BASIC DESIGN STUDY
ON
THE PROJECT
FOR
THE IMPROVEMENT OF URBAN AND RURAL ROADS IN KOROR AND AIRAI STATES
IN
THE REPUBLIC OF PALAU

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ABBREVIATIONS

AASHTO	:	American Association of State Highway and Transportation Officials
BAC	:	Bureau of Arts and Culture
B/D	:	Basic Design Study
BLS	:	Breau of Land and Surveys
BPW	:	Bureau of Public Works
CIP	:	Capital Improvement Program
DDE	:	Department of Design and Engineering
EA	:	Environmental Assessment
EDP	:	Economic Development Plan l995-1999
EIA	:	Environmental Impact Assessment
EIS	:	Environmental Impact Statement
EQPB	:	Environmental Quality Protection Board
GDP	:	Gross Domestic Product
GIS	:	Geographic Information System
JICA	:	Japan International Cooperation Agency
MOCCA	:	Ministry of Community and Cultural Affairs
MOJ	:	Ministry of Justice
MRD	:	Ministry of Resources and Development
NEPA	:	National Environmental Policy Act of 1969
NGO	:	Non Government Organization
NMDP	:	National Master Development Plan (2020)
NWB	:	National Weather Bureau
OP	:	Office of the President
PALARIS	:	Palau Automated Land and Resource Information System
PCS	:	Palau Conservation Society
PNC	:	Palau National Code
PNCC	:	Palau National Communications Corporation
PPR	:	Palau Pacific Resort
PPUC	:	Palau Public Utilities Corporation
PTC	:	Palau Transportation Company
PVA	:	Palau Visitors Authority
ROP	:	Republic of Palau

Chapter 1

Background of the Project

Chapter 1 Background of the Project

The Government of Palau faces the financial difficulty since 1994 Independence from U. S. A. to depend upon foreign aids. The annual budget of Ministry of Resources and Development (MRD), the executing agency of highway sector, is at the level of 6 million US dollars. It is good only for routine road repair and maintenance works and it is difficult to carry out large-scale road improvement works due to the insufficient budgetary condition. Therefore, the deterioration of pavement structure especially surface course of existing roads is in progress, and it becomes traffic bottlenecks to keep smooth traffic flow. The traffic condition is getting worse and worse because traffic volume increase remarkably 8% growth at an annual average due to sharp increase of driver license issuance and road related facilities such as shoulder, drainage, sidewalk and traffic safety measures are improper.

Under such circumstances, the Government of Palau has requested to implement the improvement of trunk roads in metropolitan area by Japanese Grant Aid Program, in July 2002. The request includes comprehensive repair and improvement of metropolitan trunk roads of 17 km in total. In response to the application for Japanese Grant Aid, JICA dispatched the Preliminary Design Study Team to Palau in March 2003 for the clarification of degree of road deterioration, necessity of improvement and priorities of section by section. The Study Team identified the priority and urgency of improvement for causeways of around 2 km which connect Koror Island to neighboring 3 islands (Babeldaob Island, Malakal Island and Arakebesang Island) and a trunk road of about 1.6 km in Malakal Island. Based on this study result, the scope of works for Basic Design Study was established, and, consequently, the study name was amended from the “Metropolitan Road (Koror & Airai) Improvement Project” to “Improvement of Interisland Access Road”. However, the Basic Design Study Team was dispatched to Palau in November 2003, and then the Palauan side strongly stated that their highest priority is to be given to the improvement of trunk road in Koror urban area. The Palauan side requested the inclusion of the said road section into the scope of Basic Design Study, but it was not accepted by the Japanese side.

In August 2004, the Government of Palau made a request again for grant aid to the Government of Japan for the Project for the Improvement of Urban and Rural Roads in Koror and Airai States in the Republic of Palau (hereinafter referred as "the Project"). In response to the application for Japanese Grant Aid, JICA dispatched the Preliminary Design Study Team to Palau in August 2005 and to examine the viability of the Project. Hence, JICA decided to conduct a Basic Design Study for the Project (hereinafter referred as "the Study").

Chapter 2

Contents of the Project

Chapter 2 Contents of the Project

2-1 Basic Concept of the Project

The final items requested by the Palauan side were confirmed as follows:

(1) Study Road Length: totaling 12.845 km (revised from the requested length of 12.237 km based on the result of site survey) in Koror Island, Arakabesang Island and Babeldaob Island as shown in Figure 2-1-1.

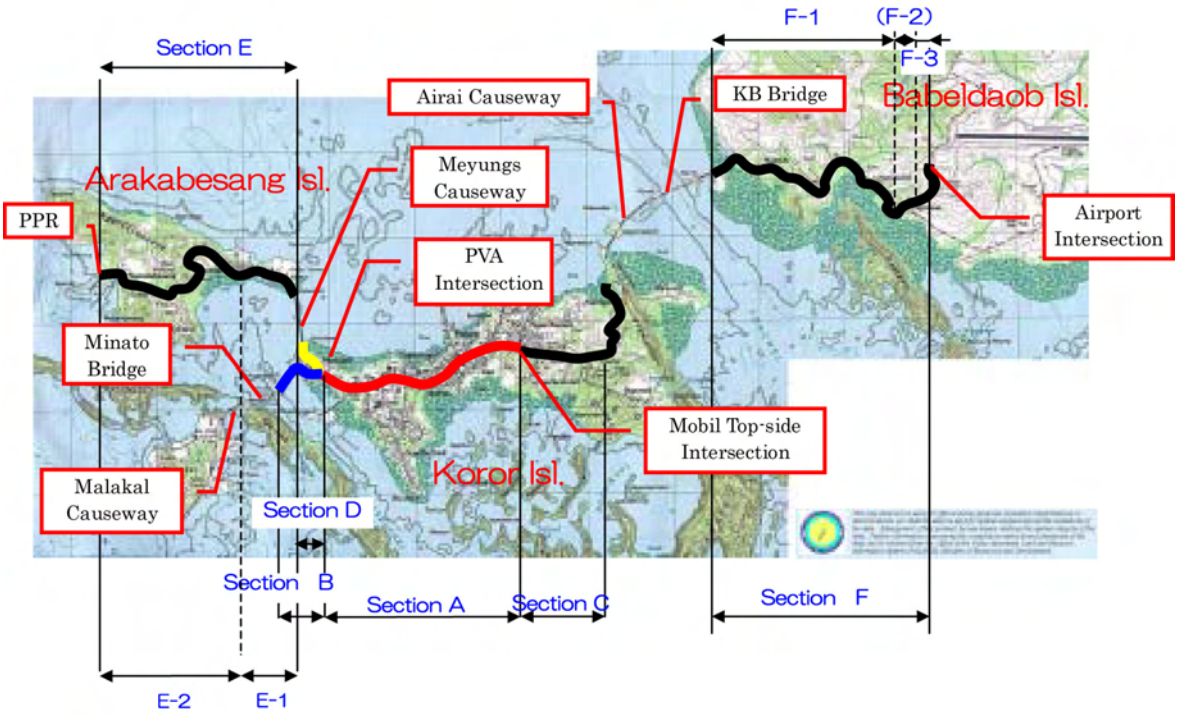


Figure 2-1-1 Location Map

(2) Improvement of urban trunk roads in Koror and Airai area: Total length 12.845km of which each section length is shown in Table 2-1-1.

Table 2-1-1 Length of Study Road by Section

Section		Length (m)
(1) Minato Bridge to Airport Intersection		
Section A	PVA Intersection to Mobil Top-side Intersection	2,700
Section B	Minato Bridge to PVA Intersection	530
Section C	Mobil Top-side Intersection to Airai Causeway	2,377
Section F	New KB Bridge to Airport Intersection	3,912
Subtotal (m)		9,519
(2) PVA Intersection to PPR		
Section D	PVA Intersection to Meyungs Causeway	341
Section E	Meyungs Causeway to PPR	2,985
Subtotal (m)		3,326
Total length (m)		12,845

Beginning Point (B.P.) and Ending Point (E.P.)

Note-1: B.P. of Section B is the northern abutment of Minato Bridge at Sta. 2+380.

Note-2: E.P. of Section F is the iron peg on the pavement nearby the Airport Gate.

Note-3: E.P. of Section E is the western gate of PPR.

Note-4: Other B.P. and E.P. of each section is the construction limit of Inter-island Access Road Improvement Project and New KB Bridge Construction Project.

(3) The Project includes i) improvement and rehabilitation of pavement, ii) installation of drainage and sidewalk, iii) improvement of intersections, iv) land slide stabilization, v) traffic safety measures at sharp S-curve, vi) improvement at flood prone areas and vii) road incidental works such as street lighting, road marking, traffic sign and guardrail.

There exist several on-going road projects in the study area, namely “Improvement of Inter-island Access Road” under Japanese grant aid, “Compact Road Construction Project” under U.S aid and “Compact Connecting Road Project” under Taiwanese aid. The planned road project is also identified as “Coral Leaf Road Project” that is planned to run parallel to Section A and C of the study road.

The Project by Japanese Grant Aid Scheme will assist the realization of “Development of Trunk Road in Koror Urban Area” in associate ion with “Improvement of Inter-island Access Road” by pursuing to improve the durability of trunk roads, optimize the disbursement of operation/maintenance cost, improve the safety of both vehicles and pedestrians, and realize more smooth transport activities.

2-2 Basic Design of the Requested Japanese Assistance

2-2-1 Design Policy

2-2-1-1 Basic policy

In order to meet the immediate concerns of the Project, the following points are deemed important:

i) Since the Project is planned to improve the existing roads without any resettlement of Project-Affected-Persons (PAPs), it is indispensable to minimize public disturbance by making full use of existing facilities.

ii) Practical considerations should be taken to physical constraints such as elevation controls stemmed from access to/egress from adjacent facilities, on-road manholes, undesirable geometries (sharp S-curve and steep slope), existing drainage system, and etc.

iii) Due attentions should be paid to traffic safety, especially separation of pedestrian from vehicular traffic, maintaining sufficient sight distance at sharp S-curve and channelization at intersection

As for the basic policy of the project basic design, the following six aspects were taking into account.

i) To provide safety in roads/structures design.

ii) To keep full attention on environmental issues and eliminate adverse influences to the existing environment by the Project as much as possible.

iii) To minimize the required land acquisition for the Project.

iv) To attain the full requirement of the Project with the least construction cost.

v) To apply practical and reasonable design criteria for the required functions of the Project.

vi) To implement the Project with the least construction period, comply with Japan Grant Aid program operated under fiscal year basis.

2-2-1-2 Design policies for natural conditions

The salient features of natural conditions in Palau are the typical tropical weather such as extraordinary high rainfall up to 4,000 mm and 200 rainy days a year. Accordingly, ti is necessary to take appropriate countermeasures against storm water during construction.

2-2-1-3 Design policies for social conditions

(1) Land Acquisition and Relocation of Structures

The design concept of road improvement in Section A is planned to build undivided 3-lane carriageway with sidewalks in the whole stretch on condition that no person is resettled due to the Project. Since undivided 2-lane carriageway exists between Shell Intersection and Mobil Top-side Intersection, the existing road right-of-way (ROW) should be widened inevitably. Additional lands may be required at PVA Intersection and along the stretches between Shell Intersection and Mobil Top-side Intersection, and existing properties and facilities should be relocated or removed.

14m (46 ft) ROW should be secured to maintain existing traffic during construction and to avert any resettlement of Project-Affected-Persons (PAPs).

(2) Minimizing relocation of facilities

There exist many properties and facilities along roads such as electric posts, hydrants, trees and school gates/stone platforms as a historical heritage. Any new horizontal alignment is not designed to achieve minimal public disturbance and each cross section is designated as the location of new road to avoid excessive land acquisition, relocation/demolition of buildings and facilities.

2-2-1-4 Design policies for Road Design

(1) Design Standard

AASHTO Design Standard is prevailing in Palau, and it should apply to the study road if necessary. It is more practical that the study road refers to the standard design applied in the "Improvement of Inter-island Access Road" and. "Compact Road Project" in principle.

However, the objective of the Project is to improve the existing roads and the Project should pursue that the improvement works should be carried out without any resettlement of Project-Affected-Persons (PAPs) even though the Project includes the construction of the third lane in Section A and widening of roads at PVA Intersection. Accordingly, it is recommendable that no geometric design criteria including design speed are determined and only prevailing standard designs should be applied to the Project as much as possible.

(2) Horizontal and Vertical Alignments

1) Horizontal Alignment in Section A

The design concept of road improvement in Section A is planned to build undivided 3-lane carriageway with sidewalks in the whole stretch on condition that no person is

resettled due to the Project. Since undivided 2-lane carriageway exists between Shell Intersection and Mobil Top-side Intersection, the existing road right-of-way (ROW) should be widened inevitably. Additional lands may be required at PVA Intersection and along the stretches between Shell Intersection and Mobil Top-side Intersection, and existing properties and facilities should be relocated or removed.

It was confirmed by the joint-survey on 12 February 2006 that no resettlement may take place even during construction provided that proposed 14m (46 ft) ROW should be secured. However, there are many physical constraints and the direction of widening is determined section by section. Therefore, any new horizontal alignment is not designed to achieve minimal public disturbance and each cross section is designated as the location of new road to avoid excessive land acquisition, relocation/demolition of buildings and facilities.

2) Vertical Alignment in Section A

There exist two water supply pipes in the existing ROW and one of two pipes is made of asbestos and it is enough old to be affected by vehicular traffic if existing pavement structure is removed and the thickness of cover be lessened. The survey results of Benkelmann Beam Test conclude that existing base course is enough strong and it is confirmed by the laboratory test results of samples at test pits. Therefore, the elevation of existing roads should be kept as much as possible and deteriorated surface course is scarified and designed asphalt concrete surface course is newly built after base course is compacted and designed cross-fall is formed.

This design concept has advantages in the aspects of minimizing troublesome earthwork and facilitating maintenance and protection of existing traffic due to minimizing deep excavation. Moreover, it can easily maintain the present access from the project roads to adjacent buildings/facilities even during construction.

3) Horizontal and Vertical Alignments in Sections other than Section A

The improvement works are planned to follow the existing alignments horizontally and vertically in principle. However, the vertical alignment is designed to raise the elevation up to 50cm in the flood prone area at Sta. 11+700 in Section F1.

(3) Improvement of Pavement

Asphalt concrete pavement is superior to cement concrete pavement in the study area where existing traffic should be maintained during construction and land use along the road is densely developed. It is the most remarkable advantage that it takes a few hours to open to public after construction of asphalt concrete pavement, while the curing of concrete is

indispensable in case of cement concrete pavement and it must keep vehicular traffic and pedestrian away for a few weeks. It is impossible to provide detour space without resettlement of PAPs. Moreover, it will become troublesome once cement concrete pavement is damaged and urgent repair is required.

Life-cycle cost analysis is required to demonstrate the value-for-money in the aspect of quantitative parameter, namely cost-performance. The cost-performance fully depends upon the cumulative cost for pavement repair in the project life that theoretically is equivalent to cumulative application of design axle loads. However, such a quantitative parameter will make sense on condition that enforcement to over-loaded vehicles shall come in reality.

Accordingly, asphalt concrete pavement is recommended for the Project in the rehabilitation section as well as the new construction.

(4) Drainage

The design concept of the drainage for the Project is as follows:

1) Section A

A new drainage facility such as U-ditch is required as 3-lane carriageway with sidewalk is planned in the whole stretch. Ten inlets of existing drainage systems are identified in Section A. Existing drainage system is maintained as it is and no additional drainage system is planned because the Project is a road improvement within existing ROW. Accordingly, all storm water on pavement is planned to drain to tributary of urban drain system through each drainage system. Since existing drainage systems presently have individual drain capacity, the discharge capacity of U-ditch installed should keep consistency to that of inlet in the existing drainage system.

2) Sections other than Section A

There are four flood prone areas in Section B, Section E1 and Section F1. No outstanding outlet is found in the sag at three among four areas and it causes flood to retain storm water for a long time. It is necessary to install a new drainage facility to drain storm water.

The flood prone area at Sta. 11+700 in Section F1 exists in the vicinity of 3-cell box culvert where the box culvert is submerged during high tide. It may cause flood that the elevation of road surface is too low and the discharge capacity of box culvert is insufficient. It is necessary to raise road elevation and to provide box culvert with additional head room.

Existing drainage facilities are kept in the sections other than Section A and no additional drainage is provided except these four areas.

(5) Adjustment of Manhole Elevation

There are a lot of manholes in the existing roads and its elevation should coincide with the finished grade of road after the improvement. Hence, the adjustment of manhole elevation is required to be carried out together with the road improvement in the aspect of traffic safety where the existing traffic over 20 thousands car/day should be maintained during construction.

(6) Improvement of Intersection

Nine (9) major intersections exist in Section A, namely i) PVA（3-leg）, ii) Courthouse（3-leg）, iii) Shell（3-leg）, iv) Hanpa（4-leg）, v) Mokko（3-leg）, vi) T-Dock（3-leg）, vii) Etpison Museum（3-leg）,viii) Island Mart (4-leg) and ix) Mobil Top-side（3-leg）. These intersections are congested during morning and evening peak hours due to poor traffic capacity. Although the causes of congestion are various and complicated, it is sure that lack of channelization is one of major causes from engineering viewpoint. Improvement of the major intersections aims at the adaptation to the increasing traffic and improvement of the traffic safety in Section A by channelization. Standard channelization such as separation of the traffic by direction at the entrance of the intersection will be adopted to regulate the traffic flow. In order to avoid the traffic accident of vehicles or a vehicle and pedestrian, and improve traffic safety, stop lines will be marked. PVA intersection and Shell inter section have a lot of traffic in each direction and people crossing the road, so that the traffic island will be constructed.

(7) Slope Stabilization and Protection

There are four locations having damages of pavement caused by settlement in Section C, Section E2, Section F1 and Section F2.

1) Section C: Top-side

The damaged pavement caused by settlement is 35m long, and the cause of settlement is the landslide because 6 m long slope failure is found in the road embankment. There is 30 m distance from the top of embankment to adjacent existing structure. The design concept for slope stabilization and protection is to be settled by the practical measures that comprise bench cut down to the sliding face, installation of French drain, refill by selected material with geotextile, and slope protection by sod.

2) Section E2: Access to Maritime Surveillance Advisor’s Residence

The damaged pavement caused by settlement is 80m long, and the cause of settlement is “depressions” due to shortfall of bearing capacity because 5 – 8m high steep slope looks sound but raked guardrail is found on the top of slope. The space between the project road

and access road is very limited and the ground water seeps at the toe of the slope.

The design concept for slope stabilization and protection is to be settled by the practical measures that comprise bench cut down 1.5 m deep, installation of French drain, refill by selected material with geotextile, and slope protection by concrete wall.

3) Section F1: Nearby Airai View Hotel

The damaged pavement caused by settlement is 40m long, and the cause of settlement is the landslide because slope failure is found in the road embankment. The space is enough wide from the top of embankment to adjacent arable land.

The design concept for slope stabilization and protection is to be settled by the practical measures that comprise bench cut down to the sliding face, installation of French drain, refill by selected material with geotextile, and slope protection by gabion.

4) Section F2: Airport Access Road

The damaged concrete pavement caused by settlement is 35m long, and the cause of settlement is "depressions" due to shortfall of bearing capacity because the concrete parapet along the pavement is kept as it was, and no phenomenon of landslide is observed in the slope and its surroundings.

The design concept for depression repair is the practical measures that comprise demolition of damaged concrete pavement, excavation of base course and subgrade 1.5 m deep, refill by selected material, compaction and construction of concrete pavement.

(8) Traffic Safety Measure against Sharp S-curve

Sharp S-curve sections are found in Sections C, E and F, and steel guardrails are installed to give caution to drivers and to prevent uncontrolled car from driving out carriageway. However, guardrails suffer many damages due to narrow carriageway and inappropriate position. It is "sight distance" that is one of the most important factors to enhance traffic safety, and sufficient sight distance is badly required at sharp S-curve sections.

Table 2-2-1 Location of Sharp S-curves

Section	From	To	Section	From	To
C	STA6+500	STA6+650	E	STA2+450	STA2+550
	STA6+850	STA6+950		STA3+050	STA3+150
	STA7+000	STA7+100	F	STA10+900	STA11+100
	STA7+300	STA7+400		STA11+150	STA11+250

(9) Provision of the Third Lane in Section A

The third lane is designated as auxiliary lane in the vicinity of at-grade intersection where turning traffic movement may wait for crossing opposite lane without any hampering through

traffic. However, the third lane may be used as reversible lane during peak hours where the interval between two intersections is long enough such as PVA IS to Mokko IS. If the interval between two intersections is not long enough and queuing traffic may be affected each other, the third lane should be used for the separation of traffic to regulate traffic flow during peak hours. It can be used for the space for waiting vehicles to access adjacent building and facilities during off-peak hours.

(10) Application of Concrete Cover to Existing V-shaped Ditch

Pedestrian and bicyclist are observed even in Sections other than Section A, and traffic safety measures are not always taken especially in Sections B and D where they manage to escape from overtaking large vehicles. It is desirable to provide sidewalk for them but it is hard to build because the land availability is very severe along the road.

One of practical countermeasures is to provide additional space with concrete cover on the top of existing V-shaped ditch. However, it is observe that vehicles sometimes run over existing V-shaped ditch. It is indispensable to separate pedestrian and bicyclist from vehicular traffic, and accordingly the curbstone is designed at the end of concrete cover to keep away from vehicles. The curbstone also works out significantly to protect concrete cover itself that is designed not for vehicles but for pedestrian and bicyclist.

2-2-1-5 Design policies for local construction conditions

(1) Utilization of pavement material by local products

Existing quarries and dredging sites will be able to supply fine and coarse aggregates for the Project. In the surface layer of the Compact Road Project and the runway pavement of the airport financed by United States Aid, the coarse aggregate of the pavement is imported from Taiwan from the viewpoint of the quality assurance. On the other hand, the examination value of aggregate from the same quarry lot is reported to vary in a certain rage. However, such values are found to vary within tolerance and to satisfy the standard. Accordingly, the local coarse aggregate has been used in the Project for improvement of inter-island access road executed by Japan's Grant Aid. Moreover, the process to open a new quarry site needs long time due to obtain EA issued by EQPB. It is unsuitable for the Grant Aid project to spend a long term on the application and approval of it before construction is started. It is preferable to use the locale material because Palauan side will conduct the maintenance by themselves after the project. Considering the above-mentioned, it is concluded to apply a local coarse aggregate for the asphalt mixture providing that the quality control should be performed and modified asphalt and two times heated aggregates should be used.

Table 2-2-2 shows the comparison of major properties based on the test results for coarse

aggregate

Table 2-2-2 Outline of Comparison of Major Properties for Coarse Aggregate

Quarry Site	Polycarp	Ngaremlengui	PTC	HBR	Japanese Standard (Surface and binder layer)
Location	Ngechesar, Babeldaob	Ngaremlengui, Babeldaob	Malakal	Koror	
Rock Type	Basalt	Basalt	Basalt	Limestone	
Bulk specific gravity, Dry	2.45～2.73	2.31～2.48	2.56～2.61	2.42	
Absorption (%)	1.6～4.8	3.1～6.4	2.2～2.3	2.8	
Abrasion (%)	11～30	20～28	23～31	35	<30*1)

*1): Federal Lands Highways (USA) applies 40% max.
Source: quarry companies or owner

Although "Compact Road Construction Project" and Airport Project under U. S. Aid use imported aggregates for the surface course. through market basis. As coral has ample deposits along Palau coastal area, and shows stable and strong characteristics when compacted well, it is scheduled to use coral as a base course material.

Based on the comparative design study and cost comparison, it was proposed to apply an asphalt concrete pavement for the project road. However, as stated below, it is noted that the supply of asphalt mixture by the local supplier would be not stable, and the construction cost of cement concrete pavement is quite competitive, or sometimes cheaper than the asphalt paving in Palau. Since the Japanese Grant Aid Project is strictly required to keep the original construction period, it is recommended to leave the possibility of applying the cement concrete pavement for the causeway section, in order to make a smooth work progress, not suffered by the unstable or insufficient asphalt mixture supply. Malakal Island Road will be applied an asphalt concrete pavement only, due to the viewpoint of work efficiency with ample roadside spaces.

(2) Design policies for utilization of local contractors

Majority of registered 30 contractors in Palau are architectures. Number of contractors who is able to carry out civil work construction is quite limited. Taking into consideration such condition, the Project was aimed to design by applying general construction methods as much as possible. Table 2-2-3 shows the list of potential contractors possible to deploy for the Project.

Table 2-2-3 Major Contractors in Metropolitan Area

Contractors	Civil	Architect	Equipment Materials
Black Micro Corporation	○	○	○
Socio Micronesia Incorporated	○	○	○
Surangel & Sun's Construction	○	○	○
Fortune Investment & Development. Corp., Ltd.	○		○
Palau Transportation Company (PTC)	○		
FR Construction Company	○		

Note: Socio and Surangel are associated firm.

2-2-1-6 Design policies for operation and maintenance ability of executing agency

Major maintenance works such as minor repair and cleaning are required, and it is estimated $47,000 for annual maintenance cost. Although it account for 16% against total maintenance budget for Public Works Department that the Government of Palau allocates around 300,000 US dollars annually, the Office of President recognizes the important roles and functions of trunk roads in Koror urban area and commits to put high priority for budget allocation.

The level of operation and maintenance is kept fair in terms of technical aspect, compared to that of other Oceanian countries because technical staffs who are experienced Filipino engineers and have studied in U.S.A are involved. The organization, personnel and equipment are substantially workable. Therefore, no technical matters are found in the operation and maintenance of improved roads.

Table 2-2-4 Schedule of Periodic Inspection and Maintenance

	Frequency	Place	Works
Cleaning of Drainage	2 times/year	Ditch & Culvert	Remove of deposit
Road Signs	1 time/year	Markings	Re-painting
Traffic Signs	2 times/year	Sign Plate	Cleaning
Mowing	2 times/year	Shoulders	Grass cutting
Repair of Pavement	1 time/year	Surface	Patching
			Overlay
Repair of Sidewalk	1 time/year	Concrete pavement	Reconstruction
Road lighting	1 time/year	Bulb	Change
		Electric wire	Repair of wire

2-2-1-7 Design policies for environmental considerations

Based on the review of preliminary report, the results of the field survey, and the comments from the related agencies, identification of environmental impacts and the mitigation measures are summarized in Table 2-2-5.

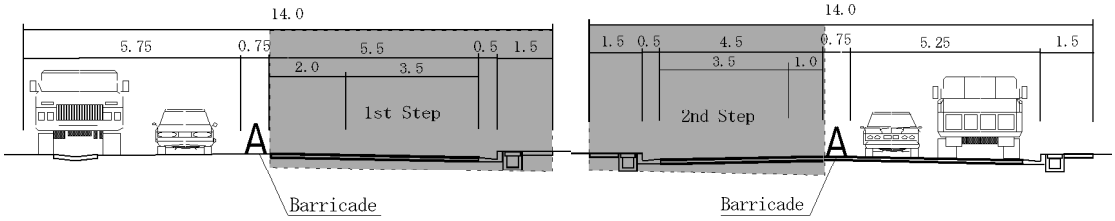
Table 2-2-5 Environmental Impacts and Mitigation Measures

Environmental Impacts	Mitigation Measures	Related Laws and Regulations	Priority
Design Stage			
Encroachment to private property and historic/cultural sites	To minimize the impact on properties and ensure a peaceful land acquisition	Laws for Historic-Cultural Conservation	Middle
Water contamination due to runoff water	Adopting adequate runoff drainage system	Environmental Conservation Law and Regulations	High
Temporary yard for stockpiling	To plan the location of the temporary yard for stockpiling at the area as near as possible to the Project site in order to minimize the negative impact along the road	Environmental Conservation Law and Regulations	High
Impact to aquatic life by Raising Box Culvert	To consider the condition of the habitat along the road and to make appropriate construction planning	Environmental Conservation Law and State's regulations for Mangrove Conservation	High
Traffic congestion	To secure two lanes two ways during construction in Section A	Environmental Conservation Law and Regulations	Middle
Construction Stage			
Air pollution / Noise/ Vibration	Equipment and machinery with air pollution control and noise dampening devices that are operating correctly. Vehicles transporting sand and soil shall be covered with a tarpaulin. The operation of heavy equipment in daylight hours. Spraying of bare areas with water. Equipment with scheme for excessive noise control & dust control Limitation of equipment use in the night	Environmental Conservation Law and State's Regulations for Mangrove Conservation	High
Spoil and Construction Waste Disposal	Estimate the amounts and types of spoil and waste. Investigation of reusing of waste. Designated appropriate disposal sites.	Solid Waste Management Regulations	Low (Available)
Damage to aquatic life (corals and mangroves) caused by siltation	Installation of silt curtains with floats to enclose the construction site, in order to prevent damages to aquatic life by siltation.	State's Regulations for Mangrove Conservation	High
Water contamination by accidental oil spills from construction equipment	Proper construction management such as training of operators, labors and workers shall avoid oil pollution of water bodies by operating the construction equipment. Providing spill kits and training in their usage for construction personnel.	Environmental Conservation Law and State's Regulations for Mangrove Conservation	High
Traffic condition	Installation of traffic warning signs. Information dissemination in densely populated areas. Assign traffic man. Introducing traffic rerouting schemes for the construction. Planning stock piling area at nearest place to the site to avoid traffic jam.	Environmental Conservation Law and State's Regulations for Mangrove Conservation	Middle

2-2-1-8 Design policies for construction methodology/construction period

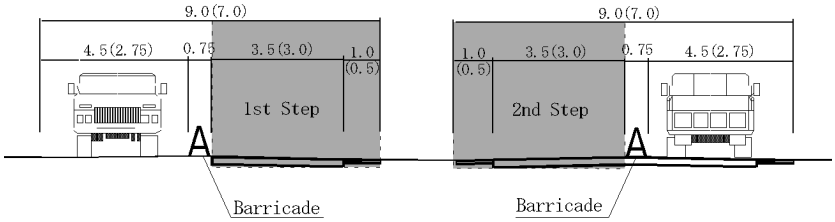
The system of supervision and construction management to secure the safety and smooth traffic is incorporated, because the construction will be conducted while changing traffic. Because the land problem is severe in Palau, it is necessary to accommodate the changing traffic within right-of-way. If the adjoining land need for securing the traffic, it is necessary to confer with the landowner, and to follow the procedure for leased land and so forth.

Figure 2-2-1 and Figure 2-2-2 show example of traffic management by lateral, and construction method.



1st Step 2nd Step

Section A



1st Step 2nd Step

Note: Value in parentheses are applied in case of Section E2.

Section B, C, D, E and F

Figure 2-2-1 Image of Traffic Management under Construction

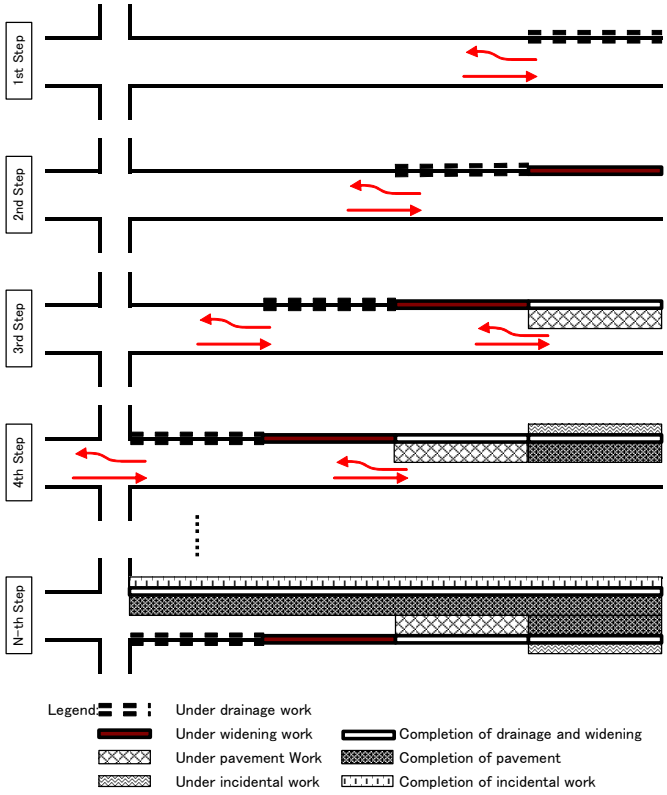


Figure 2-2-2 Image of Construction Method

2-2-2 Basic Plan

2-2-2-1 General Plan

Table 2-2-6 and Table 2-2-7 show the road length of each section for the Project.

Table 2-2-6 Road Length of Each Section

Section			Length* (m)
Section A		PVA Intersection～Mobil Top-side Intersection	2,700
Section B		Minato Bridge～PVA Intersection	530
Section C		Mobil Top-side Intersection～Airai Causeway	2,377
Section D		PVA Intersection～Meyungs Causeway	341
Section E		Meyungs Causeway～PPR	2,985
	E 1	Meyungs Causeway～Sta. 2+175	1,150
	E 2	Sta. 2+175～PPR	1,835
Section F		New KB Bridge～Airport Intersection	3,912
	F 1	New KB Bridge～Airport Access Intersection	3,122
	F 2*	Concrete Pavement Section	314
	F 3	Concrete Pavement Section～Airport Intersection	476
Total Length (m)			12,531

* denotes that Section F2 is to be set aside from the Project through discussion with the Palauan side.

Table 2-2-7 Road Length of Section A

Section		length（m）
Section A-1	PVA Intersection～Courthouse Intersection	420
Section A-2	Courthouse Intersection～Shell Intersection	350
Section A-3	Shell Intersection～Hanpa Intersection	440
Section A-4	Hanpa Intersection～Mokko Intersection	480
Section A-5	Mokko Intersection～T-Dock Intersection	150
Section A-6	T-Dock Intersection～Etpison Museum Intersection	190
Section A-7	Etpison Museum Intersection～Island Mart Intersection	210
Section A-8	Island Mart Intersection～Mobil Top-side Intersection	460
Total（m）		2,700

For the project basic design, international design standards as listed in Table 2-6 were applied.

Table 2-2-8 Applied Design Standards to the Project

Design Item	**Applied Design Standards**
Highway design	A Policy on Geometric Design of Highway and Street, 2004, AASHTO Japanese Road Structure Ordinance, 2003
Structural design	Standard Design Drawings, Ministry of Construction, Japan, 2000
Pavement design	Guide for Design of Pavement Structure, 1993, AASHTO Manual for Asphalt Pavement, Japan Road Association, 1996
Drainage design	Manual for Road Drainage, Japan Road Association Manual for Road Earthwork, Japan Road Association

2-2-2-2 Difference between Request of Palau and the Project

Table 2-2-9 shows the details of Palauan request by their original application to Grant Aid Assistance and items approved to implement by the Project.

Table 2-2-9 Difference between Request of Palau and Basic Design Policy

	Requested Item	The Project
Total length of Roads	12.237km	12.531km
Repair of road surface cracks, potholes, etc.	Improve	Improve
Repair of subgrade, subbase course and base course	Improve	Improve
Widening of Section A	Widen	Widen
Provision of sidewalk, guardrail and concrete barrier	Newly install, Improve	Newly install, Improve
Improvement of road drainage system (side ditch, cross drainage, catch basin, outlet, etc.)	Improve	Improve
Improvement of 9 Intersections	Improve	Improve
Provision of street light	Newly install	Newly install
Provision of road markings and traffic signs	Newly install	Newly install
Adjustment of Manhole Elevation	Improve	Improve
Slope Stabilization and Protection	4 Locations	3 Locations

2-2-2-3 Design Concept of Facility

(1) Design Concept of Road

1) Typical Cross Sections

Typical cross section of each road section is given in Figure 2-2-3 thru Figure 2-2-7, considering that of "Improvement of Inter-island Access Road" and. "Compact Road Project".

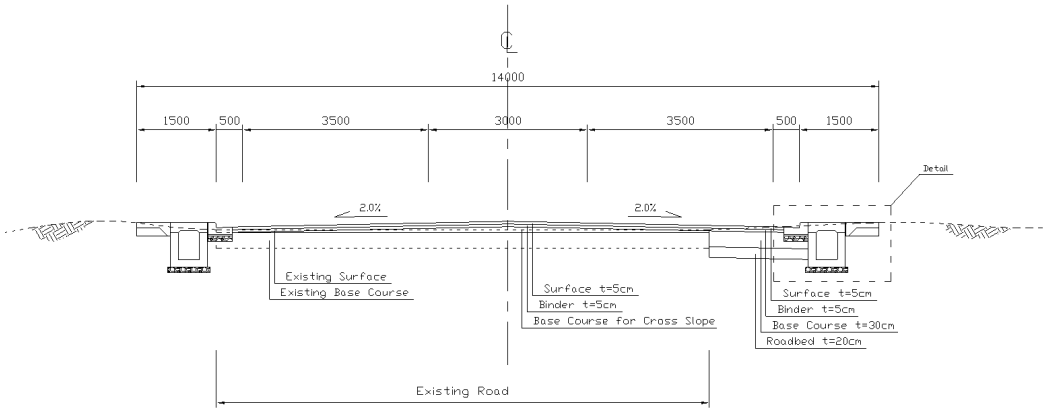


Figure 2-2-3 Typical Cross Section (Section A)

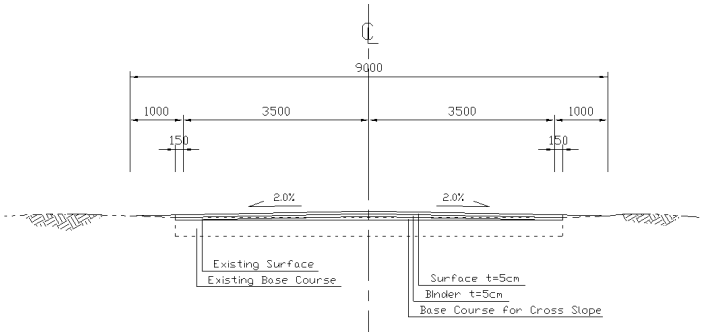


Figure 2-2-4 Typical Cross Section (Section B, C & D)

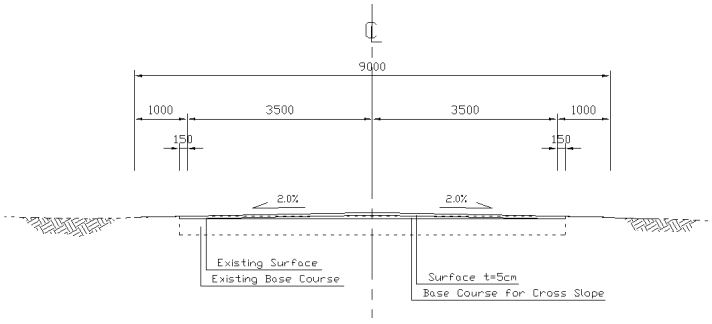


Figure 2-2-5 Typical Cross Section (Section E1 & F1)

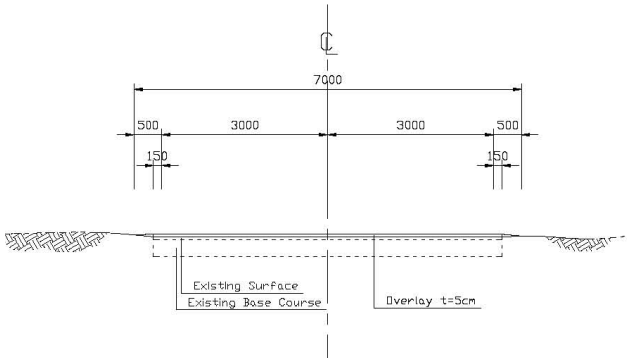


Figure 2-2-6 Typical Cross Section (Section E2)

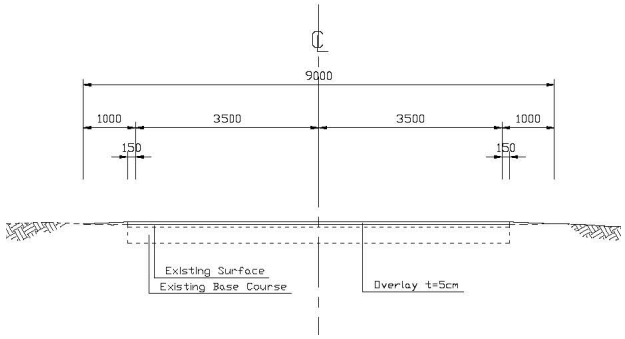


Figure 2-2-7 Typical Cross Section (Section F3)

2) Horizontal Alignment

The existing alignment is followed in principle. The centerline of existing road is planned to shift its position in the widening section in Section A to accord with new center of road and the alignment is tapered in the transition section between the existing and the new.

3) Vertical Alignment

The existing alignment is followed in principle. The profile is planned to rise 0.5 m high in the flood prone area in Section F1 in order to prevent road surface from inundation.

4) Improvement of Pavement

a) Road Inventory Survey

Road Inventory Survey was conducted in order to determine the improvement method for respective sections from the aspects of traveling performance, degree of the damage of the surface (visual observation), and deflection.

b) Improvement Method

The method of improvement is categorized into four types evaluated in aspect of road inventory survey as shown in Table 2-2-10 based on the result of Road Inventory Survey. Each design section is approximately 500m long considering practicability and efficiency of work and, the comprehensive evaluation of each design section is made accumulating evaluation results of each 200m long sub-section.

Table 2-2-10 Improvement Method

Type	Methods of Improvement
Type A	No requirement of improvement
Type B	Overlay after sealing and patching
Type C	Partial strengthening of base course and re- surfacing
Type D	Partial strengthening of base course and construction of new surface course

c) Criteria for Evaluation

i) Traveling Performance

The comfort of car riding measured by Roughness Index is the factor for evaluation. The criteria are given in Table 2-2-11.

Table 2-2-11 Traveling Performance Evaluation

Traveling Performance	Roughness Index	Type
Very Good	IRI<6	A
Good	6<IRI<8	A
Fair	8<IRI<10	B
Poor	10<IRI<12	C
Bad	12<IRI	D

ii) Degree of Damage

The surface condition by visual observation is the factor for evaluation. The criteria are shown in Table 2-2-12.

Table 2-2-12 Criteria for Surface Damage Evaluation

No.	Surface Condition	Cause of deterioration	Type	Sample
a	Alligator Crack	Low asphalt quality Harden asphalt Bad drainage condition	C／D	
b	Linear Clacks	Low asphalt quality Harden asphalt Low temperature	B／C	
c	Pot holes	Low asphalt quality Harden asphalt	B／C	
d	Rutting	Excessive asphalt content Poor aggregate material	C／D	
e	Raveling	Excessive asphalt content Bad drainage condition Poor base material	B／C	

iii) Deflection

Criteria

Deflection of existing pavement that demonstrates strengthening of pavement structure was measured by Benkelmann Beam Test. The evaluation criterion for deflection is based on Table 2-2-13.

Table 2-2-13 Overlay Thickness by Deflection

(Unit : cm)

Deflection (mm)	Classification of Traffic				
	L-traffic	A-traffic	B-traffic	C-traffic	D-traffic
<0. 6	—	—	—	4	4
0. 6<D<1.0	—	—	—	6	8
1.0<D<1.5	—	—	6	10	12
1.5<D<2.0	—	6	10	12	15
2.0<D	6	10	12	15	—

The classification of traffic is based on Table 2-2-14, considering number of heavy

vehicles such as buses and trucks.

Table 2-2-14 Classification of Traffic

Classification	Heavy Vehicles (Veh./ Day·Way)
L-traffic	Less 100
A-traffic	100<T<250
B-traffic	250<T<1,000
C-traffic	1,000<T<3,000
D-traffic	Over 3,000

Estimation of Heavy Vehicles

24-hour Traffic count survey was conducted at PVA Intersection. Table 2-2-15 gives the result of survey.

Table 2-2-15 Traffic Count Survey (24-hour) at PVA Intersection

unit: vehicle

	2-wheel	Sedan	Pick-up	Buses	Trucks	Total
For Malakal	64	7,842	1,052	192	325	9,475
For Airai	82	7,435	1,099	177	103	8,896
Total	146	15,277	2,151	369	428	18,371

Axle load survey was conducted in the vicinity of PVA Intersection to grasp distribution of axle loads of heavy vehicles.

Table 2-2-16 Result of Axle Load Survey (Gym and Supreme Court, Malakal Bound)

	Average (t)	Max. (t)	Min. (t)	No.	%
Medium Truck	3.6	5.1	2.5	21	22.8%
Medium Bus	3.5	4.2	2.9	7	7.6%
Large Bus	9.0	12.9	5.5	15	16.3%
Large Truck	13.9	24.7	5.6	32	34.8%
Trailer Truck	21.3	39.2	9.1	17	18.5%
Total				92	

Table 2-2-17 Result of Axle Load Survey (Neco Marin, Airai Bound)

	Average (t)	Max. (t)	Min. (t)	No.	%
Medium Truck	2.9	4.4	2.0	27	27.8%
Medium Bus	3.3	3.7	2.7	8	8.2%
Large Bus	7.3	8.8	6.2	9	9.3%
Large Truck	13.3	33.0	4.3	37	38.1%
Trailer Truck	16.2	36.6	6.5	16	16.5%
Total				97	

65% - 70% of buses and trucks are regarded as heavy vehicles that have an axle more than 10 ton.

Dairy traffic at three major intersections of Shell Intersection, Hanpa Intersection and

Mobil Top-side Intersection is estimated based on 16-hour traffic, applying conversion factor of 1.0893.

Table 2-2-18 24-hour Traffic at 3 Major Intersections

Shell Intersection (Airai Side)

	2-wheel	Sedan/Pick-up	Buses/Trucks	Total
For Malakal	58	11,943	676	12,677
For Airai	60	12,379	620	13,058
Total	118	24,322	1,296	25,735

HANPA Intersection (Airai Side)

	2-wheel	Sedan/Pick-up	Buses/Trucks	Total
For Malakal	68	11,322	702	12,092
For Airai	37	10,458	406	10,901
Total	105	21,780	1,109	22,993

Mobil Top-side Intersection (Airai Side)

	2-wheel	Sedan/Pick-up	Buses/Trucks	Total
For Malakal	15	5,948	360	6,324
For Airai	14	4,958	358	5,331
Total	29	10,906	719	11,654

The number of buses and trucks at Section A is observed at the range of 350 - 700 Veh./Day・Way, and 70% of them are deemed as heavy vehicles.

Accordingly, the classification of traffic at Section A falls under B-traffic, in which number of heavy vehicles range from 250 to 1,000 Day·Way and overlay is required in case that deflection is more than 1.0 mm.

iv) Comprehensive Evaluation

The comprehensive evaluation for each 500m long section is summarized in Table 2-2-19. Each type of rehabilitation comprises the following length.

Type A:	0 m	(0 %)
Type B:	2,312 m	(18 %)
Type C:	4,272 m	(34 %)
Type D:	5,949 m	(47 %)

Table 2-2-19 Summary of Comprehensive Evaluation

Section		Station			Traveling Performance		Degree of Damage									Benkelman Deflection		Rehabilitation	
		From	-	To	IRI (m/km)	Evaluation	Alligator Crack	Evaluation	Pot Holes & Patching	Evaluation	Rutting & Depretion	Evaluation	Raveling	Evaluation	Sub-total Evaluation	Deflection (mm)	Evaluation	Total Score	Proposed Type
A		02+903	-	03+100	6.77	3	●	5	▲	2	●	5	○	3	15	1.17	3	21	
		03+100	-	03+300	7.68	3	●	5	▲	2	●	5	○	3	15	1.80	4	22	
		03+300	-	03+500	8.13	4	●	5	○	3	●	5	○	3	16	0.80	2	22	
		03+500	-	03+700	8.47	4	●	5	○	3	●	5	○	3	16	0.75	2	22	
		03+700	-	03+900	8.02	4	●	5	○	3	●	5	○	3	16	0.81	2	22	
		03+900	-	04+100	8.36	4	●	5	○	3	●	5	○	3	16	0.81	2	22	
		04+100	-	04+300	13.36	6	●	5	○	3	●	5	○	3	16	1.44	3	25	D
		04+300	-	04+500	8.70	4	●	5	○	3	●	5	○	3	16	1.05	3	23	
		04+500	-	04+700	10.40	5	●	5	○	3	●	5	○	3	16	0.59	1	22	
		04+700	-	04+900	9.72	4	●	5	○	3	●	5	○	3	16	0.41	1	21	
		04+900	-	05+100	9.83	4	●	5	○	3	●	5	○	3	16	0.97	2	22	
		05+100	-	05+300	5.97	2	●	5	○	3	●	5	○	3	16	0.95	2	20	
		05+300	-	05+476	6.54	3	●	5	○	3	●	5	○	3	16	1.02	3	22	
B		02+312	-	02+500	5.06	2	●	5	○	3	●	5	○	3	16	0.88	2	20	
		02+500	-	02+700	8.13	4	●	5	○	3	●	5	○	3	16	1.05	3	23	D
		02+700	-	02+903	5.18	2	●	5	○	3	●	5	○	3	16	0.43	1	19	
C		05+476	-	05+700	5.52	2	●	5	▲	2	●	5	○	3	15	1.62	4	21	
		05+700	-	05+900	7.56	3	●	5	○	3	●	5	○	3	16	1.03	3	22	
		05+900	-	06+100	7.68	3	●	5	○	3	●	5	○	3	16	1.07	3	22	
		06+100	-	06+300	7.56	3	●	5	▲	2	●	5	○	3	15	1.36	3	21	
		06+300	-	06+500	7.56	3	●	5	▲	2	●	5	○	3	15	1.48	3	21	
		06+500	-	06+700	7.56	3	●	5	▲	2	●	5	○	3	15	2.30	5	23	D
		06+700	-	06+900	9.27	4	●	5	▲	2	●	5	○	3	15	1.58	4	23	
		06+900	-	07+100	10.18	5	●	5	▲	2	▲	3	○	3	13	1.89	4	22	
		07+100	-	07+300	9.61	4	●	5	▲	2	●	5	○	3	15	0.89	2	21	
		07+300	-	07+500	5.41	2	●	5	○	3	●	5	○	3	16	0.98	2	20	
		07+500	-	07+700	7.00	3	●	5	▲	2	●	5	○	3	15	0.89	2	20	
		07+700	-	07+900	7.68	3	●	5	▲	2	●	5	○	3	15	0.66	2	20	
D		00+000	-	00+200	7.80	3	●	5	▲	2	●	5	○	3	15	1.01	3	21	D
		00+200	-	00+342	4.96	2	●	5	○	3	●	5	○	3	16	1.34	3	21	
E	E1	01+025	-	01+250	7.91	3	○	3	○	3	○	3	○	3	12	1.02	3	18	
		01+250	-	01+500	6.78	3	○	3	○	3	○	3	○	3	12	1.59	4	19	C
		01+500	-	01+750	6.66	3	○	3	○	3	○	3	○	3	12	0.86	2	17	
	E2	01+750	-	02+000	4.39	2	▲	2	-	0	○	3	▲	2	7	0.99	2	11	
		02+000	-	02+250	4.50	2	▲	2	○	3	-	0	▲	2	7	0.88	2	11	
		02+250	-	02+500	6.21	3	▲	2	▲	2	▲	2	▲	2	8	0.87	2	13	
		02+500	-	02+750	4.61	2	▲	2	○	3	-	0	▲	2	7	0.83	2	11	
		02+750	-	03+000	4.05	2	▲	2	-	0	▲	2	▲	2	6	1.14	3	11	B
		03+000	-	03+250	6.32	3	▲	2	○	3	-	0	○	3	8	0.42	1	12	
		03+250	-	03+500	5.75	2	▲	2	▲	2	▲	2	○	3	9	0.81	2	13	
		03+500	-	03+750	5.18	2	▲	2	-	0	▲	2	○	3	7	1.23	4	13	
		03+750	-	04+000	7.23	3	▲	2	-	0	▲	2	○	3	7	0.74	2	12	
		04+000	-	04+025	7.57	3	▲	2	▲	2	▲	2	○	3	9	0.41	1	13	
F	F1	09+400	-	09+650	9.32	4	○	3	○	3	○	3	○	3	12	0.71	2	18	
		09+650	-	09+900	10.48	5	○	3	▲	2	○	3	○	3	11	1.47	3	19	
		09+900	-	10+150	7.46	3	○	3	▲	2	○	3	▲	2	10	1.21	3	16	
		10+150	-	10+300	5.83	2	○	3	▲	2	○	3	○	3	11	1.41	3	16	
		10+300	-	10+550	6.18	3	○	3	▲	2	▲	2	○	3	10	0.62	2	15	
		10+550	-	10+800	7.81	3	○	3	▲	2	○	3	○	3	11	0.47	1	15	
		10+800	-	11+050	7.23	3	○	3	▲	2	○	3	○	3	11	0.51	1	15	C
		11+050	-	11+300	5.71	2	○	3	▲	2	○	3	○	3	11	0.86	2	15	
		11+300	-	11+550	7.81	3	▲	2	○	3	○	3	○	3	11	0.83	2	16	
		11+550	-	11+800	10.95	5	▲	2	▲	2	▲	2	○	3	9	1.51	3	17	
		11+800	-	12+050	7.69	3	○	3	▲	2	○	3	○	3	11	1.55	3	17	
		12+050	-	12+300	5.83	2	○	3	▲	2	○	3	○	3	11	0.78	2	15	
		12+300	-	12+550	9.67	4	○	3	○	3	▲	2	○	3	11	1.21	3	18	
	F2	12+550	-	12+800	7.23	3	-	0	▲	2	-	0	-	0	2	0.37	1	6	-
		12+800	-	13+050	6.53	3	-	0	▲	2	-	0	-	0	2	0.21	1	6	
	F3	13+050	-	13+300	7.46	3	▲	2	-	0	▲	2	○	3	7	1.55	4	14	B
		13+300	-	13+316	6.88	3	▲	2	▲	2	-	0	○	3	7	1.43	3	13	

Note: Evaluation of IRI, Pavement Condition and Deflection

IRI

IRI	Surface Condition of Asphalt Pavement Road by Visual Inspection	Score
3 - 0	Very Smooth	0
4 - 3	Very Good Condition, Generally Smooth	1
6 - 4	Good	2
8 - 6	Fair, A few potholes and road surface is smooth.	3
10 - 8	Bad, Many potholes and surface is not smooth	4
12 - 10	Damaged, Waving and many potholes	5
16 - 12	Heavy Damage, Many potholes and all pavement area damaged	6
> 16	Can't passed expect 4WD vehicle	7

Pavement Condition

Class	Condition	Score
●	Very Bad	5
○	Bad	3
▲	Somewhat bad	2
–	Fair	0

Benkelman Deflection	
Score	Deflection
1	D < 0.6
2	0.6 < D <1.0
3	1.0 < D < 1.5
4	1.5< D < 2.0
5	2.0 < D

Criteria
D > 20
20 > C >15
15 > B

5) Improvement of Intersection

a) Results of Traffic Survey

i) Traffic Count Survey(16 hours)

The heaviest traffic of 23,632 veh./16-hour was observed in between Shell Intersection - Hanpa Intersection.

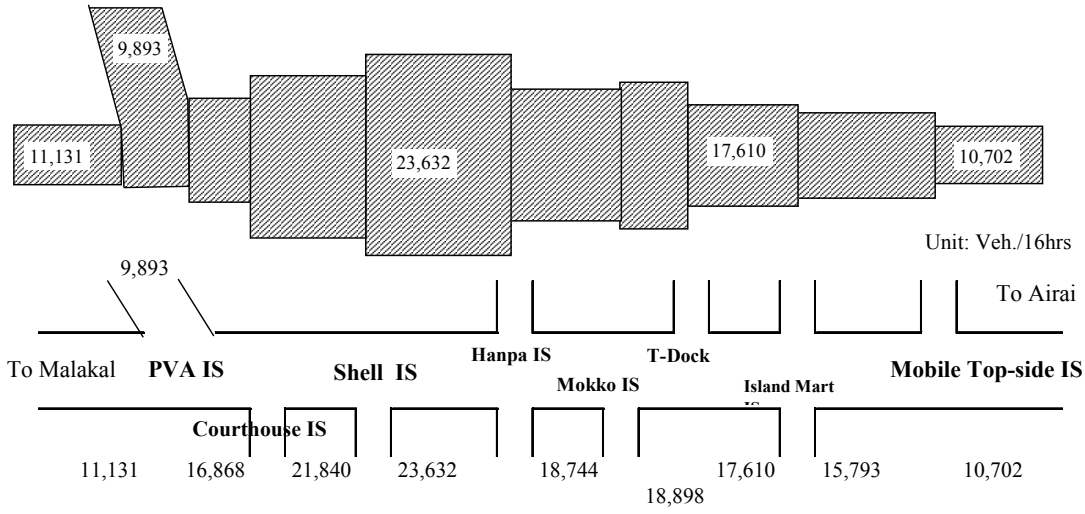


Figure 2-2-8 Result of Traffic Count Survey（16 hours）

Peak-hour traffic was observed during 7 – 8 am in the morning and 4 -6 pm in the evening. It is salient feature that both directions have peak traffic during same hours and high level of traffic is maintained even between two peak-hours. It means that degree of saturation is almost full level.

Airai - Malakal

Time (Hrs)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	Total
Volume	205	780	837	598	581	554	557	554	551	543	597	621	570	439	373	389	8,749

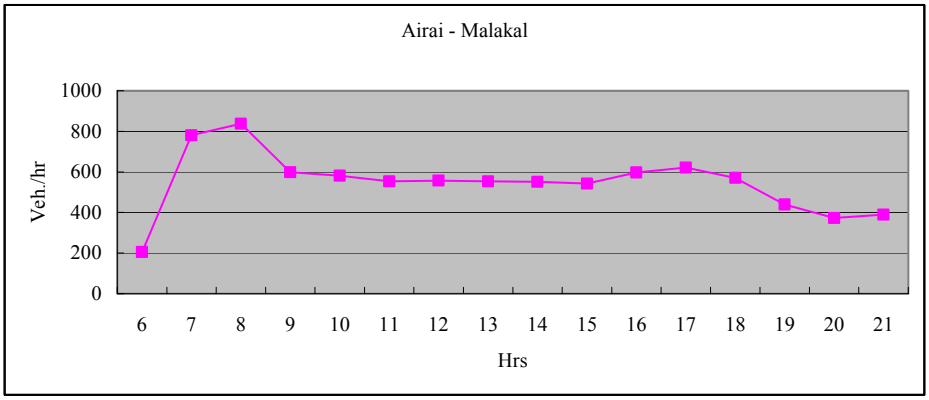


Figure 2-2-9 West-bound Traffic (For Malakal)

Malakal - Airai

Time (Hrs)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	Total
Volume	151	584	622	523	553	598	524	504	584	529	705	591	554	452	313	332	8,119

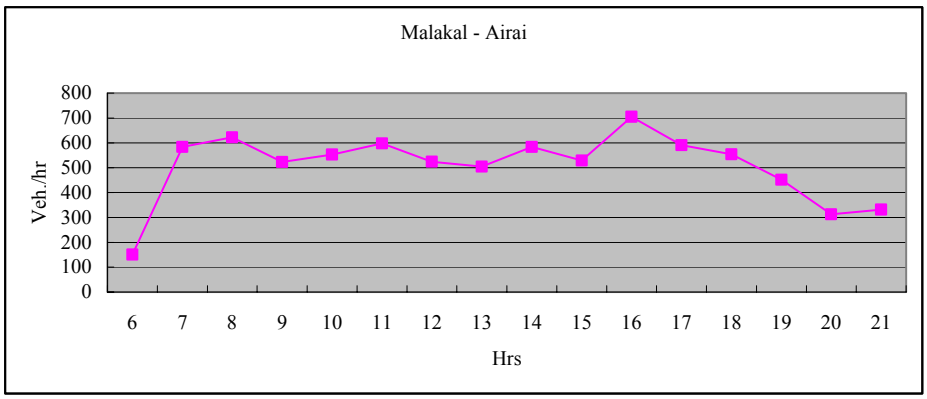


Figure 2-2-10 East-bound Traffic (For Airai)

ii) Directional Traffic(16 hours)

Considerable turning traffic was observed at 3 major intersections of Shell Intersection, Hanpa Intersection and Mobil Top-side Intersection, while T-Dock Intersection and Mobil Top-side Intersection have also significant turning traffic.

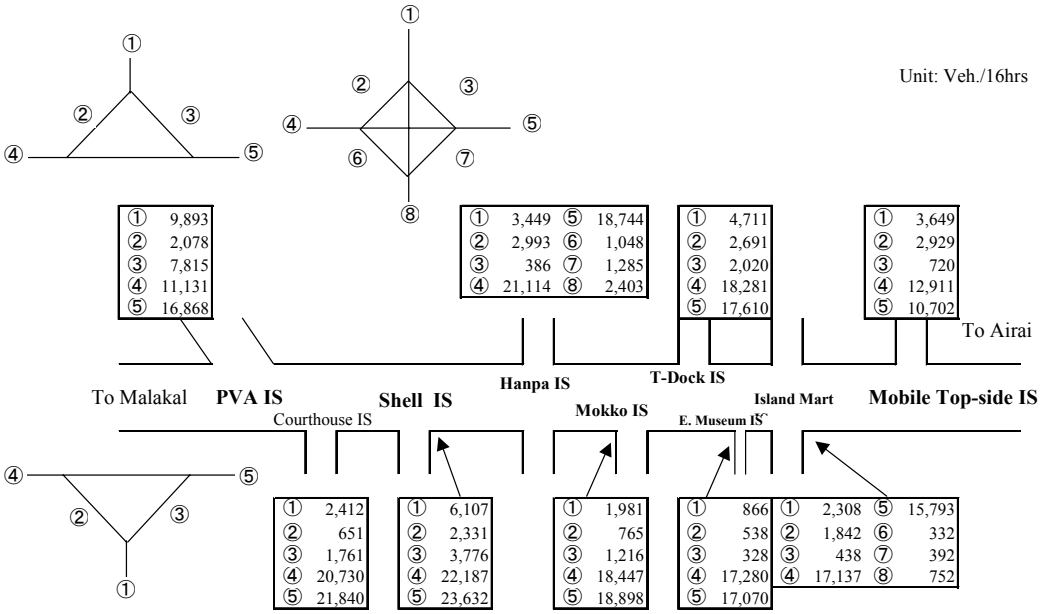


Figure 2-2-11 Traffic at each intersection in all directions

iii) Traffic Count Survey(24 hours)

8.9% of 16 hours traffic was counted to pass during nighttime of 10 pm to 6 am.

Table 2-2-20 Comparison of Traffic Volume between 16-hour and 24-hour

Airai Side at PVA Intersection

16hrs	Airai to Malakal	8,749	unit
	Malakal to Airai	8,119	unit
	Total	16,868	unit
24hrs	Airai to Malakal	9,475	unit
	Malakal to Airai	8,896	unit
	Total	18,371	unit
24 hrs/16 hrs RATIO		1.089	

iv) Travel Speed Survey

9 consecutive intersections exist in Section A (L=2,570m) and turning traffic at intersection makes through traffic delay, especially peak hours.

Normal travel speed of 30 km/h is maintained during off-peak hour but it is forced to slow down up to 10 km/h during peak hour.

Table 2-2-21 Result of Travel Speed Survey

Airai Bound Speed (Km/hr)

	9:45 AM	11:30 AM	4:40 PM	7:35 AM
PVA - Courthouse	26.8	27.3	26.8	12.1
Courthouse - Shell	23.6	8.0	5.1	10.1
Shell - Hanpa	23.6	17.8	12.9	20.4
Hanpa - T-Dock	25.3	25.6	24.3	15.6
T-Dock - Island Mart	25.3	28.1	27.6	23.6
Island Mart - Mobile Top-side	27.4	32.0	26.8	32.8
Average Speed	25.2	19.3	14.9	16.7

Malakal Bound Speed (Km/hr)

	10:25 AM	12:30 PM	4:50 PM	7:25 AM
Mobile Top-side - Island Mart	28.8	33.9	25.6	11.4
Island Mart - T-Dock	32.3	28.7	27.6	14.2
T-Dock - Hanpa	30.3	27.8	29.5	10.6
Hanpa - Shell	27.0	26.5	24.4	31.6
Shell - Courthouse	31.6	28.8	21.2	30.4
Courthouse - PVA	30.7	21.1	25.9	16.5
Average Speed	30.1	27.1	25.9	16.7

Section A: PVA - Mobil Top-side

Date	2006/2/7		2006/2/7	
Time	9:45 AM	10:25 AM	11:30 AM	12:30 PM
Direction	Malakal - Airai	Airai - Malakal	Malakal - Airai	Airai - Malakal
Speed (Km/hr)	25.2	30.1	19.3	27.1
Required Time (min)	0:06:07	0:05:08	0:08:00	0:05:42

Date	2006/2/7		2006/2/8	
Time	4:40 PM	4:50 PM	7:35 AM	7:25 AM
Direction	Malakal - Airai	Airai - Malakal	Malakal - Airai	Airai - Malakal
Speed (Km/hr)	14.9	25.9	16.7	16.7
Required Time (min)	0:10:20	0:05:58	0:09:15	0:09:15

b) Improvement Plan of Intersection

The degree of saturation at each intersection warrants accommodating future traffic as shown in Table 2-2-22, provided that traffic police manage traffic at major intersection during peak hours and the third lane should be managed properly. Traffic islands are provided at intersections of Shell and PVA, considering remarkable pedestrian crossing.

Table 2-2-22 Saturation Degree at Each Intersection

	PVA Intersection	Courthouse Intersection	Shell Intersection	Hanpa Intersection	Mokko Intersection
Saturation Degree	0.614	0.876	0.906	0.943	0.885

	T-Dock Intersection	Etpison Museum IS	Island Mart Intersection	Mobile Top-side IS
Saturation Degree	0.863	0.830	0.736	0.590

c) Layout of Channellization

The layout of intersection is designed based on determined number of lane at each approach as well as geometric design criteria. Proposed layout of intersection is given below.

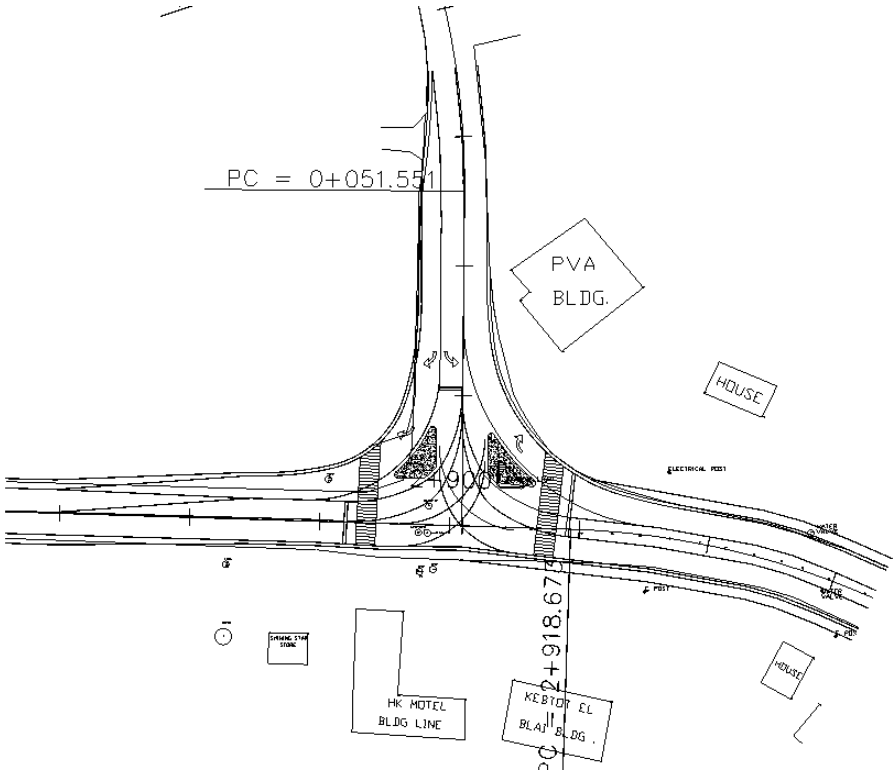


Figure 2-2-12 PVA Intersection

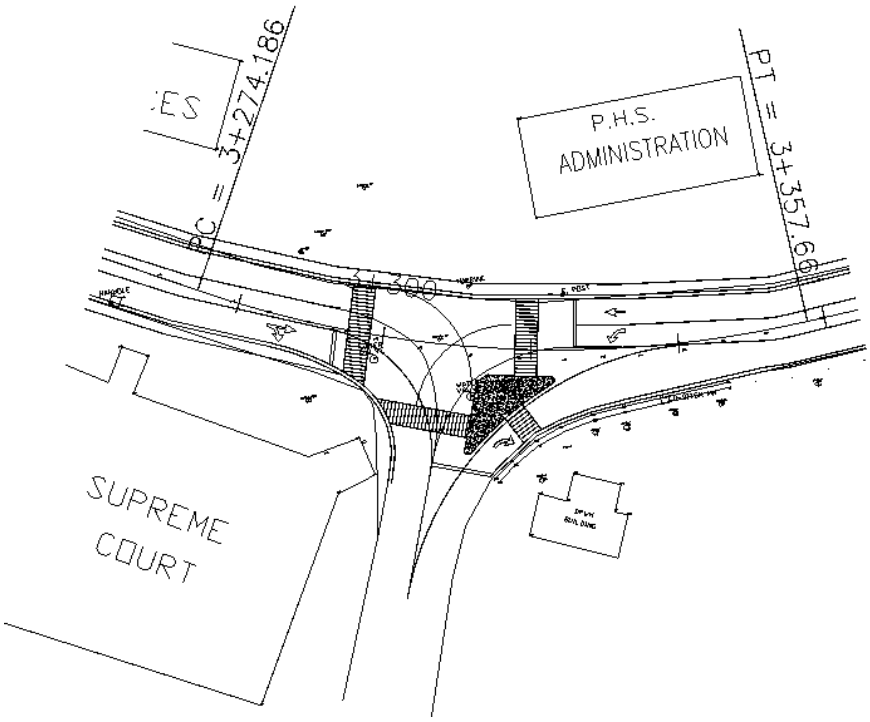


Figure 2-2-13 Courthouse Intersection

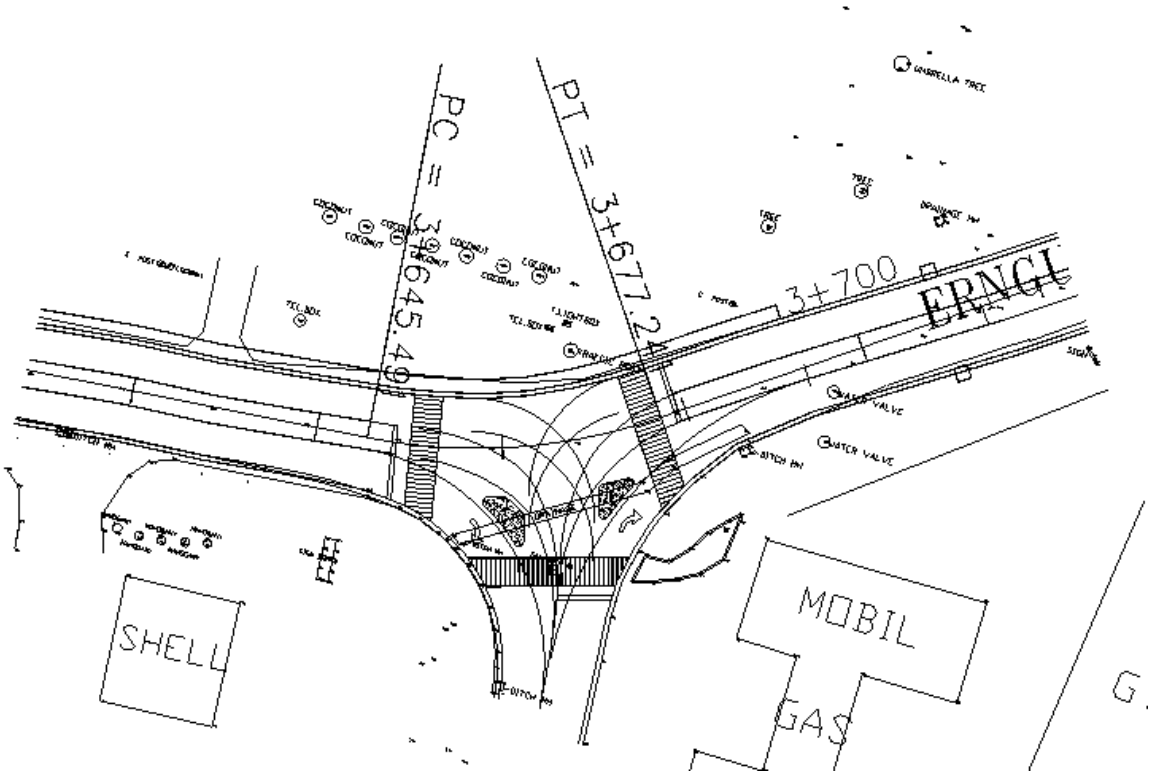


Figure 2-2-14 Shell Intersection

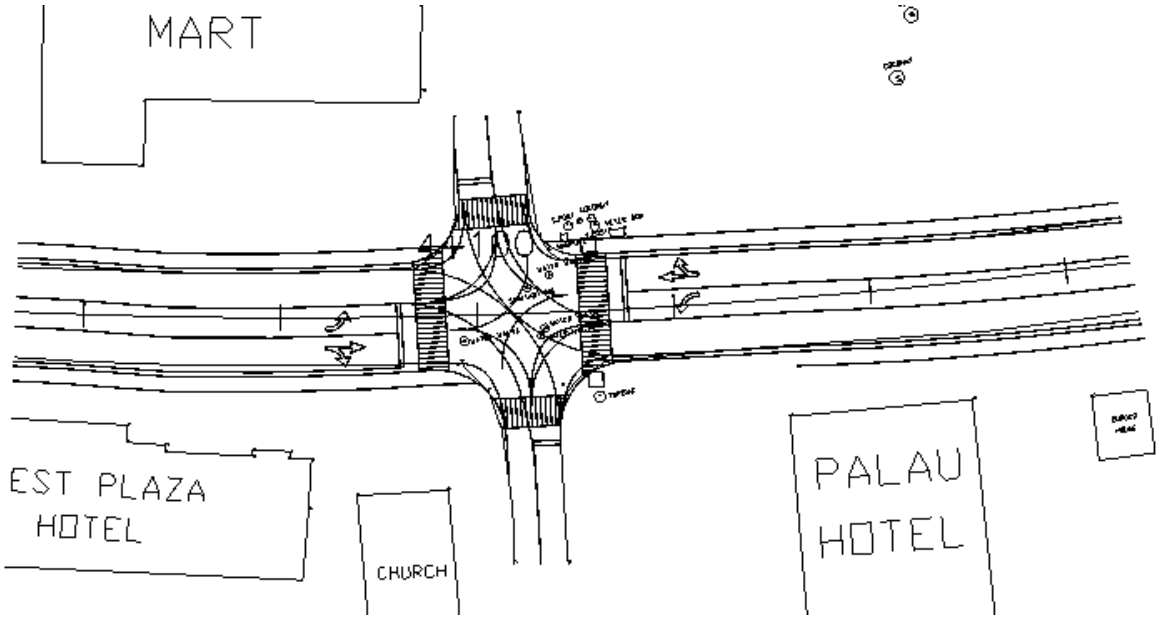


Figure 2-2-15 Hanpa Intersection

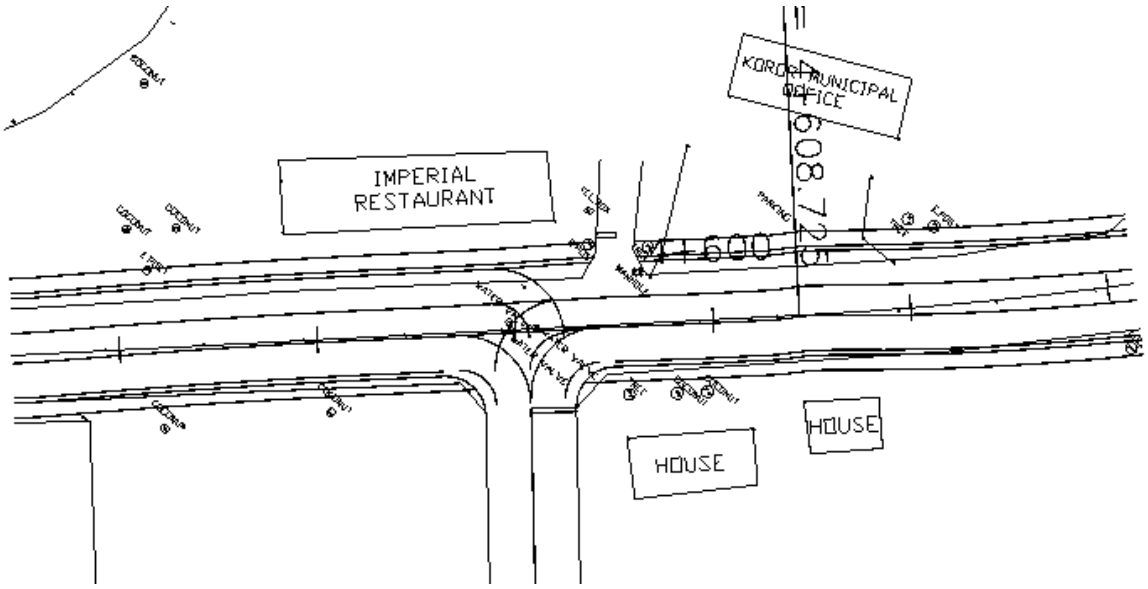


Figure 2-2-16 Mokko Intersection

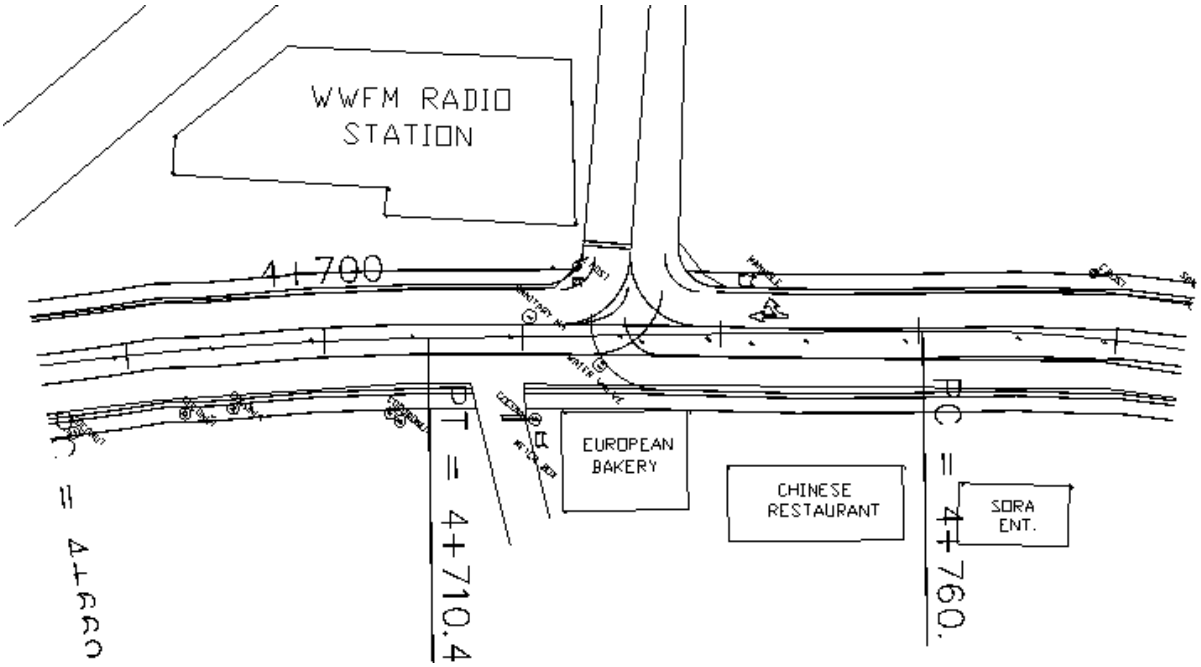


Figure 2-2-17 T-Dock Intersection

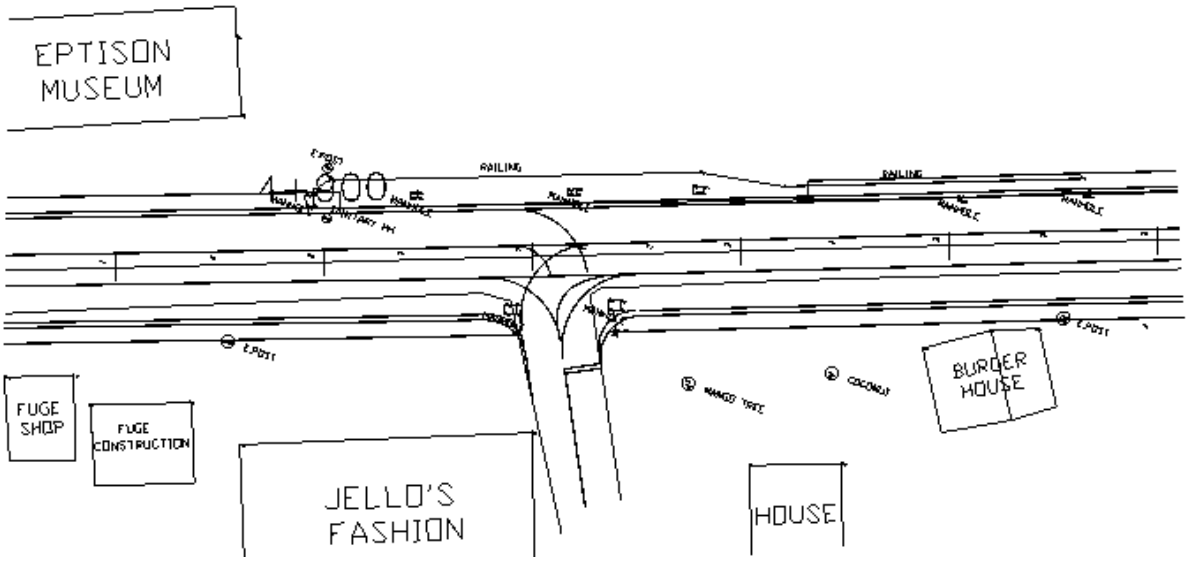


Figure 2-2-18 Etpison Museum Intersection

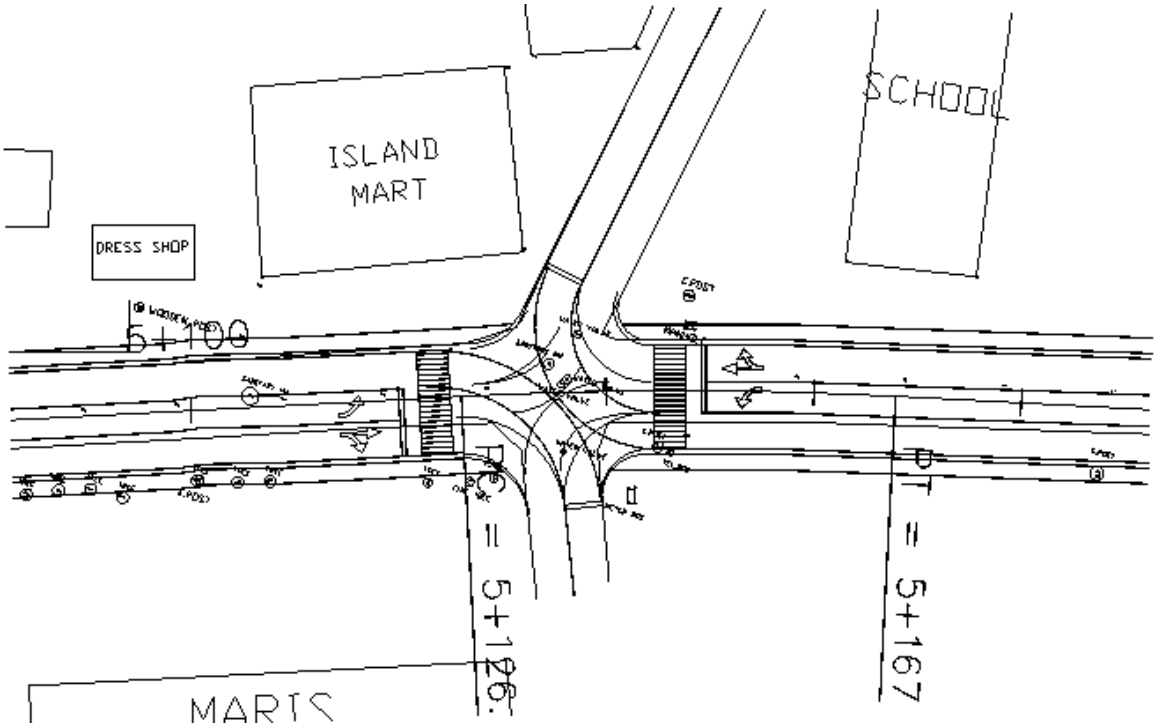


Figure 2-2-19 Island Mart Intersection

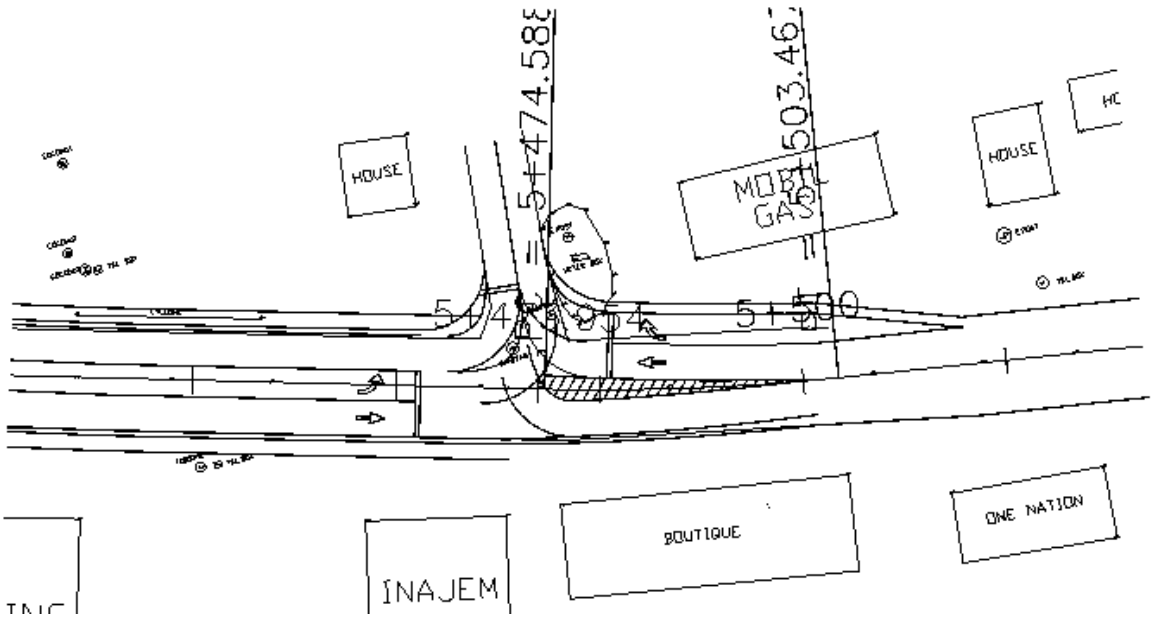


Figure 2-2-20 Mobil Top-side Intersection

6) Improvement Plan of Box Culvert

As a measure against the flood, the road between Sta. 11+535and Sta. 11+729, and the top of the box culvert is raised. The causes of the flood are a rise in ocean level at high tide and inappropriate location of the box culvert. Flooded road will be cleared with a drop in sea level so that the road will not be submerged for a long time. Therefore, the target of this improvement is to construct a sturdy road against the flood.（The top of the culvert is raised at 50 cm.）This is also the result of consideration on the neighbor requiring the access to the road.)

Proposed Improvement of the box culvert is shown in 2-3.

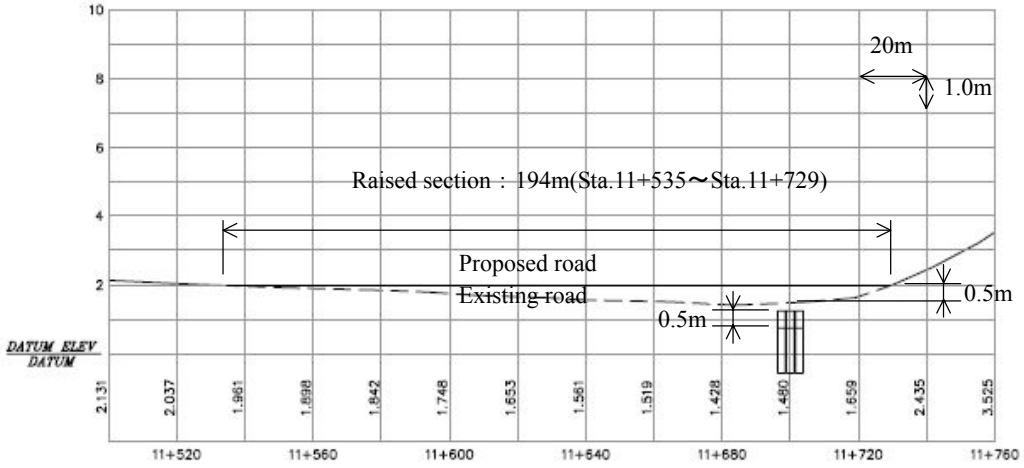


Figure 2-2-21 The raising section of the road for the measure against the flood

7) Traffic Safety Facilities

a) Traffic Sign

Traffic signs shall be installed at the following locations:

- Sharp S-curve Sections
- Nine (9) Intersections at Section A

b) Guardrail

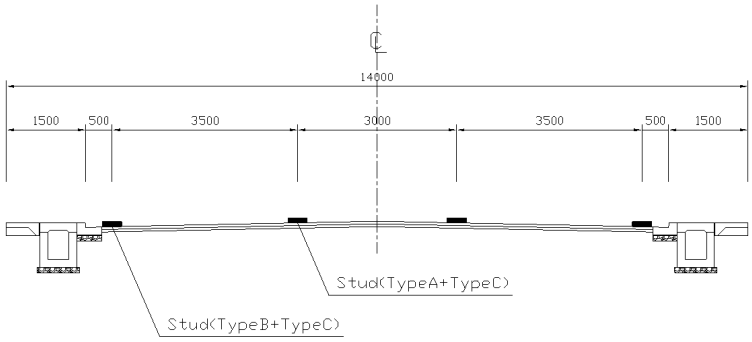
Guardrail, guard pipe and concrete barrier are installed at the following locations:

- Approach road to Minato Bridge
- Northern side of sidewalk between Courthouse Intersection and Shell Intersection
- In the vicinity of Sta. 5+300 in Section A
- In the vicinity of STA2+500 and STA3+100 in Section E
- In the vicinity of STA11+000 and STA11+200 in Section F

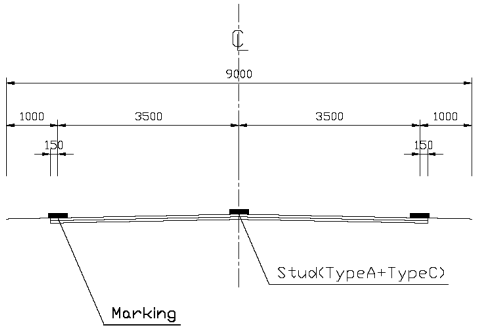
8) Road Markings

Road Markings that comprise stud and paint shall be installed at the following lines and locations:

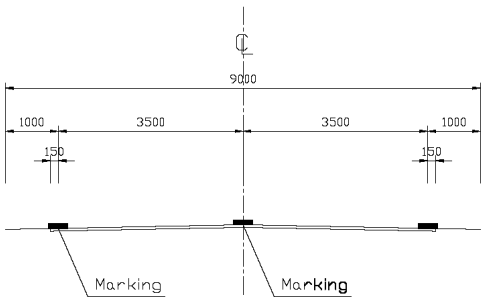
- Centerline
- Roadside line on marginal strip
- Channelization
- Pedestrian Crossing

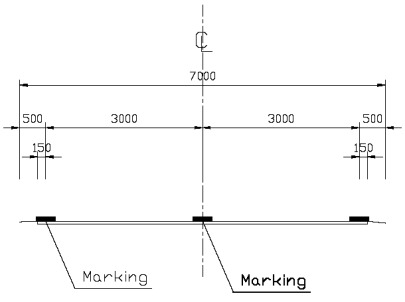


【Section A】



【Section B, C, D】





【Section E1, F1, F3】 【Section E2】

Figure 2-2-22 Arrangement of the road marking in crosswise direction

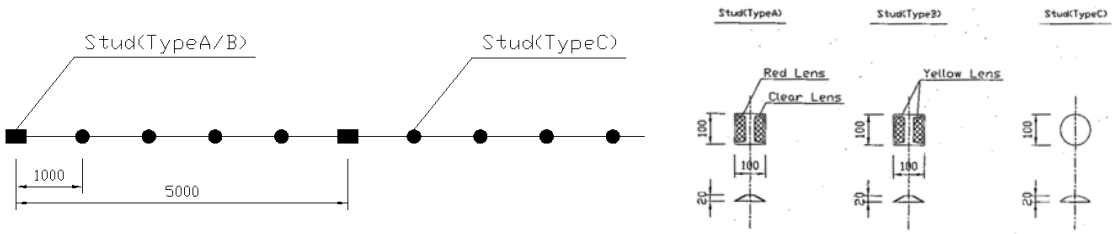


Figure 2-2-23 Longitudinal Stud Arrangement

9) Accessibility

The project roads exist to accommodate daily road users, especially users access to/egress from adjacent facilities. It is necessary to provide entrance points such as access road and lowered curbstone. It is also important to secure parking lots along the project roads where commercial buildings presently use the space beside the road. The sidewalk pavement is planned to share the space to accommodate pedestrian and car users.

10) Slope Stabilization and Protection

The following four locations were identified having damages of pavement caused by settlement. The cause of settlement is investigated respectively in Section C, Section E2, Section F1 and Section F2.

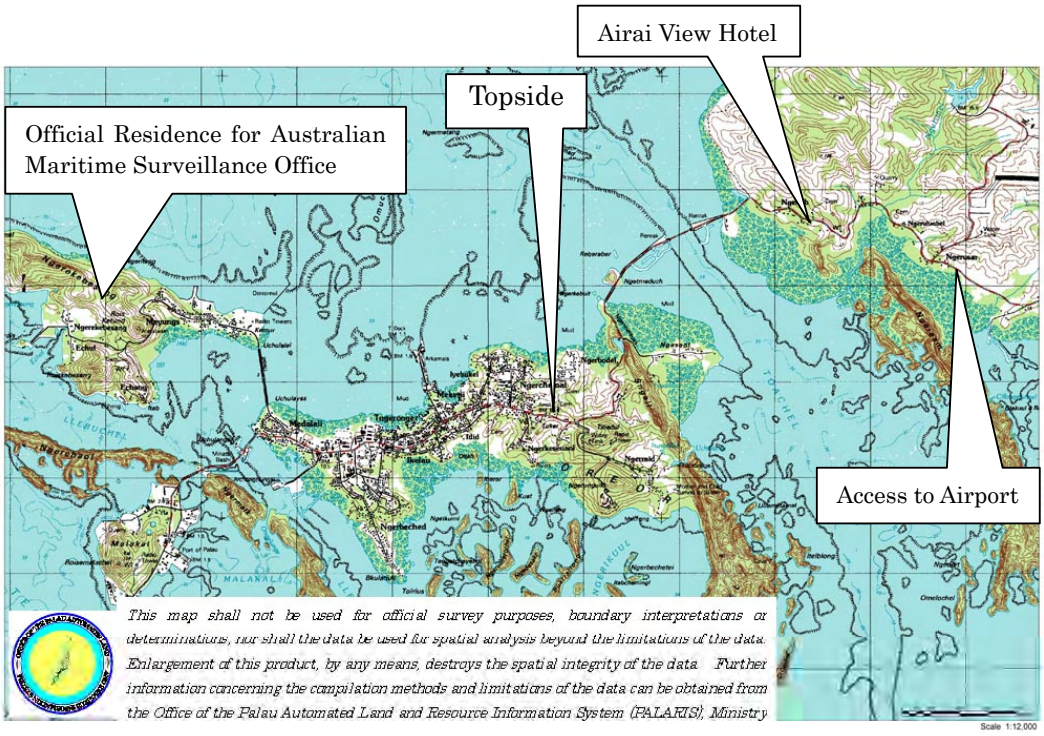
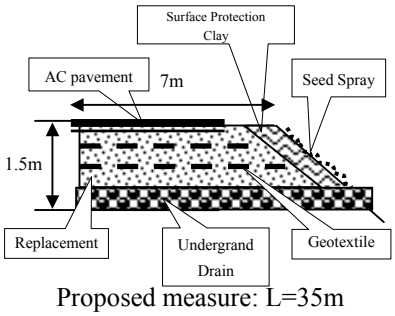
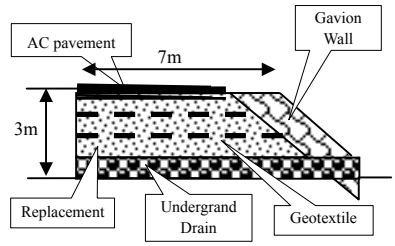
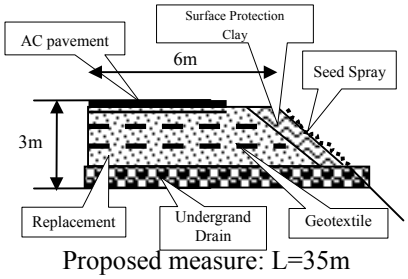
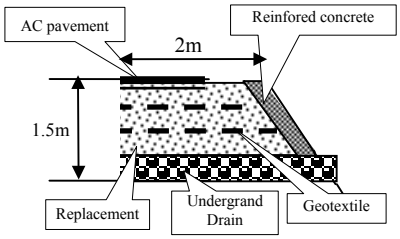


Figure 2-2-24 Location of the Slope Stabilization

Table 2-2-23 Slope Stabilization and Protection

Location	Cause of Damage	Proposed Measure
Access to Airport (CH12+780)	・The site is landslide-prone area consisting of soft tuff and sandstone. ・The second and third landslides can be partially due to improper earthwork at installation of underground utility and heavy run-off rain water on the road with small drain capacity.	 Proposed measure: L=35m
Airai View Hotel (CH10+760)	・Site with gentle valley is located in landslide prone area ・Groundwater surface is quite high according to information obtained. ・Poor backfilling for underground utility and seepage of groundwater seem to be the causes of landslide.	 Proposed measure: L=40m
Topside (CH5+960)	・Collapse of the shoulder of ridge way consisting of weathered basaltic rocks in the landslide area ・Tap water may be leaking from underground water pipeline since chloride was detected and the groundwater level is low.	 Proposed measure: L=35m
Official Residences for Australian Maritime Surveillance Officer (CH2+620)	・Ground condition are better with basalt and conglomerate outcropped. ・Groundwater is being seepage out at the toe of the slope. ・Improper work of underground utility seems to be the cause.	 Proposed measure: L=80m

11) Drainage Structures

Drainage Structures such as U-ditch, L-gutter, V-ditch and Catchbasin are designed for the Project. They are given in the drawings. Details of box culvert modification in Section F1 are also given in the drawings.

2-2-3 Basic Design Drawing

Basic Design Drawings listed below are shown as follows are provided in Appendix.

1) Plan

2) Profile

3) Typical cross section

4) General view of box culvert

5) Others

The scope, major improvement measures and construction volumes of the road improvement project agreed on with the Palau's side in the basic design to be provided under the grant aid of Japan are summarized in the following table.

Table 2-2-24 Major Improvement Measures and Construction Volumes

Section		Improvement	Contents of Work
A		1) Pavement	Partial strengthening of base course and construction of new surface course (t=10cm)
		2) Auxiliary Lane	L＝1.80km Between Shell IS-Mobil Top-side IS
		3) Sidewalk & Drainage	L= 2.5 km except the southern side in between Courthouse IS-Shell IS（L=360m）
		4) Intersection	9-IS with traffic signs and markings. Traffic Island at PVAIS and Shell IS
		5) Road Markings	Stud markings
		6) Street Lighting	In the vicinity of intersections (9-IS)
		7) Guardrail	Concrete barrier for pedestrian in between Courthouse IS and Shell IS.
B		1) Pavement	Partial strengthening of base course and construction of new surface course (t=10cm)
		2) Sidewalk & Drainage	In between Sta. 2+360 - Sta. 2+640
		3) Road Markings	Stud markings
		4) Guardrail	Concrete barrier in the approach section of Minato Br.
C		1) Pavement	Partial strengthening of base course and construction of new surface course (t=10cm)
		2) Road Markings	Stud markings
		3) Traffic Safety Measures	Curb stone (Barrier type) and widening at sharp S-curve
		4) Landslide Measures	Slope stabilization and protection at Top-side
D		1) Pavement	Partial strengthening of base course and construction of new surface course (t=10cm)
		2) Road Markings	Stud markings
E	E1	1) Pavement	Partial strengthening of base course and construction of new surface course (t=5cm)
		2) Drainage	Flood prone area between Sta. 1+025 - Sta. 1+510
		3) Road Markings	Paint markings
	E2	1) Pavement	Overlay (5cm) after sealing and patching
		2) Road Markings	Paint markings
		3) Traffic Safety Measures	Guardrail and concrete cover on existing V-ditch
		4) Landslide Measures	Slope stabilization and protection at Official Residences for Australian Maritime Surveillance Officer
F	F1	1) Pavement	Partial strengthening of base course and construction of new surface course (t=5cm)
		2) Drainage	Flood prone area between Sta. 9+400 - Sta. 9+890 and Sta. 11+250 - Sta. 11+350. Raising road elevation and box culvert up to 50 cm between Sta. 11+535 - Sta. 11+729
		3) Road Markings	Paint markings
		4) Traffic Safety Measures	Guardrail and concrete cover on existing V-ditch
		5) Landslide Measures	Slope stabilization and protection at Airai View Hotel
	F3	1) Pavement	Overlay (5cm) after sealing and patching
		2) Road Markings	Paint markings

2-2-4 Implementation Plan／Procurement Plan

2-2-4-1 Implementation Plan

This project will be divided two stages from viewpoints of project scale and safety and smooth implementation. Table 2-2-25 shows the planned period by stage and Figure 2-2-25 shows the location of facilities related to construction.

Table 2-2-25 Period by Stage

Stage	Detailed Design	Procurement and Construction
Period	3 months	19 months

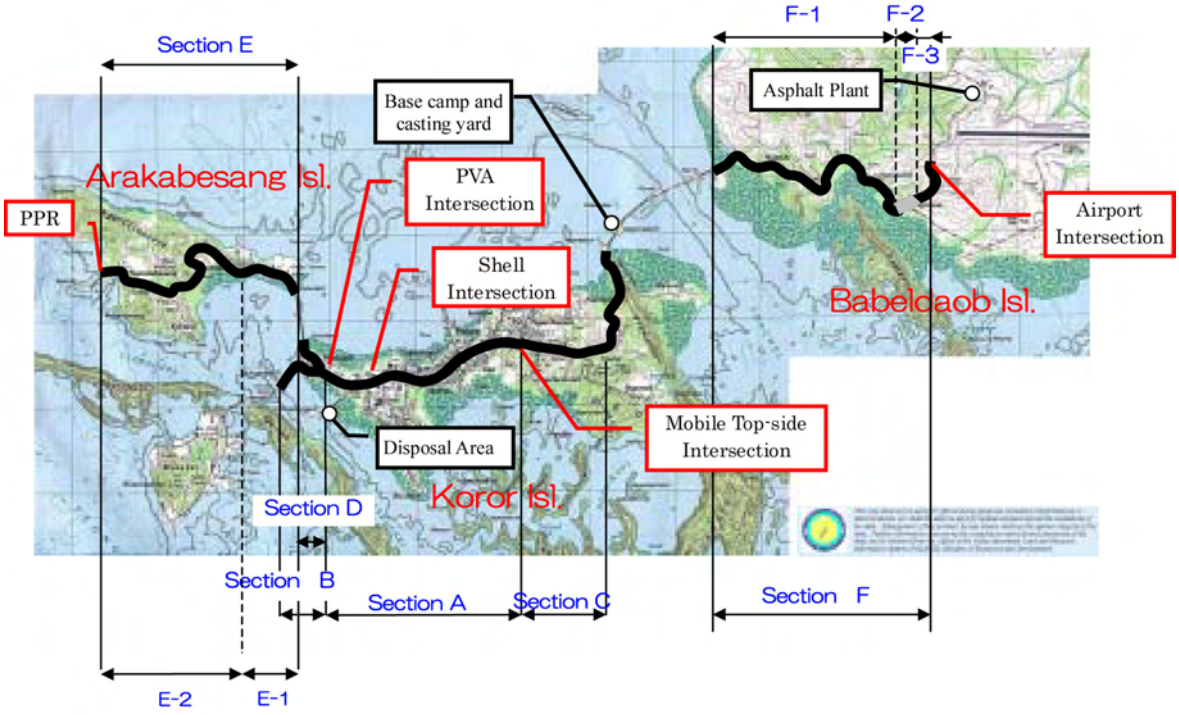


Figure 2-2-25 Location of Facilities Related to Construction

For the implementation of the project under the Japan's Grant Aid, other basic conditions are follows;

(1) Traffic Management

It is necessary that the work timing, the work period and the work content should be notified to roadside users and be given an announcement to the road users previously, because the construction will be conducted while changing traffic. The road user's understanding and cooperation are indispensable at the same time.

(2) Road Markings

Road marking is hardly adopted in the Palau. The Japanese skill worker who can coach the road markings will be dispatched, and will transfer the installation technology of the effective

road markings.

(3) Asphalt Plant

The asphalt plant is limited in Palau, and there are few workers who have installed experience. The Japanese skill worker who can install and can dismantle it will be dispatched, and will be transfer the installation and dismantling technology safety and smoothly.

(4) Landslide

The countermeasures are few, though there is a landslide in Palau. Some countermeasures were conducted by load or grant aid projects. Then, the Japanese skill worker for the countermeasure of landslide will be dispatched, and will be transfer the effective technology.

(5) Use of Local Consultant

A local consultant will be utilized as a local stuff for the supervision.

(6) Use of Local Contractor

A local contractor will be utilized as a subcontractor. Especially, use of local contractor will be expected for smooth execution, because concrete barrier and road studs are adopted with common type in Palau.

2-2-4-2 Procurement Plan

(1) Labor from Third Country

Though the laborer will be employed in Palau, The possibility of the procuring the laborer from the third country is contained due to laborer shortage. On the other hand, there is a precedent to which the third country laborer's procedure of entering to Palau is not smoothly processed when the new KB Bridge was constructed. Therefore, The procedure that promptly issues the admission into Palau to a necessary third country laborer is necessary for the smooth implementation for the project.

(2) Meteorological Condition

Meteorological conditions of Palau are characterized to many of the amount of the rainfall and the rainfall days. On the other hand, the ground of Palau consists mainly of the loam, which has the character that necessary compaction strength is not obtained under the high moisture contents. Therefore, avoiding the ground from rainfall is important in the construction plan as much as possible. From the above mention, the system of supervision and construction management to reflect such a severe natural condition is incorporated.

(3) Securing the Existing Traffic under Construction

The system of supervision and construction management to secure the safety and smooth traffic is incorporated, because the construction will be conducted while changing traffic. Because the land problem is severe in Palau, it is necessary to accommodate the changing traffic within right-of-way. If the adjoining land need for securing the traffic, it is necessary to confer with the landowner, and to follow the procedure for leased land and so forth.

(4) Underground Facilities

A lot of public utilities such as optical fiber, telephone line, water pipeline and sewerage are laid under the project road. The buried positions of some utilities are not certain because the time of installation is old and other reasons. Many users suffered damages when these services are stopped by the project. Therefore, the contractor should request and get the documents from the management company or the related organization previously, and careful work is required. At the same time, the management company or the related organization should provide the necessary documents in time.

(5) Palauan Environmental Law

Since EA concerning the project was approved with the some condition, it is necessary to secure the final approval for EA, prior to the construction starting. In addition to these conditions, the acquisition of the permission issued by the EQPB is obligated regarding to the digging within 5 meter from a historical heritage. Therefore, the site is often confirmed, and the permission should be applied and be acquired before the digging work near the historical heritage for the smooth implementation.

2-2-4-3 Scope of Works

For the implementation of the project under the Grant Aid of Japan, the scope of works to be undertaken by the Government of Japan and the Government of Palau is shown in Table 2-2-26.

Table 2-2-26 Scope of Works for Palauan Side and Japanese Side

Item	Description	Undertaking		Remarks
		Japan	Palau	
1. Land/Yard	Secure lands such as construction sites, construction yards and work roads necessary for the Project		○	
	Clear construction sites including removal and replacement of obstacles within construction sites		○	
	Construction and restoration of detour roads	○		
	Construction and restoration of stock yards and parking lots along roads	○		
	Provide distributing line of electricity to base camps and casting yards		○	
	Provide drop wiring, circuit breaker and transformer within base camps and plant yards	○		
	Provide communication means such as telephone trunk line to main distribution frame/panel (MDF) of base camps and plant yards or allocation of wireless frequency		○	
	Provide MDF and extension after MDF	○		
	Secure site for disposal of waste		○	
2. Construction	Improve existing road of Section A	○		
	Improve existing road of Section B	○		
	Improve existing road of Section C	○		
	Improve existing road of Section D	○		
	Improve existing road of Section E1 & E2	○		
	Improve existing road of Section F1 & F3	○		
	Improve existing road of Section F2		○	

2-2-4-4 Consultant Supervision

(1) Basic Policy

The basic policy regarding construction supervision is as follows:

1) Since the construction schedule will be affected by many external factors such as relocation of affected properties, land acquisition, relocation of underground utilities and so forth, it is necessary to establish the system of the construction supervision to execute a severe process control, considering local meteorological conditions and the project scale.

2) The possibility to regain the delaying is low under the meteorological conditions in Palau, if the work progress is delayed. Therefore, the system of the construction supervision that

keeps the required quality without any delay is considered.

3) In the project, the pavement quality control is important from meteorological conditions of many rainfall days and use of the local coarse aggregate for the asphalt mixture. Therefore, the system of construction supervision should be established for the sufficient quality control of the pavement.

(2) Important Notice

The important notice regarding construction supervision is as follows:

1) Project Manager of consultant will be dispatched to Palau only at the commencement /completion of the construction and the warranty inspection for the smooth implementation of the project.

2) The resident engineer will stay in Palau for the entire construction period to supervise the construction, and he will be responsible for the following three work items;

- Schedule control (including safety control)
- Quality control
- Measurement of quantity for completed works

3) The road engineer will be dispatched to supervise the road construction and to support the resident engineer during construction for completion of the project in a short term as much as possible.

4) The pavement specialist and the landslide specialist will be arranged considering the importance to keep the quality of works, and they will be dispatched to Palau at the commencement of the construction work.

5) Local engineer will be employed and properly arranged to assist Japanese engineers and to receive technology transfer.

(3) Schedule Control

The resident engineer will check the execution plan and the work schedule (the plan includes the schedule of construction machine, quantities of construction materials and the number of workers, etc.) submitted by the contractor.

Moreover, the resident engineer will convene the weekly meeting for progress and other relevant issues. The constructor will make the report of weekly progress and construction planning forward, the issued matters such as construction problems, safety measures, etc. Attendants mainly discuss the progress of works and stand on mutual understandings regarding issued matters and status quos. The result of discussion will be summarized as the minutes of meeting and will be reported to the project manager (Employer).

The Employer, the consultant, and the contractor will sometimes check the construction site jointly

and severally at the construction site. They will check the progress of construction, the construction method, the problem part, the quality control situations and measures for safety, etc. Some instructions will be made by the engineer for the contractor to improve the situation whenever necessary.

The safety control measures will be taken the following items;

- Pedestrian's measures for safety
- Traffic management to the current traffic
- Detour road measures
- Traffic safety measure at nighttime

2-2-4-5 Procurement Plan

(1) Construction Materials

1) Basic Policy

The basic policy regarding procurement of construction materials is as follows:

a) As a general rule, the essential materials for the construction shall be procured from local sources if available. Even imported materials, which are easily available in Palau, are regarded as local materials and are procured locally as far as volume of materials is sufficient. If it takes long time in the procurement process, such as materials will be procured form Japan or the third countries.

b) The asphalt mixture will be produced by the contractor in the viewpoint from the quality control and no asphalt plant that can be leased to the locale.

2) Current Situation for Procurement

The current situation for the major construction materials required for the project is shown as follows:

a) Coarse Aggregate for asphalt mixture

In the surface layer of the Compact Road Project and the runway pavement of the airport executed by United States Aid, the coarse aggregate of the pavement is imported from Taiwan from the viewpoint of the quality securing. On the other hand, in the examination result of the same quarry by its own, the value is not steady. However, there is the local coarse aggregate to indicate the value that can endure using as shown in Table 2-4-8, too. And, the local coarse aggregate has been used in the Project for improvement of interisland access road executed by Japan's Grant Aid.

Moreover, the process to open a new quarry site needs long time due to obtain EA issued by EQPB. It is unsuitable for the Grant Aid project to spend a long term on the

application and approval of it before construction is started.

And, it is preferable to use the locale material because Palauan side will conduct the maintenance by themselves after the project.

Considering the above-mentioned, it was assumed to apply a local coarse aggregate for the asphalt mixture by the enough quality control and using modified asphalt.

b) Bitumen and Asphalt emulsion

Bitumen and asphalt emulsion are unavailable in the market of Palau. The bitumen material from Singapore, Taiwan, and South Korea, and the asphalt emulsion from the Philippines and Taiwan are generally imported only by the drum. Comparing the economy and the past performance, the bitumen and the asphalt emulsion is assumed to be procured from Taiwan.

c) Fuel

Generally, fuel such as petrol and diesel oil is imported from Singapore as well as bitumen, but always available at petrol stations in Palau.

d) Admixture for Modified Asphalt

In this project, it was assumed that the modified asphalt would be applied as one of solution regarding the quality issue of the local coarse aggregate. The admixture of plant mix type to produce the modified asphalt is unavailable in Palau, will be procured from Japan.

e) Street Lighting Materials

The street lighting materials such as lighting pole and distribution board is not available in Palau, and they are procured from the third countries such as Taiwan. However, it is planned for the project to procure them from Japan because Japanese products have advantage in quality as well as New KB Bridge project.

3) Procurement Plan of Major Construction Materials

Considering the present procurement conditions, the procurement plan of the major construction materials is shown in Table 2-2-27.

Table 2-2-27 Procurement Plan of Major Construction Materials

Materials		Supply Country		
Items	Specification	Palau	Japan	Third Country
Deformed Bar		○		
Wire mesh for gabion mat		○		
Portland Cement		○		
Plywood	12mm	○		
Rectangular timber	7.5cmx7.5cm	○		
Road stud		○		
Traffic Sign		○		
Geotextile		○		
Silt fence		○		
Ready mixed concrete		○		
Fine aggregate (Fine Sand)		○		
Fine aggregate (Coarse Sand)		○		
Coarse aggregate		○		
Embankment material		○		
Sub-grade material		○		
Base material		○		
Gravel		○		
Gasoline	Regular	○		
Diesel		○		
Straight asphalt	60/70			○
Asphalt emulsion				○
Guardrail			○	
Paint	JIS K 5655-3-1		○	
Glass bead	JIS R 3301		○	
Admixture for asphalt mixture	Plant mix type		○	
Street Lighting Materials			○	

(2) Construction Equipment

1) Basic Policy

The basic policy for the procurement of construction equipment is as follows:

a) As a general rule, the essential equipment for the construction shall be procured from local sources if available. Otherwise, it is planned to procure from Japan or the third countries taking into account of the maintenance condition, the state of possession, the possession amount, the procurement circumstances, the economical viewpoint, and so forth.

b) The asphalt plant will be produced from Japan due to no asphalt plant that can be leased in Palau and to keep the quality.

2) Current Situation for Procurement

The current procurement situation for the major construction equipment required for the project is shown as follows:

a) Asphalt Plant

There are three asphalt plants in Palau excluding the one brought from foreign countries by the loan projects. But, two asphalt plants, which are private companies, are

impossible to lease, and one, which is PWD, is difficult to secure the quality and quantities because it is small capacity and manual. On the other hand, the establishment of a consistent system from procuring materials to production of the modified asphalt as well as other loan projects is indispensable to secure the specific quality by using the local coarse aggregate. Considering to the above-mentioned, it is planned to procure it from Japan.

b) Testing Instruments

The testing instruments such as Marshall Test, Los Angels Test and so forth are not available in Palau, and they are procured from the third countries. However, it is planned for the project to procure them from Japan since Japanese products have advantage in quality, and are easy to deal with by the Japanese contractor.

c) Trucks

The number of trucks is assumed to be insufficient for the early completion though tracks can be procured in Palau. Therefore, some trucks to which it is assumed to run short will be planned to procure from Japan.

3) Procurement Plan of Major Construction Equipment

Considering the present procurement conditions, the procurement plan of the major construction equipment is shown in Table 2-2-28.

Table 2-2-28 Procurement Plan of Major Construction Equipment

Equipment		Supply Country		
Items	Specification	Palau	Japan	Third Country
Bulldozer	3 ton	○		
Bulldozer	15 ton	○		
Back hoe	0.28 (0.20) m3	○		
Back hoe	0.45 (0.35) m3	○		
Back hoe	0.5 (0.4) m3	○		
Back hoe	0.8 (0.6) m3	○		
Truck	4 ton	△	△	
Dump truck	4 ton	△	△	
Dump truck	10 ton	△	△	
Track crane	4.9 ton	○		
Track crane	25 ton	○		
Track crane	50 ton	○		
Concrete pumping vehicle	Boom type, 90 − 110 m3/h	○		
Asphalt finisher	2.4 - 4.5 m	○		
Motor grader	3.1 m	○		
Macadam roller	10 - 12 ton	○		
Vibration roller	Hand guide, 0.5−0.6 ton	○		
Vibration roller	Hand guide, 0.8−1.1 ton	○		
Vibration roller	Combined, 3−4 ton	○		
Tired roller	8 - 20 ton	○		
Concrete breaker	600 - 800 kg	○		
Concrete cutter	45 - 56 cm	○		
Line marker	Hot type, Hand guide, 80 - 120kg		○	
Asphalt plant	60 ton/h with 1,000 kg mixer		○	
Testing instrument			○	

Note: Triangle marks mean a part of procurement from Japan.

(3) Transportation Plan

The common transportation route either from the ports in Japan, or from ports in third countries is same. After it is transported by marine to the Palau port in the Malakal Island, and it is delivered by the trailer.

The minimum transportation period is required approximately 30 days in the case of using the conventional ship (irregular service) as shown in Table 2-2-29. However, it takes a time and delay according to the interval of shipping, waiting at the offing for unloading, the customs clearance, weather conditions and so on. Because, the marine route is a feeder and freight service is irregular.

Table 2-2-29 Transportation Schedule

Items	Origin - Destination	Assumed Duration
Packing & shipping	Factory to Japanese port	7 days
Marine transport	Japanese port to Palauan port	15 days
Unloading, customs clearance & transshipment	Palauan port	7 days
Inland transport	Palauan port to site	1 day
Total		30 days

2-2-4-6 Quality Control Plan

(1) Criteria for Quality Control

The contractor should examine whether the quality of the construction material used has suited the construction specifications and take the resident engineer approval before the construction start. (Bitumen, cement, aggregate, asphalt emulsion, reinforced steel, and lane marking materials, etc.)

The asphalt concrete mixture and the cement concrete take the design of mixing and the mixing test in the plant, and it is necessary to decide the mixing proportion of the doing execution and to take the resident engineer's approval. The rolling times for the asphalt mixture are decided by the trial pavement.

The contractor will procured necessity examination instruments for the quality control of the asphalt mixture, and executes a consistent quality control form the material procurement to production and construction. Especially, the coarse aggregate for the asphalt mixture should be considered the measures that buy only the passing goods through the inspection when delivering it.

For the ready mixed concrete, the contractor will enter and inspect a factory of the local supplier regarding the quality control before purchase. and will execute the measurement of the slump and air contents of it.

The cement concrete executes the mixing design, the strength test and the slump value on

each transit mixer. The quality certificate from the vendor of a local material is not used for the quality control. The quality controls for the other materials will be submitted the guarantee letter of quality from the supplier, if necessary.

The quality control items for the concrete, embankment, subgrade, base course and asphalt are assumed as shown in Table 2-2-30 to 2-2-35. Statistically analysis will be conducted for the asphalt concrete mixture and concrete compressive test.

Table 2-2-30 Tests Related to Soil and Base Materials

1) Embankment Material

Item	JIS No.	AASHTO	ASTM	Frequency
Method of preparing soil samples	A 1201	T - 87	D 421	For every 1,500 cu.m. or fraction thereof or every change in soil properties one (1) complete test
Method of test for specific gravity of soils	A 1202	T - 100	D854	
Method of test for moisture content of soils	A 1203	T - 265	D2216	
Method of test for grain-size analysis of soils	A 1204	T - 88	D422	
Method of test for liquid limit of soils (Atterberg Limits)	A 1205	T - 89	D4318	
Method of test for plastic limit of soils (Atterberg Limits)	A 1206	T - 90	D4318	
Method of test for compacting soils	A 1210	T-99, T-180	D698,D1557	
Method of test for CBR	A 1211	T-193	D1883	
Method of test for density of soils by sand replacement	-	T-191	D1556	For every 500 cu.m. or fraction thereof at least three (3) density tests.
Proof Rolling test				Preparation of subgrade

2) Subbase and Base Course

Item	JIS No.	AASHTO	ASTM	Frequency
Method of test for specific gravity and absorption of fine aggregate	A 1109	T - 84	C 128	For every 1,500 cu.m. or fraction thereof
Method of test for specific gravity and absorption of coarse aggregate	A 1110	T - 85	C 127	For every 1,500 cu.m. or fraction thereof
Method of test for sieve analysis of aggregate	A 5001	T - 27	C 136	For every 1,500 cu.m. or fraction thereof
Method of test for abrasion of coarse aggregate by use of the Los Angeles Machine	A 1121	T - 96	C 131	For every 1,500 cu.m. or fraction thereof
Method of test for soundness of aggregate by use of sodium sulfate	A 1122	T - 104	C 88	For every 1,500 cu.m. or fraction thereof
Method of test for liquid limit of soils (Atterberg Limits)	A 1205	T - 89	D4318	For every 1,500 cu.m. or fraction thereof
Method of test for plastic limit of soils (Atterberg Limits)	A 1206	T - 90	D4318	For every 1,500 cu.m. or fraction thereof
Method of test for compacting soils	A 1210	T-99, T-180	D698,D1557	For every 1,500 cu.m. or fraction thereof
Method of test for CBR	A 1211	T-193	D1883	For every 1,500 cu.m. or fraction thereof
Method of test for density of soils by sand replacement	-	T-191	D1556	For every 500 cu.m. or fraction thereof at least three (3) density tests.

Table 2-2-31 Tests Related to Bituminous and Cement Materials

1)Test method for petroleum asphalt quality

Item	JIS No.	AASHTO	ASTM	Frequency
Method of test for penetration of asphalt	K 2207	T - 49	D 5	Every Delivery, mill test certificate and lab. test
Method of test for softening point of asphalt	K 2207	T - 53	D 36	Every Delivery, mill test certificate
Method of test for ductility of asphalt	K 2207	T - 51	D 113	Every Delivery, mill test certificate
Method of test for solubility of asphalt in trichoroethane	K 2207	T - 44	D 2042	Every Delivery, mill test certificate
Method of test for flash point of asphalt	K 2265	T - 48	D 92	Every Delivery, mill test certificate
Method of thin film oven test	K 2207	T - 179	D 1754	Every Delivery, mill test certificate
Method of test for loss on heating of asphalt	K 2207	T - 47	D 6	Every Delivery, mill test certificate
Method of test for gravity of asphalt	K 2207	T - 228	D 70	Every Delivery, mill test certificate
Method of test for kinematic viscosity of asphalt	-	T - 201	D 2170	Every Delivery, mill test certificate

2)Test method for petroleum asphalt emulsion quality

Item	JIS No.	AASHTO	ASTM	Frequency
Method of test for Engler Degree of emulsified asphalt	K 2208	T - 54	D 1665	Every Delivery, mill test certificate
Method of test for residue retained of emulsified asphalt on sieve	K 2208	T - 59	D 244	Every Delivery, mill test certificate
Method of test for adhesiveness of emulsified asphalt	K 2208	T - 59	D 244	Every Delivery, mill test certificate
Method of test for aggregate coating of emulsified asphalt	K 2208	T - 59	D 244	Every Delivery, mill test certificate
Method of test for evaporation residue of emulsified asphalt	K 2208	T - 59	D 244	Every Delivery, mill test certificate
Method of test for penetration of evaporation residue	K 2208	T - 59	D 244	Every Delivery, mill test certificate
Method of test for settlement of emulsified asphalt	K 2208	T - 59	D 244	Every Delivery, mill test certificate

3)Test method for cut-back asphalt quality

Item	JIS No.	AASHTO	ASTM	Frequency
Method of test for flash point of cut-back asphalt	-	T - 79	D 3143	Every Delivery, mill test certificate
Method of test for kinematic viscosity of cut-back asphalt	-	T - 201	D 2170	Every Delivery, mill test certificate
Method of test for distillation of cut-back asphalt products	-	T - 78	D 402	Every Delivery, mill test certificate
Method of test for penetration of distillation residue of cut-back asphalt	-	T - 49	D 5	Every Delivery, mill test certificate

4) Portland Cement

Item	JIS No.	AASHTO	ASTM	Frequency
Method of test for grading	-			Every Delivery, mill test certificate
Method of test for specific gravity	-			Every Delivery, mill test certificate
Method of test for fineness	-			Every Delivery, mill test certificate
Method of test for setting time	-			Every Delivery, mill test certificate
Method of test for mortar test	-			Every Delivery, mill test certificate

5) Water for Cement Concrete

Item	JIS No.	AASHTO	ASTM	Frequency
Quality test for water	-	T - 26		Before start, every chang in source

6) Reinforcing Steel

Item	JIS No.	AASHTO	ASTM	Frequency
				Every Delivery, mill test certificate

Table 2-2-32 Quality Control Tests of Aggregate for Asphalt and Cement Concrete

Item	JIS No.	AASHTO	ASTM	Frequency
Method of test for specific gravity and absorption of fine aggregate	A 1109	T - 84	C 128	For every 1,500 cu.m. or fraction thereof
Method of test for specific gravity and absorption of coarse aggregate	A 1110	T - 85	C 127	For every 1,500 cu.m. or fraction thereof
Method of test for organic impurities of fine aggregate				
Method of test for clay lumps and shale				
Method of test for abrasion of coarse aggregate by use of the Los Angeles Machine	A 1121	T - 96	C 131	For every 1,500 cu.m. or fraction thereof
Method of test for soundness of aggregate by use of sodium sulfate	A 1122	T - 104	C 88	For every 1,500 cu.m. or fraction thereof
Method of test for soft particles in coarse aggregate	A 1126	-	-	For every 1,500 cu.m. or fraction thereof
Method of test for unit weight of aggregate	A 1104	-	-	For every 1,500 cu.m. or fraction thereof
Method of test for moisture content in mineral filler	A 1203	-	-	Every Delivery, mill test certificate
Method of test for specific gravity of mineral filler	A 5008	A - 1202	-	Every Delivery, mill test certificate
Method of test for sieve analysis of aggregate	A 5001	T - 27	C 136	For every 1,500 cu.m. or fraction thereof
Method of test for swelling rate of mineral filler due to water absorption	-	-	-	Every Delivery, mill test certificate
Method of test for stripping resistance of coarse aggregate	-	T - 182	-	Every change quarry or fraction thereof
Method of test for Fractured Faces				BS-8 or FLH T 507

Table 2-2-33 Quality Control Tests for Asphalt Concrete

Item	JIS No.	AASHTO	ASTM	Frequency
Method of test for density of compacted asphalt mixtures		T - 166	D 2726	1-2 times/day or any time required
Method of Marshall Stability Test (including submerged specimens in water at 60°C)		T - 245	D 1559	1-2 times/day or any time required
Method of test for extraction of asphalt by use of Soxhelt Extractors, and sieve analysis		T - 164	D 2172	1-2 times/day or any time required
Method for measuring roughness of pavement surface			E 950	As instructed by the Engineer
Temperature				Every Delivery

Table 2-2-34 Quality Control Tests of Portland Cement Concrete

Item	JIS No.	AASHTO	ASTM	Frequency
Design mixing				Every change quarry
Method of compresive strength test for cement concrete		T- 22		1set per 75cu.m
Method of slump test for frsh concrete		T-119		Every tansit mixer
Making test specimens		T - 23		
Method of air content test for fresh concrete		T-152,T196		Every tansit mixer
Temperature				Every tansit mixer

Note: FLH: Federal Lands Highways (USA)

Table 2-2-35 Quality Control Items and Tolerance

Pavement Course	Control Item	Frequency	Inspection Tolerance
Subgrade	Proof rolling	Any time required	-
Subbase	Moisture Content	Any time required	-
	Grading	Any time required	-
	Proof rolling	Entire surface	-
	Degree of compaction	Every 1,000m^2 or as required	93%
Base	Moisture Content	Any time required	±15 %
	Grading	1-2 times/1,000m^2 or as required	±6.0 %
	Proof rolling	Entire surface	
	Degree of compaction	Every 1,000m^2 or as required	93%
Surface (Binder and Wearing)	Temperature	Any time required	—
	Grading 2.36mm	1-2 times/day or as required	±12%
	0.074mm		±4.5%
	Asphalt Content	1-2 times/day or as required	±0.4%
	Degree of compaction	Every 1,000m^2 or as required	94%
Reinforcement Concrete	Slump test	Every transit mixer	
	Strength	every 75 c.m	
	Bending test	every 10,000kg	
	Air Content	Every transit mixer	

Source: Manual for Asphalt Pavement 1989, Japan Road Association

- Tolerance is a reference value
- Judgment method

$x - k\sqrt{v} >$ tolerance for individual measurements

where

$v = \{(x1-x)2+ (x2-x) \}+.....$

$+ (x0 - x) 2\} / (n-1)$

$x = (x1+x2+.....+xn) / n$

- Quality judgment coefficient k

Number of Control data	Quality Judgment Coefficient k
5	1.59
6	1.46
7	1.37
8	1.31
9	1.28
10	1.22
11	1.19
12	1.16
13	1.14
14	1.12
15	1.1

(2) Measurement of Quantity for Completed Works

The measurement of quantity for completed works, which should be obviously different from the quality control, includes following inspection items in the paving works.

- Design height
- Pavement thickness
- Width of pavement
- Smoothness

In concrete structure works, inspection items iclude a check of design height, amount of reinforced concrete, thickness of covering, and concrete sizes (thickness, length, width, and height).

The inspection will be conducted at the following day of paving work, and the re-paving will be instructed in case that the completed work should not conform to the specifications.

The inspection of the design height will be made to measure the center and edge of the road (every 10m). This measurement result can be used to check the design height and the pavement thickness.

The example of standard for the quality of completed work is shown in Table 2-2-36.

Table 2-2-36 Criteria for Judgment of Work Quality Completed by Control Data

Pavement Course	**Inspection Item**	**Individual Measurement**
Subbase Course	Elevation (cm)	± 4.0
	Width (cm)	-5.0
	Thickness (cm)	-4.5
Base Course	Elevation (cm)	± 3.0
	Width (cm)	-5.0
	Thickness (cm)	-2.5
Binder Course	Elevation (cm)	± 2.0
	Width (cm)	-2.5
	Thickness (cm)	-0.9
Wearing Course	Elevation (cm)	± 1.0
	Width (cm)	-2.5
	Thickness (cm)	-0.7
	Evenness (cm)	2.4 (max)*

Source: Manual for Asphalt Pavement 1989, Japan Road Association

Note: *Using 3m profilmeter

- Judgment method

$x-k\sqrt{v} > $ tolerance for individual measurements

where k is a quality judgement coefficient, Wearing and binder k-1.10,base and subbase k=0.94

$v = \{(x1-x)2+ (x2-x) \}+ \cdots + (x0 - x) 2)/ (n-1)$

$x= (x1+x2+.....+xn) / n$

2-2-4-7 Implementation Schedule

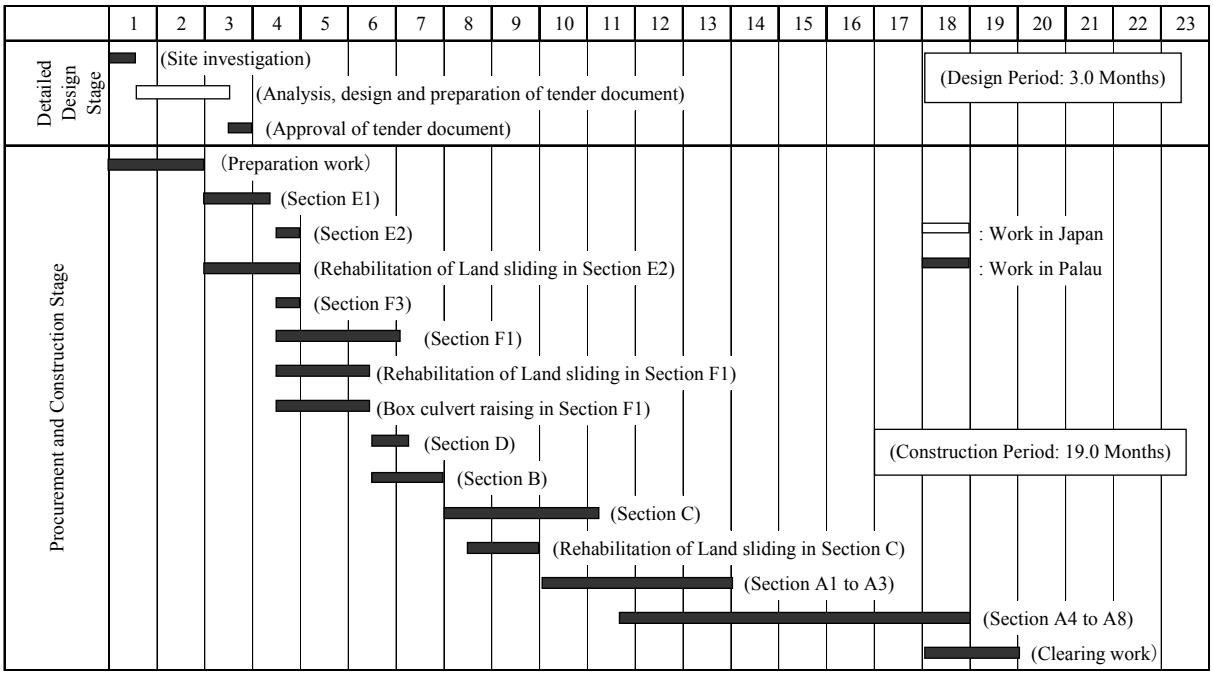
(1) Basic Policy

A basic policy of the implementation schedule of this project is as follows, and Table 2-2-37 shows the summarized implementation schedule.

1) The execution process of the project consists of the detailed design and the construction supervision because only basic design was conducted.

2) The implementation schedule was divided two packages, and aims at completion of the construction work in two terms.

Table 2-2-37 Implementation Schedule



(1) Important Notice

Meteorological conditions of Palau are characterized the high temperature and frequent rains. It will influence the earth works and the pavement work largely. And, prior to digging in the vicinity of a historical heritage, the acquisition of the permission issued by the EQPB is obligated. The factor that the influence gives to the implementation schedule of each package is as follows:

1) Detailed Design Stage

Although the EA approval has been obtained conditionally, the detailed design for the Project is not conducted yet. Therefore, it is necessary to obtain some final EA approval from EQPB during the detailed design period.

2) Procurement and Construction Stage

a) Although the EA approval has been obtained conditionally, a contractor is not selected yet. Therefore, it is necessary to obtain the final EA approval from EQPB prior to the commencement of works.

b) The implementation schedule would be planned on the assumption that the contractor will procure the asphalt plant for this project. Therefore, the delay of procuring time of the plant will influence the implementation schedule.

c) The above plant will be planned to procure from Japan. Therefore, the delay of marine transport by the weather condition might influence the implementation schedule.

d) The project site has high traffic volume and faces a lot of objects such as houses, buildings, trees and so forth. The possibility to influence the implementation schedule by trouble with resident concerning settlement and removal of the obstacles or securing of ROW or traffic safety or so on might be contained.

e) The delay of the settlement and removal of the obstacles might influence the implementation schedule.

2-3 Obligations of the Government Palau

2-3-1 General Matters

1) To set Banking Arrangement (B/A)

2) To advise commission of Authorization to Payment (A/P) and make payment for the commission

3) To secure all the expenses and prompt execution of customs clearance for products purchased under the Grant Aid

4) To accord Japanese nationals whose services may be required in connection with supply of the products and the services under the verified contracts

5) To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the supply of the products and services under the verified contracts

6) To maintain and use properly and effectively the constructed facilities and procured equipment under the Grant Aid

2-3-2 Facilities Matters

1) To secure lands such as construction sites, construction yards and work roads necessary for the project

2) To clear construction sites including removal and replacement of obstacles within construction sites

3) To compensate costs for resettlement, if any

4) To provide distributing line of electricity to construction yards

5) To provide telephone trunk line to main distribution frame/panel (MDF) of construction yards

6) To relocate, improve and/or repair existing utilities (power lines, telecommunication lines, water lines, etc.), if necessary

7) To make detour or set up a diversion at necessary sections

8) To Secure site for disposal of waste

2-3-3 Others

1) To contract with a Japanese consulting firm for detail design (D/D) and construction supervision

2) To contract with a Japanese contractor

3) To Maintain the security at the sites and yards for the Project

4) To make public relations for inconvenience and deal with complaint raised by affected persons

5) To Secure exemption of contractor's responsibility in case of occurrence of damage against unidentified utilities after identification of underground utilities located within the site by the Employer

6) To coordinate relevant agencies regarding traffic control during construction

2-4 Project Operation Plan

2-4-1 Ability for Operation and Maintenance of the Executing Agency

2-4-1-1 Road Operation Maintenance Organization

The Road Construction Machine Department of the Bureau of Public Works is in charge for maintenance of the national roads around Koror, Babeldaob and Peleliu. After the completion of this Project, the same department has responsibility for maintenance of the project road.

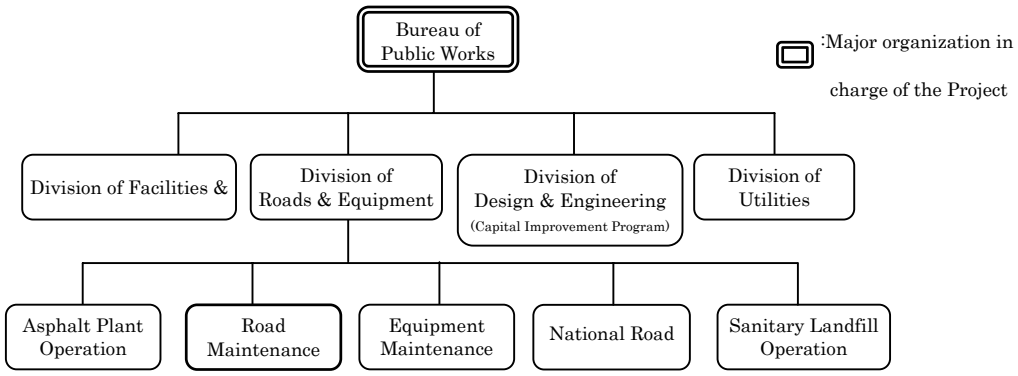


Figure 2-4-1 Organization Chart of Bureau of Public Works

2-4-1-2 Equipment owned by the Executing Agency

The Bureau of Public Works owns the following equipment for road maintenance in Koror and its surrounding.

Table 2-4-1 List of Equipment owned by Bureau of Public Works

Equipment	Quantity	Equipment	Quantity
Bulldozer (D-4)	2	Motor Grader	1
Wheel Loader (2.5 m3)	1	Chainsaw	1
Truck (1.5ton/5 ton)	2	Battery Charger	1
Backhoe	1	Sedan/Jeep/Pickup	8
Breaker	1	Dump Truck, out-of-order	8
Compressor	1	Jeep, out-of-order	5

2-4-2 Capacity Building for Maintenance Ability of the Executing Agency

2-4-2-1 Periodical Inspection and Maintenance

A standard method of periodical inspection and maintenance for the road and structures is shown in Table 2-4-2.

Table 2-4-2 Method of Periodical Inspection and Maintenance

	Inspection Item	Maintenance & Repair	Inspection Interval
Road	Road Surface	Inspection with small repair	1 month
	Shoulder & Slope	Treatment, planting & refill	1 month
	Ditch	Cleaning of sediments	1 month
	Marking	Repainting	1 month
	Culvert	Cleaning of sediments & removal of debris	1 month

It is important to keep records (date of inspection, location of inspection, result of inspection, and name of inspector) of periodical checking at the road maintenance office and to grasp the condition of damage if any for the purpose of making a repair plan and its schedule. Therefore, the periodical checking system must be established at the initial stage.

2-4-2-2 Maintenance of Asphalt Pavement

An emergency repair should be made timely as required to avoid expanding damage, and routine maintenance including minor maintenance works (patching, leveling) is also carried out. The periodic maintenance such as overly on deteriorated section will be required at several years interval.

2-4-2-3 Drawing public attention to traffic rules and road maintenance

It is essential for the drivers to keep the traffic regulations in order to make the traffic safe and flowing after the completion of the project. In addition, to avoid the damage of the roads, the regulation against the heave vehicle is necessary. The Government of Palau should educate drivers on the matter of traffic safety and regulate against the traffic violation, especially against heavy vehicles.

2-5 Project Cost Estimation

2-5-1 Initial Cost Estimation

2-5-1-1 Cost Covered by the Japanese Side

This cost estimation is provisional and will be further estimated by the Government of Japan for the approval of the Grant Aid.

Cost Covered by the Japanese Side: 1,432 Million Yen

Road Improvement: totaling approximately 12.5 km

Table 2-5-1 Cost Covered by the Japanese Side

Item			Cost Covered by the Japanese Side (Unit: Million Yen)	
Road Improvement	Earth Work	Excavation, Subgrade	17	1,323
	Pavement Work	Base Course, Asphalt Pavement	656	
	Drainage Work	Ditch, Gutter, Box Culvert Raising	400	
	Incidental Work	Sidewalk, Street Lightings, Road Markings, Road Studs, Traffic Signs	209	
	Slope Stabilization Worlk		41	
Detailed Design and Supervision			109	
Total			1,432 (Approximatery, $ 12,364,000)	

2-5-1-2 Cost Borne by the Palauan Side

For the implementation of the project under the Japan's Grant Aid, the estimated cost in Basic Design Stage borne by the Palauan side will be approximately 223,200 U.S.$.

Additional costs for improvement of the concrete pavement and the slope stabilization at the airport access road will be approximately 100,000 U.S.$.

Table 2-5-2 Cost Covered by the Palauan Side

Item	Cost Covered by the Palauan Side (Unit: U.S.$)
Land acquisition cost	0
Secure lands such as construction sites, construction yards and work roads necessary for the Project	200,000
Provide distributing line of electricity to base camps and casting yards	4,000
Clear construction sites including removal and replacement of obstacles within construction sites	19,200
Total	223,200

2-5-1-3 Condition of Cost Estimation

1) Time of Cost Estimation: As of February, 2006
2) Exchange Rate: 1.0 U.S.$=¥ 115.82
3) Others: This project will be implemented in accordance with the Japan's Grant Aid system.

2-5-2 Operation and Maintenance Cost

2-5-2-1 Operation and Maintenance

Annual required fund for operation and maintenance is estimated US Dollar 47 thousand.

Table 2-5-3 Operation and Maintenance Cost

	Inspection Period	Maintenance Period	Place	Works	Unit Price $/km	Cost ($)
Drainage	3 times/month	2 times/year	Ditch & culvert	Remove of deposits, Repair of crack	1,000	2,500
Road Surface	1 time/month	1 time/year	Surface	Patching/ Overlay	5,000	16,000
Road Incidental Work	1 time/month	2 times/year	Markings	Re-painting	500	5,000
			Sign plate	Cleaning	500	1,250
			Shoulders	Grass cutting,	1,000	12,500
			Concrete pavement	Reconstruction	6,000	4,800
			Road lighting	Repair of wire/bulb	2,000	5,000
				Annual total		47,050

2-5-2-2 Budget Preparation

The budget for the Ministry of Natural Resources and Development was allocated as shown in Table 2-5-4. Remarkable increase of BPW budget in 2005 is due to the implementation of the Project "Improvement of Inter-island Access Road".

Table 2-5-4 Budget of MRD and BPW

Unit: 1,000 $

		2004	2005	2006
MRD Budget	Growth Rate	-	-5%	6%
	BPW General Expense	1,395	1,395	1,395
	BPW Road Maintenance	456	275	300
	BPW Other Expense	1,975	3,045	3,278
	BPW Total	3,826	4,715	4,973
	Other Bureaus	2,221	1,020	1,083
	MRD Total	6,047	5,735	6,056

Major maintenance works such as minor repair and cleaning are required, and it is estimated $47,000 for annual maintenance cost. Although it account for 16% against total maintenance budget for Public Works Department that the Government of Palau allocates around 300,000 US dollars annually, the Office of President recognizes the important roles and functions of trunk roads in Koror urban area and commits to put high priority for budget allocation.

2-6 Other Relevant Issues

The Project is planned to improve the existing roads without any resettlement of Project-Affected-Persons (PAPs) . However, additional lands may be required at PVA Intersection and along the stretches between Shell Intersection and Mobil Top-side Intersection, and existing properties and facilities should be relocated or removed.

The EA approved by EQPB has provisions regarding mitigation measures against adverse environmental impacts as follows, and it should be incorporated the design and construction stages.

1) Noise and dust control brought by construction equipment and heavy vehicles
2) Traffic safety measures during construction where existing traffic should be maintained
3) Asphalt plan with air pollution control and noise dampening devices
4) Environmental considerations in the vicinity of plant and casting yards
5) Installation of silt curtains with floats to enclose the site of box culvert modification in order to prevent damages to aquatic life by siltation.

The EQPB requests that a contractor for the Project should obtain both earth-moving permits and

historical clearances prior to their work.

It is indispensable to achieve the following Palauan undertakings prior to the construction works because the construction period is crushed.

1) To obtain the permission for remove and/or relocation of trees, structural object, and any other objects affecting the implementation of the Project
2) To secure the land necessary for the Project (including the land for temporary yards and parking, detour during the construction etc.)
3) To relocate, improve and/or repair existing utilities (power lines, telecommunication lines, water lines, etc.)
4) To secure a site for disposal of waste
5) To identify underground utilities located within the site

Chapter 3

Project Evaluation and Recommendations

Chapter 3 Project Evaluation and Recommendations

3-1 Project Effect

The following effects are expected to implement the Project.

(1) Direct Effects

1) To increase traffic capacity and to make traffic flow smooth

The average travel speed between PVA Intersection and Mobil Top-side Intersection decreases up to 15km/h during morning and evening peak hours. It will be improved 25km/h after the completion of the Project.

2) To mitigate traffic disturbance by occurrences of submerged road sections

Some road sections are submerged 208 days a year (5 years average having more than 1 mm rainfall). It will be free from submergence due to installation of drainage.

3) To decrease traffic accidents with pedestrian

Traffic accidents with pedestrian occur about 40 times in the metropolitan (7 years average). It will reduce up to 20 times due to the improvement of sidewalk

(2) Indirect Effects

1) To contribute to enhancement of transport reliability and efficiency by the improvement of road
2) To induce road user's comfort as well as to improve tourist's impression by making road transport reliable
3) To improve accessibility to public service facilities such as hospital and school, regional development and urban function by providing smooth road traffic
4) To alleviate air pollution by reduction of automobile exhaust due to decrease of traffic congestion

3-2 Recommendations

The recommendations are made providing that the Project is implemented.

(1) Timely Achievement of Palauan Undertakings

The construction schedule will be affected by removal/relocation of affected properties/structures, maintenance of existing traffic and traffic safety measures due to heavy traffic, considering densely developed landuse along road. It is indispensable to achieve Palauan undertakings prior to the construction works because the construction period is

crushed.

(2) Drawing Public Attention to Heavy Vehicle Users against Road Operation and Maintenance

It is necessary for road users to comply with traffic rules in order to secure safe and smooth traffic. In addition to traffic rules, it is necessary to control over-loaded vehicles in order to prevent road structure from excessive damage. The Palauan side should educate drivers to comply with traffic rules and enforce traffic rules strictly, especially for over-loaded vehicles.

(3) Organization of Construction Supervision

It will be very difficult to catch up on construction schedule due to weather condition in Palau once the progress of work might delay. It is important to establish a practical team to supervise the construction works in order to keep quality of work as well as to make it sure construction sequence.

Since pavement defects are issued due to uncertain quality of local aggregates, the quality control of asphalt mixture should be carried out under a practical team of construction supervision.