting Services

1.3 Study Purpose

1.3.1 Urban Transportation Line-3

The purpose of this study is as follows:

- Confirmation of the necessity/validity of the Panama City Urban Transportation Line-3 Project;
- Undertaking of a feasibility study including a preliminary design and cost estimate for the Project; and
- Selection of the most suitable urban transit system that would reinforce the connectivity of the East-West axis of the Panama Metropolitan Area.

1.3.2 4th Panama Canal Bridge

Pre-F/S was conducted by ACP based on the cable-stayed bridge option; however, the comparative study on the selection of the main bridge type was not conducted.

Main purposes in this Study are as follows:

- Review Pre-F/S on the Project
- Conduct alternative study on the main bridge type of 4th Panama Canal Bridge
- Conduct preliminary design of the selected main bridge type and approach sections
- Determine Project scope
- Estimate Project cost
- Compare the main bridge type of 4th Panama Canal Bridge
- between the option proposed by the Pre-F/S and the option proposed by this Study
- Prepare reports and documents on project evaluation

1.4 Study Scope

Study scope is in accordance with the following minutes of meeting between GOP and GOJ:

- Minutes of Meeting on the 4th Panama Canal Bridge Study (September 3, 2013)
- Minutes of Meeting on the 4th Panama Canal Bridge Study (December 6, 2013)

Summary of study scope in the above minutes of meeting is as follows:

- Confirmation of the project background and necessity
- Demand forecast
- Review of existing studies and the implementation of additional studies
- Proposal of the project framework
- Consideration of environmental and social impacts
- Assessment of the project's effectiveness
- Recommendation for the project implementation and operation phase (risks and issues), including the identification of matters which may require further development

1.5 Survey Area

The survey area is shown in

Figure 1.1. The survey area for the demand forecast covers the metropolitan area of Panama City including La Chorrera, Arraijan, Panama, and San Miguelito districts, while the survey area for the route study covers the corridor between Albrook and Arraijan.



Figure 1.1 Survey area for route study

1.6 Work Schedule

The study was commenced at the end of July 2013; the Inception Report and Interim Report were submitted in July 2013 and November 2013, respectively. The study on the 4th Bridge was added to the original scope in August 2013, and the amendment of the contract between the JICA Study Team and JICA was signed on February and April 2014 for Environmental Impact Assessment and other tasks. The work was completed in August 2014.

		1					2013						1							2	014							
		7		8		9		10	1	1		12		1		2		3		4	T	5	1	6		7	1	8
	cessity and Issues of the Project																											П
	rnational Organization and Public Sector																											
	uitable Urban Transport System												\square	\square				\square		\square			++	\square		\square	\square	++-
[T4]	[T4-1] Review of route recommended in the METI Study											Ш																Ш
Alignment Plan	[T4-2] Review of Modal Split Model							++	_			⊢		\square		++		┼┼	-	\vdash	╉┼┼	++		++		\vdash	┢┼┤	┼┼
	[T4-3] Update of Previous Demand Forecast	+++										Щ.		\square		Ц_		Ц.			\downarrow	1		\square			\square	Щ.
	[T4-4] Selection of the Route Alignment	+++						++-			\vdash	╟╟		╟┼		++	\vdash	┼┼		\vdash	╂┼	╈	++-	┼┼		\vdash		┼┼
	[T4-5] Utility Survey along the Planned Route	+++										11-		\square				\square		\square	\downarrow	\parallel		\square		\square	\square	++
	[T4-6] Land Acquisition Plan			++										++		++		++		++	++	++	++	++		\square	++	++-
[T5]	[T5-1] Rolling Stock Design and Specifications	+++	++-	\square							\vdash	_		\square			\vdash	_		\vdash		╨		_		\square	\vdash	╨
Project Plan	[T5-2] Train Operation Plan [T5-3] Civil Engineering Plans	+++	┼╋	++								\vdash		++		++	\vdash	++		\vdash	++	++	++	++		\vdash	╂┼╴	++-
	[T5-4] Depot and Workshop Plan	+++	┼╋	++	ΗE	ļ		ij			\vdash	┢┼┝		++	+	++-	\vdash	++		\vdash	╈	++		++	++	\vdash	╉┼┤	++-
	[T5-5] Electrical & Mechanical Facilities Plan											Ħ		\square				Ħ			\square	$^{++}$		Ħ		IT	\square	Ħ
	[T5-6] Signaling and Telecommunication Facilities											Ħ									+			Ħ		H	Ħ	Ħ
	[T5-7] Station Area Development (Draft)		++	++								\square		\vdash				\square		\vdash	┼┼	++		++		\vdash	++	┼┼
	[T5-8] Intermodal Facility Plan for Smooth Transfer of Passengers											П		Π			Π	Π				П		Π			Π	T
[T6]	[T6-1] Preliminary Construction Plan																											\pm
Project	[T6-2] Traffic and Safety Management Plan during Construction																			IT	Π	Π				IT		IT
Implementation	[T6-3] Material and Equipment Procurement Plan																	Ħ										
Plan	[T6-5] Project Implementation Schedule																											
	[T6-6] Study of Consulting Services [T6-7] Project Cost Estimate		++	++			_				\vdash	\square	\square	\square		\square	\vdash	++		\vdash	++	++	++	++		\vdash		++-
											\vdash	++		++			\vdash	++		\vdash	╈			++		$\left \right $	++	++
[77]	[T7-1] Study of Project Executing Organization				-			++						\square				_		\vdash		┼┼				\square	\vdash	╨
Project	[T7-2] Financial/Budgetary Structure of Executing Organization											Ш						Ш.			\square	Ш.		\square				Ш
Executing	[T7-3] Operation and Maintenance Organization	+++										Ш				Ц_		Ш.			\square	Ш.		\square			\square	Ш
Organization	[T7-4] Financial/Budgetary Structure of Operator																											
	[T7-5] Technical Assistance																											
	[T7-6] Application of PPP Scheme	+++	++													⊢	\square	\square		\square		++-	\square	++		\square	\vdash	╨
[T8]	[T7-7] Procurement Package Plan			++										$\left \right $		\square		\square			\square	++	++	++			\square	++
	[T8-1] Environmental Categorization of the Project			++														++						++		\vdash	++	++
Environmental and	[T8-2] Preparation of Draft EIA Report	+++							_													++-	T.	\square		\square	\square	╨
Social considerations	[T8-3] Preparation of Resettlement Action Plan	+++		Ш.											_								T.	\square			\square	Щ.
	[T8-4] Survey on Project Affected Persons																						H.					
	im Report and Discussion	+++												\square				11		\square	\square	++	\square	\square			\square	++
[T10] Climate Change	[T10-1] Required Data Identification and Collection	$\downarrow\downarrow\downarrow\downarrow$	\square	\square				\square		_		Ш	\square	\square		Щ	\square	\square			\square	\square	\square	\square		\square	\square	\square
Mitigation Effects	[T10-2] Estimation for Reduction of Greenhouse Gas Emission																											
[T11]	[T11-1] Estimation of Operation and Effect Indicators												-															П
Estimation of	[T11-2] Evaluation of Qualitative Effect											П						П				П		П			П	П
Project Effect	[T11-3] Calculation of EIRR and FIRR	+++	++	++		\square	+	++	\square	\square	\vdash	_				\square	\vdash	\square	\square	\vdash	++	++	++	++	\square	\vdash	\vdash	
IT121 Recommendation	[T11-4] Preparation of Promotion Video s and Suggestions for the Project Implementation	+++					+		++	+	\vdash	+					\vdash	++	++	+	+					+	++	++
[T12] Recommendations [T13] Study for Cost Re		+++					++		\square		\vdash				\vdash		\vdash	\square	+		+						H	++
[T14] Study Tour in Japa	an												Ш								Ħ							
Subcontract Works	Topographic survey																											
	Transportation survey	++1										\square	\square	\square	\square	\square	\square	\square	\square	\square	ЦĹ	11	\square	\square		Ц	ЦĹ	++
	Geological survey	+++	++	++					-							\square						\square		++	\square	\vdash	\vdash	++
Reports	EIA,Socioeconomic survey on RAP Reports for Line-3 Project		+	+				+		\square	\vdash	\square	T											++	\square	\vdash	\mathbb{H}	++
	Reports for 4th Bridge Project	ICR	┼┼	++		++	+	++	ITR		\vdash	⊢⊢		\square	\vdash		\vdash	++		\vdash	╀┼	++	+	++	\vdash	\vdash	╟	╈
	Common Reports	+++	┼┼	++	ICF	+	+	++	$\left \right $		\vdash	⊢⊢		\square	\vdash	ITR	\vdash	++		\vdash	╀┼	▲ FR	+	++	\square	\vdash	╟	┼┢
	Common reports	+++	1		\mathbb{H}				+	\square	\vdash	+	\square	+		+	\vdash	+			×	_	++	+	\square	\mathbb{H}	++	FF
Key Discussion		Ro	oute se	election		Sys	tem sek	ection											Bridge	е Туре	e Sele	ection						

Source: JICA Study Team

Figure 1.2 Work Schedule

1.7 Stakeholder Meeting

A stakeholder meeting for the Project was held by SMP and the JICA Study Team on August 6, 2013 at Hotel Holiday Inn, Panama City. The team leader of the JICA Study Team made a presentation on the project, focusing on the necessity of the project, route alternatives, system alternatives, and the necessary studies for environmental considerations. After the presentation, eight participants expressed their opinion and questions as follows:

1) The project would have social impacts from the resettlements around the project area.

- 2) The present public transportation system and its connection with the project's system should be considered.
- 3) Information on the location of Panama Pacifico is necessary.
- 4) The Line-3 should provide a safe transportation system for making a modal shift from car to public transportation.
- 5) Arraijan and La Chorrera municipalities should take advantage of the project for their urban development plans.
- 6) Passenger volume should be considered in the planning of the Albrook Station where Line-1 and Line-3 connect.
- 7) There is no space to accommodate a mass transit system on the streets in the center of La Chorrera.
- 8) Information on the alignment is necessary because there is a possibility that it may affect the concessions of the Administrative Unit of Reverted Properties (UABR).
- 9) Although the future population in the western area such as Arraijan and La Chorrera will be very large, the project will contribute to proper urban development.
- 10) The municipalities along the project route should update their regulatory plan for urban development to incorporate the project.
- 11) Information on the project, especially the resettlement plan, should be given to relevant municipalities.
- 12) The experience of Line-1 regarding traffic management can be used for traffic management of Line-3, which is one of the important areas of the project.

1.8 Study Tour in Japan

Study tour has taken place in Japan from 21 to 30 September 2013 to be understood Japanese technology regarding Line-3 and 4th Panama Canal Bridge project. The tour invited four and two staffs belong to SMP and ACP, six participants in total as shown in Table 1.1 and Table 1.2. The tour introduced urban transportation system such as monorail, railway, AGT and liner metro in Japan. In addition to the system, the tour included visiting schedule about 4th Panama Canal Bridge such as girder assembling factory and Rainbow Bridge, which has road and AGT system and so on.

No	Name	Organization	Position		
1	1 Mr. Agustin Arias		Chief technical advisor		
2	Mr. Ciro Limone	SMP	Technical advisor (Railway technology)		
3	3 Ms. Ana Laura Morais		Technical advisor (Transport/ Urban planning)		
4	4 Mr. Alvaro Uribe		Technical advisor (Urban planning)		
5 Mr. Máximo Molina		ACP	Supervisor structural engineering unit of ACP		
6	Ms. Gloribel Céspedes	ACP	Structural engineer of ACP		

Table 1.1Attendance List of Study Tour in Japan.

Source: JICA Study Team

onth	Date	Day	Day:	Time	Contents Travel day AM7920/ AM058	Contacting agency	Place for the invitation	Purpose
Sep	21	Sat	1	Dept. Panama	11:36 Panama - 15:26 M exico			
	22	Sun	2	Via M exco	23:15 M exico - (6:45(+2)NRT) Travel day			Traveling from Panama t Japan
	23	Mon	3	6:45	Arrival at NRT	JICA Study Team		
				7:30-8:30	Move from NRT to Hotel			
	24	Tue	4	8:45-9:00	Move from Hotel to JICA HQ by Bus	JICA Study Team	Kasumigaseki, Tokyo	
				9:00-9:30	a	ЛСА		
				9:00-9:50	Courtesy visit to JICA HQ	ЛСА	Kasumigaseki, Tokyo	
				10:00-10:30	Courtesy visit to Ministry of Foreign	MFA	MFA HQ Kasumigaseki 2-2-1,	
				10.00-10.50	Affairs(MFA)	MIA	Chiyoda-ku, Tokyo Tel.+81-3-3580-3311	
							161-81-5-5580-5511	
							MLITT HQ 6F Room of the	
				11:00-11:30	Courtesy visit to Ministry of Land,	MLITT	Executive technical advisor on the city bureau	
				11:00-11:50	Infrastructure, Transport and Tourism (MLITT)	MLITT	Tel.+81-3-5253-8111 2-1-3 Kasumigaseki,	
							Chiyoda-ku, Tokyo	
				11:30-13:15	Lunch		Around Hibiya park	
							METI HQ	
				13:15-13:45	Courtesy visit to Ministry of Economy,	METI	Kasumigaseki 1-3-1,	
					Trade and Industry (METI)		Chiyoda-ku, Tokyo +81-3-3501-1511	
				13:45-15:15	Move from METI HQ to Tachikawa-kita Sta. by bus	JICA Study Team		
					Experience of Tama monorail ride from			Conform a case of monoral hills and understand the
				15:15-15:45	Tachikawa-kita sta. to Tama center sta.	JICA Study Team		milis and understand the monorail.
				15:45-17:15	Move by bus from Tama center sta. to the	1		
				18:00	Hotel Welcome Party	JICA Study Team	Kojimachi, Tokyo	
	25	Wed	5	9:30-9:40	Move from the Hotel to Iidabashi sta. by bus	JICA Study Team		
					bus			Experiencing Linear metro
				9:40-10:20	Experience of Toei Oedo line from Iidabashi			conform actual conformabi and operation system.
					sta. to Shiodome sta. via Tochomae sta.			
								Experiencing AGT and
				10:20-10:40	Experience of New-Transit Urikamome from Shiodome sta. to Diba sta.	1		conform actual conformabi and operation system.
								Understand the structure o
				10:40-11:30			D 1 7 1	the bridge which have a roa
				10:40-11:50	Observation of the Rainbow bridge		Daiba, Tokyo	and AGT system both by watching from a distance.
				11:30-12:30	Lunch		Daiba, Tokyo	
				12:30-13:30	Move from Daiba to Hamamatsucho			
								Experiencing an urban monorail and understand
				13:30-16:30	Experience of Tokyo monorail ride, the depot and OCC	Tokyo Monorail Co., Ltd.	Hamamatsucho depot	actual train operation, conformability, headways,
								turnout and etc.
				16:30-17:00	Move from Hamamatsu depot fo JICA HQ			
				17:00-17:30	Meeting	ЛСА	JICA HQ	
	26	Thu	6	8:30-9:30	Move from the hotel to Haneda airport by		Tokyo	
	20	Thu	0		hotel limousine bus Flight from Haneda to Itami airport by		-	
				10:30-11:35	JAL113		Haneda airp ort	
					Meet Mr. Hino, MD of Japan Monorail			
				11:35-13:30	Association and take Lunch and move from the airport to Osaka airport sta. on foot		Itami airport	
		-			Station facility introduction and Observation			Understand station facility
				13:30-13:43	Station facility introduction and Observation of the monorail turnout	1	Osaka airport sta.	functions and turnout
				12.42.1	Experience of Osaka monorail ride from			Experiencing monorail train ride and understand and
				13:43-14:19	Osaka airport sta. to Kadomashi sta. and turnout on the sta.			understand actual train operation, conformability,
					Experience of Osaka monorail ride from	Osaka Manerril Cr. 7 . 1		headways and also visit
				14:23-14:50	Kadomashi sta. to Bamoaku-kinen koen sta.	Osaka Monorail Co., Ltd.		Yodogawa bridge having Nielsen-Lohse structure w
		-		14:50-15:20	and move to the depot on foot	ł	Poper-local -	632m long.
				14:30-15:20	Visit the depot, OCC and the Q&A	ł	Bampaku depot	Understand the deport
				15:20-16:00	Company overviews and history introduction and visit the workshop		Workshop	operation and O&M.
				16:00-16:30	Move from the workshop to the hotel in Osaka			
			-	7.00	Move from the hotel to the girder factory of			
	27	Fri	7	7:00-8:00	IHI Infrastructure systems Co., Ltd.			
					The company and factory introduction,	IHI infrastructure system Co., Ltd.		Visit SBHS girder producti line and understand of the
				8:00-9:15	presentation of the Sumidagawa bridge, etc.	3-banchi, Ohama-		steel bridge materials to ap
				9:30-10:45	Factory visit	nishimachi, Sakai-ku, Sakai city, Osaka		for 4th bridge
				11:00-11:50	Lunch and Q&A	Tel.+81-72-223-0981	Sakai, Osaka	
				11:50-12:30	Move from the factory to Shin-kidugawa bridge			
								Visit shin-kidugawa half- through arch bridge having
				12:30-13:00	Observation of the Shin-kidugawa bridge			495m long span, to apply
				13:00-13:45	Move from the bridge to Shin-Osaka sta.			4th bridge
				14:27-17:03	Traveling from Shin-Osaka sta. to Tokyo			
				17:30-18:00	sta. by bullet train(Nozomi-364) Move from Tokyo sta. to the hotel by taxi			
	28	Sat	8		Experiencing transport in Tokyo			
	29	Sun	9		Visit property development sites Travel day AM057/AM7921			

Table 1.2Study Tour Schedule

Source: JICA Study Team



Source: JICA Study Team

Figure 1.3 Shots of Courtesy Visit



Source: JICA Study TeamFigure 1.4Shots of OCC(Left) and Garter Assembling Factory(Right) Visit

Chapter 2 Necessity of the Project

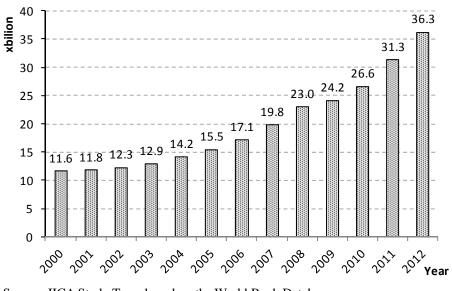
2.1 Current Situation and Issues of Urban Transportation Sector

2.1.1 Socioeconomic Situation and Urban Development

(1) Socioeconomic Situation

The Republic of Panama is the southernmost country of Central America connecting North and South America. It is bordered by Costa Rica to the west, Colombia to the southeast, the Caribbean Sea to the north and the Pacific Ocean to the south. The capital is Panama City. The country boasts the world-renown Panama Canal connecting the Pacific Ocean and Atlantic Ocean. Tolls paid by ships passing through the Panama Canal totaled USD 2.4 billion, with a total traffic of 320.6 million tons, in the fiscal year 2013¹ (October 1, 2012 - September 30, 2013)

The country is categorized as an upper-middle income country with a GDP of USD36.25 billion and a 10.8% annual growth rate. As shown in Figure 2.1, Panama's economy has grown rapidly in recent years. The nominal GDP per capita of Panama is USD 9,850 surpassing that of Costa Rica, at USD 8,740 in 2012 (2012, The World Bank).



Source: JICA Study Team based on the World Bank Database Figure 2.1 Annual GDP (current USD) of Panama

Panama's total population is 3.4 million with 1.7 million in the metropolitan area (Panama City, San Miguelito, Arraijan and La Chorrera Districts). 51% of the total population is in the Panama City metropolitan area as shown in Table 2.1. The population growth rate is 1.84% per year for the last 10 years (National Census, 2010). The population increase and concentration in the metro area have multiplied the number of cars resulting in serious traffic congestion.

¹ ACP Annual Report 2013

A		
Area	Population in 2010	Ratio
Panama Metropolitan Area	1,723,284	51%
Arraijan District	230,311	13%)
La Chorrera District	167,799	10%)
Panama District	989,100	57%)
San Miguelito District	336,074	20%)
Other Districts	1,682,529	49%
Panama Total	3,405,813	100%

Table 2.1Population breakdown of Pa	Panama
-------------------------------------	--------

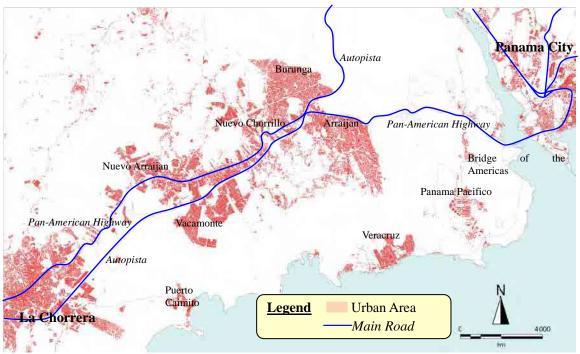
Source: JICA Study Team

The main industry in the west area is agriculture. But the main source of employment for the inhabitants of these districts is Panama City highlighting the need for efficient public transportation.

(2) Urban Development

Two roads run east and west in the study area. These are the old Pan-American Highway and the newly constructed "Autopista" Highway. The Pan-American Highway is an old main corridor which runs from the western border of Panama and Costa Rica to Yaviza at the eastern border of the country over the Bridge of the Americas crossing the Panama Canal. On the other hand, the "Autopista" connects La Chorrera with Panama City and Colon, located at the north of the country touching the Caribbean Sea.

La Chorrera and Arraijan districts have been urbanized mainly along the Pan-American Highway. Furthermore, the area along the "Autopista" was urbanized in recent years as shown in Figure 2.2. This figure also shows that urbanizations in several areas have spread vertically from the main corridors, such as in Burunga, Arraijan and Vacamonte.



Source: JICA Study Team

Figure 2.2 Map of Urbanized Areas and Main Roads

Panama Pacifico, located to the southwest of the Panama Canal, has planned an urban development project for the future. Howard airport is located in the area, but only a few chartered aircrafts use the airport. The area will have 20,000 houses and 40,000 employees according to the master plan.

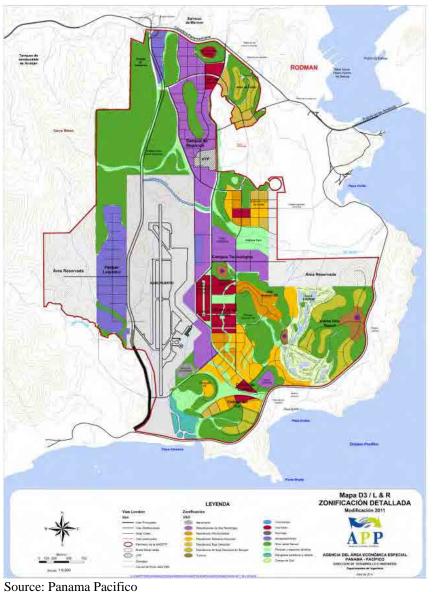


Figure 2.3 Master Plan of Panama Pacifico

2.1.2 Transportation Network

(1) Bridge of Americas

The Bridge of Americas is a 4-lane road bridge (2-lanes in each direction) opened in 1962, which is located on the Pacific side of the Panama Canal, connecting the center of Panama City and the western area such as Arraijan and La Chorrera by the Pan-American Highway and the Autopista. The total length of the bridge is 1,654m with the longest span having 344m, with a clearance under the main span of 61.3m. The daily traffic flow is approximately 50,000 vehicles and the congestion in the morning and evening peak hours is very heavy. Besides the Bridge of Americas, the Centennial Bridge crosses the Panama Canal, however its function as an alternative route is limited because it is located 15km north

of the Bridge of Americas and accesses Panama City approximately 10km east of the Bridge of Americas.

There were one-way operations and night time closures of the bridge due to rehabilitation works, and such rehabilitation work will continue to take place consecutively in the future.

(2) Centenario Bridge

The Centenario Bridge is a 6-lane road bridge (3-lanes in each direction) crossing the Panama Canal, which opened in 2004. It is a cable-stayed bridge with a total length of 1,052m, the longest span having 420m, with a clearance of 80m. As a part of the Autopista, the bridge connects the Pan-American Highway near Burunga in Arraijan on the west side with the center of Panama City after crossing Corredor Norte on the east side. The daily traffic of the Centenario Bridge is approximately 30,000 vehicles, most of which are private cars, and the number of buses is very small.

(3) Express Roads

There are two toll roads in Panama, namely, Corredor Norte and Corredor Sur. The former starts at Albrook connecting the northeast area of Panama City on the mountain side of the city, while the latter is a seaside expressway connecting Balboa Avenue along the seaside and the international airport. In the plan for the 4th Bridge, the bridge will connect to the Corredor Norte on the east side. In Arraijan and La Chorrera, the Autopista - an expressway but not a toll road - runs east and west accessing Panama City across the Centenario Bridge.

(4) **Pan-American Highway**

The Pan-American Highway is a 4-lane road passing through the urban areas of Arraijan and La Chorrera to the west of the canal, connecting to the Bridge of Americas. The 4th Bridge is also planned to connect to the Pan-American Highway. The section between the Bridge of Americas and Loma Coba near Arraijan is a hilly non-urban area, and the traffic on this section is very heavy in the morning and evening peak hours. According to the Ministry of Public Works, this section between the Bridge of Americas and Arraijan will be widened from 4-lane to 6-lane together with the completion of the 4th Bridge. Since the 4th Bridge will be a 6-lane bridge, if this section remains 4-lanes it will be a bottleneck for traffic flow. Therefore, this section needs to be widened to 6-lanes.

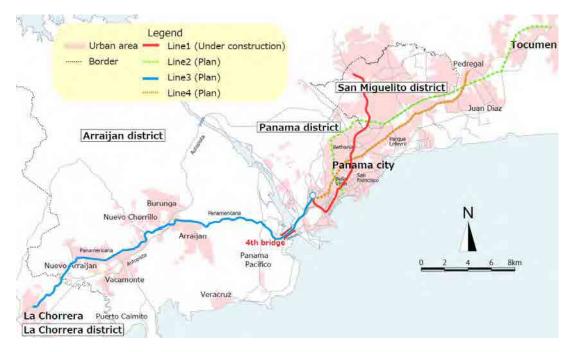
(5) Albrook Bus Terminal

This is the large national bus terminal located in the western part of Panama City, where the bus routes from Arraijan and La Chorrera as well as from the interior of the country concentrate. In order to access the terminal, which is located in a narrow area between Albrook Airport and Corredor Norte, there is an intersection to the south of the terminal with a very complex combination of a roundabout and flyovers. This intersection is one of the issues in planning the access road to the 4th Bridge. The terminal station for Line-1 is constructed in front of the bus terminal, and the station for Line-3 is planned to be in the same location as Line-1. Bus routes will remain even after the construction of Line-3 and their access to the bus terminal will still be necessary. This should be taken into account when planning the access road to the 4th Bridge.

2.1.3 Public Transport

(1) Metro

This is a Metro project to reduce worsened traffic congestion in Panama City. The first line of an urban railway system in Panama City, Metro Line 1, opened in 2014. The total route length is 13.7km (underground: 7.2km and viaduct: 5.3km) with 12 stations at opening, and to be extended to 15km with 14 stations by 2025. Loans from the Inter-American Development Bank and Corporación Andina de Fomento (CAF) are included in the project, which costs estimated as USD1,880.5 million. A total of four metro lines are proposed as shown in the Figure 2.4: Line-1, 2 and 4 will cover Panama City, and Line-3, the target of this study, will connect Panama City to Arraijan and La Chorrera, to the west, by crossing the Panama Canal which is the bottleneck of the traffic connected between east and west side of the canal.



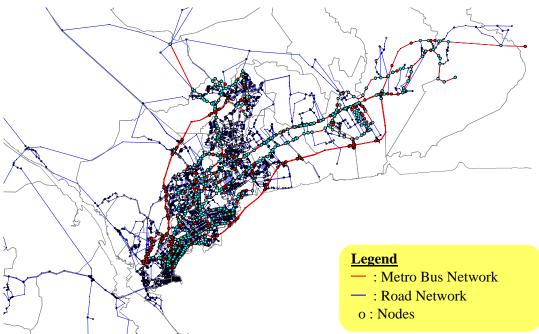
Source: JICA Study Team based on SMP plan Figure 2.4 Metro Plan

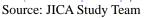
(2) Metro bus

The Metro bus project is one of the urban transportation systems, together with the Metro, being promoted by the current president of Panama for the Metropolitan area. The Metro bus project replaced the former "Diablo Rojo" buses with 1,200 air-conditioned, low-level buses (VOLVO) and it is operated by private company, Mibus.

Mibus is the operating company responsible for managing the buses and bus operators. ATTT is the governmental authority supervising the various contracts established for the bus system. Mibus transports more than 730,000 passengers daily with more than 9,000 daily services². The first service started in 2010 in Corredor Sur and the number of service routes has since increased to more than 150. The routes are shown in the Mibus website and identified in the report as shown in the figure below.

² Mibus website at http://www.mibus.com.pa/









Source: JICA Study Team Figure 2.6 Metro Bus (center) with the Fare Collection Gate (right) and Exit (left)

The fixed fare is USD0.25 for regular routes and USD1.25 for the north and south corridor routes. Two free transfers can be made to another bus going in the same direction, within 40 minutes of alighting each bus. The fare system uses a contactless IC card that was introduced in 2012. The cards can be purchased for USD2.00 at bus terminals and supermarkets and comes without value. The purchaser needs to add value to the card at a charging machine or charging counter before use. Passengers touch the card on the fare collection equipment at the entrance of the bus to enter the cabin as shown in the right photo in Figure 2.6. Also, by touching the equipment at the exit door (left photo in Figure 2.6) before alighting the bus, passengers can make a free transfer to another bus within 40 minutes.

TABLETA MELANCARIA DAL METRIMANO	Chargeable pr	e-paid card for the Metro bus
	Price of card	US\$2.00 (Deposit)
	Fare	US\$ 0.25 per trip
MEINUBUS	Transfer	Free up to 40min. after alighting
	Payment period	At boarding time
	Туре	А

Table 2.2Contactless IC Card for the Metro bus

Source: JICA Study Team



Source: JICA Study Team
Figure 2.7 Contactless IC Card charging machines and charging counter

(3) Pirata

The "Pirata" is an unlicensed public transportation provider using a private van. The fee from La Chorrera to Albrook is generallyUSD0.90 and USD1.50 for a higher quality vehicle. Thus, the fare depends on the quality of the vehicle. The van windows are darkened with black film. The Piratas stop at the Metro bus stops to pick up passengers. The Metro bus service cannot cover all the target areas or rider demand and the Piratas cover areas that are inconvenient for large buses, or at peak hours when bus service is insufficient. The number of Pirata users has increased according to SMP, but its quantification is difficult.

(4) Taxi

Many yellow cabs can be seen in the suburban and metropolitan areas of Panama City. Taximeters are not installed in the taxis and passengers negotiate the fare with the driver according to the official fare zone of the destination.



Source: JICA Study Team Figure 2.8 Examples of a typical Pirata (left) and taxi (right)

2.1.4 Current Situation and Problems of Urban Transportation

There is serious traffic congestion in Panama City not only in commuter hours but also other day times due to the high concentration of urban functions. Traffic congestion afflicts not only Panama City, but also the Pan-American Road, specifically between the Bridge of the Americas and Arraijan, during the morning and evening hours. This section becomes so congested that drivers use the shoulder as a traffic lane during peak hours because the capacity of 2-lane per direction is insufficient as shown in Figure 2.9.



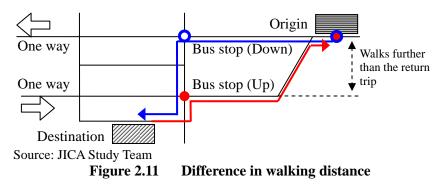
Source: JICA Study TeamFigure 2.9Congested conditions during morning peak hour on the Pan-American Highway

The Metro Bus of Panama City is a functional public transportation system, but the buses do not operate with a time schedule. Many times the buses cannot carry all the waiting passengers at peak hours due to traffic congestion and overcrowded buses. This requires bus users to leave their homes at earlier hours in the morning to be able to arrive at work on time, with 2-hour or longer commutes being common.



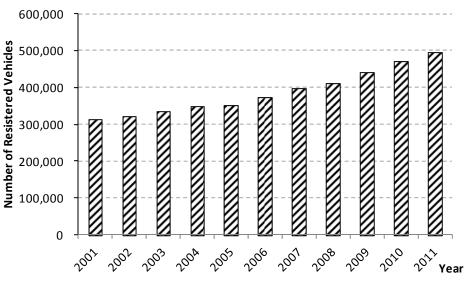
Source: JICA Study Team Figure 2.10 Fully loaded Metro Bus and a waiting passenger

Moreover, there are many one-way streets in Panama City center, which complicates the bus network, so that bus stops for "up" and "down" buses are not on same road. Some parallel one-way roads are distant from each other making it inconvenient for passengers. Figure 2.11 shows that the walking distance from a bus stop to the destination on the forward trip is longer than the walking distance to a bus stop on the return trip. It is expected that passengers take a roundabout route to avoid walking longer distances.



Once an urban transportation system with improved up-and-down routes can be established, the walking distance for passengers can be reduced, thereby increasing passenger convenience. Consequently, an urban transportation system having a dedicated lane is required as soon as possible.

In addition to the above urban transportation problems, the number of cars is increasing year by year in Panama as shown in Figure 2.12, but the frequency of buses between Panama City, Arraijan and La Chorrera is low. This is another reason the number of cars continue to increase.

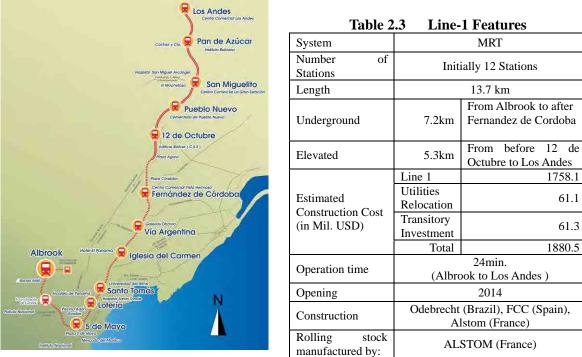


Source: INEC – National Institute of Statistics and Census - Panama Figure 2.12 Number of Registered Vehicles by year

2.2 Policies and Plans for the Urban Transportation Sector

(1) Line-1 Project

Line-1 is the first urban railway system in Panama. The system characteristics are 1435mm standard gauge, DC 1500 V power supply through overhead wires, 3-car train (600 passengers with 6 persons per m^2), CBTC system, and so on. SMP has implemented the Line-1 project in the metro network plan. Figure 2.13 shows the Line-1 route, running from the Albrook bus terminal to 5 de Mayo to the south and then going northeast through the metropolitan area and finally reaching Los Andes. It will have 13 stations (with 1 future station site) with a total length of 13.7km.



Source: SMP³ Figure 2.13 Location of Line-1 Stations

Source: JICA Study Team

The section between Los Andes and 12 de Octobre is elevated and the rest of the track is constructed underground. The total cost for Line-1 is estimated to be USD1,880.5 million. Its major features are summarized in Table 2.3. Scheduled opening is early 2014. Table 2.4 shows the cost breakdown for Line-1.

³ SMP website: http://www.elmetrodepanama.com/imagesrm/LineaUno.pdf, accessed in October 2013.

Table 2.4 Cost Breakdown for Line-1						
Design	Line 1 Construction and Equipment	Million	ns USD			
Panama Metro Line 1	966.2	1,758.1				
	Integrated Railway System: Design, supply and installation of rails, cables, controls, signaling and trains	431.8				
	Design and Engineering: Electromechanical systems and other civil works					
	Depots and Workshops: Earthworks, infrastructure, buildings and pavements					
	Variation of international prices of indexed material (Steel, cement, concrete, diesel)	23				
	Elevation systems: Escalators and elevators Provisions for strengthening structures, changes in soil					
	5					
	Environmental Management Plan	3				
Relocation of	Relocation and burying of public utilities	43.8	61.1			
Public Utilities	New 54 inch waterline for Panama City	17.2				
Transitory	Project Management	29.5	61.3			
Investments	OCIP - Insurance policy of the State	16.2				
	Transitory expenses of SMP (administration, Metro culture, Clearing of roads, etc.)	15.6				
Total Cost of Line 1 of	Panama Metro	1,880.50				

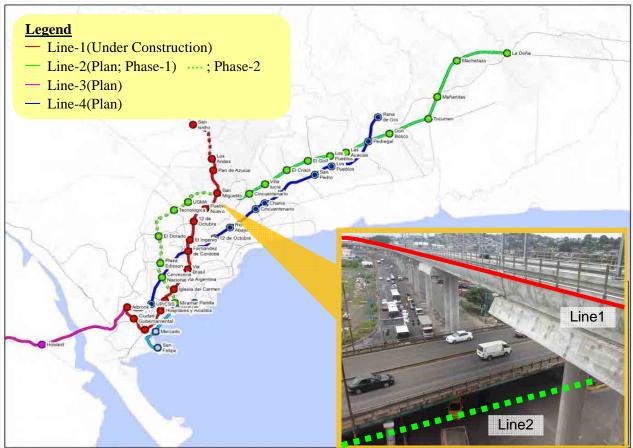
Table 2.4 Cost Dicakdown for Line-1	Table 2.4	Cost Breakdown for Line-1
-------------------------------------	-----------	---------------------------

Source: SMP⁴

(2) Line-2 Project

The Line-2 project is planned to run from San Miguelito to the north of Tocumen International Airport in Phase-1, and from San Miguelito station to Miramar Paitilla in Phase-2 as shown in Figure 2.14. The San Miguelio station is a transfer station where Line-2 will pass under Line-1 as shown in the lower-right figure of Figure 2.14. Line-2 is still under study, but the same system as Line-1 will be used in Line-2.

⁴ http://www.elmetrodepanama.com/pdf_doc/Metro-cuadro-gastos.pdf, accessed in October 2013.



Source:SMP, JICA Study Team Figure 2.14 Metro System and interconnection at San Miguelito Station

(3) Development of Pre-paid Zones for Metro Bus

The Metro Bus is developing pre-paid zones at major bus stops. For example, the 5 de Mayo Pre-paid Zone opened in October of this year. Passengers use the contactless IC car to pay their fare and enter the pre-paid zone where they can board their buses at the respective bus bay without touching the fare collection equipment on the bus.



Source: JICA Study Team **Figure 2.15** Entrance gate of the 5 de Mayo Pre-paid Zone for Metro Bus

The pre-paid zones attract a huge number of passengers and have the potential for business development. An example of successful integration of bus service and commercial development is the Grand Transportation Terminal in Albrook, shown in Figure 2.16. It is the main terminal for Metro Bus, all bus lines to the interior of the country and will connect

to the Metro Line 1 station as well. Besides having its own commercial area, it also provides convenient access to a mall, hotel and the nearby domestic airport.



Figure 2.16 Layout of Albrook Terminal

2.3 International Assistance in Transportation Sector

(1) Strategy of Public Debt Reduction

The Social and Fiscal Responsibility Law (SFRL), passed in 2008, sets limits on public borrowing level and is aimed at reducing debt level to less than 40% of the GDP by 2014. According to the Ministry of Economy and Finance (MEF), the debt level was 42.8% of the GDP in 2012, and as of April, 2013, 37.9% of the GDP projection for 2013.

(2) Main Donors

The main international donors to the Government of Panama are the Inter-American Development Bank (IDB), Corporacion Andina de Fomento (CAF), International Bank for Reconstruction and Development (IBRD), European Investment Bank (EIB) and Central American Bank for Economic Integration (CABEI). Among them, IDB is the major financing source, which represents 12% of total public debt and 65% of total external debt from multilateral financial organizations in 2012. CAF has approved US\$1,989 million in five years from 2008 to 2012 with US\$906 million designated for financing the transportation sector, which is almost 2 times the amount approved by IDB in the same period.

Private financing is utilized for the Panama Canal Expansion Project, and some road development projects have also been carried out by private initiative.

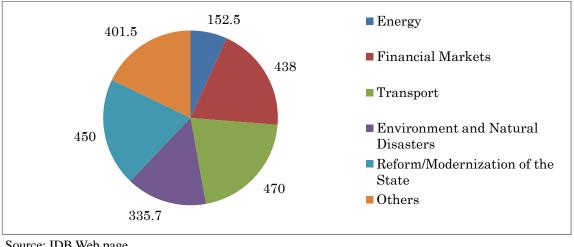
					(US\$ million)
	IDB	CAF	IBRD	EIB	CABEI
Approved	1,593.69	1,989.30	516.00	711.00	25.00
No. of Projects	33	20	8	2	1
Transportation Sector	470	906	0	0	0
No. of Project	2	4	0	0	0

Table 2.5	Donor Approval of loans to Panama in the last 5 years (cumulative)
-----------	--

Source: Web page of each organization

(3) **IDB** Support for Panama

In accordance with the IDB Country Strategy with Panama 2010-2014 (CS), the Bank's financial framework for sovereign-guaranteed approvals during the period is estimated at US\$990 million and focuses on the following 6 sectors: public finance, transport, water and sanitation, energy, education, and health. A total of US\$13,342 million was loaned to Panama from 1961 to 2012, which is the 7th place among IDB member countries, and US\$566 million total was financed in 2012 as sovereign/non-sovereign-guaranteed loans and grant facility, which is the 8th place among other members. The bank's portfolio in Panama for the past 5 years totals US\$2,248 million and the transportation sector accounts for 21%, or US\$470 million.



Source: IDB Web page

Figure 2.17 IDB Portfolio for the past 5 years in Panama

(4) **IDB** Support for the Transport Sector in Panama

The CS raises the issue of the fragmented urban transportation system in Panama. It aims to improve the quality of road infrastructure and its maintenance by providing technical support for the design and implementation of a comprehensive transportation and transit plan for Panama, and by supporting the institutional strengthening of the Ministry of Public Works (MOP) in carrying out the projects. In 2010, the bank approved a US\$70 million loan to a project for the rehabilitation and maintenance of priority corridors and rural roads in Panama. The bank set up in the CS that road rehabilitation in Panama will be carried out in coordination with CAF.

In July 2013, SMP announced the request for expressions of interest for the study of the Comprehensive Plan for Sustainable Urban Mobility for the metropolitan area of Panama with IDB financing. 44 consulting companies expressed their interests and the study will be completed during the following year by the selected consultant.

(5) **CAF Support for Panama**

Since becoming a full member of CAF in 2008, Panama has received a total of US\$1,989 million in loans in 5 years. Transportation, health and sanitation are the principal sectors of the bank's assistance, as can be appreciated from the fact that it financed a total of US\$296 million of the Panama Bay Sanitation Project and US\$100 million of the program to improve potable water and sewage network in the province of Panama.

(6) CAF Support for the Transportation Sector in Panama

The bank approved a US\$400 million loan for the Panama Canal Expansion Project in 2008 and a total loan of US\$500 million in 2011 and 2012 for the construction of Panama Metro Line-1. Since it financed US\$1 million of the on-going Feasibility Study for Panama Metro Line-2, it is thought that the bank intends to finance the project's implementation as well. Co-financing with IDB for the project is prospected from the fact that IDB also financed US\$1.5 million of the aforementioned study.

(7) **IBRD Support for Panama**

To support the governmental policy to reduce fiscal deficit, the bank's assistance focuses on the projects aimed at strengthening the management of financial operations, improving transparency, enhancing efficiency of public expenditures, and strengthening social protection.

(8) IBRD Support for the Transportation Sector in Panama

According to the Progress Report of the Country Partnership Strategy (CPS) for Panama for FY11-14, the Government relied primarily on other sources of financing for the transportation sector, thus no bank engagement in support of road expansion and improvement is planned for the remainder of CPS. Secondary Roads Development Project, which was planned to be carried out in 2014, has been dropped due to the execution of rigorous debt management and fiscal space limits set by the SFRL.

On the other hand, MIGA (Multilateral Investment Guarantee Agency) of the World Bank Group has issued a guarantee of US\$320 million in June 29, 2012 to cover a loan arranged by Citi Bank Group for the construction of Panama Metro Line-1.

(9) **EIB** support

The bank set a lending ceiling of US\$3.8 billion for the Latin America Region in the mandate covering 2007-2013. Panama had received a loan from the bank during the 1993-2010 period for a total of US\$970 million, which was the second largest operation in the region next to Brazil. US\$542 million was approved for the Panama Canal Expansion Project in 2009, US\$192 million for the Dos Mares Hydroelectric Plant Construction in 2009, and in 2007 US\$37 million for financing the Panama Bay Sanitation Project. Initially, the bank intended to finance the construction of Panama Metro Line-1, however, it did not succeed in doing so.

2.4 Necessity of the Project

2.4.1 Necessity of transport infrastructure crossing the canal

The urbanized area in and around Panama City is shown in the pink color area in Figure 2.2, which clearly shows that the development of Panama City is distributed in the east of the city and that to the west of the canal delays due to hilly area along the canal. However, commuter time is getting longer and longer recently becaue the development area to the east of the canal has reached beyond the Tocumen International Airport, which focuses on the nearer areas such as Arraijan and La Chorrera where development becomes active.



Source: SMP

The population of Panama Metropolitan area (Panama, City, San Miguelito, Arraijan and La Chorrera Districts) is 1.72 million at present (2010), and it is forecasted that the population would reach 2.17 million in 2020 and 2.87 million in 2050 (Chapter 3). The population of Arraijan and La Chorrera in total is 398,000 at present (2010) and is forecasted to reach 553,000 in 2020 and 778,000 in 2050. In Panama Metropolitan area, car ownership shows rapid expansion and the suburban style residential development which subjects to usage of cars is very active in the west of the Study Area as shown in the photo above. From these, it is expected that the traffic connecting the western side of the canal as a suburban residential area and the eastern side as the commercial and business district would continue to increase.

Presently, the Bridge of Americas, the age of which has exceeded more than 50 years, and the access roads of the both sides of the bridge cannot respond to the increasing traffic demand, which causes heavy traffic congestion every day. Since the congestion will become heavier and heavier, development of transport infrastructure crossing the canal is necessary for the development in the west area. Under the circumstances mentioned above, the Government of Panama plans to construct a new bridge crossing the canal near the Bridge of Americas and an urban transportation system. The necessity and justification of these transport infrastructures is described in the subsequent sections.

2.4.2 Necessity of the 4th Bridge

The 4th Bridge is necessary because of the following reasons.

- 1) For Post-Panamax vessels
- 2) Expansion of road capacity across the Panama Canal
- 3) Construction of Metro Line-3
- 4) Alternative to the Bridge of Americas

(1) For Post-Panamax

Once the Panama Canal Expansion Project is completed, the New Panamax ships, larger than the current Panamax ships, will be able to transit the canal, with an increased transportation capacity per ship of approximately 5,000 TEU to 12,000 TEU. On the other hand, some Post-Panamax ships will not be able to use the canal due to the limit of the air draft of the Bridge of Americas (57.91m), which could result in insufficient economic benefit from the canal expansion. In order to enable the transit of such Post-Panamax ships, the height restriction of the bridge should be 70m, the same as the Centennial Bridge. This means the removal of the Bridge of Americas and the construction of a new bridge. Although there is no committed plan for its removal, preparation should be made by constructing the 4th Bridge in line with the canal expansion to deal with market changes, such as the increasing size of vessels.

(2) Expansion of the capacity of roads crossing the Panama Canal

Presently, traffic on the Bridge of Americas (4-lanes in both directions) at peak hours is almost saturated with a traffic flow of approximately 2,800 vehicles per hour for peak direction. The traffic demand is increasing because of recent, rapid urban development in the area west of the canal. As a result, traffic congestion extends from the Bridge of Americas toward Arraijan in the western direction in the morning peak and toward the city center in the evening peak hour. It is expected that longer travel times due to traffic congestion will increase the duration of the peak hours. In the western area of the canal, the population is increasing with rapid housing developments, and Panama Pacifico, which is the former Howard Air Force Base, is attracting companies. However, it is expected that the population increase and urban development could cease due to the constraint caused by the traffic congestion of the Bridge of Americas resulting in greater economic disparity between the eastern and western areas. For these reasons, a new road besides the Bridge of Americas is necessary to 1) reduce the traffic congestion and 2) encourage the regional development of the western area.

(3) Construction of Metro Line-3

The Metro Line-3, planned by SMP, is to connect the east and west of the canal and is expected to improve the public transport system and encourage the regional development of the western area by connecting Arraijan and La Chorrera with the center of Panama City. Since Line-3 needs to cross the canal, whether by a tunnel or bridge, if it is constructed as an independent project an additional investment of several hundreds of million dollars will be required. To make for a more efficient investment, it would be desirable to construct Line-3 together with the road bridge that needs to be constructed in the near future any way. Since Line-3 will be an important transit system in around 2020 due to the increasing transportation demand, it is necessary to implement the 4th Bridge project to accommodate Line-3.

(4) Alternative to the Bridge of Americas

Over half a century has passed since the Bridge of Americas opened in 1962, and the bridge requires regular maintenance work. Traffic regulation and night-time closures are necessary during the maintenance of the bridge's road surface. Presently, there is no alternative route other than the Centennial Bridge, which means that the economic loss due traffic restrictions will continue to increase year by year with increased traffic demand. The economic loss will occur until the Bridge of Americas is replaced with the new bridge in the future. Therefore, an alternative road bridge to the Bridge of Americas is necessary on the Pacific Ocean side of the Panama Canal.

2.4.3 Necessity of Urban Transportation Line-3

- Urban Transportation Line-3 is necessary from the following views:
- 1) To alleviate congestion in the area to the west of the canal
- 2) To improve public transport services
- 3) To promote public transport

(1) Alleviation of congestion in the area to the west of the canal

Even the number of lanes becomes 10 after the construction of the 4th Bridge as a 6-lane road in addition to the Bridge of Americas as a 4-lane road, the congestion will not be alleviated if the number of lanes between Arraijan and the Bridge of Americas remains four. Therefore, there is a plan to widen the hilly section between Arraijan and the Bridge of Americas from 4-lane to 6-lane in parallel with the construction of the 4th Bridge, although the capacity will become insufficient in the future even if the section is widened to 6-lane. In addition, since the capacity expansion such as road widening and bypass construction for Arraijan - La Chorrera section is difficult, traffic situation in the area would be worsen. Therefore, it is necessary to introduce a high capacity public transport system.

(2) Improvement of public transport services

The urbanized area to the west of the canal is far from the center of the city with the distance of approximately 15km between Albrook and Arraijan, and 30km between Albrook and La Chorrera, and express buses are operated in the area. However, the level of service is very low. The service is deteriorated and not reliable due to the traffic congestion, and the transport capacity is small. In addition, the fare is high due to the long distance. Although housing development for car-owning households in the area to the west of the canal is expanding, many residents who lived there for a long time depend on public transport. Therefore, it is necessary to improve the public transport services in the area.

(3) **Promotion of public transport**

Line-2 construction is planned after Line-1 in Panama. These urban transport lines contribute not only to traffic relieve but also the environment with the smaller CO_2 emission rate per passenger than cars and buses. It is necessary to formulate the public transport network by constructing an urban transportation system in the area to the west of the canal to promote public transport use.

2.5 Evaluation of Alternatives

2.5.1 Without Project Case

In the "Without Project Case", the problems mentioned above will become aggravated, namely: 1) the size of ships that can transit the Panama Canal will be restricted to the New Panamax size in the future, 2) Traffic congestion will worsen, which will cause inactivity in the development of the western area and increase the economic disparity between the east and west, and 3) economic loss because of the lack of an alternative road in case of the closure of the Bridge of Americas.

2.5.2 Metro Line-3 as a Separate Project

Even if only Line-3 is developed independently without the construction of a new road, it will contribute to the reduction of traffic congestion. However, even if Line-3 is constructed it is expected that the traffic on the Bridge of Americas will become similar to the present situation because car traffic would increase along with the increased number of households owning cars. This means that the demand of Line-3 will be larger than the demand forecast as the population in the western area continues to increase. The demand forecast of Line-3 shows that Line-3 will carry approximately 20,000 passenger per hour for peak direction in peak hours in Phase-1, and approximately 25,000 in case of the Phase-2 line extension to La Chorerra. If the demand of Line-3 increases more than this, the present plan should be reviewed, which would cause an increase in the project cost. If Line-3 is

constructed separately, a bridge or tunnel will be necessary to cross the canal. Greater passenger capacity and the additional infrastructure for crossing the canal will increase the project cost, and there is a possibility that the economic benefit from the project would become negative.

In addition, the problem would remain that the size of ships transiting the Panama Canal are restricted by the clearance of the Bridge of Americas.

2.5.3 Tunnel

In the case of a road being constructed with a tunnel under the canal, it is possible to compare this with the bridge plan under the same conditions because it would satisfy the necessity described in 4.2.1.

In the case of the tunnel plan, it would be rational that the road and Line-3 each have a separate tunnel; the road tunnel would be a twin tunnel consisting of a tunnel for each direction. In this case, the plan would be two road tunnels with a diameter of 16m for 3-lanes, and two tunnels with a diameter of 7.6m for Line-3. Although other types of tunnels are possible, the selection of the tunnel type is not necessary for comparison purposes because the difference of tunnel type is not a large factor. The route of the tunnels would be almost the same as that of the bridge, but it is possible to shorten the distance a little.

The advantages of the tunnel plan are: 1) there is no restriction to the air surface of Albrook Airport; 2) there is no impact on the urban landscape; and 3) there is no risk of channel closure of the Panama Canal.

On the other hand, the disadvantages of the tunnel are: 1) the project cost is higher than that of the bridge plan; 2) regular maintenance of facilities such as ventilation, lighting and pumping is necessary; 3) the construction will generate a huge amount of excavated material, and 4) there is a risk of a catastrophic disaster such as a fire in the tunnel caused by a traffic accident.

The length of the tunnel is approximately 3km. The cost is estimated at approximately USD1.5 billion as shown the table below, which is 50% greater than the cost of the 4th Bridge.

Item	Work	Dimensions	Quantities	Unit cost	Cost
				$(US\$/m^3)$	(Million US\$)
Road	Launch and Arrival Shaft	$40m \times 20m \times 20m \times 2$	32,000m ³	500	16
	(Cut and Cover)				
	Tunnel	φ16, 3km×2	1,206,372m ³	800	965.1
Line-3	Launch and Arrival Shaft	$20m \times 15m \times 15m \times 2$	9,000m ³	500	4.5
	(Cut and Cover)				
	Tunnel	φ7.6, 3km×2	272,188m ³	800	217.75
Subtotal					1,203
Contingency*					240
Total					1,443

 Table 2.6
 Preliminary Construction Cost for Tunnel

* Note: Although the tunnel work requires cross passage, improvement of access roads, facilities such as ventilation and others not mentioned above, and the project requires design, land acquisition, utility relocation and others, it is simply assumed that these costs are 20% of the subtotal.

Source: JICA Study Team

2.6 Conclusion

The Project will implement the construction of the 4th Bridge and Urban Transportation Line 3 as a unified project. The objective of the Project is to meet the increase in traffic demand crossing the Panama Canal by expanding the transportation capacity connecting the east and the west areas of the Panama Canal.

The metropolitan area of Panama is growing as one of the economic centers in the Central America, and the west area of the canal is emerging as the suburban area of the metropolitan. On the other hand, the traffic on the Bridge of Americas, connecting the west and the east of the Panama Canal, has rapidly increased and the congestion in the morning and evening peak hours is getting heavier and heavier due to the capacity limitation, which becomes a threaten to the economic development of the metropolitan area of Panama. In addition, public transport services in the west area is very poor presently depending on buses and taxis, which causes increase in car usage and deteriorate the traffic congestion.

The Project is necessary in order to respond the increasing traffic demand in the metropolitan area of Panama and alleviate traffic congestion, and encourage the urban development in the west area of the Panama Canal. In addition, the urban transport Line-3 is necessary to improve public transportation in the west area of the canal and to reduce CO_2 emission.

Chapter 3 Demand Forecast

3.1 Methodology

3.1.1 Introduction

The traffic demand of Line-1 was estimated by SMP in 2011¹, in which the peak hour peak direction traffic (PHPDT) in 2035 is estimated to be 18,034 between 12 de Octubre and F. de Cordoba stations in the direction of Albrook. Since Line-1 runs through a high demand corridor within Panama City, the demand for Line-3 would be lower than that of Line-1.

The demand forecast for Line-3 was carried out for a 1) full development case and 2) Phase-1 case in the Study. In the full development case, Line-3 runs from Albrook to La Chorrera, while in the Phase-1 case the line is between Albrook and Nuevo Arraijan.

The traffic demand forecast for the 4th Bridge was carried out by ACP in 2013. In the beginning of the Study, the traffic demand forecast for the 4th Bridge was not included in the Study, although it was carried out after the study of the 4th Bridge was added to the Study.

The horizontal years for the demand forecast in the Study are 2020, 2025, 2030, 2035, 2040, and 2050, while the base year of the demand forecast is 2013.

3.1.2 Origin and Destination Matrix

An origin and destination (OD) matrix of private and public transportation modes during peak hours (6:00 to 8:00) was prepared by SMP in 2009 based on estimations. It is not the result of origin and destination surveys, but the product of a demand and supply model based on socioeconomic data and transport infrastructures using TRANUS software. Another OD matrix was prepared in the study for the 4th Bridge, however it cannot be used for the demand forecast of Line-3 because it focuses on vehicle traffic crossing the Bridge of Americas.

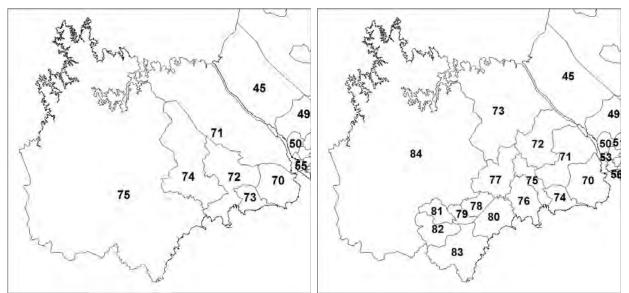
To make an OD matrix from actual surveys requires a large number of samples and time, and given the schedule of this Study it was not feasible to conduct a home interview survey which is usually applied to a traditional demand forecast modeling. Therefore, a demand forecast model for Line-3 was formulated by using the 2009 OD matrix of SMP and making supplementary traffic surveys.

3.1.3 Modifying the SMP 2009 OD

The Study's OD matrix was prepared by modifying the SMP 2009 OD matrix, which consists of 75 zones, with 5 zones in the Arraijan District and one zone in the La Chorrera District. In the Study, nine zones were added by subdividing the zones in Arraijan and La Chorrera Districts based on the political divisions called "corregimiento". In the Arraijan District, Nuevo Emperador and Santa Clara Corregimientos were combined into Zone No. 73, while in the Chorrera District, 14 Corregimientos were combined into Zone No. 84.

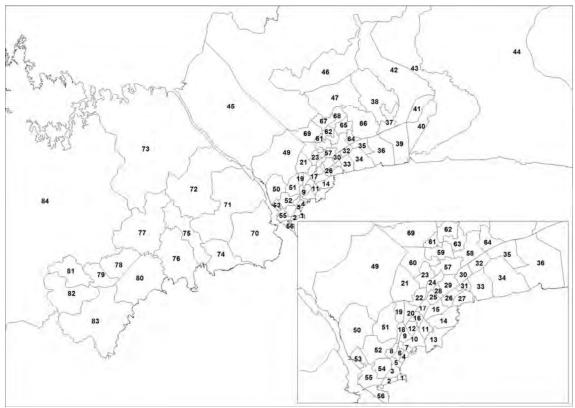
The 84-traffic zone system was further subdivided taking into consideration the areas of the future stations for trip assignment.

¹ Final Report "Updating of Demand, Operation Costs, and Various Indicators required by EIB for the new configuration of Panama Metro Line-1." (Actualización de la Demanda, Costos de Operación e Indicadores Varios requeridos por el BEI para la nueva configuración de la Línea 1 del Metro de Panamá. Informe de Final)



75 Zones of the 2009 SMP OD84 Zones of the StudySource: JICA Study Team. Left – based on SMP reports, Right – based on Corregimiento boundary map.Figure 3.1Zone Divisions west of the Canal

Figure 3.2 shows the OD zoning system with the zone numbers used in the demand forecast model for the Study. The traffic zones from 1 to 69 are the same as those in the demand forecast model for Line-1.



Source: JICA Study Team

Figure 3.2 Traffic Zoning System

The process for projecting the future OD matrix is shown in Figure 3.3. The major points of the flowchart are:

- 1) Replaces the OD that crosses the canal with the estimated OD based on the traffic survey.
- 2) Modal shift from public mode to private mode takes into account the increasing number of cars.
- 3) Increases the OD data by including the population growth.
- 4) Adds new traffic related to the development of Panama Pacifico.
- 5) Makes new traffic zones within the walking distance of stations by splitting the OD.
- 6) Modal shifts made from private mode to public mode for the OD pairs along Line-1, 2, and 3.

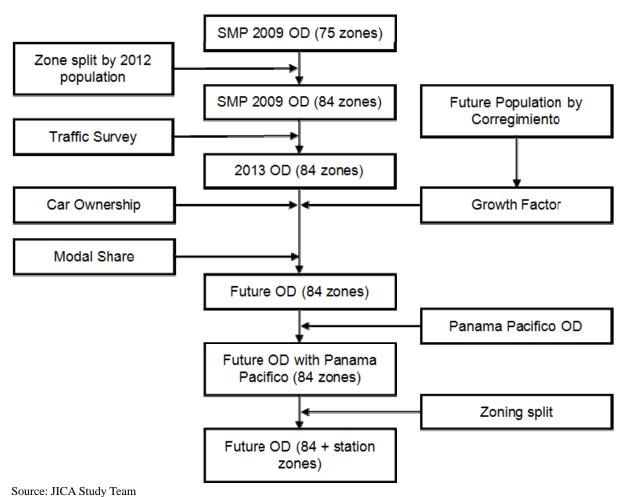


Figure 3.3 Flow for making the OD Matrix

Note that the estimated OD is the morning peak hour OD.

3.1.4 Transit Assignemnt

Transit network models were developed and the estimated OD matrix was applied to the transit network by using JICA STRADA¹.

¹ JICA STRADA is a package software for demand forecast developed by JICA.

3.2 Demand Forecast of ACP's Pre-Feasibility Study

3.2.1 Result of the Demand Forecast in ACP's Study

The ACP's Study estimated the future traffic on the 4th Bridge for the years from 2017 to 2036 in terms of AADT. The result of the forecast is shown in Table 3.1. The result shows that traffic flow on the Bridge of Americas would be approximately 1.9 times larger than that of the 4th Bridge. The traffic flow on the 4th Bridge was estimated at 25,328 vehicles in 2020 and 35,431 vehicles in 2035 in terms of AADT. It is estimated that the traffic flow on the Bridge of Americas would reach almost the same level as the present traffic in 2020 even if the 4th Bridge is constructed. The traffic flow in the case of "4th Bridge without Bridge of Americas" is estimated to be the same as the sum of the traffic flow on the 4th Bridge and the Bridge of Americas in case that the 4th Bridge is constructed.

Table 5.1 If affice 1 fojection in AC1's Study (venicles per day)							
Year	4 th Bridge	Bridge of	Centenario	Pan-American	4 th Bridge Without		
		Americas	Bridge	Highway	Bridge of Americas		
2020	25,328	48,056	28,251	73,384	73,384		
2025	28,129	53,370	31,375	81,499	81,449		
2030	31,240	59,272	34,845	90,512	90,512		
2035	35,431	67,223	39,518	102,654	102,654		

Table 3.1Traffic Projection in ACP's Study (vehicles per day)

Source: ACP's Feasibility Study

Based on the demand forecast above, Level of Services (LOSs) are calculated for the Bridge of Americas, the 4th Bridge, and the Panamerican Road, and Equivalent Single Axle Loads (ESALs), which is generally used for the pavement design, are also calculated

The Highway Capacity Manual (USA) is used to evaluate the LOSs. Six LOSs are defined, represented by letters A to F. LOS "A" means the best operating conditions, and LOS "F" means the worst. In the ACP's Study, it is estimated that the 4th Bridge would reach "D" level in 2037 while the Bridge of Americas would reach "F" level in 2021.

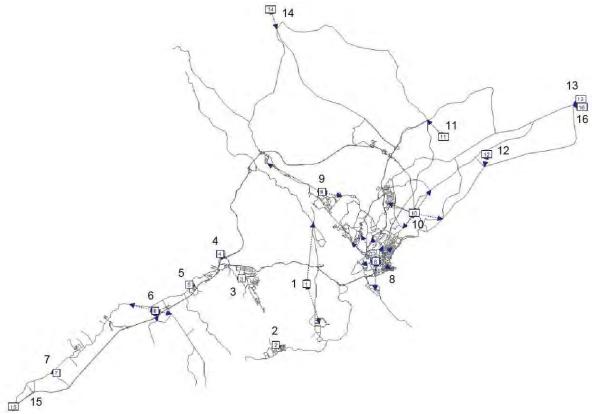
3.2.2 Demand Forecast Method in ACP's Study

The origin-destination (OD) matrices used in the ACP's Study were developed from OD data in "Feasibility Study for the Project Panama Canal Crossing, 2001, Ministry of Public Works (MOP's Study)". The OD matrix in MOP's Study consists of 10 traffic zones, in which only two zones represent the west area of the canal. The MOP's Study estimated the OD matrices based on an interview survey at a survey point along the Pan-American Highway. This means that only OD information between the west and the east of the canal was taken and the OD information within Panama City and within the west area was not estimated. However, such internal movement is not necessary for the estimation of traffic demand on the 4th Bridge.

The ACP's Study divided one of the zones west of the canal into 7 zones and applied a 16 traffic zone system for the demand forecast. Since the OD matrix in MOP's Study represents the traffic in 2000, ACP's Study applied an annual growth rate to each traffic zone to estimate the OD in 2012. The estimated OD matrix in 2012 was calibrated by the result of the traffic count survey conducted in 2012 in the ACP's Study. The OD information is sufficient for the demand forecast of the 4th Bridge in the ACP's Study, in which the approach road to the 4th Bridge is directly connected to Corredor Norte.

However, the OD information of ACP's Study is insufficient for the traffic simulation at

Omar Torrijos Interchange which is included in the TOR of the Study. A shown in Figure 3.4, the east area of the canal belongs to the zone 8 in the 16 zoning system in the ACP' Study, the traffic demand forecast by direction using the same zoning system at Omar Torrijos Intersection is difficult.



Source: ACP's Pre-F/S (Numbers are added for better understanding) Figure 3.4 Traffic Zoning in ACP's Pre-F/S

The ACP's Study forecasted the future traffic assuming the population growth rate from 2012 to 2036 to be 2.12% per year. Using the growth rate, the traffic in 2036 is calculated at 1.65 times that of 2012. However, it is expected that the traffic growth rate would be higher than the estimation sue to the rapid increase in the number of cars in Panama, especially in the west area of the canal.

The review is summarized as:

- ACP' Study lacks the forecast years because the Study need the demand forecast for 20 years after the opening of the bridge while ACP's Study estimated it till 2026.
- Since the area of traffic zone is very large, the zoning cannot be used for the traffic simulation at Omar Torrijos Intersection which is required in the Study.
- Since traffic growth rate is estimated based on the population growth only, the rapid growth in the number of cars is not taken into account.
- It is not clear how Line-3, which is planned to be constructed with the 4th Bridge, is considered in the ACP's Study.

3.3 Traffic Surveys

3.3.1 Present Traffic

Three traffic count surveys were available for the Study.

- 1) METI Study: August 9 (Thursday), 2012
- 2) ACP¹: October 23 (Tuesday), 2012
- 3) ATTT: July 8-14 (Monday-Sunday), 2013
- 4) This Study: August 13 (Wednesday), 2013

In the METI Study, the vehicles were classified into three types: sedans, buses, and trucks. Taxis were included in sedans. In the ACP's Study, buses and trucks were counted as the same category. The data of ACP's Study and ATTT were obtained after the commencement of the Study.

(1) Bridge of Americas

In the ACP's Study, the number of vehicles passing the Bridge of Americas was counted on October 20th, 2012 (Saturday) and October 23rd, 2012 (Tuesday), and the traffic flow in Annual Average Daily Traffic (AADT) on the Bridge of Americas was calculated at 49,834 vehicles as shown in Table 3.2. AADT represents the average traffic in a year, calculated by dividing the total yearly traffic volume by 365. In the ACP's Study, 16-hours of traffic (5:00-21:00) is considered to be the daily traffic. The peak hour is 6:00-7:00.

	East \rightarrow West	West \rightarrow East	Total
Cars	22,540	24,235	46,776
Buses + Trucks	2,102	2,273	4,375
Total	23,326	26,508	49,834

Table 3.2AADT of Bridge of Americas (no. of vehicles per day)

Source: Pre-F/S (Draft Final Report, November 2013)

A traffic count survey on August 9th, 2012 (Thursday) in the METI Study shows the traffic flow on the Bridge of Americas for the same period (5:00-21:00) was 58,337 vehicles, which is 17% greater than that of the ACP's Study. The result of the traffic survey in the METI Study is shown in Table 3.3. The result shows that heavy traffic was observed from the east to the west in the early morning, which is usually not the peak direction, and the number of buses counted was very high compared to other surveys. The peak hour of bus traffic was from 5:00 to 6:00 in the direction toward Albrook. The number of buses at peak hour was 334.

A traffic count survey in the Study, conducted on August 30th, 2013 (Wednesday), shows that the traffic flow on the Bridge of Americas for 16 hours was 45,557 vehicles for both directions, which is 8.6% less than that of the ACP's Study. The number of buses from 5:00 to 6:00 (the peak hour) for the Albrook direction was 210 as shown in Table 3.4.

The ATTT traffic survey (Table 3.5) shows that the volume of buses at this same time in the same direction was between 122 and 179 depending on the day of the week. Although hourly traffic data is not given in the ACP report, the bar chart in the report shows that the number of buses was 100-150 at the peak hour.

¹ Studies and Preliminary Design for a New (Fourth) Bridge over the Panama Canal at the Pacific Side

Table 5.5 Tranc Count Survey (2012)											
	From Albro	ook To Arra	aijan		From Arra	ijan To Alb	rook				
Time	Car	Bus	Truck	Total	Car	Bus	Truck	Total			
4:00-5:00	155	48	4	207	878	147	31	1,056			
5:00-6:00	499	171	28	698	2,444	334	36	2,814			
6:00-7:00	1,253	245	39	1,537	2,965	271	25	3,261			
7:00-8:00	1,231	199	68	1,498	2,593	235	28	2,856			
8:00-9:00	1,294	142	48	1,484	2,515	215	47	2,777			
9:00-10:00	1,051	133	88	1,272	1,503	182	52	1,737			
10:00-11:00	1,239	144	116	1,499	1,555	164	73	1,792			
11:00-12:00	953	150	88	1,191	1,281	146	75	1,502			
12:00-13:00	1,177	137	78	1,392	1,342	182	51	1,575			
13:00-14:00	1,310	152	92	1,554	1,202	168	57	1,427			
14:00-15:00	1,396	152	88	1,636	1,298	150	65	1,513			
15:00-16:00	1,898	122	78	2,098	1,445	230	53	1,728			
16:00-17:00	2,372	164	58	2,594	1,645	209	39	1,893			
17:00-18:00	2,310	233	41	2,584	1,496	240	33	1,769			
18:00-19:00	2,745	253	27	3,025	1,147	230	18	1,395			
19:00-20:00	2,220	262	51	2,533	821	170	26	1,017			
20:00-21:00	1,842	154	12	2,008	538	128	12	678			
21:00-22:00	1,190	88	16	1,294	507	89	7	603			
Total	26,135	2,949	1,020		27,175	3,490	728				

Table 3.3Traffic Count Survey (2012)

Source: Traffic Survey, METI F/S (2012)

Table 3.4	Traffic Count Survey (2013)	
-----------	-----------------------------	--

	From Albr	ook To Arr	aijan			From Arraijan To Albrook				
Time	Cars	Taxis	Buses	Trucks	TOTAL	Cars	Taxis	Buses	Trucks	TOTAL
00:00-01:00	273	84	8	1	366	124	57	6	10	197
01:00-02:00	111	34	1	2	148	53	25	1	11	90
02:00-03:00	73	21	0	3	97	64	33	6	11	114
03:00-04:00	53	21	0	3	77	165	57	13	12	247
04:00-05:00	72	17	7	6	102	686	223	82	20	1,011
05:00-06:00	194	34	37	5	270	2,018	401	210	26	2,655
06:00-07:00	354	33	82	9	478	2,362	291	124	17	2,794
07:00-08:00	571	72	97	26	766	1,647	104	144	13	1,908
08:00-09:00	530	45	58	37	670	1,350	166	118	94	1,728
09:00-10:00	668	52	63	72	855	1,210	207	84	73	1,574
10:00-11:00	811	63	73	60	1,007	1,107	169	113	107	1,496
11:00-12:00	804	58	73	73	1,008	912	152	103	91	1,258
12:00-13:00	837	63	90	59	1,049	905	145	85	77	1,212
13:00-14:00	908	76	86	72	1,142	948	143	92	103	1,286
14:00-15:00	878	90	85	59	1,112	837	118	96	85	1,136
15:00-16:00	1,570	240	140	81	2,031	894	104	98	65	1,161
16:00-17:00	1,787	238	167	65	2,257	868	161	145	59	1,233
17:00-18:00	1,810	204	149	40	2,203	830	118	133	43	1,124
18:00-19:00	2,096	190	170	33	2,489	959	98	124	21	1,202
19:00-20:00	1,871	237	184	26	2,318	705	111	94	19	929
20:00-21:00	1,750	259	167	13	2,189	810	133	79	15	1,037
21:00-22:00	958	200	91	10	1,259	822	143	37	18	1,020
22:00-23:00	624	123	47	3	797	428	99	19	5	551
23:00-24:00	422	82	14	0	518	249	78	3	7	337
TOTAL	19,544	3,017	1,889	758	25,208	20,953	3,336	2,009	1,002	27,300

Source: Traffic Survey, JICA (2013)

	ay 111uu	ty) III ITallic Survey by ATTT								
	From Albr	ook To Arr	aijan			From Arraijan To Albrook				
Time	Monday	Tuesday	Wednesday	Thurs	Friday	Monday	Tuesday	Wednesda	Thurs	Friday
00:00-01:00	2	5	3	0	7	12	13	16	16	17
01:00-02:00	4	4	2	0	3	7	16	8	9	9
02:00-03:00	3	4	3	0	10	7	14	14	17	8
03:00-04:00	2	16	8	2	14	36	31	34	34	25
04:00-05:00	25	35	33	10	12	34	113	134	130	134
05:00-06:00	57	94	58	38	10	122	167	158	128	179
06:00-07:00	31	55	37	38	26	103	126	83	48	106
07:00-08:00	76	79	10	26	51	103	11	120	31	101
08:00-09:00	59	54	87	31	101	107	34	101	68	120
09:00-10:00	45	49	92	61	107	113	137	126	90	98
10:00-11:00	35	64	142	53	105	108	118	125	99	134
11:00-12:00	42	51	122	62	104	122	89	134	107	134
12:00-13:00	35	46	88	72	107	116	111	134	118	130
13:00-14:00	44	57	71	49	104	123	126	127	126	146
14:00-15:00	78	79	61	44	116	103	101	124	121	147
15:00-16:00	119	90	105	84	92	94	130	135	126	160
16:00-17:00	160	113	110	94	96	142	127	156	140	141
17:00-18:00	139	101	113	92	60	141	141	152	143	134
18:00-19:00	128	103	65	53	60	112	107	96	119	111
19:00-20:00	117	106	53	60	74	95	90	101	88	122
20:00-21:00	28	15	21	35	103	65	57	71	80	87
21:00-22:00	35	25	17	26	87	45	54	38	35	78
22:00-23:00	32	16	8	14	55	26	18	22	20	30
23:00-24:00	20	9	3	10	33	15	14	22	16	17
Total	1,316	1,270	1,312	954	1,537	1,951	1,945	2,231	1,909	2,368

 Table 3.5
 No. of Buses (Monday-Friday) in Traffic Survey by ATTT

Source: Traffic Survey, ATTT (2012)

(2) Centenario Bridge

In the ACP's Study, the traffic flow in AADT on Centenario Bridge was calculated at 31,405 vehicles based on a traffic count survey conducted on September 1st, 2nd, and 3rd, 2012 (Saturday, Sunday, and Monday) as shown in Table 3.6.

Tuble 2.0 Thild I of Centenario Dirage (no. of Venteres)											
	East \rightarrow West	West \rightarrow East	Total								
Cars	12,816	14,532	27,348								
Buses + Trucks	1,971	2,085	4,056								
Total	14,787	16,618	31,405								

Table 3.6AADT of Centenario Bridge (no. of vehicles)

Source: Pre-F/S (Draft Final Report, November 2013)

The traffic survey data in the METI Study (Table 3.7) shows that the traffic for the same period was 29,529 vehicles, which is 6% less than that of the ACP's Study. The number of buses was as small as 17 even in the peak hour (5:00-6:00) for the peak direction.

The Study did not conduct the traffic survey at Centenario Bridge.

	Table 5.7 AAD1 of Centenario Bridge (no. of venicles)										
	From Pana	ma City To	Arraijan		From Arrai	ijan To Pan	ama City				
Time	Car	Bus	Truck	Total	Car	Bus	Truck	Total			
4:00-5:00	67	1	56	124	206	1	105	312			
5:00-6:00	180	4	59	243	982	17	110	1,109			
6:00-7:00	354	2	106	462	1,964	6	32	2,002			
7:00-8:00	433	8	107	548	2,242	0	38	2,280			
8:00-9:00	475	7	87	569	1,035	2	149	1,186			
9:00-10:00	468	1	132	601	534	0	135	669			
10:00-11:00	470	1	125	596	452	1	128	581			
11:00-12:00	428	1	122	551	401	2	171	574			
12:00-13:00	502	0	126	628	361	2	157	520			
13:00-14:00	449	1	153	603	477	2	186	665			
14:00-15:00	609	5	195	809	684	5	242	931			
15:00-16:00	868	7	125	1,000	642	5	215	862			
16:00-17:00	1,269	11	128	1,408	643	6	187	836			
17:00-18:00	2,175	8	103	2,286	619	6	159	784			
18:00-19:00	1,937	8	97	2,042	456	6	84	546			
19:00-20:00	1,394	7	136	1,537	282	5	110	397			
20:00-21:00	559	6	92	657	206	2	91	299			
21:00-22:00	407	1	63	471	195	2	76	273			
Total	13,044	79	2,012	15,135	12,381	70	2,375	14,826			
5:00-21:00	12,570	77	1,893	14,540	11,980	67	2,194	14,241			

 Table 3.7
 AADT of Centenario Bridge (no. of vehicles)

Source: Traffic Survey, METI F/S (2012)

(3) Pan-American Highway

Table 3.8 (Arraijan - Nuevo Arraijan) and Table 3.9 (Nuevo Arraijan - Chorrera) show the traffic along the Pan-American Highway. Compared to traffic of the Bridge of Americas, the number of taxis of Pan-American Highway is larger and the number of buses is smaller.

In the section of Arraijan - Nuevo Arraijan, the daily traffic of taxis is approximately 12,600 while that of buses is approximately 1,400. The peak hour of the traffic toward Panama City is 5:00-6:00 for buses and 7:00-8:00 for cars.

In the section of Nuevo Arraijan - Chorrera, the daily traffic of taxis is approximately 19,100 while that of buses is approximately 810.

(4) Autopista

A traffic count survey of Autopista was conducted in the METI Study, the result of which is shown in Table 3.10. Traffic in the period of 4:00-22:00 is approximately 51,900 in which the number of cars accounts for approximately 46,200. Express buses are operated along Autopista with a daily traffic of approximately 1,500.

	Table 5.6 IT and Volume between Arraijan and Nuevo Arraijan											
	From Arra	ijan To Nu	evo Arraija	n		From Nuevo Arraijan To Arraijan						
Time	Cars	Taxis	Buses	Trucks	TOTAL	Cars	Taxis	Buses	Trucks	TOTAL		
00:00-01:00	157	88	9	0	254	129	85	3	0	217		
01:00-02:00	66	37	3	1	107	65	48	1	4	118		
02:00-03:00	39	38	4	1	82	42	35	0	3	80		
03:00-04:00	56	52	16	3	127	73	54	11	5	143		
04:00-05:00	97	69	32	0	198	378	177	47	9	611		
05:00-06:00	187	114	29	8	338	793	259	68	14	1,134		
06:00-07:00	447	234	38	12	731	794	266	41	8	1,109		
07:00-08:00	721	298	33	23	1,075	1,078	297	37	50	1,462		
08:00-09:00	480	213	49	41	783	823	301	34	53	1,211		
09:00-10:00	550	246	39	28	863	738	345	32	41	1,156		
10:00-11:00	509	303	36	46	894	787	419	36	47	1,289		
11:00-12:00	574	277	32	42	925	847	501	30	58	1,436		
12:00-13:00	624	253	38	46	961	981	409	38	59	1,487		
13:00-14:00	604	302	32	48	986	869	395	37	48	1,349		
14:00-15:00	615	257	26	35	933	1,106	413	20	68	1,607		
15:00-16:00	682	354	38	22	1,096	897	420	32	49	1,398		
16:00-17:00	638	420	44	29	1,131	867	412	42	42	1,363		
17:00-18:00	742	483	32	19	1,276	917	482	37	35	1,471		
18:00-19:00	768	375	29	5	1,177	973	351	28	25	1,377		
19:00-20:00	772	288	40	12	1,112	907	338	23	12	1,280		
20:00-21:00	720	295	46	8	1,069	765	326	31	19	1,141		
21:00-22:00	516	257	19	1	793	634	278	26	14	952		
22:00-23:00	340	209	16	2	567	457	201	15	3	676		
23:00-24:00	281	123	14	4	422	238	156	5	4	403		
Total	11,185	5,585	694	436	17,900	16,158	6,968	674	670	24,470		

 Table 3.8
 Traffic Volume between Arraijan and Nuevo Arraijan

Source: Traffic Survey, JICA (2013)

Table 3.9	Traffic Volume between Nuevo Arraijan and La Chorrera
-----------	---

	From Nuev	vo Arraijan				From La Chorrera To Nuevo Arraijan				
Time			Buses	Trucks	TOTAL	Cars	Taxis		Trucks	TOTAL
00:00-01:00	67	26	1	4	98	101	12	0	1	114
01:00-02:00	36	13	0	1	50	88	7	0	4	99
02:00-03:00	36	16	1	3	56	51	9	1	5	66
03:00-04:00	30	13	0	3	46	126	21	9	5	161
04:00-05:00	38	19	3	5	65	170	58	28	18	274
05:00-06:00	143	31	2	6	182	471	53	37	16	577
06:00-07:00	472	75	6	15	568	596	84	24	12	716
07:00-08:00	671	49	12	62	794	786	150	25	62	1,023
08:00-09:00	480	62	9	52	603	557	100	22	52	731
09:00-10:00	471	57	6	57	591	560	137	20	70	787
10:00-11:00	328	32	8	51	419	480	108	17	57	662
11:00-12:00	409	37	8	50	504	462	102	17	58	639
12:00-13:00	464	52	4	66	586	568	122	17	56	763
13:00-14:00	395	29	10	43	477	531	96	20	65	712
14:00-15:00	421	44	10	50	525	623	107	13	58	801
15:00-16:00	457	66	14	46	583	639	126	41	57	863
16:00-17:00	522	91	27	30	670	644	104	46	42	836
17:00-18:00	641	118	28	30	817	720	123	46	35	924
18:00-19:00	581	107	21	14	723	760	120	24	14	918
19:00-20:00	431	67	22	5	525	594	88	44	14	740
20:00-21:00	424	61	21	10	516	509	65	37	12	623
21:00-22:00	336	71	22	3	432	466	77	48	9	600
22:00-23:00	234	63	7	5	309	302	47	26	7	382
23:00-24:00	102	29	4	2	137	150	32	2	10	194
Total	8,189	1,228	246	613	10,276	10,954	1,948	564	739	14,205

Source: Traffic Survey, JICA (2013)

	Trance volume of Autopista (between Arraijan and La Chorrera)										
	From Arrai	ijan To Cho	orrera		From Chor	rera To Ari	aijan				
Time	Car	Bus	Truck	Total	Car	Bus	Truck	Total			
4:00-5:00	1,068	51	92	1,211	85	6	42	133			
5:00-6:00	3,953	105	55	4,113	242	32	77	351			
6:00-7:00	3,721	51	16	3,788	686	61	117	864			
7:00-8:00	2,501	36	63	2,600	1,126	56	161	1,343			
8:00-9:00	1,388	30	150	1,568	832	45	127	1,004			
9:00-10:00	1,223	33	159	1,415	833	41	198	1,072			
10:00-11:00	971	20	120	1,111	904	55	180	1,139			
11:00-12:00	1,674	14	147	1,835	848	35	169	1,052			
12:00-13:00	727	18	118	863	544	33	162	739			
13:00-14:00	871	34	135	1,040	1,106	39	216	1,361			
14:00-15:00	867	50	191	1,108	1,430	43	153	1,626			
15:00-16:00	795	39	101	935	1,669	49	170	1,888			
16:00-17:00	1,013	70	132	1,215	2,186	56	153	2,395			
17:00-18:00	737	57	103	897	2,971	52	119	3,142			
18:00-19:00	642	44	47	733	2,931	61	94	3,086			
19:00-20:00	465	32	52	549	2,118	60	103	2,281			
20:00-21:00	387	17	50	454	1,465	40	101	1,606			
21:00-22:00	316	14	41	371	914	15	61	990			
Total	23,319	715	1,772	25,806	22,890	779	2,403	26,072			
5:00-21:00	21,935	650	1,639	24,224	21,891	758	2,300	24,949			

Table 3.10Traffic Volume of Autopista (between Arraijan and La Chorrera)

Source: Traffic Survey, METI F/S (2012)

3.3.2 Passenger OD Survey

A Passenger OD Survey was carried out at Albrook Terminal and major bus stops along the Line-3 route. Table 3.11 shows the locations where the surveys were made. Passengers in taxis and "pirata" buses (unauthorized buses) were interviewed at site No. 3 (Calle 25-Calidonia). In total, 5,042 samples were collected.

No.	Location	No. of Samples	Target	Direction	Time
1	Albrook Terminal	1,285	Bus	To Chorrera	0:00-20:00
2	Xtra supermarket in Arraiján	929	Bus	Both directions	6:00-14:00
3	Calle 25- Calidonia	93	Taxi	To Chorrera	16:00-20:00
4	Nuevo Chorrillo	319	Bus	To Albrook	6:00-14:00
5	Rey supermarket in Vista Alegre	424	Bus	To Albrook	6:00-14:00
6	Tajonaso bus stop in Vista Alegre	83	Bus	To Albrook	6:00-14:00
7	HOPSA in Vista Alegre	72	Bus	To Albrook	6:00-14:00
8	Super 99 supermarket in Valle	329	Bus	To Albrook	6:00-14:00
	Hermoso				
9	Bus stop in San José	95	Bus	To Albrook	6:00-14:00
10	Ciudad del Futuro	94	Bus	To Albrook	6:00-14:00
11	Bus stop at El Machetazo	61	Bus	To Albrook	6:00-14:00
12	Plaza Italia	80	Bus	To Albrook	6:00-14:00
13	El Pueblo supermarket	32	Bus	To Albrook	6:00-14:00
14	Rey supermarket in La Chorrera	1,146	Bus	To Albrook	6:00-14:00

 Table 3.11
 Locations of Passenger OD Surveys

Source: Traffic survey, JICA Study Team (2013)

It was found that the majority of the trips along the route are long distance trips between the western areas (La Chorrera and Arraijan) and Albrook. Since the number of samples for short distance trips was very small, the internal trips in the OD matrix could not be estimated.

In the Passenger OD Interview Survey, the average travel time of the interviewees was 110 minutes, and the average fare they paid was USD2.00.

Table 3.12 shows the modal share of feeder transport along Panamerican Highway taken from the Passenger OD Interview Survey. The feeder bus is an important transport mode to bus stops along the road, and taxi also plays an important role as the feeder mode. Car accounts for approximately 5% of the feeder modes, which means that pick-up and drop-off by private car is necessary for some people. Taxi and car use implies that public transport system as the feeder system is poor in this area.

14		70 01 111	ouur onur	e of i ceut	I Hunspo	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
Mode	Arraijan	Burunga	Nuevo	Vista	Ciuda de	Rey
WIGue	Allaljali	Burunga	Chorrillo	Alegre	Futuro	Chorrera
Walk	30.4%	10.3%	24.1%	42.3%	78.1%	7.9%
Car	4.6%	4.6%	4.2%	7.1%	3.5%	5.3%
Taxi	23.6%	38.6%	29.6%	22.5%	6.7%	19.9%
Pirata	1.1%	1.2%	0.3%	0.7%	0.7%	0.5%
Bus	39.9%	45.0%	41.7%	27.1%	9.5%	66.0%
Others	0.4%	0.2%	0.0%	0.3%	1.6%	0.4%
a na						

Table 3.12% of Modal Share of Feeder Transport

Source: JICA Study Team

3.3.3 Stated Preference Survey

The Stated Preference Survey (SP) was carried out for bus passengers, taxi passengers, and car users. This is a survey where travelers were asked their choice between using a metro system and a bus (or car). Although different transportation conditions were presented to the interviewees, the tendency shows a strong preference for the metro system as shown in Table 3.13.

Table 5.15 Wode Treference in the ST Survey							
Preference mode	Bus passengers	Taxi passengers	Car drivers				
Metro	39.6%	36.3%	55.6%				
Bus	60.4%	-	-				
Taxi	-	63.7%	-				
Car	-	-	44.4%				

Table 3.13Mode Preference in the SP Survey

Note: These are the percentages of all the samples consisting of the different travel conditions (travel time, fare, etc.). Source: Traffic Survey, JICA Study Team (2013)

The SP survey shows that bus passengers in the western area pay an average fare of USD1.70 per trip, while taxi passengers pay USD3.20 in average.

A disaggregated model analysis was carried out and the value of time of bus passengers was calculated to be 19.2 minutes per dollar (or USD3.10 per hour). The value of time of taxi passengers and car drivers was not estimated because the "t-value" of each parameter in the disaggregated model analysis was very low. Table 3.14 shows that the result of the logit model analysis for bus and taxi users.

Table 3.14 Result of Logit Would Analysis						
Variable	Bus	Taxi				
Travel Time (minutes)	-0.01766 (t = -5.54)	-0.05617 (t = -5.29)				
Fare (USD)	-0.3388 (t = -3.4)	-0.7969 (t= -5.16)				
Seat availability (0=seat, 1=standing)	-0.404 (t = -5.1)	-0.3991 (t = -1.02)				
Constant (Line- $3 = 1$, the other =0)	-0.3344 (t = -2.32)	-0.8351 (t = -3.84)				
No. of data	1,428	226				
Goodness-of-fit	63.5%	73.5				
Chi-square	134	85.3				
Rho-square	0.068	0.267				
Note: t – Student's T Value						

Table 3.14	Result of	of Logit Model Analysis

Note: t = Student's T Value Source: JICA Study Team

3.3.4 Travel Time Survey

A travel time survey was carried out along the Panamericana Road for normal buses and along the Autopista for express buses. In the morning peak hours, it took 130 minutes from La Chorrera to Albrook along the Panamericana while it took 100 minutes along the Autopista. It took 70 minutes from Arraijan to Albrook (approximately 15km/h). The travel time of passenger cars was also measured and the speed between Arraijan and Albrook by car was calculated to be 17 km/h.

At the evening peak hours, it took 110 minutes from Albrook to La Chorrera along the Panamericana while it took 100 minutes along the Autopista. The travel time from Albrook to Arraijan was 40-50 minutes (21-27km/h).

3.4 Socioeconomic Framework

3.4.1 Economic Growth Rate

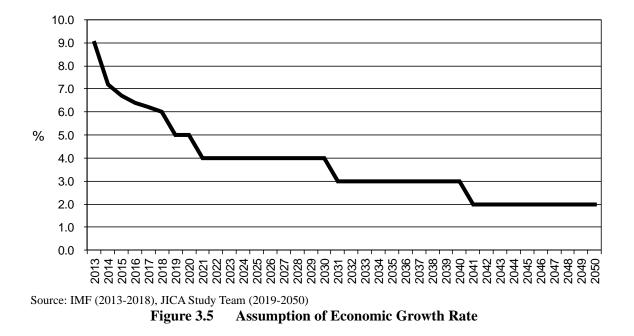
The assumption on the economic growth rates are applied to the estimation of the future car ownership and truck traffic in the Study. IMF estimated the economic growth rate (real GDP) of Panama from 2013 to 2018 as shown Table 3.15. The World Bank' estimation is similar to that of IMF.

10010 0110	He omonine						
	2013	2014	2015	2016	2017	2018	
IMF	9.0	7.2	6.7	6.4	6.2	6.0	
World Bank	7.9	7.3	6.9	6.5	-	-	

Table 3.15Economic Growth Rate Projection from 2013 to 2018 (%)

Source: IMF Web page, The World Bank Web Page

The Study employed the forecast by IMF for the economic growth rates from 2013 to 2018. The economic growth rates after 2018 need to be assumed in the Study because there is no official prospect. Although IMF forecasted that a high economic growth would continue up to 2018, it is not sure that such high growth rates continue in long term. In the study, the economic growths after 2018 were assumed as 5.0% (2019, 2020), 4.0% (2021-2030), 3.0% (2031-2040), and 2.0% (2041-2050) as shown in Figure 3.5. Under this assumption, the GDP of Panama in 2050 would be four times that of 2012 and the per capita GDP would be approximately 2.7 times, becoming the level in developed countries at present.



3.4.2 Population Projection

Presently, Arraijan and La Chorrera districts have a population of 230,000 and 168,000, respectively, according the Census of 2010. The total population of both districts is 398,000. The metropolitan area (Panama, San Miguelito, Arraijan, and La Chorrera districts) has a population of 1.7 million in total.

The National Institute of Statistics and Census (INEC) estimated the population in Panama at the district level up to the year 2020. The same methodology as the INEC projection was used to estimate the population up to 2050 for the Study Area. There are three variables for projecting the population: 1) birth rate, 2) mortality rate, and 3) migration rate. With the combination of these variables, low, medium, and high case projections were made. PRODEM, which was developed by the Latin America Demographic Center (CELADE), was used for the calculations.

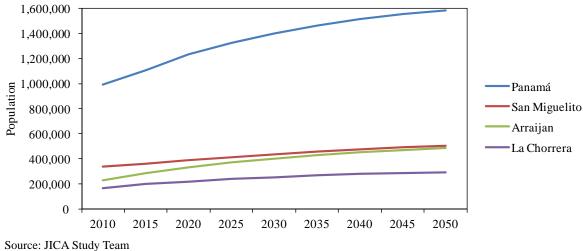
In the high case projection, the population of the western area (Arraijan and La Chorrera) in 2050 is estimated at 778,000, which is 1.96 times the population in 2010.

In planning for an urban transportation system, it is necessary to evaluate the capacity of the candidate systems whether or not they can satisfy the future demand. Therefore, the high case of population projection is used for the Line-3 demand forecast.

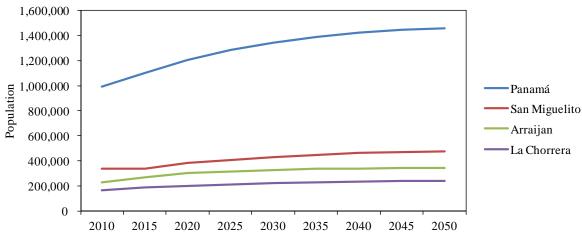
High Case	14	510 0110	- opulat	ion i roject		
Year	Panamá	San Miguelito	Arraijan	La Chorrera	Subtotal	Metropolitan
2010	989,100	336,074	230,311	167,799	398,110	1,723,284
2015	1,109,286	362,484	287,329	197,659	484,988	1,956,758
2020	1,231,582	390,810	333,072	219,971	553,043	2,175,435
2025	1,324,951	413,951	373,677	239,373	613,050	2,351,952
2020	1,399,486	437,855	403,452	253,486	656,938	2,494,279
2035	1,462,119	458,500	431,054	266,288	697,342	2,617,961
2033	1,514,134	438,300	453,973	200,288	731,632	2,017,901
		470,890				2,808,174
2045	1,555,295	493,774 506,836	471,981 484,499	287,124	759,105	
2050	1,584,017	506,836	464,499	293,927	778,426	2,869,279
Growth Rate	2.3%	1.5%	4.5%	3.3%	4.0%	2.6%
2010-15	2.3%			2.2%		
2015-20		1.5%	3.0%		2.7%	2.1%
2020-25	1.5%	1.2%	2.3%	1.7%	2.1%	1.6%
2025-30	1.1%	1.1%	1.5%	1.2%	1.4%	1.2%
2030-35	0.9%	0.9%	1.3%	1.0%	1.2%	1.0%
2035-40	0.7%	0.8%	1.0%	0.8%	1.0%	0.8%
2040-45	0.5%	0.7%	0.8%	0.7%	0.7%	0.6%
2045-50	0.4%	0.5%	0.5%	0.5%	0.5%	0.4%
Madium O	_					
Medium Case		Son Migualit-	Arroller	La Charrana	Subtatal	Motronalite
Year	Panamá	San Miguelito	Arraijan	La Chorrera	Subtotal	Metropolitan
2010	989,100	336,074	230,311	167,799	398,110	1,723,284
2015	1,098,068	335,429	270,191	186,640	456,831	1,890,328
2020	1,206,774	380,899	300,979	201,301	502,280	2,089,953
2025	1,284,681	407,878	317,368	213,761	531,129	2,223,688
2030	1,343,430	429,725	328,637	223,301	551,938	2,325,093
2035	1,389,161	447,677	336,102	230,773	566,875	2,403,713
2040	1,423,801	461,748	340,621	236,434	577,055	2,462,604
2045	1,447,456	471,695	342,369	240,296	582,665	2,501,816
2050	1,458,992	477,303	341,670	242,149	583,819	2,520,114
Growth Rate						
2010-15	2.1%	0.0%	3.2%	2.2%	2.8%	1.9%
2015-20	1.9%	2.6%	2.2%	1.5%	1.9%	2.0%
2020-25	1.3%	1.4%	1.1%	1.2%	1.1%	1.2%
2025-30	0.9%	1.0%	0.7%	0.9%	0.8%	0.9%
2030-35	0.7%	0.8%	0.5%	0.7%	0.5%	0.7%
2035-40	0.5%	0.6%	0.3%	0.5%	0.4%	0.5%
2040-45	0.3%	0.4%	0.1%	0.3%	0.2%	0.3%
2045-50	0.2%	0.2%	0.0%	0.2%	0.0%	0.1%
Low Case						
Year	Panamá	San Miguelito	Arraijan	La Chorrera	Subtotal	Metropolitan
2010	989,100	336,074	230,311	167,799	398,110	1,723,284
2015	1,086,850	348,374	253,048	175,619	428,667	1,863,891
2020	1,181,967	370,988	286,235	188,290	474,525	2,027,480
2025	1,244,411	401,804	300,036	200,954	500,990	2,147,205
2030	1,287,373	421,594	309,805	213,240	523,045	2,232,012
2035	1,316,203	436,854	317,601	220,625	538,226	2,291,283
2040	1,333,468	446,600	324,793	228,186	552,979	2,333,047
2045	1,354,617	455,616	331,538	233,607	565,145	2,375,378
2050	1,375,967	465,769	335,837	236,972	572,809	2,414,545
Growth Rate						
2010-15	1.9%	0.7%	1.9%	0.9%	1.5%	1.6%
2015-20	1.7%	1.3%	2.5%	1.4%	2.1%	1.7%
2020-25	1.0%	1.6%	0.9%	1.3%	1.1%	1.2%
2025-30	0.7%	1.0%	0.6%	1.2%	0.9%	0.8%
2030-35	0.4%	0.7%	0.5%	0.7%	0.6%	0.5%
2035-40	0.3%	0.4%	0.4%	0.7%	0.5%	0.4%
2040-45	0.3%	0.4%	0.4%	0.5%	0.4%	0.4%
	0.3%	0.4%	0.3%	0.3%	0.3%	0.3%
2045-50	0.070					

Table 3.16Population Projection

Source: JICA Study Team

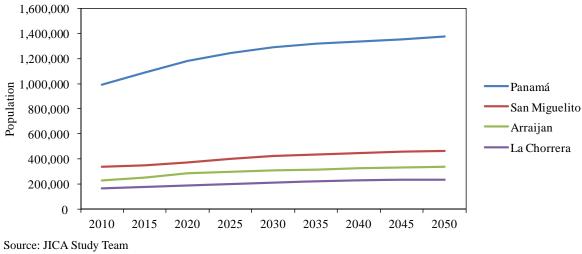


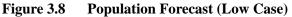




Source: JICA Study Team

Figure 3.7 Population Forecast (Mid Case)





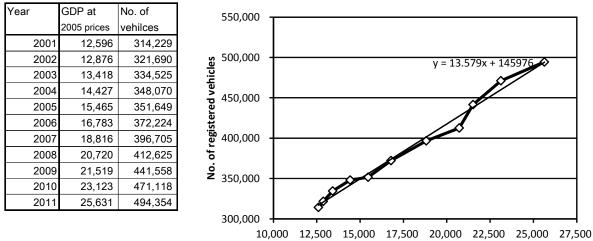
3.4.3 Car ownership

The number of cars in Panama has been rapidly increasing in recent years. The number of vehicles per 1,000 inhabitants is calculated to be 129 (2010). Although this rate is high compared to other neighboring countries, car ownership in Panama is still lower than most developed countries. Table 3.17 shows the number of vehicles per 1000 inhabitants for several countries.

797 679 591 572 527 393 314	USA	Italia	Japan	German	Netherlands	Malaysia	Argentina
	797	679	591	<i>ער</i>	577	393	314

Source: The World Bank (web database)

Figure 3.9 shows the time series data of the GDP and the number of vehicles of Panama, which shows that the number of cars has a strong correlation with the GDP.



GDP at 2005 prices

Source: JICA Study Team

Figure 3.9 No. of Vehicles in Panama

The future number of vehicles was estimated by using the linear function based on the regression analysis as shown in Table 3.18. It is estimated that car ownership will be 2.08 times the current rate in 2050. Under this projection, even in 2050 the number of vehicles per 1000 inhabitants will still be lower than that of developed countries.

1abic 5.10	5 110.01	venicies per 100	v innabitants (1 i	ojection)
Year	Population	No. of vehilcles	No. of vehicles	
			per 1000	Ratio to
	('000)	('000)		2013
2013	3,851	566	146.9	1.00
2020	4,279	780	182.3	1.24
2030	4,835	1,084	224.3	1.53
2040	5,230	1,407	269.0	1.83
2050	5,507	1,683	305.6	2.08

Table 3.18No. of Vehicles per 1000 inhabitants (Projection)

Source: Projection by JICA Study Team

3.5 **Demand Forecasting Model**

3.5.1 **Present OD**

(1) **Traffic Volume crossing the Panama Canal**

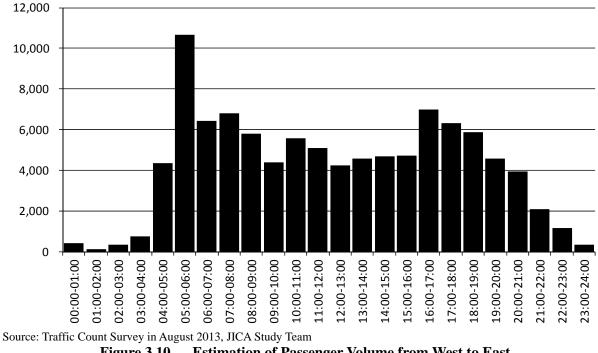
The number of passengers (public transportation) crossing the Panama Canal in the morning peak hour peak direction was estimated to be 10.653 (5:00-6:00), 6.453 (6:00-7:00), and 6,792 (7:00-8:00), based on the results of the traffic count survey. The number of buses using the Centenario Bridge in the peak hour was as little as 17 (2012) carrying an estimated 935 passengers (55 passengers per bus). Table 3.19 and Figure 3.10 show the estimated number of passengers traveling from the west to east of the canal, while Table 3.21 shows that for the east- west direction.

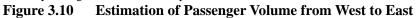
	Public	Public					Private	
	Vehicles		Passengers	5		Car		
Time	Bus	Taxi	Bus	Taxi	Total	Vehicles	Passengers	
			45/bus	3/taxi			1.5/car	
5:00-6:00	210	401	9,450	1,203	10,653	2,018	3,027	
6:00-7:00	124	291	5,580	873	6,453	2,362	3,543	
7:00-8:00	144	104	6,480	312	6,792	1,647	2,471	
2 hour (5-7)	334	692	15,030	2,076	17,106	4,380	6,570	
2 hour (6-8)	268	395	12,060	1,185	13,245	4,009	6,014	
Peak Centenario	23	-	1,265	-	1,265	2,946	4,419	
Peak (2 hour)					18,371		10,989	

Table 3.19 Estimation of Passenger Volume from West to East

Note: Large size buses (seating capacity of 55) account for 50% according to another traffic survey by COTRANS at the same place. Since seating capacity of small buses is 35 in general, the average occupancy rate of a bus is calculated at 45 (55*0.5+35*0.5).

Source: Traffic Count Survey in August 2013, JICA Study Team





Tuble 5.20 Estimation of Lassenger volume from East to West							
	Public					Private	
	Vehicles		Passengers	5		Car	
Time	Bus	Taxi	Bus	Taxi	Total	Vehicles	Passengers
			45/bus	2/taxi			1.5/car
5:00-6:00	37	194	1,665	388	2,053	194	291
6:00-7:00	82	33	3,690	66	3,756	354	531
7:00-8:00	97	72	4,365	144	4,509	571	857
2 hour (5-7)	119	227	5,355	454	5,809	548	822
2 hour (6-8)	179	105	8,055	210	8,265	925	1,388
Peak Centenario	8	-	440	-	440	433	650
Peak (7-8)					4,949		1,506

Table 3.20	Estimation of Dessanger	Volume from Fast to West
1able 3.20	Estimation of Tassenger	• Volume from East to West

Source: Traffic Count Survey in August 2013, JICA Study Team

(2) Peak 2 hours OD Matrix

At present, the travel time from Arraijan to Albrook at the peak hour is approximately 30 minutes longer than that of off-peak hours. In order to save on travel time, people travel in the early morning hours to avoid the congestion creating a higher traffic demand before the peak hour. If the urban transport system were not affected by traffic congestion, more people could travel in the peak hour, although a part of the passengers would still need to make early morning trips because of the congestion in the center of Panama City.

This logic does not apply to the traffic demand for the opposite direction in the same period because the opposite direction is not congested in the morning peak hour; therefore the peak hour traffic still represents the traffic demand at peak hour even if the urban transport system is introduced. In addition, the peak hour traffic using the Centenario Bridge is considered to be the peak hour demand because traffic congestion is not observed along the route.

The SMP 2009 OD consists of trips in the peak 2 hours from 6:00 to 8:00. However, according to the traffic survey, the peak hour in the west area appears one hour earlier (5:00-6:00) than the peak time in the center of the city.

The number of trips by zone pair between the west and east of the canal in the peak 2 hours from 5:00 to 7:00 was estimated from the passenger interview survey and the traffic count survey in 2013. The corresponding OD pairs in the SMP 2009 OD were replaced with the estimated OD.

For the traffic assignment, the 2 hours OD is used as the peak hour demand, although its justification needs to be reviewed in the sensitivity analysis of the economic and financial analysis.

3.5.2 Modal Share

(1) **Private Mode in the Without Case**

The share of the private mode is very high in Panama City, although neither statistics nor reliable estimation of modal share in Panama are available. Table 3.21 shows the modal share that was estimated by using the SMP 2009 OD matrix. The calculated private mode share is as high as 41.6% for the total metropolitan area, while the private mode share is only 23.3% in Arraijan and La Chorrera.

Table	J.21 MIO		SIMI 2007	JD (0.00-0.00	, 2 nours)	
	Total			Arraijan and	La Chorrera	
	Private	Public	Total	Private	Public	Total
No. of trips	137,826	193,717	331,543	12,191	40,292	52,483
%	41.6%	58.4%	100%	23.2%	76.8%	100%
Source: SMP						

Table 3.21	Modal Share in SMP 2009 OD (6:00-8:00, 2 hours))
1abic 3.21	1100a1 Share in Sini 2007 OD ($0.00-0.00, 2$ nours)	í

Source: SMI

In this Study, the modal share is calculated based on the traffic survey of 2013 as shown in Table 3.22. The public mode share in 2013 is estimated to be 66%.

The private mode share in Panama and San Miguelito districts is already high and it is assumed that the share will remain the same. On the other hand, the private mode share in Arraijan and La Chorrera is assumed to increase in proportion to the car ownership rate of the country. In the case that the urban transport system is not developed, the private mode share is estimated to be 54.4% in 2050 for Arraijan and La Chorrera as shown in Table 3.22.

1abic 3.22	Louina			i aijan ana i	
	No. of trip	os (2hours)	% ti	rips	Ratio of car
Year	Public	Private	Public	Private	ownership
					to 2013
2013	21,316	10,972	66.0	34.0	1.00
2020	27,716	19,388	58.8	41.2	1.24
2025	30,307	24,401	55.4	44.6	1.37
2030	31,873	29,196	52.2	47.8	1.53
2035	32,484	32,672	49.9	50.1	1.66
2040	34,249	35,312	49.2	50.8	1.83
2050	35,765	42,651	45.6	54.4	2.08
<u>a</u> n.:	· 1 HOLD	1			

Table 3.22 Estimation of Modal Share in Araijan and La Chorrera

Source: Estimation by JICA Study Team

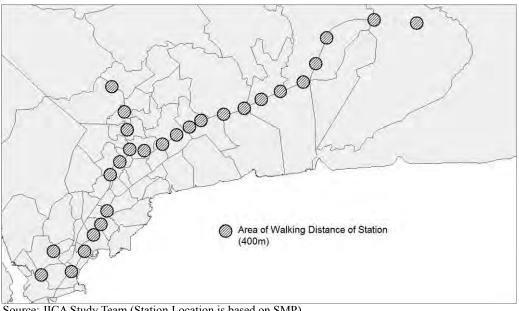
(2) Modal Shift from Car to Line-3

The stated preference survey for passenger car users shows that half of the car users will select the metro system if it is faster than cars by more than 20 minutes. The Park & Ride scenario also shows the same preference. This means that if the destination is within walking distance, approximately half of the car users will shift to the metro system. Figure 3.11 shows the areas within walking distance from the metro stations. The number of trips to these areas was estimated based on the proportion of the area to the intersect zones. The number of trips that shift to Line-3 was assumed to increase from 55% to 70% of the estimated trips as shown in Table 3.23.

Table 3.2	3 Mo	dal Shift	Rate from	Car to L	ine-3

2020	2025	2030	2035	2040	2050
55%	57.5%	60%	62.5%	65%	70%
	m				

Source: JICA Study Team



Source: JICA Study Team (Station Location is based on SMP) Figure 3.11 Area of Walking Distance for Modal Shift

3.5.3 **Demand of Panama Pacifico**

(1) **Trip Generation and Attraction**

Panama Pacifico will have 20,000 houses and 40,000 employees in the future according to the master plan. The peak hour trips from/to Panama Pacifico were estimated based on several assumptions as shown in Table 3.24.

From Panama Pacifico			
No. of households		20,000	
No. of persons per household		3.8	
Population		76,000	
% of economically active population 41.5%			
Economically active population	31,540		
% commuters to outside of Panama Pacifico	67% (2/3)		
No. of commuters from Panama Pacifico	21,000		
No. of commuters within Panama Pacifico	10,540		
Peak hour rate	40%		
Peak hour trips from Panama Pacifico	8,400		
Public mode share	2030	2040	2050
	50%	65%	70%
Public transport demand in peak hour	4,200	5,460	5,880
To Panama Pacifico			
No. of employees		40,000	
No. of commuters from outside		29,460	
Peak hour rate		40%	
Peak hour trips to Panama Pacifico		11,784	
Public mode share	2030	2040	2050
	50%	65%	70%
Public transport demand in peak hour	5,900	7,670	8,260

Table 3.24 Trip Generation and Attraction in Panama Pacifico

Source: Estimation by JICA Study Team

(2) Intermediate Year Forecast

Since the development schedule of Panama Pacifico is not clear, it is assumed that the number of trips would reach 50% of the estimated number of trips in 2020, 80% in 2025, and 100% in 2030. The intermediate year forecast of the demand of Panama Pacifico is shown in Table 3.25.

Table 3.25Intermediate Year Forecast of Public Transport Trips from/to Panama Pacifico
--

	2020	2025	2030	2035	2040	2050
Generation	2,100	3,360	4,200	4,200	5,460	5,880
Attraction	2,950	4,720	5,900	5,900	7,670	8,260
Carrier Estima	tion has HCA Sta	J				

Source: Estimation by JICA Study Team

(3) Trip Distribution

The OD matrix relating to Panama Pacifico was estimated by applying the following trip distribution model.

No. of trips = $V/x_{ij}^{0.12}$, where x = distance between the center of zone *i* and *j* (m)

V is the trip generation of Panama Pacifico when i is the zone of Panama Pacifico, while it is the trip attraction when j is the zone of Panama Pacifico. This model was developed using the data in the SMP 2009 OD.

Since the sum of the calculated number of trips $(\sum V/x_{ij}^{0.12})$ does not meet the number of trips (V) estimated in Table 3.24, the number of trips was adjusted by the ratio of V and $\sum V/x_{ij}^{0.12}$.

3.5.4 Transit Assignment

(1) Transit Assignment Model

JICA STRADA is a package of demand forecast applications. The Transit Assignment component of JICA STRADA was used in the Study. The transit assignment model applies a multipath search with the generalized cost of each transit route. The generalized cost consists of: 1) in-vehicle travel time, 2) walking time, 3) waiting time, and 4) fare. Alternative transit routes with a generalized cost less than 110% of the minimum generalized cost are selected for each OD pair and the traffic is assigned according to the route share calculated as:

Route Share of route $i = \exp(GC_i) / \sum \exp(GC_j)$, where $GC_j = \text{generalized cost of route } j$

The maximum number of transfers is five.

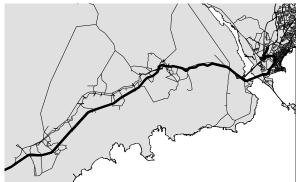
(2) Transit Lines

The Metro Bus routes, which were identified in the Mibus (operator of Metro Bus) web page, were incorporated into the network model. Table 3.26 shows the list of Metro Bus routes in the transit network data. In Arraijan and La Chorrera, express bus services and standard services are built into the model. Figure 3.12 and Figure 3.13 show the bus routes in the transit network model.

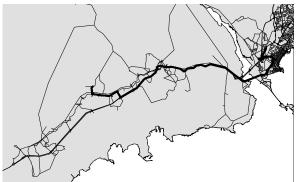
No.	Table 3.26 Transit	Lines in Network	Remark
INO.	Route Name	Transit Network	Remark
MB01	Albrook-Via España-Balboa-Directo	-	Route is included in MB10.
MB02	Alcalde Díaz-Corredor Norte	MB02A, MB02B	-
MB03	Alcalde Díaz-Transistmica	MB03A, MB03B	-
MB04	Alcalde Díaz-Vía España	MB04A, MB04B	-
MB05	Boca La Caja-Marañón-Calle 50-Circular	MB05	-
MB06	Ciudad Bolívar-Corredor Norte Albrook	-	Route is included in MB02.
MB07	Chilibre-Transistmica	-	Route is included in MB03.
MB08	Ciudad Bolívar-Tumba Muerto	MB08A, MB08B	-
MB09	Concepción-Circular	-	Route is excluded due to short length
MB10	Concepción-Via España	MB10A, MB10B	-
MB11	Don Bosco-Corredor Sur-Mercado de Marisco	MB11A, MB11B	-
MB12	Don Bosco-Transístmica-Albrook	MB12A, MB21B	-
MB13	Don Bosco- Via España -Albrook	MB13A, MB13B	-
MB14	El Dorado-Betania-Ave. La Paz	MB14	-
MB15	Felipillo-Corredor Sur-Albrook	MB15A, MB15B	-
MB16	Gran Estación – Transístmica – Albrook - Directo	-	Route is included in MB08.
MB17	La Doña-Corredor Sur-Albrook	-	Route is included in MB15 Difference is inside the same zone and it does not have impact of demand model.
MB18	La Doña-Costa Del Este-Corredor Sur-Urracá	-	ditto
MB19	Los Andes - Corredor Norte – Albrook	MB19A, MB19B	-
MB20	Los Andes – Tumba Muerto - Albrook	MB20A, MB20B	-
MB21	Los Andes- Via España -Albrook	MB21A, MB21B	-
MB22	Mañanitas-Corredor Sur-Albrook	-	Route is included in MB23.
MB23	Mañanitas-Hora Valle-Albrook	MB23A, MB23B	-
MB24	Parque Real – Corredor Sur – Albrook	-	Route is included in MB23.
MB25	Mañanitas-Tumba Muerto-Albrook	MB25A, MB25B	-
MB26	Mañanitas- Via España – Albrook	MB26A, MB26B	-
MB27	Mano de Piedra-Corredor Norte-Albrook	MB27A, MB27B	-
MB28	Pacora-Corredor Sur-Albrook	- MD204_MD20D	Route is included in MB15.
MB29	Padregal-Corredor Sur-Mlechi	MB29A, MB20B	
MB30 MB31	Pedregal-Transístmica-Albrook Pedregal-Tumba Muerto-Albrook	MB30A, MB30B	- Route is included in MB25.
MB31 MB32	Pedregal-Tumba Muerto-Albrook Pedregal-Via España – Albrook	-	Route is included in MB25.
MB32 MB33	Panamá Viejo-Ave. Balboa	- MB33A, MB33B	-
MB34	Panamá Viejo-Ave. Baldoa Panamá Viejo-Vía Porras-Albrook	MB34A, MB34B	-
MB34 MB35	San Pedro-Circular	-	Route is excluded because it is shown
			in the same zone.
MB36	San Pedro-Corredor Sur-Ancón	MB36A, MB36B	-
MB37	San Pedro-Via Espaná	MB37A, MB37B	-
MB38	Santa Librada-Corredor Norte-Albrook	MB38A, MB38B	-
MB39	Santa Librada- Transístmica-Albrook	MB39A, MB39B	-
MB40	Santa Librada- Tumba Muerto-Albrook	MB40A, MB40B	-
MB41	Santa Librada- Vía Espanañ-Albrook	MB41A, MB41B	-
MB42	Tocumen-Corredor Sur-Albrook	MB42A, MB42B	-
MB43	Tocumen-Transístmica-Albrook	MB43A, MB43B	-
MB44	Tocumen-Tumba Muerto-Albrook	MB44A, MB44B	-
	Tocument-Vía España-Albrook	MB45A, MB45B	-
MB45		MB46A, MB46B	-
MB45 MB46	Torrijos Carter-Corredor Norte-Albrook	· · ·	
MB45 MB46 MB47	El Valle-Corredor Norte-Albrook	-	Service area is covered by MB38.
MB45 MB46 MB47 MB48	El Valle-Corredor Norte-Albrook El Valle- Transístmica -Albrook	-	Service area is covered by MB39.
MB45 MB46 MB47 MB48 MB49	El Valle-Corredor Norte-Albrook El Valle- Transístmica -Albrook El Valle- Vía España-Albrrok	-	Service area is covered by MB39. Service area is covered by MB41.
MB45 MB46 MB47 MB48	El Valle-Corredor Norte-Albrook El Valle- Transístmica -Albrook	-	Service area is covered by MB39.

Table 3.26	Transit Lines in	Network Model
-------------------	------------------	---------------

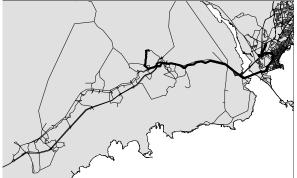
Source: JICA Study Team (Bus route: http://www.mibus.com.pa/rutas/)



Autopista -- Bridge of Americas - Albrook



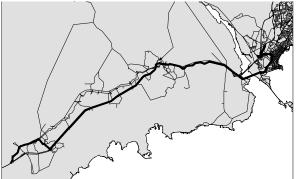
Ciudad del Futuro - Autopista – Bridge of Americas - Albrook



Burunga - Bridge of Americas – Albrook



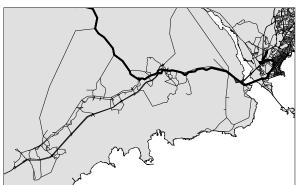
La Chorrera - Panamericana - Bridge of Americas - Albrook Source: JICA Study Team



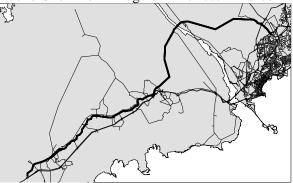
Panamericana - Autopista - Bridge of Americas -Albrook



Veracrus - Bridge of Americas - Albrook

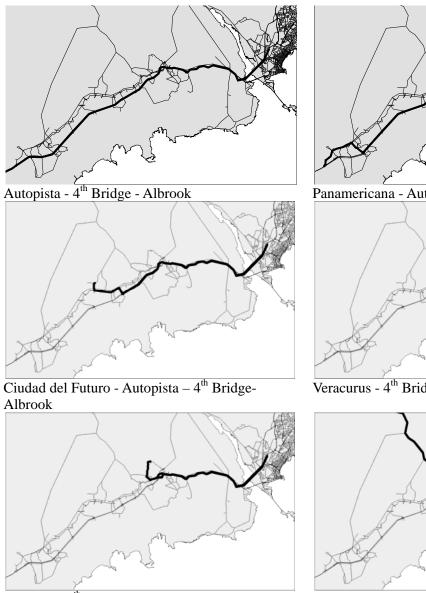


Nuevo Chorrillo - Bridge of Americas - Albrook

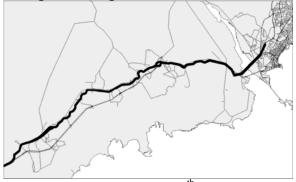


La Chorrera - Panamericana - Centerario Bridge -Albrook





Burunga - 4th Bridge - Albrook



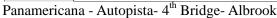
La Chorrera - Panamericana - 4th Bridge -Albrook Source: JICA Study Team

Other feeder routes



Figure 3.14 shows the underlying link data for the transit data. Length and speed in the link data are used for the transit network data.

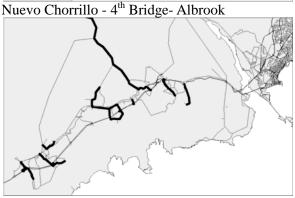






Veracurus - 4th Bridge - Albrook





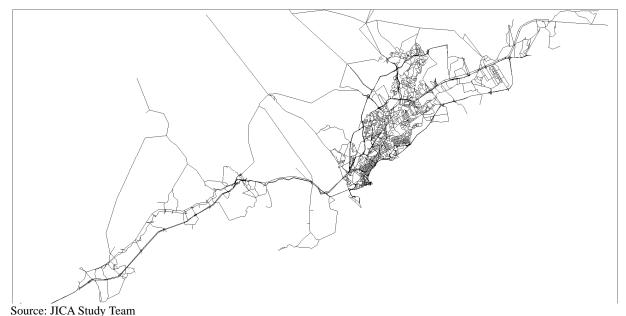
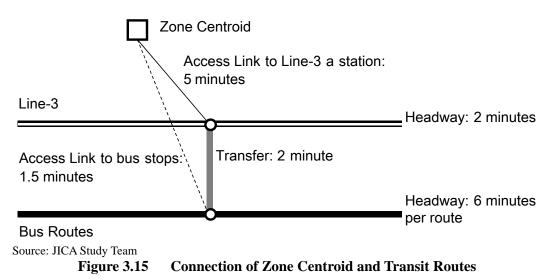


Figure 3.14 Links in the Network Model

In the demand forecast model, each Line-3 station has a zone centroid that represents the trip generation and attraction point within the walking distance of the station. The zone centroids are also connected to the nodes of bus routes, although each node does not necessarily mean a bus stop. The nodes of the bus routes are considered as representative nodes of several bus stops of the routes. Figure 3.15 illustrates the network model of the connection of zone centroid to Line-3 and bus routes.



(3) Speed

In the transit assignment model, the travel speed is defined by line speed and link speed. The lower speed is applied for the calculation. Table 3.27 shows the setting of the speed in the transit network data. According to the Ministry of Public Works (MOP), the Panamericana Highway between Arraijan and the canal will be widened to a 6-lane road after the construction of the 4th Bridge, which will increase the travel speed. However, since the number of private cars will also increase in the future, it is assumed that the travel speed will be the same for the period from 2020 to 2050.

Mode	Maximum*	Expressway	In Panama	In Arraijan &	Rail Link
			City	La Chorrera	
Metro Bus	40km/h	40km/h	10km/h	20km/h	-
Bus	40km/h	40km/h	10km/h	20km/h	-
Bus (Express)	60km/h	60km/h	10km/h	20km/h	-
Line-1	35km/h	-		-	35km/h
Line-3	40km/h	-		-	40km/h*2
					35km/h

Table 3.27Speed Setting

*2: Long distance sections Source: Setting by JICA Study Team

(4) Transit Fare

Presently, the bus fare between Arraijan and Albrook is USD0.35. Table 3.28 shows the present transit fare in the Study Area. From this information, the fare per kilometer between Arraijan and La Chorrera (18.7km) is estimated at (0.8-0.35)/18.7 = USD 0.0024/km. The fares of air-conditioned buses and express buses are more expensive.

Table 3.28 Transit Fare between Albrook and La Chor	rera
---	------

Section		Present Transit Fare
Albrook – Arraijan	USD 0.35	Extra supermarket
	USD 0.60	Vista Alegre
	USD 0.75	Express (Ciudad Futuro)
	USD 1.50	Express (Ciudad Futuro, Autopista)
Albrook – La Chorrera	USD 1.50	Autopista
	USD 0.80	Panamericana
	USD 2.00	Air-conditioned

Source: Surveyed by the JICA Study Team

In JICA STRADA, the fare setting is modeled as following formula.

Fare = F + R * Max(Distance - X, 0)

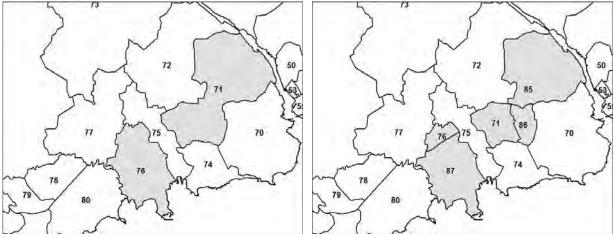
The fare setting applied in the Study is shown in Table 3.29. The fare of Line-3 is assumed to be approximately USD 1.2 between Albrook and La Chorrera, which is higher than the normal bus along Panamericana Road and lower than express bus services.

	Table 3.29Fare Setting					
No.	Mode	F: Fix Rate	X:	R:	Transfer among	
		(USD)		Variable Rate	same modes	
1	Metro Bus	0.25	-	-	Free	
2	Bus	0.35	18km	0.024	-	
3	Express (Autopista)	1.50	-	-	-	
4	Express (Panamericana)	0.75	-	-	-	
5	Express (Corredor Norte,	1.25	-	-	-	
	Corredor Sur)					
6	Feeder	0.25	-	-	-	
7	Access dummy	0.0	-	-	-	
8	Metro	0.65	-	-	Free	
9	Line-3*	0.65	18km	0.042	-	

*: Fare of Line-3 between Albrook and La Chorrera (31km) = 0.65 + 0.042 (31-18) = USD 1.2 Source: JICA Study Team

(5) Traffic Zones for Stations

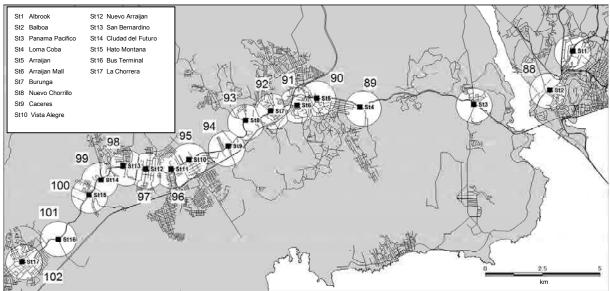
There are 14 stations in the Phase-1 section and 3 stations in the Phase-2 section of Line-3. The 84 traffic zoning system, which was prepared based on corregimiento boundaries, was further subdivided to take into account the stations for the demand forecast. Firstly, Arraijan and Vista Alegre Corregimientos (Zone 71 and 76) were subdivided and new zones 85, 86 and 87 were added as shown in Figure 3.16. The trip generation of each Corregimiento was distributed in proportion to the number of buildings in each zone. The number of buildings was calculated using a GIS data provided by ANATI.



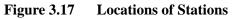
Source: JICA Study Team

Figure 3.16 Zone Division of Arraijan and Vista Alegre

Secondly, each station was given a new traffic zone as a circle with a radius of 800m (walking distance) as shown in Figure 3.17. Zone codes in the 87 traffic zones were used for St1 (Albrook) and St3 (Panama Pacifico) stations.



Note: Numbers in the circles are the zone codes for stations. Source: JICA Study Team



3.5.5 Traffic Assignment

(1) Traffic Assignment Model

The traffic assignment of private modes (private cars) was done by JICA STRADA applying the incremental assignment method. In the traffic assignment, the number of buses was added to the link flow before the private car assignment, and the private OD matrix (peak hour) was assigned to the minimum path of the road network. The passenger car unit (PCU) of a bus is assumed to be 2.0.

(2) Road Network

1) Link Classification

Each link has a link cost function that calculates the travel time from the traffic volume on the link. The proper link cost function was applied to each link in the road network model in the Study Area taking into account the link parameters such as lane capacity, number of lanes, and maximum speed. For this, the road links are classified into seven categories in this study. Table 3.30 shows the classification of links with corresponding capacity and speed settings used in this study.

	Table 5.50		lassificati		apacity and spee	u
			Adjustmer	nt Factor		
No.	Classification	Base	Roadside	Signal	Capacity per lane	Speed
		(a)	(b)	(c)	(a)*(b)*(c)	(km/h)
1	Motorway	2,000	0.95	1.00	1,900	120
2	Trunk	2,000	0.95	0.85	1,600	80
3	Primary	2,000	0.90	0.70	1,200	60
4	Secondary	2,000	0.85	0.60	1,000	60
5	Collector	2,000	0.80	0.50	800	50
6	Local-1	2,000	0.70	0.45	600	40
7	Local-2	2500*	0.70	0.45	400	30

 Table 3.30
 Link Classification with Capacity and Speed

Source: Setting by the JICA Study Team

2) Link Cost Function

For the link cost function, the BPR formula, which is commonly used in traffic demand forecast models, shown below, was employed.

$$T = T_0 \left[1 + \alpha \left(\frac{V}{C} \right)^{\beta} \right]$$

Where,

T : Travel time on link

- T_0 : Free flow travel time on link
- α, β : Parameters
- *V* : Traffic volume on link in terms of Passenger Car Unit (PCU)

C : Capacity of link (PCU)

The constant values (α, β) were prepared by the maximum speed of each link as shown in Table 3.31. The congestion speed in the table represents the speed at the volume to capacity rate of 1.0, and was assumed for each maximum speed. It was assumed that the speed becomes 4km/h at the volume to capacity ratio of 2.0.

Free Speed (km/h)	Congestion Speed	Speed at V/C=2.0	alpha	beta
120	30	4	3.000	3.273
100	30	4	2.333	3.363
80	30	4	1.667	3.511
60	25	4	1.400	3.322
50	20	4	1.500	2.939
40	18	4	1.222	2.880
30	15	4	1.000	2.700

Table 3.31BPR Parameters

Source: Setting by the JICA Study Team

3) Fare

There are two toll roads in Panama City: 1) Corredor Norte and 2) Corredor Sur. The fare cost was converted to "time" by applying a value of time (USD 6.57 per car) which is estimated in Chapter 18 (18.4.6).

	Toll Gate	Fare
Corredor Norte	Ascanio Entrance	\$0.90
	Ascanio Exit	\$0.90
	Martin Sosa Entrance	\$0.90
	Martin Sosa Exit	\$0.90
	Juan Pablo Entrance	\$0.50
	El Dorado Exit	\$0.25
	La Amistad Entrance (Albrook)	\$0.25
	Patacon Entrance	\$0.75
	Patacon Exit	\$0.75
	Madden Entrance from Tinajitas	\$2.00
	Madden Entrance rest of the Corredor	\$2.50
	Madden Exit toward Tinajitas	\$2.00
	Madden Exit rest of the Corredor	\$2.50
	Tinajitas Entrance	\$1.50
	Tinajitas Exit	\$1.50
	Transistmica Entrance to Tocumen	\$0.50
	Transistmica Entrance to Tocumen	\$0.50
	Brisas del Golf Entrance	\$1.25
	Brisas del Golf Exit	\$1.25
	Villa Lucre Entrance	\$1.25
	Villa Lucre Exit	\$1.25
Corredor Sur	Ciudad Radial A tollgate (toward Tocumen)	\$0.55
	Ciudad Radial A tollgate (from Paitilla)	\$0.75
	Ciudad Radial B tollgate (from Tocument)	\$0.55
	Ciudad Radial B tollgate (toward Paitilla)	\$0.75
	Ciudad Radial main tollgate (both directions)	\$1.25
	Costa del Este A and B tollgates	\$0.50
	Chanis A and Chanis B tollgates	\$0.25
	Atlapa main tollgate (both directions)	\$1.40
	Atlapa A and Atlapa B tollgates	\$1.25
	Via Israel A tollgate	\$0.35
	Via Israel B tollgate	\$0.60

Table 3.32Toll Road Rate

Source: ENA

(3) **Network Scenarios**

There are three network scenarios in the Study: 1) Present, 2) 4th Bridge, and 3) 4th Bridge and Line-3 scenarios. It is assumed that the Bridge of Americas remains in these scenarios, although the fourth scenario prepared from the third scenario excluding the Bridge of Americas was also studied. Cinta Costera III, which is under construction, is included in all network scenarios. The elements of the different scenarios are as follows:

- No. of lanes of Pan-American Highway between Arraijan and the Bridge of Americas •
- Existence of the 4th Bridge with new bus routes on the bridge .
- Existence of the Line-3 ٠
- Improvement of Omar Torrijos Roundabout •

These scenarios are summarized as show in Table 3.33.

		Se	cenario	
-	1) Present	2) 4 th Bridge	3) 4 th Bridge and	4) 4 th Bridge and
			Line-3	Line-3 without the
				Bridge of Americas
No. of lanes of Pan-American	4	6	6	6
Highway				
4 th Bridge	Non existant	Exists	Exists	Exists
Line-3	Non existant	Non existant	Exists	Exists
Omar Torrijos	Non existant	Exists	Exists	Exists
Roundabout Improvement				
Bridge of Americas	Exists	Exists	Exists	Non existant
Courses HCA Study Team			*	

Table 3.33 **Network Scenarios**

Source: JICA Study Team

(4) Truck Assignment

In the peak hour, the number of trucks is very small - according to the 2013 traffic survey of this study, trucks account for only 0.8% in the peak hour (6:00-7:00). Therefore, it is assumed that trucks in peak hours are included in the private mode OD. Since freight transportation avoid the congestion hours, the peak hour of the truck traffic is different from that of cars, and the truck traffic is very small in the peak hours of cars. From this, daily traffic volume of trucks was estimated separately considering the difference of the peak hour rate.

To estimate the future growth rates of cargo traffic, a regression model between Panama's GDP and the number of cargo vehicles in Panama Province was made as shown in Figure 3.18.

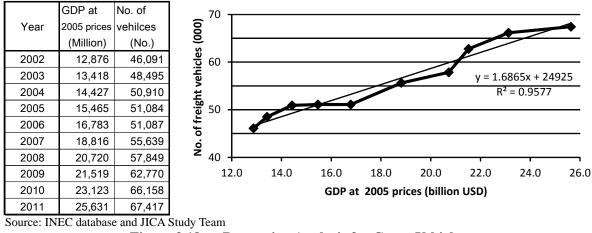


Figure 3.18 Regression Analysis for Cargo Vehicles

The result of the projection of the number of trucks crossing the canal is shown in Table 3.34 using the linear regression model above. The assumption of the future GDP growth rates are explained in 3.3.1. It was assumed that the number of trucks on the Bridge of Americas and the 4th Bridge would be the same.

	Table 5.54 Trojection of Future Truck Traine (100 of Venicles per Day)								
	Growth	Present Case	e	4th Bridge (Case		4th Bridge a	and Line-3 C	ase
Year	Ratio	Contonorio	Bridge of	Contonorio	Bridge of	4th Bridge	Centenario	Bridge of	4th Bridge
	(2013=1)	Centenario	Americas	Centenario	Americas	411 Bridge	Centenario	Americas	411 Blidge
2013	1.00	4,387	1,760	4,387			4,387		
2020	1.35	5,901	2,367	5,901	1,184	1,184	5,901	1,184	1,184
2025	1.57	6,872	2,757	6,872	1,379	1,379	6,872	1,379	1,379
2030	1.84	8,054	3,231	8,054	1,616	1,616	8,054	1,616	1,616
2035	2.08	9,110	3,655	9,110	1,827	1,827	9,110	1,827	1,827
2040	2.36	10,335	4,146	10,335	2,073	2,073	10,335	2,073	2,073
2045	2.57	11,263	4,519	11,263	2,259	2,259	11,263	2,259	2,259
2050	2.80	12,288	4,930	12,288	2,465	2,465	12,288	2,465	2,465

 Table 3.34
 Projection of Future Truck Traffic (No. of Vehicles per Day)

Source: JICA Study Team

Although there are many types of trucks, trucks were classified into one category in the traffic surveys mentioned in this report. To estimate ESALs for the pavement design, the proportion of small trucks, whose ESAL is very small, was assumed to be 67%, which was calculated from the INEC statistics on the number of trucks in the country. In the statistical data, "Pickup and Delivery" were considered as small trucks while "Trucks, Heavy Trucks, and Trailers" were others.

3.6 Future Passenger Demand

3.6.1 Fare Scenario

(1) Distance base Fare

To determine the fare level for the demand forecast, transit assignment was carried out for several fare scenarios. In view of financial sustainability, the fare should be determined at the level that maximizes the total revenue. Table 3.35 shows the estimation of the fare revenue in the peak hour for different fare levels in the case of the Panamericana Route in 2050. The revenue is maximized when the fixed fare is USD0.90. It is recommended that the fare be set at this level in view of the financial aspect. However, the economic benefit may be as important as the financial stability.

Table 3.35	Peak Hour Fare Revenue by Fixed Rate (Full development case, 2050)
-------------------	--

Fixed Rate	No. of boarding	Fare Revenue	PHPDT
(USD)	passengers	(USD)	
0.6	32,315	23,285	24,492
0.7	30,419	25,115	23,555
0.8	28,535	26,550	22,694
0.9	26,117	26,996	21,104
1.0	23,348	26,554	19,574
1.1	20,899	25,888	17,626
1.2	19,141	25,745	16,316

Note: Since the number of passengers shifting from car to Line-3 is estimated irrespective of the fare, the fare revenue from these passengers increases in proportion to the fixed rate. Source: JICA Study Team

(2) Fare Integration

For the initial assessment of Line-3, the fixed fare is set at USD 0.65, which is the same as that in the METI F/S. In the case of the USD0.65 fixed rate, the fare revenue is 90% of the maximum fare revenue from the USD0.90 fixed rate.

The impact of a flat fare system and fare integration with Line-1 and Line-2 were evaluated as shown in Table 3.36. PHPDT in 2050 was estimated at 24,519 in the case of the distance base fare (Fare=0.65+0.042X). This feasibility study is conducted based on this fare scenario. The difference in demand between the distance base fare and the flat fare is small. In the case of fare integration, PHPDT exceeds 25,000.

140	Tuble 5.50 Demand 1 of cease in 1 are integration and 1 are cases					
Integration	Fare	No. of boarding	Fare Revenue	PHPDT		
	(USD)	passengers	(USD)			
Not	Fare=0.65+0.042X	31,862	25,919	24,519		
integrated	Fare=0.65	33,190	21,574	24,789		
Integrated	Fare=0.65+0.042X	34,994	*	25,542		
	Fare=0.65	37,221	*	25,741		

Table 3.36Demand Forecast in Fare Integration and Flat Fare Cases

Note: Full Development Case

* Revenue is not calculated in the integrated fare case because passenger revenue should be shared among Line-1, 2, and 3.

Source: JICA Study Team

3.6.2 Peak Hour Passenger Demand

(1) Comparison of Panamericana and Autopista Routes

For route comparison between Panamericana and Autopista, a passenger demand forecast was carried out for the Autopista Route using the same method as the Panamaricana route. In this case, the end station is assumed to be Guadalupe, near the intersection of the Autopista and Panamericana. The number of stations is 13 as shown in Figure 3.19.

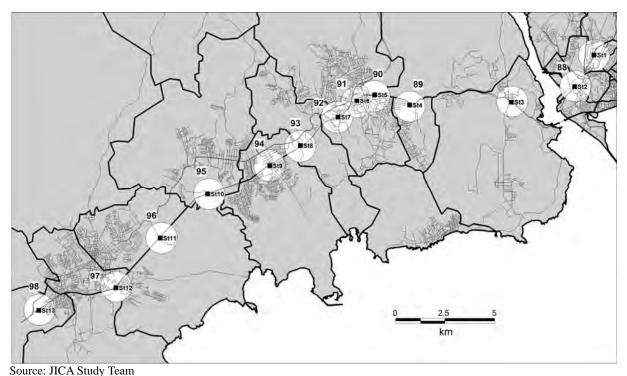


Figure 3.19 Station Locations of Autopista Case

The following table shows the results of the demand forecast in peak hour. The passenger demand in the Panamericana route is estimated to be higher than that of the Autopista route. This is one of the reasons for the justification of the Panamerian route.

Table 3.37 Comparison of Passenger Demand between Panamericana and Autopista (2)	050)
--	------

Route	No. of boarding passengers	PHPDT
	(peak)	
Panamericana	31,862	24,519
Autopista	27,186	21,431

Source: JICA Study Team

(2) Section Traffic

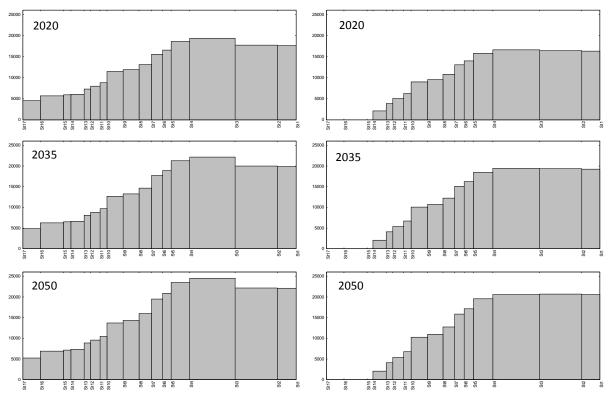
The peak hour traffic in the full development case is estimated at 19,359 in 2020, 22,153 in 2035, and 24,519 in 2050 as shown in Table 3.38. It is estimated that the modal share of public transport will decrease in accordance with the increase in the number of vehicles per inhabitant. However, the modal share of public transport will be higher than that in the without project case.

	Full	Development	Case	Phase-1 Case					
	Public	No. of		Public	No. of				
	Mode	boarding	PHPDT	Mode	boarding	PHPDT			
	Share (%)	passengers		Share (%)	passengers				
2013	66.0	-	-	66.0	-	-			
2020	61.7	23,703	19,359	60.6	19,015	16,578			
2025	58.5	25,375	20,493	57.4	20,664	17,824			
2030	55.6	26,765	21,367	54.4	21,794	18,620			
2035	53.7	28,034	22,153	52.3	22,881	19,408			
2040	53.7	29,336	22,905	52.0	23,684	19,945			
2050	50.9	31,862	24,519	48.8	24,740	20,667			

Table 3.38 Forecast of Peak Hour Traffic
--

Note: Fare= 0.65 + 0.042 * MAX(0, x-18), where x = distance of travel Source: JICA Study Team

Figure 3.20 shows the traffic volume by section in the case of full development. The peak section is found between St3 (Panama Pacifico) and St4 (Loma Coba), due to the development of Panama Pacifico.



Note: Left=Full development case, Right=Phase-1 Case (Both are high population growth case) Source: JICA Study Team

Figure 3.20 Section Traffic for Peak Direction

(3) Station-to-station Matrix

The station-to-station matrix of the peak hour is shown in Table 3.39 and Table 3.40 for the full development case and phase-1 case, respectively. For the phase-1 case, the results of medium growth case and low growth case of population are shown in Table 3.41 and Table 3.42, respectively.

10000		1	able .	5.39	St	atior	1-to-3	Stati	on M	atri	K (Fu	ll dev	velop	omen	t cas	e)		
Y2020 Line	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9	ST10	ST11	ST12	ST13	ST14	ST15	ST16		Boarding
ST1 ST2	0	318	0	34	117	63 1	235	303	94	347	137	118 0	165	58	104	61	508 33	2662 135
ST3 ST4	106 750	10	0	13	58 0	4	32	24		7	4		5	0		4	98 29	371 828
ST5	2007	16	145	0	0		19	0	0	5	2	1	3	0	-	19	89	2313
ST6 ST7	912 2466	8		0	0	0	0	0	0	0	0			0	0	0 45	10 133	1050 2941
ST8	1180	2	95	0	0	0	0	0	-	0	0	0	0	0	0	0	50	1327
ST9 ST10	445 2403	2	47 244	0	3	0	0	0	0	0	0		0	0		0	13 26	510 2711
ST11	742	12	40	1	8	1	2	1	0	0	0	0		0		0	29	836
ST12 ST13	531 1122	6	98 125	4	12 16		8	1	1	0	0	0	0	0		0	10 16	669 1306
ST14 ST15	100 181	1	19 24	1	2	0	0	1	0	0	0		0	0		0	0	124 221
ST16	939	26	102	0	14		22	6	0	0	0	0	0	0	0	0	0	1109
ST17 Alighting	3621 17581	81 532	385 1758	22	65 328		244 586	100 440	32 130		11 154			0 59		0	0 1046	4590 23703
Y2025	17501															•		
Line ST1	ST1 0	ST2 331	ST3 0	ST4 43	ST5 126	ST6 69	ST7 266	ST8 343	ST9 105	ST10 375	ST11 152	ST12 133	ST13 194	ST14 67	ST15 118	ST16 68	ST17 556	Boarding 2946
ST2	100	0	5	4	9	1	6	0	0	1	0	0		3	6	6	556 31	172
ST3 ST4	149 781	15	54	14 0	88 0		38 1	32		9	6		1	0		2	124 34	508 880
ST5 ST6	2086 948	17	185 149	0	0		20	0	0	5	4		3	0		22	89 13	2441 1120
ST7	2592	23	349	0	0	0	0	0	0	0	0	0	1	1	1	49	139	3155
ST8 ST9	1238 465	2	123 60	0	0	0	0	0	0	0	0	-	0	0	-	0	57 13	1420 543
ST10	2516	17	317		24	1	0	0	0	0	0	0	0	0	0	0	28	2903
ST11 ST12	772 537	12	50 120	1	9 14	1	3	1	0	0	0		0	0		0	29 11	878
ST13	1151	7	159	4	17	3	13	3	1	0	0	0	0	0	0	0	17	1375
ST14 ST15	106 186	1	24 29	1	2		0	2	0	0	0			0		0	0	136
ST16	1059	29	147	0	16	0	24	6		0	0	0	0	0	0	0	0	1281
ST17 Alighting	3651 18337	85 564	421 2192	24 95	68 380	20 101	253 639	102 494	32	9 399	13 175	0 135	4 211	0 71		0 156	0 1143	4682 25375
Y2030 Line	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9	ST10	ST11	ST12	ST13	ST14	ST15	ST16	ST17	Boarding
ST1	0	358	513	514 46	140		303	382	519	391	168	154	216	5114 71		88	619	3265
ST2 ST3	128 182	0	7	4	11 93	1	6 44	0	0	1	0		0	4	7	9	34 133	212 584
ST4	827	7	63	0	0	0	1	0	0	0	0	0	1	0	0	2	35	936
ST5 ST6	2186 995	18 10		0	0	0	21	1	-	5	5		3	0			99 13	2575 1188
ST7	2749	25	401	0	0	0	0	0	0	0	0	÷	1	1	1	55	147	3380
ST8 ST9	1319 489	3	142	0	0	0	0	0	0	0	0	0	0	0	0	2	68 16	1533 577
ST10	2576	17	351	1	25	1	0	0	0	0	0		0	0		0	29	3000
ST11 ST12	783 530	14	127	3	10 14	1	4	1	0	0	0	0	0	0	0	-	33 11	702
ST13 ST14	1173 105	7	174 25	5	18	4	13	3	1	0	0		0	0		0	17	1415 135
ST15	189	1	32	1	4	0	6	4	-	0	0	0	0	0	0	-	2	239
ST16 ST17	1124 3655	30 88		27	18 71		25 263	6 102		0				0			0	1367 4755
Alighting	19010	604	2445	108	409	113	695	538	151	416	196	156	236	76	164	192	1256	26765
Y2035 Line	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9	ST10	ST11	ST12	ST13	ST14	ST15	ST16	ST17	Boarding
ST1	0	375	0	53	156	83	340	425	125	430	180	173	242	86		102	670	3597
ST2 ST3	144 218	0	0	20	12		45	0	5	10	0		9	4	8	17	30 107	238
ST4	882	8	64	0	0		1	0	0	0	0		1	0		3	37 100	996
ST5 ST6	2273 1072	10	171	0	0		23	0	0	0	0		4	0		1	15	2671 1270
ST7 ST8	2929 1394	26	412 146	0	0	0	0	0	0	0	0		1	1	1	58	155 72	3583 1617
ST9	513	3	67	0	4		0	0	0	0	0	0	0	0	0	0	17	604
ST10 ST11	2656 806	17	348	1	27	1	0	0	0	0	0	-	0	0	0	0	32	3082 928
ST12	533	6	128	4	14	1	9	1	0	0	0	0	0	Ő		0	12	708
ST13 ST14	1207 109	8	167 25	5	19	4	13 0	4	1	0	0		0	0		0	18 0	1446
ST15	193	1	32	2	4		6	5	0	0	0		0	0		0	3	246
ST16 ST17	1181 3746	29 91	159 446	0 30	21 77	23	28 271	5 106	27	10	0 15			0		0	0	1423 4849
Alighting	19856	627	2431	122	445	122	747	587	159	457	208	175	266	91	188	250	1303	28034
Y2040 Line				ST4		ST6			ST9			ST12	ST13		ST15			Boarding
ST1 ST2	0	398	0	63	175 14	93 1	382	473	136	486	203 0	187 0	256	97	175	119 18	726 34	3969 258
ST3	264	20	0	21	117	7	50	44	6	11	10	1	9	0	16	50	119	745
ST4 ST5	926 2370	8 21	73 230	0	0		1 21	0		5	0		1	0		3 23	42 112	1054 2809
ST6 ST7							0	0	0	0	0	0	1	0	0	1	15	1347
	1128	11	191	0			-						1		2	62	160	3753
ST8	1128 3057 1437		191	0 0 0	0	0	0	0			0			0		5	75	10/ 3
ST8 ST9	3057 1437 525	11 26 2 3	191 444 159 69	000000000000000000000000000000000000000	0 0 4	0	0	0	0	0	0	0	0	0	1	-	20	621
ST8 ST9 ST10 ST11	3057 1437 525 2687 812	11 26 2 3 17 16	191 444 159 69 372 57	0 0 0 1 1	0 0 4 28 12	0 0 0 1 2	0 0 0 4	000000000000000000000000000000000000000	000000000000000000000000000000000000000		000000000000000000000000000000000000000	0 0 0 0	000000000000000000000000000000000000000	000000000000000000000000000000000000000	1 0 0 0	0	20 33 35	621 3139 941
ST8 ST9 ST10 ST11 ST12	3057 1437 525 2687 812 521	11 26 2 3 17	191 444 159 69 372 57 139	000000000000000000000000000000000000000	0 0 4 28 12 15	0 0 1 2 1	0 0 0 4 9	0	000000000000000000000000000000000000000		0 0 0 0	0 0 0 0 0	0 0 0 0 0		1 0 0 0 0	0	20 33 35 12	621 3139 941 708
ST8 ST9 ST10 ST11 ST12 ST13 ST14	3057 1437 525 2687 812 521 1225 112	111 26 2 3 177 16 6 8 8 1	191 444 159 69 372 57 139 178 27	0 0 1 1 4 5 5	0 0 4 28 12 15 19 3	0 0 1 2 1 5 0	0 0 0 4 9 13	0 0 2 1 4 1	0 0 0 0 0 0 0 0		0 0 0 0 0 0	0 0 0 0 0 0			1 0 0 0 0 0 0	0 0 0 0	20 33 35 12 20 1	621 3139 941 708 1478 146
ST8 ST9 ST10 ST11 ST12 ST13 ST14 ST15	3057 1437 525 2687 812 521 1225 112 194	11 26 2 3 17 16 6 8 8 1 1	191 444 159 69 372 57 139 178 27 34	0 0 1 1 4 5 5	0 0 4 28 12 15 19	0 0 1 2 1 5 0	0 0 0 4 9 13 0 7	0 0 2 1 4 1 5	0 0 0 0 0 0 0 1 1 0 0		0 0 0 0 0 0 0	0 0 0 0 0 0 0 0			1 0 0 0 0 0 0 0 0 0 0	0 0 0 0	20 33 35 12 20	621 3139 941 708 1478 146 252
ST8 ST9 ST11 ST12 ST13 ST14 ST15 ST16 ST17	3057 1437 525 2687 812 521 1225 112 1225 112 194 1252 3765	111 26 2 3 3 177 16 6 6 8 1 1 1 1 29 93	191 444 159 69 372 57 139 178 27 34 195 484	0 0 0 1 1 1 4 5 5 1 1 2 2 0 0 34	0 0 4 12 15 19 3 5 5 23 80	0 0 1 2 1 5 0 1 0 25	0 0 0 4 9 13 0 7 7 31 261	0 0 2 1 4 1 5 4 103	0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0		0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0				20 33 35 12 20 1 3 0 0	621 3139 941 708 1478 1478 252 1534 4903
ST8 ST9 ST10 ST11 ST12 ST13 ST14 ST15 ST16	3057 1437 525 2687 812 521 1225 112 1225 112 194	11 26 2 3 17 16 6 8 8 1 1 1 29	191 444 159 69 372 57 139 178 27 34 195 484	0 0 1 1 1 4 5 5 1 2 0	0 0 4 28 12 15 19 3 5 5 23	0 0 1 2 1 5 0 1 0	0 0 0 4 9 13 0 7 31	0 0 2 1 4 4 1 5 4	0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0		0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		1 0 0 0 0 0 0 0 0 0 0 0 0 0		20 33 35 12 20 1 3 3 0	
ST8 ST9 ST10 ST11 ST12 ST13 ST14 ST15 ST16 ST17 Alighting Y2050 Line	3057 1437 525 2687 812 521 1225 112 1225 112 194 1252 3765 20430 ST1	11 26 3 3 17 16 6 8 8 1 1 1 29 93 660 ST2	191 444 159 69 372 57 139 178 27 34 195 484 2657 ST3	0 0 0 1 1 4 5 1 1 2 0 0 34 137 ST4	0 0 4 28 12 15 19 3 5 5 23 80 495 ST5	0 0 1 1 5 0 1 1 0 25 136 ST6	0 0 0 4 9 13 0 7 7 31 261 787 ST7	0 0 2 1 4 1 5 5 4 103 638 ST8	0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 13 231 ST11	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 281 ST16	20 33 35 12 20 1 3 0 0 1407 ST17	621 3139 941 708 1478 146 252 1534 4903 29336 Boarding
ST8 ST9 ST10 ST11 ST12 ST13 ST14 ST15 ST16 ST17 Alighting Y2050 Line ST1 ST2	3057 1437 525 2687 812 521 1225 112 1252 112 1252 112 1252 3765 20430 ST1 0 185	111 26 3 3 177 16 6 6 8 8 1 1 1 29 9 33 660 ST2 456 0 0	191 444 159 69 372 57 139 178 27 34 195 2657 ST3 0 6 6	0 0 0 1 1 4 5 5 1 1 2 0 0 34 137 5 5 74 5 74 774	0 0 4 28 12 15 15 5 5 5 23 80 80 495 ST5 210 17	0 0 1 2 1 5 0 0 1 1 0 25 136 ST6 ST6 2	0 0 0 4 9 13 0 7 7 31 261 787 ST7 ST7 450 10	0 0 2 1 4 1 5 5 4 103 638 538 ST8 551 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 13 231 ST11 ST11 232 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 281 ST16 136 12	20 33 35 12 20 1 3 0 0 1407 ST17 ST17 854 49	621 3139 941 708 1478 1478 252 252 252 253 29336 29336 Boarding 4551 305
ST8 ST9 ST10 ST11 ST12 ST13 ST14 ST16 ST17 Alighting Y2050 Line ST1 ST2 ST3	3057 1437 525 2687 812 521 1225 112 1252 3765 20430 20430 ST1 0 855 357	11 26 2 3 17 16 6 6 8 8 1 1 29 93 6600 ST2 4566 0 21	191 444 159 69 372 57 139 178 27 34 1955 484 2657 ST3 0 6 0 0	0 0 0 1 1 1 4 5 5 1 1 2 0 0 34 1 37 5 5 7 4 77 24	0 0 4 288 12 15 19 3 5 5 23 80 495 ST5 210 177 122	0 0 1 2 1 5 0 0 1 1 0 25 136 ST6 ST6 2	0 0 0 4 9 13 0 7 7 31 261 787 ST7 ST7 450 10	0 0 2 1 4 4 1 0 3 6 38 551 551 0 4 8	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 133 231 5711 232 0 0 10	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 281 ST16 136 12 33	20 33 35 12 20 1 3 0 0 1407 ST17 ST17 854 49 147	621 3135 941 708 1476 1446 2555 1534 4903 29336 Boarding 4551 300 8866
ST8 ST9 ST10 ST11 ST11 ST13 ST14 ST15 ST16 ST17 Alighting Y2050 Line ST1 ST2 ST3 ST4 ST5	3057 1437 525 2687 812 1225 112 1225 112 1225 20430 ST1 0 185 357 991 22555	111 26 2 3 17 16 6 8 1 1 29 933 6600 ST2 0 5 21 8 23 23 3 5 25 25 25 25 25 25 25 25 25	191 444 159 69 372 57 139 178 27 34 484 2657 ST3 0 6 6 0 0 84 251	0 0 0 1 1 4 5 1 1 2 0 0 3 4 4 137 5 5 1 1 7 4 7 4 7 7 2 4 0 0 0 0 0	0 0 4 288 12 15 19 3 5 23 800 495 ST5 210 17 122 0 0 0 0	0 0 0 1 2 5 0 0 1 1 0 0 255 136 ST6 ST6 0 1011 2 2 8 8 0 0 0 0	0 0 0 4 9 9 13 0 7 7 31 261 787 7 877 557 10 555 1 29	0 0 2 1 4 4 103 638 638 551 0 0 48 0 0 1 1	0 0 0 0 0 0 0 0 0 0 0 0 0 0 277 1771 5T9 0 0 7 7 0 0 1 1	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	20 33 35 12 20 1 1 3 0 0 0 1407 ST17 854 49 147 466 119	62 3139 94' 700 1477 147 146 252 153- 29336 Boarding 455' 300 886 1133 3044
ST8 ST9 ST10 ST11 ST13 ST14 ST15 ST16 ST17 Alighting Y2050 ST1 ST2 ST3 ST4 ST5 ST3 ST4 ST17 ST16 ST17 ST17 Alighting Y2050 ST2 ST3 ST4 ST5 ST6 ST6	3057 1437 525 2687 812 521 1225 112 194 1252 3765 20430 ST1 0 855 357 991 2555 2255	111 266 2 3 3 177 166 6 6 8 1 1 29 9 33 660 8 572 456 0 0 211 8 8 23 111	191 444 159 69 372 57 139 139 178 277 34 484 2657 ST3 0 6 6 0 0 84 2251 207	0 0 0 1 1 4 5 5 1 1 2 0 0 344 137 5 74 74 74 74 0 0 0 0 0 0 0 0	0 0 4 28 12 15 19 3 5 233 800 495 ST5 210 177 122 0 0 0 0 0 0	0 0 0 1 1 25 136 ST6 ST6 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 4 3 9 9 13 0 7 7 31 261 787 787 557 55 55 1 1 29 0 0	0 0 2 1 1 4 4 103 638 551 0 0 48 0 0 48 0 0 1 1 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 277 171 167 0 7 7 0 0 7 7 0 0 1 1 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 13 231 232 0 232 0 10 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	20 33 35 12 20 1 3 0 0 0 1407 ST17 ST17 ST17 ST17 ST17 49 9 147 46 119	62 3133 94 700 1478 148 252 153- 4900 29336 800 800 800 800 800 800 800 80
ST8 ST9 ST11 ST112 ST113 ST14 ST15 ST16 ST17 Alighting Y2050 Line ST1 ST3 ST4 ST3 ST4 ST5 ST6 ST7 ST7 ST8	3057 1437 525 2687 8121 521 1225 1122 1094 1252 3765 20430 ST1 0 855 357 991 1219 3315	111 26 2 3 17 16 6 8 1 1 29 93 3 660 ST2 456 0 21 8 23 11 29 3 3 11 29 3 3 12 16 16 17 16 17 16 17 18 17 18 18 19 19 19 19 19 19 19 19 19 19	1911 4444 1599 699 372 577 1399 1788 277 344 2657 ST3 0 6 6 0 0 844 2511 2077 483 1733	0 0 0 1 1 1 1 2 5 5 1 1 2 0 0 3 4 1 37 7 4 7 4 7 4 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 4 28 12 15 5 23 80 495 21 23 80 495 210 17 17 122 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 1 1 2 5 0 0 0 0 25 1 36 101 25 136 101 2 2 8 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 4 4 9 9 133 0 0 7 7 8 7 7 8 7 7 8 7 7 8 7 7 8 7 7 8 7 8 7 8 7 8 7 8 7 8 7 8 7 8 7 8 7 8 7 8 7 8 7 9 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 2 1 4 1 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	0 0 0 0 0 0 0 0 0 0 0 0 0 0 7 7 7 0 0 7 7 0 0 1 1 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 13 231 231 232 0 2 0 10 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 218 ST15 2000 12 27 0 12 27 0 12 27 0 19 0 2 1	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	20 33 355 12 20 1 3 3 0 0 1407 ST17 ST17 ST17 ST46 46 119 16 183 889	62 3133 94: 700 1478 144 255 1533 4903 29336 800 800 800 800 800 800 800 80
ST8 ST9 ST10 ST11 ST11 ST113 ST115 ST16 ST117 Alighting Y2050 Line ST1 ST3 ST3 ST3 ST4 ST5 ST6 ST7 ST7 ST8 ST9 ST9	3057 1437 525 2687 812 521 1225 112 194 1255 20430 \$716 \$71 0 185 3765 20430 \$711 0 185 3577 991 22555 1219 3315 1611 5566	111 26 2 3 177 16 6 8 1 1 29 93 660 ST2 4566 0 21 8 23 111 29 3 3 3 3 3 3 3 3	991 444 1599 69 3722 57 139 1788 27 34 1955 488 2657 ST3 0 6 6 0 0 84 484 2657 ST3 0 8 484 2657 371 371 371 371 483 771 771	0 0 0 1 1 1 4 5 5 1 1 2 0 0 34 137 137 5 74 7 7 244 0 0 0 0 0 0 0 0 0 0 0	0 0 4 28 12 15 5 23 3 5 5 23 80 0 495 210 17 122 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4 4 4	0 0 0 1 1 2 5 0 0 1 1 0 0 2 55 136 5 136 5 136 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 4 4 9 9 13 0 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	0 0 0 2 1 1 4 1 1 5 5 5 5 5 5 1 0 0 4 8 8 0 0 4 8 8 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 7 7 1 0 7 7 0 0 7 7 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 13 231 231 232 232 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 12 12 27 0 19 0 2 1 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	20) 33 355 12 20) 11 3 0 0 1407 ST17 854 49 1477 466 119 146 183 89 24	621 3133 944 706 1477 1477 2555 1534 4903 29336 29336 80arding 4551 3004 886 8137 3044 1456 4075 1885 666
ST8 ST9 ST10 ST11 ST12 ST13 ST14 ST15 ST16 ST17 ST18 ST9 ST10 ST10 ST11	3057 1437 525 2687 812 521 1225 1122 1225 1122 3765 20430 20430 ST1 0 857 20430 20430 20430 20430 20430 2055 2053 3767 991 2555 2053 2057 991 2199 2555 2672 2053 2057 2057 2057 2057 2057 2057 2057 2057	111 26 2 3 17 16 6 8 1 1 29 93 3 660 ST2 456 0 21 8 23 11 29 3 3 11 29 3 3 12 16 16 17 16 17 17 18 18 17 18 18 19 19 19 19 19 19 19 19 19 19	1911 4444 1599 69 3722 57 57 139 1788 27 344 195 484 2657 ST3 0 6 6 0 0 844 251 2077 483 771 483 771 376 556	0 0 0 1 1 4 4 5 5 1 1 2 0 0 0 3 4 4 1 37 4 1 37 4 1 37 4 1 37 4 1 37 4 1 37 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 4 28 12 15 5 23 5 23 800 495 210 17 122 0 0 0 0 0 0 0 4 31 13 13 15 15 15 19 19 19 19 19 19 19 19 19 19	0 0 0 1 1 2 5 5 1 3 6 1 1 1 0 0 2 5 5 1 3 6 1 1 1 0 2 5 1 3 6 1 1 1 0 0 2 5 5 1 3 6 1 1 1 0 0 2 5 5 1 1 1 0 0 0 0 0 0 0 1 1 1 2 1 1 1 1 5 5 1 1 1 0 0 0 0 0 0 1 1 1 1 5 5 1 1 1 0 0 0 0	0 0 0 4 9 133 0 7 7 311 261 7 877 555 1 1 29 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 2 1 1 4 1 1 5 5 5 5 5 5 1 0 0 4 8 8 0 0 4 8 8 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 12 277 0 19 0 12 11 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	20 33 35 12 20 10 1407 854 49 1447 854 49 1447 46 119 16 183 89 24 35 36 40 0	621 3135 9447 706 1447 252 1533 4903 29336 Boarding 4551 306 886 1133 3044 1456 666 666 3282 967
ST8 ST9 ST10 ST11 ST11 ST11 ST13 ST14 ST15 ST16 ST17 Alighthing Y2050 Line ST1 ST2 ST3 ST4 ST5 ST6 ST7 ST8 ST9 ST10 ST10 ST11 ST9 ST10 ST11 ST9 ST10 ST11 ST11	3057 1437 525 22687 8121 521 1225 112 144 1252 3765 20430 \$765 20430 \$711 0 1855 357 1219 991 1219 3315 16111 16111 5666 2818 833 530	111 26 2 3 177 16 6 8 8 11 29 93 660 572 211 8 233 111 299 33 20 16 7 7	911 444 159 69 372 57 199 178 2657 34 484 2657 573 0 6 6 0 0 0 84 2511 2077 483 471 2657 573 0 6 573 0 6 575 713 711 955 725 73 727 713 955 73 727 73 73 727 73 727 73 74 727 73 74 727 73 74 727 73 74 727 73 74 727 73 74 727 73 74 727 73 74 727 73 74 757 73 74 777 73 74 727 73 74 777 757 73 74 757 77 74 74 757 77 73 74 777 757 777 74 74 777 74 74 74 777 757 777 74 74 74 74 74 757 777 74 74 74 74 74 757 777 74 74 777 74 74 777 74 74 777 757 777 74 74 74 74 777 777	0 0 0 1 1 1 1 1 2 2 0 0 34 1 37 5 1 1 2 2 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 4 28 12 15 19 3 5 233 80 495 ST5 217 172 0 0 0 0 0 0 0 0 4 4 5 5 19 19 19 19 19 19 19 19 19 19	0 0 0 1 1 2 5 0 0 25 1 36 1 36 1 36 1 36 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 4 4 9 9 133 10 787 787 555 10 555 10 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 2 1 1 4 4 1 5 5 5 5 1 0 3 8 8 8 5 5 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 12 277 0 12 277 0 19 0 12 11 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	20 33 35 12 200 1 1 3 0 0 0 1407 854 49 1447 46 119 16 1833 89 24 35	621 3132 9411 700 1472 1472 1534 4903 29336 806 806 806 807 4075 1037 1047 1057
ST8 ST9 ST10 ST11 ST11 ST12 ST13 ST15 ST16 ST17 Alighting Y2050 Line ST1 ST1 ST15 ST16 ST17 ST3 ST4 ST5 ST6 ST6 ST7 ST7 ST8 ST7 ST8 ST9 ST10 ST6 ST7 ST7 ST8 ST10 ST12 ST11 ST12 ST12 ST12 ST12 ST13 ST12 ST14	3057 1437 525 22687 812 521 1225 112 144 1252 20430 3765 20430 3765 3765 3765 3765 20430 315 1252 3765 367 1219 1219 1219 3315 1611 1611 15566 2818 3315 5300 1304 1200	111 26 2 3 17 16 6 8 1 1 1 29 9 3 660 8 21 21 8 23 11 11 29 9 3 3 20 20	911 444 159 69 372 57 1399 178 2657 573 0 6 6 0 0 0 84 484 2657 573 0 6 8 4 84 4 84 2657 573 0 8 4 84 4 84 27 55 57 57 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9	0 0 0 0 1 1 1 4 5 1 1 2 0 0 3 4 1 3 7 7 2 4 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 4 28 12 15 19 3 3 5 23 80 4955 ST5 210 177 1222 1222 0 0 0 0 0 0 4 3 3 15 210 15 15 15 19 19 19 19 19 19 19 19 19 19	0 0 0 1 1 2 5 0 0 1 1 6 5 5 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 4 9 9 0 7 7 311 2611 787 555 1 1 29 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 2 1 1 4 4 1 0 3 6 38 551 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 7 7 281 3 07 2 21 12 12 11 5 5 12 12 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 12 277 0 12 27 0 19 0 2 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 281 136 126 12 3 3 3 6 6 4 8 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	20 33 35 12 200 11 3 0 0 0 0 1407 ST17 S514 49 147 46 119 16 183 89 24 40 24 35 40 147 147 147 147 147 147 147 147	621 3139 941 708 1476 252 1534 4903 29336 8007 800 8007 800 8007 137 3094 807 807 807 807 807 807 807 807
ST8 ST9 ST10 ST11 ST112 ST112 ST113 ST14 ST15 ST16 ST17 Alighting Y2050 Line ST1 ST5 ST5 ST5 ST6 ST7 ST7 ST8 ST9 ST10 ST112 ST112 ST112 ST112	3057 1437 525 2687 521 1225 1122 1925 1122 3765 20430 ST1 0 185 20430 ST1 0 185 20430 3765 20430 115 2555 1219 3375 2555 2555 2555 2555 2555 2555 2555	111 266 2 3 177 166 6 8 1 1 29 9 33 660 5T2 4666 0 21 8 23 111 29 33 3 3 20 0 0 17 7 8 8 17 16 16 16 10 17 17 16 16 10 17 16 16 10 17 17 16 16 10 17 17 16 16 10 17 17 16 16 10 17 17 17 16 16 10 10 17 17 16 10 10 10 10 10 10 10 10 10 10	1911 4444 159 69 372 57 1399 178 277 34 484 2657 573 0 6 6 0 0 844 2251 2077 483 771 3766 566 566 1444 1778 277 333	0 0 0 1 1 1 4 5 5 1 1 1 2 0 0 0 3 4 1 37 7 4 7 7 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 4 2 8 12 15 5 5 5 5 7 3 3 8 0 4 95 2 10 17 1 2 210 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 1 2 1 5 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 4 9 9 13 13 0 7 7 8 7 8 7 8 7 8 7 8 7 8 7 8 7 8 7 8	0 0 0 2 1 1 4 4 1 0 3 551 6 388 551 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 7 7 2811 3077 2811 3077 2 12 12 12 12 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 12 277 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 281 136 122 333 64 4 8 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	20 33 35 12 20 1 1 3 0 1407 ST17 854 49 1407 ST17 46 1199 146 183 89 24 355 40 14 15 16 16 16 16 16 16 16 16 16 17 17 18 18 18 18 18 18 18 18 18 18	621 3139 9411 708 1478 1478 1478 1478 252 252 252 252 252 252 252 25
ST8 ST10 ST10 ST11 ST11 ST112 ST11 ST113 ST115 ST116 ST117 Alighting Y20500 Line ST13 ST14 ST15 ST3 ST6 ST7 ST5 ST6 ST10 ST112 ST112 ST13 ST11 ST112 ST113 ST13 ST13 ST14	3057 1437 525 2687 812 525 1122 521 1225 20430 571 0 185 20430 571 0 185 3765 20430 571 0 185 3765 20430 115 357 991 1219 3315 16111 566 633 570 1201 2088 530 530 530 1304 2088 530 530 530 530 530 530 530 530 530 530	111 266 2 2 3 177 166 660 88 11 1299 933 660 872 29 933 111 29 933 117 88 83 23 117 128 129 139 146 146 146 147 147 147 147 147 147 147 147	911911 4444 159 69 372 57 1399 178 27 34 2657 873 0 6 6 0 0 844 2657 207 483 277 483 71 207 483 717 376 6 566 566 576 917 713 927 207 713 917 817 817 817 817 817 817 817 817 817 8	0 0 0 0 0 0 0 1 1 1 1 2 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 4 28 12 15 19 3 3 5 23 800 4955 210 177 1222 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 1 2 1 5 0 0 1 1 0 0 2 5 1 36 5 1 2 2 8 0 0 0 0 0 0 2 5 1 36 5 1 1 2 1 5 1 1 0 0 0 0 1 1 5 1 1 0 0 0 0 1 1 5 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 4 4 9 9 1 3 11 261 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	0 0 0 2 1 1 4 4 1 0 3 6 38 6 38 6 38 6 38 6 38 6 38 6 38	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 12 277 0 19 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	20 33 35 12 20 0 1407 ST17 ST17 ST17 ST17 46 119 16 183 89 24 355 40 144 21 1 3 3	621 3139 941 708 1478 146 252 1533 4903 29336 Boarding 4551 309 886 1137 304 4551 11456 304 407 11855 668 3282 967 7282 1563 1563 154 265 1563 154 265 154 265 155 155 155 155 155 155 155 1

Table 3.39 Station-to-Station Matrix (Full development case)

Source: JICA Study Team

Table 3.40Station-to-Station Matrix (Phase-1 development case: High Growth)

Alighting 1 200821 4091 50 Source: JICA Study Team

Line ST1 ST2 ST3 ST4 ST5 ST6 ST1 0 123 0 11 33 ST2 95 0 0 3 8 ST2 402 7 0 12 62					
ST2 95 0 0 3 8	ST7 ST8	ST9 ST10	ST11 ST12	ST13	ST14 Boarding
	42 63 281			125 180	284 155
	1 5 0		0	0 0	42 15
ST3 103 7 0 13 62 ST4 712 7 0 0 0	4 28 24 0 1 0		3	1 9	114 37 0 72
ST5 1,714 16 15 0 0	1 15 1		-	5 20	0 72 54 185
ST6 803 8 0 0 0	0 0 0			0 1	1 81
ST7 2,056 20 29 0 0	0 0 0		0	0 1	1 210
ST8 1,084 2 5 0 0	0 0 0		0	0 0	0 109
ST9 458 4 17 0 3	0 0 0	0 0	0	0 0	0 48
ST10 2,396 23 40 0 22	1 0 0			0 0	0 248
ST11 1,015 23 19 1 8	1 1 0			0 0	0 106
ST12 984 22 24 2 13	1 10 1			0 0	0 105
ST13 1,499 26 45 4 18 ST14 1,808 51 56 1 33	2 14 1 0 0 1			0 0	0 160
ST14 1,808 51 56 1 33 Alighting 14727 332 250 35 200	0 0 1 53 137 309	, , ,		0 0 131 211	0 195 496 1732
Y2025	55 157 503	100 200	155	211	430 1732
Line ST1 ST2 ST3 ST4 ST5 ST6	ST7 ST8	ST9 ST10	ST11 ST12	ST13	ST14 Boarding
ST1 0 134 0 14 37	46 64 317	7 110 209	133	146 200	290 170
ST2 122 0 0 4 10	1 5 0	0 0 2	2	2 2	42 19
ST3 141 7 0 14 89	5 35 32		5	5 15	146 50
ST4 735 7 0 0 0	0 1 0			0 0	0 74
ST5 1,745 17 15 0 0	1 15 1		5	4 21	56 188
ST6 827 9 0 0 0	0 0 0		0	0 1	1 83
ST7 2,120 22 33 0 0 ST8 1,121 2 5 0 0	0 0 0			0 1	1 217 0 112
ST9 474 4 17 0 3	0 0 0			0 0	0 49
ST10 2,500 24 41 0 23	1 0 0			0 0	0 258
ST11 1,042 24 19 1 9	1 2 0			0 0	0 109
ST12 989 24 25 3 15	1 10 1			0 0	0 106
ST13 1,508 28 44 4 18	3 14 2			0 0	0 162
ST14 1,782 50 51 1 36	0 0 1			0 0	0 192
Alighting 15106 352 250 41 240	59 146 354	114 226	145	157 240	536 1796
Y2030	077 070	070	0744	0740	0744
Line ST1 ST2 ST3 ST4 ST5 ST6 ST1 0 141 0 14 40	ST7 ST8 51 68 346	ST9 ST10 5 124 228	ST11 ST12 150	ST13 166 218	ST14 Boarding 303 184
ST2 138 0 0 4 12	1 5 0		2	2 2	48 21
ST3 166 7 0 18 98	5 39 34		7	5 20	157 57
ST4 746 7 0 0 0	0 1 0		0	0 0	0 75
ST5 1,797 17 14 0 0	1 16 1	0 6	5	6 23	57 194
ST6 846 9 0 0 1	0 0 0		0	0 1	1 85
ST7 2,193 24 35 0 0	0 0 0			0 1	1 225
ST8 1,168 2 7 0 0 ST9 492 5 17 0 3	0 0 0			0 0	0 117
ST9 492 5 17 0 3 ST10 2,500 25 41 0 23	0 0 0			0 0	0 259
ST11 1,034 24 18 1 9	1 2 0			0 0	0 108
ST12 963 24 24 3 16	1 10 1			0 0	0 104
ST13 1,495 28 44 5 19	3 14 3			0 0	0 161
ST14 1,732 52 48 1 38	0 0 1		0	0 0	0 187
Alighting 15270 365 248 46 259	64 155 386	5 129 247	164	179 265	567 1834
Y2035	077 070	ET0 ET10	CT11 CT12	CT12	CT14 Roording
Line ST1 ST2 ST3 ST4 ST5 ST6 ST1 0 150 0 13 43	ST7 ST8 53 77 371	ST9 ST10 126 244	ST11 ST12 156	ST13 182 235	ST14 Boarding 308 195
ST2 163 0 0 4 14	1 5 0		4	4 5	46 25
ST3 191 7 0 19 98	5 39 35		7	6 20	158 60
ST4 762 7 0 0 0	0 1 0	0 0			
ST5 1,818 17 14 0 0	1 18 1	0 6		0 0	0 77
			5	5 24	0 77 60 196
ST6 854 10 0 0 0	0 0 0	0 0	0	5 24 0 1	0 77 60 196 1 86
ST7 2,252 25 37 0 0	0 0 0	0 0 0	0	5 24 0 1 0 1	0 77 60 196 1 86 1 231
ST7 2,252 25 37 0 0 ST8 1,191 2 7 0 0	0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	5 24 0 1 0 1 0 0	0 77 60 196 1 86 1 231 0 120
ST7 2,252 25 37 0 0 ST8 1,191 2 7 0 0 ST9 495 5 17 0 3	0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0	5 24 0 1 0 1 0 0 0 0	0 77 60 196 1 86 1 231 0 120 0 52
ST7 2,252 25 37 0 0 ST8 1,191 2 7 0 0 ST9 495 5 17 0 3 ST10 2,493 25 40 0 24	0 0 0 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0	5 24 0 1 0 0 0 0 0 0 0 0 0 0 0 0	0 77 60 196 1 86 1 231 0 120 0 52 0 258
ST7 2,252 25 37 0 0 ST8 1,191 2 7 0 0 ST9 495 5 17 0 3 ST10 2,493 25 40 0 24 ST11 1,022 25 15 1 9	0 0 0 0 0 0 0 0 1 0 0 1 2 00	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0	5 24 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 77 60 196 1 86 1 231 0 120 0 52 0 258 0 107
ST7 2,252 25 37 0 0 ST8 1,191 2 7 0 0 ST9 495 5 17 0 3 ST10 2,493 25 40 0 24	0 0 0 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0	0 0 0 0 0 0 0	5 24 0 1 0 0 0 0 0 0 0 0 0 0 0 0	0 77 60 196 1 86 1 231 0 120 0 52 0 258
ST7 2.252 25 37 0 0 ST8 1,191 2 7 0 0 ST9 495 5 17 0 3 ST10 2,493 25 40 0 24 ST11 1.022 25 15 1 9 ST12 945 24 24 3 16 ST13 1,478 28 41 5 19 ST14 1,700 51 45 1 39	0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 1 2 0 0 1 10 1 1 4 15 3 3 0 0 0 1	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0	5 24 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 777 60 1196 1 866 1 231 0 1202 0 258 0 107 0 107 0 102 0 159 0 183
ST7 2,252 25 37 0 0 ST8 1,191 2 7 0 0 ST9 495 5 17 0 3 ST10 2,493 25 40 0 24 ST11 1,022 25 15 1 9 ST12 945 24 24 3 16 ST13 1,478 28 41 5 19 ST14 1,700 51 45 1 39 Alighting 15364 376 240 46 265	0 0 0 0 0 0 0 1 0 0 0 1 10 1 1 4 15 3 3	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0	5 24 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 77 60 196 1 86 1 231 0 120 0 52 0 258 0 107 0 102 0 102 0 159
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 1 1 0 0 1 10 1 1 4 115 3 3 0 0 1 67 167 412 167 412 167 167	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3 0 0 2 131 264	0 0 0 0 0 0 0 0 172	5 24 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 197 286	0 77 60 196 1 86 1 231 0 120 0 52 0 258 0 107 0 100 0 159 0 183 574 1856
ST7 2.252 25 37 0 0 ST8 1,191 2 7 0 0 ST9 495 5 17 0 3 ST10 2.493 25 40 0 24 ST11 1.022 25 15 1 9 ST12 945 24 24 3 16 ST13 1,478 28 41 5 19 ST14 1,700 51 45 1 39 Alighting 15364 376 240 46 265 Y2040 Line ST1 ST2 ST3 ST4 ST5 ST6	0 0 0 0 0 0 0 0 1 0 0 0 1 1 2 0 1 10 1 4 15 3 0 0 1 67 167 412 ST7 ST8	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 131 264 ST9 ST10 ST10	0 0 0 0 0 0 0 172 ST11 ST12	5 24 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 77 60 196 1 86 1 231 0 122 0 52 0 258 0 107 0 102 0 102 0 103 574 1856 ST14 Boarding
ST7 2,252 25 37 0 0 ST8 1,191 2 7 0 0 ST9 495 5 17 0 3 ST10 2,493 25 40 0 24 ST11 1,022 25 15 1 9 ST12 945 24 24 3 16 ST13 1,478 28 41 5 19 ST14 1,700 51 45 1 39 Alighting 15364 376 240 46 265 Y2040 V ST3 ST4 ST5 ST6 ST1 0 156 0 13 46	0 0 0 0 0 0 0 0 1 0 0 1 2 0 1 10 1 4 15 3 0 0 1 67 167 412 ST7 ST8 54 82 396	0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 1 1 264 ST10 265 ST10 265 S	0 0 0 0 0 0 0 172 ST11 ST12	5 24 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 197 286	0 777 60 196 1 866 1 231 0 122 0 52 0 258 0 107 0 102 0 1159 0 1135 574 1856 ST14 Boarding 320 209
ST7 2.252 25 37 0 0 ST8 1,191 2 7 0 0 ST9 495 5 17 0 3 ST10 2,493 25 40 0 24 ST11 1,022 25 15 1 9 ST12 945 24 24 3 16 ST13 1,478 28 41 5 19 ST14 1,700 511 45 1 39 Alighting 15364 376 240 46 265 Y2040 ST5 ST6 ST6 ST6 0 13 46 ST1 0 156 0 13 46 ST5 ST6	0 0 0 0 0 0 0 0 1 0 0 0 1 2 00 1 1 0 1 4 15 3 0 0 1 67 167 412 ST7 ST8 54 82 396 1 5 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 131 264 ST9 ST10 140 2655 0 6 6	0 0 0 0 0 0 0 0 172 ST11 ST12 173 4	5 24 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 197 286 \$T13 195 5 5	0 77 60 196 1 86 1 231 0 120 0 52 0 0 258 0 107 0 102 0 159 0 183 574 1856 ST14 Boarding 320 209 47 26
ST7 2,252 25 37 0 0 ST8 1,191 2 7 0 0 ST9 495 5 17 0 3 ST10 2,493 25 40 0 24 ST11 1,022 25 15 1 9 ST12 945 24 24 3 16 ST13 1,478 28 41 5 19 ST14 1,700 51 45 1 39 Alighting 15364 376 240 46 265 Y2040 5 ST4 ST5 ST6 Line ST1 ST2 ST3 ST4 ST5 ST6 ST2 176 0 5 14 5 ST3 220 7 0 19 98	0 0 0 0 0 0 0 0 1 0 0 1 2 0 1 10 1 4 15 3 0 0 1 67 167 412 ST7 ST8 54 82 396	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 131 264 ST9 ST10 265 0 6 5 10	0 0 0 0 0 0 172 ST11 ST12 173 4 7	5 24 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 195 251	0 77 60 176 1 86 1 231 0 120 0 52 0 258 0 120 0 52 0 120 0 120 0 52 0 120 0 155 0 120 0 133 574 1856 ST14 Boarding 47 26 16 6 3
ST7 2,252 25 37 0 0 ST8 1,191 2 7 0 0 ST9 495 5 17 0 3 ST10 2,493 25 40 0 24 ST11 1,022 25 15 1 9 ST12 945 24 24 3 16 ST13 1,478 28 41 5 19 ST14 1,700 511 45 1 39 Alighting 15364 376 240 46 265 Y2040 Line ST1 ST2 ST3 ST4 ST5 ST6 ST1 0 156 0 13 46 ST1 0 156 0 5 14 ST3 220 7 0 19 98	0 0 0 0 0 0 0 0 1 0 0 1 2 0 1 10 1 4 15 3 0 0 1 67 167 412 ST7 ST8 ST7 ST8 54 82 396 1 5 0 5 38 35	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 131 264 ST9 ST10 5 140 2 5 100 6 0 0 0 0	0 0 0 0 0 0 0 172 ST11 ST12 ST11 ST12 4 7 0	5 24 0 1 0 1 0 0 197 261 5 5 7 20	0 77 60 176 1 86 1 231 0 120 0 52 0 258 0 120 0 52 0 120 0 120 0 52 0 120 0 155 0 120 0 133 574 1856 ST14 Boarding 47 26 16 6 3
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	0 0 0 0 0 0 0 0 0 0 0 1 0 0 1 1 10 1 1 4 15 3 3 0 0 1 1 67 167 412 ST7 ST8 396 5 38 35 0 1 0 1 18 1 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 131 264 ST9 ST10 5 140 2 5 100 0 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 1772 ST11 ST12 173 4 7 7 0 6 0	5 24 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 195 251 5 5 7 20 0 0 0 0	0 777 60 196 1 86 1 231 0 122 0 52 0 258 0 107 0 102 0 1159 0 1859 0 1859 0 1859 0 1859 0 1859 0 1859 0 1859 0 1859 0 196 0 209 47 266 0 177 0 60 196 0 197 0 196 0 196 0 209 47 266 0 177 0 0 77 60 199 1 886 0 777 1 886 0 777 0 778 0 777 0 778 0 777 0 778 0 777 0 777
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 1 1 0 0 1 4 15 3 0 0 1 67 167 412 396 1 5 0 1 5 0 1 5 0 1 0 0 1 1 1 1 1 1 1 1 1 1 1 1 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 131 264 265 0 6 5 140 265 0 6 6 5 10 0 <t< td=""><td>0 0 0 0 0 0 0 172 ST11 ST12 173 4 7 0 6 0 0 0</td><td>5 24 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 195 2511 5 5 7 20 0 5 0 24 0 1</td><td>0 777 60 196 1 86 1 231 0 120 0 52 0 0 256 0 107 0 102 0 155 0 183 574 1856 ST14 Boarding 320 209 47 26 160 63 0 77 60 199 1 232</td></t<>	0 0 0 0 0 0 0 172 ST11 ST12 173 4 7 0 6 0 0 0	5 24 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 195 2511 5 5 7 20 0 5 0 24 0 1	0 777 60 196 1 86 1 231 0 120 0 52 0 0 256 0 107 0 102 0 155 0 183 574 1856 ST14 Boarding 320 209 47 26 160 63 0 77 60 199 1 232
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 1 1 0 0 1 10 1 1 4 15 3 3 0 0 1 1 6 5 38 35 3 3 5 38 35 0 1 0 1 1 5 0 0 0 1 1 5 0 0 0 1 1 8 1 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 131 265 0 0 0 5 140 265 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 172 ST11 ST12 173 4 7 7 0 6 6 0 0 0	5 24 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 5 5 7 200 0 0 5 24 0 1 0 0	0 77 60 196 1 86 1 231 0 120 0 52 0 258 0 107 0 102 0 102 0 102 0 102 0 103 574 1856 ST14 Boarding 320 209 47 26 160 63 0 77 60 199 1 86 21 20 1 86 20 19 21 20 21 20 20 20
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 1 1 0 0 1 10 1 1 4 15 3 3 0 0 1 1 1 54 82 396 1 5 0 1 15 3 3 5 0 1 1 0<	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 131 264 5 140 265 0 0 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 172 5T11 5T12 5T11 5T12 5T11 5T12 6 0 0 0 0 0 0 0	5 24 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 195 251 5 5 7 200 0 0 0 1 0 1 0 0 0 0	0 777 60 196 1 86 1 231 0 120 0 52 0 0 228 0 107 0 102 0 189 0 183 574 1856 ST14 Boarding 320 209 47 26 160 6 39 0 77 60 199 1 86 1 232 0 122 0 51
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 1 1 0 0 1 10 1 1 4 15 3 0 0 67 167 412 396 1 5 0 1 0 5 38 35 0 1 0 1 18 1 0 0 0 0 1 18 1 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 131 264 ST9 ST10 265 0 6 5 10 0 0 6 6 5 0 0 6 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 172 5T11 ST12 173 4 7 7 0 6 6 0 0 0 0 0 0 0 0 0	5 24 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0	0 777 60 196 1 86 1 231 0 120 0 52 0 0 52 0 107 0 102 0 107 0 102 0 159 0 183 574 1856 ST14 Boarding 320 209 47 26 160 63 0 77 60 199 1 86 1 232 0 122 0 122 0 122 0 52 1 23 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 1 1 0 0 1 10 1 1 4 15 3 3 0 0 1 1 67 167 412 ST7 ST8 5 5 38 38 0 1 1 0 0 0 0 1 18 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 1 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 131 264 ST9 ST10 5 6 5 140 265 5 10 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 1772 173 4 7 7 0 6 6 0 0 0 0 0 0 0 0 0 0 0	$\begin{array}{c c} 5 & 24\\ 0 & 1\\ 0 & 1\\ 0 & 0 &$	0 777 60 196 1 86 1 231 0 122 0 52 0 258 0 107 0 102 0 1159 0 1859 0 196 0 197 0 196 0 197 0 196 0 197 0 196 0 197 0 196 0 197 0 196 0 196 0 197 0 196 0 197 0 196 0 196 0 196 0 197 0 192 0 197 0 197
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 1 1 0 0 1 2 0 0 1 10 1 1 4 15 3 0 0 67 167 \$167 \$12 57 \$5 38 35 0 1 10 0 1 18 1 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 1 0 0 0 1 1 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 131 264 ST9 ST10 8 0 0 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 1772 5T11 5T12 5T11 5T12 4 7 0 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0	5 24 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0	0 777 60 196 1 86 1 231 0 120 0 52 0 0 258 0 107 0 102 0 183 574 1856 ST14 Boarding 320 209 47 266 160 63 0 777 60 199 1 866 1 232 0 122 0 122 0 51 0 256 0 266 0 99
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 1 1 0 0 1 2 0 0 1 10 1 1 4 15 3 0 0 67 167 \$167 \$12 57 \$5 38 35 0 1 10 0 1 18 1 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 1 0 0 0 1 1 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 131 265 140 265 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 10 0	0 0 0 0 0 0 0 0 172 ST11 ST12 173 4 7 7 0 6 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	$\begin{array}{c c} 5 & 24\\ 0 & 1\\ 0 & 1\\ 0 & 0\\ 0 & 0\\ 0 & 0\\ 0 & 0\\ 0 & 0\\ 0 & 0\\ 0 & 0\\ 0 & 0\\ 0 & 0\\ 0 & 0\\ 0 & 0\\ 0 & 0\\ 0 & 0\\ 0 & 0\\ 0 & 0\\ 0 & 1\\ 0 & 1\\ 0 & 1\\ 0 & 0 &$	0 777 60 196 1 86 1 231 0 120 0 52 0 0 258 0 107 0 102 0 183 574 1856 ST14 Boarding 320 209 47 266 160 63 0 777 60 199 1 866 1 232 0 122 0 122 0 51 0 256 0 266 0 99
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 1 1 0 0 1 10 1 1 4 15 3 3 0 0 1 1 67 167 412 ST7 ST8 5 5 38 35 0 1 0 0 5 38 35 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 2 0 1 1 10 1 1 4 15 3 3	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 131 264 ST9 ST10 5 140 5 5 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 1772 173 173 4 7 7 0 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	$\begin{array}{c c} 5 & 24\\ 0 & 1\\ 0 & 1\\ 0 & 0 &$	0 777 60 196 1 86 1 231 0 122 0 528 0 107 0 107 0 102 0 189 0 107 0 112 0 320 209 47 26 160 633 0 77 60 199 1 866 1 232 0 77 60 199 1 866 1 232 0 77 60 199 1 866 1 232 0 122 0 516 0 122 0 155 0 107 1 866 1 232 0 196 1 866 1 867 1 866 1 867 1 866 1 867 1 866 1 866 1 867 1 866 1 866 1 866 1 867 1 866 1
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 131 264 ST9 ST10 5 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 <t< td=""><td>0 0 0 0 0 0 0 0 0 1772 173 4 7 7 7 0 6 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td><td>5 24 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 195 251 5 5 7 200 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 <td>0 777 60 196 1 86 1 231 0 120 0 528 0 107 0 102 0 1159 0 1859 574 1856 574 1856 574 260 160 633 0 77 60 199 1 222 0 209 47 266 160 633 0 777 60 199 1 886 1 232 0 122 0 51 0 258 1 861 1 232 0 125 0 125 0 125 0 125 0 125 0 125 0 196 1 85 1 866 1 967 1 866 1 977 1 866 1 987 1 866 1 987 1 866 1 987 1 866 1 987 1 866 1 987 1 866 1 987 1 987 1</td></td></t<>	0 0 0 0 0 0 0 0 0 1772 173 4 7 7 7 0 6 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0	5 24 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 195 251 5 5 7 200 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 <td>0 777 60 196 1 86 1 231 0 120 0 528 0 107 0 102 0 1159 0 1859 574 1856 574 1856 574 260 160 633 0 77 60 199 1 222 0 209 47 266 160 633 0 777 60 199 1 886 1 232 0 122 0 51 0 258 1 861 1 232 0 125 0 125 0 125 0 125 0 125 0 125 0 196 1 85 1 866 1 967 1 866 1 977 1 866 1 987 1 866 1 987 1 866 1 987 1 866 1 987 1 866 1 987 1 866 1 987 1 987 1</td>	0 777 60 196 1 86 1 231 0 120 0 528 0 107 0 102 0 1159 0 1859 574 1856 574 1856 574 260 160 633 0 77 60 199 1 222 0 209 47 266 160 633 0 777 60 199 1 886 1 232 0 122 0 51 0 258 1 861 1 232 0 125 0 125 0 125 0 125 0 125 0 125 0 196 1 85 1 866 1 967 1 866 1 977 1 866 1 987 1 866 1 987 1 866 1 987 1 866 1 987 1 866 1 987 1 866 1 987 1
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 1 1 0 0 1 10 1 1 4 15 3 3 0 0 1 1 67 167 412 ST7 ST8 5 0 0 1 5 0 1 5 0 1 18 1 0 0 0 0 0 0 0 0 0 1 10 1 2 0 0 0 0 1 10 1 4 15 3 3 0 1 10 1 4 15 3 0 1 68 171 437	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 1772 ST11 ST12 ST11 ST12	5 24 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 777 60 196 1 86 1 231 0 120 0 52 0 0 256 0 107 0 102 0 183 574 1856 ST14 Boarding 320 209 47 26 160 63 0 177 60 199 1 86 1 232 0 122 0 122 0 51 0 256 0 104 1 232 0 123 0 177 60 199 1 232 0 123 0 177 60 199 1 232 0 125 1 232 0 177 1 255 1 232 1 33 1 33
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	0 0 0 0 0 0 0 1 0 0 0 1 0 0 0 1 1 0 0 0 1 2 0 0 1 4 15 3 3 0 0 1 67 167 412 396 1 5 0 1 1 0 0 0 1 1 0 0 0 1 1 1 5 0 1 0 1 1 1 1 1 1 1 1 1 1 1 1	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 172 ST11 ST12 173 4 7 0 6 0 0 0 0 0 0 0 0 0 0 0 173 5 173 5 173 5 173 173 173 173 173 173 173 173	5 24 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0	0 777 60 196 1 86 1 231 0 122 0 52 0 258 0 107 0 102 0 159 0 135 0 107 1 856 ST14 Boarding 320 209 47 26 160 633 0 77 60 199 1 866 1 232 0 122 0 514 1 856 0 107 1 856 0 107 1 856 1 857 1 857 1 856 1 857 1 856 1 857 1 856 1 857 1 856 1 857 1 856 1 857 1 857 1 856 1 857 1 857 1 856 1 857 1 857
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 1 1 0 0 1 10 1 1 4 15 3 0 0 57 ST8 54 82 396 1 5 0 1 2 0 1 5 0 1 1 5 0 1 5 0 1 0 1 68 171 437 58 90 438 1 6 0 0 1 1 1 1 1 1 1 1 1 1	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 131 264 ST9 ST10 6 5 5 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 <t< td=""><td>0 0 0 0 0 0 0 0 0 172 ST11 ST12 173 4 7 0 6 0 0 0 0 0 0 0 0 0 0 5 173 173 173 173 173 173 173 173</td><td>5 24 0 1 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0</td><td>0 777 60 196 1 86 1 231 0 120 0 52 0 0 226 0 107 0 102 0 159 0 185 574 185 574 185 574 26 160 63 0 77 60 199 1 866 1 232 0 77 60 199 1 866 1 232 0 77 60 199 1 866 1 232 0 77 60 199 1 866 1 232 0 177 60 199 1 866 1 232 0 177 1 866 1 232 0 177 1 866 1 866 1 97 1 866 1 97 1 866 1 985 1 867 1 866 1 985 1 867 1 866 1 985 1 867 1 866 1 985 1 866 1 985 1 867 1 866 1 985 1 866 1 866 1 985 1 866 1 985 1 866 1 866</td></t<>	0 0 0 0 0 0 0 0 0 172 ST11 ST12 173 4 7 0 6 0 0 0 0 0 0 0 0 0 0 5 173 173 173 173 173 173 173 173	5 24 0 1 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0	0 777 60 196 1 86 1 231 0 120 0 52 0 0 226 0 107 0 102 0 159 0 185 574 185 574 185 574 26 160 63 0 77 60 199 1 866 1 232 0 77 60 199 1 866 1 232 0 77 60 199 1 866 1 232 0 77 60 199 1 866 1 232 0 177 60 199 1 866 1 232 0 177 1 866 1 232 0 177 1 866 1 866 1 97 1 866 1 97 1 866 1 985 1 867 1 866 1 985 1 867 1 866 1 985 1 867 1 866 1 985 1 866 1 985 1 867 1 866 1 985 1 866 1 866 1 985 1 866 1 985 1 866 1 866
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 1 2 0 0 1	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 140 285 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 <td>0 0 0 0 0 0 0 0 0 172 5T11 ST12 173 4 7 0 6 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>5 24 0 1 0 1 0 0</td> <td>0 777 60 196 1 86 1 231 0 120 0 52 0 0 256 0 107 0 102 0 159 0 183 574 1856 ST14 Boarding 320 209 47 26 160 63 1 232 0 177 60 199 1 232 0 122 0 155 0 183 574 266 183 574 1856 ST14 Boarding 1 232 0 125 0 199 1 235 0 176 1 233 0 177 60 199 1 235 0 199 1 235 0 177 60 199 1 255 1 235 1 235 1 235 1 235 1 255 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1</td>	0 0 0 0 0 0 0 0 0 172 5T11 ST12 173 4 7 0 6 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	5 24 0 1 0 1 0 0	0 777 60 196 1 86 1 231 0 120 0 52 0 0 256 0 107 0 102 0 159 0 183 574 1856 ST14 Boarding 320 209 47 26 160 63 1 232 0 177 60 199 1 232 0 122 0 155 0 183 574 266 183 574 1856 ST14 Boarding 1 232 0 125 0 199 1 235 0 176 1 233 0 177 60 199 1 235 0 199 1 235 0 177 60 199 1 255 1 235 1 235 1 235 1 235 1 255 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 1 0 0 0 0 1 0 0 0 0 1 10 1 1 0 4 15 3 3 0 54 82 396 0 1 54 82 396 0 1 0 0 1 5 0 1 0 0 0 0 1 0 <td< td=""><td>0 0 0 0 0 0 6 0 15 10</td><td>0 0 0 0 0 0 0 0 0 0 172 173 4 7 0 0 0 0 0 0 0 0 0 0 0 0 0</td><td>5 24 0 1 0 1 0 0 214 274 5 6 7 20 0 0</td><td>0 777 60 196 1 86 1 231 0 120 0 52 0 258 0 107 0 102 0 159 0 185 0 117 0 102 0 155 0 160 160 633 0 77 60 199 1 866 1 633 0 777 60 199 1 866 1 633 0 777 60 199 1 866 1 633 0 777 60 199 1 866 1 633 0 777 60 199 1 866 1 633 0 777 60 199 1 866 1 633 0 777 60 199 1 866 1 633 0 777 60 199 1 866 1 633 0 777 60 199 1 866 1 855 1 86 1 807 1 232 1 807 1 80</td></td<>	0 0 0 0 0 0 6 0 15 10	0 0 0 0 0 0 0 0 0 0 172 173 4 7 0 0 0 0 0 0 0 0 0 0 0 0 0	5 24 0 1 0 1 0 0 214 274 5 6 7 20 0 0	0 777 60 196 1 86 1 231 0 120 0 52 0 258 0 107 0 102 0 159 0 185 0 117 0 102 0 155 0 160 160 633 0 77 60 199 1 866 1 633 0 777 60 199 1 866 1 633 0 777 60 199 1 866 1 633 0 777 60 199 1 866 1 633 0 777 60 199 1 866 1 633 0 777 60 199 1 866 1 633 0 777 60 199 1 866 1 633 0 777 60 199 1 866 1 633 0 777 60 199 1 866 1 855 1 86 1 807 1 232 1 807 1 80
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 1 4 15 3 0 0 1	0 0 0 0 0 6 5 10 0 0	0 0 0 0 0 0 0 0 0 172 ST11 ST12 173 4 7 0 6 0 0 0 0 0 0 0 0 0 0 0 0 0	5 24 0 1 0 1 0 0	0 777 60 196 1 86 1 231 0 120 0 52 0 0 256 0 107 0 102 0 159 0 183 574 1856 ST14 Boarding 320 209 47 26 160 63 1 232 0 177 60 199 1 232 0 122 0 155 0 183 574 266 183 574 1856 ST14 Boarding 1 232 0 125 0 199 1 235 0 176 1 233 0 177 60 199 1 235 0 199 1 235 0 177 60 199 1 255 1 235 1 235 1 235 1 235 1 255 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 1 4 15 3 0 0 1	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 131 264 3 150 5 140 265 5 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 131 288 153 288 15 10 0 0 0 0	0 0 0 0 0 0 0 0 0 173 173 4 7 0 6 0 0 0 0 0 0 0 0 0 0 0 0 0	5 24 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 777 60 196 1 86 1 231 0 120 0 52 0 0 258 0 107 0 102 0 183 574 1856 ST14 Boarding 320 209 47 26 160 63 0 177 60 199 0 182 0 183 0 77 60 199 1 866 1 232 0 51 0 256 0 107 1 232 0 177 60 199 1 867 1 232 0 177 1 232 0 177 1 235 1 232 0 177 1 235 1 235
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 1 1 0 0 0 1 1 0 0 1 4 15 3 0 0 1 67 167 412 3 3 3 1 5 0 0 1 1 5 0 1 0 0 1 0 0 1 0 1 1 1 1 </td <td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>0 0 0 0 0 0 0 0 0 172 ST11 ST12 173 4 7 0 6 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>5 24 0 1 0 1 0 0</td> <td>0 77 60 196 1 86 1 231 0 122 0 52 0 122 0 52 0 122 0 122 0 122 0 159 0 133 574 1856 ST14 Boarding 30 209 47 26 160 633 0 77 60 132 0 122 0 516 0 122 0 155 0 1165 0 125 589 1861 ST14 Boarding 336 225 51 29 161 68 0 77 60 135 1 86 </td>	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 172 ST11 ST12 173 4 7 0 6 0 0 0 0 0 0 0 0 0 0 0 0 0	5 24 0 1 0 1 0 0	0 77 60 196 1 86 1 231 0 122 0 52 0 122 0 52 0 122 0 122 0 122 0 159 0 133 574 1856 ST14 Boarding 30 209 47 26 160 633 0 77 60 132 0 122 0 516 0 122 0 155 0 1165 0 125 589 1861 ST14 Boarding 336 225 51 29 161 68 0 77 60 135 1 86
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 131 264 ST9 ST10 5 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 <t< td=""><td>0 0 0 0 0 0 0 0 0 0 1772 ST11 ST12 173 4 4 7 0 6 0 0 0 0 0 0 0 0 0 0 0 0 0</td><td>5 24 0 1 0 1 0 0</td><td>0 777 60 196 1 86 1 231 0 120 0 52 0 25 0 107 0 102 0 15 0 113 574 186 574 186 574 186 574 186 160 63 0 77 60 199 1 88 1 123 0 122 0 51 0 122 0 51 0 125 0 176 589 186 1 233 0 122 0 51 1 233 161 68 1 233 0 177 60 199 1 186 1 233 0 177 1 186 1 233 0 177 1 186 1 233 0 122 0 55 1 29 161 68 1 233 0 177 1 186 1 233 0 122 0 55 1 29 161 68 1 233 0 122 0 55 1 29 161 68 1 233 0 122 0 55 1 29 161 68 1 233 0 122 0 55 1 29 161 68 1 233 0 122 0 55 1 29 161 68 1 233 0 122 0 55 1 29 161 68 1 233 0 122 0 55 1 29 161 68 1 233 0 122 0 55 1 29 161 68 1 233 0 122 0 55 1 29 161 68 1 233 0 122 0 55 1 29 161 68 1 233 0 122 0 55 1 29 161 68 1 233 0 122 0 55 1 29 161 68 1 233 0 122 0 55 1 29 161 68 1 233 0 122 0 55 1 29 161 68 1 233 0 122 0 55 1 29 161 68 1 233 0 122 0 55 1 29 161 68 1 233 0 122 0 55 1 29 161 68 1 233 0 122 0 55 1 29 161 68 1 233 0 122 0 55 1 29 161 68 1 233 0 122 0 55 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1</td></t<>	0 0 0 0 0 0 0 0 0 0 1772 ST11 ST12 173 4 4 7 0 6 0 0 0 0 0 0 0 0 0 0 0 0 0	5 24 0 1 0 1 0 0	0 777 60 196 1 86 1 231 0 120 0 52 0 25 0 107 0 102 0 15 0 113 574 186 574 186 574 186 574 186 160 63 0 77 60 199 1 88 1 123 0 122 0 51 0 122 0 51 0 125 0 176 589 186 1 233 0 122 0 51 1 233 161 68 1 233 0 177 60 199 1 186 1 233 0 177 1 186 1 233 0 177 1 186 1 233 0 122 0 55 1 29 161 68 1 233 0 177 1 186 1 233 0 122 0 55 1 29 161 68 1 233 0 122 0 55 1 29 161 68 1 233 0 122 0 55 1 29 161 68 1 233 0 122 0 55 1 29 161 68 1 233 0 122 0 55 1 29 161 68 1 233 0 122 0 55 1 29 161 68 1 233 0 122 0 55 1 29 161 68 1 233 0 122 0 55 1 29 161 68 1 233 0 122 0 55 1 29 161 68 1 233 0 122 0 55 1 29 161 68 1 233 0 122 0 55 1 29 161 68 1 233 0 122 0 55 1 29 161 68 1 233 0 122 0 55 1 29 161 68 1 233 0 122 0 55 1 29 161 68 1 233 0 122 0 55 1 29 161 68 1 233 0 122 0 55 1 29 161 68 1 233 0 122 0 55 1 29 161 68 1 233 0 122 0 55 1 29 161 68 1 233 0 122 0 55 1 29 161 68 1 233 0 122 0 55 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 1 1 0 0 0 1 1 0 0 1 4 15 3 3 3 0 0 1 4 1 54 82 396 1 5 1 5 0 1 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 <td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 6 5 110 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>0 0 0 0 0 0 0 0 0 0 172 ST11 ST12 T73 4 7 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>5 24 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>0 777 60 196 1 866 1 231 0 120 0 52 0 107 0 102 0 120 0 159 0 183 574 1856 574 1856 574 1856 574 1856 0 77 60 199 1 867 1 232 0 51 0 226 0 107 589 1861 5714 Boarding 336 225 5 1 29 161 688 0 77 60 195 1 232 0 155 1 29 161 688 0 77 60 195 1 28 0 175 1 86 0 77 60 195 1 86 0 77 60 195 1 86 0 77 60 195 1 86 0 77 60 195 1 86 0 77 60 195 1 86 0 77 60 195 1 86 0 77 60 195 1 86 0 77 60 195 1 86 0 77 60 195 1 86 0 77 60 195 1 86 0 77 60 195 1 86 0 77 60 195 1 86 0 77 60 195 1 86 0 77 60 195 1 86 0 77 60 195 1 86 1 233 0 122 0 55 1 29 161 68 0 77 7 60 195 1 86 0 77 7 60 195 1 86 0 77 7 60 195 1 86 0 77 7 60 195 1 86 0 77 7 60 195 1 86 0 77 7 60 195 1 86 0 77 7 60 195 1 86 0 77 7 60 195 1 86 0 77 7 60 195 1 86 0 77 7 60 195 1 86 0 77 7 60 195 1 86 1 233 0 122 0 55 1 29 161 68 1 233 1 0 122 1 0 55 1 29 161 68 1 233 1 0 122 1 0 55 1 2 1 0 55 1 2 1 0 55 1 2 1 0 55 1 2 1 0 55 1 2 1 0 55 1 2 1 0 55 1 2 1 0 55 1 2 1 0 55 1 2 1 0 55 1 2 1 0 55 1 2 1 0 55 1 0 5 1 0 5 1 0 5 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td>	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 6 5 110 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 172 ST11 ST12 T73 4 7 0 0 0 0 0 0 0 0 0 0 0 0 0	5 24 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 777 60 196 1 866 1 231 0 120 0 52 0 107 0 102 0 120 0 159 0 183 574 1856 574 1856 574 1856 574 1856 0 77 60 199 1 867 1 232 0 51 0 226 0 107 589 1861 5714 Boarding 336 225 5 1 29 161 688 0 77 60 195 1 232 0 155 1 29 161 688 0 77 60 195 1 28 0 175 1 86 0 77 60 195 1 86 0 77 60 195 1 86 0 77 60 195 1 86 0 77 60 195 1 86 0 77 60 195 1 86 0 77 60 195 1 86 0 77 60 195 1 86 0 77 60 195 1 86 0 77 60 195 1 86 0 77 60 195 1 86 0 77 60 195 1 86 0 77 60 195 1 86 0 77 60 195 1 86 0 77 60 195 1 86 0 77 60 195 1 86 1 233 0 122 0 55 1 29 161 68 0 77 7 60 195 1 86 0 77 7 60 195 1 86 0 77 7 60 195 1 86 0 77 7 60 195 1 86 0 77 7 60 195 1 86 0 77 7 60 195 1 86 0 77 7 60 195 1 86 0 77 7 60 195 1 86 0 77 7 60 195 1 86 0 77 7 60 195 1 86 0 77 7 60 195 1 86 1 233 0 122 0 55 1 29 161 68 1 233 1 0 122 1 0 55 1 29 161 68 1 233 1 0 122 1 0 55 1 2 1 0 55 1 2 1 0 55 1 2 1 0 55 1 2 1 0 55 1 2 1 0 55 1 2 1 0 55 1 2 1 0 55 1 2 1 0 55 1 2 1 0 55 1 2 1 0 55 1 2 1 0 55 1 0 5 1 0 5 1 0 5 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	0 0 0 0 0 0 0 1 0 0 0 1 0 0 0 1 1 0 0 0 1 1 0 0 0 1 10 1 1 1 4 15 3 0 0 1 67 167 412 396 1 5 0 1 167 412 54 82 396 1 5 0 1 0 0 1 0 1 1 1 1 1 1 1 1 1 1	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 172 ST11 ST12 173 4 7 0 6 0 0 0 0 0 0 0 0 0 0 0 0 0	5 24 0 1 0 1 0 0	0 77 60 196 1 86 1 231 0 122 0 525 0 107 0 102 0 135 0 143 374 1856 ST14 Boarding 320 209 47 26 160 63 0 77 60 132 0 122 0 51 0 122 0 51 0 122 0 1155 0 116 589 1861 ST14 Boarding 336 225 51 29 161 88 1 233 0 177 60 195 1 233 0 122
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 131 264 5 140 265 0 0 6 5 5 10 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 1772 173 4 7 0 6 0 0 0 0 0 0 0 0 0 0 0 0 0	$\begin{array}{c c} 5 & 24 \\ 0 & 1 \\ 0 & 1 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 \\$	0 777 60 196 1 866 1 231 0 120 0 52 0 120 0 120 0 120 0 120 0 135 0 107 0 102 0 159 0 183 574 186 574 186 5714 Boarding 320 209 47 26 160 63 0 77 60 199 1 86 1 233 0 77 60 199 0 155 0 176 589 1861 5714 Boarding 336 225 0 176 589 1861 ST14 Boarding 336 225 161 68 0 0 77 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 77 60 195 1 86 0 77 60 195 1 86 0 77 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 177 0 97 0 97 0 97 0 97 0 97 0 97 0 97 0
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 1 1 0 0 0 1 1 0 0 1 4 15 3 0 0 1 67 167 412 3 3 3 0 0 1 5 0 1 5 0 1 0 1 1 1 1 1 1 1 1 1 </td <td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>0 0 0 0 0 0 0 0 0 172 ST11 ST12 173 4 7 0 6 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>5 24 0 1 0 1 0 0</td> <td>0 777 60 196 1 86 1 231 0 120 0 552 0 252 0 252 0 107 0 102 0 155 0 107 0 102 0 155 0 177 60 199 1 86 1 232 0 122 0 51 0 255 0 104 0 99 0 155 0 104 0 99 0 155 0 104 0 99 0 155 0 104 0 99 0 155 0 177 60 195 1 86 1 222 0 51 1 86 1 222 0 51 1 86 1 222 0 51 1 86 1 222 0 51 1 86 1 222 0 51 1 86 1 222 0 5 5 1 22 0 5 5 5 1 22 0 5 5 1 22 0 5 5 5 1 22 0 5 5 5 1 22 0 5 5 5 1 22 0 5 5 5 1 22 0 5 5 5 1 22 0 5 5 5 1 22 0 5 5 5 1 22 0 5 5 5 1 2 2 0 5 5 5 1 2 2 0 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5</td>	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 172 ST11 ST12 173 4 7 0 6 0 0 0 0 0 0 0 0 0 0 0 0 0	5 24 0 1 0 1 0 0	0 777 60 196 1 86 1 231 0 120 0 552 0 252 0 252 0 107 0 102 0 155 0 107 0 102 0 155 0 177 60 199 1 86 1 232 0 122 0 51 0 255 0 104 0 99 0 155 0 104 0 99 0 155 0 104 0 99 0 155 0 104 0 99 0 155 0 177 60 195 1 86 1 222 0 51 1 86 1 222 0 51 1 86 1 222 0 51 1 86 1 222 0 51 1 86 1 222 0 51 1 86 1 222 0 5 5 1 22 0 5 5 5 1 22 0 5 5 1 22 0 5 5 5 1 22 0 5 5 5 1 22 0 5 5 5 1 22 0 5 5 5 1 22 0 5 5 5 1 22 0 5 5 5 1 22 0 5 5 5 1 22 0 5 5 5 1 2 2 0 5 5 5 1 2 2 0 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 1 1 0 0 0 1 1 0 0 1 4 15 3 0 0 1 67 167 412 3 3 3 0 0 1 5 0 1 5 0 1 0 1 1 1 1 1 1 1 1 1 </td <td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 131 264 ST9 ST10 5 140 5 140 265 0 6 5 100 6 5 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>0 0 0 0 0 0 0 0 0 0 1772 173 4 7 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>$\begin{array}{c c} 5 & 24 \\ 0 & 1 \\ 0 & 1 \\ 0 & 0 \\ 0 \\$</td> <td>0 777 60 196 1 866 1 231 0 120 0 52 0 120 0 120 0 120 0 120 0 135 0 107 0 102 0 159 0 183 574 186 574 186 5714 Boarding 320 209 47 26 160 63 0 77 60 199 1 86 1 233 0 77 60 199 0 155 0 176 589 1861 5714 Boarding 336 225 0 176 589 1861 ST14 Boarding 336 225 161 68 0 0 77 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 77 60 195 1 86 0 77 60 195 1 86 0 77 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 177 0 97 0 97 0 97 0 97 0 97 0 97 0 97 0</td>	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 131 264 ST9 ST10 5 140 5 140 265 0 6 5 100 6 5 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 1772 173 4 7 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	$\begin{array}{c c} 5 & 24 \\ 0 & 1 \\ 0 & 1 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 \\$	0 777 60 196 1 866 1 231 0 120 0 52 0 120 0 120 0 120 0 120 0 135 0 107 0 102 0 159 0 183 574 186 574 186 5714 Boarding 320 209 47 26 160 63 0 77 60 199 1 86 1 233 0 77 60 199 0 155 0 176 589 1861 5714 Boarding 336 225 0 176 589 1861 ST14 Boarding 336 225 161 68 0 0 77 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 77 60 195 1 86 0 77 60 195 1 86 0 77 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 177 60 195 1 86 0 177 0 97 0 97 0 97 0 97 0 97 0 97 0 97 0

Table 3.41	Station-to-Station Matrix (Phase-1 development case: Mid Growth)
Y2020	_

Alighting | 14998| 3001 21 Source: JICA Study Team

Line ST1 ST2	OTI														
	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9	ST10	ST11	ST12	ST13		Boarding
	0 94	119 0	0			39		277	100	181	120	123	176		1512 154
ST2 ST3	94	7			-	3		22			3	0	9		365
ST4	668	5		0		0		0		0	0	0	0		673
ST5	1,636	16	15	0	0	1	8	1	0	6	4	4	19	53	1763
ST6	768	8	1	0	-	0	-	0			0	0	1	1	779
ST7	1,966	19		0		0		0			0	0	1		2015
ST8 ST9	1,028 437	2	5	0		0		0			0	0	0		1035 459
ST10	2,256	21	40	0		1	0	0			0	0	0		2339
ST11	952	22		1		1		0			0	0	0		1001
ST12	925	20		2	12	1		1	0		0	0	0		995
ST13	1,403	23	42	4		2	14	1	0	0	0	0	0	0	1507
ST14	1,702	53		0		0		1	0		0	0	0		1834
Alighting	13933	317	237	33	190	49	127	303	103	196	127	127	206	483	16431
Y2025 Line	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9	ST10	ST11	ST12	ST13	ST14	Boarding
ST1	0	126	0	10		44		305	108	202	124	142	199	289	1649
ST2	109	0				1	5	0	0		0	0	0		177
ST3	133	7	0	14		5		32	3	9	5	3	14	143	482
ST4	692	5		0		0		0		0	0	0	0		697
ST5 ST6	1,656 781	16 8		0	-	0	11 0	0	0		4	5	18	53	1786 792
ST7	2,002	21	32	0		0		0			0	0	1	1	2057
ST8	1,061	2	5	0		0		0			0	0	0	0	1068
ST9	439	4		0	3	0	0	0			0	0	0		463
ST10	2,329	23		0		1		0			0	0	0		2415
ST11 ST12	979 930	23	16 23	1	8	1	2	0	0		0	0	0		1030
ST12 ST13	1,418	22		4		2		1	0		0	0	0		1002
ST14	1,418	49	42	1		0		1	0		0	0	0		1828
Alighting	14227	332	239	36		56		341			133	150	233		1697
Y2030															
Line	ST1	ST2 126	ST3	ST4	ST5	ST6	ST7	ST8	ST9	ST10	ST11	ST12	ST13		Boarding
ST1 ST2	0	136	0	12		46	65 5	330	115	213	130	156	203	297 45	1739
ST2 ST3	132	7	0	4		5		34		9	7	4	19	45	200
ST4	714	7	0	0		0		0		0	0	0	0		722
ST5	1,696	16		0		1	15	1	0		5	4	21		1835
ST6	796	8		0		0		0			0	0	1		808
ST7 ST8	2,071 1,098	21	34 5	0		0		0			0	0	1		2128
ST9	465	4		0		0		0			0	0	0		488
ST10	2,321	22		0		1		0			0	0	0		2406
ST11	973	24		1	9	1	2	0			0	0	0		1026
ST12	914	24	23	3		1	10	1	0		0	0	0		990
ST13	1,417	28 47	41 47	4		2		1	0		0	0	0		1525 1799
ST14 Alighting	1,668 14421	346	237	43		58		368	119		144	166	247	550	17319
Y2035															
Line	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9	ST10	ST11	ST12	ST13	ST14	Boarding
ST1	0	140	0	11	39	50	69	357	121	229	140	170	221	304	1851
ST2 ST3	157								-				221		
ST3 ST4	101	0	0	4		1	5	0	0	4	4	4	4	43	238
	181 721	7	0	18	93	5	38	34		4	4	4 5	4 20	43 152	238 573
	721	7	0	18 0	93 0	5	38 1	34 0	0	4 9 0	4 7 0	4 5 0	4 20 0	43 152 0	238 573 729
ST5 ST6		7 7 17 8	0 0 15	18	93 0 0	5	38 1 15	34	0	4 9 0 6	4	4 5	4 20	43 152 0	238 573
ST5 ST6 ST7	721 1,729 810 2,124	7 7 17 8 22	0 0 15 0 36	18 0 0 0 0	93 0 0 0 0	5 0 1 0	38 1 15 0 0	34 0 1 0	0 0 0 0	4 9 0 6 0 0	4 7 0 5 0 0	4 5 0 5 0 0	4 20 0 23 1 1	43 152 0 57 1 1	238 573 729 1874 820 2184
ST5 ST6 ST7 ST8	721 1,729 810 2,124 1,125	7 7 17 8 22 2	0 0 15 0 36 5	18 0 0 0 0 0 0	93 0 0 0 0 0	5 0 1 0 0 0	38 1 15 0 0 0	34 0 1 0 0 0	0 0 0 0 0	4 9 0 6 0 0 0 0	4 7 0 5 0 0 0	4 5 0 5 0 0 0 0	4 20 0 23 1 1 0	43 152 0 57 1 1 1 0	238 573 729 1874 820 2184 1132
ST5 ST6 ST7 ST8 ST9	721 1,729 810 2,124 1,125 469	7 7 17 8 22 2 2	0 0 15 0 36 5 16	18 0 0 0 0 0 0 0	93 0 0 0 0 0 3	5 0 1 0 0 0 0	38 1 15 0 0 0 0	34 0 1 0 0 0 0 0		4 9 6 0 0 0 0 0 0	4 7 0 5 0 0 0 0 0	4 5 0 5 0 0 0 0 0 0	4 20 0 23 1 1 1 0 0	43 152 0 57 1 1 0 0 0	238 573 729 1874 820 2184 1132 492
ST5 ST6 ST7 ST8	721 1,729 810 2,124 1,125 469 2,360	7 7 17 8 22 2	0 0 15 0 36 5	18 0 0 0 0 0 0	93 0 0 0 0 0 3	5 0 1 0 0 0	38 1 15 0 0 0	34 0 1 0 0 0		4 9 0 6 0 0 0 0 0 0 0 0 0	4 7 0 5 0 0 0	4 5 0 5 0 0 0 0	4 20 0 23 1 1 0	43 152 0 57 1 1 0 0 0	238 573 729 1874 820 2184 1132 492 2446
ST5 ST6 ST7 ST8 ST9 ST10	721 1,729 810 2,124 1,125 469	7 7 17 8 22 2 2 4 23	0 0 15 0 36 5 16 39	18 0 0 0 0 0 0 0	93 0 0 0 0 0 3 23 9	5 0 1 0 0 0 0 0	38 1 15 0 0 0 0 0 0	34 0 1 0 0 0 0 0 0 0		4 99 00 66 00 00 00 00 00 00	4 7 0 5 0 0 0 0 0 0 0	4 5 0 5 0 0 0 0 0 0 0 0 0 0	4 20 23 1 1 0 0 0 0	43 152 0 57 1 1 1 0 0 0 0 0	238 573 729 1874 820 2184 1132 492
ST5 ST6 ST7 ST8 ST9 ST10 ST11 ST12 ST13	721 1,729 810 2,124 1,125 469 2,360 956 901 1,404	7 7 17 8 22 2 2 4 23 22 24 22 24 29	0 0 15 0 36 5 16 39 14 23 34	18 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	93 0 0 0 0 0 0 3 3 23 9 15 18	5 0 1 0 0 0 0 0 1 1 1 1 3	38 1 15 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	34 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		4 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 20 0 23 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0	43 152 0 57 1 1 1 0 0 0 0 0 0 0 0 0	238 573 729 1874 820 2184 1132 492 2446 1005 978 1507
ST5 ST6 ST7 ST8 ST9 ST10 ST11 ST12 ST12 ST13 ST14	721 1,729 810 2,124 1,125 469 2,360 956 901 1,404 1,632	7 7 17 8 22 2 2 4 23 22 24 23 22 24 29 49	0 0 15 0 36 5 16 39 14 23 34 34	18 0 0 0 0 0 0 0 1 3 3 4 4	93 0 0 0 0 0 0 0 0 23 23 9 9 15 15 18 36	5 0 1 0 0 0 0 0 1 1 1 1 3 0	38 38 1 15 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	34 0 1 0 0 0 0 0 0 0 1 1 1 1		4 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 20 0 23 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	43 152 0 57 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	238 573 729 1874 820 2184 1132 2446 1005 978 1507 1758
ST5 ST6 ST7 ST8 ST9 ST10 ST11 ST12 ST12 ST13 ST14 Alighting	721 1,729 810 2,124 1,125 469 2,360 956 901 1,404	7 7 17 8 22 2 2 4 23 22 24 22 24 29	0 0 15 0 36 5 16 39 14 23 34	18 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	93 0 0 0 0 0 0 0 0 23 23 9 9 15 15 18 36	5 0 1 0 0 0 0 0 1 1 1 1 3	38 38 1 15 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	34 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		4 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 20 0 23 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0	43 152 0 57 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	238 573 729 1874 820 2184 1132 492 2446 1005 978 1507
ST5 ST6 ST7 ST8 ST9 ST10 ST11 ST12 ST13 ST14 Alighting Y2040	721 1,729 810 2,124 1,125 469 2,360 956 901 1,404 1,632 14569	7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	0 0 15 36 36 39 14 23 34 39 221	18 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	93 0 0 0 0 0 3 23 9 15 18 36 248	5 0 1 0 0 0 0 0 1 1 1 1 3 0 63	38 1 15 0 0 0 0 0 0 0 0 0 2 2 10 10 154	34 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 9 0 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 20 0 23 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	43 152 0 57 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	238 573 722 1874 820 2184 1132 492 2446 1005 978 1507 17587
ST5 ST6 ST7 ST8 ST10 ST11 ST12 ST13 ST14 Alighting Y2040	721 1,729 810 2,124 1,125 469 2,360 956 901 1,404 1,632	7 7 17 8 22 2 2 4 23 22 24 23 22 24 29 49	0 0 15 0 36 5 16 39 14 23 34 34	18 0 0 0 0 0 0 0 1 3 3 4 4	93 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	5 0 1 0 0 0 0 0 1 1 1 1 3 0	38 38 1 15 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	34 0 1 0 0 0 0 0 0 0 1 1 1 1		4 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 20 0 23 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	43 152 0 57 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	238 573 729 1874 820 2184 1132 2446 1005 978 1507 1758
ST5 ST6 ST7 ST8 ST10 ST11 ST12 ST11 ST12 ST13 ST14 Alighting Y2040 Line ST1 ST1 ST1	721 1,729 810 2,124 1,125 469 2,360 901 1,404 1,632 14569 ST1 0 169	7 7 7 8 22 2 2 4 4 23 22 24 24 23 22 24 24 23 354 ST2 ST2 143 0	0 0 15 36 5 16 39 14 23 34 39 221 ST3 0 0 0	18 0 0 0 0 0 0 0 0 0 1 1 3 3 4 4 2 2 5 7 4 2 5	93 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	5 0 0 0 0 0 0 0 0 1 1 1 1 1 3 3 0 63 52 52 52 1	38 1 15 0 0 0 0 0 0 0 0 0 0 0 0 0	344 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 1 3395 ST8 3777 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 20 0 23 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	43 152 0 57 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	238 577 729 1874 820 2184 1005 977 1507 17587 17587 17587 17587 1943 2057
ST5 ST6 ST7 ST8 ST9 ST10 ST11 ST12 ST13 ST13 ST14 Alighting Y2040 Line ST1 ST2 ST2 ST3	721 1,729 810 2,124 1,125 469 2,360 956 901 1,404 1,632 14569 ST1 0 1699 210	7 7 7 8 22 2 2 4 4 23 22 24 24 29 49 354 ST2 ST2 143 0 7 7	0 0 15 0 36 5 16 39 14 23 34 39 221 ST3 0 0 0 0	18 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	93 0 0 0 0 0 3 3 23 9 15 18 36 248 248 ST5 41 144 95	50 0 0 0 0 0 0 0 0 0 0 0 0 0	38 1 15 0 0 0 0 0 0 0 0 0 0 0 0 0	34 0 1 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 1 1 395 ST8 377 0 34	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 7 0 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 5 0 0 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 20 0 233 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0	43 152 0 57 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0	238 577 729 1877 820 2184 1133 492 2444 1005 977 1507 17587 17587 Boarding 1943 2567 607
ST5 ST6 ST7 ST8 ST9 ST10 ST11 ST12 ST13 ST14 Alighting Y2040 Line ST1 ST1 ST1 ST2 ST3 ST3 ST3 ST4	721 1,729 8100 2,124 1,125 469 2,3600 956 901 1,404 1,632 14569 ST1 0 169 2100 738	7 7 7 17 8 22 2 4 4 23 22 24 29 354 29 355 ST2 143 0 7 7 7	0 0 15 36 5 16 39 14 221 ST3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	18 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	93 0 0 0 0 0 3 23 9 9 15 18 36 248 ST5 41 14 14 95 0 0	5 0 1 0 0 0 0 0 0 1 1 1 1 1 1 3 3 0 6 3 52 52 1 5 5 0 0	38 1 15 0 0 0 0 0 0 0 0 0 0 0 0 0	344 0 1 0 0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 20 0 23 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0	43 152 0 57 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0	238 577 729 1877 820 2184 1000 978 1500 1758 1758 1758 Boarding 1943 257 600 746
ST5 ST6 ST7 ST8 ST9 ST11 ST12 ST13 ST14 Alighting Y2040 Line ST1 ST2 ST3 ST4 ST3 ST4 ST5	721 1,729 810 2,124 1,125 469 2,360 901 1,404 1,632 14569 ST1 0 0 169 2,10 738 1,771	7 7 7 7 7 7 8 22 2 4 4 23 22 24 4 29 49 354 29 49 354 572 572 7 7 7 7 7 7 7	0 0 15 36 5 16 39 14 23 39 221 ST3 0 0 0 0 0 0 0 0 15	18 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 4 4 2 2 5 5 18 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	93 0 0 0 0 0 3 3 23 9 9 15 18 36 248 ST5 18 41 14 95 0 0 0 0	5 0 1 0 0 0 0 0 1 1 1 3 0 63 52 52 1 55 0 1 1 52 1 1 1 52 1 52 1 1 1 1 1 52 1 1 1 1 1 1 1 1 1 1 1 1 1	38 1 15 0 0 0 0 0 0 0 0 0 0 0 0 0	34 0 1 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 395 ST8 ST8 377 0 34 34 1 1 395 ST8 1 377 0 1 1 1 1 1 1 1 1 1 1 1 1 1	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 200 0 233 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0	43 152 0 57 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0	238 577 729 1874 822 2184 1133 492 2446 1000 978 1500 1758 17588 Boarding 1943 255 600 7444 1917
ST5 ST6 ST7 ST8 ST9 ST10 ST11 ST12 ST12 ST14 Alighting Y2040 Line ST1 ST2 ST3 ST4 ST5 ST5 ST6	721 1,729 8100 2,124 1,125 469 2,3600 956 901 1,404 1,632 14569 ST1 0 169 2100 738	7 7 7 17 8 22 2 4 4 23 22 24 29 354 29 355 ST2 143 0 7 7 7	0 0 155 16 39 144 23 34 23 221 221 ST3 0 0 0 0 0 0 0 0 0 0 0 5 0 0 0 0 0 0 0	18 0 0 0 0 0 0 0 0 0 0 0 1 1 4 4 2 5 5 5 12 5 5 18 0 0 0 0	93 0 0 0 0 0 0 0 0 0 0 0 0 3 3 223 9 5 15 15 18 366 248 5T5 41 14 955 0 0 0 0 0 0	5 0 1 0 0 0 0 0 0 1 1 1 1 1 1 3 3 0 6 3 52 52 1 5 5 0 0	38 38 1 1 5 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	344 0 1 0 0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 20 0 23 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0	43 152 0 57 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0	238 577 722 1874 820 2184 1132 494 492 977 1500 1758 1500 1758 1500 1758 1500 1758 1500 1758 1500 1758 1500 1758 1500 1758 1500 1758 1500 1758 1500 1758 1757 1758 1757 1757 1757 1757 1757
ST5 ST6 ST7 ST8 ST9 ST10 ST11 ST12 ST14 ST14 ST14 ST12 ST14 ST12 ST14 ST15 ST3 ST4 ST5 ST6 ST7 ST8	721 1,729 810 2,124 1,125 469 956 901 1,404 1,632 14569 ST1 0 1699 210 738 1,771 825 2,146 1,778 1,778 1,778 1,788 1,788 1,789 2,060 1,956 1,957 1,95	7 7 7 7 7 7 7 7 2 2 2 2 4 9 354 2 9 354 2 9 354 8 77 7 7 7 7 7 7 7 7 7 7 7 7 2 3 3 2 2 2 2	0 0 15 5 16 39 14 4 39 221 ST3 0 0 0 0 0 0 0 0 39 5 5	18 0 0 0 0 0 0 0 0 0 0 0 0 0 11 42 51 18 0 0 0 0 0 0 0 0 0 0 0 0 0	93 0 0 0 0 0 0 3 3 23 9 15 18 36 248 ST5 41 44 95 0 0 0 0 0 0 0 0 0 0 0 0 0	5 0 0 0 0 0 0 0 0 0 0 1 1 1 1 3 63 55 52 1 5 5 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0	38 38 1 15 5 0 0 0 0 0 0 0 0 0 10 14 0 0 154 55 38 155 5 38 1155 0 0 0 0 0 0 0 0	34 34 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 200 0 233 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0	43 152 0 57 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0	238 577 722 1874 820 2184 1133 492 2444 1000 978 1500 17587 17587 8007 17587 8007 746 746 746 746 746 1911 838 2210
ST5 ST6 ST7 ST8 ST9 ST10 ST11 ST12 ST13 ST14 Alighting Y2040 Line ST1 ST3 ST4 ST3 ST4 ST5 ST6 ST7 ST8 ST9	721 1,729 810 2,124 1,125 469 901 1,404 1,632 14569 ST1 0 169 210 738 1,771 825 2,146 1,153 484	7 7 7 7 7 7 7 8 2 2 2 2 4 4 2 2 2 2 2 2 2 2 2 2 2 2 2	0 0 15 5 6 399 14 23 34 39 221 ST3 0 0 0 0 0 0 0 0 0 0 0 5 5 5 5 5	18 0 0 0 0 0 0 0 0 0 0 0 0 1 1 3 3 4 4 2 5 5 18 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	93 0 0 0 0 0 0 0 0 0 0 0 0 0	5 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0	38 38 1 1 5 5 0 0 0 0 0 0 0 0 0 0 0 2 10 0 0 0 14 4 5 5 38 37 7 6 5 38 11 5 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	34 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 200 0 233 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0	43 152 0 57 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0	233 573 722 2187 820 2184 499 2440 1000 977 1500 1758 17583 1943 255 600 740 740 1913 833 2210 1913 833 2211 160 500
ST5 ST6 ST7 ST8 ST9 ST10 ST11 ST12 ST13 ST14 ST13 ST14 ST12 ST13 ST14 ST13 ST14 ST13 ST14 ST13 ST14 ST3 ST1 ST2 ST3 ST4 ST5 ST6 ST7 ST8 ST9 ST40	721 1,729 810 2,124 1,125 469 956 901 1,404 1,632 14569 ST1 0 738 1,771 825 2,146 1,153 484 2,348 484 2,348 484	7 7 7 7 7 7 7 7 7 22 2 2 2 2 2 2 2 2 2	0 0 15 5 16 39 14 4 23 39 221 573 0 0 0 0 0 5 5 5 5 5 5 338	18 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 11 44 12 55 18 0 0 0 0 0 0 0 0 0 0 0 0 0 0	93 0 0 0 0 0 0 0 0 3 3 23 3 6 248 ST5 41 44 95 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	5 0 1 0 0 0 0 0 0 0 1 1 3 0 63 52 1 5 0 1 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	38 38 11 15 0 0 0 0 0 0 0 0 0 0 0 0 10 0 15 4 4 1 5 5 38 38 11 5 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	34 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 5 5 5 7 11 7 7 0 0 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 184 5 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 20 0 0 23 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0	43 152 0 57 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0	233 573 722 1874 820 2184 1133 492 2444 1000 978 1500 17587 1500 17587 17587 17587 80arding 1943 255 600 7744 1911 1913 836 2210 1914 2251 600 774 1917 2018 1018 1917 2018 10 100 100 100 100 1000 1000 1000
ST5 ST6 ST7 ST8 ST9 ST10 ST11 ST12 ST13 ST14 Alighting Y2040 Line ST1 ST1 ST1 ST1 ST1 ST1 ST1 ST1 ST3 ST4 ST6 ST7 ST8 ST9 ST10 ST10 ST11	721 1,729 810 2,124 1,125 469 2,360 956 901 1,404 1,632 14669 ST1 0 169 2100 738 1,771 825 2,146 1,153 484 484 2,348 9,449 9,499 9,490 1,155 1	7 7 7 7 7 7 7 8 8 22 2 4 4 29 29 49 354 8 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 23 2 2 5 5 25 25 22 24 24 29 29 29 29 29 29 29 29 29 29 29 29 29	0 0 15 0 366 5 16 399 14 233 344 339 221 ST3 0 0 0 0 0 0 15 5 5 5 5 5 5 5 5 5 5 5 5 5	18 0 0 0 0 0 0 0 0 0 0 0 1 1 3 3 4 4 2 5 5 4 8 7 4 2 5 0 0 0 0 0 0 0 0 0 0 0 0 1 1 3 3 4 4 2 5 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	93 93 0 0 0 0 0 0 0 0 3 3 9 5 5 5 5 5 5 5 6 6 7 41 1 4 1 9 5 5 0 0 0 0 0 0 0 0 0 0 0 0 3 3 6 7 3 6 7 9 9 9 9 5 5 7 5 7 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	5 0 1 0 0 0 0 0 0 0 1 1 1 1 3 633 ST6 52 1 5 0 1	38 38 1 15 5 0 0 0 0 0 0 0 2 10 0 0 2 10 0 0 0 154 5 5 388 1 1 5 5 0 0 0 0 0 0 0 0 0 0 2 2 10 0 154 5 4 5 4 5 4 5 4 5 4 5 5 5 5 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	34 0 1 0 0 0 0 0 0 0 0 0 0 1 1 1 1 3955 ST8 3777 0 0 344 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 200 0 0 233 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0	43 152 0 57 1 1 0	233 573 722 1874 1133 493 2444 1005 9774 1500 1765 17581 8007 1765 17581 8007 744 1911 836 2210 744 1911 1166 500 2433 1000
ST5 ST6 ST7 ST8 ST10 ST11 ST12 ST13 ST13 ST13 ST13 ST14 ST12 ST13 ST14 ST12 ST3 ST4 ST5 ST4 ST5 ST4 ST5 ST6 ST7 ST8 ST9 ST10 ST4 ST6 ST7 ST8 ST9 ST10 ST11 ST11	721 1,729 810 2,124 1,125 469 956 901 1,404 1,632 14569 ST1 0 738 1,771 825 2,146 1,153 484 2,348 484 2,348 484	7 7 7 7 7 7 7 7 7 22 2 2 2 2 2 2 2 2 2	0 0 15 5 16 39 14 23 34 39 221 5 3 4 0 0 0 0 0 0 0 5 5 5 38 38 14 222	18 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 11 33 4 11 42 55 18 0<	93 93 0 0 0 0 0 0 0 0 0 3 3 9 15 18 36 248 ST5 41 14 95 0 0 0 0 0 0 0 0 0 0 0 0 0	5 0 1 0 0 0 0 1 1 1 3 0 63 55 0 1 5 0 1 1	38 38 1 1 5 5 0 0 0 0 0 0 0 2 2 10 0 0 0 2 154 5 5 38 15 15 15 0 0 0 0 0 0 0 0 0 0 0 12 154 155 155 155 155 155 155 155 155 155	34 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 20 0 0 23 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0	43 152 0 57 17 1 0 0 0 0 0 0 0 0 0 0 0 0 0	233 57, 722 2183 493 2444 1000 977 1758 Boarding 1943 255 600 7444 1911 1758 800 7444 1911 1160 500 2432 1000
ST5 ST6 ST7 ST8 ST10 ST11 ST11 ST12 ST14 Alighting Y2040 Line ST1 ST5 ST6 ST7 ST6 ST7 ST8 ST9 ST11 ST11 ST11 ST5 ST6 ST7 ST8 ST9 ST11 ST12 ST13 ST13 ST14	721 1,729 810 2,124 1,125 469 956 901 1,404 1,632 14569 ST1 0 169 2,106 1,632 14569 2,146 1,632 2,146 1,632 2,146 1,632 2,144 1,935 2,144 1,935 2,144 1,935 2,144 1,935 2,144 1,935 1,935 2,144 1,935	77777777777777777777777777777777777777	0 0 15 5 6 16 399 14 23 39 14 221 ST3 0 0 0 0 0 0 0 15 5 5 39 15 15 16 14 23 39 14 221 ST3 0 0 0 0 0 15 16 16 16 16 16 16 16 16 16 16	18 0 0 0 0 0 0 0 0 0 0 1 3 3 4 4 2 5 5 18 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	93 93 0 0 0 0 0 0 0 0 3 3 9 9 15 18 36 248 ST5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	5 0 1 0 0 0 0 0 0 1 1 3 63 55 0 1 5 0 0 0 0 0 0 0 0 0 0 0	38 38 1 15 0 0 0 0 0 0 2 10 0 0 2 10 154 5 5 388 1 1 5 3 8 1 1 5 0 0 0 0 0 0 0 0 0 14 4 5 3 8 15 5 3 8 15 5 3 8 15 5 15 5 15 5	34 0 1 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 395 ST8 3777 0 0 34 0 0 34 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 9 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 7 7 0 0 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 20 0 0 0 0 1 1 1 1 0 0 0 0 0 0 0 0 0 0	43 152 0 57 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 5714 326 3246 154 0 57 1 1 1 0	233 573 7222 2184 1133 492 2446 1005 977 1500 977 1500 977 1500 977 1500 977 1500 977 1500 1758 1758 1758 1758 1944 255 600 1944 255 600 1944 1941 1945 255 600 1944 1945 255 600 1944 1945 255 600 1944 1945 255 600 1944 1945 255 600 1946 1945 255 600 1946 1945 255 600 1946 1945 1945 1945 1945 1945 1945 1945 1945
ST5 ST6 ST7 ST8 ST11 ST11 ST11 ST11 ST12 ST13 ST14 Alighting Y2040 Line ST3 ST4 ST5 ST6 ST7 ST8 ST6 ST7 ST8 ST9 ST10 ST12 ST12 ST10 ST11 ST12 ST12 ST14 Alighting	721 1,729 810 2,124 1,125 469 956 901 1,404 1,632 14569 ST1 0 738 1,771 825 2,146 1,153 484 2,348 949 877 1,396	7 7 7 7 7 7 7 8 8 22 2 2 4 4 29 49 29 49 354 ST2 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 2 3 5 4 22 2 2 4 9 29 49 29 29 49 29 29 49 29 29 49 29 29 49 20 29 29 49 20 29 29 49 20 29 29 49 20 29 29 49 20 29 29 49 20 29 29 49 354 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	0 0 15 0 36 5 16 39 14 23 34 34 34 34 34 34 34 34 34 3	18 0 0 0 0 0 0 0 0 0 0 0 0 0 0 11 42 55 18 0 <td>93 93 0 0 0 0 0 0 0 0 3 3 9 9 15 18 36 248 ST5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>5 0 0 0 0 0 0 0 0 0 0 1 1 1 1 3 3 52 1 1 52 1 1 5 5 0 0 1 1 0 0 0 0 0 0 0 1 1 1 1 1</td> <td>38 38 1 15 0 0 0 0 0 0 2 10 0 0 2 10 154 5 5 388 1 1 5 3 8 1 1 5 0 0 0 0 0 0 0 0 0 14 4 5 3 8 15 5 3 8 15 5 3 8 15 5 15 5 15 5</td> <td>34 0 0 0 0 0 0 0 0 0 0 0 1 1 1 1 1 3355 ST8 377 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>4 9 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>4 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 156 5 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 184 5 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>4 200 0 0 233 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>43 152 0 57 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>233 573 7222 2184 1133 492 2446 1005 977 1500 977 1500 977 1500 977 1500 977 1500 977 1500 1758 1758 1758 1758 1944 255 600 1944 255 600 1944 1941 1945 255 600 1944 1945 255 600 1944 1945 255 600 1944 1945 255 600 1944 1945 255 600 1946 1945 255 600 1946 1945 255 600 1946 1945 1945 1945 1945 1945 1945 1945 1945</td>	93 93 0 0 0 0 0 0 0 0 3 3 9 9 15 18 36 248 ST5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	5 0 0 0 0 0 0 0 0 0 0 1 1 1 1 3 3 52 1 1 52 1 1 5 5 0 0 1 1 0 0 0 0 0 0 0 1 1 1 1 1	38 38 1 15 0 0 0 0 0 0 2 10 0 0 2 10 154 5 5 388 1 1 5 3 8 1 1 5 0 0 0 0 0 0 0 0 0 14 4 5 3 8 15 5 3 8 15 5 3 8 15 5 15 5 15 5	34 0 0 0 0 0 0 0 0 0 0 0 1 1 1 1 1 3355 ST8 377 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 9 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 156 5 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 184 5 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 200 0 0 233 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0	43 152 0 57 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0	233 573 7222 2184 1133 492 2446 1005 977 1500 977 1500 977 1500 977 1500 977 1500 977 1500 1758 1758 1758 1758 1944 255 600 1944 255 600 1944 1941 1945 255 600 1944 1945 255 600 1944 1945 255 600 1944 1945 255 600 1944 1945 255 600 1946 1945 255 600 1946 1945 255 600 1946 1945 1945 1945 1945 1945 1945 1945 1945
ST5 ST6 ST7 ST8 ST10 ST11 ST12 ST13 ST14 Alighting Y2040 Line ST1 ST2 ST3 ST4 ST6 ST7 ST6 ST7 ST6 ST7 ST8 ST10 ST11 ST12 ST11 ST11 ST12 ST11 ST12 ST13 ST14 ST14 ST14 ST14 Alighting Y2050	721 1,729 810 2,124 1,125 469 2,360 956 901 1,404 1,632 14569 ST1 0 169 2,100 738 1,771 825 2,146 1,153 484 2,348 949 877 1,396 1,581 1,581 1,4647	7 7 7 7 7 7 7 7 8 22 2 4 4 29 29 49 354 8 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	0 0 15 0 366 399 14 233 344 339 221 ST3 0 0 0 0 0 0 0 15 0 5 15 399 14 233 344 233 344 221 ST3 0 0 0 0 0 0 0 0 0 0 0 0 0	18 0 0 0 0 0 0 0 0 0 0 0 0 0 0 11 42 55 18 0 <td>93 93 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>5 0 1 0 0 0 0 0 0 0 1 1 1 1 3 633 ST6 52 1 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 655 <td>38 38 1 15 5 0 0 0 0 0 0 0 2 2 100 14 4 5 5 5 5 38 8 11 15 5 5 0 0 0 0 0 0 0 0 0 0 161</td><td>34 0 1 0 0 0 0 0 0 0 0 0 0 0 1 1 1 3955 ST8 3777 0 0 0 1 1 1 3955 ST8 3777 0 0 0 0 0 0 0 0 0 0 0 0 0</td><td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td><td>4 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td><td>4 7 7 0 0 5 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td><td>4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td><td>4 20 0 0 23 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0</td><td>43 152 0 57 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0</td><td>238 577 729 2184 2184 1133 492 2446 1003 977 1500 1758 1758 17587 17587 17587 17587 17587 17587 17587 17587 17587 17587 17587 17587 17587 17587 17587 17587 17587 17587 1759 19434 1500 1500 954 1500 1700 1500 1700 1500 1700 1500 17775</td></td>	93 93 0 0 0 0 0 0 0 0 0 0 0 0 0	5 0 1 0 0 0 0 0 0 0 1 1 1 1 3 633 ST6 52 1 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 655 <td>38 38 1 15 5 0 0 0 0 0 0 0 2 2 100 14 4 5 5 5 5 38 8 11 15 5 5 0 0 0 0 0 0 0 0 0 0 161</td> <td>34 0 1 0 0 0 0 0 0 0 0 0 0 0 1 1 1 3955 ST8 3777 0 0 0 1 1 1 3955 ST8 3777 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>4 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>4 7 7 0 0 5 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>4 20 0 0 23 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>43 152 0 57 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>238 577 729 2184 2184 1133 492 2446 1003 977 1500 1758 1758 17587 17587 17587 17587 17587 17587 17587 17587 17587 17587 17587 17587 17587 17587 17587 17587 17587 17587 1759 19434 1500 1500 954 1500 1700 1500 1700 1500 1700 1500 17775</td>	38 38 1 15 5 0 0 0 0 0 0 0 2 2 100 14 4 5 5 5 5 38 8 11 15 5 5 0 0 0 0 0 0 0 0 0 0 161	34 0 1 0 0 0 0 0 0 0 0 0 0 0 1 1 1 3955 ST8 3777 0 0 0 1 1 1 3955 ST8 3777 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 7 7 0 0 5 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 20 0 0 23 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0	43 152 0 57 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0	238 577 729 2184 2184 1133 492 2446 1003 977 1500 1758 1758 17587 17587 17587 17587 17587 17587 17587 17587 17587 17587 17587 17587 17587 17587 17587 17587 17587 17587 1759 19434 1500 1500 954 1500 1700 1500 1700 1500 1700 1500 17775
ST5 ST6 ST7 ST8 ST9 ST10 ST11 ST12 ST14 ST3 ST4 ST5 ST6 ST7 ST8 ST10 ST11 ST12 ST13 ST14 Alighting Y2050 Line	721 1,729 810 2,124 1,125 469 956 901 1,404 1,632 14569 ST1 0 0 0 169 2,10 738 1,771 825 2,146 1,153 14569 2,10 1,404 1,521 1,405 1,505	7 7 7 7 7 7 7 8 22 2 4 4 23 22 24 49 354 8 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	0 0 15 0 366 5 16 39 221 ST3 0 0 0 0 0 0 0 0 5 5 16 0 0 0 0 0 0 15 14 23 39 221 ST3 39 20 15 5 5 5 5 5 5 5 5 5 5 5 5 5	18 0 0 0 0 0 0 0 0 0 0 0 0 0 11 42 52 58 18 0 </td <td>93 0 0 0 0 0 0 0 0 0 0 3 23 9 15 18 366 248 375 41 144 95 0 0 0 0 0 0 0 3 23 9 9 15 5 18 366 248 375 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>5 0 1 0 0 0 0 1 1 3 5 0 5 0 1 5 0 0 0 0 0 0 0 65 ST6</td> <td>38 38 39 39 30 30 30 30 30 30 30 30 30 30 30 30 30</td> <td>34 0 1 0 0 0 0 0 0 0 0 0 0 0 1 1 1 395 ST8 3777 07 34 0 0 34 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>4 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>4 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 184 5 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>4 20 0 0 23 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>43 152 0 57 11 0<td>233 573 722 2183 493 2444 1000 977 1756 17583 Boarding 1943 2653 600 7744 1911 1160 1913 2014 2014 2014 2014 2014 2014 2014 2014</td></td>	93 0 0 0 0 0 0 0 0 0 0 3 23 9 15 18 366 248 375 41 144 95 0 0 0 0 0 0 0 3 23 9 9 15 5 18 366 248 375 0 0 0 0 0 0 0 0 0 0 0 0 0	5 0 1 0 0 0 0 1 1 3 5 0 5 0 1 5 0 0 0 0 0 0 0 65 ST6	38 38 39 39 30 30 30 30 30 30 30 30 30 30 30 30 30	34 0 1 0 0 0 0 0 0 0 0 0 0 0 1 1 1 395 ST8 3777 07 34 0 0 34 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 184 5 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 20 0 0 23 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0	43 152 0 57 11 0 <td>233 573 722 2183 493 2444 1000 977 1756 17583 Boarding 1943 2653 600 7744 1911 1160 1913 2014 2014 2014 2014 2014 2014 2014 2014</td>	233 573 722 2183 493 2444 1000 977 1756 17583 Boarding 1943 2653 600 7744 1911 1160 1913 2014 2014 2014 2014 2014 2014 2014 2014
ST5 ST6 ST7 ST8 ST9 ST11 ST11 ST12 ST13 ST14 Alighting Y2040 Line ST3 ST4 ST5 ST6 ST7 ST6 ST7 ST6 ST7 ST8 ST10 ST11 ST11 ST6 ST7 ST8 ST11 ST12 ST13 ST14 ST13 ST14 ST12 ST13 ST14 ST13	721 1,729 810 2,124 1,125 469 901 1,404 1,632 14569 ST1 0 169 210 738 1,771 825 2,146 1,771 825 2,146 1,1581 1,404 738 1,771 1,404 1,581 1,4647 ST1 0 0 0 0 0 0 0 0 0 0 0 0 0	7 7 7 7 7 7 7 7 8 22 2 4 4 29 29 49 354 8 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	0 0 15 0 36 5 16 39 14 23 34 34 34 34 34 34 34 36 0 0 0 0 0 0 0 0 0 0 0 0 0	18 0 0 0 0 0 0 0 0 0 0 0 0 0 0 11 42 55 18 0 <td>93 0 0 0 0 0 0 0 0 0 0 3 3 9 15 18 36 248 ST5 41 14 955 0 0 0 0 0 0 0 0 3 3 9 9 15 18 36 248 ST5 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>5 0 1 0 0 0 0 0 0 0 1 1 1 1 3 633 ST6 52 1 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 655 <td>38 38 11 15 0 0 0 0 0 0 0 2 10 0 154 5 5 5 76 5 5 38 8 11 5 5 0 0 0 0 0 0 0 0 0 0 0 154 5 5 5 5 5 16 17 5 5 5 5 5 16 5 5 5 5 76 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td><td>34 0 1 0 0 0 0 0 0 0 0 0 0 0 1 1 1 3955 ST8 3777 0 0 0 1 1 1 3955 ST8 3777 0 0 0 0 0 0 0 0 0 0 0 0 0</td><td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td><td>4 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td><td>4 7 7 0 0 5 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td><td>4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td><td>4 20 0 0 23 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0</td><td>43 152 0 57 1 1 0<td>238 238 238 239 249 218 1132 492 2446 1000 976 1758 17587 Boarding 1943 255 600 746 1913 1943 251 600 500 22116 1000 1975 Boarding 1000 1775 Boarding 1775 Boarding 1775 Boarding 1775</td></td></td>	93 0 0 0 0 0 0 0 0 0 0 3 3 9 15 18 36 248 ST5 41 14 955 0 0 0 0 0 0 0 0 3 3 9 9 15 18 36 248 ST5 0 0 0 0 0 0 0 0 0 0 0 0 0	5 0 1 0 0 0 0 0 0 0 1 1 1 1 3 633 ST6 52 1 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 655 <td>38 38 11 15 0 0 0 0 0 0 0 2 10 0 154 5 5 5 76 5 5 38 8 11 5 5 0 0 0 0 0 0 0 0 0 0 0 154 5 5 5 5 5 16 17 5 5 5 5 5 16 5 5 5 5 76 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>34 0 1 0 0 0 0 0 0 0 0 0 0 0 1 1 1 3955 ST8 3777 0 0 0 1 1 1 3955 ST8 3777 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>4 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>4 7 7 0 0 5 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>4 20 0 0 23 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>43 152 0 57 1 1 0<td>238 238 238 239 249 218 1132 492 2446 1000 976 1758 17587 Boarding 1943 255 600 746 1913 1943 251 600 500 22116 1000 1975 Boarding 1000 1775 Boarding 1775 Boarding 1775 Boarding 1775</td></td>	38 38 11 15 0 0 0 0 0 0 0 2 10 0 154 5 5 5 76 5 5 38 8 11 5 5 0 0 0 0 0 0 0 0 0 0 0 154 5 5 5 5 5 16 17 5 5 5 5 5 16 5 5 5 5 76 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	34 0 1 0 0 0 0 0 0 0 0 0 0 0 1 1 1 3955 ST8 3777 0 0 0 1 1 1 3955 ST8 3777 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 7 7 0 0 5 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 20 0 0 23 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0	43 152 0 57 1 1 0 <td>238 238 238 239 249 218 1132 492 2446 1000 976 1758 17587 Boarding 1943 255 600 746 1913 1943 251 600 500 22116 1000 1975 Boarding 1000 1775 Boarding 1775 Boarding 1775 Boarding 1775</td>	238 238 238 239 249 218 1132 492 2446 1000 976 1758 17587 Boarding 1943 255 600 746 1913 1943 251 600 500 22116 1000 1975 Boarding 1000 1775 Boarding 1775 Boarding 1775 Boarding 1775
ST5 ST6 ST7 ST8 ST11 ST11 ST11 ST11 ST11 ST11 ST11 ST11 ST11 ST13 ST14 Alighting Y2040 Line ST2 ST3 ST4 ST5 ST6 ST7 ST8 ST9 ST12 ST13 ST14 ST13 ST14 ST13 ST14 ST13 ST14 ST14 ST14 ST1 ST1 ST1 ST12 ST3	721 1,729 810 2,124 1,125 469 956 901 1,404 1,632 14569 ST1 5T1 825 2,146 1,153 1,404 1,153 1,404 1,581 1,396 1,581 1,464 ST1 1,464 ST1 1,581 1,464 ST1 1,581 1,464 ST1 1,464 ST1 1,581 1,464 ST1 1,581 1,464 ST1 1,464 ST1 1,581 1,464 ST1 1,581 1,464 ST1 1,464 ST1 1,581 1,464 ST1 1,464 ST1 1,581 1,464 ST1 1,581 1,464 ST1 1,464 ST1 1,581 1,464 ST1 1,581 1,464 ST1 1,464 ST1 1,581 1,464 ST1 1,464 ST1 1,464 ST1 1,581 1,464 ST1 1,464 ST1 1,581 1,464 ST1 1,464 ST1 1,464 ST1 1,581 1,464 ST1 1,464 ST1 1,464 ST1 1,464 ST1 1,464 ST1 1,581 1,464 ST1 1,464 S	7 7 7 7 7 7 7 7 8 22 2 2 4 4 29 49 29 49 354 ST2 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	0 0 15 0 36 5 16 39 221 ST3 0 0 0 0 0 0 0 0 0 15 5 0 0 0 0 0 15 5 16 39 9 221 ST3 0 0 0 0 0 0 0 0 0 0 0 0 0	18 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 11 42 55 0 15 5	93 93 0 0 0 0 0 0 0 3 3 9 9 15 18 36 248 ST5 141 14 95 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	5 0 1 0 0 0 0 0 0 1 1 1 1 633 52 1 52 1 5 0 0 0 0 0 0 655 ST6 556 ST6 557 1 5	38 38 11 15 0 0 0 0 0 0 0 10 15 4 1 5 5 5 5 5 5 5 5 6 1 5 5 0 0 0 0 0 0 0 0 0 0 0 0 15 4 5 5 5 5 5 5 5 5 6 15 5 5 6 6 15 5 5 6 7 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	34 34 0 1 1 0 0 0 0 0 0 1 1 3955 ST8 3777 0 0 0 0 0 0 0 0 0 0 0 1 1 1 3955 ST8 3777 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 20 0 0 23 1 1 1 1 0 0 0 0 0 0 0 0 2700 ST13 228 5 200 0 0 233 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0	43 152 0 57 1 1 0 <td>238 573 7292 2184 22184 22184 22184 2218 2218 2218</td>	238 573 7292 2184 22184 22184 22184 2218 2218 2218
ST5 ST6 ST7 ST8 ST9 ST11 ST12 ST13 ST14 Alighting Y2040 Line ST1 ST3 ST4 ST4 ST4 ST4 ST4 ST12 ST4 ST5 ST6 ST7 ST8 ST4 ST5 ST6 ST7 ST8 ST10 ST11 ST14 Alighting Y2050 Line ST1 ST2 ST3 ST3 ST3 ST3 ST4	721 1,729 810 2,124 1,125 469 2,360 956 901 1,404 1,632 14569 ST1 0 169 2,100 738 1,771 825 2,146 1,153 484 2,348 949 877 1,396 1,581 1,4647 ST1 0 1,581 1,682 2,146 1,581 1,682 2,146 1,682 2,146 1,405 1,581 1,581 1,581 1,581 1,581 1,581 1,581 1,581 1,581 1,00 1,581 1,581 1,581 1,581 1,581 1,581 1,581 1,581 1,581 1,581 1,581 1,581 1,581 1,00 1,581 1,581 1,00 1,581 1,581 1,00 1,581 1,00 1,581 1,00 1,581 1,00 1,581 1,00 1,581 1,00 1,581 1,00 1,00 1,581 1,00 1,00 1,581 1,00 1	7 7 7 7 7 7 7 7 8 22 2 4 4 9 354 8 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	0 0 0 15 0 36 5 16 39 14 23 34 34 34 34 39 221 ST3 0 0 0 0 0 0 0 15 0 0 0 0 0 0 0 0 0 0 0 0 0	18 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 13 44 12 55 19 0	93 93 0 0 0 0 0 0 0 0 0 0 0 0 0	5 0 1 0 0 0 0 0 0 0 1 1 1 1 3 0 63 ST6 52 1 5 0 1 1 3 1 <td>38 38 11 15 0 0 0 0 0 0 2 2 100 154 55 76 5 388 11 15 5 388 11 15 0 0 0 0 0 0 0 0 0 0 10 10 154 5 5 5 388 11 5 5 5 5 388 15 5 5 5 5 7 6 6 5 37 8 2 6 6 7 6 7 6 7 7 6 7 7 6 7 7 7 6 7 7 7 6 7 7 7 6 7 7 7 6 7 7 7 7 6 7 7 7 7 6 7</td> <td>34 34 0 0 1 1 0 0 0 0 0 0 0 0 1 1 1 3955 ST8 3777 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>4 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>4 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>4 20 0 0 23 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>43 152 0 57 1 1 0<td>233 577 722 187 822 218 1133 493 2444 1000 97 1500 1750 1750 1750 1750 1750 1750 175</td></td>	38 38 11 15 0 0 0 0 0 0 2 2 100 154 55 76 5 388 11 15 5 388 11 15 0 0 0 0 0 0 0 0 0 0 10 10 154 5 5 5 388 11 5 5 5 5 388 15 5 5 5 5 7 6 6 5 37 8 2 6 6 7 6 7 6 7 7 6 7 7 6 7 7 7 6 7 7 7 6 7 7 7 6 7 7 7 6 7 7 7 7 6 7 7 7 7 6 7	34 34 0 0 1 1 0 0 0 0 0 0 0 0 1 1 1 3955 ST8 3777 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 20 0 0 23 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0	43 152 0 57 1 1 0 <td>233 577 722 187 822 218 1133 493 2444 1000 97 1500 1750 1750 1750 1750 1750 1750 175</td>	233 577 722 187 822 218 1133 493 2444 1000 97 1500 1750 1750 1750 1750 1750 1750 175
ST5 ST6 ST7 ST8 ST10 ST11 ST12 ST14 Alighting Y2040 Line ST1 ST1 ST1 ST14 Alighting Y2040 Line ST3 ST4 ST5 ST6 ST7 ST8 ST6 ST7 ST8 ST10 ST11 ST12 ST13 ST14 Alighting Y2050 Line ST1 ST2 ST3 ST4 ST5	721 1,729 810 2,124 1,125 469 956 901 1,404 1,632 14569 ST1 0 169 2,100 738 1,771 825 2,146 1,153 1,4569 877 1,396 1,581 1,4647 ST1 0 1,581 1,4647 ST1 0 1,581 1,4647 ST1 0 1,581 1,4647 ST1 0 1,582 1,581 1,4647 ST1 0 1,896 1,582 1,586 1,585 1,586 1,776 1,777 1,776 1,777 1,776 1	7777788 7777788 222 244 233 222 244 299 354 572 777777 77777777777777777777777777	0 0 15 0 36 5 16 39 221 ST3 0 0 0 0 0 0 0 15 5 0 0 0 0 0 15 5 16 39 9 221 ST3 0 0 0 0 0 0 0 0 0 0 0 0 0	18 0 0 0 0 0 0 0 0 0 0 0 0 0 0 11 42 51 18 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	93 0 0 0 0 0 0 0 0 0 0 3 23 9 15 18 366 248 ST5 41 144 95 0 0 0 0 0 0 0 0 3 3 8 248 ST5 5 5 5 5 5 5 5 5 5 5 5 5 5	5 0 1 0 0 0 0 0 0 0 0 0 0 1 1 3 0	38 38 1 15 0 0 0 0 0 0 0 0 0 0 0 0 154 55 38 1 55 38 1 55 38 1 55 38 1 55 38 1 55 38 1 55 38 1 66 37 1 16	34 34 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 3955 ST8 ST8 377 0 77 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 9 0 0 0 0 0 0 0 0 0 0 0 0 0	4 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 20 0 0 23 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0	43 152 0 57 11 0 <td>233 577 722 1877 822 2188 1132 493 2444 1000 977 1500 1758 8000 1758 8000 1758 8000 2433 255 600 744 1911 1160 1913 2014 1000 2433 1000 2433 1000 17700 8000 17707 8000 17777 8000 1777 1777</td>	233 577 722 1877 822 2188 1132 493 2444 1000 977 1500 1758 8000 1758 8000 1758 8000 2433 255 600 744 1911 1160 1913 2014 1000 2433 1000 2433 1000 17700 8000 17707 8000 17777 8000 1777 1777
ST5 ST6 ST7 ST8 ST10 ST11 ST11 ST12 ST14 Alighting Y2040 Line ST1 ST3 ST4 ST5 ST6 ST7 ST8 ST4 ST6 ST7 ST8 ST9 ST4 ST10 ST11 ST12 ST13 ST14 ST11 ST12 ST13 ST14 ST11 ST12 ST13 ST14 ST15 ST6	721 1,729 810 2,124 1,125 469 9356 901 1,404 1,632 14569 ST1 0 169 210 738 1,771 825 2,146 1,771 825 2,146 1,1581 1,404 7,388 9,499 8,77 1,396 1,581 1,4647 ST1 0 1,837 0 1,581 1,4647 ST1 0 1,837 1,581 1,4647 1,779 8,388 2,666 7,488 1,779 8,388 1,779 8,388 1,779 8,388 1,779 8,388 1,779 8,388 1,779 8,388 1,779 8,388 1,779 8,388 1,779 8,388 1,779 8,388 1,779 8,388 1,779 8,388 1,779 8,388 1,779 8,388 1,779 8,388 1,779 1,779 1,838 1,779 1,838 1,779 1,838 1,779 1,838 1,779 1,838 1,779 1,838 1,779 1,838 1,779 1,838 1,779 1,838 1,779 1,838 1,779 1,838 1,779 1,838 1,779 1,838 1,779 1,838 1,779 1,838 1,779 1,838 1,779	7 7 7 7 7 7 7 7 8 22 2 4 4 29 49 29 49 354 ST2 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	0 0 0 15 5 16 39 14 23 34 34 34 34 34 34 34 34 34 3	18 0 0 0 0 0 0 0 0 0 0 0 0 0 11 42 55 18 0	93 0 0 0 0 0 0 0 0 0 0 3 3 9 15 18 36 248 ST5 41 14 955 0 0 0 0 0 0 0 0 0 0 0 0 0	5 0 1 0 0 0 0 0 1 1 1 1 1 55 0 0 0 0 0 0 0 0 0 0 0 655 555 1 55 0 1 55 0 1 55 0 1 55 0 1	38 38 11 15 0 0 0 0 0 2 100 154 5 5 76 5 5 76 5 388 11 15 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 100 154 5 5 5 5 388 11 5 5 5 5 76 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	34 34 0 0 1 1 0 0 0 0 0 0 1 1 3955 ST8 3777 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 5 0 0 0 0 0 0 0 0 0 0 0 0 0	4 20 0 0 23 1 1 1 1 0 0 0 0 0 0 270 ST13 228 5 200 0 0 233 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0	43 152 0 57 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 577 1 1 0 </td <td>233 57: 722 218: 113: 499 2444 1000 97: 1758 Boarding 194: 255 600 744 1911 1160 500 744 1911 1160 500 744 1911 1160 500 744 1911 1160 500 744 1911 1160 500 744 1911 1160 744 1945 1945 1945 1950 1950 1770 775 1950 1952 1952 844 844 844 844 844 844 844 844 844 84</td>	233 57: 722 218: 113: 499 2444 1000 97: 1758 Boarding 194: 255 600 744 1911 1160 500 744 1911 1160 500 744 1911 1160 500 744 1911 1160 500 744 1911 1160 500 744 1911 1160 744 1945 1945 1945 1950 1950 1770 775 1950 1952 1952 844 844 844 844 844 844 844 844 844 84
ST5 ST6 ST7 ST8 ST9 ST10 ST11 ST12 ST13 ST14 Alighting Y2040 Line ST3 ST4 ST5 ST6 ST7 ST7 ST3 ST4 ST6 ST7 ST14 ST6 ST12 ST14 ST15 ST6 ST12 ST14 Alighting Y2050 Line ST1 ST3 ST4 ST6 ST6 ST6	721 1,729 810 2,124 1,125 469 9,360 991 1,404 1,632 14,659 901 1,404 1,632 14,669 901 1,609 2,146 1,153 484 2,348 949 877 1,366 1,581 14647 ST1 0 1833 2666 748 1,779 838 2,209	7 7 7 7 7 7 7 7 7 2 2 2 4 4 29 49 354 ST2 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	0 0 0 15 5 16 399 14 233 344 233 39 221 ST3 0 0 0 0 0 0 0 0 0 0 5 5 5 5 5 5 5 5 5 5 5 5 5	18 0 0 0 0 0 0 0 0 0 0 0 0 0 0 11 44 15 5 19 0 0 0 0 0 0 0	93 93 0 0 0 0 0 0 3 3 9 9 155 18 36 248 ST5 15 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	5 0 1 0 0 0 0 0 1 1 3 63 55 0	38 31 15 0 0 0 0 0 0 0 0 0 0 0 154 ST7 76 5 388 1 155 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 161 ST7 16 0 0	34 0 1 0 0 0 0 0 0 0 0 0 0 0 1 1 1 3995 ST8 3777 0 0 344 0 0 0 1 1 1 3995 ST8 3777 0 0 344 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 9 0 0 0 0 0 0 0 0 0 0 0 0 0	4 7 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 20 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	43 152 0 57 1 1 0 <td>23357722 187722 218822 218949 2444 2444 2444 2555 2566 2660 2439 2555 2660 2439 2555 2439 2555 2439 2419 2555 2439 2419 2555 2439 24555 24555 24555 24555 24555 24555 24555 24555 245555</td>	23357722 187722 218822 218949 2444 2444 2444 2555 2566 2660 2439 2555 2660 2439 2555 2439 2555 2439 2419 2555 2439 2419 2555 2439 24555 24555 24555 24555 24555 24555 24555 24555 245555
ST5 ST6 ST7 ST8 ST11 ST11 ST11 ST11 ST11 ST11 ST11 ST11 ST11 ST13 ST14 Alighting Y2040 Line ST3 ST4 ST5 ST6 ST7 ST8 ST9 ST14 ST14 ST15 ST6 ST12 ST14 Line ST11 ST12 ST14 Line ST1 ST2 ST3 ST6 ST7 ST8	721 1,729 810 2,124 1,125 469 9356 901 1,404 1,632 14569 ST1 0 169 210 738 1,771 825 2,146 1,771 825 2,146 1,1581 1,404 7,388 9,499 8,77 1,396 1,581 1,4647 ST1 0 1,837 0 1,581 1,4647 ST1 0 1,837 1,581 1,4647 1,779 8,388 2,666 7,488 1,779 8,388 1,779 8,388 1,779 8,388 1,779 8,388 1,779 8,388 1,779 8,388 1,779 8,388 1,779 8,388 1,779 8,388 1,779 8,388 1,779 8,388 1,779 8,388 1,779 8,388 1,779 8,388 1,779 8,388 1,779 1,779 1,838 1,779 1,838 1,779 1,838 1,779 1,838 1,779 1,838 1,779 1,838 1,779 1,838 1,779 1,838 1,779 1,838 1,779 1,838 1,779 1,838 1,779 1,838 1,779 1,838 1,779 1,838 1,779 1,838 1,779 1,838 1,779	7 7 7 7 7 7 7 7 8 22 2 4 4 29 49 29 49 354 ST2 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	0 0 15 0 36 5 16 39 221 ST3 0 0 0 0 0 0 0 0 0 0 0 0 0	18 0 0 0 0 0 0 0 0 0 0 0 0 0 0 11 44 15 5 19 0 0 0 0 0 0 0	93 0 0 0 0 0 0 0 0 0 0 0 3 3 9 155 18 366 248 ST5 41 144 955 0 0 0 0 0 0 0 0 0 0 0 0 0	5 0 1 0 0 0 0 0 1 1 1 1 1 55 0 0 0 0 0 0 0 0 0 0 0 655 555 1 55 0 1 55 0 1 55 0 1 55 0 1	38 31 15 0 0 0 0 0 0 0 0 0 0 0 0 154 5 38 15 38 115 38 15 38 15 38 15 38 15 38 15 38 15 38 161 ST7 82 6 377 1 16 0 0 0 0 0 0 0 0 0	34 34 0 0 1 1 0 0 0 0 0 0 1 1 3955 ST8 3777 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 9 0 0 0 0 0 0 0 0 0 0 0 0 0	4 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 5 0 0 0 0 0 0 0 0 0 0 0 0 0	4 20 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	43 152 0 57 11 1 0 <td>233 577 722 218 1137 499 2444 1000 975 1758 Boarding 1944 255 600 744 1911 833 2211 1166 500 744 1911 833 2211 1160 150 1707 1707 1707 1707 1707 1707 1922 243 1000 955 150 1707 1707 1707 1707 1922 2122 2122 2122 2122 2122 2122 212</td>	233 577 722 218 1137 499 2444 1000 975 1758 Boarding 1944 255 600 744 1911 833 2211 1166 500 744 1911 833 2211 1160 150 1707 1707 1707 1707 1707 1707 1922 243 1000 955 150 1707 1707 1707 1707 1922 2122 2122 2122 2122 2122 2122 212
ST5 ST6 ST7 ST8 ST10 ST11 ST12 ST13 ST14 Alighting Y2040 Line ST1 ST3 ST4 ST4 ST4 ST3 ST4 ST4 ST3 ST4 ST3 ST4 ST6 ST7 ST6 ST7 ST14 Alighting Y2050 Line ST1 ST3 ST14 Alighting Y2050 Line ST3 ST3 ST3 ST4 ST6 ST7 ST8 ST9	721 1,729 810 2,124 1,125 469 956 901 1,404 1,632 14569 ST1 0 169 2,10 7,38 1,771 825 2,146 1,153 14569 2,10 7,38 1,771 825 2,146 1,153 1,4569 877 1,396 1,581 1,4647 ST1 0 1,581 1,4647 ST1 0 1,582 1,581 1,4647 1,582 1,581 1,4647 1,582 1,586 1,	7777788 7777788 222 244229 29949 3544 29949 3544 29949 354 777777 7777777777777777777777777777	0 0 15 0 36 5 16 39 221 ST3 0 0 0 0 0 0 0 15 5 15 38 14 221 ST3 0 0 0 0 0 0 0 0 0 0 0 0 0	18 0 0 0 0 0 0 0 0 0 0 0 0 0 0 11 42 51 18 0 <td>93 93 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>5 0 1 0 0 0 0 0 0 1 1 1 1 633 52 1 52 1 5 0 0 0 0 0 0 655 556 11 33 655 556 11 55 11 55 11 55 0 1 55 0 1 0 0 0 0 0 0 0 0</td> <td>38 38 37 38 38 37 38 38 37 38 38 37 38 38 37 38 38 38 38 37 38 38 38 38 38 38 38 38 38 38 38 38 38</td> <td>34 34 0 0 0 0 0 0 0 0 0 1 1 33955 ST8 3777 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>4 9 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>4 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>4 20 0 0 23 1 1 1 0 0 0 0 0 0 0 270 ST13 228 5 200 0 0 233 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>43 152 0 57 11 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 577 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 11 11 0 11 0 0 0 0 0 0 0 </td> <td>233 577 722 2183 1133 4932 2444 1003 977 1500 1753 1753 1753 1753 1753 2444 255 600 1754 1500 2433 2211 1160 500 2433 2211 1160 500 1700 1777 8 8 4 4 4 3 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5</td>	93 93 0 0 0 0 0 0 0 0 0 0 0 0 0	5 0 1 0 0 0 0 0 0 1 1 1 1 633 52 1 52 1 5 0 0 0 0 0 0 655 556 11 33 655 556 11 55 11 55 11 55 0 1 55 0 1 0 0 0 0 0 0 0 0	38 38 37 38 38 37 38 38 37 38 38 37 38 38 37 38 38 38 38 37 38 38 38 38 38 38 38 38 38 38 38 38 38	34 34 0 0 0 0 0 0 0 0 0 1 1 33955 ST8 3777 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 9 0 0 0 0 0 0 0 0 0 0 0 0 0	4 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 20 0 0 23 1 1 1 0 0 0 0 0 0 0 270 ST13 228 5 200 0 0 233 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0	43 152 0 57 11 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 577 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 11 11 0 11 0 0 0 0 0 0 0	233 577 722 2183 1133 4932 2444 1003 977 1500 1753 1753 1753 1753 1753 2444 255 600 1754 1500 2433 2211 1160 500 2433 2211 1160 500 1700 1777 8 8 4 4 4 3 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5
ST5 ST6 ST7 ST8 ST10 ST11 ST12 ST14 Alighting Y2040 Line ST3 ST4 ST5 ST6 ST7 ST11 ST11 ST11 ST11 ST12 ST13 ST14 ST2 ST3 ST4 ST5 ST6 ST7 ST8 ST6 ST7 ST8 ST9 ST0 ST10 ST11	721 1,729 810 2,124 1,125 469 9356 901 1,404 1,632 14569 ST1 0 169 2100 738 1,771 825 2,146 1,4569 1,404 1,4569 1,4569 1,404 1,4569 1,404 1,4569 1,404 1,4569 1,404 1,4569 1,456	7 7 7 7 7 7 7 7 7 8 22 2 4 4 29 49 354 ST2 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	0 0 0 15 5 16 39 14 23 34 34 34 34 34 34 34 34 34 3	18 0 0 0 0 0 0 0 0 0 0 0 0 0 0 11 42 55 18 0 <td>93 93 0 0 0 0 0 0 0 0 0 15 18 36 248 ST5 16 98 575 16 98 575 16 98 575 16 98 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>5 0 1 0 0 0 0 0 1 1 1 1 1 55 0</td> <td>38 38 37 38 38 37 38 38 37 37 38 38 37 37 38 38 38 37 37 37 37 37 37 37 37 37 37 37 37 37</td> <td>34 34 0 0 1 1 0 0 0 0 0 0 1 1 1 3955 ST8 3777 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>4 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>4 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>4 20 4 20 0 0 0 23 1 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>43 152 0 57 11 1 0</td> <td>233 233 235 235 237 247 218 218 492 2444 1000 975 1758 Boarding 1943 255 600 746 500 2210 1166 500 2210 1775 Boarding 1943 255 600 746 1943 255 600 746 1943 255 600 746 1943 255 600 746 1943 255 600 746 1943 255 600 746 1943 255 600 746 1943 255 600 746 1943 255 600 746 1943 255 600 746 1943 255 600 746 1943 255 600 746 1943 255 600 746 1943 255 600 746 1943 255 600 746 1943 255 600 746 1943 255 600 746 1943 255 746 500 2126 838 2210 1775 800 2126 844 2277 800 2126 243 755 844 255 1775 800 2126 243 1925 844 255 1756 1775 800 1775 1775 800 1775 1775 800 1775 800 1775 800 1775 800 1775 800 1775 800 1775 800 1775 800 1775 800 1775 800 1775 800 1775 800 1775 800 1775 800 1775 800 1775 800 1775 800 1775 800 1775 800 1276 1276 1276 1276 1276 1277 1276 1276 1277 1276 1277 1276 1277 1276 1277 1276 1277 1276 1277 1276 1277 1277 1276 1277 1277 1276 1277</td>	93 93 0 0 0 0 0 0 0 0 0 15 18 36 248 ST5 16 98 575 16 98 575 16 98 575 16 98 0 0 0 0 0 0 0 0 0 0 0 0 0	5 0 1 0 0 0 0 0 1 1 1 1 1 55 0	38 38 37 38 38 37 38 38 37 37 38 38 37 37 38 38 38 37 37 37 37 37 37 37 37 37 37 37 37 37	34 34 0 0 1 1 0 0 0 0 0 0 1 1 1 3955 ST8 3777 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 20 4 20 0 0 0 23 1 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0	43 152 0 57 11 1 0	233 233 235 235 237 247 218 218 492 2444 1000 975 1758 Boarding 1943 255 600 746 500 2210 1166 500 2210 1775 Boarding 1943 255 600 746 1943 255 600 746 1943 255 600 746 1943 255 600 746 1943 255 600 746 1943 255 600 746 1943 255 600 746 1943 255 600 746 1943 255 600 746 1943 255 600 746 1943 255 600 746 1943 255 600 746 1943 255 600 746 1943 255 600 746 1943 255 600 746 1943 255 600 746 1943 255 600 746 1943 255 746 500 2126 838 2210 1775 800 2126 844 2277 800 2126 243 755 844 255 1775 800 2126 243 1925 844 255 1756 1775 800 1775 1775 800 1775 1775 800 1775 800 1775 800 1775 800 1775 800 1775 800 1775 800 1775 800 1775 800 1775 800 1775 800 1775 800 1775 800 1775 800 1775 800 1775 800 1775 800 1775 800 1775 800 1276 1276 1276 1276 1276 1277 1276 1276 1277 1276 1277 1276 1277 1276 1277 1276 1277 1276 1277 1276 1277 1277 1276 1277 1277 1276 1277
ST5 ST6 ST7 ST10 ST11 ST12 ST13 ST14 Alighting Y2040 Line ST1 ST1 ST1 ST12 ST14 Alighting Y2040 Line ST3 ST4 ST6 ST6 ST7 ST8 ST6 ST11 ST6 ST12 ST14 Alighting Y2050 Line ST1 ST1 ST1 ST6 ST1 ST1 ST1 ST6 ST1 ST6 ST7 ST8 ST6 ST7 ST8 ST9 ST10 <t< td=""><td>721 1,729 810 2,124 1,125 469 9,360 9901 1,404 1,632 14,659 901 1,404 1,632 14,669 901 1,404 1,532 2,146 1,532 2,146 1,532 2,146 1,533 484 2,348 949 8777 1,396 1,581 1,4647 ST1 6 949 838 2,206 907 828 2,356 907 821</td><td>7 7 7 7 7 7 7 7 7 7 22 2 4 4 9 9 354 8 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7</td><td>0 0 0 15 5 16 399 14 233 344 233 344 221 ST3 0 0 0 0 0 0 15 15 39 39 221 ST3 0 0 0 0 0 0 0 0 0 0 0 0 0</td><td>18 0 0 0 0 0 0 0 0 0 0 0 0 0 0 11 42 574 12 5 18 0<</td><td>93 93 0 0 0 0 0 0 0 0 3 3 9 5 5 5 5 41 1 41 4 9 5 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td><td>5 0 1 0 0 0 0 0 0 1 1 1 3 0 633 ST6 52 1 0</td></t<> <td>38 31 15 0 0 0 0 0 0 0 0 0 0 0 0 154 ST7 76 5 388 1 155 0 0 0 0 0 0 0 0 161 ST7 66 377 161 ST7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 <tr< td=""><td>34 34 0 0 0 0 0 0 0 0 0 0 0 0 0</td><td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td><td>4 9 0 0 0 0 0 0 0 0 0 0 0 0 0</td><td>4 7 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td><td>4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td><td>4 20 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td><td>43 152 0 57 1 1 0<td>233 573 722 2184 1133 492 2444 1000 977 1500 1758 1758 1758 1758 1758 1758 1758 1758</td></td></tr<></td>	721 1,729 810 2,124 1,125 469 9,360 9901 1,404 1,632 14,659 901 1,404 1,632 14,669 901 1,404 1,532 2,146 1,532 2,146 1,532 2,146 1,533 484 2,348 949 8777 1,396 1,581 1,4647 ST1 6 949 838 2,206 907 828 2,356 907 821	7 7 7 7 7 7 7 7 7 7 22 2 4 4 9 9 354 8 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	0 0 0 15 5 16 399 14 233 344 233 344 221 ST3 0 0 0 0 0 0 15 15 39 39 221 ST3 0 0 0 0 0 0 0 0 0 0 0 0 0	18 0 0 0 0 0 0 0 0 0 0 0 0 0 0 11 42 574 12 5 18 0<	93 93 0 0 0 0 0 0 0 0 3 3 9 5 5 5 5 41 1 41 4 9 5 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	5 0 1 0 0 0 0 0 0 1 1 1 3 0 633 ST6 52 1 0	38 31 15 0 0 0 0 0 0 0 0 0 0 0 0 154 ST7 76 5 388 1 155 0 0 0 0 0 0 0 0 161 ST7 66 377 161 ST7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 <tr< td=""><td>34 34 0 0 0 0 0 0 0 0 0 0 0 0 0</td><td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td><td>4 9 0 0 0 0 0 0 0 0 0 0 0 0 0</td><td>4 7 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td><td>4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td><td>4 20 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td><td>43 152 0 57 1 1 0<td>233 573 722 2184 1133 492 2444 1000 977 1500 1758 1758 1758 1758 1758 1758 1758 1758</td></td></tr<>	34 34 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 9 0 0 0 0 0 0 0 0 0 0 0 0 0	4 7 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 20 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	43 152 0 57 1 1 0 <td>233 573 722 2184 1133 492 2444 1000 977 1500 1758 1758 1758 1758 1758 1758 1758 1758</td>	233 573 722 2184 1133 492 2444 1000 977 1500 1758 1758 1758 1758 1758 1758 1758 1758
ST5 ST6 ST7 ST8 ST10 ST11 ST12 ST14 Alighting Y2040 Line ST1 ST1 ST14 ST14 ST14 ST14 ST14 ST1 ST1 ST3 ST4 ST6 ST7 ST8 ST6 ST7 ST8 ST4 ST10 ST11 ST12 ST14 Alighting Y2050 Line ST1 ST6 ST7 ST8 ST7 ST8 ST7 ST10 ST11 ST12 ST13	721 1,729 810 2,124 1,125 469 956 901 1,404 1,632 14569 ST1 0 0 169 2,10 738 1,475 2,146 1,4569 2,10 7,388 1,475 2,146 1,405 2,146 1,581 1,404 1,582 1,405 1,581 1,404 1,582 1,405 1,581 1,404 1,585 1,406 1,585 1,406 1,585 1,406 1,585 1,406 1,585 1,406 1,585 1,406 1,585 1,406 1,585 1,406 1,585 1,406 1,585 1,406 1,585 1,406 1,585 1,406 1,585 1,585 1,585 1,585 1,585 1,585 1,585 1,585 1,585 1,585 1,585 1,585 1,585 1,585 1,585 1,585 1,585 1,585 1,585 1,775 1,585 1,785 1,585 1,775 1,585 1,785 1,585 1,785 1,585 1,785 1,585 1,785 1,585 1,785 1,585 1,785 1,785 1,585 1,785 1,585 1,775 1,585 1,575 1,585 1,575 1,585 1,575 1,585 1,575 1,585 1,575 1,585 1,575 1,585	777788 7777788 222 244233 222 244229 299 499 3544 572 777777 77777 7777799 223 55 225 244 244 249 299 499 364 572 153 00 66 77777999 225 22 22 22 22 22 22 22 22 22 22 22 22	0 0 0 15 0 36 5 16 39 221 ST3 0 0 0 0 0 0 0 0 0 0 0 0 0	18 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 11 42 55 15 55 19 0<	93 93 0 0 0 0 0 0 0 0 0 0 3 3 9 155 18 366 248 ST5 41 144 955 0 0 0 0 0 0 0 0 0 0 0 0 0	5 0 1 0 0 0 0 0 0 1 1 1 1 52 1 52 1 55 0 0 0 0 0 0 0 655 ST6 555 1 55 1 55 1 55 ST6 55 55 1 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1	38 31 15 0 0 0 0 0 0 0 0 0 0 0 0 154 ST7 15 0 0 0 0 0 0 0 0 0 161 ST7 110 ST7 12 6 0	34 34 0 0 0 0 0 0 0 0 0 0 1 1 33955 ST8 3777 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 9 0 0 0 0 0 0 0 0 0 0 0 0 0	4 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 5 0 0 0 0 0 0 0 0 0 0 0 0 0	4 20 0 0 23 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0	43 152 0 57 11 0 <td>233 577 722 1877 822 2188 1133 493 2444 1000 977 1758 Boarding 1945 255 600 7744 255 600 7744 255 600 7744 2017 833 2017 833 2017 1700 1700 1700 1700 1700 1700 1700</td>	233 577 722 1877 822 2188 1133 493 2444 1000 977 1758 Boarding 1945 255 600 7744 255 600 7744 255 600 7744 2017 833 2017 833 2017 1700 1700 1700 1700 1700 1700 1700
ST5 ST6 ST7 ST8 ST10 ST11 ST12 ST14 ST14 ST17 ST12 ST14 ST1 ST3 ST4 ST5 ST6 ST12 ST14 ST15 ST14 Alighting Y2050 Line ST1 ST4 ST5 ST6 ST7 ST8 ST6 ST11 ST6 ST7 ST8 ST6 ST7 ST8 ST9 ST10	721 1,729 810 2,124 1,125 469 9,360 9901 1,404 1,632 14,659 901 1,404 1,632 14,669 901 1,404 1,532 2,146 1,532 2,146 1,532 2,146 1,533 484 2,348 949 8777 1,396 1,581 1,4647 ST1 6 949 838 2,206 907 828 2,356 907 821	7 7 7 7 7 7 7 7 7 7 22 2 4 4 9 9 354 8 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	0 0 0 15 0 36 5 16 39 221 ST3 0 0 0 0 0 0 0 0 0 0 0 0 0	18 0 0 0 0 0 0 0 0 0 0 0 0 0 0 11 42 574 12 5 18 0<	93 93 0 0 0 0 0 0 0 0 0 0 0 0 0	5 0 1 0 0 0 0 0 0 1 1 1 3 0 633 ST6 52 1 0 <td>38 38 37 38 38 37 38 38 37 38 38 37 38 38 37 38 38 37 38 38 37 38 38 38 38 38 38 38 38 38 38 38 38 38</td> <td>34 34 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>4 9 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>4 7 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>4 20 0 0 23 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>43 152 0 57 1 1 0<td>233 577 722 1877 822 2188 1133 1133 1130 1758 1130 1758 1758 1758 1758 1758 1758 1758 1758</td></td>	38 38 37 38 38 37 38 38 37 38 38 37 38 38 37 38 38 37 38 38 37 38 38 38 38 38 38 38 38 38 38 38 38 38	34 34 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 9 0 0 0 0 0 0 0 0 0 0 0 0 0	4 7 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4 20 0 0 23 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0	43 152 0 57 1 1 0 <td>233 577 722 1877 822 2188 1133 1133 1130 1758 1130 1758 1758 1758 1758 1758 1758 1758 1758</td>	233 577 722 1877 822 2188 1133 1133 1130 1758 1130 1758 1758 1758 1758 1758 1758 1758 1758

Table 3.42	Station-to-Station Matrix (Phase-1 development case: Low Growth)
Y2020	-

Alighting | 14692| 309| 20 Source: JICA Study Team

3.6.3 Daily Traffic

The estimated OD matrices represent the traffic in the morning peak hours, and it is likely that the OD matrix in the afternoon peak hours is the transposed matrix of the morning peaks. It is assumed that the daily OD is calculated from the combined matrix of the morning and afternoon peak hours by multiplying a scalar value.

According to the traffic survey, the bus traffic in the morning peak hours for both directions accounts for 12% of the daily traffic. The rate of the total trips in the morning peaks to that of a day is assumed to be 12%. From this, the number of boarding and alighting passengers in a day was calculated from that of peak hours by multiplying 1/0.12.

The result of the calculation of barding passengers is shown in Table 3.43 and Table 3.44.

Tau	le 5.45 Dali	y boarung r	assengers by	Station (Fun	Developmen	(Case)
Station	2020	2025	2030	2035	2040	2050
1	84,346	88,679	92,813	97,721	101,663	110,854
2	2,779	3,067	3,400	3,604	3,825	4,358
3	8,871	11,250	12,621	12,783	14,175	15,163
4	3,788	4,063	4,350	4,658	4,963	5,392
5	11,004	11,754	12,433	12,983	13,767	15,021
6	4,754	5,088	5,421	5,800	6,179	6,688
7	14,696	15,808	16,979	18,042	18,917	20,692
8	7,363	7,975	8,629	9,183	9,654	10,854
9	2,667	2,854	3,033	3,179	3,300	3,613
10	12,833	13,758	14,233	14,746	15,225	15,783
11	4,125	4,388	4,575	4,733	4,883	5,117
12	3,283	3,488	3,575	3,679	3,742	3,975
13	6,179	6,608	6,879	7,133	7,329	7,917
14	763	863	879	958	1,033	1,167
15	1,413	1,558	1,679	1,808	1,958	2,204
16	5,179	5,988	6,496	6,971	7,563	8,242
17	23,483	24,271	25,046	25,633	26,292	28,479
Total	197,525	211,458	223,042	233,617	244,467	265,517

 Table 3.43
 Daily Boarding Passengers by Station (Full Development Case)

Source: JICA Study Team

Table 3.44 Daily Boarding and Alighting Passengers by Station (I	Phase-1 Case)
--	---------------

		Dour ang and	ing	Station (I have I cuse)			
Station	2020	2025	2030	2035	2040	2050	
1	74,496	80,529	84,750	88,913	91,975	96,058	
2	2,150	2,438	2,708	2,925	3,079	3,279	
3	2,846	3,646	4,083	4,363	4,667	5,146	
4	3,483	3,783	4,054	4,267	4,500	4,767	
5	9,442	10,321	11,083	11,800	12,308	13,021	
6	4,004	4,433	4,779	5,142	5,346	5,663	
7	10,300	11,242	12,008	12,871	13,508	14,221	
8	6,392	7,021	7,725	8,296	8,771	9,525	
9	2,700	2,967	3,150	3,388	3,496	3,713	
10	12,504	13,758	14,383	15,075	15,463	16,092	
11	5,529	5,954	6,217	6,421	6,542	6,629	
12	5,388	5,833	6,071	6,279	6,358	6,388	
13	8,292	8,963	9,296	9,663	9,975	10,392	
14	10,933	11,313	11,308	11,275	11,379	11,275	
Total	158,458	172,200	181,617	190,675	197,367	206,167	

Source: JICA Study Team

3.6.4 Results of Traffic Assignment

(1) Peak Hour Traffic

Under the Present scenario, the future peak hour traffic of the Bridge of Americas must be almost the same as the present traffic because the peak hour traffic volume cannot exceed the traffic capacity of the Pan-American Road. After the peak hour traffic on the Centenario Bridge exceeds the capacity, the hourly traffic crossing the canal in the future becomes the same as the present traffic. On the other hand, traffic flow in off-peak hour will continue to increase.

In the demand forecast model, the peak hour traffic is estimated using the peak hour OD matrix although the "peak hour traffic" does not necessarily represent the peak hour traffic, because it should be considered that a part of the traffic would shift to other hours. Table 3.45 (A-C) shows the result of the demand forecast for the peak hour.

(2) Daily Traffic

The peak hour traffic on the Bridge of Americas accounts for 7% of 24 hours of traffic according to the traffic survey conducted in 2013 by the JICA Study Team. The daily traffic was estimated from the peak hour traffic by applying the peak hour rate. Table 3.45 (D) shows the result of the demand forecast of the daily traffic (no. of vehicles). The results of the demand forecast represent the traffic flow in a typical weekday instead of AADT used in the ACP's Study.

To compare the results with the ACP's Study, the results of the demand forecast were converted to AADT (5:00-21:00) using the conversion factors (from a daily to AADT) of 1.0595 and 1.0246 for cars and buses, respectively, which are used in the ACP's Study. The results are shown in Table 3.45 (E).

Table 3.46 and Table 3.47 show the results of the demand forecast of other population scenarios.

Scenario	Present		4th Bridge			4th Bridge a	nd Line-3		Without Brid Americas	lge of	
Year	Centenario	Bridge of Americas	Centenario	Bridge of Americas	4th Bridge	Centenario	Bridge of Americas	4th Bridge	Centenario	4th Bridge	
2020	1,746	3,445	1,379	1,921	1,877	1,157	1,709	1,451	1,264	2,985	
2025	2,578	3,871	1,823	2,186	2,425	1,512	2,045	1,841	1,642	3,68	
2030	3,282	4,362	2,329	2,425	2,875	1,914	2,222	2,323	2,067	4,31	
2035	3,669	5,124	3,133	2,598	3,045	2,287	2,436	2,711	2,607	4,75	
2040	4,533	5,522	3,379	2,799	3,953	2,746	2,715	3,118	3,106	5,40	
2045	5,131	5,979	4,008	3,123	3,963	3,459	2,754	3,175	3,420	5,89	
2050	5,173	6,956	4,083	3,442	4,611	3,391	2,904	3,977	4,208	5,99	
	our Off-peal						· · · · ·		,	,	
Scenario	Present		4th Bridge			4th Bridge a	nd Line-3		Without Brid Americas	lge of	
Year	Centenario	Bridge of Americas	Centenario	Bridge of Americas	4th Bridge	Centenario	Bridge of Americas	4th Bridge	Centenario	4th Bridge	
2020	635	670	609	85	598	604	82	549	605	62	
2025	694	713	655	89	648	645	88	588	645	67	
2030	751	742	699	86	693	697	84	631	698	71	
2035	812	779	766	98	712	759	98	650	760	74	
2040	885	820	834	101	752	825	101	684	829	77	
2045	922	868	870	101	799	862	101	717	864	81	
2050	958	890	928	113	815	896	112	738	897	84	
	our Both Di			115	015	070	112	750	0,77	01.	
	Present	rections (r c	4th Bridge			4th Bridge and Line-3 Without Bri Americas			-		
Year	Centenario	Bridge of Americas	Centenario	Bridge of Americas	4th Bridge	Centenario	Bridge of Americas	4th Bridge	Centenario	4th Bridge	
2020	2,381	4,115	1,988	2,006	2,475	1,761	1,791	2,000	1,869	3,61	
2025	3,272	4,584	2,478	2,275	3,073	2,157	2,133	2,429	2,287	4,35	
2030	4,033	5,104	3,028	2,511	3,568	2,611	2,306	2,954	2,765	5,02	
2035	4,481	5,903	3,899	2,696	3,757	3,046	2,534	3,361	3,367	5,49	
2035	5,418	6,342	4,213	2,900	4,705	3,571	2,816	3,802	3,935	6,17	
2040	6,053	6,847	4,878	3,229	4,762	4,321	2,858	3,892	4,284	6,71	
2045	6,131	7,846	5,011	3,555	5,426	4,287	3,016	4,715	5,105	6,83	
	hours: No.		5,011	3,335	5,420	4,207	5,010	4,715	5,105	0,05	
	Present	or venicies)	4th Bridge			4th Bridge a	nd Line-3		Without Bridge of		
Year	Centenario	Bridge of	Centenario	Bridge of	4th Bridge	Centenario	Bridge of	4th Bridge	Americas Centenario	4th Bridge	
2020		Americas		Americas			Americas	Ĵ		Ű.	
2020	39,280	56,132	33,837	28,269	33,112	30,615	25,905	28,705	32,144	52,560	
			41,794	32,236	41,507	37,222	30,950	34,900	39,072	63,457	
2025	52,951	62,800		25.000	40 -1 -	44.000				73,48	
2025 2030	64,982	70,495	50,818	35,830	48,616	44,882	33,651	42,566	47,068		
2025 2030 2035	64,982 72,418	70,495 82,126	50,818 64,310	38,663	51,342	52,146	37,113	48,520	56,718	80,50	
2025 2030 2035 2040	64,982 72,418 87,071	70,495 82,126 89,361	50,818 64,310 70,021	38,663 41,823	51,342 65,002	52,146 60,857	37,113 41,402	48,520 55,009	56,718 66,050	80,503 90,668	
2025 2030 2035 2040 2045	64,982 72,418 87,071 97,013	70,495 82,126 89,361 96,226	50,818 64,310 70,021 80,442	38,663 41,823 46,709	51,342 65,002 65,867	52,146 60,857 72,492	37,113 41,402 42,195	48,520 55,009 56,424	56,718 66,050 71,949	80,503 90,668 98,619	
2025 2030 2035 2040 2045 2050	64,982 72,418 87,071 97,013 99,138	70,495 82,126 89,361 96,226 110,894	50,818 64,310 70,021	38,663 41,823	51,342 65,002	52,146 60,857	37,113 41,402	48,520 55,009	56,718 66,050	80,505 90,668 98,619 100,808	
2025 2030 2035 2040 2045 2050	64,982 72,418 87,071 97,013	70,495 82,126 89,361 96,226 110,894	50,818 64,310 70,021 80,442	38,663 41,823 46,709	51,342 65,002 65,867	52,146 60,857 72,492	37,113 41,402 42,195	48,520 55,009 56,424	56,718 66,050 71,949 84,695	80,50 90,660 98,619 100,800	
2025 2030 2035 2040 2045 2050 E: AADT	64,982 72,418 87,071 97,013 99,138	70,495 82,126 89,361 96,226 110,894 cles)	50,818 64,310 70,021 80,442	38,663 41,823 46,709 51,608	51,342 65,002 65,867	52,146 60,857 72,492	37,113 41,402 42,195 44,665 nd Line-3	48,520 55,009 56,424	56,718 66,050 71,949	80,50 90,66 98,61 100,80	
2025 2030 2035 2040 2045 2050 E: AADT	64,982 72,418 87,071 97,013 99,138 (No. of Vehic	70,495 82,126 89,361 96,226 110,894	50,818 64,310 70,021 80,442 83,367	38,663 41,823 46,709 51,608 Bridge of Americas	51,342 65,002 65,867	52,146 60,857 72,492 73,024	37,113 41,402 42,195 44,665	48,520 55,009 56,424	56,718 66,050 71,949 84,695 Without Brid Americas Centenario	80,50 90,66 98,61 100,80	
2025 2030 2035 2040 2045 2050 E: AADT Scenario	64,982 72,418 87,071 97,013 99,138 (No. of Vehic Present	70,495 82,126 89,361 96,226 110,894 cles) Bridge of	50,818 64,310 70,021 80,442 83,367 4th Bridge	38,663 41,823 46,709 51,608 Bridge of	51,342 65,002 65,867 75,508	52,146 60,857 72,492 73,024 4th Bridge a	37,113 41,402 42,195 44,665 nd Line-3 Bridge of	48,520 55,009 56,424 68,351	56,718 66,050 71,949 84,695 Without Brid Americas	80,50 90,66 98,61 100,80 ge of	
2025 2030 2035 2040 2045 2050 E: AADT Scenario Year	64,982 72,418 87,071 97,013 99,138 (No. of Vehi Present Centenario	70,495 82,126 89,361 96,226 110,894 cles) Bridge of Americas	50,818 64,310 70,021 80,442 83,367 4th Bridge Centenario	38,663 41,823 46,709 51,608 Bridge of Americas	51,342 65,002 65,867 75,508 4th Bridge	52,146 60,857 72,492 73,024 4th Bridge a Centenario	37,113 41,402 42,195 44,665 nd Line-3 Bridge of Americas	48,520 55,009 56,424 68,351 4th Bridge	56,718 66,050 71,949 84,695 Without Brid Americas Centenario	80,50 90,66 98,61 100,80 ge of 4th Bridge 48,98	
2025 2030 2035 2040 2045 2050 E: AADT Scenario Year 2020	64,982 72,418 87,071 97,013 99,138 (No. of Vehi Present Centenario 31,525	70,495 82,126 89,361 96,226 110,894 cles) Bridge of Americas 50,906	50,818 64,310 70,021 80,442 83,367 4th Bridge Centenario 26,382	38,663 41,823 46,709 51,608 Bridge of Americas 25,615	51,342 65,002 65,867 75,508 4th Bridge 30,246	52,146 60,857 72,492 73,024 4th Bridge a Centenario 23,341	37,113 41,402 42,195 44,665 nd Line-3 Bridge of Americas 23,361	48,520 55,009 56,424 68,351 4th Bridge 26,010	56,718 66,050 71,949 84,695 Without Brid Americas Centenario 25,613	80,50 90,66 98,61 100,80 ge of 4th Bridge 48,98 59,24	
2025 2030 2035 2040 2045 2050 E: AADT Scenario Year 2020 2025	64,982 72,418 87,071 97,013 99,138 (No. of Vehi Present Centenario 31,525 43,512	70,495 82,126 89,361 96,226 110,894 cles) Bridge of Americas 50,906 56,846	50,818 64,310 70,021 80,442 83,367 4th Bridge Centenario 26,382 32,976	38,663 41,823 46,709 51,608 Bridge of Americas 25,615 29,177	51,342 65,002 65,867 75,508 4th Bridge 30,246 37,996	52,146 60,857 72,492 73,024 4th Bridge a Centenario 23,341 28,661	37,113 41,402 42,195 44,665 nd Line-3 Bridge of Americas 23,361 27,940	48,520 55,009 56,424 68,351 4th Bridge 26,010 31,677	56,718 66,050 71,949 84,695 Without Brid Americas Centenario 25,613 31,427	80,50 90,66 98,61 100,80 ge of 4th Bridge	
2025 2030 2035 2040 2045 2050 E: AADT (Scenario Year 2020 2025 2030	64,982 72,418 87,071 97,013 99,138 (No. of Vehi Present Centenario 31,525 43,512 53,754	70,495 82,126 89,361 96,226 110,894 cles) Bridge of Americas 50,906 56,846 63,668	50,818 64,310 70,021 80,442 83,367 4th Bridge Centenario 26,382 32,976 40,379	38,663 41,823 46,709 51,608 Bridge of Americas 25,615 29,177 32,346 34,821	51,342 65,002 65,867 75,508 4th Bridge 30,246 37,996 44,488	52,146 60,857 72,492 73,024 4th Bridge a Centenario 23,341 28,661 34,775	37,113 41,402 42,195 44,665 nd Line-3 Bridge of Americas 23,361 27,940 30,266	48,520 55,009 56,424 68,351 4th Bridge 26,010 31,677 38,690	56,718 66,050 71,949 84,695 Without Brid Americas Centenario 25,613 31,427 38,078	80,50 90,66 98,61 100,80 ge of 4th Bridge 48,98 59,24 68,56	
2025 2030 2035 2040 2045 2050 E: AADT (Scenario Year 2020 2025 2030 2035	64,982 72,418 87,071 97,013 99,138 (No. of Vehi Present Centenario 31,525 43,512 53,754 59,775	70,495 82,126 89,361 96,226 110,894 cles) Bridge of Americas 50,906 56,846 63,668 74,253	50,818 64,310 70,021 80,442 83,367 4th Bridge Centenario 26,382 32,976 40,379 52,116	38,663 41,823 46,709 51,608 Bridge of Americas 25,615 29,177 32,346	51,342 65,002 65,867 75,508 4th Bridge 30,246 37,996 44,488 46,867	52,146 60,857 72,492 73,024 4th Bridge a Centenario 23,341 28,661 34,775 40,634	37,113 41,402 42,195 44,665 nd Line-3 Bridge of Americas 23,361 27,940 30,266 33,334	48,520 55,009 56,424 68,351 4th Bridge 26,010 31,677 38,690 44,113	56,718 66,050 71,949 84,695 Without Brid Americas Centenario 25,613 31,427 38,078 46,464	80,50 90,66 98,61 100,80 ge of 4th Bridge 48,98 59,24 68,56 75,00	

Table 3.45 Result of Demand Forecast (Population High Projection)

Source: Estimation by the JICA Study Team

Scenario	Hour Peak Di Present	```	4th Bridge			4th Bridge a	nd Line-3		Without Brid Americas	lge of
Year	Centenario	Bridge of Americas	Centenario	Bridge of Americas	4th Bridge	Centenario	Bridge of Americas	4th Bridge	Centenario	4th Bridge
2020	1,428	3,227	1,194	1,759	1,689	960	1,547	1,291	1,085	2,703
2025	1,916	3,582	1,461	1,972	2,051	1,210	1,832	1,515	1,358	3,190
2030	2,452	3,884	1,753	2,215	2,355	1,476	2,039	1,770	1,634	3,640
2035	2,911	4,158	2,082	2,358	2,617	1,707	2,092	2,124	1,894	4,019
2040	3,332	4,515	2,408	2,489	2,937	1,957	2,302	2,330	2,136	4,444
2045	3,528	4,867	2,750	2,593	3,039	2,115	2,319	2,579	2,353	4,650
2050	3,735	5,196	3,240	2,639	3,039	2,303	2,430	2,781	2,788	4,716
	Iour Off-peal			_,,	0,000	_,	_,	_,	_,	.,
Scenario	Present		4th Bridge			4th Bridge a	nd Line-3		Without Brid Americas	lge of
Year	Centenario	Bridge of Americas	Centenario	Bridge of Americas	4th Bridge	Centenario	Bridge of Americas	4th Bridge	Centenario	4th Bridge
2020	610	653	575	82	594	584	78	515	577	624
2020	665	680	631	82	616	620	81	535	617	644
2023	716	711	675	83	658	673	79	565	671	670
2030	710	711 742	711	82	638	714	85	596	710	710
				94			90			
2040	807	770	758	-	714	757		619	752	738
2045	841	793	788	97	737	794	94	632	790	755
2050	870	808	818	99	749	826	94	643	818	771
C: Peak F	Hour Both Di Present	rections (PC	4th Bridge			4th Bridge and Line-3			Without Bridge of Americas	
Year	Centenario	Bridge of Americas	Centenario	Bridge of Americas	4th Bridge	Centenario	Bridge of Americas	4th Bridge	Centenario	4th Bridge
2020	2,038	3,880	1,769	1,841	2,283	1,544	1,625	1,806	1,662	3,327
2025	2,581	4,262	2,092	2,057	2,263	1,830	1,913	2,050	1,975	3,834
2020	3,168	4,595	2,428	2,037	3,013	2,149	2,118	2,335	2,305	4,310
2035	3,673	4,900	2,793	2,297	3,309	2,14)	2,110	2,333	2,503	4,729
2035	4,139	5,285	3,166	2,583	3,651	2,714	2,392	2,720	2,888	5,182
2040	4,369	5,660	3,538	2,585	3,776	2,714	2,372	3,211	3,143	5,405
2043	4,605	6,004	4,058	2,030	3,788	3,129	2,413	3,424	3,606	5,487
	, ,	<i>,</i>	4,038	2,758	3,788	5,129	2,324	5,424	5,000	3,487
D: Day (2	4 hours: No.	of venicles)	1			1			W/4 (D)	1 6
Scenario	Present	1	4th Bridge		1	4th Bridge a	r		Without Brid Americas	lge of
Year	Centenario	Bridge of Americas	Centenario	Bridge of Americas	4th Bridge	Centenario	Bridge of Americas	4th Bridge	Centenario	4th Bridge
2020	34,430	53,182	30,751	26,055	30,627	27,573	23,841	26,305	29,223	48,596
2025	43,151	58,843	36,336	29,336	36,129	32,615	28,150	29,907	34,658	56,128
2030	52,718	64,045	42,318	33,044	41,223	38,346	31,330	34,180	40,561	63,388
2035	60,989	68,805	48,596	35,420	45,606	43,282	32,392	39,856	45,882	69,755
2040	68,878	74,832	55,157	37,673	50,709	48,693	35,723	43,337	51,171	76,689
2045	73,085	80,569	61,399	39,424	52,652	52,399	36,217	47,259	55,742	80,240
2050	77,495	85,987	69,867	40,365	53,072	56,574	38,022	50,486	63,388	81,808
E: AADT	(No. of Vehi	cles)								
	Present		4th Bridge			4th Bridge a	nd Line-3		Without Brid Americas	lge of
Scenario		Bridge of	а. ·	Bridge of	4th Bridge	Centenario	Bridge of Americas	4th Bridge	Centenario	4th Bridge
Scenario Year	Centenario	Americas	Centenario	Americas			7 milerieus			
	Centenario 26,945		23,468	Americas 23,521	27,891	20,467	21,403	23,732	22,761	45,119
Year		Americas	23,468		e	20,467 24,310	21,403	23,732 26,951		
Year 2020	26,945 34,260	Americas 48,109 53,090	23,468 27,823	23,521 26,433	27,891 32,906		21,403 25,286	26,951	27,119	52,090
Year 2020 2025 2030	26,945 34,260 42,175	Americas 48,109 53,090 57,554	23,468 27,823 32,354	23,521 26,433 29,708	27,891 32,906 37,493	24,310 28,605	21,403 25,286 28,063	26,951 30,761	27,119 31,727	45,119 52,090 58,713 64,513
Year 2020 2025 2030 2035	26,945 34,260 42,175 48,984	Americas 48,109 53,090 57,554 61,647	23,468 27,823 32,354 37,282	23,521 26,433 29,708 31,750	27,891 32,906 37,493 41,432	24,310 28,605 32,266	21,403 25,286 28,063 28,865	26,951 30,761 35,920	27,119 31,727 35,889	52,090 58,713 64,513
2020 2025 2030	26,945 34,260 42,175	Americas 48,109 53,090 57,554	23,468 27,823 32,354	23,521 26,433 29,708	27,891 32,906 37,493	24,310 28,605	21,403 25,286 28,063	26,951 30,761	27,119 31,727	52,090 58,713

Table 3.46 Result of Demand Forecast (Population Medium Projection) Hour Peak Direction (PCU) Population Medium Projection

Source: Estimation by the JICA Study Team

Scenario	lour Peak Di Present		4th Bridge			4th Bridge a	nd Line-3		Without Bric Americas	lge of
Year	Centenario	Bridge of Americas	Centenario	Bridge of Americas	4th Bridge	Centenario	Bridge of Americas	4th Bridge	Centenario	4th Bridge
2020	1,283	3,061	1,081	1,693	1,558	897	1,418	1,233	992	2,54
2025	1,669	3,476	1,349	1,932	1,850	1,106	1,729	1,414	1,240	2,99
2030	2,308	3,676	1,638	2,178	2,155	1,373	1,880	1,716	1,529	3,43
2035	2,689	4,011	1,956	2,262	2,470	1,601	2,106	1,896	1,759	3,83
2040	3,299	4,277	2,298	2,470	2,796	1,882	2,216	2,266	2,049	4,30
2045	3,453	4,662	2,549	2,537	3,018	2,054	2,350	2,389	2,241	4,54
2050	3,689	5,075	3,135	2,624	2,993	2,246	2,410	2,704	2,609	4,74
	our Off-peal			,		,	· · · ·	· · · · ·		· · · ·
Scenario	Present	,	4th Bridge			4th Bridge a	and Line-3		Without Bric Americas	lge of
Year	Centenario	Bridge of Americas	Centenario	Bridge of Americas	4th Bridge	Centenario	Bridge of Americas	4th Bridge	Centenario	4th Bridge
2020	593	634	556	78	580	553	77	507	551	60
2020	635	664	605	83	600	606	76	523	604	62
2023	678	677	640	80	624	635	76	543	630	64
2030	706	690	667	79	639	662	70	554	659	65
				84						
2040	747	713	708		656	711	80	564	708	67
2045	764	750	722	86	696	723	82	595	719	70-
2050	808	767	757	92	716	761	88	611	759	72:
C: Peak H	C: Peak Hour Both Directions (PC Scenario Present					4th Bridge a	und Line-3		Without Bric	lge of
Year	Centenario	Bridge of	Centenario	Bridge of	4th Bridge	Centenario	Bridge of	4th Bridge	Americas Centenario	4th Bridge
2020	1.076	Americas	1 (27	Americas	2 1 2 9	1 450	Americas	1 740	1.542	2.15
2020	1,876	3,695	1,637	1,771	2,138	1,450	1,495	1,740	1,543	3,15
2025	2,304	4,140	1,954	2,015	2,450	1,712	1,805	1,937	1,844	3,62
2030	2,986	4,353	2,278	2,258	2,779	2,008	1,956	2,259	2,159	4,07
2035	3,395	4,701	2,623	2,341	3,109	2,263	2,181	2,450	2,418	4,48
2040	4,046	4,990	3,006	2,554	3,452	2,593	2,296	2,830	2,757	4,97
2045	4,217	5,412	3,271	2,623	3,714	2,777	2,432	2,984	2,960	5,24
2050	4,497	5,842	3,892	2,716	3,709	3,007	2,498	3,315	3,368	5,46
D: Day (2	4 hours: No.	of Vehicles)	1						T	
Scenario	Present		4th Bridge			4th Bridge a	and Line-3		Without Brid Americas	lge of
Year	Centenario	Bridge of Americas	Centenario	Bridge of Americas	4th Bridge	Centenario	Bridge of Americas	4th Bridge	Centenario	4th Bridge
2020	32,137	50,753	28,887	25,134	28,691	26,244	22,012	25,384	27,551	46,182
2025	39,222	57,350	34,386	28,814	33,193	30,951	26,636	28,321	32,808	53,20
2030	50,146	60,831	40,196	32,551	38,058	36,346	29,044	33,130	38,489	60,13
2035	57,046	66,219	46,189	33,985	42,927	41,046	32,477	36,042	43,253	66,398
2040	67,578	70,839	52,893	37,323	48,030	46,985	34,373	41,687	49,314	73,82
2045	70,956	77,226	57,606	38,509	51,917	50,542	36,509	44,052	53,156	78,04
2050	75,974	83,816	67,502	40,079	52,051	54,852	37,672	48,965	60,002	81,59
	(No. of Vehi		-			· · ·	•			
Scenario	Present	/	4th Bridge			4th Bridge a	and Line-3		Without Bric Americas	lge of
Year	Centenario	Bridge of Americas	Centenario	Bridge of Americas	4th Bridge	Centenario	Bridge of Americas	4th Bridge	Centenario	4th Bridge
2020	24,780	45,810	21,708	22,648	26,060	19,212	19,676	22,862	21,130	42,76
2025	30,551	51,673	25,982	25,938	30,130	22,739	23,856	25,453	25,313	49,23
2023	39,747	54,513	30,351	29,241	34,501	26,717	25,905	29,769	29,705	55,53
2030	45,262	59,198	35,009	30,393	38,898	30,155	23,903	32,318	33,323	61,23
2035			40,180							
	54,046	63,095		33,310	43,484	34,604	30,502	37,416	38,043	68,00
2045	56,358	68,772	43,753	34,254	46,978	37,085	32,342	39,473	40,887	71,75
2050	60,127	74,603	52,126	35,540	46,910	40,187	33,245	43,916	46,569	74,82

Table 3.47 Result of Demand Forecast (Population Low Projection)

Source: Estimation by the JICA Study Team

The future traffic volume by vehicle type on the 4th Bridge in the case of the "4th Bridge and Line-3 Scenario" is summarized in Table 3.48, with the calculation of ESALs. There are three demand forecast results based on the population projection scenarios. As explained in 3.2.2, High Population Projection was used for the planning. It was assumed that ESAL of each vehicle type was: Car=0, Bus=1, Small truck=0.018, 2-Axle truck=0.64, and 3 or more axle truck=2.03. These ESALs are the same as those in ACP' Study except for small truck. The proportion of 2-axle trucks to 3 or more axle trucks was assumed to be 9:1 based on the ACP's Study.

		High	Population	Projection				
			No. of vehicl	es			ESAL	
Year	Car	Bus	Light Truck	2-Axle Truck	3 or more axle truck	Total	Year	Accumlate (million)
2020	26,471	1,050	793	352	39	28,705	451,629	0.45
2025	32,343	1,179	924	409	45	34,900	511,358	2.86
2030	39,700	1,250	1,082	480	53	42,566	555,977	5.53
2035	45,371	1,321	1,224	543	60	48,520	598,375	8.41
2040	51,557	1,379	1,389	616	68	55,009	639,056	11.51
2045	52,729	1,436	1,514	671	75	56,424	674,447	14.79
2050	64,414	1,471	1,651	732	81	68,351	704,486	18.24
	-					Medium	Population	Projection
			No. of vehicl	es			ESAL	
Year	Car	Bus	Light Truck	2-Axle	3 or more	Total	Year	Accumlate
1 eai	Cai	Bus	Light Huck	Truck	axle truck	Total	i eai	(million)
2020	24,443	679	793	352	39	26,305	329,058	0.33
2025	27,771	757	924	409	45	29,907	372,286	2.08
2030	31,771	793	1,082	480	53	34,180	405,120	4.03
2035	37,200	829	1,224	543	60	39,856	435,732	6.13

616

671

732

352

409

480

543

616

671

732

2-Axle

Truck

43,337

47,259

50,486

Total

25,384

28,321

33,130

36,042

41,687

44,052

48,965

68

75

81

39

45

53

60

68

75

81

3 or more

axle truck

469,342

488,232

513,558

Low Population Projection

ESAL

Year

321,987

362,858

393,334

421,589

452,842

476,447

501,772

8.39

10.78

13.29

0.32

2.03

3.92

5.96

8.15

10.47

12.92

Accumlate

(million)

Table 3.48	Results of Demand Forecast - 4th Bridge (No. of Vehicles per day)

Source: Estimation by the JICA Study Team

40,400

44,129

47,129

Car

23,543

26,214

30,757

33,429

38,800

40,957

45,643

864

871

893

657

729

757

786

814

836

857

Bus

1,389

1,514

1,651

No. of vehicles

793

924

1,082

1,224

1,389

1,514

1,651

Light Truck

2040

2045

2050

Year

2020

2025

2030

2035

2040

2045

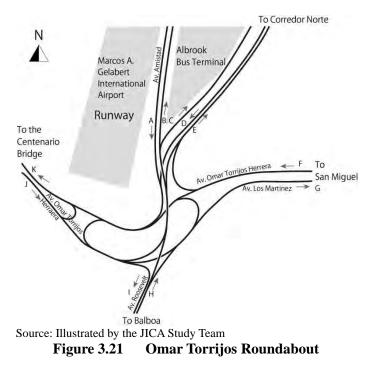
2050

3.7 Traffic Simulation at Omar Torrijos Roundabout

3.7.1 Traffic Flow at the Roundabout

The approach road of the 4th Bridge on the east side is to connect directly to the Corredor North as planned in ACP's Study, whereas, in the JICA Study, the approach would connect to a road network before the Corredor North. It is proposed that the approach road would connect to the road network at the Omar Torrijos Roundabout located to the south of the Albrook Airport.

Omar Torrijos Roundabout is basically a 5-way intersection as shown in Figure 3.21. For the traffic simulation of this roundabout, information on traffic flow between each entering leg and exiting leg is necessary. Since there was no such data available, the JICA Study Team conducted a traffic survey at this roundabout on December 5, 2013. In the survey, the license plate numbers were recorded at each leg and the entering and exiting pair was identified for each vehicle.



The result of the morning peak is shown in Table 3.49. The maximum traffic volume is observed from J to G, followed by the traffic from F to K. Both are traffic in the east-west direction in the above figure.

Table 3.49

Final Report

	:00-	-	able 3	·· · ·	11 a1	iic ut	Omai	· Torrij		7:00-		. (1	1.00				
Sedar									Seda								
				Destinatio	n								Destinatio	n			
		К	I	G	E	В	С	Total			K	I	G	E	В	С	Total
	J		102	287	23	135	114	661		J	0	702	1017	75	265	144	2203
≘⊢	Н	456		406	42	46	149	1099	.E	Н	552	0	301	45	218	182	1298
Origin	F	765	439	054		143	70	1417	Origin	F	852	276	5	0	148	95	1376
	D	301 390	188	351 160	Г	28	22	890 839		D	466 462	233	315 257	0 12	35	27 32	1076
	A Total	390 1912	276 1005	160 1204	5 70	352	8 <i>363</i>	839 4906		A Total	462 2332	322 1533	257 1895	12	0 666	32 480	1085 7038
	Total	1912	1005	1204	70	352	303	4900		Total	2332	1533	1893	132	000	480	7038
Small	bus								Sma	ll bus							
				Destinatio	n								Destinatio	n			
	ľ	К	I	G	E	В	С	Total			K	I	G	E	В	С	Tota
	J		10	33	2	4	0	49		J	0	12	13	0	2	0	27
_	Н	22		20	0	11	8	61	.=	Η	20	0	19	4	14	10	67
Origin	F	62	21			1	2	86	Origin	F	45	26	0	0	0	1	72
Ĭ	D	27	17	29		0	8	81	Ŭ	D	16	25	8	0	3	6	58
	A	6	1	4	0	1/	0	11		A	9	3	5	0	0	0	17
	Total	117	49	86	2	16	18	288		Total	90	66	45	4	19	17	241
arge	hus								Laro	e bus							
urge	bus			Destinatio	n				Larg	0 003			Destinatio	n			
		К	I	G	E	В	С	Total			К	I	G	E	В	С	Total
	J		2	1	0	1	8	12		J	0	8	5	0	7	12	32
_	Н	0		6	1	0	17	24	_	Н	2	0	3	2	3	15	25
Origin	F	11	9			76	87	183	Origin	F	13	12	0	0	52	43	120
Ľ	D	39	61	92		3	84	279		D	13	49	88	0	16	53	219
	A	3	2	2	6		2	15		A	1	3	5	3	0	10	22
	Total	53	74	101	7	80	198	513		Total	29	72	101	5	78	133	418
Small	truck								Sma	ll truck							
man	adon			Destinatio	n					in the deriv			Destinatio	n			
	ľ	К	I	G	E	В	С	Total			K	I	G	E	В	С	Total
	J		0	12	0	3	0	15		J	0	15	31	0	2	3	51
<u>_</u>	Н	2		4	0	2	0	8	.=	Н	10	0	12	0	2	0	24
Origin	F	16	9			8	2	35	Origin	F	27	17	0	0	5	1	50
Ĭ	D	4	1	3		0	0	8	Ŭ	D	7	4	7	0	1	0	19
	A	2 24	0 10	4 23	0	13	0	6		A	6	0 36	3 53	0 0	0 10	0	9 153
	Total	24	10	23	0	13	2	72		Total	50	30	53	U	10	4	153
arae	truck								Lara	e truck							
J				Destinatio	n								Destinatio	n			
		Κ		G	E	В	С	Total			Κ		G	E	В	С	Total
Τ	J		4	0	0	0	0	4		J	0	6	2	3	0	0	11
≡⊢	H	0		1	0	3	0	4	.=	H	5	0	4	5	10	0	24
Origin	F	4	11			2	0	17	Origin	F	7	9	0	0	2	0	18
	D	2	5	1		0	0	8	-	D	3	3	1	0	0	0	7
	A Total	0 6	0 20	0 2	0 0	5	0 0	0 33		A Total	0 15	3 21	0 7	0 <i>8</i>	0 12	0 0	3 63
	TULAI	0	20	2	U	5	U	33		TULAI	15	21	/	0	12	U	03
otal									Tota	I							
				Destinatio	n								Destinatio	n			
		K	I	G	E	В	С	Total			K	I	G	E	В	С	Total
	J	0	118	333	25	143	122	741	Ţ	J	0	743	1068	78	276	159	2324
≘L	Н	480	0	437	43	62	174	1196	. <u> </u>	H	589	0	339	56	247	207	1438
	F	858	489	0	0	230	161	1738	Origin	F	944	340	5	0	207	140	1636
Ĕ.	D	373	272	476	0	31	114	1266		D	505	314	419	0	55	86	1379
	٨	401	279	170 1416	11 79	0 466	10 581	871 5812	\vdash	A	478 2516	331 1728	270	15 140	0 785	42 634	1136
Origin	A Total	2112	1158					J012		Total	2010	<i>1/2</i> ŏ	2101	149	100	1 014	7913

Traffic at Omar Torrijos Roundabout (AM 7:00- AM 8:00) AM 7:00-

AM	8:00
Sed	an

Destination Κ I G Ε В С Total J Η Origin F D А Total

	Destination									
		К		G	E	В	С	Total		
	J		479	590	72	331	43	1515		
c	Н	329		376	101	443	247	1496		
Origin	F	652	115	188		114	139	1208		
0	D	285	98	263		90	78	814		
	Α	298	456	308	21		10	1093		
	Total	1564	1148	1725	194	978	517	6126		

Small bus

			[Destinatio	n				
	K I G E B C								
	J		21	22	3	2	3	51	
_	Н	38		16	12	19	41	126	
Origin	F	29	26			0	1	56	
0	D	12	24	5		1	8	50	
	Α	8	19	12	3		5	47	
	Total	87	90	55	18	22	58	330	

Sma	all bus										
	Destination										
		K	I	G	E	В	С	Total			
	J		26	23	3	11	0	63			
_	Н	18		34	5	21	11	89			
Origin	F	11	31			0	0	42			
0	D	9	34	7		5	6	61			
	Α	20	8	16	1		1	46			
	Total	58	99	80	9	37	18	301			

Destination

G

Е

В

С

21

Total

Large bus

				Destinatio	n			
		K	I	G	E	В	С	Total
	J		4	2	0	4	5	15
L	Н	2		3	1	3	18	27
Origin	F	7	8			31	93	139
0	D	6	46	81		46	86	265
	Α	2	3	9	2		25	41
Total 17 61 95 3 84					84	227	487	

Sma	Small truck											
	Destination											
	K I G E B C											
	J		22	51	2	11	5	91				
c	Н	9		11	3	2	0	25				
Origin	F	37	16			7	1	61				
0	D	10	5	10		1	0	26				
	Α	13	0	6	1		0	20				
	Total	69	43	78	6	21	6	223				

		K I G E B C								
	J		20	81	2	11	4	118		
L	Н	17		22	4	4	0	47		
Origin	F	43	24			19	4	90		
0	D	7	4	10		2	0	23		
	Α	16	3	14	0		0	33		
	Total	83	51	127	6	36	8	311		

	Destination							
		K		G	E	В	С	Total
	J		2	1	1	0	0	4
_	Н	2		13	12	6	0	33
Origin	F	4	11			2	0	17
0	D	1	3	2		0	0	6
	Α	0	6	2	1		0	9
	Total	7	22	18	14	8	0	69

				Destinatio	n						
		K I G E B C									
	J		12	2	0	0	1	15			
_	Н	6		19	8	17	0	50			
Origin	F	0	15			0	0	15			
0	D	0	4	0		0	0	4			
	Α	1	9	0	4		0	14			
	Total	7	40	21	12	17	1	98			

Tota	Total												
	Destination												
		K I G E B C											
	J	0	644	768	125	155	293	1985					
_	Н	574	0	224	71	453	305	1627					
Origin	F	853	225	0	0	144	129	1351					
0	D	434	306	399	0	73	142	1354					
	Α	488	463	360	22	0	105	1438					
	Total	2349	1638	1751	218	825	974	7755					

Tota	Total											
	Destination											
	K I G E B C											
	J 0 538 696 77 353 56											
_	Н	371	0	452	121	486	279	1709				
Origin	F	713	194	188	0	196	223	1514				
	D	306	178	389	0	138	202	1213				
	Α	337	480	346	29	0	39	1231				
Total 1727 1390 2071 227 1173 799												

А Total

Origin

Large bus

J

Н

F

D

Κ

Т

AM 9:00-

Sedan

-3-48-

Final Report

AM Seda	10:00- an								AM Sed	11:00- an							
				Destinatio	n								Destination	1			
		K	I	G	E	В	С	Total			K	I	G	E	В	С	Total
	J	15	397	615	69	428	172	1696		J		302	780	95	427	206	1810
.⊆	Н	400		333	106	599	103	1541	. <u> </u>	Н	409		342	119	753	134	1757
Origin	F	650	108	21		208	107	1094	Origin	F	651	108	22		174	130	1085
0	D	188	201	221		41	15	666		D	208	385	178		35	10	816
	A	321	303	278	32	19	31	984		A	374	317	474	57	1000	9	1231
	Total	1574	1009	1468	207	1295	428	5981		Total	1642	1112	1796	271	1389	489	6699
Sma	II bus								Sma	III bus							
			1	Destinatio			-						Destination				
		K		G	E	B	С	Total			K		G	E	В	С	Total
	J		16	16	2	5	1	40		J		26	34	2	4	3	69
Ë	H	26	11	25	9	23	12	<i>95</i>	Ë	H	20	47	25	3	28	19	<i>95</i>
Origin	F	13	11	11		4	2	30	Origin	F	26	17	0		0	2	45
-	D	9	34	16	1	5	8	72		D	12	15	9	1	3	5	44
	A Total	1 49	22 <i>83</i>	8 65	1 12	37	0 23	32 269		A Total	12 70	3 61	8 76	1 6	35	3 <i>32</i>	27 280
	TOLAI	49	83	00	12	37	23	209		TOTAL	70	01	/0	0	35	32	280
Larg	je bus								Larg	le bus							
				Destinatio			-						Destination			-	
		K		G	E	В	С	Total			K		G	E	B	С	Total
	J		2	11	0	0	5	18		J		5	5	0	6	9	25
. <u> </u>	H	1		9	0	8	6	24	. <u> </u>	H	1		4	1	3	12	21
Origin	F	8	6			15	38	67	Origin	F	5	7			42	40	94
-	D	10	40	89		99	76	314		D	7	44	117		40	64	272
	A	3	5	16	3	122	10	37		A	2	6	9	2	01	17	36
	Total	22	53	125	3	122	135	460		Total	15	62	135	3	91	142	448
Sma	Small truck							Sma	III truck								
				Destinatio	n								Destination	1			
		K	I	G	E	В	С	Total			K	I	G	E	В	С	Total
	J		8	44	3	16	3	74		J		39	98	4	24	3	168
. 드	Н	17		30	6	15	0	68	.⊆	Н	27		29	3	5	0	64
Origin	F	40	20			29	2	91	Origin	F	73	27			24	1	125
Ŭ	D	1	5	14		2	0	22	Ŭ	D	21	9	19		2	0	51
	A	12	29	22	3		0	66		A	48	5	24	2		0	79
	Total	70	62	110	12	62	5	321		Total	169	80	170	9	55	4	487
Larg	e truck								Larg	e truck							
				Destinatio			-						Destination		-		
		K	I	G	E	В	С	Total			K	I	G	E	В	С	Total
	J		6	2	0	0	0	8		J		9	5	4	0	0	18
. 	Н	4		14	12	12	0	42	.⊆	Н	4		12	5	14	1	36
Origin	F	2	34			2	0	38	Origin	F	5	11			1	0	17
0	D	5	6	7		5	0	23		D	2	15	6		2	0	25
	Α	0	10	0	2		0	12		Α	0	3	1	1		0	5
	Total	11	56	23	14	19	0	123		Total	11	38	24	10	17	1	101
Tota	il								Tota	d							
				Destinatio	n								Destination	1			
		K		G	E	В	С	Total			K	I	G	E	В	С	Total
	J	15	429	688	74	449	181	1836		J	0	381	922	105	461	221	2090
Ē	Η	448	0	411	133	657	121	1770		Η	461	0	412	131	803	166	1973
Origin	F	713	179	21	0	258	149	1320	Origin	F	760	170	22	0	241	173	1366
0	D	213	286	347	0	152	99	1097		D	250	468	329	0	82	79	1208
	A		369				41	1131		Α	436		516	63	0		1378
L	Total	1726	1263	1791	248	1535	591	7154		Total	1907	1353	2201	299	1587	668	8015
	A Total	337 1726	369 1263	324 1791	41 248	19 <i>1535</i>	41 <i>591</i>	1131 7154			436 1907	334 1353	516 <i>2201</i>	63 299	0 1587	29 668	

PM 2:00-Sedan

Scuali												
		Destination										
	K I G E B C											
	J		306	723	163	343	186	1721				
ч	Н	286		470	121	674	110	1661				
Origin	F	571	325	83		253	245	1477				
0	D	340	267	195		8	13	823				
	Α	201	455	402	25		76	1159				
	Total	1398	1353	1873	309	1278	630	6841				

_	Sed	an									
I		Destination									
			K	I	G	E	В	С	Total		
I		J	0	403	726	408	525	260	2322		
	_	Н	297	0	480	284	953	154	2168		
	Origin	F	665	226	47	0	249	343	1530		
	0	D	368	289	210	0	8	18	893		
		Α	206	404	450	37	0	105	1202		
I		Total	1536	1322	1913	729	1735	880	8115		

PM 3:00-

Small bus

	Destination							
		K	I	G	E	В	С	Total
	J		25	33	4	7	4	73
_	Н	10		18	5	26	20	79
Origin	F	35	24			5	5	69
0	D	16	33	25		8	14	96
	Α	15	2	17	2		2	38
	Total	76	84	<i>93</i>	11	46	45	355

Small bus											
	Destination										
	K I G E B C										
	J	0	14	35	10	25	15	99			
_	Н	11	0	22	7	23	18	81			
Origin	F	43	31	0	0	0	3	77			
0	D	29	30	15	0	9	20	103			
	Α	21	5	9	0	0	0	35			
	Total	104	80	81	17	57	56	395			

Large bus

	Destination								
		К	I	G	E	В	С	Total	
	J		3	2	4	3	4	16	
_	Н	2		4	5	4	23	38	
Origin	F	11	12	3		59	62	147	
0	D	8	49	133		28	75	293	
	Α	1	4	8	8		10	31	
	Total	22	68	150	17	94	174	525	

Small Truck

	Destination							
	K I G E B C					Total		
	J		9	72	8	18	6	113
_	Н	11		32	7	34	3	87
Origin	F	47	20			12	7	86
0	D	28	10	0		0	0	38
	Α	4	12	15	5		2	38
	Total 90 51 119 20 64 18						362	

Larg	Large Truck											
			Destination									
		K	K I G E B C									
	J		8	8	2	2	0	20				
_	Н	10		12	9	7	0	38				
Origin	F	9	17			5	0	31				
0	D	2	12	1		0	0	15				
	А	3	5	1	2		0	11				
	Total	24	42	22	13	14	0	115				

Total

	Destination									
		K	I	G	E	В	С	Total		
	J	0	351	838	181	373	200	1943		
Ē	Н	319	0	536	147	745	156	1903		
Origin	F	673	398	86	0	334	319	1810		
0	D	394	371	354	0	44	102	1265		
	Α	224	478	443	42	0	90	1277		
	Total 1610 1598 2257 370 1496 867									

Large bus Destination Κ G В С Total Ε J Н Origin F D А Total

Sma	Small Truck										
			[Destinatio	n						
	K I G E B C										
	J		24	38	10	26	6	104			
	Н	14		17	8	41	5	85			
Origin	F	32	21			14	6	73			
0	D	14	17	3		0	0	34			
	Α	10	11	4	3		3	31			
	Total	70	73	62	21	81	20	327			

Large Truck										
	Destination									
	K I G E B C									
	J 2 3 2 1 0									
_	Н	1		9	10	8	0	28		
Origin	F	12	15			5	0	32		
0	D	2	8	1		1	0	12		
	Α	3	4	1	3		0	11		
Total 18 29 14 15 15 0										

Total

	Destination									
		K		G	E	В	С	Total		
	J	0	446	805	430	578	287	2546		
L	Н	325	0	533	316	1028	197	2399		
Origin	F	760	305	47	0	304	406	1822		
0	D	429	406	398	0	43	136	1412		
	Α	241	427	470	43	0	120	1301		
	Total	1755	1584	2253	789	1953	1146	9480		

PM 4:00-Sedan

Destination										
	K I G E B C									
	J	15	331	442	503	520	213	2024		
_	Н	280		245	350	1079	127	2081		
Origin	F	502	184	56		308	284	1334		
	D	298	309	158		19	15	799		
	Α	429	449	214	45		87	1224		
Total 1524 1273 1115 898 1926 726										

				[Destinatio	l			
L			K	I	G	E	В	С	Total
1		J		273	422	299	444	240	1678
1	L	Н	316		269	208	1007	143	1943
1	Origin	F	610	241	51		366	318	1586
	0	D	210	216	222		6	16	670
1		Α	260	342	174	27		98	901
?		Total	1396	1072	1138	534	1823	815	6778

Small bus

	Destination								
		K		G	E	В	С	Total	
	J		23	21	3	8	7	62	
_	Н	9		12	4	19	24	68	
Origin	F	30	16		0	7	11	64	
0	D	28	34	14		13	30	119	
	Α	15	4	10	2		4	35	
	Total 82 77 57 9 47 76					348			

Small bus										
	Destination									
	K I G E B C									
	J 15 9 2 6 4									
_	Н	7		10	8	24	27	76		
Origin	F	15	13			4	6	38		
0	D	9	29	11		7	19	75		
	Α	6	10	8	1		4	29		
	Total	37	67	38	11	41	60	254		

Destination

G

2

8

116

6

132

E

1

5

4

10

В

2

4

29

17

52

С

4 39 70

83

12

208

Total

11

57

114

284

27

493

Large bus

				Destinatio	n			
		K		G	E	В	С	Total
	J		7	5	3	4	12	31
_	Н	3		7	5	5	42	62
Origin	F	7	11		0	32	60	110
0	D	9	74	133		24	98	338
	Α	2	6	11	6		20	45
	Total 21 98 156 14 65 232					586		

Small Truck											
Destination											
		K I G E B C									
	J		21	23	8	23	4	79			
_	Н	11		9	6	34	3	63			
Origin	F	24	21		0	12	5	62			
0	D	4	6	0		0	0	10			
	Α	15	19	3	5		2	44			
	Total	54	67	35	19	69	14	258			

Sma	all Truck							
				Destinatio	n			
		K	I	G	E	В	С	Total
	J		7	9	4	9	1	30
_	Н	5		4	2	16	3	30
Origin	F	20	17			10	4	51
0	D	4	5	2		0	0	11
	Α	8	7	5	3		2	25
	Total	37	36	20	9	35	10	147

Total

			Destination								
		K		G	E	В	С	Total			
	J		2	6	2	1	0	11			
_	Н	2		18	17	20	0	57			
Origin	F	7	5		0	4	1	17			
0	D	2	10	1		0	0	13			
	Α	1	1	1	1		0	4			
	Total	12	18	26	20	25	1	102			

Larg	je Truck											
			Destination									
		Κ		G	E	В	С	Total				
	J		0	0	0	0	0	0				
_	Н	2		23	14	8	0	47				
Origin	F	3	2			0	0	5				
0	D	1	8	0		0	0	9				
	Α	3	3	4	3		0	13				
	Total	9	13	27	17	8	0	74				

1015	11							
				Destinatio	1			
		K		G	E	В	С	Total
	J	15	384	497	519	556	236	2207
ч	Н	305	0	291	382	1157	196	2331
Origin	F	570	237	56	0	363	361	1587
0	D	341	433	306	0	56	143	1279
	Α	462	479	239	59	0	113	1352
	Total	1693	1533	1389	960	2132	1049	8756

Tota	ıl											
	Destination											
		K	I	G	E	В	С	Total				
	J	0	297	442	306	461	249	1755				
_	Н	331	0	314	237	1059	212	2153				
Origin	F	651	285	51	0	409	398	1794				
0	D	229	321	351	0	30	118	1049				
	Α	278	366	197	38	0	116	995				
	Total	1489	1269	1355	581	1959	1093	7746				

Source: JICA Study Team

Large bus

J

Н

D

А

Total

К

3

5

1

10

2

12

63

4

81

PM 5:00-

Sedan

Small	Τrι

Origin F

Total

3.7.2 Adjustment of the Demand Forecast Model

(1) Comparison of Actual Traffic Flow and the Result of Traffic Assignment

For the traffic demand forecast In the Study, the OD matrix in the SMP's study in 2009 is used, although there is a large difference between the result of the traffic assignment using the OD matrix and the result of the traffic survey mentioned above as shown in Table 3.50. It can be pointed out that one of the reasons of this is that the demand forecast model cannot reproduce internal trips (for example, there two major trip generation and attraction points such as bus terminal and mall in Albrook Area, although they belong to the same zone in the demand forecast model). It can be also identified as one of the reason that the peak hour traffic assignment cannot consider the remaining traffic in the road network in the previous hours. In addition, the OD matrix is not detail enough to reproduce the traffic flow at an intersection.

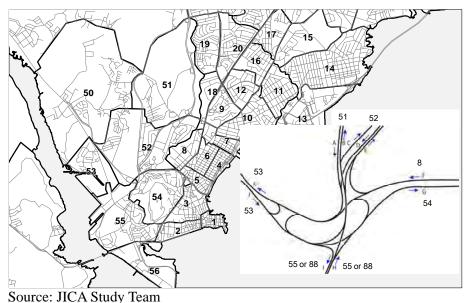
Table 3.50Comparison of Actual Traffic and Traffic Assignment at Omar Torrijos
Roundabout

Tota	Total Traffic in Traffic Survey (7:00-8:00) Unit							Jnit: PCU	U Output of Traffic Assignment with OD before calibration					τ	Jnit: PCU			
		Destination											Destinatio	n				
		K	I	G	E	В	С	Total				К	I	G	E	В	С	Total
	J	0	729	1052	81	267	147	2276			J	0	2	139	0	1	5	147
c	Н	572	0	321	55	240	182	1370		_	Н	4	0	90	8	4	40	146
Origin	F	893	311	5	0	157	96	1462		rigi	F	183	104	0	22	0	34	343
0	D	479	243	324	0	36	27	1109		0	D	36	78	17	0	0	0	131
	Α	468	328	260	12	0	32	1100			Α	0	40	0	0	0	0	40
	Total	2412	1611	1962	148	700	484	7317			Total	223	224	246	30	5	79	807

Source: JICA Study Team

(2) Adjustment of the OD Matrix

The traffic flow by the traffic assignment using the SMP's OD matrix in 2009 is smaller than that of the actual traffic at Omar Torrios Roundabout. Pairs of origin and destination were assigned to the pairs of entering and exiting, and traffic flow was added to the OD matrix so that the traffic flow of each entering and exiting pair can agree the actual traffic. Zoning system around Omar Torrijos Roundabout is shown in Figure 3.22 with a figure in the bottom-right indicating zone numbers that correspond to the pair of entering and exiting legs.

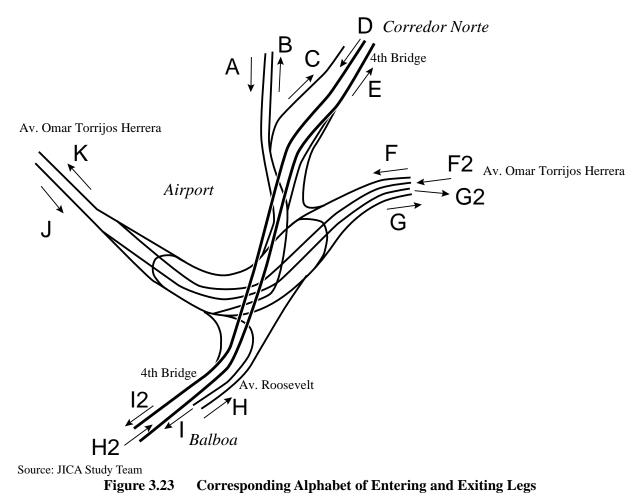




In the traffic forecast by direction, impact of the improvement of Omar Torrijos Roundabout on the traffic flow in the area could not be ignored. Therefore, it was concluded that the future traffic by direction should not be estimated irrespective of the formation of the intersection. In the Study, the network model was developed for each improvement plan and the future traffic by direction was estimated by the traffic assignment. Therefore, the result of the demand forecast is different by improvement plan. In the traffic assignment, incremental traffic assignment was employed instead of equilibrium assignment in order to sum up the traffic volume for each entering and exiting pair.

3.7.3 Future Traffic

The result of the future traffic of Omar Torrijos Roundabout is shown in Table 3.51. Figure 3.23 shows the location of alphabets used in the table for entering and exiting legs.



2020	K	I	G	Е	В	С	G2	I2	Total
J	0	820	0	87	302	185	1,270	0	2,664
H	638	0	601	216	276	47	0	0	1,778
F	164	431	208	497	273	118	0	10	1,701
D	565	324	314	0	73	112	0	203	1,591
A	516	366	268	18	0	55	0	205	1,249
F2	887	0	208	0	0	0	0	346	1,245
H2	47	0	140	84	0	82	1,134	0	1,235
								-	
Total	2,817	1,941	1,531	902	924	599	2,404	585	11,703
2025	V	т	C	Б	р	C	C 2	10	T-+-1
T	K	I	G	E	B 210	C 101	G2	I2	Total
J	0	841	0	90	310	191	1,334	3	2,769
Н	656	0	628	224	283	48	0	0	1,839
F	168	438	216	521	278	120	0	12	1,753
D	585	345	325	0	74	112	0	218	1,659
А	530	384	275	19	0	56	0	32	1,296
F2	909	0	0	0	0	0	0	363	1,272
H2	60	0	230	115	0	103	1,343	0	1,851
Total	2,908	2,008	1,674	969	945	630	2,677	628	12,439
2030									
	K	Ι	G	E	В	С	G2	I2	Total
J	0	866	1	92	318	196	1,390	4	2,867
H	675	0	670	232	290	50	0	0	1,917
F	257	421	224	539	283	121	0	14	1,859
D	593	355	298	0	76	112	0	240	1,674
A	544	398	252	19	0	57	0	34	1,304
F2	845	0	0	0	0	0	0	382	1,304
H2	69	0	570	261	0	110	1,341	0	2,351
Total	2,983	2,040	2,015	1,143	967	646	2,731	674	13,199
2035	2,965	2,040	2,015	1,145	907	040	2,731	0/4	15,195
2035	TZ I	T	0	Г	р	C	<u> </u>	10	TT (1
×	K	I	G	E	B	C	G2	I2	Total
J	0	896	0	95	331	204	1,480	4	3,010
Н	698	0	701	241	300	52	0	0	1,992
F									
	268	422	233	565	289	123	0	15	
D	612	367	311	0	77	112	0	258	<u>1,915</u> 1,737
D A	612 563		311 261					258 45	1,737 1,359
D A F2	612 563 877	367 412 0	311 261 0	0 20 0	77	112 58 0	0 0 0	258	1,737 1,359 1,251
D A	612 563 877 71	367 412 0 0	311 261 0 595	0 20 0 432	77 0	112 58	0 0	258 45	1,737 1,359 1,251
D A F2 H2 Total	612 563 877	367 412 0	311 261 0	0 20 0	77 0 0	112 58 0	0 0 0	258 45 374	1,737 1,359 1,251 2,753
D A F2 H2	612 563 877 71	367 412 0 0	311 261 0 595	0 20 0 432	77 0 0 0 997	112 58 0 117	0 0 1,538 3,018	258 45 374 0	1,737 1,359 1,251 2,753
D A F2 H2 Total	612 563 877 71	367 412 0 0	311 261 0 595	0 20 0 432	77 0 0 0	112 58 0 117	0 0 0 1,538	258 45 374 0	1,737 1,359 1,251 2,753
D A F2 H2 Total	612 563 877 71 3,089	367 412 0 2,097	311 261 0 595 2,101	0 20 0 432 1,353	77 0 0 0 997	112 58 0 117 666	0 0 1,538 3,018	258 45 374 0 696	1,737 1,359 1,251 2,753 14,017 Total
D A F2 H2 Total 2040	612 563 877 71 3,089 K 0	367 412 0 2,097 I	311 261 0 595 2,101 G	0 20 0 432 1,353 E 99	77 0 0 0 997 B	112 58 0 117 666 C	0 0 1,538 3,018 G2	258 45 374 0 696 I2	1,737 1,359 1,251 2,753 14,017 Total 3,147
D A F2 H2 Total 2040 J H	612 563 877 71 3,089 K 0 726	367 412 0 2,097 I 929 0	311 261 0 595 2,101 G 1 716	0 20 0 432 1,353 E	77 0 0 997 B 343 310	112 58 0 117 666 C 211 54	0 0 1,538 3,018 G2 1,559	258 45 374 0 696 12 5 0	1,737 1,359 1,251 2,753 14,017 Total 3,147 2,057
D A F2 H2 Total 2040 J H F	612 563 877 71 3,089 K 0 726 188	367 412 0 2,097 I 929 0 439	311 261 0 595 2,101 G 1 716 243	0 20 0 432 1,353 E 99 251 572	77 0 0 997 B 343 310 296	112 58 0 117 666 C 211 54 123	0 0 1,538 3,018 G2 1,559 0 0	258 45 374 0 696 I2 5 0 16	1,737 1,359 1,251 2,753 14,017 Total 3,147 2,057 1,877
D A F2 H2 Total 2040 J H F D	612 563 877 71 3,089 K 0 726 188 634	367 412 0 2,097 I 929 0 439 384	311 261 0 595 2,101 G 1 716 243 284	0 20 0 432 1,353 E 99 251	77 0 0 997 B 343 310	112 58 0 117 666 C 211 54	0 0 1,538 3,018 G2 1,559 0	258 45 374 0 696 12 5 0	1,737 1,359 1,251 2,753 14,017 Total 3,147 2,057 1,877 1,763
D A F2 H2 Total 2040 J H F D A	612 563 877 71 3,089 K 0 726 188 634 584	367 412 0 2,097 I 929 0 439 384 432	311 261 0 595 2,101 G 1 716 243	0 20 0 432 1,353 E 99 251 572 0	77 0 0 997 B 343 310 296 79 0	112 58 0 117 666 C 211 54 123 112	0 0 1,538 3,018 G2 1,559 0 0 0 0	258 45 374 0 696 12 5 0 16 270 45	1,737 1,359 1,251 2,753 14,017 Total 3,147 2,057 1,877 1,763 1,379
D A F2 H2 Total 2040 J H F D A F2	612 563 877 71 3,089 K 0 726 188 634 584 992	367 412 0 2,097 I 929 0 439 384 432 0	311 261 0 595 2,101 G 1 716 243 284 238 0	0 20 0 432 1,353 E 99 251 572 0 20 0	77 0 0 997 B 343 310 296 79 0 0	112 58 0 117 666 211 54 123 112 60 0	0 0 1,538 3,018 G2 1,559 0 0 0 0 0 0 0 0	258 45 374 0 696 12 12 5 0 16 270 45 394	1,737 1,359 1,251 2,753 14,017 Total 3,147 2,057 1,877 1,763 1,379 1,386
D A F2 H2 Total 2040 J H F D A F2 H2	612 563 877 71 3,089 K 0 726 188 634 584 584 992 79	367 412 0 2,097 <u>1</u> 929 0 439 384 432 0 0 0	311 261 0 595 2,101 G 1 716 243 284 238 238 0 714	0 20 0 432 1,353 E 99 251 572 0 20 0 826	77 0 0 997 B 343 310 296 79 0 0 0 0 0 0	112 58 0 117 666 211 54 123 112 60 0 123	0 0 1,538 3,018 G2 1,559 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	258 45 374 0 696 12 12 5 0 16 270 45 394 0	1,737 1,359 1,251 2,753 14,017 Total 3,147 2,057 1,876 1,379 1,386 3,137
D A F2 H2 Total 2040 J H F D A F2 H2 Total	612 563 877 71 3,089 K 0 726 188 634 584 992	367 412 0 2,097 I 929 0 439 384 432 0	311 261 0 595 2,101 G 1 716 243 284 238 0	0 20 0 432 1,353 E 99 251 572 0 20 0	77 0 0 997 B 343 310 296 79 0 0	112 58 0 117 666 211 54 123 112 60 0	0 0 1,538 3,018 G2 1,559 0 0 0 0 0 0 0 0	258 45 374 0 696 12 12 5 0 16 270 45 394	1,737 1,359 1,251 2,753 14,017 Total 3,147 2,057 1,876 1,379 1,386 3,137
D A F2 H2 Total 2040 J H F D A F2 H2	612 563 877 71 3,089 K 0 726 188 634 584 584 992 79 3,203	367 412 0 2,097	311 261 0 595 2,101 G 1 716 243 284 238 0 714 2,196	0 20 0 432 1,353 E 99 251 572 0 20 0 826 1,768	77 0 0 997 8 343 310 296 79 0 0 0 0 1,028	112 58 0 117 666 211 54 123 112 60 0 123 683	$\begin{array}{c} 0\\ 0\\ 0\\ 1,538\\ 3,018\\ \hline \\ G2\\ 1,559\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 1,395\\ 2,954\\ \end{array}$	258 45 374 0 696 12 5 0 16 270 45 394 0 730	1,737 1,359 1,251 2,753 14,017 Total 3,147 2,057 1,877 1,765 1,379 1,386 3,137 14,746
D A F2 H2 Total 2040 J H F D A F2 H2 Total 2045	612 563 877 71 3,089 K 0 726 188 634 584 992 79 3,203 K	367 412 0 2,097	311 261 0 595 2,101 G 1 716 243 284 238 0 714 2,196 G	0 20 0 432 1,353 E 99 251 572 0 20 0 826 1,768 E	77 0 0 997 8 343 310 296 79 0 0 0 1,028 B	112 58 0 117 666 211 54 123 112 60 0 123 683 C	$\begin{array}{c} 0\\ 0\\ 0\\ 1,538\\ 3,018\\ \hline \\ G2\\ 1,559\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 1,395\\ 2,954\\ \hline \\ G2\\ \end{array}$	258 45 374 0 696 12 5 0 16 270 45 394 0 730	1,737 1,359 1,251 2,753 14,017 Total 3,147 2,057 1,877 1,765 1,379 1,386 3,137 14,746 Total
D A F2 H2 Z040 J H F D A F2 H2 T0tal Z045 J	612 563 877 71 3,089 K 0 726 188 634 584 992 79 3,203 K 0	367 412 0 2,097	311 261 0 595 2,101 G 1 716 243 284 238 0 714 2,196 G 1	0 20 0 432 1,353 E 99 251 572 0 20 0 826 1,768 E 104	77 0 0 997 B 343 310 296 79 0 0 0 1,028 B 361	112 58 0 117 666 211 54 123 112 60 0 123 683 C 222	$\begin{array}{c} 0\\ 0\\ 0\\ 1,538\\ 3,018\\ \hline \\ G2\\ 1,559\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 1,395\\ 2,954\\ \hline \\ G2\\ 1,954\\ \hline \end{array}$	258 45 374 0 696 12 5 0 16 270 45 394 0 730 730	1,737 1,359 1,251 2,753 14,017 Total 3,147 2,057 1,877 1,763 1,379 1,386 3,137 1,386 3,137 1,764 1,379 1,386 3,137 1,386 3,137 1,386 3,137 1,255
D A F2 H2 Z040 J H F D A F2 H2 Total 2045 J H	612 563 877 71 3,089 K 0 726 188 634 584 992 79 3,203 K K 0 761	367 412 0 2,097	311 261 0 595 2,101 G 1 716 243 284 238 0 714 2,196 G G 1 763	0 20 0 432 1,353 E 99 251 572 0 20 0 20 0 826 1,768 E E 104 269	77 0 0 997 B 343 310 296 79 0 0 0 1,028 B 361 326	112 58 0 117 666 211 54 123 112 60 0 123 683 C 222 54	$\begin{array}{c} 0\\ 0\\ 0\\ 0\\ 1,538\\ 3,018\\ \hline \\ G2\\ 1,559\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 1,395\\ 2,954\\ \hline \\ G2\\ 1,954\\ 0\\ \end{array}$	$ \begin{array}{r} 258 \\ 45 \\ 374 \\ 0 \\ 696 \\ \hline 12 \\ 5 \\ 0 \\ 16 \\ 270 \\ 45 \\ 394 \\ 0 \\ 730 \\ \hline 12 \\ 6 \\ 0 \\ \hline 0 \\ \hline 0 \\ \hline 0 \\ \hline$	1,737 1,359 1,251 2,753 14,017 70tal 3,147 1,763 1,379 1,386 3,137 14,740 Total 3,622 2,173
D A F2 H2 Z040 J H F D A F2 H2 Total 2045 J H F	612 563 877 71 3,089 K 0 726 188 634 584 992 79 3,203 K 0 761 200	367 412 0 2,097 I 929 0 439 384 432 0 0 2,184 I 976 0 455	311 261 0 595 2,101 G 1 716 243 284 238 0 714 2,196 G G 1 763 261	0 20 0 432 1,353 E 99 251 572 0 20 0 826 1,768 E 104 269 609	77 0 0 997 B 343 310 296 79 0 0 0 1,028 B 361 326 306	112 58 0 117 666 211 54 123 112 60 0 123 683 683 C 222 54 124	$\begin{array}{c} 0\\ 0\\ 0\\ 0\\ 1,538\\ 3,018\\ \hline \\ G2\\ 1,559\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 1,395\\ 2,954\\ \hline \\ G2\\ 1,954\\ 0\\ 0\\ 0\\ 0\\ \end{array}$	$\begin{array}{c} 258 \\ 45 \\ 374 \\ 0 \\ 696 \\ \hline \\ 12 \\ 5 \\ 0 \\ 16 \\ 270 \\ 45 \\ 394 \\ 0 \\ 730 \\ \hline \\ 12 \\ 6 \\ 0 \\ 17 \\ \end{array}$	1,737 1,359 1,251 2,753 14,017 Total 3,147 2,057 1,877 1,763 1,379 1,388 3,137 14,740 Total 3,624 2,173 1,972
D A F2 H2 Z040 J H F D A F2 H2 Total 2045 J H F D D	612 563 877 71 3,089 K 0 726 188 634 584 992 79 3,203 K 0 761 200 659	367 412 0 2,097 I 929 0 439 384 432 0 0 2,184 I 976 0 455 403	311 261 0 595 2,101 G 1 716 243 284 238 0 714 2,196 G G 1 763 261 314	0 20 0 432 1,353 E 99 251 572 0 20 0 826 1,768 E 104 269 609 0	77 0 0 997 B 343 310 296 79 0 0 0 0 1,028 B 361 326 306 81	112 58 0 117 666 211 54 123 112 60 0 123 683 C 222 54 124 112	$\begin{array}{c} 0\\ 0\\ 0\\ 0\\ 1,538\\ 3,018\\ \hline \\ G2\\ 1,559\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 1,395\\ 2,954\\ \hline \\ G2\\ 1,954\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\$	$\begin{array}{c} 258 \\ 45 \\ 374 \\ 0 \\ 696 \\ \hline \\ 12 \\ 5 \\ 0 \\ 16 \\ 270 \\ 45 \\ 394 \\ 0 \\ 730 \\ \hline \\ 12 \\ \hline \\ 6 \\ 0 \\ 17 \\ 284 \\ \end{array}$	1,737 1,355 1,251 2,755 14,017 Total 3,147 2,055 1,877 1,765 1,376 1,376 1,376 1,376 1,376 1,376 1,376 1,376 1,376 1,376 1,376 1,376 1,376 1,376 1,376 1,275
D A F2 H2 Z040 J H F D A F2 H2 Total 2045 J H Cotal 2045 J H Cotal 2045	612 563 877 71 3,089 K 0 726 188 634 584 992 79 3,203 K 0 761 200 659 614	367 412 0 2,097	311 261 0 595 2,101 G 1 716 243 284 238 0 714 2,196 G G 1 763 261 314 284	0 20 0 432 1,353 E 99 251 572 0 20 0 826 1,768 E 104 269 609 0 21	77 0 0 997 B 343 310 296 79 0 0 0 0 1,028 B 361 326 326 81 0	112 58 0 117 666 211 54 123 112 60 0 123 683 C 222 54 54 124 112 62	$\begin{array}{c} 0 \\ 0 \\ 0 \\ 0 \\ 1,538 \\ 3,018 \\ \hline \\ 62 \\ 1,559 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ $	$\begin{array}{c} 258 \\ 45 \\ 374 \\ 0 \\ 696 \\ \hline \\ \hline \\ 12 \\ 5 \\ 0 \\ 16 \\ 270 \\ 45 \\ 394 \\ 0 \\ 730 \\ \hline \\ 12 \\ 6 \\ 6 \\ 0 \\ 17 \\ 284 \\ 53 \\ \end{array}$	1,737 1,355 1,251 2,755 1,257 2,755 1,275 1,275 1,275 1,275 1,377 1,765 1,377 1,765 1,378 1,378 1,378 1,378 1,378 1,4740 Total 3,622 2,177 1,855 1,497
D A F2 H2 Z040 J H F D A F2 H2 Total 2045 J H H F D D A F2	612 563 877 71 3,089 K 0 726 188 634 584 992 79 3,203 K 0 761 200 659 614 1,033	367 412 0 2,097	311 261 0 595 2,101 G 1 716 243 284 284 284 0 714 2,196 G G 1 763 261 314 284 0	0 20 0 432 1,353 E 99 251 572 0 20 0 826 1,768 E 104 269 609 0 21 0	77 0 0 997 B 343 310 296 79 0 0 0 0 0 1,028 B 361 326 306 81 0 0 0	112 58 0 117 666 211 54 123 112 60 0 0 123 683 C 222 54 124 112 62 0	$\begin{array}{c} 0\\ 0\\ 0\\ 0\\ 1,538\\ 3,018\\ \hline \\ G2\\ 1,559\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\$	$\begin{array}{c} 258 \\ 45 \\ 374 \\ 0 \\ 696 \\ \hline \\ \hline \\ 12 \\ 5 \\ 0 \\ 16 \\ 270 \\ 45 \\ 394 \\ 0 \\ 730 \\ \hline \\ 12 \\ 6 \\ 0 \\ 730 \\ \hline \\ 12 \\ 6 \\ 5 \\ 394 \\ 408 \\ \hline \end{array}$	1,737 1,359 1,251 2,753 14,017 70tal 3,147 2,057 1,877 1,763 1,379 1,386 3,137 14,740 Total 3,622 2,173 14,740 Total 3,622 2,173 1,972 1,855 1,497 1,441
D A F2 H2 2040 J H F D A A F2 H2 Total 2045 J H F C D A F2 H2 H2	612 563 877 71 3,089 K 0 726 188 634 584 992 79 3,203 K 0 761 200 659 614 1,033 72	367 412 0 2,097	311 261 0 595 2,101	0 20 0 432 1,353 E 99 251 572 0 20 0 826 1,768 E 104 269 609 0 21 0 745	77 0 0 997 B 343 310 296 79 0 0 0 1,028 B 361 326 306 81 0 0 0 0 0	112 58 0 117 666 211 54 123 112 60 0 123 683 C 222 54 124 112 62 0 128	$\begin{array}{c} 0\\ 0\\ 0\\ 0\\ 0\\ 1,538\\ 3,018\\ \hline \\ G2\\ 1,559\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\$	$\begin{array}{c} 258 \\ 45 \\ 374 \\ 0 \\ 696 \\ \hline \\ \hline \\ \hline \\ 5 \\ 0 \\ 16 \\ 270 \\ 45 \\ 394 \\ 0 \\ 730 \\ \hline \\ \hline \\ 12 \\ 6 \\ 0 \\ 17 \\ 284 \\ 53 \\ 408 \\ 0 \\ \hline \end{array}$	1,735 1,359 1,255 2,755 14,017 Total 3,147 2,055 1,877 1,765 1,379 1,386 3,137 14,746 Total 3,622 2,175 1,977 1,977 1,855 1,474 441 3,176
D A F2 H2 2040 J H F D A F2 H2 Total 2045 J H F D D A F2 H2 Total Z H2 Total	612 563 877 71 3,089 K 0 726 188 634 584 992 79 3,203 K 0 761 200 659 614 1,033	367 412 0 2,097	311 261 0 595 2,101 G 1 716 243 284 284 284 0 714 2,196 G G 1 763 261 314 284 0	0 20 0 432 1,353 E 99 251 572 0 20 0 826 1,768 E 104 269 609 0 21 0	77 0 0 997 B 343 310 296 79 0 0 0 0 0 1,028 B 361 326 306 81 0 0 0	112 58 0 117 666 211 54 123 112 60 0 0 123 683 C 222 54 124 112 62 0	$\begin{array}{c} 0\\ 0\\ 0\\ 0\\ 1,538\\ 3,018\\ \hline \\ G2\\ 1,559\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\$	$\begin{array}{c} 258 \\ 45 \\ 374 \\ 0 \\ 696 \\ \hline \\ \hline \\ 12 \\ 5 \\ 0 \\ 16 \\ 270 \\ 45 \\ 394 \\ 0 \\ 730 \\ \hline \\ 12 \\ 6 \\ 0 \\ 730 \\ \hline \\ 12 \\ 6 \\ 5 \\ 394 \\ 408 \\ \hline \end{array}$	1,735 1,359 1,255 2,755 14,017 Total 3,147 2,055 1,877 1,765 1,379 1,386 3,137 14,746 Total 3,622 2,175 1,977 1,977 1,855 1,474 441 3,176
D A F2 H2 2040 J H F D A A F2 H2 Total 2045 J H F C D A F2 H2 H2	612 563 877 71 3,089 K 0 726 188 634 584 992 79 3,203 K 0 761 200 659 614 1,033 72 3,339	$\begin{array}{c} 367\\ 412\\ 0\\ 0\\ 2,097\\ \hline \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\$	311 261 0 595 2,101 G 1 716 243 284 238 0 714 2,196 G G 1 763 261 314 284 0 751 2,374	0 20 0 432 1,353 E 99 251 572 0 20 0 20 0 826 1,768 E 104 269 609 0 21 0 745 1,748	77 0 0 997 B 343 310 296 79 0 0 0 1,028 B 361 326 306 81 0 0 0 0 1,074	$\begin{array}{c} 112 \\ 58 \\ 0 \\ 117 \\ 666 \\ \hline \\ \hline \\ 211 \\ 54 \\ 123 \\ 112 \\ 60 \\ 0 \\ 123 \\ 683 \\ \hline \\ \hline \\ \\ \hline \\ \\ \hline \\ \\ \hline \\ \\ \\ \hline \\ \\ \\ \hline \\ \\ \\ \\ \hline \\ \\ \\ \\ \\ \hline \\ \\ \\ \\ \\ \hline \\$	$\begin{array}{c} 0\\ 0\\ 0\\ 0\\ 0\\ 1,538\\ 3,018\\ \hline \\ G2\\ 1,559\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 1,395\\ 2,954\\ \hline \\ G2\\ 1,954\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 1,480\\ 3,434\\ \hline \end{array}$	$\begin{array}{c} 258 \\ 45 \\ 374 \\ 0 \\ 696 \\ \hline \\ 12 \\ 5 \\ 0 \\ 16 \\ 270 \\ 45 \\ 394 \\ 0 \\ 730 \\ \hline \\ 730 \\ \hline \\ 12 \\ 6 \\ 0 \\ 17 \\ 284 \\ 53 \\ 408 \\ 0 \\ 768 \\ \hline \end{array}$	1,737 1,359 1,251 2,753 14,017 Total 3,147 2,057 1,877 1,765 1,379 1,386 3,137 14,746 Total 3,624 2,173 1,977 1,853 1,497 1,497 1,497 1,497 1,5,736
D A F2 H2 Z040 J H F D A F2 H2 Total Z045 J H F D A F2 H2 Total Z045 J H F D A F2 H2 Total Z045 C C C C C C C C C C C C C C C C C C C	612 563 877 71 3,089 K 0 726 188 634 584 992 79 3,203 K 0 761 200 659 614 1,033 72 3,339 K	367 412 0 2,097	311 261 0 595 2,101 G 1 716 243 284 238 0 714 2,196 G G 1 763 261 314 284 2,196 0 751 2,374 G	0 20 0 432 1,353 E 99 251 572 0 20 0 20 0 20 0 826 1,768 E 104 269 609 0 21 0 745 1,748 E	77 0 0 997 B 343 310 296 79 0 0 0 1,028 B 361 326 306 81 0 0 0 1,074 B	112 58 0 117 666 211 54 123 112 60 0 123 683 C 222 54 124 112 62 0 128 702 C	$\begin{array}{c} 0\\ 0\\ 0\\ 0\\ 1,538\\ 3,018\\ \hline \\ G2\\ 1,559\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\$	$\begin{array}{c} 258 \\ 45 \\ 374 \\ 0 \\ 696 \\ \hline \\ 12 \\ 5 \\ 0 \\ 16 \\ 270 \\ 45 \\ 394 \\ 0 \\ 730 \\ \hline \\ 12 \\ 6 \\ 0 \\ 17 \\ 284 \\ 53 \\ 408 \\ 0 \\ 768 \\ \hline \\ 12 \\ \hline \end{array}$	1,735 1,355 1,251 2,755 1,207 1,215 2,755 1,275 1,275 1,377 1,377 1,376 3,137 1,376 3,137 1,376 3,137 1,376 3,137 1,376 3,137 1,376 1,377 1,377 1,376 1,377 1,377 1,377 1,377 1,377 1,377 1,377 1,497 1,441 3,177 1,573 1,575 1,575 1,575 1,575 1,575 1,497 1,575 1,
D A F2 H2 Total 2040 J H F D A F2 H2 Total 2045 J H F D A F2 H2 Total 2045 J H F D C A F2 H2 Total 2040 J J J J J J J J J J J J J J J J J J	612 563 877 71 3,089 K 0 726 188 634 584 992 79 3,203 K 0 761 200 659 614 1,033 72 3,339 K 0 72 3,339	367 412 0 2,097	311 261 0 595 2,101 G 1 716 243 284 0 714 2,196 G 1 763 261 314 284 0 751 2,374 G 7	0 20 0 432 1,353 E 99 251 572 0 20 0 20 0 826 1,768 E 104 269 609 0 21 0 745 1,748 E 109	77 0 0 997 B 343 310 296 79 0 0 0 1,028 B 361 326 306 81 0 0 0 1,074 B 368	112 58 0 117 666 211 54 123 112 60 0 123 683 C 222 54 124 112 62 0 128 702 C C 227	$\begin{array}{c} 0\\ 0\\ 0\\ 0\\ 0\\ 1,538\\ 3,018\\ \hline \\ G2\\ 1,559\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\$	$\begin{array}{c} 258 \\ 45 \\ 374 \\ 0 \\ 696 \\ \hline \end{array}$	1,735 1,355 1,251 2,755 1,207 2,755 1,4017 Total 3,147 2,055 1,877 1,765 1,376 1,776 1,765 1,377 1,765 1,386 3,135 14,740 Total 3,660
D A F2 H2 Z040 J H F D A F2 H2 Total 2045 J H F D A F2 H2 Total Z045 C F D A F2 H2 Total Z050 J H	612 563 877 71 3,089 K 0 726 188 634 584 992 79 3,203 K 0 761 200 659 614 1,033 72 3,339 K 0 784	367 412 0 2,097	311 261 0 595 2,101 G 1 716 243 284 238 0 714 2,196 G 1 763 261 314 284 0 751 2,374 G 7 803	0 20 0 432 1,353 E 99 251 572 0 20 0 826 1,768 E 104 269 609 0 21 0 745 1,748 E 109 284	77 0 0 997 B 343 310 296 79 0 0 0 0 1,028 B 361 326 306 81 0 0 0 1,074 B B 368 333	112 58 0 117 666 C 211 54 123 112 60 0 123 683 C 222 54 124 112 62 0 128 702 C C 227 55	$\begin{array}{c} 0\\ 0\\ 0\\ 0\\ 0\\ 1,538\\ 3,018\\ \hline \\ \\ \hline \\ \\ \\ \hline \\ \\ \\ \\ \hline \\ \\ \\ \\ \\ \\$	$\begin{array}{c} 258 \\ 45 \\ 374 \\ 0 \\ 696 \\ \hline \end{array}$ $\begin{array}{c} 12 \\ 5 \\ 0 \\ 16 \\ 270 \\ 45 \\ 394 \\ 0 \\ 730 \\ \hline \end{array}$ $\begin{array}{c} 6 \\ 0 \\ 17 \\ 284 \\ 53 \\ 408 \\ 0 \\ 768 \\ \hline \end{array}$ $\begin{array}{c} 12 \\ 6 \\ 0 \\ 768 \\ \hline \end{array}$	1,737 1,359 1,251 2,752 14,017 Total 3,147 2,057 1,877 1,762 1,379 1,385 14,740 Total 3,662 2,177 1,977 1,975 1,497 1,441 3,170 1,5730 Total 3,660 2,259
D A F2 H2 Total 2040 J H F D A F2 H2 Total 2045 J H F D A F2 H2 Total 2045 J H F D C A F2 H2 Total 2040 J J J J J J J J J J J J J J J J J J	612 563 877 71 3,089 K 0 726 188 634 584 992 79 3,203 K 0 761 200 659 614 1,033 72 3,339 K 0 72 3,339	367 412 0 2,097	311 261 0 595 2,101 G 1 716 243 284 284 284 0 714 2,196 G 1 763 261 314 284 0 751 2,374 G 7 803 276	0 20 0 432 1,353 E 99 251 572 0 20 0 20 0 826 1,768 E 104 269 609 0 21 0 745 1,748 E 109	77 0 0 997 B 343 310 296 79 0 0 0 1,028 B 361 326 306 81 0 0 0 1,074 B 368	112 58 0 117 666 211 54 123 112 60 0 123 683 C 222 54 124 112 62 0 128 702 C C 227	$\begin{array}{c} 0\\ 0\\ 0\\ 0\\ 0\\ 1,538\\ 3,018\\ \hline \\ G2\\ 1,559\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\$	$\begin{array}{c} 258 \\ 45 \\ 374 \\ 0 \\ 696 \\ \hline \end{array}$	1,73° 1,35° 1,25° 2,75° 14,01° Total 3,14° 2,05° 1,87° 1,76° 1,37° 1,47° 1,37° 1,47° 1,37° 1,47° 1,47° 1,47° 1,57° 1,47° 1,57° 1,49° 1,44° 1,57° 1
D A F2 H2 Z040 J H F D A F2 H2 Total 2045 J H F D A F2 H2 Total Z045 C F D A F2 H2 Total Z050 J H	612 563 877 71 3,089 K 0 726 188 634 584 992 79 3,203 K 0 761 200 659 614 1,033 72 3,339 K 0 784	367 412 0 2,097	311 261 0 595 2,101 G 1 716 243 284 238 0 714 2,196 G 1 763 261 314 284 0 751 2,374 G 7 803	0 20 0 432 1,353 E 99 251 572 0 20 0 826 1,768 E 104 269 609 0 21 0 745 1,748 E 109 284	77 0 0 997 B 343 310 296 79 0 0 0 0 1,028 B 361 326 306 81 0 0 0 1,074 B B 368 333	112 58 0 117 666 C 211 54 123 112 60 0 123 683 C 222 54 124 112 62 0 128 702 C C 227 55	$\begin{array}{c} 0\\ 0\\ 0\\ 0\\ 0\\ 1,538\\ 3,018\\ \hline \\ \\ \hline \\ \\ \\ \hline \\ \\ \\ \\ \hline \\ \\ \\ \\ \\ \\$	$\begin{array}{c} 258 \\ 45 \\ 374 \\ 0 \\ 696 \\ \hline \end{array}$ $\begin{array}{c} 12 \\ 5 \\ 0 \\ 16 \\ 270 \\ 45 \\ 394 \\ 0 \\ 730 \\ \hline \end{array}$ $\begin{array}{c} 6 \\ 0 \\ 17 \\ 284 \\ 53 \\ 408 \\ 0 \\ 768 \\ \hline \end{array}$ $\begin{array}{c} 12 \\ 6 \\ 0 \\ 768 \\ \hline \end{array}$	1,737 1,359 1,251 2,753 14,017 Total 3,147 2,057 1,877 1,763 1,379 1,388 3,137 14,740 Total 3,662 2,177 1,972 1,853 1,497 1,441 3,176 15,736 Total 3,666 2,259 1,977
D A F2 H2 Z040 J H F D A F2 H2 Total 2045 J H F D A F2 H2 Total 2045 J H H2 Total Z050 J H H F	612 563 877 71 3,089 K 0 726 188 634 584 992 79 3,203 K 0 761 200 659 614 1,033 72 3,339 K 0 784 207 674	367 412 0 2,097	311 261 0 595 2,101 G 1 716 243 284 238 0 714 2,196 G 1 763 261 314 284 0 751 2,374 G 7 803 276 305	0 20 0 432 1,353 E 99 251 572 0 20 0 20 0 826 1,768 E 104 269 609 0 21 0 745 1,748 E 109 284 626 0 0	77 0 0 997 343 310 296 79 0 0 0 0 1,028 B 361 326 306 8 1 1,074 B B 368 333 311	112 58 0 117 666 C 211 54 123 112 60 0 123 683 C 222 54 124 112 62 0 128 702 C C 227 55 125	$\begin{array}{c} 0\\ 0\\ 0\\ 0\\ 0\\ 1,538\\ 3,018\\ \hline \\ \\ \hline \\ \\ \\ \\ \\ \hline \\ \\ \\ \\ \\ \\ \\ \\ \\$	$\begin{array}{c} 258 \\ 45 \\ 374 \\ 0 \\ 696 \\ \hline \\ 12 \\ 5 \\ 0 \\ 16 \\ 270 \\ 45 \\ 394 \\ 0 \\ 730 \\ \hline \\ 12 \\ 6 \\ 0 \\ 17 \\ 284 \\ 53 \\ 408 \\ 0 \\ 768 \\ \hline \\ 12 \\ 6 \\ 0 \\ 14 \\ \end{array}$	1,735 1,355 1,255 2,755 1,255 2,755 1,255 1,255 1,255 1,255 1,877 1,765 1,379 1,386 3,137 1,379 1,386 3,137 1,474 Total 3,622 2,175 1,877 1,386 3,137 1,497 1,
D A F2 H2 2040 J H F D A A F2 H2 Total 2045 J H F D A A F2 H2 Total 2050 J H H F F D D A A F2 H2 Total 2050 J	612 563 877 71 3,089 K 0 726 188 634 584 992 79 3,203 K 0 761 200 659 614 1,033 72 3,339 K 0 784 207	367 412 0 2,097	311 261 0 595 2,101 G 1 716 243 284 284 284 0 714 2,196 G 1 763 261 314 284 0 751 2,374 G 7 803 276	0 20 0 432 1,353 E 99 251 572 0 20 0 20 0 826 1,768 E 104 269 609 0 21 0 745 1,748 E 109 284 626 0 21	77 0 0 997 8 343 310 296 79 0 0 0 0 1,028 8 361 326 306 8 1 326 306 8 1 0 0 0 0 1,074 8 8 368 333 311 82	112 58 0 117 666 211 54 123 112 60 0 123 683 C 222 54 124 124 122 62 0 128 702 C C 227 55 125 112	$\begin{array}{c} 0\\ 0\\ 0\\ 0\\ 0\\ 1,538\\ 3,018\\ \hline \\ G2\\ 1,559\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\$	258 45 374 0 696 12 5 0 16 270 45 394 0 730 12 6 0 730 12 6 0 768 12 12 6 0 768	1,737 1,359 1,251 2,753 14,017 70tal 3,147 2,057 1,877 1,763 3,137 1,763 3,137 1,379 1,386 3,137 1,474 4 7 0 14,74614,746 14,746 14,746 14,746 14,746 14,74614,746 14,746 14,74614,746 14,74
D A F2 H2 Z040 J H F D A F2 H2 Total 2045 J H F D A F2 H2 Total 2045 J H F D A F2 H2 Total Z050 J H E F2 H2 Total Z050 C C F2 H2 Total Z040 C F2 F C F C F C F C F C F C F C F C F	612 563 877 71 3,089 K 0 726 188 634 584 992 79 3,203 K 0 761 200 659 614 1,033 72 3,339 K 0 784 207 674 628 1,049	367 412 0 2,097	311 261 0 595 2,101 G 1 716 243 284 238 0 714 2,196 G 1 763 261 314 284 0 751 2,374 G 7 803 276 305 255 0	0 20 0 432 1,353 E 99 251 572 0 20 0 20 0 826 1,768 E 104 269 609 0 21 0 745 1,748 E 109 284 626 0 21 0 0	77 0 0 997 B 343 310 296 79 0 0 0 1,028 B 361 326 306 81 0 0 0 0 1,074 B 368 333 311 1,074 B 368 333 311	112 58 0 117 666 211 54 123 112 60 0 123 683 C 222 54 124 112 62 0 128 702 C 227 55 125 112 63 0	$\begin{array}{c} 0\\ 0\\ 0\\ 0\\ 0\\ 1,538\\ 3,018\\ \hline \\ G2\\ 1,559\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 1,395\\ 2,954\\ \hline \\ G2\\ 1,954\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 1,480\\ 3,434\\ \hline \\ G2\\ 1,933\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\$	$\begin{array}{c} 258 \\ 45 \\ 374 \\ 0 \\ 696 \\ \hline \\ 12 \\ 5 \\ 0 \\ 16 \\ 270 \\ 45 \\ 394 \\ 0 \\ 730 \\ \hline \\ 12 \\ 6 \\ 0 \\ 730 \\ \hline \\ 12 \\ 6 \\ 0 \\ 768 \\ \hline \\ 12 \\ 6 \\ 0 \\ 768 \\ \hline \\ 12 \\ 6 \\ 0 \\ 14 \\ 298 \\ 56 \\ 419 \\ \hline \end{array}$	1,737 1,359 1,251 2,753 14,017 2,057 1,877 1,763 1,379 1,386 3,137 1,763 1,379 1,386 3,137 1,763 1,379 1,387 1,379 1,387 1,379 1,379 1,386 3,137 1,763 1,379 1,379 1,386 3,147 1,379 1,379 1,386 3,147 1,379 1,379 1,386 3,147 1,379 1,379 1,386 3,147 1,379 1,449 1,449 1,5736 1,379 1,448 1,448 1
D A F2 H2 2040 J H F D A F2 H2 Total 2045 J H F D A F2 H2 Total 2045 J H F D A F2 H2 Total 2050 J H F D A F2 H2 Total 2050 C F2 H2 Total 2050 C F2 H2 Total 2040 C F F D A F F D A A F F D C A C F C F D A C F C F C F C F C F C F C F C F C F C	612 563 877 71 3,089 K 0 726 188 634 584 992 79 3,203 K 0 761 200 659 614 1,033 72 3,339 K 0 784 207 674 628	367 412 0 2,097	311 261 0 595 2,101 G 1 716 243 284 238 0 714 2,196 G 1 763 261 314 284 0 751 2,374 G 7 803 276 305 255	0 20 0 432 1,353 E 99 251 572 0 20 0 20 0 826 1,768 E 104 269 609 0 21 0 745 1,748 E 109 284 626 0 21	77 0 0 997 8 343 310 296 79 0 0 0 1,028 8 361 326 306 81 0 0 0 0 1,074 8 8 333 311 1 11 82 0	112 58 0 117 666 C 211 54 123 112 60 0 123 683 C 222 54 124 112 60 0 123 683 C 222 54 124 112 62 0 128 702 C 227 55 125 112 63	$\begin{array}{c} 0\\ 0\\ 0\\ 0\\ 0\\ 1,538\\ 3,018\\ \hline \\ G2\\ 1,559\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\ 0\\$	$\begin{array}{c} 258 \\ 45 \\ 374 \\ 0 \\ 696 \\ \hline \\ 12 \\ 5 \\ 0 \\ 16 \\ 270 \\ 45 \\ 394 \\ 0 \\ 730 \\ \hline \\ 12 \\ 6 \\ 0 \\ 730 \\ \hline \\ 12 \\ 6 \\ 0 \\ 768 \\ \hline \\ 12 \\ 6 \\ 0 \\ 768 \\ \hline \\ 12 \\ 6 \\ 0 \\ 768 \\ \hline \\ 12 \\ 53 \\ 408 \\ 0 \\ 768 \\ \hline \\ 12 \\ 55 \\ \hline \\ 56 \\ \hline \end{array}$	1,737 1,359 1,251 2,753 14,017 Total 3,147 2,057 1,877 1,763 1,379 1,386 3,137 14,746 Total 3,624 2,173 1,972 1,853 1,497 1,449 1,3,176

Table 3.51	Future Traffic at Omar Torrijos Roundabout
-------------------	--

Chapter 4 Natural Conditions

4.1 Geography

Panama is located in the Central America region, bordering both the Caribbean Sea in the north and the Pacific Ocean in the south, and between Colombia in the east and Costa Rica in the west. The total land area is 77,082 square kilometers. Panama is located on the narrow isthmus, where the world critical sea lane Panama Canal runs, between the North and South American Continents as per Figure 4.1.



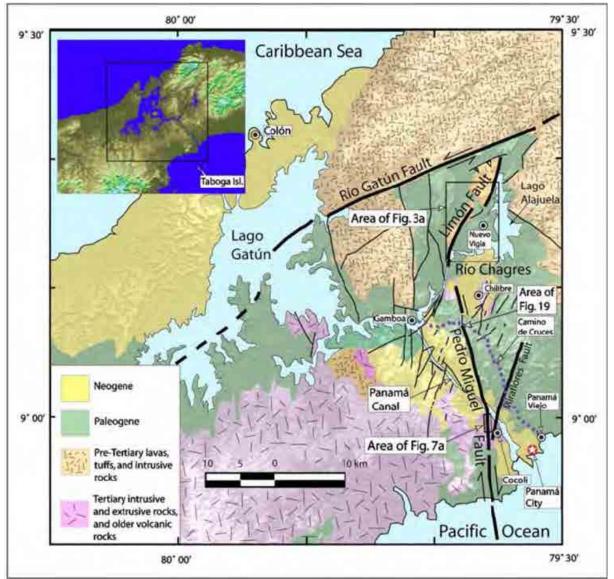
Source: Google Earth

Figure 4.1 Map of Panama Canal Area

4.2 Geography of Project Site

The Republic of Panama sits atop two colliding tectonic plates - Central and South America and the Project site of the 4th Panama Canal Bridge is located in the Panama Canal Basin. The Pedro Miguel, Limon and related faults comprise a zone that extends from the southern flank of the mountain range in north central Panama southward crossing the Panama Canal between the Miraflores and Pedro Miguel Locks, and extending southwards. The Pedro Miguel fault ruptured in a large earthquake in 1621.

Figure 4.2 shows the geography and active fault distribution of the Study Area.

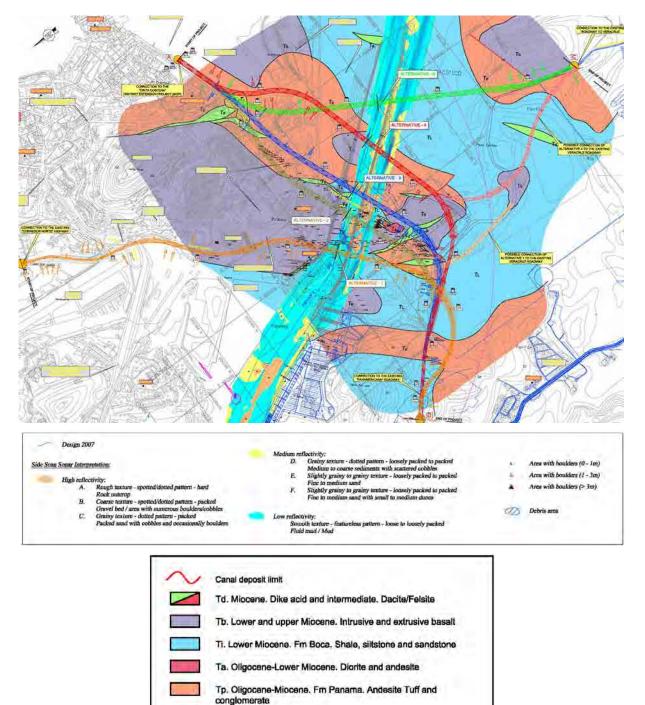


Source: Bulletin of the Seismological Society of America (BSSA) Figure 4.2 Geography and Active Fault Distribution of the Study Area

4.3 Subsoil Conditions

Basalt rocky mountain extends to the east bank of the Panama Canal, and siltstone and sandstone are found westwards. Low-land swamps containing soft and weak mud sediments cover the Panama Canal area.

Figure 4.3 shows the subsoil conditions of the Study Area.





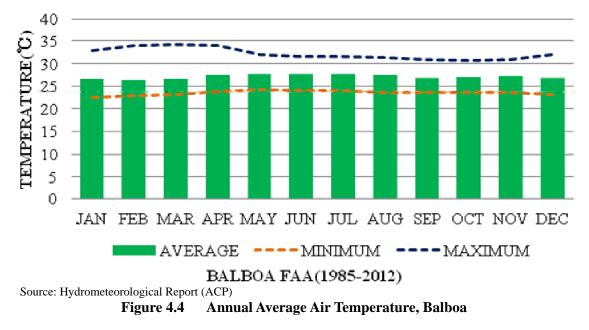


Tr. Rilotih. Extrusive riolith

4.4 Climate

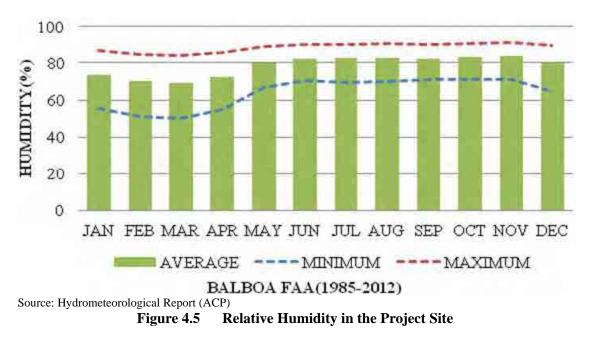
4.4.1 Temperature

Air temperature in Panama is almost stable at around 27C throughout the year. Annual monthly average air temperature in Balboa at the Project site is shown in Figure 4.4.



4.4.2 Humidity

Relative humidity around the Project site is shown below. According to the records for the years between 1985 and 2012, the monthly relative humidity ranges from 73.7% to 83.7% and is constantly above 80% in the high-humidity season from May to November.



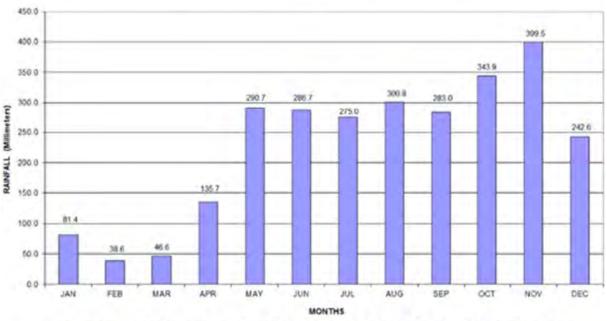
Average relative humidity is shown in Figure 4.5.

4.4.3 Rainfall

Panama has a tropical climate with high humidity and high temperature, and rainy season is from May to November with heaviest rainfall in November.

Figure 4.6 shows the annual monthly average rainfalls of the Panama Canal basin from 1965 to 2012.





Monthly average from 25 stations, those are: Agua Clara, Alhajuela, Barro Colorado, Cascadas, Candelaria, Chico, Chorro, Caño, Ciento, Escandalosa, Gamboa, Gatún, Guacha, Humedad, Monte Lirio, Peluca, Pedro Miguel, Raices, San Miguel, Arca Sonia, Cañones, Chamon, Esperanza, Rio Piedras and Vistamares. Source: Hydrometeorological Report (ACP)

Figure 4.6 Annual Monthly Average Rainfalls, Panama Canal Basin

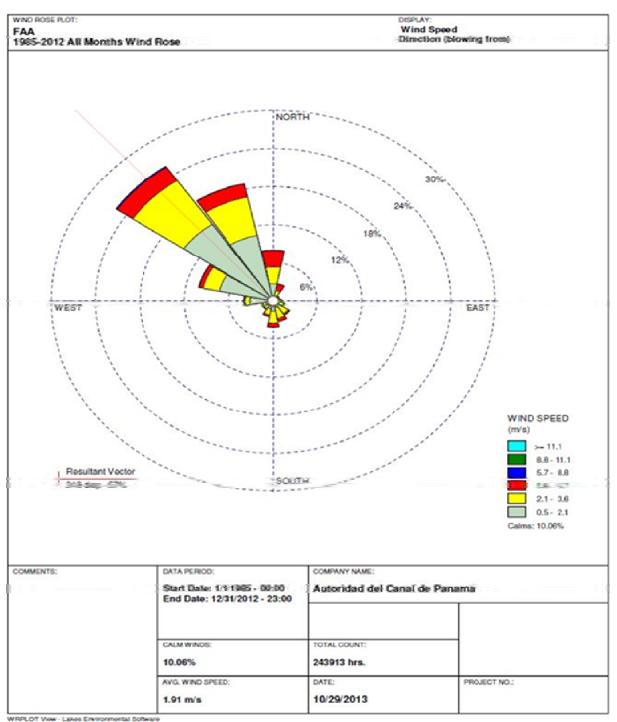
4.4.4 Wind

Wind direction and velocity at the Balboa Observation Station, the nearest location to the 4th Panama Canal Bridge, is discussed below.

(1) Wind Direction

Northwest wind is predominant in the vicinity of the 4th Panama Canal Bridge site.

Figure 4.7 shows wind rose at Balboa in the Project site.



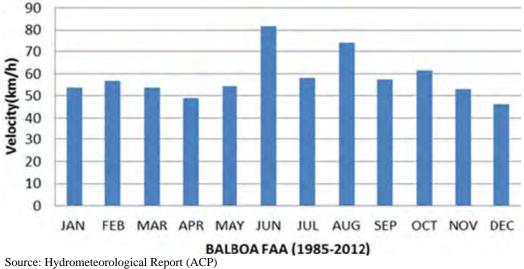
Source: Hydrometeorological Report (ACP)

Figure 4.7 Wind Rose showing Direction and Velocity, Balboa

(2) Wind Velocity

In the Project site, the maximum wind speed of 81.9km/hr (22.7m/sec) was observed in June, 1990.

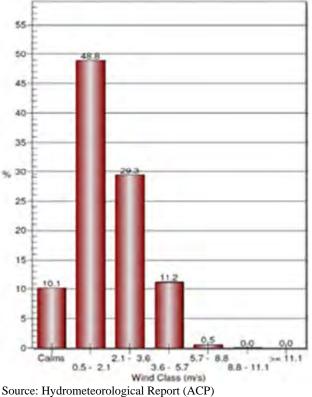
Figure 4.8 shows the monthly maximum wind speed at Balboa between 1985 and 2012.

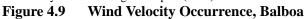




(3) Occurrence of Wind Velocity

In the vicinity of the Project site of the 4th Panama Canal Bridge, wind velocity between 0.5 to 2.1 m/sec is predominant sharing 50% of occurrence as per Figure 4.9.





4.5 Hydrology (Including Channel Bed Scouring)

Flow velocity of the Panama Canal is very low and stable at approximately 0.3 m/sec in the vicinity of the Project site. According to the interview survey made to ACP, scouring of the channel bed materials does not occur in the Project site.

Table 4.1 shows the flow velocity in the channel of the Panama Canal.

Table 4.1Channel Flow Velocity of the Panama Canal near the 4th Panama Canal Bridge Site

	Locali	zación						Velocidad	del viento
Punto	UTM Este Norte	Latitud Longitud	Profun-didad ⁽¹⁾ , m	Magnitud ⁽¹⁾ , m/s	Dirección (21.(5) grados (N=0, E=90)	Intervalo del promedio ⁽²⁾ , min,	Hora In	Magnitud MPH	Dirección
				Marea sub	lendo				-
-			2	0.25	169				
B19	Boya 19	Verde	4	0.27	194	6	11:11	7.4	167
	1	1.4	6	0.31	213	1			
			2	0.25	170			4,9	
821	Boya 21		6	0.24	179	4	11:58		114
			10	0.3	196		1.1.1.1.1		
	(Marea baj	ando				1
	1		2	0.31	180		1.		
824	Boya 24A	Roja	6	0.29	160	4	16:41	12.3	359
	10.000		10	0.27	177	1 ·····			
			2	0.31	168				
B19	Boya 19	Verde	6	0.28	156	3	18:16	9.2	334
1	10 mil		10	0.31 154					
	821 Boya 21		2	0,34	160				
B21			6	0.33	160	2	18:55	3.4	332
	1.000		10	0.27	170			1 A - I	1.00

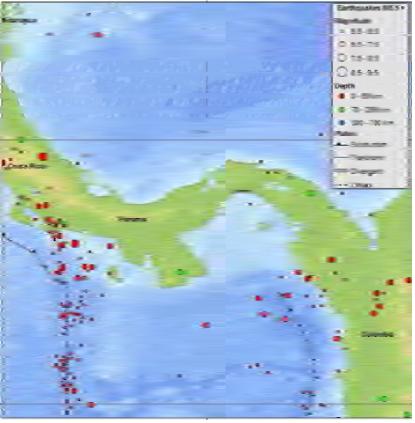
Source: Hydrometeorological Report (ACP)

4.6 Earthquake

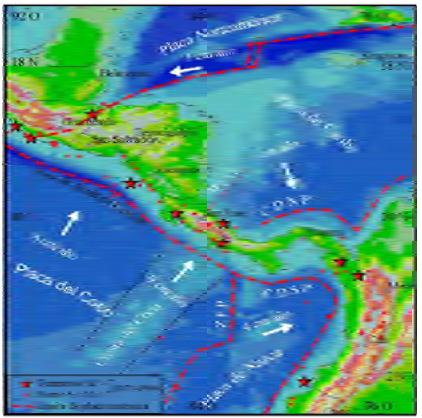
Panama is earthquake prone and was damaged by earthquakes in the past. In 1882, earthquakes collapsed many buildings in the Panama City. The Pedro Miguel fault, close to the Project site, was the epicenter of a large earthquake in 1621 which ruptured Panama City in Spanish colonial time.

Figure 4.10 shows the epicenter locations since 1997, and the distribution of active faults has been shown in Figure 4.2.

Plate tectonic elements in Central America is shown in Figure 4.11.



Source: USGS Network, Panama Seismicity Map (1900 to March 2012) **Figure 4.10** Distribution of Epicenters of Past Earthquakes since 1997, Panama



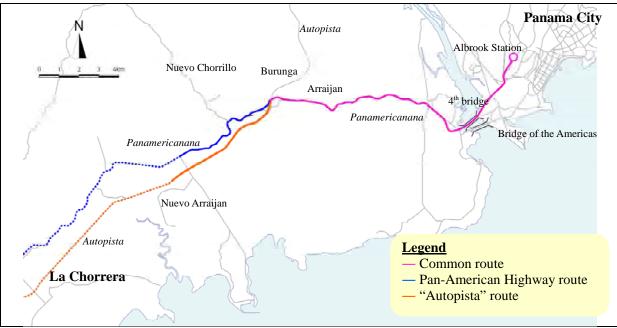
Source: Seismic Hazard Assessment of the Second Panama Canal Crossing (Preliminary Report) Figure 4.11 Major Tectonic Elements in Central America

Chapter 5 System Selection

5.1 Route Alternatives

The Pan-American Highway is a highway connecting Panama City and La Chorrera to the west. The newly constructed "Autopista" also connects Panama City and La Chorrera, but the section between Panama City and Arraijan forms a long detour to the north connecting the north area of Panama City. Since the detour section is far from the plan route of Line-3, there is no choice other than Pan-American Highway from Panama City to Arraijan.

The METI study proposed that Line-3 be constructed along the existing roads, however from the intersection in Arraijan there are two roads running to the west. Consequently, there are two route alternatives for Line-3, one following only the Pan-American Highway and the other following the Pan-American Highway to Arraijan and from there the "Autopista", as shown below.



Source: JICA Study Team

Figure 5.1 Route Alternatives

The METI Study recommended the "Autopista" route for Line-3 because the route has a wide Right-of-Way and has no steep slopes or sharp curves. On the other hand, the Pan-American route was not selected because of its severe topographic conditions for urban transport system, such as slopes with more than 6% gradient and curve radiuses less than 100m. Alignments having more than 6% slopes are generally not considered as a route for urban transit system when other alternative routes are available.

When this study began, SMP requested the reconsideration of the Pan-American route because of the greater accessibility it would provide to Line-3 and its future demand. As a consequence, the study for route selection was conducted and concluded as described in this report.

5.1.1 Comparison items

In the discussions with SMP, various comparison items were suggested by the JICA Study Team to evaluate the two alternative routes. As a result of several meetings, eleven (11) comparison items were agreed upon, categorized in four (4) sections as follows: (1) Demand and Service, (2) Physical Aspects, (3) Land Availability and Resettlement and (4) Environmental Impacts. In addition, the weights, as shown below, were set through discussions with SMP. The total score of each alternative is calculated as the sum of all comparison items.

Although the project purpose should be fixed between the two alternatives for making a fair comparison, the type of transportation service provided by each alternative would not necessarily be the same because of the difference in land use along the two routes. The service for the Pan-American route should be a more local service because there are local communities along the Pan-American route. The service for the "Autopista" route should focus on rapid commuter service because multiple stations along the "Autopista" would have a negative impact on the highway.

Categories	Comparison items	Weight
		allocated
1. Demand and		50
	(1) Concept of the Route Selection: Type of Service for each route	
	1) Commuter 2) Commuter and local	
	(2) Potential for generation of demand from current and future development	-
	(3) Expected demand considering future extension to La Chorrera	-
	(4) Stations	-
	(5) Intermodal Facilities (Park & Ride)	-
	(6) Feeder bus services	
	(7) Operation speed	
2. Physical As	pects	18
	(1) Total length of Phase 1 and future extension to La Chorrera	
	(2) Alignment between Arraijan - Nuevo Arraijan	
	1) Steep gradient sections	
	2) Small curves	
	3) Impacts on utilities	
3. Land Availa	bility and Resettlement	12
	(1) Depot	
	(2) Stations	
	(3) Intermodal facilities	
	(4) Alignment	
4. Environmen	tal Impact on natural and human environment during construction and operation	20
	(1) Temporary impact	
	1) Air pollution	
	2) Noise and vibration	
	3) Safety	
	4) Traffic	
	(2) Long term impact	
	1) Local economy, employment and livelihoods	
	2) Land use	
	Total	100

Table 5.1	List of	Comparison Items	
Iuble col	LISC OI	Comparison rooms	

Source: JICA Study Team

5.1.2 Comparison method

All the comparison items were evaluated in 6 grades, from Excellent to Not Applicable as shown below. A coefficient is given to each grade, from 1.0 to 0. These coefficients are multiplied by the allocated weight of each category to calculate the scores.

Table 5.2	Evalua	ation Grades and	Coefficients
Evaluation		Coefficient	Evaluation score
(A) Excellent:		1.0	Weight x 1.0
(B) Good:		0.8	Weight x 0.8
(C) Fair:		0.6	Weight x 0.6
(D) Insufficient:		0.4	Weight x 0.4
(E) Poor:		0.2	Weight x 0.2
(F) Not applicable:		0.0	Weight x 0.0

Table 5.2	Evaluation Grades	and Coefficients

Source: JICA Study Team

5.1.3 Evaluation

The comparison items of "Autopista" and Pan-American routes were analyzed and evaluated in meetings between SMP and JICA Study Team.

(1) Demand and Service

1) Type of Service (Commuter)

Route	Analysis	Evaluation
Autopista	Train operation speed is favorable for commuters because	Excellent
	of the moderate topographic conditions, long distance	
	between stations, and the shorter route length than the	
	Pan-American route.	
Pan-American	Train operation speed is lower than the "Autopista"	Fair
	because of longer route length and more frequent train	
	stops for serving local community, although the speed is	
	satisfactory.	

2) Type of Service (Commuter and Local)

Route	Analysis	Evaluation
Autopista	Demand of local trips along the route is low.	Poor
Pan-American	The route runs through the populated area in the region	Excellent
	and passengers making local trips are the beneficiaries of	
	the project. For commuter trips, express train operation	
	can be planned during morning and evening peak hours.	

3) Potential for Generation of Demand

Route	Analysis	Evaluation
Autopista	The "Autopista" is an intercity highway and development has not been planned along the road. The unplanned residential developments are dispersed and are for middle-income car users. Development toward the south is for middle income housing.	Fair

Pan-American	The urban area between Arraijan and La Chorrera is	Excellent
	focused on the Pan-Amrican Highway. Most local	
	businesses and residences (particularly of lower income	
	families) are nearby. The area is a mix of old buildings	
	and new developments. Development toward the north	
	seems to be for low to middle income housing. Demand	
	generation is expected because of the creation of local	
	businesses.	

4) Expected Demand Considering Future Expansion to La Chorrera

Route	Analysis	Evaluation
Autopista	Although the route can be extended up to the intersection	Fair
	of the Pan-American Highway with the "Autopista" in La	
	Chorrera, the route is located far from the center of La	
	Chorrera.	
Pan-American	Although it is difficult to extend the route to the center of	Excellent
	La Chorrera due to the narrow streets, the route can reach	
	the entrance to the city and has good access to the	
	planned bus terminal.	

5) Station (Accessibility)

Route	Analysis	Evaluation
Autopista	Pedestrian facilities to the stations are poor.	Insufficient
Pan-American	The present pedestrian routes can be used for access by walking.	Excellent

6) Park & Ride (Accessibility)

Route	Analysis	Evaluation
Autopista	Access roads to the Park & Ride facility of the stations	Insufficient
	need to be developed.	
Pan-American	Existing road network provides car access to the stations.	Good

7) Feeder bus services

Route	Analysis	Evaluation
Autopista	Access roads to the stations and intermodal transfer areas need to be developed because feeder bus transfers on the "Autopista" would interrupt the traffic flow of the highway.	Insufficient
Pan-American	Existing road network provides feeder bus access to the stations, although intermodal transfer areas need to be developed.	Good

8) Operation Speed

Route	Analysis	Evaluation
Autopista	The scheduled speed will be 45-50km/h	Excellent
Pan-American	The scheduled speed will be 35-40km/h	Fair

(2) Physical Aspects

1) Total Length

Total project cost will depend on the total length of the line including the future extension to La Chorrera.

Route	Analysis	Evaluation
Autopista	Arraijan - Nuevo Arraijan: 7.42km	Excellent
	Nuevo Arraijan - Chorrera: 7.07km	
	Total: 14.49km	
Pan-American	Arraijan - Nuevo Arraijan: 8.91km	Good
	Nuevo Arraijan - Chorrera: 7.62km	
	Total: 16.53km	

2) Alignment between Arraijan and Nuevo Arraijan (Steep Gradient Section)

Route	Analysis	Evaluation
Autopista	There is no section with gradient higher than 6%.	Excellent
Pan-American	There are three sections where the gradient is higher than	Poor
	6%. The total length of these sections is 780m.	

3) Alignment between Arraijan and Nuevo Arraijan (Small curves)

Route	Analysis	Evaluation
Autopista	There is no curve with a radius less than 160m.	Excellent
Pan-American	There are 5 curves where the radius is larger than 160m.	Fair

4) Impacts on Utilities

Route	Analysis	Evaluation
Autopista	The number of affected utilities will be small.	Excellent
Pan-American	There are many utilities along the road.	Fair

(3) Land Availability and Resettlement

1) Depot

Route	Analysis	Evaluation
Autopista	Depot can be located adjacent to the "Autopista".	Excellent
Pan-American	Site for depot can be found to the west of Nuevo Arraijan.	Fair

2) Stations

Route	Analysis		Evaluation
Autopista	Stations will be located at the roadside.	ROW at the	Excellent
	roadside is sufficient for the stations.		
Pan-American	Stations will be located in the road median.		Good

3) Intermodal Facilities

Route	Analysis	Evaluation
Autopista	Intermodal facilities cannot be constructed at the roadside	Fair
	because the "Autopista" is a freeway. Intermodal	
	facilities need to be constructed outside the ROW.	
Pan-American	Intermodal facilities can be constructed at the roadside,	Good
	although they would affect road intersections.	

4) Alignment

Route	Analysis	Evaluation
Autopista	ROW can accommodate the alignment.	Excellent
Pan-American	Due to the winding and hilly terrain, it is difficult to keep the alignment within ROW.	Insufficient

(4) Environmental Impact (Temporary)

1) Air pollution and noise & vibration

Route	Analysis	Evaluation
Autopista	Impact is very small because the population density is	Excellent
	low.	
Pan-American	There will be impact on the communities along the road	Fair
	because of medium density population.	

2) Safety

Route	Analysis	Evaluation
Autopista	Risk of traffic accidents during construction is low	Good
	because pedestrian traffic is low along the construction	
	sites.	
Pan-American	Risk of traffic accidents during construction is high	Fair
	because of many pedestrians along the construction sites.	

3) Traffic

	Analysis	Evaluation
Autopista	Impact of traffic disturbance is low because the structures	Good
	are constructed along the roadside.	
Pan-American	Traffic is highly disturbed because the structures are	Fair
	constructed in the middle of the road.	

(5) Environmental Impact (Long term)

1) Local Economy, Employment and Livelihoods

Route	Analysis	Evaluation
Autopista	The project will generate business around the stations in	Fair
	the future.	
Pan-American	The project will contribute to the local economy of	Excellent
	existing communities in addition to future business	
	generation.	

2) Land Use

Route	Analysis	Evaluation
Autopista	New urban developments are expected along the road.	Good
Pan-American	New urban development and densification of urbanized areas are expected.	Excellent

5.1.4 Conclusion

Through a series of discussions held between the JICA Study Team and SMP, an agreement was reached on the route evaluation as shown in the table below. The total points allocated to the Pan-American route were 79.8 against 71.8 for the "Autopista" route, out of 100 points.

		Components				Comparison Table	Same	Ban Amorican Deute	6		
lo.		Components	Subjects for Comparison		Weight	Autopista Route	Score	Pan American Route	Scor		
		Concept of the Route Selection: Type of Service for each route	Commuter		4	Main target users will be commuters to Panama. Due to relatively moderate topographic	4	Not only commuters to Panama, but also local passengers within Arraijan - La Chorrera will be the	2.4		
1			Commuter and local		6	condition, train operation speed can be higher that that on Pan Americana road and line is shorter.	1.2	target users. Express train operation can be planned during morning and evening peak hours. Line is longer.	6		
Demand and service	Potential for generation of demand from current and future development			12	The Autopista is an intercity highway and development has not been planned along the road. The unplanned developments are mainly detached houses intended for middle-income car users. Development toward the south is for middle income housing.	7.2	The urban area between Arraijan and La Chorrera has the Pan Am road as its focus. Most local business and residences (particularly of lower income families) are nearby. The area is a mix of old buildings and new developments. Development toward the north seems for low to middle income housing.	12			
3	Dem	Expected demand considering future extension to La Chorrera	Current and future population in the area of influence (walking distance)		8	Limited access for people living along Pan Am road	4.8	High demand can be expected because all housing complexes have access roads to Pan Am road.	8		
4		Station	Number and accessibility		5	4 stations, access is difficult and limited	2	5 stations, easy access	5		
5		Intermodal Facilities (Park & Ride)	Accessibility		5	Access roads to parking facilities shall be provided	2	Existing road network provide easier access	4		
6		Feeder bus services	Accessibility		5	Local access roads to highway are limited and network to feeder facilities has to be constructed	2	Bus bays can be constructed along Pan Am road with some road widenning	4		
7		Operation speed	Speed including stop time at stations		5	Schedule speed: 40km/h	5	Schedule speed: 35km/h or less	3		
в		Total length of Phase 1 and future extension to La Chorrera	Length between Arraijan - Nuevo Arraijan - La Chorrera				5	Arraijan - N. Arraijan: 7.42km Arraijan - Chorrera: 7.07km Total: 14.49km	5	Arraijan - N. Arraijan: 8.91km Arraijan - Chorrera: 7.62km Total: 16.53km	4
	THE	Alignment between Arraijan - Nuevo									
	Physical	Arraijan (1) Steep gradient sections	Number and length of slope steeper than 6%	18	5	No slope higher than 6%	5	3 locations. Total length is 780m	2		
9	_	(2) Small curves	Number of curves with radius less than R160m		5	No curve less than R=160m	5	5 locations.	3		
		(3) Impacts on utilities	Number of affected utilities		3	Affected utilities are limited	3	Manyutilities	1.		
	70	Land acquisition and resettlement (land availability for)									
	nt an	(1) Depot	Distance from main line to avoid resettlement		3	Adjacent to Autopista	3	800m from Pan Am road.	1.		
0	Land Availability and Resettlement	(2) Stations	Location and space and need for resettlement		3	Road side. There seems to be enought Right-of-Way (ROW).	3	Above the road and may exceed ROW space.	2.		
	nd Av Rese	(3) Intermodal facilities	Location and space	1	3	Bus terminal and P&R space are outside of ROW	1.8	Bus terminal is along the road, P&R space is outside of ROW	2.		
	La	(4) Alignment	Consideration for resettlement		3	Within existing ROW	3	Existing ROW is not enough	1.		
		Impact on natural and human environme during construction and operation	nt								
		(1) Air pollution	Impacts for inhabitants during construction	32	1	Low density of population	1	Medium density of population	0.		
_		(2) Noise and vibration	ditto	1	1	ditto	1	ditto	0.		
nenta		(2) Noise and vibration (3) Safety (4) Traffic	Impacts on traffic and pedestrians		3	Low risk	2.4	High risk	1.		
Environmental			Disturbance for road traffic during construction		3	Low disturbance	2.4	High disturbance	1.		
Ľ	term	(5) Local economy, employment and livelihoods	Business generation and service for existing community			8	May generate business around stations in future	4.8	Much better service for existing community	8	
	- Jone	ピ」 (6) Land use	Availability of land for future development and potential densification of urban areas	1	4	Space is available for future development	3.2	Land development and densification of urban development can be expected.	4		

able 5.3	Route Selection	Comparison Table

Source: JICA Study Team

Based on the results of the comparison, the Pan-American route was selected for Line-3.

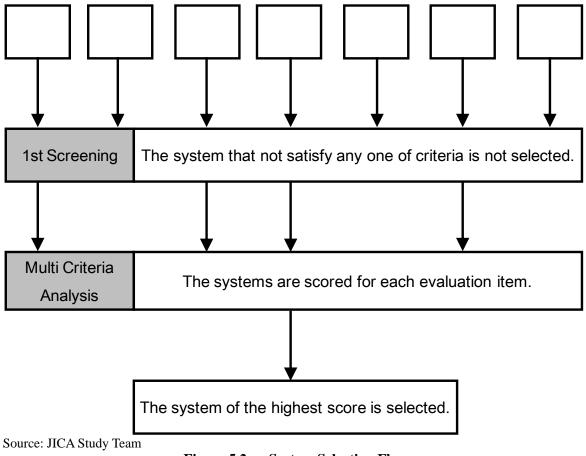
5.2 Candidate Systems and the First Screening

5.2.1 Procedures for System Screening

The suitable transportation system for Line-3 was selected based on two stages: 1^{st} screening and 2^{nd} screening as shown in the table below.

First, all potential urban transportation systems were listed in the 1st screening and each system was evaluated by several criteria. The systems that were NOT screened out would be considered in the second stage of the comparison.

Next, the remaining systems were scored using several sectionalized criteria, such as capacity, maintainability, and cost, in the 2^{nd} stage of the comparison. Finally, the most suitable system would be selected according to the evaluation score.



Candidate systems

Figure 5.2 System Selection Flow

5.2.2 Candidate Systems

There are various transportation systems all over the world, from which the major systems are listed below.

		ua	te Systems	
Candidate systems	Features		Candidate systems	Features
BRT at grade	Buses run on the same level as the road making for a lower transportation capacity.	_	Monorail hanging type	The vehicle is suspended from the track beam constructed on the space above the road and runs with rubber tire.
BRT using dedicated lane	Buses run in dedicated lanes and have no effect on other traffic conditions.		Monorail straddle type	The vehicle straddles and runs with rubber tires on the track beam constructed on the space above the road.
LRT at grade	The track can be installed in the carriageway and/or an exclusive space on the ground. This system can also adapt to viaduct and underground.		Maglev	The car is levitated by the magnet equipped on the track and bogie. However, only a few cases exist.
LRT using dedicated lane	The track is installed on a dedicated structure. The car size is smaller and transportation capacity is categorized as medium.		Linear Metro	The traction power is produced by the linear motor and the reaction plate, which are equipped on the bogie and track, respectively. Steel wheels and rails are used for guide and supporting the load.
AGT	The vehicle runs on rubber tires on an exclusive track constructed by concrete slabs.		Conventional MRT	Many cases are seen all over the world; it has high transportation capacity.
Source: JICA Study Team			LRT/MRT for steep slope	The system is applied to steep slopes that conventional MRT cannot climb. However, the train requires many motorized bogies.

Table 5.4Candidate Systems

The JICA Study Team made a comparative analysis of all these candidate systems in the first screening.

5.3 Candidate Systems and the First Screening

In the first screening all the potential urban transport systems were listed and evaluated by four criteria which were agreed between SMP and the JICA Study Team, as listed below.

- 1) Impact on road traffic;
- 2) A system in use or in experimental stage;
- 3) Uses fossil fuel; and
- 4) Nominal standard capacity greater than 20,000 PHPDT.

BRT (either at grade or in a dedicated lane), surface LRT, hanging type monorail and maglev were filtered out because they do not meet above-mentioned criteria.

As a result, six systems are considered in the second stage of the comparison.

			ns			
		BRT at grade	BRT using dedicated lane	LRT at grade	LRT using dedicated lane	AGT
	Impacts to road traffic					
Subjects for 1st	Experimental stage					
Screening	U sing fossil fuel					
	Standard capacity	3,000-5,000	5000-10,000	3,000-8,000	8,000-20,000	8,000-2,2000
	1st Screening					

Table 5.5First System Screening Chart

		Monorail hanging type	Monorail straddle type	Maglev	Linear Metro	M R T conventional	LRT/MRT for steep slope
	Impacts to road traffic						
Subjects for 1st	Experimental stage						
Screening	U sing fossil fuel						
	Standard capacity	5,000-10,000	10,000-36,000	5,000-12,000	20,000-50,000	25,000-60,000	15,000-45,000
1st Screening							

Source: JICA Study Team

5.4 Multi-criteria Analysis

5.4.1 System Selection Chart

Six systems were evaluated in the second stage of the comparison. The results of the evaluation are shown in Table 5.6. Ten criteria were selected from a long list of potential criteria, via brainstorming and discussion sessions held among the SMP and Study Team members. In the evaluation process, the weighted points for each criterion were first established by the SMP and the Study Team. After the weighted distribution was

determined, the systems were evaluated by each criterion. Finally, the overall calculation was made by adding the product of the coefficient values $(0 \sim 1)$ multiplied by weighted points for each criterion.

It should be noted that the differences in scores are not absolute but correlated. For example, all the compared systems offer a very safe service. The difference of 1.0 and 0.9 in scoring does not mean that one system is 10% safer than the other or vice versa, but that there is a relative advantage between the evaluated elements.

After a series of discussions and analysis, **it was concluded that a straddle type monorail system is the most appropriate technology for the Line-3**. The comparison table shows that the straddle type monorail has the best score followed by the conventional MRT. The dedicated lane LRT, AGT, linear metro and steep slope MRT were judged as not being appropriate systems for Line-3 because of significant disadvantages compared to the monorail and MRT. There are some notable aspects that reinforce the monorail as the better option for Line-3. Two of which are as follows:

- The initial cost for the monorail is more than USD200 million lower than the MRT for Line-3
- Technical difficulties are observed for some sections of the MRT line where very high piers are required to avoid large scale land acquisition.

			Urban Transportation Systems						
			LRT using dedicated lane	AGT (Automated Guideway Transit) Tokyo Yurikamome		Linear Metro	MRT conventional	LRT/MRT for steep slope	
Typical Systems under operation (Country)			(Philippine)	(Japan)		Line (Japan)	Many cities in the world	Kobe Electric Railway Arima Line (Japan)	
	Evaluating Items	Points allocated							
1)	Capacity (*1)	15	0.8	0.4	0.8	0.7	1.0	0.8	
2)	Initial Cost(System) (*2)	10	1.0	0.9	0.8	0.9	1.0	0.9	
3)	Initial Cost(Infrastructure) (*2)	20	0.6	0.8	1.0	0.8	0.6	0.8	
4)	O&M Cost (*3)	10	1.0	0.8	0.9	0.8	1.0	0.9	
5)	Proprietary (*4)	10	0.8	0.6	0.5	0.5	1.0	0.8	
6)	Safety (*5)	5	1.0	0.9	0.9	1.0	1.0	0.7	
7)	Resettlement (*6)	15	0.8	1.0	1.0	1.0	0.8	0.8	
8)	Impacts on Natural Environment (*7)	5	0.8	0.9	1.0	0.8	0.8	0.8	
9)	Landscape /Cityscape (*8)	5	0.6	0.6	1.0	0.6	0.6	0.6	
10)	Maintainability (*9)	5	1.0	1.0	0.9	1.0	1.0	0.9	
	Total Points	100	81.2	76.6	88.6	80.4	86.5	82.3	

Table 5.6System Comparison Chart

Note:

The total points score is the sum of ten criteria scores calculated from each coefficient multiplied by points allocated (weighting).

*1: Headway is fixed at 3min., and the train composition is 6 coaches for all systems.

*2: Initial costs cover civil work, E&M, and rolling stock costs. Maximum height of pier was set to 20m.

*3: Calculation of the adjusted yearly O&M costs.

*4: International competitive tender is possible.

*5: Evacuation method, possibility of derailment, and rescue methods are evaluated.

*6: Land acquisition and resettlement are evaluated.

*7: Green area that would be removed

*8: Impacts of elevated structure on landscape and cityscape

*9: Ease of maintenance work.

Source: JICA Study Team

5.4.2 Conditions and Method of Comparison

The following preconditions and assumptions were used for the comparison exercise.

- Route length is L=25km via the Pan-American Highway.
- 10 stations are considered for the purpose of comparison.
- Initial demand is set at 20,000 PHPDT and final demand at 35,000 PHPDT;
- 4% slope is used for MRT and LRT whereas 6% slope is used for the monorail and other systems;
- R=100m is used for the minimum horizontal curve for the monorail, AGT and Linear Metro, whereas R=160m was used for MRT and the rest; and
- 4 passengers $/m^2$ and 3 minute interval were used for the purpose of comparison.

In the discussions between SMP and the JICA Study Team it was pointed out that assessment of a unique condition across the different systems is difficult because each system can be customized to meet the local conditions in different ways. One example of this difficulty is that the capacity of a system was calculated based on the area available for passengers, i.e. length x width of each system's car. The passenger density was set at 4 passengers per square meter and the interval (or headway) of train operation was set at 3 minutes. Under these conditions, the AGT and linear metro are likely to be filtered out for not meeting the target demand of 35,000 PHPDT, and the LRT with dedicated lane and steep slope MRT have to be considered as a conventional MRT to be attractive. The Monorail and MRT seem to be acceptable systems that can service a demand of 35,000 PHPDT.

Another example is the difficulty in evaluating the impact on landscape. The comparison was made based on the area that would be covered by each system's permanent structures, from plan view and lateral view. The score was based on the width of superstructure in the plan view, and width of columns and other superstructure in the lateral view. The result is directly calculated in proportion to the area which obscures the view. The appropriateness of the scoring can be argued widely.

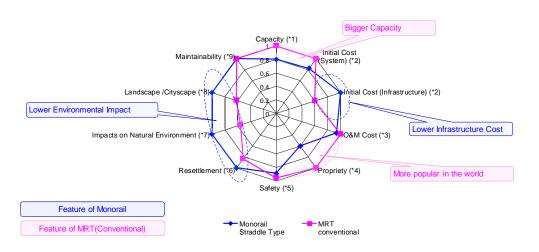
The intention was to only employ elements that can be evaluated objectively. However, in some cases experts' subjective opinions were taken into consideration for the scoring. The criterion "proprietary status" is one such case.

5.4.3 Comparison in a Radar Chart

Despite the above mentioned difficulties, the Consultant believes that a multi-criteria comparison helps to highlight the different characteristics of the available systems, while the scoring result also represents the applicability of the systems to a specific condition, in this case Line-3.

Figure 5.3 shows the result of the comparison made between MRT and monorail; the two systems which obtained the highest scores. A monorail system enjoys a significant advantage in lower initial investment in infrastructure, a better land/cityscape, lower impact on natural environment, and lower impact on land acquisition and resettlement. On the other hand, MRT shows its advantage in its capacity and proprietary aspects.

It should be noted that in order for the MRT system to achieve the aforementioned advantages over the monorail, it would have to be the large type with a car length of 20m; if shorter cars were used the advantages in capacity become insignificant in comparison to the monorail.



Feature Comparison between Monorail and MRT (Conventional)

Source: JICA Study Team based on multi-criteria comparison Figure 5.3 Radar Chart comparison between monorail and MRT

5.4.4 Evaluation by Ten Criteria

(1) System Capacity

A density of four passengers/ m^2 was used for comparing the capacity of the different systems. The score is essentially determined by the area of each car, calculated from car width and car length. The number of cars per train for this comparison purpose was set at six for all the systems and the train interval (headway) at 3 minutes. The results are an automatic calculation using this formula. AGT has the lowest score due to its small car size. The highest score of MRT with significance difference from other systems is based on the condition that 20m length large-scale cars are used for MRT.

Table 5.7 Comparison of System Capacity								
Capacity: Size of car and floor space	LRT using dedicated lane	AGT	Monorail straddle Type	Linear Metro	MRT conventional	LRT/MRT for steep slope		
Car Width (m)	2.7	2.5	3.0	2.5	2.8	2.7		
Car Length (m)	17.0	9.0	15.0	16.0	20.0	17.0		
No. of cars	6	6	6	6	6	6		
Floor Area:	263.64	128.16	259.26	228.96	322.38	263.64		
Train Capacity	1,055	513	1,037	916	1,290	1,055		
Car Capacity	176	85	173	153	215	176		
Pax/hour/direction	21,091	10,253	20,741	18,317	25,790	21,091		
Score 1)	12.27	5.96	12.06	10.65	15.00	12.27		
Coefficient for 1)	0.82	0.40	0.80	0.71	1.00	0.82		

Table 5.7 Comparison of System Capacity

Note: Coefficient = Each Score / Maximum of Score

Source: JICA Study Team, based on the information obtained from different sources for car size

(2) Initial Cost of the Systems

The score was calculated as a function of the number of cars, the unit price of the cars and the initial E&M cost. The estimated initial demand of 20,000 PHPDT was used to calculate the required number of cars for the initial investment. The total service length of 50km

(round trip of 25km line length) and a planned speed of 35km/h were employed. It should be noted that the prices are for comparison purposes only and would require further analysis for feasibility studies. The proportional relationship among the systems is considered acceptable for this criterion.

The result shows that the MRT is the most cost effective in this comparison item, followed by the LRT.

Initial Cost (System)		LRT using dedicated lane	AGT	Monorail Straddle Type	Linear Metro	MRT conventional	LRT/MRT for steep slope
Rolling Stock	Cars	186	354	186	210	156	186
	Unit Cost (\$ million) approx.	1.8	1.0	2.4	2.0	2.0	2.1
	Total	340	350	450	420	310	390
E&M (\$ mi	E&M (\$ million)		430	430	420	410	410
Total (\$ million)		750	780	880	840	720	800
Coefficient for 2)		0.97	0.93	0.82	0.86	1.00	0.91

Table 5.8	Comparison of Initial Cost of the Systems
	comparison of initial cost of the systems

Note: Coefficient = Minimum of Total / Each Total

Cost of car for Line-1 project is around US\$2.7 million/ car which includes training, design, prototype testing, preparation of manuals and so on. The above comparison is net price only.

Source: JICA Study Team, based on the information obtained from different sources for Unit Price

The unit prices of cars were established based on researching the market price and adjusting them to the local conditions. The prices for monorail and AGT were taken from market research. The prices for conventional MRT (L=20m) were based on the market price adjusted to the local conditions of Line-3 where 4% slopes are foreseen. The prices for LRT and other MRT are calculated in proportion to the conventional MRT. The difference in car size is considered, but not in proportion to the size. The increased number of motorized cars is also taken into consideration.

In this comparison, it was noted that the price difference between the monorail and the conventional MRT is larger than the technical rough estimate made initially. It appears that the MRT car market is more mature and this keeps the prices more competitive. It is possible that the price gap will be narrowed when the international monorail market starts to expand. This is likely to happen with the opening of new monorail lines in China, Korea, UAE, and Malaysia, and the construction of monorails in India and Brazil. Furthermore, many cities are currently considering the development of new metro lines using monorail technology.

(3) Initial Cost of Infrastructure

The comparison of the initial cost of infrastructure was made for the main structures only. The number of stations considered for the purpose of comparison was ten stations, including the terminal stations at both ends. The comparison included three elements, namely; 1) cost of elevated structures 2) cost of stations and 3) additional costs due to the difference in the alignment for each system.

The base cost of the elevated structure was calculated from the costs of Line-1, estimated at USD 28 million per kilometer of elevated section. The cost of the stations is calculated from the station length based on the required number of cars plus 5m at each end of the station. The assumed demand is 35,000 PHPDT at the peak hour with 2 minute train intervals. An additional cost is included for LRT and conventional MRT because these systems require higher piers to maintain the maximum 3.5% longitudinal slope. This

occurs in the section between the access to Panama Pacifico, after crossing the canal, and Nuevo Arraijan. A comparison of the vertical alignments is summarized below. An additional cost is also included for the difference in the average height of the structures. Conventional MRT and LRT (maximum 3.5% slope) require higher piers on average in comparison to AGT, monorail, linear metro and steep slope MRT (maximum 6% slope).

Tuble 5.5 Comparison of vertical Anglinent Features								
	Conventional MRT and LRT	AGT, monorail, linear metro and						
		steep slope MRT						
Vertical alignment maximum slope	3.5%	6.0%						
Average pier height:	14.8m	8.5m						
Maximum pier height	45.6m	18.6m						
Classification by pier height	Less than 20m: 78.9% (14.47km) 20m <h<30m (2.66km)<br="" :14.5%="">30m<h<40m (0.66km)<br="" :3.6%="">More-than-40m :3.0% (0.54km)</h<40m></h<30m>	Less than 20m: 100% (18.41km)						

Table 5.9	Comparison of Vertical Alignment Features
	Comparison of vertical Angiment reatures

Source: JICA Study Team

The results of the comparison are shown in the table below. The monorail system enjoys the first place in this criterion due to its flexible alignment both horizontally and vertically. Other systems such as AGT, linear metro and steep slope MRT share second place because of their ability to manage 6% maximum slope. The difference in cost between the monorail and these 6% slope systems is due to the simple structure used by the monorail.

Table 5.10 Comparison of Initial Cost of Infrastructure									
Initial Cost (Infrastructure)	LRT using	AGT	Monorail	Linear	MRT	LRT/MRT			
	dedicated		Straddle	Metro	conventional	for steep			
	lane		Туре			slope			
Station length (m)	130	140	120	140	130	130			
Number of cars per train (cars)	7	14	7	8	6	7			
Elevated Structure (US\$)	640.0	637.2	450.0	625.9	640.0	625.9			
Station (10)	157.3	169.4	145.2	157.3	157.3	157.3			
Civil work (extra work)	182.7	0.0	0.0	0.0	182.7	0.0			
Total	980	807	595	783	980	783			
Coefficient for 3)	0.6	0.8	1.0	0.8	0.6	0.8			

Table 5.10Comparison of Initial Cost of Infrastructure

Note: Coefficient = Minimum of Total / Each Total

1. Extra civil work is included where high piers (over H=20m) are required.

2. 35,000 PHPDT and 30 trains per hour were assumed for the calculation

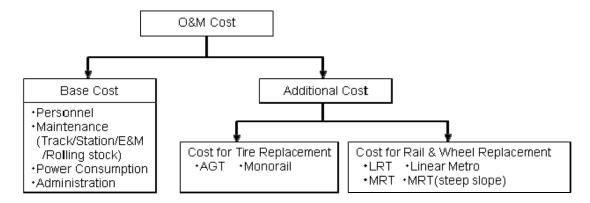
3. Prices are for reference for comparison purpose only

Source: JICA Study Team based on the cost of Line-1

(4) Operation and Maintenance (O&M) Cost

Through meetings held between SMP and the Consultant, it was decided that O&M costs would be compared in two ways, 1) base cost of required personnel, maintenance, power consumption and administration; 2) additional costs based on the type of technology. In both cases, the same demand was used for the comparison.

The base cost is mainly affected by the number of cars and the running kilometers. The unit costs were taken from the previous METI study and available statistical data. For the additional maintenance costs arising from the different technologies employed, the replacement of rubber tires was assumed for every 150,000km of running distance for the monorail and AGT, and the replacement of rails was assumed for every 20 years for LRT/ MRT and every 10 years for steep slope type systems (linear metro and steep slope MRT). The replacement of steel wheels was assumed for every 1 million km running distance.



Note:

1) Rubber tires are replaced after running 150,000km, price of one tire \$1,000 for monorail, \$600 for AGT

2) Rails are replaced every 20 years (LRT/MRT), and every 10 years (Linear Metro/MRT(steep slope), replacement of wheels after running 1 million km.

Source: JICA Study Team

Figure 5.4 Structure of O&M Cost Comparison

The results of this comparison were that the conventional MRT ranked first place, closely followed by LRT and monorail.

	Table 5.11	i Compa	Comparison of Octive Cost			
O&M Cost	LRT using	AGT	Monorail	Linear	MRT	LRT/MRT
	dedicated		Straddle	Metro	conventional	for steep
	lane		Туре			slope
Regular	31.8	38.7	31.9	41.9	30.4	37.5
Operation/Maintenance work	51.0	50.7	51.7	41.9	50.4	57.5
Rubber tire replacement cost	0.0	0.9	1.5	0.0	0.0	0.0
Rail/wheel Replacement cost	0.4	0.0	0.0	0.5	0.4	0.5
Total 4)	32.2	39.6	33.4	42.4	30.8	38.0
Coefficient for 4)	0.97	0.79	0.94	0.73	1.00	0.83

Table 5.11Comparison of O&M Cost

Note: Coefficient = Minimum of Total / Each Total

Source: JICA Study Team

(5) **Proprietary**

Two comparisons were made for this criterion, namely the comparison at the initial construction stage and at the expansion stage. The expert's opinions were taken into consideration to establish the points for each comparison. For the initial construction stage, MRT enjoys the highest score because of the large market and competition among manufacturers. LRT, AGT, linear metro and monorail received reduced points due to smaller market size or lower number of possible bidders to supply rolling stock. These considerations have less impact at the initial construction stage because, in theory, there is no preference at that time. The 3-point score for the AGT, monorail and linear metro indicate SMP's position against a limited market. In the expansion stage, the difference between conventional MRT and other system becomes larger. This is explained by the fact that a non-standardized system would force SMP to purchase additional rolling stock from the same manufacturer. It is not exactly the same case for purchasing parts. To some extent this phenomenon would apply to conventional MRT also, although not to a degree meriting a lower score. This bias occurs because of manufacturers' efforts to try and keep their clients.

Proprietary	LRT using dedicated	AGT	Monorail Straddle	Linear Metro	MRT conventional	LRT/MRT for steep
	lane		Туре			slope
Monopoly in initial construction stage	5	3	3	3	5	4
Monopoly in expansion stage	3	3	2	2	5	4
Total	8	6	5	5	10	8
Coefficient for 5)	0.8	0.6	0.5	0.5	1.0	0.8

Table 5.12	Comparison of P	Proprietary

Note: Coefficient = Each Total / Maximum of Total Source: JICA Study Team

(6) Safety

A comparison of safety was made for the events that could occur in the different technologies. It should be noted that all the compared systems offer a high level of safety in general. The difference in score between 1.0 and 0.9 does not mean that one system is 10% safer than the other or vice versa, but that there is relative advantage between the evaluated elements. The comparative risk score (a higher score means greater exposure to risk) was calculated by multiplying the probability of an event by the severity of an event.

The table below shows the steps taken in the evaluation. The probability and severity of each safety related event were assessed by professionals from SMP and the JICA Study Team. The evaluations are shown in the upper and middle sections of the table. The results of the probability multiplied by severity are shown in the lower section of the table as the overall risk score. The integrated overall score and coefficient scores to be used in the summary comparison are shown at the bottom of the table.

PROBABILITY	LRT using dedicated lane	AGT	Monorail Straddle Type	Linear Metro	MRT conventional	LRT/MRT for steep slope
Derailment	2	2	1	2	2	3
Fire	2	3	3	2	2	2
Obstacle	3	3	2	3	3	3
Platform fall	2	2	2	2	2	2
Major System/Car Trouble	4	4	4	4	4	5
5: Frequent, 4: Likely, 3:Possi	ble, 2: Unusual, 1:	Impossible				
SEVERITY	LRT using dedicated lane	AGT	Monorail Straddle Type	Linear Metro	MRT conventional	LRT/MRT for steep slope
Derailment	4	4	5	4	4	4
Fire	3	4	4	3	3	3
Obstacle	2	2	2	2	2	2
Platform fall	2	2	4	2	3	3

Table 5.13Comparison of Safety Aspects

5: Fatal, 4: Severe, 3: Moderate, 2: Minor, 1: Negligible

Major System/Car Trouble

Overall risk score = probability x severity	LRT using dedicated lane	AGT	Monorail Straddle Type	Linear Metro	MRT conventional	LRT/MRT for steep slope
Derailment	8	8	5	8	8	12
Fire	6	12	12	6	6	6
Obstacle	6	6	4	6	6	6
Platform fall	4	4	8	4	6	6
Major System/Car Trouble	8	8	8	8	8	15
Total Risk Score	32	38	37	32	34	45
Coefficient for 6)	1.00	0.87	0.89	1.00	0.96	0.71

2

Note: Coefficient = Minimum of Total Risk Score/ Each Total Risk Score

Source: JICA Study Team based on discussions among experts

2

Some of the relevant considerations that were made for each evaluated event are as follows.

1) Derailment

Monorail systems have a bogic structure that grips the track beam by both stable wheels and guide wheels. Therefore, even if the running speed is high or the alignment includes sharp curves, or even if a strong crosswind is blowing, derailment is extremely unlikely.

As for the LRT/MRT systems for steep slope, the probability of derailment is considered higher than that for the standard slope due to its steep slope operations.

2) Fire

It was assumed that rubber tire systems would have a higher risk of fire than conventional steel wheel systems. There have been some cases of rubber tires catching fire, but it should be noted that there has not been any such event in Japan. Additionally, it was supposed that if a fire occurred the damage sustained in the rubber tire systems could be more severe than the steel wheel systems. This was reflected in the severity scoring.

3) Obstacles

A monorail's track is narrower than that of other systems for which the tracks are built on a slab or on the ground, therefore the probability of obstacles blocking the track is considered to be lower for the monorail than for other systems.

4) Danger of falls from the platform

Monorail systems have a disadvantage due to the greater height from the platform to the floor. This difference is noted in the severity score only, as the probability of falls occurring would be the same for all the systems.

5) Major System/Car Trouble

Major system or car trouble is a situation in which the train cannot move from the point of occurrence. Minor system or car trouble was deleted from the comparison because it was thought that there is no significant difference among the technologies. In the evaluation, LRT/MRT for steep slope was considered to have a disadvantage due to its large number of equipment in the traction system. The same argument could be applied to a linear metro system as it uses more equipment for traction. Conventional MRT would be given the same score when more motorized cars are required.

(7) Land Acquisition and Resettlement

The comparison was made based on the surface area of land acquisition and the extent of resettlement likely to be required for the construction. In some sections of the route, all the systems would need to exit the existing right of way, requiring land acquisition. In other sections, only the LRT/MRT require additional land acquisition due to the application of a larger horizontal curve (R=160m) in contrast to R=100m for the monorail, linear metro and AGT. The likely extent of resettlement is the same for all systems in this comparison. Therefore, the results show that the AGT, monorail and Linear metro enjoy a better score in this criterion.

In this comparative study, higher piers were used for LRT and MRT to comply with the 3.5% maximum slope. This is taken into consideration in the initial cost of infrastructure. Large land acquisitions and resettlements would be necessary if such high piers are not employed.

Land acquisition area and the number of affected houses were weighted as 30% and 70%, respectively. The overall score is calculated based on the factored sum of these two elements. For example the overall score of 0.8 for LRT is obtained as follows: $0.4 \times 30\% + 1.0 \times 70\%$.

Table 5.14 Comparison of Land Acquisition and Resettlement									
Impacts on Natural Environment	LRT using dedicated lane	AGT	Monorail Straddle Type	Linear Metro	MRT conventional	LRT/MRT for steep slope			
Required area for land acquisition (m2)	7,724	3,432	3,432	3,432	7,724	7,724			
30%	0.4	1.0	1.0	1.0	0.4	0.4			
Number of houses for resettlement	3	3	3	3	3	3			
70%	1.0	1.0	1.0	1.0	1.0	1.0			
Coefficient for 9)	0.8	1.0	1.0	1.0	0.8	0.8			

Table 5.14Comparison of Land Acquisition and Resettlement

Source: JICA Study Team

(8) Impacts on Natural Environment

A comparison was made of the surface area from which trees would have to be removed for the construction of each system. This was calculated as the area covered by a permanent structure or the car width in each system from plan view, in the heavily forested stretch from Panama Pacifico to the entrance of Arraijan. The total distance of this section was estimated to be L=7,200 m. The widths used in this comparison were 8.0m car width for Monorail, 10.0m slab width for MRT, LRT, linear metro and LRT/MRT for steep slope, and 9.0m slab width for AGT. The results show that the monorail has a lower impact on the natural environment compared to the other systems.

Tuble ette comparison of impacts on futural Environment								
Impacts on Natural Environment	LRT using dedicated lane	AGT	Monorail Straddle Type	Linear Metro	MRT conventional	LRT/MRT for steep slope		
Green area to be deforested by construction (m ²) Only in the section from Panama Pacifico to Arraijan	72,000	64,800	57,600	72,000	72,000	72,000		
Coefficient for 9)	0.8	0.9	1.0	0.8	0.8	0.8		

 Table 5.15
 Comparison of Impacts on Natural Environment

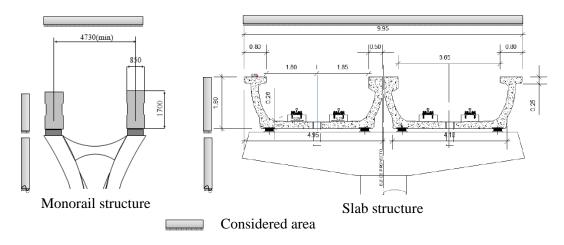
Source: JICA Study Team

Noise impact was discussed as a criterion but was finally dismissed. Even though rubber tire systems such as the monorail and AGT have an advantage of being much quieter than steel based systems, steel system noises can be mitigated by improved technology (i.e.: U-shape slabs used in Line-1) and longer rails.

Several other environmental impacts were considered in the systems comparison (i.e.: the amount of dewatering required, energy consumption and construction period), but the engineering and environment teams determined that the differences in these elements between the systems were minimal, and thus were not included in the scored analysis.

(9) Landscape/ Cityscape

A comparison was made of the area that would be covered by a permanent structure in each system from plan view and lateral view. Scores were calculated based on the width of superstructure from plan view and width of column from lateral view. The results were directly calculated in proportion to the area that obstructs the landscape view.



Source: JICA Study Team based on Line-1 and JICA Study for Sao Paulo Urban Transit Figure 5.5 Comparison of Impact on Landscape (Area shaded by Structure)

The results show a large advantage for the monorail in this criterion. This is one of the well-known strong selling points of the monorail arising from its simple superstructure. The results here reflect this as well.

1401		nparison or i	impact on De	muscupe / C	<i>lyscape</i>	
Landscape/Cityscape	LRT using dedicated lane	AGT	Monorail Straddle Type	Linear Metro	MRT conventional	LRT/MRT for steep slope
Area that would be covered (shaded) by the elevated structure (m^2)	323,750	323,750	207,000	323,750	331,250	323,750
Coefficient for 9)	0.6	0.6	1.0	0.6	0.6	0.6

 Table 5.16
 Comparison of Impact on Landscape / Cityscape

Source: JICA Study Team

(10) Maintainability

Maintainability was evaluated by examining how difficult / easy maintenance works are for each system. The cost of maintenance is not a factor in this part of the evaluation as it was considered in the O&M cost. The elements that are considered to have different levels of difficulty in maintenance are listed in the comparison table below. In this comparison the overall difference in maintainability is insignificant between the systems. The table, however, helps to provide an understanding of the different characteristics of each system.

Maintainability	LRT using dedicated lane	AGT	Monorail Straddle Type	Linear Metro	MRT conventional	LRT/MRT for steep slope
Track structure	4	5	5	3	4	3
Electric facilities (on track)	5	4	3	5	5	5
Rolling stock	4	5	5	5	5	4
Wheel reprofiling	4	5	5	4	4	4
Tire replacement	5	3	3	5	5	5
Total	22	22	21	22	23	21
Coefficient for 10)	0.96	0.96	0.91	0.96	1	0.91

Table 5.17Comparison of Maintainability

Source: JICA Study Team based on the discussions among experts

Some of the relevant considerations that were made for each evaluated element are as follows.

1) Track structure

The track structure for AGT and monorail (rubber tire systems) are almost maintenance free, whereas the track structure for linear metro and MRT/LRT for steep slope are harder to maintain due to its steeper profile. In addition, the linear metro has a unique structure with the reaction plate.

2) Electric facilities (on the track)

AGT and monorail have a multiple rigid contact line, whereas LRT, linear metro, conventional MRT and MRT/LRT for steep slope (steel wheel systems) have a simple overhead catenary. The monorail has to use a special maintenance vehicle inspecting the contact line.

3) Rolling stock

All the vehicles for the MRT/LRT for steep slope are configured with motorized cars; therefore they have more electric facilities to maintain.

4) Wheel reprofiling/Tire replacement

AGT and Monorail (rubber tire systems) have to have their rubber tires replaced more frequently than the steel wheels of LRT, linear metro, conventional MRT and MRT/LRT for steep slope (steel wheel systems).

Steel wheel systems have to have their steel wheels reprofiled several times before replacement. The frequency increases for alignments with small horizontal curves, which is the case for Line-3.

5.5 Conclusion

The total point of scores is calculated from the coefficient of each evaluation item for candidate systems by multiplying the coefficient by the weight as shown in Table 5.6.

A multi-criteria comparison was carried out to determine the characteristics of each system taking the route conditions of Line-3 into consideration. Through the analysis described in this chapter, it was confirmed that the monorail is the most appropriate system for Line-3, followed by the conventional MRT. The difference between the two systems is not

significant in terms of scores, but there are decisive factors which make the monorail system the most appropriate for Line-3 as shown below.

- The initial cost of the monorail is more than USD200 million lower than the conventional MRT for Line-3
- Technical difficulties are observed for some sections of the MRT line where very high piers (over 40m) would be required to avoid large scale land acquisition needed for softening the vertical profile of the railway infrastructure.

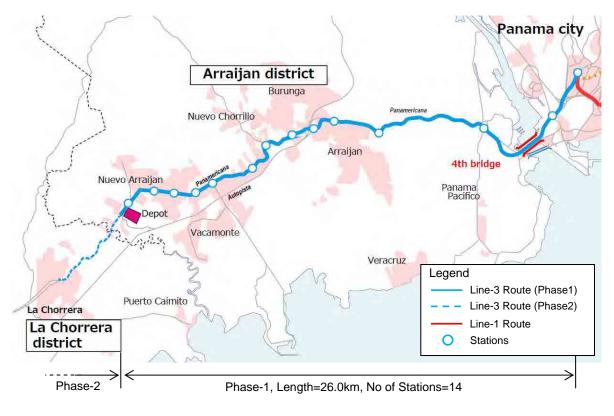
Considering the above results, this report concludes that the monorail is the most appropriate system for Line-3.

Chapter 6 Route Plan

6.1 Route of Line-3

The route of Line-3 is as same as that of Pan-American Road. Lying east and west and linking three districts of Panama Province: Panama District, Arraijan District and La Chorrera District, Line-3 reaches a total length of more than 30km. Line-3 is divided into two stages: Phase-1 is a 26km section from Albrook station to the Depot, which is to be located near Arraijan and La Chorrera bourder, and Phase 2 is an extension of the line toward La Chorrera, although the route and the location of the terminal station have not yet been determined for Phase 2.

Line-3 starts from Albrook station, which is also the beginning point of Line-1, and extends to the southwest parallel to the road leading to the future 4th bridge over the canal. The route crosses the canal via the 4th bridge, and from the west bank of the canal it enters rough terrain zigzagging over the rugged hills along the Pan-American road until reaching Arraijan. Here it crosses over the Autopista highway and continues westward along the Pan-American road ending at the Depot, which is located about 3km west of Nuevo Arraijan.



Source: JICA Study Team

Figure 6.1 Outline of Line-3 Route

6.2 Route Condition

6.2.1 Topographical Conditions

The topographical conditions to the west and east of the canal differ widely. On the east side of the canal the terrain is almost flat although there is a hill in the middle of the route, with a height of approximately 80m, which will require some earth moving works. The route will touch this hill and connect to the 4th Bridge.

To the west of the Canal the terrain is hilly and no flat area can be observed in this area. The elevation gradually increases from the end of the 4th bridge on the west bank of the canal (approx. altitude 10m) and reaches an altitude of 130m at the highest point just before Arraijan. In the section between Panama Pacifico and Arraijan, jungles spread out on both sides of the road and the road has consecutive sharp curves and steep slopes. There is a section of steep slope for a distance of 1,300m just before Arraijan; the average gradient of this long slope is 6%.

Figure 6.2 shows a satellite image with the horizontal alignment, the vertical alignment, and photos of the first half of the route.

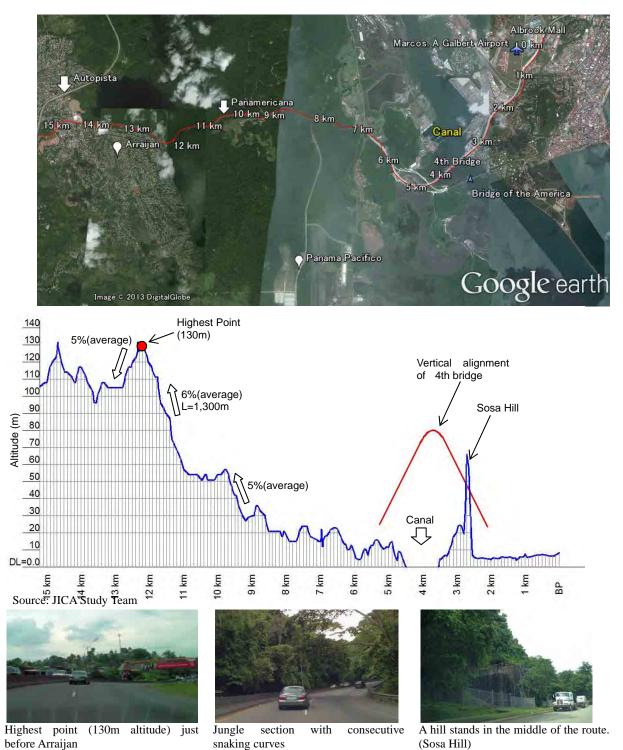
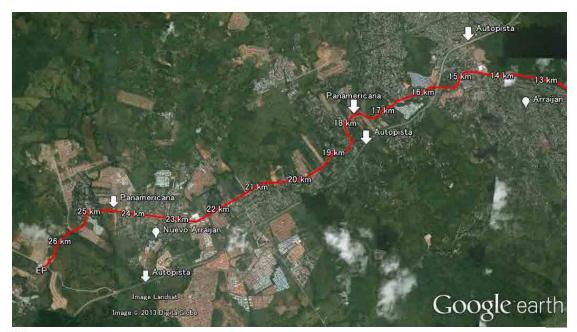
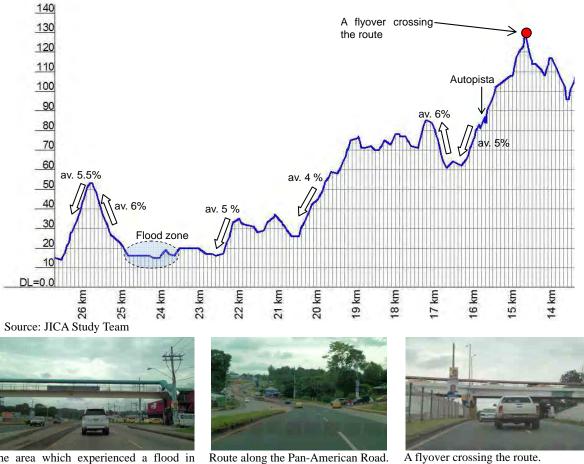


Figure 6.2 Satellite image, profile outline and photos along the first half of the project route

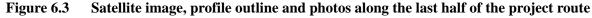
After passing Arraijan, houses and stores can be seen intermittently along the Pan-American Road. Since the Pan-American Road was constructed on the surface of hilly terrain, the selected route has consecutive sharp curves and steep slopes although the surrounding area has developed to some extent. By comparison, the Autopista, which runs parallel to the Line-3 route, has less curves and slopes since it is a highway that was constructed with considerable earth works. The elevation decreases toward Nuevo Arraijan in last half of the route. There is a flat area in Nuevo Arraijan with an elevation of around 10m. This flat area experienced extensive flooding in 2012.

Figure 6.3 shows a satellite image with the horizontal alignment, the vertical alignment, and photos of the last half of the route.





The area which experienced a flood in 2012. (near the end point of the route)



6.2.2 Geographical Conditions

A geotechnical survey was carried out at 51 locations. Based on the result of investigation and the data obtained from ACP on the east bank of the canal, bearing layer depths to be used for this study were determined as shown in Table 6.1.

 Table 6.1
 Bearing Layer Depths Determined Based on Geotechnical Investigation

Section	Bearing Layer	Notes
B.P ∼2+600	20m	Determined based on 1 boring result from this Study and 7 locations provided by ACP
2+600~5+050		Monorail is constructed on the structure of the 4 th Bridge.
5+050~10+000	10m	Determined from 9 borings results
(6+900~7+100)	(20m)	(This section shall be 20m depth.)
10+000~19+000	15m	Determined from 19 borings results
19+000~終点	25m	Determined from 18 borings results
(24+000~25+500)	(30m)	(This section shall be 30m depth.)

Source: Result of Geotechnical Investigation

(1) Geological Outline from Fourth Bridge to Arraijan

In this section, the geological strata mainly consist of loam with different consolidation levels by depth. Un-consolidated loam lies at the top stratum; followed by semi-consolidated loam. Underneath this layer lies consolidated loam up to an average depth of 9m. The surface is covered by a thin layer of gravel or vegetation and N-value ranges from 3 to 15, depending on the level of consolidation. Sound rock is observed at an average depth of 10~20 m.

(2) Geotechnical Outline from Arraijan to Nuevo Arraijan

Geological conditions of this section are similar to the above section, with trend of having the bearing layer deeper, as it goes west. The bearing layer at nearby existing rivers reaches as deep as 25 m.

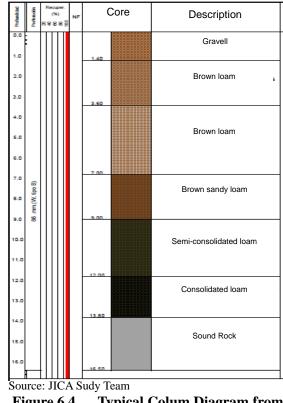


Figure 6.4 Typical Colum Diagram from the 4th Bridge to Arraijan

6.2.3 Utilities

There are different types of utilities along the project route. Some of the utilities such as fuel pipeline and water main should be considered as design controls to avoid the high cost and social impact of their relocation. Other utility service infrastructures such as minor water pipes, relatively small capacity transmission lines, telecommunication lines and so on should be relocated when they interfere with the project alignment.

The information on utility locations was collected not only through field visits but also through interviews with relevant authorities such as IDAAN for water pipes and the Administrative Unit for Reverted Estate of MEF for fuel pipelines. The data was obtained from these entities as physical copies or in digital formats.

The list of authorities related to public utilities along the project route is shown below.

Table 0.2 The List of Authorities Related to Fublic Ounities					
Type of utility	Name of authority	Description			
Fuel pipeline and water pipe in the	Unidad Administrativa	Fuel pipelines from fuel tanks at Finca de			
reverted area	de Bienes Revertidos/	Tanque de Arraijan to Vasco Núñez de Balboa			
	Petroamerica Terminal	navy base should be avoided. Location			
	S.A.	information was obtained in CAD format.			
Water / Sewerage	IDAAN	There are pipes along the project route. The			
		location information was obtained partially in			
		GIS format.			
Power supply	ETESA	Line-3 route crossing some transmission lines			
		of medium capacity			
		Network information was obtained in paper			
Propane gas supply	Tropigas / Panagas	Gas service is provided in gas cylinders			
Telecommunication/Cable	Cable & Wireless /	Major service providers covers the area along			
	Cable Onda	the project route			

1able 0.2 The List of Authorities Kelated to Public Utilities	Table 6.2	The List of Authorities Related to Public Utilities
---	-----------	---

Source: JICA Study Team

The most challenging issue related to the utility service seems to be fuel pipelines and water/sewerage pipes along the project route. Through field visits and interviews with authorities, the important installations were identified. Some examples of the utilities are shown below.

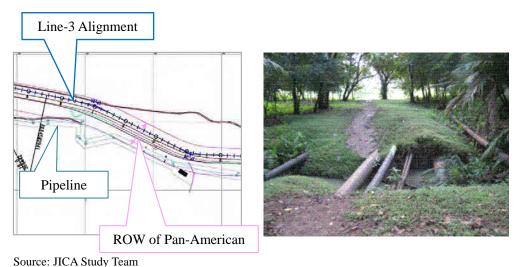
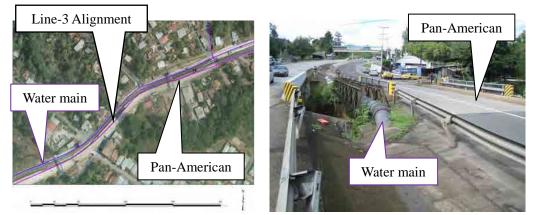


Figure 6.5 Location and photo of Fuel Pipelines along the Line-3 Alignment



Source: JICA Study Team



6.2.4 Hydrological Conditions

(1) Surface Water

The Panama Canal is the body of water with greatest importance in the study area. The estuary formed where the Canal enters the Pacific Ocean is affected by the Pacific tides mixing with the freshwater from the Canal watershed.

Panama City has a number of important watersheds: the Matasnillo River, the Matias Hernandez River, the Cabuya River, the Rio Abajo River, the Tocumen River, the Tapia River, and the Curundu River. These watersheds are formed by secondary rivers, brooks and creeks.

The Line-3 project is located in watershed N°142 (the watershed between the Caimito and Juan Diaz Rivers) and watershed N°140 of Caimito River (see Figure 6.7). Line-3 crosses the following rivers: Caimito; Curundu; Velazquez; Perico; Caceres; Burunga; Aguacate; and Bernardino.

The eastern end of the Line-3 alignment is located in the western watershed of the Curundu River, which includes the Canal, the Marcos A. Gelabert International Airport, and the Balboa area. The small streams in the area were channeled and pass under the existing buildings.

Watershed N°140 is formed by the rivers Aguacate, Caceres, San Bernardino, Potrero and Caimito, the latter being the main river in the watershed.

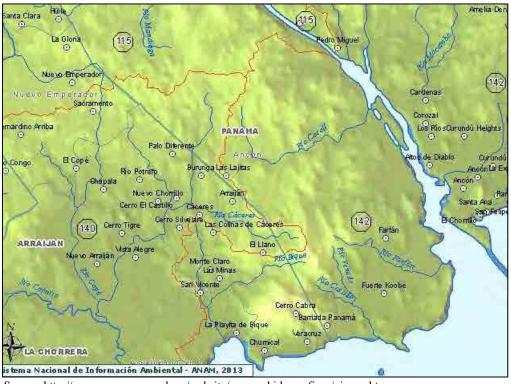
Water use in the watershed is devoted to crop irrigation and domestic use; the watershed is the main source of water for the community of La Chorrera. Near the urban area, the river is under pressure from over-extraction of water, disposal of waste materials and direct discharge of industrial wastes and sewage into the river.

As a result of the pressures on the Caimito River watershed, the quality of the rivers in the watershed has already declined, and it is likely to decline further.

(2) Groundwater

The Hydrogeological Map of ETESA (1999) establishes an aquifer in the study area, within the geological groups of La Boca and Panama Formations. The aquifer is composed of marine deposits, generally of a clastic nature, with occasional sections of biochemical (limestone) origin. The chemical quality of the water is variable.

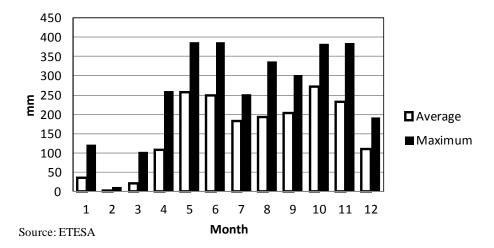
The water table of the area exhibits significant seasonal variation; during the dry season it can decline to more than five meters below the surface. The water table rises during the rainy season to less than 50 cm from the surface creating problems in surface drainage, and in some cases, welling up onto the surface.

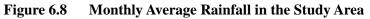


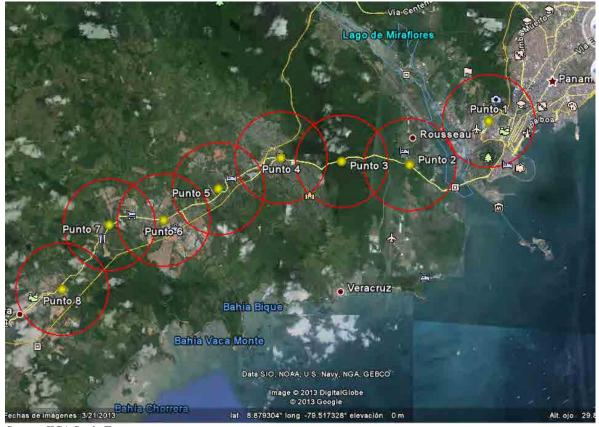
Source: http://mapserver.anam.gob.pa/website/cuencashidrograficas/viewer.htm Figure 6.7 Watershed distribution - Project Area

6.2.5 Meteorological Condition

Panama belongs to a tropical climate, having the average temperature of 27 degree through the year with the highest of 39 degree and the lowest of 15 degree. Panama has dry season and wet season, and the rain falls hard with thunders in wet season from May to November. The number of days when thunders are observed is approximately 50 in a year along the study route, and most of them are observed in the wet season (average from 2008 to 2012, ETESA). The number of days of lighting in the area where monorail is operated in Japan is Tokyo-12.9 days, Osaka-16.2 days, Fukuoka-24.7 days, Naha-21.6 days (the average in 30 years from 1981-2010: Japan Meteorological Agency). Since the above isokeraunic level in Panama represents that of very narrow area, the condition about lighting is much more severe than that of Japan. On the other hand, wind is moderate through the year and there is no typhoon and hurricane.







Source: JICA Study Team

Figure 6.9 **Locations of Lighting Statistics**

Table 6.3Yearly Average No. of Days of Lighting (2008-2012)							
8	7	6	5	7	3	2	1
43.4	45.6	48.6	50.2	57.2	53.6	53.4	53
C ETECA							

	able 6.3 Y	Yearly A	Average No.	of Days of L	ighting ((2008-2012)
--	------------	----------	-------------	--------------	-----------	-------------

Source: ETESA

6.3 Station Location

The stations of Line-3 are located in the central area of each region where there is a high potential for attracting passengers. The locations were decided as described below.

- In a level section of the railway alignment
- Adjacent to existing intermodal facilities such as a bus terminal or bus stop
- Adjacent to intersections of main roads
- Close to existing or developing residential areas
- Close to existing or developing industrial areas

The alignment of Line-3 begins from the Albrook area passing through Balboa and reaches the area where the 4^{th} Bridge is to be constructed in the near feature. After passing over the 4^{th} Bridge to the west side of the canal, the alignment follows the Pan-American Road up to Nuevo Arraijan. The total length of the alignment is approximately 26km from Station No.1 Albrook to Station No.14 Ciudad del Futuro. The longest distance between stations is 5.56km from Station No.3 Panama Pacifico to Station No.4 Loma Coba. An emergency station is planned for the mid point between these stations to provide for evacuation in case of an emergency event.

As mentioned above, Line-3 will have 14 stations and 1 emergency station. The structure of most stations is elevated with the exception of Station No.14 Ciudad del Futuro which is at grade level. Table 6.4 shows the locations of stations and the distances between stations.

Out of 14 planned stations, three stations – E9 (Caceres) and E13 (San Bernardino), which serve newly developed areas and E6 (Arraijan Mall), which is planned at the location where a shopping mall is planned, are projected to have less passengers than other stations and can be supplemented with their neighboring stations. Therefore, these three stations will be considered at the future stations in the implementation plan.

N.T.	C:	Table 6.4	Station	Location	
No.	Station		eage	(\mathbf{V}_{m})	Note
		Location (Km)	Distance	(Km)	
E1	Albrook	0+000			Integration with Line-1 and AGNT
			2.0	50	(Albrook bus terminal)
E2	Balboa	2+050	2.0	50	Connection with administrative
ΕZ	Dalboa	2+030			district
			4.8	00	
E3	Panama Pacifico	6+850	4.0	00	Connection with industrial area
<u>L</u> J		01050	3.450		
	(Emergency	10+300	51150		
	Platform)	10+500		5.560	
			2.110		
E4	Loma Coba	12+410		1	Connection with existing
		_			residential area
-			1.9	40	
E5	Arraijan	14+350			Intersection with Arraijan and
	5				Burunga area
			1.1	20	
E6	Arraijan Mall	15+470			Connection with future shopping
	(Future Station)				mall
			0.9	80	
E7	Burunga	16+450			Connection with existing
					residential area
			1.4	10	
E8	Nuevo Chorrillo	17+860			Intersection with Nuevo Chorrillo
					area
			1.2	.90	
E9	Caceres	19+150			Connection with
					newly-constructed residential area
			1.450		
E9-1	(Future Station)	20+600		2.300	
			0.850		
E10	Vista Alegre	21+450			Intersection of two routes between
					Panamerica road and Vacamonte
				20	area
E 11	X ^r - (- A 1,	22.270	0.9	20	
E11	Vista Alegre 2	22+370			Connection with existing shopping
			1 1	<u>00</u>	mall
E12	Nuque Ameiian	22+550	1.1	ðU	Connection with existing
E12	Nuevo Arraijan	23+550			Connection with existing residential area
			0.7	00	
E13	San Bernardino	24+250	0.7	00	Connection with newly
Е13	(Future Station)	24+230			Connection with newly constructed development area
			1.6	00	
E14	Ciudad del Futuro	25+850	1.0	00	Intersection with La Chorrera area
L14	Ciudad dei Fulufo	Total	25.	250	Incisection with La Chorrera area
	IICA Study Teem	10181	23.	550	ļ

	~
Table 6.4	Station Location

Source: JICA Study Team

The average distance between stations for the entire line is 1.99km. It would appear that this distance is great, but this situation arises largely from the existence of a protected forest along Line-3. This forest has the function of protecting the canal watershed. There is no large development in the area, nor is there a plan to install a station here.

If the distance of the protected forest is removed, the average distance between stations is 1.34km. This distance is close to the figure for existing urban railways in the world.

The outline of typical stations is shown below.

	Table 0.5 Outline of Typical	
Station	St.No.1 Albrook	Photos
Structure	Opposite Platforms and two lines	Planned site of station
Structure	Switching point for turn-back	
Daily Ridership	Person / Day; 221,708	
Characteristics	The station is located midway between AGNT (Albrook bus terminal) and Line-1, in a key transportation area for Panama. Accessibility needs to be increased between Line-3 and the other mass rapid transit systems. An appropriate platform size is needed to meet the traffic demand of the morning peak hour.	Terminal station of Metro Line-1

Table 6.5	Outline	of Typical	Stations
Indic of	outilite	or rypreur	Stations

Station	St.No.4 Panama Pacifico	Photo
Structure	 Opposite Platforms and two lines Platform length is longer than the normal station's for emergency measures 	Planned site of Station
Daily Ridership	Person / Day; 30,325	
Characteristics	The station is located at the entrance of the Panama Pacifico industrial area. In the morning peak hour, it has the second largest passenger volume. The platform length is longer than the normal station to accommodate the lead vehicle of another train	Entrance/ Exit of Panama Pacifico

Station	St.No.6 Arraijan Mall	Photo
Structure	Opposite Platforms and two lines	
Daily Ridership	Person / Day; 13,375	
Characteristics	The station is located at the planned site for a commercial development. The direct connection between the station and the commercial area increases passenger convenience and use. This area is a transportation hub for local traffic and an Intermodal Facility is also installed in the shopping area to accomodate the traffic.	Planned site of Station.

Station	St.No.8 Nuevo Chorrillo	Photo
Structure	 Two Platforms and three lines Switching point for turn-back	
Daily Ridership	Person / Day; 21,708	Planned site of Station
Characteristics	The station is located at the mid-point between Albrook Station and the Phase-2 La Chorrera station. A switching point for turn-back is installed. A difference in demand occurs at this station. In addition, a Park & Ride Facility is installed for passengers with cars.	

Station	St.No.10 Vista Alegre	Photo
Structure	Opposite Platform and two lines	
Daily Ridership	Person / Day; 31,567	
Characteristics	The station is located at the intersection of Pan-American road and the main road to Vacamonte. Vacamonte area is expanding rapidly with the widening of the Autopista. An Intermodal Facility is installed for feeder traffic.	Planned site of Station

Station	St.No.14 Ciudad del Futuro	Photo
Structure	 Opposite Platforms and two lines Switching point for access to Depot / Workshop 	Planned site of Station
Daily Ridership	Person / Day; 2,333	
Characteristics	This is the last station of Phase-1. In addition, the Depot/Workshop and a large Intermodal Facility will be built in the vicinity of this station. The station has the role of a transportation hub for feeder traffic from La Chorrera.	

Note; Numbers of the daily ridership are based on the demand forecast for Phase-2. Source: JICA Study Team