REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS (DPWH)

PREPARATORY SURVEY FOR SOUTHERN MINDANAO ECONOMIC CORRIDOR IMPROVEMENT (DAVAO CITY BYPASS CONSTRUCTION) PROJECT

FINAL REPORT

FEBRURARY 2015

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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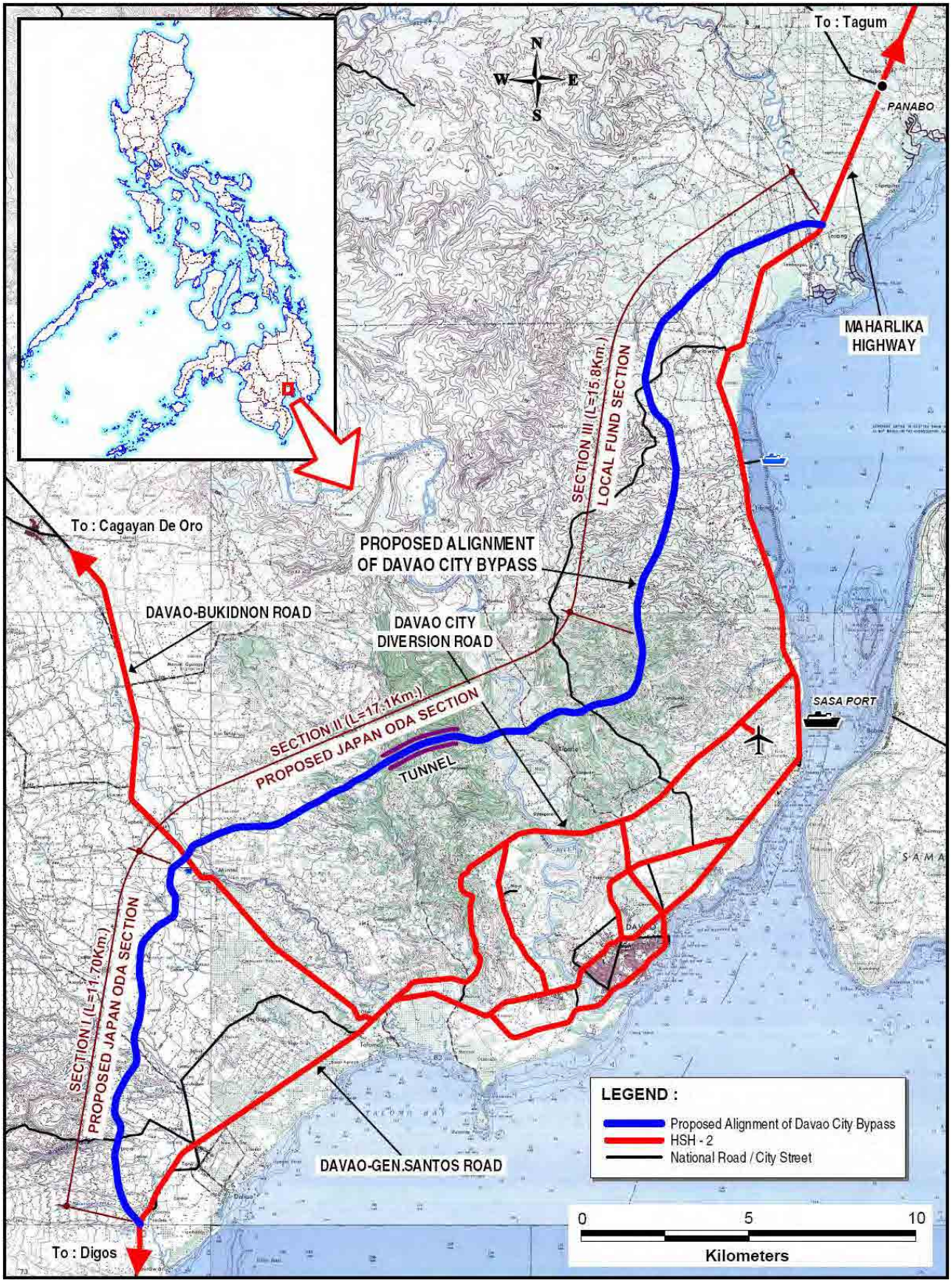
EXCHANGE RATE

December 2014

1PhP= 2.50 Japan Yen

1US$= 45.0 Philippine Peso

1US$= 116.2 Japan Yen



LOCATION MAP OF PROJECT AREA

ACRONYMS AND ABBREVIATIONS

AASHTO	:	American Association of State Highway and Transportation Officials
ADB	:	Asian Development Bank
ASEAN	:	Association of Southeast Asian Nations
BCS	:	Business Case Study
BPI	:	Bureau of Plant Industry
CLUP	:	Comprehensive Land Use Plan
DENR	:	Department of Environment and Natural Resources
DPWH	:	Department of Public Works and Highways
ECAs	:	Environmentally Critical Areas
ECC	:	Environmental Clearance Certificate
ECPs	:	Environmentally Critical Projects
EIA	:	Environmental Impact Assessment
EIS	:	Environmental Impact Statement
EMB	:	Environment Management Bureau
EO	:	Executive Order
GDP	:	Gross Domestic Product
GRDP	:	Gross Regional Domestic Product
HCM	:	Highway Capacity Manual
HSH Master Plan	:	High Standard Highway Master Plan
IEC	:	Information Education and Communication
IMF	:	International Monetary Fund
JICA	:	Japan International Cooperation Agency
LGUs	:	Local Government Units
MDG	:	Millenium Development Goals
MILF	:	Moro Islamic Liberation Front
MinDA	:	Mindanao Development Authority
NCIP	:	National Commission on Indigenous Peoples
NEDA	:	National Economic Development Authority
NTP	:	National Transport Policy
O-D	:	Origin-Destination
PCC	:	Portland Cement Concrete
PCU	:	Passenger Car Unit
PD	:	Presidential Decree
PDP	:	Philippine Development Plan
PDS	:	Project Description for Scoping
PEISS	:	Philippine Environmental Impact Statement System
PIP	:	Public Investment Plan
PPP	:	Public-Private Partnership
RAP	:	Resettlement Action Plan
RDP	:	Regional Development Plan
RORO	:	Roll-On Roll-Off
ROW	:	Right-Of-Way
SOCCSKSARGEN	:	SOuth Cotabato, Cotabato, Sultan Kudarat, SARangani, GENeral Santos City
STRADA	:	System for TRAffic Demand Analysis
WB	:	World Bank

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Executive Summary

EXECUTIVE SUMMARY

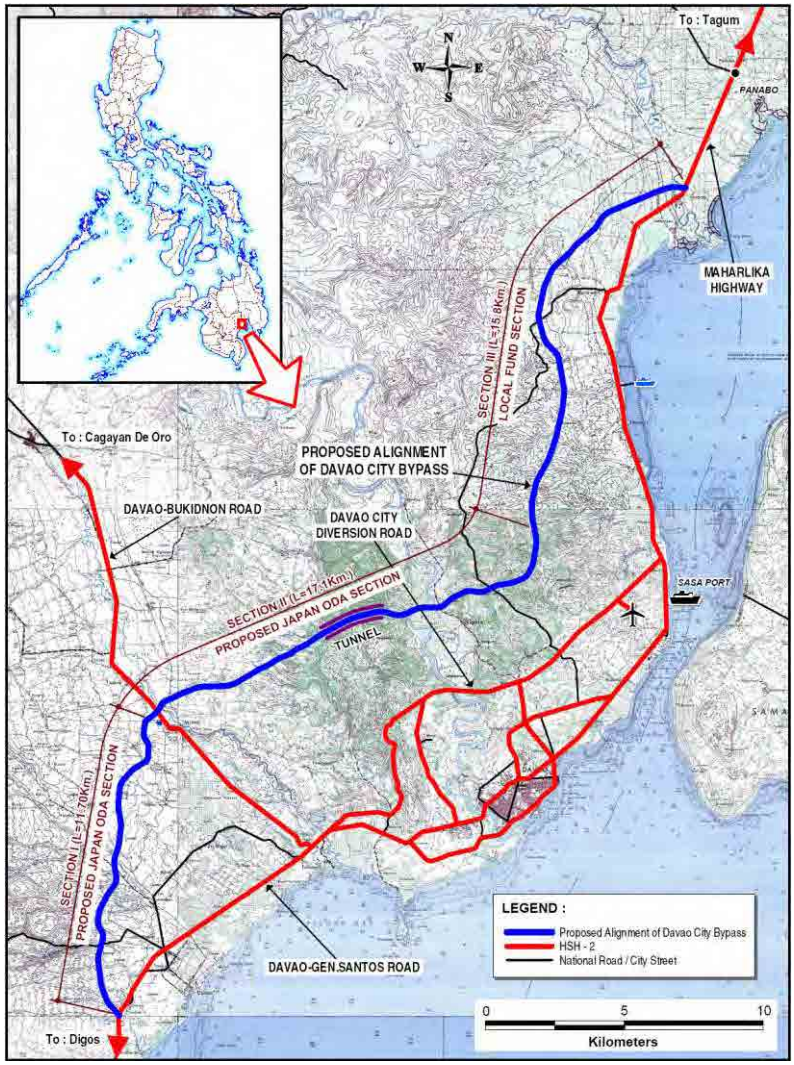
1. BACKGROUND AND OBJECTIVES

1.1 BACKGROUND

- Signing of the Bangsamoro Peace Framework Agreement in Oct. 2012 is expected to accelerate the economic development of Mindanao.
- Davao City is the largest urban center in Mindanao.
- JICA-assisted Master Plan Study on High Standard Highway Network Development (2010) proposed Davao City Bypass.
- DPWH undertook the Business Case Study (BCS) for Davao City Bypass. BCS recommended that the project should be implemented as a conventional Government finance project.

1.2 STUDY AREA

The Study Area covers Davao Region (i.e. Region XI).



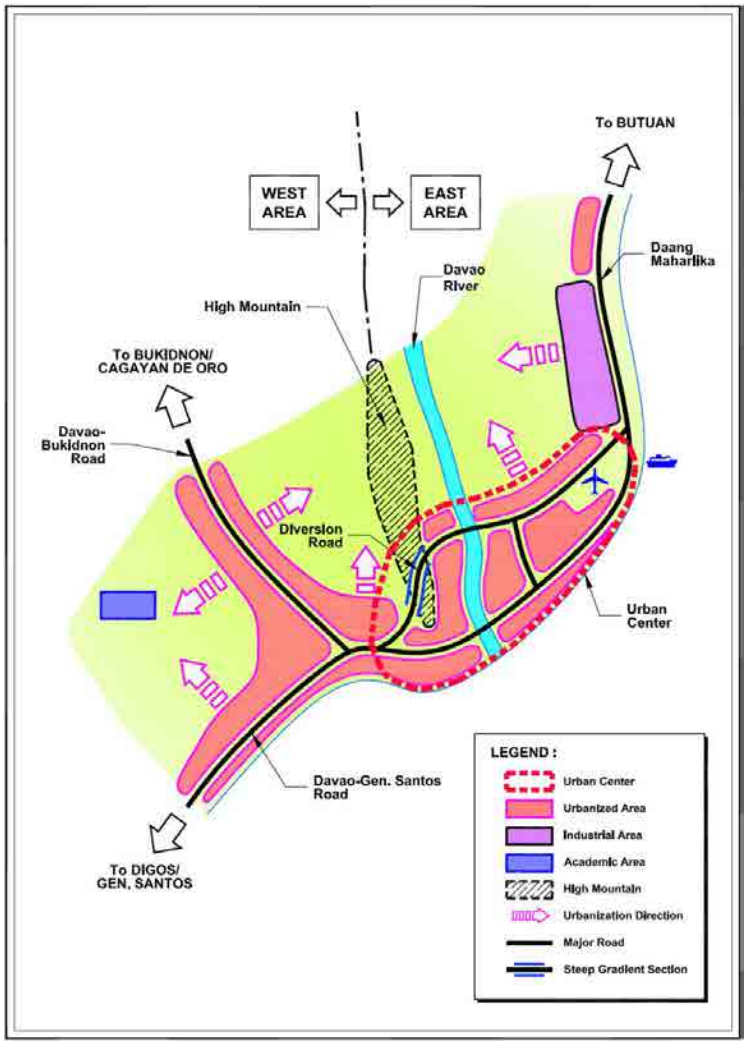
1.3 OBJECTIVE OF THE PROJECT

Objective of the project is to improve the transport logistics and mitigate congestion in Davao City, thereby contributing to economic and social development in Mindanao.

2. NECESSITY OF THE PROJECT

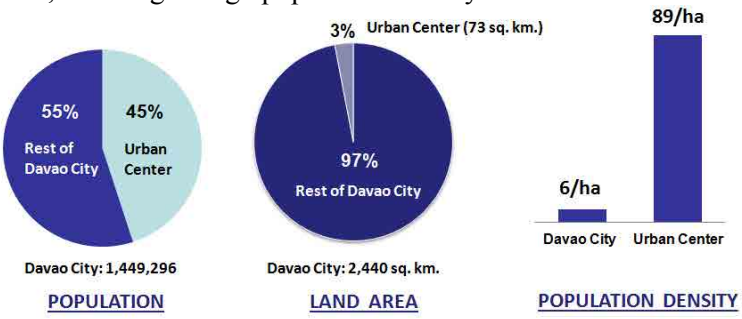
2.1 THE URBAN CENTER

Urban Center is defined as the area surrounded by the Diversion Road and the sea.



2.2 OVERCONCENTRATION OF POPULATION AND ECONOMIC ACTIVITIES IN THE URBAN CENTER

Forty-five (45%) of Davao City population is concentrated at the Urban Center which shares only 3% of the Davao City land area, resulting in high population density.



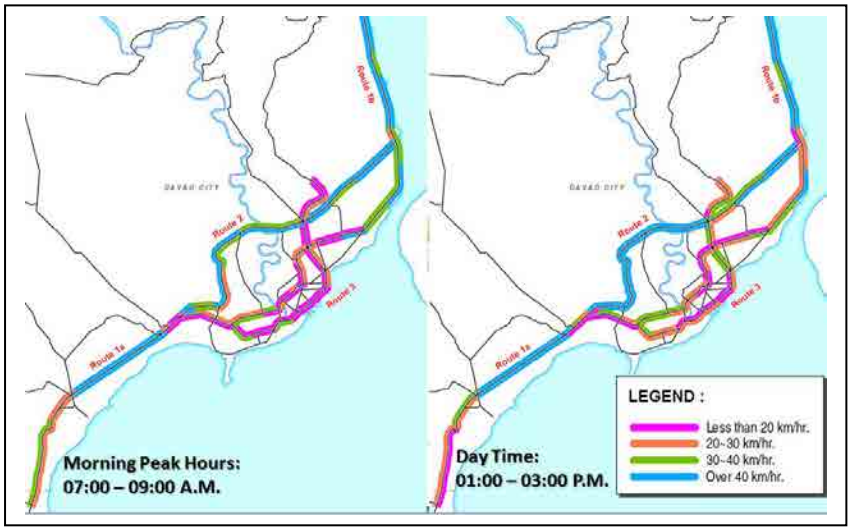
Large scale shopping malls are concentrated in the Urban Center. Also, International Port/Airport and Bus Terminals are located within the Urban Center.

2.3 POPULATION GROWTH TREND

- Population Growth Rate (2007 – 2010)
  - Urban Center : 1.07% per annum
  - Davao City : 2.19% per annum
- Urbanization is rapidly progressing at neighboring areas of the Urban Center.

2.4 CHRONIC TRAFFIC CONGESTION IN URBAN CENTER

The travel speed of most roads in the Urban Center is less than 20 km/hr. Traffic congestion is being experienced not only in the morning peak hours but also day time. Thus, the urban center suffers chronic traffic congestion throughout the day.



2.5 DIVERSION ROAD

- **Diversion Road** is becoming **very important road**.
- Traffic which used to pass through Urban Center is now diverting to Diversion Road.
- Most trucks are now using Diversion Road due to "Truck Ban" in the Urban Center.

Problems

- Due to roadside development, roadside friction along Diversion Road is rapidly increasing.
- Diversion Road climbs up and down the mountain with a steep gradient of 6.5 ~ 7.0%. Loaded trucks can only travel with a low speed of 20~25km/hr.

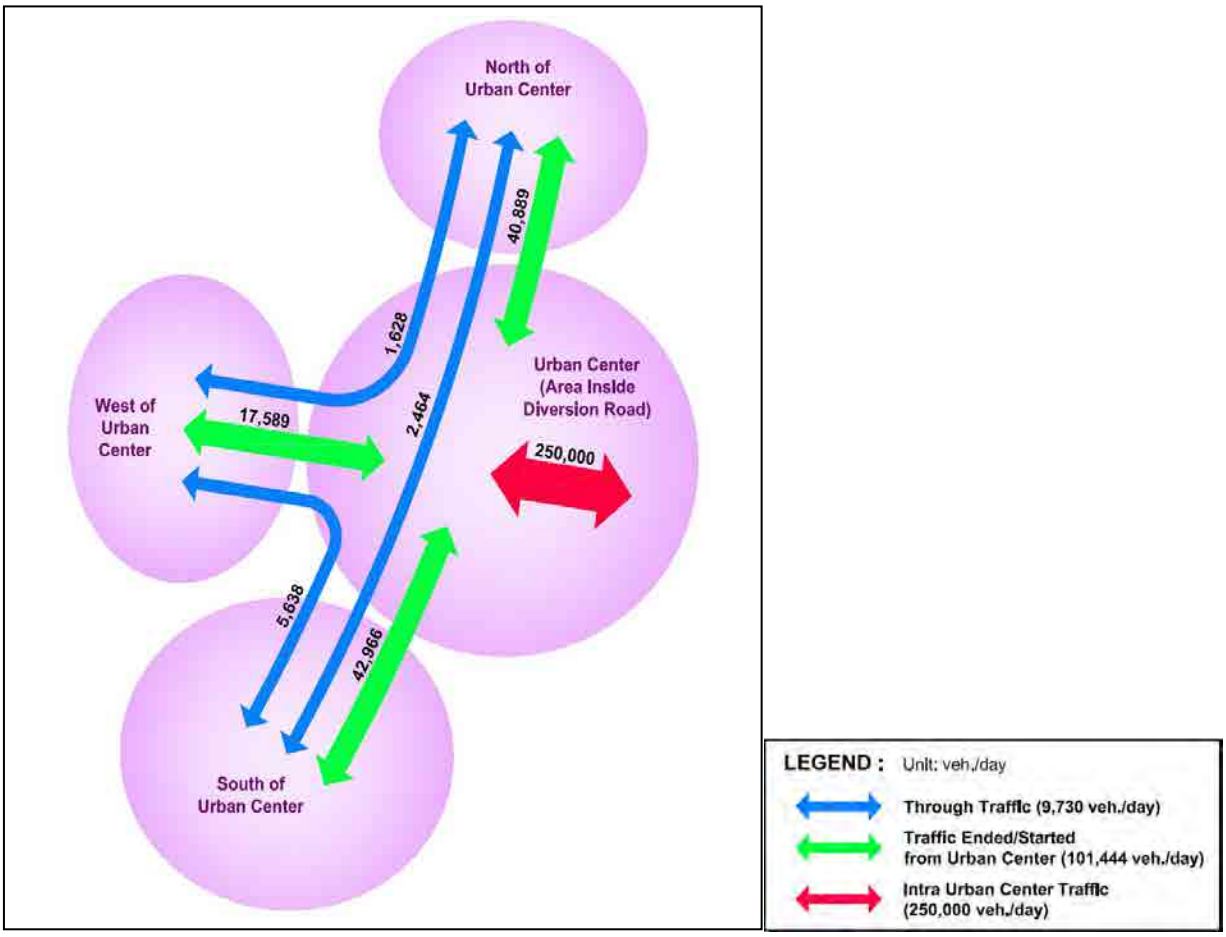
Near Future

- Traffic congestion is currently experienced only at Buhangin section.
- Traffic congestion will occur most of Diversion Road due to more diverted traffic and severe roadside friction.

2.6 TRAFFIC CHARACTERISTICS

In order to reduce traffic burden of the Urban Center,

- The BYPASS should attract;
  - Through Traffic – 9,730 veh./day (most of this traffic will utilize a bypass)
  - Urban Center-related Traffic – 101,444 veh./day (some of this type of traffic will be able to use a bypass)

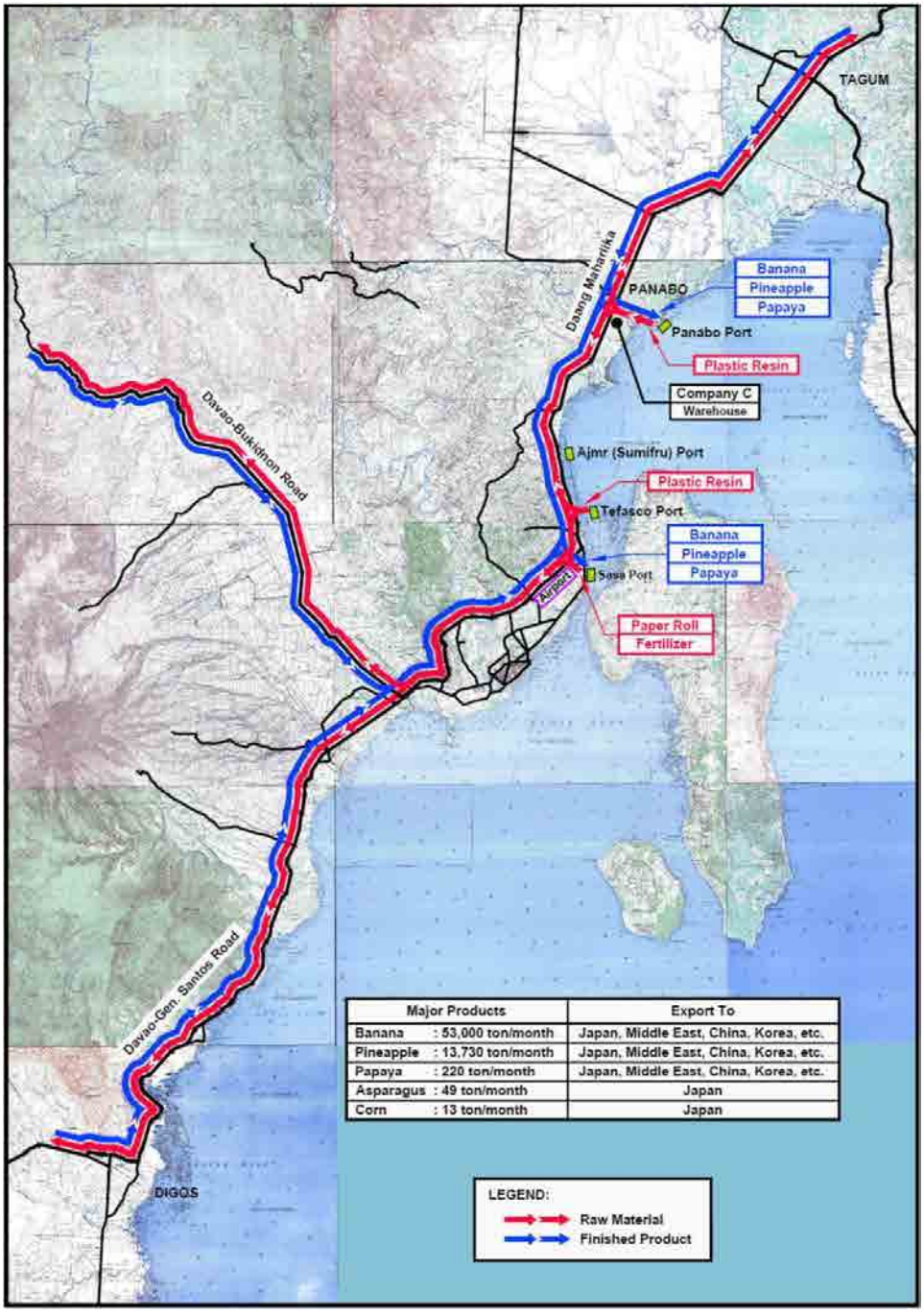


2.7 INTERVIEW RESULT OF MANUFACTURING/AGRI-BUSINESS COMPANY

Interview with manufacturing/agri-business companies were conducted. Sample for an interview result with company C is as follows:

Company C:

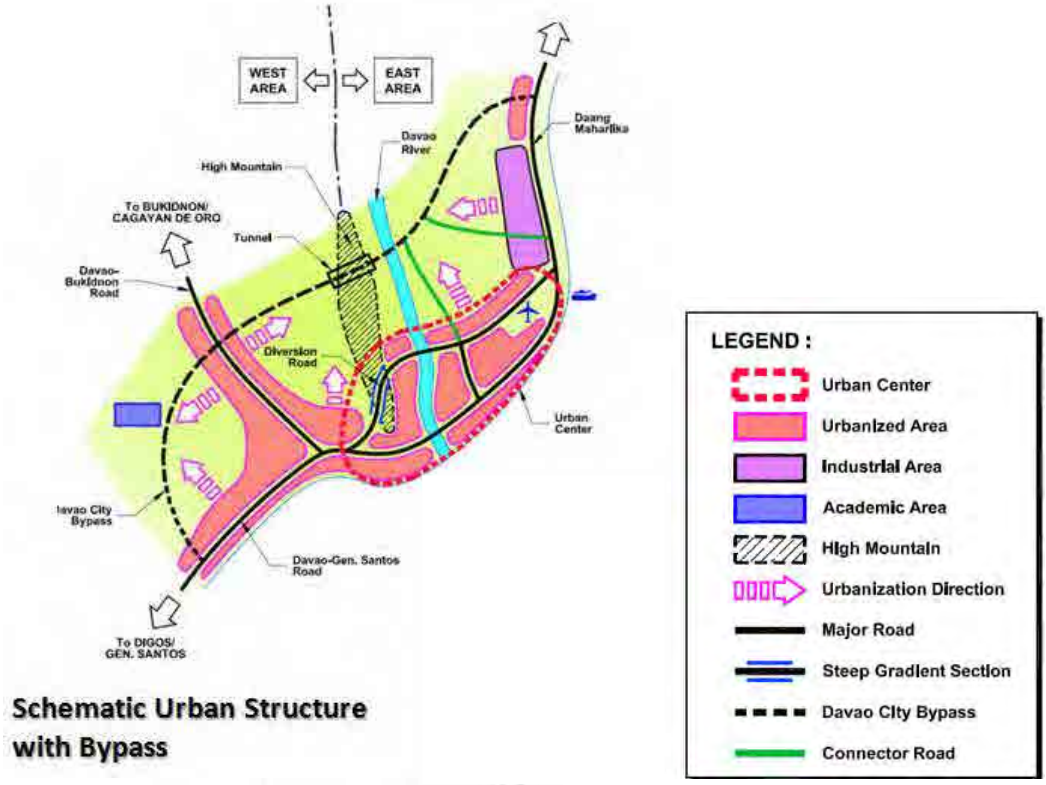
- Exporting Banana, Pineapple, Papaya, etc., to Japan, Middle East, China, Korea.
- Materials necessary for farming are unloaded at Sasa Port, Panabo Port, TEFASCO Port and distributed all over Mindanao.
- Products come to Davao City and Panabo City and exported through Sasa Port and Panabo Port.
- Transportation highly rely on Diversion Road.
- Transport Route of Raw Materials and Finished Products: Company C is shown in the figure below.



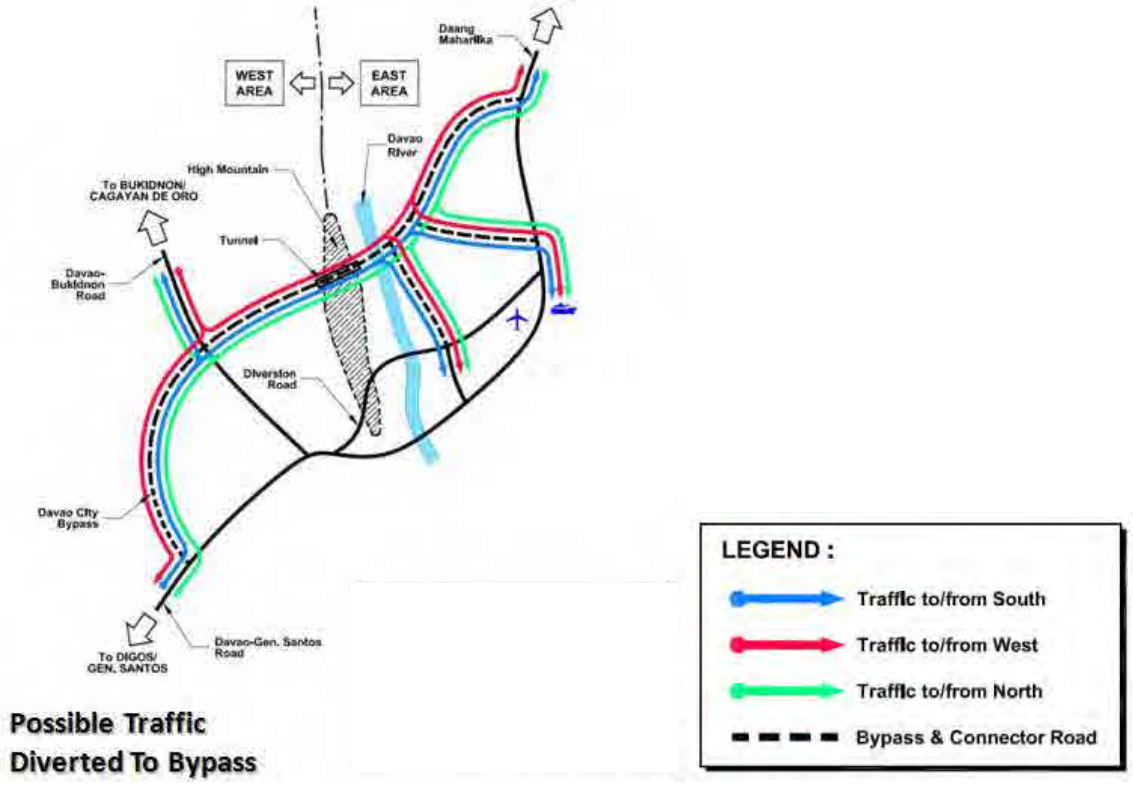
2.8 NECESSITY OF THE PROJECT

The Davao City Bypass Road is necessary for the following reasons;

- To reduce chronic traffic problems in the Urban Center.
- To strongly support manufacturing/agri-business and other industrial sectors for economic development.
- To guide sound urbanization towards inland areas.



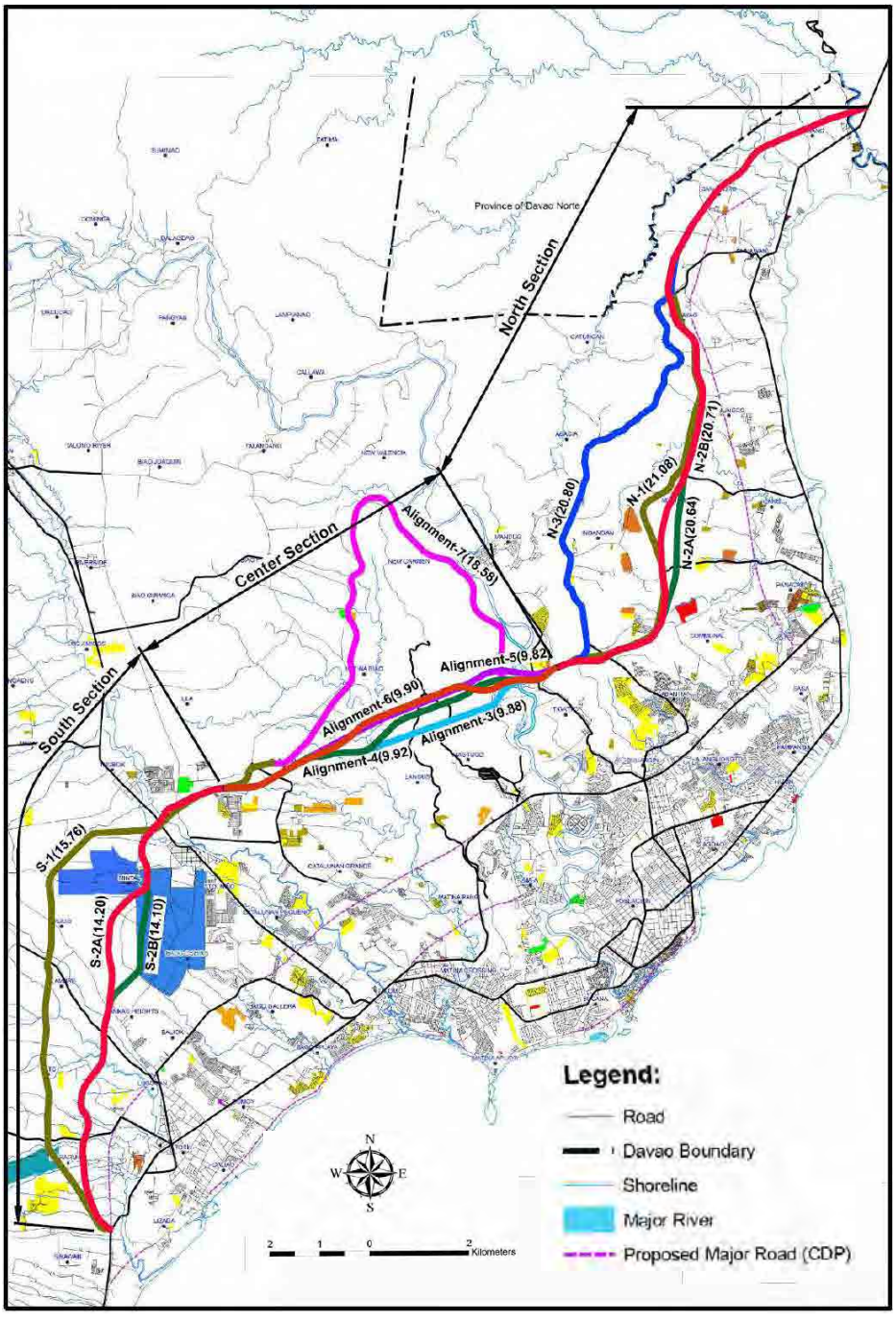
Schematic Urban Structure with Bypass



Possible Traffic Diverted To Bypass

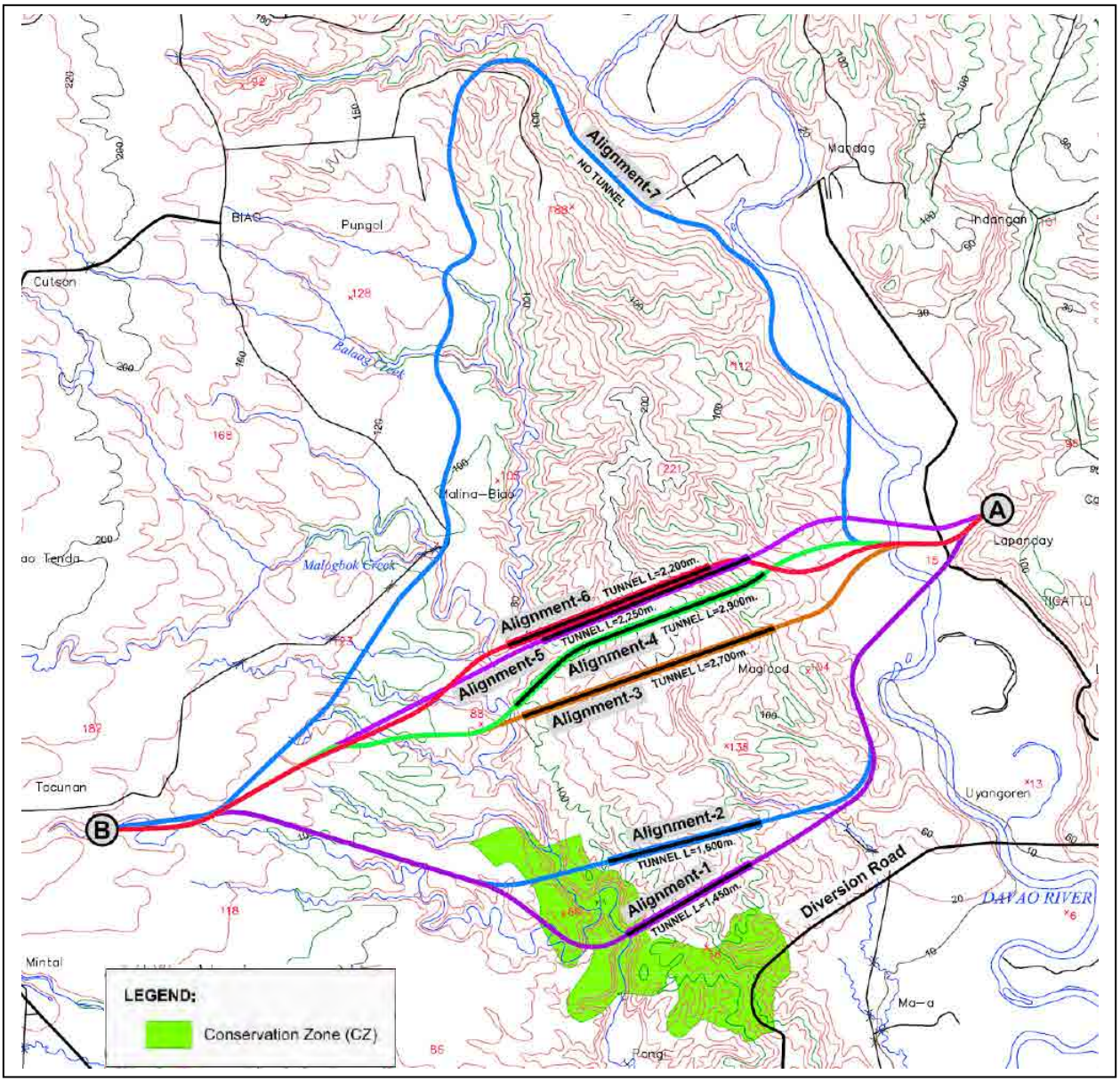
3. ALIGNMENT SELECTION

Alternative alignments were studied section by section to select an optimum alignment for each section – Center, South and North Sections.

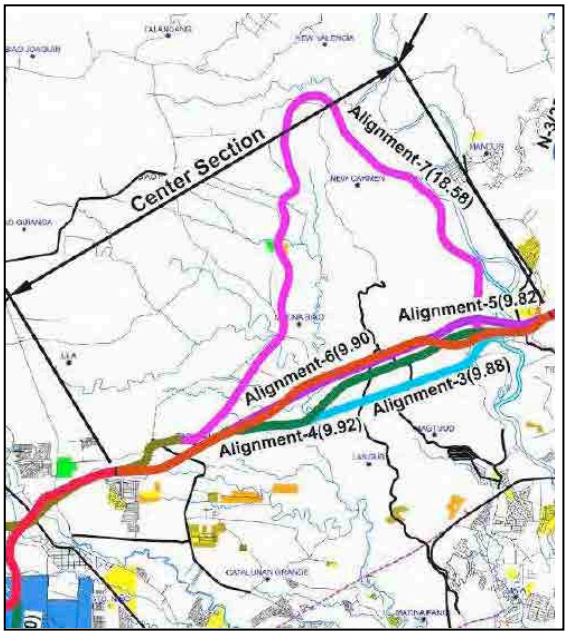


3.1 CENTER SECTION

- Possible tunnel alignments (seven (7) routes) were pre-screened
- Alternative-1 & 2 were screened out due to
  - Although tunnel length is shorter than Alternatives 3-6, road length becomes longer and requires longer travel time.
  - Due to longer travel time, these routes attract less traffic than Alternatives 3-6.
  - Approach section to west tunnel portal has to passes through “Conservation Zone”.

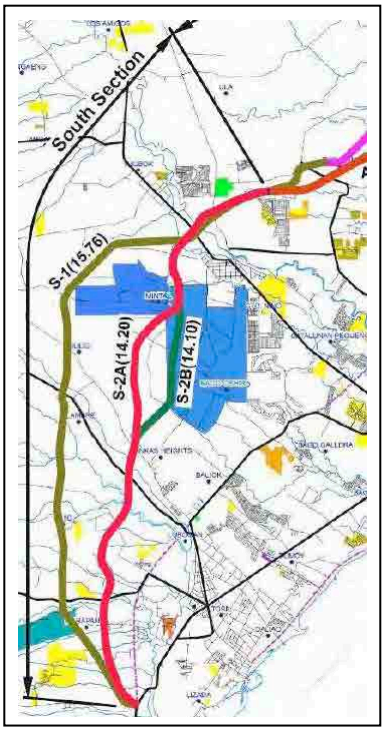


- **Alternative-7** is the plan to avoid a tunnel.
  - The route becomes longer by 8.8 km and requires longer travel time (15~20 min.), thus attract only 1,600 veh./day.
  - It does not function as a bypass and does not contribute to mitigate traffic problems of Davao City.
  - It passes through forest areas, requiring tree cutting and slope cutting, thus environmentally disadvantageous.



- Among tunnel alignment alternatives**,** **Alternative-6** is recommended;
  - Shortest tunnel length
  - Less construction & ROW acquisition cost.
  - Less number of houses affected.

3.2 SOUTH SECTION



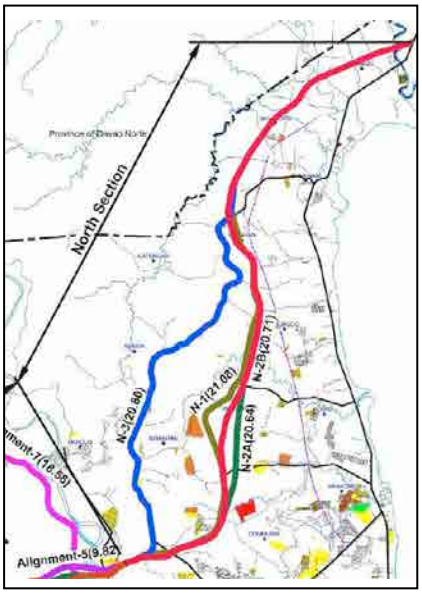
- Three (3) alternatives were evaluated.

  Alternative S-1 was not selected;
  - Longest in length, highest in construction cost
  - Attract less traffic, since it passes through remote area from the urban center
  - More nature damaged and affects more houses.

- Difference of S-2A and S-2B is whether it passes Bureau of Plant Industry (BPI) and Philippine Coconut Authority (PCA) area longer or shorter. Nature and Land Use of Green Areas are preserved in BPI/PCA areas.

  Alternative S-2A was selected;
  - It passes through BPI/PCA area shorter.
  - The Land Use of Green Area is less affected.
  - Contribute to future urbanization, since areas are designated as "Residential".

3.3 NORTH SECTION



- Four (4) alternatives were evaluated;

  Alternative N-3 is the plan to convert the existing City Road to a bypass, but not recommended;
  - 780 houses (3,350 people) are affected, which will create serious social problems
  - Less traffic is attracted

- Among the remaining three (3) alternatives,

  Alternative N-2B was recommended;
  - Least cost (construction + ROW cost)
  - Least number of houses affected
  - There is no big difference in other evaluation factors among three (3) alternatives.

4 ESTIMATED VOLUME ON THE BYPASS

Estimated traffic volume on the Bypass was estimated as shown in the table below.

Unit: Veh./day

Year	South Section	Center Section	North Section
2018 2023 2033	7,500 9,800 12,300	7,900 10,600 12,000	8,000 9,300 11,000
Year when Level of Service becomes E	2030	2029	2034
Widening to 4-lane should be completed within	2029	2028	2033

5. PRELIMINARY DESIGN

5.1 ROAD DESIGN

(1) General Design Concept

- Road design is based on two lanes, considering four lanes widening in the future Stage Construction
  Initial Stage : 2-lane
  2nd Stage : widening to 4-lane
- To minimize the road construction cost and soil disposal impact, the volume of cutting and embankment should be balanced as much as possible.
- To consider not only the accessibility of connecting road and roadside area but also high mobility function as bypass.

(2) Design Criteria

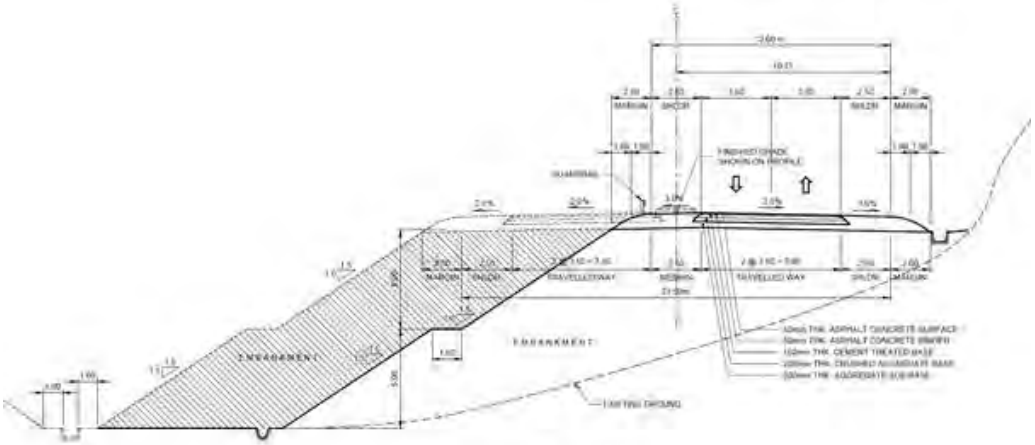
Design criteria are as follows;

Design Speed	60 km/hr
Minimum Horizontal Radius	123 m (target: 250 m)
Maximum Vertical Gradient	5% (Flat) 6% (Rolling) 8% (Mountainous) (Target : Less than 6%)
Road Right-of-Way	60 m

(3) Cut/Embankment Section

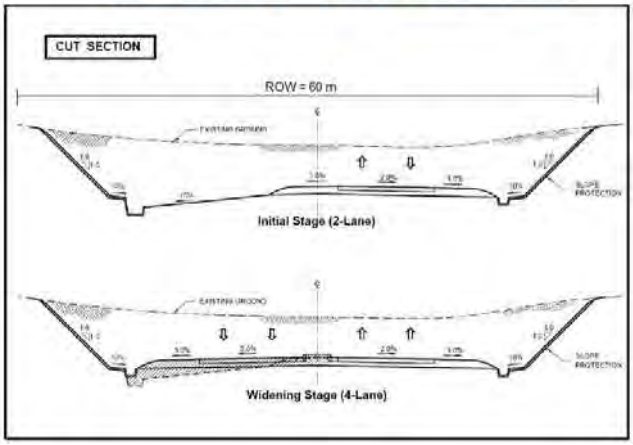
The Study Team proposes to provide four-lane cut/embankment cross section instead of a two-lane for the Davao City Bypass. Although it might be expensive at initial stage, it would still be beneficial due to the following;

- To minimize traffic impact during widening construction work (as widening road work may affect one lane closed that would cause serious effect on the bypass traffic)
- To reduce the waste cost of slope protection facilities' demolition constructed during the initial stage.
- Additional embankment at the embankment section might cause erosion. (see figure below).
- It is also one way of development control within the Road Right-of-Way (RROW).

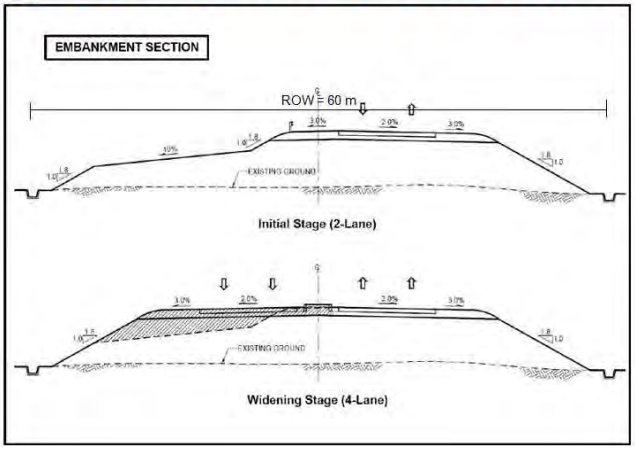


TYPICAL ROADWAY SECTION
Embankment

Typical Cross Section of Cut Section



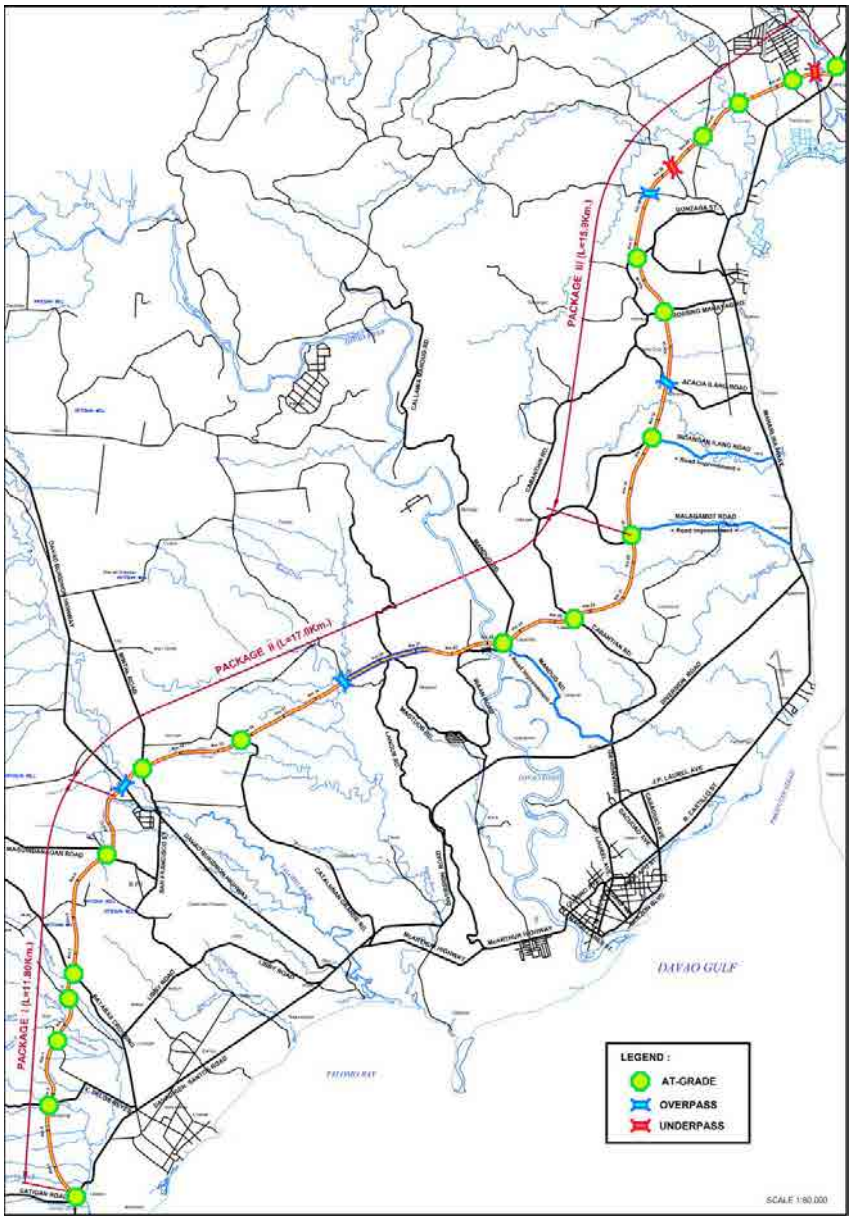
Typical Cross Section of Embankment Section



(4) Intersecting Roads

Intersections were classified into three types: At-grade, Overpass, and Underpass.

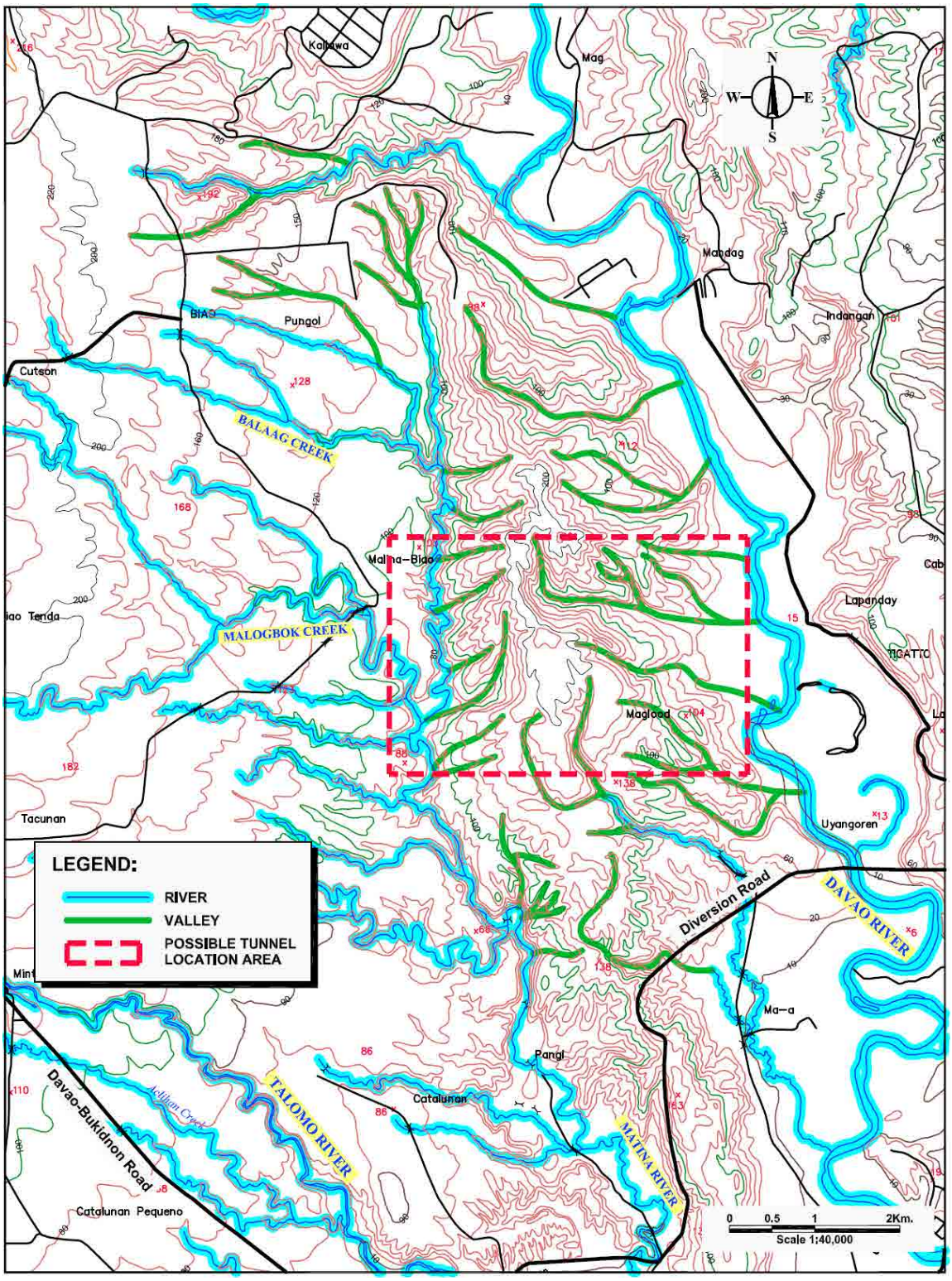
Intersection Type	No. of Intersection
At-grade	18
Overpass	12
Underpass	6



5.2 TUNNEL DESIGN

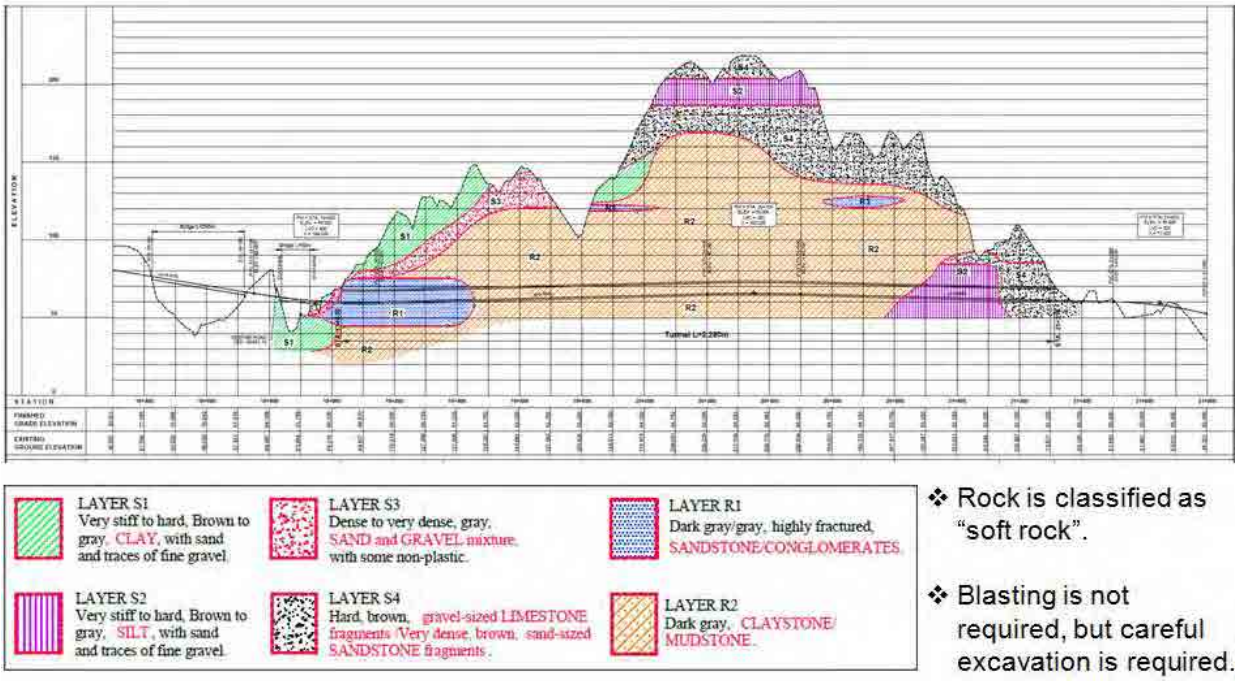
(1) Topographic Conditions

- Elevation varies from 15m to 215m within the length of 1.5 to 2.0 km.
- Ground surface gradient ranges from 10% to 15%.
- The mountain is surrounded by two rivers, Davao River and Matina River.
- The mountain has been eroded and many valleys were formed.



(2) Geological Conditions

Based on the geological survey conducted by the Study Team, the rock is classified as a "soft rock", therefore, blasting is not required, but careful excavation is required.



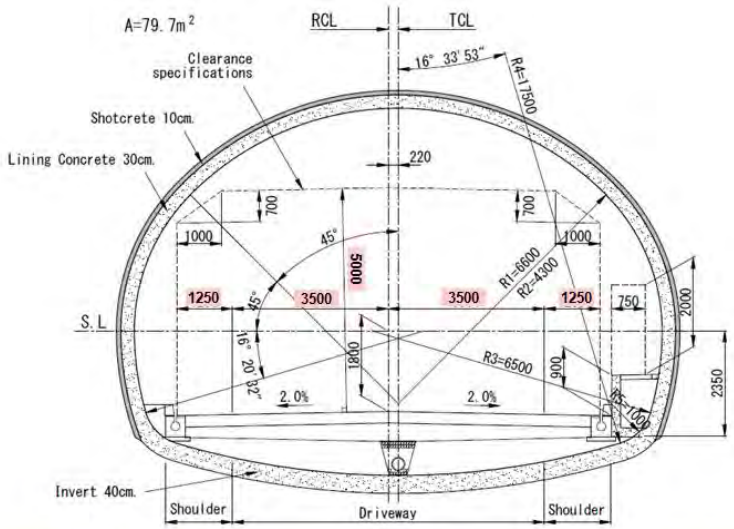
From the quarry site, about 1 km away from the Tunnel (Center) Section, the condition of the excavated material is shown below.

(3) Tunnel Cross Section

Cross-sectional components are as follows;

Number of Lanes	=	2
Lane Width	=	3.5m
Shoulder Width	=	1.25m on both sides
Cross Sectional Slope	=	2%
Vertical Clearance	=	5.0m

The typical cross section of a tunnel is shown below;



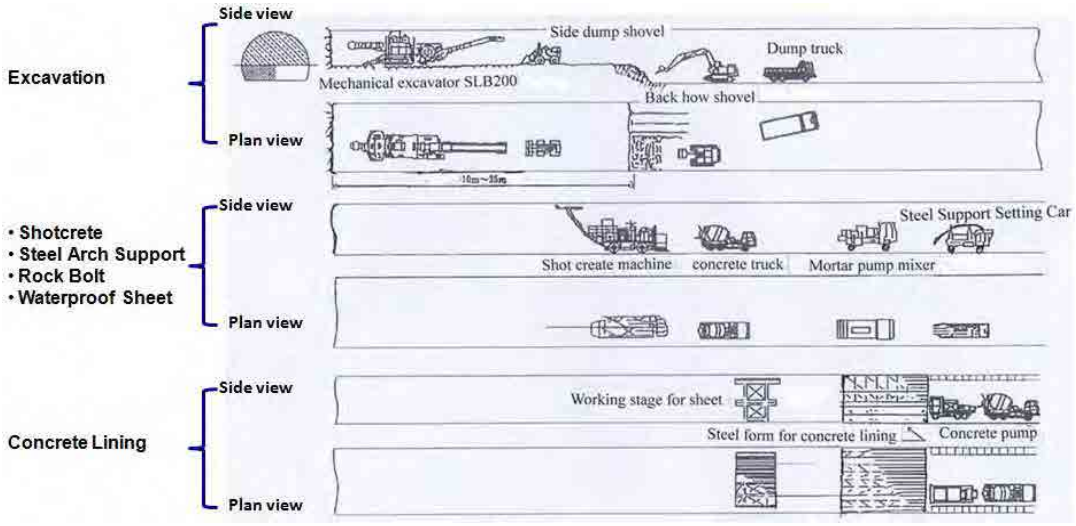
Note: *Overtaking inside a tunnel shall not be allowed to prevent traffic accident as much as possible.*
Horizontal Curvature used : 3,000m
Vertical Gradient used : 0.5%

Two-lane Tunnel in Japan

(4) Tunnel Construction Procedure

Tunnel construction procedure is as shown in the figure below.

Excavation Method: Upper Half Advance Excavation Method by Mechanical Excavator (**Blasting** is not required for this tunnel).

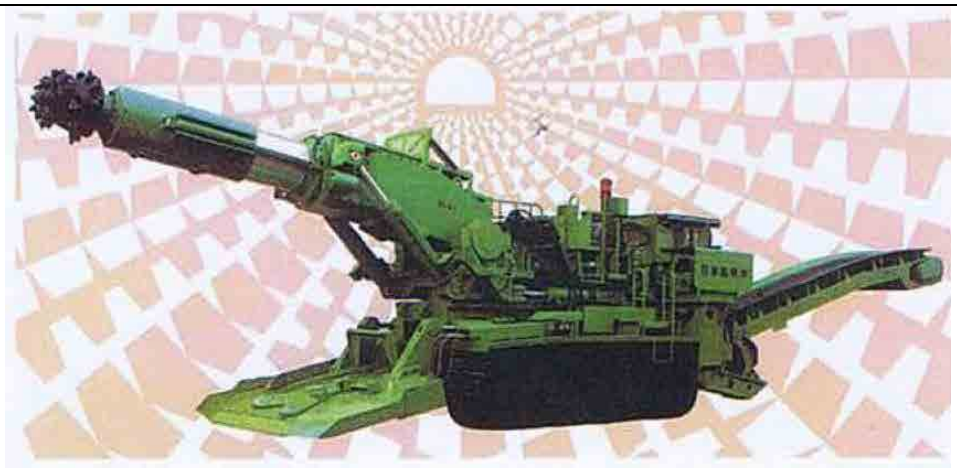


Upper Half Advancing Excavation Method

(5) Tunnel Construction Equipment

The following photos show the different tunnel construction equipments;

- Road header for tunnel excavation
- Shotcrete Machine for shotcreting
- Steel Form for concrete lining



Road Header S-200 Type, Total Power 302.5Kw

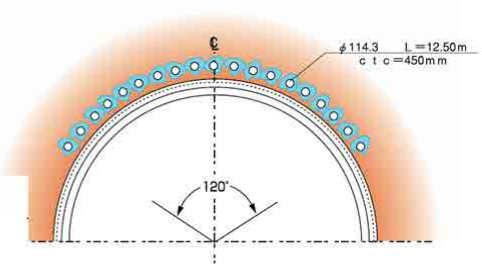
Shotcrete Machine

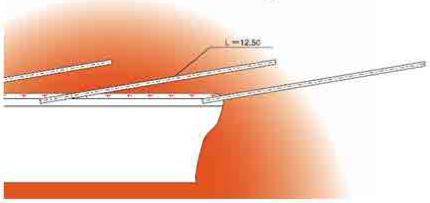
Steel Form for concrete lining

(6) Tunnel Construction – Auxiliary Method near Tunnel Portal (Davao City Bypass, Total = 250m)

AGF (All Ground Fasten) Method, one of the methods developed by Japan

Long steel tubes (approx. Φ 100mm) are driven into outer circumferential part of working face. Then silicate resin is injected to form improved zone between the steel tubes to stabilize working face and to restrict frontal loosening.





Reliable effect can be expected under various fragile conditions ranging from clayey soil to finely section can be selected depending on geological structure.

(7) Various Facilities Inside a Tunnel for Safe Operation

A. Ventilation Equipment
(1) Jet Fan

B. Monitoring Equipment
(2) Visibility Index Meter (VIM)
(3) Wind Velocity Meter (WVM)
(4) CO Meter (COM)
(5) CCTV

C. Equipment for Emergency Case
(6) Fire Hydrant
(7) Fire Detection
(8) Push Button Fire Notification
(9) Emergency Telephone

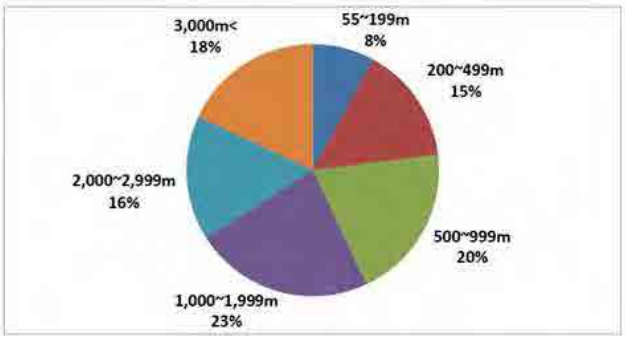
D. Information Provision Equipment
(10) Variable Information Signboard
(11) Exit Direction Signboard
(12) Radio Broadcasting
(13) Loud Speaker

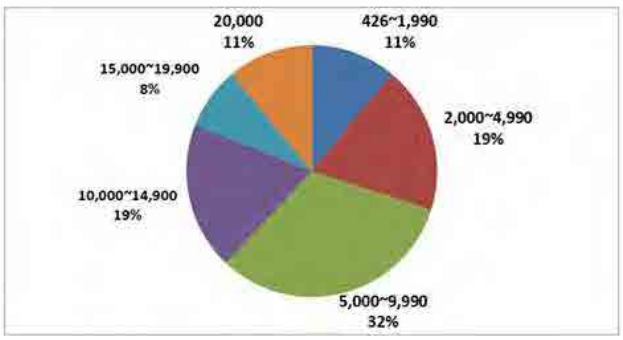
E. Others
(14) Lighting
(15) Cable Duct
(16) Water Supply
(17) Lay Bay (Emergency Stopping Bay)
(18) Variable Information Signboard at Tunnel Portals

(8) Needs of Evacuation Tunnel

Fire Incidents Inside a Tunnel

The two (2) graphs below shows the fire incidents inside a tunnel: 94 incidents from 1960 to 2000 (40 years) in a 2-lane 2-way tunnels in Japan. Probability of Fire Incidents is not so high, but not zero. Countermeasures against fire incident such as an evacuation tunnel should be considered.



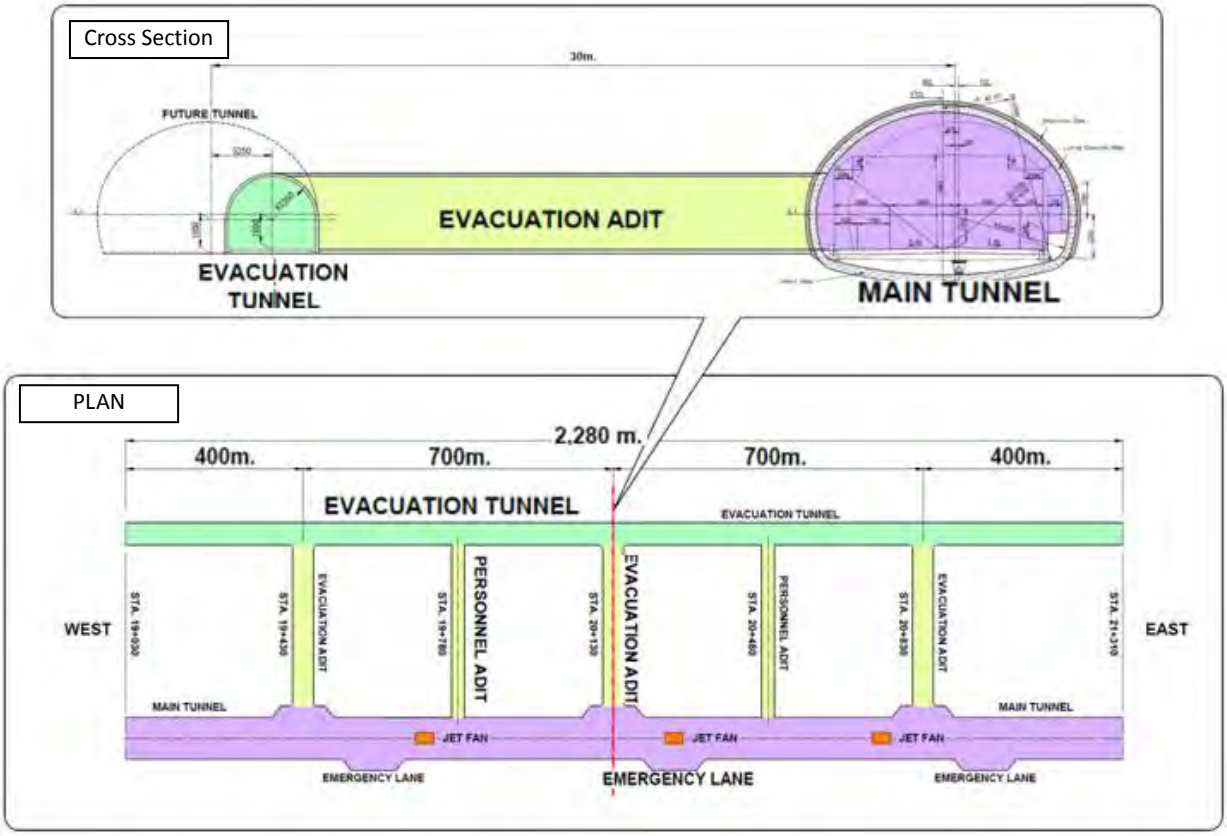


Fire Incidents vs. Tunnel Length	**Fire Incidents vs. Traffic Volume**
Even at short tunnels, fire incidents still occur	About 60% of fire incidents occurred at tunnel with traffic volume of less than 10,000 veh./day

(9) Proposed Evacuation Tunnel

In Japan, an evacuation tunnel is provided for a tunnel with more than 3,000m.

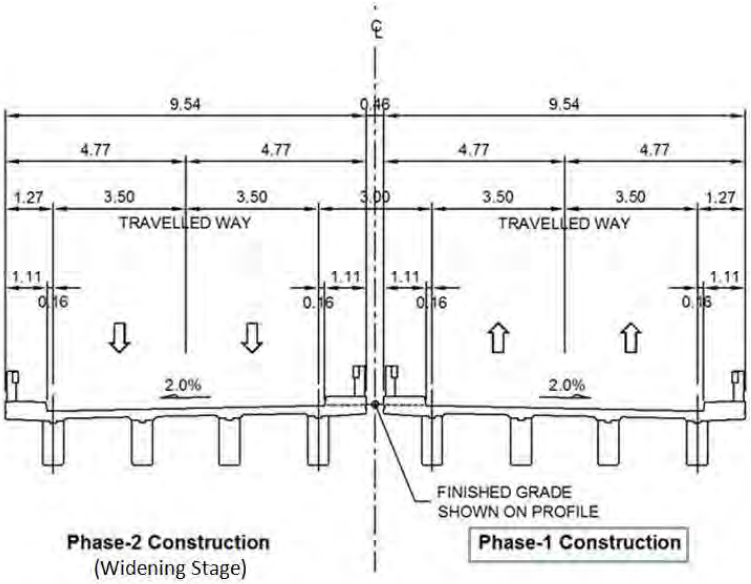
The Study Team proposes to provide an evacuation tunnel for the Davao City Bypass tunnel, although its length is less than 3,000m to secure higher safety for road users during emergency cases. Evacuation tunnel can be used as a part of main tunnel when the Bypass is widened to a 4-lane.



5.3 STRUCTURAL DESIGN

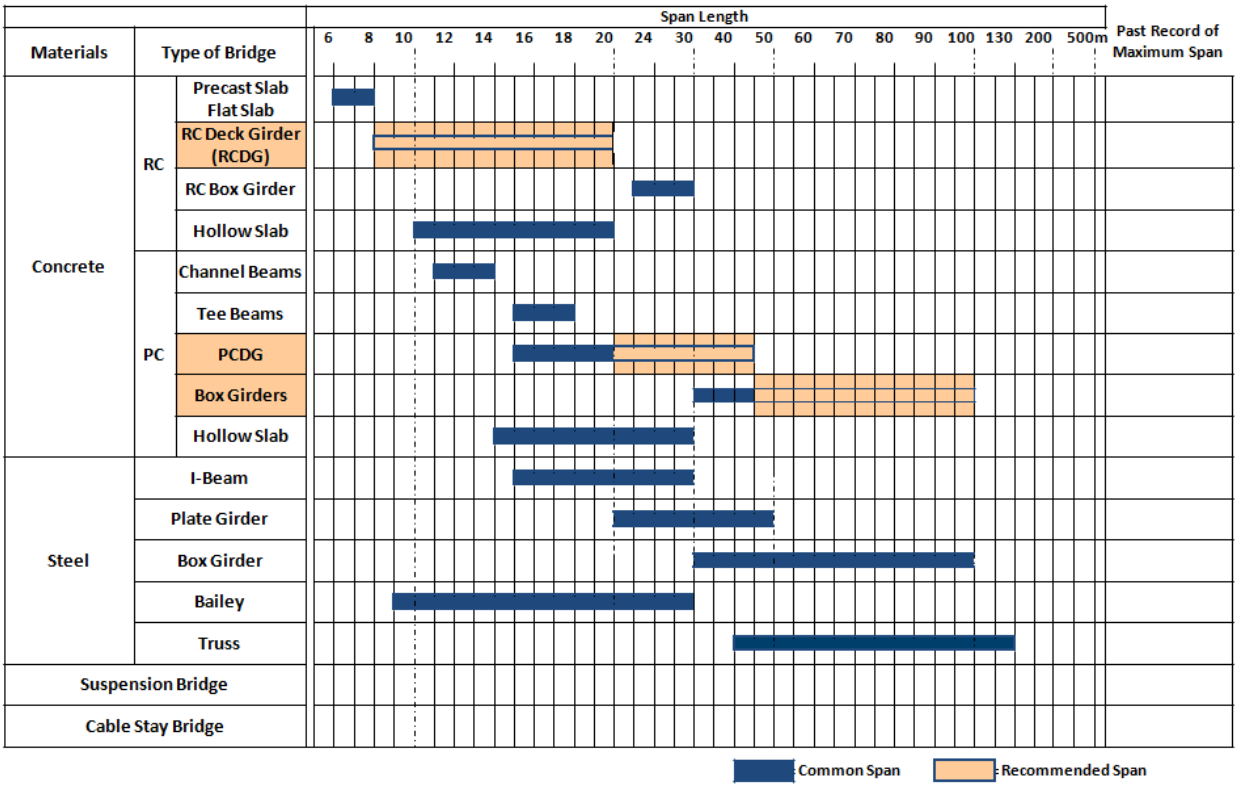
(1) Bridge Cross Section

The typical bridge cross section is shown below;



(2) Applicable Bridge Type for Various Span Length

Recommended bridge types for various span length are RCDG, PCDG and Box Girders.



(3) Summary of Bridge Plan for Each Section

Number of bridges for main road and overpass in each section is summarized below;

	For Main Road					For Overpass
	Number of Bridges	RCDG (L<24m)	PSCG (24<L<40m)	Cantilever PC-Box (60m<L)	Steel Truss (60m<L)	L=40~60m
South	10	0	9	1	0	2
Center	14	0	14	0	0	4
North	21	0	20	1	0	6
Total	**45**	**0**	**43**	**2**	**0**	**12**

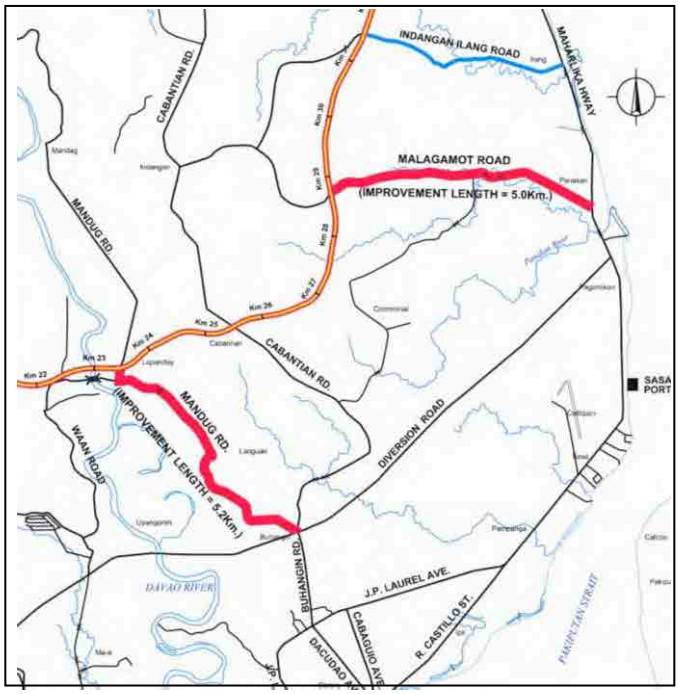
Cantilever PC-Box (L = 65m): 2 Bridges

5.4 IMPROVEMENT OF IMPORTANT CONNECTION ROADS BETWEEN BYPASS AND CITY URBAN CENTER

The Bypass should be connected to the connected to the City Urban Center through the Connection Roads in order for the Bypass to fully function as traffic distributor.

The following two (2) existing roads should be improved within the existing road ROW;

- Mandug Road:
  Improve Length = 5.2 km
- Malagamot Road:
  Improve Length = 5.0 km



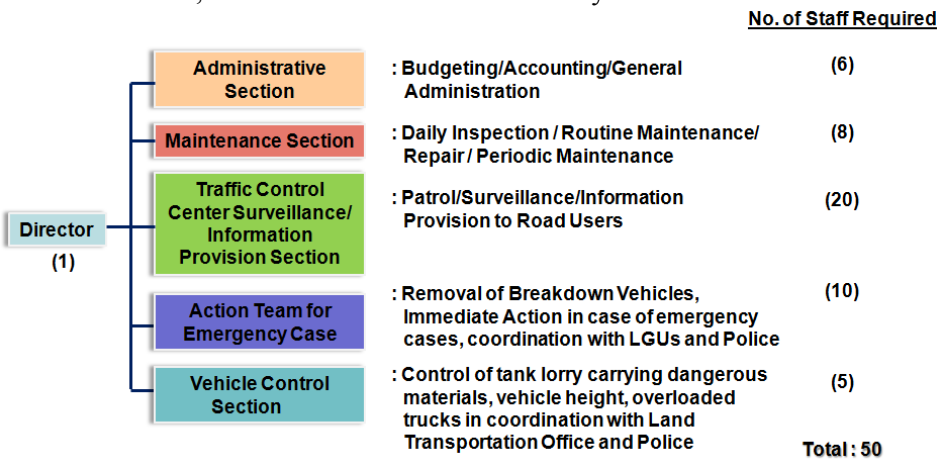
6. TUNNEL OPERATION AND MAINTENANCE (O&M)

6.1 MAJOR TUNNEL O&M ACTIVITIES

1) Inspection
2) Maintenance : tunnel structure and facilities
3) Monitoring of traffic movement, traffic accident, fire incident, etc. (24 hours a day x 365 days)
4) Immediate actions when some incidents are found or reported
   - Traffic Accidents
   - Fire Incidents
   - Vehicle Breakdown
   - Stalled Vehicles
   - Others
5) Vehicle Control
   - Vehicle carrying hazardous material
   - Vehicle height
   - Overloaded trucks

6.2 ORGANIZATION REQUIRED FOR TUNNEL O&M

The organization required for tunnel O&M is shown below. The required number of staff is 50, if toll collection work is included, an additional 26 staff is necessary.



6.3 TUNNEL O&M COST

(CONFIDENTIAL)

6.4 FUND SOURCES OF TUNNEL O&M COST AND TUNNEL OPERATOR

The following options were studied;

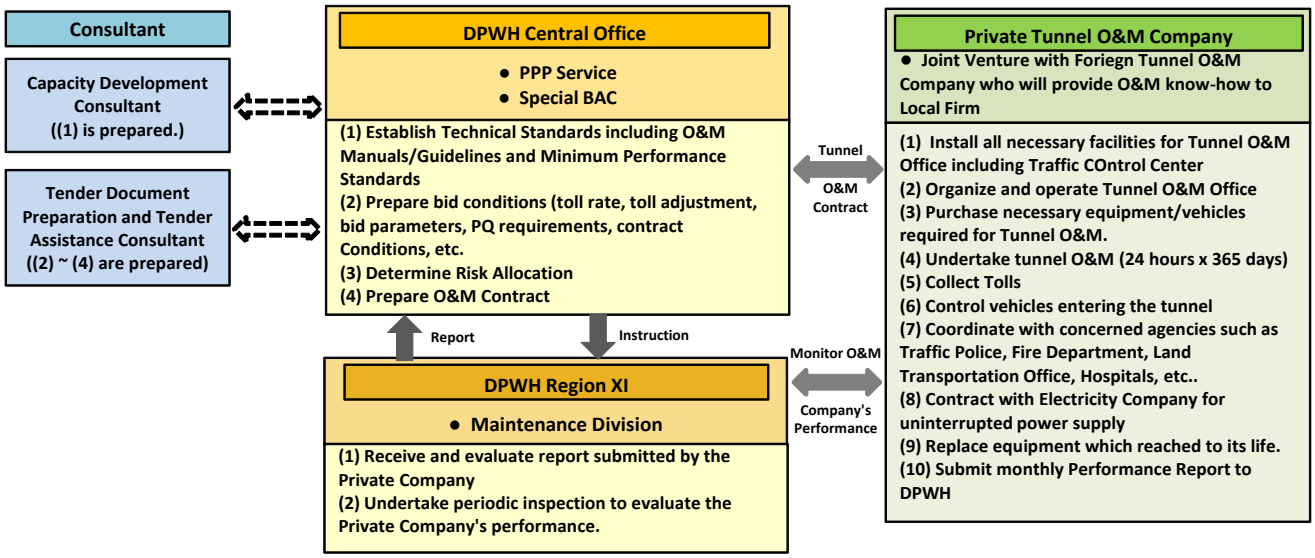
Option	Fund Source	Tunnel Management Office Operator
1	Government's Road Maintenance Fund (MVUC + GAA)	DPWH Region XI (Tunnel Management Office shall be newly established)
2	Toll Fee is collected by DPWH (Region XI) (Toll collection may be outsourced to a private company by DPWH)	DPWH Region XI (Tunnel Management Office shall be newly established)
3	Toll Fee is collected by a Private Company	Private Company on the condition that he shall joint ventured with a foreign company who has enough tunnel O&M

- Options 1 & 2 requires to employ 50 ~ 76 new people which may be difficult under the current Rationalization Plan and they must be trained for tunnel O&M and toll collection.

- Under Option-3, a private company can employ flexibly required staff. O&M can be implemented together with experiences person(s) of a foreign company, and local staff can get on-the-job training through actual O&M work. **Option-3** is **recommended.**

6.5 TUNNEL O&M ARRANGEMENT

The tunnel O&M arrangement is shown below;


Consultant
Capacity Development Consultant ((1) is prepared.)
Tender Document Preparation and Tender Assistance Consultant ((2) ~ (4) are prepared)
DPWH Central Office
● PPP Service
● Special BAC
(1) Establish Technical Standards including O&M Manuals/Guidelines and Minimum Performance Standards
(2) Prepare bid conditions (toll rate, toll adjustment, bid parameters, PQ requirements, contract Conditions, etc.
(3) Determine Risk Allocation
(4) Prepare O&M Contract
Report
Instruction
DPWH Region XI
● Maintenance Division
(1) Receive and evaluate report submitted by the Private Company
(2) Undertake periodic inspection to evaluate the Private Company's performance.
Tunnel O&M Contract
Monitor O&M
Company's Performance
Private Tunnel O&M Company
● Joint Venture with Foriegn Tunnel O&M Company who will provide O&M know-how to Local Firm
(1) Install all necessary facilities for Tunnel O&M Office including Traffic COntrol Center
(2) Organize and operate Tunnel O&M Office
(3) Purchase necessary equipment/vehicles required for Tunnel O&M.
(4) Undertake tunnel O&M (24 hours x 365 days)
(5) Collect Tolls
(6) Control vehicles entering the tunnel
(7) Coordinate with concerned agencies such as Traffic Police, Fire Department, Land Transportation Office, Hospitals, etc..
(8) Contract with Electricity Company for uninterrupted power supply
(9) Replace equipment which reached to its life.
(10) Submit monthly Performance Report to DPWH

7. SCOPE OF WORK OF THE PROJECT

7.1 ROAD, BRIDGE, AND TUNNEL COMPONENT (IN KM)

(1) Along Bypass Alignment

Section	Road Component (km)			
	Road	Bridge	Tunnel	Total
South Section	**10.55** (89.4%)	**1.25** (10.6%)	-	**11.80** (100%)
Center Section	**12.91** (76.0%)	**1.81** (10.6%)	**2.28** (13.4%)	**17.00** (100%)
North Section	**13.68** (86.6%)	**2.12** (13.4%)	**-**	**15.80** (100%)
Total	**37.15** (83.3%)	**5.17** (11.6%)	**2.28** (5.1%)	**44.60** (100%)

(2) Improvement of Connection Roads

- Mandug Road, L = 5.2 km
- Malagamot Road, L = 5.0 km

Total **L = 10.2 km**

7.2 CONSULTING SERVICES

The different consulting services are as follows;

1) Detailed Design
2) Tender Assistance for Procurement of Contractor
3) Construction Supervision
4) Capacity Development of DPWH Staff for Tunnel O&M
5) Preparation of Tender Document for Procurement of Tunnel O&M Company

7.3 ROW ACQUISITION

The estimated total hectare of land for ROW acquisition for all sections is about 267.6 Ha.

Section	Area
South Section	70.2 Ha.
Center Section	102.6 Ha.
North Section	94.8 Ha.
Total	**267.6 Ha.**

8. PROJECT COST

8.1 CIVIL WORK COST

(CONFIDENTIAL)

8.2 CONSULTANCY COST

(CONFIDENTIAL)

8.3 ROW ACQUISITION COST

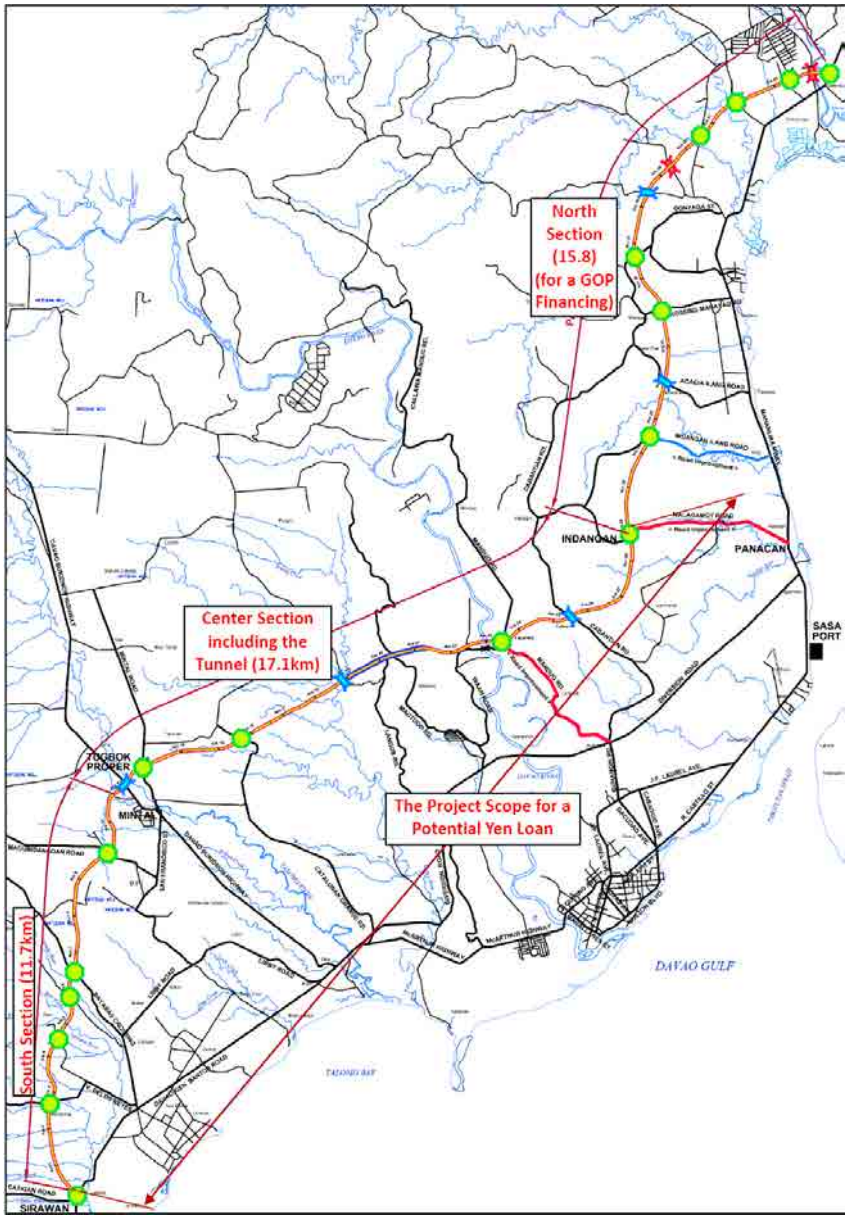
(CONFIDENTIAL)

8.4 TOTAL PROJECT COST (W/O CONTINGENCY)

(CONFIDENTIAL)

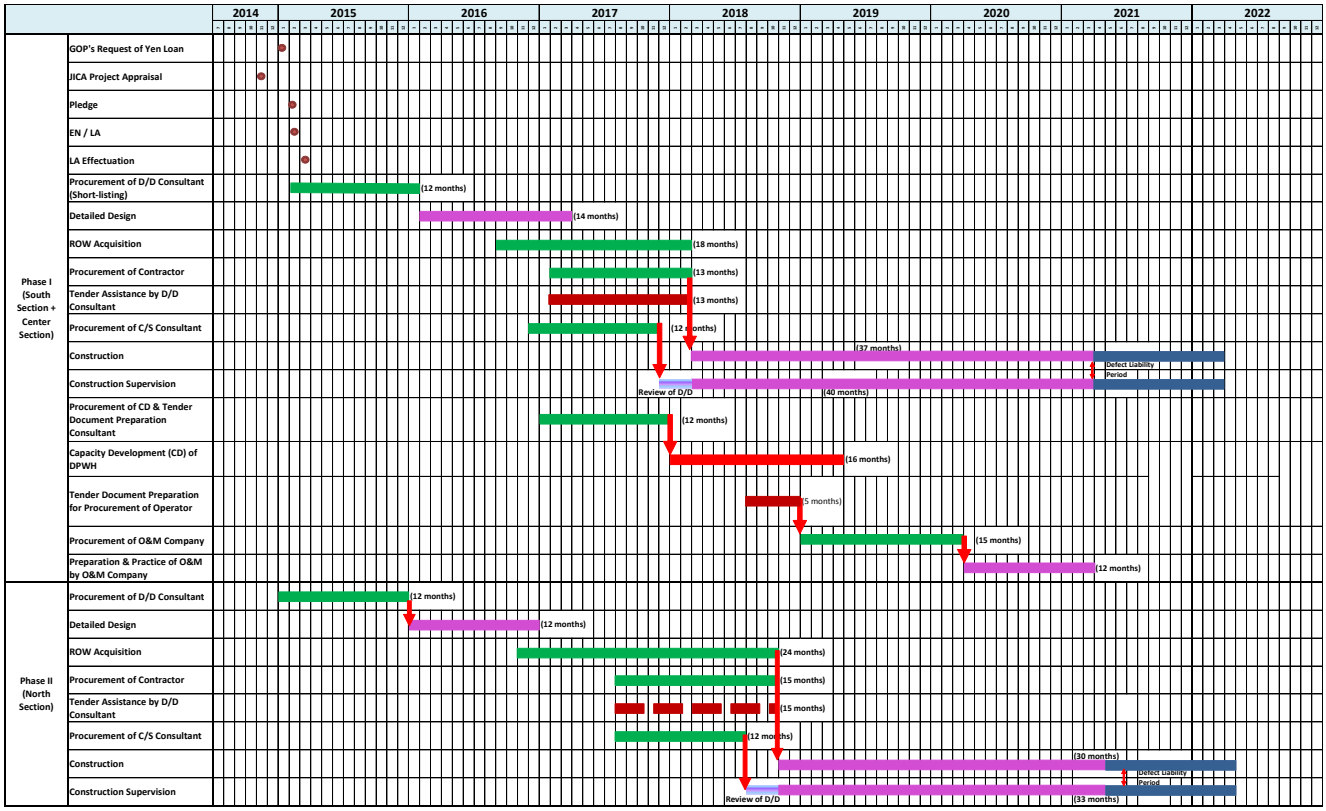
9. IMPLEMENTATION STRATEGY

- **Center Section** requires a 2.28 km tunnel for which Japan's tunnel construction technology should be fully utilized for safe, fast and reliable construction.
- **Center Section alone** does not fully function (as a bypass/traffic distributor) and **South Section** should be constructed simultaneously.
- **North Section** can be constructed individually and it can still function as a traffic distributor.
- It is **recommended** that; **[South Section + Center Section]** including two (2) connector roads should be financed by Japan's ODA (JICA Finance).



10. IMPLEMENTATION SCHEDULE

The proposed implementation schedule for the Davao Bypass Construction Project is as shown below.



11. PROCUREMENT OF CONSULTANT

Consultants for the following will be procured;

- Detailed Design + Tender Assistance
- Construction Supervision
- Capacity Development of DPWH Staff for Tunnel O&M and Tender Document Preparation for Procurement of Tunnel O&M Company

The Procurement Method will either be by short-listing approach or by quality-based evaluation method:

- Short Listing Approach
- Quality-based Evaluation Method is highly recommended, since the Consultant with rich experiences for tunnel technology must be selected for the first long tunnel project in the Philippines

12. PROCUREMENT OF CONTRACTOR

The procurement of contractor will be by two-envelope system.

Envelope-1:

Company Experience + Technical Proposal

Envelope-2:

Financial Proposal (Bids will be opened of those who are qualified under Envelope-1.

13. ECONOMIC EVALUATION

13.1 UNIT VEHICLE OPERATING COST

The unit VOC by four (4) vehicle types in 2014 were estimated as follows;

Unit: Peso/km/veh

Speed (km/hr)	Passenger Car	Jeepney	Bus	Truck
20	17.01	13.16	46.01	42.12
30	14.49	11.16	38.77	36.49
40	12.67	9.83	33.65	32.79
50	11.76	9.31	31.24	31.46
60	11.33	9.26	30.33	31.35

The unit travel time cost for the four vehicle types in 2014 were estimated as follows;

Peso/min/veh

Vehicle Type	Y2014
Passenger Car	9.39
Jeepney	10.26
Bus	38.36
Truck	1.84

The economic evaluation results were as follows;

Economic Evaluation Result		
	Case-1	**Case-2** *(Note)*
EIRR	18.1%	21.6%

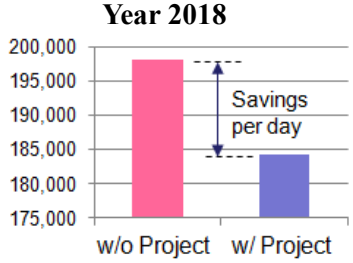
Note: For Yen Loan, cost for future widening to a 4-lane Bypass is not included.

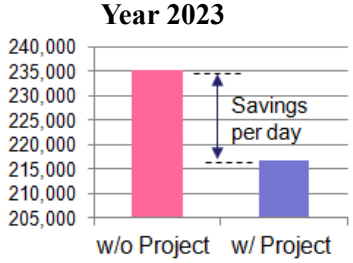
14. EFFECT OF THE PROJECT

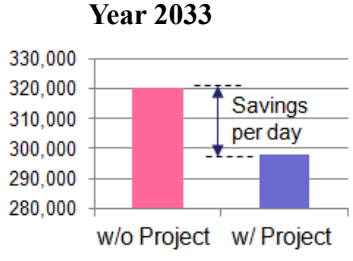
(1) Impacts on Total Road Network in the Project Area

a) Total Vehicle Time Savings (veh.-hour)

		Year 2018	Year 2023	Year 2033
Total Vehicle Hour	w/o Project	198,179	235,299	320,332
	w/ Project	184,350	216,682	297,710
	Savings per day	13,829	18,617	22,622
	Savings per year	5.05 Million Hours	6.80 Million Hours	8.26 Million Hours







b) Total Vehicle Distance (veh.-km.)

		Year 2018	Year 2023	Year 2033
Total Vehicle Hour	w/o Project	5,259,435 (100.0)	5,840,688 (100.0)	7,100,186 (100.0)
	w/ Project	5,247,059 (99.7)	5,896,688 (101.0)	7,210,408 (101.6)
	Savings per day	12,376	-55,980	-110,222
	Savings per year	4.52 Million veh.km.	-20.43 Million veh.km.	-40.23 Million veh.km.

- Travelers will avoid to pass through congested areas even though trip distance become slightly longer.
- Thus, veh. km. of the "w/ Project Case" in 2023 and 2033 becomes longer than "w/o Project Case".

c) Average Travel Speed

		Year 2018	Year 2023	Year 2033
Average Travel Speed (km/hour)	w/o Project	26.5	24.8	22.2
	w/ Project	28.5	27.2	24.2
	Improvement	2.0	2.4	2.0

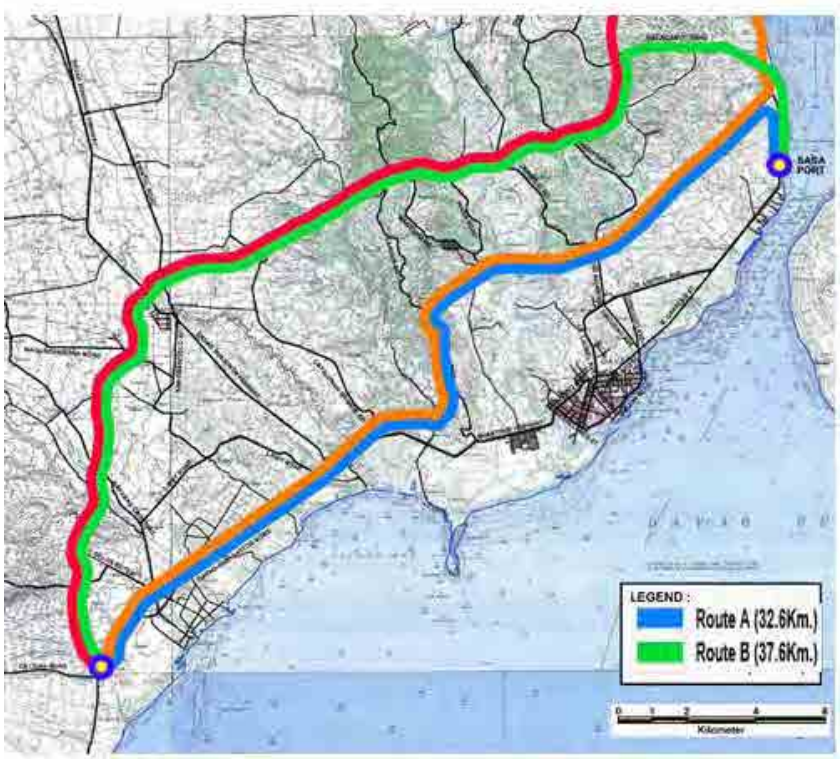
- The Project contributes to improve/increase travel speed of the overall network and drastically contributes to vehicle-hour savings as shown in the previous slide

(2) Travel Time Savings of a Specific Route

Route: **SIRAWAN (Beginning of Bypass in the South) to SASA PORT**

Route Choice	Distance (km)	Travel Time
Route-A : using Existing Road (Diversion Road)	32.6	1 hr. 27 min.
Route-B : using Bypass	37.6	47 min.

Travel Time	
Savings per Vehicle	40 min.
Time savings per day	3,580 hrs/day (5,370 veh/day x 40 min)
Time savings per year	1.31 Million hours/year



Main Report

CHAPTER 1

INTRODUCTION

CHAPTER 1
INTRODUCTION

1.1 BACKGROUND OF THE STUDY

The Mindanao has for decades lagged behind the rest of the Philippines in terms of economic development despite its agro-fishery, mineral and human resources potentials. However, in recent years the region has been showing faster economic growth than the rest of the country, and the signing of the Bangsamoro Peace Framework Agreement between the government and the Moro Islamic Liberation Front (MILF) in October 2012 is expected to accelerate the recent economic development. Davao City, the third and the most major city in Mindanao, is expected to play a leading role in the economic growth. Major urban roads in Davao City have 4-lanes (2-lane per direction), but are insufficient to ease it severe traffic congestion. Similarly, traffic from and to Sasa and Panabo Ports is also frequently experiencing traffic congestion, affecting the transportation of goods. JICA conducted a Master Plan on High Standard Highway Network Development (July 2010), which proposed improvement of the Tagum-Davao-General Santos Corridor and the construction of a diversion road in Davao City as a priority project.

Road widening and improvement project of the above corridor is on-going for many parts of sections, such as four (4) lane widening of present two-lane section, and slope protection construction by World Bank and other funds.

Regarding Davao City Bypass project, the Department of Public Works and Highways (DPWH) conducted a Business Case Study (hereinafter referred to as BCS) and the study results, both economic and financial aspects was the basis to determine whether the Project is qualified for a PPP and/or as a conventional Government project.

DPWH is studying the utilization of Yen loan as one of candidate sources of funding in order to implement the Davao City Bypass Project. Both JICA and DPWH recognized that this Project is a very important project for traffic improvement in Davao City and Mindanao Eastside Area as agreed upon in the Minutes of Discussion on the contents of Preparatory Survey for the Project in 1 February 2013.

1.2 OBJECTIVE OF THE STUDY

The objective of the Study is to prepare all the data, information and document necessary for JICA to appraise the Davao City Bypass Project for Japan's Yen Loan. Data, information and construction documents include the objectives of the Project, project scope of work, project costs, implementation organization, environmental and social consideration related documents, etc.

1.3 OBJECTIVE AND SCOPE OF THE PROJECT

Objective: To improve the transport logistics and mitigate congestion in Davao City, thereby contributing to economic and social development in Mindanao.

Scope: Davao City Bypass (Total of 30 ~ 40 km, **including** about 2 km Tunnel Section). (As for the Davao City – General Santos City Corridor, only the present condition, implementation program, fund sources, etc. will be confirmed.)

1.4 STUDY AREA

The Survey Area shall cover Region XI.

1.5 SCOPE OF THE STUDY

In order to achieve the above objective, the Study shall cover the following:

(1) Information collection on background and necessity of the Project
(2) Review of Previous Studies
(3) Study on Design Principles and Standards
(4) Engineering Surveys
(5) Preliminary Design/Construction Execution Plan/Construction Cost Estimate/ROW Acquisition Plan
(6) Environmental Impact Assessment
(7) Resettlement Action Plan
(8) Traffic Survey
(9) Traffic Demand Forecast
(10) Evaluation of the Project
(11) Operation and Maintenance Plan
(12) Project Implementation Organization and Overall Implementation Schedule
(13) Project Cost Estimate
(14) Survey on Procurement Conditions

CHAPTER 2

NATIONAL / REGIONAL DEVELOPMENT PLANS

CHAPTER 2
NATIONAL / REGIONAL DEVELOPMENT PLANS

2.1 PHILIPPINE DEVELOPMENT PLAN (2011-2016)

The Philippine Development Plan (PDP), 2011-2016, was launched in 2011. Under this Plan, development policies for infrastructure are as follows:

DEVELOPMENT POLICIES FOR INFRASTRUCTURE

"**Accelerating Infrastructure Development"**

(1) To optimize resources and investment
- Improve project preparation, development and implementation.
- Synchronize planning and budgeting.
- Coordinate and integrate infrastructure initiatives.

(2) To attract investments in infrastructure
- Improve the institutional and regulatory environment of the infrastructure sector.
- Encourage PPPs.

(3) To foster transparency and accountability in infrastructure development
- Encourage stakeholder participation.

(4) To adopt to climate change and mitigate the impacts of natural disasters
- Institutionalize Climate Change Act (CCA) and Disaster Risk Reduction Management (DRRM).

(5) To provide productive employment opportunities
- Adopt labor-intensive schemes where applicable.

With regard to the transport sector, issues and challenges are established as follows:

TRANSPORT SECTOR ISSUES AND CHALLENGES

(a) Assessment and Issues
- Lack of integrated and coordinated transport network.
- Overlapping and conflicting functions of transport and other concerned agencies.
- Transport safety and security concerns.

(b) Strategic Plan and Focus
- Adopt a comprehensive long-term National Transport Policy (NTP).
- Develop strategic transport infrastructure assets
  - Prioritize asset preservation.
  - Provide access to major and strategic tourism destinations and production areas.
  - Promote environmentally sustainable and people-oriented transport.

(c) Develop an Integrated Multi-modal Logistics and Transport System
- Identify and develop strategic logistics corridors based on a National Logistics Master Plan.
- Improve Roll-on Roll-off (RORO) terminal system.
- Explore ASEAN connectivity through sea linkages.

(d) Separate the Regulatory and Operation Functions of Transport and Other Concerned Agencies. Address the overlapping and conflicting functions of transport and other concerned agencies.

(e) Comply with Safety and Security Standards. Ensure transport safety and standards.

(f) Provide Linkages to Bring Communities into the Mainstream of Progress and Development. Promote development in conflict-affected and highly impoverished areas.

2.2 MINDANAO DEVELOPMENT PLAN 2020

Mindanao 2020, Peace and Development Framework Plan 2011-2030 was announced in 2011 by Mindanao Development Authority. This development plan described the necessity of infrastructure and logistics development in "Requisites for Realizing Mindanao 2020".

Requisites for Realizing Mindanao 2020

Vision
Infrastructure, knowledge and financing support systems are well in place, effectively propelling a wide array of peace and development initiatives in Mindanao towards successful outcomes beneficial to all Mindanawons.

Strategy that are specific to each infrastructure are the following sub-sector

- Transportation and Logistics System
- Information and Communications Technology Support
- Energy and Power
- Water Supply, Irrigation and Sanitation

"Transportation and Logistics System's Strategy" is included below

- Widen the role of inland, coastal and inter-island water-based transport in the Mindanao transport and logistics system.

- Reform policies and regulations that have rendered the transport and logistics system inefficient and costly (e.g. cabotage law and high import tariffs on steel products), along with industries linked to them.

- Integrate land, air and water transport systems into a coherent and interactive array of interdependent networks.

- Upgrade main arterial roads into world-class all-weather highways, and build new ones where necessary (e.g. Mindanao's east and west links).

- Promote alliances among LGUs and partnerships among government and community in the construction of municipal and barangay roads through the provision of an enabling legal environment and a system of incentives.

- Prepare a long-term plan for a railway system that is closely coordinated with the other infrastructure plans mentioned above, to complement the proposed inter-modal transportation and logistics superhighway.

- Prioritize the upgrading, expansion or modernization of existing airports, particularly the community airports located inland, and pursue construction of a state-of-the-art airport in the Mindanao heartland out of one of such existing inland airports.

- Strengthen implementation of policies on user payments for infrastructure facilities to address inefficiencies in resource mobilization and utilization.

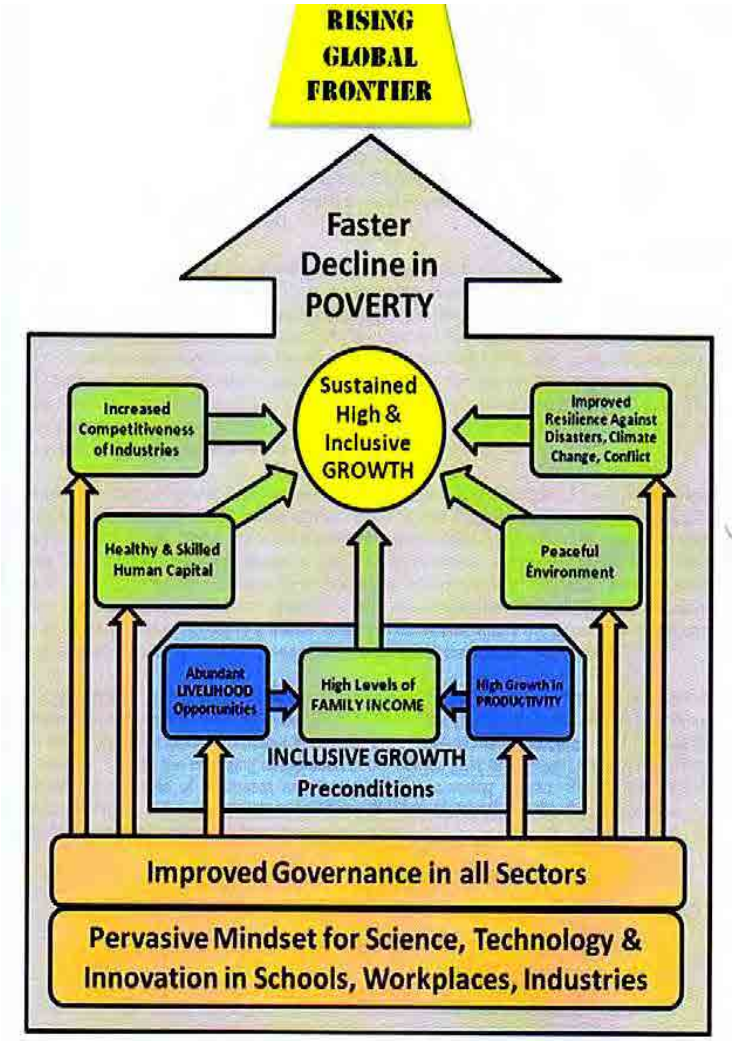
Davao City Bypass Project should be in harmony with the above strategy.

2.3 REGION XI REGIONAL DEVELOPMENT PLAN (2011-2016)

Davao Regional Development Plan (RDP) 2011-2016 was announced in 2011.

Goal and Objectives:
Aiming as the Nation's Rising Global Frontier, Davao Region shall focus in the goal of a faster decline in its poverty numbers by 2016.

Region's poverty incidence among families:
26.2% (Year2006) → 22.3% (2016)
To achieve above goal, the overall framework for Davao Region's development was prepared.



Source: Davao Regional Development Plan, 2011-2016

FIGURE 2.3-1 DAVAO REGIONAL DEVELOPMENT FRAMEWORKS

Sectoral Development Directions

The Davao RDP mentioned the following ten (10) sectoral development directions.

1. Macroeconomic Management
2. Modern and Competitive Agriculture
3. Competitive Industry and Service Sectors
4. Strategic and Sustainable Infrastructure
5. Science, Technology and Innovation
6. Good Governance
7. Human Resource Development
8. Peace and Development
9. Sustainable Environment and Resources
10. Social Protection for inclusive Growth

Strategic and Sustainable Infrastructure

"Need to improve access to and quality of infrastructure support."

RDP mentioned that "Davao Region still need to catch up in terms of construction of more or better quality roads in order to achieve high standard highway quality and internationally accepted road safety standards."

Davao City Bypass Project will realize the above target of RDP.

2.4 REGION XII REGIONAL DEVELOPMENT PLAN (2011-2016)

SOCCSKSARGEN Regional Development Plan 2011-2016 was announced in 2011.

SOCCSKSARGEN (or Region XII) is located in Central Mindanao. The region consists of four (4) provinces and one (1) city: South Cotabato, Cotabato, Sultan Kudarat , Sarangani and General Santos City.

SOCCSKSARGEN Vision of Development

"By 2016, Region XII is the home of God-centered and empowered, culturally diverse people, provider of world class high value crops, fishery, mineral and tourism products and services, propelled by dynamic and dedicated leaders and living in a green and healthy environment".

Development Goals and Strategic Outcomes

1) Inclusive Growth and Poverty Alleviation

- Achieving 7% Economic Growth by 2016
- Meeting the MDG Poverty Reduction Targets by 2015
- Management of Population Growth Rate
- Stabilizing Inflation Rate

2) Increased and Sustained Growth in Agriculture, Fishery and Industry.

- Boosting Agriculture and Fishery Production and Agriculture industrialization
- Development of High Impact Industries
- Propagating Micro, Small and Medium Enterprises (MSMEs)
- Science Technology (S & T)

3) Equal Access to Quality Basic Social Service

- Ensuring Universal Access to Quality Health Care and Sanitation
- Raising the Quality of Education and Training for Globally Competitive Human Resources
- Promoting Strong and Effective Social Protection Service
- Equal Access to Land and Land Rights
- Equal Access to Adequate and Safe Housing

4) Effective Infrastructure Support

- Integrated and Effective Transport System
- Efficient Water Resource Management
- Communication

5) Adequate and Reliable Energy Supply

- Energy Independent
- Energy Saving
- Barangay Electrification
- Legislative Agenda

6) Improved Ecological Integrity: Green and Healthy Environment

- Rehabilitation, Conservation and Protection of Ecosystems
- Enforcement and Compliance to Environmental Laws.

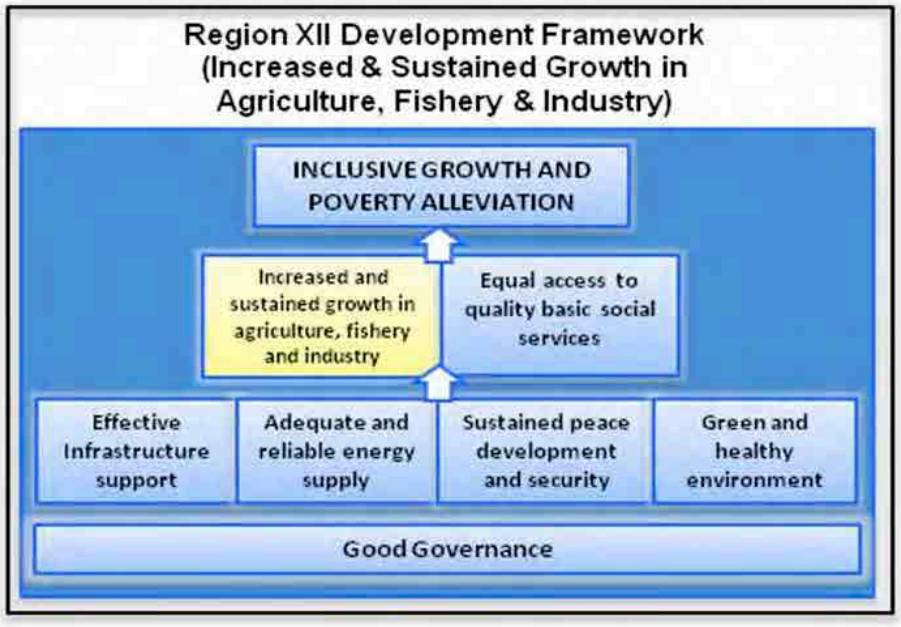
7) Sustained Peace, Development and Sea

- Strengthening the Justice System
- Improved Peace and Order
- Improved Public Safety
- Resilient and Progressive Communities in Conflict-affected and Vulnerable Areas

8) Good Governance

- Establishment of the Regional Government Center (RGC)
- Reform in Institution
- Enhancing Local Governance
- Strengthen Private/ Civil Society Participation the Development Process in the "effective Infrastructure Supports"

An effective infrastructure system would enable the integration of local and economic units not only with the major trading and service centers within the region, but also with the other regions in Mindanao and rest of the regions in the country and the world. The region shall continue to pursue the attainment of an effective infrastructure support system that would make possible the achievement of the twin goals of inclusive growth and poverty alleviation.



Source: SOCCSKSARGEN Regional Development Plan 2011-2016

FIGURE 2.4-1 REGION XII DEVELOPMENT FRAMEWORK (EFFECTIVE INFRASTRUCTURE SUPPORT)

2.5 TRANSPORT STUDIES AND PROJECTS

Various transport studies and projects are being planned and implemented as follows;

1) ADB-assisted Davao Sustainable Urban Transport Project

This study has four components;

- Development of a comprehensive public transport strategy for Davao
- Development and implementation of a public transport reform program
- Capacity Development
- Stakeholder participation program

The study is being implemented.

2) Davao International Airport Development, Operation/Maintenance Project

This project is planned to be implemented as a "PPP Project" and NEDA Board has already approved this project.

Major component of the project is to expend the passenger terminal building (additional 33,600 sq. meters) and to be implemented in three (3) phases.

3) Davao Sasa Port Modernization Project

This project is planned to be implemented as "PPP Project" and NEDA Board has already approved this project. Major components of the project are as follows;

- Expansion of Quay Length : 500 to 750m
- Draft : from -9.0m to -14.0m
- Annual Capacity : Approx. 1.2M TEU
- Largest Vessel : from 800 TEU to 9,000 TEU
- Equipment : 5 ship-to-shore cranes, 14 rubber-tyred gantry
- Additional ROW : 6.2 Ha.

4) Introduction of Urban Rail System in Davao City

Davao City Government and the Korea Engineering and Construction (KEC) agreed in June 2014 that a feasibility study for the construction of the Davao Light Rail Transit project be undertaken by KEC. Two routes will be studied, one has a length of 13km and the other is 17km.

CHAPTER 3

ROAD SECTOR OVERVIEW

CHAPTER 3
ROAD SECTOR OVERVIEW

3.1 DPWH PUBLIC INVESTMENT PROGRAM (2011-2016)

3.1.1 Road Development Goal

The DPWH Public Investment Program (PIP) (2011 - 2016) was formulated by that Department in 2011. Goals were set as follows:

DEVELOPMENT GOALS UNDER DPWH PIP

1. Provide safe environment through quality infrastructure facilities;
2. Increase mobility and total connectivity of people through quality infrastructure resulting to improved quality of life;
3. Strengthen national unity, family bonds and tourism by making the movement of people faster, cheaper and safer;
4. Facilitate the decongestion of Metro Manila via a transport logistics system that would ensure efficient linkages between its business centers and nearby provinces;
5. Implement more Public-Private Partnership (PPP) projects for much needed infrastructure and level playing field for investment;
6. Ensure adequate and sustained maintenance of roads and bridges; and
7. Generate more transport infrastructure with minimal budget requirements and contingent liabilities.

The strategic focus of the DPWH PIP was set as follows;

STRATEGIC FOCUS

- Implement activities in the following order of priorities:
  a. Maintenance or asset preservation – to preserve existing roads in good condition.
  b. Rehabilitation – to restore damaged roads to their original designed condition.
  c. Improvement – to upgrade road features so that they efficiently meet traffic demands.
  d. New Construction
- Prioritize upgrading of the national road network, as to quality and safety standards.
- Prioritize national roads to address traffic congestion and safety in urban centers and designated strategic tourism destinations.
- Complete on-going bridges along national roads.
- Develop more Public-Private Partnership (PPP) projects to accelerate the provision of key infrastructure and level the playing field for investments.
- Study the mechanism for a longer maintenance period (5 – 10 years) for road and bridges under performance-based contracts.
- Prioritize flood control projects in major and principal river basins to address climate change based on master plan and adopt new technologies in flood control and slope management.
- Prioritize adequate flood control and upgraded drainage design standards and facilities in flood-disaster prone areas to mitigate loss of rivers and damage to properties.
- Promote innovative technology such as geo-textiles and coco-netting in slope protection and soil erosion control.
- Promote retarding basin and rain water harvesting for non-domestic use.
- Prioritize water supply in designated strategic tourist destinations/centers.

3.2 DPWH ORGANIZATION

DPWH has recently implemented the Rationalization Plan (RatPlan) pursuant to E.O. No. 366, series of 2004, as per Department Order No. 89, dated September 25, 2013. Important Services and Bureaus have been added and some changes namely: the Bureau of Quality and Safety under the Technical Services; the Public-Private Partnership Service under the Planning and PPP; under the Support Services the Procurement Service and Stakeholders Relations Service were added, Administrative & Manpower Management Service was changed to Human Resource & Administrative Service, Comptrollership & Financial Management Services was changed to Financial and Management Service, and Monitoring & Information Service was changed to Information Management Service; and the PMO Operations become a Unified PMO Operations where it was divided into five (5) different management clusters, namely: Bridges, Flood Control, Roads (Bilateral), Roads (Multilateral) and Buildings. **Table 3.2-1** shows the detailed list of the renaming of some existing services and some of its divisions and divisions in existing bureaus as per Department Order No. 107, series of 2013.

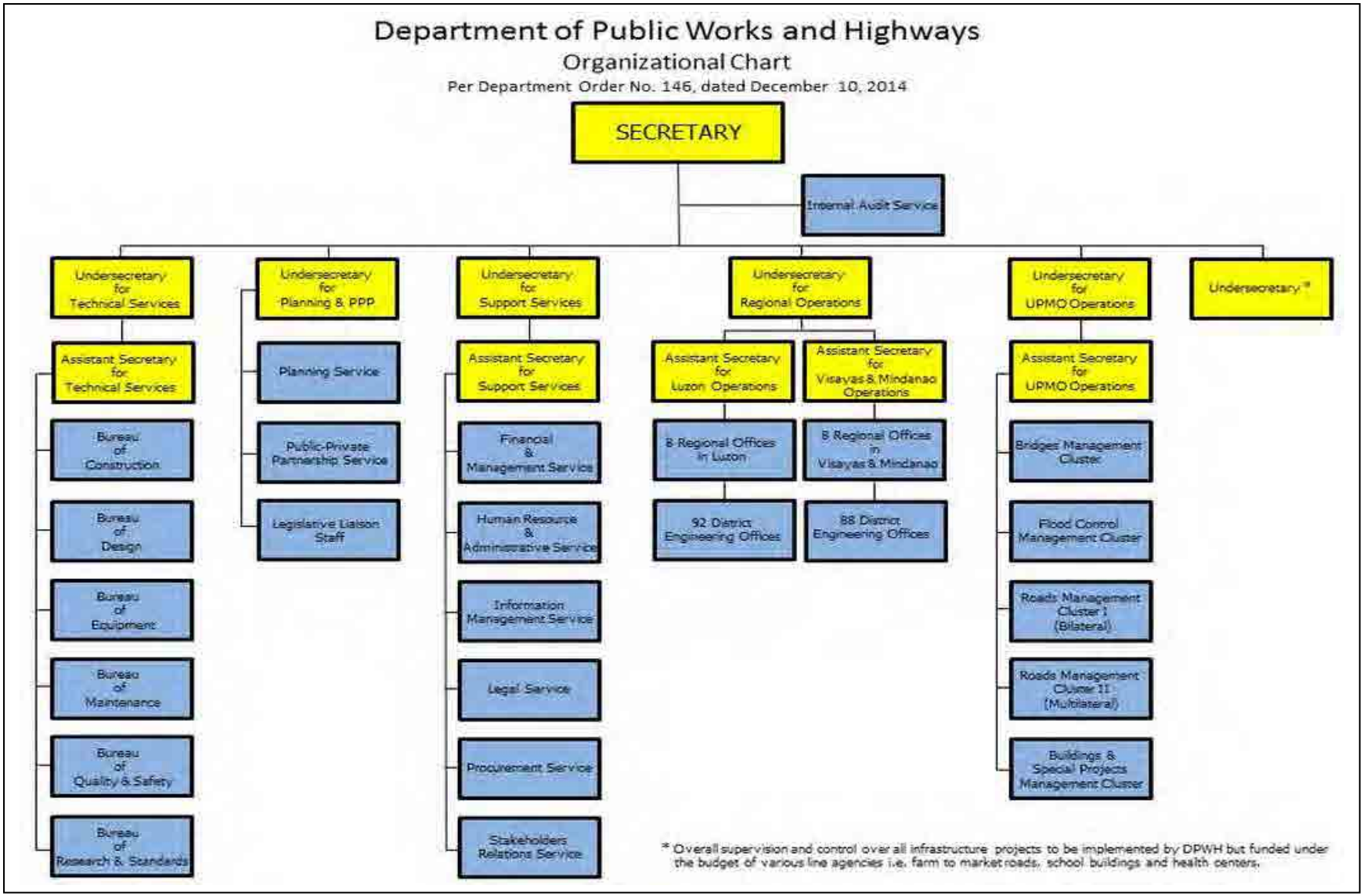
TABLE 3.2-1 LIST OF RENAMING OF SOME EXISTING SERVICES, BUREAUS AND DIVISIONS

Old Name	New Name
SERVICES	
• **Internal Audit Service**	
Financial Audit Division	Financial Operations Audit Division
Operations Audit Division	Technical Operations Audit Division
• **Project Management Office**	**Unified Project Management Office**
PMO for Special Bridges	Bridge Management Office
Flood Control and Sabo Engineering Center	Flood Control Management Office
• **Administrative and Manpower Management Service**	**Human Resource Administrative Service**
Personnel Division	Human Resource Management Division
Human Resource Planning & HR Training & Materials Development Division	Capacity Development Division
• **Comptrollership and Financial Management Service**	**Financial and Management Service**
• **Planning Service**	
Project Evaluation Division	Project Preparation Division
Infrastructure Planning Research & Statistic Division	Statistic Division
• **Legal Service**	
Complaints and Investigation Division	Internal Affairs Division
Site Acquisition and Law Enforcement Division	Right-of-Way Acquisition and Enforcement Division
• **Monitoring and Information Service**	**Information Management Service**
Application Development Division	Application Support Group
BUREAUS	
• **Bureau of Design**	
Hydraulics Division	Water Projects Division
Architectural Division, Structural Division, and Mechanical-Electrical Division	Buildings Division
• **Bureau of Construction**	
Contract Management Division	Claims Review Division
Project Review & Evaluation Division, A, B, C and Pre-Construction Division	Pre-Construction Division

Old Name	New Name
• **Bureau of Maintenance**	
Inspectorate Division	Road Condition Monitoring and Evaluation Division
Monitoring & Methods Division	Policies and Standards Division
Building Services Division	National Building Services Division
• **Bureau of Equipment**	
Equipment Utilization Div. & Equipment Planning Division	Equipment Planning Division
Central Equipment & Spare Parts Division and Equipment Maintenance Division	Equipment Operation and Maintenance Division
• **Bureau of Research & Standards**	
Systems and Standards Division	Standards Development Division
Technical Service and Evaluation Division	Technical Services Division

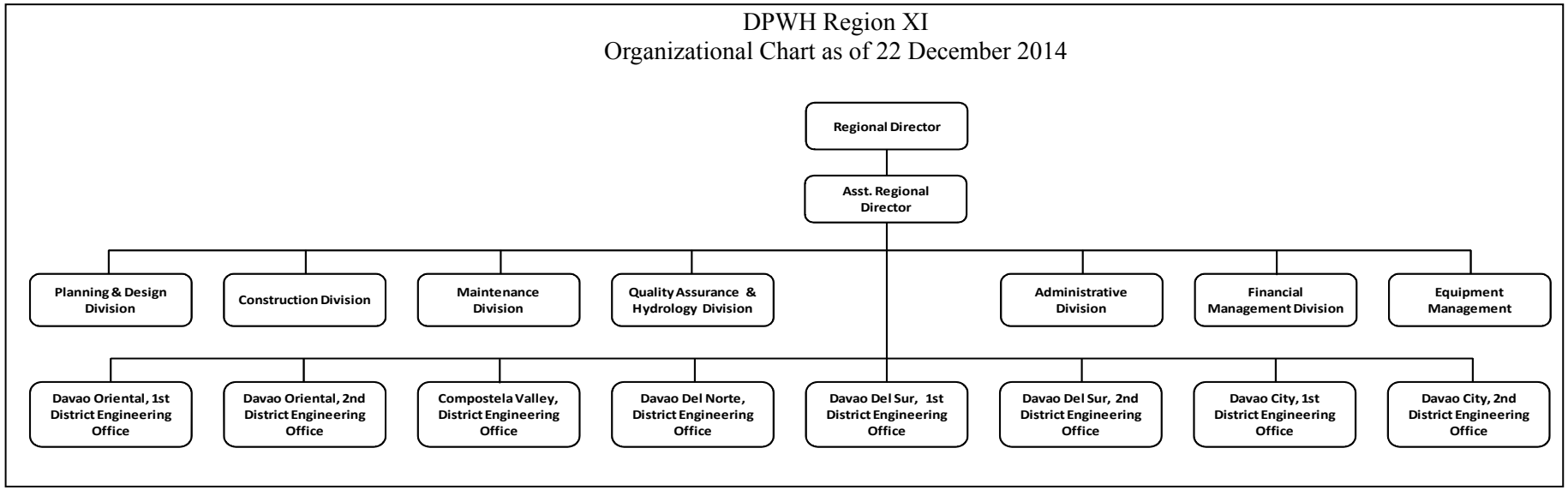
Source: DPWH Website

Figure 3.2-1 shows the current Organizational Chart of DPWH. The project site is located within the jurisdiction of DPWH Region XI. DPWH Region XI Office is organized with seven (7) divisions and eight (8) district engineering offices as shown in **Figure 3.2-2.**



Source: DPWH Website

FIGURE 3.2-1 DPWH ORGANIZATIONAL STRUCTURE



Source: DPWH Region XI

FIGURE 3.2-2 DPWH REGION XI ORGANIZATIONAL STRUCTURE

3.3 DAVAO CITY GOVERNMENT

Davao City's road/land development appropriations from Year 2010 to 2013 is shown in **Table 3.3.-1.**

TABLE 3.3-1 DAVAO COTY ROAD/LAND DEVELOPMENT APPROPRIATIONS

Year	Road/Land Development Appropriations (in Million Php)
2010	13.075 (1.00)
2011	30.525 (2.33)
2012	56.162 (4.30)
2013	111.522 (8.53)

City Engineer's Office (CEO) is in charge of construction, improvement and maintenance of roads and bridges. CEO is staffed with 455 people and its organizational chart is shown in **Figure 3.3-1.**

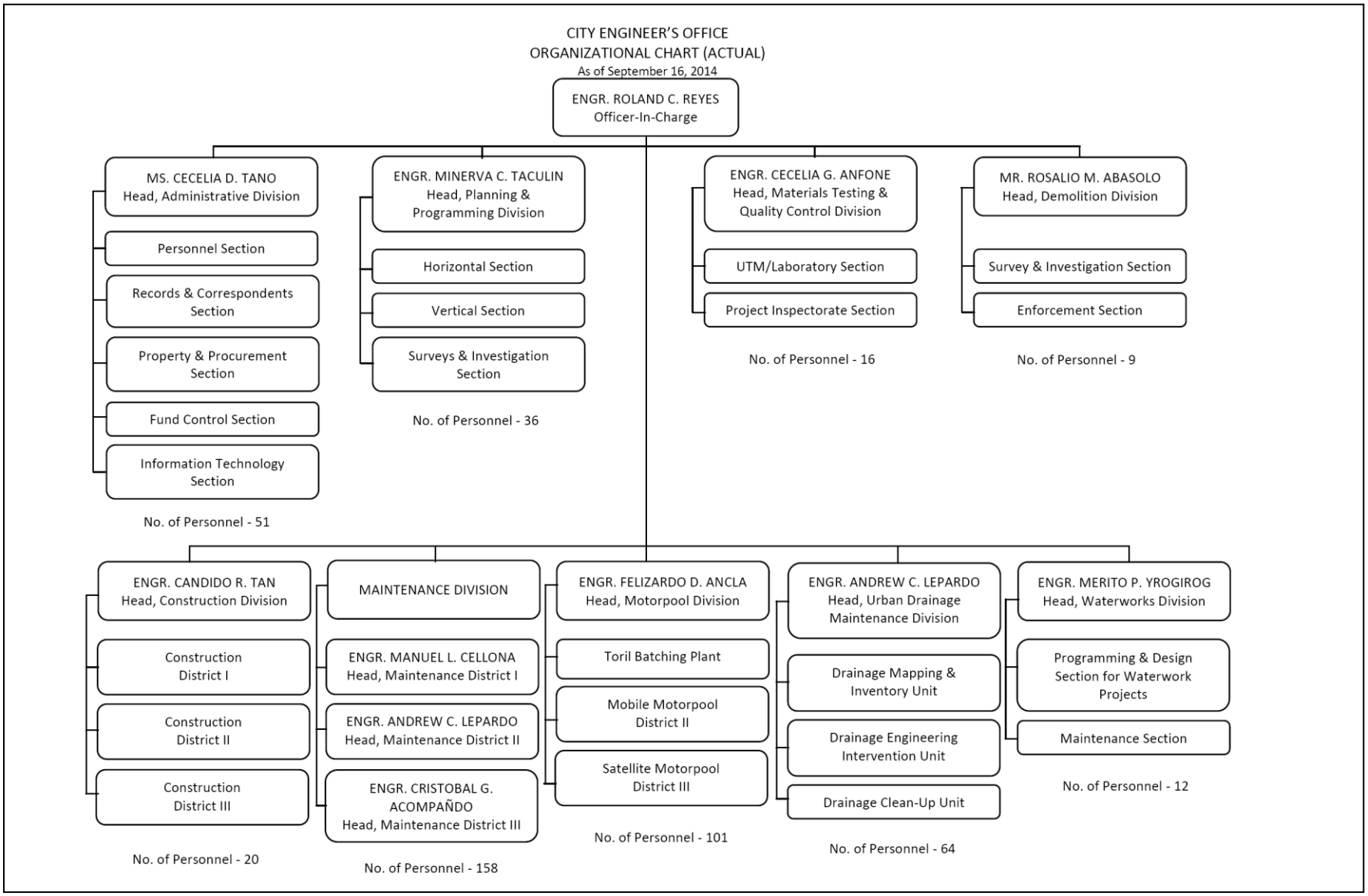


FIGURE 3.3-1 ORGANIZATIONAL CHART OF CITY ENGINEER'S OFFICE

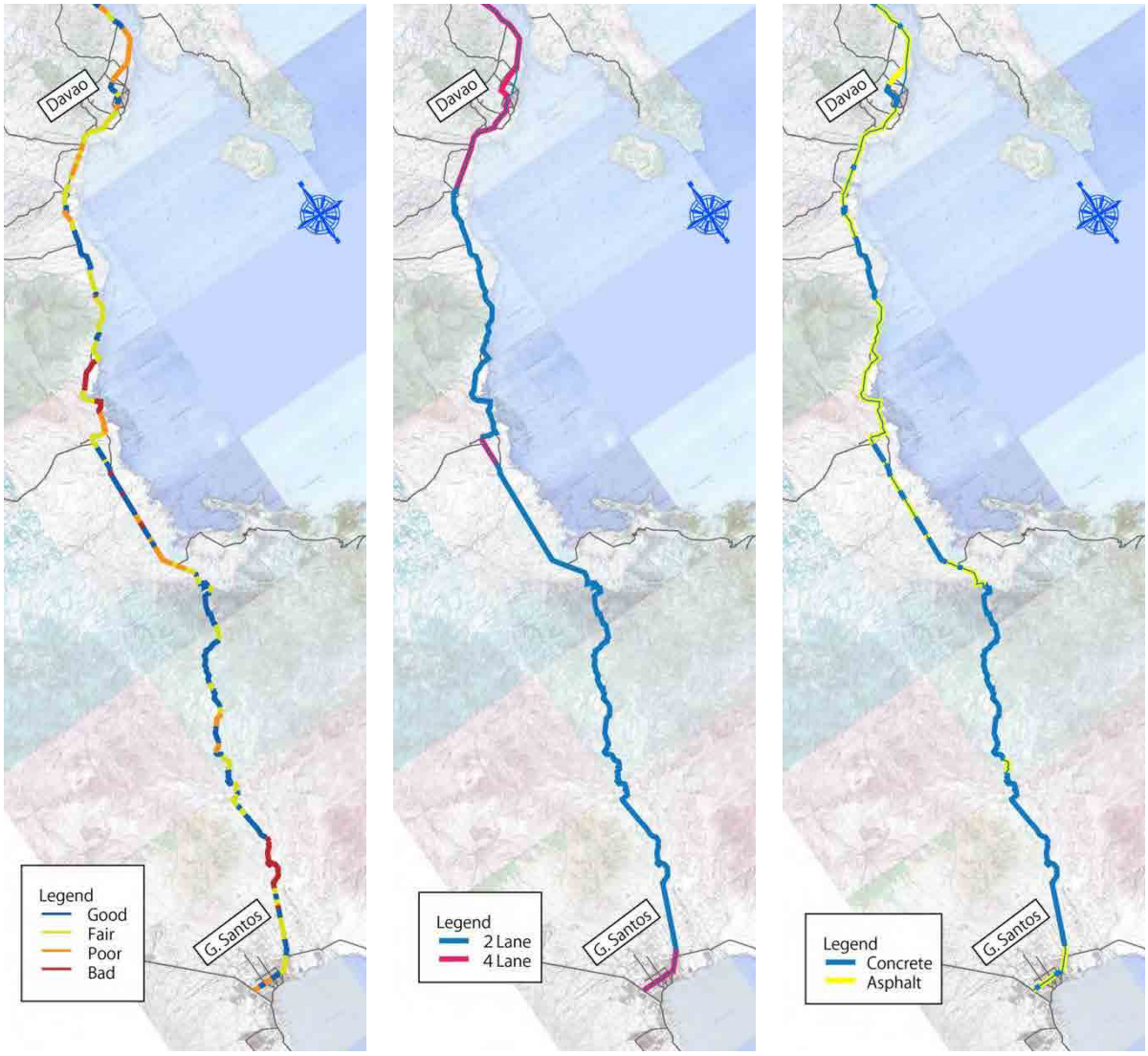
CHAPTER 4

DAVAO CITY – GENERAL SANTOS CITY ROAD IMPROVEMENT PLAN

CHAPTER 4
DAVAO CITY – GENERAL SANTOS CITY ROAD IMPROVEMENT PLAN

4.1 PRESENT ROAD CONDITION

JICA Study Team conducted the inventory survey of Davao City – General Santos City Road. **Figure 4.1-1** shows the road condition, the number of lanes and pavement type.



Road Condition　　No. of Lane　　Pavement Type

Source: JICA Study Team (2013.7)

FIGURE 4.1-1 PRESENT ROAD CONDITION OF DAVAO CITY – GENERAL SANTOS CITY ROAD

For the type of pavement, 103.56km were concrete road and 70.74km were asphalt road, as shown in **Table 4.1-1**.

Most of the road sections are two-lane roads, excluding Davao City, General Santos City and Digos City.

TABLE 4.1-1 PAVEMENT TYPE OF DAVAO CITY – GENERAL SANTOS ROAD

Pavement Type	Length (km)	
Concrete	103.56	(59.4%)
Asphalt	70.74	(40.5%)
Gravel	0.12	(0.1%)
Total	**174.42**	**(100%)**

Source: JICA Study Team

TABLE 4.1-2 PAVEMENT CONDITION BY PAVEMENT TYPE OF DAVAO CITY – GENERAL SANTOS ROAD

Pavement Type / Pavement Condition	Concrete	Asphalt	Gravel	Total
Good	4.67 (4.5%)	20.05 (28.3%)	0 (0%)	24.72 (14.2%)
Fair	8.60 (8.3%)	22.45 (31.7%)	0 (0%)	31.05 (17.8%)
Poor	46.41 (44.8%)	11.34 (16.0%)	0 (0%)	57.75 (33.1%)
Bad	41.15 (39.7%)	11.88 (16.8%)	0 (0%)	53.03 (30.4%)
No Assessment	2.73 (2.6%	5.02 (7.1%)	0.12 (100%)	7.87 (4.5%)
Total	103.56 (100%)	70.74 (100%)	0.12 (100%)	174.42 (100%)

Source: JICA Study Team

Detailed Road Inventory Survey Result is attached in **Appendix 4.1.**

4.2 PRESENT BRIDGE CONDITION

There are twenty seven (27) bridges along the Davao City – General Santos City road stretch with a total bridge length of 1,187.83m. Out of the 27 bridges; only three (3) are in good condition, namely Lasang Bridge, Bunawan Bridge and Padada Bridge. Two (2) bridges however need repairs namely; Coronon Bridge needs repair of pier and Pilan Bridge needs some repair of pavement. Twelve (12) of these bridges are in the Study Area. **Table 4.2-1** shows the result of inventory result of the bridge condition.

TABLE 4.2-1 BRIDGE INVENTORY SURVEY RESULT

No.	District	Road Name	Bridge Name	KM	Position	Number of Lane	Bridge Width (m)	Length (m)	Span	Necessity of Repair	Necessity of Another Bridge Construction	Bridge Type	Condition
1	Davao Del Norte		Lasang Br.	1482+960.50	51 N 794387 804247	4-lane	16.6	60	3	No	No	Concrete	Good
2	Davao City	Daang Mahar	Bunawan Br.	1487+407.00	51 N 791964 800835	4-lane	14.0	43.5	1	No	No	Steel	Good
3	Davao City	Daang Mahar	Ilan Br.	1494+412.12	51 N 793053 794210	4-lane	14.6	18.6	3	No	No	Concrete	Fair
4	Davao City	Daang Mahar	Panacan br.	1497+206.00	51 N 793606 791547	4-lane	16.0	19.4	1	No	No	Concrete	Fair
5	Davao City	Daang Mahar	Sasa br.	1501+501.00	51 N 793201 787497	4-lane	15.4	13.15	1	No	No	Concrete	Fair
6	Davao City	ABS-CBN-Qu	Bolton Br. I	1511+742.80	51 N 787864 780983	4-lane	14.8	185.33	6	No	No	Concrete	Fair
7	Davao City	Davao-Cotaba	Matina Br.	1516+301.69	51 N 783592 781111	4-lane	15.0	26.6	3	No	No	Concrete	Fair
8	Davao City	Davao-City Di	Davao River Br.	1506+764.44	51 N 786567 786232	2-lane	7.4	140.6	4	No	Yes	Concrete	Fair
9	Davao City	Davao-City Di	Pangi Br.	1531+930.50	51 N 783735 781760	2-lane	8.6	100.6	4	No	Yes	Concrete	Fair
10	Davao City	Davao-Cotaba	Talomo Br.-I	1518+406.30	51 N 781623 780948	4-lane	14.8	34.75	1	No	No	Concrete	Fair
11	Davao City	Davao-Cotaba	Bago Br.	1521+009.35	51 N 779590 779332	4-lane	15.0	27.6	3	No	No	Concrete	Fair
12	Davao City	Davao-Cotaba	Lipadas Br.	1528+001.02	51 N 774567 774806	4-lane (Under Construction)	14.8	37.8	3	No	No	Concrete	Fair
13	Davao del Sur	Davao-Cotaba	Inawayan Br.	1532+900.00	51 N 773514 770178	2-lane	7.4	10.4	1	No	Yes	Concrete	Fair
14	Davao del Sur	Davao-Cotaba	Quinokol Br.	1534+900.00	51 N 773156 768432	2-lane	7.2	21	1	No	Yes	Concrete	Fair
15	Davao del Sur	Davao-Cotaba	Cebulan Br.	1536+900.00	51 N 772774 766539	2-lane	7.6	25	1	No	Yes	Steel	Fair
16	Davao del Sur	Davao-Cotaba	Coronon Br. I	1542+950.00	51 N 770937 761005	4-lane (Under Construction)	14.7	24	1	Repair of Pier	No	Concrete	Poor
17	Davao del Sur	Davao-Cotaba	Coronon Br. II	1543+276.75	51 N 770703 760615	2-lane	7.6	36.65	3	No	Yes	Concrete	Fair
18	Davao del Sur	Davao-Cotaba	Pilan Br.	1549+835.00	51 N 766105 756383	2-lane	7.6	21	1	Repair of Pavement	Yes	Concrete	Fair
19	Davao del Sur	Davao-Cotaba	Tagabuli Br.	1555+037.00	51 N 762904 753767	2-lane	7.2	20.6	1	No	Yes	Concrete	Fair
20	Davao del Sur	Davao-Cotaba	Digos Br. - II	1562+458.30	51 N 762345 746705	4-lane	14.8	31.35	1	No	No	Concrete	Fair
21	Davao del Sur	Davao-Cotaba	Balutakay Br.	1568+700.00	51 N 760052 743201	2-lane	7.4	24	1	No	Yes	Concrete	Fair
22	Davao del Sur	Digos-Makar	Padada br.	1571+958.50	51 N 759781 739914	2-lane	7.4	92.5	3	No	Yes	Concrete	Good
23	Sarangani	Digos-Makar	Banate Br.	1601+377.65	51 N 756902 716605	4-lane (Under Construction)	7.6	21.1	1	No	No	Concrete	Fair
24	Sarangani	Digos-Makar	Biangan Br.	1613+489.10	51 N 751960 706711	2-lane	8.4	45.9	3	No	Yes	Concrete	Poor
25	Sarangani	Digos-Makar	Nagpan Br.	1618+418.35	51 N 751325 702869	2-lane	8.2	21.8	1	No	Yes	Concrete	Fair
26	Sarangani	Digos-Makar	Upper Buayan Br.	1623+374.90	51 N 750281 699354	2-lane	7.8	39.6	3	No	Yes	Concrete	Fair
27	South Cotobato	Digos-Makar	Tinagakan Br.	1639+055.00	51 N 747307 686737	2-lane	7.4	45	3	No	Yes	Concrete	Fair

Source: JICA Study Team (2013.7)

CHAPTER 5

SOCIO-ECONOMIC CONDITION OF THE PROJECT AREA:

REGION XI AND DAVAO CITY

CHAPTER 5
SOCIO-ECONOMIC CONDITION OF THE PROJECT AREA: REGION XI AND DAVAO CITY

5.1 STANDING OF DAVAO CITY IN MINDANAO

Davao City has one million four hundred thousand population in year 2010 and it is the largest city in the Mindanao island. In the Philippines, Davao City is the third largest metropolis. As shown in **Figure 5.1-1**, Davao City is the center of Mindanao for commercial, business, financial, industrial and culture. It is also an important city as the center of East ASEAN Growth Region. It has likewise a role of important hub station for land, sea, and air transportation as shown in **Figure 5.1-2**.

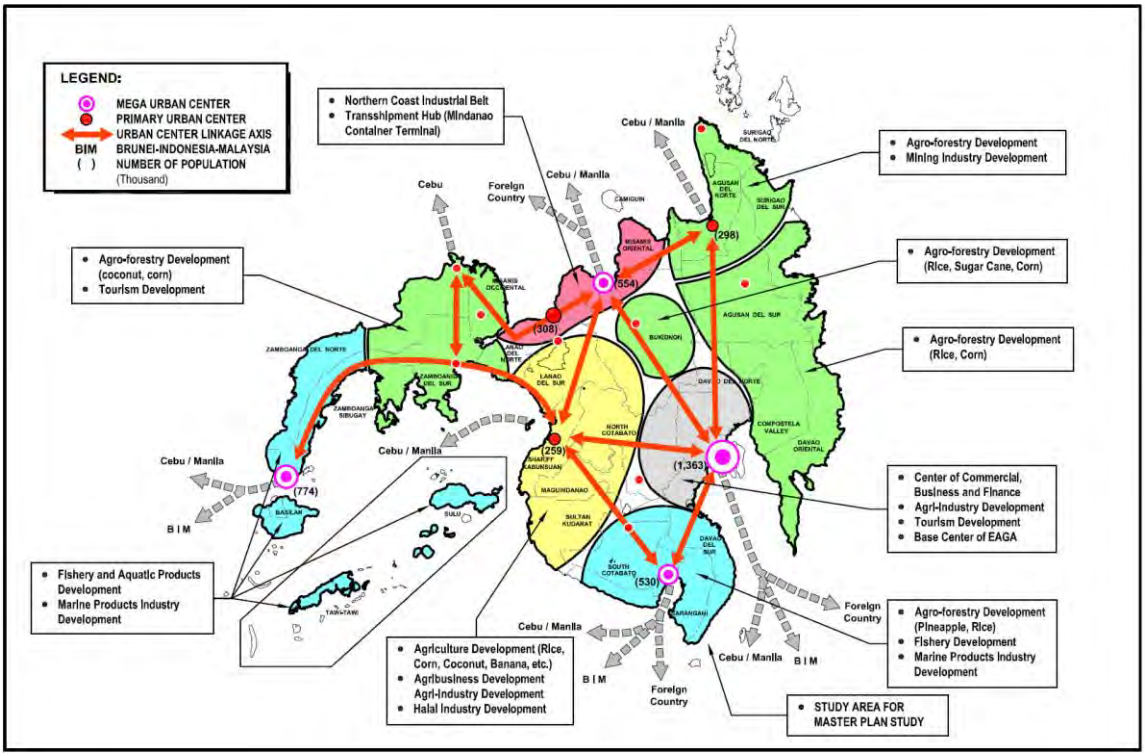


FIGURE 5.1-1 MINDANAO DEVELOPMENT CENTER

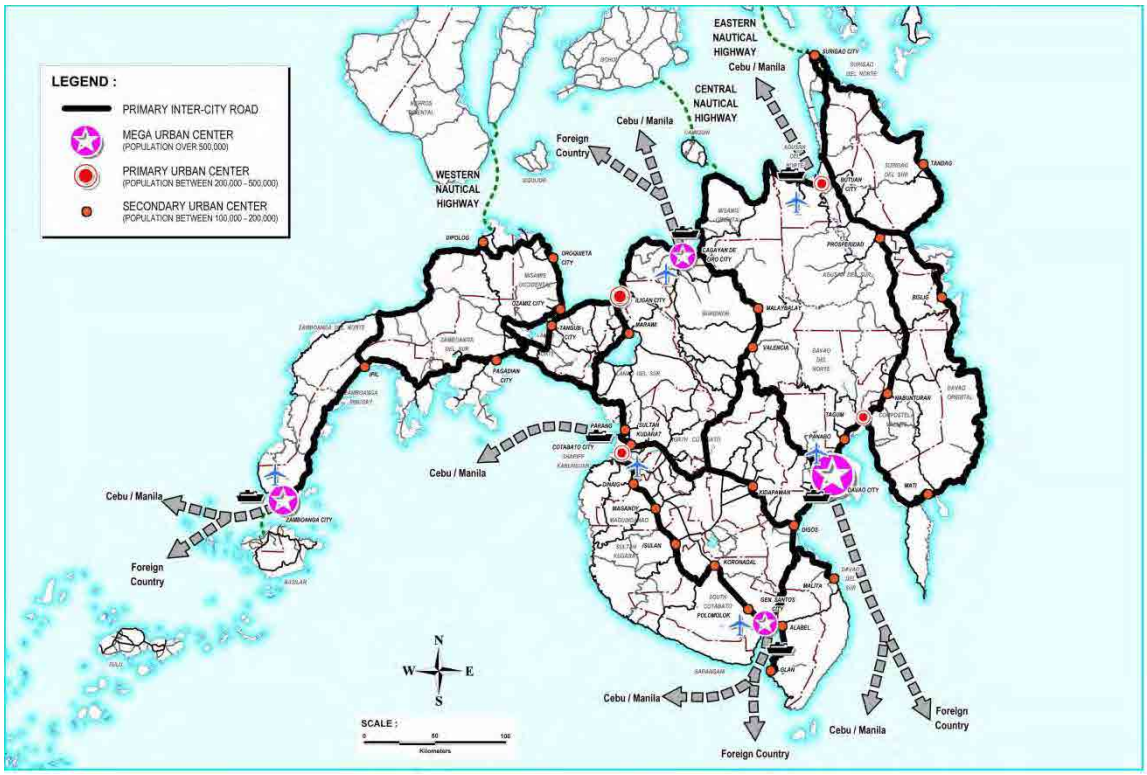


FIGURE 5.1-2 MINDANAO INTER-URBAN TRANSPORT NETWORK

5.2 PHYSICAL PROFILE

The project is located on Region XI specifically in the Davao City and Panabo City. Region XI is composed of four (4) provinces of Compostela Valley, Davao Del Norte, Davao Oriental and Davao Del Sur. The region covers 20,244 sq.km. or 5.8% of country's land area. **Table 5.2-1** shows the land area share of Region XI to country as well as share of neighboring region to the country.

TABLE 5.2-1 LAND AREA SHARE

Region	Land Area (sq.km.)	Share to Philippine	Population (2010)	Density
Philippines	344,879			308/km^2
Region X	20,132	5.8%	4,297,323	210/km^2
Region XI	**20,244**	**5.8%**	**4,468,563**	**260/km^2**
Region XII	22,466	6.5%	4,109,571	180/km^2
Region XIII	21,471	6.2%	2,429,224	110/km^2

5.3 DEMOGRAPHIC TREND

The population of Region XI is 4.47 million in 2010. This number represents 4.8% of the total population of the country. Growth rate in the region is higher than that of national average between 2007-2010 as presented in **Table 5.3-1.**

The population of Davao City is 1.45 million in 2010. As mentioned before, Davao City is the third metropolis in the Philippines and the growth rate of Davao City is much higher than that of the national average. Likewise, the population of Panabo City is 0.17 million in 2010.

Figure 5.3-1 illustrates the population density. High population density of the city center is expanded and the area of coastal side (or along Pan-Philippine Highway) became high density. **Figure 5.3-2** illustrates the population growth rate. Though the growth rate in the city center were

low (0-2%), that of inland area were very high (over 5%).

Barangays directly affected by the Davao City Bypass Project are listed in **Table 5.3-2** as illustrated in **Figure 5.3-3.**

TABLE 5.3-1 POPULATION GROWTH RATE

Region/City	District	Actual Population			Land Area	Density (Person /sq km)			Annual Population Growth Rate	
		2000	2007	2010	(sq km)	2000	2007	2010	2000-2007	2007-2010
Philippines		76,504,077	88574614	92,337,852	340,575	225	260	271	2.1%	1.4%
Region XI		3,676,163	4,156,653	4,468,563	20,244	182	205	221	1.8%	2.4%
Davao City	POBLACION	133,639	153,005	156,450	11.5	11,626	13,311	13,611	2.0%	0.7%
	TALOMO	284,100	360,010	382,652	88.1	3,226	4,089	4,346	3.4%	2.1%
	AGDAO	91,397	98,586	99,406	6.1	14,993	16,172	16,307	1.1%	0.3%
	BUHANGIN	193,519	232,865	256,959	96.5	2,005	2,413	2,662	2.7%	3.3%
	BUNAWAN	97,641	123,767	131,704	64.5	1,513	1,918	2,041	3.4%	2.1%
	PAQUIBATO	35,270	38,266	39,698	656.3	54	58	60	1.2%	1.2%
	BAGUIO	24,379	27,255	30,384	188.4	129	145	161	1.6%	3.7%
	CALINAN	67,077	70,840	81,844	229.9	292	308	356	0.8%	4.9%
	MARILOG	42,736	42,718	45,125	631.6	68	68	71	0.0%	1.8%
	TORIL	108,054	126,978	133,452	297.8	363	426	448	2.3%	1.7%
	TUGBOK	69,304	83,863	91,622	149.0	465	563	615	2.8%	3.0%
	TOTAL	**1,147,116**	**1,358,153**	**1,449,296**	**2,419.7**	**474**	**561**	**599**	**2.4%**	**2.2%**

Source: National Statistics Office

TABLE 5.3-2 NUMBERS OF AFFECTED BARANGAYS BY DISTRICT

City	District	Barangay Name	# of Affected Barangays
Davao City	1st	Catalunan Grande	3
		Magtuod	
		Langub	
	2nd	Waan	10
		Tigatto	
		Cabantian	
		Communal	
		Indangan	
		Mudiang	
		Tibungco	
		Mahayag	
		San Isidro	
		Lasang	
	3rd	Sirawan	12
		Marapangi	
		Bato	
		Lubogan	
		Alambre	
		Bangkas Heights	
		Mulig	
		Bago Oshiro	
		Mintal	
		Tugbok Proper	
		Tacunan	
		Matina Biao	
Panabo City		J.P. Laurel	1

Source: City Planning and Development Offices

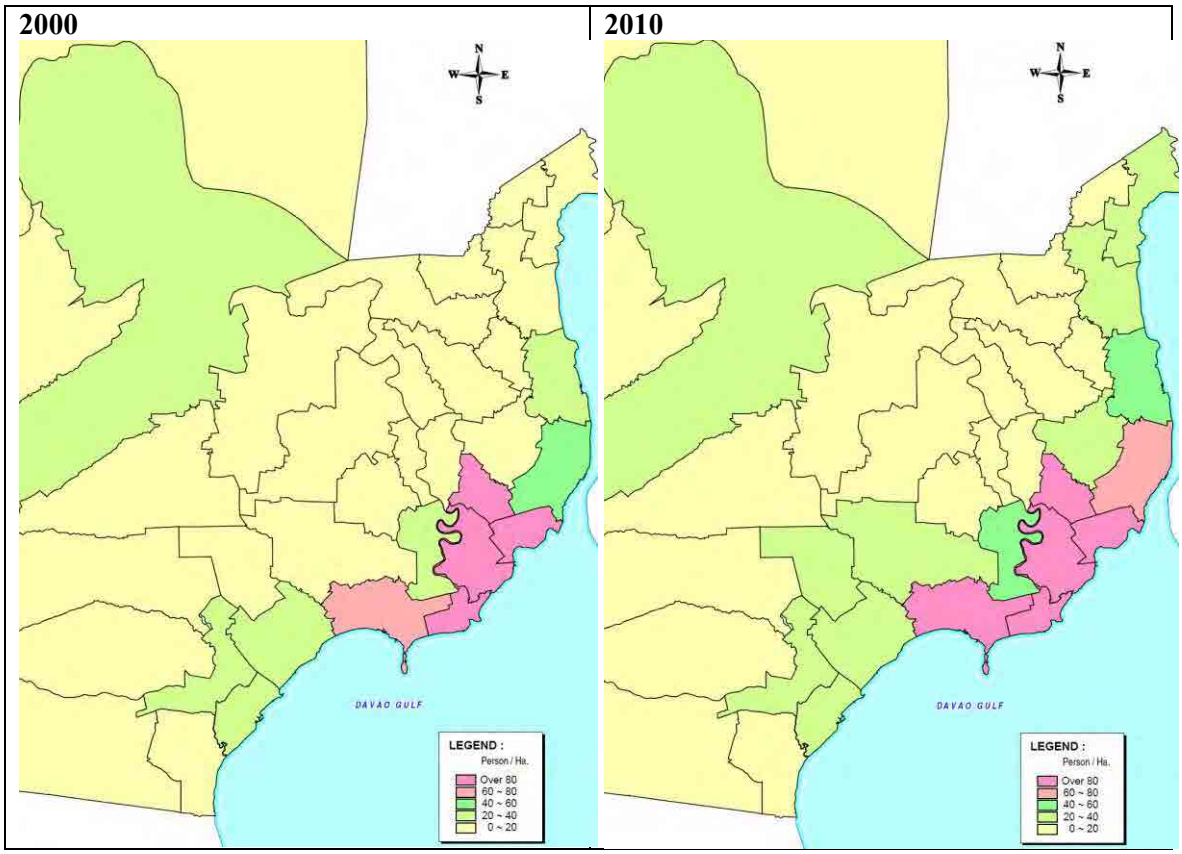


FIGURE 5.3-1 POPULATION DENSITY

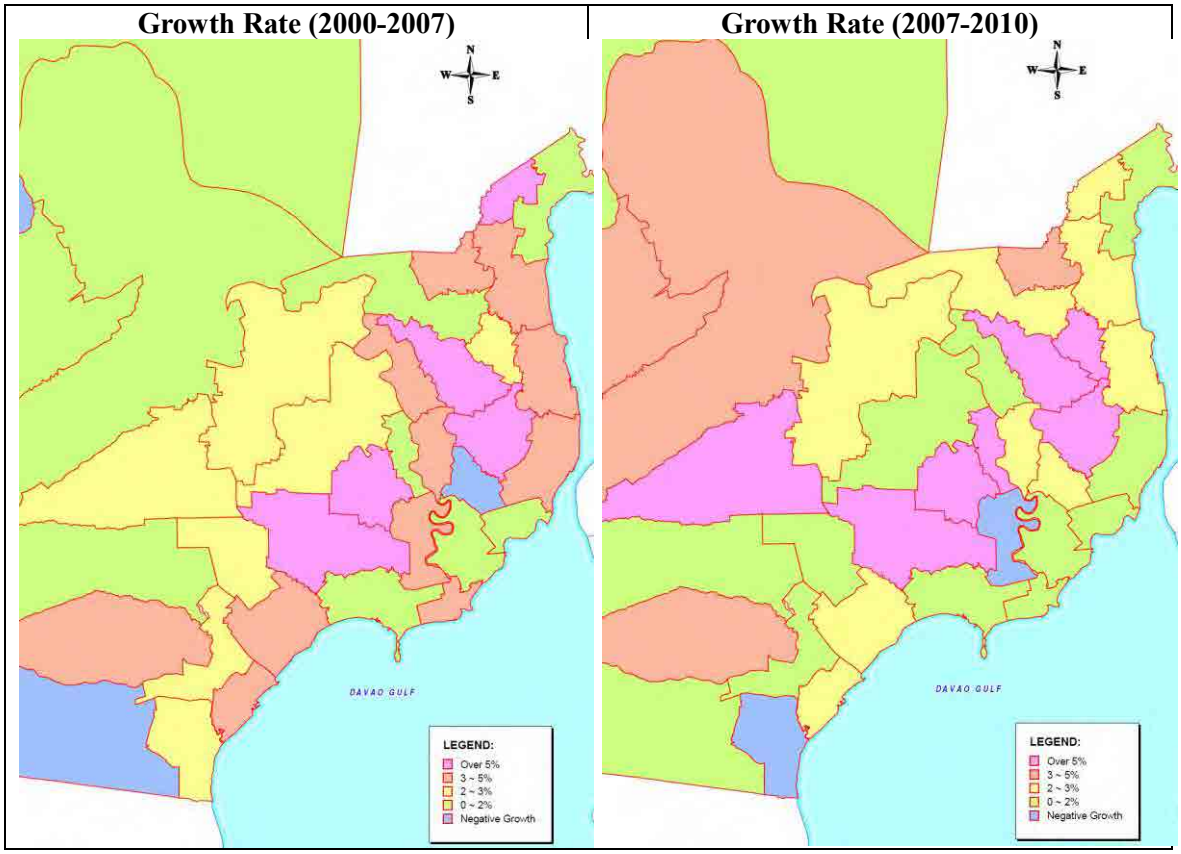
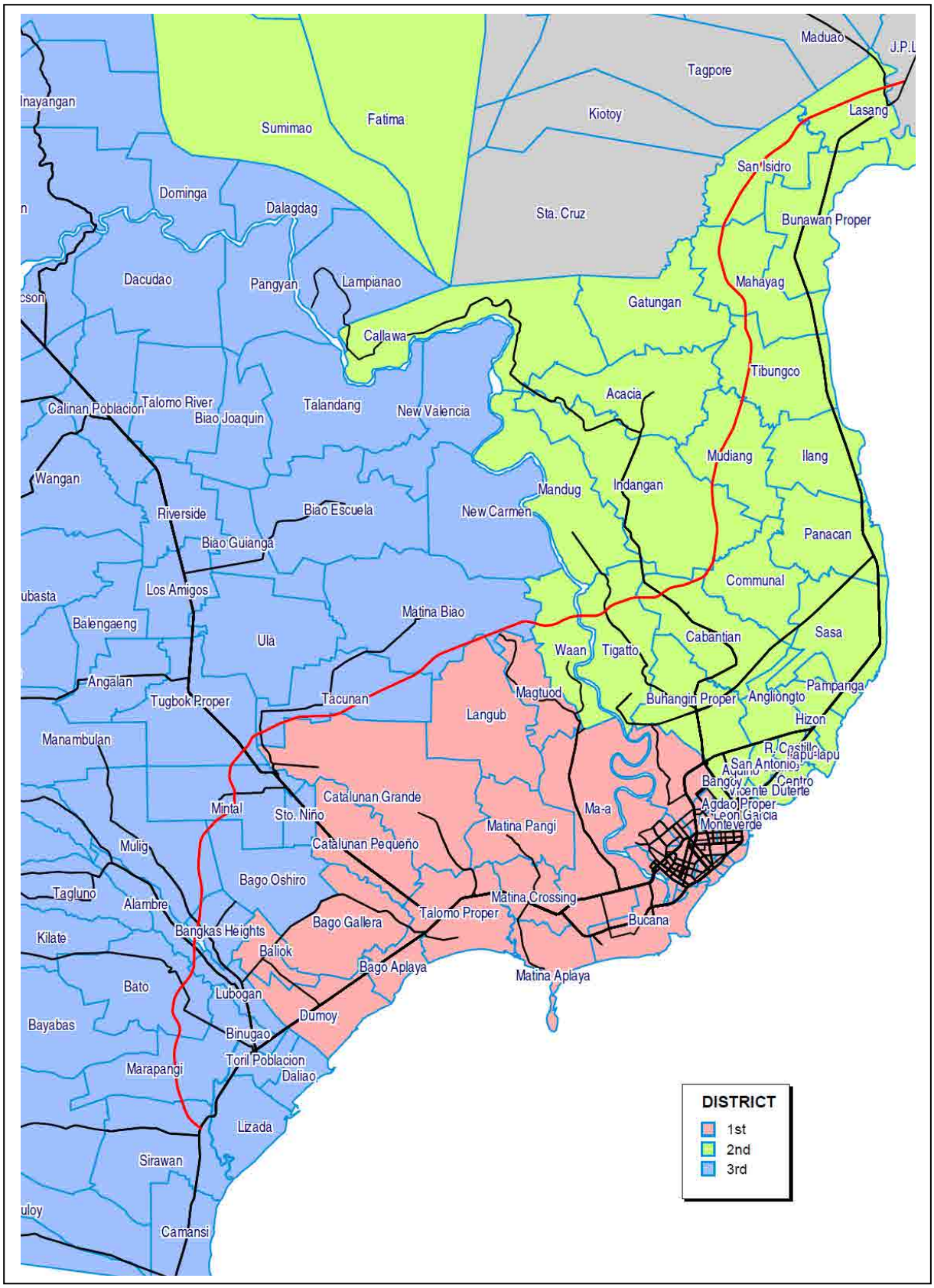


FIGURE 5.3-2 POPULATION GROWTH RATE



Source: Davao City Planning and Development Office

FIGURE 5.3-3 DISTRICT MAP OF DAVAO CITY

5.4 ECONOMIC TREND

The GRDP of Region XI as well as neighboring regions is shown in **Table 5.4-1.** The highest share of GRDP in Mindanao was 27% in Region XI. Region XI (Davao City) and Region X (Cagayan de Oro City and etc.) are the main key players for Mindanao' economic growth.

Growth rate of Region XI was lower than that of Mindanao, but it was higher than the national growth rate.

TABLE 5.4-1 GDP AND GRDP IN CONSTANT PRICE

Item	GRDP in Constant Price (thousand Php)			Share in Mindanao (2012)	Growth Rate	
	2010	2011	2012		2010-2011	2011-2012
Philippines	5,701,539,196	5,908,999,733	6,311,670,842		3.64%	6.81%
NCR	2,038,178,776	2,101,687,899	2,255,116,040		3.12%	7.30%
Region IX	117,018,919	117,182,723	131,695,644	14%	0.14%	12.38%
Region X	210,965,521	223,160,739	239,677,173	26%	5.78%	7.40%
Region XI	***217,313,462***	***225,455,325***	***242,230,400***	***27%***	***3.75%***	***7.44%***
Region XII	151,318,180	159,309,865	172,262,219	19%	5.28%	8.13%
Region XIII	64,534,772	70,002,372	77,426,887	8%	8.47%	10.61%
ARMM	47,610,858	47,478,614	48,038,871	5%	-0.28%	1.18%

Source: NSCB website 2013

The industrial structures of the economy of Region XIare as follows: Primary sector (23%), Secondary sector (26%) and Tertiary sector (51%) as shown in **Table 5.4-2.**

The share of Tertiary sector of Region XI was higher than that of other regions in Mindanao.

TABLE 5.4-2 INDUSTRIAL STRUCTURE OF THE ECONOMY 2013

At Current Prices **Unit: in Million Pesos**

	Primary	Secondary	Tertiary	Total
Philippines	1,250,616	3,284,508	6,029,762	10,564,886
NCR	9,945	649,018	3,171,872	3,830,834
Region IX	56,741	66,747	93,122	216,610
Region X	110,879	127,461	171,258	409,598
Region XI	97,974	109,121	216,624	423,719
Region XII	113,473	82,208	104,008	299,689
Region XIII	28,328	34,978	59,156	122,462
ARMM	60,907	4,385	28,022	93,314
Mindanao	468,301	424,899	672,190	1,565,390
In percentage				
Philippines	11.8%	31.1%	57.1%	100%
NCR	0.3%	16.9%	82.8%	100%
Region IX	26.2%	30.8%	43.0%	100%
Region X	27.1%	31.1%	41.8%	100%
Region XI	**23.1%**	**25.8%**	**51.1%**	**100%**
Region XII	37.9%	27.4%	34.7%	100%
Region XIII	23.1%	28.6%	48.3%	100%
ARMM	65.3%	4.7%	30.0%	100%

Source: NSCB 2013

5.5 PER CAPITA GDP AND GRDP

The per capita GRDP in current price and constant price are shown in **Table 5.5-1** and **Table 5.5-2** respectively. Though GRDP of Region XI was higher than that of other regions in Mindanao, it was a bit lower than national average.

The country's per capita GDP grew by 4.2% per year from 2009 to 2012. Region XI's growth rate was 3.8%.

TABLE 5.5-1 PER CAPITA IN CURRENT PRICE

unit: Peso

	2009	2010	2011	2012	
Philippines	88,180	97,227	103,056	110,314	1.00
NCR	245,500	271,255	286,458	312,137	2.83
Region IX	50,731	53,822	56,863	61,324	0.56
Region X	71,424	79,901	86,447	91,654	0.83
Region XI	**76,435**	**83,721**	**89,156**	**91,312**	**0.83**
Region XII	54,155	60,204	64,782	69,663	0.63
Region XIII	36,318	40,345	43,935	48,954	0.44

Source: NSCB website 2013

TABLE 5.5-2 PER CAPITA IN CONSTANT PRICE OF YEAR 2000

unit: Peso

	2009	2010	2011	2012	Growth Rate
Philippines	58,199	61,570	62,739	65,904	4.2%
NCR	162,321	171,442	173,975	183,747	4.2%
Region IX	34,353	34,245	33,726	37,284	2.8%
Region X	46,818	48,940	50,838	53,632	4.6%
Region XI	**46,721**	**48,487**	**49,431**	**52,201**	3.8%
Region XII	36,688	36,688	37,813	40,043	3.0%
Region XIII	24,264	26,504	28,362	30,951	8.5%

Source: NSCB website 2013

5.6 EMPLOYMENT

The number of establishments in Davao City reached 34,566 in 2011. This said number of establishment generated 216,648 employees in Davao City.

The share of establishment and employees of Poblacion in 2011 is high at 38% and 42%, respectively.

TABLE 5.6-1 NUMBER OF ESTABLISHMENTS AND EMPLOYMENTS IN DAVAO CITY

District	No. of Establishments		No. of Employees		Growth Rate	
	2010	2011	2010	2011	No. of Establishments	No. of Employees
Poblacion	11,711	12,321	74,262	91,666	5.2%	23.4%
Talomo	7,696	8,099	32,722	44,755	5.2%	36.8%
Agdao	2,765	2,906	12,673	13,237	5.1%	4.5%
Buhangin	5,257	5,568	34,084	33,783	5.9%	-0.9%
Bunawan	1,225	1,312	11,435	11,541	7.1%	0.9%
Paquibato	77	91	57	60	18.2%	5.3%
Baguio	181	175	1,742	1,764	-3.3%	1.3%
Calinan	1,081	1,183	4,212	4,969	9.4%	18.0%
Marilog	147	161	199	1,864	9.5%	836.7%
Toril	1,718	1,779	9,545	9,873	3.6%	3.4%
Tugbok	833	921	2,994	3,106	10.6%	3.7%
No barangay		50		30	-	-

Source: NSO, Statistical Sampling and Operation Division, List of Establishments

5.7 PRESENT AND FUTURE LAND USE PLAN OF DAVAO CITY

Figure 5.7-1 shows the Present Land Use. The proposed alignment is avoiding the residential, industrial and institutional areas.

Figure 5.7-2 shows the Land Use Plan, the proposed alignment is passing through planned industrial zone (I-1, I-2 and I-3), medium density residential zone (R-2) and agricultural and pasture land zone. There is conservation area near the alignment.

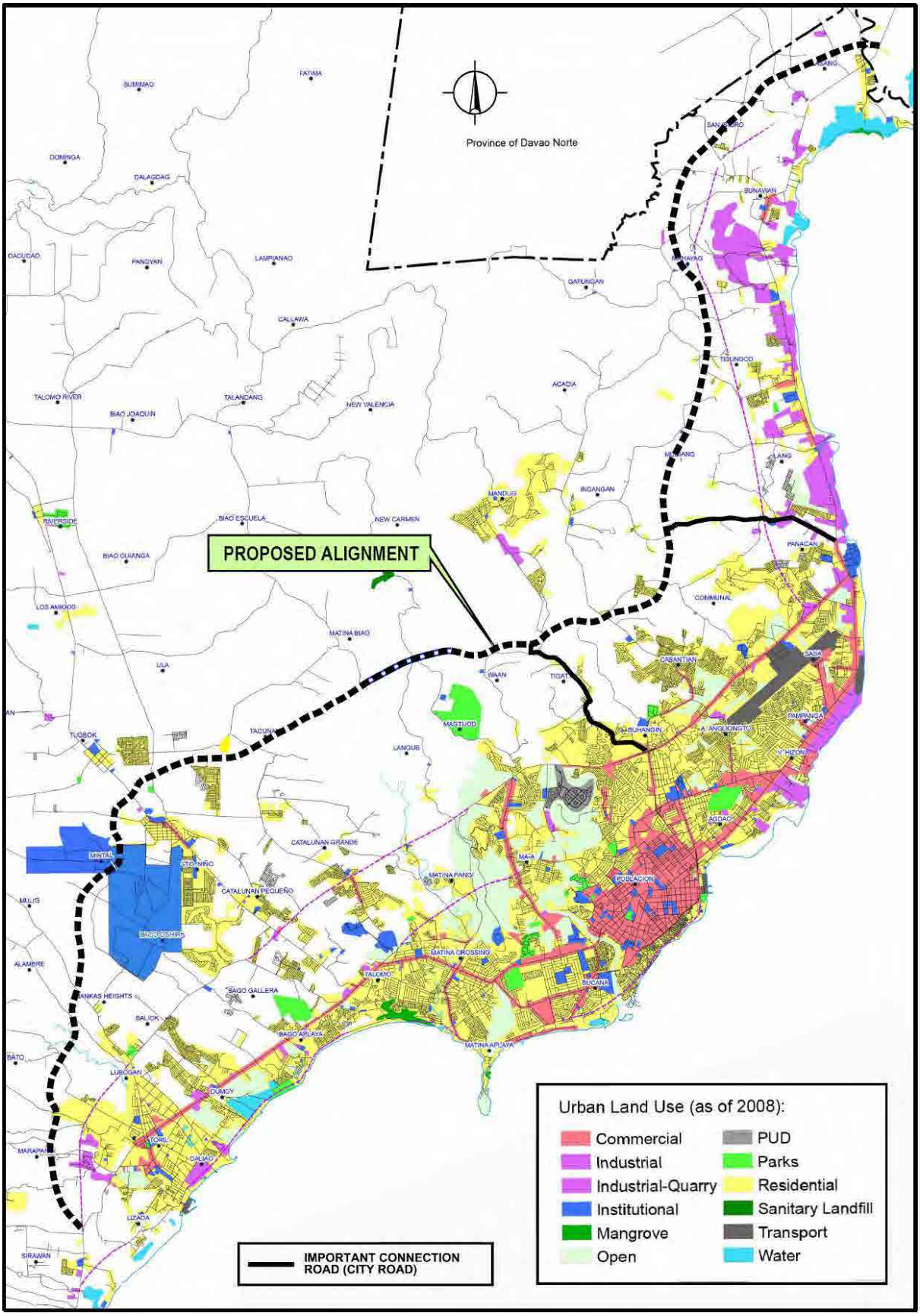


FIGURE 5.7-1 PRESENT LAND USE IN DAVAO CITY (AS OF 2008)

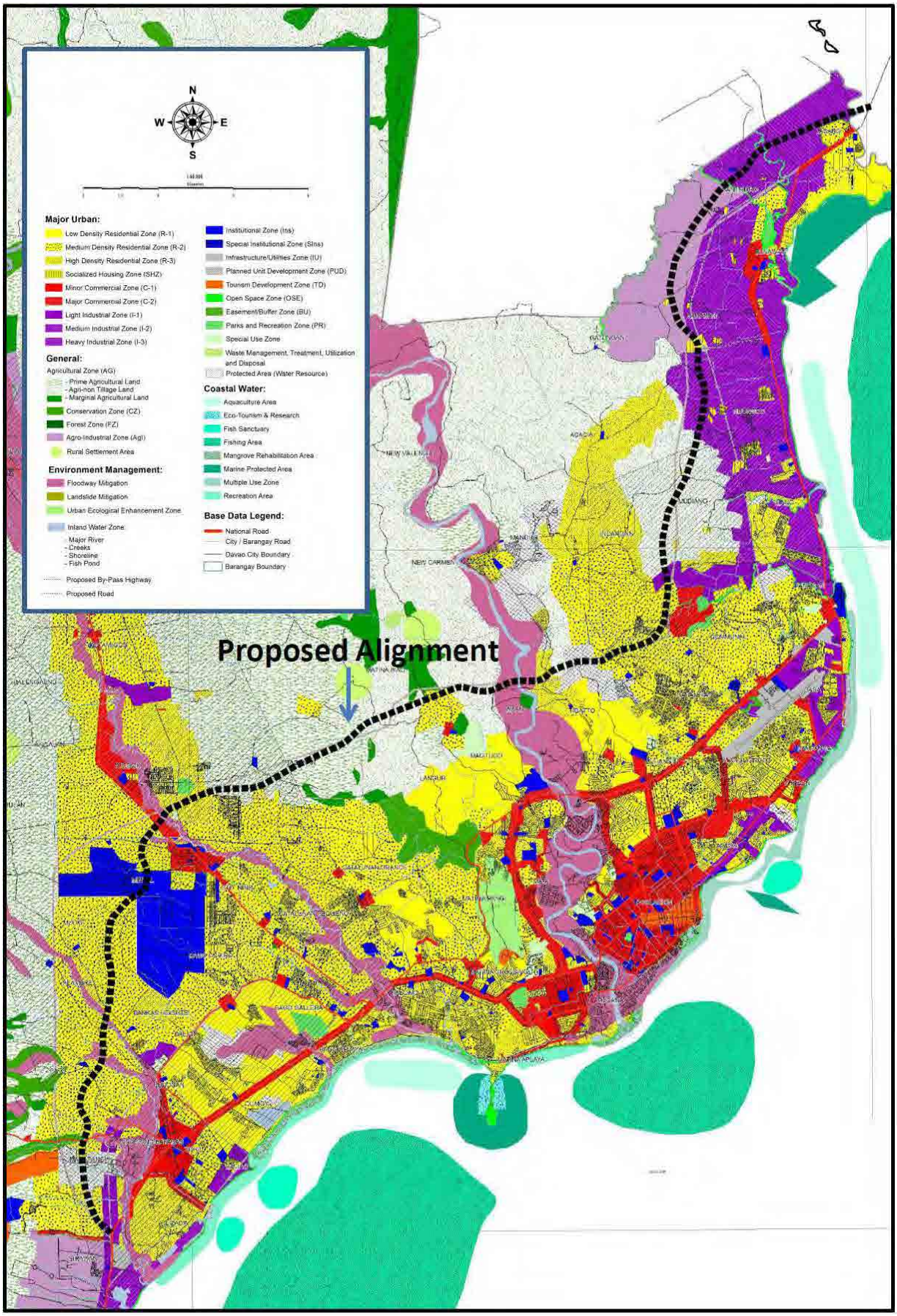


FIGURE 5.7-2 LAND USE PLAN IN DAVAO CITY

CHAPTER 6

TRAFFIC STUDY

CHAPTER 6
TRAFFIC STUDY

6.1 PRESENT TRAFFIC CONDITION

Several traffic of surveys was carried out to better understand the characteristics of the survey area as shown in **Table 6.1.1-1**. Aside from the traffic survey, focus was also given to logistics movement to determine which roads are heavily used by trucks and which port/airport serve as gateway to the manufacturing companies in Davao City. All survey forms are available in **Appendix 6-1**. Detail discussions of each type of survey are presented in the succeeding sections.

6.1.1 Type of Surveys Carried Out

There were six (6) kinds of traffic surveys that were carried out to better understand the characteristics of the survey area. (see **Table 6.1-1**).

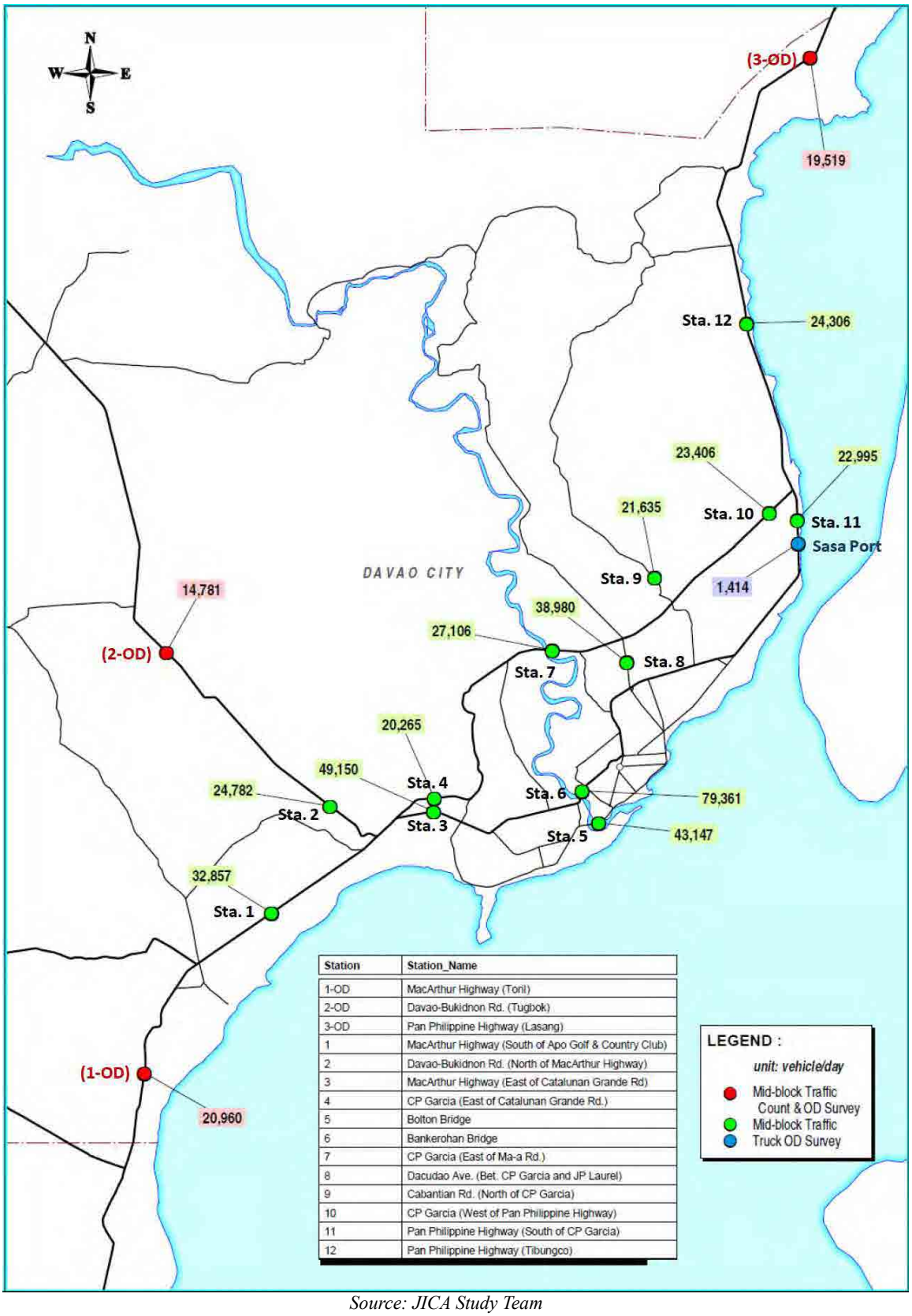
TABLE 6.1-1 TYPE OF SURVEYS CARRIED OUT

Survey Type	Number of Stations/Samples
(1) 24 hour Traffic Count Survey	12
(2) Roadside OD Survey	3
(3) Truck OD and Traffic Count Survey at Sasa Port	1
(4) Interview Survey at Ports/Airports	3/1
(5) Japanese Company Interview Survey	10
(6) Travel Time Survey	3

6.1.2 Traffic Volume

Traffic Volume Count Survey was carried out to count and classify motor vehicles traversing a particular road section and recording the data to determine the present traffic volume and traffic composition. The 24-hour traffic counts were undertaken in the busy city corridors of Davao City.

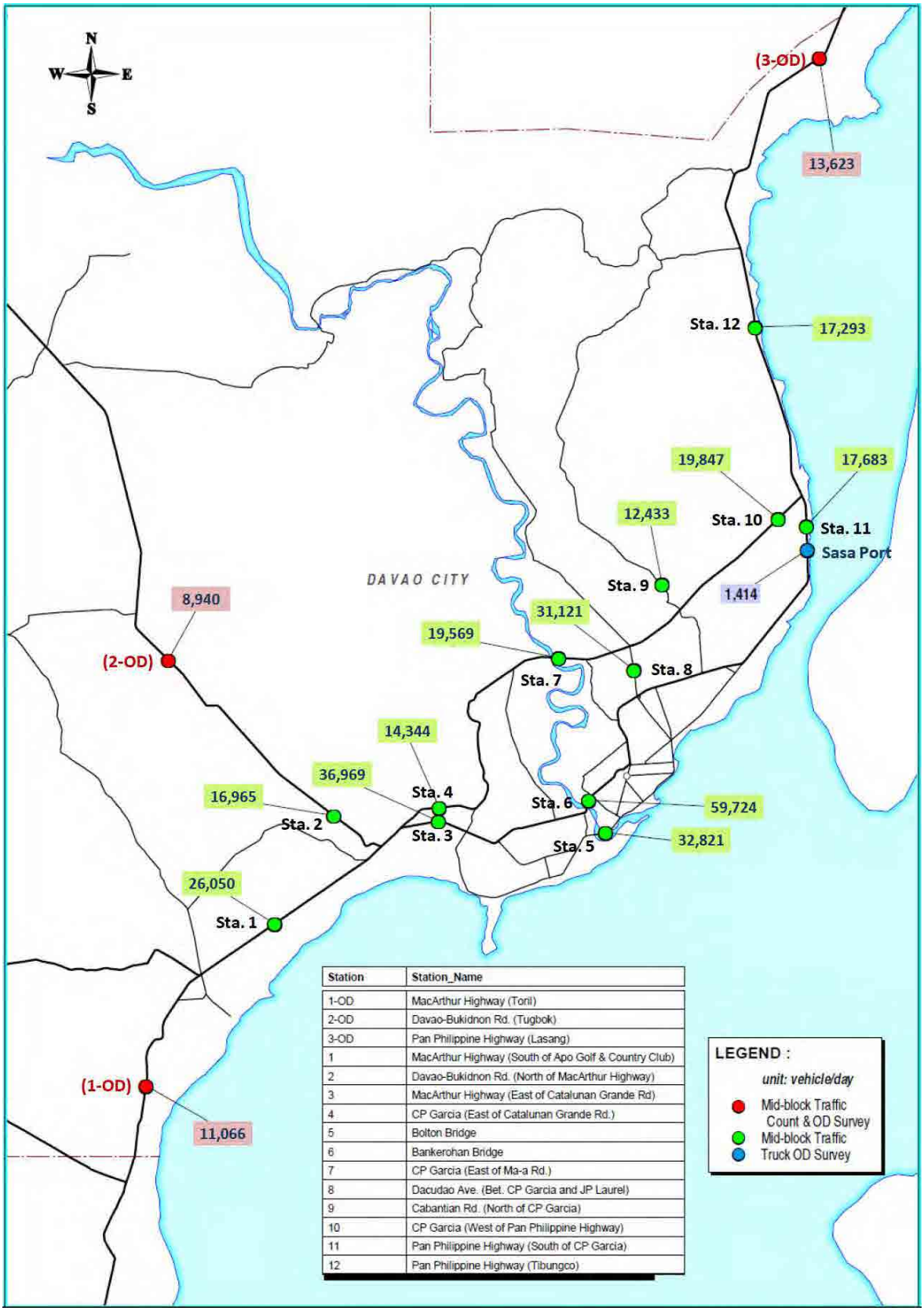
Figure 6.1-1 and **Figure 6.1-2** illustrates the 24-hour traffic count result. The highest volume was 79,361 veh./day (or 59,724 veh/day excluding tricycle and motorcycle) at Bankerohan Bridge along Mc. Arthur Highway. The traffic volume along Diversion Road was from 20,265 ~ 27,106 veh/day (or 14,344 ~ 19,569 veh/day excluding tricycle/motorcycle). The traffic volume along Mc Arthur Highway at the south section was 20,960 ~ 32,857 veh/day (or 11,066 ~ 26,050 veh/day excluding tricycle/motorcycle). While the traffic volume along Mc Arthur Highway at the north section was 19,519 ~ 24,306 (or 13,623 ~ 17,293 veh/day excluding tricycle/motorcycle). It was quite notable that volume of tricycles/motorcycles composed about 35~ 50% of the entire traffic volume. Furthermore, volume of tracks at the Sasa Port was 1,414 vehicle/16 hour.



Station	Station_Name
1-OD	MacArthur Highway (Toril)
2-OD	Davao-Bukidnon Rd. (Tugbok)
3-OD	Pan Philippine Highway (Lasang)
1	MacArthur Highway (South of Apo Golf & Country Club)
2	Davao-Bukidnon Rd. (North of MacArthur Highway)
3	MacArthur Highway (East of Catalunan Grande Rd)
4	CP Garcia (East of Catalunan Grande Rd.)
5	Bolton Bridge
6	Bankerohan Bridge
7	CP Garcia (East of Ma-a Rd.)
8	Dacudao Ave. (Bet. CP Garcia and JP Laurel)
9	Cabantian Rd. (North of CP Garcia)
10	CP Garcia (West of Pan Philippine Highway)
11	Pan Philippine Highway (South of CP Garcia)
12	Pan Philippine Highway (Tibungco)

Source: JICA Study Team

FIGURE 6.1-1 24-HOUR TRAFFIC COUNT SURVEY RESULT (INCLUDING TRICYCLE/MOTORCYCLE)



Station	Station_Name
1-OD	MacArthur Highway (Toril)
2-OD	Davao-Bukidnon Rd. (Tugbok)
3-OD	Pan Philippine Highway (Lasang)
1	MacArthur Highway (South of Apo Golf & Country Club)
2	Davao-Bukidnon Rd. (North of MacArthur Highway)
3	MacArthur Highway (East of Catalunan Grande Rd)
4	CP Garcia (East of Catalunan Grande Rd.)
5	Bolton Bridge
6	Bankerohan Bridge
7	CP Garcia (East of Ma-a Rd.)
8	Dacudao Ave. (Bet. CP Garcia and JP Laurel)
9	Cabantian Rd. (North of CP Garcia)
10	CP Garcia (West of Pan Philippine Highway)
11	Pan Philippine Highway (South of CP Garcia)
12	Pan Philippine Highway (Tibungco)

Source: JICA Study Team

FIGURE 6.1-2 24-HOUR TRAFFIC COUNT SURVEY RESULT (EXCLUDING TRICYCLE/MOTORCYCLE)

6.1.3 Hourly Traffic Variation

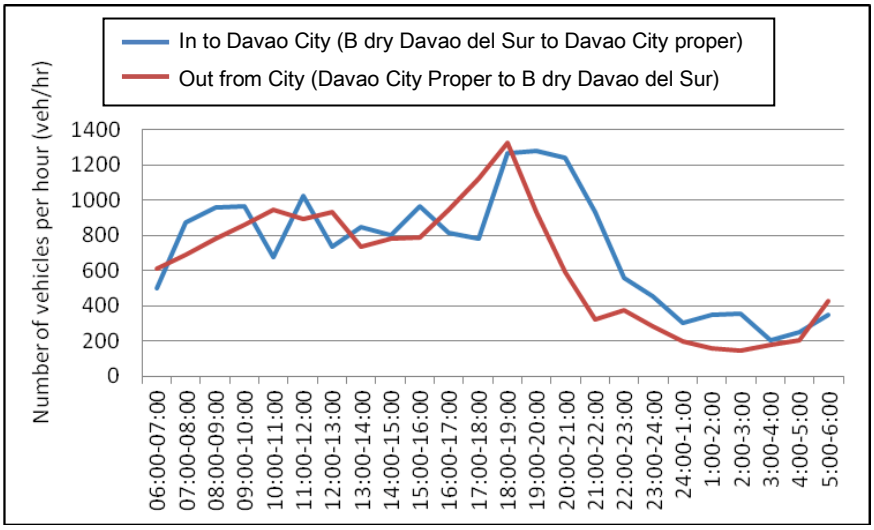
Major points were summarized below.

- The peak time of "In to Davao City" is from 7:00 – 8:00 in the morning. Peak rate is very high at 9.8% in Station 3, Mc Arthur Highway.
- The peak time of "Out from Davao City" is at 17:00. This evening peak rate is lower than the morning peak of "In to Davao City"

The following were the observed hourly traffic variation in the following stations:

Station 1: Mc Arthur Highway (South of Apo Golf and Country Club)

- The highest number of passing vehicles was recorded between 18:00 to 19:00 with 1,330 veh/hr and the direction was going out from the city, from the Davao City Proper going out to the Bdry. of Davao del Sur.
- Peak time for vehicles going in to the city was from 18:00 to 21:00 while peak time for vehicles going out of the city was from 17:00 to 19:00.

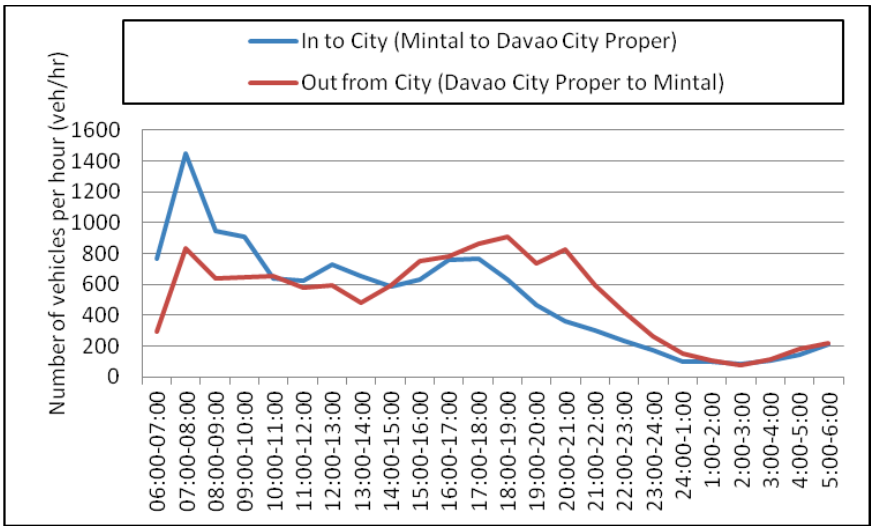


Source: JICA Study Team

FIGURE 6.1-3 HOURLY TRAFFIC VARIATION AT MAC ARTHUR HIGHWAY (MC ARTHUR HIGHWAY SECTION)

Station 2: Davao – Bukidnon Road (North of Mc Arthur Highway)

- The highest number of passing vehicles was recorded between 7:00 to 8:00 with 1,447 veh/hr and the direction was going in to the Davao City Proper coming from Mintal.
- Peak time for vehicles going in to the city was from 7:00 to 8:00 while peak time for vehicles going out of the city is at 17:00 to 18:00.

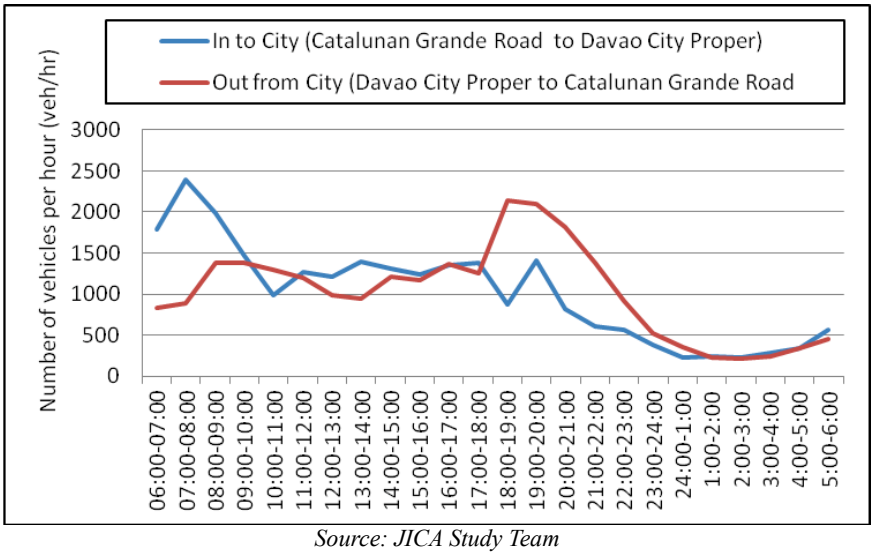


Source: JICA Study Team

FIGURE 6.1-4 HOURLY TRAFFIC VARIATION AT DAVAO – BUKIDNON ROAD (NORTH OF MC ARTHUR HIGHWAY)

Station 3: Mc Arthur Highway (East of Catalunan Grande Road)

- The highest number of passing vehicles was recorded between 7:00 to 8:00 with 2,389 veh/hr and the direction was going in to the Davao City Proper coming from East of Catalunan Grande Road.
- Peak time for vehicles going in to the city was from 7:00 to 8:00 while peak time for vehicles going out of the city is at 18:00 to 20:00.

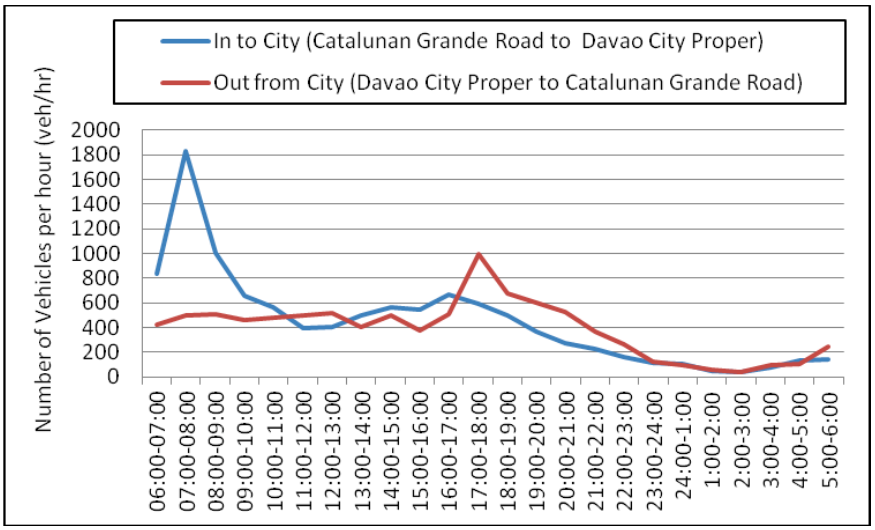


Source: JICA Study Team

FIGURE 6.1-5 HOURLY TRAFFIC VARIATION AT MC ARTHUR HIGHWAY (EAST OF CATALUNAN GRANDE ROAD)

Station 4: CP Garcia (East of Catalunan Grande Road)

- The highest number of passing vehicles was recorded between 7:00 to 8:00 with 1,830 veh/hr and the direction was going in to the Davao City Proper coming from CP Garcia (East of Catalunan Grande Road).
- Peak time for vehicles going in to the city was from 7:00 to 8:00 while peak time for vehicles going out of the city is at 17:00 to 18:00.

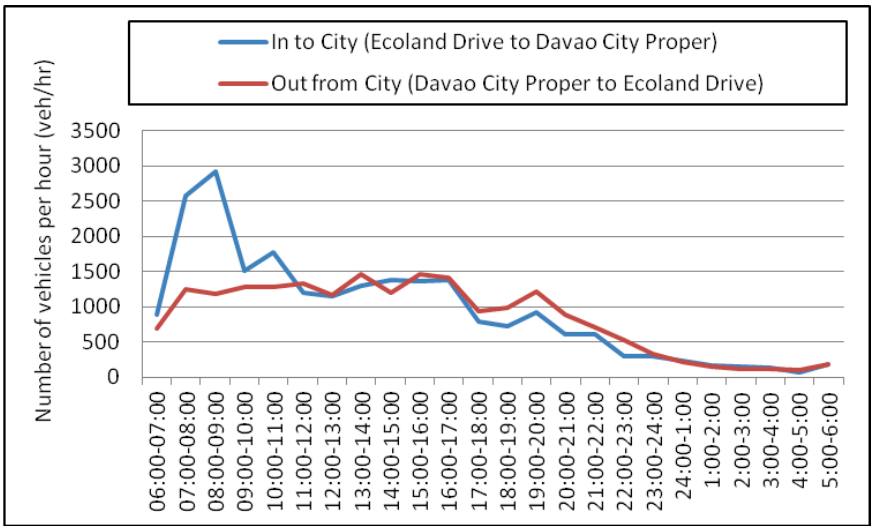


Source: JICA Study Team

FIGURE 6.1-6 HOURLY TRAFFIC VARIATION AT CP GARCIA (EAST OF CATALUNAN GRANDE ROAD)

Station 5: Bolton Bridge

- The highest number of passing vehicles was recorded between 8:00 to 9:00 with 2,916 veh/hr and the direction was going in to the Davao City Proper passing through the Bolton Bridge.
- Peak time for vehicles going in to the city was from 7:00 to 9:00 while vehicles going out of the city varied just at a range 1,000 to 1,500 veh/hr from 7:00 to 17:00.

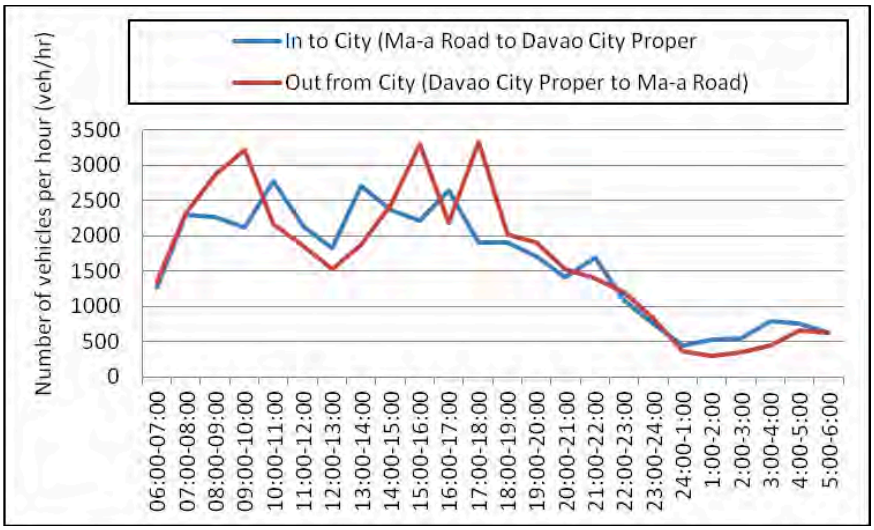


Source: JICA Study Team

FIGURE 6.1-7 HOURLY TRAFFIC VARIATION AT BOLTON BRIDGE

Station 6: Bankerohan Bridge

- The highest number of passing vehicles was recorded between 17:00 to 18:00 with 3,328 veh/hr and the direction was going out from Davao City Proper passing through the Bankerohan Bridge.
- Vehicular traffic at Bankerohan Bridge was almost all-the-time heavy from 6:00 to 23:00 ranging only from more than 1,000 to less than 3,500 veh/hr.

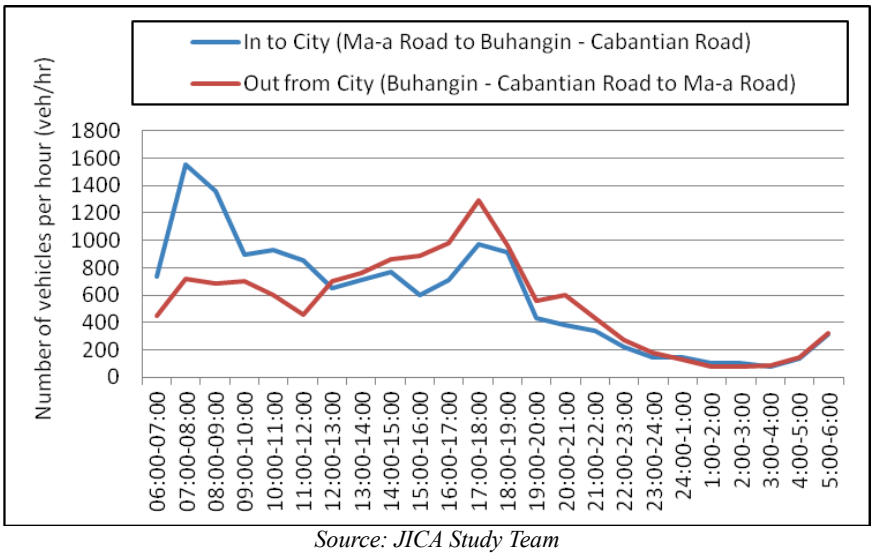


Source: JICA Study Team

FIGURE 6.1-8 HOURLY TRAFFIC VARIATION AT BANKEROHAN BRIDGE

Station 7: CP Garcia (East of Ma-a Road)

- The highest number of passing vehicles was recorded between 7:00 to 8:00 with 1,550 veh/hr and the direction was going in to the Davao City Proper.
- Peak time for vehicles going in to the city was from 7:00 to 9:00 while for going out of the city was from 17:00 to 18:00.

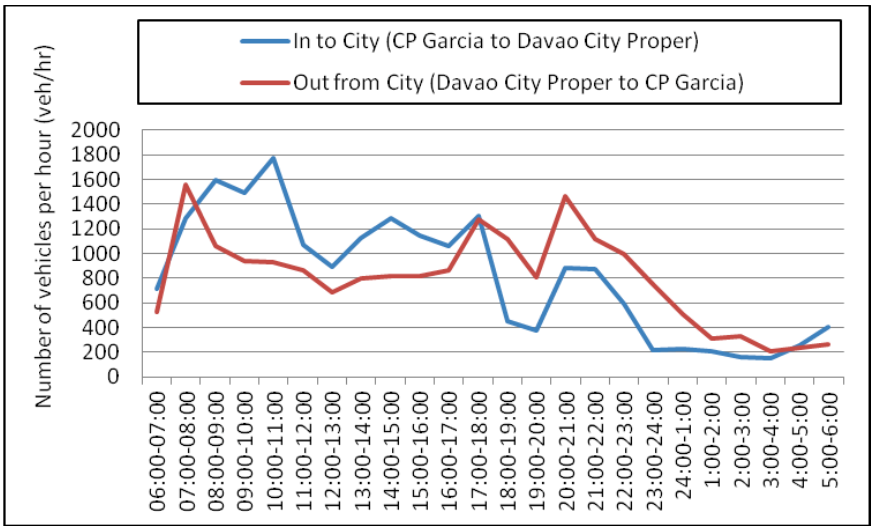


Source: JICA Study Team

FIGURE 6.1-9 HOURLY TRAFFIC VARIATION AT CP GARCIA (EAST OF MA-A ROAD)

Station 8: Dacudao Avenue (between CP Garcia and JP Laurel)

- The highest number of passing vehicles was recorded between 10:00 to 11:00 with 1,770 veh/hr and the direction was going in to the Davao City Proper.
- Peak time for vehicles going in to the city was from 8:00 to 11:00 while for going out of the city was from 7:00 to 8:00.

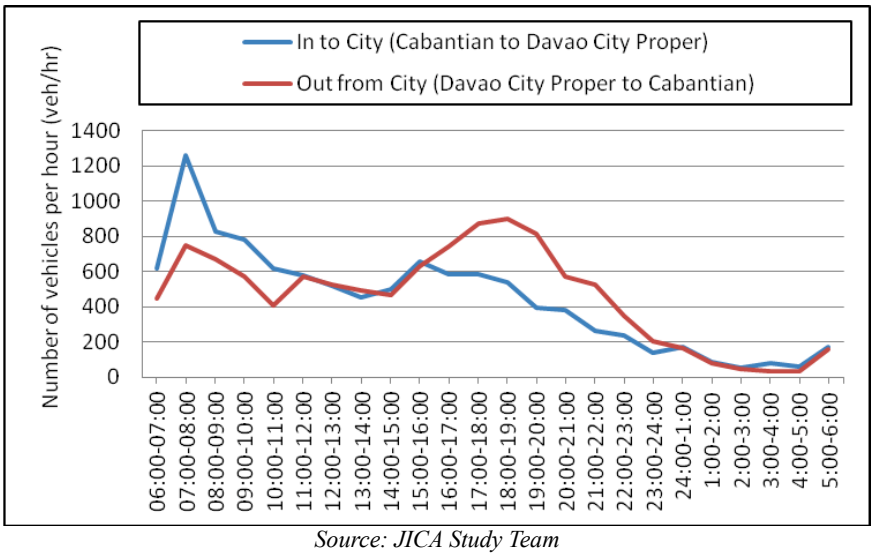


Source: JICA Study Team

FIGURE 6.1-10 HOURLY TRAFFIC VARIATION AT DACUDAO AVENUE (BETWEEN CP GARCIA AND JP LAUREL)

Station 9: Cabantian Road (North of CP Garcia)

- The highest number of passing vehicles was recorded between 7:00 to 8:00 with 1,259 veh/hr and the direction was going in to the Davao City Proper.
- Peak time for vehicles going in to the city was from 7:00 to 8:00 while for going out of the city was from 17:00 to 20:00.

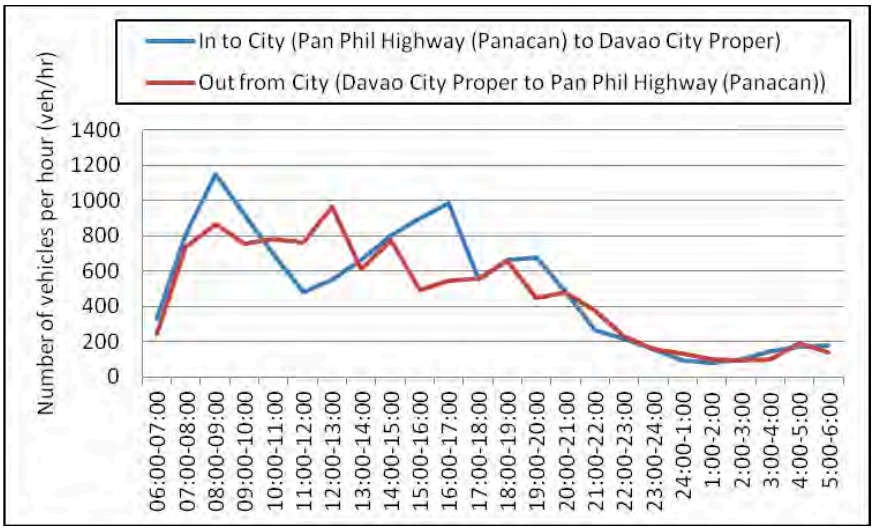


Source: JICA Study Team

FIGURE 6.1-11 HOURLY TRAFFIC VARIATION AT CABANTIAN ROAD

Station 10: CP Garcia (West of Pan Philippine Highway)

- The highest number of passing vehicles was recorded between 8:00 to 9:00 with 1,151 veh/hr and the direction was going in to the Davao City Proper.
- Peak time for vehicles going in to the city was from 7:00 to 8:00 while for going out of the city was from 17:00 to 20:00.

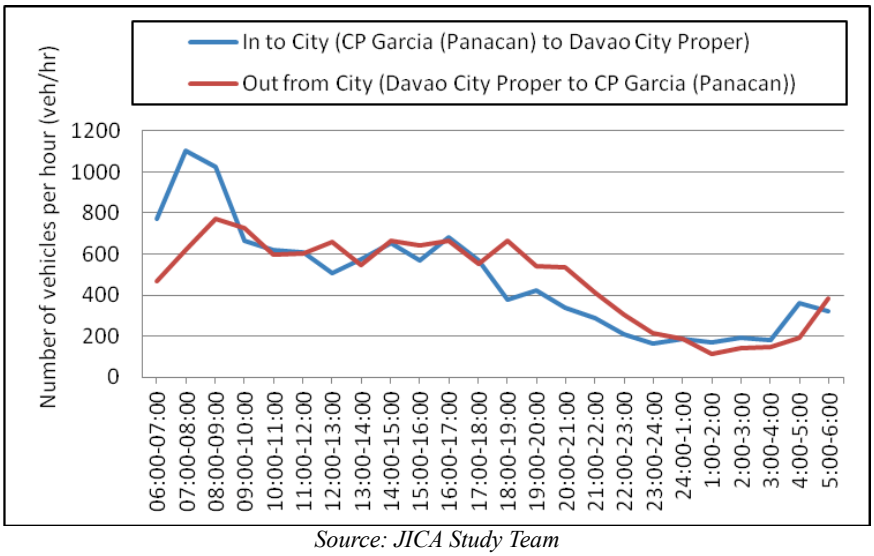


Source: JICA Study Team

FIGURE 6.1-12 HOURLY TRAFFIC VARIATION AT CP GARCIA (WEST OF PAN PHILIPPINE HIGHWAY)

Station 11: Pan Philippine Highway (South of CP Garcia)

- The highest number of passing vehicles was recorded between 7:00 to 8:00 with 1,101 veh/hr and the direction was going in to the Davao City Proper.
- Peak time for vehicles going in to the city was from 7:00 to 9:00 while for going out of the city was from 8:00 to 9:00.

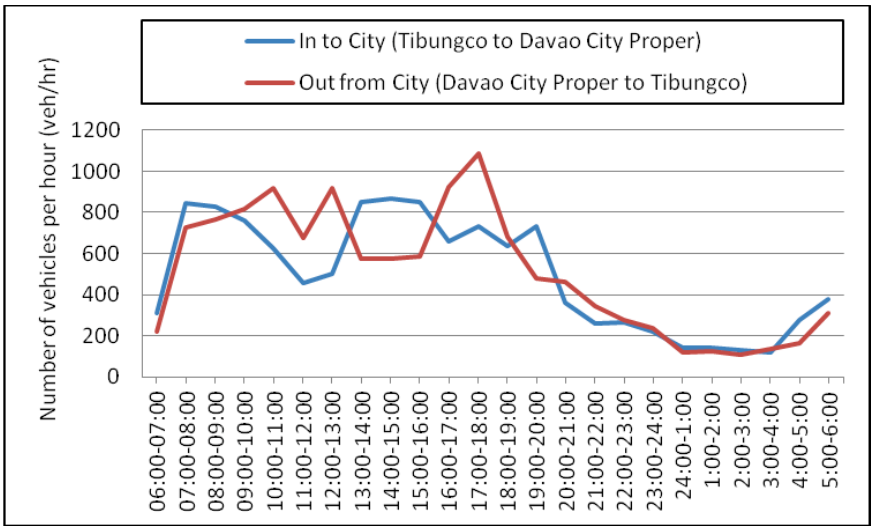


Source: JICA Study Team

FIGURE 6.1-13 HOURLY TRAFFIC VARIATION AT PAN PHILIPPINE HIGHWAY (SOUTH OF CP GARCIA)

Station 12: Pan Philippine Highway (Tibungco)

- The highest number of passing vehicles was recorded between 17:00 to 18:00 with 1,087 veh/hr and the direction was going out of the Davao City Proper.
- Peak time for vehicles going in to the city was from 14:00 to 15:00 while for going out of the city was from 17:00 to 16:00.

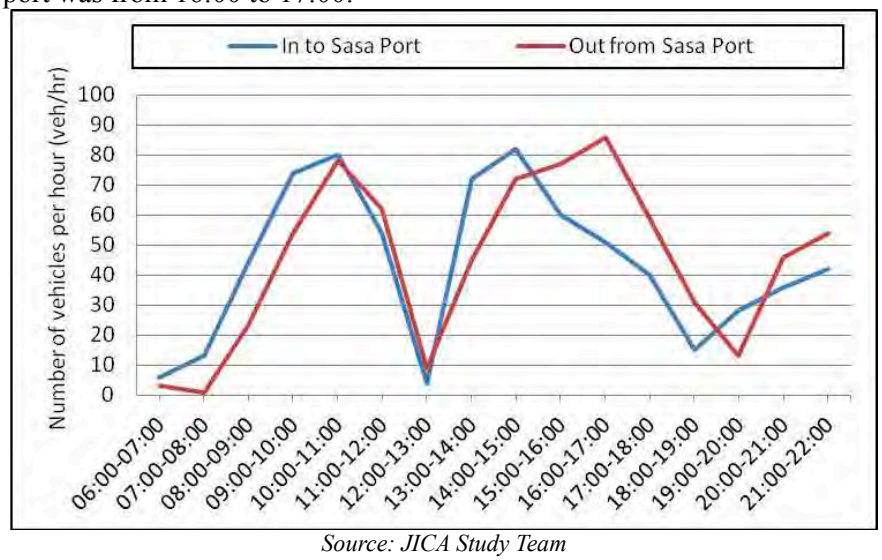


Source: JICA Study Team

FIGURE 6.1-14 HOURLY TRAFFIC VARIATION AT PAN PHILIPPINE HIGHWAY (TIBUNGCO)

Station 13: Sasa Port

- A 16-hour traffic count survey was conducted at the Sasa Port. The highest number of vehicles was recorded between 16:00 to 17:00 with 86 veh/hr and the direction was going out of the Sasa Port.
- Peak time for vehicles going in to the port was from 14:00 to 15:00 while for going out of the port was from 16:00 to 17:00.



Source: JICA Study Team

FIGURE 6.1-15 HOURLY TRAFFIC VARIATION AT SASA PORT

6.1.4 Traffic Composition

Traffic composition is primarily classified into private cars/taxi/van, jeepney, buses, trucks and tricycles/motorcycles. It is noteworthy that along the north and south of Mc Arthur and Diversion Roads, passing truck percentage is almost 20% while at the city roads passing trucks percentage is barely 5%. This is brought about by the truck ban at a certain time frame at the city roads, thus diverting all the truck traffic to Mc Arthur and Diversion Roads.

Mc Arthur Highway

- Composition of vehicular traffic passing along the Mc Arthur Highway is dominated mainly of private cars/taxi/van; 35.03% at Mc Arthur Highway (South of Apo Golf and Country

Club), 42.67% from the North (Davao-Bukidnon Road), and 44% from the East of Catalunan Grande Road. (see **Figure 6.1-16** and **Figure 6.1-18**)

CP Garcia

- Composition of vehicular traffic passing along CP Garcia is likewise dominated mainly of private cars/taxi/van; 47.91% from the East of Catalunan Grande Road), 49.27% from the East of Ma-a Road, 44% from the East of Catalunan Grande Road and 43.69% at the West of Pan Philippine Highway. (see **Figure 6.1-19, Figure 6.1-22** and **Figure 6.1-25**).

Pan Philippine Highway

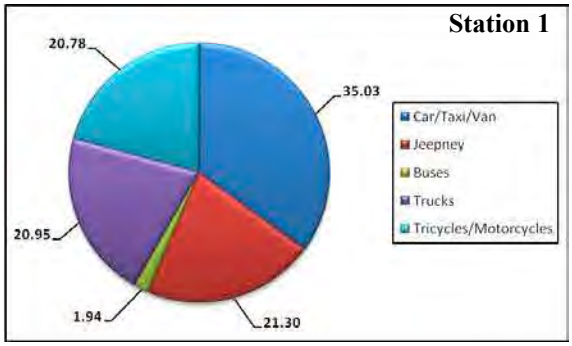
- Vehicular traffic passing along the Pan Philippine Highway is a mixed up of car/taxi/van, jeepneys, trucks and tricycles/motorcycles. Passing trucks percentage (17.11% and 21.22%) in this highway is high because of the presence of the nearby Sasa Port (see **Figure 6.1-26** to **Figure 6.1-27**).

Bolton Bridge

- Almost half (49.07%) of the vehicular traffic passing through the Bolton Bridge is composed of car/taxi/van, while nearly half (47%) is composed of jeepneys and tricycles/motorcycles, while a meager 4.04% is composed of trucks and buses (3.05% and 0.99% respectively). (see **Figure 6.1-20**).

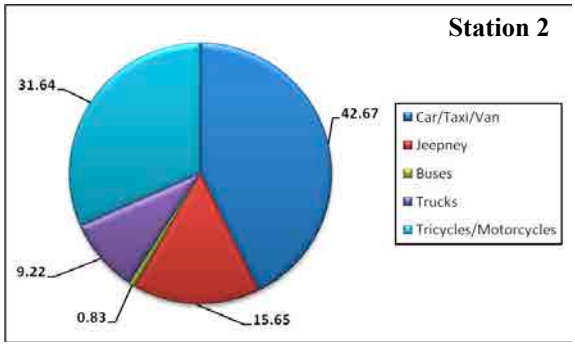
Dacudao Avenue

- This avenue connects CP Garcia and JP Laurel St. The vehicular traffic passing along Dacudao Avenue is dominated by 40.06% car/taxi/van, 30.09% jeepneys, and 20.24% tricycles/motorcycles. (see **Figure 6.1-23**).



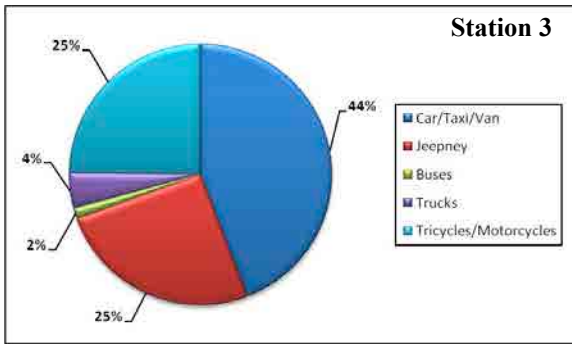
Source: JICA Study Team

FIGURE 6.1-16 TRAFFIC COMPOSITION AT MC ARTHUR HIGHWAY (SOUTH OF APO GOLF AND COUNTRY CLUB)



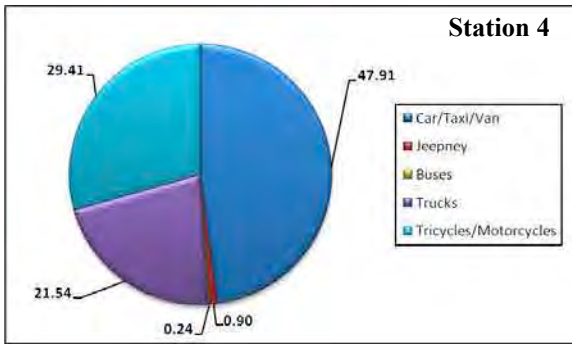
Source: JICA Study Team

FIGURE 6.1-17 TRAFFIC COMPOSITION AT DAVAO – BUKINDON ROAD (NORTH OF MC ARTHUR HIGHWAY)



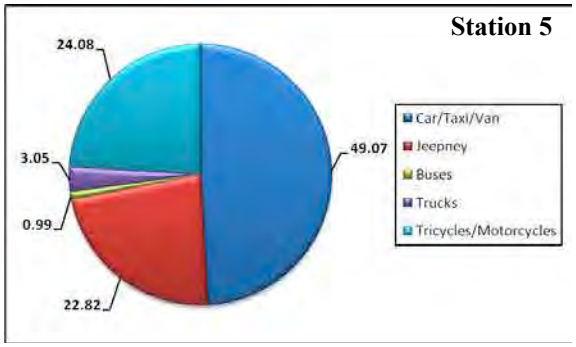
Source: JICA Study Team

FIGURE 6.1-18 TRAFFIC COMPOSITION AT MAC ARTHUR HIGHWAY (EAST OF CATALUNAN GRAND ROAD)



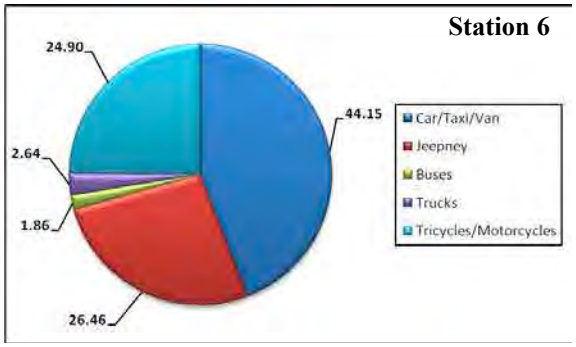
Source: JICA Study Team

FIGURE 6.1-19 TRAFFIC COMPOSITION AT CP GARCIA (EAST OF CATALUNAN GRAND ROAD)



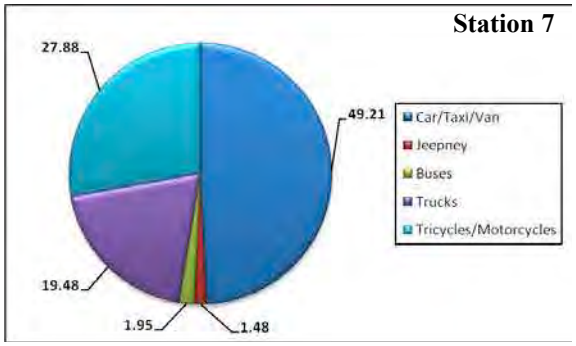
Source: JICA Study Team

FIGURE 6.1-20 TRAFFIC COMPOSITION AT BOLTON BRIDGE



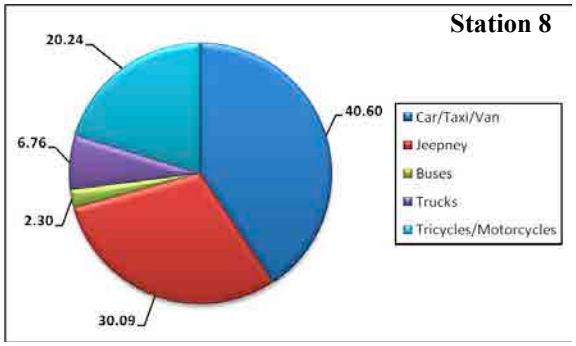
Source: JICA Study Team

FIGURE 6.1-21 TRAFFIC COMPOSITION AT BANKEROHAN BRIDGE



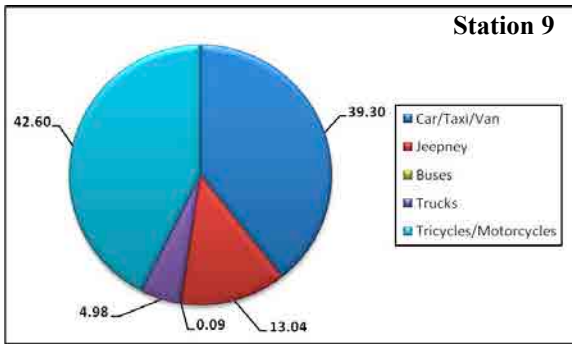
Source: JICA Study Team

FIGURE 6.1-22 TRAFFIC COMPOSITION AT CP GARCIA (EAST OF MA-A ROAD)



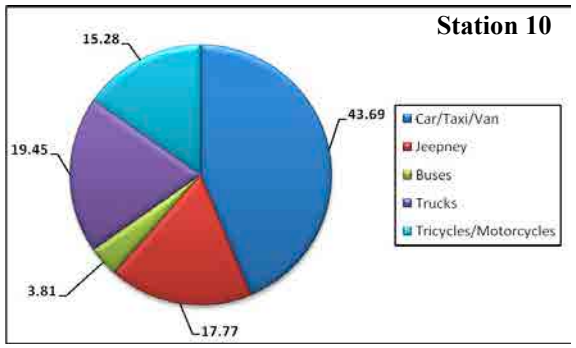
Source: JICA Study Team

FIGURE 6.1-23 TRAFFIC COMPOSITION AT DACUDAO AVENUE



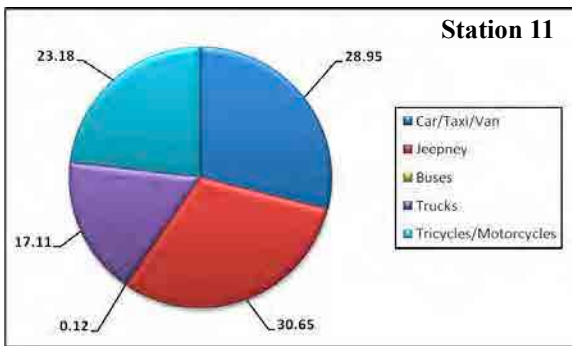
Source: JICA Study Team

FIGURE 6.1-24 TRAFFIC COMPOSITION AT CABANTIAN ROAD



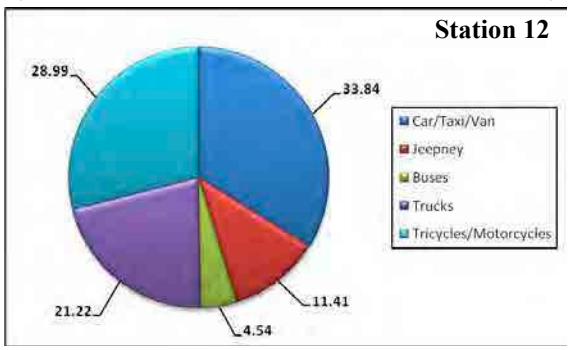
Source: JICA Study Team

FIGURE 6.1-25 TRAFFIC COMPOSITION AT CP GARCIA (WEST OF PAN PHILIPPINE HIGHWAY)



Source: JICA Study Team

FIGURE 6.1-26 TRAFFIC COMPOSITION AT PAN PHILIPPINE HIGHWAY (SOUTH OF CP GARCIA)



Source: JICA Study Team

FIGURE 6.1-27 TRAFFIC COMPOSITION AT PAN PHILIPPINE HIGHWAY (TIBUNGCO)

6.1.5 Summary of Roadside Interview Survey Results

Table 6.1-2 shows the accomplishment of Roadside Interview Survey. Total sample was 3,572 including truck interview conducted at Sasa Port.

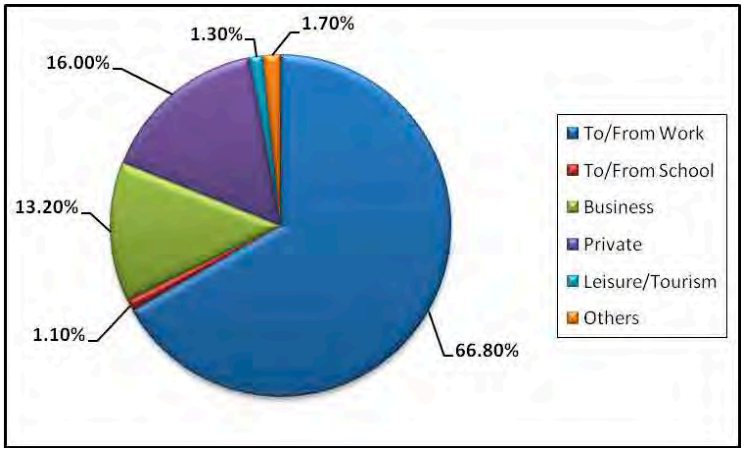
TABLE 6.1-2 ACCOMPLISHMENT OF ROAD SIDE INTERVIEW SURVEY

Code	Station	Vehicle/day	No. of Samples	Sample Rate
1-OD	Mc Arthur (Toril)	11,066	666	6.02%
2-OD	Davao-Bukidnon Road	8,940	1,145	12.81%
3-OD	Pan Philippine Highway (Lasang)	13,623	939	6.89%
T-OD	Sasa Port	1,414	822	58.13%
		Total = 3,572		

Source: JICA Study Team

(1) Trip Purpose

Of the total vehicle trips, 66.8% were "To/from Work". This data does not include the Truck OD Survey at Sasa Port.



Source: JICA Study Team

FIGURE 6.1-28 TRIP PURPOSE

(2) Average Number of Passengers by Vehicle Type

Table 6.1-3 shows the average number of passenger on-board by vehicle type.

TABLE 6.1-3 AVERAGE NUMBER OF PASSENGERS BY VEHICLE TYPE

Station	Vehicle Type							Total
	Car/Van / PUV	Jeepney	Mini-bus	Large bus	2-axle Truck	3-axle Truck	Truck/ Trailer	
1-OD	6.47	18.31	17.40	30.75	2.63	2.02	2.37	10.60
2-OD	2.90	9.42	16.50	29.89	2.30	1.92	1.79	7.22
3-OD	5.10	9.99	18.00	30.31	2.33	2.49	2.23	9.60
Average	4.77	10.75	17.25	30.32	2.40	2.11	2.05	6.81

Source: JICA Study Team

(3) Average Commodity Weight and Average Net Load Capacity

Table 6.1-4 shows the average commodity weight and net load capacity. The average commodity weight by truck was 8.5 ton.

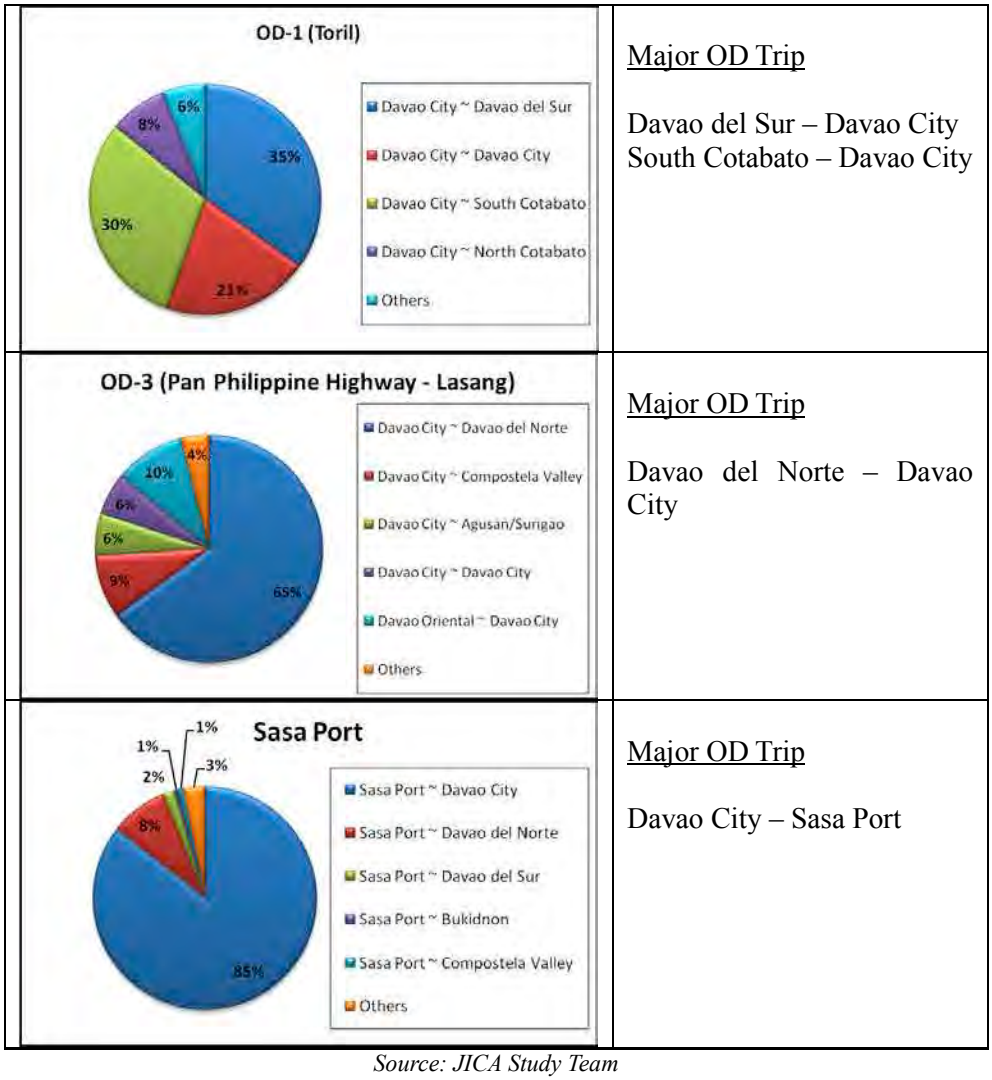
TABLE 6.1-4 AVERAGE COMMODITY WEIGHT AND NET LOAD CAPACITY

Code	Station	Ave. Commodity Weight (kg)	Ave. Net Load Capacity (kg)
1-OD	Mc Arthur (Toril)	12,614	5,921
2-OD	Davao-Bukidnon Road	10,063	6,351
3-OD	Pan Philippine Highway (Lasang)	7,033	6,402
T-OD	Sasa Port	12,617	13,564
Average		8,543	5,268

Source: JICA Study Team

(4) Origin and Destination by Province

Figure 6.1-29 shows the OD at Stations 1,3 and Sasa Port.



Source: JICA Study Team

FIGURE 6.1-29 ORIGIN AND DESTINATION OF VEHICLULAR TRAFFIC

6.1.6 Port, Airport Trips

The following three (3) ports and one (1) airport officials' interview were conducted to know the present cargo volume in terms of number of trucks to be used daily in transporting their respective products.

(1) Airport

Davao City have one international airport, namely Francisco Bangoy International Airport

(Davao International Airport). The number of flights, number of passengers, and cargo traffic are presented in **Table 6.1-5.**

Annual growth rate is high, 6~17% for the number of passengers and 6~18% for cargo movement.

TABLE 6.1-5 NUMBER OF FLIGHTS, NUMBER OF PASSENGERS AND CARGO TRAFFIC

	Year	Domestic	Foreign	Total	Growth Rate
Number of Plane Arrival (times)	2009	7,393	280	7,673	-
	2010	7,720	217	7,937	3.4%
	2011	9,325	284	9,609	21.2%
	2012	10,534	323	10,857	13.0%
Number of Passengers (in thousands)	2009	991	16	1,007	-
	2010	1,115	10	1,125	11.7%
	2011	1,306	15	1,321	17.4%
	2012	1,383	20	1,403	6.2%
Cargo Movement (ton)	2009	34,173	84	34,257	-
	2010	40,569	63	40,632	18.6%
	2011	39,713	55	39,768	-2.1%
	2012	42,119	67	42,186	6.1%

Source: Davao (Francisco Bangoy) International Airport and Philippine Ports Authority

(2) Port

There are three (3) ports in the Study Area, namely Sasa Port, TEFASCO (TErminal FAcilities & Services Corporation) and AJMR Port as shown in **Figure 6.1-30**.

Source: JICA Study Team

FIGURE 6.1-30 LOCATION MAP OF SASA PORT, TEFASCO AND AJMR PORT

1) Sasa Port

Sasa port is served as the container ship, general cargo ship for foreign and domestic cargo. Though it had served as RORO, it was not operated since last year due to decrease of passengers (see **Table 6.1-6**).

TABLE 6.1-6 NO. OF PASSENGERS IN SASA PORT

Year	No. of Passenger
2008	89,168
2009	71,673
2010	62,220
2011	26,643
2012	No operation

Source: Philippine Ports Authority

Sasa Port was used about one thousand vessels per year shown in **Table 6.1.6-3**.

TABLE 6.1-7 NUMBER OF VESSEL ARRIVAL AT SASA PORT

Year	Domestic	Foreign	Total
2008	519	370	889
2009	510	459	969
2010	550	515	1065
2011	496	568	1064
2012	435	438	873

Source: Philippine Ports Authority

Table 6.1-9 shows the volume of cargo handled by commodity type. A foreign volume was 2.94 million ton and a domestic volume was 2.15, total volume was 5.095 million ton in 2012.

Major commodities are Fruits and Vegetables Products (CT05), Pulp and Paper Products (CT23), Metal Ores Products and Scraps (CT15), Grains (CT04), Fertilizer (CT14) and etc.

Table 6.1-8 shows the container traffic by month. April was the busiest month at Sasa Port and August, September which conducted by traffic count were off peak month.

TABLE 6.1-8 MONTHLY CONTAINER TRAFFIC AT SASA PORT

Month	Container Traffic (TEU)	Monthly Variation
JAN	44,167	1.06
FEB	40,518	0.97
MAR	41,933	1.01
APR	46,364	1.11
MAY	44,143	1.06
JUN	37,839	0.91
JUL	41,148	0.99
AUG	36,851	0.88
SEP	39,844	0.96
OCT	42,966	1.03
NOV	40,717	0.98
DEC	43,801	1.05
TOTAL	**500,288**	

Source: Philippine Ports Authority

TABLE 6.1-9 VOLUME OF COMMODITY TYPE AT SASA PORT (YEAR 2012)

Unit: Ton

CODE	COMMODITY NAME	Foreign	Domestic	Total
CT 01	Live Animals	0	2,432	2,432
CT 02	Meat, Dairy Prods & Eggs	1,920	14,384	16,304
CT 03	Fish and Fish Prep	2,193	15,627	17,820
CT 04	Grains	95,189	146,257	**241,446**
CT 05	Fruits and Vegtbls Prods	1,228,422	29,680	**1,258,102**
CT 06	Sugar Cane and By-Prods	18,222	7,465	25,687
CT 07	Animal Feeds	20,713	25,857	46,570
CT 08	Bottled Cargo	-	116,890	**116,890**
CT 09	Tobacco and Manf	-	18	18
CT 10	Coconut and By-Prods	78,243	38,263	**116,506**
CT 11	Wood and By-Prods	57,928	72,671	**130,599**
CT 12	Abaca	3,123	1,568	4,691
CT 13	Textile and Like Prods	2,032	2,642	4,674
CT 14	Fertilizer	123,126	47,049	**170,175**
CT 15	Metal Ores, Prods & Scraps	64,688	214,501	**279,189**
CT 16	Fuel and By-Prods	2,824	14,987	17,811
CT 17	Chems and Related Prods	109,527	31,738	**141,265**
CT 18	Cement	25	108,284	**108,309**
CT 19	Mach & Elctl. Eqpmnt	17,912	21,055	38,967
CT 20	Crude Minerals	56,169	3,864	60,033
CT 21	Transport Eqpt Parts and Acc	6,156	86,510	92,666
CT 22	Furniture	10,553	10,037	20,590
CT 23	Pulp and Paper Prods	235,012	83,973	**318,985**
CT 24	Other General Cargo	618,010	1,056,428	**1,674,438**
-	Tires	5,943		5,943
-	Ceramic Tiles	116,415		**116,415**
-	UKAY-UKAY	34,237		34,237
-	Rubber Cuplump	34,241		34,241
	TOTAL	**2,942,823**	**2,152,180**	**5,095,003**

Source: Philippine Ports Authority

2) TEFASCO

TEFASCO Port is operated by private company for container ship and general cargo ship. TEFASCO was used more than three hundred vessels per year shown in **Table 6.1-10**.

TABLE 6.1-10 NUMBER OF VESSEL ARRIVAL AT TEFASCO

Year	Domestic	Foreign	Total
2008	196	139	335
2009	186	125	311
2010	188	134	322
2011	198	132	330
2012	219	189	405

Source: Philippine Ports Authority

Table 6.1-11 shows the volume of cargo handled by commodity type. Major commodities are Fertilizer, Banana, Sugar, Salt, Rice, Cement etc.

TABLE 6.1-11 VOLUME OF COMMODITY TYPE AT TEFASCO

Unit: Ton

Commodity Type	Incoming Cargo		Outgoing Cargo	
	Domestic	Foreign	Domestic	Foreign
Fertilizer	10,880	275,686	8,290	-
Rice	6,058	102,343	9,883	-
Banana	-	-	-	64,240
Salt	-	41,344	-	-
Sugar	-	-	-	30,149
Plywood	-	-	13,682	-
Cement	13,375	-	-	-
Logs	-	9,795	-	-
Soya Bean Meal	7,153	-	-	-
Container	548,420	106,740	437,840	136,580
Total	**585,886**	**535,908**	**469,695**	**230,969**

Source: Philippine Ports Authority

3) AJMR Port

AJMR Port is operated by private company for container ship and refrigerated ship from/to only domestic. **Table 6.1-12** shows the number of vessel arrival and volume of cargo.

TABLE 6.1-12 VESSEL ARRIVAL AND VOLUME OF CARGO AT AJMR PORT

Year	Vessel Arrival	Volume of Cargo(Ton)
2008	154	402,543
2009	130	186,574
2010	124	237,799
2011	181	407,538
2012	201	461,564

Source: Philippine Ports Authority

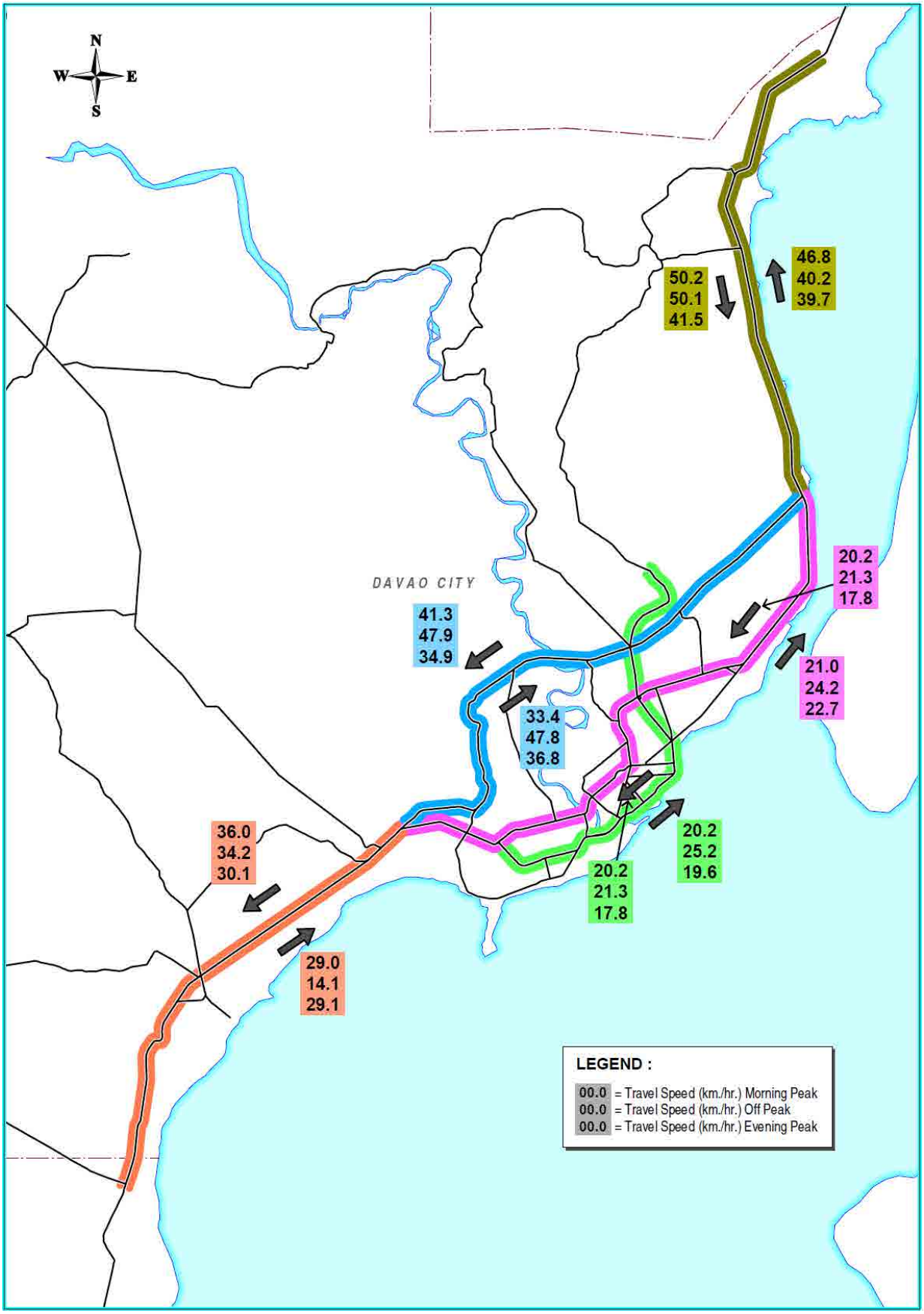
Major outgoing cargo from this port is Banana, Pineapple and Papaya.

6.1.7 Travel Time Survey

Travel Time Survey was carried out to identify the actual travel time and speed along Mc. Arthur Highway, Pan-Philippine Highway, Diversion Road, and the city road. Survey time was during the morning peak (07:00-09:00A.M), off peak (01:00-03:00P.M.) and evening peak (04:30-06:30P.M) on a week day.

Figure 6.1-31 shows the average travel speed.

North Section :	Travel speed was around 40~50km/hr, high speed
South Section :	Travel speed was around 30km/hr, moderate (off-peak, north direction was congested due to construction works, etc.)
Center Section :	Travel speed along Diversion Road was 35~45km/hr, high speed.
	Travel speed along JP Laurel Ave. was around 20km/hr from morning peak to evening peak, low speed.
	Travel speed along Quimpo Blvd., Dacudao Ave. was also around 20km/hr from morning peak to evening peak, low speed.

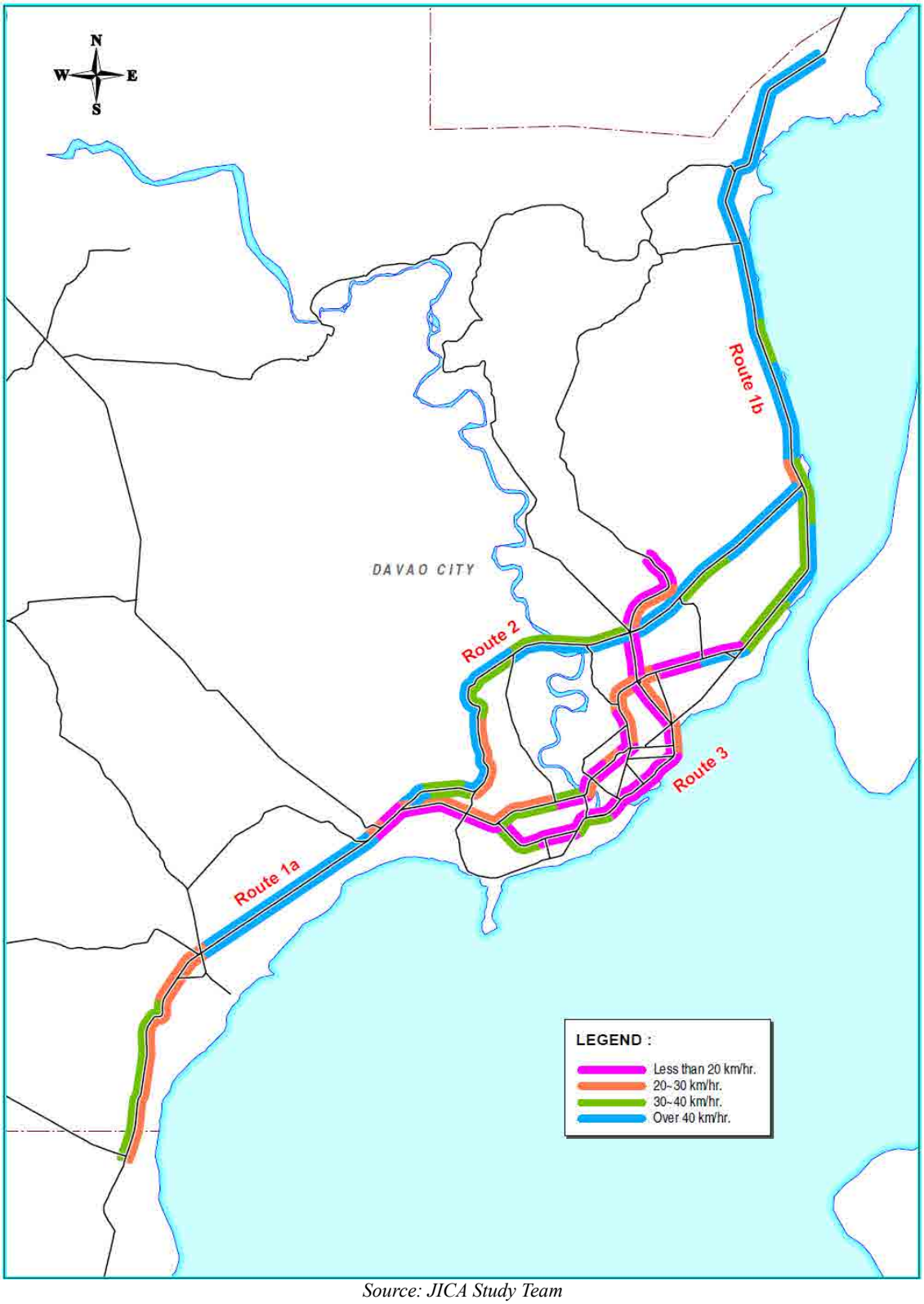


Source: JICA Study Team

FIGURE 6.1-31 AVERAGE SPEED OF MAJOR CORRIDOR

Figure 6.1-32 (1) ~ (3) shows the travel speed condition during morning peak, off peak and evening peak hours.

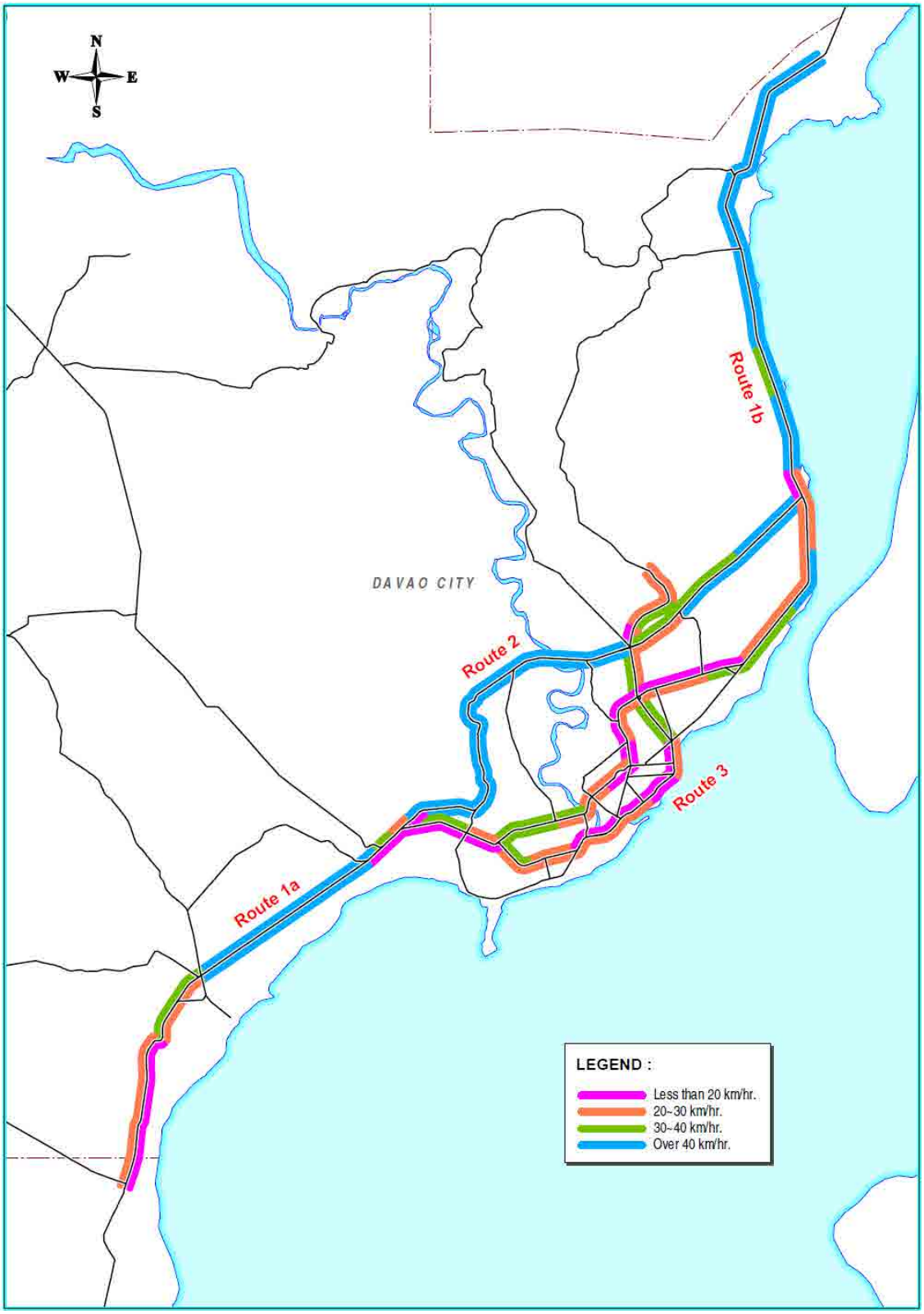
Morning Peak: Many roads in the City Center are very crowded; especially direction coming from the south to the City Center has a long low-speed section as shown in the figure.



Source: JICA Study Team

FIGURE 6.1-32 (1) TRAVEL SPEED OF MAJOR CORRIDORS IN DAVAO CITY (MORNING PEAK HOURS (07:00-09:00A.M))

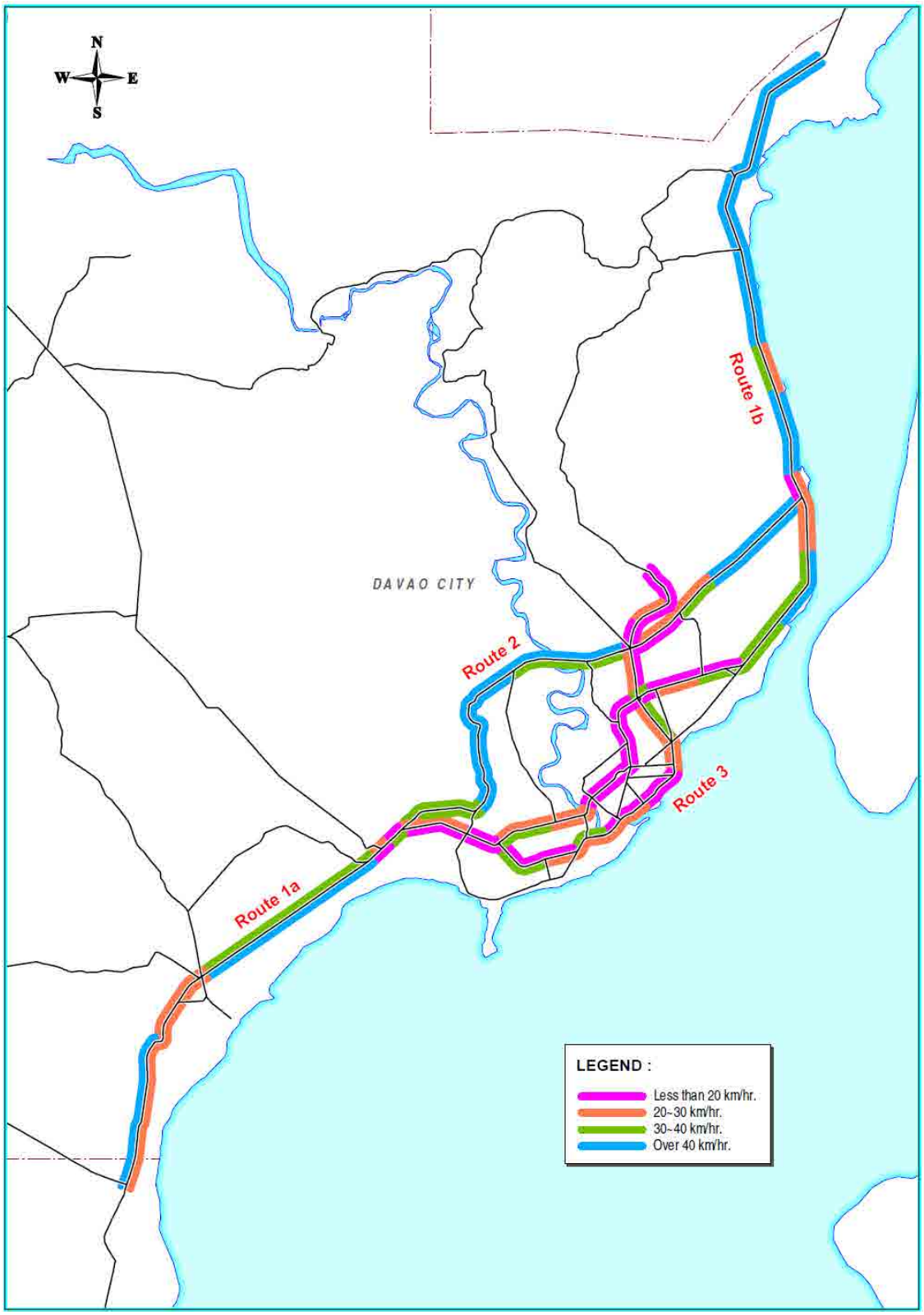
Off-peak: Relatively lesser congested section than the morning peak, travel speed along Diversion Road was almost over 40km/hr.



Source: JICA Study Team

FIGURE 6.1-32 (2) TRAVEL SPEED OF MAJOR CORRIDORS IN DAVAO CITY (OFF PEAK HOURS (01:00-03:00P.M))

Evening Peak: JP Laurel Ave. was congested, especially City Center area, both for the north and south direction. Diversion Road was also observed to be with less than 20km/hr section during the evening peak.



Source: JICA Study Team

FIGURE 6.1-32 (3) TRAVEL SPEED OF MAJOR CORRIDORS IN DAVAO CITY (EVENING PEAK (04:30-06:30P.M))

6.2 FUTURE TRAFFIC DEMAND

6.2.1 Approach

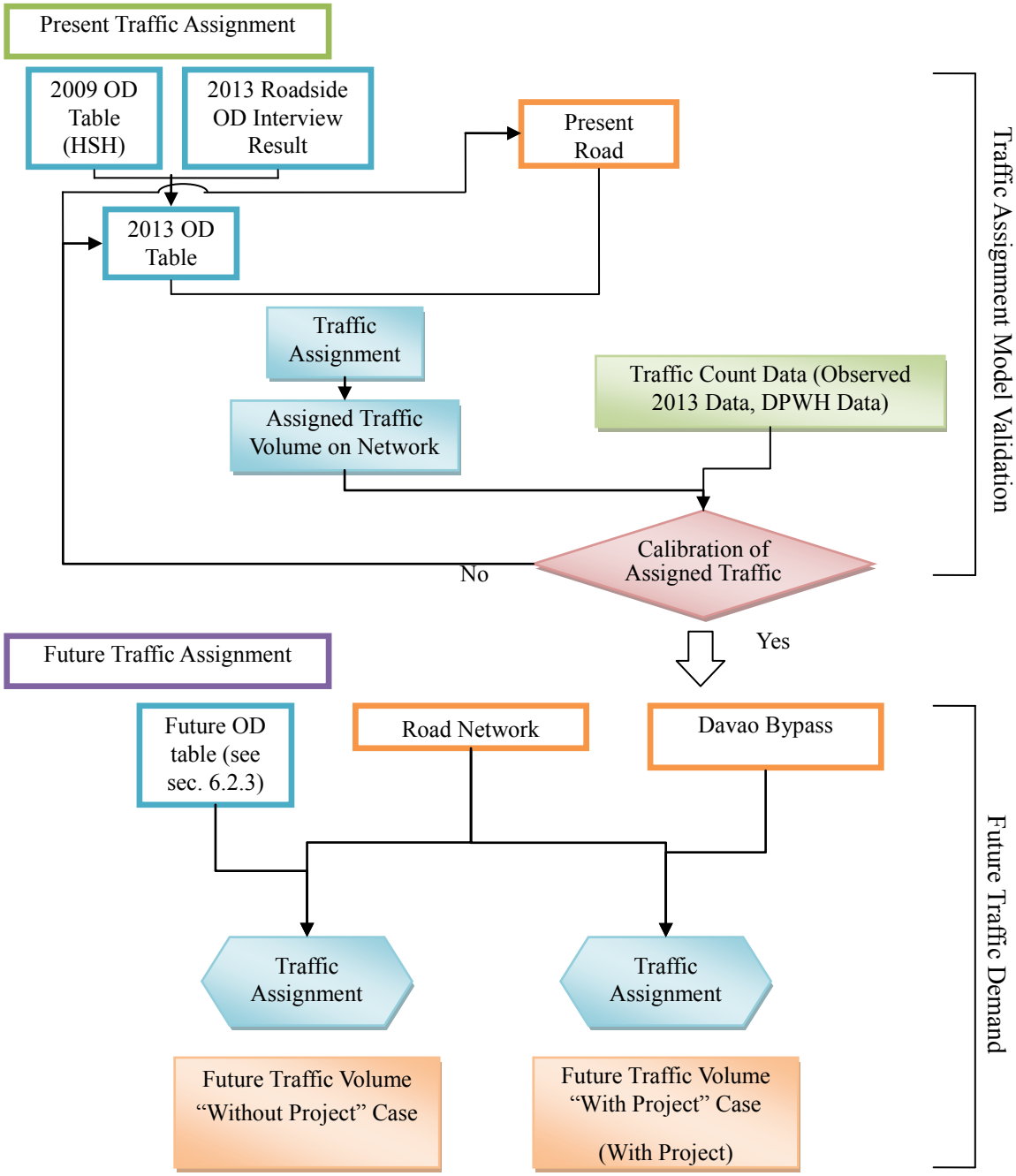
To estimate the traffic volumes on Davao Bypass, traffic demand forecast was conducted. **Figure 6.2-1** shows the traffic forecast procedure.

(1) Present Traffic Assignment

Based on analyzed roadside interview survey result in this project and year 2009 OD tables prepared by the Study of Master Plan on High Standard Highway Network Development (herein HSH Study), the present OD table was prepared and updated as year 2013. Traffic assignment was conducted using the present OD table and present road network, and then validation was conducted for the traffic count data (i.e. traffic survey result and year 2012 traffic volume carried out by DPWH for statistics) and assigned traffic volume on each link.

(2) Future Traffic Assignment

After validation of present OD table, future traffic demand was forecasted. Future traffic assignment was conducted using future OD table and future road network (with Bypass Project Case and Without Project Case).



Source: JICA Study Team

FIGURE 6.2-1 FORECAST OF TRAFFIC VOLUMES ON ROAD NETWORK

In this traffic assignment, the zoning system is comprised of Davao City, and Mindanao Island (Region 9, 10, 11, 12, 13, and ARRM). The zoning system is modified as divided zoning in the Davao City area using that of the HSH Study. The total zoning number is 59 zones as shown in **Figure 6.2-2** to **Figure 6.2-3** and **Table 6.2-1** to **Table 6.2-2**.

TABLE 6.2-1 TRAFFIC ZONING SYSTEM IN DAVAO CITY AREA

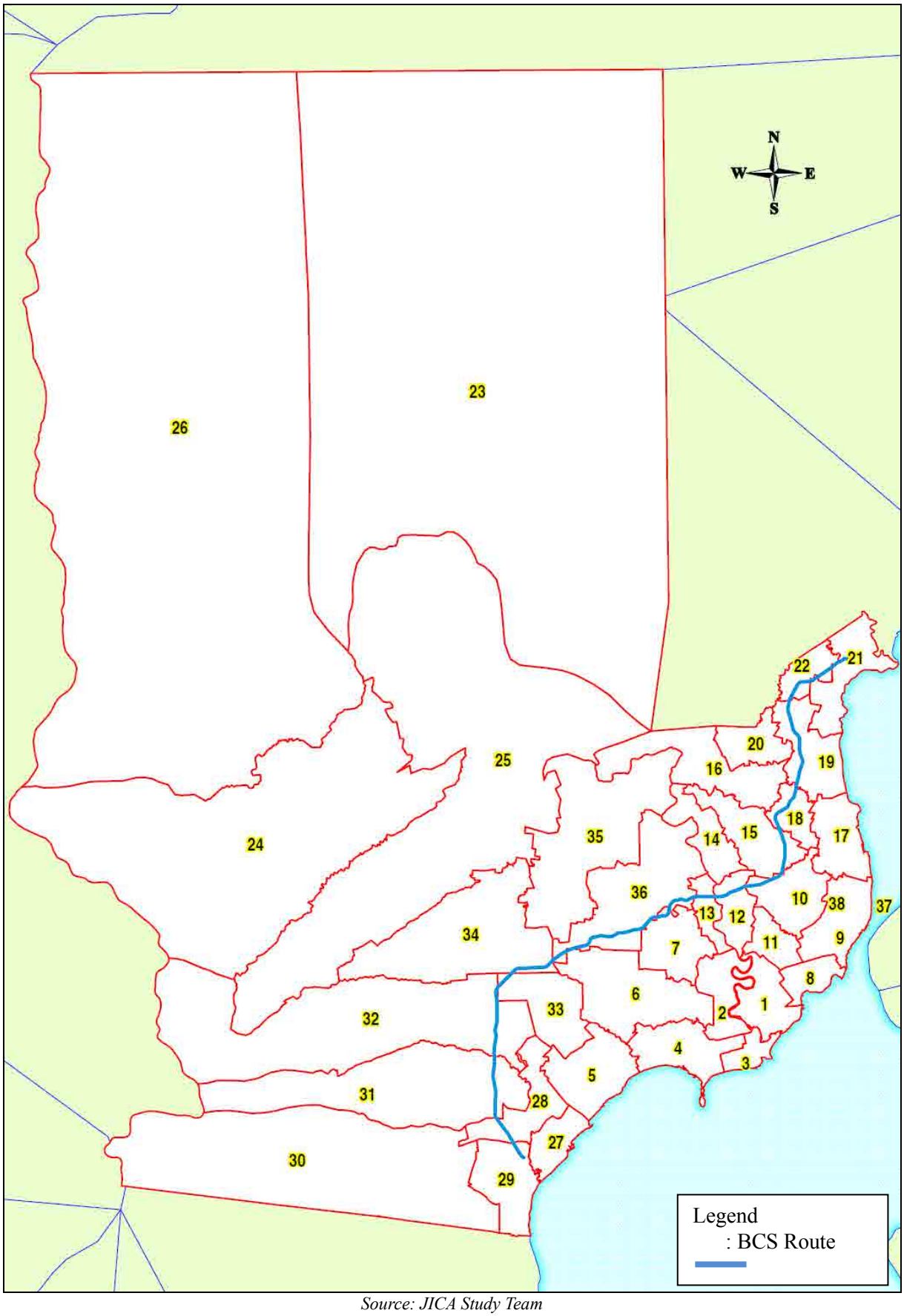
Zone No.	Barangay	District
1	Barangay 1-A (Pob.) ~ Barangay 10-A (Pob.)	POBLACION
	Barangay 11-A (Pob.) ~ Barangay 20-B (Pob.)	
	Barangay 21-C (Pob.) ~ Barangay 30-C (Pob.)	
	Barangay 31-D (Pob.) ~ Barangay 40-D (Pob.)	
2	Ma-a	TALOMO
3	Bucana	
4	Matina Aplaya, Matina Crossing, Talomo (Pob.)	
5	Bago Aplaya, Bago Gallera, Langub, Baliok, Dumoy	
6	Catalunan Grande, Catalunan Pequeño, Matina Pangi	
7	Magtuod	
8	Agdao, Centro (San Juan), Gov. Paciano Bangoy, Gov. Vicente Duterte	AGDAO
	Kap. Tomas Monteverde, Sr. , Lapu-lapu, Leon Garcia, Sr. , Rafael Castillo	
	San Antonio, Ubalde, Wilfredo Aquino	
9	Alfonso Angliongto Sr., Pampanga, Sasa, Vicente Hizon Sr.	BUHANGIN
10	Cabantian, Communal	
11	Buhangin (Pob.),	
12	Tigatto	
13	Waan	
14	Acacia, Callawa	
15	Indangan	
16	Mandug	
17	Ilang, Panacan	BUNAWAN
18	Mudiang	
19	Gatungan	
20	Mahayag, Tibungco	
21	Alejandra Navarro (Lasang), Bunawan (Pob.)	
22	San Isidro (Licanan)	
23	Colosas , Fatima (Benowang), Lumiad, Mabuhay, Malabog, Mapula	PAQUIBATO
	Panalum, Pandaitan, Paquibato (Pob.), Paradise Embak	
	Salapawan, Sumimao, Tapak	
24	Baguio (Pob.), Cadalian, Carmen, Gumalang	BAGUIO
	Malagos, Tambobong, Tawan-tawan, Wines	
25	Biao Joaquin, Calinan (Pob.), Cawayan, Dacudao, Dalagdag , Dominga	CALINAN
	Inayangan, Lacson, Lamanan, Lampianao, Megkawayan, Pangyan	
	Talomo River, Tamayong, Saloy, Sirib, Subasta, Riverside, Wangan	
26	Baganihan, Bantol, Buda, Dalag, Datu Salumay, Gumitan, Magsaysay	MARILOG
	Malamba, Marilog, Salaysay, Suawan (Tuli), Tamugan	
27	Daliao, Lizada, Lubogan, Marapangi	TORIL
28	Bangkas Heights, Binugao, Toril (Pob.)	
29	Camansi, Sirawan	
30	Atan-Awe, Baracatan, Crossing Bayabas, Sibulan, Tibuloy	
31	Bato, Bayabas, Eden, Kilate, Tagurano	
32	Alambre, Catigan, Daliaon Plantation, Mulig, Tagluno, Tungakalan	
33	Bago Oshiro, Mintal, Santo Niño	TUGBOK
34	Angalan, Balengaeng, Los Amigos, Manambulan, Manuel Guianga	
	Tagakpan, Tugbok (Pob.)	
35	Biao Escuela, Biao Guianga, New Valencia, Talandang, Ula	
36	Matina Biao, New Carmen, Tacunan	
37	SASA PORT	OTHERS
38	DAVAO AIRPORT	OTHERS

Source: JICA Study Team

TABLE 6.2-2 TRAFFIC ZONING SYSTEM OUTSIDE DAVAO CITY AREA

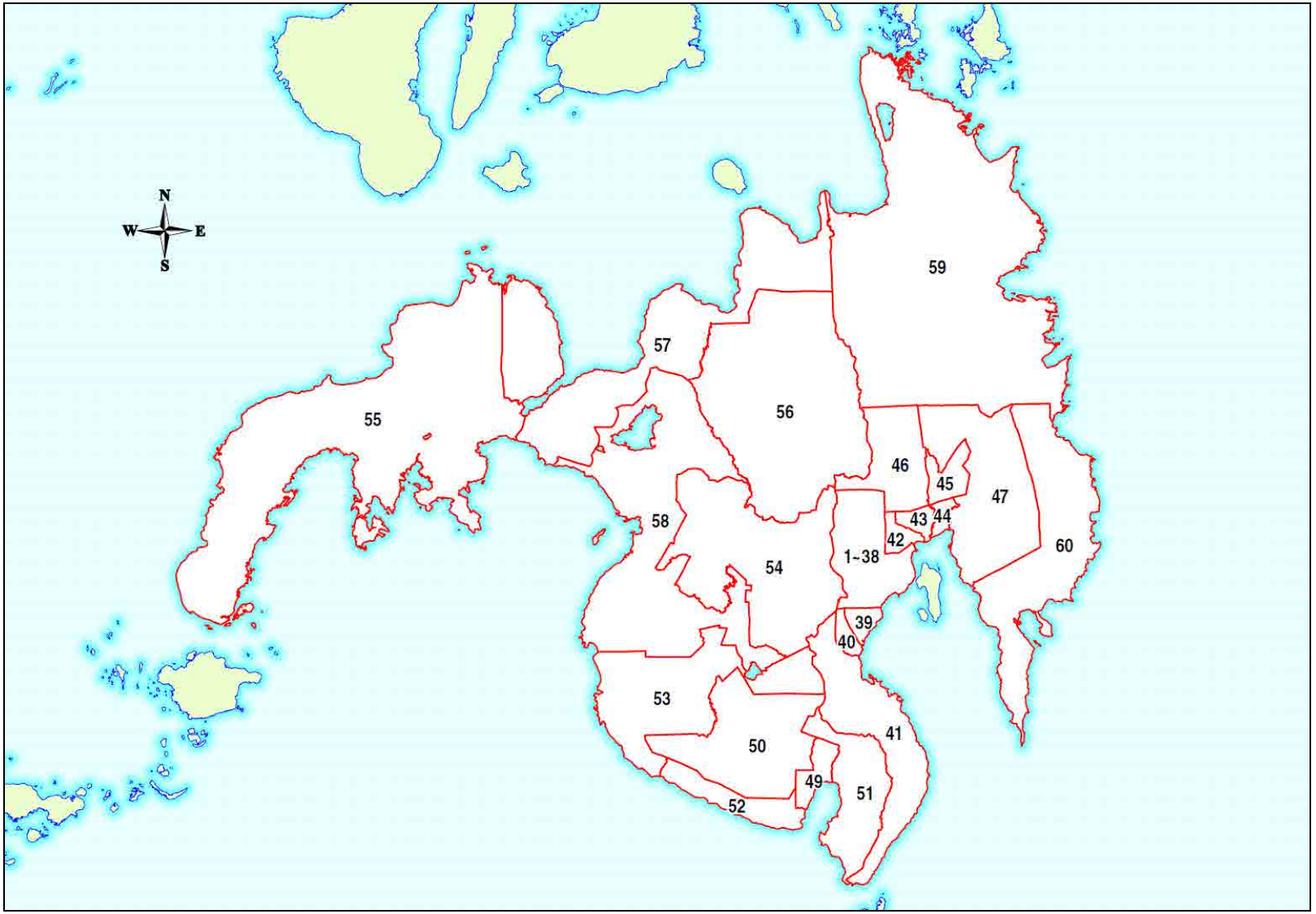
Zone No.	City/Municipality	Province	Region
39	Santa Cruz	Davao del Sur	Region XI
40	City of Digos		
41	Bansalan, Hagonoy, Kablaway, Magsaysay, Malalag, Malita, Matanao, Padada, Santa Maria, Sulop, Jose Abad Santos, Don Marcelino		
42	City of Panabo	Davao del Norte	
43	Carmen, Braulio Dujali		
44	City of Tagum		
45	Asuncion, New Corella		
46	Kapalong, Santo Tomas, Talaingod		
47	-	Compostela Valley	
48	-	Davao Oriental	
49	General Santos City	South Cotabato	Region XII
50	Polomolok, Tboli, Banga, City of Koronadal, Norala, Surallah, Tampakan, Tantangan, Tupi, Snto Nino, Lake Sebu		
51	Alabel, Malungon, Malapatan, Glan	Sarangani	
52	Maitum, Kiamba, Massim	-	
53	-	Sultan Kudarat	
54	-	Cotabato (North Cotabato)	
55	-	Zamboanga Del Norte, Zamboanga Del Sur, Zamboanga Sibugay	Region IX
56	-	Bukidnon	Region X
57	-	Lanao del Norte, Misamis Occidental, Misamis Oriental	
58	-	Cotabato City, Lanao del Sur, Maguindanao, Shariff Kabunsuan	Region XIV
59	-	Agusan del Sur, Agusan del Norte, Surigao del Norte, Surigao del Sur	Region XIII

Source: JICA Study Team



Source: JICA Study Team

FIGURE 6.2-2 ZONING MAP IN DAVAO CITY



Source: JICA Study Team

FIGURE 6.2-3 ZONING MAP OUTSIDE DAVAO CITY

6.2.2 Future Socio-economic Framework

The future socio-economic framework indicators were formulated by the national statistics data of National Statistics Office (NSO) and Davao City Planning and Development Office (DCPDO). Future socio-economic framework was revised considering the current development direction and the nature of each private developer in the Study Area by the JICA Study Team. The future socio-economic profile is summarized below.

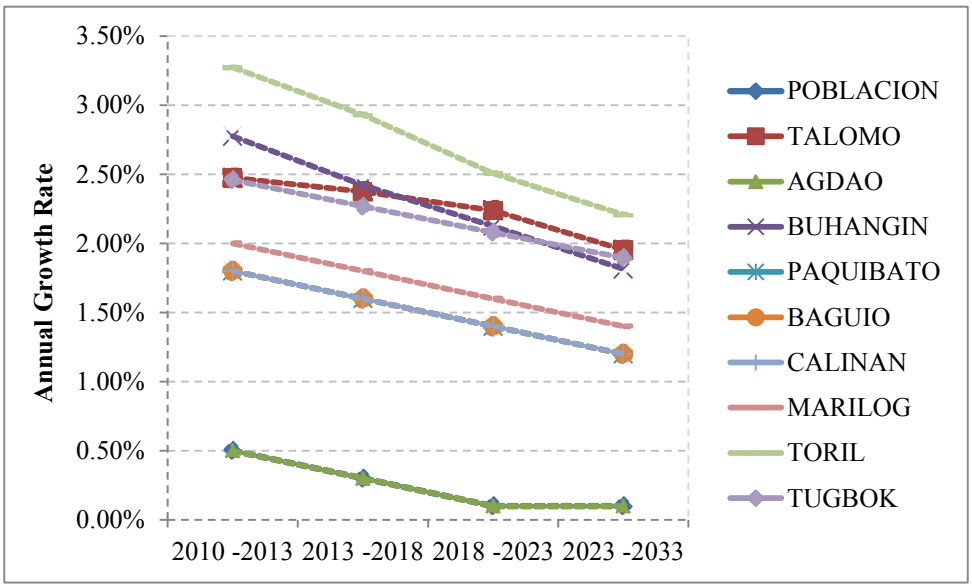
(1) Population Projection

The population of Davao City is based on the acquired data from private developers and the land use plan of Davao City Planning and Development Office. On the other hand, outside Davao City area is revised based on the statistical data of NSO.

Figure 6.2-4 shows the annual growth rate of population projection from 2010 to 2033 in Davao City and **Table 6.2-3** shows the summarized population projection considered in the development plan of Davao City. Average growth rate in Davao City is 2.00% from year 2013 to year 2018, 1.80% from year 2018 to 2023 and 1.60% from year 2023 to year 2033.

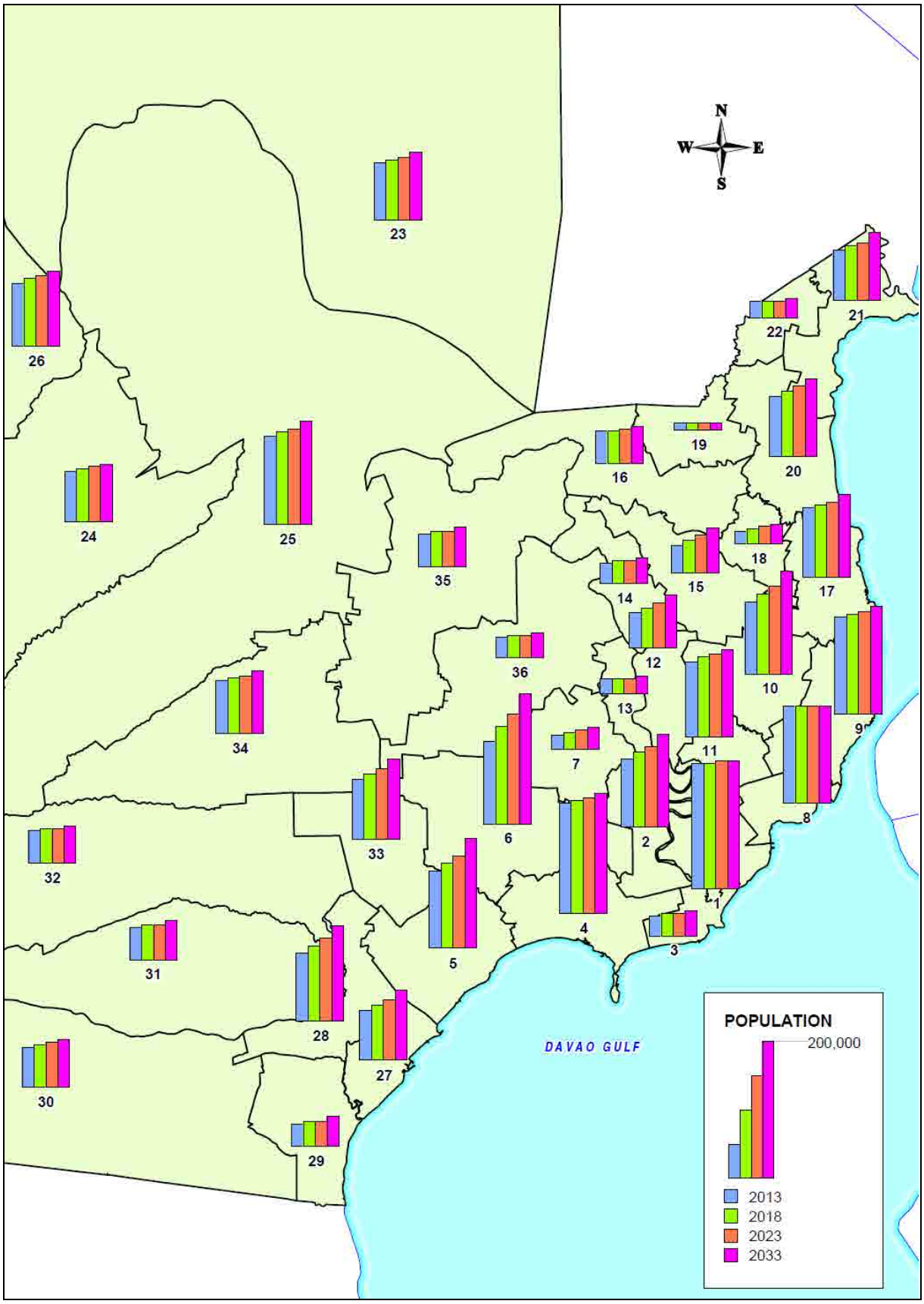
Central area in Davao City such as Poblacion and Agdao are already saturated, the annual growth rate is low. However, areas next to Buhangin, Talomo, Tugbok, and Toril have recently increased population showed ahigh growth rate.

Figure 6.2-5 shows the population by zone and **Figure 6.2-6** shows the population density. The projected population of each zone are all increasing.



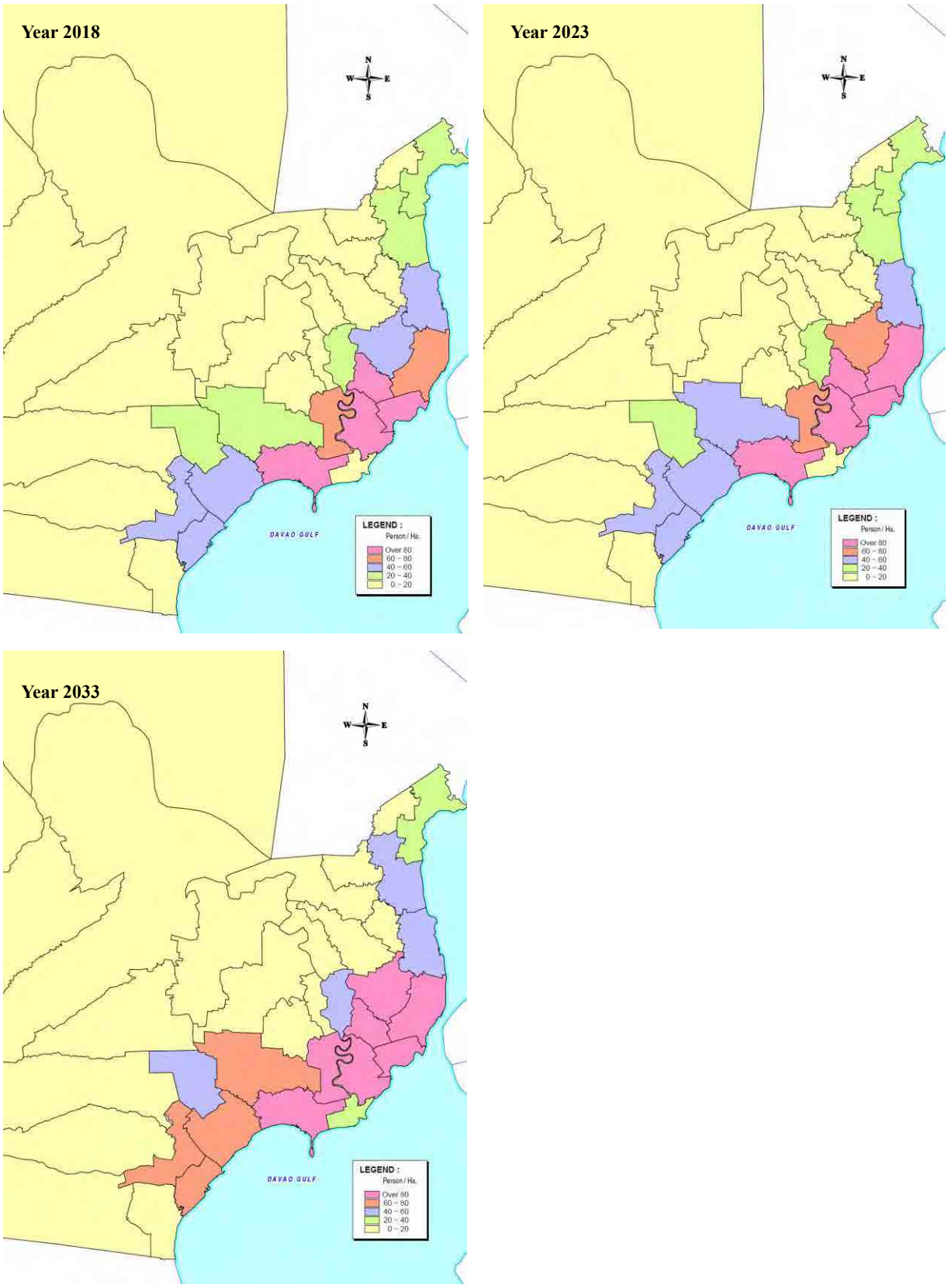
Source: JICA Study Team

FIGURE 6.2-4 ANNUAL GROWTH RATE OF POPULATION PROJECTION



Source: JICA Study Team

FIGURE 6.2-5 PROJECTED POPULATION IN THE STUDY AREA



Source: JICA Study Team

FIGURE 6.2-6 PROJECTED POPULATION DENSITY

TABLE 6.2-3 FUTURE POPULATION AND DENSITY IN THE STUDY AREA

Zone	Municipality	Land Area (Ha)	Year 2013		Year 2018		Year 2023		Year 2033	
			Population	Density (Persons/Ha)	Population	Density (Persons/Ha)	Population	Density (Persons/Ha)	Population	Density (Persons/Ha)
1	POBLACION	1,149.5	158,809	138	161,205	140	162,013	141	163,640	142
2	TALOMO	1,000.7	55,181	55	63,970	64	73,085	73	91,746	92
3		497.0	79,533	160	80,733	162	81,138	163	81,953	165
4		1,466.7	125,925	86	131,695	90	137,048	93	146,949	100
5		1,728.5	70,244	41	79,863	46	94,395	55	126,859	73
6		2,803.7	76,500	27	101,413	36	125,174	45	171,519	61
7		1,308.7	4,365	3	5,362	4	6,399	5	8,600	7
8	AGDAO	609.6	100,905	166	102,427	168	102,940	169	103,974	171
9	BUHANGIN	1,358.3	102,418	75	108,177	80	113,695	84	124,352	92
10		1,342.4	59,767	45	73,066	54	86,780	65	114,380	85
11		665.7	65,223	98	71,308	107	77,198	116	85,275	128
12		810.2	17,114	21	21,429	26	25,574	32	35,213	43
13		525.5	3,454	7	3,907	7	4,314	8	5,194	10
14		1,059.6	6,577	6	7,557	7	8,409	8	10,236	10
15		1,524.3	11,188	7	14,951	10	18,454	12	26,032	17
16		2,366.2	14,044	6	15,354	6	16,623	7	19,102	8
17	BUNAWAN	1,271.5	55,988	44	61,212	48	66,268	52	75,778	60
18		667.5	3,131	5	4,069	6	4,914	7	6,359	10
19		916.3	1,044	1	1,153	1	1,258	1	1,458	2
20		1,547.2	44,900	29	51,048	33	57,195	37	70,407	46
21		1,408.7	32,568	23	37,390	27	42,303	30	52,587	37
22		641.3	4,494	7	4,865	8	5,200	8	5,859	9
23	PAQUIBATO	65,630.7	41,881	1	45,340	1	48,604	1	54,762	1
24	BAGUIO	18,838.6	32,054	2	34,702	2	37,200	2	41,913	2
25	CALINAN	22,989.6	86,344	4	93,476	4	100,205	4	112,900	5
26	MARILOG	63,158.7	47,887	1	52,355	1	56,679	1	65,134	1
27	TORIL	773.5	32,747	42	38,893	50	45,088	58	58,282	75
28		1,359.8	54,676	40	64,938	48	75,281	55	97,311	72
29		1,509.0	7,721	5	9,038	6	10,176	7	12,650	8
30		10,946.5	21,729	2	23,874	2	25,846	2	29,701	3
31		5,701.8	15,272	3	16,779	3	18,165	3	20,874	4
32		9,486.3	14,840	2	16,304	2	17,651	2	20,284	2
33	TUGBOK	1,576.9	42,855	27	49,200	31	55,937	35	70,909	45
34		4,762.1	33,660	7	36,801	8	39,841	8	45,783	10
35		5,110.7	15,166	3	16,581	3	17,950	4	20,628	4
36		3,455.1	6,866	2	7,655	2	8,451	2	10,102	3
Total		241,968	1,547,069	1,190	1,708,090	1,295	1,867,452	1,396	2,188,702	1,601

Source: JICA Study Team

(2) Employment Projection

The employment at job site was selected as an index to reflect traffic generation/attraction. The number of projected employment is taken from the CLUP of Davao City, the growth rate is shown at a medium rate between population growth rate and GRDP growth rate.

Table 6.2-4 shows the projected employment by zone.

TABLE 6.2-4 PROJECTED POPULATION AND EMPLOYMENT BY ZONE

Zone	Municipality	Year 2013		Year 2018		Year 2023		Year 2033	
		Population	Employment	Population	Employment	Population	Employment	Population	Employment
1	POBLACION	158,809	207,713	161,205	229,332	162,013	247,055	163,640	281,118
2	TALOMO	55,181	22,315	63,970	29,165	73,085	35,654	91,746	52,272
3		79,533	44,271	80,733	48,401	81,138	52,399	81,953	60,215
4		125,925	47,947	131,695	58,334	137,048	68,119	146,949	92,440
5		70,244	21,360	79,863	27,067	94,395	33,650	126,859	51,020
6		76,500	22,887	101,413	31,283	125,174	39,736	171,519	60,829
7		4,365	2,200	5,362	2,405	6,399	2,604	8,600	2,992
8	AGDAO	100,905	44,593	102,427	48,753	102,940	52,780	103,974	60,653
9	BUHANGIN	102,418	58,853	108,177	64,343	113,695	69,658	124,352	80,048
10		59,767	12,931	73,066	14,137	86,780	15,305	114,380	17,587
11		65,223	2,090	71,308	2,285	77,198	2,473	85,275	2,842
12		17,114	2,284	21,429	2,498	25,574	2,704	35,213	3,107
13		3,454	2,025	3,907	2,214	4,314	2,396	5,194	2,754
14		6,577	7,131	7,557	9,083	8,409	10,961	10,236	15,829
15		11,188	2,339	14,951	3,210	18,454	4,077	26,032	6,332
16		14,044	2,356	15,354	2,929	16,623	3,487	19,102	4,895
17	BUNAWAN	55,988	46,602	61,212	50,950	66,268	55,159	75,778	63,386
18		3,131	2,258	4,069	3,056	4,914	3,840	6,359	5,714
19		1,044	2,253	1,153	2,814	1,258	3,363	1,458	4,742
20		44,900	20,003	51,048	25,348	57,195	30,692	70,407	44,565
21		32,568	14,957	37,390	19,043	42,303	23,169	52,587	33,805
22		4,494	2,195	4,865	2,716	5,200	3,213	5,859	4,468
23	PAQUIBATO	41,881	1,702	45,340	2,106	48,604	2,495	54,762	3,468
24	BAGUIO	32,054	1,983	34,702	2,454	37,200	2,907	41,913	4,042
25	CALINAN	86,344	2,124	93,476	2,628	100,205	3,114	112,900	4,329
26	MARILOG	47,887	2,054	52,355	2,553	56,679	3,040	65,134	4,267
27	TORIL	32,747	32,624	38,893	35,668	45,088	38,614	58,282	44,374
28		54,676	7,490	64,938	9,929	75,281	12,226	97,311	17,247
29		7,721	7,366	9,038	9,468	10,176	11,492	12,650	16,767
30		21,729	2,124	23,874	2,647	25,846	3,190	29,701	4,287
31		15,272	2,201	16,779	2,802	18,165	3,377	20,874	4,538
32		14,840	2,145	16,304	2,732	17,651	3,292	20,284	4,424
33	TUGBOK	42,855	2,281	49,200	2,904	55,937	3,542	70,909	5,218
34		33,660	2,275	36,801	2,828	39,841	3,367	45,783	4,726
35		15,166	1,999	16,581	2,485	17,950	2,958	20,628	4,153
36		6,866	2,051	7,655	2,574	8,451	3,094	10,102	4,429
Total		1,547,069	661,979	1,708,090	763,145	1,867,452	859,205	2,188,702	1,077,881

Source: JICA Study Team

(3) GDP Projection

The National Economic and Development Authority in the Philippines have not yet released the future GDP growth rate. Thus, the JICA Study Team based the growth rate of future GDP on future development of Davao City from the CLUP report and GDP growth rate of IMF, ADB, and WB in the Philippines (shown in **Table 6.2-5**). As the estimated result, GDP in Davao City is 6.00% from year 2013 to year 2018, 5.50% from year 2018 to 2023 and 5.50% from year 2023 to year 2033.

TABLE 6.2-5 ESTIMATED GDP GROWTH RATE ON EACH FINANCIAL INSTITUTION

Year	2012	2013	2014	2015	2016	2017	2018
IMF Estimated	6.59%	6.02%	5.47%	5.30%	5.40%	5.50%	5.50%
ADB Estimated	-	7.00%	6.10%	-	-	-	-
WB Estimated	-	7.50%	-	-	-	-	-

Source: IMF, ADB, World Bank

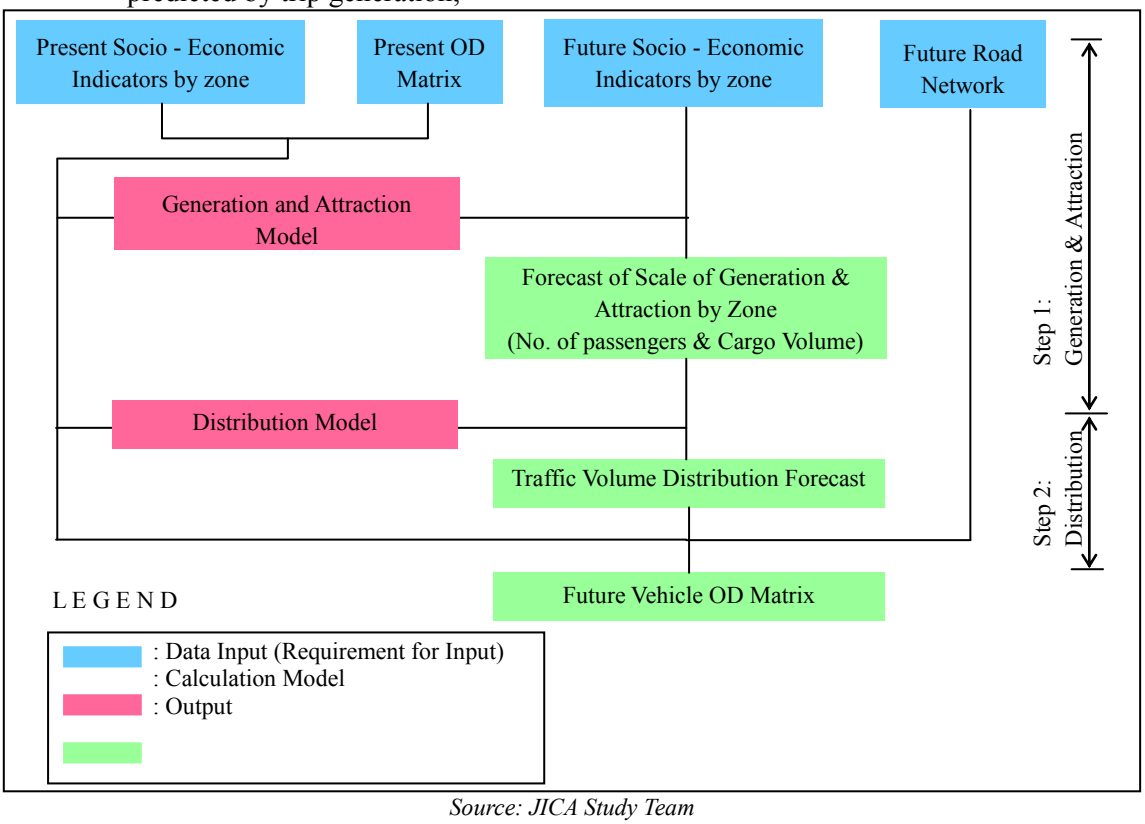
6.2.3 Present and Future OD Matrix

The Present OD matrix was prepared based on the 2009 OD matrix of HSH and revised and updated for Year 2013 taken from the roadside OD interview survey result. The ttraffic assignment model was validated using this present OD matrix (see 6.2.5 Assignment Validation). In order to formulate the future OD table, traffic demand forecast was conducted by applying the revised future socio-economic indicators by zone.

(1) Future OD Estimation Approach

The future OD Matrix was prepared by the following as shown in **Figure 6.2-7**.

- Trip Generation and Attraction – the prediction of trips produced and attracted to each zone;
- Model Growth Method – the growth rate of existing reproduced demand and future reproduced demand to OD pair;
- Trip Distribution – the prediction of origin-destination flows, the linking of trip ends predicted by trip generation;



Source: JICA Study Team

FIGURE 6.2-7 CONCEPT OF TRANSPORTATION MODELING IN THE STUDY

(2) Modeling and Forecasting Tools

During traffic demand forecasting, JICA STRADA system and EXCEL spreadsheet were employed. JICASTRADA is a geographic information system designed specifically for planning, managing, and analyzing of transportation systems. The software provides a set of tools for travel

demand modeling as well as capabilities for geographic database management, presentation graphics and transportation models. JICASTRADA system is applied for simulation of travel time and cost. For better precision, efficiency and minimization of trial errors, model calibrations and forecasts in trip generation, trip distribution and modal split steps are programmed using Excel spreadsheet, and the final step, traffic assignment stage is computed by JICA STRADA system.

(3) Traffic Demand Forecast Modeling

1) Trip Generation and Attraction Model

The objective of trip generation and attraction model is to forecast the number of trips by vehicle type that will depart and arrive in each traffic zone within the Davao City area. The linear regression models were adopted. The model parameters were calibrated as shown in **Table 6.2-6**.

Figure 6.2-8 shows the verification results between observed (present OD trips) and estimated trips for each vehicle type trips, and **Figure 6.2-11** shows the estimated desire line of each vehicle trips.

$$G_i = a_i * X1_i + b_i * X2_i$$

$$A_j = a_j * X1_j + b_j * X2_j$$

Where,

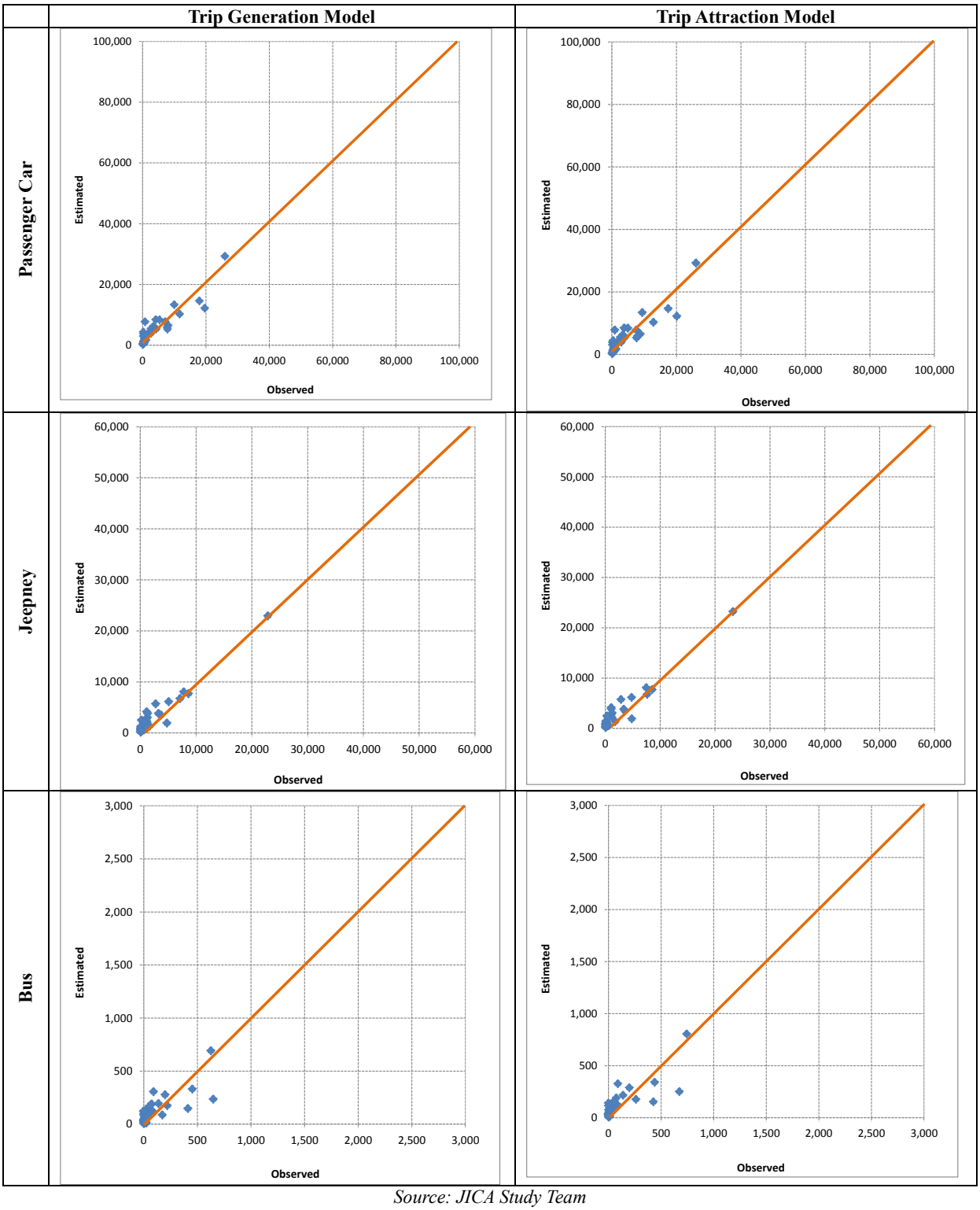
G_i – Trip Generation in zone i $X1_i$, $X2_j$ – Attributes in zone i,j

A_j – Trip Attraction in zone j a_i, aj, b_i,b_j – Coefficients

TABLE 6.2-6 GENERATION/ATTRACTION MODELS BY VEHICLE TYPE

Model Type	Vehicle Type	Population	Employment	R2 Multiple Correlation Coefficient
Trip Generation	Car	0.0876	0.0740	0.837
	Jeepney	0.0270	0.0898	0.935
	Bus	0.0019	0.0019	0.700
Trip Attraction	Car	0.0881	0.0732	0.822
	Jeepney	0.0265	0.0916	0.932
	Bus	0.0017	0.0026	0.753

Source: JICA Study Team

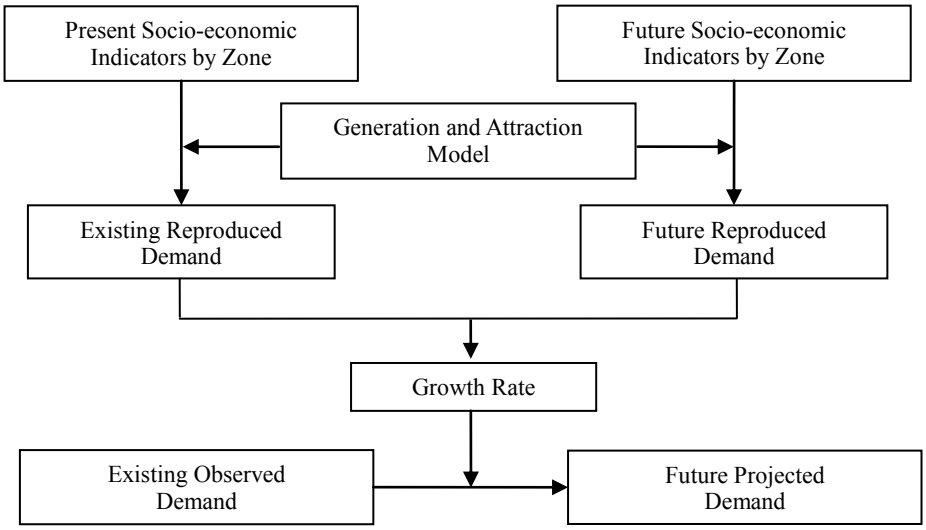


Source: JICA Study Team

FIGURE 6.2-8 VERIFICATION OF TRIP GENERATION AND ATTRACTION MODEL

2) Model Growth Method

The transport demand obtained from the transport survey covers inter Davao City trip and reproduced by observed traffic flows. The transport models are built by utilizing that demand data without intra-municipality demand, this causes much errors in the process of developing the models. In order to avoid the model error and bias from the demand forecasting, the Model Growth method (shown in **Figure 6.2-9**) was applied in the study.

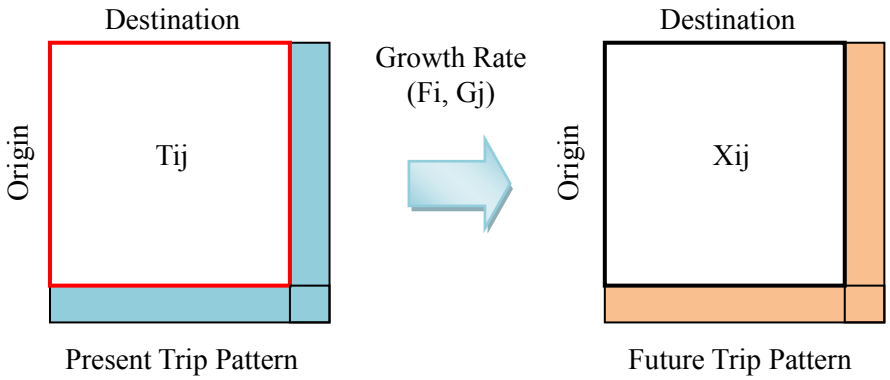


Source: JICA Study Team

FIGURE 6.2-9 CONCEPT OF MODEL GROWTH METHOD

3) Trip Distribution Model

Comparing the present and future road network, the future road network is almost the same as the present road network. Therefore, present trip pattern will not change on the future road network. In this case, trip distribution assumed that future trip pattern was estimated by multiplying growth rate to present trip pattern in the method of "Present Pattern Method" (shown in **Figure 6.2-10**). The truck trips was estimated by using this method.

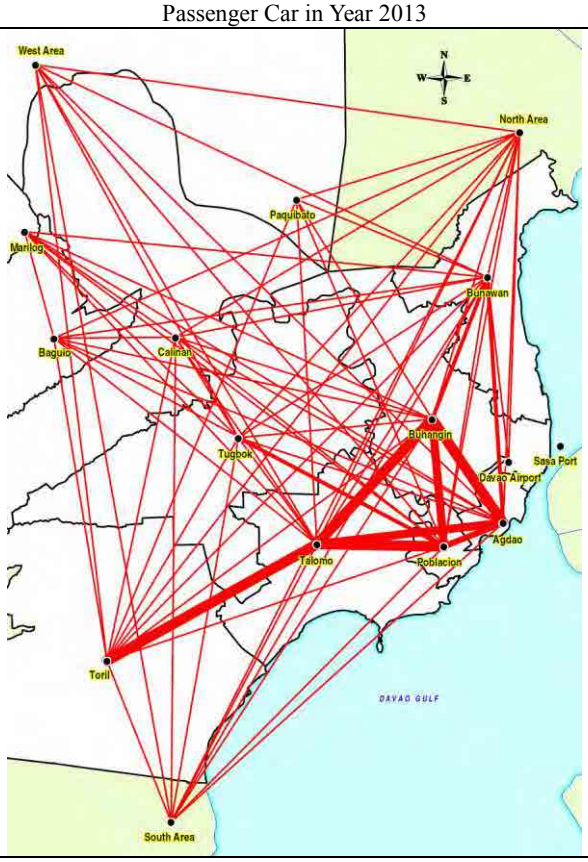
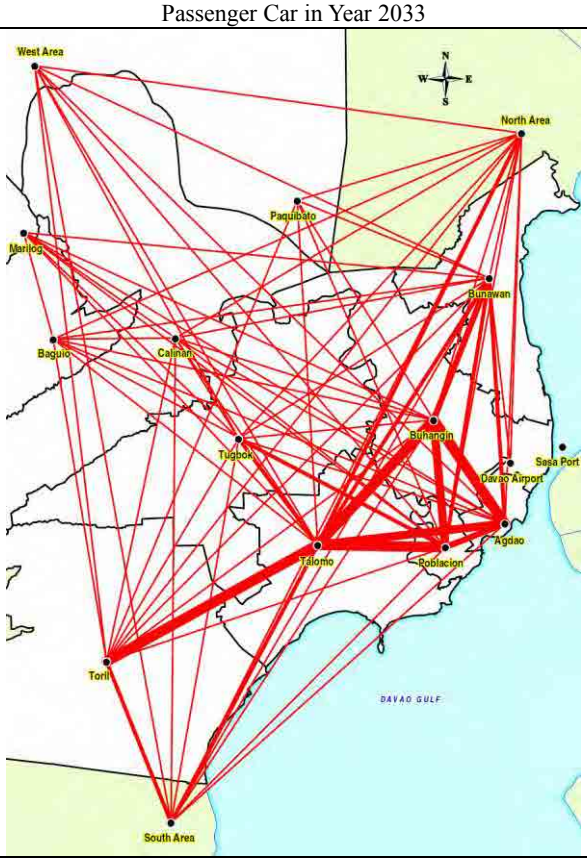
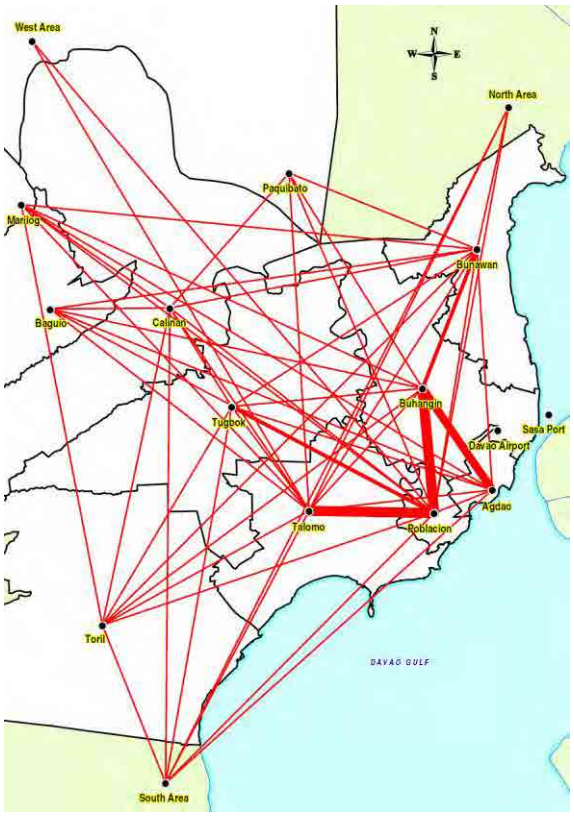
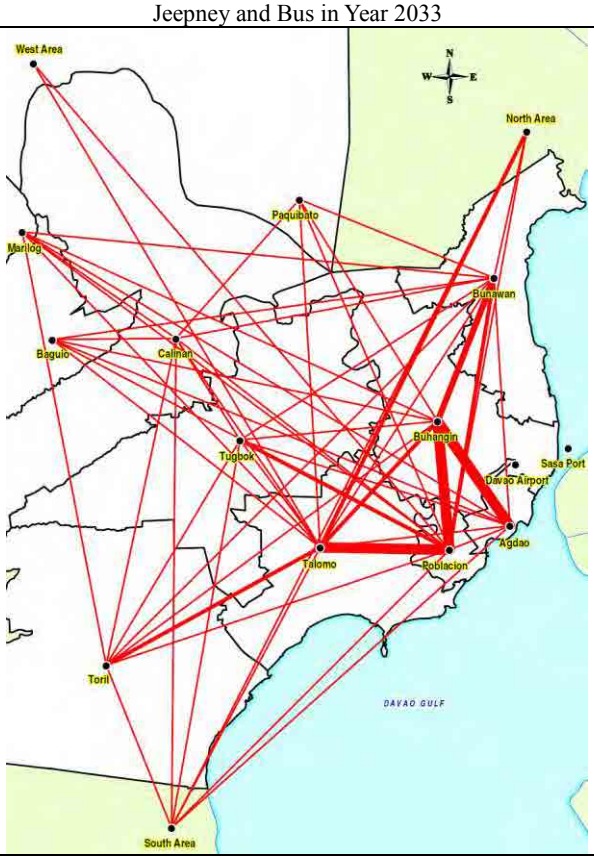


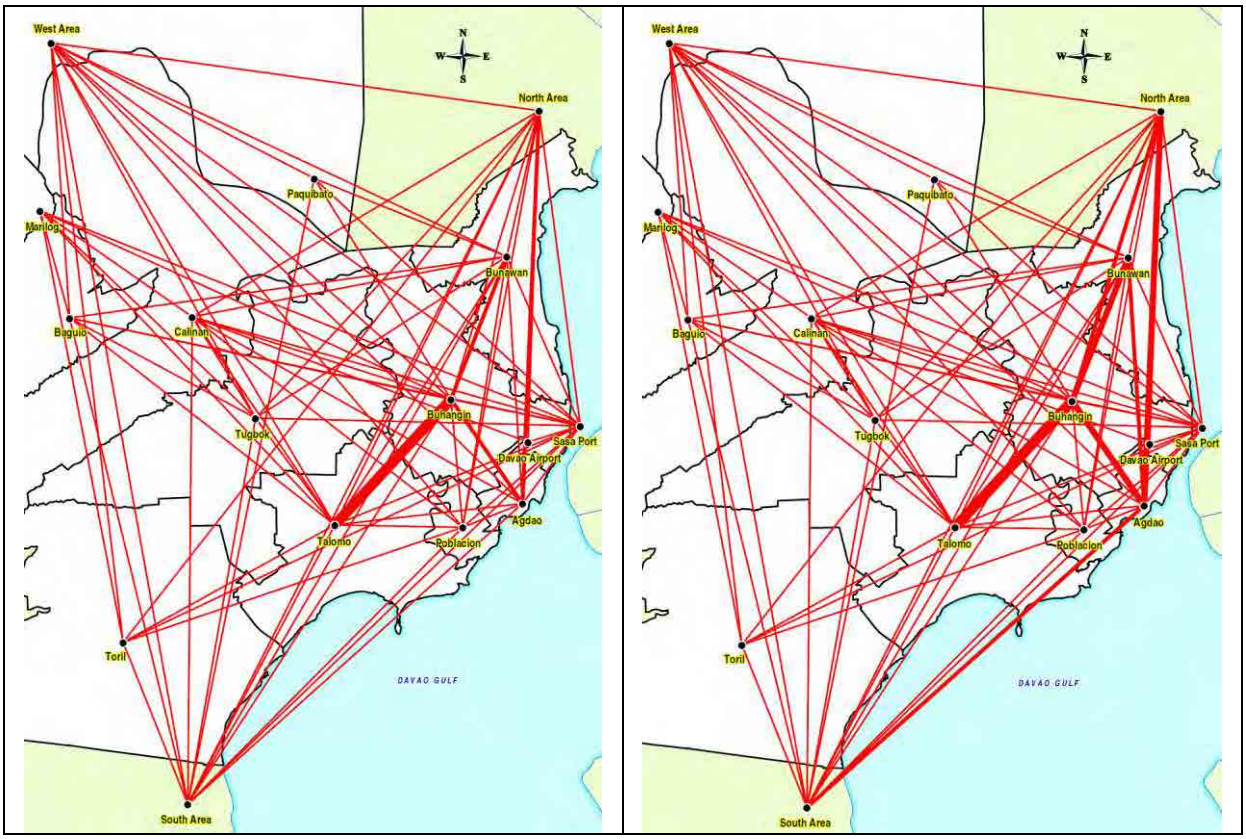
Source: JICA Study Team

FIGURE 6.2-10 PRESENT PATTERN METHOD

4) Desire Lines

Desire lines for Passenger Car, Jeepney and Truck are illustrated in **Figure 6.2-11**.

Passenger Car in Year 2013	Passenger Car in Year 2033
	
Jeepney and Bus in Year 2013	Jeepney and Bus in Year 2033
	
Truck in Year 2013	Truck in Year 2033



Source: JICA Study Team

FIGURE 6.2-11 DESIRE LINE

Estimated traffic generated by the Bypass project in the urban and sub-urban center of Davao City is shown in **Table 6.2-7** below.

TABLE 6.2-7 ESTIMATED TRAFFIC GENERATION

Zone		Year 2013					Year 2018					Year 2023					Year 2033				
		Car	Jeepney	Bus	Truck	Total	Car	Jeepney	Bus	Truck	Total	Car	Jeepney	Bus	Truck	Total	Car	Jeepney	Bus	Truck	Total
Davao City (urban)	(veh/day)	105,633	61,131	2,564	14,786	184,114	115,311	67,391	3,599	17,116	203,417	122,548	72,879	3,861	19,137	218,425	137,724	84,324	4,503	22,013	248,564
	(%)	-	-	-	-	-	1.8%	2.0%	7.0%	3.0%		1.2%	1.6%	1.4%	2.3%		2.4%	3.0%	3.1%	2.8%	
Davao City (sub-urban)	(veh/day)	45,738	17,717	867	7,486	71,808	58,952	22,239	1,103	8,682	90,976	67,880	25,810	1,303	9,717	104,710	87,592	34,151	1,732	11,144	134,619
	(%)	-	-	-	-	-	5.2%	4.7%	4.9%	3.0%		2.9%	3.0%	3.4%	2.3%		5.2%	5.8%	5.9%	2.8%	
Total		255,922					294,393					323,135					383,183				
Increase from 2013		-					1.15					1.26					1.50				

Source: JICA Study Team

From the traffic baseline of 2013, the estimated increase of traffic generated in 2018 is an increase of 0.15%, 0.26% in 2023 and 0.50% in 2033. The Davao City Urban Center is comprised of traffic zoning 1, 2, 3, 4, 8, 9, 10 and 11.

6.2.4 Traffic Assignment Model

The traffic assignment procedure allocates the vehicle traffic into the individual road links. This step uses as input for the matrix of flows (vehicles) that indicate the volume of traffic between origin and destination pairs.

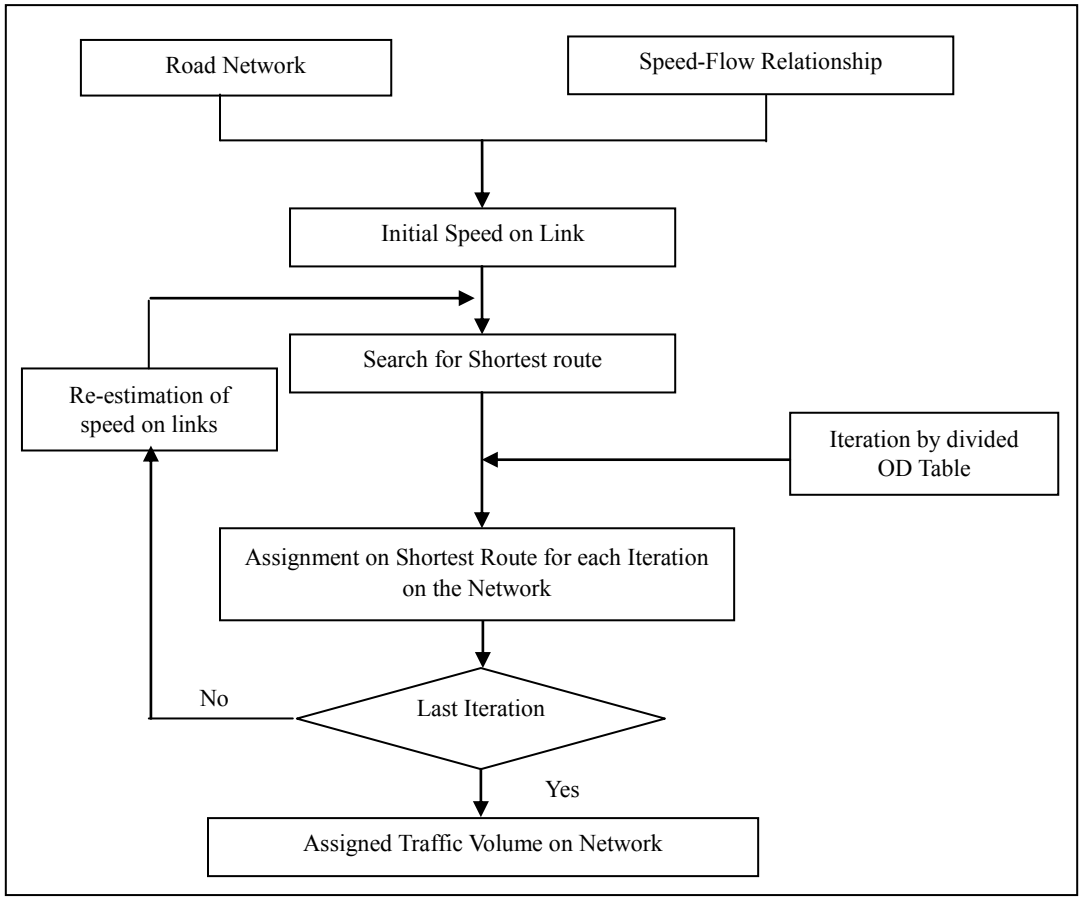
(1) Assignment Method

There are so many assignment techniques that can be used to estimate the traffic volume ranging from manual methods to complex iterative procedures by using computer programs. In this study, the capacity restraint assignment which is the most straightforward to use in network models was applied. This assignment technique is based on the speed – flow relationship. The flow chart of

the applied methodology is presented in **Figure 6.2-12**.

In this assignment technique, the program determines the fastest routes between each origin and destination by evaluating the time utilized on each links by calculating the required travel time for each link according to its travel speed and road conditions, and then assigns the trips between the given origin and destination. As congestion increases until a certain level, alternative routes are introduced to handle the unassigned traffic. Zone-to-zone routing is built, which is the fastest path from each zone to another, and all trips are assigned to these optimum routes.

Since the link-travel time varies with the traffic volume of vehicles using that link, the OD tables are divided to apply an iteration procedure on five (5) stages, this can be explained as a degree of link congestionAt each iteration, and depending on the current link loadings, the flows are divided between all the shortest routes generated and a new travel time is computed for the average assigned link flow at each pass. The iteration continues to re-estimate the speed on that links considering the assigned traffic on links, and to produce the alternative routes so that more accurate allocation can be achieved. The accumulated assigned traffic volume from each OD pair on the links composes the total assigned traffic volumes per direction for the network. JICA STRADA is used to estimate traffic volumes.

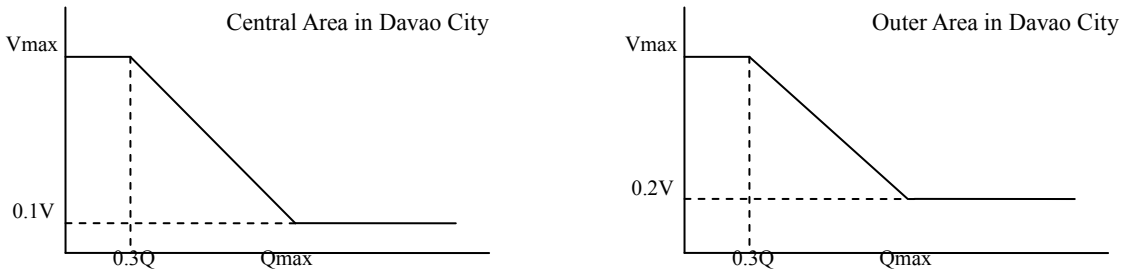


Source: JICA Study Team

FIGURE 6.2-12 TRAFFIC ASSIGNMENT PROCEDURE

(2) Speed-Flow Relationship

The speed-flow relationship used in the traffic assignment procedure is shown in **Figure 6.2-13** Speed – Flow Relationship. When the traffic volumes are over the maximum capacity 0.3*Q*max*, it is assumed that vehicle speed drastically reduces. These speed-flow relationships are classified for the central area and for the outer area in Davao City. The basic free flow and capacity is shown in **Table 6.2-8**.



Source: JICA Study Team

FIGURE 6.2-13 SPEED – FLOW RELATIONSHIP

TABLE 6.2-8 FREE SPEED AND CAPACITY BY ROAD TYPE

QV Type	Pavement	Road Class	Topography	Lane	Vmax	Qmax
1	Paved	Urban Arterial	Plain	6	50	72,000
2				4	40	48,000
3				2	30	24,000
4			Mountains	4	30	36,000
5				2	25	18,000
6		Local	Plain	4	40	40,000
7				2	30	12,000
8				1	30	7,000
9			Mountains	2	30	8,400
10				1	20	6,000
11	Unpaved		Plain	2	20	6,000
12			Mountains	3	10	4,200

Source: JICA Study Team

(3) Passenger Car Unit

Table 6.2-9 shows the Passenger Car Unit (PCU) used in vehicle traffic conversion. This value is the same used by the DPWH.

TABLE 6.2-9 PASSENGER CAR UNIT (PCU)

Vehicle Type	Passenger Car Unit
Passenger Car	1.0
Jeepney	1.5
Bus	2.0
Truck	2.5

Source: DPWH

6.2.5 Assignment Validation

The procedure of model validation entails two steps. First, the present OD matrix is assigned on an existing network. Second, the assigned traffic volume is compared with the result of the traffic count surveys at each corresponding location. This verification aims to check the accuracy of both the current OD matrix and an existing network model which represents the existing transport situation.

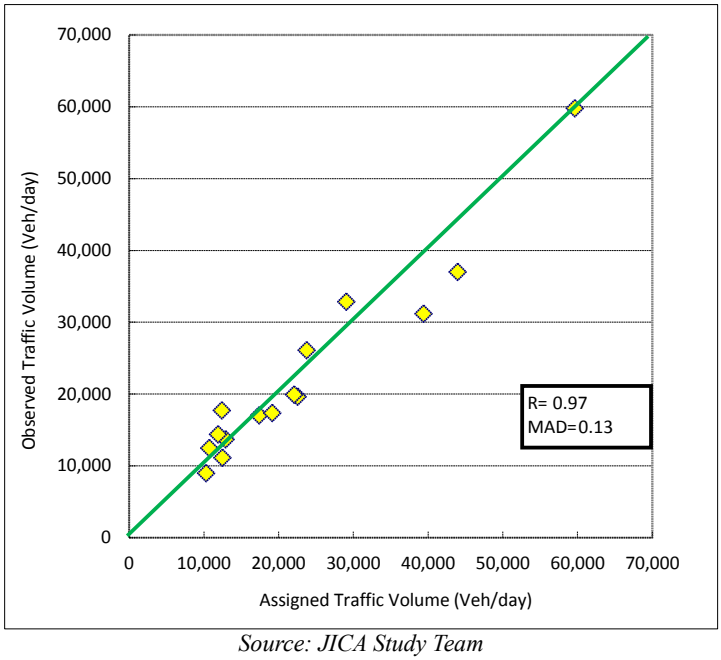
Table 6.2-10 presents the traffic volumes generated from traffic assignment volume and observed traffic volume (traffic count survey). **Figure 6.2-14** shows the result of comparison between the

assigned traffic volume and observed traffic volume. This comparison between observed traffic count and assigned traffic flow at individual sites is done via the Correlation and the Mean Absolute Difference (MAD) Ratio. For daily traffic counts, the correlation is 0.97, the value of the MAD ratio is 0.12 which is considered to reflect a good calibration. By all indicators the assignment was accurately replicated by year 2013.

TABLE 6.2-10 COMPARISON OF OBSERVED (SURVEY DATA) AND ASSIGNED TRAFFIC VOLUME

No	Station	Observed Traffic Volume	Assigned Traffic Volume	Difference	Rate
1	MacArthur Highway (South of Apo Golf & Country Club)	26,050	23,752	2,298	10%
2	MacArthur Highway (Toril)	11,066	12,480	-1,414	-11%
3	Davao-Bukidnon Rd. (North of MacArthur Highway)	16,965	17,406	-441	-3%
4	Davao-Bukidnon Rd. (Bet. Mintal and Tugbok)	8,940	10,310	-1,370	-13%
5	MacArthur Highway (East of Catalunan Grande Rd.)	36,969	43,978	-7,009	-16%
6	Pan Philippine Highway (Lasang)	13,623	12,927	696	5%
7	CP Garcia (East of Catalunan Grande Rd.)	14,344	11,914	2,430	20%
8	Bolton Bridge	32,821	29,063	3,758	13%
9	Bankerohan Bridge	59,724	59,635	89	0%
10	CP Garcia (East of Ma-a Rd.)	19,569	22,567	-2,998	-13%
11	Dacudao Ave. (Bet. CP Garcia and JP Laurel)	31,121	39,389	-8,268	-21%
12	Cabantian Rd. (North of CP Garcia)	12,433	10,732	1,701	16%
13	CP Garcia (West of Pan Philippine Highway)	19,847	22,073	-2,226	-10%
14	Pan Philippine Highway (South of CP Garcia))	17,683	12,417	5,266	42%
15	Pan Philippine Highway (Tibungco)	17,293	19,146	-1,853	-10%
Total		**338,448**	**347,789**	**-9,341**	**-3%**

Source: JICA Study Team



Source: JICA Study Team

FIGURE 6.2-14 COMPARED OBSERVED AND ASSIGNED TRAFFIC VOLUME

6.2.6 Traffic Assignment Result

Traffic assignment case is shown below;

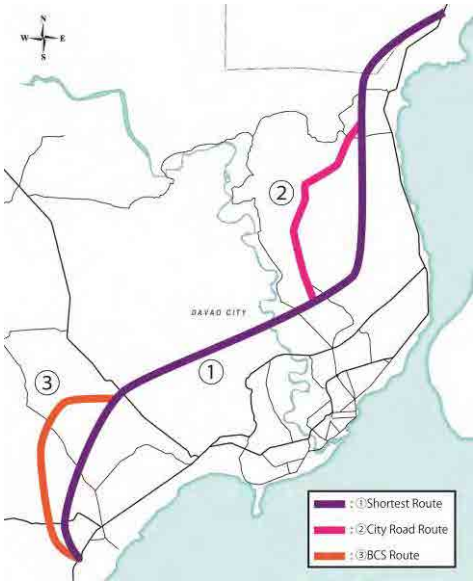
1. Alternative Route of Alignment: 4 cases (Base on Year 2013)
2. Alternative Route of Tunnel Section: 4 cases (Base on Year 2013)
3. Davao Bypass Construction Case: Year 2018, Year 2023, Year 2033

(1) Alternative Routes of Alignment

In order to come up with the most optimum route alignment, the team conducted several alternative studies as discussed in Chapter 9.

Several Cases were run-through and evaluated. Alternative routes of alignment case is shown below and in **Figure 6.2-15**.

- Case-1: Shortest Route (No.1)
- Case-2: Shortest Route and City Road Route (No1 and No.2)
- Case-3: Shortest Route and BCS Route (No.1 and No. 3)
- Case-4: City Road Route and BCS Route (No. 2 and No.3,)



Source: JICA Study Team

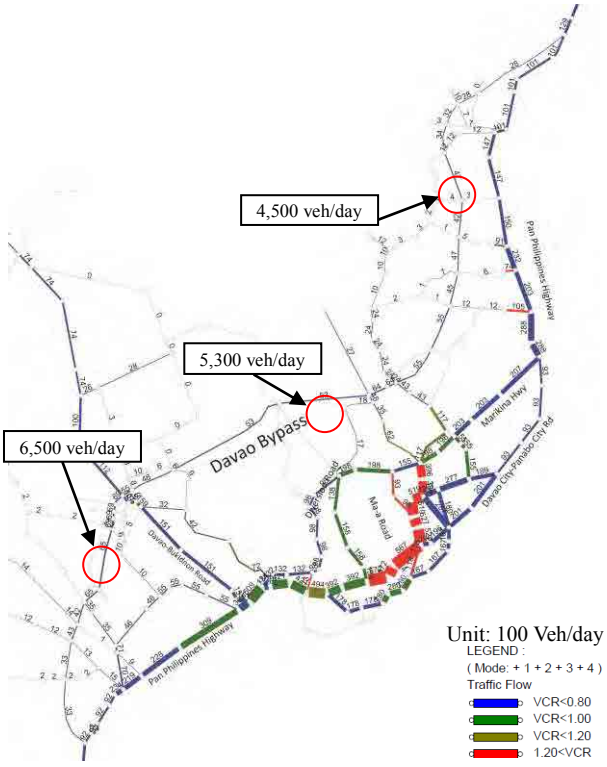
FIGURE 6.2-15 ALTERNATIVE ROUTE

These cases were estimated using JICA STRADA as shown in **Figure 6.2-16**. The traffic indicators such as total vehicle-time (veh*hour/day), total vehicle-km (veh*km/day) and average speed are calculated within each cases comparing with a Do Nothing Case. As a result of comparing these cases, case-1 is with the most saved total vehicle-time and average speed, and case-3 is with the most saved total vehicle-km. However, traffic volume which is shifted from ordinary road is higher for alternative-1 than case-2. Totally, case-1 is a contributory route for Davao City.

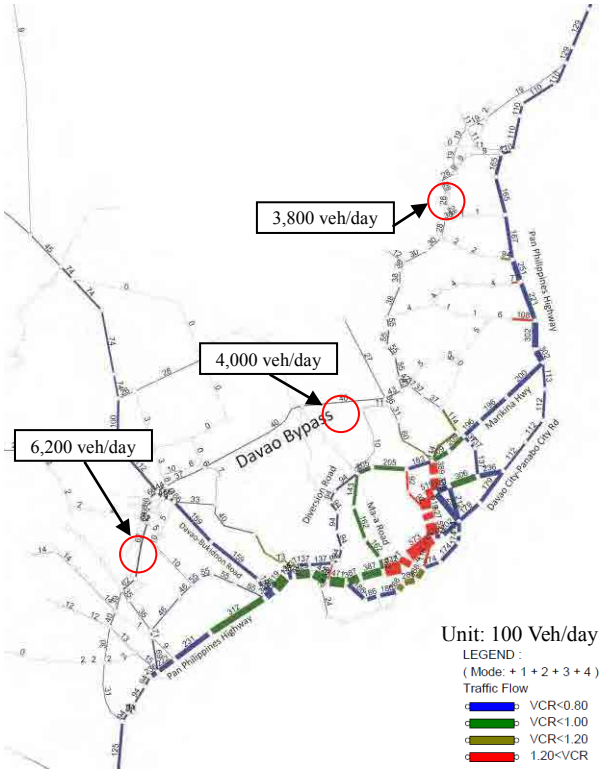
TABLE 6.2-11 TRAFFIC INDICATOR OF WITH DAVAO BYPASS AND DO-NOTHING CASE ON YEAR 2013

Traffic Indicators		Case-1	Case-2	Case-3	Case-4
Total Vehicle Time (veh*hr/day)	With (W)	143,228	144,488	144,610	146,248
	Without (WO)	149,813	149,813	149,813	149,813
	Difference (WO-W)	6,585	5,325	5,203	3,565
Total Vehicle Km (veh*km/day)	With (W)	4,339,010	4,344,891	4,330,059	4,341,441
	Without (WO)	4,351,359	4,351,359	4,351,359	4,351,359
	Difference (WO-W)	12,349	6,468	21,300	9,918
Average Speed (km/h)	With (W)	30.3	30.1	30.0	29.8
	Without (WO)	29.0	29.0	29.0	29.0
	Difference (WO-W)	-1.3	-1.1	-1.0	-0.8
Average Traffic Volume (veh /day)	North Section	4,271	3,851	3,146	2,688
	Tunnel Section	5,321	4,012	4,606	3,485
	South Section	4,986	4,541	2,676	2,359

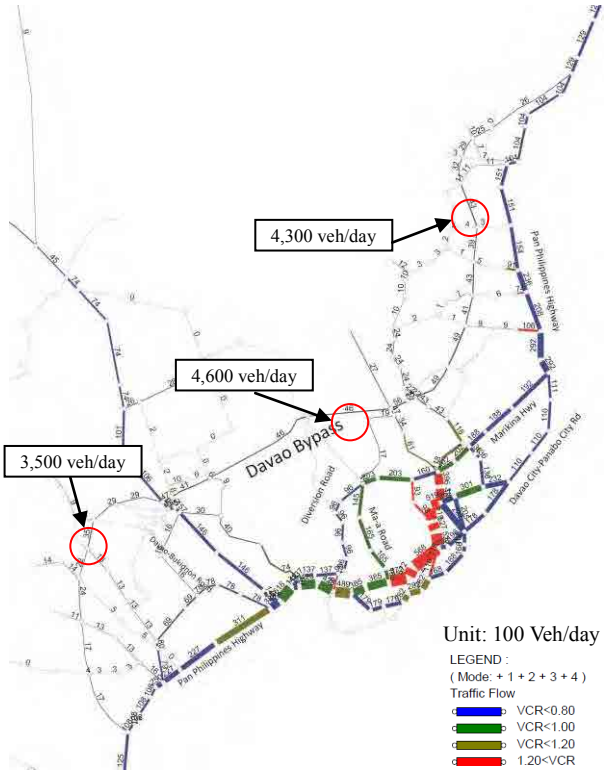
Source: JICA Study Team



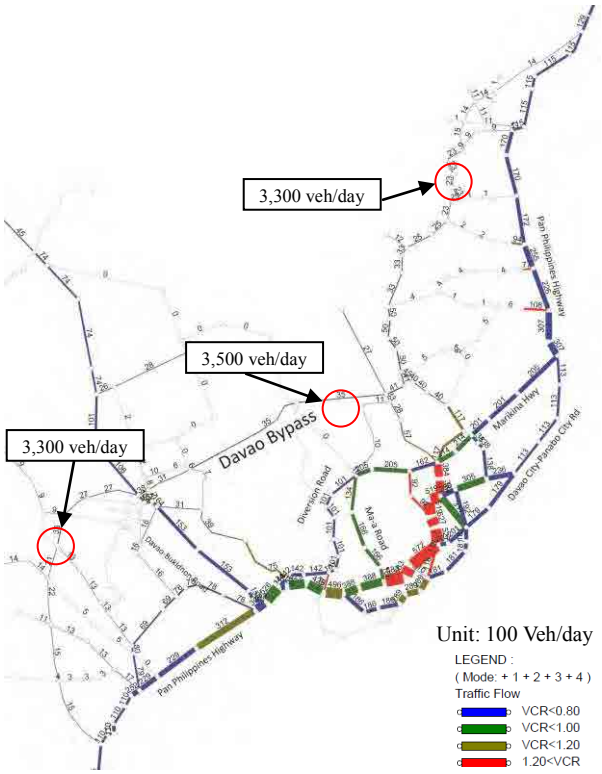
Case-1



Case-2



Case-3



Case-4

Source: JICA Study Team

FIGURE 6.2-16 RESULT OF ALL ALTERNATIVE TRAFFIC VOLUME ON ALIGNMENTS BASE YEAR 2013

TABLE 6.2-12 ALTERNATIVE ROUTE FOR EACH CASE

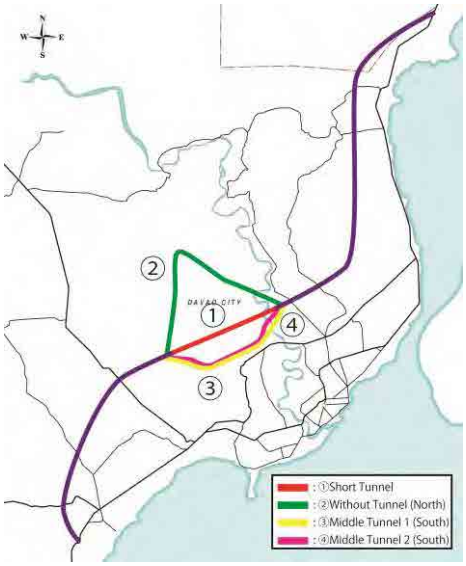
	Alternative Route (see Figure 9.6-6)		
	North Section	Center Section	South Section
Case-1	N-2A N-2B	Alignment 3 ~ 6	S-2A S-2B
Case-2	N-3	Alignment 3 ~ 6	S-2A S-2B
Case-3	N-2A N-2B	Alignment 3 ~ 6	S-1
Case-4	N-3	Alignment 3 ~ 6	S-1

(2) Alternative Routes of Tunnel Section

Alternative routes of tunnel section case is shown below and in **Figure 6.2-17**.

As forecasted, the traffic volume was estimated by using JICA STRADA, Case-1 is 5,321 veh/day, Case-2 is 1,619 veh/day, Case-3 is 3,490 veh/day, Case-4 is 3,623 veh/day. Case-1 is with the highest volume of all cases.

And, comparing all these cases regarding traffic indicators, Case-1 is with the most saved total vehicle-time, total vehicle-km and average speed. Therefore, Case-1 is the recommended main route for the future network.



Source: JICA Study Team

FIGURE 6.2-17 TUNNEL ROUTE

TABLE 6.2-13 TRAFFIC INDICATOR OF WITH DAVAO BYPASS AND DO-NOTHING CASE ON YEAR 2013

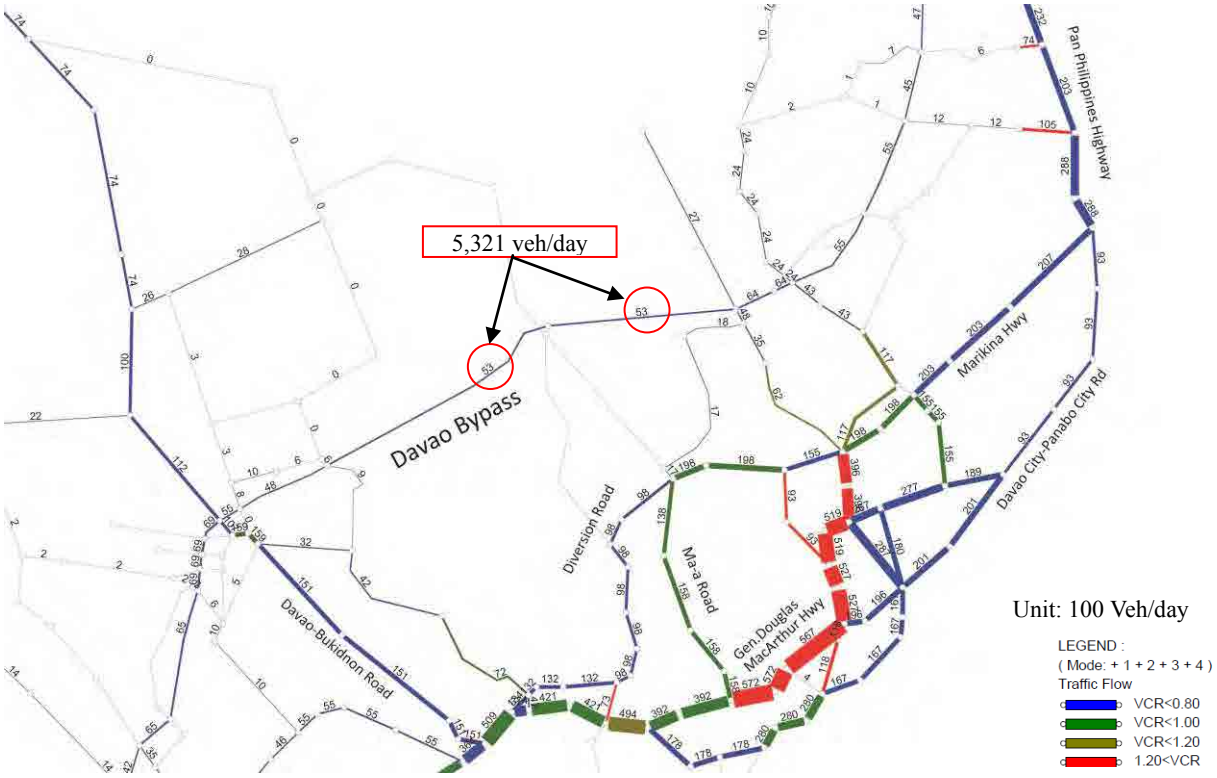
Traffic Indicators		Case-1	Case-2	Case-3	Case-4
Total Vehicle Time (veh*hr/day)	With (W)	143,228	146,619	144,383	144,254
	Without (WO)	149,813	149,813	149,813	149,813
	Difference (WO-W)	6,585	3,194	5,430	5,559
Total Vehicle Km (veh*km/day)	With (W)	4,339,010	4,388,330	4,357,271	4,354,971
	Without (WO)	4,351,359	4,351,359	4,351,359	4,351,359
	Difference (WO-W)	12,349	-36,971	-5,912	-3,612
Average Speed (km/h)	With (W)	30.3	29.9	30.2	30.2
	Without (WO)	29.0	29.0	29.0	29.0
	Difference (WO-W)	-1.3	-0.9	-1.2	-1.2
Average Traffic Volume (veh/day)		5,321	1,619	3,490	3,623

Source: JICA Study Team

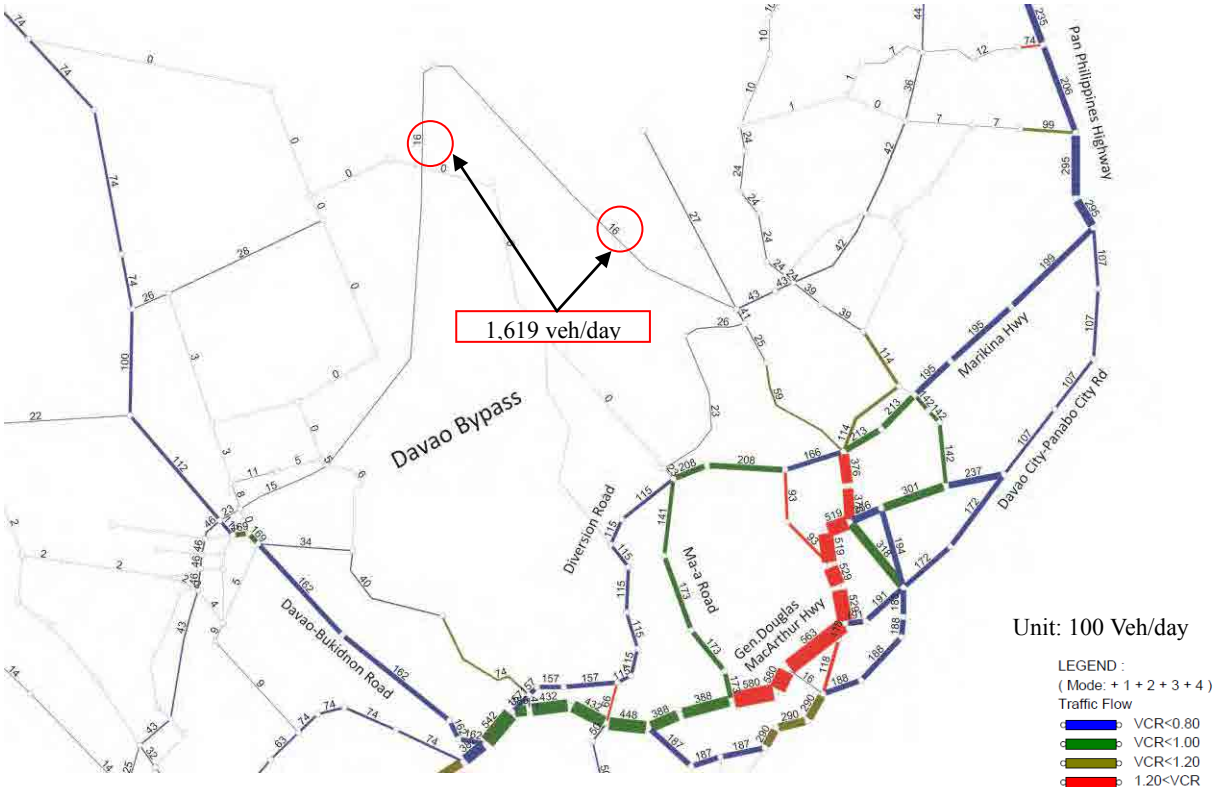
TABLE 6.2-14 ALTERNATIVE ROUTE FOR TUNNEL SECTION

	Route	Alternative for Center Section (see **Figure 9.6-4**)
Case-1	Shortest Route , l = 9.80km (Tunnel length 2.20 ~ 2.90 km)	Alignment 3~6
Case-2	Route which does not require a tunnel, l = 18.60 km	Alignment 7
Case-3	Reduce tunnel length, l = 12.0 km (Tunnel length 1.45km)	Alignment 1
Case-4	Reduce tunnel length, l = 11.4 km (Tunnel length 1.60km)	Alignment 2

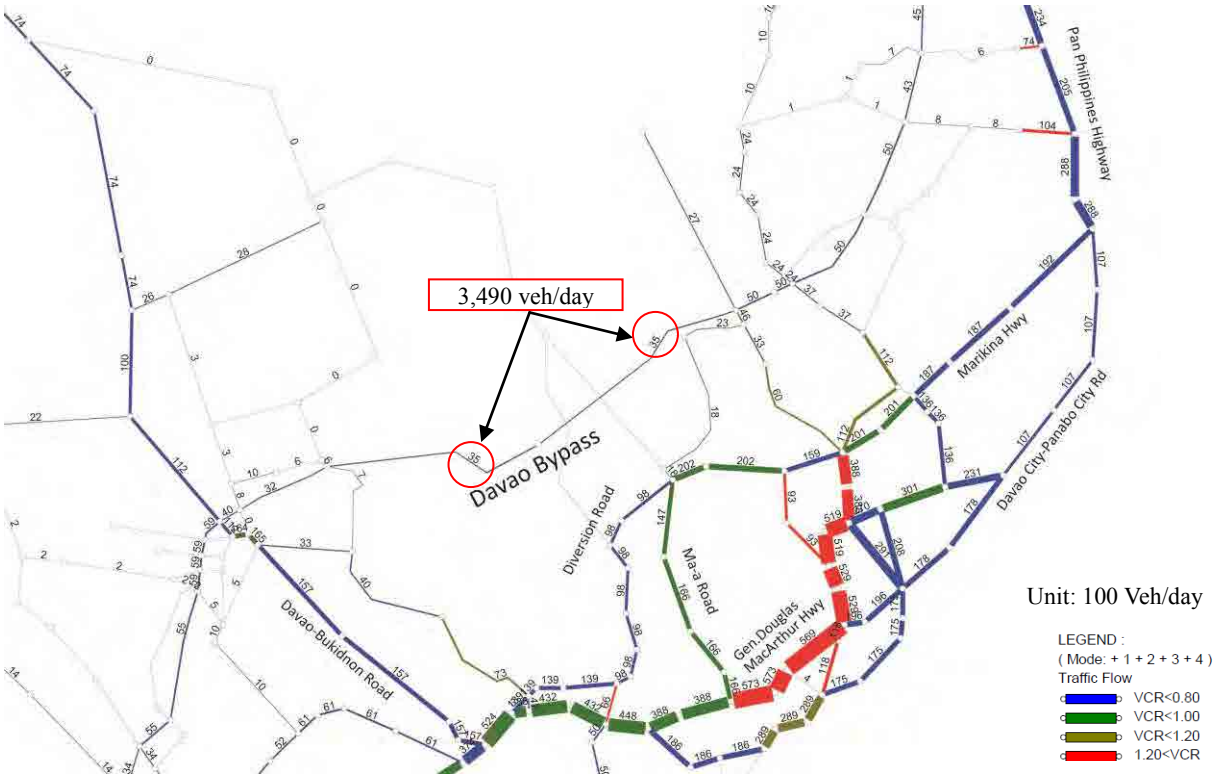
Source: JICA Study Team


5,321 veh/day
Davao Bypass
Diversion Road
Ma-a Road
Gen.Douglas MacArthur Hwy
Davao-Bukidnon Road
Marikina Hwy
Davao City-Panabo City Rd
Pan Philippines Highway
Unit: 100 Veh/day
LEGEND :
(Mode: + 1 + 2 + 3 + 4)
Traffic Flow
VCR<0.80
VCR<1.00
VCR<1.20
1.20<VCR

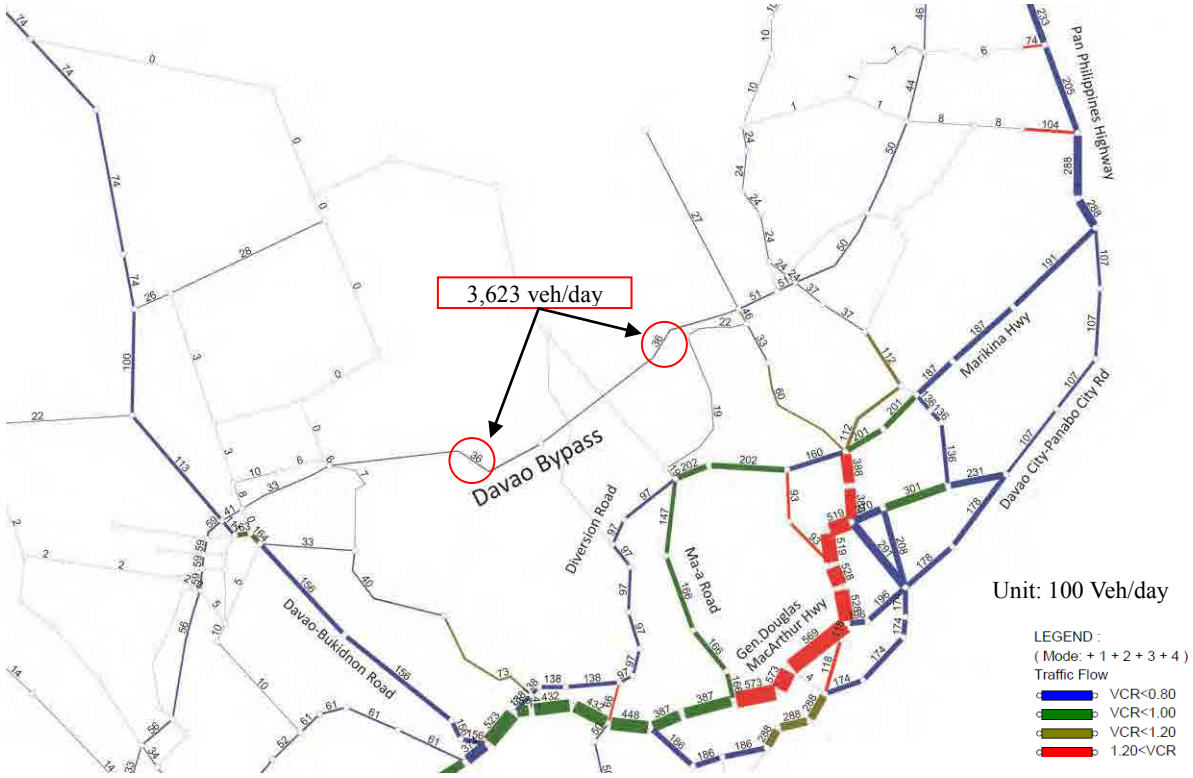
Case-1


1,619 veh/day
Davao Bypass
Diversion Road
Ma-a Road
Gen.Douglas MacArthur Hwy
Davao-Bukidnon Road
Marikina Hwy
Davao City-Panabo City Rd
Pan Philippines Highway
Unit: 100 Veh/day
LEGEND :
(Mode: + 1 + 2 + 3 + 4)
Traffic Flow
VCR<0.80
VCR<1.00
VCR<1.20
1.20<VCR

Case-2



Case-3



Case-4

Source: JICA Study Team

FIGURE 6.2-18 RESULT OF ALL ALTERNATIVE TRAFFIC VOLUME ON TUNNEL SECTION BASE YEAR 2013

(3) Davao Bypass Construction Case: Year 2018, Year 2023, Year 2033

The future traffic demand was estimated based on the results of alternative alignment and tunnel section as shown in **Figure 6.2-19** to **Figure 6.2-21.** Traffic indicators were calculated in years

2018, 2023 and 2033 as shown in **Table 6.2-15.**

- Total vehicle time saved in each year are 13,829 veh*hr/day, 18,617 veh*hr/day, 22,622 veh*hr/day respectively.

- Total vehicle-km saved in each year are 12,349 veh*km/day, -55,980 veh*km/day, -110,222 veh*km/day. This decreasing phenomenon in year 2023 and year 2033 are affected by the traffic congestion in central area of Davao City.

TABLE 6.2-15 TRAFFIC INDICATOR OF WITH DAVAO BYPASS DO-NOTHING CASE ON YEAR 2018, 2023, 2033

Traffic Indicators		Year 2018	Year 2023	Year 2033
Total Vehicle Time (veh*hr/day)	With (W)	184,350	216,682	297,710
	Without (WO)	198,179	235,299	320,332
	Difference (WO-W)	13,829	18,617	22,622
Total Vehicle Km (veh*km/day)	With (W)	5,247,059	5,896,668	7,210,408
	Without (WO)	5,259,435	5,840,688	7,100,186
	Difference (WO-W)	12,376	-55,980	-110,222
Average Speed (km/h)	With (W)	28.5	27.2	24.2
	Without (WO)	26.5	24.8	22.2
	Difference (WO-W)	-2.0	-2.4	-2.0

Source: JICA Study Team

TABLE 6.2-16 (1) ESTIMATED TRAFFIC AT NORTH SECTION

Year	2018		2023		2033	
	Veh/day	(%)	Veh/day	(%)	Veh/day	(%)
Car	4,162	-	4,726	2.6%	5,544	1.6%
Jeepney	1,117	-	1,539	6.6%	1,783	1.5%
Bus	413	-	534	5.3%	465	-1.4%
Truck	2,299	-	2,539	2.0%	3,126	2.1%
Total	7,991	-	9,338	3.2%	10,917	1.6%

Source: JICA Study Team

TABLE 6.2-16 (2) ESTIMATED TRAFFIC AT CENTER SECTION

Year	2018		2023		2023	
	Count	(%)	Count	(%)	Count	(%)
Car	4,054	-	5,374	5.8%	6,090	1.3%
Jeepney	1,089	-	1,771	10.2%	1,845	0.4%
Bus	29	-	151	39.0%	55	-9.7%
Truck	2,711	-	3,321	4.1%	3,968	1.8%
Total	7,884	-	10,616	6.1%	11,957	1.2%

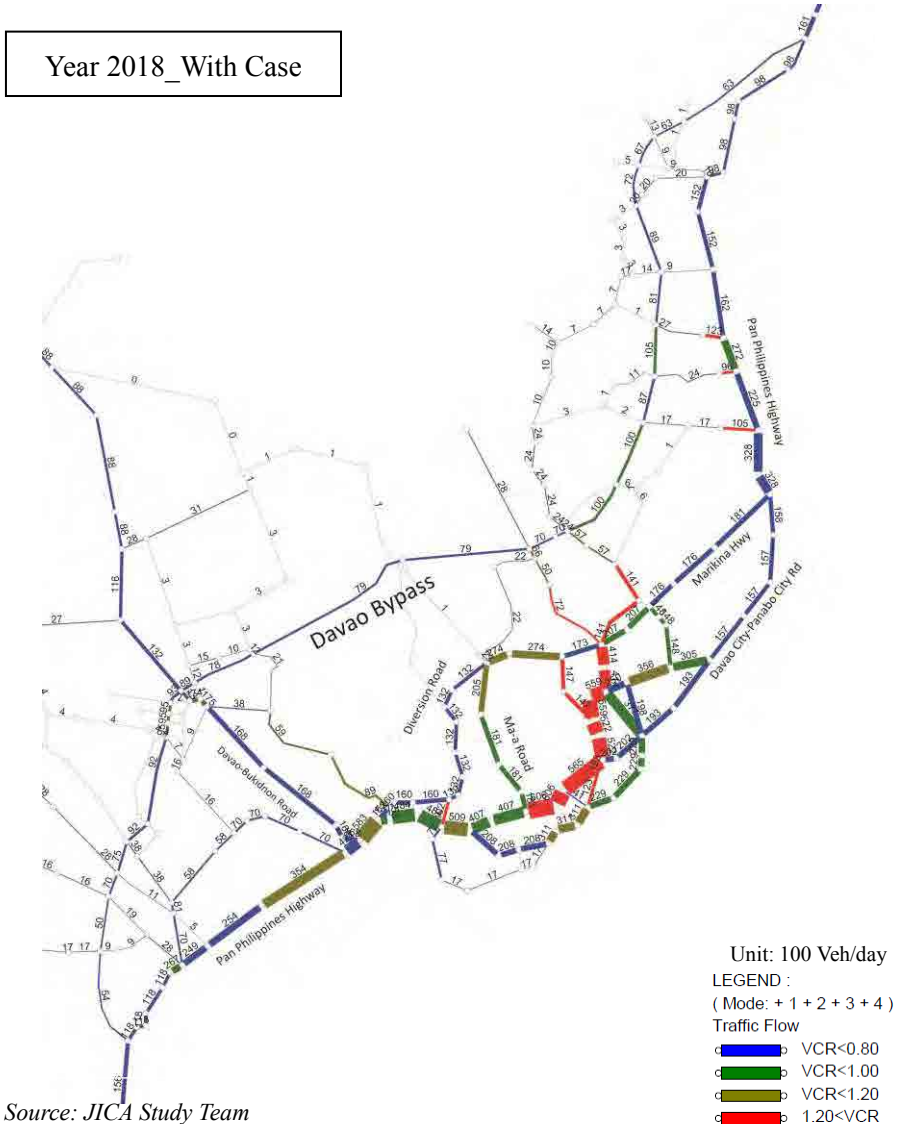
Source: JICA Study Team

TABLE 6.2-16 (3) ESTIMATED TRAFFIC AT SOUTH SECTION

Year	2018		2023		2033	
Car	4,252	-	5,497	5.3%	6,868	2.3%
Jeepney	851	-	1,247	7.9%	1,582	2.4%
Bus	135	-	215	9.7%	254	1.7%
Truck	2,287	-	2,867	4.6%	3,554	2.2%
Total	7,524	-	9,825	5.5%	12,258	2.2%

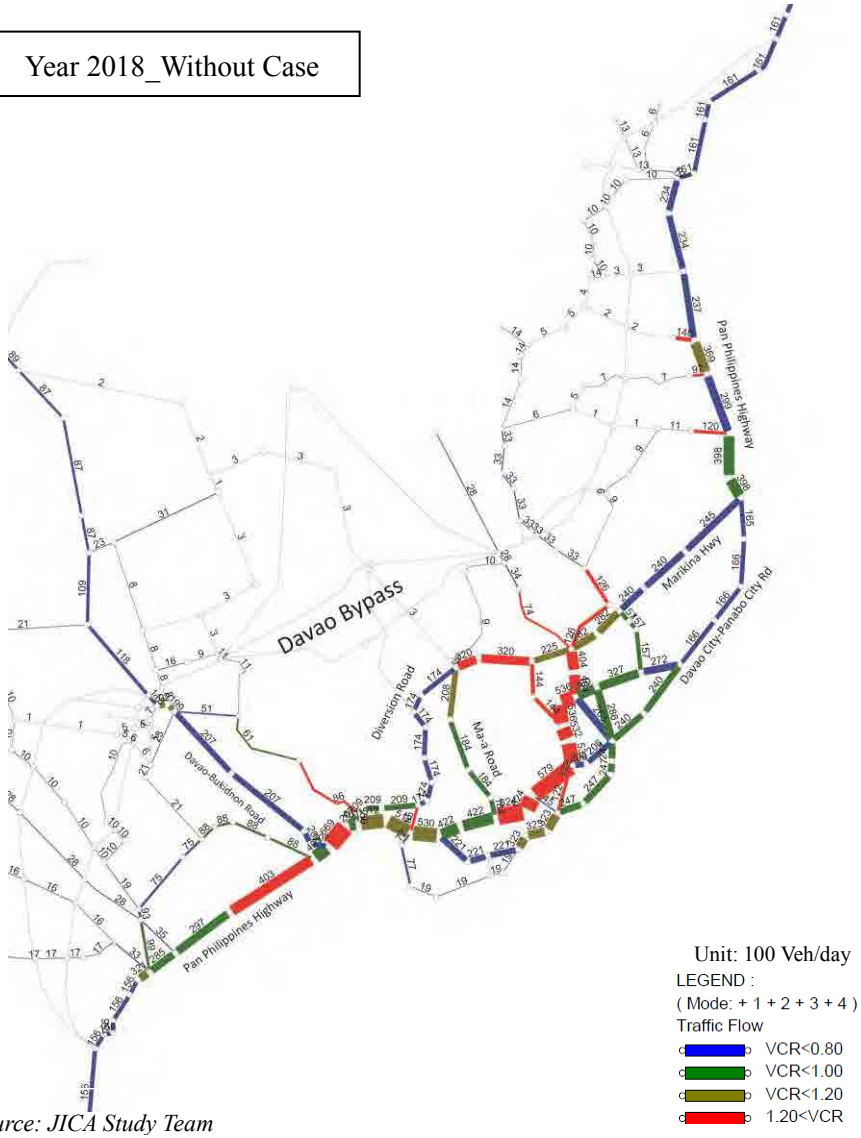
Source: JICA Study Team

Year 2018_With Case



Source: JICA Study Team

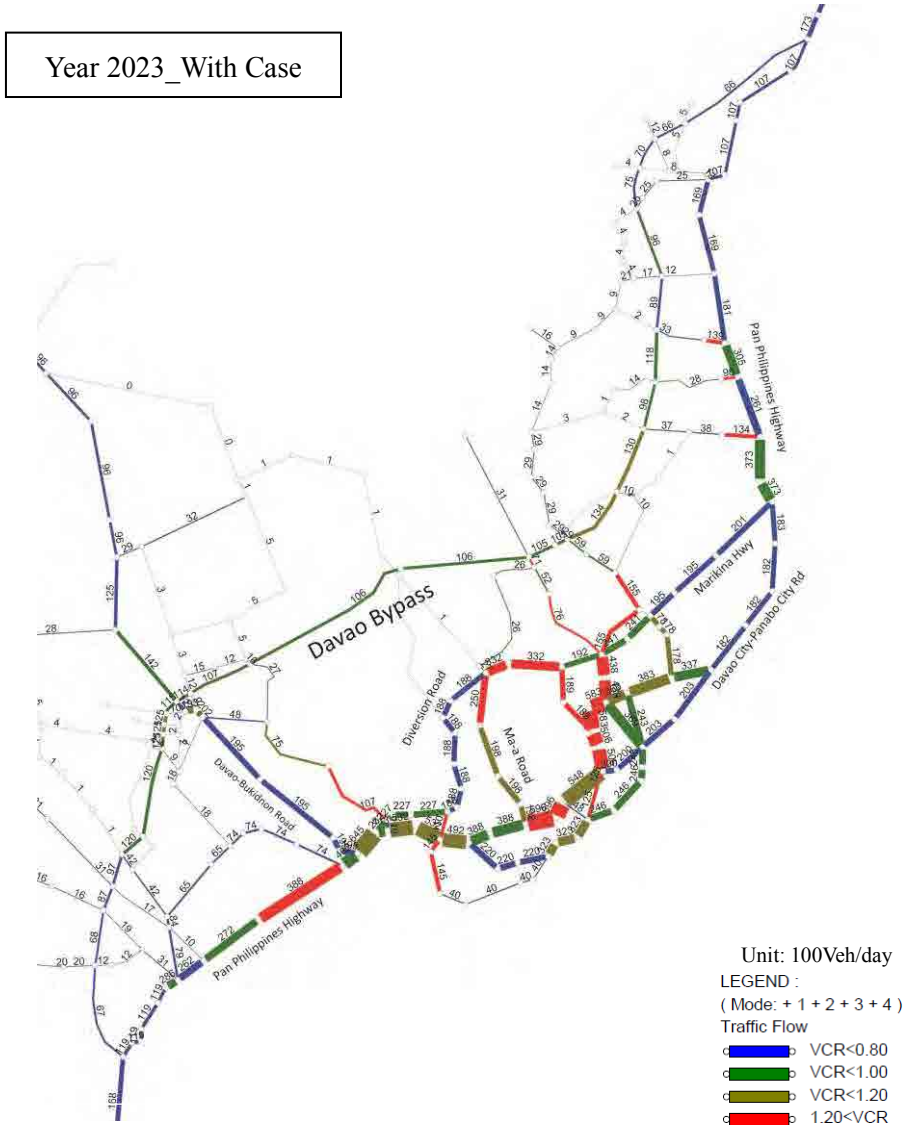
Year 2018_Without Case



Source: JICA Study Team

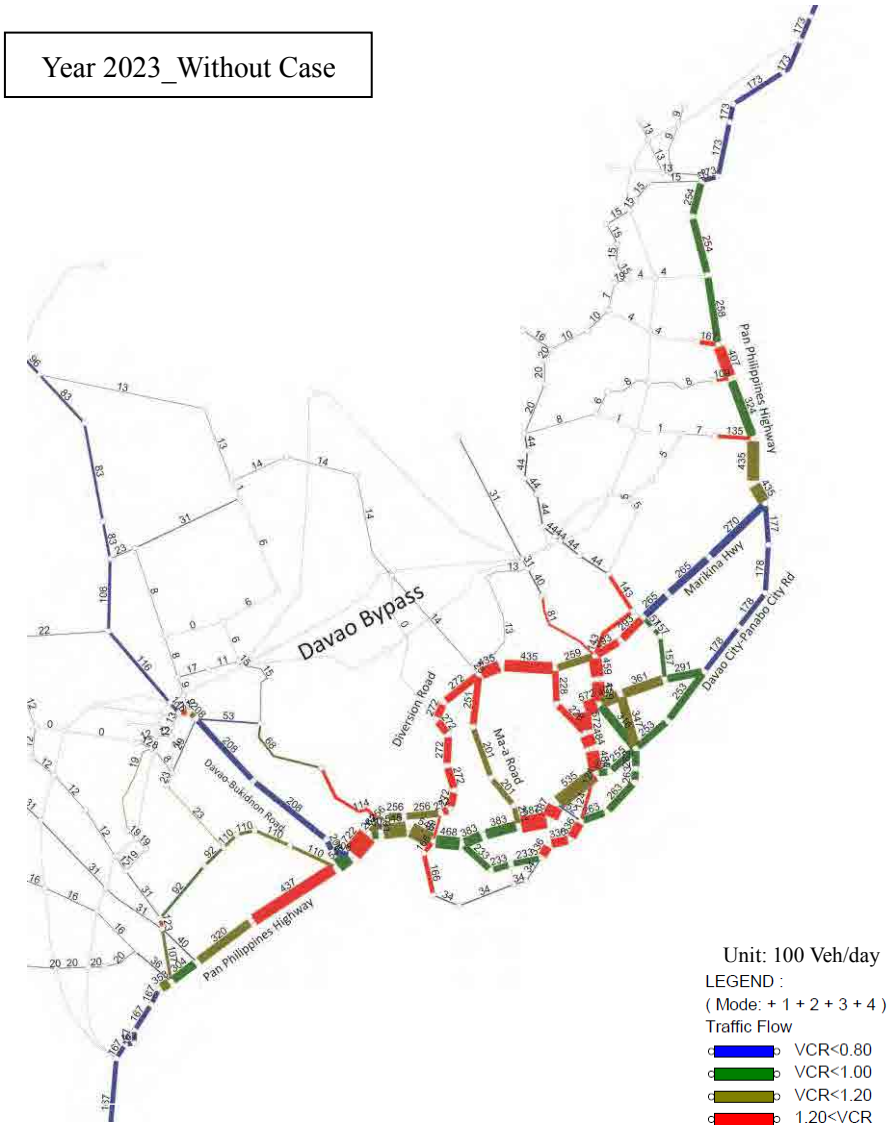
FIGURE 6.2-19 RESULT OF TRAFFIC ASSIGNMENT IN YEAR 2018

Year 2023_With Case



Source: JICA Study Team

Year 2023_Without Case

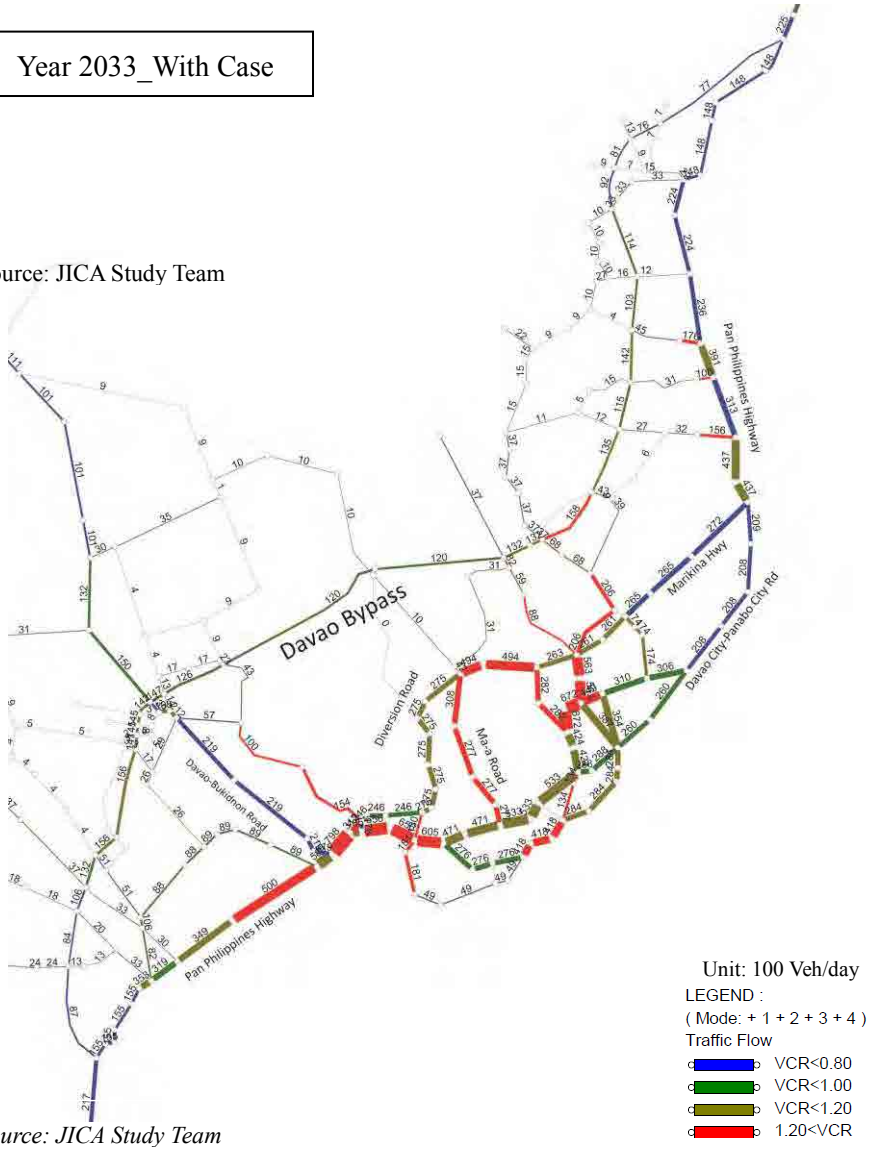


Source: JICA Study Team

FIGURE 6.2-20 RESULT OF TRAFFIC ASSIGNMENT IN YEAR 2023

Year 2033_With Case

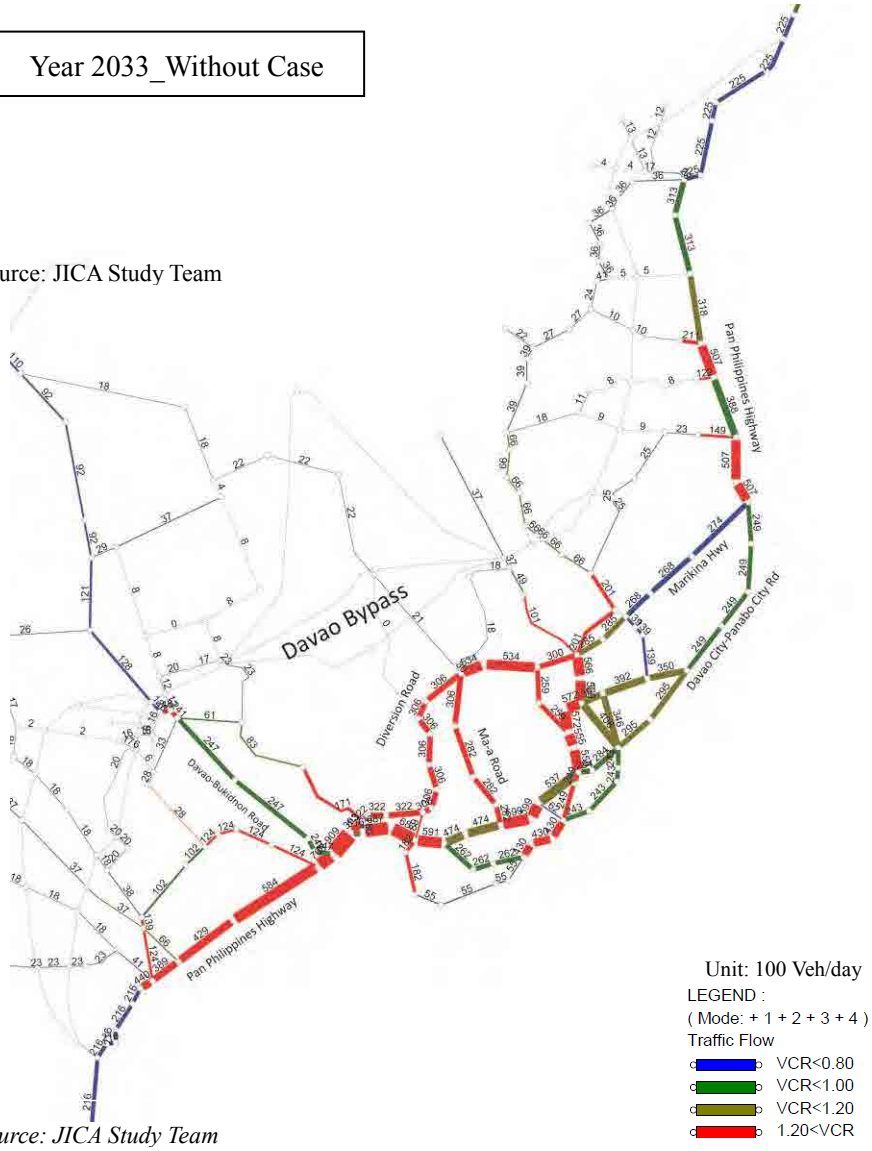
Source: JICA Study Team



Source: JICA Study Team

Year 2033_Without Case

Source: JICA Study Team



Source: JICA Study Team

FIGURE 6.2-21 RESULT OF TRAFFIC ASSIGNMENT IN YEAR 2033

6.2.7 Level of Service (LOS) Analysis

Definition of Level of Service (LOS) by the Highway Capacity Manual (HCM) 2000 of USA for a 2-lane highway is shown in **Table 6.2-17**.

TABLE 6.2-17 DEFINITION OF LOS FOR A TWO-LANE HIGHWAY

LOS A	The highest quality of traffic service, when motorists are able to travel at their desired speed. Without strict enforcement, this highest quality would result in average speeds of 90 km/h or more on two-lane highways.
LOS B	Traffic flow with speeds of 80 km/h or slightly higher on level-terrain Class I highways. The demand for passing to maintain desired speeds becomes significant and approximates the passing capacity at the lower boundary of LOS B.
LOS C	Further increases in flow, resulting in noticeable increases in platoon formation, platoon size, and frequency of passing impediments. The average speed still exceeds 70 km/h on level-terrain
LOS D	Unstable traffic flow. The two opposing traffic streams begin to operate separately at higher volume levels, as passing becomes extremely difficult. speeds of 60 km/h still can be maintained under base conditions
LOS E	Even under base conditions, speeds may drop below 60 km/h. Average travel speeds on highways with less than base conditions will be slower, even down to 40 km/h on sustained upgrades. the capacity of the highway, Generally 3,200 pc/h total in both directions. Operating conditions at capacity are unstable and difficult to predict.
LOS F	Heavily congested flow with traffic demand exceeding capacity. Volumes are lower than capacity and speeds are highly variable.

Source: HCM 2000

Appropriate Level of Service by AASHTO

A Policy on Geometric Design of Highways and Streets, 2011 (AASHTO) suggests the appropriate level of service for each functional class of road as follows;

TABLE 6.2-18 GUIDELINES FOR SELECTION OF DESIGN LEVEL OF SERVICE

Functional class	Appropriate level of service for specified combinations of area and terrain type			
	Rural level	Rural rolling	Rural mountainous	Urban and suburban
Freeway	B	B	C	C or D
Arterial	B	B	C	C or D
Collector	C	C	D	D
Local	D	D	D	D

Source: A Policy on Geometric Design of Highways and Streets, 2004, AASHTO

According to the above guidelines, recommended for a Bypass road are that of LOS "B" or "C", however, the guidelines seems to be aiming quite high LOS. LOS may be lowered by one rank, say from "C or D" to "D or E".

Service Traffic Volume of a Two-lane Bypass

In accordance with the HCM formula, the service traffic volume was estimated at 3 sections as shown in **Table 6.2-20** to **Table 6.2-22.** And, service volume for LOS is shown in **Table 6.2-19.** These were prepared in consideration with traffic situations (directional split, peak hour factor etc). The LOS of the Davao Bypass at the opening year will be "D", and it will be "E" in year 2029. The widening to a 4-lane bypass plan should be considered when LOS reaches "E".

TABLE 6.2-19 SERVICE TRAFFIC VOLUME OF TWO-LANE BYPASS

LOS	Service volume for LOS	
	Veh/Hour (both directions)	Veh/Day (both directions)
A	Less than 70	Less than 875
B	Less than 180	Less than 2,250
C	Less than 460	Less than 5,750
D	Less than 910	Less than 11,375
E	Less than 1,360	Less than 16,875
F	Over 1,360	Over 16,875

Consultant's estimate based on Highway Capacity Manual 2000 (HCM2000)
Note: Assumptions: Rural Area, 34 percent truck and bus; 14 percent Jeepney; free flow speed; 60km/hr.

TABLE 6.2-20 ESTIMATED TRAFFIC VOLUME (NORTH SECTION)

Year	Daily Traffic Assignment (veh./day)	Peak Hour Traffic Volume (veh./hour)	LOS	Volume/Capacity Ratio
	(a)	(b = a * 0.08)		
2018	7,991	639	D	0.47
2019	8,244	659		0.49
2020	8,505	680		0.50
2021	8,774	702		0.52
2022	9,052	724		0.54
2023	9,338	747		0.55
2024	9,485	759		0.56
2025	9,634	771		0.57
2026	9,786	783		0.58
2027	9,940	795		0.59
2028	10,097	808		0.70
2029	10,255	820		0.71
2030	10,417	833		0.72
2031	10,581	846		0.74
2032	10,747	860		0.75
2033	10,917	873		0.76
2034	11,190	895		0.78
2035	11,469	918	E	0.80
2036	11,756	940		0.82
2037	12,050	964		0.84
2038	12,351	988		0.86

Source: JICA Study Team

TABLE 6.2-21 ESTIMATED TRAFFIC VOLUME (CENTER SECTION)

Year	Daily Traffic Assignment (veh./day)	Peak Hour Traffic Volume (veh./hour)	LOS	Volume/Capacity Ratio
	(a)	(b = a * 0.08)		
2018	7,884	631	D	0.47
2019	8,367	669		0.50
2020	8,880	710		0.53
2021	9,425	754		0.56
2022	10,003	800		0.59
2023	10,616	849		0.63
2024	10,743	859		0.64
2025	10,872	870		0.64
2026	11,002	880		0.65
2027	11,134	891		0.66
2028	11,267	901		0.78
2029	11,402	912	E	0.79
2030	11,538	923		0.80
2031	11,676	934		0.81
2032	11,816	945		0.82
2033	11,957	957		0.83
2034	12,256	980		0.85
2035	12,563	1,005		0.87
2036	12,877	1,030		0.90
2037	13,199	1,056		0.92
2038	13,528	1,082		0.94

Source: JICA Study Team

TABLE 6.2-22 ESTIMATED TRAFFIC VOLUME (SOUTH SECTION)

Year	Daily Traffic Assignment (veh./day)	Peak Hour Traffic Volume (veh./hour)	LOS	Volume/Capacity Ratio
	(a)	(b = a * 0.08)		
2018	7,524	602	D	0.45
2019	7,937	635		0.47
2020	8,372	670		0.50
2021	8,831	706		0.52
2022	9,315	745		0.55
2023	9,825	786		0.58
2024	10,045	804		0.60
2025	10,270	822		0.61
2026	10,499	840		0.62
2027	10,734	859		0.64
2028	10,974	878		0.76
2029	11,220	898		0.78
2030	11,471	918	E	0.80
2031	11,727	938		0.82
2032	11,990	959		0.83
2033	12,258	981		0.85
2034	12,564	1,005		0.87
2035	12,878	1,030		0.90
2036	13,200	1,056		0.92
2037	13,530	1,082		0.94
2038	13,869	1,109		0.96

Source: JICA Study Team

6.2.8 Effect of Toll for Tunnel Section

(1) General

Since operation for tunnel section requires much electricity for lighting, jet fans and other facilities during the 24-hour, operation cost of the tunnel section will be much higher than that of the roadway section.

To solve the above issue, one option is to collect toll for covering the tunnel section's operation and maintenance cost.

This section describes the traffic study of toll for tunnel section.

(2) Time Evaluation Value

An important input for the demand forecast of toll road is the trip maker's time value. This time value is the basis for a trip maker to decide whether to use toll road or not. The time values were derived from MMUEN (JICA, The Development of the Public-Private Partnership Technique from the Metro Manila Urban Expressway Network) survey results. Though MMUEN data is based on the Metro Manila and surrounding area, Time Evaluation Value in Region XI is lower than that of MMUEN. Based on the rate of GRDP per capita (GRDP per capita of Region XI/that of NCR and Region XI = 91,312 pesos / 282,199 pesos = 0.320), Time Evaluation Value in Region XI was set.

Supposing time value in the future will increase in accordance with inflation rate of 5.5% per year, the figures in **Table 6.2-23** will be the time value.

TABLE 6.2-23 TIME EVALUATION VALUE BY VEHICLE TYPE

Unit: Peso/hour

Area	MMUEN (Metro Manila and Surrounding Areas)		Region XI (Study Area)	
Year	2009	2013	2013	2018
		(a)	*(b = a x 0.320)*	*(c = b x 1.055^5)*
Car	331	429	137	179
Jeepney	465	600	192	251
Bus	1,524	2,000	640	836
Truck	873	1,200	384	502

Source: JICA Study Team

(3) Case Study

The traffic assignment of the following case was conducted to estimate the number of vehicles and revenues.

TABLE 6.2-24 TOLL FEE SETTING

(Peso)

	Class 1 (Car, Jeepney, Pick-up)	Class 2 (Light Truck)	Class 3 (Heavy Truck, Trailer)
Case-0	Free	Free	Free
Case-1	5	10	15
Case-2	10	20	30
Case-3	20	40	60
Case-4	30	60	90
Case-5	40	80	120
Case-6	50	100	150

Source: JICA Study Team

(4) Toll Rate vs. Revenue

The traffic volume at the tunnel section and the amount of revenue are estimated by the traffic assignment model. **Figure 6.2-22** shows the result of traffic assignment of toll rate in year 2018.

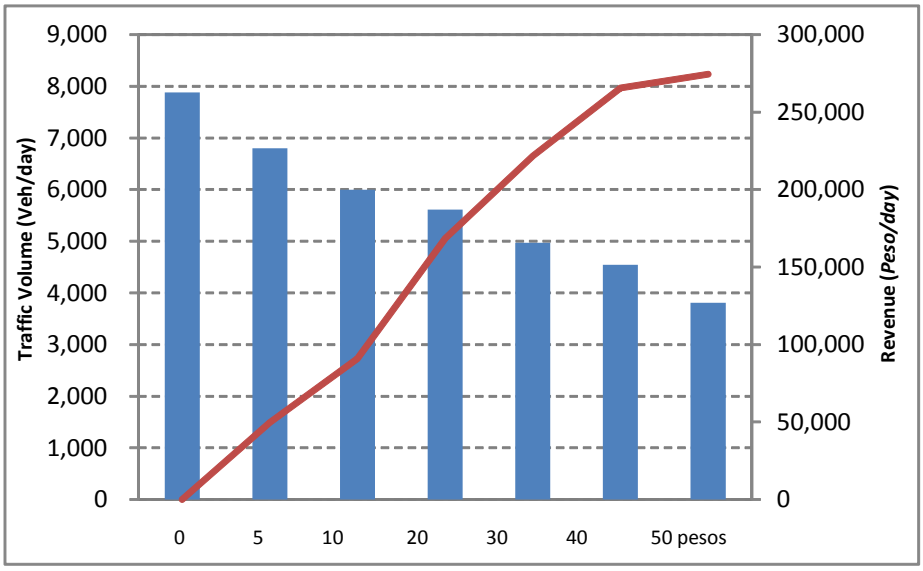
- In case of toll free, traffic volume of tunnel section is 7,883 vehicles/day.
- The objective of toll collection is to acquire the O & M Cost for tunnel section. Though O & M cost for tunnel section is described in Chapter 14, 20 or 30 pesos for Class I will be required to collect toll for tunnel O & M.

TABLE 6.2-25 ESTIMATED TRAFFIC VOLUME

Unit: Pesos

	Traffic Volume (vehicle/day)				Revenue (day)	Revenue (Year)
	Class1	Class2	Class3	Total		
Case 0 (Free)	5,143	2,285	455	7,883	0	0
Case 1 (5Php)	4,103	2,251	447	6,801	49,732	18,152,123
Case 2 (10Php)	3,344	2,216	436	5,996	90,840	33,156,478
Case 3 (20Php)	3,207	2,006	402	5,615	168,502	61,503,196
Case 4 (30Php)	2,892	1,728	347	4,967	221,673	80,910,606
Case 5 (40Php)	2,747	1,495	300	4,542	265,486	96,902,335
Case 6 (50Php)	2,360	1,209	237	3,806	274,463	100,179,112

Source: JICA Study Team



Source: JICA Study Team

FIGURE 6.2-22 TOLL RATE VS. REVENUE (YEAR 2018)

(5) Service Traffic Volume considering toll collected at tunnel

If toll is collected at tunnel section, traffic volume of bypass will decrease. **Table 6.2-26** and **Table 6.2-27** show the service traffic volume at south and center section in case of toll collection.

Assumption: Toll rate, 33 peso/vehicle for class-1 in year 2021(based on 30 peso in year 2018)
Toll rate adjustment, 8% / Every 2 years

TABLE 6.2-26 ESTIMATED TRAFFIC VOLUME, CENTER SECTION (CASE: TOLL COLLECTED AT TUNNEL)

Year	Daily Traffic Assignment (Veh./day)	Peak Hour Traffic Volume (Veh./hour)	LOS	VCR
2018	4,967	397	C	0.29
2019	5,272	422		0.31
2020	5,595	448		0.33
2021	5,938	475	D	0.35
2022	6,302	504		0.37
2023	6,689	535		0.40
2024	6,886	551		0.41
2025	7,088	567		0.42
2026	7,297	584		0.43
2027	7,511	601		0.45
2028	7,732	619		0.54
2029	7,960	637		0.55
2030	8,194	655		0.57
2031	8,435	675		0.59
2032	8,683	695		0.60
2033	8,938	715		0.62
2034	9,197	736		0.64
2035	9,464	757		0.66
2036	9,738	779		0.68
2037	10,021	802		0.70
2038	10,311	825		0.72

*Note: LOS: Level of Service (see **Table 6.2-19**)*

TABLE 6.2-27 ESTIMATED TRAFFIC VOLUME, SOUTH SECTION (CASE: TOLL COLLECTED AT TUNNEL))

Year	Daily Traffic Assignment (Veh./day)	Peak Hour Traffic Volume (Veh./hour)	LOS	VCR
2018	5,643	451	C	0.33
2019	5,952	476	D	0.35
2020	6,279	502		0.37
2021	6,623	530		0.39
2022	6,986	559		0.41
2023	7,369	590		0.44
2024	7,583	607		0.45
2025	7,802	624		0.46
2026	8,028	642		0.48
2027	8,261	661		0.49
2028	8,501	680		0.59
2029	8,747	700		0.61
2030	9,001	720		0.63
2031	9,261	741		0.64
2032	9,530	762		0.66
2033	9,806	784		0.68
2034	10,090	807		0.70
2035	10,383	831		0.72
2036	10,684	855		0.74
2037	10,994	880		0.76
2038	11,313	905		0.79

*Note: LOS: Level of Service (see **Table 6.2-19**)*

CHAPTER 7

NECESSITY OF THE PROJECT

CHAPTER 7
NECESSITY OF THE PROJECT

7.1 PRESENT AND FUTURE URBAN STRUCTURE

(1) Definition of Urban Center

Urban Center is defined by this study as follows;

AREA OF URBAN CENTER

- All barangays of Poblacion District
- All barangays of Agdao District
- Six (6) barangays of Talomo District
  - Barangay of Ma-a, Matina Pangi, Matina Crossing, Matina Aplaya, Talomo Proper and Bucana
- Three barangays of Buhangin District
  - Barangays of Buhangin, Sasa and Pampanga

(2) Present Urban Structure

Schematic urban structure is shown in **Figure 7.1-1.**

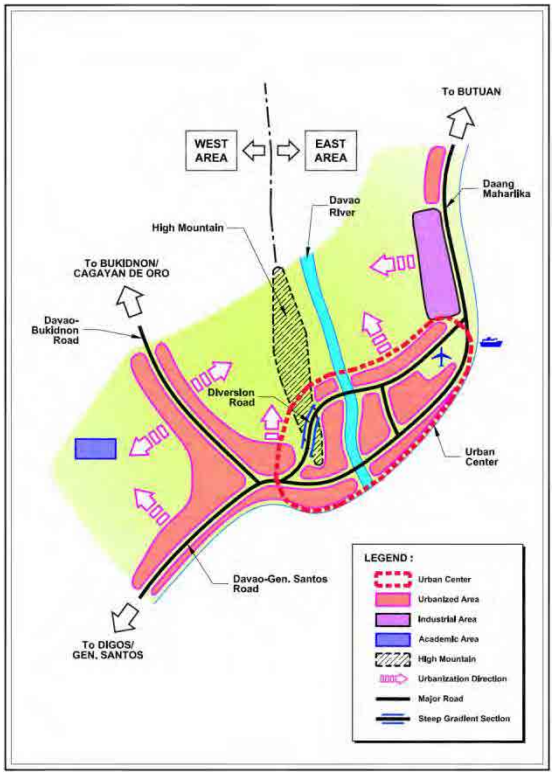
Urbanization is progressing in the Urban Center and areas along major roads (national roads) of Daang Maharlika in the north, Davao-Bukidnon Road in the west, Davao-General Santos Road in the south and Diversion Road along the boundary of Urban Center.

Industrial area is developed along Daang Maharlika.

Davao International Airport and Sasa Port (international port) are located in the Urban Center.

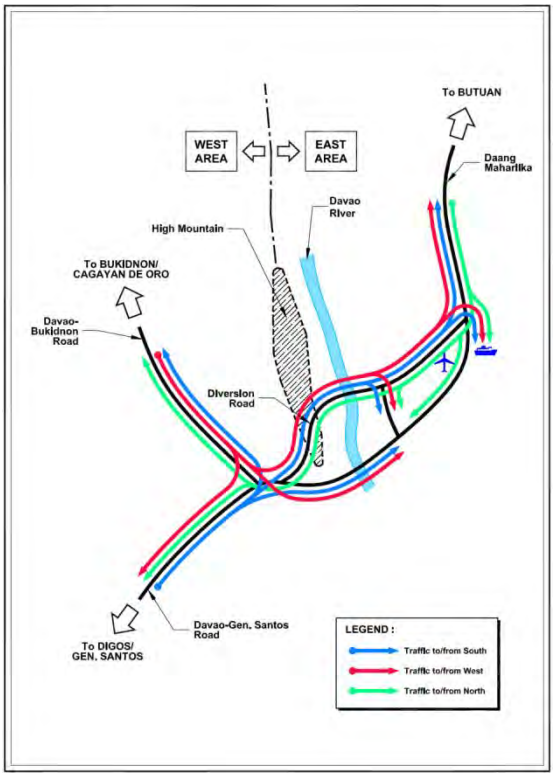
The Study Area is physically divided into two (East Area and West Area) by Davao River and a high mountain which restrict movement of people and goods.

Urbanization Trend: Urbanization trend is seen towards the inland areas along narrow City Roads. Many large scale housing (subdivision) development is on-going.



Source: JICA Study Team

FIGURE 7.1-1 SCHEMATIC URBAN STRUCTURE



Source: JICA Study Team

FIGURE 7.1-2 TRAFFIC MOVEMENT

(3) Traffic Movements

Traffic movements to/from the north, west and south from/to Urban Center rely on national roads of Daang Maharlika, Davao-Bukidnon Road and Davao-General Santos Road. Traffic from the north, west and south is distributed by the Diversion Road.

Most roads within the Urban Center except the Diversion Road are heavily congested and traffic speed is less than 20km/hour. Thus, many drivers are selecting the Diversion Road instead of other roads in Urban Center, even though travel distance becomes much longer when they select the Diversion Road.

Truck Ban from 6:00 A.M. to 9:00 A.M. and from 5:00 P.M. to 8:00 P.M. is imposed on roads within the Urban Center except the Diversion Road. Thus, trucks are concentrating on the Diversion Road.

Diversion Road is becoming very important road not only for Davao City but for entire Mindanao. It has 4 to 6 lanes and its road sides are being developed as commercial areas and residential areas, therefore, local traffic is drastically increasing and traffic flow of through traffic is being affected. Another serious issue is that it climbs up and down the mountain with steep gradient of 6.5% to 7%, therefore, loaded trucks can only travel with slow speed of 20-25km/hour. Due to truck ban imposed in the Urban Center, all trucks have to use this road, slow travel speed due to steep gradient will aggravate overall transport efficiency of Davao City.

(4) Problems of the Urban Center

- **Overconcentration of population in the narrow Urban Center:** About 45% of Davao City population (or 652,600 people out of 1,449,000 population of Davao City) is settled in the 3% of land area of Davao City (or 73 sq.km. out of 2,440 sq.km. of Davao City). An average population density of the Urban Center reached to 89 persons/hectare. Population growth rate of the Urban Center is lower than that of Davao City.Thus, urbanization is

expanding towards the inland areas.

TABLE 7.1-1 CHARACTERISTICS OF URBAN CENTER

	Davao City	Urban Center
Land Area	2,440 sq. km.	73 sq. km. (3% of Davao City)
Population (2010)	1,449,296	652,607 (45% of Davao City)
Population Density	5.9 person/ha.	89.4 person/ha. (15 times of Davao City)
Population Growth Rate (2007-2010)	2.19% per annum	1.07% per annum

Source: Prepared by JICA Study Team based on NSO, Davao City data

- **Overconcentration of economic activities** in the Urban Center: Large scale shopping malls, banks and other financial institutions, universities, government offices are concentrated in the Urban Center.

- **Concentration of major transport facilities** in the Urban Center: International port and airport and bus terminals are located in the Urban Center.

- **Chronic Traffic Congestion:** Traffic congestion of roads in the Urban Center is chronic. Travel speeds of most roads are less than 20km/hr.

- **Concentration of diverted vehicles/truck traffic on Diversion Road:** Traffic which used to pass through the urban Center is now diverting to the Diversion Road. Most trucks are using the Diversion Road due to truck ban in the Urban Center. In addition to above, local traffic on the Diversion Road is increasing due to commercial activities along the Diversion Road. Due to steep gradient of climbing up the mountain, loaded trucks can travel only with low speed which is hampering smooth travel. It is expected that the Diversion Road will experience heavy traffic congestion in the near future.

7.2 TRAFFIC CHARACTERISTICS

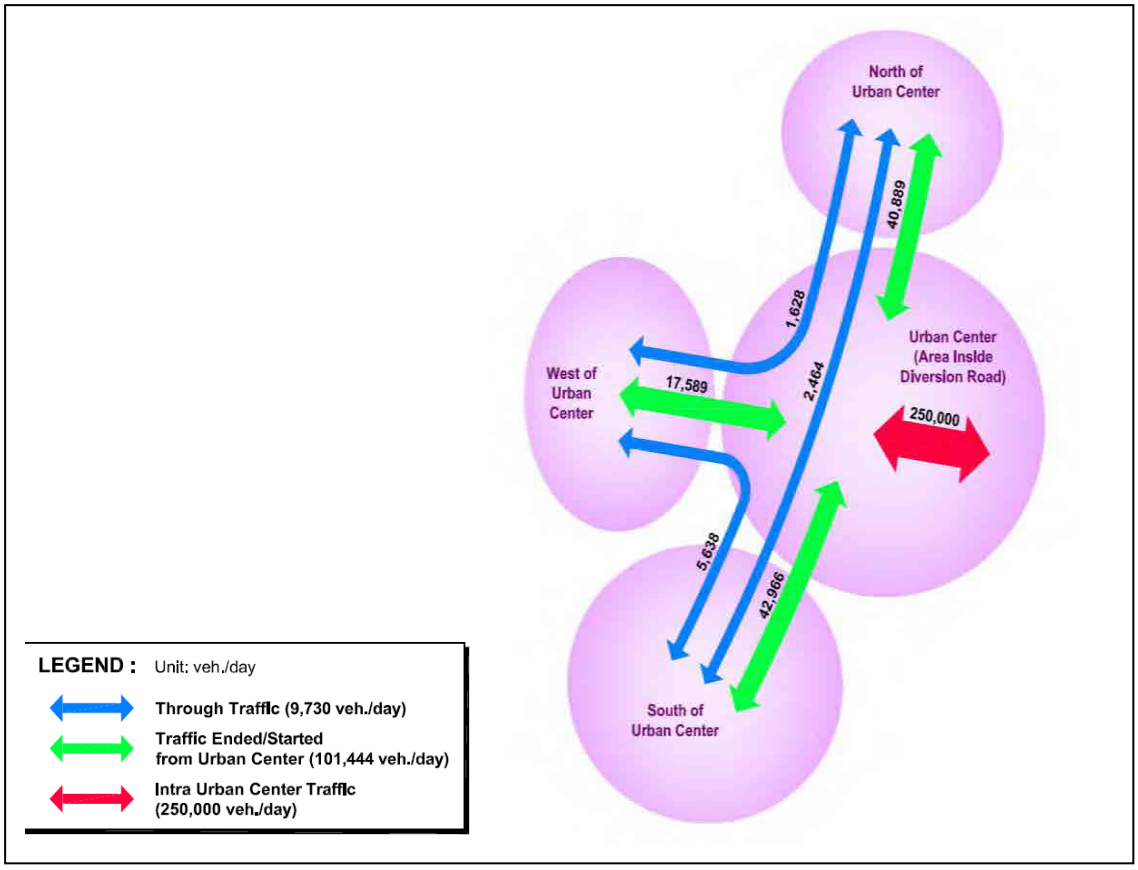
(1) Overall Traffic Characteristics

Based on the traffic surveys undertaken in August 2013, traffic flow is estimated as shown in **Figure 7.2-1** and summarized below:

Through Traffic: Traffic which passes through the Urban Center is 9,730 veh./day (=1,628 + 2,464 + 5,638)

Urban Center Related Traffic: Traffic which starts or end at the Urban Center from/to the north, the west and the south is 101,444 veh./day.

Intra Urban Center Traffic: Traffic which moves within Urban Center is 250,000 veh./day.



Source: JICA Study Team

FIGURE 7.2-1 TRAFFIC CHARACTERISTICS

(2) Traffic Desire Line

Traffic desire line which shows O-D pattern of Traffic Zone 1 (Poblacion), Traffic Zone 3 (Matina/Talomo), traffic zones north of Davao City, traffic zones west of Davao City, traffic zones south of Davao City and track O-D pattern of Sasa Port is shown in **Figure 7.2-2.**

Traffic Zone-1 (Poblacion): Heavily traffic movements between Poblacion and traffic zones along the coastal line and between south as well as north areas outside Davao City.

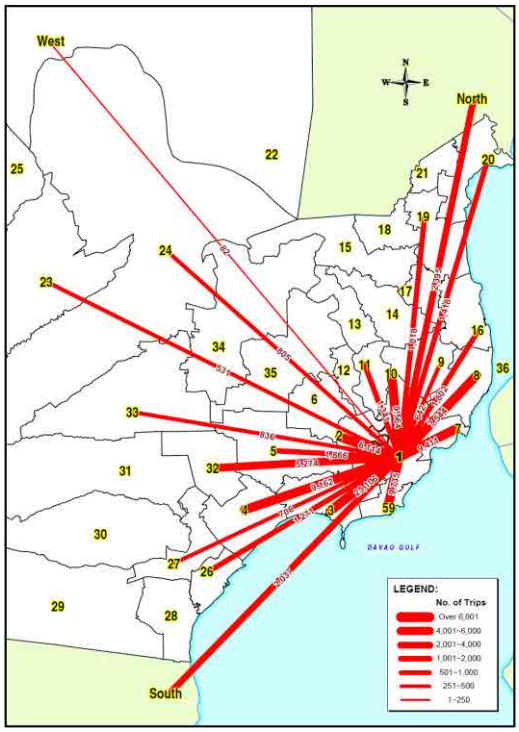
Traffic Zone-3 (Matina/Talomo): Heavy traffic movements between Matina/Talomo and traffic zones along the coastal line.

Traffic Zones North of Davao City: Heavy traffic movements between North of Davao City and Poblacion and its surrounding zones.

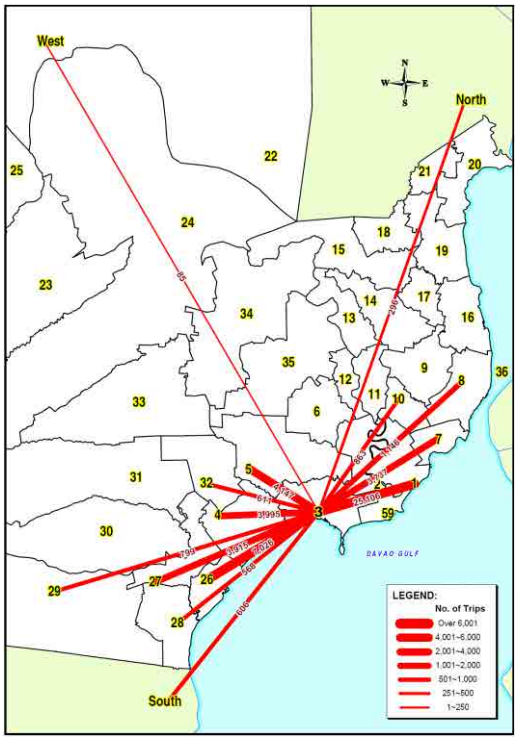
Traffic Zones West of Davao City: No strong traffic movements with specific traffic zones.

Traffic Zones South of Davao City: Relatively strong relation with Poblacion and its surrounding traffic.

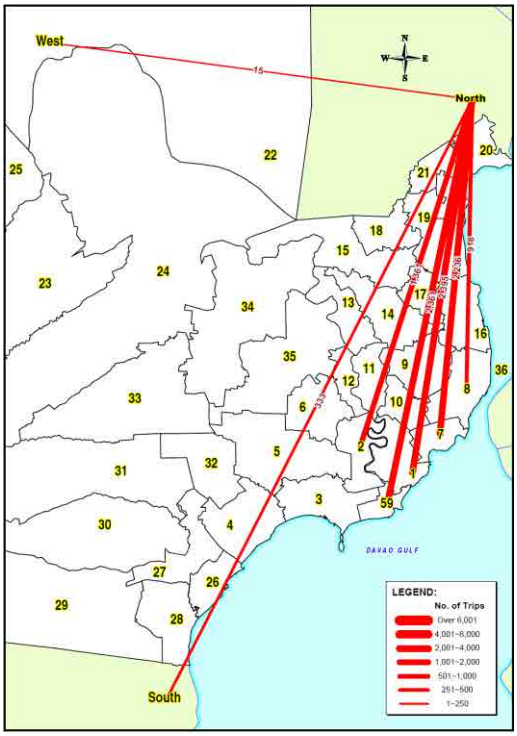
Sasa Port: Relatively strong movements between Sasa Port and nearby traffic zones where industrial areas/warehouses are located. Traffic relation with South and North of Davao City is also relatively strong.



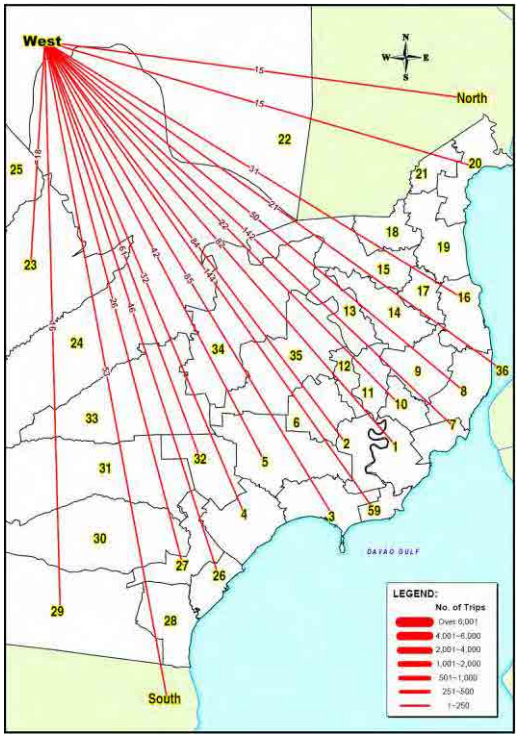
DESIRED LINE RELATED TO ZONE-1: POBLACION



DESIRED LINE RELATED TO ZONE-3: MATINA/TALOMO

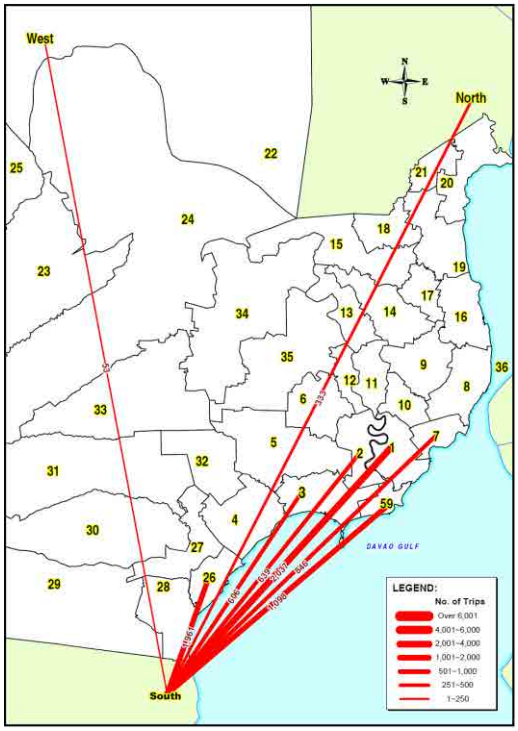


DESIRED LINE RELATED TO ZONES NORTH OF DAVAO CITY

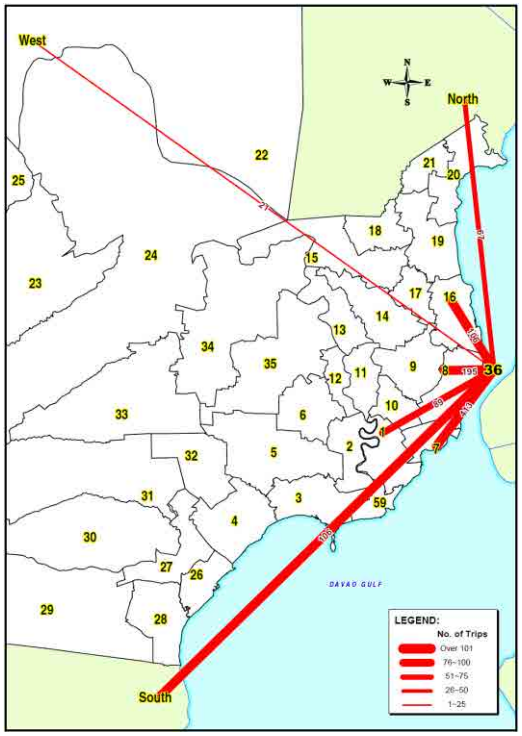


DESIRED LINE RELATED TO ZONES WEST OF DAVAO CITY

FIGURE 7.2-2 (1/2) TRAFFIC DESIRE LINE



DESIRED LINE RELATED TO ZONES SOUTH OF DAVAO CITY



TRUCK DESIRED LINE RELATED TO SASA PORT

Source: JICA Study Team

FIGURE 7.2-2 (2/2) TRAFFIC DESIRE LINE

7.3 INTERVIEW RESULTS OF MANUFACTURING /AGRI-BUSINESS COMPANIES

A total of ten (10) manufacturing/agri-business companies were interviewed mainly to identify transport problems. Transport routes of raw materials and finished products, transport problems they are encountering and expected benefits they will enjoy were interviewed.

(1) Company A (see Figure 7.3-1)

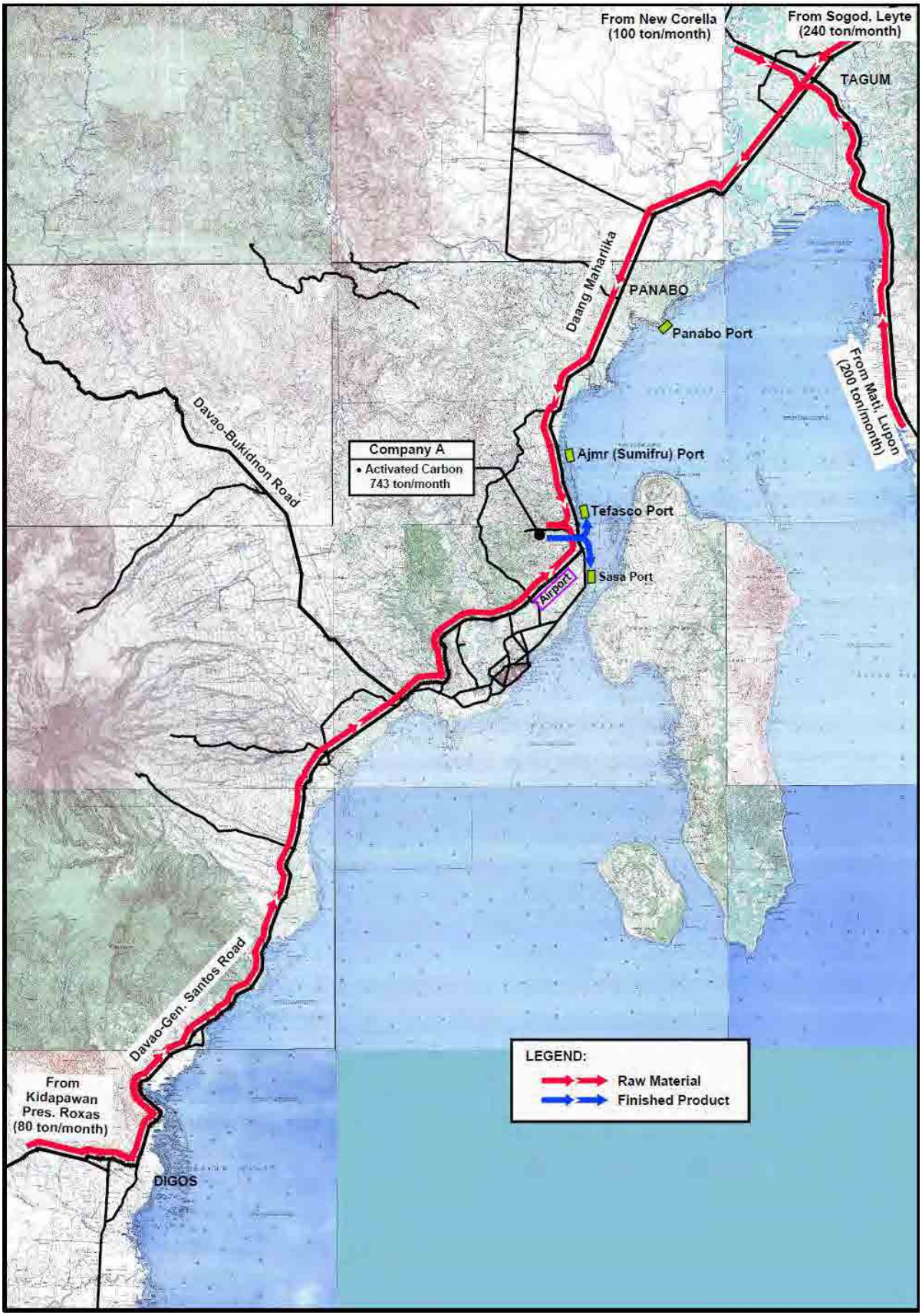
- Producing activated carbon from coconut shell charcoal
- Produces 450 Mt of activated carbon monthly
- Finished products are mostly for export to Japan, Europe and Korea
- Raw materials are being transported from all-over south and north of Mindanao and also from Leyte
- Transport routes of raw materials are as follows;
  - South of Mindanao : Cotabato – Digos – Davao Road
  - North of Mindanao : Daang Maharlika
- Transport routes of finished products
  - Transported to Sasa Port and TEFASCO Port for export

(2) Company B (see Figure 7.3-2)

- The factory is located at Digos
- Producing building materials, kitchen set, metal roofing, unit baths, etc., which are all for export to Japan (95%) and Korea (5%)
- Raw materials come from all-over Mindanao, (from Zamaboanga, Cagayan de Oro, Bukidnon, Butuan and Agusan)
- Transport routes are Cotabato-Digos Road from the south, Davao-Bukidnon Road from the west and Daang Maharlika from the north
- Finished products are exported from Sasa Port and Panabo Port

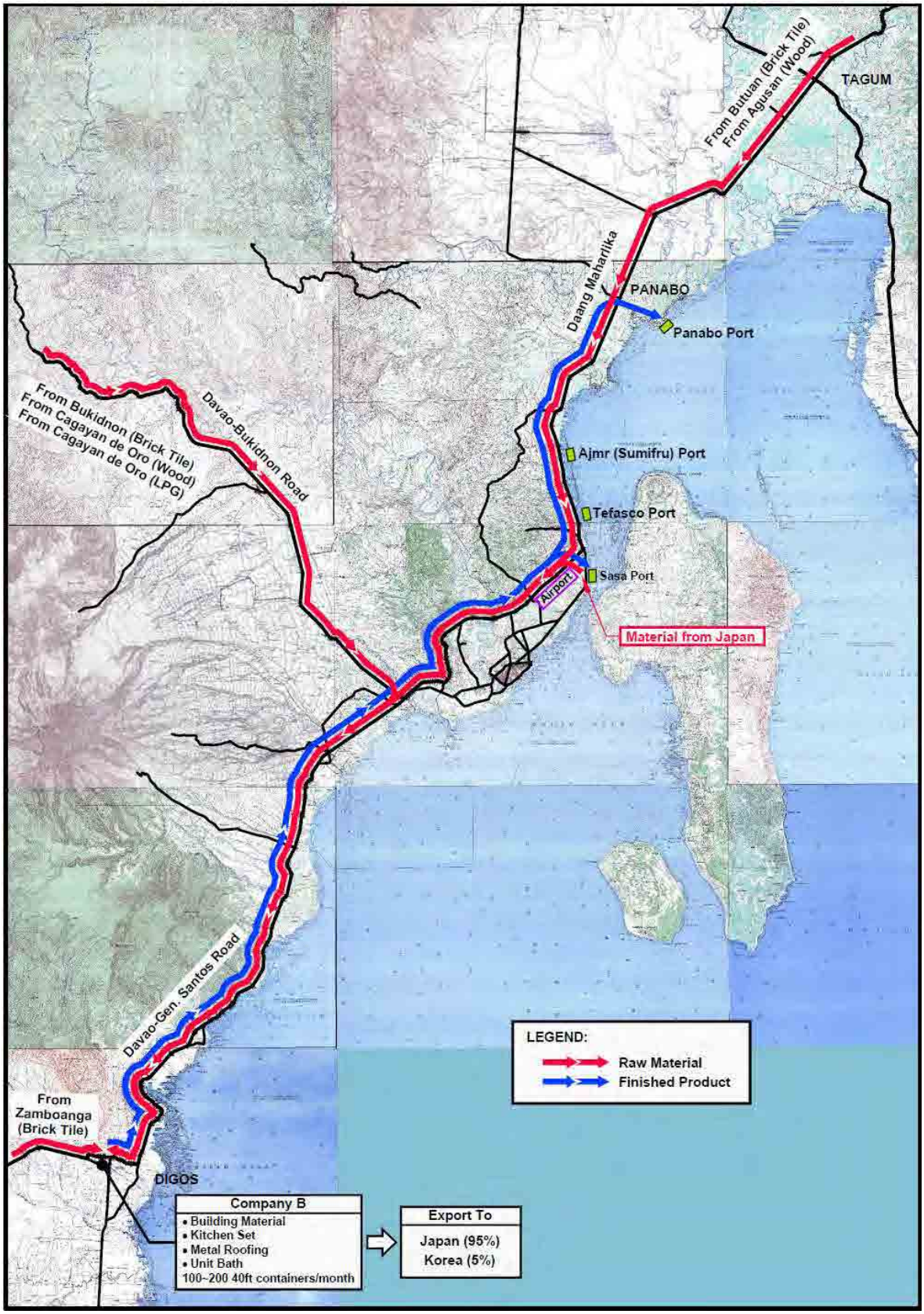
(3) Company C (see Figure 7.3-3)

- Exporting bananas, pineapples, papayas, asparagus and corns to Japan, Middle East, China, Korea, etc.
- Materials necessary for farming are unloaded at Sasa Port, TEFASCO Port and Panabo Port and transported all over /Mindanao utilizing Daang Maharlika, Davao-Bukidnon Road, Davao-Gen. Santos Road.
- Produced fruits and vegetables are exported from Sasa Port and Panabo Port by way of the same routes used for material transportation.



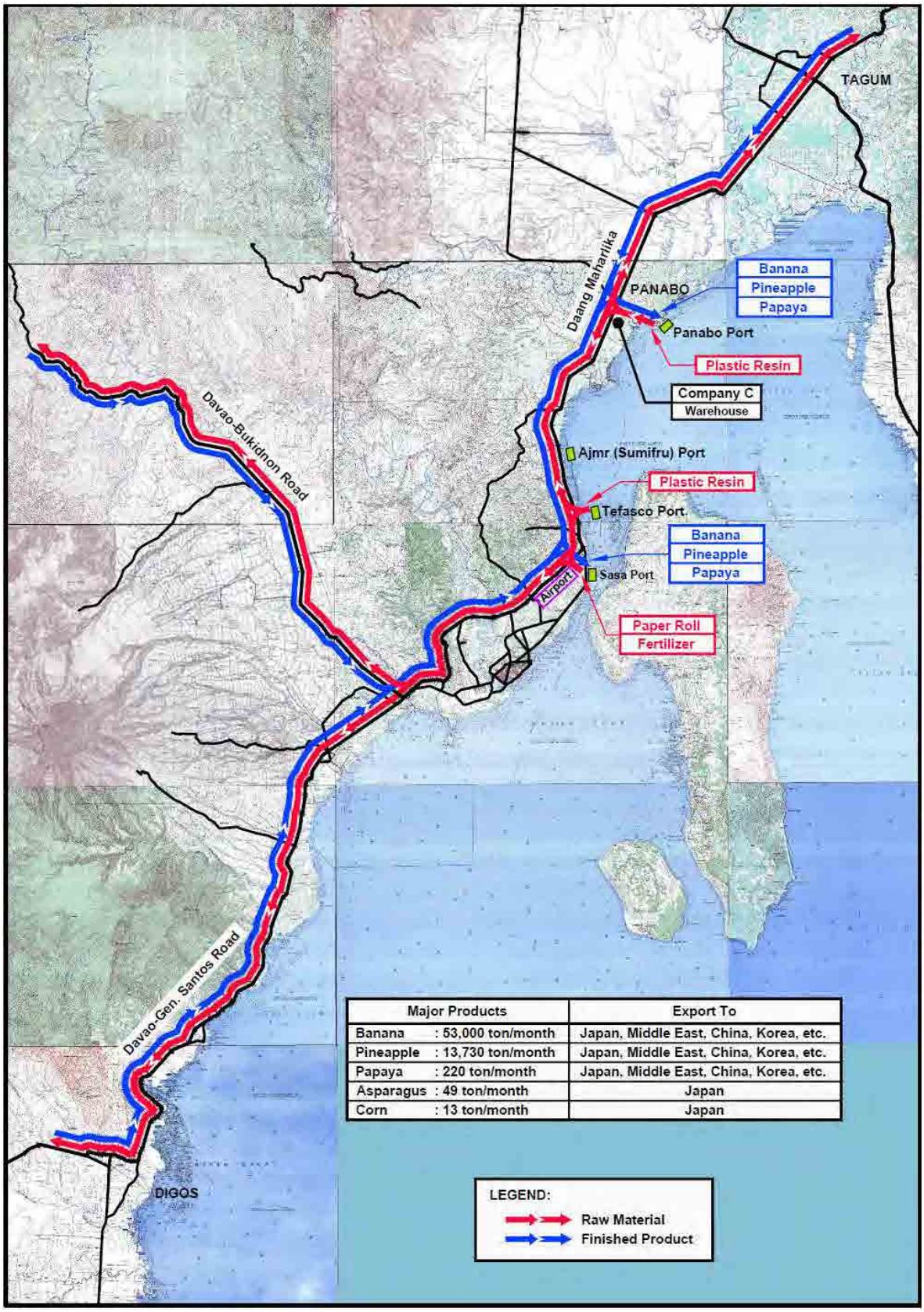
Source: JICA Study Team

FIGURE 7.3-1 TRANSPORT ROUTE OF RAW MATERIAL AND FINISHED PRODUCT: COMPANY A



Source: JICA Study Team

FIGURE 7.3-2 TRANSPORT ROUTE OF RAW MATERIAL AND FINISHED PRODUCT: COMPANY B



Source: JICA Study Team

FIGURE 7.3-3 TRANSPORT ROUTE OF RAW MATERIAL AND FINISHED PRODUCT: COMPANY C

(4) Transport problems they are encountering

Their answers are summarized in **Table 7.3-1.**

TABLE 7.3-1 TRANSPORT PROBLEMS

	Problems	Number of Companies answered "Yes" out of 10 companies
1	Unpredictable arrival time of raw materials and products due to traffic congestion	10
2	High transport cost due to bad road construction	6
3	Trucks are having a hard time to travel due to steep gradient of road	6
4	Poor accessibility to Port/Airport	4
5	Are your employees experiencing traffic problems	7
6	Any other transport/traffic problems	• No shoulder roads for pedestrians • Traffic congestion in the Urban Center • Traffic problems at Panacan, Tibungco, due to commercial activities along the National Road • Never ending road repairs

Source: JICA Study Team

(5) Possible Benefits From the Bypass Project

Their answers are summarized in **Table 7.3-2.**

TABLE 7.3-2 POSSIBLE BENEFIT FROM BYPASS PROJECT

	Problems	Number of Companies answered "Yes" out of 10 companies
1	Faster delivery of cargo	10
2	Delivery of Cargo on Time	9
3	Increase access to source of materials	9
4	Transport cost reduction	9
5	Minimize damage on cargo	9
6	Others	• Smooth travel • Reduce travel time

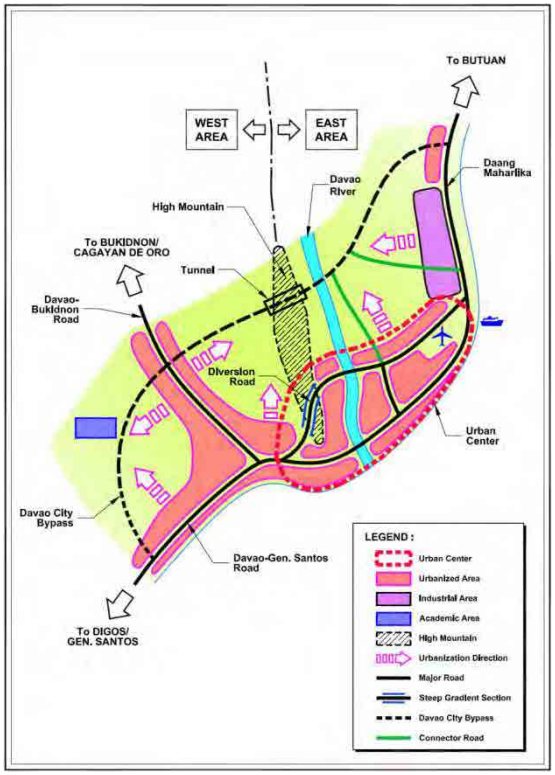
Source: JICA Study Team

7.4 NECESSITY OF DAVAO CITY BYPASS

Davao City Bypass is necessary due to the following reasons;

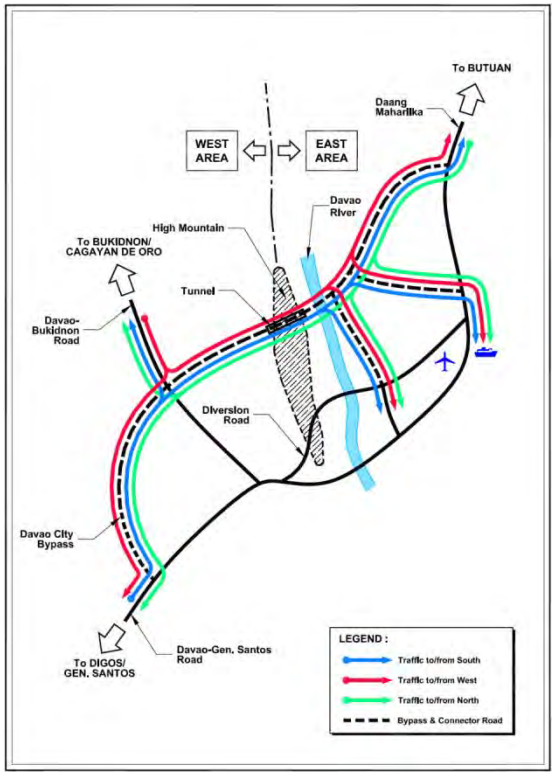
- Traffic condition in the Urban Center is chronic. Traffic which does not need to pass through the Urban Center should be diverted to the Bypass, thus a Bypass contributes to reduce traffic problems in the Urban Center.
- The Urban Center of Davao City is over saturated. Urban environment is getting worse. Urban areas must be expanded. Urbanization towards the inland areas should be orderly guided by a new road network which is Davao City Bypass.
- To strongly support economic activities, particularly manufacturing and agri-business industries of not only in the city but also in Mindanao as a whole, road transport access to the ports and the airport must be strengthened. Davao City Bypass will provide smooth access to ports and the airport.
- To support a strong road network in Davao City, especially in case of a major disaster. The

Davao Bypass Road should be constructed with a high standard of safety and strong enough which could function as an emergency route in case of major disaster that would be able to maintain and sustain the social and economic activities of the area.



Source: JICA Study Team

FIGURE 7.4-1 SCHEMATIC URBAN STRUCTURE WITH BYPASS



Source: JICA Study Team

FIGURE 7.4-2 POSSIBLE TRAFFIC DIVERTED TO THE BYPASS

7.5 DAVAO SASA PORT AS PPP PROJECT

The Department of Transportation and Communication (DOTC) is currently undertaking the feasibility study for Sasa Port as a key or flagship project for the Public-Private Partnership of the Philippine Government. The Davao Bypass Project would be substantial in the accessibility of the Davao Sasa Port. Davao Sasa Port would subsequently enhance the economic viability of the Davao City Bypass. Container traffic for the Davao Sasa Port is forecasted to double up in the next five years as shown in **Figure 7.5-1** below.

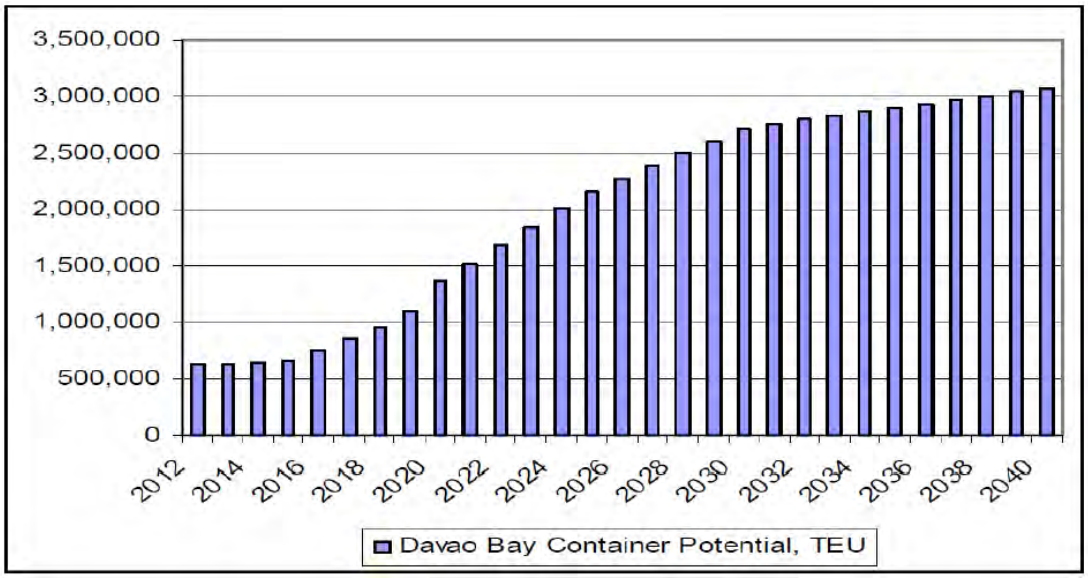
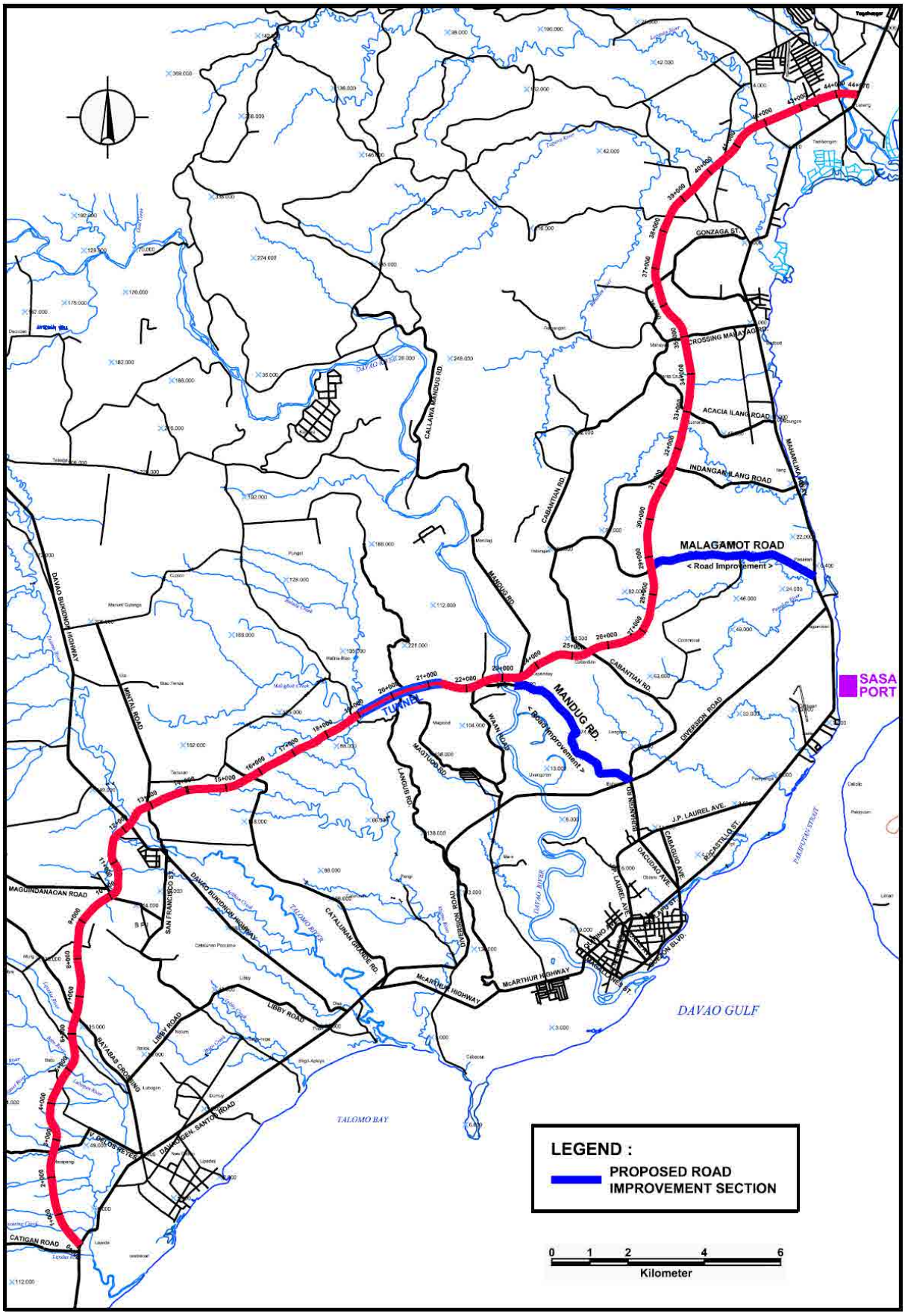


FIGURE 7.5-1 CONTAINER TRAFFIC FORECAST – DAVAO BAY (TOTAL)

With the above container traffic forecast for the Davao Bay at Sasa Port, the Davao City Bypass is undoubtedly necessary for easy movement of traffic in the area.

For easier access between Davao City Bypass and Sasa Port, the existing city road – Malagamot Road should be improved as shown in **Figure 7.5-2.**



Source: JICA Study Team

FIGURE 7.5-2 LOCATION MAP OF DAVAO CITY BYPASS AND SASA PORT AND THE PROPOSEC ROAD IMPROVEMENT OF EXISTING CITY ROAD

CHAPTER 8

REVIEW OF THE BUSINESS CASE STUDY

CHAPTER 8
REVIEW OF THE BUSINESS CASE STUDY

A Davao City Bypass was originally proposed by the JICA-assisted Master Plan Study on High Standard Highway Network Development Master Plan (HSH Master Plan), based on which DPWH undertook the Business Case Study (BCS) in 2013 to examine whether it can be implemented as a PPP scheme. The BCS concluded that the project as a PPP scheme is not feasible due to low financial viability and recommended that the project should be implemented as a conventional Government finance project. It also recommended that the Davao City Bypass should be first a non-toll 2-lane road.

8.1 ALIGNMENT

The proposed alignment is shown in **Figure 8.1-1**.

- Road Length : 41km
- Number of Lanes : 2 lanes
- Alignment recommended passes through the outskirt of Davao City urbanized area
- Alignment was discussed with Davao City Government and basically agreed
- No description in the Report on alternative alignment study

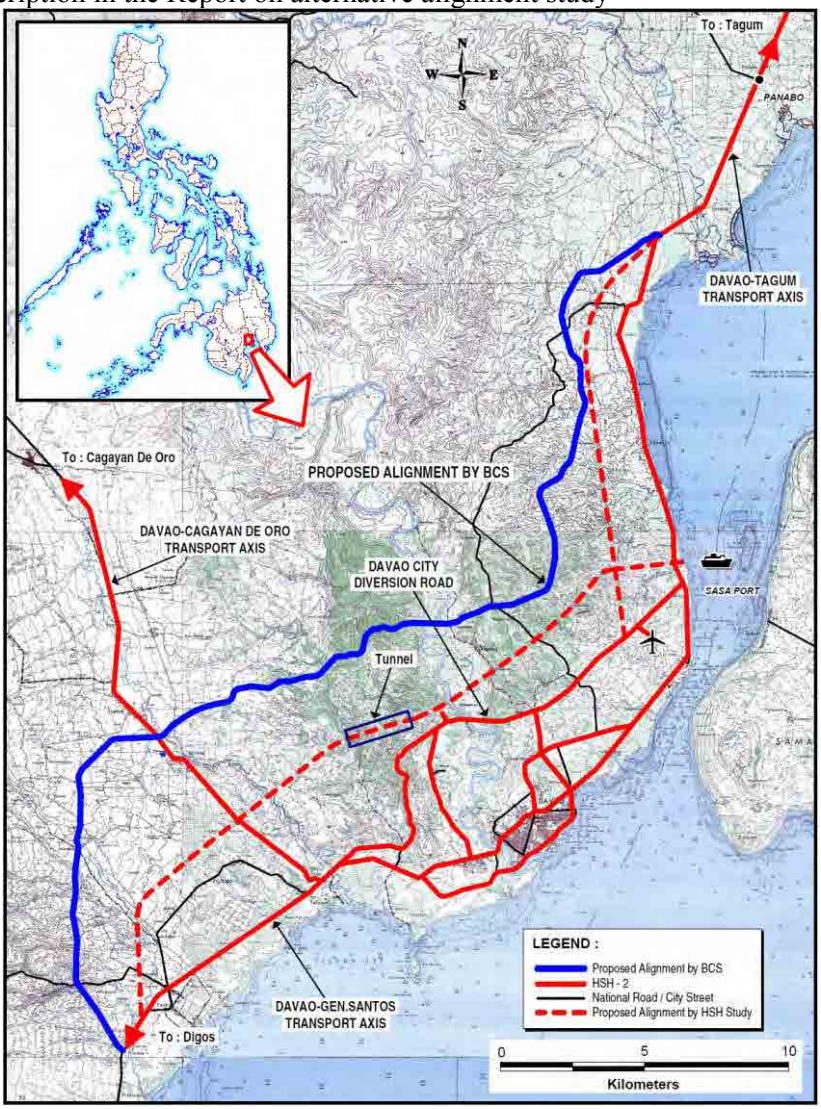


FIGURE 8.1-1 PROPOSED ALIGNMENT BY BCS

8.2 SCOPE OF THE PROJECT

Table 8.2-1 shows the scope of the Project and issues.

TABLE 8.2-1 REVIEW OF CONTENTS OF BCS

Items		Scope of the project by BCS	Issues
1) DESIGN SPEED AND CROSS SECTION ELEMENT	DESIGN SPEED	• Not described in the BCS report	• Assumed to be 60 – 80 km/hr dependent on the terrain.
	LANE WIDTH	• 2.40m	• Very sub-standard.
	SHOULDER WIDTH	• 1.50m	• Should be selected based on a terrain.
	ROW WIDTH	• 40m	• DPWH's standard is 30m for national roads. • ROW width will vary depending upon cut or embankment height.
2) ROAD SECTION	EMBANKMENT	• Embankment height more than 10m at the road center ⇨ L=720m • Highest embankment height ⇨ 23 m (90m ROW required.) (see **Figure 8.2-1**)	• Above result in severe natural destruction and high construction cost.
	CUT	• Cut height is more than 20m at the road center ⇨ L= 3,670m • Highest cut height ⇨ 49m • Cut height is more than 30m ⇨ 7 locations (see **Figure 8.2-2**)	
3) TRAFFIC DEMAND FORECAST	DIVERTED TRAFFIC	• Estimated by section (2012) – South section : 2,570 veh/day – Central section : 5,289 veh/day – North section : 3,787 veh/day	• Methodology of traffic demand forecast is not explained well. • Traffic network analysis is needed. • Traffic demand forecast should be done based on future socio-economic framework.
	GENERATED TRAFFIC	• Assumed to be 25% of diverted traffic	
	FUTURE TRAFFIC	• Annual traffic growth rate was assumed. – Car : 6.2 ~ 6.5% per annum – Bus : 5.5 ~ 5.8% per annum – Truck : 4.5 ~ 4.8% per annum	
4) STRUCTURES	BRIDGE	• 22 bridges (less than 100m : 11 bridges, 100 ~ 220m : 11 bridges) total bridge length = 2,185m	• There are many cases, a valley (river) location is filled with embankment (no bridge or box culvert) based on JICA Study Team's review, 47 bridges and total bridge length=3,900m (see **Table 8.2-2**) • There are many cases where a proposed road elevation is lower than the bottom elevation of valley (see **Table 8.2-3**)
	FLYOVER BRIDGE	• 6 bridges (15 ~ 25 m in length)	
	OVERPASS BRIDGE FOR CROSSING ROADS	• 13 bridges	
	TUNNEL	• 1 tunnel, l = 2,020m	• Detailed study on selection of tunnel location was not done. • Tunnel section has some curves alignment. • Detailed geological studies needed.

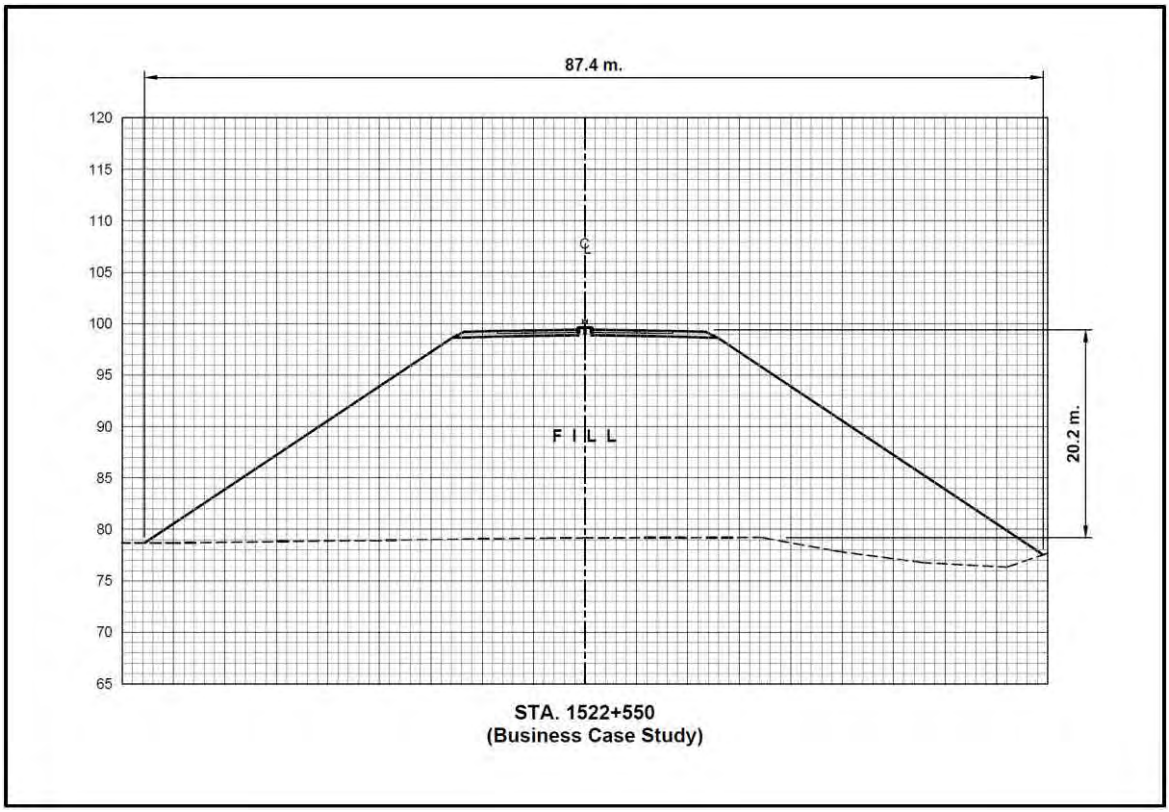


FIGURE 8.2-1 EXAMPLE OF EMBANKMENT CROSS SECTION BY BCS

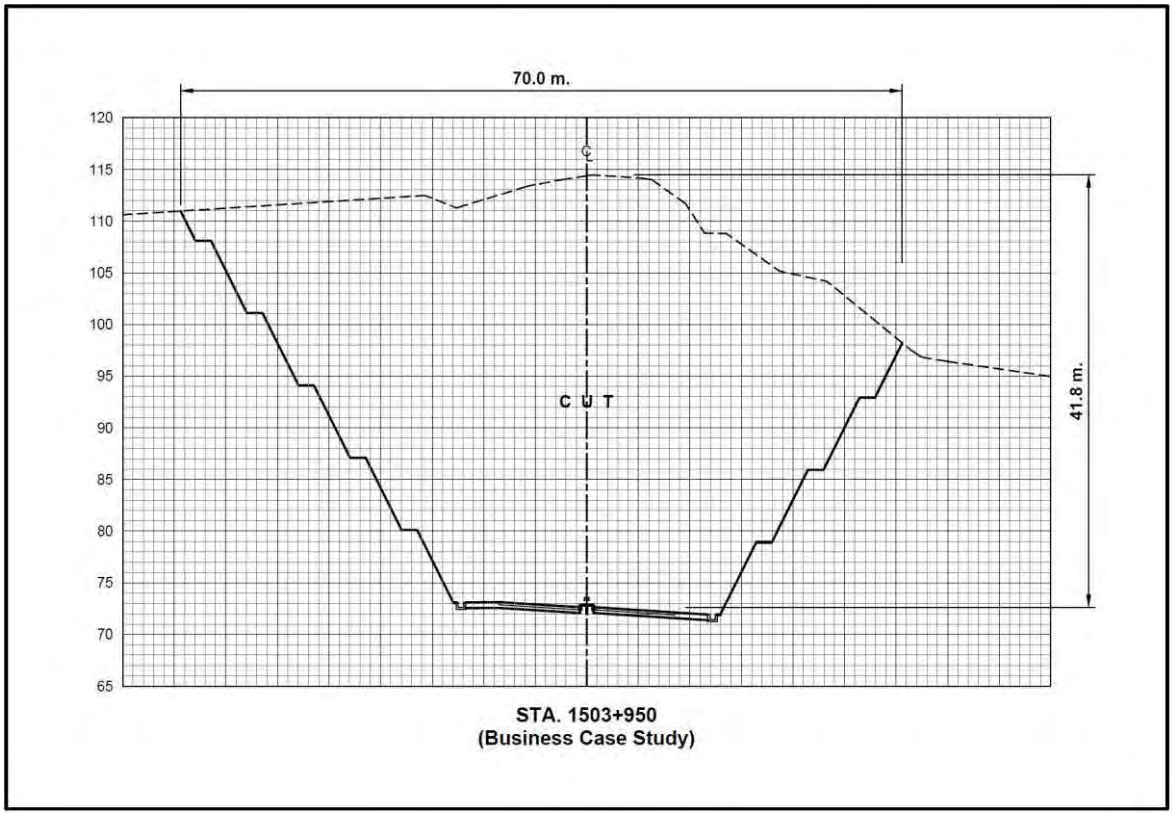


FIGURE 8.2-2 EXAMPLE OF CUT CROSS SECTION BY BCS

TABLE 8.2-2 (1/2) BRIDGE LIST PROPOSED BY BCS AND JICA TEAM

Station	Valley	River	Road	BCS Proposed			JICA Study Team Proposed			Remark
				Type of Bridge	Bridge Number	Proposed Bridge Length	Type of Bridge	Bridge Number	Proposed Bridge Length	
1483 + 250	O	O		RB	1	30m				
350			O	FO	1	25m				
1484 + 375	O			RB	2	30m				
1485 + 200			O	FO	2	20m				
550			O	FO	3	15m				DR
1486 + 375			O	OP	1					
1488 + 125			O	FO	4	20m				
350	O			RB	3	60m				
1489 + 300	O	O					RB	23	40m	
800	O	O					RB	24	45m	
850			O	OP	2					DR
900	O	O					BC	1	10m	
1490 + 200	O	O					RB	25	20m	
550			O							DR
950	O	O		RB	4	80m				
1491 + 50	O	O					RB	26	25m	
200	O	O					RB	27	25m	
400			O	OP	3					
1492 + 650			O				OP	14		DR
850	O						BC	2	10m	
1493 + 100	O						RB	28	55m	
500	O	O					RB	29	30m	
1494 400	O	O					RB	30	60m	
1495 150	O	O					RB	31	100m	
650	O	O		RB	5	110m				
875	O	O					RB	32	30m	
1496 + 0	O	O					RB	33	25m	
200	O			RB	6	140m				
500			O	IC	1					IC
700	O	O					RB	34	30m	
875	O	O					RB	35	25m	
1497 25			O	OP	4					
250	O	O		RB	7	100m				
650	O	O		RB	8	120m				
850			O	OP	5					
900	O	O					BC	3	5m	
1498 + 225	O	O					RB	36	30m	
650	O						RB	37	90m	
1499 50	O	O					RB	38	40m	
650			O	OP	6					
1500 + 0	O	O					RB	39	50m	
100	O	O					RB	40	15m	
650	O	O		RB	9	100m				
1501 + 300			O	IC	2					IC,DR
650			O				BC	4	10m	DR
950			O				BC	5	10m	DR
1502 + 100	O	O		RB	10	80m	RB	10	200m	Davao Rv
1503 + 450	O	O		RB	11	90m				

Source: JICA Study Team

TABLE 8.2-2 (2/2) BRIDGE LIST PROPOSED BY BCS AND JICA TEAM

Station	Valley	River	Road	BCS Proposed			JICA Study Team Proposed			Remark
				Type of Bridge	Bridge Number	Proposed Bridge Length	Type of Bridge	Bridge Number	Proposed Bridge Length	
1507 + 50	O	O					RB	41	110m	
1508 + 100	O	O		RB	12	120m	RB	12	180m	
800			O	OP	6					DR
1509 + 100	O						RB	42	80m	
1510 + 200			O	OP	7					
550	O	O					RB	43	25m	
775			O	OP	8					
900	O	O					BC	6	10m	
1511 + 250		O					BC	7	10m	
650	O						RB	44	75m	
1512 + 850			O	OP	9					
1513 + 200	O	O		RB	13	90m				
450			O	OP	10					Davao - Bukinodon Rd.+Canal
1514 + 0		O					BC	8	10m	
1515 425			O	OP	11					DR
1516 300	O	O		RB	14	60m				
950			O	FO	3	20m				DR
1518 200			O	FO	4	25m				DR
1519 125			O				BC	9	10m	DR
200		O		RB	15	30m				
250		O	O	OP	12					DR+Canal
650	O	?					BC	10	10m	
1520 + 0	O	O		RB	16	115m				
750	O	O		RB	17	105m				
950	O	O					BC	11	10m	
1521 750	O	O		RB	18	220m				
1522 250	O						RB	45	450m	
1523 650	O	O		RB	19	150m				
825	O						BC	12	10m	
1524 300	O	O		RB	20	160m				
1525 500	O						RB	46	40m	
800			O	OP	13					
1526 100	O	O		RB	21	70m				
600	O	O		RB	22	80m				
800	O	O					RB	47	20m	
						1125m			560m	
				RB	22	2185m	RB	47	3900m	
				FO+IC	6	80m	FO+IC	6	80m	
				OP	13		OP	14		
							BC	12	115m	

Abbreviated Name
RB:River Bridge
FO:Fly Over
OP:Over Pass
BC:Box Culvert

DR:District Road

Source: JICA Study Team

TABLE 8.2-3 LOCATIONS OF PROPOSED PROFILE IS LOWER THAN WATERWAY BED

No.	Station			Finished Grade	Original Grade	Difference	
1	1489	+	750	79.6	84.3	−4.7	m
2	1490	+	200	87.5	85.0	2.5	m
3	1491	+	800	55.7	68.5	−12.8	m
4	1494	+	650	57.2	62.2	−5.0	m
5	1495	+	400	59.2	70.2	−11.0	m
6	1497	+	775	42.4	45.8	−3.4	m
7	1497	+	900	50.4	49.2	1.2	m
8	1500	+	300	62.7	65.5	−2.8	m
9	1504	+	0	63.9	63.5	0.4	m
10	1507	+	275	35.4	55.5	−20.1	m
11	1513	+	450	126.0	126.6	−0.6	m
12	1520	+	950	124.3	122.2	2.1	m
13	1524	+	0	80.5	101.2	−20.7	m
14	1524	+	550	76.6	85.4	−8.8	m

8.3 PROJECT COST

(Confidential)