BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR RECONSTRUCTING
THE LUNGGA BRIDGE IN SOLOMON ISLANDS

November 1989

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

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In response to the request of the Government of Solomon Islands, the Government of Japan has decided to conduct a basic design study on the Project for Reconstructing the Lungga Bridge and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Solomon Islands a survey team headed by Mr.Kazunori Yuki, Deputy Chief, First Engineering Section, Engineering Division, Hanshin Expressway Public Corporation, from June 25 to July 28, 1989.

The team exchanged views with the officials concerned of the Government of Solomon Islands and conducted a field survey in Guadalcanal Island.

After the team returned to Japan, further studies were made.

Then a mission was sent to Solomon Islands in order to discuss the draft report and the present report has been prepared.

I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

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

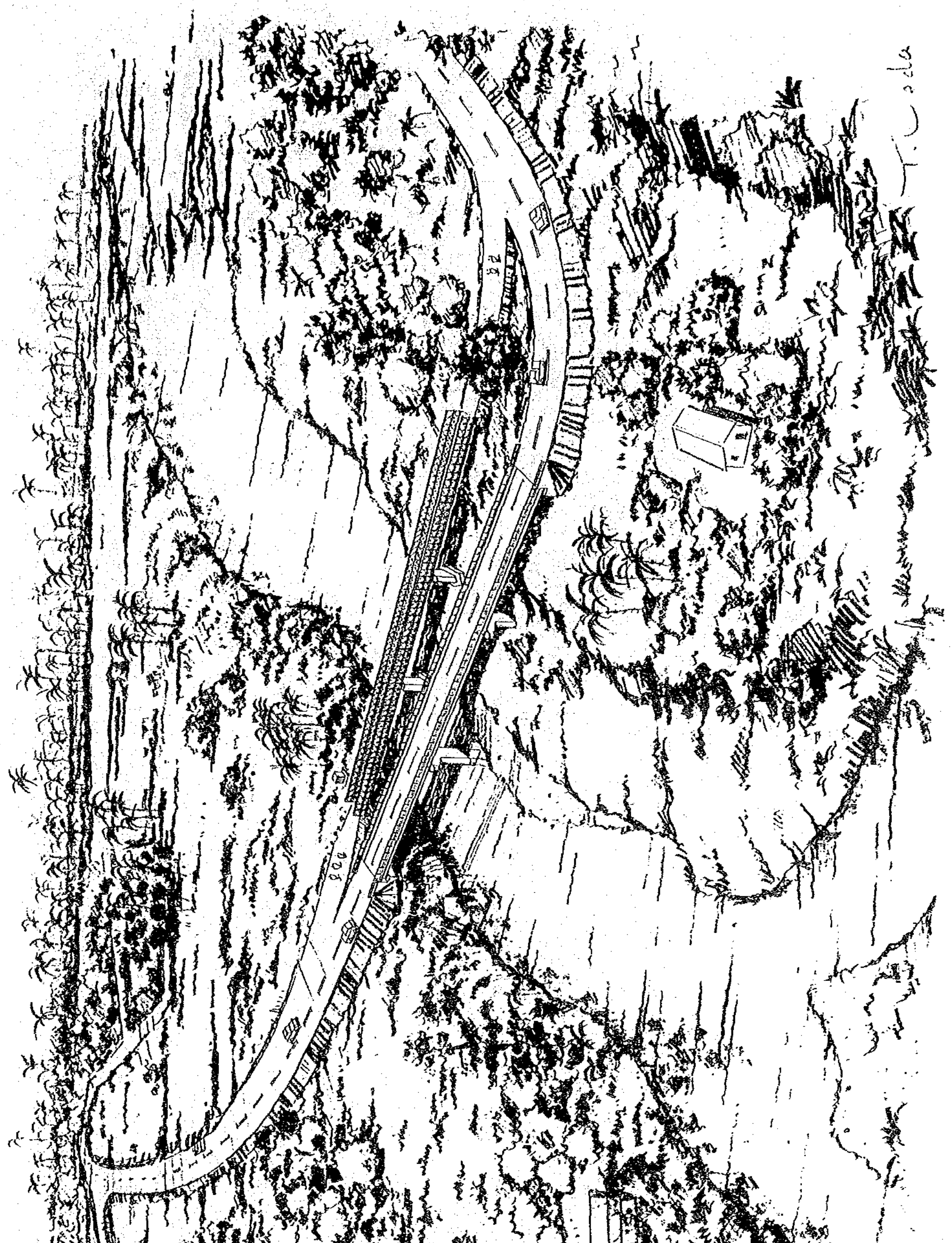
November 1989.

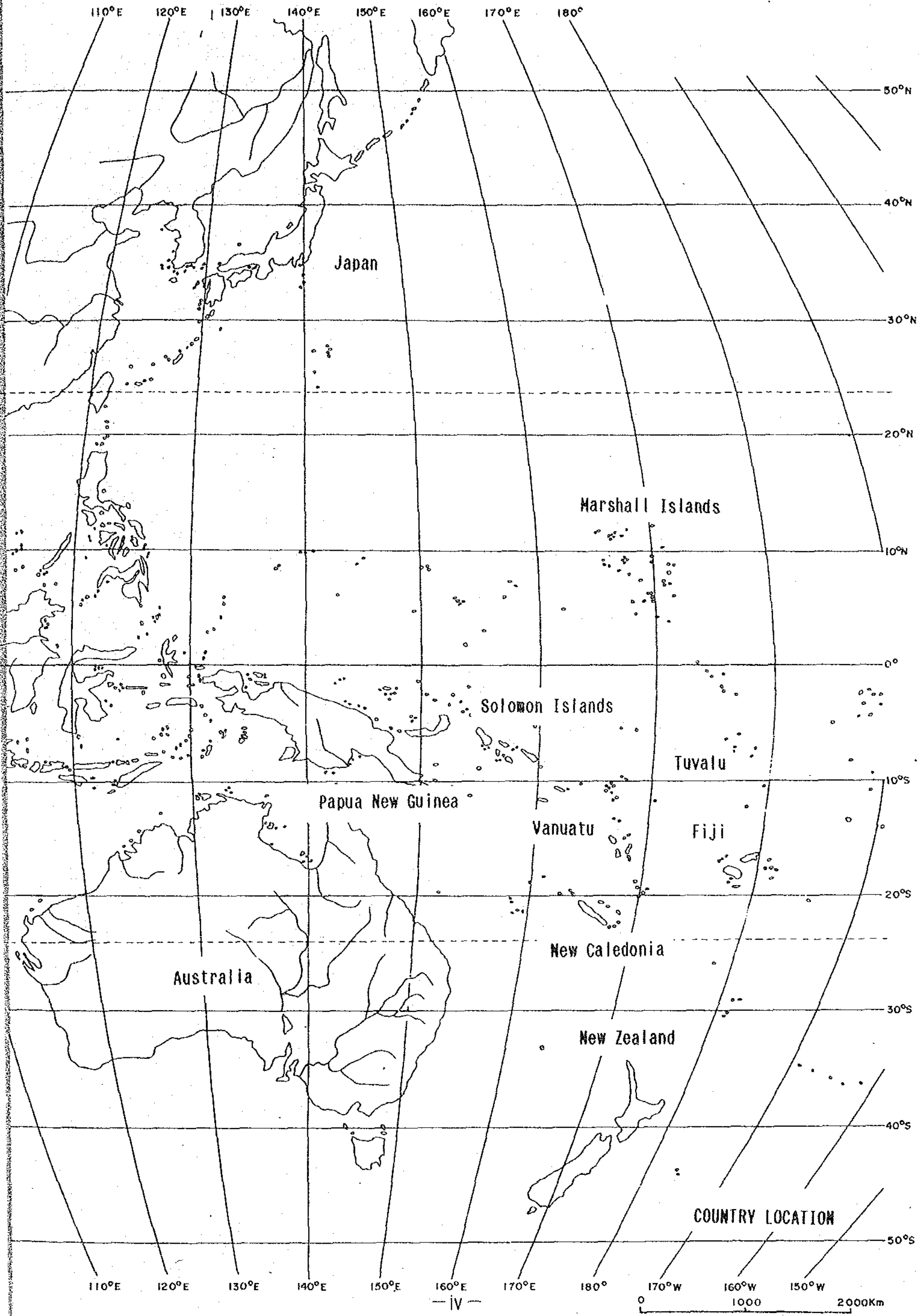
Kensuke Yanagiya

President

Japan International

Cooperation Agency





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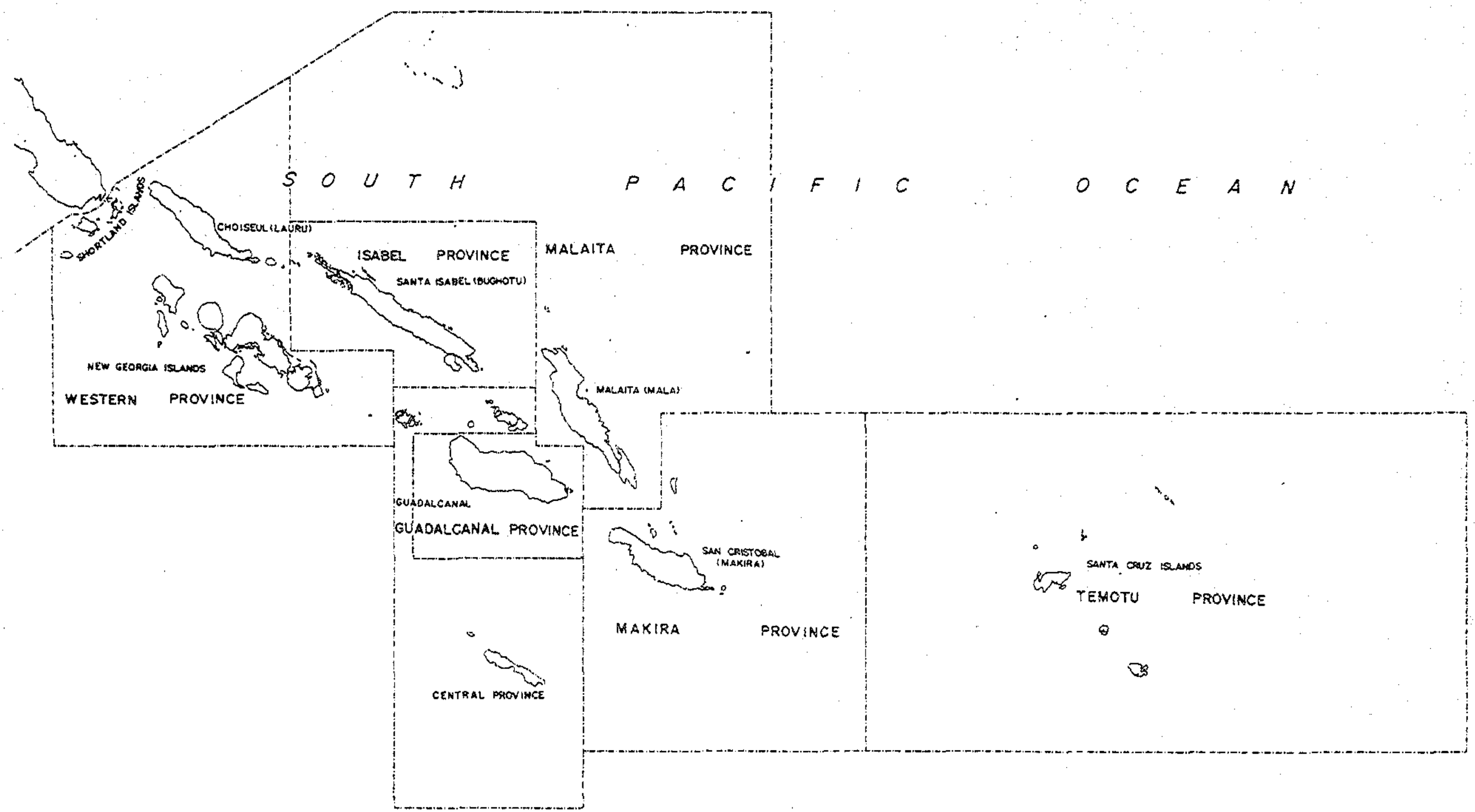

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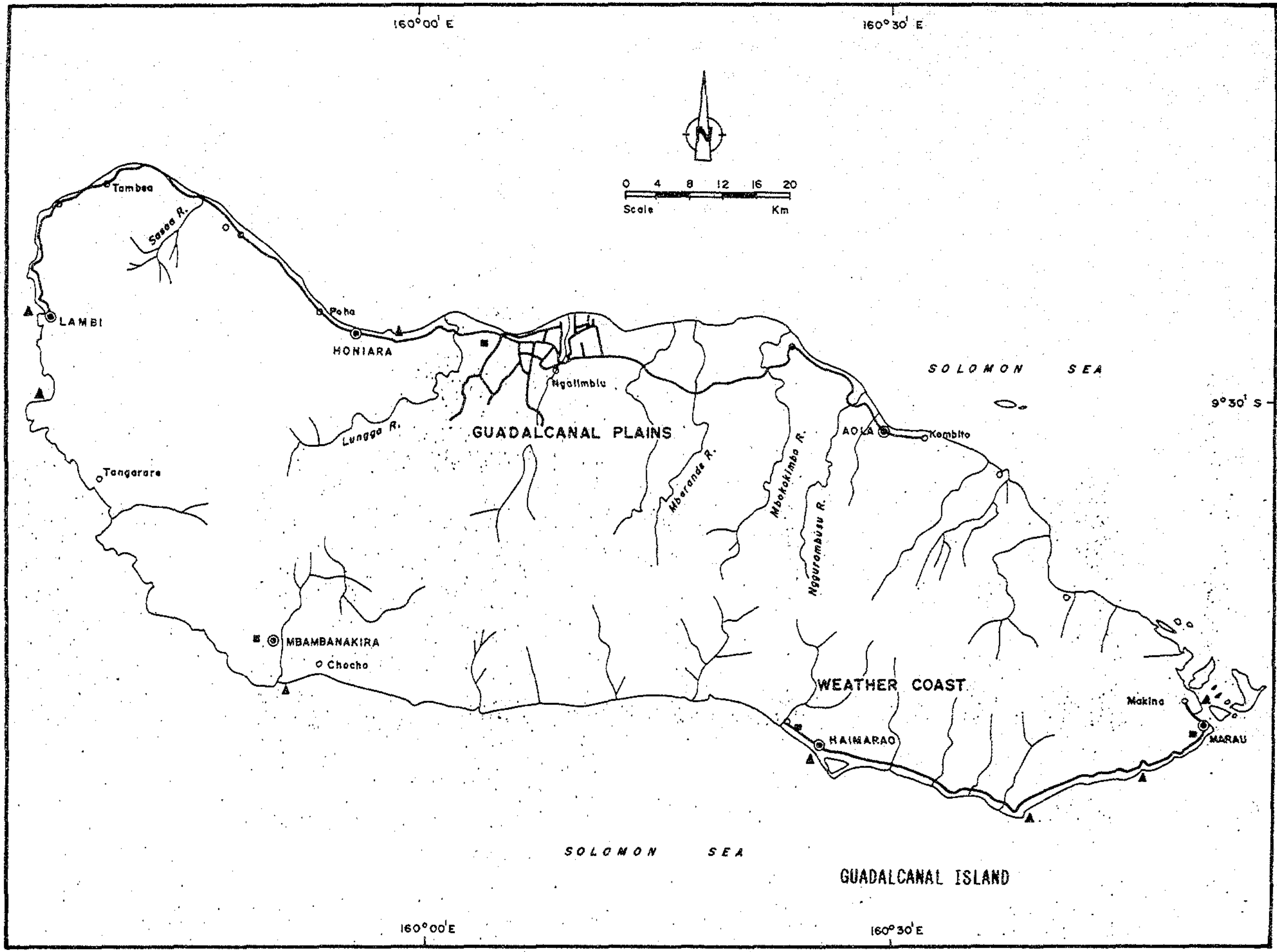
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Makina
MARAU
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160°00'E
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SUMMARY

SUMMARY

The Lungga Bridge, in Guadalcanal Island, Solomon Islands, is situated about 10 kilometers east of the capital, Honiara City, and crosses over the Lungga River on the north Guadalcanal road.

The Lungga Bridge is a one-lane Bailey-type bridge constructed in 1955. Bailey bridges were developed during the Second World War and designed for quick installation mostly using manual labor.

Members of the Bailey bridge structure are designed to be small, thin and light usually providing a lower, factor of safety than is usually used.

Consequently Bailey bridges have been used principally as temporary structures under emergency conditions.

The existing Lungga Bridge has been in existence for nearly 35 years, and has undergone deterioration due to the long term use. Although the bridge was strengthened by adding a new pier in 1984, it still has posted a 15 ton load limit.

The single lane traffic capacity does not meet the current increased traffic volume(approximately 2600 vehicles per day),and consequently traffic congestion has become a problem lately at peak times in the morning and evening on both ends of the bridge.

The Lungga Bridge is a bottleneck in the traffic flow on the north Guadalcanal road which is the main arterial road on the island.

The major sources of income of Solomon Islands are agriculture and fishing. The principal agricultural products are coconut, palm-oil, cocoa,and forestry. Agriculture is concentrated at the Guadalcanal Plains located in the north-eastern part of the

island and the products are transported to Honiara Port using the north Guadalcanal road which is the only existing, important means of transportation.

To carry out the urgent development of the industries in the north-east plains, it is necessary to reconstruct the Lungga Bridge to accommodate at least two-lanes.

Based on the aforementioned objective, the Government of Solomon Islands has requested the Government of Japan for grant aid to replace the existing Lungga Bridge with a new 2-lane permanent structure.

In response to the request of the Government of Solomon Islands, the Government of Japan agreed to conduct a basic design study of a project involving the replacement of the Lungga Bridge and assigned the study to the Japan International Cooperation Agency (JICA).

JICA dispatched a survey team to Solomon Islands from June 25 to July 28, 1989. The team exchanged views with officials of the Government of Solomon Islands, collected necessary data for a basic design and conducted a topographic survey and geotechnical investigation at the site. After the team returned to Japan, further studies were conducted.

Based on the study and analysis of the flood records of the Lungga River, the present condition of the island's infrastructure, the maintenance system, future traffic volumes, feasibility of construction, etc., and after evaluating the significance and appropriateness of the Project, the basic design of the Project was formulated.

JICA dispatched a second mission to Solomon Islands to discuss the final draft report. This mission visited Solomon Islands from September 27 to October 4, 1989 and carried out final discussions of the contents of the basic design report of the Project.

The contents of the Project are as follows.

1.BRIDGE LENGTH	126m
2.SPAN	3 spans @42m
3.WIDTH	
ROADWAY	3.75mx2=7.50m
FOOTWAY	1.2m EACH (EACH SIDE OF ROADWAY)
4.SUPERSTRUCTURE	3 SPANS CONTINUOUS STEEL GIRDER BRIDGE WITH CONCRETE SLAB
5.SUBSTRUCTURE	REINFORCED CONCRETE PIERS AND ABUTMENTS
6.FOUNDATION	DRIVEN STEEL PIPE PILE FOUNDATION SUPPORTING THE PIERS AND ABUTMENTS
7.APPROACH ROAD	ABOUT 340m LONG(TOTAL)

ESTIMATED WEIGHT OF STRUCTURAL STEEL	322 TONS
ESTIMATED VOLUME OF CONCRETE	1205 CUBIC METER
ESTIMATED STEEL PIPE PILES	157 TONS

The construction period is to be 11 months. The Ministry of Transport, Works and Utilities (MTWU) of Solomon Islands is responsible for the implementation of the Project (The Executing Agency).

The MTWU will be responsible for maintaining the bridge after its completion.

The first step in the maintenance of the bridge is inspection.

These inspections include monthly and periodic and in special cases such as floods and earthquakes. In each case appropriate maintenance must take place, and records should be kept.

The reconstruction of the Lungga Bridge will improve the safety, meet the increased traffic, and make an important contribution to the development of the economy of Solomon Islands.

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1. INTRODUCTION

1. INTRODUCTION

The Lungga Bridge is a Bailey-type, single-lane bridge constructed in 1955. Bailey bridges were developed during World War II and designed for assembly and erection with manual labor. Bailey bridge members are designed to be small, thin and light, and the load carrying capacity provides a lower factor of safety than is usual. Consequently, Bailey bridges have been used principally as temporary bridges, frequently in cases of emergency.

The Lungga Bridge has been in use for about 35 years and is showing some deterioration due to long-term use. Although the bridge was strengthened by adding a new pier in 1984, it is still restricted to a 15 ton load limit.

The north Guadalcanal road including the Lungga Bridge is a very important trunk road connecting Honiara Port and the Guadalcanal Plains which is the main agricultural production district. Traffic volumes on the north Guadalcanal road have increased year by year due to the development of industries.

The daily traffic volume at the Lungga Bridge is approximately 2600 vehicles. Traffic congestion has been occuring lately at both ends of the bridge at peak-times in the morning and evening.

The single-lane Lungga Bridge is a bottleneck in the traffic flow on the north Guadalcanal road which is life-line of the island. Furthermore, in order to carry out the urgent development of the industries in the north-east plains it is necessary to replace the existing Lungga Bridge with a new two-lane structure.

Based on the above-mentioned background, the Government of Solomon Islands requested the Government of Japan for grant aid to replace the existing Lungga Bridge with a new modern type structure responsive to the traffic conditions.

In response to the request, the Government of Japan agreed to conduct a basic design study on the Project for Reconstruction of the Lungga Bridge and assigned the study to the Japan International Cooperation Agency (JICA).

JICA dispatched to Solomon Islands a basic design study team headed by Mr.Kazunori Yuki, Deputy Chief, First Engineering Section, Engineering Division, Hanshin Expressway Public Corporation. The team carried out its work from June 25 to July 28, 1989.

During that visit, the team comfirmed the relevancy of the request and the objectives of the Project, explained the grant aid system to relevant government officials of Solomon Islands, discussed the undertakings by both governments, collected necessary data for a basic design, and conducted a topographic survey and a geotechnical investigation at the site. Upon returning to Japan, the team carried out further studies.

Based on the study which analyzed the flood records of the Lungga River, the present condition of the island's infrastructure, the maintenance system, future traffic volumes, feasibility of construction, etc., and after evaluating the significance and appropriateness of the Project, the basic design of the Project was formulated.

JICA dispatched a second mission to Solomon Islands to discuss the final draft report. This mission visited the Solomon Islands from September 27 to October 4, 1989 and was headed by Mr. Kazunori Yuki, Deputy Chief, First Engineering Section,

Engineering Division, Hanshin Expressway Public Corporation.
The mission carried out final discussions of the contents of the basic design report of the Project.

This report summarizes the results of the above-mentioned survey. Members of study teams, itineraries, names of members contacted, and minutes of discussions are included in Appendices 1.1 - 1.4.

2. BACKGROUND OF THE PROJECT

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2.1 Profile of Solomon Islands

2.1.1 Land and Population

(a) Land

Solomon Islands are situated in the South-western Pacific Ocean, between latitudes 5-12 degrees south of the equator and between longitudes 154-162 degrees east, about 1800km north-east of Australia. They form a scattered archipelago of several hundred islands stretching some 1400km south-east from Papua New Guinea to the north-west of Vanuatu. They comprise a land area of 28,370 sq km and are on a major earthquake belt.

The 6 main islands are Guadalcanal, Malaita, Choiseul, New Georgia, San Cristobal and Santa Isabel. They vary from 144km to 193km in length and from 32km to 48km in width. The islands are mountainous, covered with tropical rain forest and intersected by rivers. The largest island, Guadalcanal, contains the capital, Honiara, and the highest mountain, Mt.Makarakomburu (2,477m). Guadalcanal also has extensive coastal plains on its north-east coast.

There are numerous small inhabited and uninhabited islands, coral reefs and lagoons as well as the artificial islands of Malaita built from chunks of coral.

Most islands are of volcanic origin and there is some volcanic and thermal activity, with hot springs in certain areas.

(b) Population

According to the 1976 census, the population was 196,823 comprised of 93.4% Melanesians, 4% Polynesians, 1.4% Micronesians, 0.7% Europeans, 0.2% Chinese, and 0.3% others. The estimated population for 1987 is 297,000. The 1976 census indicated an annual population growth of 3.4% with a life expectancy of 54 years for both men and women. The quality of life has been steadily improving with infant and total mortality rates dropping and life expectancy increasing.

TABLE APP-2.1 shows the land area, population and population density in 1986.

2.1.2 National Economy

(a) Outline of Economy

The subsistence (non-cash) economy contributes about 37% of the Gross Domestic Product(GDP) and provides a large part of the population with food crops, fish, meat, housing, fuel, canoes and certain services. It plays an important role in the economy, especially when the cash sector is under considerable strain.

Agriculture, including forestry, livestock, fisheries, palm oil, cocoa and copra accounts for over 60% of the GDP.

Manufacturing is still in its initial stages and accounts for a small percentage of the GDP. The tourist industry provides a minor contribution. TABLE APP-2.2 shows the estimated GDP for 1972-1986.

(b) The Trend of Trade

1) Exports and Imports

TABLES 2.1 and 2.2 show the principal export and import products respectively in Solomon Islands.

TABLE 2.1 Principal Export Products

unit:Million SI$

	1984	1985	1986	1987
Copra	33.2	23.5	5.9	10.3
Wood Products	30.1	24.8	35.7	37.2
Fish Products	28.8	31.9	52.9	52.6
Palm Products	19.1	13.7	6.0	7.6
Cocoa	3.4	5.0	6.5	9.5
Others	5.0	5.0	7.9	11.1
Total Exports	118.6	103.9	114.9	128.3

(Source:Solomon Islands Trade Directory 1987)

TABLE 2.2 Principal Import Products

unit:Million SI$

	1984	1985	1986	1987
Fuel	19.1	20.8	21.7	19.9
Machinery and Transport	20.1	27.0	30.8	39.3
Manufactures	20.2	26.0	21.7	40.1
Food	13.1	15.7	18.0	15.4
Others	11.3	13.2	12.1	20.2
Total Imports	83.8	102.7	104.3	134.9

(Source:Solomon Islands Trade Directory 1987)

TABLE APP-2.3 shows the value share of principal exports.

TABLE APP-2.4 shows a chart of commodities imported (%)

2) Trade Balance

TABLE 2.3 shows the trade balance in 1983-1987.

TABLE 2.3 Trade Balance (Unit:Million SI$)

	1983	1984	1985	1986	1987
Total Exports	71.2	118.6	103.9	114.9	128.3
Total Imports	70.6	83.8	102.7	104.3	134.9
Balance	0.6	34.8	1.2	10.6	-6.6

(Source:Solomon Islands Trade Directory 1987)

TABLE APP-2.5 shows the balance of merchandise trade.

3) Trade Between Solomon Islands and Japan

The exports to and the imports from Japan in 1986 are as follows.

Unit:Million SI$

(Source:Solomon Islands Trade Directory 1987)

Exports to Japan	
Wood Products	24.1
Fish Products	15.1
Copra	2.0
Total Exports	41.2

Imports from Japan	
Machinery and Transport	10.8
Manufactures	4.8
Food	1.3
Others	0.7
Total Imports	17.6

These values related to Japan account for 36% and 17% of total exports to and imports from Solomon Islands respectively.

(c) National Budget

TABLE 2.4 shows the national budget in 1984-1989

TABLE 2.4 National Budget (Unit:Million SI$)

	1984	1985	1986	1987	1988	1989
Revenue	52.66	56.73	65.71	64.55	88.04	110.33
Expenditure	50.41	53.32	63.44	70.53	94.23	115.56

(Source:Solomon Islands 1984-1989 Recurrent Estimate)

TABLE APP-2.6 shows a summary of the recurrent estimate 1988.

2.1.3 National Development Plan (NDP)

In the Third National Development Plan 1985-1989, the national development objectives are to:

(a) promote physical, mental and social wellbeing and the advancement of knowledge;

(b) promote the equitable distribution of the benefits of development;

(c) promote greater self-reliance and local control of the national economy;

(d) strengthen and diversify the productive base and capacity of the national economy;

(e) preserve the values, traditions and integrity of Solomon Islands society;

(f) consolidate devolution and inter-governmental relations;

(g) promote national unity within the diversity of the nation;

(h) promote international cooperation and world peace.

These national development objectives form the basis for the specific sectoral, regional and rural development objectives and consequently the objectives of the development programs and projects.

The land transportation items related to the Lungga Project in the National Development Plan 1985-1989 are as follows.

Program one : Roads and Bridges

Project 1. Guadalcanal Road Improvement

The project's objective is to upgrade the main north Guadalcanal road between Tambea and Poha west of Honiara and between Ngalimbiu and Aola east of Honiara. It will bridge the Sasaa, Mberande and Mbokokimbo rivers.

Project 3. Extension of the North Guadalcanal Road

The project will extend the road from Aola to Marau.

Project 4. Improvements to North Guadalcanal Road

The project will widen and strengthen the road from Doha, through Honiara to Ngalimbiu.

Project 9. Guadalcanal Bridges

This project will increase the load carrying capacity of bridges over Alligator Creek, Big Tenaru, Small Tenaru, Metapona and Mbalisuna rivers, provide bridges over the Tanaemba, Njarapuhe and Ngurambusu rivers and replace the existing single lane bridge over the Lungga river with a two lane bridge.

2.2 General Condition of Transportation

2.2.1 Land Transport

Public transportation in Guadalcanal Island is by bus and taxi. At present the motor traffic road has Honiara at its midpoint and extends from Lambi about 70km west of Honiara to Aola about 80km east, with many access roads.

Buses run between Poha (10km west) and No.3 plantation (40km east). All bus firms are private enterprises and operate irregularly as to time and route.

Bus fares are uniform, 40 cents in Honiara City and 3.0 dollars from Honiara to No.3 plantation.

Most villages situated outside the bus routes have a few trucks which are locally owned.

Many villagers bring their harvests such as vegetable, fruits etc., to the markets in Honiara using their trucks. They also bring back commodities such as rice, bread, instant-rahmen, fish, fuel, clothes and other necessities.

Registered vehicles in Honiara total 4157 in 1989.

TABLE APP-2.7 shows newly registered motor vehicles from 1971 to 1986.

2.2.2 Sea Transport

TABLE 2.5 shows overseas shipping which entered and cleared Honiara Port.

TABLE 2.5 Overseas Shipping

	1982	1983	1984	1985	1986
Number	337	298	325	348	345
Gross Tonnage	1,322.0	1,329.9	1,708.2	1,471.7	1,823.8
Cargo-In	150.0	86.3	104.9	123.7	104.4
-Out	94.1	101.8	140.8	82.8	103.0

G.Tonnage & Cargo 1,000ton

(Source:1985/6 Statistical Yearbook)

The liners dropping in Honiara Port in July 1989 belong to the following shipping lines.

1) New Zealand Central Pacific Trade Line

Auckland-Brisbane-HONIARA-Port Moresby-Brisbane

2) Containers Pacific Express Line

Melbourne-Sydney-Brisbane-Port Moresby-HONIARA

3) New Guinea Pacific Line

Hongkong-Singapore-Port Moresby-HONIARA

4) Bari Hai Service Line

Kobe-Nagoya-Yokohama-(omit)-HONIARA-(omit)-Kobe

2.2.3 Air Transport

TABLE 2.6 shows calls by aircraft on international routes at Henderson Airport 1982-1986.

TABLE 2.6 calls by Aircraft

		1982	1983	1984	1985	1986
Aircraft		903	800	777	749	689
Cargo	In	262.2	268.5	357.6	345.9	611.7
x 1000ton	Out	106.1	64.2	67.7	65.0	47.3
Passenger	In	14,892	15,429	16,051	17,871	18,315
	Out	16,053	15,335	15,873	17,154	17,038

The international routes via Honiara are as follows as of July 1989.

1) Honiara-Brisbane
   Quantas Airways, Solomon Islands Airways
   2 Flights/a week Boeing B-737

2) Honiara-Port Moresby
   Air New Guinea
   2 Flights/a week Fokker F-28

3) Honiara-Nadi(Fiji)
   Air Pacific, Solomon Islands Airways
   1 Flight/a week Boeing B-737

2.3 Road Improvement Plan of Guadalcanal Island

2.3.1 Guadalcanal Road Improvement Plan (GRIP)

This project is a part of Project 1 for land transportation in NDP 1985-1989 which consists of

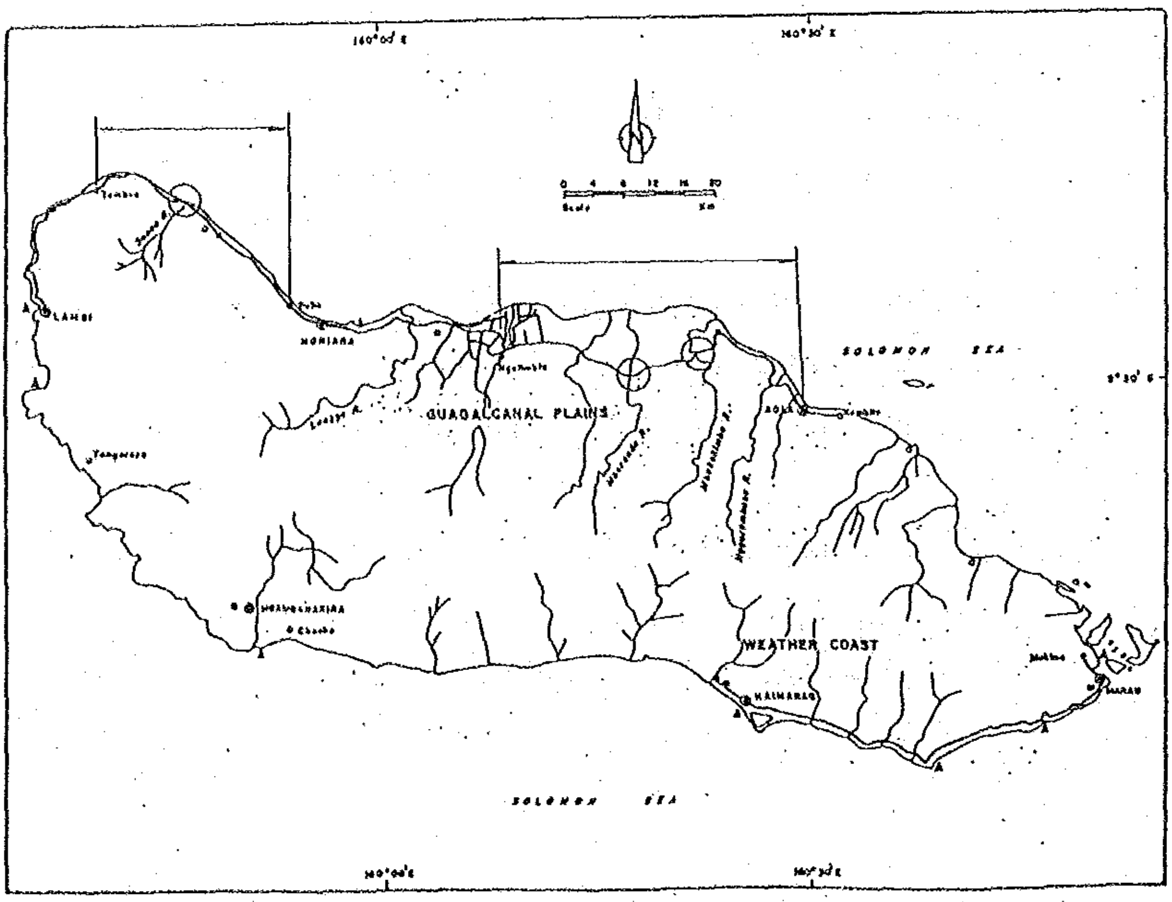
(a) improvement and rehabilitation of 90km of Guadalcanal road (Tambae-Poha, Ngalimbiu-Aola)

(b) construction of three major bridges : Sasaa, Mberande and Mbokokimbo

(c) procurement of construction equipment

(d) consulting services to assist MTWU in the implementation of the project

FIGURE 2.1 Shows the extent of the Project



This project commenced in 1984 and was completed in December 1988, 12 months behind the original scheduled completion date.

The initial total cost of the project with its foreign and local components was co-financed by the Asian Development Bank (ADB), the International Development Agency of the World Bank (IDA), the OPEC Fund for International Development (OPEC) and Solomon Islands Government (SIG). A summary of the financing arrangements is shown below in TABLE 2.7.

TABLE 2.7 Financing Arrangement(Million US$)

	ADB	IDA	OPEC	SIG	Total
Foreign	1.75	1.75	1.50	—	5.00
Local	0.25	0.25	—	1.00	1.50
Total	2.00	2.00	1.50	1.00	6.50

2.3.2 Second Road Project Solomon Islands

This project covers the two following components of land transportation in the NDP;

1) Project 4 Improvements to North Guadalcanal Road

2) Project 9 Guadalcanal Bridges

Phase 1 of this project was carried out by Australian consultants (Cardno and Davies) in December 1987, financed by ADB.

Their report includes feasibility studies for various improvements to the existing 31km road from Poha and Ngalimbiu and the bridges along that road.

According to the report, estimated costs of the project are shown below in TABLE 2.8.

TABLE 2.8 Estimated Costs of Project (Million US$)

ROADWORKS	
Option 2 Roadworks	7.946
Addition of One-way Town Section	0.200
Estimated Cost for Lungga Diversion	0.333
BRIDGEWORKS	
Kakambona	0.175
White River	0.138
Lungga River	2.449
Alligator Creek	0.614
Big Tenaru	1.017
Small Tenaru	0.095
Poha	1.000
Contingencies(10% of above)	1.397
TOTAL ESTIMATED CONSTRUCTION COST	15.364
CONSULTANTS SERVICES	
Design services	0.450
Supervision of construction	2.000
contingencies(10%)	0.245
TOTAL ESTIMATED COST OF CONSULTANTS SERVICES	2.695
TOTAL COST TO CONSTRUCT	18.059

FIG. APP-3.1 shows Road Improvement Plan Option 2.

2.3.3 Improvement Plan of Henderson Airport

Solomon Islands has a plan to improve the existing road from the east side of the Lungga Bridge to Henderson Airport to coincide with the improvement plan of the Henderson Airport.

This plan consists of the extension of the runway and construction of a new terminal building at the north end of the existing Henderson Road.

FIG. APP-3.2 shows the proposed upgrading of Henderson Airport. Based on this plan, the existing Henderson Road itself will be relocated to the north side. (Alignment c)

It is very desirable to improve the poor road alignment east of the Lungga River, which directly connects with Alignment c.

The present terminal building is inadequate and provides poor access for processing through immigration and customs. Consequently, there is a high priority to construct a new terminal building at the north side of the existing Henderson Road.

2.4 Traffic Volumes

2.4.1 Present Traffic Volumes

The traffic count data prior to 1983 is shown in TABLE 2.9, and the recent traffic counts are shown in TABLE 2.10.

TABLE 2.9 Traffic Count Data Prior to 1983

	Sept. 1971	Apr. 1972	Jun. 1973	Mar. 1974	Aug. 1976	May 1977	Nov. 1979	Nov. 1980	Jun. 1982
Mataniko Br.	5106	5529	6178	5868	7865	7837	9457	11387	11541
KG VI School	979	1228	1268	1358	1565	1538	1760	2142	2679
Tenaru Br.	232	412	361	556	493	509	649	900	946

(Source:Economic and Engineering Studies for Extension and Upgrading of the Lambi-Aola to Marau Scond Road, Phase 1 Report, Roughtor & Partners, April 1984.)

TABLE 2.10 Recent Traffic Counts

	Nov. 1985	Dec. 1986
Honiara Town Council	14,229	14,510
KG IV School	2,675	3,579
Tenaru Bridge	992	959

12-hour counts 6:00-18:00

(Source:MTWU)

In general, the traffic data shows a reasonably consistent and uninterrupted growth trend, with annual increases between Mataniko Bridge and Tenaru Bridge in the order of 7-10%.

2.4.2 Survey of Traffic Volumes

More recent 12 and 16 hour traffic counts were carried out by MTWU.

* Date	July 20, 1989
* Time	6:00-22:00 (16 hours)
* Location	East side of Lungga Bridge

Results of the survey are as follows:

16-hour traffic counts	2,379 (6:00-22:00)
12-hour traffic counts	2,061 (6:00-18:00)

Hourly distribution of traffic is shown below in FIGURE 2.2.

FIGURE 2.2 Hourly Distribution of Traffic

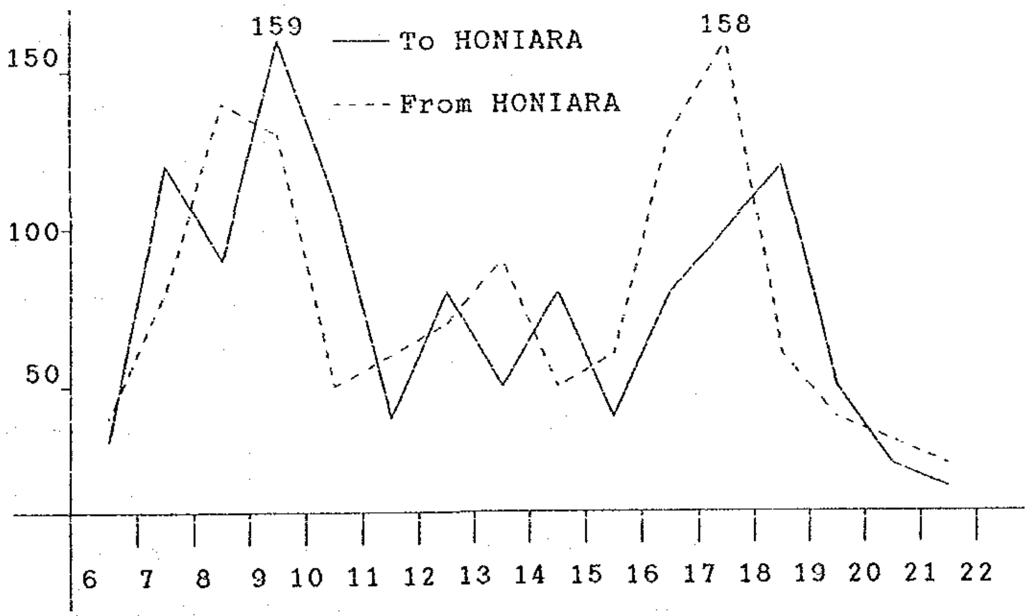


TABLE APP-2.8 shows classified hourly traffic counts.

2.4.3 Traffic Forecasts

Traffic forecasts at the Lungga Bridge are shown below in TABLE 2.11.

TABLE 2.11 Traffic Forecasts

	1987	1997	2007
Vehicle/day	2437	4245	7820

(Source:Second Road Project Solomon Islands)

Growth ratio	1987-1997	5.55%
	1997-2007	6.30%

2.5 Maintenance of the Lungga Bridge

2.5.1 Implementing Body

The ROADS, BRIDGES AND AIRFIELDS DIVISION (RBA) of MTWU is responsible for maintenance of all roads, bridges and the airfield in Guadalcanal Island including the existing Lungga Bridge.

2.5.2 Records of Maintenance

Major maintenance work which has been done on the existing Lungga Bridge includes the following two items.

(a) Construction of an additional pier.

A new pier was constructed in 1984 with assistance from the Australian Government. The purpose was to strengthen the deteriorated bridge. Since the superstructure of this bridge was already using the largest size panels, in double-double units, it was no longer feasible to strengthen it further. The only alternative was to add a new pier.

(b) Replacement of the broken timber deck plates.

The timber deck plates directly carrying the axle loads of vehicles are always subjected to breakage and loosening due to the impact of vehicles and the vibration of the bridge.

These timber elements have been replaced continuously whenever damages have occurred.

2.5.3 Loading Capacity

(a) Bridge Load Ratings

Calculated existing bridge load ratings are given in TABLE 2.12. These ratings are based on the capacity of the superstructure steelwork which can be measured and include a subjective adjustment to allow for the assessed degree of the deterioration that can be visually observed. Ratings are based on NAASRA T44 standard vehicle.

TABLE 2.12 Load Rating of Existing Bridges

(Unit:ton)

Bridge Name	Load Rating	Overload Rating
Mataniko River	33.0	104.0
Lungga River	24.5	70.4
Alligator Creek	31.1	100.0
Big Tenaru	4.8	*
Small Tenaru	10.7	*

*Not computed as requires steel to yield

(Source:Second Road Project Solomon Islands)

(b) Risk Ratings

A comparison of the existing bridges considering load rating, future life, scour risk and earthquake risk is given in TABLE 2.13.

TABLE 2.13 Comparison of Existing Bridges

Name of Stream	Risk Ratings				
	Loading	Life	Scour	Earthquake	Total
Mataniko	0	0	1	2	3
Lungga	5	9	7	10	31
Alligator	1	7	4	8	20
Big Tenaru	10	5	4	7	26
Small Tenaru	8	5	1	7	21

(Source:Second Road Project Solomon Islands)

A high rating in a classification indicates that the bridge has a high risk of failure due to overloading, scour or earthquake and/or that high costs would be associated with a failure of the bridge. Those bridges with the highest overall rating are those structures considered to be most at risk. These ratings are only a subjective guide to the urgency of required work.

(c) Consideration

The necessary technical work to decrease the risk ratings of the Lungga Bridge are as follows:

1) remove rust and repaint all members of super-structure to prevent deterioration.
2) construct scour protection works to prevent the spread of scour that is growing at the newly added pier.

3) widen the caps of all piers and abutments to prevent the fall of the bridge itself in case of earthquake.

Since the above-mentioned work does not increase the load carrying capacity, it is necessary to maintain the load limit of 15 tons.

2.6 Review of the General Conditions of Similar Facilities

2.6.1 Investigation of Existing Bridges

The following 8 bridges located between Honiara and Aola, along the 80km north Guadalcanal road, were investigated to measure the major dimensions and to inspect for damage and deterioration through visual observation.

The general view of the Lungga Bridge is shown in FIG.APP 3.3.

The locations of these 8 bridges are shown in FIG.APP 3.4.

(a) Mataniko Bridge (Refer to FIG.APP-3.5)

This bridge was constructed in 1984 with assistance from the Australian Government. It is located at the mouth of Mataniko river, which flows through Honiara city, and is the only bridge with a two lane deck in Guadalcanal Island.

The bridge consists of three-composite girders with five main girders which are H-shaped steel with cover plate. The structure and the paint appear to be in good condition.

(b) Alligator Creek Bridge (Refer to FIG.APP-3.6)

This is a one-lane Bailey bridge with three 18m spans. The surface of roadway is a steel checkered plate and the footway is of timber construction. It is not known when the bridge was constructed, however, it is assumed that it was built in the late sixties or early seventies. No distress was noted, and the paint appears to be in fair condition.

(c) Big Tenaru Bridge (Refer to FIG.APP-3.7)

This is a one-lane steel girder bridge with two main girders. It is assumed to have been constructed in the late sixties or early seventies.

Although several rust spots were observed, the overall painting seems to be in fair condition. Whenever heavy trucks pass over the bridge, the girder of the main span vibrates noticeably in the vertical and transverse directions. This implies a deficiency in flexural rigidity. It appears reasonable that the risk rating of this bridge under "loading" is 10 points indicating high risk [See item 2.5.3(b)].

(d) Ngalimbiu Bridge (Refer to FIG.APP-3.8)

This one-lane bridge was constructed in 1989 with assistance from the United Kingdom. It replaces the old bridge which had lost one of its four spans in the May 1986 flood.

The new bridge is a steel pratt-truss using galvanized steel (unpainted). The new bridge has two footways outside the roadway. The roadway and footway have checkered steel plates.

(e) Matepono Bridge (Refer to FIG.APP-3.9)

This is a one-lane steel girder bridge with two main girders similar to the Big Tenaru bridge. The year of construction and paint condition are also the same.

(f) Mbalisuna Bridge (Refer to FIG.APP-3.10)

(g) Mbrande Bridge (Refer to FIG.APP-3.11)

(h) Mbokokimbo Bridge (Refer to FIG.APP-3.12)

These 3 bridges were constructed in 1987 by the Guadalcanal Road Improvement Plan as spillway-type bridges without handrails. The superstructure of these bridges is a continuous reinforced concrete slab type (with 10m span lengths) supported by steel pipe piles 400mm in diameter.

2.6.2 Considerations

According to the officials of MTWU connected with RBA, the paint of steel bridges has received no maintenance. Although Big Tenaru, Small Tenaru and Matepono bridge have served for almost 20 years since construction, the condition of their paint is still not considered poor.

Big and Small Tenaru bridges are surrounded by tropical forest and Metapono bridge is located close to the land mass. It is felt that even if the particles of salt carried by the wind should adhere to the surface of paint, they may be washed away by rain water of the squalls falling throughout the year.

In connection with the new Ngalimbiu bridge which has been built with two spans instead of the original four spans it replaced, it is noted that such a design increases the hydraulic opening to better handle flood waters.

2.7 Background and Contents of the Project Request

2.7.1 Background of the Request

The Lungga Bridge has been in service for almost 35 years. It is a single-lane Bailey type bridge and has been deteriorating due to long-term use. Although the bridge was strengthened through the addition of a new pier in 1984, its traffic is still regulated by a 15 ton limit.

The north Guadalcanal road including the Lungga Bridge is a very important trunk road connecting Honiara Port and the Guadalcanal Plains which represent the principal agricultural producing district. Traffic volumes on this road have increased year by year coincident with the ongoing development.

The traffic volume at the Lungga Bridge is approximately 2600 cars per day. Traffic congestion has been occurring lately at both ends of the bridge at peak-times in the morning and evening. The single lane of the bridge is a bottleneck the traffic flow on the north Guadalcanal road which is the life-line of the island.

With the above-mentioned background, the Government of Solomon Islands has requested the Government of Japan for grant aid to reconstruct the Lungga Bridge.

2.7.2 Contents of the Request

Contents of the Project are as follows:

(1) New Lungga Bridge : two lanes with footway including superstructure and substructure

(2) Approach road : connecting the new Lungga Bridge with existing road

3. OUTLINE OF PROPOSED SITE

3. OUTLINE OF PROPOSED SITE

3.1 Description of the Site.

3.1.1 Present Conditions of the Proposed Site.

The Lungga Bridge is situated about 10km east of Honiara and crosses over the Lungga River which is the longest river in Guadalcanal flowing for the most part from south to north. The river bed on the upstream side of the bridge is 300-400m wide. At the bridge the river bed is narrow and is about 100m between the opposite banks with the left bank forming a cliff. On the down stream side of the bridge the river bed is also wide, forming a delta for a distance of 2km toward the sea.

The topography around the bridge is a terrace-like terrain 10 to 30m in elevation with the low land area of 5 to 10m in elevation. Although the terrace is discontinuous, the comparatively flat lands are scattered. These flat lands form the foot of the south mountains.

3.1.2 Topographic Survey

The topographic survey was conducted as follows

(1) Center line survey	350m long
(2) Planimetric survey	350m x 100m
(3) Cross-sectional survey	10m pitch

3.1.3 Geotechnical Investigation

The investigation results indicate that the soil materials in the right bank are composed of about 10m of loose-medium dense sands and gravels, overlying loose/firm silts. The silts range in thickness from about 12m (Borehole 3) to 30m (Borehole 2), increasing in thickness towards the river. Dense to very dense sands and gravels were found to underlie the loose/firm silts. An engineering geological model has been developed for the proposed Lungga Bridge site, and development and foundation design criteria have been formulated for the proposed bridge project. Subsurface strata have been identified and it was found that they will provide adequate foundation support (with respect to bearing capacity) to the bridge and approach fill embankments. Settlement arising from embankment fill loading is not predicted to be excessive.

An evaluation of the seismic hazard indicates that whilst the seismicity of the site is high, the liquefaction potential of the subsurface materials is low.

The detailed log of boreholes is provided in FIG.APP-3.13 and 3.14.

3.2 Natural Conditions

3.2.1 Atmospheric Phenomena

(a) Temperature

Monthly average maximum,(8:00AM, 2:00PM) and minimum temperature from 1974 to 1989 at Henderson Airport are shown in TABLE 3.1.

TABLE 3.1 Monthly Average Temperature (15 years)

	1	2	3	4	5	6	7	8	9	10	11	12
Maximum	31.2	30.4	30.5	31.3	30.4	30.5	30.6	30.8	30.6	30.2	30.2	30.5
8:00AM	25.7	24.9	25.0	24.9	24.7	24.0	23.3	23.6	24.5	23.9	24.7	24.4
2:00PM	29.5	29.2	29.5	29.7	29.6	29.5	29.0	29.2	29.2	27.6	27.6	27.8
Minimum	23.2	23.0	22.9	23.2	23.1	23.0	22.7	22.5	22.0	21.6	21.6	21.8

(b) Rainfall, Rainy days, Sunshine hours and Humidty

The monthly total rainfall, rainy days, sunshine hours and humidity at Henderson Airport are indicated in TABLE 3.2.

TABLE 3.2 Monthly Rinfall, Rainy Days, Sunshine and Humidity

		1	2	3	4	5	6	7	8	9	10	11	12
Rainfall(mm)		237	297	252	162	130	60	106	106	103	88	174	200
Rainy Days		18	19	18	14	12	10	15	12	12	11	13	14
Sunshine(hr)		6.2	5.6	6.3	6.4	6.9	6.6	5.6	6.7	6.2	7.1	7.0	5.8
Humidity	8:00	82	86	85	83	85	85	86	85	87	78	77	80
(%)	17:00	78	79	76	76	75	75	74	72	72	72	76	76

3.2.2 Hydrological Survey

(a) Water flow at Lungga Bridge

Monthly water flows are shown below in TABLE 3.3.

TABLE 3.3 Monthly Water Flows

(ton/sec)

		1	2	3	4	5	6	7	8	9	10	11	12
1986	Min.	23	26	18	21	19	9	8	5	17	7	17	12
	Mean	47	59	20	38	126	15	12	11	29	13	55	20
	Max.	84	263	106	116	1784	23	30	65	68	33	289	49
1987	Min.	10	23	19	18	16	8	5	5	4	9	15	21
	Mean	22	85	43	42	31	12	7	5	10	36	43	45
	Max.	48	271	146	121	67	27	10	10	31	80	136	80
1988	Min.	24	29	19	16	13	11	11	8	7	6	15	30
	Mean	57	66	32	38	21	16	16	11	9	21	42	91
	Max.	113	237	52	159	54	27	36	23	18	63	122	386

(Source:Data Audit Report For Site 5004601 at Lungga Bridge)

(b) Design Flood Discharge

According to the above report, the design flood discharge is 2547 ton/sec (average recurrence interval 100years) at the Lungga Bridge on the Lungga River.

(c) Design High Water Level

From the same report, the highest high water level (H.H.W.L) is 7.227m and its flood discharge is 2320 ton/sec or cum/sec, dated May 19, 1986.

Highest high water level is 7.227 and corresponds to 6.747m of the topographic survey level.

Since the cross sectional area of the river at this level is 630sqm, it is assumed that the velocity of the flow

2320cu.m/sec/630sqm =3.68m/sec

If the velocity of the flow for Q100=2547ton/sec is assumed to be 3.0m/sec (conservatively), the rise of water level from 6.747m h is

$$h=\frac{2547-2320}{126x3.0}=0.600m.$$

Consequently, the highest high water level for Q100 is

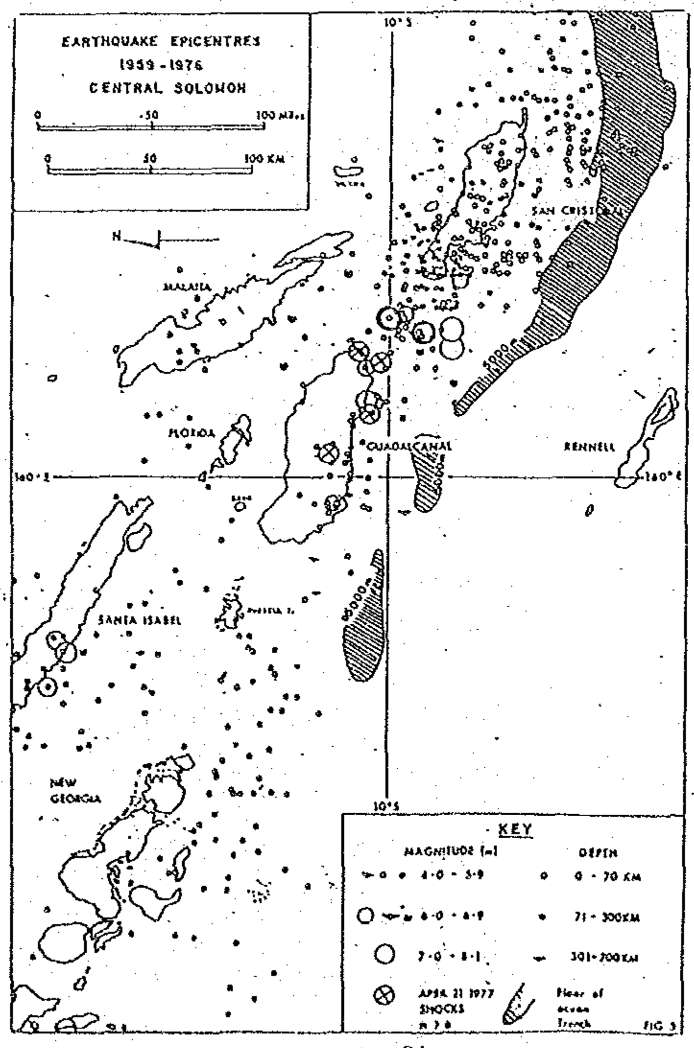
H.H.W.L=6.747+0.600

=7.347, or about 7.35m

3.2.3 Earthquakes

The Solomon Islands form a linear chain of islands and are part of the convergent boundary between the westward moving Pacific plate and the northward moving Indo-Australian plate. There is a continuous zone of seismicity associated with this tectonic plate interaction, although the concentration varies. In the Guadalcanal region, the Indo-Australian plate is being subducted steeply under the Pacific plate and seismicity is diffuse to a depth of 100km. Earthquake hypocentres are taken from the ISC data files covering the period 1964 to mid-1984 and are shown in FIGURE 3.1 below.

FIGURE 3.1 Seismic Tectonic Activity



3.2.4 Cyclones

Cyclone associated with rainfall of more than 300mm (24hr) in Honiara are shown below in TABLE 3.4.

TABLE 3.4 Cyclones and their rainfall (mm)

Cyclone		Data	Rainfall
1	Angela	Nov. 1966	392
2	Glenda	Mar. 1967	635
3	Isa	Apr. 1970	332
4	Ursula	Dec. 1971	447
5	Wendy	Jan. 1972	958
6	Emily	Mar. 1972	359
7	Bernnie	Apr. 1982	352
8	Hina	Mar. 1985	557
9	Namu*	May 1986	366
10	Anne	Jan. 1988	318

(Source:water resources)

In mid-May of 1986 the severe tropical cyclone "NAMU" hit three of the country's main islands killing 140 people and causing widespread damage to natural forest, coconut and cocoa plantations and, in particular, the extensive oil palm plantations on the Guadalcanal Plains. Villages, subsistence gardens, cash crops and the supporting environment of about one-third of the total population of 290,000 were destroyed or badly damaged. Total damage caused to public buildings and infrastructure has been estimated at almost SI$15 million.

3.3 Other Social Conditions(Source:1985/6 Statistical Yearbook)

3.3.1 Electricity

Electricity generated by station is shown in TABLE 3.5.

TABLE 3.5 Electricity

Year	Customers	Electricity (10 KWH)	Fuel (KL)
1982	3,062	17,019	4,999
1983	3,284	18,881	5,588
1984	3,626	19,610	5,684
1985	3,880	22,267	6,153
1986	3,605	23,923	6,953

3.3.2 Communication

(a) Telephone

Telephone connections in Honiara are given in TABLE 3.6.

TABLE 3.6 Telephone Connections

1982	1983	1984	1985	1986
1,284	1,358	1,522	1,470	1,533

(b) Telecommunication Services

Telecommunication Services are provided in TABLE 3.7.

TABLE 3.7 Telecommunication Services

		1982	1983	1984	1985	1986
Telegraph Internal		373	331	451	469	392
Telegraph Overseas	In	338	249	219	142	----
	Out	316	219	221	177	137
Telexes	In	159,320	220,817	260,857	190,703	—
	Out	165,967	233,806	265,472	264,877	256,599

3.4 Construction Conditions

3.4.1 Ongoing Construction Activities on Guadalcanal

Two major office buildings are being built on the main street in Honiara City.

One is the National Provident Fund (NPF) building, a six-story structure located opposite side of Hotel Mendana on the main street, and another is the Solomon Islands National Bank (SINB) building which is being constructed in the center of the city, east of Hotel Mendana.

The NPF building has reached the 4th floor level whereas the SINB building has already reached the completion stage.

In the suburban area, a school building is under construction.

The Second Honiara Port Project (SHPP), which is a salient public works contract, has been under construction since July 1989 at Point Cruz Harbor, north of the SINB building.

This large project is being executed by the Port Authority of Solomon Islands with ADB funding and involves the renovation of ocean-going ship berthing facilities which have deteriorated due to erosion and aging. The new berth to be provide uses 1.2meter diameter steel pipe pile bulk heads retained by a tie-back system.

The construction process is well organized so that the site activities would not interfere with the stevedoring of moored ships. The steel pipe piles have been imported from Japan, and the pile driving machine with a six-ton ram has been brought from New Zealand but is supposed to be sent back to New Zealand when it is no longer needed. No other major on-going construction activities are seen in Honiara.

3.4.2 Companies Engaged in Construction

Among top contractors in Honiara are:

(a) Fletcher Kwaimani joint venture

(b) Kitano Construction Company LTD

(c) John Holand LTD

(d) Donsan Construction Co.LTD

(e) John Lee Construction Co.LTD

(f) Earth Movers Solomons LTD

(g) Shorncliffe LTD

These companies are foreign affiliated corporations of New Zealand, Japan, Australia, Korea, etc. The order of the companies cited above does not represent ranking, however, it was learned that the largest general contractor in Solomon Islands is Fletcher Construction Co.LTD of New Zealand which has many branch offices all over the Pacific Rim.

Fletcher Kwaimani, a joint venture of Fletcher and local contractor Kwaimani, won the SHPP and NPF building construction contracts.

John Holand, an Australian contractor, is not active at present, and the staff is said to have returned to the home office.

Donsan is a Korean contractor and is constructing a school building in the suburban area. Donsan is capable of public works contracts as well.

John Lee is working on the SINB building construction.

Earth Movers Solomons specializes in earth works and in addition, engages in the timber business.

Schorncliffe is a subcontractor with experience in asphalt pavement, the head office of Schorncliffe is in Port Moresby.

3.4.3 Construction Equipment and Materials Supply

The following companies are identified as having construction equipment and for supplying materials.

(a) Bowman LTD

Bowman deals with hardware.

(b) Solomon Islands Investment Co.LTD

Concrete Industries LTD, is a subsidiary of Solomon Islands Investment Co.LTD, and is located near the Lungga Bridge. It supplies ready-mixed concrete and concrete blocks, and its batching plant is in fair to good condition with a production capacity of 35cum/hr. However quality control thru full processing would require substantial attention.

3.4.4 Architecture and Engineering Companies (Consultants)

The following two companies are well known in Honiara.

(a) Murry North

(b) Cameron McNamara

Murry North is the designer of the SINB building.

Cameron McNamara designed Mataniko Bridge and Ngalimbiu Bridge.

3.4.5 Construction Plants and Materials

MTWU owns about 50 units of usable construction plants. The types and numbers of main plants are shown below in TABLE 3.8.

TABLE 3.8 Usable Plants

Description	Number of units	Description	Number of units
dump truck	13	loader	6
bull dozer	4	trailer	1
conc.mixer	4	conc.pump	1
compressor	5	crane	1
breaker	1	grader	1
submerged pump	1	generator	1
vibrator(conc.)	2	truck	1
backhoe	1	other	

These plants are managed and maintained by the Plants & Vehicle Division of MTWU. Oftentimes, the types and the numbers of the plants are not enough to undertake a major construction project.

Most plants are for concrete and earth works, and the plants necessary for bridge construction work are not all available from MTWU. Numbers and types of plants that are in the possession of top contractors such as Fletcher and Earth Movers far outnumber the MTWU's. However, heavy equipment such as pile driving machines and vibration hammers are not yet available from either source.

The pile driving machine and the vibration hammer for pulling out the existing piles that Fletcher Kwaimani JV is working with on the SHPP job are in its temporary possession, and therefore, this equipment is scheduled to be sent back to New Zealand.

In general, machines that are used for some special functions in Honiara are usually sent back to New Zealand, Australia, PNG, etc., because there is no continuous demand for such equipment.

There are also no hot-mix asphaltic concrete plants in Honiara. Schorncliffe once had a hot-mix plant, but later on they sold it to a company in Brisbane Australia. Schorncliffe could however, upon request, bring one from its head office in Port Moresby, PNG.

Construction materials produced in Solomon Islands include timber rocks, and sand. All other construction materials are imported from foreign countries, except concerte blocks which are secondary products and are produced there.

In Solomon Islands, river beds are private properties and the Government of Solomon Islands pays for the extraction of sand and gravel. Rocks are crushed into several sizes of aggregate. MTWU has a monopoly on the sale of sand, rocks and aggregates. Timber is exported, but some is manufactured into planks. In order to use the lumber for forms, additional work needs to be done on the planks. Therefore, locally made forms are not necessarily cheaper than forms imported from overseas.

Steel wire nets, paints and plywoods are abundant in Honiara. These commodities are imported mostly from Port Moresby. However, structural steels such as H-steel,

steel pipes, angle steels and reinforcing steel bars are not readily available indicating low demand and limited stockpiles.

3.4.6 Labor Conditions

In Solomon Islands, because of the short technological history, labor specialization and classification of technical skills have not yet been clearly designated. Carpenters have been said to have "what it takes to do it right" in many categories of work except for the very few jobs that must be undertaken by journeyman specialists such as electricians, welders and heavy machine operators. Given the size of the project, labor specializations in the SHPP are divided into eight different categories as shown below in TABLE 3.9.

TABLE 3.9 Labor Cost

1)Scaffoldman	2.9(73.6) SI$/hr
2)Carpenter	2.9(3.5)
3)Welder	3.6(5.7)
4)Steelworker	2.9(3.5)
5)Unskilled laborer	2.5(2.5)
6)Driver(less than 10ton vehicle)	3.0(3.4)
7)Operator(light machinary)	3.0(3.9)
8)Operator(heavy machinary)	6.0(11.68)

The unit labor costs shown above are by Fletcher and Kitano (in parentheses). Kitano's figures may be the average among competing companies except for the figures for scaffoldman and heavy machinary operator which seem to imply the use of expatriate Japanese skilled laborers.

The minimum wage rate in June 1988 was 0.74$/hr, but in Honiara, the actual minimum wage rate of unskilled laborer is 1.1SI$/hr or above.

The pay structure of the Government of Solomon Islands stipulates minimum and maximum fortnight pay rates at eleven different pay levels from about 70 to 750$ per fortnight.

Because of the limited experience with modern technology, and the difficulties of working under tropical temperature of about 30°C, laborer productivity is not high. The government does not quantify the man-hours required to perform a definite task. The experience of Fletcher Kwaimani indicates that the equivalent cost per man-hour on a job in Honiara is two to six times as much as that in New Zealand for the same type of work. Therefore, it appears that the rate per man-hour required to perform a certain job in Honiara is about three times that in Japan on the average. Labor unions are active on Guadalcanal and picket lines have been frequently observed. In the construction of the Central Bank, completed in Honiara in 1988, the actual construction period reportedly took twenty-four months, including a six month delay due to labor strikes.