PUBLIC WORKS DEPARTMENT
THE REPUBLIC OF VANUATU

BASIC DESIGN STUDY REPORT ON THE PROJECT FOR IMPROVEMENT OF THE RING ROAD IN EFATE ISLAND IN THE REPUBLIC OF VANUATU

DECEMBER 1997

JAPAN INTERNATIONAL COOPERATION AGENCY
KATAHIRA & ENGINEERS INTERNATIONAL

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PREFACE

In response to a request from the Government of the Republic of Vanuatu, the Government of Japan decided to conduct a basic design study on the Project for Improvement of the Ring Road in Efate Island. The study was entrusted to the Japan International Cooperation Agency (JICA).

JICA sent a study team to Vanuatu from June 29 to July 31, 1997.

The team held discussions with the officials concerned of the Government of Vanuatu, 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 Vanuatu in order to discuss a draft basic design, and as a 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 Vanuatu for the close cooperation they extended to the teams.

December, 1997

Kimio Fujita
President
Japan International Cooperation Agency

December, 1997

Letter of Transmittal

We are pleased to submit the basic design study report on the Project for Improvement of the Ring Road in Efate Island in the Republic of Vanuatu.

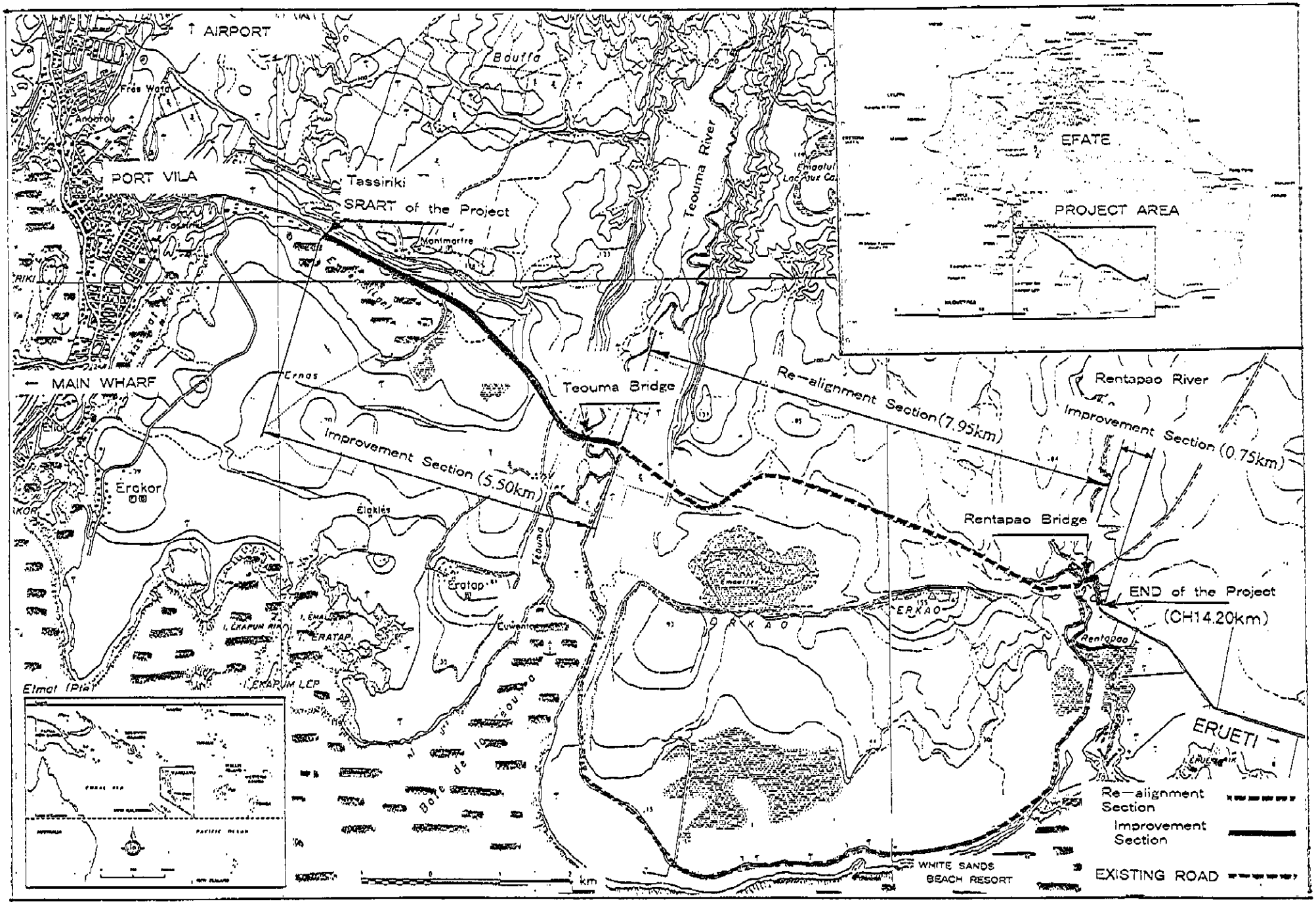
This study was conducted by Katahira & Engineers International, under a contract to JICA, during the period from June 20 to December 1, 1997. In conducting the study, we have examined the feasibility and rationale of the project, with due consideration to the present situation of Vanuatu, and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

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

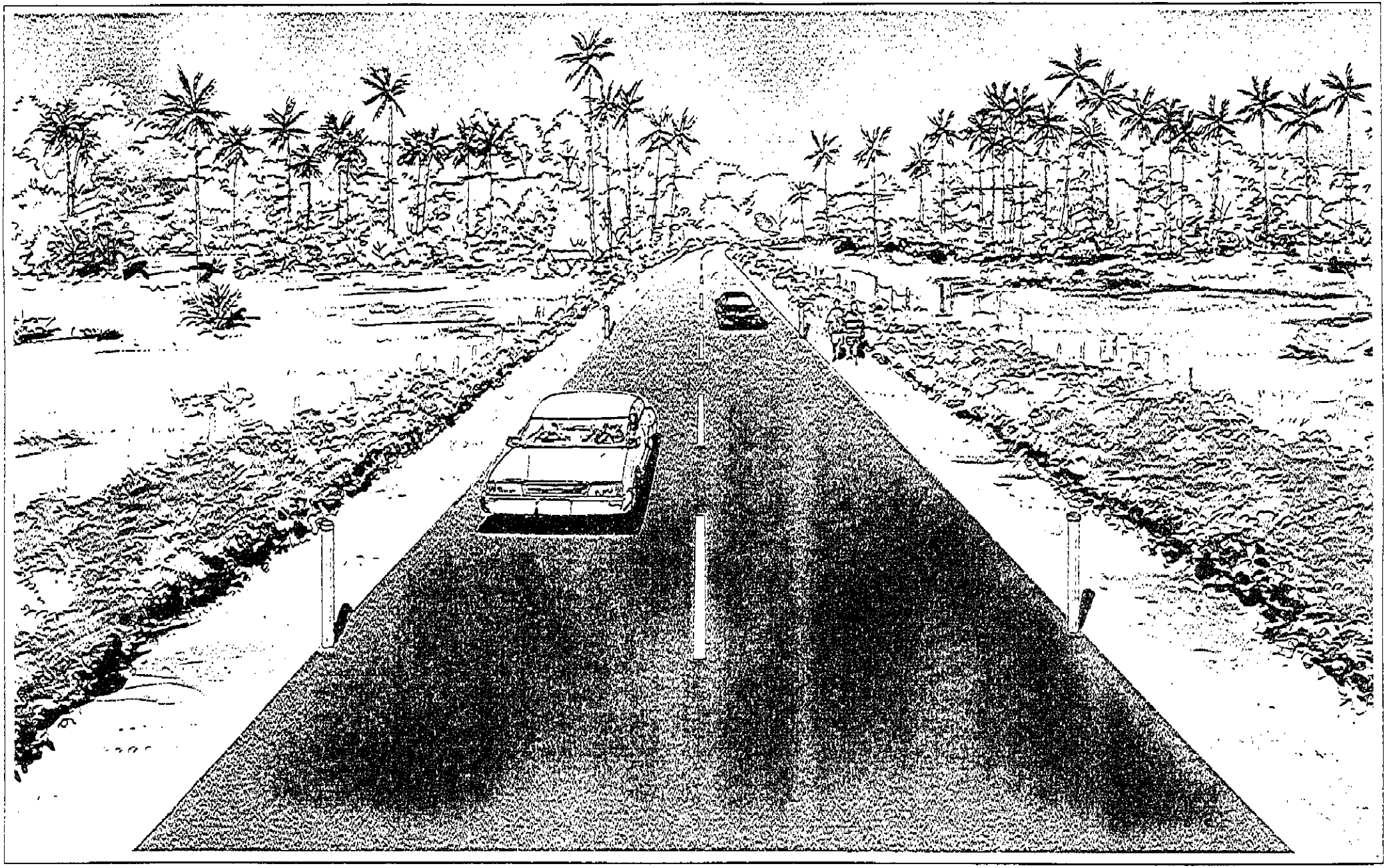
Very truly yours,

M. Miura

Minoru Miura
Project Manager,
Basic Design Study Team on the Project for
Improvement of the Ring Road in Efate Island
In the Republic of Vanuatu
Katahira & Engineers International



LOCATION MAP



PERSPECTIVE (Eastside view at 6.1km point)

Abbreviation

A D B	:	Asian Development Bank
AUSTROADS	:	The National Association of Road Transport and Traffic Authorities in Australia
C B R	:	California Bearing Ratio
C H	:	Chainage
D / D	:	Detailed Design
E U	:	European Union
P W D	:	Public Works Department
R C	:	Reinforced Concrete
R O W	:	Right of Way
V A T	:	Value Added Tax
V T (vt)	:	Vatu

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CHAPTER 1

BACKGROUND OF THE PROJECT

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The Island of Efate has a ring road that allows travel all around the island. The existing ring road has a general width of between 5 and 8 meters and is about 127 km long.

Most development on the island, including villages and towns, agricultural facilities, public facilities and tourism locations, is situated along the outer circumference of the island and are thus linked by the ring road. The single most important component of the internal transportation sector in Efate is the ring road. It is the linchpin for the entire road system on the island and is vital to many of the economic and social activities of the island.

A portion of this road along the southern cost, between the mouth of the Teouma and Rentapao Rivers, traverses the exposed foreshore. High wave action generated by the frequent cyclonic conditions experienced during the summer period often causes severe erosion and road closures along this section.

The ring road has an unsealed coral surface in a severely deteriorated condition, with many potholes and pools during rain.

In response to such road conditions, the Republic of Vanuatu planned the Project of improvement of the Ring Road in Efate (the Project), giving this a high priority. To implement the Project, the Republic of Vanuatu requested Japan's grant aid assistance.

In response to the request, the Government of Japan decided to conduct a basic design study of the Project. The Japan International Cooperation Agency (JICA) dispatched the Basic Design Study Team from June 30 to July 29, 1997, for a field survey and discussions with the officials of the implementing agency in Vanuatu.

The Study Team, during its stay in Vanuatu, confirmed the background, objectives and contents of the Project, collected relevant data, and surveyed the Project site. After returning to Japan, the Study Team evaluated the Project in respect of necessity, socioeconomic effects, appropriateness and other factors, and studied a basic design and implementation plan.

As a result, a draft basic design of the improvement of the road section from Tassiriki to the first 0.75 km from Rentapao bridge was proposed. After explanation and consultation on the draft basic design with the officials of Vanuatu side, the basic design of the Project was developed.

CHAPTER 2

CONTENTS OF THE PROJECT

CHAPTER 2 CONTENTS OF THE PROJECT

2.1 Objectives of the Project

The Project aims to improve the road section from Tassiriki to the first 0.75 km from Rentapao bridge (14.2 km) of the main road in Efate Island.

Major work of the Project is as follows:

- Improvement of the existing road.
- Realignment of the road.
- Procurement of the road maintenance equipment.

2.2 Basic Concept of the Project

2.2.1 Existing Condition of the Project Roads

2.2.1.1 Condition of improvement road section

(1) Road condition

- Unsealed coral surface road.
- The road width of the section is about 5.0～8.0m.
  The average width is 6.5m excluding shoulders.
- The road surface is in a severely deteriorated condition, with many potholes.

(2) Condition of drainage facilities

- No side ditch is furnished along the road.
- 7 places have pipe culvert installed.
- No structural damage to the culverts, but heavy sedimentation.

(3) Appraisal of urgent countermeasures

- Enough width for 2 lanes.
- High quality sealed road required.
- Installation of side ditch on the outside of shoulders in cuttings.
- Rehabilitation and a new construction of pipe culvert is required.

2.2.1.2 Condition of a new construction road sections

(1) Condition of design section

1) Topographic, geographic and land use from CH 5.45 to CH 13.45 (8.00 KM)

Section	Length (km)	Characteristics
5.45 ~ 6.40 km	0.95	Altitude: 6~7m, narrow width alluvium plate but vehicle passable, pastureland
6.40 ~ 6.80 km	0.40	Altitude: 6~26m, slipper at ascend section cattle farm, coral plateau, thin surface soil
6.80 ~ 7.20 km	0.40	Altitude: 26~40m, new alignment in farming area, scattered trees, thin surface soil
7.20 ~ 7.30 km	0.10	Altitude: 40~42m, along the existing road, cattle farm, coral plateau, thin surface soil
7.30 ~ 7.80 km	0.50	Altitude: 46~56m, new alignment in farming area, scattered trees, coral plateau, thin surface soil
7.80 ~ 9.00 km	1.20	Altitude: 56~39~50~40m, vehicle passable if dry surface, farming area, coral plateau
9.00 ~ 10.85 km	1.85	Altitude: 40~33~40~33~48m, only 4WD passable
10.85 ~ 11.65 km	0.80	Altitude: 46~32m, unpassable old American road, cattle farming area, coral plateau
11.65 ~ 11.94 km	0.29	Altitude: 32~29m, basin, cattle farming area , obstacled trees
11.94 ~ 12.75 km	0.81	Altitude: 29~28m, coral flat in basin
12.75 ~ 12.85 km	0.10	Altitude: 28~35m, coral plateau (cut portion)
12.85 ~ 13.20 km	0.35	Altitude: 35~6m, coral plateau, high bush
13.20 ~ 13.45 km	0.25	Altitude: 6~3m, farming area, some houses
Total	8.00	

2) Cultural assets around the Project Road

Cultural and historical sites have been identified on the route between CH 8,500m and CH 13,200m through inspection by the Vanuatu Cultural Center.

It should be clarified that the study of the above historical sites took place during the Basic Design Study. (refer to Figure 2.2.1-1)

3) Necessity of drainage facilities

- The realignment section is composed of a cut portion and an embankment portion. There are no plans to install a drainage facility at the embankment section.
- Side ditches are proposed at the cut portion.
- Additional culverts across the road are proposed for installation at the hollow of the embankment portion, in order to avoid pooling.

(2) Urgent countermeasures

1) Comparison with the existing road

The existing road alignment runs very close to the sea and was often closed to traffic by high waves from cyclones.

The new realignment section is in hilly terrain in an inland area. This 7.95 km of the realignment section replaces a 17 km existing road section reducing the total length of the road by 9 km.

2) Damage condition of the existing road

- There are many potholes and pools which disturb and reduce the trafficability of the road.

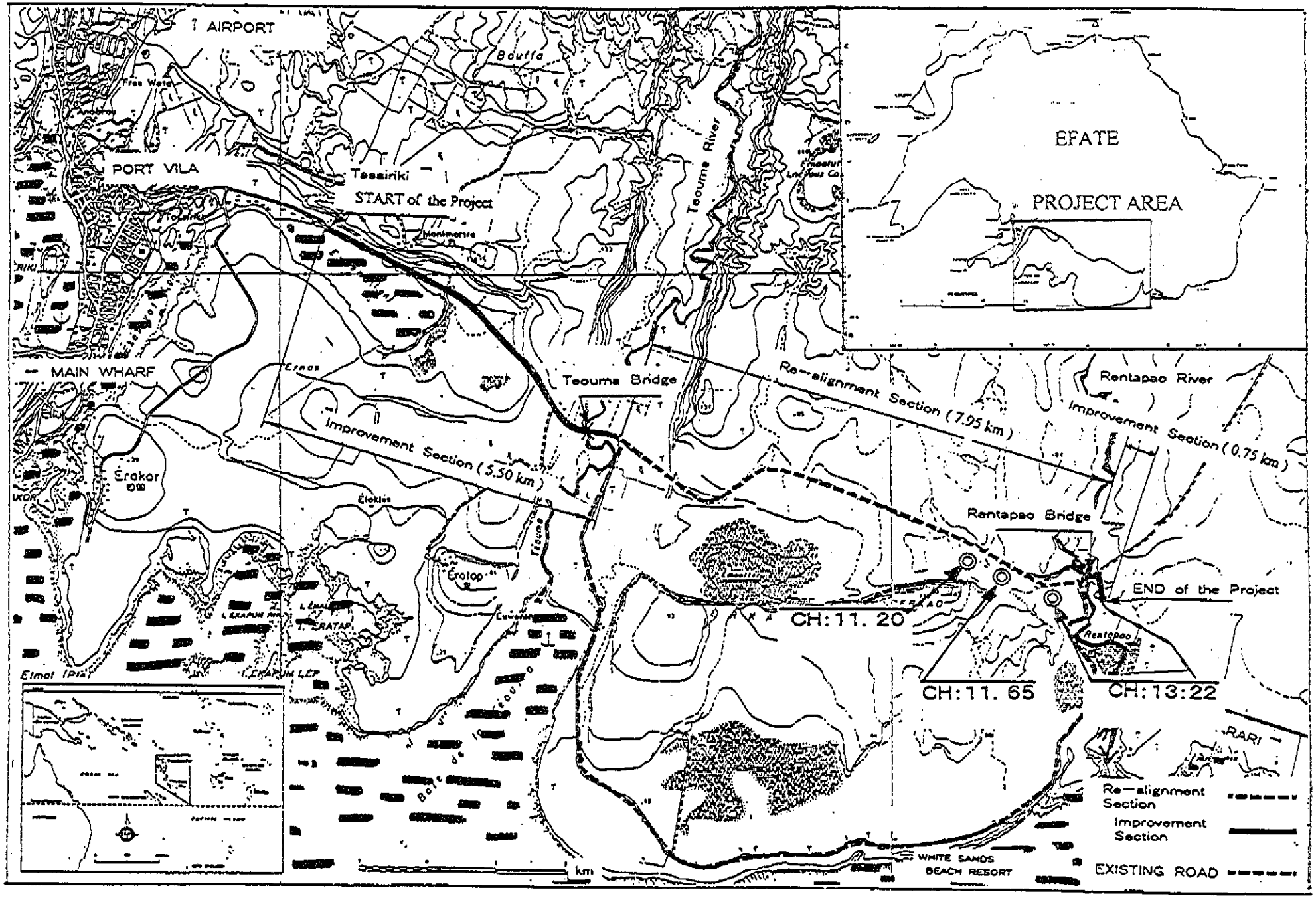


Figure 2.2.1-1 LOCATION OF CULTURAL ASSETS ◎ Site identified

2.2.1.3 Evaluation and importance of the Project Road

- The Ring Road is the only circumference road in Efate Island, interconnecting the Capital, port, airport, villages, public facilities and tourist spots.

- The Project Road directly serves about 1,900 people along the section. About 43,000 people in Efate Island are considered to be indirect beneficiaries.

- The results of the traffic survey are as follows:

CH 0.000 km	:	1,063 vehicles / 12 hours / 2 directions
CH 5.040 km	:	482 vehicles / 12 hours / 2 directions
CH 13.450 km	:	98 vehicles / 12 hours / 2 directions

- Recommended road classification
  Road classification by section is proposed as follows, taking into consideration the purpose of user, traffic volume, and terrain.

		Design Class	Terrain	Design Speed
CH 0.000km～CH 5.080km	:	II (ADT 1,000～ 3,000)	Rolling	80 km/h
CH 5.080km～CH 14.200km	:	III (ADT 300～100)	Mountain	60 km/h

Evaluation and importance of the Project Road are summarized in Table 2.2.1-2.

Table 2.2.1-2 EVALUATION AND IMPORTANCE OF THE PROJECT ROAD

Sub-section		Chainage (km)	Road Length (km)	Priority Order by Vanuatu Government	Importance of the Project Road				
					Road Class	Main Purpose	Population along the Project Road	A D T	Evaluation
I	Improvement of the existing road	0.000 ~ 2.300	2.30	1	Major Road	The most important section among the Ring Road in Efate Island. The only access road to Gabage Dump from Port Vila. No alternative road.	1,900 people	1,063 ~ 568	A
	Realignment route	2.300 ~ 2.900	0.60						
	Improvement of the existing road	2.900 ~ 3.700	0.80						
	Realignment route	3.700 ~ 4.100	0.40						
II	Improvement of the existing road	4.100 ~ 5.500	1.40	2	Major Road	Part of the Ring Road	43,000 people all in the Efate Island	482	
III	Realignment route (A)	5.500 ~ 9.100	3.60	4	Bypass Road of Major Road	9 km length shortcut compared the existing White Sand Road		≒10	B
	Realignment route (B)	9.100 ~13.450	4.35					0	
IV	Improvement of the existing road	13.450 ~14.200	0.75	3	Major Road	Part of the Ring Road		98	A

Sub-section		Chainage (km)	Road Length (km)	Existing Condition			Assistance by other foreign donor
				Type of Road Surface	Condition of Road Surface	Road Width (m)	
I	Improvement of the existing road	0.000 ~ 2.300	2.30	coral seal	bad	6.7m on average	not applicable
	Realignment route	2.300 ~ 2.900	0.60	cattle farm			
	Improvement of the existing road	2.900 ~ 3.700	0.80	coral seal	bad	7.4m on average	
	Realignment route	3.700 ~ 4.100	0.40	cattle farm			
II	Improvement of the existing road	4.100 ~ 5.500	1.40	coral seal	bad	6.4m on average	
III	Realignment route (A)	5.500 ~ 9.100	3.60	path in bush			
	Realignment route (B)	9.100 ~13.450	4.35	cattle farm, bush			
IV	Improvement of the existing road	13.450 ~14.200	0.75	coral seal	bad	4.9m on average	

Note: 1) Realignment route (A) means passable section by vehicle (farm road)
2) Realignment route (B) means unpassble section by vehicle (no existing road)
3) ADT means 12 hours (both lanes)
4) Evaluation criteria, A : very high importance B : high importance C : low importance
5) Road width excludes road shoulder

2.2.1.4 Existing condition and importance of the bridges

(1) Teouma Bridge

Bridge length	:	25.34 m (5.17 + 15.00 + 5.17)
Bridge type	:	Continuous RC rigid frame bridge (3 spans)
Bridge width	:	Carriageway width : 3.8 m, foot ways : 0.8 m x 2 Total width : 5.4 m
Girder	:	5 main girders, height 0.8m, thickness of deck : 0.13 m
Abutment	:	Gravity type, structure type : concrete plastered gabions
Piers	:	Three 600 mm diameter concrete columns with a connecting vertical concrete wall between columns
Pile	:	Squared RC pile : 0.4 m x 0.4 m

- Only the downstream handrail remains.
  The majority of drain pipes on the deck are blocked with sediment.
  Guardrails along both approaches are heavily damaged.
  Constructed in 1989.

(2) Rentapao Bridge

Bridge length	:	12.40 m
Bridge type	:	RC simply supported girder bridge
Bridge width	:	Carriageway 3.55 m (Total width : 3.88 m)
Girder	:	2 main girders, height : 0.84 m, thickness : 0.20 m
Abutment	:	Gravity type

A concrete overlay on the bridge deck is unbonding and spalling from the deck. The majority of drain pipes on the deck are blocked with sediment. Guardrails along both approaches are heavily damaged.

The two bridges are the most important structures in the Ring Road because there are no other detour bridges.

2.2.1.5 Examination of the countermeasures for the Project

The Basic Design Study was conducted, based on the evaluation of the JICA Preliminary Study (March, 1997) and the PWD Detailed Design Study (1995).

The Team studied the existing condition of the Project road in order to review the PWD Detailed Study and conducted some supplemental study.

The Team inspected the existing condition of the bridges and proposed their safety countermeasures.

After considering implementation in Vanuatu and the CBR test results, sprayed seal pavement is proposed for the pavement type of the Project road.

The Team confirmed the following.

① The number of traffic lanes proposed is 2 lanes, except bridges based on the future traffic volume.

② The base material is composed of coral material, which has enough stability.

③ Given the existing geological condition and construction methods, a slope gradient of 1 : 0.25 is proposed.

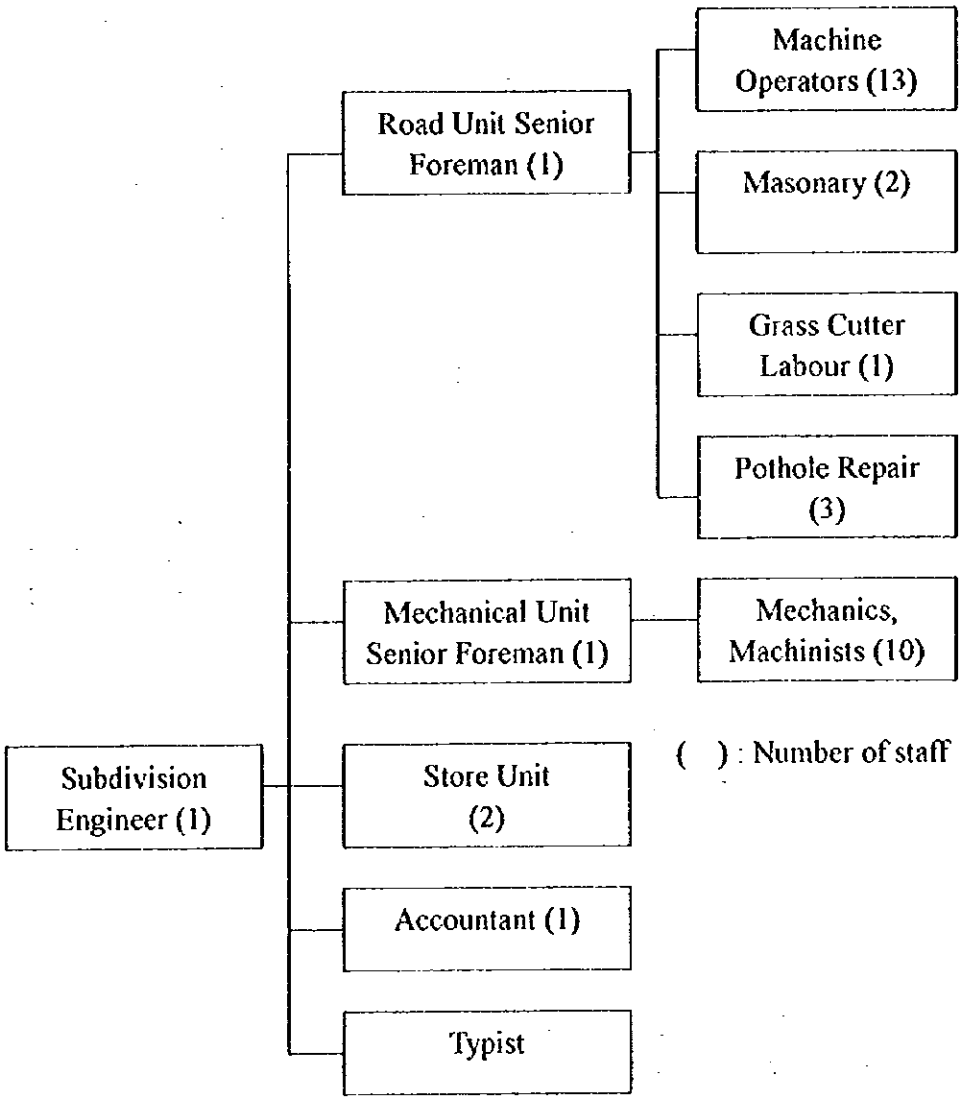
2.2.2 Existing Condition of Road Maintenance Work

The PWD has 5 Subdivisions for each province which implement the construction of roads and bridges and maintenance work.

Shafa Subdivision is in charge of the road and bridge maintenance work in Efate Island.

The layout of the Workshop in Shefa Subdivision is shown in Figure 2.2.2-1.

The organization of Shefa Subdivision is as follows:



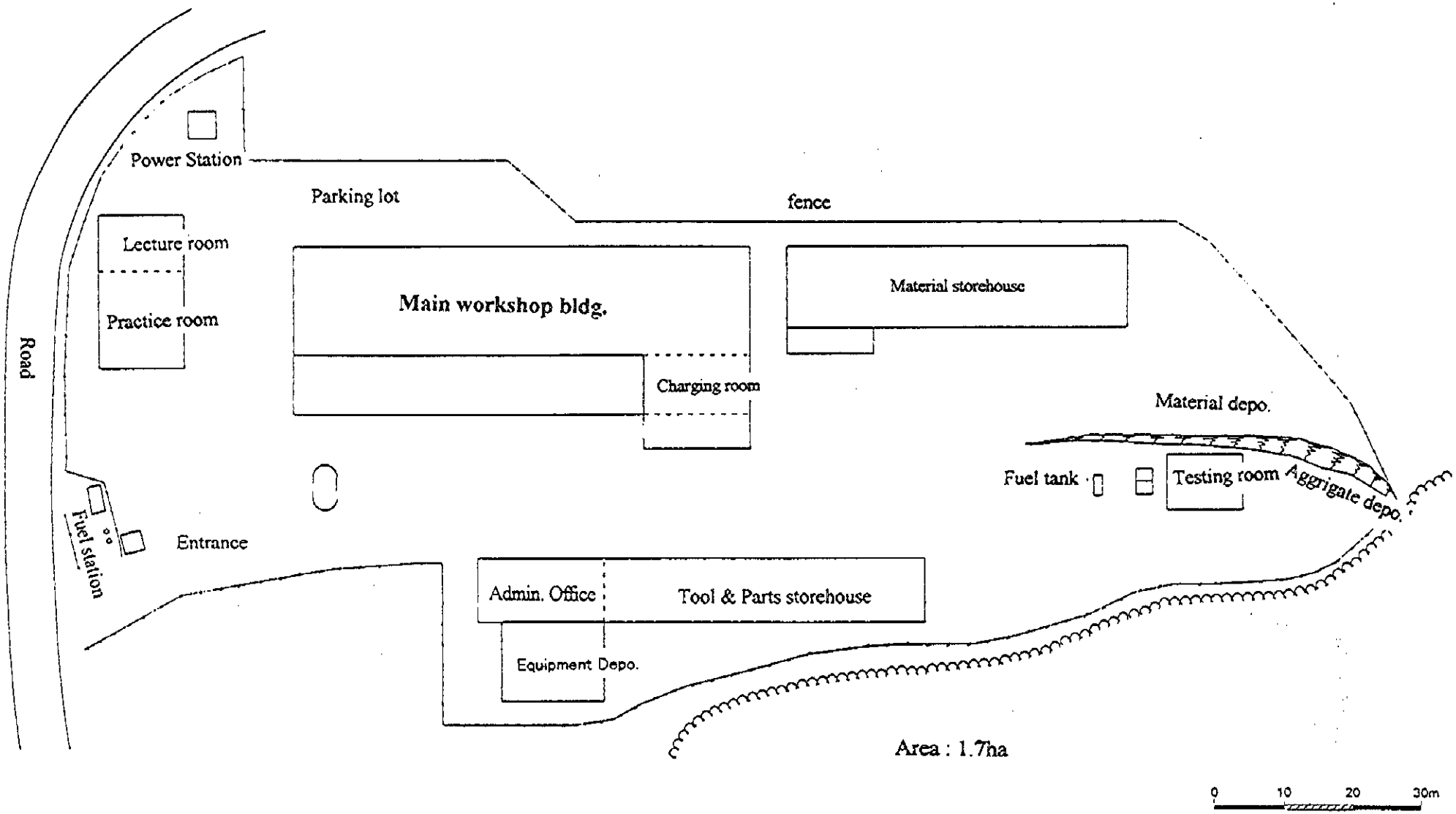


Figure 2.2.2-1 LAYOUT OF SHEFA SUBDIVISION WORKSHOP

2.2.2.1 Existing condition of the PWD owned equipment

(1) Present status of equipment stationed in Shefa Subdivision

- Almost all equipment is more than 10 years old, except a Dump truck.
- Much equipment is damaged. Major damages are oil leaking from the engines and transmission of heavy equipment, rust of vehicle body, and damage in panel.
- Working condition is shown in Table 2.2.2-1.

(2) Repair system

- A field service system has been established in which a field service vehicle goes around working site's equipment and conducts necessary services, such as oil exchange, greasing and exchange of wasted parts. The field services undertaken are reported monthly.
- Brokendown equipment is carried by semi-trailer to the mechanical workshop for repair.
- Periodical inspection is carried out after a given number of working hours.
- An equipment status report is prepared monthly, including working hours, fuel and lubricant consumed, labour hours, etc.

(3) Capability of equipment maintenance

- Since the working ratio is maintained as 76%, in spite of aged equipment, the PWD is capable of maintenance of equipment.
- In some cases, old equipment is remodeled for another use. This shows the PWD's creativity.
- An apprentice training program is executed.

(4) Parts management

- The main parts kept are expendable.
- The tools and parts store has only hand-made wooden racks but keeps them clean. All tools and parts are kept in good order.
- The stock of parts is reported monthly.

Table 2.2.2-1 PRESENT STATUS OF EQUIPMENT STATIONED IN SHEFA SUBDIVISION

Equipment	Capacity	Number	Working Condition			Rate of Operation (%)	Remarks
			Operation	Overhaul	Under Repair		
Bulldozer	15 t	2	2	-	-	100	
Wheel Loader	Bucket : 1.2 ~ 1.3m^3	2	1	-	1	50	Parts ordered
Wheel Loader with shovel	Bucket : 1.2m^3	1	-	-	1	0	Unrepairable
Dump Truck	5 t	4	4	-	-	100	
Cargo Truck with crane	1.5 t Crane Cap. 2.0 t	1	1	-	-	100	
Trailer Truck	Lowbed, 20 t	1	1	-	-	100	
Tractor	100 HP	2	1	-	1	50	Unrepairable
Motor Grader	Blade : 3.6m	2	1	1	-	100	Parts ordered
Vibration Roller	Combined Type 11 ~ 12 t	1	1	-	-	100	
Mower	Hand carry	1	-	-	1	0	Unrepairable
Total		17	12	1	4	76	Equipment (parts ordered) is considered for rate of operation as unrepairable.

(5) Present problems

- Much equipment is aged.
- Few spare parts for breakdown are stored.
- Because the models are old, even equipment manufacturers have only a few or no stock of spare parts in many cases. Therefore, obtaining necessary parts takes time.
- In some cases, repair manuals and parts books have not been available since the time of purchase, causing difficulty in identifying the parts and ordering them.
- The budget for procuring parts is insufficient.

Due to the above situation, equipment, when brokendown, remains in operable for a significant length of time.

2.2.2.2 Roads and bridges under maintenance work

The PWD Shefa Subdivision is in charge of the maintenance work in Efate Island.

The roads for maintenance work under the PWD are summarized in Table 2.2.2-2.

Table 2.2.2-2 SUMMARY OF ROADS UNDER PWD MAINTENANCE WORK

Section	Sub-section	Class	Length (km)		Carriageway Width (m)
			Sealed	Gravel	
Major road Section of Ring Road (123.00 km)	① Tagabe～Klems Hill	Major	8.00	–	5～7
	② Klems Hill～2nd Lagoon	Major	–	115.00	5～7
	Total		8.00	115.00	
Minor road Off Ring Road (37.00 km)	③ 2nd Lagoon～USP	Semi-trunk	3.00	–	5～7
	④ Mele～Devils Point	Semi-trunk	–	11.00	3～5
	⑤ Ring Road～Eratap	Semi-trunk	–	4.00	3～5
	⑥ Ring Road～Evakor	Semi-trunk	4.60	1.40	5～7
	⑦ Le Lagoon～Pango	Semi-trunk	3.80	–	5～7
	⑧ Ring Road～Monmartre	Semi-trunk	–	3.60	5～7
	⑨ Ring Road～Abbatoa	Semi-trunk	–	2.00	5～7
	⑩ Ring Road～Savaroa	Semi-trunk	–	2.00	5～7
	⑪ Ring Road～Blacksand	Semi-trunk	–	1.60	3～5
	Total		11.40	25.60	

Section	Sub-section	Class	Length (km)		Carriageway Width (m)
			Sealed	Gravel	
City Road in Port Vila (29.00 km)	Pango Road	Major	0.85	--	5~7
	Elluk Road	Major	2.32	--	5~7
	Wharf Road	Major	--	1.82	5~7
	Artois Street	Feeder	0.83	--	3~5
	Kumul Highway (Air Port)	Major	6.46	--	5~7
	Cornwall Street	Feeder	0.45	--	3~5
	Edmond Colardean Avenue	Feeder	1.10	--	3~5
	Wales Street	Feeder	--	0.30	3~5
	Base Hospital Street	Feeder	--	0.50	3~5
	Winston Churchill Avenue	Feeder	0.80	--	3~5
	General De Gaulle Avenue	Feeder	0.50	--	3~5
	Fleming Street	Feeder	0.09	--	3~5
	Emile Street	Feeder	0.18	--	3~5
	Mercet Street	Feeder	0.24	--	3~5
	Condominium Street	Feeder	0.34	--	3~5
	Gueiros Street	Feeder	0.73	--	3~5
	Carnot Street	Feeder	0.19	--	3~5
	Pasteur Street	Feeder	0.20	--	3~5
	Paris Street	Feeder	0.44	--	3~5
	Bouganville Street	Feeder	0.33	--	3~5
	Picanon Street	Feeder	0.23	--	3~5
	Alsace Lorraine Street	Feeder	0.16	--	3~5
	Henri Montfort Street	Feeder	0.37	--	3~5
	Pierre Lammy Street	Feeder	--	0.44	3~5
	Teouma Road	Major	4.46	--	5~7
	Tassiriki Road	Major	0.36	--	5~7
	Sokabo~VMF~Champagne	Major	--	1.78	5~7
	Malapoa Road	Major	--	0.70	5~7
	Manples~Ohlen Road	Major	--	1.25	5~7
	Mele Road	Major	0.58	--	5~7
	Total		22.21	6.79	
Grand Total (189.00 km)			41.61	147.39	

Note:
- For Ring Road refer to Figure 2.2.2-2
- For City Road in Port Vila refer to Figure 2.2.2-3
- Total length of City Road in Port Vila is 50.00 km
- 21.00 km City Road under the maintenance by Port Vila Municipality

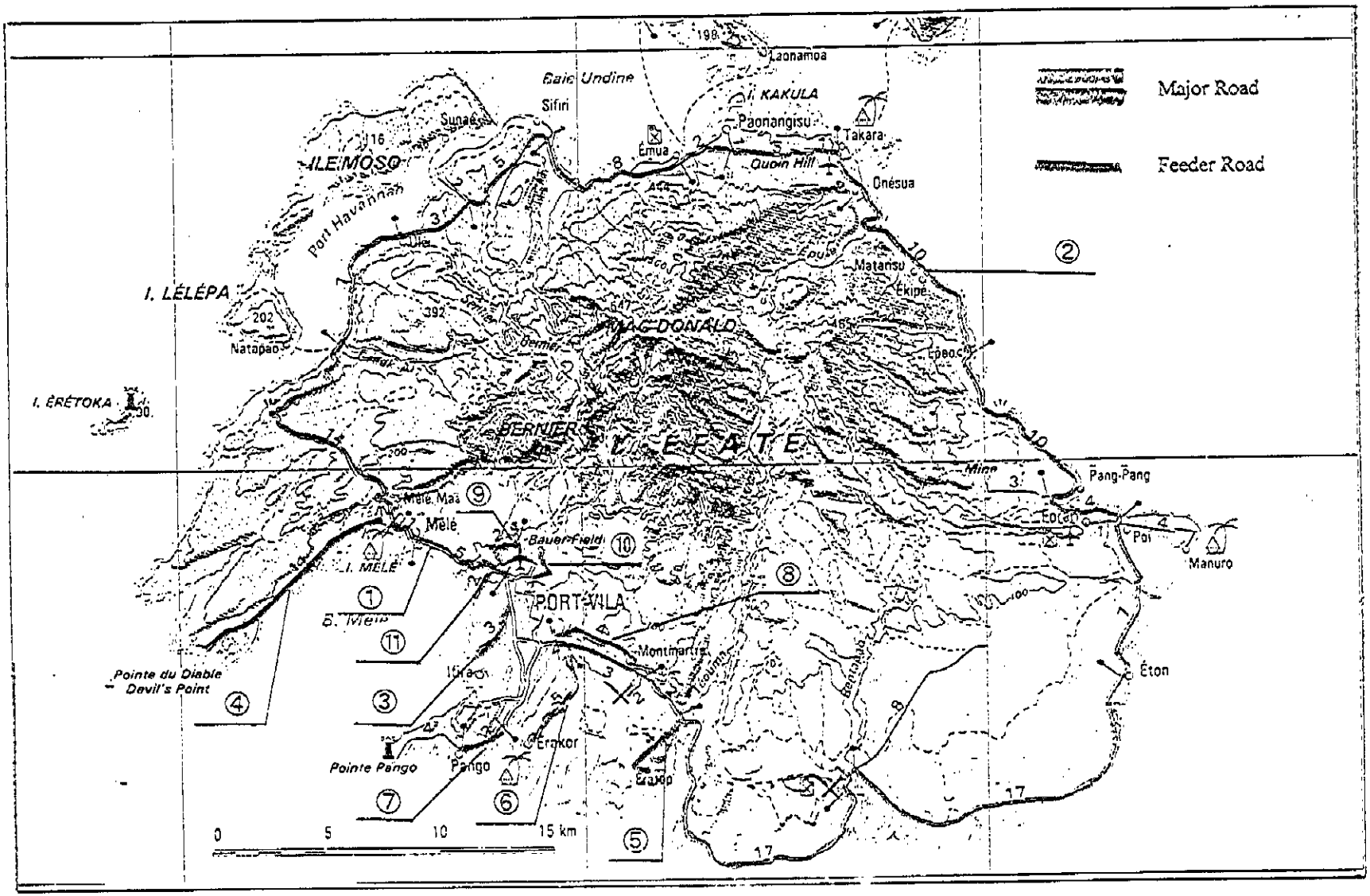


Figure 2.2.2-2 ROADS FOR MAINTENANCE WORK UNDER THE PWD IN EFATE ISLAND

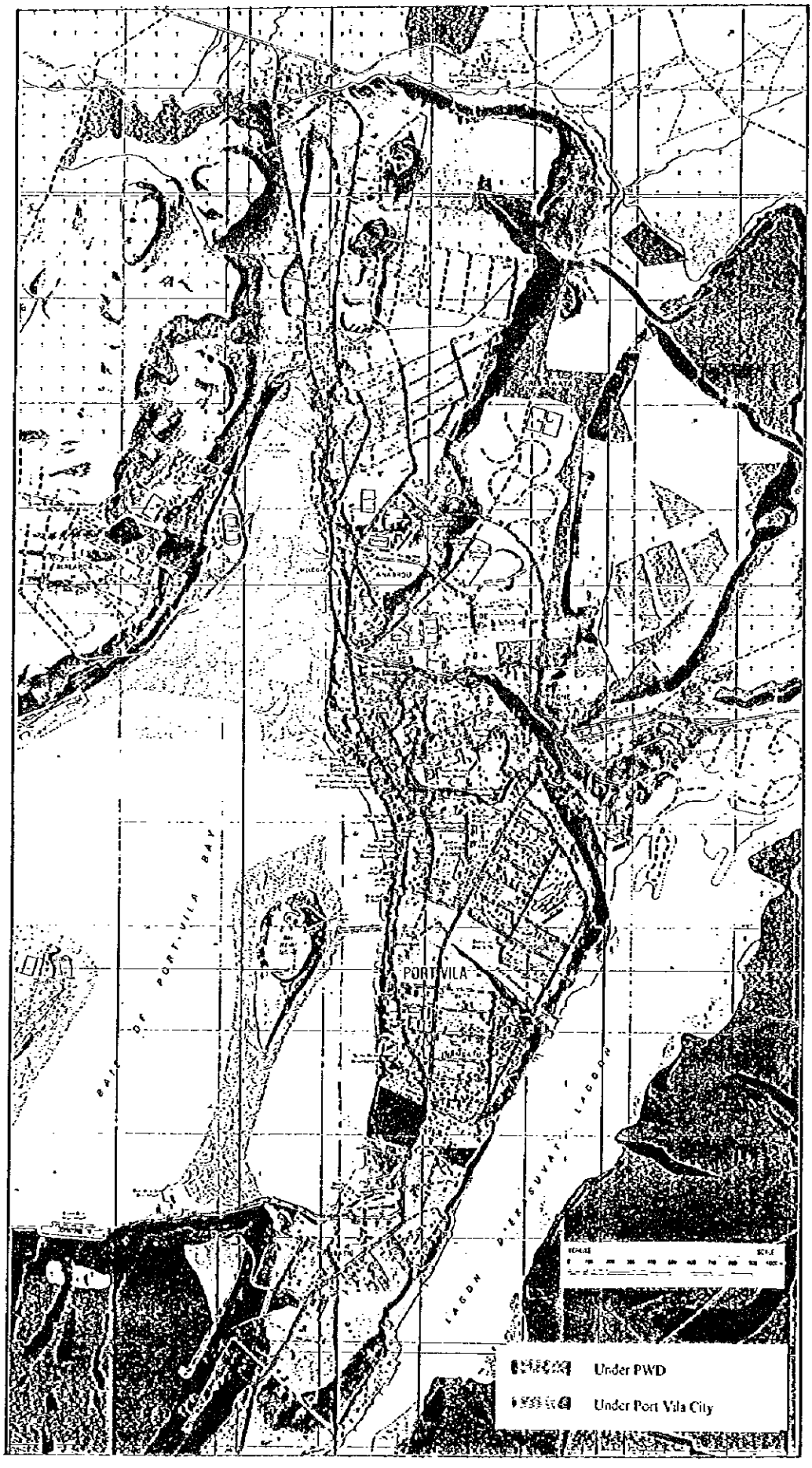


Figure 2.2.2-3 ROADS FOR MAINTENANCE WORK IN PORT VILA UNDER PWD & CITY

Table 2.2.2-3 SUMMARY OF EXISTING BRIDGES ALONG RING ROAD (maintained by the PWD)

Bridge No.	Existing Condition			Bank Protection	River Condition	Topo Condition
	Bridge Length (m)	Bridge Width (m)	Type			
1	25.8	7.3	·Bailey ·Steel deck ·RC Abut	Gabion	meander	flat
2	10.4	6.0	·Steel girder ·RC deck ·Gabion Abut	Gabion	straight	flat
3	6.4	6.0	·Steel girder ·RC deck ·RC Abut	Gabion	meander	flat
4	-	-	·No existing bridge	-	-	-
5	-	-	·No existing bridge	-	-	-
6	13.0	7.4	·Pipe culvert ·3 lines of pipe	-	straight	flat
7	-	-	·No existing bridge	-	-	-
8	5.0	6.0	·Pipe culvert	-	straight	flat
9	8.8	3.5	·Steel girder ·Timber deck ·RC Abut	-	straight	flat
10	6.5	4.2	·Steel girder ·Timber deck ·Gabion Abut	Gabion	straight	flat
11	11.8	3.8	·Steel girder ·Timber deck ·SSP Abut	Gabion	straight	flat
12-1	25.5	7.8	·Pipe culvert ·3 lines of pipe	-	straight	flat
12-2	13.0	6.1	·Pipe culvert ·4 lines of pipe	-		
13	24.1	3.6	·Steel girder (3 spans) ·Timber deck	-	straight	flat
			·Gabion Abut ·RC pier	-		
14	18.2	5.1	·Spillway ·8 lines of RC pipe	-	meander	flat
15	19.0	6.3	·Spillway ·8 lines of RC pipe	-	meander	flat
16	11.1	3.8	·Steel girder ·Timber deck ·RC Abut	-	straight	flat
17	12.6	8.7	·RC girder ·RC deck ·RC Abut	-	straight	valley
18	24.2	4.3	·Spillway ·8 lines of RC pipe	-	straight	terrace at upstream
19	7.0	3.1	·RC girder ·RC deck ·RC Abut	-	meander	flat
20	12.4	3.5	·RC girder ·RC deck ·Gabion Abut	-	straight	flat
21	25.3	3.8	·RC rigid frame(3 spans) ·RC deck ·Gabion Abut	-	straight	flat

Note: For map showing bridge location is refer to Figure 2.2.2-4.
Rentapao and Teouma bridges are maintained by PWD

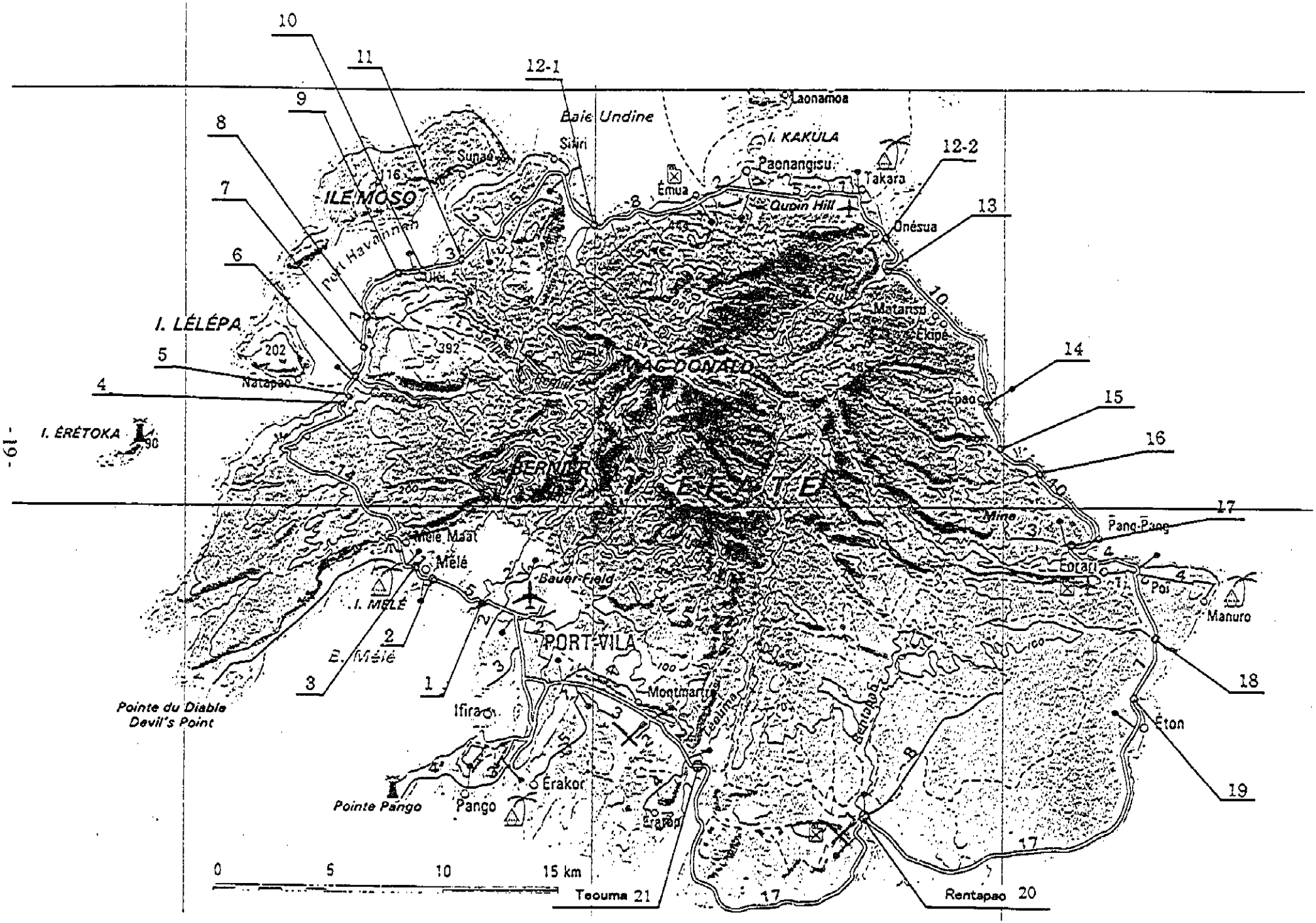


Figure 2.2.2-4 MAP OF EXISTING BRIDGES UNDER THE PWD MAINTENANCE WORK

2.2.2.3 Road and bridge maintenance system

The PWD implements their maintenance work in accordance with the PWD's maintenance standard. Road and bridge maintenance activities may be subdivided into routine and periodic maintenance.

Maintenance activities by the PWD in Efate Island are summarized as follows:

Routine Maintenance

• Patching Potholes	:	• Major Roads in Ring Road (8.0km) Minor Roads in Ring Road (11.4km) City Roads in Port Vila (22.21 km) • Implementation by administration and by contract
• Cleaning Streets	:	• City Roads in Port Vila (Sealed road : 22.21 km, Gravel road : 6.79 km) • Implementation by administration

Periodic Maintenance

• Seal patching and new construction of pavement	:	• Under implementation in Port Vila by the PWD After completion, Port Vila will maintain • Implementation by contract
• Light maintenance for gravel road	:	• Ring Road (115.0 km), Feeder Roads along Ring Road (25.6 km), City Roads in Port Vila (6.79 km) • Implementation by administration
• Heavy maintenance for gravel road	:	• Major Roads in Ring Road (115.0 km), Feeder Roads along Ring Road (25.6 km) • Implementation by administration and by contract

Maintenance work for bridges consists of repairing bridge structures, protecting the banks and providing safe facilities.

Maintenance methods and necessary equipment for the maintenance work under administration by Shefa subdivision are as follows:

(1) Unsealed Coral Road

Work items

Figure 2.2.2-5 shows standard cross sections, Table 2.2.2-4 shows technical specifications and necessary equipment.

① Light maintenance : Grading, Patching Potholes (Standard cross section Type-1, 2)

② Heavy maintenance : Regravelling (Standard cross section Type-5, 6)

③ Cleaning streets : Grass cutting, cleaning road surface and side ditches

Methods and equipment components

Table 2.2.2-5 shows methods and equipment components.

(2) Sealed Road

Work items

① Patching : Patching potholes (refer to Figure 2.2.2-6)

② Cleaning streets : Grass cutting, cleaning road surface and side ditches

③ Seal patching and new construction

Seal patching and new construction is implemented by contract, therefore it is unnecessary to consider equipment for this in the Project.

Figure 2.2.2-6 shows the standard cross section of the patching method used. Table 2.2.2-7 shows technical specifications and necessary equipment.

(3) Bridge

Maintenance methods and necessary equipment for bridges are included in gravel roads and sealed roads, which cover the work items.

Table 2.2.2-4 TECHNICAL SPECIFICATION AND NECESSARY EQUIPMENT COMPONENT FOR UNSEALED CORAL ROAD MAINTENANCE WORK (1/3)

Scope of Works	Works & Technical Specification	Necessary Equipment Component														
		Bulldozer	Wheel Loader	Wheel Loader with Shovel	Dump Truck	Cargo Truck with Crane	Trailer Truck	Motor Grader	Motor Grader with Ripper	Tire Roller	Vibration Roller	Plate Compactor	Water Tank Truck	Mower	Chain Saws	Pick-up Truck
① Light Maintenance (Standard Cross Section : Type - 1.2)		X	◎	◎	◎	◎	X	◎	◎	◎	◎	◎	◎	◎	◎	◎
1. Mobilizaton & Demobilizaton	• Mobilizaton & demobilization of equipment, material and labour					○										○
2. Grading	• Rescarify • depth : 100m/m • width : whole with of carriagewav					○			○					○	○	○
	• Reshape • pavement width : 5.0m • road reserve : 1.5 ~ 3.0m • side ditch : 1.0m • cross fall : 5.0%			○	○			○	○							○
	• Water • maintaining the moisture content												○			○
	• Compaction					○				○	○	○				○
3. Packing Pot Holes	• Packing • spacing : 2m • cutting depth : 150m/m			○	○	○					○	○				○
4. Road Verges	• Cearing road sides • long grass, trees, branch • cut not exceeding 100m/m					○								○	○	○
	• Maintaining the shape and dimension, compaction • width : 1.0m			○	○	○		○			○	○				○
	• Maintaining vegitation • removal particles bigger than 20m/m		○		○	○					○	○				○
5. Drainage	• Removal covering material • cut not exceeding 100m/m					○								○	○	○
	• Maintaining the shape and dimension, compaction • side ditch width : 1.5m			○	○	○		○			○	○				○
6. Side Drain, Culvert, Turn out	• Ceaning side drain, culvefrt drain and water cause • Grass cutting, removal stones, topping off branches			○	○	○					○	○		○	○	○
7. Cause Way	• Cearing river and creek • 10m down and upstream of the cause way • repairing gabions • cleaning obstructuves			○	○	○					○	○		○	○	○

Table 2.2.2-4 TECHNICAL SPECIFICATION AND NECESSARY EQUIPMENT COMPONENT FOR UNSEALED CORAL ROAD MAINTENANCE WORK (2/3)

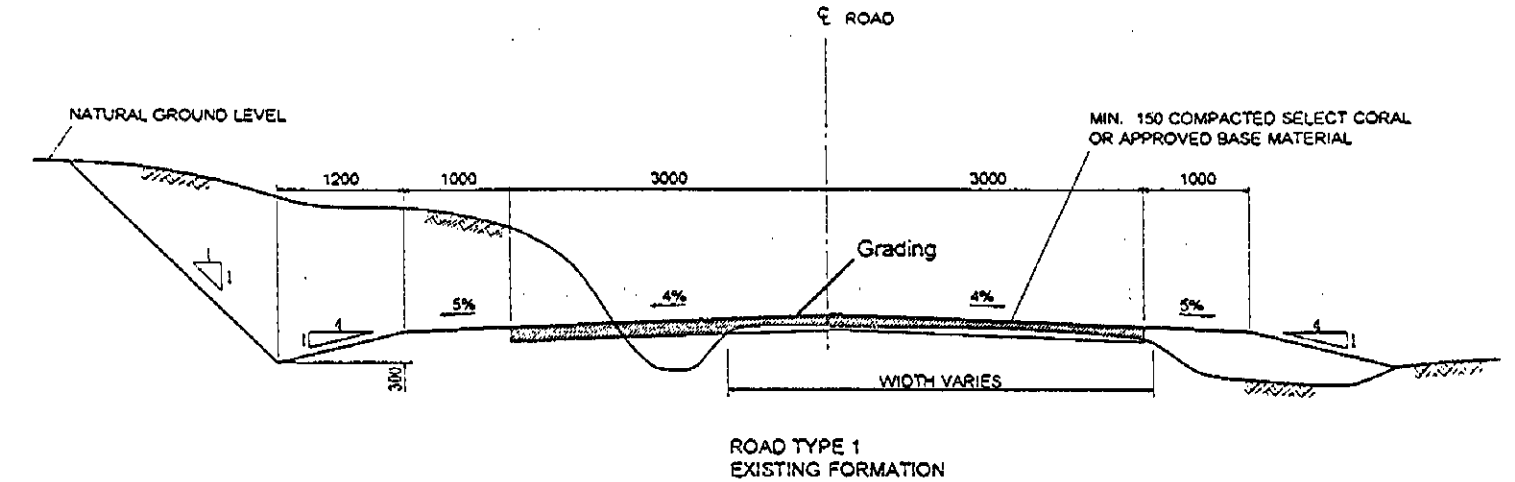
Scope of Works	Works & Technical Specification	Necessary Equipment Component														
		Bulldozer	Wheel Loader	Wheel Loader with Shovel	Dump Truck	Cargo Truck with Crane	Trailer Truck	Motor Grader	Motor Grader with Ripper	Tire Roller	Vibration Roller	Plate Compactor	Water Tank Truck	Mower	Chain Saws	Pick-up Truck
(2) Heavy Maintenance (Standard Cross Section : Type - 5.6)																
1. Mobilization & Demobilization	• Mobilization & demobilization of equipment, material and labour					○	○									○
2. Regravelling	• Rescarify • depth : 100m/m • full width of road including ditch • removal of unsuitable material															
	• Reshape • cross fall : 4.0% • shoulder cross falls : 5.0% • thickness : 100~200 m/m • finish thickness : less than 150 m/m • removal stones more than 63 m/m and branches															
	• Water • Optimum moisture content • MDD : 97% • PI : 6~12															
	• Compaction • CBR : more than 25% (MDD 98%)															
	• Materials for surfacing • River gravel except sea gravel • Transpotation distance : less than 5 km • Grain size : Grading 1 and 2 • Grading 1 : 75.0 m/m~75 μ m • Grading 2 : 37.5 m/m~75 μ m	○	○	○	○	○	○							○	○	○
3. Drainage, Culvert	• Ecavation, bedding, backfill • bedding : removal stone more than 4.75 m/m at subgrade, CBR test • backfill : selection material, each layer : less than 300 m/m, compactor			○	○	○					○	○				○
	• Repair drainage facility • removal of existing RC pipe • installation of RC pipe			○		○										○
4. Road Verges	• Cleaning and grubbing • grass cutting, cleaning trees • waste material	○				○	○							○	○	○
	• Shaping to profile • shoulder : level of shoulder lower than traffic lane edge	○	○	○	○	○	○	○	○	○	○	○	○			○
	• Vegitation • seeding, moisture control • top soil : particle size : less than 20 m/m thin layer : no exceeding 25 m/m in thickness		○		○						○	○				○

Table 2.2.2-4 TECHNICAL SPECIFICATION AND NECESSARY EQUIPMENT COMPONENT FOR UNSEALED CORAL ROAD MAINTENANCE WORK (3/3)

Scope of Works	Works & Technical Specification	Necessary Equipment Component														
		Bulldozer	Wheel Loader	Wheel Loader with Shovel	Dump Truck	Cargo Truck with Crane	Trailer Truck	Motor Grader	Motor Grader with Ripper	Tire Roller	Vibration Roller	Plate Compactor	Water Tank Truck	Mower	Chain Saws	Pick-up Truck
5. Slope Stabilization	- Gabion • replacement of damaged • gabion : rectangular unit, zinc coated wire • stone size : 120~250 m/m															
	• Crossing of Water Course															
③ Cleaning Street						○								○		○
1. Mobilization & Demobilization	• Hauling of material, equipment and labor					○										○
2. Cleaning Street	• Grass cutting, cleaning road surface and side ditch					○								○		○

Table 2.2.2-5 MAINTENANCE METHODS AND NECESSARY EQUIPMENT FOR UNSEALED CORAL ROAD

Work Item	Road Section	Implementation	Frequency	Work Description	Necessary Equipment (per formation)	Manpower (per unit)
① Light maintenance	· Major road in Ring Road : 115 km (all sections : A～D)	by administration	· 56 days/work x Twice/year = 112 days/year (Periodic Maintenance)	· Hauling of equipment and material · Grading by a grader · Material spray by manpower · Repairing and cleaning shoulder · Repairing and cleaning side ditch · Repairing and cleaning drainage facilty · Repairing and cleaning water cause	· Wheel loader : 1 (unit) · Wheel loader with shovel : 1 · Dump truck : 1 · Cargo truck with crane : 2 · Motor grader : 1 · Motor grader with ripper : 1 · Tire roller : 1 · Vibration roller : 1 · Plate compactor : 1 · Water tank truck : 1 · Mower : 1 · Chain saw : 1 · Pick-up truck : 1	· Foreman : 1 · Operator (special) : 7 · Operator (general) : 7 · Skilled labor : 4 · Common labor : 2 · Light labor : 3
	· Minor road in Ring Road : 25.6 km (all sections : 7 routes)	by administration	· 14 days/work x Twice/year = 28 days/year (Periodic Maintenance)			
	· City Road in Port Vila (all sections : 7 routes)	by administration	· 7 days/work x Twice/year = 14 days/year (Periodic Maintenance)			
② Heavy maintenance	· Major road in Ring Road : Section A 22.5 km	by contract	· 21 days/work x 6 times/year = 126 days/year (Periodic Maintenance)	· Hauling of equipment and material · Grading by crushing stone · Repairing and cleaning culvert including water causes · Improving shoulder · Slope protection and stabilization	· Bulldozer : 1 (unit) · Wheel loader : 1 · Wheel loader with shovel : 1 · Dump truck : 4～8 · Cargo truck with crane : 1 · Trailer truck : 1 · Motor grader : 1 · Motor grader with ripper : 1 · Tire roller : 1～2 · Vibration roller (Hand guide type) : 1 · Plate compactor : 1 · Water tank truck : 1 · Mower : 1 · Chain saw : 1 · Pick-up truck : 1	· Foreman : 1 · Operator (special) : 8～10 · Operator (general) : 6～10 · Skilled labor : 4 · Common labor : 2 · Light labor : 6
	· Major road in Ring Road : Section B 28.4 km	by administration	· 21 days/work x 3 times/year = 63 days/year (Periodic Maintenance)			
	· Major road in Ring Road : Section C 29.2 km	by administration	· 21 days/work x 3 times/year = 63 days/year (Periodic Maintenance)			
	· Major road in Ring Road : Section D 34.9 km	by administration	· 21 days/work x 3 times/year = 63 days/year (Periodic Maintenance)			
	· Minor road in Ring Road : 25.6 km (7 routes)	by administration	· 21 days/work x 3 times/year = 63 days/year (Periodic Maintenance)			
③ Cleaning Street	· City road in Port Vila : 6.79 km (7 routes)	by administration	· Routine maintenance	· Hauling of equipment and material · Cleaning street ·Grass cutting ·Cleaning road surface and side ditch ·Disposal of waste material	· Cargo truck with crane : 2 · Mower : 1 · Pick-up truck : 1	· Foreman : 1 · Operator (special) : 2 · Operator (general) : 1 · Skilled labor : 1 · Light labor : 5



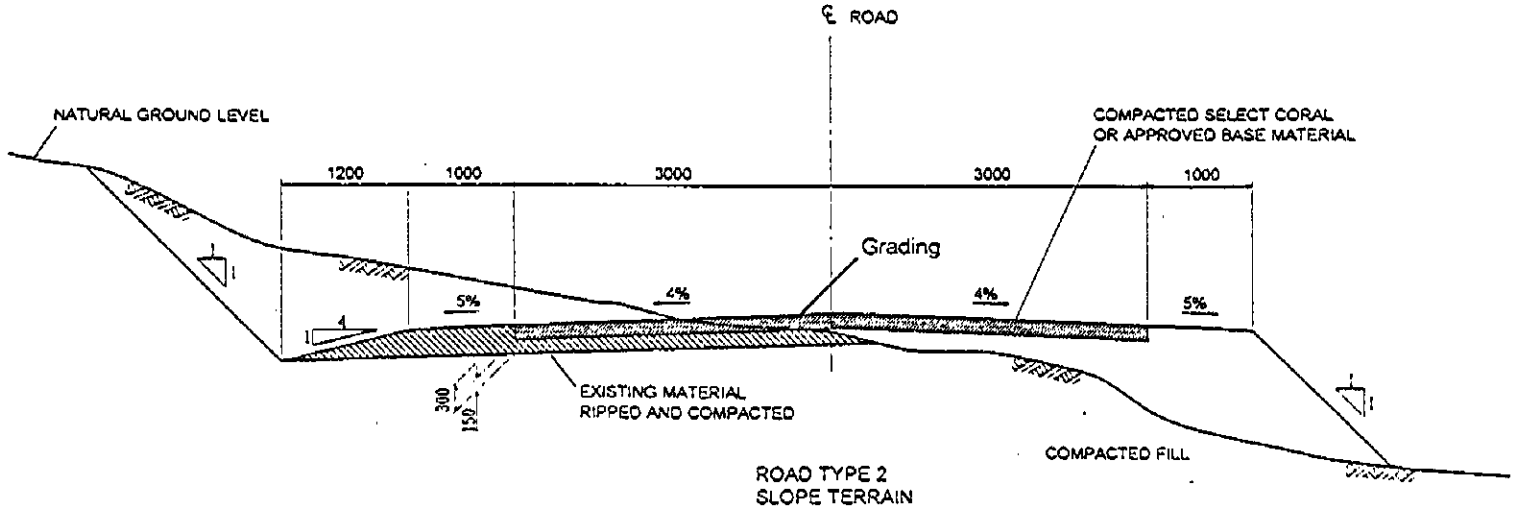
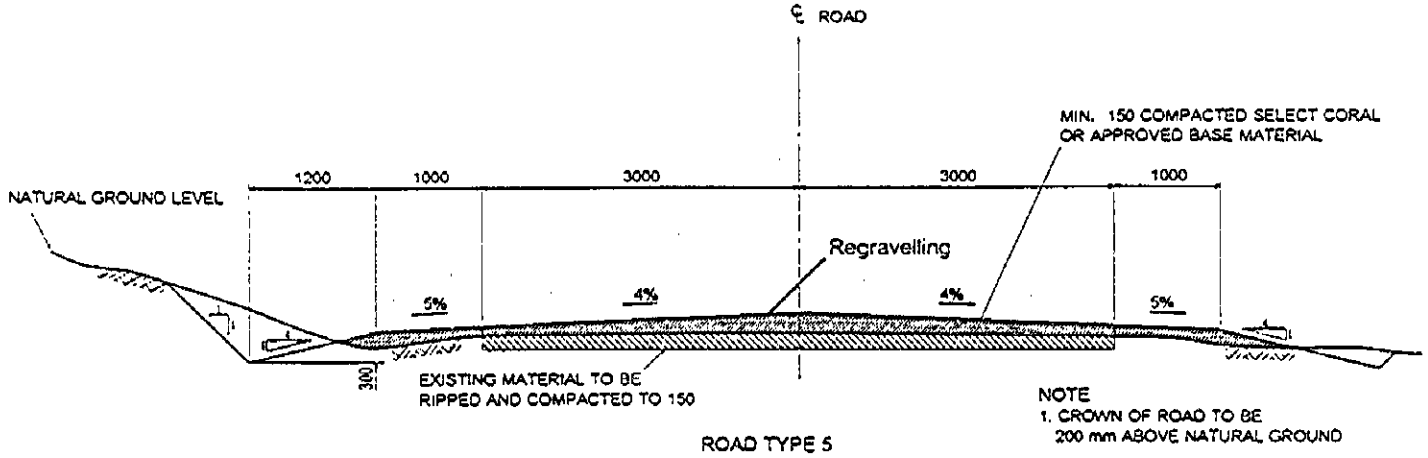
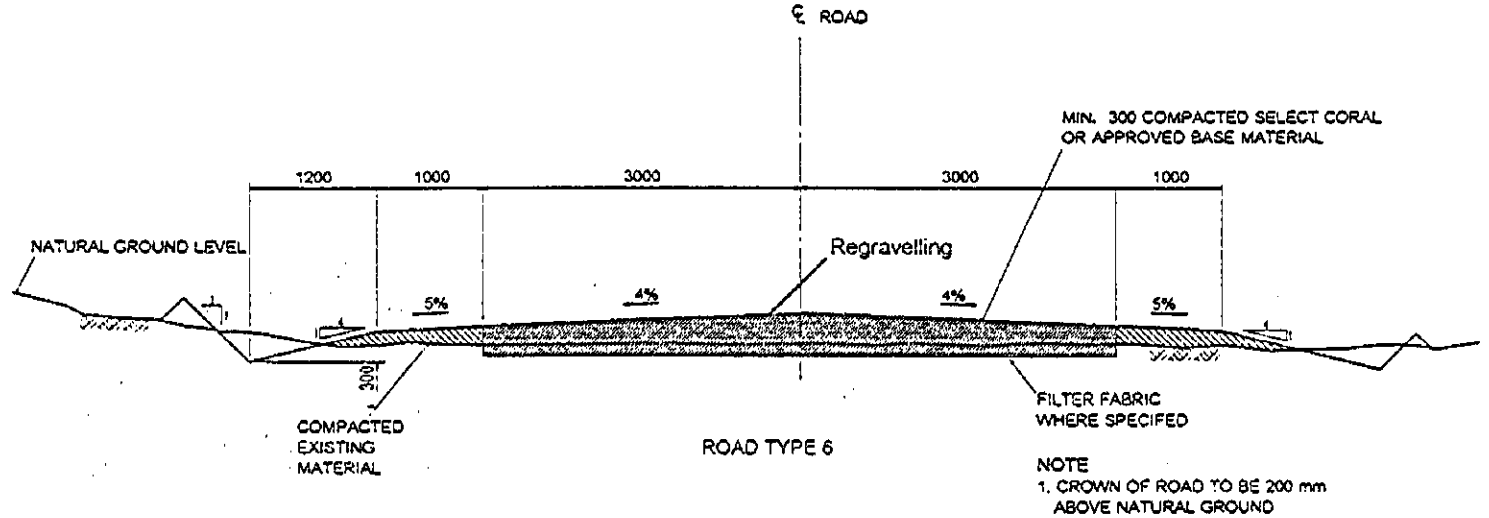


Figure 2.2.2-5 (1) STANDARD CROSS SECTION FOR LIGHT MAINTENANCE



ROAD TYPE 5

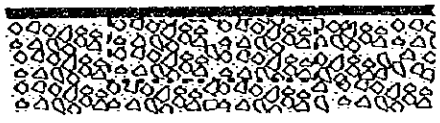


ROAD TYPE 6

Figure 2.2.2-5 (2) STANDARD CROSS SECTION FOR HEAVY MAINTENANCE

Trimming of edges and removal of loose material

Reinstating the hole by gravel or fine crushed rock and compaction



Sealing surface

Figure 2.2.2-6 STANDARD CROSS SECTION OF PATCHING POTHOLES

Table 2.2.2-6 MAINTENANCE TECHNICAL SPECIFICATIONS AND NECESSARY EQUIPMENT FOR SEALED ROAD

Work Item	Work Description and Specification	Necessary Equipment Component							
		Wheel loader with shovel	Dump truck	Cargo truck with crane	Vibration roller	Plate Compctor	Asphalt Sprayer	Mower	Pick-up truck
① Patching		○	○	○	○	○	○	X	○
1. Mobilization & Demobilization	・Hauling of equipment, material and labour			○					○
2. Patching Potholes	・Trimming of edges ・Interval : more than 2 m ・Vertical trimming : depth 150 m/m	○	○						○
	・Supplying and placing of approved material and compaction	○	○	○	○	○			○
	・Reseals ・Tack coat : 0.7 lit/㎡ ・Spreading crush stone and compaction : 5~10m/m, 10.0 lit/㎡ ・Tack coat : 1.2 lit/㎡ ・Spreading sand and compaction : 2.0 lit/㎡	○	○	○	○	○	○		○
② Cleaning Streets		X	X	○	X	X	X	○	○
1. Mobilization & Demobilization	・Hauling of equipment, material and labour			○					○
2. Cleaning Streets	・Grass cutting, cleaning road surface and side ditch ・Grass cutting ・Cleaning road surface ・Cleaning side ditch ・Disposal of waste material			○				○	○

Table 2.2.2-7 MAINTENANCE METHODS AND NECESSARY EQUIPMENT FOR SEALED ROAD

Work Item	Road Section	Implementation	Frequency	Work Description	Necessary Equipment (per formation)	Manpower (per unit)
① Patching Patching Potholes	• Major Road in Ring Road : 8.0 km	• by contract • by administration	• Routine maintenance	• Hauling of equipment and material • Repairing pothole • Trimming • Supplying and placing material • Reseals	• Wheel loader with shovel : 1 • Dump truck : 2 • Cargo truck with crane : 2 • Vibration roller (hand guide type) : 1 • Plate compactor : 1 • Asphalt sprayer : 1 • Pick-up truck : 1	• Foreman : 1 • Operator (special) : 3 • Operator (general) : 3 • Skilled labor : 3 • Common labor : 1 • Light labor : 2
	• Minor Road in Ring Road : 11.4 km (3 routes)	• by contract • by administration	• Routine maintenance			
	• City Road in Port Vila (23 routes)	• by contract • by administration	• Routine maintenance			
② Cleaning Street	• City Road in Port Vila (23 routes)	• by administration	• Routine maintenance	• Hauling of equipment and material • Repairing pothole • Trimming • Supplying and placing material • Reseals	• Cargo truck with crane : 2 • Mower : 1 • Pick-up truck : 1	• Foreman : 1 • Operator (special) : 2 • Operator (general) : 1 • Skilled labor : 1 • Common labor : 1 • Light labor : 5

2.2.2.4 Study and Examination of the Request (Equipment Procurement)

Construction capability of the PWD and necessity of procuring equipment were assessed as follows;

1. Sprayed seal pavement and resealing work has not been performed yet by the administration (PWD) and they have no equipment of their own for construction thereof. However, if improvements of the Project road are to be paved with sprayed seal, the work will be undertaken by the Government of Japan. Any other road paving needs will be carried out by the private sector. Therefore, equipment for construction thereof is not considered to be necessary.

2. Maintenance and repair of sprayed seal pavement (especially pothole patching) should be done by the PWD. However, they have equipment, therefore, according it should be procured.

3. Coral road; mainly grading and regravelling works are being constructed and maintained with existing equipment. However, the equipment is insufficient in number and some are superannuated, hampering a smooth execution of work.

Based on the above considerations, the purpose of procuring equipment is set up on;

1. Light maintenance for the unsealed coral road,
2. Heavy maintenance for the unsealed coral road,
3. Patching work for sealed road,
4. Cleaning streets.

At first, the necessary number and type of equipment for each work item above was examined and the amount owned equipment in Shefa subdivision was compared with the necessary amount. Then the deficit number of each type of equipment was obtained. Tables 2.2.2-8, 2.2.2-9 show the necessary equipment and number.

Considering the above discussion and other factors such as the degree of aging and availability of leased equipment, the equipment procurement plan was discussed between the Basic Design Study Team and the officials from the PWD.

The latter made a final request as shown in Table 2.2.2-10.

Table 2.2.2-8 NECESSARY EQUIPMENT TYPE AND NUMBER FOR ROAD MAINTENANCE WORK

Equipment	Specification	Results of Study for Necessary Equipment Type and Number					Necessary Number	PWD Owned Equipment	Working	Deficit Number	Final Request
		Light Maintenance for Gravel Road	Heavy Maintenance for Gravel Road	Maintenance for Sealed Road	Cleaning Streets	Total					
Bulldozer	15t	-	0.39	-	-	0.39	1	2	2	0	0
Wheel Loader	Backet Cap: 1.2~1.3m^3	0.48	0.39	-	-	0.87	1	2	1	0	0
Wheel Loader with Shovel	Backet Cap: 1.2m^3	0.51	0.42	0.15	-	1.08	1	1	0	1	1
Dump Truck	4 ~ 5t	1.55	2.54	0.23	-	4.32	5	4	4	1	1
Cargo Truck with Crane	4t, Crane cap. 3.0t	0.74	0.61	0.22	0.43	2.00	2	1	1	1	1
Trailer Truck	20.0t, Low bed	-	0.32	-	-	0.32	1	1	1	0	0
Motor Grader	Blade length : 3.7m	0.54	0.45	-	-	0.99	1	2	1	0	0
Motor Grader with Ripper	Blade length : 3.7m	0.54	0.45	-	-	0.99	1	0	0	1	1
Tire Roller	11 ~ 12t	0.51	0.42	-	-	0.93	1	1	1	0	0
Vibration Roller	0.5t	0.54	0.45	0.16	-	1.15	1	0	0	1	1
Plate Compactor	50 ~ 60kg	0.54	0.45	0.16	-	1.15	1	0	0	1	1
Asphalt Sprayer	200 lit. Kerosene	-	-	0.17	-	0.17	1	0	0	1	1
Water Tank Truck	4,000 lit	0.39	0.32	-	-	0.71	1	0	0	1	1
Mower	230 m/m, shoulder support	0.51	0.42	-	0.3	1.23	1	1	0	1	1
Chain Saw	Cutter : 500 m/m	0.51	0.42	-	-	0.93	1	0	0	1	1
Pick-up Truck	Double Cabin 4 x 2	0.30	0.25	0.09	0.18	0.82	1	0	0	1	1

Note: Based on PWD Implementation plan in 1997.

Table 2.2.2-9 (1) NECESSARY EQUIPMENT AND NUMBER OF UNIT FOR LIGHT MAINTENANCE OF UNSEALED CORAL ROAD

Equipment	Specification	① Annual Working Plan	② Working Ratio	③ Working Day	④ Annual Working Days	⑤ Necessary Number of Unit
Wheel Loader	Backet Cap. 1.2~1.3m^3	77 days/work x 2 times/year x 1 unit = 154 days·Unit/year	53%	81.62 days·Unit/year	170 days/year	0.48 unit
Wheel Loader with Shovel	Backet Cap. 1.2m^3	77 days/work x 2 times/year x 1 unit = 154 days·Unit/year	53%	81.62 days·Unit/year	160 days/year	0.51 unit
Dump Truck	4 ~ 5t	77 days/work x 2 times/year x 4 units = 616 days·Unit/year	53%	326.48 days·Unit/year	210 days/year	1.55 unit
Cargo Truck with Crane	4t, crane cap. 3.0 t	77 days/work x 2 times/year x 2 units = 308 days·Unit/year	53%	163.24 days·Unit/year	220 days/year	0.74 unit
Motor Grader	Blade length : 3.7m	77 days/work x 2 times/year x 1 unit = 154 days·Unit/year	53%	81.62 days·Unit/year	150 days/year	0.54 unit
Motor Grader with Ripper	Blade length : 3.7m	77 days/work x 2 times/year x 1 unit = 154 days·Unit/year	53%	81.62 days·Unit/year	150 days/year	0.54 unit
Tire Roller	Combined Type 11~12 t	77 days/work x 2 times/year x 1 unit = 154 days·Unit/year	53%	81.62 days·Unit/year	160 days/year	0.51 unit
Vibration Roller	Hand Guide Type 0.5 t	77 days/work x 2 times/year x 1 unit = 154 days·Unit/year	53%	81.62 days·Unit/year	150 days/year	0.54 unit
Plate Compactor	50 ~ 60 kg	77 days/work x 2 times/year x 1 unit = 154 days·Unit/year	53%	81.62 days·Unit/year	150 days/year	0.54 unit
Water Tank Truck	4,000 lit	77 days/work x 2 times/year x 1 unit = 154 days·Unit/year	53%	81.62 days·Unit/year	210 days/year	0.39 unit
Mower	Shoulder Harness, 230 m/m	77 days/work x 2 times/year x 1 unit = 154 days·Unit/year	53%	81.62 days·Unit/year	160 days/year	0.51 unit
Chain Saw	Cutter 500 m/m	77 days/work x 2 times/year x 1 unit = 154 days·Unit/year	53%	81.62 days·Unit/year	160 days/year	0.51 unit
Pick-up Truck	Double Cabin, 4 x 2	77 days/work x 2 times/year x 1 unit = 154 days·Unit/year	53%	81.62 days·Unit/year	270 days/year	0.30 unit

Table 2.2.2-9 (2) NECESSARY EQUIPMENT AND NUMBER OF UNIT FOR HEAVY MAINTENANCE OF UNSEALED CORAL ROAD

Equipment	Specification	① Annual Working Plan	② Working Ratio	③ Working Day	④ Annual Working Days	⑤ Necessary Number of Unit
Bulldozer	Standard Type, 15 t	21 days/work x 6 times/year x 1 unit = 126 days·Unit/year	53%	66.78 days·Unit/year	170 days/year	0.39 unit
Wheel Loader	Backet Cap. 1.2~1.3m^3	21 days/work x 6 times/year x 1 unit = 126 days·Unit/year	53%	66.78 days·Unit/year	170 days/year	0.39 unit
Wheel Loader with Shovel	Backet Cap. 1.2m^3	21 days/work x 6 times/year x 1 unit = 126 days·Unit/year	53%	66.78 days·Unit/year	160 days/year	0.42 unit
Dump Truck	4 ~ 5t	21 days/work x 6 times/year x 8 units = 1,008 days·Unit/year	53%	534.24 days·Unit/year	210 days/year	2.54 unit
Cargo Truck with Crane	4t, Crane Cap. 3t	21 days/work x 6 times/year x 2 units = 252 days·Unit/year	53%	133.56 days·Unit/year	220 days/year	0.61 unit
Trailer Truck	Low bed Type, 20.0t	21 days/work x 6 times/year x 1 unit = 126 days·Unit/year	53%	66.78 days·Unit/year	210 days/year	0.32 unit
Motor Grader	Blade length : 3.7 m	21 days/work x 6 times/year x 1 unit = 126 days·Unit/year	53%	66.78 days·Unit/year	150 days/year	0.45 unit
Motor Grader with Ripper	Blade length : 3.7 m	21 days/work x 6 times/year x 1 unit = 126 days·Unit/year	53%	66.78 days·Unit/year	150 days/year	0.45 unit
Tire Roller	Combined Type, 11 ~ 12t	21 days/work x 6 times/year x 1 unit = 126 days·Unit/year	53%	66.78 days·Unit/year	160 days/year	0.42 unit
Vibration Roller	Hand guide Type, 0.5t	21 days/work x 6 times/year x 1 unit = 126 days·Unit/year	53%	66.78 days·Unit/year	150 days/year	0.45 unit
Plate Compactor	50 ~ 60 kg	21 days/work x 6 times/year x 1 unit = 126 days·Unit/year	53%	66.78 days·Unit/year	150 days/year	0.45 unit
Water Tank Truck	4,000 lit	21 days/work x 6 times/year x 1 unit = 126 days·Unit/year	53%	66.78 days·Unit/year	210 days/year	0.32 unit
Mower	Shoulder Harness, 230 m/m	21 days/work x 6 times/year x 1 unit = 126 days·Unit/year	53%	66.78 days·Unit/year	160 days/year	0.42 unit
Chain Saw	Cutter, 500 m/m	21 days/work x 6 times/year x 1 unit = 126 days·Unit/year	53%	66.78 days·Unit/year	160 days/year	0.42 unit
Pick-up Truck	Double Cabin, 4 x 2	21 days/work x 6 times/year x 1 unit = 126 days·Unit/year	53%	66.78 days·Unit/year	270 days/year	0.25 unit

Table 2.2.2-9 (3) NECESSARY EQUIPMENT AND NUMBER OF UNIT FOR SEALED ROAD MAINTENANCE

Equipment	Specification	① Annual Working Plan	② Working Ratio	③ Working Day	④ Annual Working Days	⑤ Necessary Number of Unit
Wheel Loader with Shovel	Bucket Cap. 1.2m^3	90 days/year x 1 unit x 0.5 = 45 days・Unit/year	53%	23.85 days・Unit/year	160 days/year	0.15 unit
Dump Truck	4 ~ 5t	90 days/year x 2 units x 0.5 = 90 days・Unit/year	53%	47.70 days・Unit/year	210 days/year	0.23 unit
Cargo Truck with Crane	4t, Crane Cap. 3t	90 days/year x 2 units x 0.5 = 90 days・Unit/year	53%	47.70 days・Unit/year	220 days/year	0.22 unit
Vibration Roller	Hand guide Type, 0.5t	90 days/year x 1 unit x 0.5 = 45 days・Unit/year	53%	23.85 days・Unit/year	150 days/year	0.16 unit
Plate Compactor	50 ~ 60 kg	90 days/year x 1 unit x 0.5 = 45 days・Unit/year	53%	23.85 days・Unit/year	150 days/year	0.16 unit
Asphalt Sprayer	Kerosene, 200 lit	90 days/year x 1 unit x 0.5 = 45 days・Unit/year	53%	23.85 days・Unit/year	140 days/year	0.17 unit
Pick-up Truck	Double Cabin, 4 x 2	90 days/year x 1 unit x 0.5 = 45 days・Unit/year	53%	23.85 days・Unit/year	270 days/year	0.09 unit

Table 2.2.2-9 (4) NECESSARY EQUIPMENT AND NUMBER OF UNIT FOR CLEANING STREET

Equipment	Specification	① Annual Working Plan	② Working Ratio	③ Working Day	④ Annual Working Days	⑤ Necessary Number of Unit
Cargo Truck with Crane	4t, Crane Cap. 3t	90 days/year x 2 units = 180 days·Unit/year	53%	95.40 days·Unit/year	220 days/year	0.43 unit
Mower	Shoulder Harness, 230 m/m	90 days/year x 1 unit = 90 days·Unit/year	53%	47.70 days·Unit/year	160 days/year	0.30 unit
Pick-up Truck	Double Cabin, 4 x 2	90 days/year x 1 unit = 90 days·Unit/year	53%	47.70 days·Unit/year	270 days/year	0.18 unit

Table 2.2.2-10 FINAL LIST OF EQUIPMENT REQUESTED BY THE GOVERNMENT OF VANUATU

ITEM	SPECIFICATIONS	QUANTITY
1. Motor grader	blade length : 3.7m, with ripper	1
2. Wheel loader	1.2m^3 bucket, with shovel	1
3. Dump truck	4.0 MT, standard type	1
4. Flat bed truck	4.0 MT, with crane 2,900kg	1
5. Water tank truck	3,800 liter capacity	1
6. Baby roller	0.5 MT	1
7. Plate compactor	50-60kg	1
8. Asphalt sprayer	200 liter, kerosene heating type	1
9. Chain saw	cutter length : 50cm	1
10. Grass cutter	shoulder support, cutter diameter : 23cm	1
11. Double cab cargo truck	4 x 2, double cabin	1
12. Spare parts		Lump sum

2.3 Basic Design

2.3.1 Design Concept

2.3.1.1 Road Improvement

(1) Road Classification

The Project consists of the improvement of the existing road and the new road construction in a mountainous area. The important factor of road classification is to retain acceptable sight distances.

The study team held discussions with the PWD taking account of the importance of the road, traffic volume, topographic condition and sight distance and finalized the following road classification.

Design Standard	Station	
	CH 0.000km~CH 5.068km	CH 5.068km~CH 14.200km
Road Design Class	II	III
Traffic (ADT)	1,000 ~ 300	300 ~ 100
Terraine	Rolling	Mountain
Design Speed	80 km/h	60 km/h

(2) Road width

CH 0.000km~CH 5.068km : 3.5m x 2 (carriageway) +
1.0m x 2 (road shoulder) = 9.0m

CH 5.068km~CH 14.200km : 3.0m x 2 (carriageway) +
1.0m x 2 (road shoulder) = 8.0m

(3) Road alignment (vertical and horizontal)

The realignment of the existing road section is designed to follow the existing road as closely possible. The alignment of the new road section is designed to follow the existing topography considering economic factors.

(4) Components of the pavement

The thickness of each component is designed upon the test results of CBR.

(5) The pavement type

The pavement type is designed based upon terrain, soil condition, traffic a volume and social condition.

(6) Drainage facilities

- A side ditch is planned, to be provided along the border of the cut portion.
- Culvert: There are seven existing culverts along the existing section.
  Culvert works consist of the following:
  - Provision of new culverts;
  - Lengthening of existing culverts;
  - Replacement of existing culverts;

(7) Cut and embankment

- Slope gradient : 1 : 2 at embankment
  1 : 0.25 at cut
- Bench cut : One bench (width : 0.5m) at the bottom more than 2m vertical height
  One at bottom and additional one (width : 0.5m) more than 5m vertical height

(8) Road facilities and accessories

- Intersection: 9 spots
  A grade intersection is proposed along the Project road.
- Delineator : Installation of a delineator is proposed for safety along all curves.
- Sign boards
  Installation of guide signs and warning signs are proposed for safety and comfort along the Project road.
- Road markings
  Road centerlines and the sidelines are proposed for all sections of the Project road.

(9) Environmental aspects

The following considerations are proposed for environmental aspects at each stage.

Design Stage

① Bench at cut portion.
② Lining (stone masonry) is proposed at the section of the cut (more than 3% grade) for scour-prevention.
③ The terminal treatment at the bottom of ditches is designed as follows.
  - For a gentle slope ditch : refer to Figure 2.3.3-8
  - For a steep slope ditch : refer to Figure 2.3.3-9
④ The diameter of the culvert pipe is designed as 900 mm, in consideration for manual maintenance.

During implementation

① Traffic control is essential to protect the travelling public, workmen, plant, equipment, and the work itself.
② It is necessary to prevent run-off of deleterious material during the construction work.

After turn over

① Appropriate road maintenance work is necessary, to be carried out by the PWD.
② Appropriate bridge maintenance work is necessary, to be carried out by the PWD.

(10) Safety facilities of Teouma and Rentapao bridges

Considering the existing condition of both bridges, at least the following safety facilities should be installed, to improve their safety situation.

- Spraying seal coat is proposed, for surfacing the bridge deck.
- New handrails are proposed, to be installed for both bridges.
- Guardrails and warning signs are proposed, to be installed at approach roads for both bridges.

2.3.1.2 Equipment Procurement

The basic policy in the selection of equipment type and number is as follows:

(1) Use of Equipment

Spread sealed pavement work is mostly implemented by contract. If the improvement of 14.20 km section in Ring Road is undertaken by the Government of Japan, it is deemed that there is no other urgent demand of construction of spread sealed pavement. Therefore, the equipment for spread sealed pavement is omitted. The intended uses of the equipment are as follows:

- Light maintenance for gravel road (mainly grading)
- Heavy maintenance for gravel road (mainly regravelling)
- Maintenance for sealed road (mainly packing pot holes)
- Cleaning streets

(2) Types and Numbers of Equipment

Considering the composition of an equipment fleet necessary for the above uses, the following components are selected:

- Missing equipment.

- Equipment needing costly maintenance due to age, or those expected to become unserviceable in near future.

- Equipment so frequently used that the capacity of the fleet can be increased as a whole if additionally units are procured.

2.3.2 Design Criteria

2.3.2.1 Road Improvement

(1) Road design standard

AUSTROADS' standards have been adopted for the Project as the result of discussions between the Study Team and the Government of Vanuatu. The recommended design standard for the Project road is shown in Table 2.3.2-1.

(2) Pavement design

A double coat spray seal is proposed for the surface pavement based on traffic and local characteristics (subtropical climate, coral island, local structures).

Base course is designed from the result of CBR Tests as follows.

Chainage	Design CBR	Base CBR=80	Sub Base CBR=30	Select Fill CBR=15
CH 0.000km～CH 5.080km	5	150mm	200mm	–
CH 5.080km～CH 6.450km	3	150mm	150mm	200mm
CH 6.450km～CH11.700km	5	150mm	200mm	–
CH11.700km～CH12.725km	3	150mm	150mm	200mm
CH12.725km～CH14.200km	5	150mm	200mm	–

(3) Drainage system

- From the analysis of last 10 years rainfall data, the design should be for a rainfall intensity of 1,306mm/h.
- An earth ditch will be installed at the border line.
  Masonry lining will be installed at the fast current portion, for scour-prevention.
- 13 spots of culvert have been added to the design, adding to the 20 spots designed by PWH, 1995.

2.3.2.2 Equipment Procurement

The type and specification of equipment are determined so as to conform to the intended use in this Project. The following are the equipment which are commonly assigned to each specific use:

Wheel loader : This is used to load materials and excavate for drainage facilities. For this purpose, the shovel is attached thereto.

Cargo truck : This is used for hauling maintenance equipment. For this purpose, a crane is attached thereto.

Motor grader : This is used to rescarify the existing road surface for grading. For this purpose, a ripper is attached thereto.

Table 1.3.2-1 RECOMMENDED MINIMUM DESIGN STANDARDS FOR RURAL ROADS IN VANUATU

1) ROAD DESIGN CLASS	I			II			III			IV			V		
2) TRAFFIC (ADT)	5000 TO 1000			1000 TO 300			300 TO 100			100 TO 20			> 20		
3) TERRAIN	F	R	M	F → R		M	F	R → M		F	R	M	F	R	M
4) CARRIAGEWAY (m)	7.0	7.0	6.0	7.0	6.0	6.0	6.0	6.0	5.0	3.5	3.5	3.5	3.5	3.5	3.5
5) SHOULDER WIDTH (m)	1.0	1.0	0.5	1.0	1.0	0.5	1.0	1.0	0.5	1.25	1.25	0.75	0.75	0.75	0.50
6) FORMATION WIDTH (m)	9.0	9.0	7.0	9.0	8.0	7.0	8.0	8.0	6.0	6.0	6.0	5.0	5.0	5.0	4.5
7) MAXIMUM GRADIENT % Desirable	6	8	12	6	8	14	8	10	14	8	12	14	10	15	20
Absolute	8	10	15	8	10	15	10	12	15	10	15	15	12	20	20
8) DESIGN SPEED (km/h)	100	80	60	100	80	60	80	70	60	70	50	40	60	40	30
9) MIN HORIZONTAL CURVE RADII (m)															
Desirable	350	200	100	350	200	100	200	150	100	150	60	60	100	60	15
Absolute	350	150	70	350	150	70	140	95	65	95	45	40	65	40	12
10) MIN VERTICAL CURVES:															
a) Crest (K) to Road Surface	125	70	20	125	70	20	70	35	20	35	11	6	20	6	3
b) Sag (K) for Comfort	13.1	8.1	3.5	13.1	8.1	3.5	8.1	4.8	3.5	4.8	2.2	1.3	3.5	1.3	0.7
11) SIGHT DISTANCES															
a) Stopping	170	115	65	170	115	65	115	85	65	85	45	35	65	35	25
b) Intersection	250	175	115	250	175	115	175	140	115	140	90	70	115	70	55
c) Overtaking	430	300	205	430	300	205	300	245	205	245	165	130	205	130	110
12) SUPER ELEVATION (%)	6 to 10														
13) CURVE WIDENING (m) RADIUS <100	1.5									NIL					
100-300	1.0									–					
300-400	0.5									–					
>400	0.0									–					
14) ROAD RESERVE (m)	40 to 60									20 to 30					
15) PAVEMENT SLOPE & PAVED SHOULDERS	3 to 4									4 to 6			NS		
16) SHOULDER SLOPE & PAVED SHOULDERS	4 to 5														
(UNPAVED)	6									6 to 8			NS		
17) BRIDGE DESIGN LIVE LOAD	HS 22-24									HS 20 & 44					
18) MAXIMUM AXLE LOADING (TON)	9.2														

2.3.3 Basic Design

2.3.3.1 Road Improvement

(1) Horizontal and vertical alignment

Design Speed

- CH 0.000 km ~ CH 5.068 km : 80 km/h
- CH 5.068 km ~ CH14.200 km : 60 km/h

Sight distance, vertical alignment and horizontal alignment are designed, based on AUSTROADS' standards for the above design speed. The results are shown in Appendix-6.

(2) Run-off at the beginning point and end point

A revised design of the grade for run-off is shown in Figure 2.3.3-1.

(3) Pavement type and components

- Spread seal pavement is proposed, considering the traffic volume and local condition of construction in Vanuatu. (refer to Figure 2.3.3-2)
- The pavement components are designed, based upon the results of the CBR test. (refer to Table 2.3.3-1)

Typical cross sections of the Project road are shown in Figure 2.3.3-3 ~ 6.

(4) Drainage (side ditch)

- The run-off velocity at the side ditch at cut portion depends on the gradient of the side ditch.
  Earth ditches are proposed at areas of less than 3% gradient.
  Lining (Stone Masonry) is to be installed at areas of more than 3% gradient and more than 2.0 M/S run-off velocity. (refer to Figure 2.3.3-7)
- The structure of the side ditch outlet is designed to prevent scouring.
  - Gentle slope portion : refer to Figure 2.3.3-8
  - Steep slope portion : refer to Figure 2.3.3-9

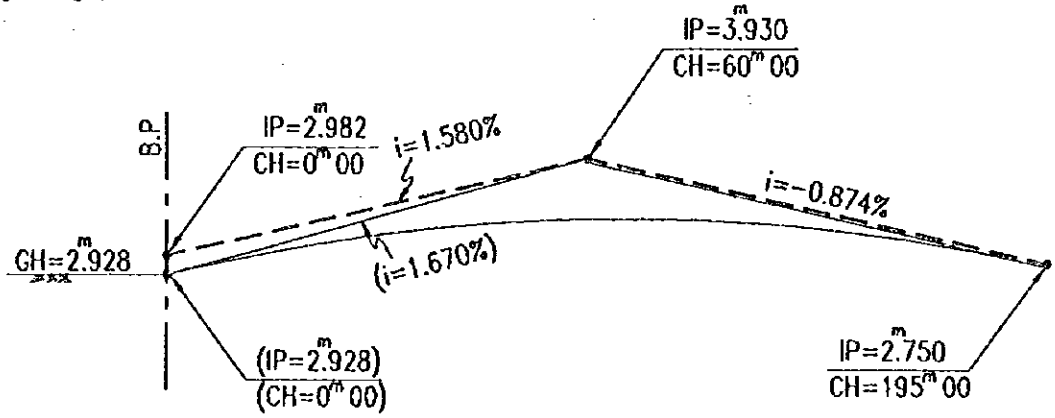
REVISED DESIGN OF GRADE

Note

------- Original Design

——— (Revised Design)

Begining point Run-off



End point Run-off

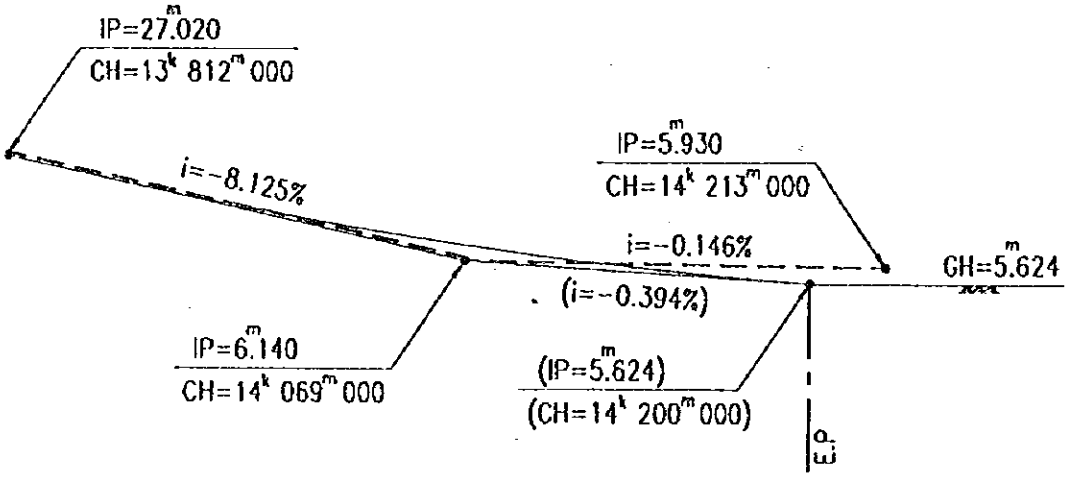
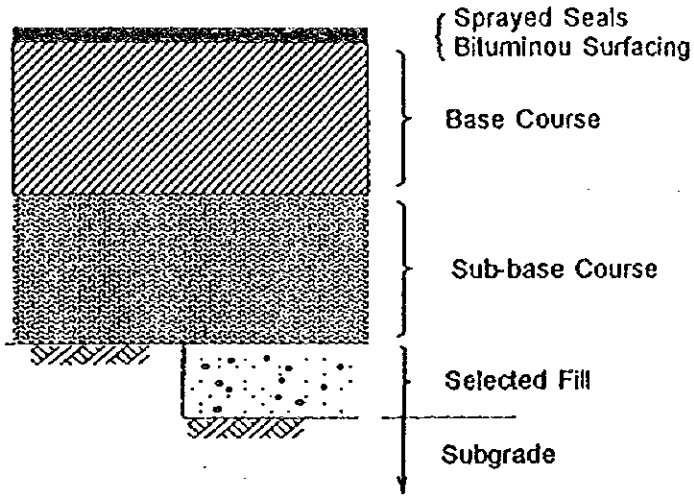


Figure 2.3.3-1 REVISED DESIGN OF GRADE FOR RUN-OFF

COMPONENTS OF ROAD PAVEMENT



Sprayed Seals Bituminous Surfacing

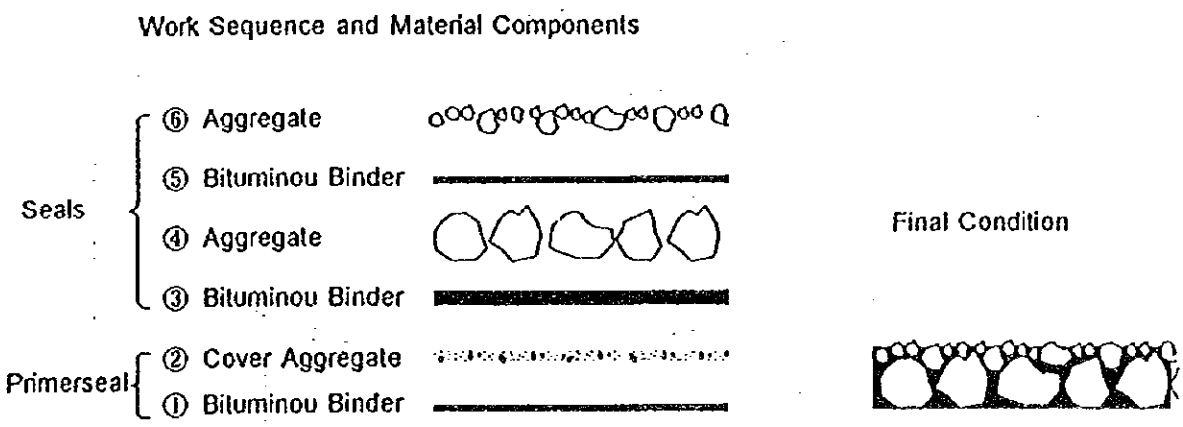


Figure 2.3.3-2 SPRAYED SEALS BITUMINOUS SURFACING

CHAINAGE		Design CBR	Base CBR=80	Sub Base CBR=30	Selected Fill CBR=15
①	$0^k 000 \sim 5^k 050$	5	150 mm	200 mm	——
②	$5^k 050 \sim 6^k 450$	3	150 mm	150 mm	200 mm
③	$6^k 450 \sim 11^k 700$	5	150 mm	200 mm	——
④	$11^k 700 \sim 12^k 725$	3	150 mm	150 mm	200 mm
⑤	$12^k 725 \sim 14^k 200$	5	150 mm	200 mm	——

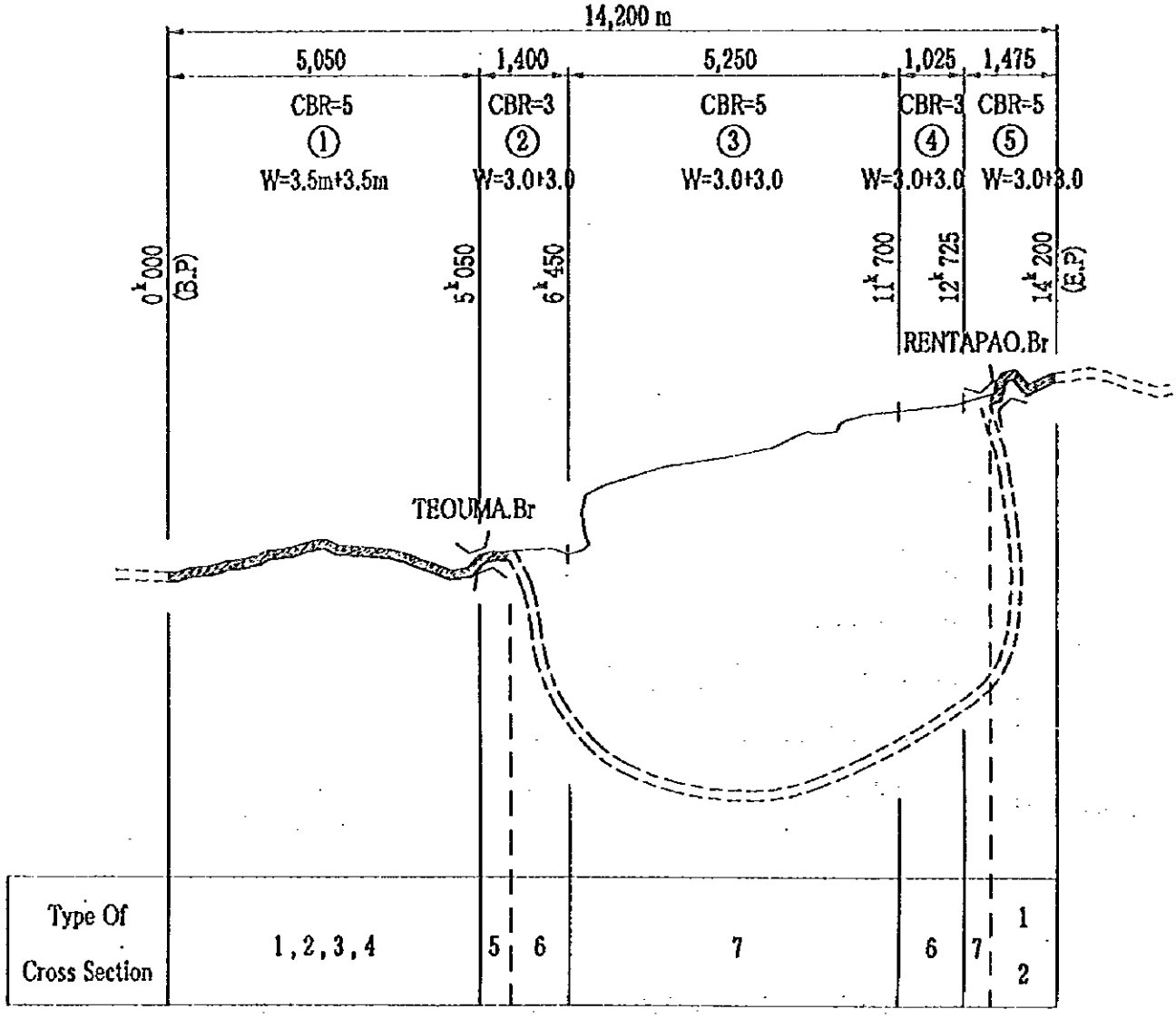
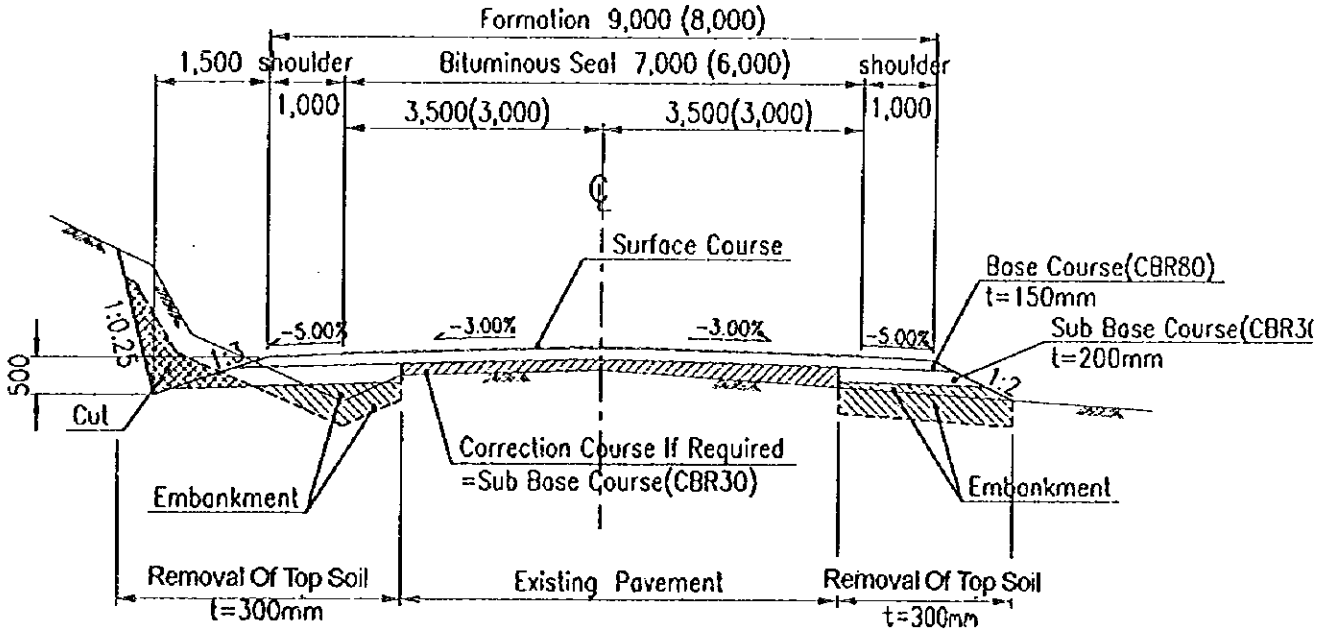


Table 2.3.3-1 RECOMMENDED PAVEMENT DESIGN

Type−1

CBR−5 (STRAIGHTS)

CH 0.000km ~ CH 5.050km
CH 13.470km ~ CH 12.200km



Type−2

CBR−5 (ON CURVES)

CH 0.000km ~ CH 5.050km
CH 13.470km ~ CH 12.200km

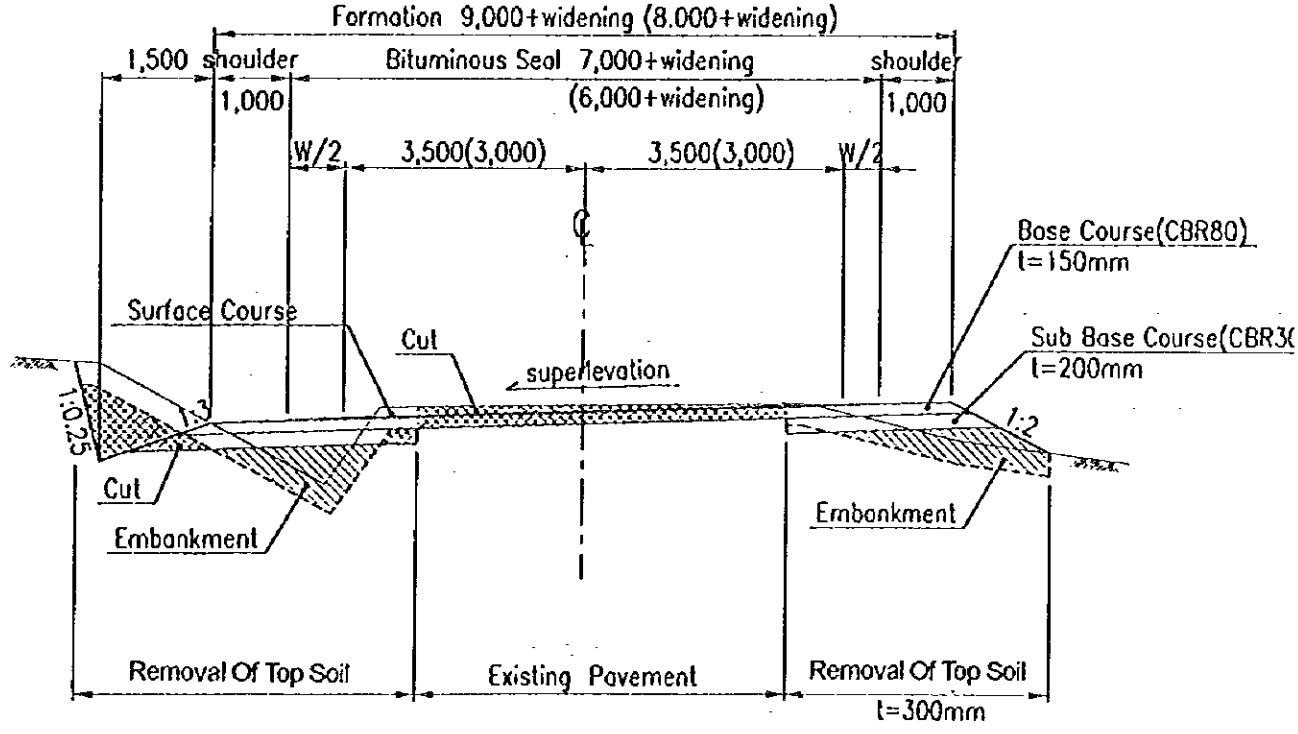
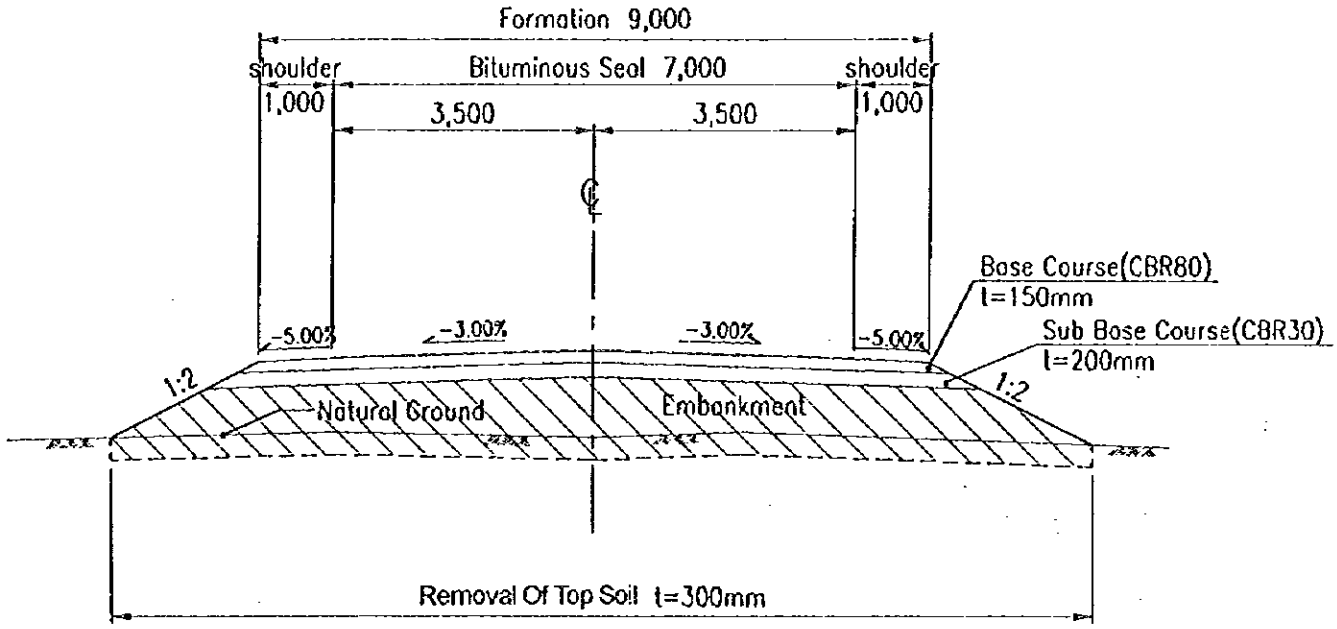


Figure 2.3.3-3 STANDARD CROSS SECTION (TYPE-1 AND 2)

Type-3

CBR-5

CH 2.300km ~ CH 2.900km
CH 3.700km ~ CH 4.100km



Type-4

CBR-5

CH 2.300km ~ CH 2.900km
CH 3.700km ~ CH 4.100km

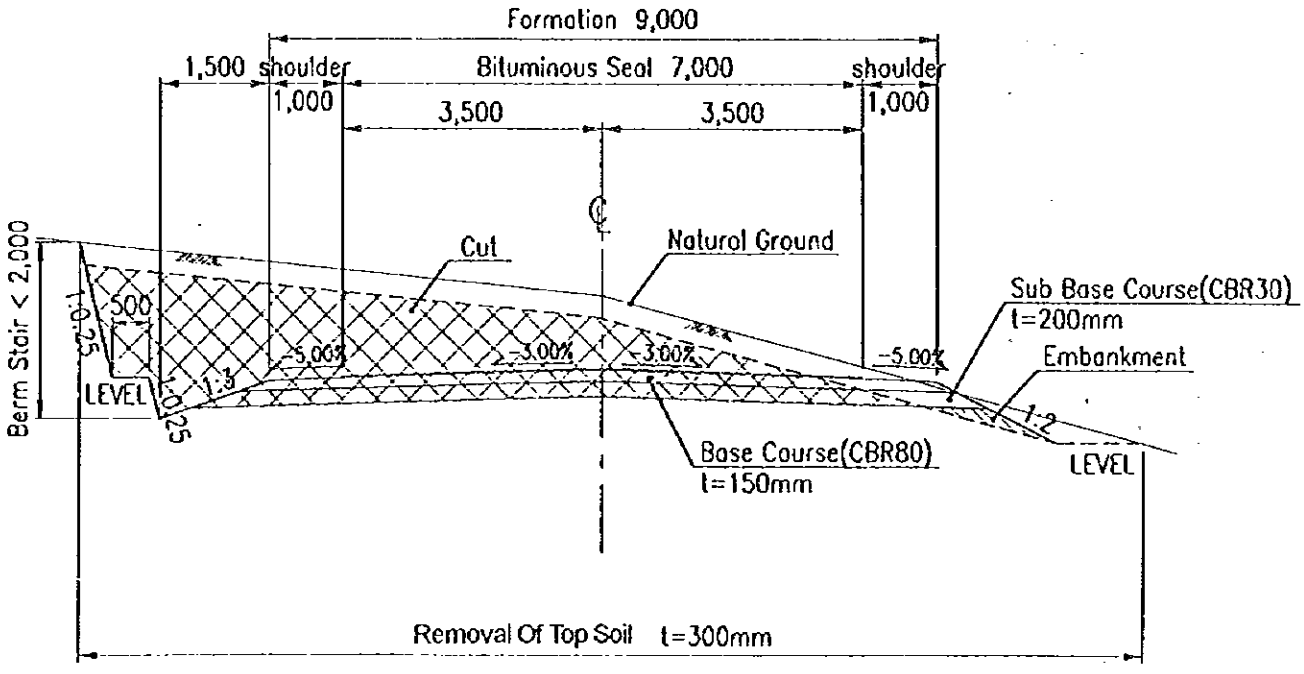
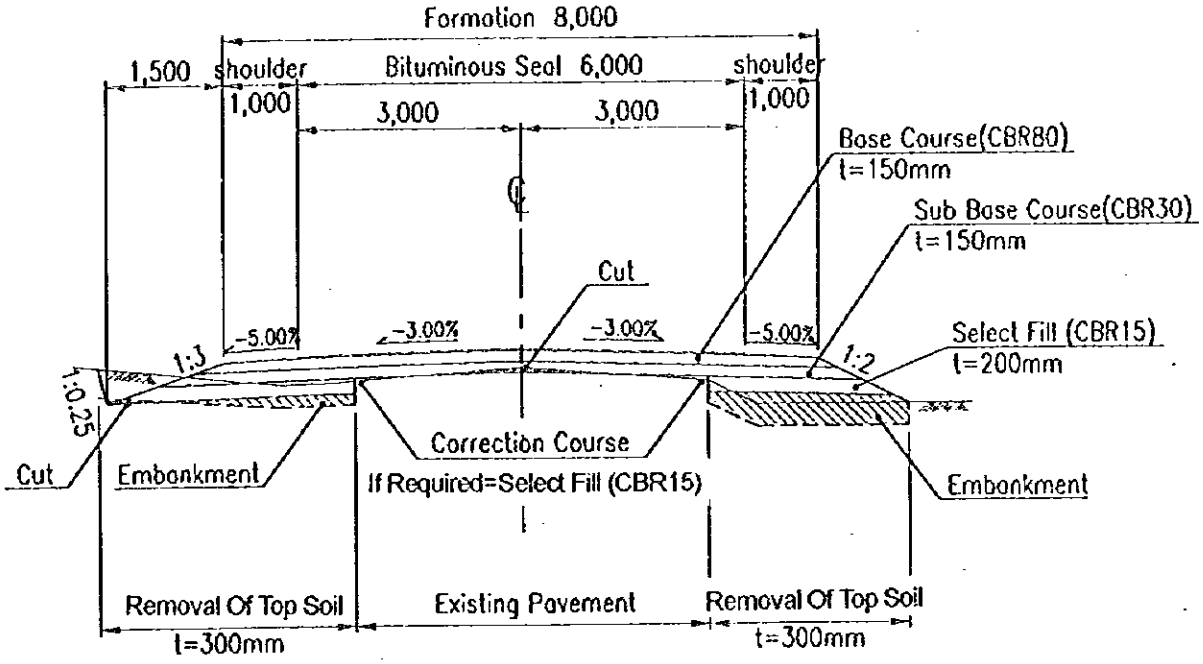


Figure 2.3.3-4 STANDARD CROSS SECTION (TYPE-3 AND 4)

Type-5

CBR-3 (STRAIGHTS) CH 5.050km ~ CH 5.450km



Type-6

CBR-3 (STRAIGHTS) CH 5.450km ~ CH 6.450km
CH 11.700km ~ CH 12.725km

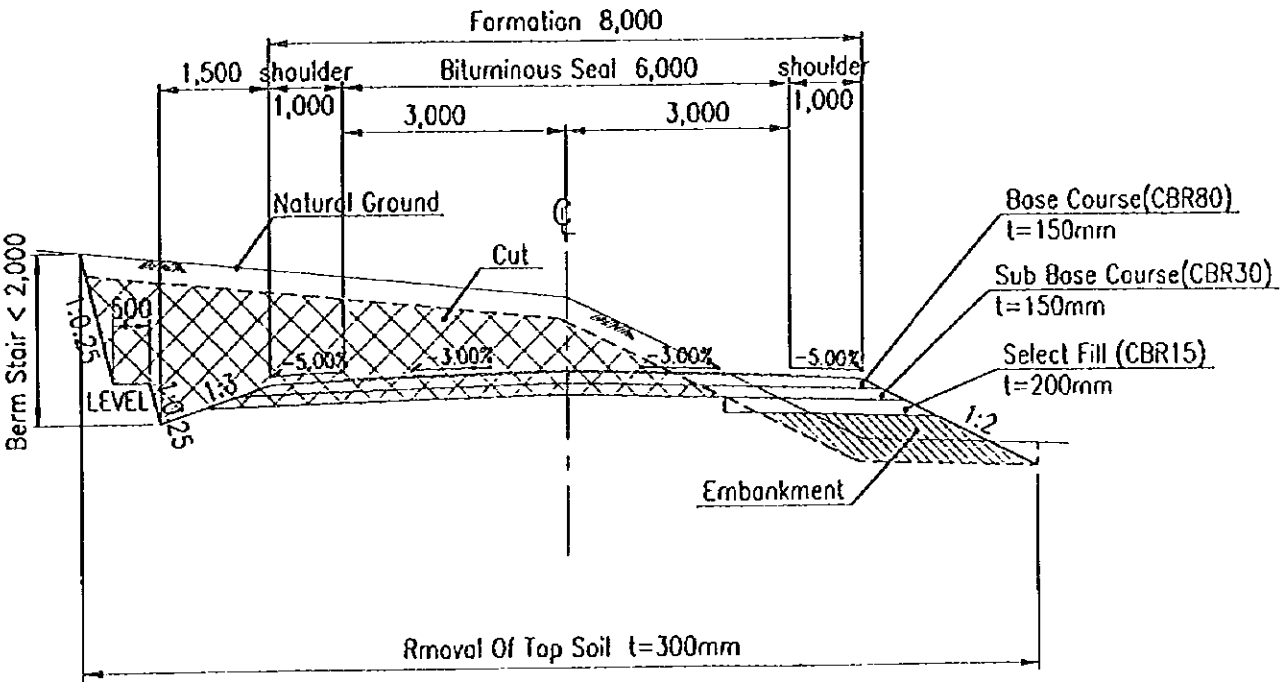


Figure 2.3.3-5 STANDARD CROSS SECTION (TYPE-5 AND 6)

Type－7

CBR－5

(STRAIGHTS)

CH 6.450km ~ CH 11.700km
CH 12.725km ~ CH 13.450km

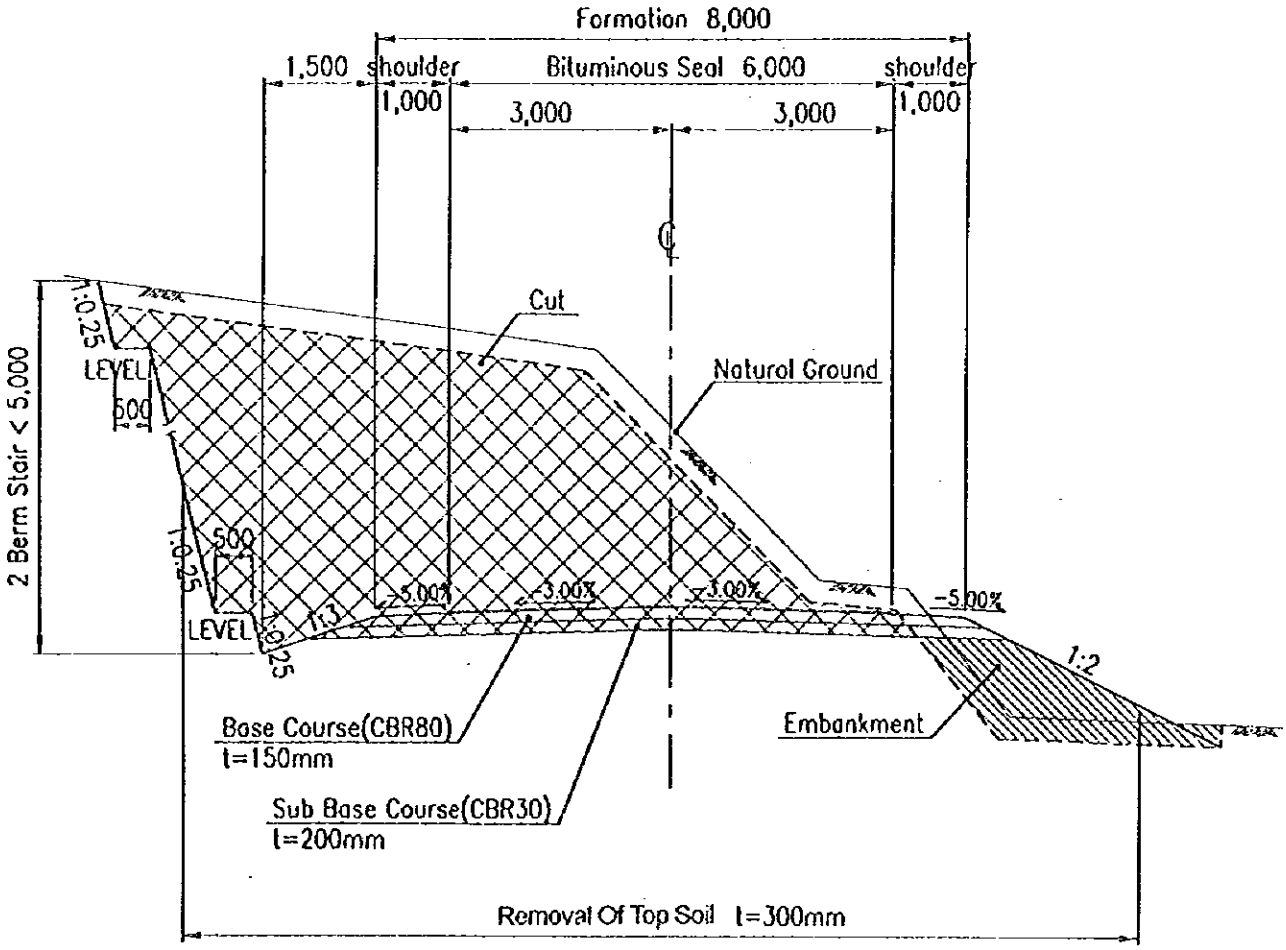
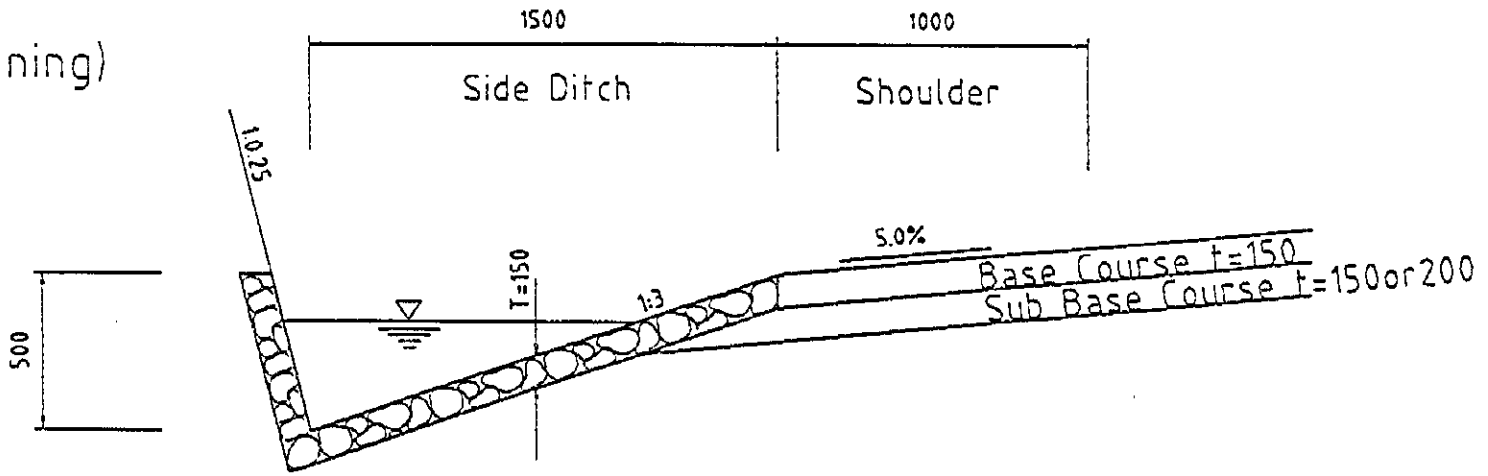
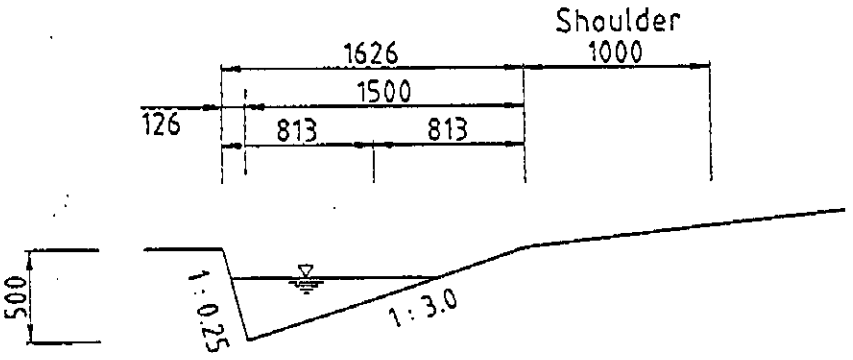


Figure 2.3.3-6 STANDARD CROSS SECTION (TYPE-7)

SIDE DITCH
(Masonry Lining)



Side Ditch Over 3.0% Gradient Shall Be Protected With Masonry Lining



$$A = 1/2 \times 0.4 \times 1.30 = 0.260\,m^2$$

$$P = 1.264 + 0.412 = 1.676 \qquad R = \frac{A}{P} = 0.156\,m$$

$$v = \frac{1}{0.025} \times 0.156^{\frac{2}{3}} \cdot i^{\frac{1}{2}} = 11.59 \times i^{\frac{1}{2}}$$

$$i = 2.0\% : v = 11.59 \times 0.02^{\frac{1}{2}} = 1.639\,m/s$$

$$3.0\% : v = 11.59 \times 0.03^{\frac{1}{2}} = \boxed{2.000}\,m/s$$

$$4.0\% : v = 11.59 \times 0.04^{\frac{1}{2}} = 2.318\,m/s$$

Figure 2.3.3-7 TYPICAL CROSS SECTION OF SIDE DITCH

SIDE DITCH OUTFALL

TYPE A

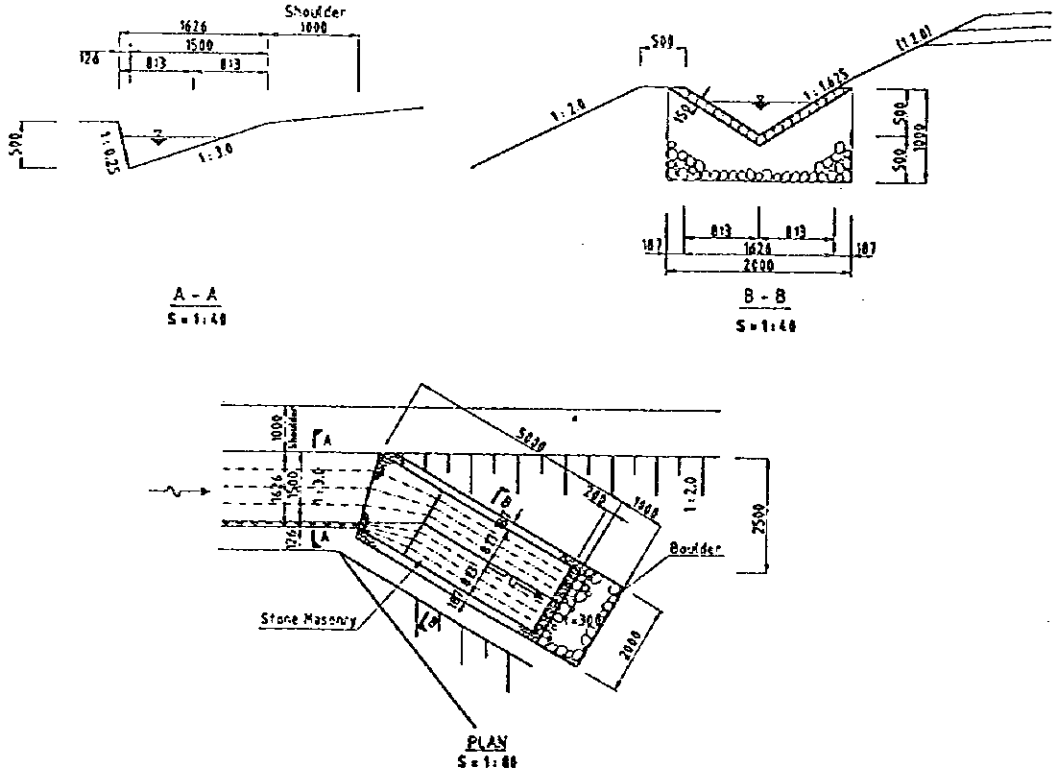


Figure 2.3.3-8 TREATMENT FOR THE TERMINAL OF SIDE DITCH (TYPE-A)

TYPE B

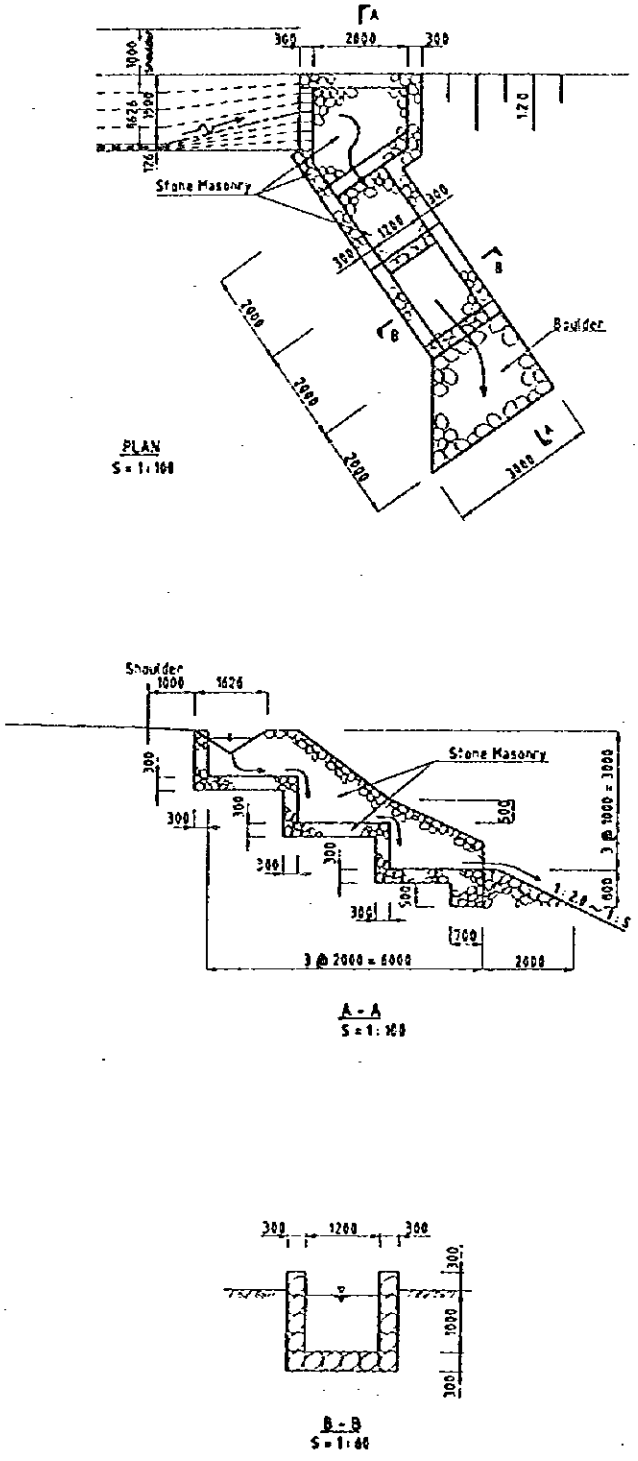


Figure 2.3.3-9 TREATMENT FOR THE TERMINAL OF SIDE DITCH (TYPE-B)

(5) Culverts cross road

- 3 existing culverts out of the 19 will be replaced. (refer to Table 2.3.3-2)
- 13 additional culverts will be newly constructed at the embankment section (Typical cross section : Type-3) (refer to Table 2.3.3-3)
- A diameter of 900 mm is proposed for the culvert pipe, to make manual maintenance work convenient.

Table 2.3.3-2 REVISED DESIGN OF CULVERT CHAINAGE

Culvert No.	Original Design Chainage	Revised Design Chainage
	K	
1	0.026	0.026
2	0.200	* 0.157
3	1.018	1.018
4	1.258	* 1.204
5	1.621	* 1.650
6	2.803	2.803
7	3.021	3.021
8	3.352	3.352
9	3.770	3.770
10	5.282	5.282
11	6.017	6.017
12	6.175	6.175
13	6.466	6.466
14	8.252	8.252
15	8.550	8.550
16	9.255	9.255
17	10.096	10.096
18	10.438	10.438
19	11.475	11.475

Table 2.3.3-3 LIST OF ADDITIONAL CULVERTS

Culvert	Chinage (km)	Existing Pipe Details			Instruction	New Pipe Details			Invert Level		Length/Extension		Headwalls		Length (m)
		Type	Size	No. of Rows		Type	Size (mm)	No. of Rows	Inlet (m)	Outlet (m)	LHS (m)	RHS (m)	Repl/Constr Type LHS	Repl/Constr Type RHS	
A - 1	2.375				Install	RCP	900	1	14.693	14.578	5.150	6.000	A	A	11.150
A - 2	5.540				"	"	900	1	6.190	6.089	4.650	5.500	A	A	10.150
A - 3	7.915				"	"	900	1	51.262	51.160	4.650	5.500	A	A	10.150
A - 4	9.350				"	"	900	1	32.639	32.537	4.650	5.500	A	A	10.150
A - 5	9.530				"	"	900	1	35.498	35.396	4.650	5.500	A	A	10.150
A - 6	10.685				"	"	900	1	46.464	46.322	4.650	5.500	A	A	10.150
A - 7	11.200				"	"	900	1	40.520	40.418	4.650	5.500	A	A	10.150
A - 8	11.745				"	"	900	1	29.175	29.056	6.200	5.700	A	A	11.900
A - 9	11.950				"	"	900	1	28.278	28.158	5.500	6.500	A	A	12.000
A - 10	12.250				"	"	900	1	28.123	28.008	5.500	6.000	A	A	11.500
A - 11	12.570				"	"	900	1	26.440	26.290	7.500	7.000	A	A	15.000
A - 12	13.260				"	"	900	1	4.666	4.361	4.650	5.500	A	A	10.150
A - 13	13.400				"	"	900	1	2.211	2.109	4.650	5.500	A	A	10.150

(6) Intersection

9 intersections are proposed for the Project road. Table 2.3.3-4 shows the location and road width.

Table 2.3.3-4 LIST OF INTERSECTIONS

No.	Chainage	Side	Width	
	K		m	Pavement
1	2.050	R	6.0	(4.0)
2	4.050	L	6.0	(4.0)
3	4.413	L	5.0	(3.0)
4	4.425	R	6.0	(4.0)
5	5.600	R	8.0	(6.0)
6	5.700	L	5.0	(3.0)
7	7.565	L	8.0	(6.0)
8	13.411	R	8.0	(6.0)
9	13.525	L	8.0	(6.0)

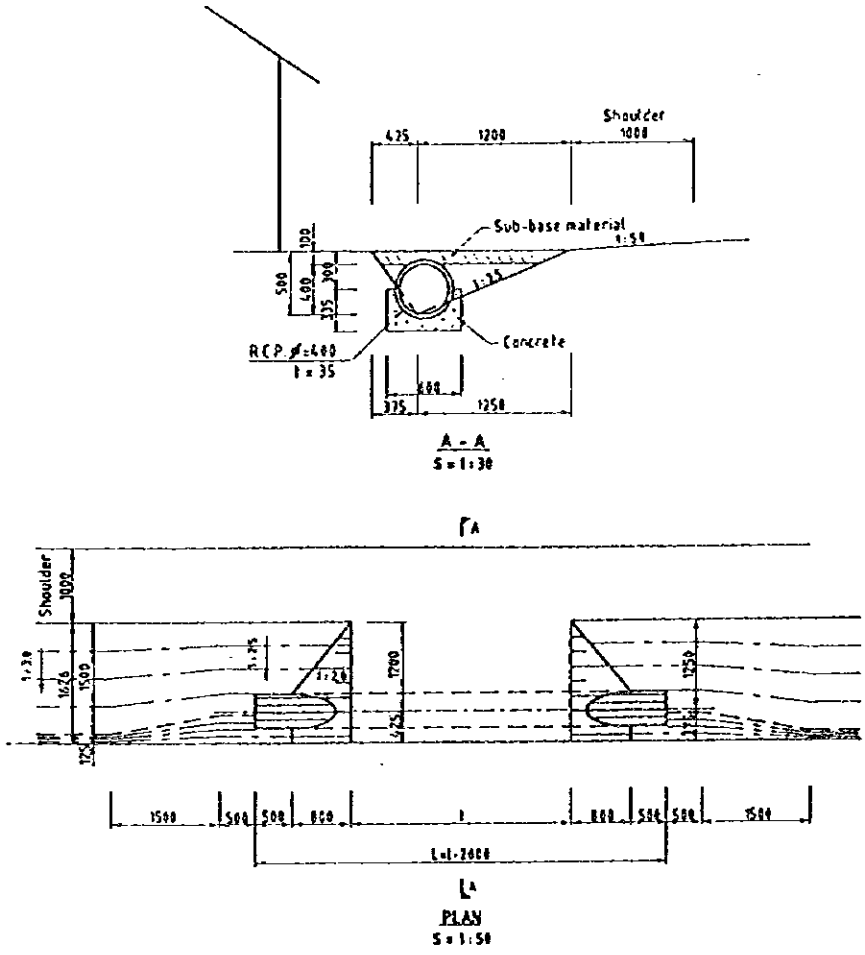
(7) Doorway

There are 41 house doorways and path approaches along the Project road.

Their locations and the widthes are shown in Table 2.3.3-5. Side ditch (pipe) is provided in front of the doorways if drainage facilities are located along the road. Figure 2.3.3-10 shows the typical structure of a side ditch.

Table 2.3.3-5 LIST OF DOORWAYS

No.	Chainage No.	Side	Width (m)	No.	Chainage (km)	Side	Width (m)
1	0.284	R	7.0	21	1.729	L	4.0
2	0.285	L	4.0	22	1.790	R	5.0
3	0.310	L	4.0	23	1.807	R	10.0
4	0.312	R	5.0	24	1.827	R	10.0
5	0.347	R	6.0	25	1.912	L	8.0
6	0.393	L	3.5	26	1.916	R	5.0
7	1.067	R	4.0	27	1.927	R	4.0
8	1.147	R	4.0	28	2.006	R	9.0
9	1.267	R	4.0	29	2.055	L	5.0
10	1.348	L	5.0	30	3.609	L	5.0
11	1.377	R	5.0	31	4.196	L	7.0
12	1.416	R	3.0	32	4.524	L	4.0
13	1.439	R	8.0	33	4.565	L	12.0
14	1.460	R	8.0	34	4.572	R	10.0
15	1.501	R	4.0	35	4.913	L	5.0
16	1.560	L	3.0	36	4.950	R	6.0
17	1.593	R	4.0	37	6.270	L	7.0
18	1.619	R	5.0	38	6.432	L	4.0
19	1.686	R	5.0	39	6.479	R	4.0
20	1.714	R	5.0	40	8.099	L	5.0
				41	8.272	L	3.0



SIDE DITCH FOR DOOR WAY

Figure 2.3.3-10 TYPICAL SIDE DITCH FOR DOOR WAY

(8) Teouma and Rentapao bridges

- Provision of guard rails to the road approaches.
- Removal of spalled topping concrete to bridge deck and provision for new deck wearing surface.
- Provision of new hand rails to both sides of the deck.

(9) The comparison of material and method

The comparison of necessary material and method for the Project is shown in Table 2.3.3-9.

2.3.3.2 Equipment Procurement

(1) Equipment types and numbers

Equipment types and numbers should be decided, taking into consideration the appropriate composition of the equipment fleet. This involve, its purpose of use, the condition of the existing equipment, availability of the equipment owned by private leasing companies, etc. The study thereon was made through discussions between the Basic Design Study Team and officials from the Government of Vanuatu.

The equipment finally proposed and its main intended use are summarized in Table 2.3.3-6.

(2) Specifications of proposed equipment

The type and specifications for the proposed equipment was determined according to its intended use, as presented in Table 2.3.3-7. The specifications are indicated in accordance with JAPAN'S CONSTRUCTION EQUIPMENT SPECIFICATION MANUAL 1992, Japan Mechanized Construction Association.

Calculation of a spare parts ratio based upon each piece of equipments' price.

A : Equipments' basic price (Yen)
B : Annual working hour (Hour)
C : Rental cost (Yen/Hour)
D : Annual consumption ration
$D = C \times 0.6 \times B \div A$ (%)
E : Effective period (Year = Life year x 1/3)
Spare parts ratio (percentage as compared with A) :
$D \times E = C \times 0.6 \times B \div A \times E$(%)

The spare parts ratio was computed for each piece of equipment as per the calculation above. The results figures are shown in Table 2.3.3-8. The spare parts should be selected carefully to avoid waste. The following are recommended as the major components of the spare parts:

- Parts specified in the Maintenance Manual, to be replaced during periodic inspection
- Consumable parts such as cutting edges, teeth, tires, springs, etc.
- Electrical parts
- Necessary parts for disassembly/reassembly, such as overhaul kits

Table 2.3.3-6 PROPOSED EQUIPMENT AND MAIN USE

Equipment	Number	Main Use Intended															
		Light Maintenance for Gravel Roads							Heavy Maintenance for Gravel Roads					Maintenance for Sealed Roads		Cleaning Streets	
		Mobilization & Demobilization	Grading	Patching Pot Holes	Road Verges	Drainage	Side Drain Culvert	Cause Way	Mobilization & Demobilization	Regravelling	Drainage Culvert	Road Verges	Slope Stabilization	Mobilization & Demobilization	Patching	Mobilization & Demobilization	Cleaning
Wheel Loader with Shovel	1		○	○	○	○	○	○		○	○	○	○		○		
Dump Truck	1		○	○	○	○	○	○		○	○	○	○		○		
Cargo Truck with Crane	1	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Motor Grader	1		○							○		○					
Vibration Roller	1		○	○	○	○	○	○		○	○	○	○		○		
Plate Compactor	1		○	○	○	○	○	○		○	○	○	○		○		
Asphalt Sprayer	1														○		
Water Tank Truck	1		○							○		○					
Mower	1		○		○	○	○	○		○		○	○		○		○
Chain Saws	1		○		○	○	○	○		○		○	○				
Pick-up Truck	1	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○

Table 2.3.3-7 SPECIFICATIONS FOR EQUIPMENT

(1/4)

EARTH WORKING EQUIPMENT			
MOTOR GRADER			
ENGINE OUTPUT	KW	more than	100
OPERATING WEIGHT	kg	more than	10500
DIMENSIONS			
• Overall Length	mm	less than	8500
• Overall Width (without Blade)	mm	less than	2450
• Overall Height	mm	less than	3400
• Blade Length x Height	mm	more than	3700 x 530
• Ground Clearance	mm	more than	360
• Wheel Base	mm	more than	5700
PERFORMANCE			
• Max. Travel Speed Forward-Reverse	kg/h	more than	44 - 45
• Min. Turning Radius	mm	less than	6900
• Front Axle Oscillation	deg	more than	15
• Blade Max. Lift	mm	more than	430
• Articulation	deg	more than	26
ENGINE			
• Type			Water Cooled Diesel
• Displacement	cc	more than	4800
POWER TRAIN			
• Clutch			Multiple Disc Type
• Transmission			Planetary Power Shift
• Brake			Air or Hydraulic Actuate
TIRE			
• Size			13 - 24 - 8PR
• No. of Tire	piece		6
ATTACHMENT			
• Scarifier No. of Teeth	piece	more than	9
Width	mm	more than	1050
• Canopy			ROPS

EXCAVATING · LOADING EQUIPMENT			
WHEEL LOADER WITH BACKHOE			
ENGINE OUTPUT	KW	more than	55
OPERATING WEIGHT	kg	more than	7500
DIMENSIONS			
• Overall Length	mm	less than	5800
• Overall Width	mm	less than	2400
• Overall Height	mm	less than	3700
• Loader Bucket Cap.	m^3	more than	1.0
• Backhoe Bucket Width	mm	more than	600
• Ground Clearance	mm	more than	300
PERFORMANCE			
• Max. Travel Speed Forward-Reverse	km/h	more than	32 - 32
• Turning Radius (over tire)	mm	less than	9000
• Breakout Force	kg	more than	
WORKING RANGE (Loader)			
• Digging Force	kgf	more than	4000
• Dumping Clearance	cc	more than	2500
• Dumping Reach	mm	more than	800
• Digging Depth	mm	more than	50
WORKING RANGE (Backhoe)			
• Arm Wind Force	kgf	more than	3300
• Bucket Digging Force	kgf	more than	5200
• Max. Digging Height	mm	more than	4500
• Max. Dumping Height	mm	more than	3700
• Max. Vertical Wall Digging Depth	mm	more than	5500
• Max. Digging Reach at Ground	mm	more than	5400
ENGINE			
• Type			Water Cooled Diesel
• Displacement	cc	more than	4000
POWER TRAIN			
• Torque Converter			Single Stage
TIRE			
• Front Size		more than	9 - 6 - 10PR
• Rear Size		more than	16.9 - 28 - 10PR
• No. of Tire (without spare)	piece		4
Canopy			ROPS

HAULING EQUIPMENT			
DUMP TRUCK			
ENGINE OUTPUT	KW	more than	78
WEIGHT			
• Max. Loading Cap.	kg	more than	3500
• Vehicle Weight	kg	more than	3500
• Gross Vehicle Weight	kg	more than	7000
DIMENSIONS			
• Overall Length	mm	less than	5750
• Overall Width	mm	less than	2200
• Overall Height	mm	less than	2500
• Wheel Base	mm	more than	3250
• Body Length	mm	more than	3000
Width	mm	more than	1850
Height	mm	more than	370
PERFORMANCE			
• Max. Travel Speed	km/h	more than	90
• Min. Turning Radius	mm	less than	5500
ENGINE			
• Type			Water Cooled Diesel
• Displacement	cc	more than	4000
POWER LINE			
• Transmission Type			Constant Mesh or Synchromesh
• No. of Speed			more than 5F - 1R
• Brake			Air or Hydraulic Actuate
TIRE			
• Size		more than	7.5 - 16 - 10PR
• No. of Tire (without spare)	piece		6
GATE			
• Type			Tail Gate

Table 2.3.3-7 SPECIFICATIONS FOR EQUIPMENT (2/4)

HAULING EQUIPMENT												
CARGO TRUCK WITH CRANE				WATER TANK TRUCK				PICK-UP TRUCK			
ENGINE OUTPUT	KW	more than	88	ENGINE OUTPUT	KW	more than	88	ENGINE OUTPUT	KW	more than	78
WEIGHT				WEIGHT				WEIGHT			
• Max. Loading Cap.	kg	more than	3500	• Max. Loading Cap.	kg	more than	4000	• Max. Loading Cap.	kg	more than	1250
• Vehicle Weight	kg	more than	4000	• Vehicle Weight	kg	more than	3100	• Gross Vehicle Weight	kg	more than	2400
• Gross Vehicle Weight	kg	more than	8000	• Gross Vehicle Weight	kg	more than	7100				
DIMENSIONS				DIMENSIONS				DIMENSIONS			
• Overall Length	mm	less than	7500	• Overall Length	mm	less than	6600	• Overall Length	mm	less than	5000
• Overall Width	mm	less than	2300	• Overall Width	mm	less than	2200	• Overall Width	mm	less than	1690
• Overall Height		less than	3100	• Overall Height	mm	less than	2500	• Overall Height	mm	less than	1640
• Wheel Base	mm	more than	3350	• Wheel Base	mm	more than	2700	• Wheel Base	mm	more than	2950
• Body				• Tank				• Body			
Length	mm	more than	3350	Loading Cap.	lit	more than	4000	Length	mm	more than	1390
Width	mm	more than	2000	Length	mm	more than	3000	Width	mm	more than	1450
Height	mm	more than	380	Width	mm	more than	1800	Height	mm	more than	390
				Height	mm	more than	900				
PERFORMANCE				PERFORMANCE				PERFORMANCE			
• Max. Travel Speed	kg/h	more than	90	• Max. Travel Speed	km/h	more than	90	• Max. Torque	kg•m	more than	15.5
• Min. Turning Radius	mm	less than	6000	• Min. Turning Radius	mm	less than	5500	• Min. Turning Radius	mm	less than	6000
ENGINE				ENGINE				ENGINE			
• Type		Water Cooled Diesel		• Type		Water Cooled Diesel		• Type		Water Cooled Diesel	
• Displacement	cc	more than	4000	• Displacement	cc	more than	4000	• Displacement	cc	more than	1990
POWER LINE				POWER LINE				POWER LINE			
• Transmission Type		Constant Mesh or Synchromesh		• Transmission Type		Constant Mesh or Synchromesh		• Drive		4 x 2	
• No. of Speed		5F - 1F		• No. of Speed		5F - 1F		• No. of Speed		5F - 1R	
• Brake		Air-Hydraulic Actuate		• Brake		Air-Hydraulic Actuate		TIRE			
TIRE				TIRE				• Front Size		more than	6 - 14 - 6PR
• Size		7.5 - 16 - 10PR		• Size		more than 7.5 - 16 - 10PR		• Rear Size		more than	6.5 - 14 - 8PR
• No. of Tire (without spare)	piece	6		• No. of Tire (without spare)	piece	6		• No. of Tire (without spare)	piece	4	
CRANE				SPRINKLER				CABIN			
• Max. Lifting Cap.	kg	more than	3000	• Pump Type		PTO Drive		• Type		Double Cabin	
• Max. Boom Length	mm	more than	8000								
• Boom Expansion		less than	3								

Table 2.3.3-7 SPECIFICATIONS FOR EQUIPMENT (3/4)

COMPACTING EQUIPMENT								PAVING EQUIPMENT			
VIBRATION ROLLER				PLATE COMPACTOR				ASPHALT SPRAYER			
ENGINE OUTPUT	KW	more than	3.7	ENGINE OUTPUT	KW	more than	2.5	ENGINE OUTPUT	KW	more than	3.6
OPERATING WEIGHT	kg	more than	500	WEIGHT	kg	more than	50	OPERATING WEIGHT	kg	more than	260
DIMENSIONS				DIMENSIONS				DIMENSIONS			
• Overall Length	mm	less than	2400	• Overall Length	mm	less than	950	• Overall Length	mm	less than	1800
• Overall Width	mm	less than	710	• Overall Width	mm	less than	360	• Overall Width	mm	less than	1000
• Overall Height	mm	less than	1200	• Overall Height	mm	less than	900	• Overall Height	mm	less than	1000
• Wheel Base	mm	more than	500								
PERFORMANCE				PERFORMANCE				PERFORMANCE			
• Max. Travel Speed	km/h	more than	3.0	• Max. Travel Speed	km/h	more than	1.0	• Spraying Cap.	L/min	more than	25
• Frequency	vpm	more than	2800	• Frequency	vpm	more than	5500	• Tank Cap.	L	more than	200
• Centrifugal Force	kg	more than	940	• Centrifugal Force	kg	more than	850	• Burner Fuel		Kerosene	
ENGINE				ENGINE				ENGINE			
• Type		Air Cooled Diesel		• Type		Air Cooled Gasoline		• Type		Water Cooled Gasoline	
ROLLER				POWER LINE				TIRE			
• Diameter x Width	mm	more than	355 x 510	• Type		V-Belt		• Size		4.00 - 8 - 4PR	
				VIBRATING PLATE				• No. of Tire	piece	2	
				• Length x Width	mm	more than	420 x 292	ATTACHMENT			
								• Spray Nose	m x no.	5 x 2	
								• Hand Spray Bar	no.	5	
								• Spray Nozzle	piece	10	

Table 2.3.3-7 SPECIFICATIONS FOR EQUIPMENT (4/4)

MAINTENANCE · REPAIR							
CHAIN SAWS				MOWER			
ENGINE OUTPUT	KW	more than	1.5				
OPERATING WEIGHT	kg	less than	5.0	WEIGHT	kg	more than	6.0
DIMENSIONS				DIMENSIONS			
· Overall Length	mm	more than	400	· Overall Length	mm	more than	1850
· Overall Width	mm	more than	280	· Overall Width	mm	more than	600
· Overall Height	mm	more than	410	· Overall Height	mm	more than	500
PERFORMANCE				PERFORMANCE			
· Max. Cutter Length	mm	more than	450	· Cutting Blade	mm	more than	230
				· Type of Support		shoulder harness	
ENGINE							
· Displacement	cc	more than	35	ENGINE			
· Fuel Tank	L	more than	0.4	· Displacement	cc	more than	21
				· Fuel Tank	L	more than	0.5

Table 2.3.3-8 SPARE PARTS RATIO IN NET PRICE OF EQUIPMENT

Equipment	Specification	Spare Parts Ratio (%)
Wheel loader with shovel	Bucket cap. 1.2m^2	16
Dump truck	Loading cap. 4 t	19
Cargo truck with crane	4 t, crane cap. 2.9 t	16
Motor grader with ripper	Blade length : 3.7 m	16
Vibration roller	Net weight 0.5 ~ 0.6 t	17
Plate compactor	Net weight 50 ~ 60 kg	18
Asphalt sprayer	Kerosene 200 lit	17
Water tank truck	Tank cap. 3,800 lit	17
Mower (shoulder harness)	Cutter diameter 230 mm	24
Chain saw	Cutter length 500 mm	23
Pick-up truck (double cabin)	Loading cap. 1,250 kg	19

Table 2.3.3-9 THE COMPARISON OF NECESSARY MATERIAL AND METHOD

Work Item	General Local Method	Proposed Method	Reasons
Road pavement	• Single or double coated sprayed seals • Existing condition of the Project road is unsealed	• Double coated sprayed seals is proposed for the Project road • Base course and sub-base course is proposed to be spread	• No existing asphalt plant • No local material for asphalt pavement • Course material is available in local
Side ditch	• Removal of road surface by grader	• Earth ditch • Masonry lining (more than 3% gradient)	• Protection for pool and erosion of road shoulder • Protection for vertical erosion of ditch by masonry
Cross and culvert	• A few cases is found	• Installed at 32 spots (ϕ 900 mm)	• Protection for pool and erosion of road shoulder
Cross pile at intersection	• Very rare case	• Installed at 9 spots (ϕ 450 mm)	• Protection for pool and erosion of road shoulder
Cross pile at doorway	• Very rare case	• Installed at 41 spots (ϕ 400 mm)	• Keeping smooth driving
Gunite-shooting for slope	• No existing method	• Wide scale slope more than 5 m height (thickness : 5 cm)	• Protection for slope failing
Road marking	• Not general	• Marked in whole road section (line width : 15 cm)	• Traffic safety
Traffic sign board	• Installed at some spot	• Installed at necessary spot	• Traffic safety

(3) Procurement plan of equipment

The equipment is planned to be procured from Japan, taking into consideration the quality, the price and the delivery time, in the cases of Vanuatu, Australia, Singapore and Japan.

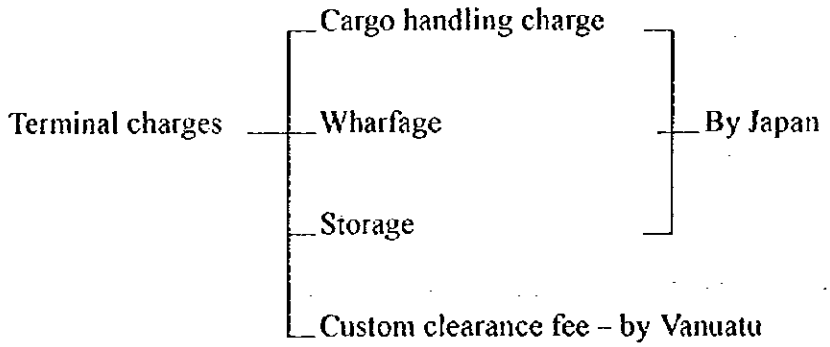
Therefore, the price is estimated in accordance with the standard Japanese estimates.

(4) VAT (in Vanuatu)

VAT is deducted from the terminal charge in Port Vila and inland transportation.

(5) Terminal charges in Port Vila

The items whose expense is to be shouldered by the both Governments are shown as follows:



Custom clearance fee for equipment : approximately 90,000 VATU

2.3.3.3 Work Volume

The work volume for the Project is shown in Table 2.3.3-9.

Table 2.3.3-10 WORK VOLUME

Work Item			Unit	Volume	Remarks
Clearing trees, Grubbing			lot	1	10.2 ha, 6.5 km Total length
Temporary Work			lot	1	
Earth work	Cut		m^3	111,500	
	Fill		m^3	28,500	
	Stripping top soil		m^2	108,700	t = 30 cm
	Excess material		m^2	80,600	
	Retaining masonry		m^2	377	
	Slope gunite shooting		m^2	3,822	thickness : 7cm
	Others		lot	1	including removal of surplus soil
Pavement work	Base 150 mm, Sub 200 mm		km	11,775	Design CBR 5
	Base 150 mm, Sub 200 mm Selected Fill 200 mm		km	2,425	Design CBR 3
	Spray seal	Project road	m	14,200	area : 93,000 m^2
		Access road	spot	41	compaction base course
Drainage facility	Side ditch	Earth ditch	m	11,640	
		Lined ditch	m	5,240	
	Terminal treatment of side ditch	Type 1	spot	75	
		Type 2	spot	10	
	Culvert		spot	32	ϕ 900 mm
	Cross drain pipe at access road		spot	41	365 m total length, ϕ 400 mm
	Cross drain pipe at intersection		spot	9	111 m total length, ϕ 450 mm
Road accessory	Road marking		m	17,260	line width : 15 cm
	Sign boards		spot	29	「STOP」, 「Give way」, 「Steep descent」 etc.
	Intersection		spot	9	grade intersection without signal
	Access road		spot	41	doorway
	Delineator		piece	544	
Safety facility of bridge	Seal on surface of deck		m^2	137	Teouma, Rentapao
	Hand rail		m	51	
	Guard rail		m	146	