

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

NOVEMBER 2006

Japan International Cooperation Agency

CTI Engineering International Co., Ltd.

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PREFACE

In response to a request from the Government of the Republic of Palau, the Government of Japan decided to conduct a basic design study on the Project for Improvement of Urban and Rural Roads in Koror and Airai States in the Republic of Palau and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Palau a study team from January 18th to February 16th, 2006.

The team held discussions with the officials concerned of the Government of Palau, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Palau in order to discuss a draft basic design, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Palau for their close cooperation extended to the team.

November 2006

Masafumi Kuroki

Vice-President

Japan International Cooperation Agency

November 2006

Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for Improvement of Urban and Rural Roads in Koror and Airai States in the Republic of Palau.

This study was conducted by the CTI Engineering International Co., Ltd., Japan under a contract to JICA, during the period of 11 months from January to November 2006. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Palau and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

Finally, we hope that this report will contribute to the further promotion of the Project.

Very truly yours,

Kenji Maruoka
Chief Consultant
Basic design study team on
Project for Improvement of Urban and
Rural Roads in Koror and Airai States
in the Republic of Palau
CTI Engineering International Co., Ltd.

Summary

The Palau Development Master Plan 2020(1996-2020)has been made to achieve self-sustainable economy not to depend upon foreign aids. Accordingly, the “Palau’s Public Sector Investment Program (PSIP) 2003-2007” gives the highest priority to “Development of Trunk Road in Koror Urban Area” in which two projects of “Improvement of Inter-island Access Road” and “Improvement of Urban and Rural Roads in Koror and Airai States” are comprised.

Trunk roads subject to the project “Improvement of Urban and Rural Roads in Koror and Airai States” connect integrated urban spheres such as Koror Island where the major governmental offices and business facilities are concentrated, Malakal Island having an international port, Arakebesang Island with a national hospital and tourism facilities and Babeldaob Island with an international airport. However, the condition of roads is deteriorated and the damages of pavement are in progress because no major rehabilitation works have been carried out since 1993. Such conditions force road users to move slowly and accordingly they cause traffic congestion.

It is a matter of fact that poor pavement conditions and facilities such as improper drainage and lack of traffic safety measures cause to worsen traffic congestion and furthermore annual growth of 8 % in vehicular traffic aggravates the traffic situation.

Under such circumstances, the Government of Palau requested to the Government of Japan to implement the improvement of trunk roads in the metropolitan area in July 2002. The request consists of the rehabilitation and improvement of metropolitan trunk roads, totalling 17 km in length. In response to the request for Japan’s Grant Aid Scheme, the Japan International Cooperation Agency (JICA) dispatched the series of preliminary study teams to Palau for the appropriateness and viability of the project. The study team identified the priority of improvement of three inter-island causeways (Babeldaob Island, Malakal Island and Arakebesang Island), totalling 2 km in length and 1.6 km long trunk road in Malakal Island as “Improvement of Inter-island Access Road”.

In August 2004, the Government of Palau made a request 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"). The Government of Japan entrusted JICA to conduct the study to examine the viability of the Project. Hence, JICA decided to conduct a Basic Design Study for the Project (hereinafter referred as "the Study")

The Basic Design Study Team was dispatched to Palau from January 2006 to February 2006 for site studies including Traffic survey, topographic survey, geotechnical investigation, natural

environmental survey, etc. The Study Team carried out the basic design study, project cost estimation, and prepared the draft Basic Design Study Report in Japan. The Team visited Palau from the end of May 2006 to explain the contents of the draft report. However, the Palauan side did not accept the proposed implementation plan of 3-phase package.

The Team revisited Palau from the end of August 2006 to explain the contents of the revised draft report, and the Palauan side accepted finally the proposed implementation plan of 2-term one package.

The scope of works to be implemented under the Japanese Grant Aid scheme that was agreed between the Palauan side and the Japanese is summarized in Tables 1 and 2.

Table 1 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 Contents of the Project

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
F	F1	4) Landslide Measures	Slope stabilization and protection at Official Residences for Australian Maritime Surveillance Officer
		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
	F3	5) Landslide Measures	Slope stabilization and protection at Airai View Hotel
		1) Pavement	Overlay (5cm) after sealing and patching
		2) Road Markings	Paint markings

On the execution of the design and the construction of this project, the following design policy and approach are taken into consideration:

(1) Road 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.

(2) Road Sections to be improved

Total length of 12.531 km is planned to be improved against requested 12.846 km in length because Section F2 (L=314m) is set aside for the Project where the loose base course and roadbed cause the defect of pavement due to poor construction method and shortfall of bearing capacity.

(3) Design Policy

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.

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.

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.

(4) Road 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.

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.

(5) Improvement of Pavement

The method of improvement is categorized into four types (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) 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.

(6) Drainage

A new drainage facility such as U-ditch is required as 3-lane carriageway with sidewalk is planned in Section A. Existing drainage system is maintained as it is and no additional drainage system is planned. 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.

There are four flood prone areas in Section B, Section E1 and Section F1. Since no outstanding outlet causes flood to retain storm water for a long time, it is necessary to install a new drainage facility to drain storm water.

(7) 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.

(8) Improvement of Intersection

Nine (9) major intersections exist in Section A and these intersections are congested during morning and evening peak hours due to poor traffic capacity. Improvement of the major intersections aims at the adaptation to the increasing traffic and improvement of the traffic safety 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.

(9) Slope Stabilization and Protection

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, gabion or concrete wall at three locations having damages of pavement caused by settlement in Section C, Section E2 and Section F1.

(10) 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.

The project implementation is estimated to require 24 months covering 3 months for the detailed design and 19 months for the construction.

Also, an approximate total project cost is estimated as 1,458 million Yen (1,432 million Yen to be borne by the Grant Aid of Japan and 26 million Yen by the Government of Palau).

As the Grant Aid Project is proposed to implement the improvement of most seriously damaged sections among the road sections requested originally as mentioned above, it is expected after the completion of the Project to secure reliable and safe traffic function as well as to enhance social and economic development.

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.

The following effects are expected to implement the Project.

Direct Effects

- (a) 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.

- (b) 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.

- (c) 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

Indirect Effects

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

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.

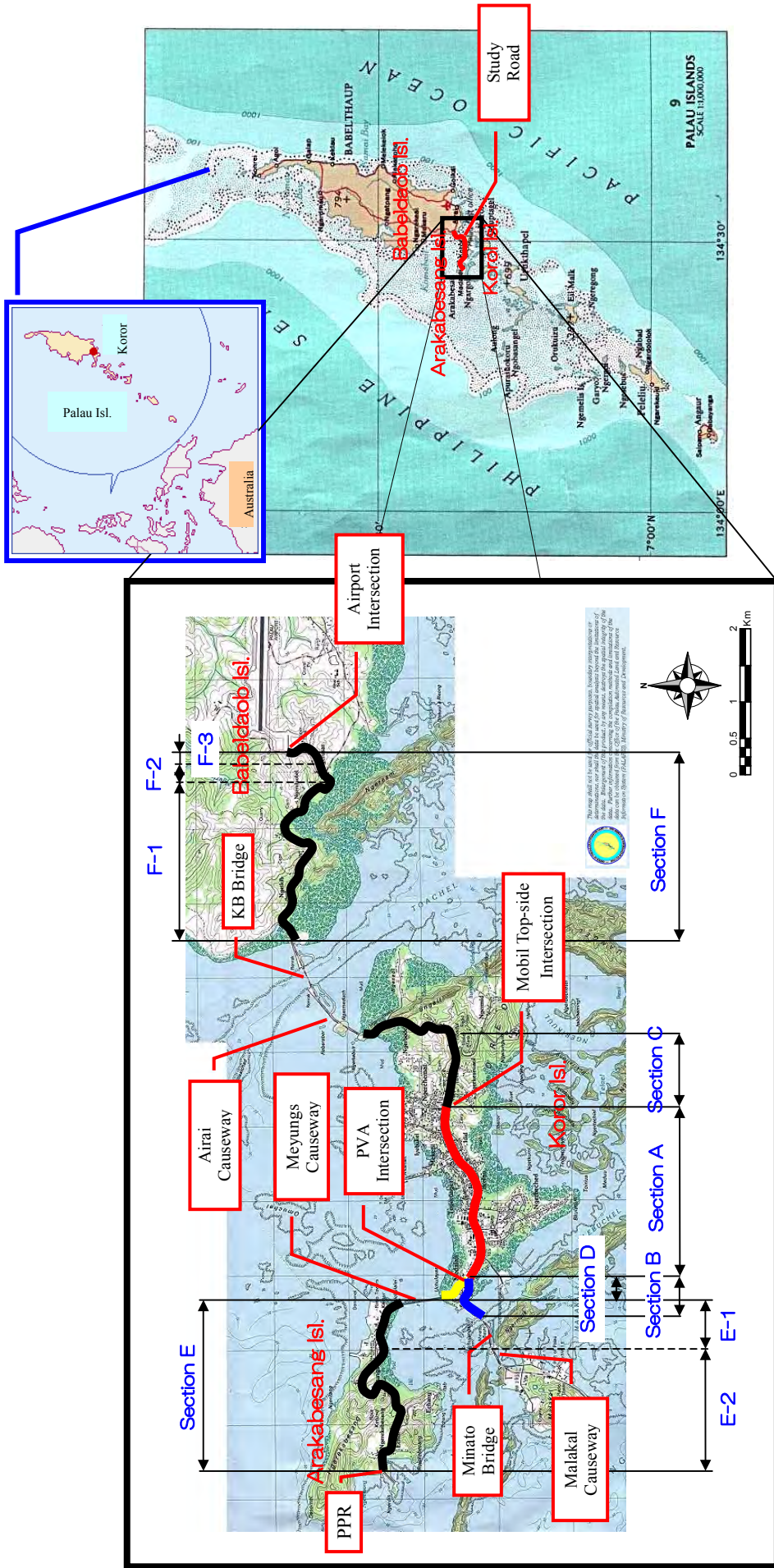
(2) Drawing Public Attention to Heavy Vehicle Users against Road Operation and Maintenance

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.

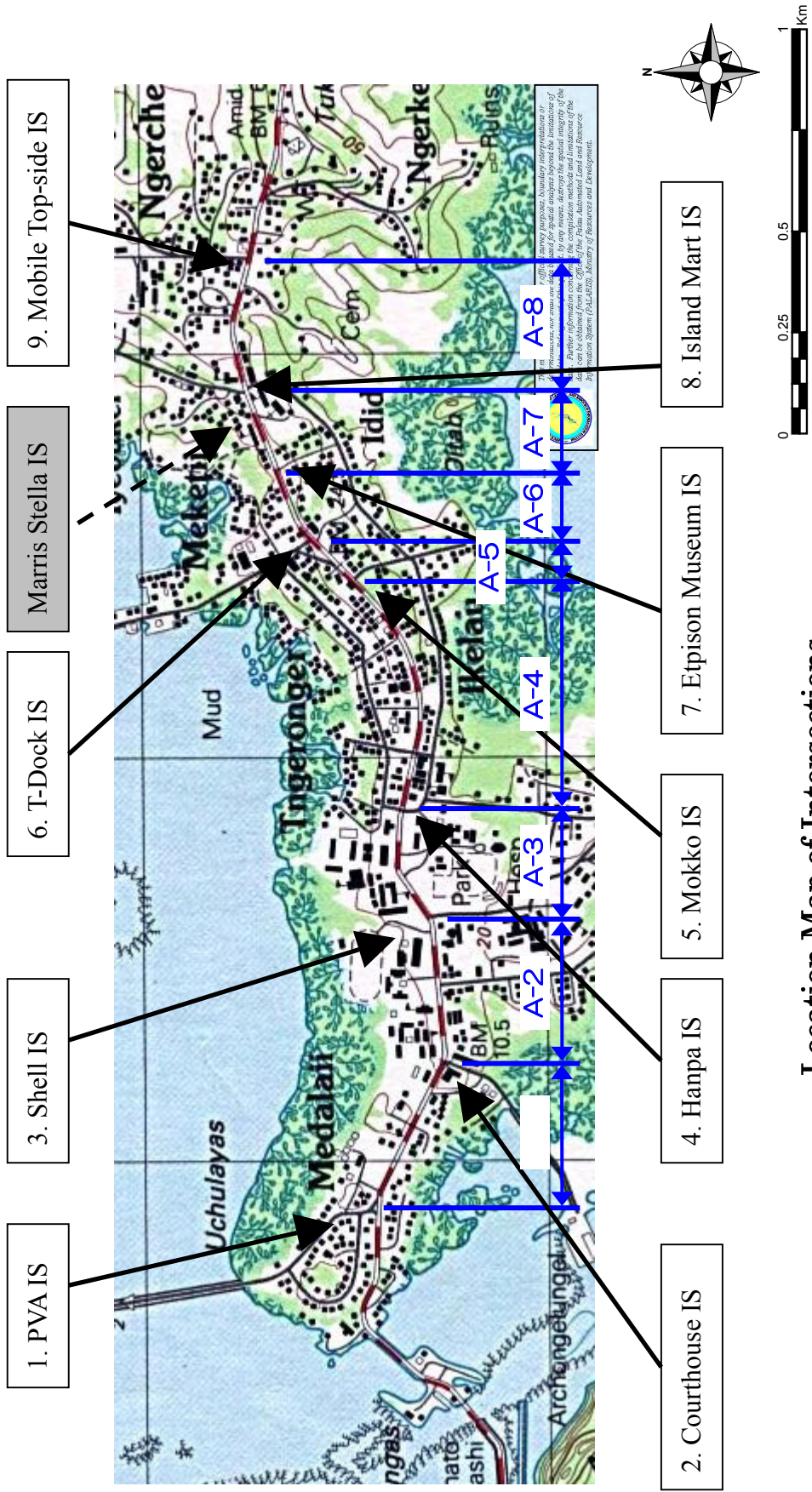
(3) Organization of Construction Supervision

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.

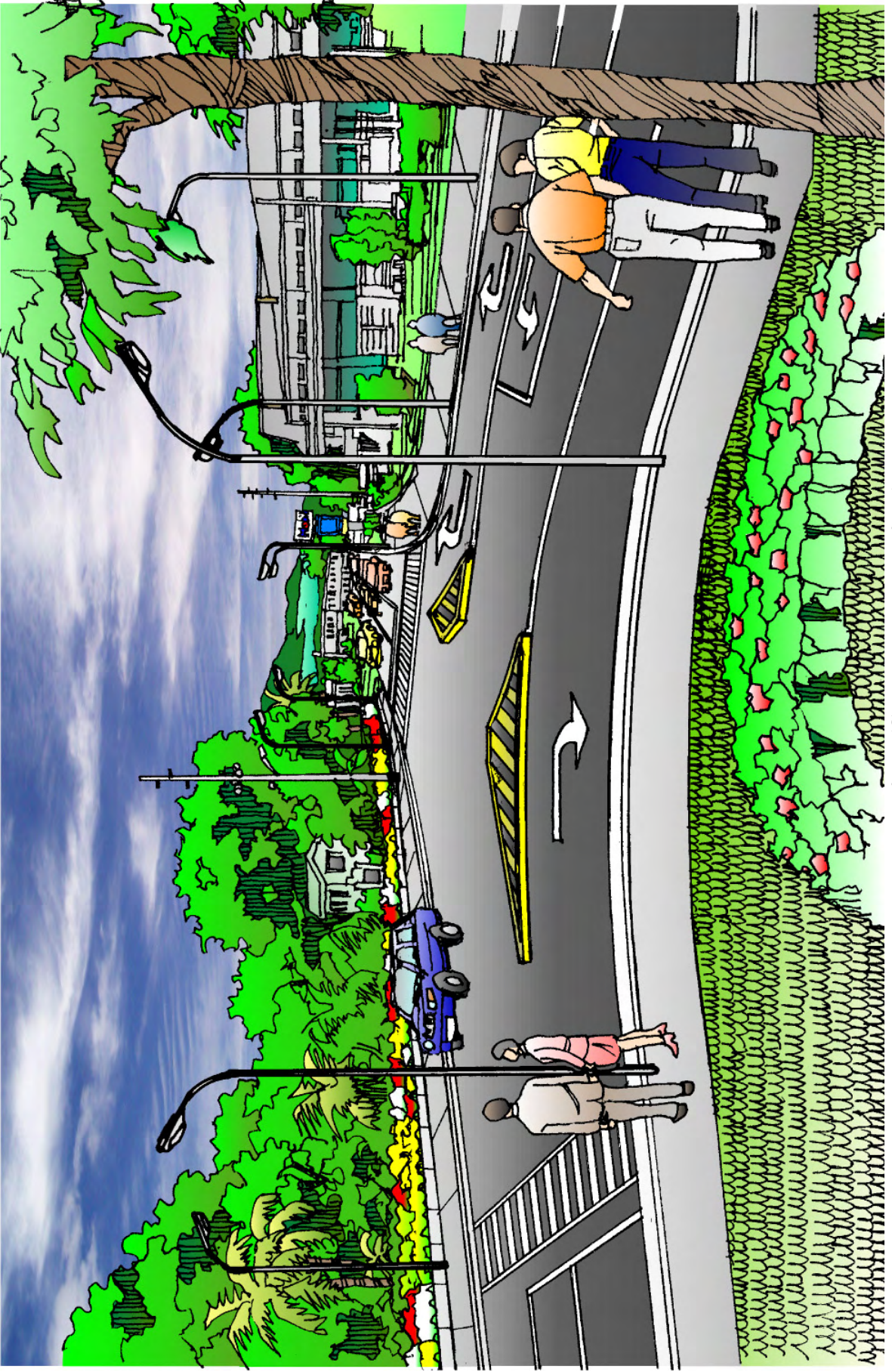
Since pavement defects are issued due to uncertain quality of local aggregates, the quality control of asphalt mixture should be carried out under a practical team of construction supervision.



Project Location Map



Location Map of Intersections



Perspective (Shell Intersection)