**Republic of Vanuatu**
**Ministry of Infrastructure and Public Utilities,**
**Public Works Department**

# PREPARATORY SURVEY ON THE PROJECT FOR THE DISASTER RECONSTRUCTION OF TEOUMA BRIDGE

# FINAL REPORT

**November 2019**


**JAPAN INTERNATIONAL COOPERATION AGENCY**

**CTI ENGINEERING INTERNATIONAL CO., LTD.**
**KOKUSAI KOGYO CO., LTD.**


| EI |
| --- |
| JR |
| 19-108 |

**Republic of Vanuatu**
**Ministry of Infrastructure and Public Utilities,**
**Public Works Department**

# PREPARATORY SURVEY ON THE PROJECT FOR THE DISASTER RECONSTRUCTION OF TEOUMA BRIDGE

# FINAL REPORT

**November 2019**

**JAPAN INTERNATIONAL COOPERATION AGENCY**

**CTI ENGINEERING INTERNATIONAL CO., LTD.**
**KOKUSAI KOGYO CO., LTD.**

# PREFACE

Japan International cooperation Agency (JICA) decided to conduct the preparatory survey and entrust the survey to the Consortium of CTI Engineering International Co., LTD. and Kokusai Kogyo Co., LTD.

The survey team held a series of discussions with the officials concerned of the Government of the Republic of Vanuatu, and conducted field investigations. As a result of further studies in Japan, 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.

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

November 2019

Itsu ADACHI
Director General
Infrastructure and Peacebuilding Department
Japan International Cooperation Agency

# SUMMARY

## 1. OUTLINE

### (1) Background and Outline of the Project

Most of the residents of Efate Island where the capital of the Republic of Vanuatu is located live along the Ring Road. The Ring Road plays an important role for inland transportation. Teouma Bridge has been constructed on the Teouma River which is the largest river in the island. It is located at the entrance to the capital from the eastern part of the island.

The bridge was completely destroyed by an earthquake of magnitude M7.2. In response, the bridge was reconstructed through the Japan's Grant Aid Program "The Project for Rehabilitation of Bridges on the Ring Road in the Efate Island in the Republic of Vanuatu" in 2003.

However, the rehabilitated Teouma Bridge had been blocked for six days due to the damage of the approach road on the right bank by Cyclone Pam in 2015. The damage was caused by the changing of the river course. The bridge has been temporarily rehabilitated and it is at the risk of being destroyed and blocked by another sever flood.

Under this circumstance, JICA conducted a data collection survey in 2016 to investigate and confirm the direction for the bridge rehabilitation. It has been proposed to implement three types of works, which are: 1) Stabilization of the river course; 2) Extension of the bridge to increase flow capacity; and 3) Overflow approach road.

Based on the survey results, background, purpose and content of the project has been identified in "The Project for the Disaster Reconstruction of Teouma Bridge in Republic of Vanuatu", based on the assumption that Japan's Grant Aid will be used. Effectiveness, human / technical / economic relevance was examined, outline design was conducted for the necessary and optimal project content and scale, and the approximate project cost was estimated. Moreover, the survey and study covered obligations of recipient country, drafted an implementation plan, operation and maintenance key points and considerations to achieve the project objectives.

### (2) Summary of Vanuatu

Vanuatu is in the Pacific Rim orogenic belt extending from the Solomon Islands to Fiji and consists of more than 80 islands. The total land area is about 12,190 $km^2$ with a population of about 270,000 (2017 estimation). The area of Efate Island, where the capital city Port-Vila locates, is about 900$km^2$. This island has the highest population density in Vanuatu.

Real GDP of Vanuatu is US$ 863,000,000 (The World Bank, 2017), and the economic growth rate has been positive since 2004 except in 2015 due to Cyclone Pam. In 2017, economic growth rate was estimated at 4.5% (The World Bank). Agriculture and tourism are two major economy sectors of Vanuatu.

Vanuatu climate is tropical oceanic with stable temperatures, high humidity, and rainy throughout the year. Wind is calm except during tropical storms (about 9.3 km/hour to18.5 km/hour). The Vanuatu climate can be classified into two seasons: dry season, from May to November, and the rest is rainy season. The annual average temperature is about 25 degrees Celsius. The average temperature of the hottest season,

that is in February, is about 27° C while the average temperature of the coolest season, that is in August is about 23° C. The average annual precipitation is about 2,100 mm.

**(3) Result of the Survey and Contents of the Project**

JICA dispatched four survey teams to Vanuatu from November 2017 to March 2019 as shown in Table 1 below.

The first field survey was conducted during the rainy season. Following discussions with concerned officials of Vanuatu, the survey team determined the scope of the project and carried out a field survey for road plans (width composition, pavement type, road geometry, etc.), bridge plans and selection of superstructure type, natural conditions and topography, procurement of construction materials and equipment as well as operation and maintenance system.

The second field survey was conducted during the dry season. The survey team carried out project site confirmation, natural conditions and geology, traffic volume survey, axle load survey, implementation plan and also cost estimation. The results of the first and second field surveys helped the survey team to design a bridge and road, draft an implementation plan as well as come up with a rough project cost estimation back in Japan.

During the third survey, Vanuatu side requested that a sidewalk be provided for the bridge. The team then redesigned the bridge as per the request.

During the fourth field survey, the design outline as well as obligations of Vanuatu side were confirmed.

**Table-1 Field Survey Period**

| Survey | Period |
|---|---|
| First Field Survey (first team) | From 12th Nov. 2017 to 22nd Dec. 2017 |
| First Field Survey (second team) | From 16th Jan. 2018 to 4th Feb. 2018 |
| Second Field Survey | From 24th Apr. 2018 to 7th Jun. 2018 |
| Third Field Survey | From 19th Mar. 2019 to 3rd Apr. 2019 |
| Fourth Field Survey | From 25th Aug. 2019 to 3rd Sep. 2019 |

In this Survey, H.W.L. was set to 100-year precipitation return period for bridge design. The survey team selected seal pavement according to the local procurement situations and specification. The proposed outline of the plan is as follows.

[Bridge Type] Superstructure : 2 Spans Continuous Steel Plate Girder
Substructure : Reversed T Type Abutment and Wall Type Pier
Pile : Spiral Steel Rotation Pile

[Bridge Length] 58 m

[Road Width] Approach road: Effective Width 8.0 m
(Lane 3.0 m * 2 + Shoulder 1.0 m * 2)
Bridge: Effective Width 9.5 m
(Lane 3.0 m * 2 + Shoulder 0.5 m * 2 + Sidewalk 1.25 m * 2)

[Approach Road] Total Length: 562 m (B.P. side 245.5 m, E.P. side 316.5 m),

20,000 $m^3$ Embankment

[River Improvement] Total Length 482.5 m, Reinforced Concrete Revetment 100.0 m, Stone Pitching 302.5 m, Riprap 80.0 m

**(4) Construction Period and Rough Cost of the Project**

The construction period of the project is approximately 7 months (including the bidding period) for the detailed design, and 26 months for the construction of facilities. The project cost to be borne by the recipient country is estimated to be about 73 million Vanuatu Vatu (75 million Japanese Yen, VUV1.0=JPY1.039).

For confidentiality, the cost to be borne by the Japan' Grant Aid is not shown in this report.

**(5) Project Evaluation**

**1) Relevancy**

Implementations of this cooperation projects is recommended using Japan's grant aid as follows:

1. The beneficiaries' populations are almost half of the east Efate Island. It is a big number.
2. The project is urgently needed on the Ring Road to contribute to the strengthening of trunk road transport networks and to stabilize and improve the livelihoods of residents.
3. Vanuatu authorities could operate and maintain bridges and roads using internal resources and technologies. There is no need for sophisticated technology for operation and maintenance.
4. This project contributes to the environmental and economic objectives of Vanuatu national development plan: "Recovery from climate change and disasters" and "Improving infrastructure".
5. There is little negative environmental and social impact.
6. In addition to the necessity and superiority of using bridge construction technology of Japan, Japanese grant aid system allows the project to be implemented without any difficulty.

**2) Effectiveness**

**a) Quantitative Effect**

There is a high possibility of interruption of bridge service and closure of the connected road due to inundation and also scouring and erosion of approach road due to the progressive erosion of riverbanks in the upstream as well as potential change in river course. However, by implementation of this project, the risk of inundation will be highly reduced by raising the road elevation, and also the river course will be stabilized by river works and erosion prevention countermeasures.

The expected quantitative effect of the project implementation is shown in Table-2. The base value was measured in 2018 and the target value is set for three years after project completion.

**Table-2 The Quantitative Effects Expected from the Implementation of the Projects**

| Items | Base Value (FY2018 Actual) | Target Value (3 yrs after completion) |
|---|---|---|
| Traffic Volume (Unit/day) | 2,980 | 3,600 |
| Number of Passengers (person/day) | 755 | 905 |
| Weight of Cargo (ton/year) | 60,000 | 72,000 |

**b) Qualitative effect**

The qualitative effects of the project are:

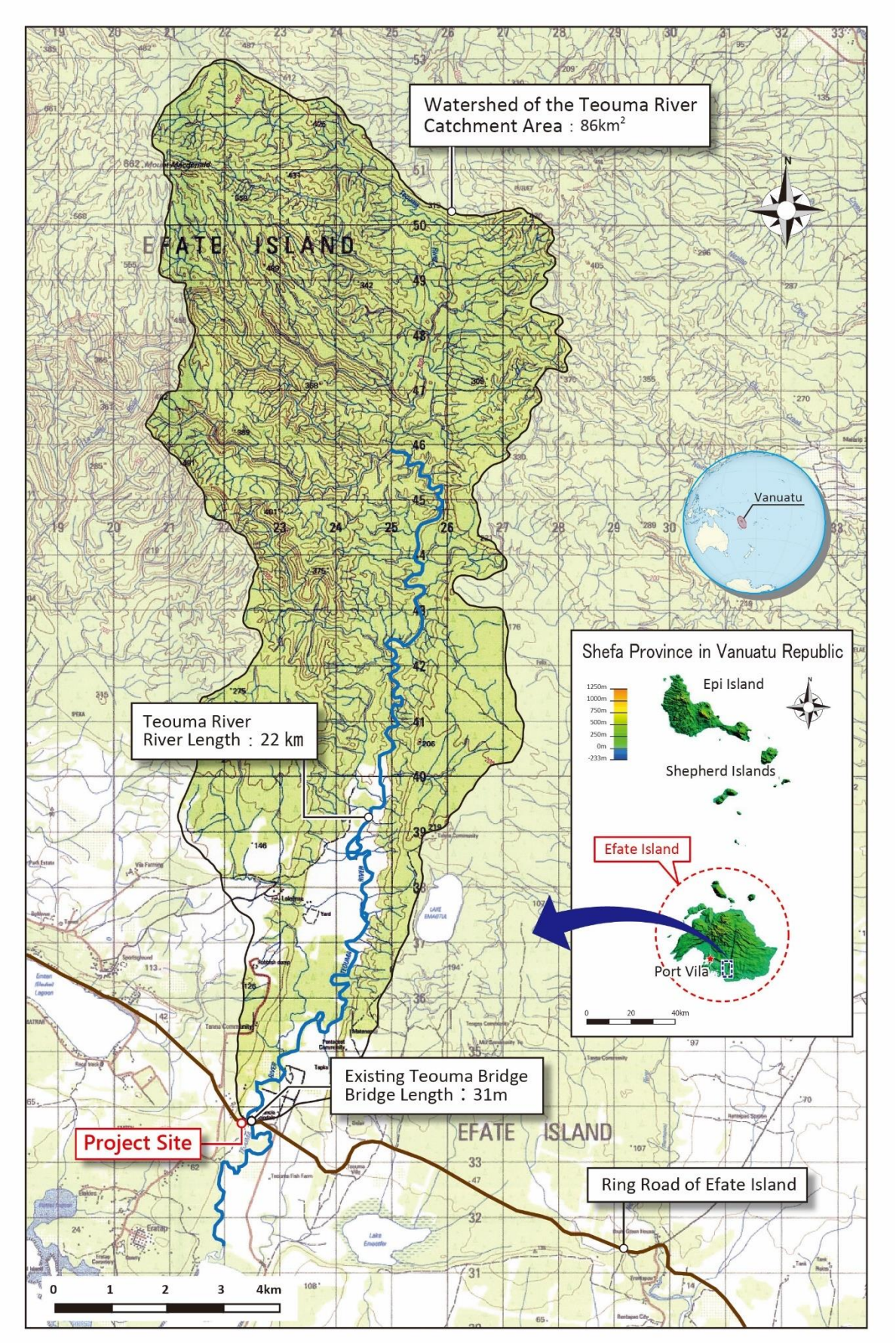
1. Maintenance of economic activities and access to various services are ensured by eliminating the blockage of logistics and commuting due to flooding after heavy rain.
2. By changing from emergency rehabilitation to permanent restoration, there is no fear of a falling bridge and the toughness of the bridge is secured.
3. River erosion to private land on the upper right bank can be avoided.

# Table of Contents

[Appendices]

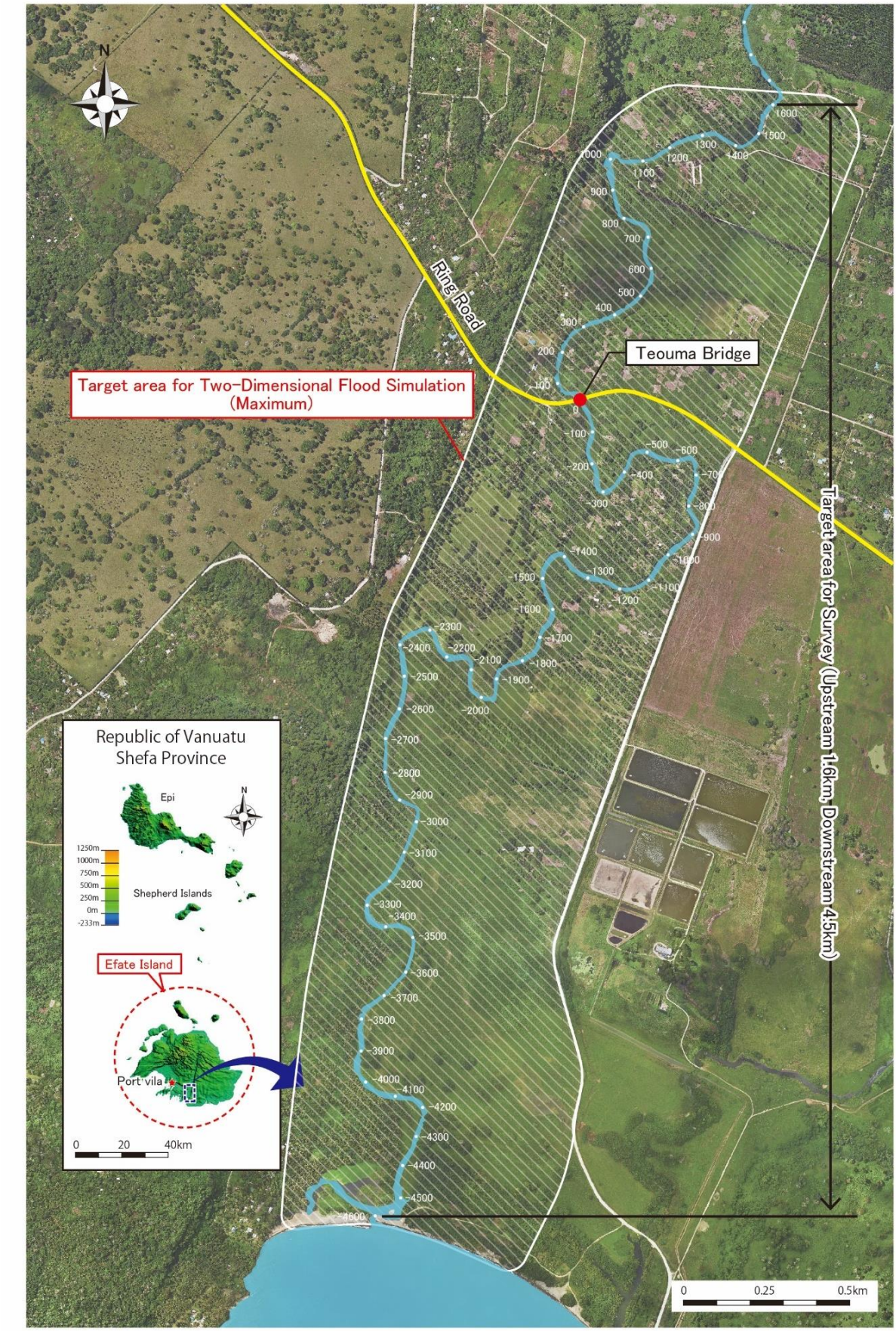
1. Survey Team Member List
2. Survey Schedule
3. List of Stakeholder
4. Minutes of Discussion/Meeting

5. Technical Note
6. Outline Design Drawings
7. Environment Monitoring Form
8. Results of Geotechnical Investigation




LOCATION MAP

**PERSPECTIVE**




**Target Area for Two-Dimensional Flood Simulation**

# List of Figures

# List of Tables

# Abbreviations

| | | |
|---|---|---|
| AADT | : | Annual Average Daily Traffic |
| AASHTO | : | American Association of State Highway and Transportation Officials |
| ADB | : | Asian Development Bank |
| ARAP | : | Abbreviated Resettlement Action Plan |
| D/D | : | Detailed Design |
| EIA | : | Environmental Impact Assessment |
| E/N | : | Exchange of Notes |
| ESAL | : | Equivalent Single Axle Loadings |
| G/A | : | Grant Agreement |
| GDP | : | Gross Domestic Product |
| IEE | : | Initial Environmental Examination |
| IOL | : | Inventory of Loss |
| JICA | : | Japan International Cooperation Agency |
| JRA | : | Japan Road Association |
| MIPU | : | Ministry of Infrastructure and Public Utilities |
| PAPs | : | Project Affected Persons |
| PWD | : | Public Works Department |
| RAP | : | Resettlement Action Plan |
| ROW | : | Right of Way |
| VRRM | : | Vanuatu Resilient Road Manual |
| WB | : | World Bank |

# CHAPTER 1 Basic Concept of the Project

## 1.1 Outline

Most of the residents of Efate Island where the capital of the Republic of Vanuatu is located live along the Ring Road. The Ring Road plays an important role for inland transportation. Teouma Bridge has been constructed on the Teouma River which is the largest river in the island. It is located at the entrance to the capital from the eastern part of the island.

The bridge was completely destroyed by an earthquake of magnitude M7.2. In response, the bridge was reconstructed by the Japan's Grant Aid Program "The Project for Rehabilitation of Bridges on the Ring Road in the Efate Island in the Republic of Vanuatu" in 2003.

However, the rehabilitated Teouma Bridge had been blocked for six days due to the damage of the approach road on right bank by Cyclone Pam in 2015. The damage was caused by the changing of river course. The bridge has been temporarily rehabilitated and it is at the risk of being destroyed and blocked by another sever flood.

Under this circumstance, JICA conducted a data collection survey in 2016 to investigate and confirm the direction of the bridge rehabilitation. It has been proposed to implement three types of works, which are 1) Stabilization of the river course; 2) Extension of bridge to increase flow capacity; 3) Overflow approach road.

Based on the results of this survey, the Vanuatu government requested a full-scale reconstruction work for Teouma Bridge to the Government of Japan.

## 1.2 Natural Condition

### 1.2.1 Climate and Hydrology

#### (1) Climate

Vanuatu has tropical marine climate with uniform temperature, high humidity and large amount of rainfall. Wind speed is generally moderate (9.3 km/hr to 18.5 km/hr) except during tropical storms.

The climate of Vanuatu could be categorized in two distinct seasons according to the Vanuatu Meteorology & Geo-Hazards Department (VMGD), Ministry of Infrastructure and Public Utilities (MIPU): One is cold (dry) season from May to October and the other one is hot (wet/cyclone) season for the rest of year. Generally speaking, the highest temperature is observed in February and the lowest one in August. The annual average temperature in Port Vila is at about 25°C, ranging from average monthly high temperature of 27°C in February and average monthly lowest temperature in August at about 23°C.

Rainfall in Vanuatu is highly affected by monsoon and varies from southeast to northwest of the island. The predominant southeast wind-flow is often moisture saturated and contributes to an extremely variable rainfall pattern. More rainfall is observed in the southeast of the islands due to winds direction compared to the northwest of the island. Rainfall in Efate Island shows this particular pattern very well. In the coming wind direction, annual rainfall ranges from 2,400 mm to 3,000 mm. However. it is almost half

on the other side. Heavier rainfall is observed during La Niña years in the South Pacific Convergence Zone (SPCZ). Higher rainfall is usually observed from January to March. Flood occurs frequently during the cyclones or La Niña season at the lowland areas close to rivers. Heavy rainfall during La Nina sometimes causes severe damage to crops and farmlands.

Vanuatu is frequently hit by cyclones which is categorized as storm with the wind speed of over 63.0 km/hr (or 34 knots). Three cyclones hit Vanuatu every year on average.

Lower rainfall and drought is very much related to El Niño Southern Oscillation (ENSO). Average annual rainfall during El Niño with negative Southern Oscillation Index (SOI) is less than half of the normal year. Last drought conditions have been observed in 1982/83, 1994/95, and 1997/98. Drought damage is normally severely occurred in rain shadow areas.

Major monthly climate indexes of Port Vila are shown in Table 1.2-1.

**Table 1.2-1 Monthly Average of Major Climate Indicators of Port Vila**

| Month | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Season | Rainy | | | | Dry | | | | | | | Rainy |
| Rainfall (mm) | 270 | 293 | 323 | 215 | 168 | 161 | 92 | 86 | 90 | 104 | 135 | 191 |
| Min Temperature (°C) | 22 | 22 | 22 | 22 | 20 | 19 | 18 | 17 | 18 | 18 | 20 | 21 |
| Max Temperature (°C) | 31 | 31 | 30 | 29 | 28 | 27 | 26 | 26 | 27 | 28 | 30 | 30 |
| Sunshine Hour (hr) | 198 | 172 | 176 | 173 | 169 | 139 | 159 | 180 | 182 | 208 | 200 | 196 |
| Relative Humidity (%) | 84 | 84 | 87 | 87 | 85 | 86 | 85 | 81 | 82 | 82 | 83 | 82 |

*Source: Vanuatu Meteorology and Geo-Hazard Department*

### (2) Rainfall during Cyclone Pam and Computation of daily Rainfall Return Period

#### 1) Rainfall Stations

The survey team collected a report of "Cyclone Dani Rehabilitation Project, Rainfall Analysis, January 2000" including historical rainfall data before 2000. As a result, daily rainfall time series of the following two stations were collected:

Station 1: Port Vila established in 1948 with 68 years observation period, 6 years missing data, 33 years consecutive record

Station 2: Bauerfield established in 1986 with 30 years observation period

#### 2) Filling of Missing Data

In the time series of daily rainfall data of Bauerfield, the most critical data during Cyclone Pam was missing due to harsh climate condition and difficulties of reading hydro-meteorological parameters. Only data for three days rainfall were available in this station. However, Port Vila station, fortunately, has complete daily rainfall observation during Cyclone Pam as shown in Table 1.2-2. Therefore, missing daily rainfall data of Bauerfield station could be estimated during Cyclone Pam using Port Vila station data by a ratio of daily rainfall in 4 days. The allotment ratios are 0.814 (514 mm) on 13th, 0.185 (117 mm) on 14th, 0.001 (1 mm) on 15th, March 2015, respectively.

**Table 1.2-2 Daily Rainfall Observed during Cyclone Pam**

| Date in March, 2015 | Bauerfield | Port Vila |
|---|---|---|
| 13 | 48 mm | 388.5 mm |
| 14 | - | 88.1 mm |
| 15 | - | 0.4 mm |
| 16 | 584 mm | 0.0 mm |
| Total | 632 mm | 477.0 mm |

*Source: Vanuatu Meteorology and Geo-Hazard Department*

**3) Daily Rainfall Return Period**

Daily rainfall data of Bauerfield and Port Vila stations as well as a few observations of Mt. Macdonald station located in the upstream of river basin have been studied. As a result, rainfall data observed at Bauerfield station is considered a better representative for spatial rainfall of Teouma river basin. Log-Pearson Type 3 has been fitted to 30 years observed data of Bauerfield station in order to estimate daily rainfall for different return period. The result is shown in Table 1.2-3.

**Table 1.2-3 Computation of Probable Daily Rainfall**

| Recurrence Period (Year) | Probable Daily Rainfall (mm) |
|---|---|
| 2 | 167.9 |
| 5 | 261.9 |
| 10 | 338.3 |
| 20 | 423.4 |
| 50 | 553.0 |
| 100 | 666.4 |

*Source: JICA Survey Team*

As described in section (2) above, maximum daily rainfall of 514 mm has been recorded on March 13 in 2015, during Cyclone Pam. This amount of rainfall is almost equal to daily rainfall with 50 years return period.

**4) Flood Return Period and Flooding Situations during Cyclone Pam**

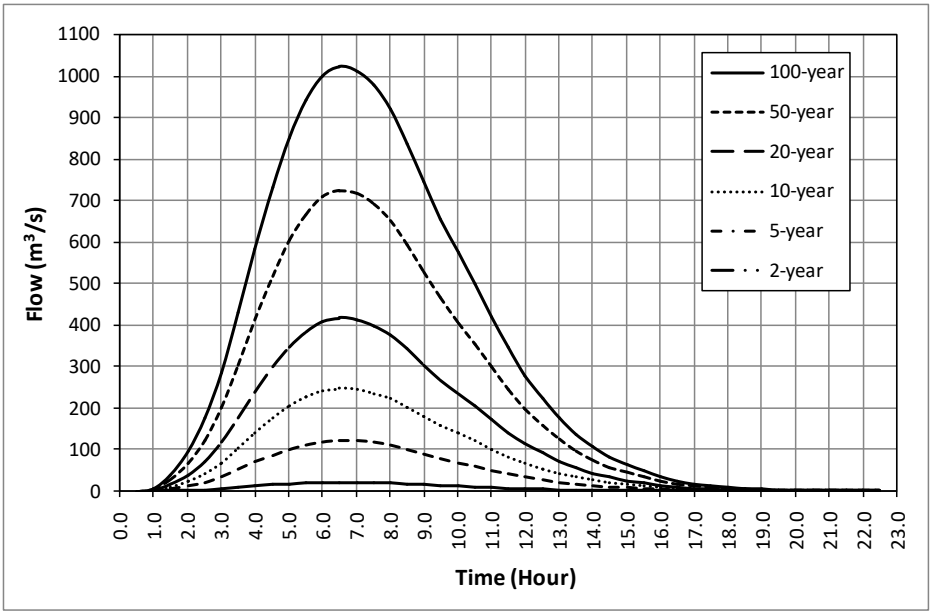
Flood hydrographs at Teouma Bridge are developed using Muskingum Routing and river discharge is estimated by SCS (Soil Conservation Service, US) Unit Hydrograph method. The maximum daily floods for different return periods at Teouma Bridge are presented in Table 1.2-4 and Figure 1.2-1.

According to the interview survey on flooding during Cyclone Pam, maximum flood level was near road surface at Teouma Bridge, which was equivalent to about 7.6 m above MSL. Flood water extended widely over the left bank along the Ring Road.

**Table 1.2-4 Probable Flood Discharges at Teouma Bridge**

| Recurrence Period (Year) | Probable Daily Rainfall (mm) | Probable Flood Peak ($m^3/s$) | Runoff Ratio |
|---|---|---|---|
| 2 | 167.9 | 20 | 0.044 |
| 5 | 261.9 | 120 | 0.165 |
| 10 | 338.3 | 250 | 0.258 |
| 20 | 423.4 | 420 | 0.350 |
| 50 | 553.0 | 720 | 0.464 |
| 100 | 666.4 | 1020 | 0.544 |

*Source: JICA Survey Team*




*Source: JICA Survey Team*

**Figure 1.2-1 Flood Hydrographs for Different Return Period at Teouma Bridge**

### (3) Tidal Conditions at Teouma River Mouth

The following tidal information in Table 1.2-5 was obtained through the harmonic analysis using observed data by tidal recorder at Port Vila with reference to "Basic Design Study Report on the Project for Improvement of Port Vila Main Wharf in Public of Vanuatu, 2017, JICA". In this study, Highest High Water Level of +0.7 m above MSL (1.58 m) is adopted for an initial condition in hydraulic analysis.

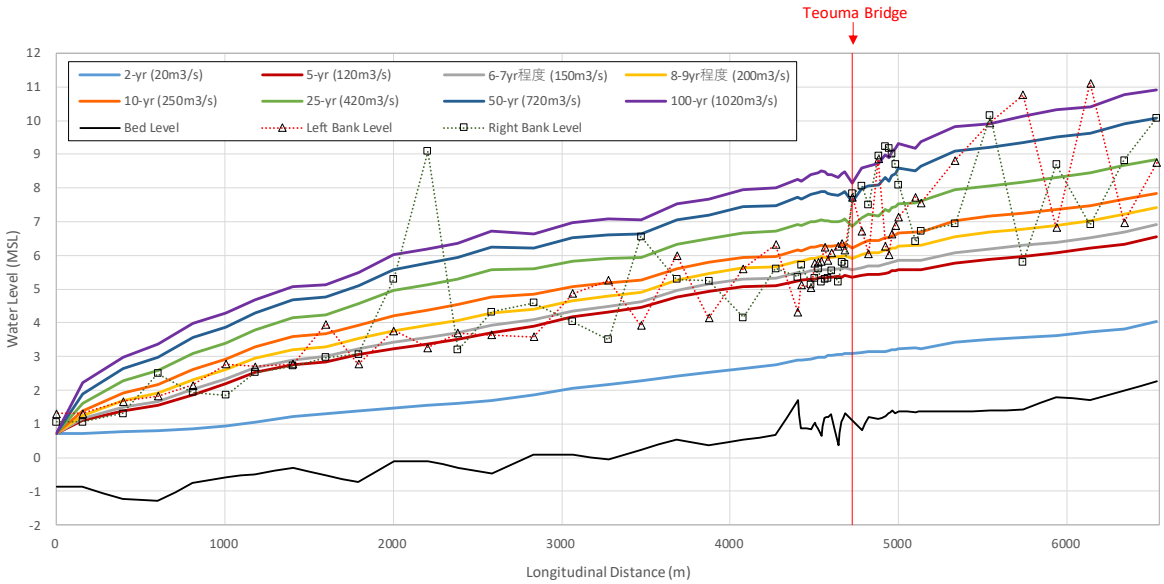
**Table 1.2-5 Harmonic Analysis Results on Tidal Data at Port Vila**

| Anharmonic Constant | Height above Base Level (m) | Height above Mean Sea Level (m) |
|---|---|---|
| Nearly Highest High Water Level | 1.58 | +0.7 |
| High Water Level Ordinary Spring Tide | 1.33 | +0.4 |
| Mean Sea Level | 0.88 | 0.0 |
| Low Water Level Ordinary Spring Tide | 0.44 | -0.4 |
| Nearly Lowest Low Water Level | 0.19 | -0.7 |
| Base Level | 0.00 | -0.9 |

*Source: Basic Design Study Report on the Project for Improvement of Port Vila Main Wharf in Public of Vanuatu, 2007, JICA*

### (4) Flood Profile and River Channel Carrying Capacity

Non-uniform flood profiles have been developed for different return period of flood using river cross-sections and examining of river channel carrying capacity. Initial water level at river-mouth is set at +0.7m above MSL and roughness coefficient of river channel is set at 0.035. Simulation results are shown in Figure 1.2-2 and the followings are summary of particular features of flood carrying capacity of Teouma River.




*Source: JICA Survey Team*

**Figure 1.2-2 Longitudinal Water Level Profile for Different Flood Return Periods**

**1) Downstream of the Teouma Bridge**

Baneful discharge is a little less than 100 $m^3/s$ equivalent to 5-year return period flood (120 $m^3/s$) or less.

**2) Teouma Bridge Section**

Since Teouma Bridge forms a man-made constriction, relatively rapid flow velocity and lowering of flood water level occurs at the bridge section. Further it accelerates water level rising in the upstream for a long distance in upstream.

**3) Upstream of the Teouma Bridge**

The flood carrying capacities in the upstream range from 120 to 250 $m^3/s$ (5- to 10-year return period), excluding unstable segment of flood water level rising immediately upstream of the bridge due to constriction of the channel.

This shows any flood exceeding 10-year return period will cause flooding in the upstream of the bridge and inundation of Ring Road. The situation is even worse downstream as any flood exceeding 5-year return period could cause inundation of Ring Road.

### 1.2.2 Topography and Geology

#### 1.2.2.1 Topographical Survey

The scope and details of conducted topographical survey are as follow:

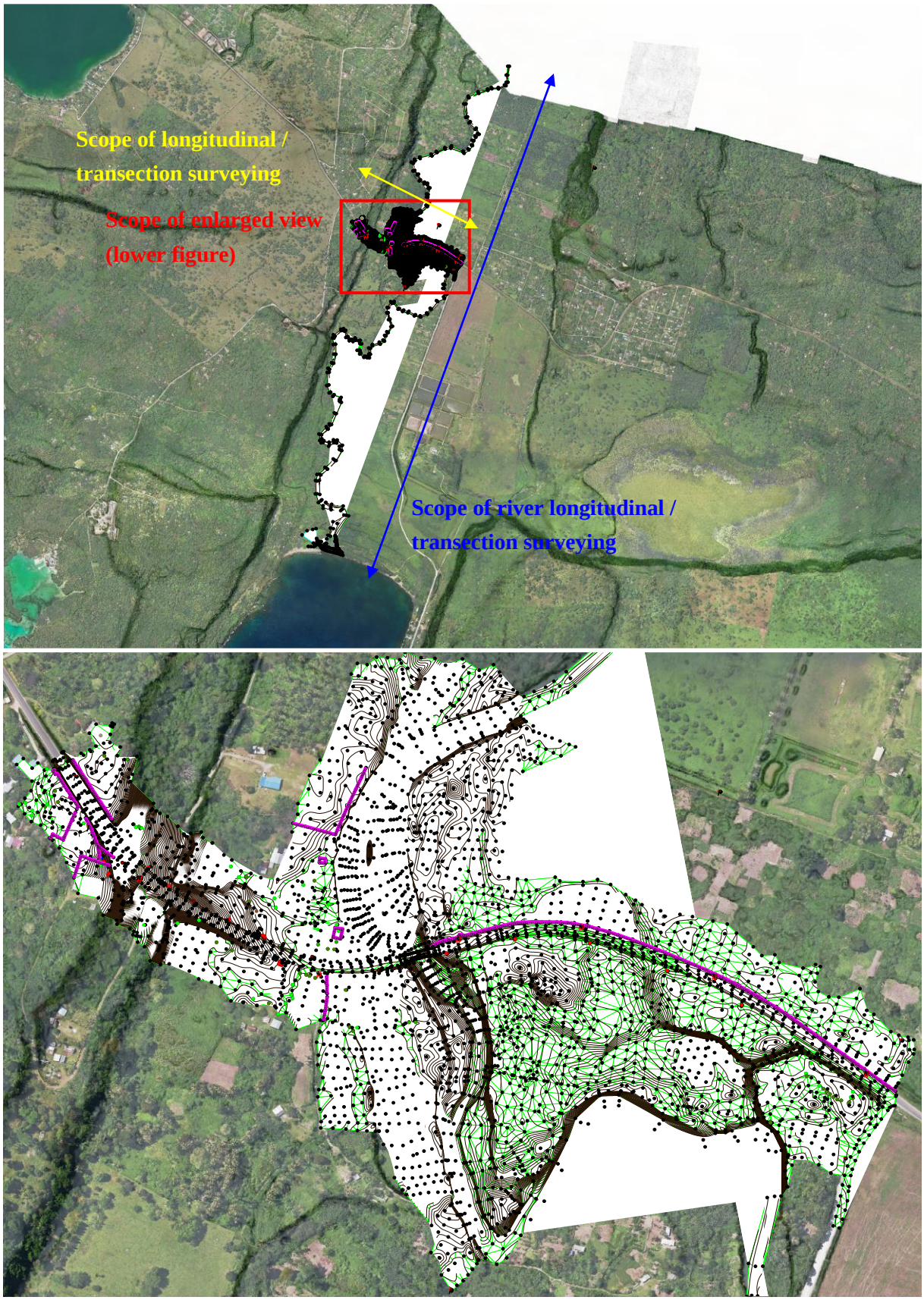
**(1) River Survey**

- Benchmark installation: 2 points (TBM1 on the right bank side, TBM2 on the left bank side)
- Longitudinal survey: 1 section from 1,600m upstream of the bridge to 4,940m downstream of the bridge for a total of 6,540m.
- Cross-section survey: 32 cross-sections with 200m interval and 100 m width

**(2) Floodplain Survey**

- Benchmark installation: 2 points (TBM1 at the start point and TBM2 at the end point)
- Reference point installation: 6 points (POLY1 to POLY6)
- Longitudinal survey: 1 section from 320m upstream of bridge to 300m downstream of bridge for total 620m
- River cross-sections: 17 cross-sections with 40m interval and 100m width
- Road centerline survey: 1 survey line for 420m from each side of bridge, total of 840m, 20m interval
- Road longitudinal survey: 1 section for 420m from each side of bridge, total of 840m, 20m interval)

The outline of surveying points is shown in the following Figure 1.2-3.

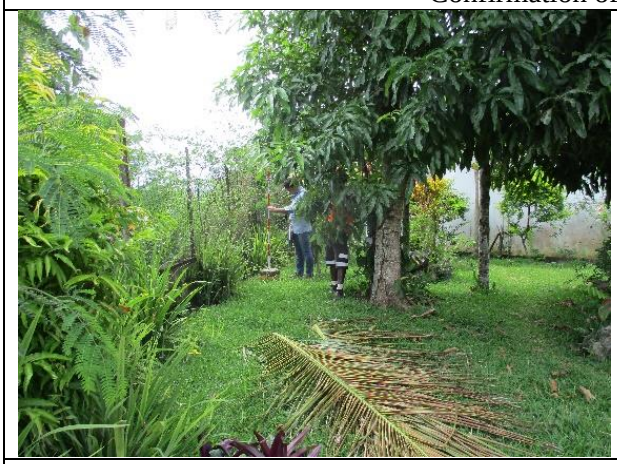



*Source: JICA Survey Team*

**Figure 1.2-3 Outline of Survey Results around Teouma Bridge**

**(3) Photos**


Confirmation of surveying method




Confirmation of National Benchmark and Temporary Benchmark

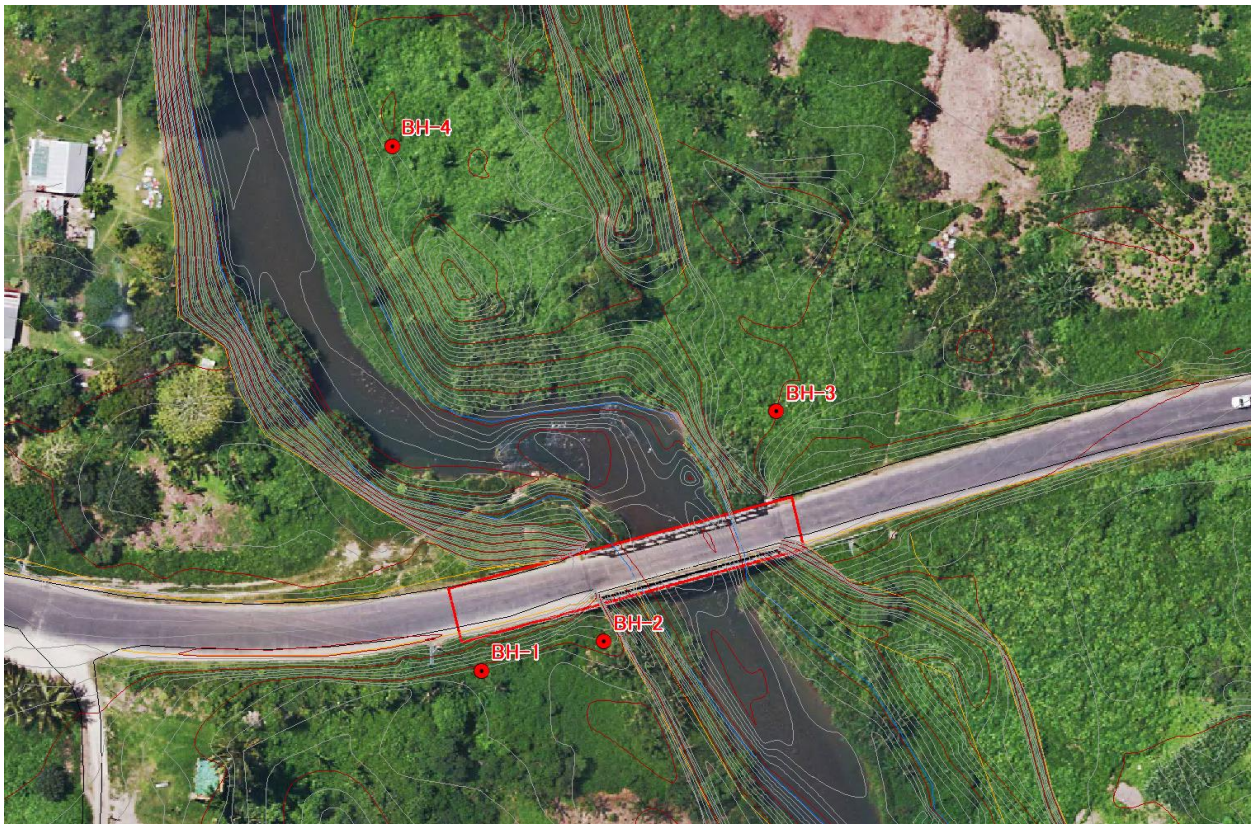

Confirm reference point

*Source: JICA Survey Team*

### 1.2.2.2 Geological Survey (Boring Survey)

#### (1) Survey Location

Boring survey was conducted at four points (BH - 1 to 4) in order to grasp the ground conditions of target bridge and revetment works. Locations of boring survey sites are shown in Figure 1.2-4 and Table 1.2-6 below.




*Source: JICA Survey Team*

**Figure 1.2-4 Location of Boring Survey Sites**

**Table 1.2-6 Coordinates, elevation and drilling depth of each boring survey sites**

| ID | Coordinates (latitude and longitude) | | Elevation (m) | Drilling depth (m) |
|---|---|---|---|---|
| | Latitude(°) | Longitude(°) | | |
| BH-1 | -17.76678 | -168.38239 | 5.80 | 45.45 |
| BH-2 | -17.76670 | -168.38258 | 5.80 | 37.50 |
| BH-3 | -17.76645 | -168.38284 | 6.00 | 45.45 |
| BH-4 | -17.76600 | -168.38226 | 5.50 | 20.00 |

*Source: JICA Survey Team*

#### (2) Equipment

The equipment shown in Table 1.2-7 is used for the boring survey.

**Table 1.2-7 Boring Survey Equipment**

| Item | Specifications |
|---|---|
| Drilling Machine | Trailer mounted drilling machine (Rotary type) |
| Hole size | φ=86mm |
| Sampler | High Quality triple tube sampler<br>Raymond-type spoon sampler |

*Source: JICA Survey Team*

*Source: JICA Survey Team*

**Figure 1.2-5 Equipment used for boring survey**

### (3) Photos

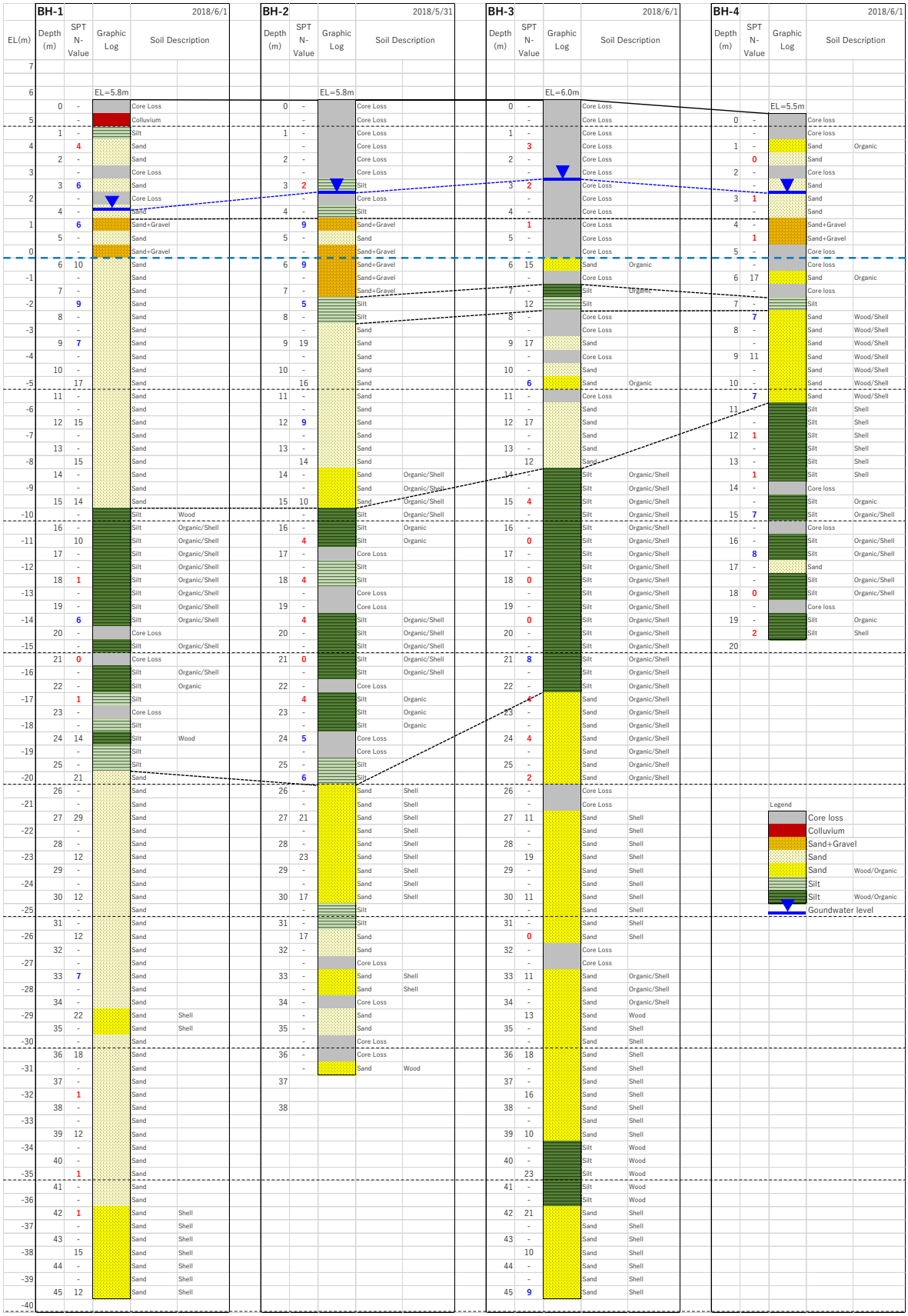
| | |
|---|---|
|  |  |
| Road maintenance for loading equipment (BH-1,2) | Loading of boring equipment (BH-3) |

| | |
|---|---|
|  |  |
| Core removal operation | Implementation of SPT |
|  |  |
| Example of acquired core | Observation of core |

*Source: JICA Survey Team*

### (4) Result of Boring Survey

The boring survey of BH-1 to BH-4 was conducted from May to June 2018. The maximum depth of drilling was -45.45m. Standard Penetration Tests (SPTs) are conducted every 1.5m. The boring logs are shown in Figure 1.2-6. No rock stratum has been found in the drilling survey.




*Source: JICA Survey Team*

**Figure 1.2-6 Boring logs of BH-1 to 4**

### 1.2.2.3 Geological Survey (Material Testing)

#### (1) Laboratory Tests

All tests were conducted at Material Laboratory under Public Works Department, Ministry of Infrastructure and Public Utilities, Port Vila. A few tests were conducted at the Japan Road Contractors Association Road Test Laboratory as the tests could not be conducted at PWD material laboratory. The test items are shown in Table 1.2-8.

**Table 1.2-8 Material test items at each laboratory**

| Material Laboratory of PWD | Road Test Laboratory in Japan |
|---|---|
| Bulk Density of Aggregate | Sieving test of aggregate |
| Aggregate PSD | Organic impurity test of aggregate |
| Flakiness Index | Stability test of aggregate with sodium sulfate |
| Particle Density and Water Absorption | Alkali silica reactivity test of aggregate (chemical method) |
| Los Angeles Value | Aggregate sieving test |
| Atterberg Limits | Organic impurity test of fine aggregate |
| Particle Size Distribution | Stability test of aggregate with sodium sulfate |
| Moisture Content | Chloride content test |
| | Apparent specific gravity test |
| | Water absorption test |
| | Compressive strength test |

*Source: JICA Survey Team*

Results of the material tests are summarized in the following Table 1.2-9, Table 1.2-10 and Table 1.2-11.

**Table 1.2-9 Test results at the Japan Road Contractors Association Road Test Laboratory**

| | | |
|---|---|---|
| **Coarse aggregate** | Sieving test of aggregate | Loss mass fraction 0.4% (Less than 12%) |
| | Alkali silica reactivity test of aggregate (chemical method) | Harmless |
| | Silt content | 0.9% (Less than 1%) |
| | Organic impurity test | Colorless |
| **Fine aggregate** | Sieving test of aggregate | Loss mass fraction 0.9% (Less than 10%) |
| | Silt content | 18.9% (Less than 5%) |
| | Organic impurity test | Colorless |
| | Chloride test | 0.001% |
| **Rubble (Semi-hard stone)** | Apparent specific gravity test | 2.293 g/cm$^3$ (Semi-hard stone) |
| | Water absorption test | 1.553 % (Hard stone) |
| | Compressive strength test | 2,908 N/cm$^2$ (Semi-hard stone) |

*Source: JICA Survey Team*

**Table 1.2-10 Test results at Material Laboratory of PWD**

| | | |
|---|---|---|
| **Coarse aggregate** | Apparent specific gravity test | 2.43 (g/cm$^3$) |
| | Water absorption test | 6.0% (Less than 3.0%) |
| | Wear test | 33% (Less than 30% : Asphalt) |

*Source: JICA Survey Team*

**Table 1.2-11 Classification based on compressive strength of Rubble (JIS5006)**

| Type | Compressive Strength N/cm$^2$ | Reference value | |
|---|---|---|---|
| | | Water absorption rate | Apparent specific gravity (g/cm$^3$) |
| Hard Stone | More than 4903.3 | Less than 5% | About 2.7 - 2.5 |
| Semi-Hard Stone | Less than 4903.3<br>More than 980.66 | More than 5%<br>Less than 10% | About 2.5 - 2.0 |
| Soft stone | Less than 980.66 | More than 10% | Less than 2.0 |

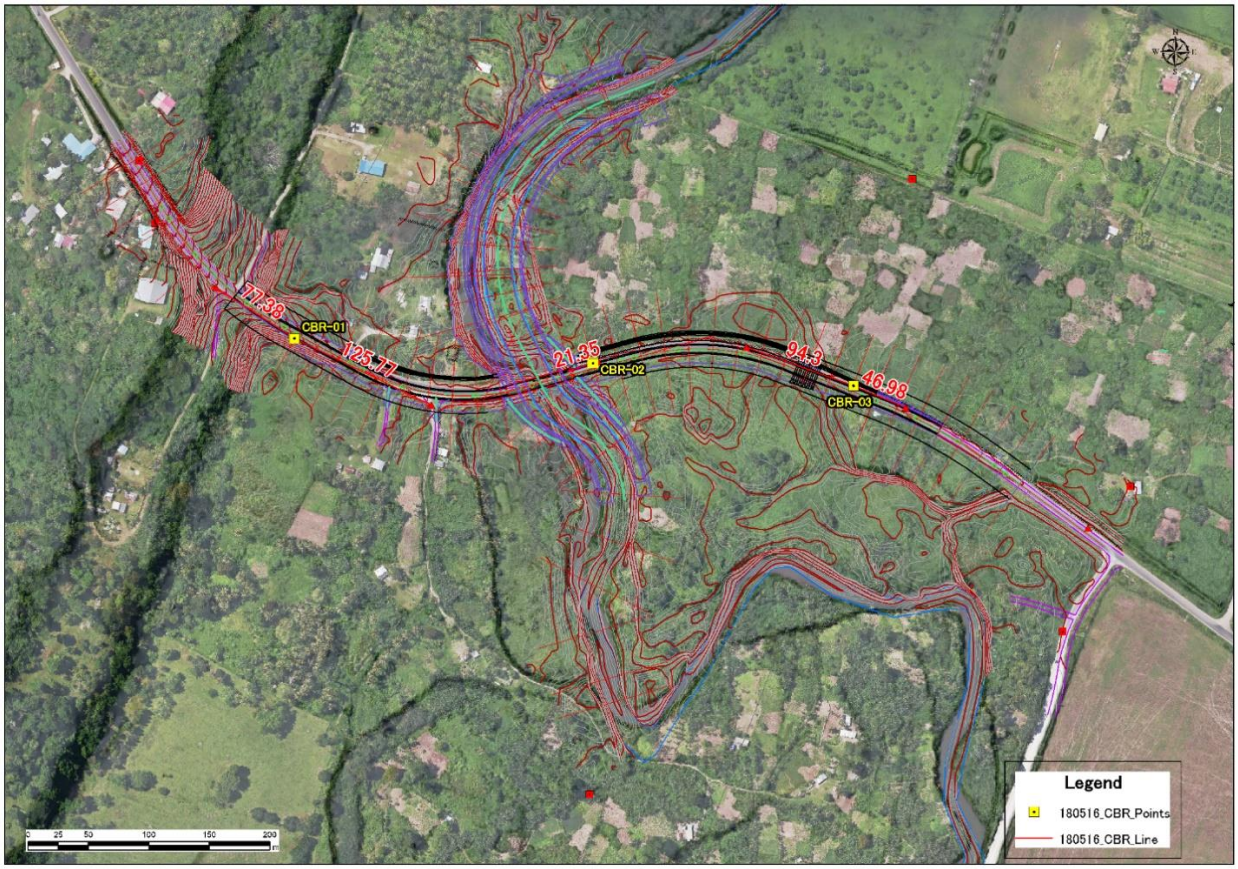
*Source: JIS5006*

### (2) California Bearing Ratio (CBR) Test

CBR tests were carried out for seven samples in total, 3 base courses around the Teouma Bridge and 4 samples obtained from the neighboring quarry. At the same time, 45 samples from boring survey were tested for moisture content.

#### 1) Location of Samples

7 samples in total: 3 base courses along the Efate Ring Road around the Teouma Bridge and 4 other samples from the quarry located 1.8km east of the Teouma Bridge. These locations are shown in Figure 1.2-7 and Figure 1.2-8.




*Source: JICA Survey Team*

**Figure 1.2-7 Locations of CBR test samples around Teouma bridge**


*Source: JICA Survey Team*

**Figure 1.2-8 Location of Quarry**

**2) Photos**

| | |
|---|---|
|  |  |
| Digging CBR-1 site | Digging CBR-1 site |
|  |  |
| Digging CBR-2 site | Sampling of base course material (CBR-4) |

*Source: JICA Survey Team*

### 3) Results

a) **Hydration Tests**

Results of the moisture content tests are shown in Table 1.2-12 below.

**Table 1.2-12 Result of Hydration Tests**

| ID | Sample location | Sample Depth (m) | Moisture Content (%) | ID | Sample location | Sample Depth (m) | Moisture Content (%) |
|---|---|---|---|---|---|---|---|
| 1 | BH-1 | 0.00 | 47.2 | 27 | BH-3 | 12.00 | 46.4 |
| 2 | BH-1 | 7.95 | 92.5 | 28 | BH-3 | 16.50 | 88.0 |
| 3 | BH-1 | 9.00 | 49.2 | 29 | BH-3 | 19.50 | 34.8 |
| 4 | BH-1 | 15.45 | 89.0 | 30 | BH-3 | 21.00 | 40.4 |
| 5 | BH-1 | 16.50 | 66.0 | 31 | BH-3 | 22.50 | 75.5 |
| 6 | BH-1 | 25.50 | 51.5 | 32 | BH-3 | 30.00 | 69.0 |
| 7 | BH-1 | 24.50 | 64.5 | 33 | BH-3 | 36.00 | 42.2 |
| 8 | BH-1 | 27.45 | 53.0 | 34 | BH-3 | 39.00 | 64.5 |
| 9 | BH-1 | 30.00 | 64.5 | 35 | BH-3 | 45.00 | 58.5 |
| 10 | BH-1 | 34.50 | 63.0 | 36 | BH-4 | 1.50 | 67.0 |
| 11 | BH-1 | 39.00 | 67.5 | 37 | BH-4 | 1.95 | 40.6 |
| 12 | BH-1 | 40.50 | 71.0 | 38 | BH-4 | 3.45 | 76.0 |
| 13 | BH-2 | 3.00 | 76.0 | 39 | BH-4 | 4.50 | 43.2 |
| 14 | BH-2 | 4.95 | 54.0 | 40 | BH-4 | 7.50 | 74.5 |
| 15 | BH-2 | 7.50 | 72.0 | 41 | BH-4 | 7.95 | 81.0 |
| 16 | BH-2 | 9.45 | 53.5 | 42 | BH-4 | 12.00 | 76.0 |
| 17 | BH-2 | 10.95 | 62.5 | 43 | BH-4 | 12.50 | 94.5 |
| 18 | BH-2 | 15.45 | 85.0 | 44 | BH-4 | 15.45 | 93.0 |
| 19 | BH-2 | 19.50 | 74.5 | 45 | BH-4 | 16.50 | 87.0 |
| 20 | BH-2 | 19.95 | 82.0 | 46 | CBR-1 | Base course | 14.3 |
| 21 | BH-2 | 28.95 | 64.5 | 47 | CBR-2 | Base course | 11.7 |
| 22 | BH-2 | 30.00 | 66.5 | 48 | CBR-3 | Base course | 10.4 |
| 23 | BH-2 | 31.50 | 68.5 | 49 | CBR-4 | Base course | 12.4 |
| 24 | BH-3 | 6.00 | 54.0 | 50 | CBR-5 | Embankment fill | 11.7 |
| 25 | BH-3 | 7.50 | 60.5 | 51 | CBR-6 | Base course | 10.9* |
| 26 | BH-3 | 10.00 | 39.2 | 52 | CBR-7 | Base course | 11.8* |

*Field moisture content from CBR test results

*Source: JICA Survey Team*

### 1) Compaction Tests

The results of the compaction test are shown in Table 1.2-13 below.

**Table 1.2-13 Compaction Tests**

| Sample | Maximum Dry Density ($t/m^3$) | Optimum Moisture Content (%) |
|---|---|---|
| CBR-1 | 1.78 | 15.5 |
| CBR-2 | 1.97 | 11.5 |
| CBR-3 | 2.01 | 11.0 |
| CBR-4 | 1.93 | 15.5 |
| CBR-5 | 1.90 | 15.5 |
| CBR-6 | 1.96 | 14.0 |
| CBR-7 | 1.90 | 13.0 |

*Source: JICA Survey Team*

**2) CBR Tests / Atterberg's Limit Tests**

The results of the CBR test / Atterberg's limits test are shown in Table 1.2-14 below.

**Table 1.2-14 Result of CBR test / Atterberg's limit test**

| Sample | CBR Value(%) | Liquid Limit | Plastic Limit | Plasticity Index |
|---|---|---|---|---|
| CBR-1 | 100 | NOT Tested | NOT Tested | NOT Tested |
| CBR-2 | 110 | NOT Tested | NOT Tested | NOT Tested |
| CBR-3 | 120 | NOT Tested | NOT Tested | NOT Tested |
| CBR-4 | 50 | NOT Obtainable | NOT Obtainable | NON-Plastic |
| CBR-5 | 50 | NOT Obtainable | NOT Obtainable | NON-Plastic |
| CBR-6 | 60 | NOT Obtainable | NOT Obtainable | NON-Plastic |
| CBR-7 | 160 | NOT Obtainable | NOT Obtainable | NON-Plastic |

*Source: JICA Survey Team*

## 1.3 Environmental and Social Considerations

### 1.3.1 Environmental Impact Assessment

#### 1.3.1.1 Outline of Project Components with Socio-environmental Impacts

**(1) Project Components**

Outline of project components is shown in Chapter 2. The following project components may have adverse environmental and social impacts in project area:

- River Improvement of Teouma River

Teouma River flows in wide meandering course through Rift Valley with approximately 1.5 km width between limestone terraces. The River bends sharply to the outer bank just at the upstream of the bridge, and this is the main cause of damages to the right bank abutment. The results of river hydrology and hydraulics analysis as explained in Chapter 3. It is suggested that the river width be increased from 30 m to 50 m for 100-year flood return period. Moreover, the river course should be straight around the bridge.

- Teouma Bridge Replacement

The design of the new bridge is also based on 100-year flood return period. This means the existing bridge will be replaced by the new bridge with a length of 58 m, increased from 30 m at the moment. The bridge deck will be elevated from E.L. 7.7 m to E.L. 10.4 m in order to pass 100-year return period flood safely, while the width of the new bridge deck will be increased from 6.5m to 8.0 m in order to improve traffic safety.

- Flood-proofing Road (Access road) Improvement

As the bridge deck has been risen from E.L.7.7 m to E.L.10.4 m, the approach road has been also risen and improved to flood-proof structure.

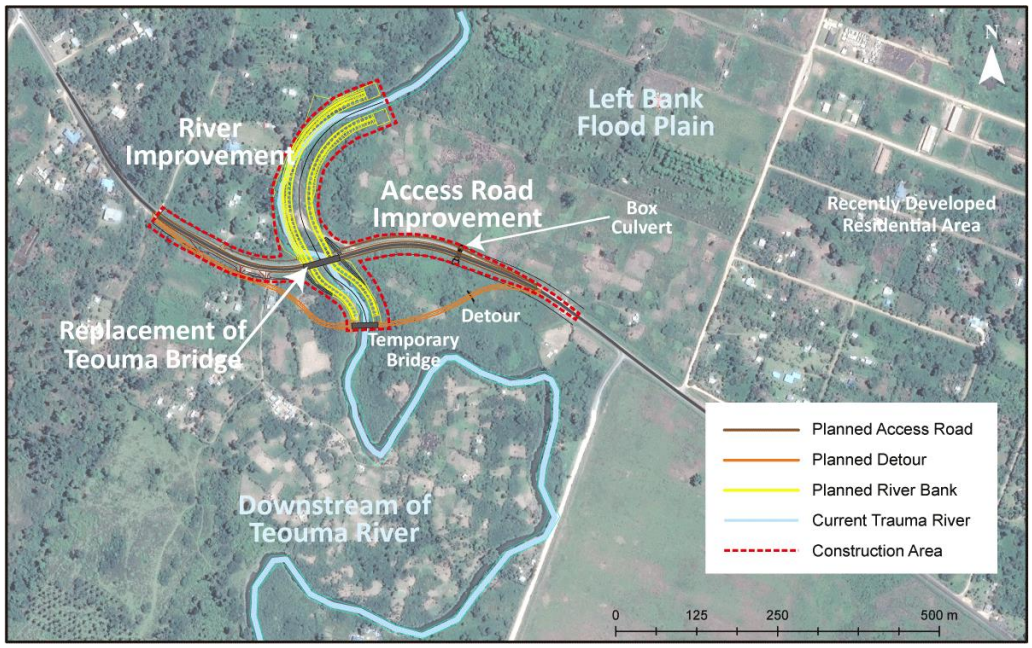
**(2) Project Area**

The Project area is located in the Eratap Region, Efate Island, Shefa Province. It consists of the following components: (1) Teouma Bridge, located on the Ring Road, over Teouma River, (2) Upstream

and downstream river banks from the bridge, and (3) Access road (400 m in the east and 300 m in the west side of the bridge).

### (3) Area for Studying Environmental Impact Assessment

Area of the Environmental Impact Assessment is summarized in Figure 1.3-1 below. This area can be divided to two segments which would be affected by the project: (1) the construction segment including the above mentioned three components and (2) the floodplain segment in the east side of the river and downstream of the bridge.




*Source: JICA Survey Team*

**Figure 1.3-1 Scope of Environmental Impact Assessment**

**Construction Area**

Improvement of Teouma River

- River improvement (250 m in the upstream and 110 m in the downstream of the bridge)
  - ✓ River widening (from 30 m to 50 m)
  - ✓ River course straightening (around the bridge)
  - ✓ Riverbank protection

Replacement of the Teouma Bridge

- Replacement of the Teouma Bridge
  - ✓ Elevation of bottom of the girder: elevated from E.L. 6.8 m to E.L. 8.9 m
  - ✓ Bridge length: from 30 m to 58 m
  - ✓ Number of spans: from 1 to 2
  - ✓ Effective width: from 6.5 m to 9.5 m
- Construction of detour and a temporary bridge

Improvement of Flood-proofing Road (access road)

- Elevation of the road surface: from E.L. 7.7 m to E.L. 10.4 m

- Flood prevention measures: installation of drainage system (box culvert and trapezoidal drainage)

**Other Areas**

- Floodplain in the east side of Teouma River (elevation of the access road will increase flooding area in the north of road)
- Downstream of the construction area (the construction work could affect water quality, ecosystem, and downstream hydrology)

#### 1.3.1.2 Current Socio-environmental Conditions

**(1) Natural Conditions**

**1) Topography and Geology**

Efate Island has a formation of raised limestone terraces and tuff rock. Teouma River has 86 $km^2$ of catchment area (at Teouma Bridge) and it is the largest catchment in Vanuatu. The river originates from McDonald Mountain at the elevation of 662 m. It meanders downstream towards the Rift Valley with width of approximately 1.5 km, sandwiched by limestone terraces.

**2) Climate**

Vanuatu climate is tropical marine climate with uniform temperature, high humidity and large amount of rainfall. Wind speed is moderate (9.3 km/hr to 18.5 km/hr) except during tropical storms. The climate of Vanuatu can be categorized by two seasons: cold (dry) season from May to October and hot (wet/cyclone) season for the rest of year. Temperature is rather high in February and relatively lower in August. Average annual temperature in Port Vila is at about 25°C, with average monthly maximum temperature in February is about 27°C and average monthly minimum temperature in August is about 23°C. Average annual rainfall is about 2,100 mm.

**(2) Biological Conditions**

The project area is located just outside of the Central Efate Forest Conservation area, as shown in the following Figure 1.3-2. The area along Teouma River is well vegetated, though modified by secondary vegetation (shrub). The diversity of freshwater fauna is low due to development activities.


*Source: The World Database on Protected Areas (WDPA)*

**Figure 1.3-2 Central Efate Forest Conservation Area**

The Terrestrial Flora survey was conducted along the Ridge and Cliff of Teouma River along with Freshwater Fauna survey inside the project area. Results of these surveys are shown in Table 1.3-1, Table 1.3-2 and Table 1.3-3 below. The survey team has not found any particular species necessary to be protected.

**Table 1.3-1 Terrestrial Flora**
**(Along the Ridge and Cliff of the Teouma-Etas Escarpment)**

| Species Name | Bislama Name | Native or Endemic | Introduced or Invasive |
|---|---|---|---|
| *Antiaris toxicaria* | Melektri | Native | |
| *Coffa arabica* | Kofi | | Introduced |
| *Hibiscus tiliaceus* | Burao | Native | |
| *Syzygium kajewskii* | Wael Nakavika | Endemic | |
| *Endospermum medulosum* | Waetwud | Native cultivated | |
| *Alangium vitiensis* | | Native | |
| *Macaranga dioica* | Navenu | | |
| *Veitchia montgomeryana* | Pamtri | Endemic | |
| *Ficus subcordata* | Big rus Nabanga | Native | |
| *Adenanthera pavonina* | Bisa | Native | |
| *Ficus virgata* | Smol nabanga | Native | |
| *Ventilago neocaledonica* | Pen blong mat | Native | |
| *Myristica fatua* | Wael natongtong | Native | |
| *Pangium edule* | Navange | Native | |
| *Dysoxylum amoroides* | Stinkwud | | |
| *Anthocarapa nitidula* | | Native | |
| *Dracontomelon vitiensis* | Nakatambol | Native | |
| *Calamus vanuatensis* | Rattan | Endemic | |
| *Chisoseton rexde* | Big fruit stinkwud | Endemic | |
| *Merremia peltata* | | Native | |

*Source: JICA Study Team*

**Table 1.3-2 Terrestrial Flora (Secondary Forest on Alluvial Soil)**

| Species Name | Bislama Name | Native or Endemic | Introduced or Invasive |
|---|---|---|---|
| *Merremia peltata* | Big lif rop | | Invasive |
| *Mikania micrantha* | Mael minit | | Invasive |
| *Panicum maximum* | Wael lemon grass | | Invasive |
| *Saccharum spp* | Wael naviso | Native | |
| *Glyricidia spp* | Glyricidia | | Introduced cultivated |
| | Elephant grass | | Invasive |
| *Pipturus argenteus* | Nadamal | Native | |
| *Trema Orientalis* | | Native | |
| *Macaranga tanneries* | Waet Navenu | Native | |
| *Leucaena ieucocephala* | Kasia | | Invasive |
| *Musa ssp* | Banana | | Introduced & cultivated |
| *Cocos nucifera* | Kokonas | Naturalised | Cultivated |
| *Bambusa Vulgaris* | Bambu | Naturalised | |
| *Terminalia catappa* | Natapoa | Native | |
| *Ricinus communis* | Kasrael | | Invasive |
| *Samonea saman* | Rentri | | Invasive |
| *Ficus subcordata* | Big rus Nabanga | Native | |
| *Carica papaya* | Popo | | Introduced |
| *Canarium indicum* | Nangai | Naturalise | Cultivated |
| *Cordia Alliodora* | Kodia | | Invasive |
| *Casuarine equisetifolia* | Oktri | Native | Cultivated |
| *Sweetenia macrophylla* | | | Introduced & Cultivated |
| *Inocarpus fagifer* | Namambe | Naturalised | Cultivated |
| *Dendrocnide harveyi* | Waet Nagalat | Native | |
| *Syzygium malaccensis* | Nakavika | Native | |
| *Spondias dulcis* | Naus | Native | |
| *Tamarindus indica* | Tamarin | | Introduced & Cultivated. |
| *Manihot Attillis* | Maniok | Cultivated | |
| *Zea mays* | Kon | Cultivated | |
| *Artocarpus altilis* | Bredfrut | Cultivated | |
| *Zea mays* | Kon | Cultivated | |
| *Artocarpus altilis* | Bredfrut | | Cultivated |
| *Dioscorea alata* | Yam | Naturalised | |
| *Dioscorea nummularia* | Wael yam | Native | |
| *Heliconia indica* | Lif Laplap | Native | |
| *Hibiscus tiliaceus* | Burao | Native | |
| *Grewia maloccoca* | Tri blong long tel | Native | |
| *Corida variegaa* | Nasasa | Native | |
| *Polyscias fruticose* | Nalalas | Native | |
| *Coryline fruticosa* | Nagaia | Native | |

*Source: JICA Study Team*

**Table 1.3-3 Freshwater Fauna**

| English Name | Scientific Name | Abundance |
|---|---|---|
| Prawn | *Macrobracium formosense* | 15 |
| | *Caridina brevicarpalis* | 5 |

| English Name | Scientific Name | Abundance |
|---|---|---|
| Gobie fish | *Glosogobius cf celebius* | 7 |
| Mosquitofish | *Gambusia affinis* | 23 |
| Tilapia | *Mozambique tilapia* | * |
| Gastropods | *Melanopsis spp* | 300 + |

*Source: JICA study team*

Literature review of terrestrial fauna was conducted for observed birds, mammals, reptiles, and amphibians in Vanuatu as shown in the following Table 1.3-4. There is no evidence of species listed in species in danger in project area and middle basin of Teouma River.

**Table 1.3-4 Terrestrial Fauna**

**Birds**

| Scientific Name | Common Name | Conservation Status | Habitat |
|---|---|---|---|
| *Ptilinopus tannensis* | Tanna Fruit Dove | Least concern | Endemic to Vanuatu and could be observed in most islands. It inhabits old-growth rainforest, and also degraded habitats with large fruiting trees, including open woodland, parkland, plantations and gardens. It is most common in the lowlands and hills, but it is also present in mountains area up to 1,500m elevation. |
| *Charmosyna palmarum* | Green Palm Lorikeet | Vulnerable | Has a fluctuating range in the Santa Cruz Island of the Solomon Islands and also in Vanuatu. It appears to occupy high mountain altitude forest at elevations above 1,000 m, but flocks regularly descending to coastal trees, especially to feed on coconut blossoms |
| *Aplonis zelandica rufipennis* | Rusty-winged Starling | Not yet assessed | Central and North Vanuatu and Banks Group |
| *Erythrura (cyaneovirens) regia* | Royal Parrot Finch (nalaklak) | | The bird is endemic to Vanuatu. It has been recorded from most islands in the archipelago but has not been observed for many years on several islands, such as Aneityum, and may be locally extinct on these. There are recent records, often of single birds, on Gaua, Espiritu Santo, Efate and Epi. |
| *Zoesterops lateralis* | Silver eye | Least concern | Bird is found in most islands of Vanuatu |
| *Ducula pacifica* | Pacific Imperial Pidgeon (Nawimba) | Least concern | Bird is found in most islands of Vanuatu |
| | Wild duck | Least concern | |
| *Tyto alba* | Barn Owl | Least concern | This owl is found throughout Vanuatu and is not at risk of being lost as a species |
| Porphyrio porphyrio | Red Head | Least concern | This bird is found in most places around Efate |
| *Rhipidura verreauxi* | Vanuatu Streaked fantail | Least concern | Bird is found is most islands of Vanuatu |
| *Tpodiramphis chloris* | Collard Kingfisher | Least concern | Bird is found in most islands of Vanuatu |
| *Gallirallus phillippensis* | Buff Banded Rail | Least concern | Bird is found in most islands of Vanuatu |
| *Lichmera incana* | Grey Eared Honeyeater | Leas concern | Bird is found throughout Vanuatu |

*Source: Republic of Vanuatu, 2014; IUCN RedList 2016 and field survey Jan 12 2019*

**Mammals**

| Scientific Name | Common Name | Conservation Status | Habitat |
|---|---|---|---|
| Fruit bats *(Pteropodidae)* | | | |
| *Notopteris macdonaldi* | Fijian Blossom-bat | Vulnerable | Restricted to Fiji and Vanuatu. Observers in Efate and other islands. Roosts in caves and forages in lowland forests and intermediate altitude vegetation. |
| | | | |
| Insectivorous bats | | | |
| *Miniopterus tristis* | Great Bent-winged Bat | Least Concern | A native species, known from the islands of Espiritu Santo and Efate in Vanuatu. Roosts only in caves and forages in agricultural areas and disturbed lowland forest near sea Level |
| *Miniopterus australis* | Little Long-fingered Bat | Least concern | Native to Vanuatu, this bat is found roosting in colonies in caves and tunnels, and may also be found roosting in tree holes. It forages for insects in rainforest, Meleleuca swamps and dry sclerophyll forests. Unlikely to be affected by this proposal |

*Source: IUCN RedList and field survey of Jan 12 2019*

**Reptiles and amphibians**

| Scientific Name | Common Name | Conservation Status | Habitat |
|---|---|---|---|
| *Amphibia* | | | |
| *Litoria aurea* | Green and golden bell frog | Vulnerable | This frog was introduced to Vanuatu in the 1960s and is native to Australia. It is found in Efate, Malekula and Santo islands. The natural habitat requirements of the species have proved difficult to define because it has been associated with almost every type of water body except fast-flowing streams. There also appears to be some confusion over whether or not forested habitats are utilized by the species (Hero et al 2004). |
| *Reptilia* | | | |
| *Brachylophus bulabula* | Banded Iguana | Endangered | Banded Iguanas are native to Fiji and were introduced to Vanuatu by a reptile dealer in the 1960s. It is found on Efate Island. The Fiji Banded Iguana lives in both wet and dry forest, but wetter forests contain preferred plant species. Iguanas are sometimes found in marginal habitats of nonnative plants, native hibiscus, and degraded forest around resorts and also along ocean margins, but always where trees are at least six meters in height (Fisher et al 2012) |
| *Gehyra oceanica* | Oceanic Gecko | Least concern | This is a nocturnal, arboreal gecko. It occurs in primary and secondary forested habitats and coastal thickets. It also occurs in edificarian habitats such as rural gardens and urban areas and many populations are commensal with humans (Fisher et al 2015). IT is known to occur on Efate Island. |
| *HeMIPU DPWactylus frenatus* | Common House Gecko | Least concern | This gecko was introduced to Vanuatu. It is a nocturnal species which is found on boulders, beneath rocks or rotting logs, on trees, and, most commonly on buildings. This species is found in both villages and large urban areas; it is usually found close to electric lights at dusk. In addition, this species also occurs in a diverse range of habitats, including rain forests, savannahs, and deserts (Ota and Whitaker 2010). This species is found on Efate Island. |
| *Lepidodactylus* | Vanuatu | Least | Endemic to Vanuatu, this gecko is known from Efate, Espiritu |

| Scientific Name | Common Name | Conservation Status | Habitat |
|---|---|---|---|
| *vanuatuensis* | Gecko | concern | Santo and Anatom Islands. It is likely, however, to occur on all main islands (Hamilton et al 2013). |
| *Emoia nigromarginata* | Vanuatu Silver Vineskink | Least Concern | Endemic to Vanuatu, it has been recorded from Efate Island, Pentecost Island, Malakula Island, Espiritu Santo Island, and Ambrym Islands, although it is possible that this species is limited to Efate Island and specimens from other islands may represent different species.<br>This is an arboreal species, found in areas covered by seral or climax forest, and to a lesser extent, in areas with reduced tree cover such as strand forest, partly cleared forest, tree-studded pasture |
| *Emoia sanfordi* | Vanuatu Green Tree Skink | Least Concern | Endemic to Vanuatu, this skink is found from the Torres Islands south to Efate. This is a strongly arboreal species, and can be found in overgrown coconut plantations, primary forest, secondary forest, rural gardens, trees within villages (Harlow 2013). |
| *Lipinia noctua* | Moth Skink | Not yet assessed | An arboreal skink that occurs in Santo, Malo, Aore, Pentecost, Malakula, Ambrym, Epi, Efate, Tanna, and Anatom. (Reptiledatabase 2016) |
| *Candoia carinata* | Pacific Boa Constrictor | Least concern | Found throughout Melanesia and in Vanuatu it is probably introduced |
| *Candoia carinata paulsoni* | White bellied brown snake | Least concern | Snake is found in Efate and other islands |

*Source: IUCN Redlist, www.iucnredlist.org/ and field survey of Jan 12 2019*

### (3) Local Livelihood

As it shown in the Table 1.3-5 below, one-third of households in Eratap are depending to fish, crops, and handicraft as their main source of income.

**Table 1.3-5 Main source of income by region: Number of households and percentage**

| Region | Main Source of household income (household number) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Wages/ salary | Landlord | Remittances | Rent House | Sale of fish/crops/ handicrafts | Individual business | Others | None |
| Vanuatu | 22,413 | 185 | 5,688 | 1,046 | 33,304 | 12,894 | 3,850 | 535 |
| Shefa | 14,060 | 68 | 1,577 | 762 | 6,735 | 4,578 | 819 | 74 |
| Port Vila | 9,810 | 21 | 580 | 638 | 1,496 | 2,027 | 148 | 20 |
| Eratap | 767 | 11 | 93 | 7 | 682 | 462 | 20 | 2 |

| Region | Main Source of household income (household %) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Wages/ salary | Landlord | Remittances | Rent House | Sale of fish/crops/ handicrafts | Individual business | Others | None |
| Vanuatu | 28% | 0% | 7% | 1% | 42% | 16% | 5% | 1% |
| Shefa | 49% | 0% | 5% | 3% | 23% | 16% | 3% | 0% |
| Port Vila | 67% | 0% | 4% | 4% | 10% | 14% | 1% | 0% |
| Eratap | 38% | 1% | 5% | 0% | 33% | 23% | 1% | 0% |

*Source: 2016 Post Pam Mini Census Report*

### (4) Poverty

Consumption-based poverty level of Vanuatu is 12.3% that is not high, but the level varies widely regionally. The poverty headcount rates are higher in North Malekula, Maewo, Pentecost and Tanna, and lower in prime agricultural areas of Santo and parts of Ambae and Ambrym.

The household well-being indicators such as poverty headcount ratio in Eratap region along with Port Villa are shown in the following Table 1.3-6.

**Table 1.3-6 Household Well-being Indicators**

| Area Council | Number of households | Poverty headcount ratio | Distribution of the poor | Population density (per km$^2$) | Average monthly consumption (PCAE) | GINI coefficient | The inequality ratio (the 90$^{th}$/10$^{th}$ percentile ratio) |
|---|---|---|---|---|---|---|---|
| VANUATU | 47,373 | 12.3% | N/A | 18.7 | 19,089 | 0.351 | 4.72 |
| SHEFA | 6,875 | 13.0% | 14.2% | 22.8 | 19,112 | 0.400 | 5.74 |
| Port Villa | 9,055 | 18.4% | 29.6% | 1,803.2 | 4,163 | 0.340 | 4.54 |
| Eratap | 721 | 3.1% | 0.4% | 51.5 3 | 1,890 | 0.399 | 5.83 |

*Source: Population and Housing Census, 2009 and Household Income and Expenditure Survey, 2010*

### (5) Social Infrastructures

#### 1) Source of Drinking Water

The sources of drinking water for households in the Eratap region are shown in the following Table 1.3-7 by number of households and percentage.

**Table 1.3-7 Main source of drinking water (Number of households and percentage)**

| Region | Total Households (Number) | Pipe | | | Rainwater | | Bottled water from shops | Surface water | Ground-water | Other |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Private | Shared | Village Stand | Private | Shared | | | | |
| Vanuatu | 55,285 | 9,226 | 16,373 | 2,345 | 10,385 | 9,743 | 314 | 4,502 | 2,203 | 194 |
| Shefa | 19,913 | 5,627 | 6,792 | 420 | 3,175 | 2,377 | 248 | 449 | 681 | 144 |
| Port Vila | 10,965 | 4,178 | 5,470 | 147 | 438 | 295 | 170 | 40 | 210 | 17 |
| Eratap | 1,293 | 253 | 47 | 8 | 497 | 188 | 19 | 96 | 108 | 77 |
| **Region** | **Total Households (Percentage)** | **Pipe** | | | **Rainwater** | | **Bottled water from shops** | **Surface water** | **Ground-water** | **Other** |
| | | **Private** | **Shared** | **Village Stand** | **Private** | **Shared** | | | | |
| Vanuatu | 100% | 17% | 30% | 4% | 19% | 18% | 1% | 8% | 4% | 0% |
| Shefa | 100% | 28% | 34% | 2% | 16% | 12% | 1% | 2% | 3% | 1% |
| Port Vila | 100% | 38% | 50% | 1% | 4% | 3% | 2% | 0% | 2% | 0% |
| Eratap | 100% | 20% | 4% | 1% | 38% | 15% | 1% | 7% | 8% | 6% |

*Source: 2016 Post Pam Mini Census Report*

Then, the alternative sources of drinking water in the Eratap region are shown in the following Table 1.3-8.

**Table 1.3-8 Household by alternative source of drinking water by region (only private houses)**

| Region | Total Households (Number) | Pipe | | | Rainwater | | Bottled water from shops | Surface water | Ground-water | Other |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Private | Shared | Village Stand | Private | Shared | | | | |
| Vanuatu | 1,949 | 2,581 | 1,842 | 2,816 | 758 | 4,358 | 834 | 6,259 | 11,248 | 4,397 |
| Shefa | 742 | 904 | 722 | 1,556 | 298 | 1,806 | 355 | 4,578 | 1,591 | 1,115 |
| Port Vila | 265 | 177 | 2 | 890 | 108 | 909 | 45 | 3,552 | 79 | 56 |
| Eratap | 55 | 111 | 71 | 114 | 10 | 95 | 13 | 225 | 321 | 211 |
| **Region** | **Total Households (Percentage)** | **Pipe** | | | **Rainwater** | | **Bottled water from shops** | **Surface water** | **Ground-water** | **Other** |
| | | **Private** | **Shared** | **Village Stand** | **Private** | **Shared** | | | | |
| Vanuatu | 3.5% | 4.7% | 3.3% | 5.1% | 1.4% | 7.9% | 1.5% | 11.3% | 20.3% | 8.0% |
| Shefa | 3.7% | 4.5% | 3.6% | 7.8% | 1.5% | 9.1% | 1.8% | 23.0% | 8.0% | 5.6% |
| Port Vila | 2.4% | 1.6% | 0.0% | 8.1% | 1.0% | 8.3% | 0.4% | 32.4% | 0.7% | 0.5% |
| Eratap | 4.3% | 8.6% | 5.5% | 8.8% | 0.8% | 7.3% | 1.0% | 17.4% | 24.8% | 16.3% |

*Source: 2016 Post Pam Mini Census Report*

It can be said local people depend on river and stream water as the sources of drinking water on the Efate Island. Judging from the observation at the Teouma Bridge, where local people often fetch water and wash clothes in the project area, the water of Teouma River is the most important water resources for domestic use.

**2) Teouma River Water Use**

An interview survey has been conducted, targeting local people who came to the bridge to fetch water or to do laundry. Outline and the result of the survey are summarized in the following:

Outline of the Interview Survey

Target: Local people who visit the Teouma Bridge to fetch water and wash clothes
Purpose: To understand Teouma River water use and users
Survey method: Interview survey
Date: June 20, 22, and 30, 2018

Result of the Interview Survey

| Respondents Sex | Number | Percentage |
|---|---|---|
| Female | 11 | 44% |
| Male | 14 | 56% |
| Total | 25 | 100% |

*Source: JICA study team*

Residence location and means of transportation

The following table is regarding residence location and commuting. Four respondents came to the Bridge by bus.

| Residence Location | Number | Percentage | Transportation |
|---|---|---|---|
| Eratap Village | 2 | 8% | By bus (both) |
| Etas | 2 | 8% | By bus (both) |
| Teouma Bridge | 18 | 72% | On foot (all) |

| Residence Location | Number | Percentage | Transportation |
|---|---|---|---|
| Teouma Valley | 2 | 8% | On foot (all) |
| Teouma White wood | 1 | 4% | By car |
| Total | 25 | 100% | |

*Source: JICA study team*

Frequency to visiting the bridge

Those who live within walking distance of the bridge answered they come once or twice per day, while respondents from other villages come to the bridge once per week.

| Location of Residence | Frequency | | | | Total |
|---|---|---|---|---|---|
| | Once per week | Twice per week | Once per day | Twice per day | |
| Eratap Village | 2 | | | | 2 |
| Etas | 2 | | | | 2 |
| Teouma Bridge | | | 14 | 4 | 18 |
| Teouma Valley | | | 1 | 1 | 2 |
| Teouma White wood | | 1 | | | 1 |
| Total | 4 | 1 | 15 | 5 | 25 |

*Source: JICA study team*

Water Use

The below table shows water use by respondents who are living within walking distance (20 respondents). They are utilizing river water for various purposes.

| Water Use | Number | % |
|---|---|---|
| Drinking and cooking | 19 | 95% |
| Domestic use (such as clearing, shower, and so on) | 20 | 100% |
| Farming | 18 | 90% |
| Production | 8 | 40% |
| Others (poultry & piggery, sandalwood nursery) | 4 | 20% |
| Total | 20 | 100% |

*Source: JICA study team*

Water use for laundry (domestic work or business)

Out of 20 respondents who mention of water use for laundry, 3 of them were laundry for business.

| Purpose of Laundry | Number | Total |
|---|---|---|
| for family | 19 | 22 |
| for business | 3 | |

*Source: JICA study team*

Water resources during the construction work

Five respondents answered they have other sources for drinking water such as well and water tank, while four respondents said they had no other choices. Two respondents asked for support.

The result of this survey shows Teouma River is very important source of water for local people. It is important to consider a place to fetch water and do laundry near the temporary bridge and to take necessary measures to prevent water pollution during the construction period.

### (6) Current Situations of HIV/AIDs

There is no data on HIV/AIDS rate in Vanuatu. Governmental authorities only recognize number of people who are confirmed to be infected by voluntary counselling and testing. The number of reported HIV cases in 2015 is shown in the following Table 1.3-9.

**Table 1.3-9 Reported HIV cases by province, 2015**

| | Number of reported cases by province | | | | | | total |
|---|---|---|---|---|---|---|---|
| | Torba | Penama | Sanma | Malampa | Shefa | Tafea | |
| Male adult | 0 | 0 | 0 | 0 | 2 | 1 | 3 |
| Female adult | 0 | 0 | 2 | 0 | 1 | 2 | 5 |
| Child | 0 | 0 | 0 | 0 | 1 | 1 | 2 |
| Total | 0 | 0 | 2 | 0 | 4 | 4 | 10 |

*Source: HIV and STI Unit, MOH*

Since the number of people who are tested for infection is limited, it seems the actual rate would be much higher.

On the other hand, the prevalence rate of sexually transmitted infections (STI) is high as shown in Table 1.3-10 below, even though this data is rather old. It is very important to increase awareness on STI including HIV/AIDS in Vanuatu in order to prevent further spreading.

**Table 1.3-10 STI situation**

| Variable | Percentage |
|---|---|
| Prevalence ANC women over 25 years | 18% |
| Prevalence ANC women under 25 years | 29% |
| Ever diagnosed with an STI: male youth | 37% |
| At least one symptom STI: female youth | 42% |
| % female youth with symptom(s) who sought treatment | 30% |
| STI client sexual partner(s) treated: male | 38% |
| STI client sexual partner(s) treated: female | 28% |

*Source:Second Generation Surveillance Survey 2008*

## 1.3.1.3 Policy, Legal, and Administrative Frameworks of Environmental and Social Considerations

### (1) Relevant Policies in Vanuatu

National Sustainable Development Plan (NSDP 2016-2030)

The National Sustainable Development Plan or NSDP (2016-2030) is the overall national planning framework that replaces the Priorities and Action & Agenda (PAA) which came to the end in 2015. The NSDP incorporates two (2) important pillars of sustainable development that has been missing in all Vanuatu's national planning since 1980, environment and culture are two pillars to compliment two other important economic and social pillars. The overall vision of the NSDP is:

Our people and place are at the very heart of our development aspirations. Together we strive for a nation that is stable, sustainable and prosperous, so that all people have a just and equal opportunity to be

well educated, healthy and wealthy. Just as we strive to progress in a way that protects and preserves our natural resources for our children, and theirs.

Vanuatu 2030 is our National Sustainable Development Plan for the period of 2016 to 2030, and serves as the country's highest level policy framework. It is founded on our culture, traditional knowledge and Christian principles, and builds on our development journey since Independence in 1980. We have already achieved a great deal, as we have encountered many difficulties and setbacks, some from natural disasters.

The four (4) main development aspirations of the NSDP are:

- A vibrant cultural identity underpinning a peaceful, just and inclusive society; supported by responsive and capable state institutions delivering quality public services, including health and education, to all citizens;
- Maintaining a pristine natural environment on land and at sea that serves our food, cultural, economic and ecological needs;
- With enhanced resilience and adaptive capacity to climate change and natural disasters; and
- A stable economy based on equitable, sustainable growth that creates jobs and income earning opportunities accessible to all people in rural and urban areas.

Vanuatu Land Use Planning & Zoning Policy

The policy aims to guide land use planning by setting priorities and outlining legislative and institutional arrangements to enable and encourages best use of the land and at the same time allowing for future generations to equitably benefit from the same resources.

The land use planning policy covers rural communities to urban centres integrates and recognizes custom basis as being part of the land planning process. The policy seeks to address land use planning issues while at the same time integrate the policy principles of custom, equity and sustainable development. These land use planning issues include:

- Minimizing the impact of economic development pressures on customary land
- Acknowledging the importance and significance of multi-stakeholder processes in the governance of land
- Highlighting the under-utilization of Vanuatu's cultivable land for productive use
- Looming effects of urbanization and informal settlements in the major urban centers of Vanuatu
- Emphasizing the role of the land sector as an important part of the framework for environmental and natural resource management
- Mandating proper planning and development of the land asset; including the management of government and public lands, the management of common property resources, individual and community based land use planning and urban planning and development.

### (2) Laws and Regulations related to Environmental Consideration

Constitution of the Republic of Vanuatu

Environmental management is enshrined in the 1980 Constitution of Vanuatu which states "to protect the Republic of Vanuatu and to safeguard the national wealth, resources and environment in the interests of the present generation and for future generation".

Environmental Management and Conservation Act (Cap 283)

The EPCA's objective is 'to provide for the conservation, sustainable development and management of the environment of Vanuatu, and the regulation of related activities' and applies 'throughout Vanuatu, including its lands, air and waters.[1]

The Act defines "environment" as the components of the earth and includes all or any of the following:

- land and water;
- layers of the atmosphere;
- all organic and inorganic matter and living organisms; and
- the interacting natural, cultural and human systems.[2]

Part 2 of the Act provides for the Administration of the Act by the Director of the Department of Environmental Protection and Conservation and for all instruments established for its implementation, namely the Environmental Registry, the National State of the Environment Reports, and the National Policies and National Plans. Part 3 regulates environmental impact assessment (EIA), and Part 4 is concerned with Biodiversity and Conservation Areas. It provides for the declaration of community conservation areas, discussed in the first part of the legislative review.

Physical Planning Act

The Act regulates land development in Vanuatu. Land use and developments occurring outside foreshore land may impact on the foreshores through, example water contamination and land contamination by pesticides and other pollutants, or sedimentation of foreshore waters.

The Act provides for Municipal Councils or Local Government Councils to declare any area within their jurisdiction as physical planning areas and this is then published in the Gazette for public to view and any interested persons can submit their objections.

Pollution Control Act

The objects of this Act are to:

- minimize and manage the discharge of air and land waste pollutants, the emission of noise, odour and electromagnetic radiation into the environment;
- minimize the adverse effects of pollution on human health and the environment; and
- encourage all levels of government to work together to control the discharge and emission of pollution.

The government proposes to achieve these objectives by:

[1] In the title and section 1 of the Environmental Protection and Conservation Act [Cap 283].
[2] Section 2 of the Environmental Protection and Conservation Act [Cap 283].

- requiring owners and occupiers of property to take reasonable and practicable measures to prevent or minimize the discharge of waste and the emission of noise, odour or electromagnetic radiation from their property;
- establishing a permit regime for owners and occupiers who wish to cause or increase the discharge of waste or pollution, or the emission of noise, odour or electromagnetic radiation from their property;
- empowering the government to issue pollution abatement notices in circumstances where pollution is being or is likely to be discharged or emitted from premises into the environment;
- establishing offences for the discharge and emission of pollution from premises of owners or occupiers of property, that unreasonably interferes with the health and/or environment of others; and
- delegating enforcement powers to Municipal Councils and Provincial Government Councils.

Water Resources Management Act

The objective of the Act is 'to provide for the protection, management and use of water resources in the Republic of Vanuatu'. Water in the Water Resources Management Act includes any:

- river, stream, creek or other natural course for water;
- lake, lagoon, bay, swamp, marsh or spring, and estuarine or coastal sea water

The Act consists of 7 Parts including inter alia water use, water management (including planning) and administration of water resources.

Section 4 defines traditional rights of water users and the rights of land owners to use water on or adjacent to their land. In both cases other water user's right must not be adversely affected.

As the operation of hotel and building tower will generate substantial solid and liquid waste near a major water body in Fatumaru Bay, serious considerations have to be made to utilize state-of-the-art wastewater treatment facilities. One option will be provided to supplement what the company is proposing.

Health & Safety at Work Act [Cap 195]

With respect to the health and safety of the workforce as stipulated in the Health and Safety at Work Act [Cap 195] It is the duty of every employer and employee to ensure, so far as is reasonably practicable, the health, safety and welfare requirements at work are met. As discussed earlier the Act (CAP 195) makes it very clear that both employers and employees have a role to play regarding health and safety at work.

The employer has the "duty of care" to provide personal protective equipment (PPE) and make workplace safe (policies, procedures, code of conduct etc.) and the employee has "due diligence" of making sure all PPE and other safety at work policies and procedure of the company are followed and used properly and looked after. The specific occupational health and safety for the identified impacts are discussed below.

The requirements of worker's safety and welfare need careful consideration as over 100 workers are expected to work during construction and operation phases.

Public Health Act, 1994

The Public Health Act makes general provisions for public health in Vanuatu, including regulation of waste management, sanitation, and prohibiting water pollution.

The Act provides for prevention of public health disease resulting for unhealthy living conditions or unhealthy environments such as poor sanitation and indiscriminate waste disposal.

The construction site must have a healthy living atmosphere for workers who will spend over 8 hours per day at the site.

Waste Management Act

An Act to provide for the protection of the environment through encouragement of effective waste services and operations as follow:

- Implement International Conventions and Treaties that relate to management of hazardous waste
- Implement the National Waste Management Strategy
- Develop environmental standards
- Undertake audit of waste generation and disposal
- Establish and implement licensing system for waste management services/operations
- Develop standard operating procedures

Public Road Act

The Act provides is for designing, planning, administration, construction, and maintenance of public roads. The objectives of this Act are as follow:

- establish a procedure for identifying and designating public roads;
- assign a level of government to be responsible for each public road;
- provide a legislative basis for strategic planning and making policies for the public road network;
- apply technical standards to the public road network;
- clarify functions and provide powers to Road Authorities to design, construct and maintain public roads; and
- regulate access, utility works, encroachments and unauthorized activities on the public road network.

**(3) Organizations related to environmental and social considerations in Vanuatu**

Department of Environmental Protection and Conservation (DEPC)

The Department of Environmental Protection and Conservation is responsible for formulation and implementation of environmental policies with the aim of ensuring ecologically sustainable development in Vanuatu by Ministry of Climate Change Adaptation and its affiliated agencies such as Meteorology & Geo-Hazards, Environment, Energy and Disaster Management.

The Environmental Protection and Conservation Act [CAP 283] (the EPC Act) outline its role in the development, coordination and implementation of the Government's environmental policies and programs.

The Department has five divisions, and one of them is the Environmental Planning and Impact Assessment Division, and it is responsible for to managing Environmental Impact Assessment (EIA) in Vanuatu.

Public Works Department/ Ministry of Infrastructure and Public Utilities

The Public Works Department (PWD) under the Ministry of Infrastructure and Public Utilities (MIPU) is in-charge of infrastructure development projects and infrastructure maintenance.

The PWD is one of the few central government departments with line staff in such provinces as Shefa, Sanma, Malampa, Tafea, Penama, and Torba. Therefore, its roles to ensure the safeguard policies in the infrastructure projects in Vanuatu are critical. The Shefa office is responsible for the maintenance of Efate Ring Road.

National Disaster Management Office (NDMO)

The National Disaster Management Office (NDMO) is a government department under the Ministry of Climate Change and Adaptation. It is a government agency coordinating disaster preparedness, response and recovery operations in the Republic of Vanuatu.

One of tis tasks to increase the resilience of communities throughout Vanuatu by integrating the coordination of Disaster Risk Management and Climate Change Adaptation into sectoral plans, policies and budget.

Local government

Both local government and decentralization are enshrined in the constitution (Section 82 and 83).

The provincial and municipal governments in Vanuatu are responsible for reginal planning, waste collection and disposal, road, along with pre-school & primary education as well as primary care. Water and sanitation are managed by both national and local governments.

**(4) EIA Approval Process**

Under the Environmental Management and Conservation Act (Cap 283), any project, proposal or development that falls within the scope of the Act is subject to a two-step EIA process. The first step is a preliminary environmental assessment (PEA) pursuant to Section 14 of the Act. The second step of the EIA process takes place where the Director has determined that an EIA is required.

The Director develops an EIA terms of reference, with "special consideration to the need for consultation, participation and involvement of custom landowners, chiefs and other interested parties, and may consult with the National Council of Chiefs for that purpose"

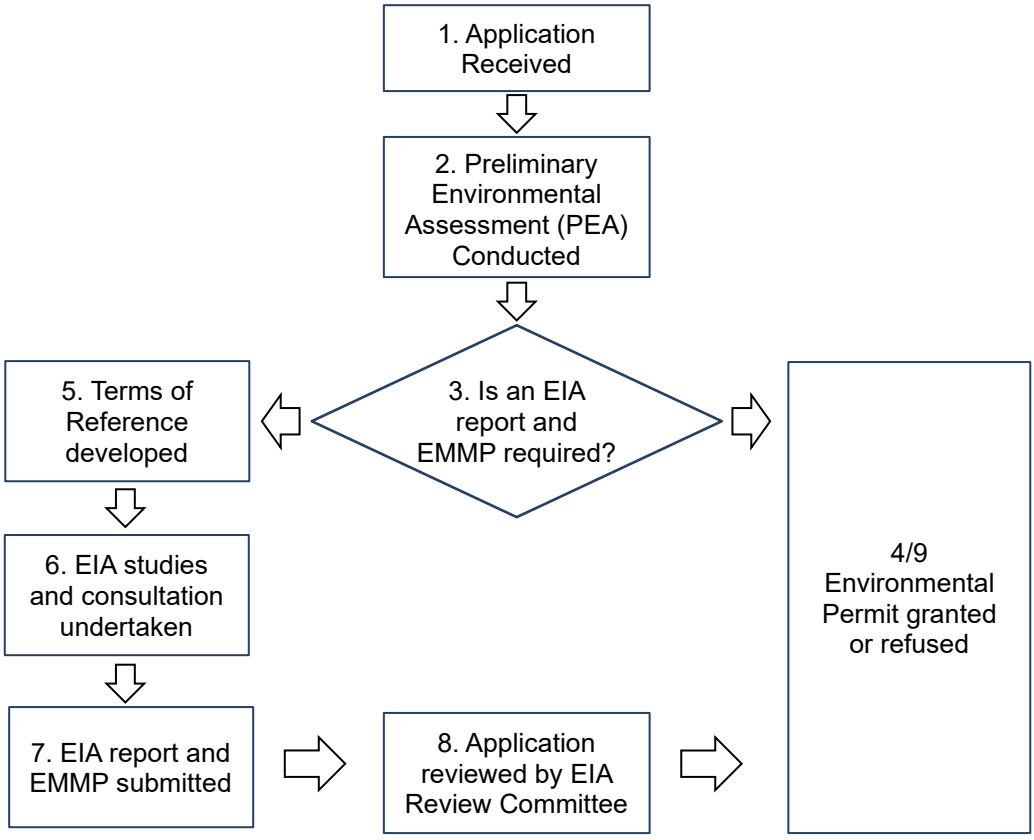
The EIA Regulations order No. 175 of 2011 sets out the following processes and procedures for EIA studies including determining which activities require environmental assessments, the formulation of guidelines for conducting the EIA in the form of a Terms of Reference, and the decision making process for EIA. It also covers miscellaneous issues such as registration of consultants, fees to pay as well as compliance monitoring and enforcement of the EPC Act as well as this regulation etc.

In addition, the EIA Regulations 2011 requires to formulate the Environmental Management and Monitoring Plan (EMMP), which under this Regulations should: (i) describe proposal or development activity of project and the environmental protection measures that will put in place by the project proponent in case of project approval; (ii) include an environmental monitoring and surveillance program of actions; and (iii) Appointing an environmental monitoring manager by project proponent in consultation with DEPC

in order to verify EMMP and protection measures are being fulfilled and also adverse impacts of project as well as proposal or development activities are documented.

The DEPC has to undertake an environmental audit in an annual basis of all projects, proposals and development activities with EIA approval.

The process for obtaining EIA approval is shown in the following Figure 1.3-3.




*Source: EIA and VIPA by DEPC*

**Figure 1.3-3 EIA Approval Process**

### (5) Comparison between JICA Guidelines and EIA Related Laws/Regulations in Vanuatu

An inter-comparison between the JICA Guidelines for Environmental and Social Considerations 2010 (hereinafter referred to as "JICA Guidelines") and EIA related laws and regulations in Vanuatu are summarized in the following Table 1.3-11.

**Table 1.3-11 Comparison between JICA Guidelines and EIA Related Laws/Regulations**

| No. | JICA Guideline | Related Laws/ Regulations in Vanuatu | Difference | Counter-measures |
|---|---|---|---|---|
| 1 | [complying with laws]<br>The Project must comply with laws, regulations and standards concerning | [Implementation of PEA and EIA]<br>- Under the Environmental Protection and Conservation Act (EPCA) (2010), all activities or proposed projects that impact or are likely to | No difference | |

| No. | JICA Guideline | Related Laws/ Regulations in Vanuatu | Difference | Counter-measures |
|---|---|---|---|---|
| | environmental and social considerations established by the governments (central and local governments) where the Project is implemented. Furthermore, the Project must satisfy policies and plans concerning environmental and social considerations established by the governments where the Project is implemented. | impact the environment must make an application for approval to the Department of Environmental Protection and Conservation (DEPC).<br>- Once an application is lodged and fee paid, the DEPC EIA Unit officers carry out a preliminary environmental assessment (PEA) and determine whether an EIA is required or not.<br>- An EIA is required for those activities/ projects that cause or are likely to cause significant impacts on "environment, social and/or custom". | | |
| 2 | [Examination of Avoidance and Mitigation Measures]<br>During the implementation of the Project, from its planning stage, the impact on the natural and social environment of the Project must be studied and examined in the as early stage as possible. Alternative and mitigation measures to avoid and minimize the impact must be studied and the result must be reflected in the Project plan. | [Examination of avoidance and mitigation measures]<br>The proponent is required to first submit an application containing a description of the proposed activity/ project and identification of likely environmental impacts and required measures to avoid or mitigate the impacts (EIA regulations (2011). | It is not clear whether the result of identification of measures to avoid or mitigate the impacts is reflected in the Project. | It is necessary to ensure that the identified required measures to avoid or mitigate the impacts are reflected in the Project plan. |
| 3 | [Examination of alternatives]<br>In order to avoid and minimize the negative impact of the Project and to select the best option from the aspect of environmental and social consideration, several alternatives must be examined. | [Notification of alternatives and mitigation measures]<br>- An EIA report must include a statement of the various alternatives that have been considered for the project, proposal or development activity, including the option of taking no action, and an outline of the reasons for choosing the proposed action.<br>- An EIA report must include a statement of the mitigation action proposed in respect of any adverse impacts identified in the report (EIA regulations (2011). | No difference | |
| 4 | [Scope of study and examination]<br>Regarding environmental and social considerations, the impact to be examined includes the impact on human health and security and that on the natural environment (including cross-border and global impact) through air, water, soil, waste, accidents, water use, climate change, ecosystem and | [EIA-covered project]<br>- All projects, proposals or development activities that will do or are likely to do all or any of the following are subject to the EIA provisions:<br>a) affect coastal dynamics or result in coastal erosion;<br>b) result in the pollution of water resources;<br>c) affect any protected, rate, threatened or endangered species, its habitat or nesting grounds;<br>d) result in the contamination of land;<br>e) endanger public health;<br>f) affect important custom resources; | The environmental standards are not mentioned in EPCA and EIA regulations. Referring to internationally acknowledged guidelines (WHO, IFC, etc.) or standards of | The expected impact shall be compared and examined. |

| No. | JICA Guideline | Related Laws/ Regulations in Vanuatu | Difference | Counter-measures |
|---|---|---|---|---|
| | fauna and flora. It also includes the impact with respect to social considerations. | g) affect protected or proposed protected areas;<br>h) affect air quality;<br>i) result in the unsustainable use of renewable resources; and<br>j) result in the introduction of foreign organisms and species.<br>(Environmental Protection and Conservation Act) | advanced countries. | |
| 5 | [Information disclosure and public involvement]<br>As for the Project which is expected to put relatively big impact on the environment, from the early stage when alternatives of the Project are examined, the information should be disclosed. And then, it is necessary that the stakeholders such as local residents are fully consulted and that the result is reflected in the Project. | [Decision-making]<br>- The project proponent must conduct public consultations on the project, proposal or development activity at times and places as determined by the Director and convenient for those likely to with to take part.<br>- At least one of the public consultation meetings must be held in the close vicinity of the area of the proposed development.<br>- Notices of public consultation meetings must be given by the project proponent in the manner directed by the Director and such notices must inform the public of:<br>a) the locality and the nature of the project, proposal or development activity<br>b) the location and the time of the public consultation meeting<br>- The cost of convening public consultation meetings is to be met by the project proponent (EIA regulations (2011).<br><br>[Decision-making on EIA]<br>- The project proponent must conduct public consultations on the project, proposal or development activity at times and places as determined by the Director and convenient for those likely to with to take part.<br>- At least one of the public consultation meetings must be held in the close vicinity of the area of the proposed development.<br>- If a public consultation meeting is held, notice of it must be given by the project proponent in the manner directed by the Director and must inform the public of:<br>a) the locality and the nature of the project, proposal or development activity;<br>b) where copies of the EIA report can be obtained;<br>c) the location and the time of the meeting; and<br>d) time limit as determined by the Director for the submission of comments in writing.<br>- The cost of convening public consultation meetings is to be met by the project proponent (EIA regulations (2011). | It is not clear from which stage of the project public consultations take place. It is not clear whether the result of public consultations is reflected in the project. | Public consultations shall take place from as early stage of the project as possible. The result of the consultations shall be recorded and reflected in the project. |
| 6 | [Monitoring] | [Monitoring System] | It is not clear | The result of |

| No. | JICA Guideline | Related Laws/ Regulations in Vanuatu | Difference | Counter-measures |
|---|---|---|---|---|
| | The donor country shall check the monitoring results which are deemed important for a certain period in order to verify whether the host country considers the environmental and social impact.<br>Information necessary for verifying the monitoring results shall be reported by the host country via a proper manner such as documentation etc. | - An environmental management and monitoring plan (EMMP) for a project, proposal or development activity must be submitted with the EIA report.<br>- An EMMP must:<br>a) describe the environmental protection measures that will be put in place by the proponent;<br>b) include and environmental monitoring and surveillance program of action; and<br>c) provide for an environmental monitoring manager to be appointed by the project proponent to verify that the EMMP and protection measures are being fulfilled and adverse impacts are documented.<br>(EIA regulations (2011) | whether the result of monitoring is documented in a proper manner. | monitoring shall be documented and submitted to relevant agencies. |

*Source: JICA study team*

#### 1.3.1.4 Alternative Analysis including No Project (No Action)

**(1) High Risk of No Action**

The abutment of existing Teouma Bridge in the right bank of Teouma river, along with the approach road, is seriously damaged by Cyclone Pam. The traffic of Ring Road was suspended for six days before implementation of an emergency reconstruction work. It is highly anticipated that another devastating cyclone cause a fatal damage to the bridge and this could lead to serious interruption of daily life in the Efate Island as well as the Vanuatu economy. Therefore, it is urgent for the Vanuatu government to replace the Teouma Bridge with the new one.

**(2) Alternatives for Flood Countermeasure**

| Items | Option 0: No Action | Option 1: Embankment | Option 2: Embankment + Culvert | Option 3: Overflow management |
|---|---|---|---|---|
| Ring Road Inundation | ×<br>No change | ○<br>Sag part of the Ring Road, the left side of the bridge, shall be elevated with soil fill embankment up to 8.7 m above MSL in height to prevent inundation of the Ring Road even at a 100-year return period flood event. | ○<br>Sag part of the Ring Road, the left side of the bridge, shall be elevated with soil fill embankment up to a height of 8.4 m above MSL to prevent inundation of the Ring Road even at a 100-year return period flood event. | ○<br>Ring Road with a decline slope of 3% will connect the bridge to the bottom of existing road in order to utilize existing drainage function of sag part of the Ring Road. |
| Overflow management | △<br>No change | ○<br>No overflow in sag part of the Ring Road | ○<br>No overflow in sag part of the Ring Road | △<br>Flood water shall flow over sag part of the Ring Road by flood of 10-year return period or larger. |

| Items | Option 0: No Action | Option 1: Embankment | Option 2: Embankment + Culvert | Option 3: Overflow management |
|---|---|---|---|---|
| Flood Management | △<br>No Change | △<br>Flooding in the upstream of the Ring Road will be slightly worse. | ○<br>This is not increasing flooding in the upstream of the Ring Road. | ○<br>This is not increasing flooding in the upstream of the Ring Road. |
| Construction Cost | ○<br>No cost | ○<br>Low | △<br>Medium | ×<br>High |
| Land Acquisition | ○<br>No land acquisition | △<br>Embankment with the maximum height of 2.5 m requires a larger land area for construction. | △<br>Embankment with the maximum height of 2.5 m requires a larger land area for construction. | △<br>The Ring Road from the bridge entrance to sag part of the road will be filled with soil |
| Safety and Convenience | X<br>Not good in road alignment | ○<br>Vertical alignment will be improved even at a 100-year return period flood event. | ○<br>Vertical alignment will be improved even at a 100-year return period flood event. | △<br>Vertical alignment will be improved, but the road risk grade is still large.<br>The road might be blocked by food with 10-year return period or larger. |
| Overall Evaluation | Not recommended | Not recommended | Recommended | Not Recommended |

*○: Good, △: Fair, X: Not Acceptable

### (3) Options for Bridge Type

| Options / Items | Option 0: No Action | Option 1: Warren Pony Truss | Option 2: Steel Plate Girder |
|---|---|---|---|
| Structural Features | No change | ○<br>The bridge structural height of the pony truss is 1.1 m, lower than that of the plate girder type. The road elevation can be lower. | △<br>One of advantages of the Girder type is its simple structure. The bridge structural height is 1.5 m and it need to elevate the road 0.4m higher than that of pony truss type. |
| Safety | X<br>The width of the road is narrow and does not meet the standards | △<br>There is risk of hitting the main steel (truss) by vehicle. Drivers also feel pressure when passing the bridge. | ○<br>There is no risk that the vehicle may hit the main steel structure since it is a deck bridge. This type of bridge is superior to pony truss type in terms of road visibility. |
| Construction | ○<br>No construction | ○<br>It is easier to manage the construction work, because the members are small and light. Special erection method is not required. | △<br>Crane erection method can be adopted, though the members are bigger. Special erection method is not required. |
| Cost | ○<br>No cost | △<br>Approx. 370 kg/m$^2$<br>Total steel weight: approx. 211t<br>(width:9.5m, length:60m) | ○<br>Approx. 240 kg/m$^2$<br>Total steel weight: approx. 137t<br>(width:9.5m, length:60m) |

| Options / Items | Option 0: No Action | Option 1: Warren Pony Truss | Option 2: Steel Plate Girder |
|---|---|---|---|
| Maintenance (15 Points) | X<br>Intensive maintenance is required due to large number of the members. Sand sedimentation has been observed on lower chord member. | X<br>Intensive maintenance is required due to large number of the members. Sand sedimentation has been observed on lower chord member. | ○<br>Numbers of members are not too many leading to an easier maintenance work. |
| Total | Not recommended | Not recommended | Recommended |

*○: Good, △: Fair, X: Not Acceptable

### (4) Options for Approach Road Alignment

| Option | Option 0: No Action | Option 1: Existing | Option 2: Upstream | Option 3: Downstream |
|---|---|---|---|---|
| Obstacles | ○<br>No obstacle | △<br>Electrical line, poles and other utilities exist. It is necessary to relocate them during the construction. | △<br>Electrical line, poles and other utilities exist. It is necessary to relocate them during the construction. | △<br>Electrical line, poles and other utilities exist. It is necessary to relocate them during the construction. |
| Road alignment (Traffic Safety) | X<br>Vertical alignment does not meet the standards | ○<br>Radius of curvature is not increased due to the extension of the bridge to the right side of the river. The alignment is the same. | ○<br>The road curve on the right bank side becomes gentler, and this enhances road safety. | △<br>The road curve on the left bank side becomes sharp, and this affects road safety |
| Construction period* | ○<br>No construction | △<br>The construction period of bridge and road will be longer, but the whole construction period depends on that of river improvement work. | △<br>The construction period of bridge and road will be shorter, but the whole construction period depends on that of river improvement work. | △<br>The construction period of bridge and road will be shorter, but the whole construction period depends on that of river improvement work. |
| Cost | ○<br>No cost | ○<br>No need to huge soil fill embankments and other construction in this option and also no need to structures such as retaining walls. Lowest cost for this option. | X<br>Large amount of soil fill embankment and structures such as retaining walls causes increase in cost. | X<br>Large amount of soil fill embankment and structures such as retaining walls causes increase in cost. |

| Option | Option 0: No Action | Option 1: Existing | Option 2: Upstream | Option 3: Downstream |
|---|---|---|---|---|
| Environmental Impact | ○<br>No impacts | ○<br>No resettlement of residents is needed.<br>Limited area of land is needed to be expropriated. | X<br>A large area of land acquisition is required. The land on the left side of the river and north of the road is on the long-term lease contract and it is difficult to negotiate the land acquisition.<br>At the time of traffic switch from the old bridge to the replaced bride, a detour is needed at the downstream side. | X<br>A large area of land acquisition is required.<br>At the time of traffic switch from the old bridge to the replaced bride, a detour is needed at the downstream side. |
| Socio-economic impacts | X<br>Safe and smooth traffic is not secured, and this could cause problems for local economic development and social welfare | ○<br>Safe and smooth traffic would enhance economic development and social welfare. | ○<br>Safe and smooth traffic would enhance the local economic development and social welfare. | ○<br>Safe and smooth traffic would enhance the economic development and social welfare. |
| Total evaluation | Not recommended | Recommended | Not recommended | Not recommended |

*○: Good, △: Fair, X: Not Acceptable

#### 1.3.1.5 Scoping

Under the Vanuatu EIA Procedures, a ToR developed by DEPC after visiting project sites and discussion with concerned organizations and people.

JICA survey team also conducted a scoping in cooperating with PWD and an EIA consultant team. Opinions and comments from residents and local governments at the first consultation meetings is reflected in the finalized scoping shown in Table 1.3-12.

**Table 1.3-12 Result of Scoping**

| Category | | Items | Evaluation | | Reason |
|---|---|---|---|---|---|
| | | | Before/ During Construction | Operation | |
| Anti-pollution measures | 1 | Air pollution | B- | C | [Before/During Construction] Ambient air quality will be affected by the dust and emission gas generated during the preparation and construction work, but the impacts will be limited due to the limited number of heavy vehicles and trucks.<br>[Operation] After the completion of the work, along with the ADB road rehabilitation project, the traffic volume of the ring road is expected to increase, and this could affect the ambient air quality. (The second phase of the ADB project will not increase the traffic volume at the bridge) |

| Category | | Items | Evaluation | | Reason |
|---|---|---|---|---|---|
| | | | Before/ During Construction | Operation | |
| | 2 | Water pollution | B- | D | [Construction] Excavation/embankment work along the river and the construction work of bridge pier could worsen river water quality during the construction period.<br>Rainfall during or just after the embankment/Cut-earth work could cause soil erosion and river water pollution.<br>[Operation] Slope protection work could mitigate soil erosion during the operation phase. |
| | 3 | Soil Pollution | C | D | [Construction] There is a possibility of soil contamination by oil during the maintenance work of heavy vehicles and trucks, but the area might be limited.<br>[Operation] There are no works which could cause soil pollution. |
| | 4 | Waste<br>✓ Municipal solid waste (MSW)<br>✓ Construction waste (CW) | B- | D | [Construction] It is unlikely that camps for construction workers would be established, and the problems caused by general waste would be very limited.<br>[Operation] There will be no works which generate general waste. |
| | | | | | [Construction] Construction waste such as excavated soil and concrete debris will be generated.<br>Organic waste and soil including organic waste will be also generated after the site clearance. |
| | 5 | Noise and Vibrations | B- | C | [Construction] During the construction period, construction work will cause problems of noise and vibrations.<br>[Operation] During the operation phase, same as air pollution, noise and vibration problems would worsen due to the increase in traffic volume. |
| | 6 | Ground subsidence | C- | C- | [Construction] No construction work could cause ground subsidence, but it is necessary to check based on the result of the ground survey.<br>[Operation] There are no elements to cause ground subsidence. |
| | | Soil erosion | B- | B- | [Construction] Construction work to widen and change the channel could cause soil erosion.<br>Rainfall during or just after the embankment/Cut-earth work could cause soil erosion.<br>[Operation] Change of river channel at and around the bridge could cause soil erosion in the downstream of the river, after the completion of the construction work. |
| | 7 | Offensive odors | D | D | [Construction]/[Operation] There is no activity to cause offensive odor. |
| Natural environment | 8 | Bottom sediment | B- | D | [Construction] Construction of a pier and excavation work would have negative impacts on bottom sediment.<br>[Operation] No negative impacts are not expected. |

| Category | | Items | Evaluation | | Reason |
|---|---|---|---|---|---|
| | | | Before/ During Construction | Operation | |
| | 9 | Protection area | C- | C | [Construction]/[Operation] No national park or conservation areas inside the project area are identified so far. The EIA survey will check if there are any protected areas inside the project area. |
| | 10 | Biota and ecosystems | B- | D | [Before/During Construction] Channel widening and excavation work would have negative impacts on aquatic organisms, in particular Benthos. Need to collect the data on fauna and flora in and around the Teouma river.<br>[Operation] |
| | 11 | Hydrology | B- | B- | [Construction] River improvement work could have impact on the hydrology of the downstream.<br>[Operation] Modified river alignment upstream and downstream of the Teouma Bridge could have impacts on the alignment of the downstream.<br>The elevated access road could worsen the flooding north of the access road. |
| | 12 | Geographical features/Landscape | B | C | [Construction/<br>Operation] Due to the elevation of the new bridge and access road, the landscape will be changed. |
| Social environment | 13 | Land acquisition and resettlement | B- | D | [Pre-construction] No households need to be resettled, but a certain area of land is needed to be permanently expropriated or temporarily used as the detour.<br>Need to estimate the compensation amount for land, structures, trees and crops.<br>[Operation] Compensation and support will be implemented based on the RAP during the preconstruction, this would minimize the negative impact. |
| | 14 | Vulnerable groups /Poor people | C | D | [Pre/During Construction] No issues of minority and indigenous people are identified, but If the result of social and economic survey finds issues to be solved, some kinds of support would be considered. Same as for poor people.<br>[Operation] Issues identified during the surveys will be dealt with. |
| | 15 | Local economies | B+/- | B+ | [Construction] The project will bring about some benefits such as job creation and economic opportunities to sell foods/goods to workers, while some households will lose a part of farmland.<br>[Operation] During the flood, traffic of the ring road is secured, and this could contribute to the local economic development. |
| | 16 | Land use | B- | C | [Construction] A part of farmland and roadside cannot be temporarily or permanently used.<br>[Operation] Due to the change of river channel around the bridge, there might be change of the river channel downstream, and this could restrict the use of the land. |

| Category | | Items | Evaluation | | Reason |
|---|---|---|---|---|---|
| | | | Before/ During Construction | Operation | |
| | 17 | Water use | B- | B+ | [Construction] The construction work could worsen water quality and this would be problems of water use for both drinking and farming water purposes. The right-side riverbank just below the bridge is the place where people take water and do the laundry (some people come from other areas in order to do laundry by bus). During the construction work, they need to look for other places<br>[Operation] the steps are planned to be installed in the bank, and this will make it easier for local people to access to river water. |
| | 18 | Existing social infrastructures and Services | B- | B+ | [Construction] The construction work will cause a problem of other infrastructure such as transmission line, as well as traffic congestion (not serious)<br>[Operation] After the project, the transportation network in Efate Island will be improved. |
| | 19 | Social institutions | D | D | [Construction] Land expropriation issues could affect the consensus formation in the community.<br>[Construction]/[Operation] The project will not affect the local social institutions and decision-making organization. |
| | 20 | Misdistribution of benefits and damages | C- | C- | [Pre-Construction] The project could cause gaps among project affected households<br>[Operation] The project could ensure the main transportation system in Efate Island during the cyclone and this is a benefit for all the local people. The change of river channel in the upstream of the bridge could affect the area in the downstream. |
| | 21 | Local conflicts of interest | D | D | [Pre-Construction/Construction] The main purpose of the project is the replacement of the bridges, and there could be no local conflicts.<br>[Operation] The project will bring about benefits the whole community can enjoy, so the local conflict of interests will not be expected. |
| | 22 | Cultural heritage | C | D | [Construction] No local archeological, historical, cultural, and religious heritages are identified inside and near the project area, but the EIA survey will check the existence.<br>[Operation] If the cultural heritage site is identified, a necessary measure will be taken. |
| | 23 | Landscape | B- | C- | [Construction] The construction work could affect the landscape, but the project site is not a tourist site or scenic spot and its impact might be limited.<br>[Operation] The elevation of the bridge and access road could change the landscape. |
| | 24 | Gender/ Children's rights | C | D | [Operation] There could be a gender bias against the employment of construction workers.<br>[Operation] The project is not expected to affect the gender/children's right related issues. |

| Category | | Items | Evaluation | | Reason |
|---|---|---|---|---|---|
| | | | Before/ During Construction | Operation | |
| | 25 | Infectious diseases such as HIV/AIDS | C | D | [Construction] Construction workers are planned to be employed locally, so the infectious diseases such as HIV/AIDS are not expected to be increased.<br>[Operation] The negative impacts are not expected. |
| | 26 | Working conditions (work safety) | B- | D | [Construction] There would be accidents, injuries and health problems at the construction sites.<br>[Operation] Problems related to working safety are not expected. |
| | 27 | Accidents | B- | B- | [Construction] There would be traffic accidents, involving local people, during the construction work.<br>[Operation] Elevation of the access road could cause traffic accidents for a certain period after the completion of the construction work |
| | 28 | Global warming | D | C | [Construction] A limited amount of global warming gas (GHS) will be emitted.<br>[Operation] The traffic volume might be slightly increased and this increases the emission amount of GHS gas, but the effect on the global warming will be very limited. |

Rating:

A+/-: Significant positive/negative impact is expected.

B+/-: Positive/negative impact is expected to some extent.

C: Extent of positive/negative impact is unknown (Examination is needed. Impacts may become clear as study progresses.)

D: No impact is expected

*Source: JICA study team*

### 1.3.1.6 ToR for Survey of Environmental and Social Considerations

A ToR for the survey of Environmental and Social Consideration Survey was made based on the ToR made by DEPC and the result of scoping in Table 1.3-13.

**Table 1.3-13 ToR of survey of Environmental and Social Considerations**

| Items of Impact | Survey Items | Survey method |
|---|---|---|
| 1. Air pollution | (1) Environmental standard, current situations of ambient air<br>(2) Impact of construction work | (1) literature survey (environmental standard, measuring method)<br>(2) project components, construction method, construction schedule, heavy vehicles/trucks, construction area, and so on (from JICA expert team) |
| 2. Water pollution | (1) Environmental standard, current situations of water quality<br>(2) Impact of construction work | (1) literature survey (environmental standard, measuring method, monitoring data)<br>(2) project components, construction method, construction schedule, construction area, and so on (from JICA expert team)<br>(3) Baseline data survey<br>(4) Result of soil and ground survey (from JICA expert team) |
| 4. Waste | (1) Laws and regulations<br>(2) Impact of construction work | (1) literature survey (Solid management systems in Vanuatu)<br>(2) project components, construction method, construction schedule, construction area, and so on (from JICA expert team) |

| Items of Impact | Survey Items | Survey method |
|---|---|---|
| 5. Noise and vibrations | (1) Environmental standard, current situations of ambient noise<br>(2) Impact of construction work | (1) literature survey (environmental standard, measuring method)<br>(2) project components, construction method, construction schedule, heavy vehicles/trucks, construction area, and so on (from JICA expert team)<br>(3) Baseline data survey |
| 6. Soil erosion | (1) Impact of construction work | (1) literature survey related to soil survey<br>(2) project components, construction method, construction schedule, construction area, and so on (from JICA expert team)<br>(3) Result of soil and ground survey (from JICA expert team) |
| 10. Biota and ecosystems | (1) data on fauna and flora (in particular endangered species)<br>(2) Impact of construction work | (1) literature survey (reports on fauna and flora along the river)<br>(2) project components, construction method, construction schedule, construction area, and so on (from JICA expert team)<br>(3) Baseline data survey |
| 11. Hydrology | (1) current situations<br>(2) Impact of construction work | (1) literature survey (reports of similar projects)<br>(2) project components, construction method, construction schedule, construction area, and so on (from JICA expert team)<br>(3) Result of soil and ground survey (from JICA expert team) |
| 13. Resettlement/ land acquisition | (1) legal framework related to resettlement<br>(2) households needed to be resettled<br>(3) compensation policies | (1) literature survey (legal framework, reports of other projects)<br>(2) project components, construction method, construction schedule, construction area, and so on (from JICA expert team)<br>(3) Socio-economic survey, Inventory survey, consultation meetings |
| 14. Vulnerable groups | (1) Current situations | (1) literature survey<br>(2) Socio-economic survey and consultation meetings |
| 15. Local economy such as employment and livelihood | (1) Impact of construction work | (1) literature survey<br>(2) Socio-economic survey (RAP)<br>(3) consultation meetings |
| 16. Utilization of land and local resources | (1) Impact of construction work | (1) literature survey<br>(2) Socio-economic survey (RAP)<br>(3) consultation meetings |
| 17. Water use (drinking water) | (1) Impact of construction work (during and after the construction work) | (1) literature survey<br>(2) Socio-economic survey (RAP)<br>(3) consultation meetings<br>(4) Interview survey at the Teouma bridge |
| 18. Existing social infrastructures and services | (1) Impact of construction work | (1) literature survey (EIA reports of other projects)<br>(2) Consultation meetings<br>(3) Site inspections |
| 20. Misdistribution of benefits and damages | (1) Impact of construction work | (1) literature survey<br>(2) Socio-economic survey (RAP)<br>(3) consultation meetings |
| 22. Cultural heritage | (1) Impact of construction work | (1) literature survey<br>(2) Consultation meetings<br>(3) Socio-economic survey |
| 22. Landscape | (1) Impact of construction work | (1) literature survey<br>(2) Consultation meetings |

| Items of Impact | Survey Items | Survey method |
|---|---|---|
| 24. Gender/ Children's right | (1) Impact of construction work | (1) literature survey<br>(2) Socio-economic survey (RAP)<br>(3) consultation meetings |
| 25. Infectious diseases such as HIV/AIDS | (1) Impact of construction work | (1) literature survey<br>(2) interview survey with organizations concerned |
| 26. Work Conditions including Work Safety | (1) Impact of construction work | (1) literature survey<br>(2) interview survey with organizations concerned<br>(3) project components, construction method, construction schedule, construction area, and so on (from JICA expert team) |
| 27. Accidents | (1) Impact of construction work | (1) literature survey<br>(2) interview survey with organizations concerned |
| 28. Global warming | (1) Impact of construction work | (1) literature survey<br>(2) project components, construction method, construction schedule, construction area, and so on (from JICA expert team) |

*Source: JICA study team*

#### 1.3.1.7 Survey Result of Environmental and Social Considerations

**(1) Air Pollution**

There are neither air quality standards nor emission standards for vehicles in Vanuatu. There are also very limited monitoring data on the ambient air[3]. An IEE report of AID project for Cyclone Pam Road Reconstruction Project[4] stated air quality at the project site is very good.

Since the main source of air pollution is dust caused by excavation/embankment work and dump trucks running on the access roads, the qualitative monitoring will be done by observation during construction.

The following risks are expected during the construction and operation period.

[Construction phase]

- Air pollution caused by dust, which are generated from excavation/embankment work and dump trucks running on the access road at the project site, is the biggest concern. Soils from the buck of the dump trucks and tires would also cause air pollution along the road.
- Emission gas from trucks and heavy vehicles would also affect air quality, though its degree is limited due to the limited number of vehicles and limited total operation days, as shown in the table of Construction Machinery Schedule, in the section of 25) Global Warming.

The following countermeasures could mitigate the above mentioned problems.

- To use trucks and heavy vehicles of good conditions with certificates and conduct a regular check and maintenance of these vehicles

[3] One of the data available is the data on the annual mean concentrations of PM2.5, provided for the Gloval Buden of Disease Study 2015 by Brauer, M. et al.The value for PM2.5 air pollution, mean annual exposure (micrograms per cubic meter) in Vanuatu was 8.52 as of 2015. (The World Health Organization's air quality guidelines recommend that the annual mean concentrations of PM2.5 should not exceed 10 μm/$m^3$ and 20 μm/$m^3$ for PM10.)

[4] Ministry of Infrastructure and Public Utilities, Initial Environmental Examination (VAN: Cyclone Pam Road Reconstruction Project - Additional Financing), June 2017, Asian Development Bank

- To implement regular watering at the construction site and stock yard and to wash tires of dump trucks
- To cover construction materials loaded on the back of the dump trucks

[Operation phase]

The result of the truck traffic volume estimation shows an increase in the light vehicle traffic volume by 15% in 2022, while the large size truck volume is estimated at the same level (refer to Chap 2.2.1.5). Due to the development of the residential area in the east side of the bridge, the volume of passenger cars and wagons (bus) would also be increased, but the current level of the traffic volume is small, and the impact of the traffic increase is very limited.

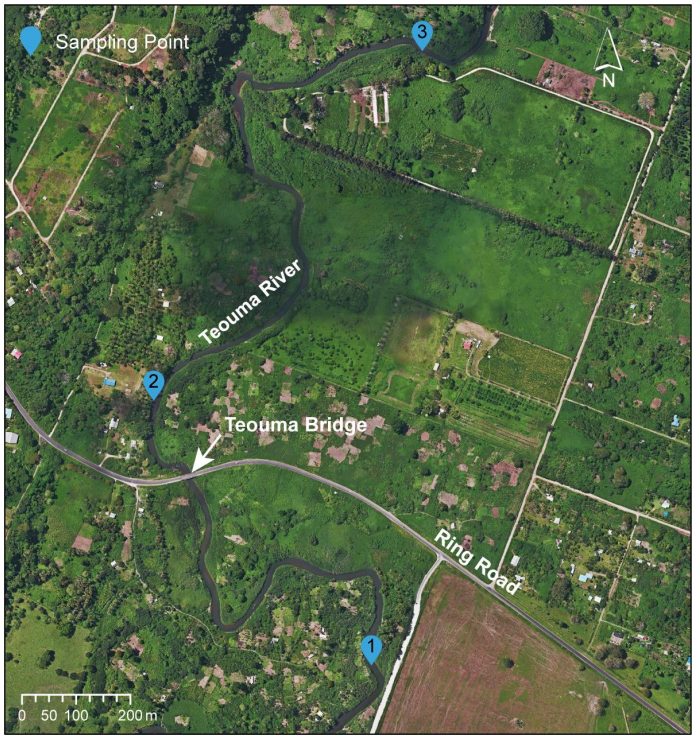
### (2) Water Contamination

The result of the water quality survey under the baseline survey and the sampling locations are shown in Table 1.3-14 and Figure 1.3-4 below.

**Table 1.3-14 Result of Baseline Survey**

| Analysis | Sample 1 | Sample 2 | Sample 3 | Unit | Standard |
|---|---|---|---|---|---|
| Fecal coliform (FC) | 9 | 21 | 2 | U/100ml | =0 (NF T 90-414) WHO Guideline |
| Enterococcus | 2 | 19 | 0 | U/100ml | =0 (NF T 90-416) WHO Guideline |
| pH | 8.03 | 8.01 | 8.27 | | >6.5 & < 9.5 (NF T 90-008) WHO Guideline |
| Conductivity | 455 | 462 | 457 | µS/cm | |
| BOD | 1 | 1 | 0 | mg/l O | (<1 mg/l for rivers categorized as AA, which water can be used as drinking water with simple filtering method in Japan) |
| Nitrate | 3.7 | 3.4 | 2.8 | mg/l | <50 mg/l (WHO guideline) |
| Nitrite | 0.2 | 0.3 | 0.2 | mg/l | < 3 mg/l (WHO guideline) |
| Phosphor reactive (orthophosphate) | 0 | 0.01 | 0 | mg/l | |
| Turbidity | 2.74 | 1.98 | 0.5 | NTU | (≦2 standards for tap water in Japan) |

*Source: JICA study team*




*Source: JICA study team*

**Figure 1.3-4 Locations of Sampling Points**

Teouma River water is clear, and concentration of organic/ inorganic matters is low, but the level of coliform is rather high for drinking water. The impacts of the project on water quality and countermeasures are summarized in the following:

[Construction Phase]

- Soil erosion caused by excavation/embankment work and piling work of the pier construction work, along with casting work, would cause water contamination.
- Heavy rain could cause soil erosion from embankment during the construction work or soon after the completion of the work.
- After watering and washing tires, wastewater with soil could pollute the river water
- Wastewater after washing tools and vehicles could pollute the river water.

Teouma River water is the most importance source of water for local people and its water is widely used as drinking water, domestic water, agricultural water, and so on. The following measures could prevent water contamination:

- Construction work at the riverbed will be done only during the dry season as much as possible.
- Excavation work and pier construction work will be done with temporary cofferdam method, using steel sheet pile or sandbags.
- A sedimentation pond or drainage will be installed in order to treat wastewater after watering and washing

### (3) Soil Contamination

[Construction Phase]

The storage facilities of oil, chemicals and vehicle maintenance are installed at the site. In order to prevent or mitigate the problems caused by leakage, spillover prevention measures such as bunding are necessary.

There is a possibility of soil contamination by oil and grease, leaked from maintenance work. The use of oil tray could mitigate this kind of problem.

### (4) Waste

[Pre-construction/Construction phase]

The organic waste and soils mixed with organic waste will be generated during the site-clearance work.

Excavated soil will be generated due to construction work, while general waste will be generated at the site office and construction site. Oil/grease waste will be also generated. In addition, due to the removal of abutment, concrete debris will be generated. A surplus soil of 10,000 $m^3$, equivalent to the volume of 2,000 dump trucks, will be also generated by removal of detour and other facilities at the end of the construction work. The following measures are necessary to be implemented:

- Organic waste and soils mixed with organic waste is generated during the site clearance work. This waste will be disposed at the authorized Bouffa landfill operated by Port Vila city.
  Disposal fee:
  small size and pick-up truck: VT 1,150/truck
  middle size truck: VT 2,875/truck
  large size truck: VT 5,750/truck
  16 wheel truck: VT 9,780/truck
- Garbage containers and temporary toilets will be installed
- Management plan of oil & grease and chemicals should be prepared.
- Excavated soils will be used for embankment work
- Concrete debris will be reused as filling materials of riverbed (PWD will reuse the superstructure)
- Temporary storage places of excavated soil and concrete debris will be prepared for proper storage of these materials
- Surplus soil will be brought to the stock yard and reused later

### (5) Noise and Vibrations

The result of the noise level survey is as follow:

| | |
|---|---|
| LAeq, 10min | 6:00 – 17:00 |
| Result | 45.6 dB |

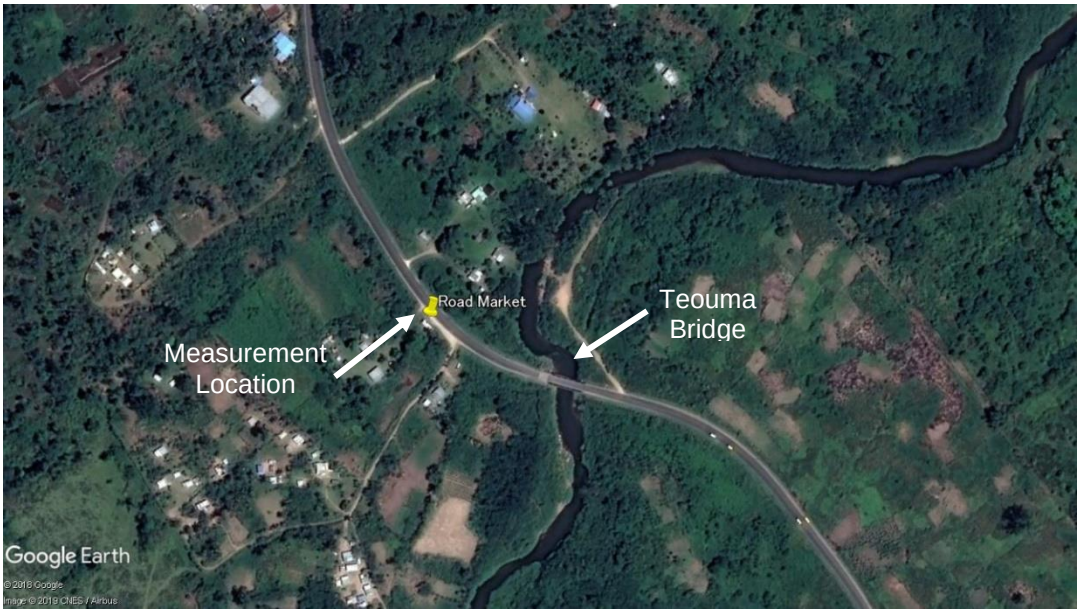
Survey date: February 4, 2019

Weather: fine

Location: in front of the market, west of the Teouma Bridge (See Figure 1.3-5)

The following Japanese standards are referred.

| | Daytime (6:00-22:00) | Night (20:00-6:00) |
|---|---|---|
| Residential area | 55 dB or less | 45 dB or less |
| Commercial area | 70 dB or less | 60 dB or less |
| Residential area along the main road with 2 or more than 2 lanes each way | 60 dB or less | 55 dB or less |
| Commercial area along the main road with 2 or more than 2 lanes each way | 65 dB or less | 60 dB or less |




*Source: JICA study team*

**Figure 1.3-5 Location of Noise Level Measurement**

Noise level is measured along the Ring Road, as shown in the above map. Compared to the Japanese standards for residential areas facing the main road with 2 or more than 2 lanes each way, the current noise level is very low. Houses near the construction area are located dozen meters away from the road and no houses are facing the road.

There are several schools in the neighboring areas but none of them are located near the project site, as shown in Figure 1.3-6.


Source: JICA study team

**Figure 1.3-6 Location of sensitive facilities such as schools around the project area**

Construction noise will cause moderate to low disturbance to the neighboring community within the immediate semi-rural area, due to the need for the temporary use of a pile driver. The pile driver has been used in the assessment below as a worst case scenario. The village of Melemaat is located approximately 300 meters downslope. The immediate vicinity of the road is uninhabited and there is one house further upslope which has no direct line of sight to the sources of noise.

Using an attenuation rate of 6 dBA per doubling of distance, the projected noise was found to be within the standard at the main village, using accepted daytime level of 55 dBA for residential land use in the village. The numbers of receptors within the each area are also shown in the table. Most of the receptors are houses along with 3 markets and one tourist facility within 1 km from the bridge.

Noise level at the nearest houses can be below the standards, but if plural heavy vehicles and machines are used at one time, it is likely that the noise level exceeds the standard. Please refer to the following Table 1.3-15.

**Table 1.3-15 Expected Noise Level**

| **Distance from source (m)** | 15.24 | 30 | 61 | 122 | 244 | 488 | 975 |
|---|---|---|---|---|---|---|---|
| Number of Receptors | 0 | 0 | 0 | 1 | 1 | 388 | +338 |
| | | | | | | | |
| Vibrator Pile Driver | 101 | 95 | 89 | 83 | 77 | 71 | 65 |
| Concrete Mixer Truck (dBA) | 79 | 73 | 67 | 61 | 55 | 49 | 43 |
| Concrete Pump Truck (dBA) | 81 | 75 | 69 | 63 | 57 | 51 | 45 |
| Dump Truck(dBA) | 76 | 70 | 64 | 58 | 52 | 46 | 40 |
| Excavator (dBA) | 81 | 75 | 69 | 63 | 57 | 51 | 45 |

*Source: JICA study team*

[Construction phase]

- Bridge construction work, in particular piling work, would cause noise and vibration problems
- The noise level caused by each excavation/embankment work by heavy vehicles and equipment or a dump truck/concrete pump truck would be within an acceptable level, but plural works are done simultaneously, it is likely that the noise level would exceed the standards.

The following countermeasure will be taken.

- Information on the construction work should be opened beforehand to local residents and authority, and the noisier construction work will be restricted to daytime.
- Low noise heavy vehicles and machines will be used.
- Simultaneous operation of plural noisy machines should be avoided as much as possible.
- The level of noise and vibrations will be regularly measured during the construction phase.

[Operation phase]

As mentioned in (1) Air pollution, the noise level would be worsening due the increase in the traffic volume, but the extent of the impact would be limited. Since the current noise level is law, the noise level during the operation would not exceed the noise standards.

**(6) Soil erosion**

[Construction phase]

The construction work of widening the width and changing the channel of Teouma River, would cause soil erosion. In addition, heavy rain could trigger soil erosion from the embankment during the construction work or the just after the completion of the construction work.

In order to prevent soil erosion, the following measures will be taken.

- Construction work at the riverbed is restricted to the dry season.
- Appropriate drainage plan will be formulated beforehand.
- Excavation work and pier construction work will be done with temporary cofferdam method, using steel sheet pile or sandbags.

[Operation phase]

In the past, Teouma River meandered freely through the rift valley with 1.5 km in width. The change of river course at the bridge could trigger the further meandering downstream. It is recommended to monitor the river morphology in the long term, from not only the environmental and social aspects but also disaster management aspect.

- The monitoring of the river course will be conducted once a year, as mentioned in the section of Hydrology.

**(7) Bed sediment**

[Construction phase]

The bridge construction and excavation/embankment work at the river could affect the bed sediment. The result of freshwater fauna survey shows very low biodiversity due to activities development along the river. There are no species to be protected necessarily.

The following measures could prevent further degradation.

- Construction work at the riverbed will be restricted to the dry season as much as possible.
- Appropriate drainage plan will be formulated beforehand.

**(8) Biota and ecosystems**

As shown in the section of 1.3.1.2(2) “Biological Conditions”, the area along Teouma River is well vegetated, though modified with secondary vegetation (shrub). The diversity of freshwater fauna is low due to the development activities. There are no species to be protected necessarily. Along the river and road, there are no trees of significant height that will be affected.

But in order to prevent further degradation, the following measures will be taken.

- An attention will be paid to wildlife at the time of site clearance (to check if there are nests along the river sides, in particular during breeding period)
- Construction work at the riverbed will restricted to the dry season as much as possible
- During the site clearance, the loss of vegetation should be restricted inside the construction area
- Temporary expropriated farmland plots must be returned after rehabilitation with top soil.

**(9) Hydrology**

[Construction phase]

Since there would be soil erosion due to the river improvement work, the following countermeasures will be taken.

- Construction work at the riverbed will restricted to dry season as much as possible
- The loss of vegetation should be restricted inside the construction area

[Operation phase]

The change of river course at the bridge could trigger a further meandering downstream.

In addition, the elevated access road would block the flow of overflown water from north to south at the time of heavy rain and could widen flooding area in floodplain at the left side of the river.

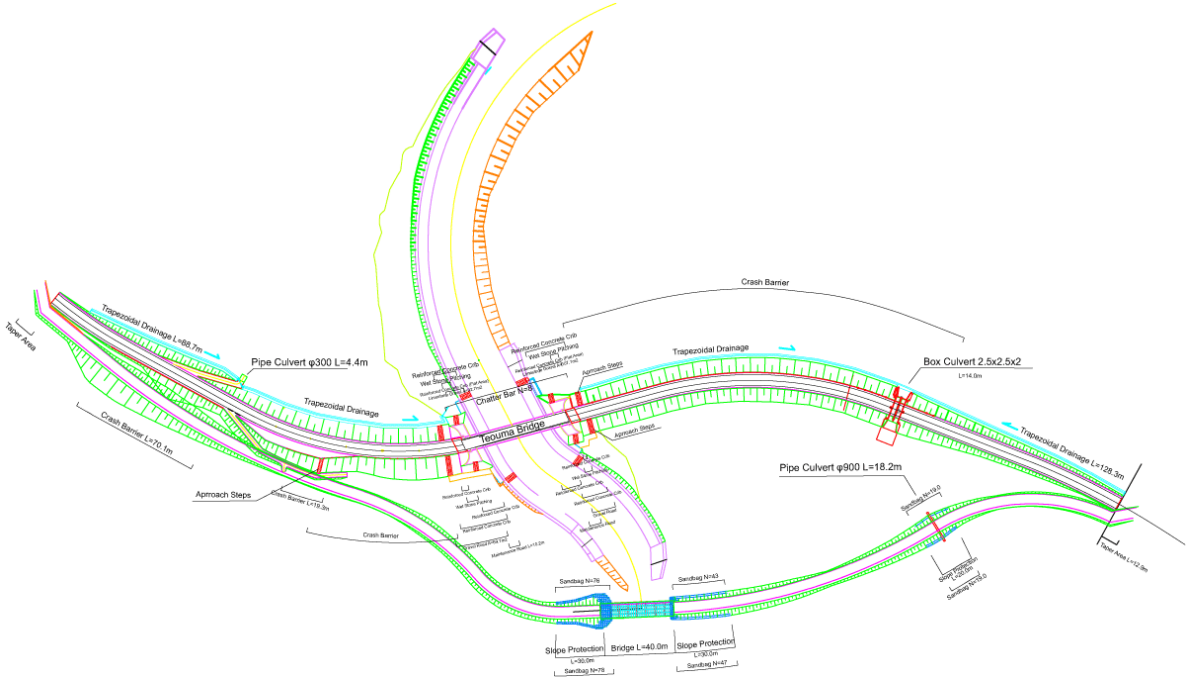
The following measures will be taken in order to mitigate these concerns:

Countermeasures against change of river channel

- Long term monitoring of river course will be conducted
- Construction of permanent structures near the river downstream should be restricted

Countermeasures against widening inundation area

- The trapezoidal drainage system will be installed along the north side of the access road and a box culvert will be buried under the access road in order to drain overflown water of flood plain to the south of the elevated waterproofing road. Please see Figure 1.3-7 below.




*Source: JICA study team*

**Figure 1.3-7 Drainage Systems along the Flood-proofing Road**

### (10) Geographical features/Landscape

Increasing elevation of the bridge and access road from 7.7 m to 10.4 m could change the landscape very much. It is a necessary action in order to protect new bridge for100-year return period flood. The following measures will assist to reduce and eliminate negative impacts of the landscape change to the daily life of local people:

- Steps to facilitate access to road and route along the riverbank under the bridge will be installed in order to connect both sides of the access road.
- Trapezoidal drainage system along the north of the access road with a box culvert will be installed, in order to prevent inundation.

### (11) Resettlement and Land acquisition

There will be no involuntary resettlement, but permanent and temporary land acquisition would be necessary. It is important to estimate and arrange compensation for land plots, structures, trees, and crops.

[Pre-construction phase]

- Resettlement action plan is formulated and implemented properly (refer to 1.3.2 Land Acquisition and Resettlement).

**(12) Vulnerable groups /Poor people**

According to the result of the RAP survey, no vulnerable groups or poor families were identified at the project area.

**(13) Local economy such as employment and livelihood**

The project would have positive effect on local economies, such as job creation (e.g. construction workers) and also increase in sales of food to construction workers. However, some houses will suffer from partial loss of farmland and business opportunities of selling vegetables along the access road.

[Pre-construction phase]

- The resettlement action plan is formulated and implemented properly (refer to 1.3.2 Land Acquisition and Resettlement).

[Construction phase]

- The Contractor should hire local people as construction worker fairly and impartially, when it needs to employ workers from local people.
- A place to fetch water will be constructed near the temporary bridge, so that local people can continue to use the river water for their business as well as drinking and domestic water.

**(14) Land use**

[Pre-construction]

During the construction work, a part of land plots and street stalls along the access road cannot be used temporarily. The following measures will be taken.

- The resettlement action plan is formulated and implemented properly (refer to 1.3.2 Land Acquisition and Resettlement).

[Operation phase]

The change of river course at the bridge section would change the river morphology in downstream in long term. This could affect farmland and houses in downstream. The following measures will be taken:

- Long term monitoring of river course will be conducted.
- Construction of permanent structures near the river in downstream should be restricted.

**(15) Water use**

[Construction phase]

Since Teouma River is the main source of water for local people, water contamination would be a serious problem. In addition, during the construction work, local people will lose access to river water. In order to mitigate these problems, the following measures will be taken:

- Construction work at the riverbed will be restricted to dry season.
- Construction work of pier and riverbank will be done by temporary cofferdam method, using steel sheet pile or sandbags.

- A sedimentation pond or drainage will be installed in order to treat wastewater after watering and washing tires and vehicles. An oil separator will be used, just in case.
- River steps will be installed near temporary bridge.

[Operation phase]

Access steps will be installed at 4 places near the new bridge. This makes it easier for local people to use river water.

**(16) Existing infrastructures and social services**

Traffic of the Ring Road will be interrupted and installed infrastructures along the access road cannot be used such as electric cable.

[Pre-construction phase]

- The relocation plan of installed infrastructures along the access road will be formulated and implemented in consultation with owners and authorities.
- Traffic management plan will be formulated. This plan should be reflected in the construction management plan.

[Construction phase]

- Traffic management plan will be implemented in order to mitigate problems such as traffic congestions.

[Operation phase]

- Turnoff will be constructed in the both side of the access road in order to secure the access to houses located on the both sides of the road.
- The pavements will be installed in both sides of the access and bridge road in order to secure the safety of pedestrians.

**(17) Unjustified sharing of benefits and damages**

[Pre-construction phase]

There would be economic gaps in project affected community and the following measures will be taken:

- A proper resettlement action plan will be formulated and implemented.

[Operation phase]

Traffic at the new Teouma Bridge will be secured even during 100-year return period flood. This is common benefit for all residents.

**(18) Local conflict of interests**

The main purpose of this project is replacing a bridge. No local conflicts of interest were observed during consultation meetings and interview surveys.

**(19) Cultural heritage**

No cultural heritages were identified in the project area during EIA survey.

### (20) Landscape

[Operation phase]

Increasing in the elevation of bridge and access road could change the landscape. However, Teouma River is not a scenic place and this change will not be a serious issue. The following measures will help local communities to adapt with the changes:

- Well explanation of the new bridge design in the consultation meetings
- Take necessary measures to improve convenience of constructed facilities for local communities to access road and riverbank, etc.

### (21) Gender and Children's right

No negative impacts of the project on gender and children's right are expected. However, it is recommended to pay attention in order to make sure of fair employment for female workers. Poorer states in Vanuatu have child labor issue in agricultural sector. However, this project site is in the area with very low poverty headcount rate. However, there is no comprehensive child protection law. It is recommended to check the age at the time of hiring even though child labor is not expected in this project.

### (22) Infectious diseases such as HIV/AIDS

The project is not expected to spread the infectious diseases such as HIV/AIDS as construction workers will be recruited locally.

### (23) Working conditions (work safety)

[Construction phase]

There would be accidents and injuries as well as health problems caused by dust and noise in the construction site. The following measures will be taken in order to mitigate these problems:

- The Work Safety Plan will be prepared based on the laws and regulations in Vanuatu and also international standards (OHSAS)
- Safety goods will be provided along with regular meetings and trainings as well as necessary measures such as watering will be implemented according to the safety plan.

### (24) Accidents

[Construction phase]

There is risk of accidents involving local residents and passenger cars. The following measures will be taken:

- A community safety plan will be formulated.
- Information of the construction plan will be shared. Necessary facilities will be installed such as fences between the construction site and surrounding houses.
- A traffic management plan will be formulated.
- Trained guards will be assigned and necessary facilities such as signboards will be installed in order to prevent accidents.

[Operation phase]

Due to the change of road alignment (longitudinal) and increase in traffic volume, the number of accidents is expected to increase for a while. The following measures will be implemented.

- Signboards will be installed.
- Information on the new road alignment will be disseminated by radio and newspaper.

## (25) Global Warming

Types, number and working days of trucks, heavy vehicles and machines are shown in the following Table 1.3-16:

**Table 1.3-16 Construction Machinery Schedule**

| code | Name | Specification | unit | number | operation days | 2020 | | | | | | 2021 | | | | | | | | | | 2022 | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| | | | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | |
| 1 | Bulldozer | 21t | vehicle | 1 | 670 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | Backhoe (extream long boom) | 0.45m3 | vehicle | 1 | 609 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | Backhoe | 0.8m3 | vehicle | 1 | 670 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | Dump truck | 10t | vehicle | 5 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | Motor grader | 3.1m | vehicle | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | Road roller | 10～12t | vehicle | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | Tire roller | 8～20t | vehicle | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8 | Rough Terrain Crane | 35t | vehicle | 1 | 639 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9 | Rough Terrain Crane | 35t | vehicle | 1 | 61 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10 | Crawler crane | 80t | vehicle | 1 | 33 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | Vibro-hammer | 60KW | vehicle | 1 | 639 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | Vibro-hammer | 60KW | vehicle | 1 | 61 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 13 | Large size breaker | 1,300kg class | breaker | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 14 | Generator | 125/150KVA | generator | 1 | 639 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 15 | Generator | 125/150KVA | generator | 1 | 61 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 16 | Generator | 25KVA | generator | 1 | 122 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 17 | Generator | 25KVA | generator | 1 | 518 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 18 | Generator | 25KVA | generator | 1 | 122 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 19 | Generator | 25KVA | generator | 1 | 700 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 20 | Distributer | 2000～3000ℓ | distributer | 1 | 7 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 21 | Line marker | walk behind type roller | marker | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 22 | Tamping rammer | 60～80kg | rammer | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 23 | Concrete pump truck | 90～110m3/hr, boom type | vehicle | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 24 | Rotary Press Fitting Machine | Nippon Sharyo DHJ-45 | machine | 1 | 68 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Japan | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | shipping periof | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

*Source: JICA study team*

The following construction materials will be procured from an authorized quarry in Efate. This material will be stored in a stock yard, located 2.1 km north-west of the bridge. Dump trucks will commute between the construction site and stock yard to carry construction materials.

- Soil for embankment work: 25,000 $m^3$ equivalent to volume of 5,000 dump trucks
- Stones: 2,000 $m^3$ equivalent to volume of 400 dump trucks

The location of the construction site, stockyard, and Bouffa disposal sites are shown in Figure 1.3-8 below.


*Source: JICA study team*

**Figure 1.3-8 Locations of Teouma Bridge, Stockyard, and Bouffa Landfill sites**

[Construction phase]

Greenhouse Gas (GHG) will be generated from trucks, heavy vehicles and machines. However, the volume of GHG is limited due to limited number of vehicles/machines. Mainly 4 heavy vehicles and 2 generators will travel in short distance between the stockyard and construction site.

$CO_2$ equivalent to GHG is estimated using the list of law emission vehicles and machines by Ministry of Land, Infrastructure, Transport and Tourism as well as based on reports of GHG generation amount by local governments and companies. It is assumed that the daily working hours of vehicles and machines are 6 hours. The result is shown in the table below.

| Heavy Vehicles | | kw | Working hours | Total working days | Fuel amount(l) | Basic Unit | CO2 (ton) | CO2 eq N2O(ton) |
|---|---|---|---|---|---|---|---|---|
| Bulldozer | 21 ton | 152 | 6 | 670 | 106,932 | 2.58 | 276 | 2.12 |
| Backhoe | 0.8m3 | 104 | 6 | 670 | 73,164 | 2.58 | 189 | 1.45 |
| Backhoe (extream long boom) | 0.4m3 | 60 | 6 | 609 | 38,367 | 2.58 | 99 | 0.76 |
| Rough Terrain Crane | 35 ton | 257 | 6 | 700 | 92,820 | 2.58 | 239 | 1.84 |
| Generstor | 150 kVA | 150 | 6 | 700 | 107,730 | 2.58 | 278 | 2.14 |
| Generator | 25 kVA | 30 | 6 | 1,462 | 43,860 | 2.58 | 113 | 0.87 |
| | | | | | | Total | 1,194 | 9.18 |

$CO_2$ equivalent to GHG generated from dump trucks is also estimated assuming traveling distance of 6.0 km including 4.2 km for round trip and 1.8 km traveling inside the construction area. The result is shown in the table below.

| Type | | No of trips | Travel Distance km | Total Travel Distance km | Fuel (l) | $CO_2$ (ton) | $CO_2$ eq $CH_4$ (ton) | $CO_2$ eq $N_2O$ (ton) | Total (ton) |
|---|---|---|---|---|---|---|---|---|---|
| Dump Truck | 10 ton | 5400 | 6 | 32,400 | 9,299 | 24 | 0.01 | 0.14 | 24.1 |

Total amount of $CO_2$ equivalent GHG is estimated at around 1,000 ton. This would have little impact on Global Warming.

[Operation phase]

Target construction area is very limited and completed project is expected to mitigate the negative impacts of the global warming. As the result, the impact of the project on cross border effect is not assumed.

The traffic volume is expected to increase in a light rate and limited number. Therefore, the impact of project on global warming is not much expected.

### 1.3.1.8 Impact Assessment

Result of the impact assessment is shown in the following Table 1.3-17.

**Table 1.3-17 Result of Impact Assessment**

| Category | | Items | Evaluation | | Evaluation | | Reason |
|---|---|---|---|---|---|---|---|
| | | | Pre/ During Construction | Operation | Before/ During Construction | Operation | |
| Anti-pollution measures | 1 | Air pollution | B- | C | B- | D | [Pre-Construction/Construction phase] Ambient air quality will be affected by the dust and emission gas generated during the preparation and construction work, but the impacts will be limited due to the limited number of heavy vehicles and trucks. [Operation phase] The traffic volume of the ring road is expected to increase, and this could affect the ambient air quality. But since the current volume is law, the impact of increased traffic volume is assumed to be small. The second phase of the ADB project will not increase the traffic volume at the bridge, since the main part of the work is in Port Vila. |
| | 2 | Water pollution | B- | D | B- | D | [Construction phase] Excavation/ embankment work along the river and the construction work of bridge pier could worsen river water quality during the construction period. Rainfall during or just after the embankment/Cut-earth work could cause soil erosion and river water pollution. (slope protection work could mitigate soil erosion during the operation phase) [Operation] Slope protection could prevent soil runoff. |

| Category | | Items | Evaluation | | Evaluation | | Reason |
|---|---|---|---|---|---|---|---|
| | | | Pre/ During Construction | Operation | Before/ During Construction | Operation | |
| | 3 | Soil Pollution | C | D | C- | D | [Construction phase] There is a possibility of soil contamination by oil during the maintenance work of heavy vehicles and trucks, but the area might be limited.<br>There is also a risk of oil/chemical leakage from the storage facilities.<br>[Operation phase] There are no element which cause soil pollution. |
| | 4 | Waste<br>✓ Municipal solid waste (MSW)<br>✓ Construction waste (CW) | B- | D | B- | D | [Construction phase] Camps for construction workers would not be arranged, and the problems caused by general waste would be very limited.<br>Construction waste such as excavated soil and concrete debris will be generated.<br>Organic waste and soil including organic waste will be also generated after the site clearance.<br>[Operation phase] There are no works which generate waste during the operation. |
| | 5 | Noise and Vibrations | B- | C | B- | D | [Construction phase] During the construction period, construction work will cause problems of noise and vibrations.<br>[Operation phase] Even though the traffic volume will be increased but the current noise level is now and the impact of the increased traffic volume on the noise level is limited and the noise level will not exceed the standards. |
| | 6 | Ground subsidence | D | D | D | D | There is no work which could cause ground subsidence. Based on the result of the ground survey, ground subsidence is not expected to occur |
| | | Soil erosion | B- | B- | B- | B- | [Construction phase] Construction work to widen and change the channel could cause soil erosion.<br>Rainfall during or just after the embankment/Cut-earth work could cause soil erosion.<br>[Operation phase] Change of river channel around the bridge could change the river channel downstream in the long term, and this would cause soil erosion, after the completion of the construction work. |
| | 7 | Offensive odors | D | D | D | D | [Construction]/[Operation] There is no activity to cause offensive odor. |
| Natural environment | 8 | Bottom sediment | B- | D | B- | D | [Construction phase] Construction of a pier and excavation work at the riverbed would have negative impacts on bottom sediment.<br>[Operation phase] The negative impacts on bottom sediment is not expected. |
| | 9 | Protection area | D | D | D | D | No national park or conservation areas inside the project areas were identified. |

| Category | | Items | Evaluation | | Evaluation | | Reason |
|---|---|---|---|---|---|---|---|
| | | | Pre/ During Construction | Operation | Before/ During Construction | Operation | |
| | 10 | Biota and ecosystems | B- | D | B- | D | [Construction phase] Channel widening and excavation work would have negative impacts on aquatic organisms, in particular Benthos. No endangered species were found.<br>[Operation phase] No negative impacts on ecosystems are not expected. |
| | 11 | Hydrology | B- | B- | B- | B- | [Construction phase] River improvement work could have impact on the hydrology of the downstream.<br>[Operation phase] Modified river alignment around the Teouma Bridge could have impacts on the alignment of the downstream.<br>The elevated access road could worsen the flooding north of the access road (left side of the river), but installation of drainage systems along the access road could mitigate this problem. |
| | 12 | Geographical features/ geology | B- | C | B- | B- | [Construction phase] The elevated access road and bridge changes the geographical feature.<br>[Operation phase] It is possible to mitigate problems caused by the change of the geographical feature, by installing steps to the access road and route along the river under the bridge to connect the both sides of the access road. |
| Social environment | 13 | Land acquisition and resettlement | B- | D | B- | D | [Pre-construction] No households need to be resettled, but a certain area of land is needed to be permanently expropriated or temporarily used as the detour.<br>Need to estimate the compensation amount for land, structures, trees and crops.<br>[Operation phase] No negative impacts are not expected. |
| | 14 | Vulnerable groups /Poor people | C | D | D | D | [Pre/During Construction] No issues of minority and indigenous people are identified, but if the result of social and economic survey finds issues to be solved, some kinds of support would be considered. Same as for poor people.<br>[Operation] Issues identified during the surveys will be dealt with. |
| | 15 | Local economies | B+/- | B+ | B+/- | B+ | [Construction] The project will bring about some benefits such as job creation and economic opportunities to sell foods/goods to workers, while some households will lose a part of farmland.<br>[Operation] During the flood, traffic of the ring road is secured and this could contribute to the local economic development. |

| Category | | Items | Evaluation | | Evaluation | | Reason |
|---|---|---|---|---|---|---|---|
| | | | Pre/ During Construction | Operation | Before/ During Construction | Operation | |
| | 16 | Land use | B- | D | B- | B- | [Construction phase] A part of farmland and roadside cannot be temporarily or permanently used.<br>[Operation phase] Modified river alignment around the Teouma Bridge could have impacts on the alignment of the downstream river in the long term, and this could affect the land use a little bit. |
| | 17 | Water use | B- | B+ | B- | B+ | [Construction] The construction work could worsen water quality and this would be problems of water use for both drinking and farming water purposes.<br>The right side riverbank just below the bridge is the place where people take water and do the laundry (some people come from other areas in order to do laundry by bus). During the construction work, a temporary place for fetching water is necessary.<br>[Operation] the river steps are planned to be installed at 4 places along the riverbank, and this will make it easier for local people to access to river water. |
| | 18 | Existing social infrastructures and Services | B- | B+ | B- | B+ | [Construction] The construction work will cause a problem of other infrastructure such as transmission line, as well as traffic congestion.<br>[Operation] After the project, the transportation network in Efate Island will be improved. |
| | 19 | Social institutions | D | D | D | D | [Construction] Land expropriation issues could affect the consensus formation in the community.<br>The project will not affect the local social institutions and decision-making body. |
| | 20 | Misdistribution of benefits and damages | B- | C- | B- | D | [Construction phase] The project could cause gaps among project affected households<br>[Operation phase] The project could ensure the main transportation system in Efate Island during the cyclone and this is a benefit for all the local people. |
| | 21 | Local conflicts of interest | B- | D | D | D | [Construction phase] This is a project of bridge replacement and would not cause local conflicts.<br>[Operation phase] No conflicts are expected. |
| | 22 | Cultural heritage | C | D | D | D | [Construction phase] No local archeological, historical, cultural, and religious heritages were identified inside and near the project area.<br>[Operation phase] Since there is no cultural heritage, no problems are expected. |
| | 23 | Landscape | B- | C- | D | D | [Construction phase] The project site is not a tourist site or scenic spot, the construction work with heavy vehicles will not be a problem.<br>[Operation phase] The elevation of the bridge and access road could change the landscape very much. At the consultation meetings, design and expected landscape were explained well and participants understood it. |

| Category | | Items | Evaluation | | Evaluation | | Reason |
|---|---|---|---|---|---|---|---|
| | | | Pre/ During Construction | Operation | Before/ During Construction | Operation | |
| | 24 | Gender/ Children's rights | C | D | B- | B+ | [Operation phase] Problems caused by gender bias and abuses of children's right are not expected to occur.<br>[Operation phase] The project is expected to mitigate flood problems and could bring about benefit for communities. Newly installed river steps at 4 places would ease their work using water. |
| | 25 | Infectious diseases such as HIV/AIDS | C | D | D | D | [Construction phase] Construction workers are planned to be recruited locally, so the infectious diseases such as HIV/AIDS are not expected to spread by the project.<br>[Operation phase] No spread of infectious disease is expected. |
| | 26 | Working conditions (work safety) | B- | D | B- | D | [Construction phase] There would be accidents, injuries and health problems at the construction sites.<br>[Operation phase] No problems related to work safety are not expected. |
| | 27 | Accidents | B- | B- | B- | B- | [Construction phase] There would be traffic accidents, involving local people, during the construction work.<br>[Operation phase] Elevation of the access road could cause traffic accidents for a certain period after the completion of the construction work |
| | 28 | Global warming | D | C | D | D | [Construction] A limited amount of global warming gas (GHS) will be emitted.<br>[Operation] The traffic volume might be slightly increased, and this increases the emission amount of GHS gas, but the effect on the global warming will be very limited. |

*Source: JICA study team*

### 1.3.1.9 Environmental Management Plan (Proposed Actions and Implementation Cost)

Proposed mitigation measures and implementation cost of these measures are summarized in the following Table 1.3-18:

**Table 1.3-18 Proposed Actions and Implantation Cost**

| No | Environmental Consideration | Suggested Actions and Mitigation Measures | Implementing Agencies | Responsible Organizations | Cost (USD) |
|---|---|---|---|---|---|
| Pre-construction phase | | | | | |
| 15 | Air pollution/ Noise and Vibrations | • Procure low noise and low emission vehicles and machines | Contractor | PWD | |
| 6 | Soil contamination | • Procure soils and stones from quarries with permission | Contractor | DEPC/PWD | - |
| 10 | Ecosystems | • Pay attentions to wildlife and restricted site-clearance inside the project area | Contractor | | - |
| 13 | Resettlement/ Land acquisition | • Land expropriation, arrangement of compensation, and supporting measures based on RAP | PWD | PWD/DOL | RAP cost |

| No | Environmental Consideration | Suggested Actions and Mitigation Measures | Implementing Agencies | Responsible Organizations | Cost (USD) |
|---|---|---|---|---|---|
| 15 | Local economy such as employment and livelihood | • Arrange the compensation and support based on the RAP | PWD | PWD/DOL | RAP cost |
| | | • Employ local people as construction workers<br>• Make sure of no discrimination against women<br>• Check the age of workers | Contractor | | Included in BoQ |
| Construction phase | | | | | |
| 1 | Air pollution | • Watering at storage place and construction site and washing tires of trucks<br>• Regular check of the conditions of heavy vehicles and trucks<br>• Try to avoid and minimize idling all vehicles<br>• Using sheet to cover truck box | Contractor | DEPC/PWD | Included in BoQ |
| 2 | Water contamination | • Construction work in the riverbed will be done in dry season<br>• Temporary cofferdam method will be used at the time of pier construction and river embankment work<br>• After watering and washing tires, a countermeasure, such as sedimentation tank will be taken in order to prevent sediment from flowing out to the river directly. | Contractor | DEPC/PWD | Included in BoQ |
| 3 | Waste | • Dispose of organic waste and soil mixed with organic waste after the site clearance work at the Bouffa Landfill.<br>• Store excavated soil and concrete debris at a temporary storage place and reuse as embankment soil and filling soil respectively<br>• Surplus soil will be brought back to the stock yard and reused later | Contractor | DEPC/PWD | Included in BoQ |
| 4 | Soil Contamination | • Use oil tray at the time of maintenance work in order to prevent soil contamination<br>• Proper storage of oil and chemicals (oil spill over management) | Contractor | DEPC/PWD | Included in BoQ |
| 5 | Noise and Vibrations | • Regular maintenance of heavy vehicle and machines will be implemented in order to prevent abnormal sound and vibrations<br>• Noisy heavy vehicles and machines will not be operated simultaneously as much as possible<br>• Safety goods are provided for workers who work near the machine, which causes noise and vibrations<br>• Noise levels will be regularly measured | Contractor | DEPC/PWD | Included in BoQ |
| 6 | Soil erosion | • Construction work in the riverbed will be done in dry season<br>• Proper drainage will be planned in advance<br>• Temporary cofferdam method will be | Contractor | DEPC/PWD | Included in BoQ |

| No | Environmental Consideration | Suggested Actions and Mitigation Measures | Implementing Agencies | Responsible Organizations | Cost (USD) |
|---|---|---|---|---|---|
| | | used at the time of pier construction and river embankment work | | | |
| 8 | Bed sediments | • Construction work in the riverbed will be done in dry season<br>• Temporary cofferdam method will be used at the time of pier construction and river embankment work<br>• Proper drainage will be planned in advanced | | | |
| 10 | Biota and ecosystems | • Construction work in the riverbed will be done in dry season<br>• Temporary expropriated farmland plots will be returned after rehabilitation. | Contractor | DEPC/PWD | Included in BoQ |
| 11 | Hydrology | • Construction work in the riverbed will be done in dry season<br>• Proper drainage will be made beforehand | Contractor | DEPC/PWD | Included in BoQ |
| 18 | Water use | • Same as water contamination<br>• A place for fetching water will be construction near the temporary bridge | Contractor /WASAC | DEPC/PWD | Included in BoQ |
| 19 | Existing infrastructures and social services | • The relocation plan of infrastructures along the access road will be formulated and implemented, in consultation with owners of infrastructures.<br>• A traffic management will be planed<br>• The plan will be implemented, assigning a person who guides traffic and installing signboards, and so on | Contractor | PWD/Police Force/Organizations concerned | Included in BoQ |
| 26 | Work Conditions including Work Safety | • Prepare for Work Safety Plan based on the Vanuatu laws and international standards such as OHSAS<br>• Provide safe goods such as masks and globes for workers<br>• Provide training programs of work safety and organize regular meetings with workers in order to promote awareness of work safety | Contractor | PWD/ | Included in BoQ |
| 29 | Accidents | • Development of a Community safety plan<br>• Take countermeasures such as disseminating information on construction work schedule, installing fences between construction site and houses, and assigning a trained guard, in order to prevent accidents<br>• Development of a traffic management plan<br>• Assign a guard to guide traffic and install signboards, in order to prevent accidents between trucks and private passenger vehicle | Contractor | PWD/ Police Force/Local authority | Included in BoQ |
| Operation phase | | | | | |
| 11 | Hydrology | • Monitor the river morphology in the long term | PWD | PWD | USD600 |
| 29 | Accidents | • Provide the information on new road | | PWD | USD5000 |

| No | Environmental Consideration | Suggested Actions and Mitigation Measures | Implementing Agencies | Responsible Organizations | Cost (USD) |
|---|---|---|---|---|---|
| | | alignment on radio and other media and install signboards<br>• Collect data on accidents | | | |

*Source: JICA study team*

### 1.3.1.10 Environmental Management and Monitoring Plan (Implementation details, Methodology and Cost)

The following Environmental and Monitoring Plan will be implemented in order to monitor mitigation measures during pre-construction, construction and operation/maintenance phase.

**Table 1.3-19 Environmental Management and Monitoring Plan (EMMP)**

| Environmental Issues | Monitoring Items | Parameter /Indicator | Location | Frequency | Responsible | Cost |
|---|---|---|---|---|---|---|
| Pre-construction and site mobilization phase | | | | | | |
| Land expropriation, compensation payment and other support | Compensation for land and lost structure | Number of structures expropriated<br>Area of land expropriated | Project area | Once before construction | PWD | RAP monitoring |
| | Complaints resolutions | GRM log book | Project area | | DOL | RAP monitoring |
| Ecosystem | Site clearance activities | Approval of cutting trees<br>Record of site clearance<br>Records of waste disposal (Bouffa) | | | | |
| Air Pollution/ Noise & vibrations | Equipment and automobiles with less emission gas and noise | Number of automobiles with certification on site | | As appropriate | Contractor | No cost applicable to monitor. |
| Soil Erosion | Source of construction materials such as soil and stones | Quarry permission | | once | | No cost |
| Construction phase | | | | | | |
| Accident and Incident | Complaint (in general such as noise, traffic jam, and accidents) | Records of complaints | Project area | | Contractor PWD | Construction cost |
| Air Pollution | Equipment and automobiles in good shape | Regular inspection and maintenance (daily check sheet) | Project area | Daily | Contractor | No cost applicable to monitor. |

| Environmental Issues | Monitoring Items | Parameter /Indicator | Location | Frequency | Responsible | Cost |
|---|---|---|---|---|---|---|
| | Air quality | Level of dust: observed by contractor<br><br>Observed by community (community survey) | Project area | Daily<br><br>Quarterly | Contractor | Construction cost<br><br>USD 2,000 |
| | Mitigation measures such as spraying of water, washing tires, covering loaded materials | Records on water spay/ washing (check sheet) | Project area | Daily | Contractor | Construction cost |
| Water Contamination | Surface water quality | Temperature, pH, EC (by portable water quality meter)<br>oil & grease (observation) | Upper site/ lower site of the river | Weekly | Contractor | US$ 2,000 |
| | Mitigation measures | Records of mitigation activities (check sheet) | Project area | Daily | Contractor | Construction cost |
| Noise and Vibrations | Restriction of noise/vibration emitting activities to working hours. | Noise level by portable noise meter<br><br>Observed by community (community survey) | Project area | At the time of earth works<br><br>Quarterly | Contractor | US$ 1,000<br><br>(Along with air pollution) |
| Soil Contamination | Check prevention measures of oil contamination | Prevention measures are done or not (based on daily check sheet) | Project area | Monthly | Contractor | Construction cost |
| Soil Erosion | Check the conditions of river bank | Conditions (check sheet) | Project area | Monthly | Contractor | Construction cost |
| Waste | Management of excavated soil, concrete debris and others | Proper storage nor not (based on check sheet)<br>reuse (check list) | Project area | Monthly | Contractor | Construction cost |
| | Management of general waste | Records of waste disposal | Project area | Monthly | Contractor | Construction cost |
| Bed sediment/ Ecosystem | Mitigation measures | Mitigation measures are done or not (based on daily check sheet) | Project area | Monthly | Contractor | Construction cost |
| Work conditions | Occupational Safety and Health plan | Availability of OHS Plan | | Monthly | Contractor | Construction cost |

| Environmental Issues | Monitoring Items | Parameter /Indicator | Location | Frequency | Responsible | Cost |
|---|---|---|---|---|---|---|
| | Meetings and trainings | Number of meetings and trainings | | | | |
| | Safety goods for workers | Number of workers with safety gear | | | | |
| | Noise and vibrations | (from noise and vibrations) | | (from noise and vibrations) | | |
| | Occurrence of accidents and injuries | Records of accident and injuries | Project area | Monthly | | |
| Accident/ Traffic Congestions | Traffic Management Plan | Availability of TMP | Project area | Monthly | Contractor | Construction cost |
| | Implementation of TMP | Availability of guard, signboard, and so on (activity records) | Project area | Monthly | Contractor | Construction cost |
| Water use | Mitigation measures of water quality | (from water pollution) | | | | Construction cost |
| | Conditions of place to fetch water | Observation by the Contractor | Project area | Monthly | Contractor community | Construction cost |
| | | Observed by community (community survey) | | Quarterly | | (along with air pollution) |
| Local Economy | Local economy (sales, employment, and so on) | Observed by community (community survey) | Communities near the project area | Quarterly | | (along with air pollution) |
| Operation phase | | | | | | |
| Accident | Number of accident Prevention measures | | | Monthly | PWD | Operational cost |
| Hydrology | River morphology in downstream | | | One a year | PWD | Operational cost |
| | **Total cost for monitoring** | | | | | **USD 5,000** |

*Source: DEPC annual environmental audit (the Contractor will bear the cost)*

#### 1.3.1.11 Stakeholder Meetings

Formal stakeholder meetings were organized in three phases, (a) at the time of scoping, (b) during environmental, socio-economic and inventory survey phase, and (c) during drafting of EIA report/RAP phase. Notice of the meeting was given in advance in Daily Posts, along with on national radio and social medial especially Facebook.

These consultation meetings have been organized from May to December 2018 by participation of government agencies, landlords, community leaders and interested groups such as market vendors and female groups. The following were the main objectives of meetings:

- promote partnerships with stakeholder communities
- Information sharing on project and its components and activities
- Communicate with stakeholders that their cooperation and participation is essential in Project activities including surveys, site investigations, planning, feasibility study and design, construction, monitoring and maintenance.

### (1) Project Scoping Phase

The first two meetings held as stakeholder inception meetings to introduce the project and its scope. Outlines of these two meetings are summarized in the following Table 1.3-20.

#### 1) Stakeholder consultation meetings on environmental & social considerations

**Table 1.3-20 Stakeholder Consultation Meeting**

| | |
|---|---|
| **Date:** | 23 May 2018 |
| **Venue:** | PWD Head Office – Conference Room |
| **Participants:**<br>**Combination of Participants:** | 28 (Male – 21; Female – 7)<br>• Local Residents – 14<br>• Officers from related government offices – 5<br>• JICA – 2<br>• JST – 7 |
| **Agenda:** | 1. Presentation of the project (by PWD)<br>1) Objectives of meeting, 2) Background, 3) Review of former meeting (Dec. 2016), 4) Outline of the project, 5) Environmental & Social considerations in the Project Area, 6) Compensation and Assistance, 7) Request for assistance, 8) Tentative schedule, 9) Open forum.<br>2. Exchange of opinions |

*Source: JICA study team*

Questions and Answers at the meetings are summarized in Table 1.3-21 below.

**Table 1.3-21 Questions and Answers**

| No | Name | Questions/Suggestions | Responses |
|---|---|---|---|
| 1 | Harold | Priorities should be given to local residents in terms of jobs opportunities for construction workers. | This will be taken into consideration and will be informed to contractor (JST/PWD) |
| 2 | J. Chabod | How about the acquisition of leased land in the upstream? | The acquired land will be compensated including properties based on the cost estimation report provided by the DOL. (JST/PWD). |
| 3 | Resident | How about compensation for properties? | All properties that will be affected by the project will be compensated and must be included in cost estimation report. (JST/PWD) |
| 4 | Resident | How about using acquired land for washing and swimming, etc? | The acquired land will not be fenced or restricted. So, residents can still use the land after the construction work finishes.<br>It is necessary for the government to have unlimited access to this area for construction works and for maintenance purposes in the future. (JST/PWD) |

| No | Name | Questions/Suggestions | Responses |
|---|---|---|---|
| 5 | SG SHEFA | Do we need compulsory acquisition, rather than just asking to have access to land? | The government intends to acquire land to minimize properties issue between government, and landowner during design, construction of concrete for river bank protection and also in the future for maintenance purposes.<br>Some river works was stopped by one of tenant when the bridge was damaged by Cyclone PAM in 2015. The project has not continued since then. It is necessary to prevent this from happening again. (PWD) |
| 6 | Resident | Will concrete river protection cause any problems in future? | The works will include widening of the river from 30m to 50m, construction of concrete river bank protection wall to stop erosion on LHS upstream and a proper alignment of the river to ensure it flows in its correct path and also protect bridge from future disasters. (JST) |
| 7 | DOL officer | Ministry of Lands has received a letter from MIPU to start the process of compulsory land acquisition.<br>DOL valuation team will then carry out their assessments with a submitted survey plan.<br>Compensation will be done according to valuation report assessments and payments will be made to landowner.<br>All rented properties will be also assessed for compensation.<br>From now till 2019, all tenants should work closely with DOL to ensure they receive a fair compensation. | Noted (JST/PWD) |

*Source: JICA study team*

At the end of the meeting, PWD asked participants to help identify the unknown tenant for the leased land as shown in the map.

**2) Preparatory Stakeholder Inception Meeting**

**Table 1.3-22 Preparatory Stakeholder Inception Meeting**

| | |
|---|---|
| Date: | 13 June 2018, 0900 – 1100 |
| Venue: | PWD Head Office Conference Room |
| Participants: 23<br>(Male: 16, Female: 7)<br>Combination of Participants: | Local residents: 15 (M. Nasak et al)<br>DOL: P. Gambetta, R. Aru<br>SHEFA Province : Z. Daniel<br>EIA Consultant (QC) : Y. Qualao<br>PWD : A. Nafuki<br>EIA consultant (AEA) : A. Williams, J. Williams |
| Agenda: | • Project Presentation<br>• Environmental & Social Impacts and Mitigation Measures<br>• Tentative Schedule<br>• Exchanging Ideas (Q&A)<br>• Acceptance of the Project |

*Source: JICA study team*

Questions and Answers at the meetings are summarized in Table 1.3-23 below.

**Table 1.3-23 Questions and Answers**

| No | Name | Questions/Suggestions | Responses |
|---|---|---|---|
| 1 | Chief Representative K. Sandy | Compensation has been paid only for the expropriated farmland during the construction of the first bridge. Need to know the compensation policies clearly this time. | This is noted and will be taken up as part of the Consultation Process. This will be discussed with the government offices concerned too. (PWD/ JST) |
| 2 | | Effluent from the landfill at Etas would pollute the water of Teouma River? | New bill passed in Parliament to deal with waste is a positive way forward. (JST) |
| 3 | Resident | Stated concern on safety of access to river water | Steps to access river water will be installed for the safe access to river water. (JST) |
| 4 | Chief rep | Is it expected to have more floods in the upstream areas due to increase in the elevation of road and blockage? Moreover, whether the increase in river width to 50 m will impact water flow/velocity or not? | Construction work will include excavation of river bed and an embankment to keep the elevation level enough for water flow. (JST/PWD) |
| 5 | Resident | Is sedimentation in the riverbed would cause more floods? | |
| 6 | Resident | Whether the drainage system planned to be installed under the access road could divert run-offs completely straight into river rather than block mid-way causing flooding on residential properties near the river banks? | It is taken note of and will be referred to project proponents for consideration in design. (JST/PWD) |
| 7 | Resident | Whether they will have another water source during the construction phase? | The Social Impact Assessment (SIA) will deal with concern during the consultation phase. (JST) |
| 8 | Chief rep | How river bank users will be compensated? | Director of Land (DOL) deals with land compensation process. DOL will evaluate damages to the agriculture products in gardens that need to be expropriated.<br>DOL will work with PWD to verify boundaries. (PWD/DOL) |
| 9 | Resident | DOA has given them a form to fill up with lots of details of crops in their garden, etc. However, no support to fill it up. They need support on this. | EIA team will assist the residents to complete the forms. (JST) |
| 10 | Resident | Where will temp road be built? | At the moment, it is considering south of the current structure (JST/PWD) |

*Source: JICA study team*

At the end of the meeting, participants agreed to hold next consultation meeting on Wednesday 20 June 2018 at Chief Jack Kalmet community hall.

### (2) Survey Phase

#### 1) First Public Consultation of the Environment & Social Impact Assessment (ESIA)

The third consultation meeting was organized as Public Consultation just before the start of the Environmental, Socio-economic and inventory survey. Outline of the meeting is summarized in the following Table 1.3-24.

**Table 1.3-24 Public Consultation of the Environment & Social Impact Assessment (ESIA)**

| | |
|---|---|
| Date: | 20 June 2018, 0940 – 1145 |
| Venue: | Chief Andrew Kalpoilep's Community hall. |
| Participants: 26<br>(Male: 19, Female: 7)<br>Combination of Participants: | Local residents of project area: 15<br>Local residents of other area: 2<br>DOL : I. Nango, D. Steve<br>JICA : R. Boekara, K. Ohara<br>DEPC : O. Melenamu<br>PWD : U. Nafuki, A. Iatipu<br>EIA consultant (AEA and QC) : A. Williams, N. Tamara |
| Agenda: | • Project Presentation<br>• Contents and schedule of the Environment and Social impact survey |

*Source: JICA study team*

Questions and answers at the meeting are summarized in Table 1.3-25 below.

**Table 1.3-25 Questions and Answers**

| No | Name | Questions/Suggestions | Responses |
|---|---|---|---|
| 1 | Paramount chief | Insisted that the project must proceed without delay to ensure connectivity of movement, facilitate the development and ensure the safety of people at the heavy rain or cyclone. Assured that there is no land dispute. | Noted by PWD |
| 2 | Resident | Insisted that the new bridge should last long, unlike the previous bridge and Mele Bridge. | Noted by PWD |
| 3 | JST | There is a tourism operator in the south side of the bridge where temporary by-pass will be constructed. More detailed on this will be provided to find out best options for this cultural dance tourism site. | |
| 4 | Chief rep | Raised the compensation issues again with respect to the previous project. | DOL rep noted and informed that they would start the survey this week. |
| 5 | Residents | Stated concerns about safety of water use and alternative water resources.<br>Suggested borehole drilling and installation of a solar pumps.<br>Expansion of the Port Vila Urban Water Supply System was also discussed. | To be considered (PWD/JST) |
| 6 | Resident | Boundary of one leased land plot has not been determined yet | DOL working with PWD will verify the boundary (DOL/PWD) |
| 7 | Residents rep | Requested DOA officer support them to fill the forms of crops and other agricultural products. | Noted (PWD/JST) |
| 8 | Resident | Where is location of detour and is it affect her farmland? | The location has not decided yet, but probably south of the existing road. The survey will investigate which crops and structures would be affected. (JST) |

*Source: JICA study team*

The EIA consultant asked participants from local communities to support ESIA survey. A community close to bridge agrees to meet with the consulting Team on Sunday 25th June 2018 at 3pm. They also agree to conduct interview survey with residents who work during daytime.

Paramount Chief has also agreed to utilize Chief Kalpoleb's community hall at any time for meetings and consultations related to the project.

### (3) Draft Phase

#### 1) Second Public Consultation of the Environment and Social Impact Assessment (ESIA)

The Public Consultation was organized in order to present the result of the ESIA survey including mitigation measures and to consult with stakeholders about the project plan. Outline of the meeting is shown in the following Table 1.3-26.

**Table 1.3-26 Public Consultation of the Environment & Social Impact Assessment (ESIA)**

| | |
|---|---|
| Date: | 24 December 2018, 0945 – 1130 |
| Venue: | Chief Andrew Kalpoilep's Community hall. |
| Participants: 20<br>(Male: 16, Female: 4)<br>Combination of Participants: | Local Residents – 16<br>Civil Servants (DOL& PWD - VGov) – 1<br>JICA - 1<br>AEA – 1<br>Other - 1 |
| Agenda: | • Project Presentation<br>• Environmental Conditions (EIA)<br>• Social Condition (Lands, Crops, Assets and Compensation including business operations after the cut-off date)<br>• Open Forum (Q&A/Discussions)<br>• Acceptance of the Project |

*Source: JICA study team*

The questions and answers at the public consultation are summarized in the following Table 1.3-27. The participants from communities in the project area asked mainly about policies and compensation procedures.

**Table 1.3-27 Questions and Answers**

| No | Name | Questions/Suggestions | Responses |
|---|---|---|---|
| 1 | Mr. Alilee | What is impacts of project on mamas market stall? | Markets stalls will be relocated and compensation for the loss of income will be arranged. (JST) |
| 2 | | How will new bridge look? | The length will be extended to 58 m and the height increased by 3 m. (showing a slide) |
| 3 | Mr. Japheth | How about his leased land without pegs? | Due to the peg issues, revaluation has been done recently done by lands department. Original survey docs have required for the review. |
| 4 | Resident | Weather houses and other structures will be affected by project? | Any affected structures will be compensated. (JST) |
| 5 | Resident | Express concern about drainage system considered in the new road. It would be better than the current system? | The new design would improve the drainage functions. (JST) |
| 6 | Mr. Alilee | Weather riverbanks and walls will be enhanced?<br>It is necessary to secure the access to the river water. | Yes, they will be enhanced.<br>River steps will be installed. The locations will be decided based on the convenience of local residents. (JST) |
| 7 | Resident | Will construction work disturb commuters? | The detour will be constructed, and the construction work will not affect commuters. |
| 8 | Resident | Weather considering importance of access to clean water? | Yes, it is considered. (PWD/ JST) |

| | | | |
|---|---|---|---|
| 9 | Resident | Insisted to install pumps far away from river. | This request is received. (PWD/JST) |

*Source: JICA study team*

At the end of the meeting, participants were asked the following questions:

- Do we support the project?
- Why we support or not?
- Will you be able to support the project?

All participants from local communities were supportive to thus project. Following people provided their motivation to support the project.

| Commentator | Reason to Support |
|---|---|
| Mr. Charles Rodin | Totally agree to support project.<br>The project will provide job opportunities for communities within and surrounding the project area. |
| Mr. Marakon Alililee | Fully support the project.<br>He believes design of new bridge will make it safer. He also mentioned water issues are affecting communities. He says it is good to widen the river channel with respect to climate change and potential more rainfall. Thus, communities must support the project. More importantly the community population will be given the priority to work in the project. He hopes it is not like some current contractors of road works around Port Vila. |
| Mr. Noel Takau (on behalf of Chief Andrew Kalpoilep) | Fully support the project from day one.<br>He stated that bridge will help community members and so they will support the project. It will facilitate and also encourage investors to come and invest in the area. He further emphasized job opportunities for youths and community members. |
| Mrs Emma Japeth | Totally agree to support project.<br>She mentioned since the Chief and Landowner Rep have already promised to support the project, all land and resource owners would like to do so. |
| Other participants | They are all agreed to support the project to proceed. |
| **Number of participants who answered yes or no to support the project** | |
| Yes | 14 participants (Approval rate: 100%) |
| No | Zero |

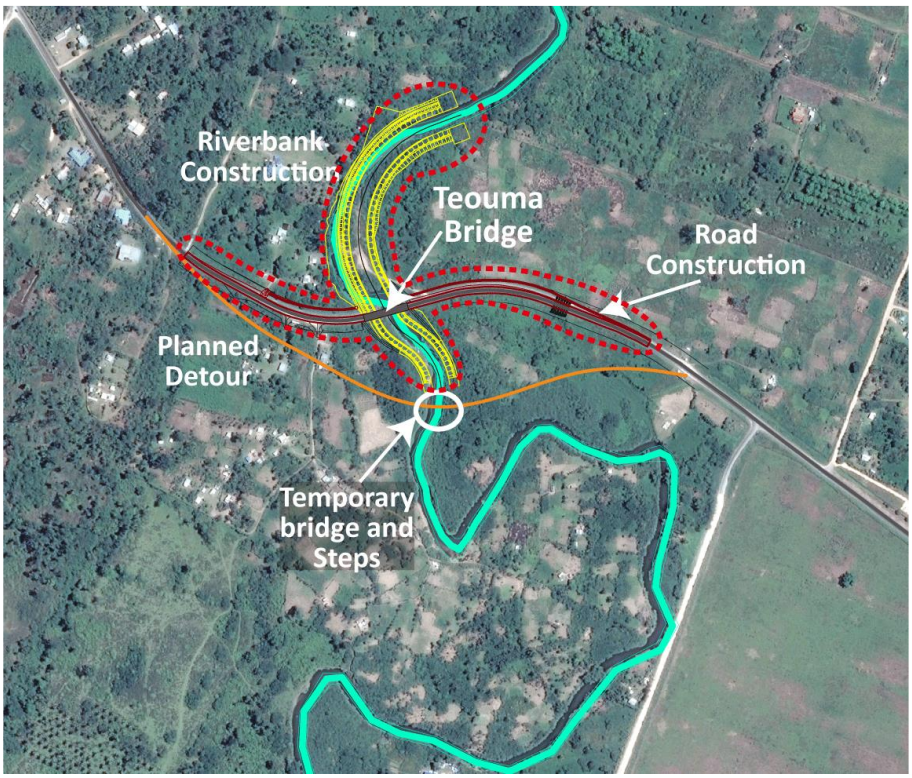
### 1.3.2 Land Acquisition and Resettlement

#### 1.3.2.1 Target Area for Action Plan

The following project components are selected as the priority project and become the target to develop a tangible land acquisition and resettlement action plan for the future project.

1. Rehabilitation of Teouma Bridge : Rehabilitation with extension of the old bridge from 30 m to 58 m and widening it from 6.5 m to 9.5 m.
2. Improvement of Teouma River : Improvement of both-side embankments and riverine from 250 m upstream to 110 m downstream of Teouma Bridge in 50 m width
3. Improvement of access road : Prevention of inundation and overflow by flood in upstream by increasing +3 m in elevation (+3 m)

Figure 1.3-9 shows locations of each component. Details of these project components are discussed in Chapter 2 of this report.




*Source: JICA Study Team*

**Figure 1.3-9 Location of Project Components**

### 1.3.2.2 Outline of Laws and Regulations regarding Land Acquisition and Resettlement

#### (1) The Constitution 1980

The Constitution as "the supreme Law of Vanuatu, contains two sections related to land acquisition and resettlement. Chapter 5, Articles 29 to 32 of the Constitution refers to "National Council of Chiefs". Article 30, in particular, recognizes National Council of Chiefs membership having authority to discuss, and may be consulted on, any issue related to customs, culture and its preservation in any matter, as required by the National Government.

Chapter 12 is another chapter considering the traditional ties between Vanuatu nationals and the land. Therefore, the majority of discussions related to land have centered on Articles 30 (in Chapter 5) and Articles 73, 74, 75 and 76 of Chapter 12. However, it would be safer to consider all nine articles of Chapter 12 (articles 73 to 81) are related to Land Acquisition and Resettlement depending upon the situation. This following are summary articles:

- All land is owned by its traditional, customary owners; parliament prescribes the criteria for compensation payment for land;

- The Government may own and acquire land for State interest and may redistribute land away from traditional owners, in such cases as informal settlements and relocating of residents from other islands; and
- Disputes in land ownership.

**(2) Land Reform Act 1980, last amended in 2014**

This Act specifies all land titles are belonging to customary or transferred to the traditional owners, whose lineage can be traced back locally to 200 years. It specifically outlines indigenous owners and the non-indigenous land users.

**(3) Land Leases Act 1988, last amended in 2013**

The Act has 23 sections that discuss Land Records Office and laws regarding leases including its definition, terms, types, registration and obligations of landlord and tenant. Of relevance to a project are the discussions on requirement to provide rights of access, rights of water and rights to sites for government infrastructure.

The Act also discusses variation of agreements and condition of lease by the Ministry of Lands and Natural Resources (MOL). This is where a change of lease agreement using a prescribed form under this Act may be executed by both landlord and tenant prior to the expiration of the lease. A landlord also may sublease the land for the remaining life of the lease. The Act also includes the registration of caution or restrictions, including its definition such as mortgage or claims arising from bankruptcy, its placement and removal on a leased property. The leaseholder may also grant easement over his land. Fees imposed on subleasing of leaseholds are also provided in the Act.

**(4) Land Acquisition Act 1992, last amended in 2000**

The Act is the key law directly related to Land Acquisition and Resettlement. This Act, gives the MOL, full discretionary powers to acquire land on behalf of the Government. It covers to an extent, that which will be compensated under the Act:

- Compensation for damages made during the process of land valuation;
- Compensation entitlements for land and for rents and business losses;
- Basic rights for grievance and appeals; and
- Notice periods.

This Act does recognize market value compensation for land but is very vague in compensation entitlements for rents and businesses.

**(5) Custom Land Management Act 2013, last amended in 2014**

This Act strengthens the legal framework concerning title to custom land and also discusses management of custom land by customary institutions. It formalizes recognition of customary institutions termed 'NAKAMALS', which means the traditional meeting and 'Custom Area Land Tribunals' to determine the rules of custom as the basis of ownership and use of land in Vanuatu. In general, the Act aims at holding of custom land by owners as a cluster. Custom land means land owned or occupied, or land in which an interest is held, by one or more persons in accordance with the rules of custom. For the purposes of this Act, each island is divided into "Custom Areas". Larger islands are divided into many custom areas.

The Act also provides for appointment of a National Coordinator of Land Dispute Management and provides with respect to the process of determination of custom owners and determination of land disputes by NAKAMALS or "Custom Area Land Tribunals and review of such determinations by court. A custom land must not be registered under the Land Leases Act unless the National Coordinator confirms by certification of the custom owners list, the names of the custom owners and the representatives of the custom owners, who may sign on behalf of the custom owners.

**(6) Customary Land Tribunal Act 2001, last amended in 2014**

As per the title, this Act details the set-up of the Customary Land Tribunal at village, island levels as well as its basic terms of reference (TOR) especially for dispute resolution and process for affected person to appeal the tribunal decision.

**(7) Valuation of Land Act 2002**

This Act stipulates relates to the organization of the "Valuation General Office" and their role. The Act does not stipulate minimum approach to valuation of the land, which is more directly specified in the "Land Acquisition Act". Furthermore, this Act is unclear about the role of the Valuation General Office in terms of relocation/involuntary displacement of households as well as valuation of structures, incomes and businesses.

### 1.3.2.3 Practices in Resettlement and Land Acquisition

**(1) Identification of Areas for Acquisition**

A majority of Government land acquisition in Vanuatu has been for smaller social services projects such as for village health facilities and educational institutions. The land acquisition legislation and process have not been utilized for urban development infrastructure projects. In the year prior to an infrastructure development project, each Ministry and other Government agencies will develop a work plans for the following fiscal year. This is inclusive of the other feasibility study requirements such as budgeting, environmental, engineering etc. At this time proposals for projects where land acquisition is involved should be submitted. This is subject to the approval of the Council of Ministers. There is no minimum standard that requires the projects to minimize land acquisition and impact on the community.

**(2) Process for Relocation and Land Acquisition**

On an annual basis, the Government allocates in its National budget 200 million VT (approximately 1.82 million USD, as of December 2018) for Government Land Acquisition projects. According to MOL, if the budget is not spent the remaining amount accrues on top of the normal, annual 200 million VT budget. In the event that the budget is used up, with finances still required, the Government and Ministry executing a project, is responsible to find further finances to cover the necessary Land Acquisition budget requirement.

Once a plot of land is selected for a government project, a notice signed by the Minister of MOL is provided to the customary owners/title holders and a public notice is erected in full public view. The notice is made for a minimum of 30 days.

After this period, the land is assessed and valued. The land valuation is stipulated by law, but generally involves valuing of the following:

1. Lease type – residential/agricultural/commercial/special industrial;
2. Location of property from CBD, aesthetic view, amenities, waterfront, type of neighborhood;
3. Marketability – number of properties marketed nearby in recent times and price range of those transactions;
4. Physical characteristics – terrain, vegetation, soil type, improvements made and size; and
5. Intangibles – interest, customary and other resource rights attached.

Valuations include both land and structures affected and may include value of income produced from land. However, this does not include "non-land producing" incomes such as income from shop business etc. Any damage to the land, caused by valuation investigations, is by law, liable for compensation to the existing owners. Once the valuation has been made and signed by the Minister, the owners have 30 days to file objections, at the same time, the MOL must disclose information on the valuation and proposed land acquisition over a 30-day period by radio at least 3 times on separate occasions, in one national newspaper each week, on the main notice boards and on the land itself. Objections must be lodged within this 30 days period, and on decision by the Minister, the objector, if dissatisfied, may appeal the Minister's decision through the Supreme Court of Vanuatu. However, if the issues are related to tradition and custom, then the National Council of Chiefs may be consulted, if necessary, although not compulsory.

**(3) Carrying out the Acquisition of Land/Structures**

After a 30-day notice period, and as long as all conflict claims and complaints are resolved, the physical compensation processes can then commence. The MOL is responsible for this process, monitored by the Ministry of Finance and Economic Management (MFEM). However, problems in moving through this stage may include complaints about the process of valuation to compensation itself; and process of the assessment of disputes. This is generally supposed to be settled through the Customary Lands Tribunal, or if unresolved, through the Supreme Court.

The land acquisition usually needs a period of 6 to 8 months from the application to completion. The period, however, can be shortened with the degree of project importance or interest by the Government of Vanuatu.

#### 1.3.2.4 Comparison between JICA Policy and Vanuatu Resettlement Laws

**(1) JICA Policy for Resettlement**

JICA Policy for resettlement includes the following items:

(a) Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives.
(b) When, after such an examination, avoidance is proved unfeasible, effective measures to minimize impact and to compensate for losses must be agreed upon with the people who will be affected.
(c) People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels.
(d) Compensation must be based on the full replacement costs as much as possible.
(e) Compensation and other kinds of assistance must be provided prior to displacement.

(f) For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. It is desirable that the resettlement action plan include elements laid out in the World Bank Safeguard Policy, OP 4.12, Annex A.

(g) In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people.

(h) Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans.

(i) Appropriate and accessible grievance mechanisms must be established for the affected people and their communities.

(j) Above principles are complemented by World Bank OP 4.12, since it is stated in JICA Guideline that "JICA confirms that projects do not deviate significantly from the World Bank's Safeguard Policies". Additional key principle based on World Bank OP 4.12 is as follows.

(k) Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advance of such benefits.

(l) Eligibility of Benefits include, the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of census but have a claim to such land or assets and the PAPs who have no recognizable legal right to the land they are occupying.

(m) Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based.

(n) Provide support for the transition period (between displacement and livelihood restoration.

(o) Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc.

(p) For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, abbreviated resettlement plan is to be prepared.

*Source: JICA Guidelines for Environmental and Social Considerations, 2010*

In addition to the above core principles of JICA Policy, it has also emphasis on a detailed resettlement policy inclusive of all the above points; specific resettlement plan; institutional arrangements for the plan implementation; monitoring and assessment; implementation schedule and detailed financial plan, etc.

### (2) Comparison between JICA Guidelines and Vanuatu Related Laws

Table 1.3-28 discuses comparison and gap analysis of the policies for some key issues between JICA Guidelines for Environmental and Social Considerations, 2010, hereinafter referred to as "JICA Guidelines" and Vanuatu's relevant regulations. The gaps are treated basically in line with the JICA Guidelines as long as not violating laws in Vanuatu.

**Table 1.3-28 Comparison result of JICA Guidelines and Vanuatu Related Laws**

| No. | JICA Guidelines | Vanuatu Related Laws/ Regulations | Differences | How to Bridge the Gap |
|---|---|---|---|---|
| 1 | [Avoidance of involuntary resettlement]<br>Involuntary resettlement and loss of means of livelihood are to be | No provision. | There is no standard to minimize land acquisition and impact on the community. | The project shall adopt the objective of minimizing involuntary land acquisition and |

| No. | JICA Guidelines | Vanuatu Related Laws/ Regulations | Differences | How to Bridge the Gap |
|---|---|---|---|---|
| | avoided when feasible by exploring all viable alternatives. | | | resettlement impacts on community and business/ productive interests are avoided through careful technical design. |
| 2 | [Mitigation measures for displacement]<br>When population displacement is unavoidable, effective measures to minimize impact and to compensate for losses should be taken. | No provision. | There is no standard to minimize land acquisition and impact on the community. | The project will ensure that all resettlement and land acquisition and impacts on community and business/ productive interests are minimized wherever possible. |
| 3 | [Securing livelihood and assistance]<br>People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels. | - Compensation is determined based on issues including land type, crops etc. (Land Acquisition Act)<br>- Land is valued by Valuer-General in the MLNR. | Compensation does not include “non-land producing” incomes such as income from shop business etc. Laws and practices in Vanuatu do not recognize the standards of living of the poor and vulnerable, in determining compensation for land acquisition and resettlement.<br>There is no provision to improve or at least restore the livelihood of all DPs. | The project will ensure all resettlement and land acquisition and impacts on community and business/ productive interests are minimized whenever possible. |
| 4 | [Valuation based on replacement cost]<br>Compensation must be based on the full replacement cost as much as possible. | - In Vanuatu valuation of land is stipulated by Law, and is conducted based on several factors regarding that specific plot of affected land such as lease and ownership type; location of property; amenities; market price of nearby properties; physical land characteristics; and intangibles. (Land Acquisition Act)<br>- The law specifically points out times for disclosure prior to valuation, time for objection to valuation and | The law does not provide any clauses for prompt compensation, income restoration and entitlements. | The RAP includes a provision for restoration for APs under the project. |

| No. | JICA Guidelines | Vanuatu Related Laws/ Regulations | Differences | How to Bridge the Gap |
|---|---|---|---|---|
| | | acquisition of lands and assets. (Land Acquisition Act)<br>- Land is valued by Valuer General in MLNR. The VG will determine compensation requirements relating to land, land-based income losses. All other compensations (monetary and non-monetary) will be based on replacement at the existing market rates. | | |
| 5 | [Compensation prior to displacement]<br>Compensation and other kinds of assistance must be provided prior to displacement. | - Compensation will be provided after a period of disclosure and a period for settlements of objections. | Legislation does not clearly state that compensation will be provided prior to commencement of construction, which force physical/ economic displacement impacts to occur. | The project will ensure that land acquisition, resettlement and/ or compensation measures are completed prior to commencing of construction. |
| 6 | [Development and disclosure of RAP]<br>For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. | - Under Vanuatu Law, land acquisition and resettlement and compensation are carried out focusing on households affected and the values of the land and structures affected. (Land Acquisition Act) | An RAP per se is not necessarily required. | The project will ensure that a RAP is prepared and is updated at the time of detailed design. |
| 7 | [Holding public consultation meetings]<br>In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. | - The law, and current practices, does require the land acquisition and relocation orders to be announced several times over radio and in the printed media for one month period and also display on project site. (ADB reports) | There is neither recognition of vulnerable groups nor the consultation with, or participation of APs/ DPs at any part of the process, except in the case of people given opportunity to make objections. | JICA GL will be enforced in that prepared RP and its implementation will require a level of participation and consultation. |
| 8 | [Use of local language]<br>When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people. | - A notice for land acquisition is writing in Bislama, English and French languages. (Land Acquisition Act) | Only the radio would be useful for the illiterate to become informed of any pending land acquisition and resettlement activity on a specific site. | The project will arrange public hearings/ meetings. |
| 9 | [Promoting public involvement] | - The law and current practices require that land acquisition and relocation | Only the radio would be useful for the illiterate to become | The project will arrange public hearings/ meetings. |

| No. | JICA Guidelines | Vanuatu Related Laws/ Regulations | Differences | How to Bridge the Gap |
|---|---|---|---|---|
| | Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans. | orders for a specific site be disclosed several times over radio and in the printed media for one month period, as well as display on project site. (ADB reports) | informed of any pending land acquisition and resettlement activity on a specific site. | |
| 10 | [Establishing grievance redness mechanism] Appropriate and accessible grievance mechanisms must be established for the affected people and their communities. | - Vanuatu already has a Grievance redress system for general village matters, followed by the chief. MLNR has also recently been set up at Provincial level, through the Customary Land Tribunal. (Land Acquisition Act, Customary Land Tribunal Act) | No difference. | The project ensures an appropriate multiple level grievance redress system, which allows AP/DP participation, relatively rapid action and results, as well as encompassing existing grievance procedures. |
| 11 | [Identifying eligibility] Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advantage of such benefits. (WB OP 4.12 Para. 6) | - The law and current practice does specify census requirements and protocols for managing inflow of ineligible people. (Land Acquisition Act) | No difference. | For this project, a census of APs will be conducted including inventory of losses and basic socio-economic information at household level. The inventory of flosses will cover the value of impacted land, structures, business/ livelihoods and assets. The 'cut-off" date for the RAP will be the date when the inventory of affected people is completed and set out in the RAP. |
| 12 | [Eligibility requirements] Eligibility of benefits includes, the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of census but have a claim to such land or assets and the PAPs who have no recognizable legal right to the land they are occupying. (WB OP 4.12 Para. 15) | No provision | Laws have no clauses that recognize encroachers in any way to be entitled or NOT entitled to compensation or rehabilitation. | The project will recognize encroachers, who are legitimately affected at the time of the census/ detailed measurement survey conducted. |

| No. | JICA Guidelines | Vanuatu Related Laws/ Regulations | Differences | How to Bridge the Gap |
|---|---|---|---|---|
| 13 | [Land-to-land Compensation] Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based. (WB OP 4.12 Para. 11) | - In Vanuatu, land acquisition, resettlement and compensation for land-based losses are included under the law. (Land Acquisition Act) | No difference | WB OP 4. 12 will be enforced to ensure that preference is given to land- based resettlement strategies for DPs whose livelihoods are land-based. |
| 14 | [Assistance during transition] Provide support for the transition period (between displacement and livelihood restoration). (WB OP 4. 12, para.6) | - In Vanuatu, land acquisition, resettlement and compensation for land-based losses are included under the law. (Land Acquisition Act) | Impacts on business and their employees are less clear and there is no recognizable transitional support mechanism under the law. | WB OP 4. 12 will be enforced in supplementing the Law of Vanuatu in order to cover transition assistance requirements, business and employees impacted, as required. |
| 15 | [Consideration to vulnerable group] Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc. (WB OP 4.12 Para. 8) | No provision. | There is no recognition of vulnerable groups nor the consultation with or participation by APs at any part of the process, except in the case of people given the opportunity to make objections. | WB OP4.12 will be enforced. Prepared RAP and its implementation will require participation and consultation of vulnerable groups. |

*Source: JICA Study Team*

### (3) Policy for Land Acquisition and Resettlement in the Project

As indicated in Table 1.3-28 crucial gaps are not identified in fundamental aspects despite of a few minor differences. For considering a more tangible policy in compensation and livelihood assistance in the future, the project examines a feasible way to satisfy both JICA Policy and Vanuatu laws in case there would be a gap between policies of these two frameworks.

## 1.3.2.5 Scale and Scope of Land Acquisition

The result of population census, asset valuation and socio-economic surveys are described in the following sections:

### (1) Affected Households and Population

The number of affected households and population is shown in Table 1.3-29. Out of 8 households, 6 were family households and the rest of 2 were commercial facilities (a street stall for agricultural products and a tourism facility).

**Table 1.3-29 List of Affected Household and Population**

| Village | Affected Households | | | Affected Population | | |
|---|---|---|---|---|---|---|
| | Legal | Illegal | Total | Legal | Illegal | Total |
| Teouma | 8 | 0 | 8 | 148 | 0 | 148 |

*Source: JICA Study Team*

Note: Approximately estimated 100 out of the 148 affected people are workers of a street stall for agricultural products.

### (2) Affected Properties

#### 1) Land

In Total 23,497 $m^2$ land will be affected in this project as it is shown in Table 1.3-30. Out of it, 4,123 $m^2$ (17.5% of the total) are leased farmland (agricultural land) and 19,374 $m^2$ (82.5% of the total) are customary land. In this project, leased farmlands are going to be compensated for eternal use and customary lands are going to be compensated both for eternal use and temporary use for temporary roads and so forth.

**Table 1.3-30 Affected Land**

| Village | Type of Use | Classification | Area ($m^2$) | Total ($m^2$) |
|---|---|---|---|---|
| Teouma | Permanent Use | Leased farmland (agricultural land) | 4,123 | 12,561 |
| | | Customary Land | 8,438 | |
| | Temporary Use | Leased farmland (agricultural land) | 0 | 10,936 |
| | | Customary Land | 10,936 | |
| | Total of Leased farmland (agricultural land) | | | 4,123 |
| | Total of Customary land | | | 19,374 |
| | **Grand Total** | | | **23,497** |

*Source: JICA Study Team*

The location and area of land and peripteries that are going to acquire by this project have been surveyed and determined by the Department of Lands, the Ministry of Climate Change Adaptation, Meteorology & Geo-Hazards, Energy, Environment and National Disaster Management Office (MCCA-DOL) based on the design result. The result of the land to be acquired for eternal and temporary use necessary in this project determined by DOL and it is shown in Figure 1.3-10. The red areas in the Figure are lands for eternal use for compensation and the yellow areas are lands for temporary use for compensation.

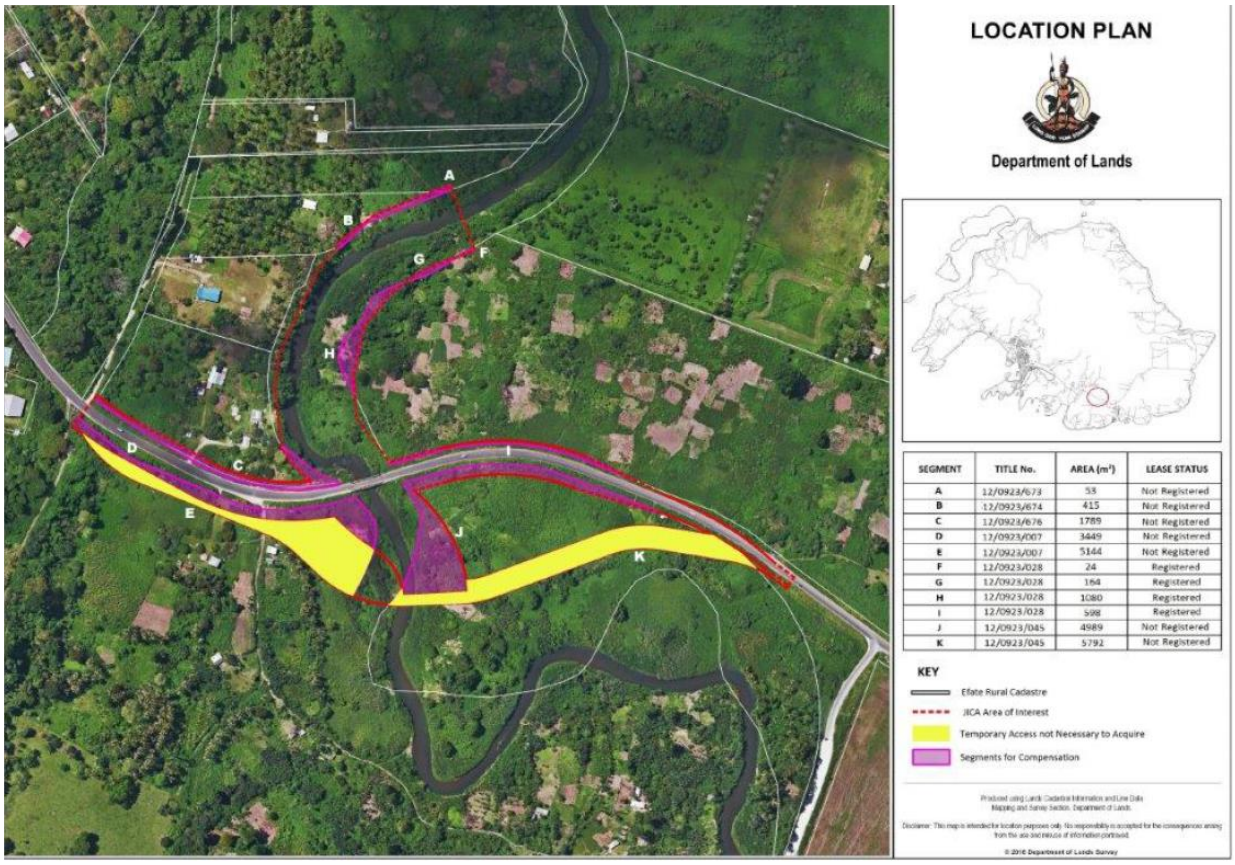
#### 2) Structures

The affected structures are shown in Table 1.3-31. Out of 6 affected structures, one is residential, three commercial facilities, one cattle stall, and one house a subsidiary facility.

**Table 1.3-31 Affected Structures**

| No. | Village | Type of Structure | Subtotal | Total |
|---|---|---|---|---|
| Residential | | | | |
| 1 | Teouma | Concrete one-story building | 1 | 1 |
| Commercial Facilities | | | | |
| 2 | Teouma | Street stall for agricultural products | 1 | 3 |
| 3 | | Ballroom for tourists | 1 | |
| 4 | | Kava Bar (Beverage Facility) | 1 | |
| Cattle Stall | | | | |
| 5 | Teouma | Pigsty | 1 | 1 |
| Facilities with a House | | | | |
| 6 | Teouma | Kitchen | 1 | 1 |

*Source: JICA Study Team*




*Source: MCCA-DOL*

**Figure 1.3-10 Location and Area of land necessary to acquire**

### 3) Agricultural Products/ Trees/ Cattle

Table 1.3-32 shows affected agricultural products, trees and cattle.

**Table 1.3-32 Affected Agricultural Products/ Trees/ Cattle**

| No. | Village | Type of Agricultural Products/ Trees/ Cattle | Subtotal | Total |
|---|---|---|---|---|
| Agricultural Products | | | | |
| 1 | Teouma | Tomato | 20 | 440 |
| 2 | | Cucumber | 20 | |
| 3 | | Kumala (tubers) | 100 | |
| 4 | | Cabbage | 100 | |
| 5 | | Lettuce | 200 | |
| Trees | | | | |
| 6 | Teouma | Naus | 1 | 90 |
| 7 | | Sandalwood | 1 | |
| 8 | | Banyan tree | 2 | |
| 9 | | Mango | 4 | |
| 10 | | Nakatambol | 4 | |
| 11 | | Coconut | 5 | |
| 12 | | Natangra | 7 | |
| 13 | | Pawpaw | 15 | |
| 14 | | Banana | 51 | |
| Cattle | | | | |
| 15 | Teouma | Pig | 1 | 1 |

*Source: JICA Study Team*

### (3) Socio-Economic Situations

The following are result of socio-economic study of eight affected households.

#### 1) Overview of Household Heads

a) Gender

Out of the eight households, 7 household heads are male (88%) except for the street stall for agricultural products. Householder of the street stall for agricultural products is considered as female as it is operated jointly by cooperation of women in neighborhood.

b) Age Composition

As is shown in Table 1.3-33 the mainstream of household heads is from their thirties to fifties. However, as the workers of the street stall for agricultural products are comprised of a wide age group from twenties to sixties, its age composition is considered as unspecified.

**Table 1.3-33 Age Composition of Household Heads**

| Age Group | Number of Population | (%) |
|---|---|---|
| Under 20 | 0 | 0 |
| 21-30 | 1 | 12.5 |
| 31-40 | 2 | 25.0 |
| 41-50 | 2 | 25.0 |
| 51-60 | 2 | 25.0 |
| Over 61 | 0 | 0 |
| Unspecified | 1 | 12.5 |
| Total | 8 | 100 |

*Source: JICA Study Team*

c) Educational Background

Table 1.3-34 shows the educational background of the household heads. 3 of them (37.5%), have finished secondary education (equivalent to junior high and high schools). Two (25.0%) have finished tertiary education (equivalent to universities). It was not able to specify the educational background of the workers of the street stall for agricultural products.

**Table 1.3-34 Educational Background of Household Heads**

| Educational Background | Number of Population | (%) |
|---|---|---|
| Primary | 1 | 12.5 |
| Secondary | 3 | 37.5 |
| Tertiary | 2 | 25.0 |
| Graduate | 0 | 0 |
| Vocational | 1 | 12.5 |
| Unspecified | 1 | 12.5 |
| Total | 8 | 100 |

*Source: JICA Study Team*

d) Occupation

Table 1.3-35 shows occupations of the household heads. Four self-employed (50.0%) are operating shops and Kava (local beverage) bars. The street stall for agricultural products is included in the category of the self-employed.

**Table 1.3-35 Occupation of Household Heads**

| Occupation | Number of Population | (%) |
|---|---|---|
| Farmer | 2 | 25.0 |
| Self employed | 4 | 50.0 |
| NGO | 1 | 12.5 |
| Unemployed | 1 | 12.5 |
| Total | 8 | 100 |

*Source: JICA Study Team*

**2) Overview of Households**

As for overview of households, the answers from 5 households out of 6 are summarized.

a) Household Size

Table 1.3-36 shows the household size. There was no household with less than five members, and the average household size was 9 members.

**Table 1.3-36 Household Size**

| Household Size | Number of Household | (%) |
|---|---|---|
| Less than 5 members | 0 | 0 |
| 5-6 members | 1 | 20.0 |
| 7-8 members | 1 | 20.0 |
| 9-10 members | 1 | 20.0 |
| 11-12 members | 2 | 40.0 |
| Total | 5 | 100 |

*Source: JICA Study Team*

b) Age Composition of Household Members

Table 1.3-37 shows the age composition of household members. The majority are younger generation (aged 20 or younger), followed by the twenties. Fifties and under consists mostly of the household members.

**Table 1.3-37 Age Composition of Household Members**

| Age Group | Number of Members | (%) |
|---|---|---|
| 10 and under | 6 | 13.0 |
| 11-20 | 15 | 32.6 |
| 21-30 | 9 | 19.6 |
| 31-40 | 5 | 10.8 |
| 41-50 | 9 | 19.6 |
| 51-60 | 1 | 2.2 |
| 61 and over | 1 | 2.2 |
| Total | 46 | 100 |

*Source: JICA Study Team*

c) Educational Background of Household Members

Table 1.3-38 shows educational background of household members. As is the case with householders, the majority consisting of 23 members (50.0%) finished secondary education (equivalent to junior high and high school). There were 4 members (8.7%) in preschools. As a side note, the number of members for each educational background of primary and secondary education includes students being enrolled in those schools.

**Table 1.3-38 Educational Background of Members**

| Educational Background | Number of Members | (%) |
|---|---|---|
| Preschool | 4 | 8.7 |
| Primary | 11 | 23.9 |
| Secondary | 23 | 50.0 |
| Tertiary | 4 | 8.7 |
| Graduate | 0 | 0 |
| Vocational | 3 | 6.5 |
| Unspecified | 1 | 2.2 |
| Total | 46 | 100 |

*Source: JICA Study Team*

d) Occupation of Household Members

Table 1.3-39 shows occupation of household members. The majority consisting of 13 (28.3%) are agricultural workers (farmers), followed by the self-employed of 5 (10.8%). Most of the unemployed are engaged in domestic help. Furthermore, the ratio of non-workers is also high; 16 students (34.8%) and 4 preschool children (8.7%).

**Table 1.3-39 Occupation of Household Members**

| Occupation | Number of Members | (%) |
|---|---|---|
| Farmer | 13 | 28.3 |
| Self employed | 5 | 10.8 |
| NGO | 1 | 2.2 |
| Student | 16 | 34.8 |
| Preschool | 4 | 8.7 |
| Unemployed | 7 | 15.2 |
| Total | 46 | 100 |

*Source: JICA Study Team*

e) Household Income

Table 1.3-40 shows the annual income of 5 households who provided information. The minimum was 851,000 Vatu (approximately 7,530 USD). The poverty line defined by the Asian Development Bank (ADB) is 1.25 USD per day (approximately 141.3 Vatu per day), which means the poverty line of the average household size (9 members) per year is approximately 464,000 Vatu. Therefore, all above-mentioned households lived above the poverty line defined by ADB.

**Table 1.3-40 Household Income**

| Annual Income Range (Vatu) | Number of Household | (%) |
|---|---|---|
| 851,000-900,000 | 1 | 20.0 |
| 1,000,100-1,500,000 | 1 | 20.0 |
| 1,501,000-2,000,000 | 1 | 20.0 |
| 2,501,000-3,000,000 | 2 | 40.0 |
| Total | 5 | 100 |

*Source: JICA Study Team*

**3) Opinion Regarding the Project**

All affected households showed favor opening to the project. In addition, all households would like implementation of the project as soon as possible, implying a high expectation for the project.

**4) Socially Vulnerable Households**

All male householders were healthy at the time of survey. However, the members of the street stall for agricultural products consisted of some 100 women. Therefore, it could be regarded as the socially vulnerable household because the construction work might temporally disturb their income opportunity.

### 1.3.2.6 Policies for Compensation and Assistance

#### (1) Loss Compensation

Under this project, the followings are the target of compensation or at least livelihood assistance:

- Those that lose lands (including farm lands), structures, agricultural products, income, regular land-use rights and customary land-use rights by the implementation of this project.
- Tenant (regardless with or without registration)

The followings are details of compensation measures:

**1) Land (Temporary use)**

Qualified Persons: Lessees, Customary landholders, Tenant farmers

Compensation Coverage: Compensated by the leased land bill calculated based on the assessed value by the Valuation General Office of the Department of Land. It is calculated considering the market price.

Note: The duration is two years applied to the land for temporary roads.

**2) Land (Permanent use)**

Qualified Persons: Lessees, Customary landholders

Compensation Coverage: Compensated by the leased land bill calculated based on the value assessed by the Valuation General Office of the Department of Land. It is calculated considering the market price.

Qualified Persons: Illegal settlers

Compensation Coverage: Compensated for damages on non-land assets (agricultural products, trees, structures and etc.)

**3) Agricultural Products and Trees**

Qualified Persons: Producers of agricultural products (regardless of whether ones are legal or illegal)

Compensation Coverage: Made to be harvested as much as possible by issuing harvest notification before land acquisition. However, the agricultural products which cannot be harvested are going to be compensated at reasonable cost by cash.

**4) Structures (Partial or total relocation)**

Qualified Persons: Owners of structures (regardless whether ones are legal or illegal)

Compensation Coverage: Actual cost compensation necessary for damages and relocation by this project or assistance to search for a relocation site. Shops shall be paid for inconvenience fee during the interference of business.

**5) Socially-vulnerable People**

Qualified Persons: Households whose householders are the socially vulnerable affected by this project (householders are women, elderly persons or disabled persons, and the poor household)

Compensation Coverage: Livelihood assistance to householders by cash.

**6) Relocation of Communal Facilities (if any)**

Qualified Persons: Managers of such facilities

Compensation Coverage: Actual cost compensation necessary for the damages and relocation by this project or assistance for relocation.

**7) Unforeseen or Unintended Impacts**

Qualified Persons: Persons directly or indirectly affected by this project (unforeseen impacts)

Compensation Coverage: Applying the compensation coverage from a) to f), the others shall be compensated according to the JICA Guideline and etc.

The Cut-off date of this project is **20th of June 2018** which is the date of the public hearing before the start of this study.

### (2) Livelihood Assistance Plan

Since this project is not going to cause resettlement or land acquisition in large scale, its impacts on the daily lives of residents are limited. Thus, it is not expected to cause forced loss or change of jobs. According to the socio-economic surveys and consultations, it became clear that the early implementation of this project is preferred. In addition, local residents expect to be actively employed as construction workers.

Furthermore, as the income of sellers and their related producers is going to be lost by the relocation of the street stall for agricultural products during the construction, livelihood compensation at uniform rate is going to be paid to the eligible persons.

### (3) Entitlement Matrix

Table 1.3-41 shows the draft entitlement matrix which lists types of asset losses, application, definition of affected persons and compensation coverage.

**Table 1.3-41 Draft Entitlement Matrix**

| Types of Loss | Application | Definition of Affected Persons | Compensation Coverage |
|---|---|---|---|
| **Land for Temporary Use** | Land to be used during construction | Lessor/ Lessee/ Customary Landholder/ Land user | Necessary to agree with landholders or affected persons. Affected landholders and persons shall be paid for an agreed lease expense. After use, the land shall be returned to owners after restoration of the land to its original condition. |
| **Land for Eternal Use** | Acquired land | Lessor/ Lessee/ Customary Landholder/ Land user | Compensation in money based on replacement cost or provision of land which has equivalent area and quality. |
| | | Illegal settlers without legal rights (inside ROW) | Compensation for non-land assets (agricultural products, trees, structures and etc.) in land affected by this project. |
| **Agricultural Products and Trees** | Agricultural products and trees in affected land | Owners of agricultural products or trees (regardless with or without legal/ customary rights) | Harvest notification of agricultural products and trees is issued before land acquisition. If harvest is impossible, compensation is made in monetary form based on replacement cost (market price). |
| **Partial or Total Clearance of Structures (Residence or Commercial Facilities)** | Structures in affected land (residential or commercial) | All affected persons (regardless with or without legal rights) | Compensation for the costs of demolition or for transferring building materials or buildings themselves of structures based on replacement cost. In addition, support for the search for a relocation site. In case of building a new structure, it should be completed before the relocation of the covered structures. In case of commercial facilities, inconvenience fee shall be paid whose amount is equivalent to the duration |

| Types of Loss | Application | Definition of Affected Persons | Compensation Coverage |
|---|---|---|---|
| | | | of impacts. |
| **The Socially vulnerable** | The socially vulnerable affected by the project (regardless with or without eligibility) | Socially vulnerable households specified by the socio-economic surveys (Its householders are female elder or disabled, or a poor household) and households severely affected | Livelihood support for householders of affected households including financial provision. Employment for construction works of this project. |
| **Relocation of Communal Facilities (if any)** | Communal facilities in affected land | A management representative specified through socio-economic surveys | Compensation by replacement cost based on market price for the affected parts of buildings. Necessary support for demolition and relocation of buildings for communities. |
| **Unforeseen or Unintended Impacts** | Impacts revealed by the detailed design | Affected residents | Application of a) to f) and compliance of the JICA guideline for any other cases. |

*Source: JICA Study Team*

#### 1.3.2.7 Grievance Redress Mechanism (GRM) and Addressing Complaints

**(1) Introduction**

JICA Guidelines requires appropriate and accessible Grievance Redress Mechanisms (GRM) to be established for persons affected by involuntary land acquisition and also their communities. Specifically, OP 4.12 requires affordable and accessible procedures for third-party settlement of disputes arising from land acquisition. GRM should take into account availability of judicial recourse as well as community and traditional dispute settlement mechanisms.

In the Republic of Vanuatu, the affected people will be given several opportunities to review the survey results and compensation policies during the planning and implementation processes. In the course of the implementation, disputes may arise which require independent resolution. The affected people will be informed of their rights and GRM is available to them. These mechanisms include traditional forms of conflict resolution, legal and also political means.

Grievance and Complaints Procedures are set up to:

- Provide support to affected persons and affected parties on problems arising from land acquisition and associated impacts;
- Provide a means by which the various conflicting stakeholders may be consulted and negotiated agreement reached; and
- Specify names of and contact numbers of officers who will be responsible for handling grievance procedures.

**(2) GRM and Addressing Complaints Procedures**

It is discussed at different levels as in the following:

**1) At Community Level**

A community committee shall be set up by membership of department representatives, community representatives and representatives of the customary owners. The committee will meet in the case a complaint. A decision should be made within 7 days of the complaint being lodged. The committee will be chaired by the Village Chief. In the event that the Village Chief is a 'customary owner', the chair of the committee may be represented by the community's religious leader.

**2) At Project Level**

A complainant has the option to appeal at the project level if it is not satisfied with the decision at community level. The project level committee would be the same as the Project Management Unit (MIPU-PWD in this project). A decision must be made within 14 days of receipt of appeal.

**3) Customary Land Tribunal**

As per the current land acquisition law, the complainant may choose to appeal to the customary land tribunal if not satisfied with the project level decision. Under the law and current procedures in Vanuatu, a complaints procedure can last up to 30 days. The decision of the tribunal is generally final, unless the tribunal procedures are challenged.

**4) Legal Procedures**

Further appeal may be made through the Supreme Court of Vanuatu, only in the case that the customary tribunal procedures were faulty in the specific case.

#### 1.3.2.8 Implementation System

**(1) Driving Organizations**

**1) Public Works Department, Ministry of Infrastructure and Public Utilities (MIPU-PWD)**

The MIPU-PWD is the main driving organization in this project and implements land acquisition and compensation through operating and supervising the project in coordination with related organizations. MIPU-PWD also receive budget at a suitable time during the RAP implementation to enforce.

**2) Department of Lands, Ministry of Climate Change Adaptation, Meteorology, Geo-Hazards, Environment, Energy and Disaster Management (MCCA-DOL)**

The MCCA-DOL is comprised of five sections such as 1) Land Survey, 2) Land Management, 3) Land Registry, 4) Customary Lands Tribunal and 5) Valuer General's Office. Therefore, the department is responsible for all procedures on land such as identification, valuation, computation of compensation values, tenure transfer and complaint handling for the land to be acquired, when endorsing a request from the project entity.

**3) Ministry of Agriculture, Livestock, Forestry, Fisheries and Biosecurity (MALFFB)**

The MALFFB plays a role in computing compensation for agricultural products and trees in land acquisition. The computation is based on the result of a socio-economic survey by the project entity. In collaboration with MCCA-DOL, the MALFFB evaluates the fair compensation values through confirming land classification and attribution.

**(2) Supporting Organizations**

**1) Department of Environmental Protection and Conservation, Ministry of Climate Change Adaptation, Meteorology, Geo-Hazards, Environment, Energy and Disaster Management (MCCA-DEPC)**

The MCCA-DEPC is responsible for all activities regarding the EIA in Vanuatu. A close collaboration with MCCA-DEPC is essential because land acquisition is tightly combined to the environmental policy.

**2) Shefa Provincial Government**

The Shefa provincial Government, in which the Teouma Bridge is located, collaborates with the central governmental units and local community mainly regarding land acquisition and complaint handling after being devolved by the central government.

**3) Community in Teouma Area**

In the community managed by the chief, most members are deemed stakeholders of the project. The chief is a title indicating a man who represents a community in a non-conventional context such as church or the state. The chief belongs to all communities, is selected with respect, and manages all issues regarding communities. The chief is a necessary person to conduct the project smoothly for acquiring customary lands and conflict resolution among the affected people.

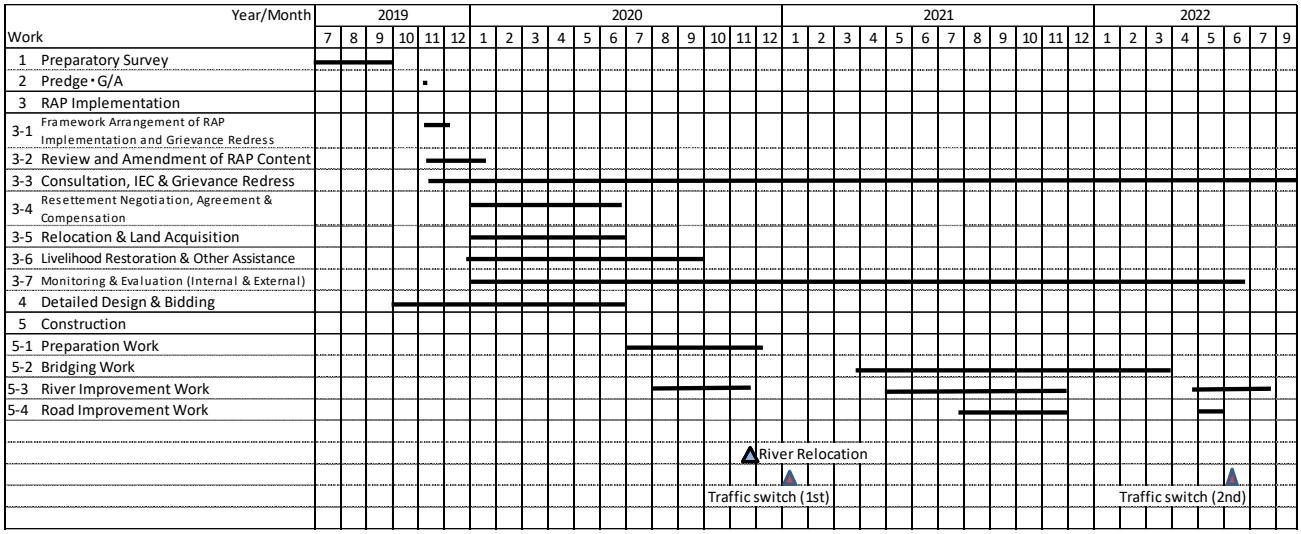
**4) NGOs**

NGOs are those who support strict implementation of the project as a third party for land acquisition and external monitoring of compensation. For instance, Oxfam Vanuatu has been operating widely in Vanuatu dealing with gender issues to become prominent recently in the country. It has contributed to empowering the socially vulnerable and eliminating sexual violence.

### 1.3.2.9 Implementation Schedule

Table 1.3-42 shows the schedule for land acquisition/resettlement and compensation. The draft RAP will be amended and finalized with revising the location and area of the acquired land and re-computing the compensation values in case the content of overall designs would be revised during the detailed design stage. On the other hand, prior to these activities, the project entity establishes the project management unit, or PMU and GRM framework. In tandem with these activities, the project entity starts public consultations, advertising activity, complaint handling, and monitoring/ evaluation (internal and external) until the completion of the project. Negotiating with the affected people and attaining an agreement are commenced in accordance with the construction progress and payment of compensation shall be finished before resettlement. The project will start preparations of livelihood restoration assistance and others in tandem with the negotiation with affected people and its agreement.

**Table 1.3-42 RAP Implementation Schedule**




*Source: JICA Study Team*

### 1.3.2.10 Costs Estimation

Table 1.3-43 shows cost estimation for land acquisition and RAP implementation. The estimated costs will be updated in the review of RAP at time of the detailed design. Costs shown here shall be financed according to the budget rules of Vanuatu Island by project implementation organization (Public Works Department, Ministry of Infrastructure and Public Utilities: MIPU-PWD).

**Table 1.3-43 Cost Estimation for RAP Implementation**

| Item | | Amount (Vatu) | Note |
|---|---|---|---|
| Properties (Land/ Buildings)[*1] | Land (Permanent Use) | 22,899,000 | Estimated based on valuation (replacement cost) by MCCC-DOL. |
| | Land (Temporary Use) | 1,749,760 | Valuation price by MCCC-DOL shall be discounted by the duration of use (2+1 years) [*2]. |
| | Buildings/ Facilities with a Structure | 730,000 | Estimated based on replacement cost. |
| | Subtotal (1) | 25,378,760 | |
| Compensation/ Support | Agricultural products/ Trees | 112,260 | Estimated based on market price according to agricultural products and trees. |
| | Livelihood Support | 300,000 | Livelihood support for workers of the street stall for agricultural products and its suppliers who are forced to be relocated. It is estimated 10,000 Vatu per person for about 100 affected persons. |
| | Inconvenience Fee | 400,000 | Inconvenience fee paid to the tourism facility of Port Vila Cultural Tour located in the downstream of Teouma River that is expected to be affected by bank protection works. Inconvenience fee of 2,000 vatu per visitor is estimated to be paid for approximately 200 visitors. |
| | Support for Socially Vulnerable Households | 0 | Householders affected by this project are not socially vulnerable and no need to relocation. Thus, this is item is not applicable. |
| | Subtotal (2) | 812,260 | |
| | Total (3) | 26,191,020 | (1) + (2) |

| Item | | Amount (Vatu) | Note |
|---|---|---|---|
| RAP Activity Cost | (4) | 3,928,650 | 15% of Total (3) (round-off) |
| Physical Contingency | (5) | 1,505,980 | 5% of Total (3) + (4) (round-off) |
| Grand Total | | 31,625,650 | (3) + (4) + (5) |

*Source: JICA study team*

*1: All lands to be acquired (leased and customary lands) are owned by the ministry of lands.

*2: Replacement Cost / Lease Period (50-75 years) * [Expected Duration of Use by this Project (2 years) + Original State Restoration & Preparatory Period (1 year)]

#### 1.3.2.11 Monitoring System

A monitoring system will be conducted in order to evaluate resettlement activities are implemented as planned in the RAP or not. In the monitoring process regular data collection and analysis will be carried out throughout the entire resettlement activities.

**(1) Internal Monitoring**

The project entity (MIPU-PWD) will do supervision and in-house monitoring on implementation of the RAPs. So, they will be alternately called the Internal Monitoring Agent (IMA). The IMA will assign internal staff of MIPU or local consultants as the members of IMA. Tasks of IMA include:

- Regularly supervise and monitor the implementation of the RAPs in coordination with the related organizations and the community in Teouma area. The findings will be documented in the quarterly report to be submitted to JICA and the supervising body;
- Verify that the re-inventory baseline information of all project-affected households (PAHs) has been carried out and that the valuation of assets lost or damaged, the provision of compensation and other entitlements, and relocation, if any, has been carried out in accordance with the respective RAP;
- Ensure that the RAP is implemented as designed and planned; and
- Record all grievances and their resolution and ensure that complaints are dealt with promptly.

**(2) External Monitoring**

An External Monitoring Agent (EMA) will be commissioned by MIPU-PWD to undertake independent external monitoring and evaluation. The EMA for the project will be either a qualified individual or a consultancy firm with qualified and experienced staff. A local NGO, an academic institution or a local consulting firm may be commissioned for the EMA. The tasks of the EMA shall include:

- Verify results of internal monitoring;
- Verify and assess the results of the information campaign for PAHs rights and entitlements;
- Verify that the compensation process has been carried out with the procedures communicated with the PAHs during the consultations;
- Assess whether resettlement objectives have been met; specifically, whether livelihoods and living standards have been restored or enhanced;
- Assess efficiency, effectiveness, impact and sustainability of resettlement and implementation;

- Review on how compensation rates were evaluated; and
- Review of the handling of compliance and grievances cases.

### (3) Monitoring Indicators

The monitoring indicators are set based on the ones shown in the LARRIPP in accordance with the conditions of priority projects and affected people. Table 1.3-44 and Table 1.3-45 show the monitoring indicators for internal and external monitoring activities in this RAP. The major monitoring indicators are as below.

- Internal Monitoring

  Budget and timeframe, delivery of compensation and entitlements, public participation and consultation, benefit monitoring.

- External Monitoring

  Basic information on PAHs, restoration of living standards, restoration of livelihoods, levels of PAH satisfaction, effectiveness of resettlement planning, other impacts (unintended impacts).

**Table 1.3-44 Internal Monitoring Indicators**

| Monitoring Indicators | Basis for Indicators |
|---|---|
| 1. Budget and Timeframe | • Have all land acquisition and resettlement staff been appointed and mobilized for the field and office work on schedule?<br>• Have capacity building and training activities been completed on schedule?<br>• Are resettlement implementation activities being achieved against the agreed implementation plan?<br>• Are funds for resettlement being allocated to resettlement agencies on time?<br>• Have resettlement offices received the scheduled funds?<br>• Have funds been disbursed according to the RAP?<br>• Has the social preparation phase taken place as scheduled?<br>• Has all land been acquired and occupied in time for project implementation? |
| 2. Delivery of Compensation and Entitlements | • Have all Affected Persons (APs) received entitlements according to numbers and categories of loss set out in the entitlement matrix?<br>• Have APs received payments for affected structures and lands on time?<br>• Have APs losing from temporary land borrow been compensated?<br>• Have all received the agreed transport costs, relocation costs, income substitution support and any resettlement allowances, according to schedule?<br>• Have all replacement land plots or contracts been provided? Was the land developed as specified? Are measures in train to provide land titles to APs?<br>• How many APs resorted to expropriation?<br>• How many APs households have received land titles?<br>• How many APs have received housing as per relocation options in the RAP?<br>• Does house quality meet the standards agreed?<br>• Have relocation sites been selected and developed as per agreed standards?<br>• Are the APs occupying the new houses?<br>• Are assistance measures being implemented as planned for host communities?<br>• Is restoration proceeding for social infrastructure and services?<br>• Are the APs able to access schools, health services, cultural sites and activities at the level of accessibility prior to resettlement?<br>• Are income and livelihood restoration activities being implemented as set out in income restoration plan? For example utilizing replacement land, commencement of production, numbers of APs trained and provided with jobs, micro-credit disbursed, number of income generating activities assisted?<br>• Have affected businesses received entitlements including transfer and payments for net losses resulting from lost business and stoppage of production? |

| Monitoring Indicators | Basis for Indicators |
|---|---|
| 3. Public Participation and Consultation | • Have consultations taken place as scheduled including meetings, groups, and community activities? Have appropriate resettlement leaflets been prepared and distributed?<br>• How many APs know their entitlements? How many know if they have been received?<br>• Have any APs used the grievance redress procedures? What were the outcomes?<br>• Have conflicts been resolved?<br>• Was the social preparation phase implemented? |
| 4. Benefit Monitoring | • What changes have occurred in patterns of occupation, production and resources use compared to the pre-project situation?<br>• What changes have occurred in income and expenditure patterns compared to pre-project situation? What have been the changes in cost of living compared to pre-project situation? Have APs' incomes kept pace with these changes?<br>• What changes have taken place in key social and cultural parameters relating to living standards?<br>• What changes have occurred for vulnerable groups? |

*Source: JICA Study Team*

**Table 1.3-45 External Monitoring Indicators**

| Monitoring Indicators | Basis for Indicators |
|---|---|
| 1. Basic Information on PAHs | • Location<br>• Composition and structures, ages, education and skill levels<br>• Gender of household head<br>• Ethnic group<br>• Access to health, education, utilities and other social services<br>• Housing type<br>• Land use and other resource ownership patterns<br>• Occupation and employment patterns<br>• Income sources and levels<br>• Agricultural production data (for rural households)<br>• Participation in neighborhood or community groups<br>• Access to cultural sites and events<br>• Value of all assets forming entitlements and resettlement entitlements |
| 2. Restoration of Living Standards | • Were house compensation payments made free of depreciation, fees or transfer costs to the APs?<br>• Have perceptions of "community" been restored<br>• Have APs achieved replacement of key social cultural elements? |
| 3. Restoration of Livelihood | • Were compensation payments free of deduction for depreciation, fees or transfer costs to the APs?<br>• Were compensation payments sufficient to replace lost assets?<br>• Was the replacement place affordable at a proper level of cost?<br>• Did transfer and relocation payments cover these costs?<br>• Did income substitution allow for re-establishment of enterprises and production?<br>• Have enterprises affected received sufficient assistance to re-establish themselves?<br>• Have vulnerable groups been provided income-earning opportunities? Are these effective and sustainable?<br>• Do jobs provided restore pre-project income levels and living standards? |
| 4. Levels of APs' Satisfaction | • How much do APs know about resettlement procedures and entitlements? Do APs know their entitlements?<br>• Do APs know if these have been met?<br>• How do APs assess the extent to which their own living standards and livelihood been restored?<br>• How much do APs know about grievance procedures and conflict resolution procedures? How satisfied are those who have used said mechanisms. |

| Monitoring Indicators | Basis for Indicators |
|---|---|
| 5. Effectiveness of Resettlement Planning | • Were the PAHs and their assets correctly enumerated?<br>• Was the time frame and budget sufficient to meet objectives?<br>• Were entitlements too generous?<br>• Were vulnerable groups identified and assisted?<br>• How did resettlement implementers deal with unforeseen problems? |
| 6. Other Impacts | • Were there unintended environmental impacts?<br>• Were there unintended impacts on employment or incomes? |

*Source: JICA Study Team*

### 1.3.2.12 Public Consultation

Public consultations on resettlement issues were held together with those for Environmental Impact Assessment (EIA) as impacts on project area and local people are considered minimum. The detailed contents of the consultations are explained in 1.3.1 Environmental Impact Assessment. Opinions and responses regarding land acquisition and compensation as well as interest in the project have been observed through 4 consultation meetings are presented in Table 1.3-46.

**Table 1.3-46 Outlines and Opinions/Attitude from Participants in each Consultation**

| Meeting No. & Date | Objective & Background | Major Questions & Opinions | Responses | Favor/ Disfavor |
|---|---|---|---|---|
| 1st<br>23 May 2018 | Project introduction, request of cooperation and exchange ideas among related organizations and local representatives | ・Scheme of land acquisition and compensation manner to make sure of a fair compensation<br>・River water use by local people in the future (whether laundry could be disturbed or not) | ・The value of compensation is computed through the site survey and will be paid to PAPs in line with JICA guidelines and domestic laws.<br>・Alternative sites are placed during construction. The planned embankment has facilities to access the river water. | All participants expressed positive attitude and promised full cooperation. |
| 2nd<br>13 June 2018 | Project introduction and also local contractor, request of cooperation and exchange ideas among related organizations and local representatives | ・Confirmation of implementing of a fair compensation as of some problems in the past.<br>・Effectiveness of flood control project (Discharge capacity after widening river course and building embankments)<br>・Compensation for crops & trees. It is not easy to make a detailed list of crops for DOA. | ・The value of compensation will be estimated through a site survey and will be paid to PAPs in line with JICA guidelines and domestic laws.<br>・This project will contribute to flood controls in this area and the designs discharge will be based on a fair flood return period.<br>・Compensation will be estimated and paid based on market transaction values. | Ditto |

| Meeting No. & Date | Objective & Background | Major Questions & Opinions | Responses | Favor/ Disfavor |
|---|---|---|---|---|
| 3rd<br>20 June 2018 | Public consultation before on-site survey<br>Outline of on-site survey, request of cooperation and exchange ideas<br>(Informing cut-off date to local residents and stakeholders) | ・The project is essential to Teouma area and there are no disputes on lands by area chief.<br>・Wish to implement compensation without failures (From a bad experiences in the past)<br>・Wish to know a particular leased or managing land would be involved or not | ・Noted. We would fully like to request local cooperation.<br>・The value of compensation will be estimated through the site survey and will be paid to PAPs in line with JICA guidelines and domestic laws.<br>・It will be revealed thru the on-site survey. However, a draft map has been showed for land acquisition | Ditto |
| 4th<br>24 Dec. 2018 | Public consultation after on-site survey<br>Outline of the results of on-site survey, request of cooperation and exchange ideas<br>(To same stakeholders as the 3rd consultation) | ・Impact on a stall along the road<br>・How to treat the leased land without border pegs?<br>・Wish to implement the project ASAP | ・We consider compensation for relocation. Livelihood assistance could be optional if necessary.<br>・DOL carried out a cadastral survey to clarify the boundary.<br>・Noted. We would fully like to request your cooperation. | Ditto |

*Source: JICA Study Team*

In the 1st and 2nd consultation meetings, JICA survey team fostered enhancement of an understanding and cooperation for the project toward the related organizations and local representatives (including affected people) through interpreting the project. In the 3rd and 4th consultation meetings, all participants showed positive opinions and favor to the project since a mutual understanding had been developed in Teouma area. All stakeholders hope a rapid implementation of the project due to obtaining a high countenance since the pre-survey in 2016.

A steady implementation of compensation and supports in accordance with relevant laws was requested by some participants. They have experienced insufficient compensation and land expropriation for a public work in the past. In addition, an affirmative engagement of local people was requested during the construction phase.

#### 1.3.2.13 Gender Equity

Attention to gender is essential. It is essential for women and men to equally benefit from and to participate in projects and do their best to avoid inequality. This study is to confirm policies and institutional arrangements related to gender equity as well as efforts on this by other donors. In case of land acquisition and resettlement, the study shall consider:

1) The gender balance of stakeholder consultation meetings;

2) The gender composition of project affected peoples,

3) Special considerations for female headed households and socially vulnerable households; and

4) Appropriate and steady measures for compensation and livelihood support.

In Vanuatu the Protection in the Pacific (ProPa) Network is established between the government and women's organizations in order to respond to cyclones and the climate change by the support of the UNDP. This study shall confirm the contents and directions of these activities for their use and application in this project.

The Government of Vanuatu addresses gender mainstreaming by formulating "National Gender Equality Policy 2015-2019[5]". The number of violence cases against women is still high and the women's social advancement is delayed. Therefore, considerations for and advancements of women is an urgent issue. The policy sets the following six principles:

1. The fundamental rights and freedoms of all men and women in Vanuatu are enshrined in the Constitution.
2. Gender equality is about all men and women.
3. Gender mainstreaming is a commitment in the Government agenda.
4. There is a high level of diversity among men and women and it must be recognized that women are more vulnerable than men.
5. The strategies and actions identified in this policy are practical, achievable, measurable and relevant to the Vanuatu context.
6. The policy framework is not prescriptive.

Furthermore, the policy prioritizes the following four strategic areas:

1. Reducing Domestic and Gender Based Violence
2. Enhancing Women's Economic Empowerment
3. Promoting Women's Leadership and Equal Political Participation
4. Building a Foundation of Gender Mainstreaming

With respect to the climate change, Vanuatu ratified the Convention on the Elimination of All Forms of Discrimination against Women (CEDAW) in 1995 and established the National Advisory Board on Climate Change & Risk reduction Project Management Unit (NAB-PMU) under the parliament in 2012. Though NBA-PMU in 2013, Vanuatu achieved gender participation in response to the increase of women in the process of the United Nations Framework Convention on Climate Change (UNFCCC). As a result, the half of the delegation from Vanuatu was women for the Conference of the Parties (COP) 19 held in Poland in 2013. In this way, it can be said that Vanuatu has addressed the advancement and utilization of women nationwide and recognized women as important actors in the field of disaster management. On the other hand, the followings are the current issues facing Vanuatu:

- Low rate of participation of women in disaster mitigation organizations;
- Limited participation of women at the community level;
- The Vanuatu Humanitarian Team (VHT) and the parliament struggle in order to ensure gender mainstreaming in policies for the climate change and disaster mitigation management. However, the activity still remains at the governmental level and does not spread to the citizen level; and

[5] https://www.pacificclimatechange.net/sites/default/files/documents/NationalGenderEqualityPolicyJuly 2015.pdf

- Limitation of capacity of the Department of Women Affairs (DWA) in order to ensure gender mainstreaming at all levels of governments.

A relevant project to this project is the Cyclone Pam Road Reconstruction Project[6] funded by the Asian Development Bank (ADB). The purpose of the project is to provide an opportunity to improve gender equality by securing continued access to markets, government services and basic social facilities (healthcare and education) to pregnant women, mothers of infants and children as well as men. The details are as below.

- Provision of concrete steps and footpaths to the edge of freshwater to make its access easy and construction and improvement of laundry facilities (for example in Mele, Tanoliu, Epau, Pangpang and Rentapau);
- Universal access provisions of all communal facilities (for example in Prima, Mele, Creek Ai, Tanoliu, Marona, Sara Epule, Lamin and Pangpang); and
- Provision of opportunities to secure income for women during construction (employment of non-skilled labor, procurement of local food and etc.).

One of NGOs active in Vanuatu on a large scale is Oxfam Vanuatu. It implements the following programs concerning gender support in collaboration with Oxfam Australia[7].

**1. Australian Humanitarian Partnership: Disaster Ready – Vanuatu**

Humanitarian support program for four and half years (2018-2022) focusing on the enhancement of disaster resilience, the establishment of cash transfer schemes and the promotion of humanitarian collaboration in cooperation with the government of Vanuatu and local organizations.

**2. Vanuatu Governance, Leadership and Accountability**

Support program for the socially vulnerable for seven years (2012-2019) focusing on sharing purposes and achieving positive effects by reflecting the voice of the socially vulnerable including women in decision making.

**3. Vanuatu Gender Justice, Youth and Livelihoods**

Support program for the socially vulnerable for three years (2016-2019) promoting livelihood supports and facilitation of the access to resources and participation in policy making targeting at the socially vulnerable including LGBTQI[8].

**4. Pacific Climate Change Collaboration, Influencing and Learning**

Participation program for the measures against the climate change for four years (2018-2022), with the purpose of reflecting opinions in the Pacific Islands Climate Action Network through gender equality activities.

**5. Unblocked Cash: Piloting Accelerated Cash Transfer Delivery in Vanuatu**

Development program of a multi-purpose cash transfer platform for one year (2018-2019) for the purpose of improving the speed of cash transfer, transparency and cost efficiency in Vanuatu and its surrounding areas with the aid of brock-chain technology.

[6] ADB Vanuatu: Cyclone Pam Road Reconstruction Project (49319-001)
https://www.adb.org/projects/49319-001/main#project-overview
[7] https://www.oxfam.org.au/country/vanuatu/
[8] An abbreviation for Lesbian, Gay, Bisexual, Transgender, Queer and Intersex

# CHAPTER 2 Contents of the Project

## 2.1 Basic Concept of the Project and Design Policy

### 2.1.1 Basic Concept for Flood Disaster Countermeasure

The following manual and guidelines highlight hydrological and hydraulic design such as setting-up of a freeboard and also flood return period:

- Vanuatu Resilient Roads Manual as a design guide for low volume rural roads in Vanuatu based on accessibility, security and sustainability (Australian Aid, June 2014)
- AUSTROADS Bridge Design Code, June 1998

Hydrological parameters for design are summarized in the following Table 2.1-1 using above documents:

**Table 2.1-1 Hydrological Parameters for Design**

| Manual /Guidelines Parameters | Vanuatu Resilient Road Manual (VRRM) | | AUSTROADS Bridge Design |
|---|---|---|---|
| | Minimum ARI | Desired ARI | |
| Secured Safety for Major Bridges | 50-year | 100-year | 100-year ARI |
| for small Bridges | 10-year | 50-year | |
| Freeboard | - | | 500 mm |
| Remarks | | | Flooding could be considered in 100-year ARI |

ARI: Average Recurrence Interval (Flood Return Period)

*Source*: JICA study team

Considering the importance of the ring road in Efate Island and the related ADB reconstruction project, policies for flood disaster countermeasures are summarized as follows:

- Bank protection structures shall be installed along the riverbank under erosion to prevent local scouring and washout damages around the bridge abutment. The structural damages occurred during Cyclone Pam in 2015.
- For this purpose, riverbank protection works shall be planned for 250 m of upstream and 100 m of downstream of the bridge.
- Furthermore, the main objectives of the above-mentioned river improvement works are prevention of bank erosion and also fixing of meandering channel. In the case of flood inundation risk in large flood such as 100-year design flood, floodwater in the river channel will flow downstream safely.

The followings are also solid working policies:

- Two-dimensional flooding simulation model will be set-up based on interview results of flooding situation during Cyclone Pam. The computation results of this 2-D flood simulation shall be utilized in bridge improvement design and necessary river improvement.
- 100-year return period flood shall be considered hydrological and hydraulic computation through the two-dimensional flooding simulation for alternative study on river and bridge improvement.
- In parallel with 100-year return period, 50-year return period flood shall be examined as well.
- Approximate cost of alternatives and their socio-economic impacts shall be examined comprehensively so that the optimum plan would be proposed.

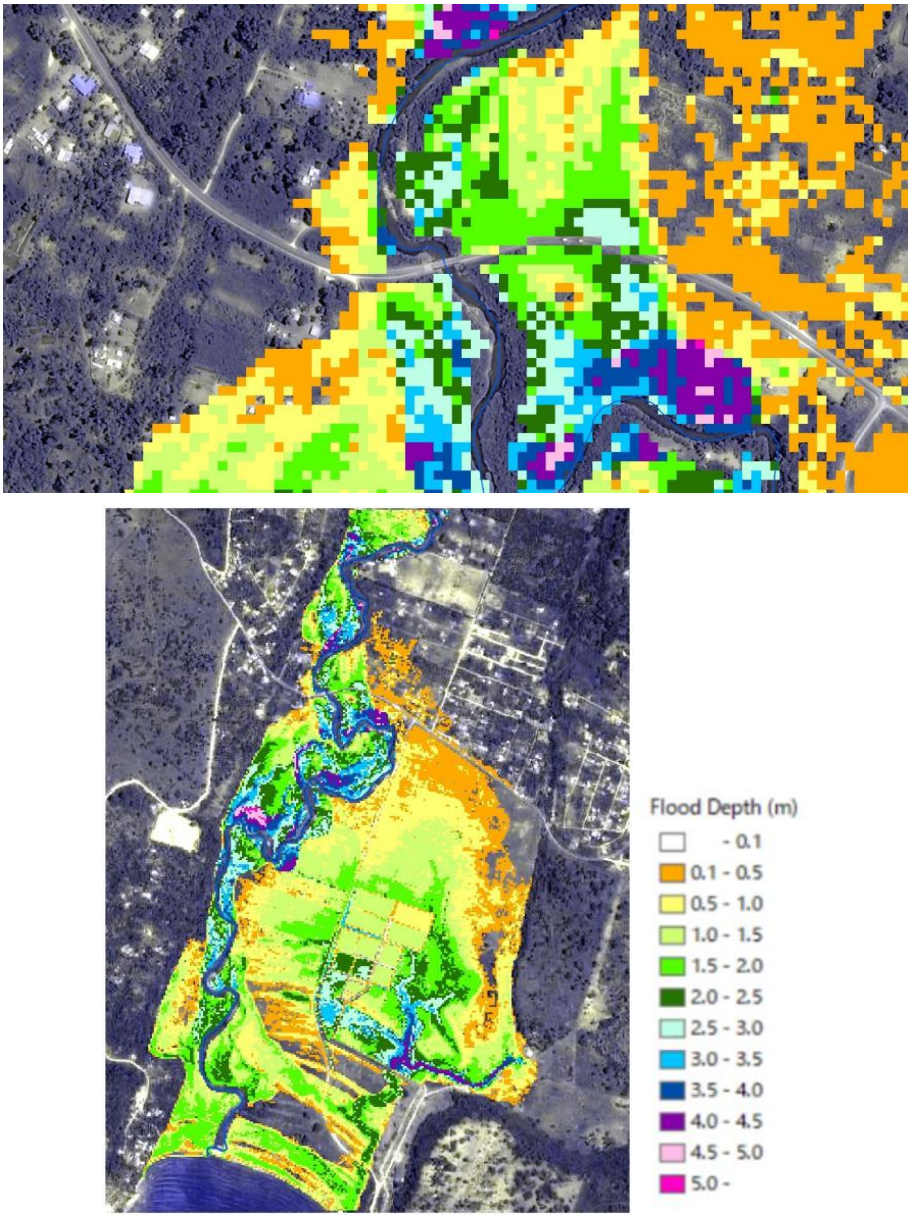
### 2.1.2 Policies for Flood Disaster Countermeasure

#### (1) Model Configuration of Two-dimensional Flooding Simulation

Two-dimensional simulation model is constructed in the following procedure:

- Digital elevation model (DTM) of 10 m grid is developed after confirmation of good agreement between topographic data produced by LIDAR survey provided by Department of Land, Vanuatu as well as results of river cross-section and also road longitudinal section survey.
- Initial conditions for simulation such as water level at river mouth and flood hydrograph are already described in "1.2 Natural Conditions (Climate and Hydrology)" in the preceding Chapter.
- Observed daily rainfall of 514 mm in Bauerfield during Cyclone Pam is nearly equivalent to 50-year return period. Since hourly and spatial distribution of daily rainfall are unknown, a probable 50-year daily rainfall is used for identification of the simulation model. The highest flood level of 7.6 m at Teouma Bridge during Cyclone Pam is an index for verification of the model. Roughness coefficients of 0.035 in river channel and 0.20 of floodplain are obtained through trial and error. As the results of model simulation, a peak discharge of 650 $m^3/s$ might pass through the bridge. In addition, 60 $m^3/s$ overtop flow might be observed in 200 m width of the ring road on the left bank. The simulation results are illustrated thus:

  The results of the simulation are shown in Figure 2.1-1.




*Remarks: Maximum flood depth is depicted throughout the flood time.*

*Source: JICA study team*

**Figure 2.1-1 Results of Flooding Simulation during Cyclone Pam**

### (2) Hydraulics Computation for River Width

From this point of view, The relationship between river width and hydraulic parameters in the river channel countermeasure section (about 400 m in length) shown in the "Data Collection Survey in 2017" are examined, and the results are shown in Table 2.2-1 and Figure 2.1-2.

In particular, the following items should be secured for a stable hydraulics flow condition:

- Average flow velocity should be kept lower than around 3 m/s in the bridge section.
- The flow capacity along with widening river width should be increased effectively.

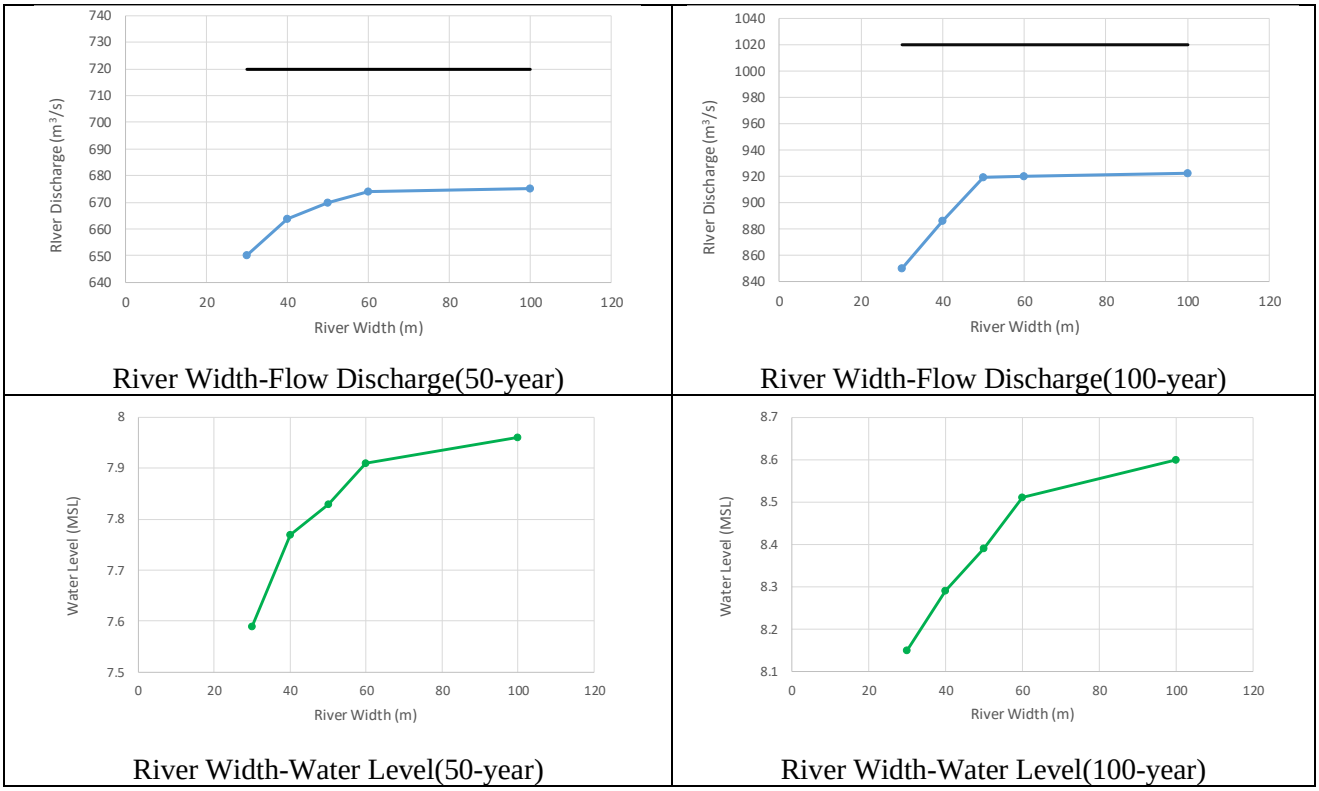
Comparing the computation results illustrated in Figure 2.1-2, 50 m channel width is considered optimum. Flood discharge capacity of river channel is limited due to overbanking flooding in the

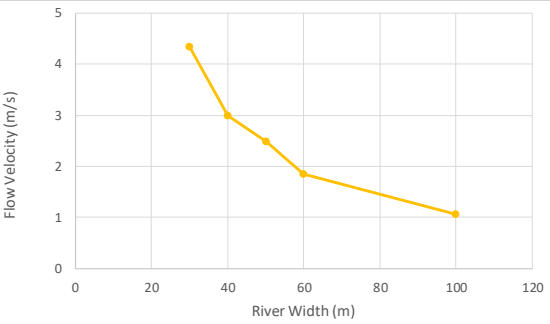
immediately upstream of the bridge. They are 680 $m^3/s$ (50-year flood return period) and 920 $m^3/s$ (100-year flood return period). The exceeding flood discharge overflows in the upper reaches and causing floodplain inundation are 40 $m^3/s$ and 100 $m^3/s$ for 50 and 100-year return period, respectively. In this case, less than 5 $m^3/s$ in 50-year and about 30 $m^3/s$ in 100-year will flow toward east along the upper part of the ring road.

**Table 2.1-2 Results of Hydraulics Analysis for Channel Widening**

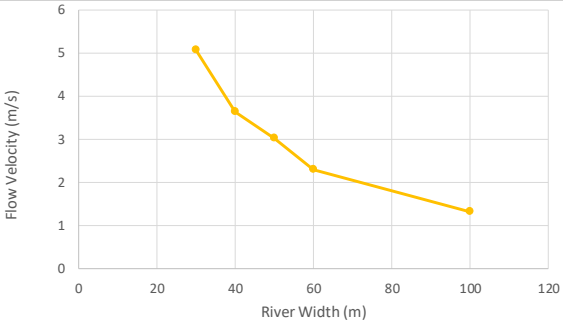
| Flood Magnitude | 50-yr | | | | | 100-yr | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| River Channel Condition (Width) | Existing (30 m) | 40 m | 50 m | 60 m | 100 m | Existing (30 m) | 40 m | 50 m | 60 m | 100 m |
| Peak Discharge at Teouma Bridge ($m^3/s$) | 650 | 665 | 670 | 675 | 680 | 850 | 890 | 920 | 920 | 920 |
| Overflow Discharge on the Ring Road($m^3/s$) | 60 | 45 | 40 | 35 | 35 | 110 | 80 | 60 | 60 | 60 |
| Water Level at Teouma Bridge (m MSL) | 7.59 | 7.77 | 7.83 | 7.91 | 7.96 | 8.15 | 8.29 | 8.39 | 8.51 | 8.60 |
| Flood Velocity at Teouma Bridge (m/s) | 4.35 | 3.00 | 2.49 | 1.85 | 1.06 | 5.06 | 3.63 | 3.07 | 2.29 | 1.31 |

*Source: JICA study team*






River Width-Flow Velocity(50-year)




River Width-Flow Velocity(100-year)

*Source: JICA study team*

**Figure 2.1-2 Changes of Hydraulics Parameters in River Widening**

### (3) Comparative Study of Alternatives

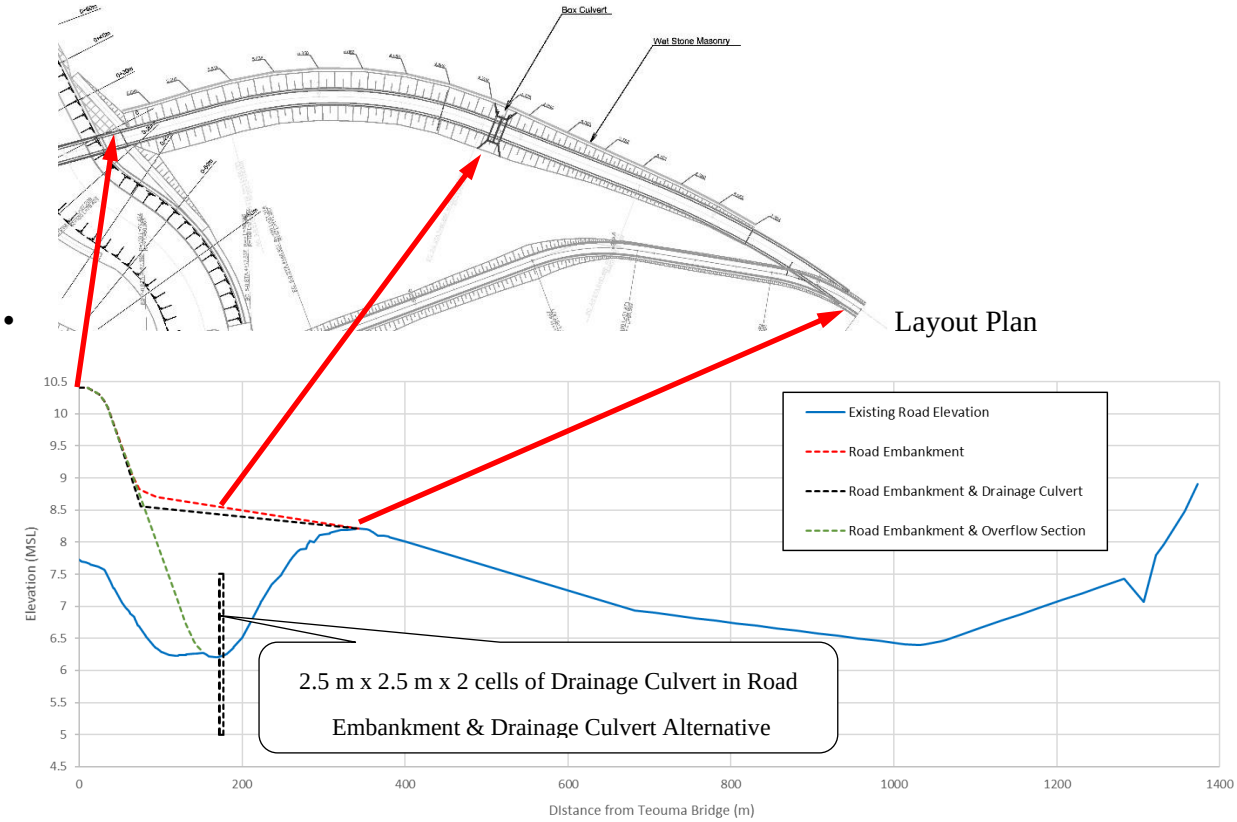
Premises of Comparative Study and Alternatives in Brief

It is better to summarize premises for comparative study prior to setting-up of alternatives and conducting hydraulics computation as follows:

- Water level in 100-year return period flood is computed at 8.39 m for 50-m wide channel. Therefore, High Water Level (HWL) can be set at 8.4 m.
- Freeboard: By considering 0.5 m freeboard following guidelines, the soffit level of Teouma Bridge would be 8.9 m.
- Considering Steel I-girder type as described in the section 2.2.1.7 (4) of this section, the structural height is 1.5 m. Therefore, the proposed road elevation would be 10.4 m.

For that reason, the road surface will be elevated from the existing 7.7 m up to 10.4m. Flood disaster mitigation alternatives are how to approach from the planned bridge to the existing road surface on the left bank. The following are the proposed alternatives and their conceptual longitudinal profile is depicted in the following too:

- ***Alternative Road Embankment Alt.:*** Embankment road with height of 8.7 m above MSL will be planned from the bridge surface to convex ridge at a distance of 340 m east in order to discharge fully through bridge section.
- ***Road Embankment & Drainage Culvert Alt.:*** Box culvert (2.5 m x 2.5 m in 2 cells) with bottom height of 5 m above MSL along the lowest part of the existing ring road will be installed to discharge flooding water. Embankment road will be planned at elevation of 8.4 m above MSL with covering earth of 1.0 m thick.
- ***Road Embankment & Overflow Section:*** Approach road will decline with a slope of 3% connecting to the bottom of existing road, and will follow the existing ring road. Flood water will overtop the reinforced overflow section.




*Source: JICA study team*

**Figure 2.1-3 Flood Disaster Mitigation Alternatives and Longitudinal Profiles**

Comparative Study of Alternatives

Hydraulics parameters of alternatives by flood magnitude, 50-year and 100-year ARI (flood return period) are shown in Table 2.1-3 below. Flooding simulation results are also illustrated in Figure 2.1-4 and Figure 2.1-5 respectively.

**Table 2.1-3 Comparative Study on Hydraulics Parameters of the Alternatives**

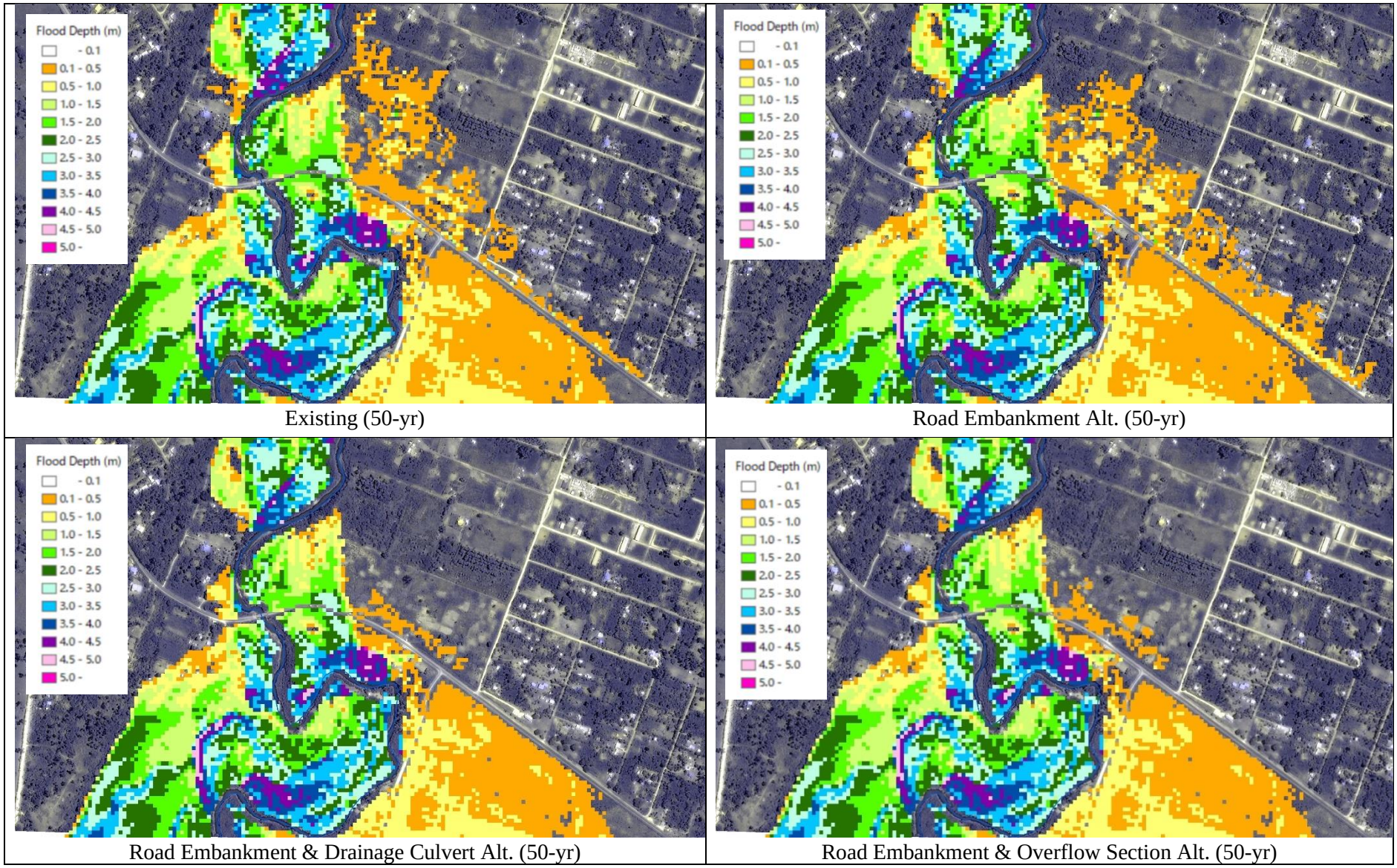
| Flood Magnitude | 50-yr | | | | 100-yr | | | |
|---|---|---|---|---|---|---|---|---|
| Alternatives | Existing | Embank-ment | Embank-ment & Culvert | Embank-ment & Overflow | Existing | Embank-ment | Embank-ment & Culvert | Embank-ment & Overflow |
| Peak Discharge at Teouma Bridge ($m^3/s$) | 650 | 710 | 690 | 670 | 850 | 960 | 940 | 920 |
| Overtopping Discharge or Outflow through Box Culvert ($m^3/s$) | 60 | 0 | 20 | 40 | 110 | 0 | 30 | 60 |
| Water Level at Teouma Bridge (m MSL) | 7.59 | 7.83 | 7.84 | 7.83 | 8.15 | 8.37 | 8.38 | 8.39 |
| Flow Velocity at Teouma Bridge (m/s) | 4.35 | 2.61 | 2.53 | 2.51 | 5.06 | 3.21 | 3.14 | 3.07 |
| Water Level Upstream of Ring Road (m MSL) | 7.80 | 8.05 | 7.93 | 7.72 | 8.38 | 8.63 | 8.56 | 8.35 |
| Water Level Downstream of Ring Road (m MSL) | 7.74 | 7.55 | 7.76 | 7.66 | 8.32 | 8.11 | 8.29 | 8.26 |

| Flood Magnitude | 50-yr | | | | 100-yr | | | |
|---|---|---|---|---|---|---|---|---|
| Alternatives | Existing | Embank-ment | Embank-ment & Culvert | Embank-ment & Overflow | Existing | Embank-ment | Embank-ment & Culvert | Embank-ment & Overflow |
| Flow Velocity through Box Culvert (Case B)/of Overtopping Flow (Case C)(m/s) | - | - | 1.67 | 0.48 | - | - | 2.10 | 0.50 |

*Source: JICA study team*

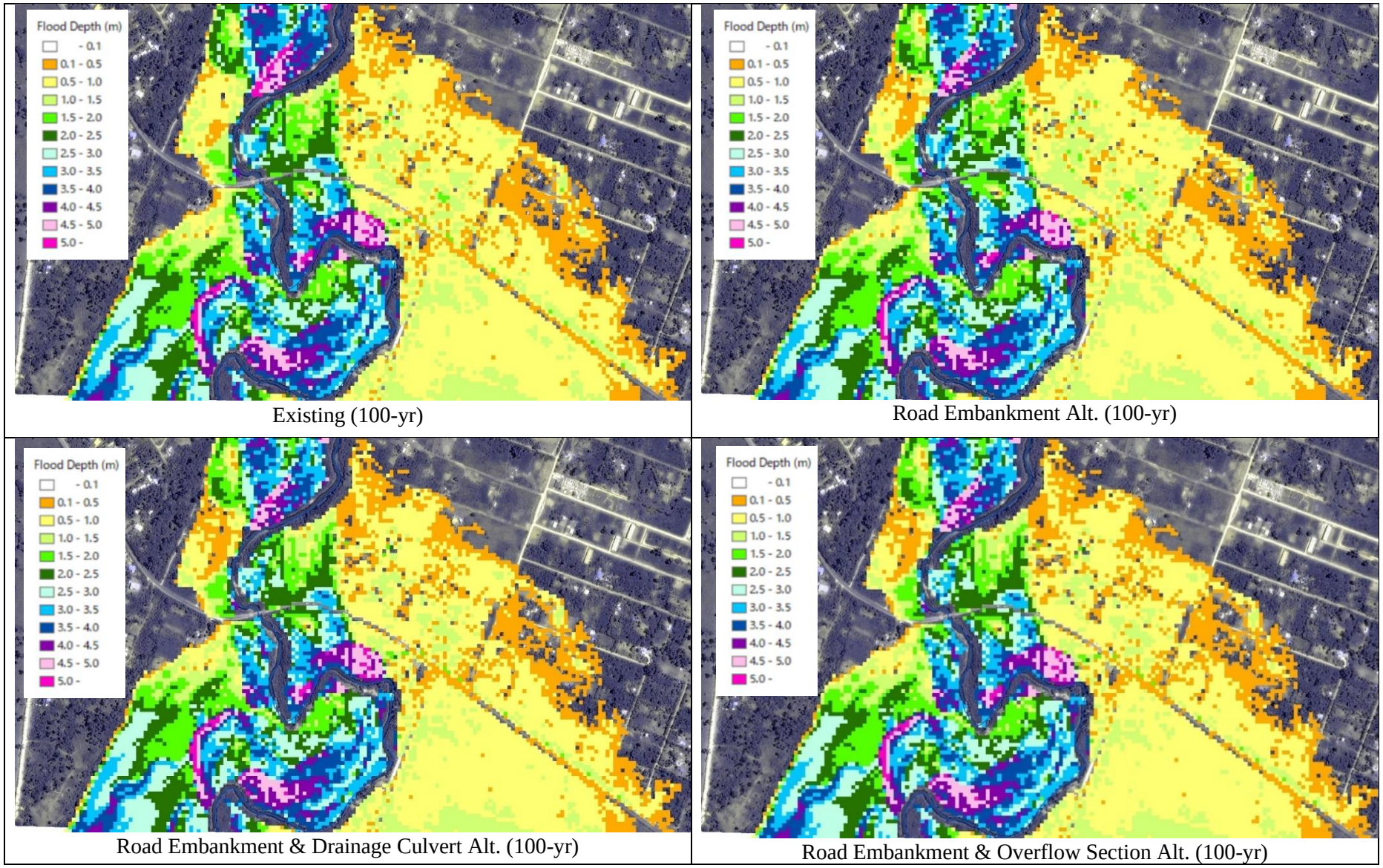
Comparative study results are summarized in Table 2.1-4.

Based on the non-deterioration principle, road embankment alternative is ruled out at first. Compare to two remaining measures, Road Embankment and Drainage Culvert Alternative would be selected because as it is cheaper with almost similar effect as the other option.




*Source: JICA study team*

**Figure 2.1-4 Result of Flooding Simulation by Alternatives in 50-year return period flood**




*Source: JICA study team*

**Figure 2.1-5 Result of Flooding Simulation by Alternatives in 100-year Return Period Flood**

**Table 2.1-4 Overall Comparative Study Results of the Flood Disaster Mitigation Alternatives**

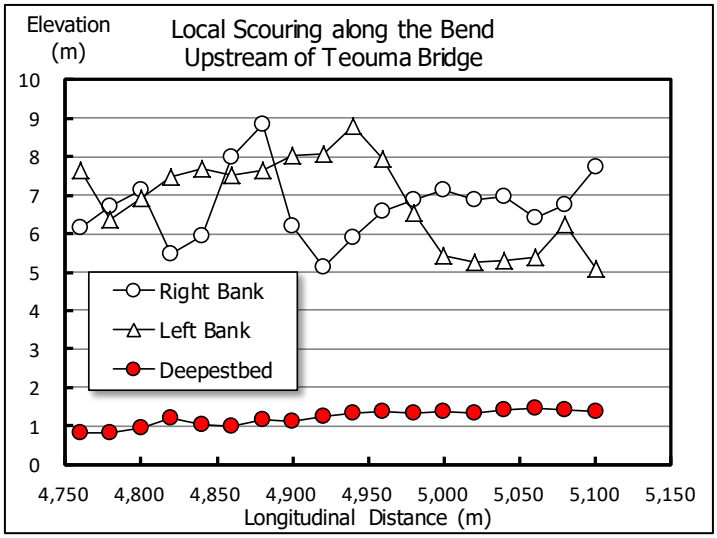
| | Road Improvement (With/Without Overtopping) | Flood Disaster Mitigation Measures | Evaluation | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Flood Disaster Mitigation Effects | Cost | Land Acquisition | Convenience & Safety of Road | Traffic Safety | Overall Evaluation |
| Road Embankment Alt. | Ring road shall be elevated with soil up to a height of 8.7 m MSL not to be overtopped by the 100-year flood. | Embankment road to guide the flooding water to the river channel along the upstream side of ring road. | Flooding situation in the upstream of ring road slightly worsen from existing conditions in both 50-year and 100-year floods. | Low (Only earth embankment) | Due to embankment road with highest one of 2.5 m, necessary area of land is widest. | All-weather type | Fair | Medium |
| Road Embankment & Drainage Culvert Alt. | Ring road shall be elevated with soil up to a height of 8.4 m MSL not to be overtopped by the 100-year flood. | Existing lower part of the road will not overtop the floodwater. | Flooding situation in the upstream of ring road will not worsen from existing conditions. | Medium (Box culverts and earth embankment) | Due to embankment road with highest one of 2.5 m, necessary area of land is wide. | All-weather type | Fair | High |
| Road Embankment & Overflow Section Alt. | Utilizing existing drainage function of lower part of the ring road, road will decline with a slope of 3% connecting to the bottom of existing road. | Floodwater will overtop the reinforced overflow section. Overtop starts in more intensive than 10-year flood. | Flooding situation in the upstream of ring road will not worsen from existing conditions.<br>Overtopping situation<br>50-year : overflow depth 1.5 m, velocity 0.48 m/s<br>100-year : overflow depth 2.1 m, velocity 0.50 m/s | High (Flood proofing road and earth embankment) | Due to embankment road, but necessary area of land is not so wide. | Road will be closed in more intensive than 10-year flood | Low | Low |

*Source: JICA study team*

### (4) Countermeasures to Protect Scouring of the Right Bank at Bend

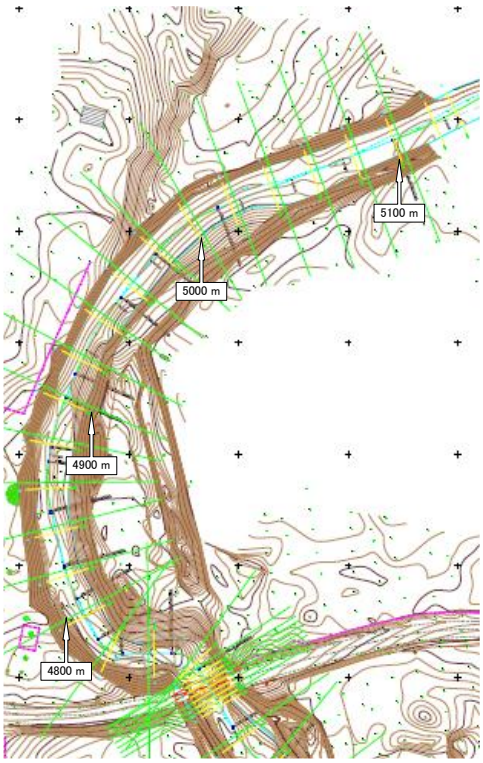
Scouring Situation at River Bend

According to the results of river cross-sectional survey, significant scouring cannot be observed in the longitudinal riverbed profile (refer to Figure 2.1-6) and river cross-sections. A few large-scale cyclones still pass Efate Island after Cyclone Pam and riverbed materials mainly consisting of movable sand and fine gravels can easily be used to backfill scoured portion after any floods.




*Source: JICA study team*

**Figure 2.1-6 Longitudinal Profile of Deepest Riverbed at Bend upstream of Teouma Bridge**




*Source: JICA study team*

**Figure 2.1-7 River Cross-sectional Survey Location at Bend upstream of Teouma Bridge**

Scouring Depth Prediction

The following guidelines are referred to for estimation of scouring depth: Revised Version of Mechanical Designing for River Revetment Works (Japanese), Japan Institute of Countryology and Engineering (2007)

Below is the estimation process for scouring depth:

(1) Relation of maximum flow depth (Hmax) and average flow depth of an average annual maximum flood (Hm) shall be confirmed Refer to Figure 2.1-8.

.

Using curvature radius of river bend (r=140 m) and river width (B=50 m), r/B of 2.8 can be estimated. Checking the figure and using r/B of 2.8, Hmax/Hm of 2.3 can be made out in the rivers without formation of sandbar (dotted line in the figure).

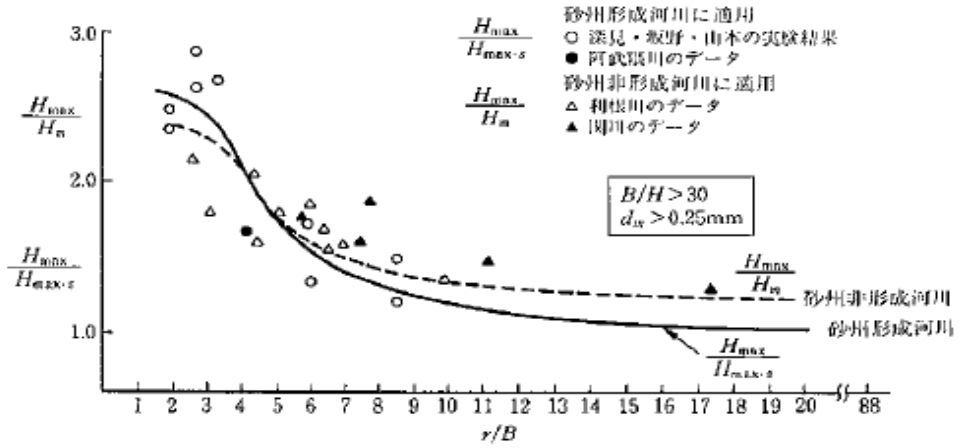
(2) From average flow depth in average annual maximum flood (Hm), maximum flow depth in design flood (Hmax) can be estimated.

Assuming Hm of 1.0 m as average annual maximum flood (40 $m^3/s$ in 3 - 4 year ARI), Hmax can be estimated as follows, referring to the Guidelines.

Hmax = 1.0 x 2.3 x 1.3 = 3.0 m

(3) Setting-up of design foundation depth

Considering average water depth of 1.0 m, design foundation depth of 2.0 m the below riverbed design can be obtained.




*Source: Rivised Revetment Dynamic Design Methods / Japan Institute of Country-ology and Engineering (2007)*

**Figure 2.1-8 Relation between Hmax/Hm and r/B at Bend**

**1) Scouring Prediction around Bridge Pier**

a) Causal Factors of Local Scouring

According to HEC 23, riverbed scouring generally occurs in complex phenomena combining the following three independent factors:

- Riverbed aggradation/degradation: Channel scouring occurs by sediment balance situation. If human/natural activities or structures which influence the sediment balance situation in the upper reaches does not exist, then it is not necessary to consider this factor.

- River channel contraction: A large amount of floodwater flowed down along the river channel and simultaneously eroded the riverbank during Cyclone Pam, resulting in the widening of the river channel. As a result, Teouma bridge remained forming a constriction section. In the Outline Design, it is planned to widen the river channel and in doing so, this factor also may influence only negligible small effects.
- Structure's effect: Occurrence of vortex caused by bridge pier accelerates local scouring around the structure. This factor is major causal factor of local scouring.

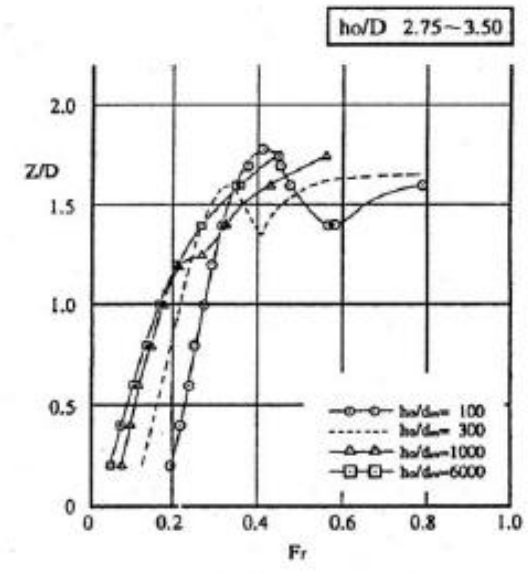
b) Scouring Prediction around Bridge Pier

Based on the following article, the scouring depth around the bridge pier shall be computed: *Planning Guidelines for River Crossing Bridge (Draft),* Japan Institute of Country-ology and Engineering, 2009

Based on the actual site conditions of Teouma Bridge, the necessary hydraulics parameters are:

- Average water depth (ho): 6 m
- Width of bridge pier(D): 2.0 m (Oval shape)
- Mean diameter of riverbed materials(dm): 1-0.5 mm (Coarse sand)
- Froude number (Fr): 0.4

Following the above figures, ho/D is 3 so that experimental result of ho/D between 2.75 to 3.50 can be used for estimation of local scouring depth. Fr is 0.4 and ho/dm ranges 6,000 to 12,000. Considering the figure below, ho/dm could be 6,000. As a result, non-dimensional scouring depth Z/D may be 1.7, and actual scouring depth Z could be computed as 3.4 m. The design scouring depth could be set at 3.5 m as a round number.




*Source: Planning Guidelines for River Crossing Bridge (Draft), Japan Institute of Country-ology and Engineering, 2009*

**Figure 2.1-9 Relation between Fr, ho/dm and Z/D for Prediction of Scouring Depth**

Assessment of the impact of climate change

Based on climate change projections, a two-dimensional flooding simulation was conducted. The results are shown in Table 2.1-5.

When climate change is considered in simulation, the maximum water level at Teouma Bridge would be 0.19 m above maximum water level without effect of climate change. However, 0.19 m is covered by free board 0.5 m. The water level at the left bank approach road 8.8 m is 0.1 m above the elevation of designed approach road 8.7 m. However, this 0.1m is absorbed in the super elevation of the approach road because this part is located in the curve section. Therefore, the increase of the water discharge due to climate change can be address by a newly design structure.

**Table 2.1-5 Changes of Hydraulics Analysis Results Considering Climate Change**

| | 50-yr | | 100-yr | |
|---|---|---|---|---|
| | **No Climate Change** | **Climate Change** | **No Climate Change** | **Climate Change** |
| Peak Discharge ($m^3/s$) | 720 | 820 | 1020 | 1160 |
| Peak Discharge at Teouma Bridge ($m^3/s$) | 690 | 780 | 950 | 1060 |
| Water Level at Teouma Bridge (m MSL) | 7.83 | 8.04 | 8.37 | 8.59 |
| Water Level at left bank approach road of Teouma Bridge (m MSL) | 7.90 | 8.18 | 8.57 | 8.80 |

*Note：Teouma Bridge HWL；8.40 m MSL、Water Level at left bank approach road；8.70 m MSL*

*Source: JICA study team*

### 2.1.3 Design Policy of River Improvement Works

Based on the design policy of Flood Disaster Countermeasure described in 2.1.1 above, the following presents the design policy for river channel improvement works around the Teouma Bridge (a stretch of about 100m downstream and about 300 m upstream from bridge). A box culvert is also proposed under the road to drain flood overflow on the left bank.

At first, the present conditions of the river channel are investigated. Then, the design items of the channel improvement works such as alignment, longitudinal profiles and typical cross section are prepared. Furthermore, design policies are considered on excavation and embankment works to shape the proposed river channel. Bank slope protection works are needed for protection of vulnerable banks from erosion, and box culvert works are needed as drainage facility on the left bank. In addition, maintenance works are planned for completed channel.

#### (1) Site Conditions of River around Teouma Bridge

The present conditions of the river channel around the Teouma Bridge are described as follows:

- The River course shows a big bend towards the right (western) side in the upstream of the bridge using topographic data. River flow cause erosion severely in the right riverbank and hits the right approach road of the bridge. The river water then turns to the left and flows under the bridge. Fast-flow and/or turbulent water flow occurring due to flooding could cause erosion easily on the vulnerable riverbanks.
- During the flood caused by Cyclone Pam in 2015, severe erosion was observed on the approach road of the bridge on the right bank as shown in Figure 2.1-10 below (left photo). Emergency rehabilitation work using stones was done (right photo).

**Damage to the Right Approach Road (2015)**

**Urgent Rehabilitation Works of Right Approach Road (Present)**

*Source: JICA study team*

**Figure 2.1-10 Teouma Bridge Damaged by Cyclone Pam**

- Present width of riverbed is 20 to 30 m approximately. The riverbed elevation ranges from 1m above Mean Sea Level (MSL) to 1.5 m (hereafter presented by EL. 1 m or EL. 1.5 m). Top elevations of upstream riverbanks range from EL. 5 m to EL. 8.6 m at the right bank and EL. 6 m to 7 m at the left bank. Top elevations of downstream riverbanks are EL. 5 m at right bank and EL. 6 m at left bank. Height of riverbanks from riverbed are 4 m to 7 m.
- Present bank full flow capacity of river channel is estimated at 120$m^3$/s which is less than 5-year return period.
- Material of river channel is fine sand.
- No riparian structures are found except gabion cylinders placed for abutments of Teouma Bridge.
- As for present land use, there is residential area for few houses on the right riverbank upstream and farm/bush land on left riverbank upstream and bush areas on both downstream riverbanks.
- At the area where a drainage facility is proposed under the road on the left bank 180 m from the bridge, there is a drainage pipe with 0.9 m diameter under the existing embanked road. Top of road is EL. 6.3 m and natural surface ground is about EL.5 m.

**(2) Design Alignment, Longitudinal Profiles and Cross Section for Channel Improvement**

As mentioned in 2.1.1 Design Policy for Flood Disaster Countermeasures, design flood level of EL.8.4m and design width of 50 m at the location of proposed new bridge are determined. Since the present river width is 20 m to 30 m, widening of channel is necessary.

Moreover, present alignment of river channel invading widely private land is not desirable due to bending. Re-alignment is necessary to stabilize the channel.

**a. Design Alignment of River Channel**

According to the collected land lot sketch map in the upstream area, the present river course invades the private area on the right riverbank. Old river course with a width of about 45 m is now filled with soils and bush land. Re-alignment of river channel is proposed to have almost the same as old channel considering the flowing:

- Alignments of new bridge and river channel should orthogonally intersect each other as much as possible, so that the bridge length can be shortened.

- Proposed alignment of river channel should be in the old river course (public land) to minimize the use of private land.

End of upstream of new river channel connects with the existing course 260 m upstream of bridge. On the other hand, end of downstream of new channel connects with existing course 110 m downstream of bridge.

**b. Design Longitudinal Profile of Riverbed**

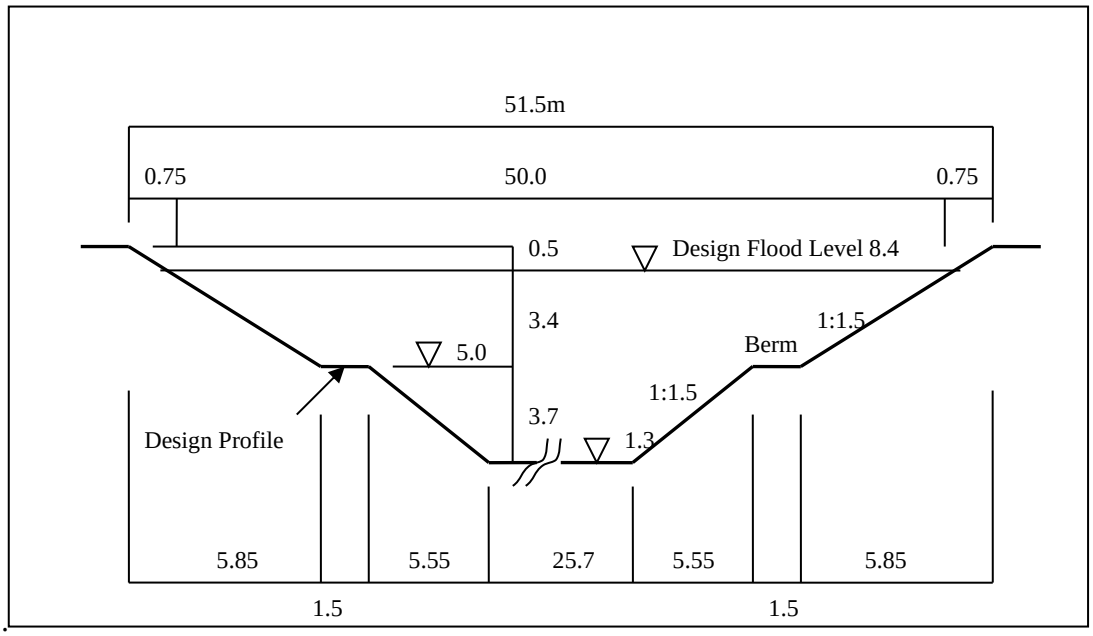
Riverbed elevations of stretch to be re-aligned are determined following the existing riverbed profile; EL. 1.2 m at the downstream end and EL. 1.5 m at the upstream end. Then, the design longitudinal riverbed gradient becomes 1:1400 (vertical and horizontal direction).

**c. Design Cross Section of River Channel**

Design standard cross section is determined under the following policy:

- 50 m width is proposed as designed river channel width measured at the design flood level (EL. 8.4 m at bridge) with a freeboard of 0.5 m.
- Design slope gradient of riverbanks is 1:1.5 (vertical: horizontal) provided that the riverbank slope protection is constructed and 1:2.0 without slope protection.
- In case the slope height is more than 5.0 m, a 1.5 m wide berm, horizontal step, in the sloping profile is provided for stability.

Design width of the riverbed is 25.7 m which is almost the same as the existing one. The design standard cross-section of the river channel is showed in the following Figure 2.1-11.




*Source: JICA study team*

**Figure 2.1-11 Proposed Typical Cross Section of River Channel (at Bridge)**

**(3) Excavation and Embankment Works to Make Re-Aligned River Channel**

Excavation and embankment works are needed to shape proposed channel in accordance with the design alignment, design longitudinal profiles and design standard cross-section of river channel. Existing soil condition shows that excavation area comprises of sandy soil without any rocks found. Selected soils

from excavation work or borrow pit are to be used for necessary embankment. Cut/embankment slope gradient is designed to be 1:1.5 under the provision of slope protection and 1:2.0 for no provision of slope protection.

**(4) Design Elevations of Riverbanks**

Design top elevations of riverbanks are proposed to be almost the same as existing ground elevations.

**(5) Bank Sections to be Covered with Revetment**

Since the soil type of riverbanks is sandy and easily eroded by flood current, provision of revetments is proposed at curve portions and around the bridge structures as shown in Table 2.1-6 below:

**Table 2.1-6 Bank Sections to be Covered with Revetment**

| Location | Left Bank | Right Bank |
|---|---|---|
| Downstream of Bridge | There are curves at both bonks and banks are eroded. Revetments are to be provided on both bonks to fix the channel alignment. | |
| Around Bridge | Stronger revetments are to be provided to reinforce the bridge structure and access roads. | |
| Upstream of Bridge | Since left bank is inside of curve, erosion of bank is not severe and area on left bank is unused area. No provision of revetment is proposed. | This bank is concave curve. Curve would be more in progress if no any protection. Revetment along the curve portion is proposed up to the existing straight channel. |

*Source: JICA study team*

**(6) Selection of Optimum Type of Slope Protection of Revetment**

Revetment/Slope protection is designed based on the Japanese standards/guidelines on river engineering works.

Design of slope protection as part of revetment and placed on slope of riverbanks needs considerations of the subsoil condition, flood velocity, necessary height of slope protection, gradient of slope, depth of riverbed scouring, available space for construction, cost, maintenance works, etc.

- Fine sandy soil which is easily eroded
- Design flood velocity 3.2 m/s
- About 7 m water depth in case of design flood with 100-year return period
- Design flood level gradient of 1:550 (classified within rapid-middle stream having gradient of 1:500 to 1:2000)
- Design riverbed slope 1:1400
- Estimated potential scouring depth 2 m approximately
- Minimizing of land acquisition by slope gradient to avoid social issues
- Possible construction space for dry works under dry work condition in 26 m at riverbed
- Utilization of locally sourced materials which result in cost minimizing and easy maintenance works

As a first step in designing of slope protection, types of slope protections which might be applicable for this river course are listed as shown in Figure 2.1-12.

**(1) Wet Stone Masonry**

**(2) Concrete Block Wet Masonry**

**(3) Concrete Lining**

**(4) Reinforced Concrete Crib**

**(5) Gabion Mattress**

**(6) Steel Sheet Piling**

**(7) Dry Stone Masonry**

*Source: JICA study team*

**Figure 2.1-12 Types of Slope Protection**

Comparison of types of slope protection is made in the following table (Table 2.1-7) considering the structural stability, applicable slope, locally available materials, cost, etc. As a result of comparison, "Dry Stone Masonry" and "Reinforced Concrete Crib" are selected. Strong reinforced concrete crib revetment is applied around the important bridge structure. Economical Dry-Stone Masonry revetment using local available stones is applied for area except bridge area.

**Table 2.1-7 Comparison of Slope Protection**

| Item No. | Slope Protection Type | Typical Structural Details | Applicable Slope Gradient | Applicability Evaluation |
|---|---|---|---|---|
| 1 | Wet Stone Masonry | Cobble stones (around 30 cm diameter) filled with concrete | 1:1.5 to 1:3.0 | Hard stone is better. However, stone produced in Vanuatu is semi-hard stone. |
| 2 | Concrete Block Wet Masonry | Concrete blocks with thickness of 20 cm filled with cement mortal | | Factory-fabricated concrete blocks are not locally available. |
| 3 | Concrete Lining | Concrete slab with thickness of 20 cm (with steel mesh-net, if needed) | | Similar to type below (item 4). However, structural strength is not enough for river with high velocity. Since surface of slope protection is smooth, function of velocity reduction cannot be expected. This is generally used for river with relatively slow velocity. Construction cost is comparatively high. |
| 4 | Reinforced Concrete Crib | Concrete cribs with 30 cm sectional square and filled with 20cm thick concrete lining | | Structure is strong and rigid. Velocity on surface of slope protection can be reduced by exposed cribs. This type is frequently used for river with high velocity like this river. This is utilized around the important structure, because of high cost. |
| 5 | Gabion Mattressess | Rocks filled in Steel mesh box | | This type is used for urgent works of disaster as temporary works. Durability is poor. |
| 6 | Steel Sheet Piling | Slope protection on steel sheet piling | Vertical Wall | This type is used where cofferdam construction is too costly due to deep water at near sea, etc. It is also preferable in urban area where land acquisition is difficult. However, construction cost is too high. |
| 7 | Dry Stone Masonry | Stones with around 0.5m diameter are placed. Void between stones is filled with small stones. | 1:1.5 to 1:3.0 | Locally available stones can be used, resulting in low construction cost. Construction and maintenance are easy. |

*Source: JICA study team*

### (7) Plan for Maintenance and River Water Use

Aggressive river flow can result in local erosion and damage of river channel. It is essential to regularly check the slope protection system and repairs should be carried out as soon as possible. A small damage could lead to a rapid deterioration of the total protection system. Moreover, local people are using

the river water for water intake, washing, etc. A step facility in bank slope is designed for the convenience of maintenance inspection and water use by local people.

**(8) Box Culvert under Road for to Discharge Flood Overflow**

A reinforced concrete box culvert with size of 2.5 m high by 2.5 m wide x 2 cells is proposed under the embanked road to drain smoothly the floodwater that overflows on the left bank. The structure design is made based on the Japanese design standards/guidelines.

### 2.1.4 Policies for Utilization of Existing Teouma Bridge

JICA team inspected existing Teouma bridge during the 1st site survey. The inspection result is described below.

- Rust had been found on many bolts of the existing bridge. If the existing bridge is to be utilized as a part of the new bridge, all bolts must be replaced.
- Rust on the bolts mainly was found on the upper chord members on the existing bridge. One of the reasons is considered that the airborne salt on the road surface may be rolled up by the vehicles passing the existing bridge which is located approximately 2 km form the coast.
- Peeling of galvanized corrosion protection was confirmed in a part of the main structural steel members, but it can be judged that it is sound as a base steel material.
- Road width of the existing bridge is 6.5 m (Carriageway:3.0 m x 2 + Side strip:0.25 m x 2). It does not satisfy the road design specification in VRRM which was enacted in June 2014.

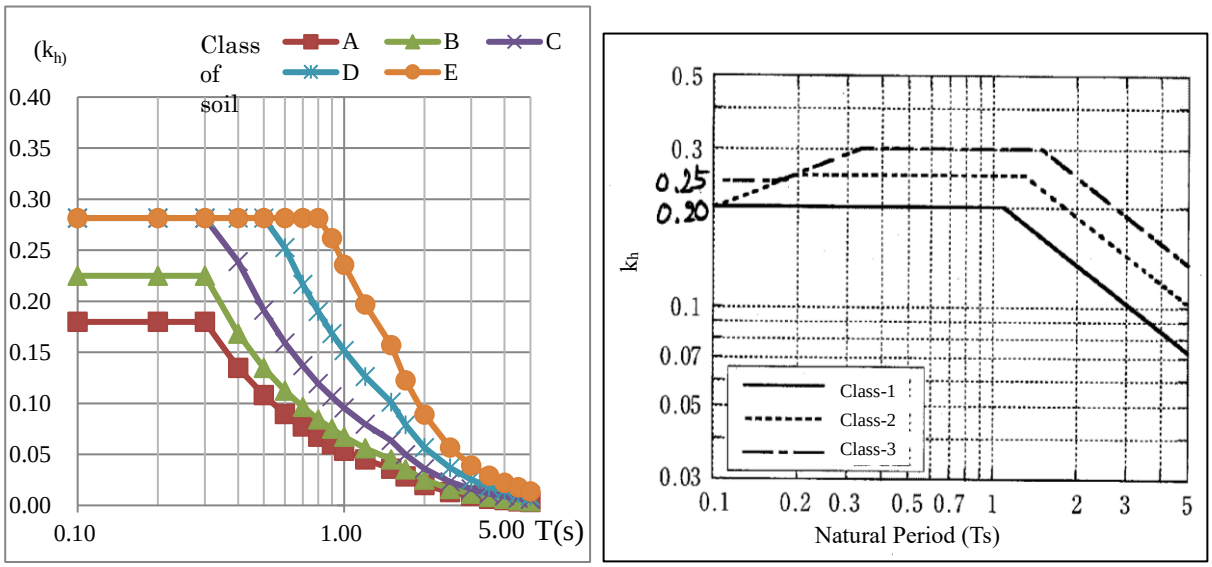
Therefore, JICA team concluded that it is difficult to utilize the existing bridge as a part of the new bridge. In that case, utilization of the existing bridge shall not be considered in the new Teouma bridge planning.

### 2.1.5 Policies for Seismic Design Condition

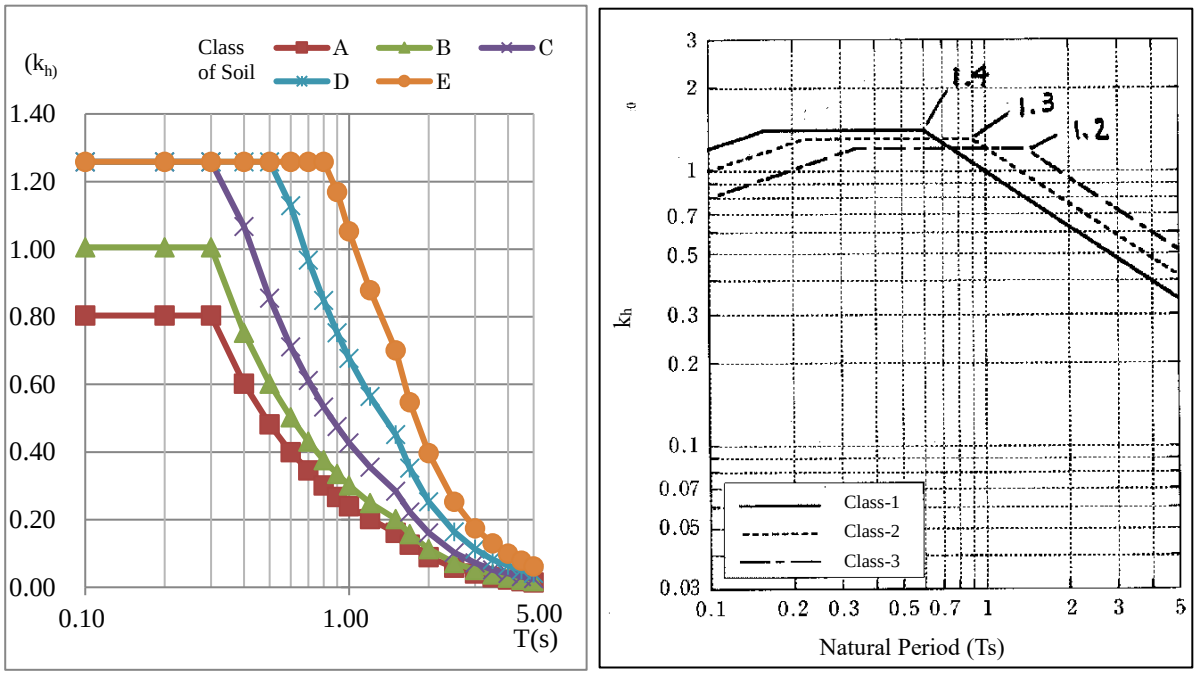
Seismic load had been considered for bridge design in a project by ADB because of the frequent earthquakes that occur around Vanuatu. In bridge seismic design in Vanuatu, Australian standards normally apply. The Australian standard has been applied too in the ADB project.

By comparison of earthquake response spectra between Australian standard and Japanese standard is shown in Figure 2.1-13. The earthquake force in both standards is deemed mostly the same. Therefore, Japanese standard named “SPECIFICATIONS FOR HIGHWAY BRIDGES, PART V SEISMIC DESIGN, 2012” will be applied in seismic design of this project.

Going by the construction report of the existing bridge, the soil class around Teouma bridge was classified as Class-2, with a horizontal acceleration coefficient determined as $k_H$=0.26. But, based on the result of the soil investigation implemented in this survey, the soil class is classified as Class-3 (that is, softer than Class-2), with the horizontal acceleration coefficient determined as $k_H$=0.3.




Level 1 Earthquake (Exceedance probability 1/50)




Level 2 Earthquake (Exceedance probability 1/1000)

(a)Australian Standard (b)Japanese Standard

*Source: Specifications for Highway Bridges*

**Figure 2.1-13 Comparison of Earthquake Response Spectra**

### 2.1.6 Policies for Bridge Planning

The following items shall be considered for the bridge planning such as bridge location, superstructure type, substructure type, etc.

(1) The road alignment and bridge location shall be appropriately studied taking into consideration the construction plan.

(2) The external requirement of the bridge planning, ex) live load and flood flow, shall be satisfied

(3) Consideration of quality, easiness and rapidity shall be considered
(4) The traffic safety and run-ability shall be considered
(5) Ease of maintenance shall be considered.
(6) The design standard shall be determined comparing both the Australian and Japanese standards.
(7) The procurement condition for equipment and materials in Vanuatu shall be considered.
(8) Utilization of the existing bridge is not possible.

**(1) Condition on Bridge Location**

Considering the function of the bridge as a trunk national road and the security of traffic flow during construction, three alternatives in the same location as well as upstream and downstream of the bridge will be compared and examined with respect to road alignment, obstacles, environmental impact, construction period and economic efficiency.

There are houses and street stalls around the Teouma Bridge. In the bridge planning, consideration shall be given to the geometric shapes of bridges and approach roads to minimize the relocation of these facilities and houses. When selecting a bridge type, the elevation of the road surface should be suppressed as much as possible. When the road surface height changes, consideration should be given to installing stairs, etc. in order to maintain access to facilities and houses.

**(2) Condition on Bridge Profile**

The High-Water Level (HWL) for the bridge design shall be determined based on Two-dimensional Flooding Simulation as mentioned in 2.1.1. The impact of climate change shall also be considered for HWL.

The appropriate freeboard and the cross-sectional area of the river shall be maintained to make the river flow smoothly during floods. The freeboard in this project is determined as 0.5 m in accordance with Australian standard as mentioned in 2.1.1.

**(3) Condition on Cross Section**

The following shall be considered for typical cross section:

- Width of carriage way and marginal strip shall comply with the VRRM.
- Typical cross section shall be considered to maintain the continuity of the existing ring road.
- Sidewalks shall be installed on both sides of the carriage way only on the bridge.

Sine there is a manual for road design (VRRM) in Vanuatu, the condition on road width shall be complied as per the VRRM. According to the VRRM, the width on ordinary road and bridge are not well-defined, and pedestrians will walk on the road shoulder. However, in this project, a sidewalk shall be installed only on the bridge area in respect to the strong request by the Vanuatu.

**(4) Condition on Comparative Study of Bridge Planning**

Bridge planning including bridge location, superstructure, substructure, pile etc., should be comprehensively determined in consideration of the following requirements:

- To select a proper location and road alignment for bridge construction
- To satisfy any external requirements for the bridge planning

- To be structurally stable and economical
- To consider the quality, ease and rapidity of construction
- To consider safety and comfort of driving
- To select structural type superior in easiness of bridge maintenance

**(5) Condition on Comparative Study of Bridge Planning**

The bearing layer of the bridge foundation shall be selected based on:

- The bearing layer of the bridge shall be determined based on the Standard Penetration Test (SPT). The N-value of bearing layer shall be more than or equal to 30 for the sand or gravel layer and 20 for the clay layer.
- The bearing layer shall be carefully decided for gravel layer to consider the errors due to existing of boulders, possibility of scouring and the scale of the structure. The N-value of more than or equal to 30 is not the absolute condition in case of gravel.
- The thin layer shall not be selected even if the N-value was satisfied.

### 2.1.7 Policies for Road Planning

**(1) Policies for Plan of Approach Road Alignment**

Approach road will be planned based on the following policies:

- In principal, to follow VRRM
- To refer to AUSTROADS Guide, Road Design Part 3: Geometric Design (hereinafter referred to as the "AGRD") or Government Order on Road Design Standards of Japan)
- To provide guardrail in high embankment section as a traffic safety measure
- To consider the ease of maintenance
- To maintain the continuity of the existing road
- To design with an emphasis on safety because the curve radius of existing road is small and the road is steep
- To plan to minimize land acquisition

**1) Consideration of Road Alignment**

In planning approach of the road alignment, the survey compared three options: See Table 2.2-14.

Option-1: Almost same alignment as existing road, Option-2: Moving the alignment to the upstream side, and Option-3: Moving the alignment to the downstream side. The items for comparison were:

Obstacles

High-voltage and low-voltage electric wires are laid around the Teouma bridge. The height of embankment will be 2.5 m to 3.0 m due to the elevation of new bridge. Therefore, the relocation of the poles and cables are indispensable for all options. In that case, the 3 options do not have much difference.

Environmental Impact

Vanuatu has a traditional customary land use system and this custom remains deeply rooted at present. Therefore, there are many lands where landowners are not clear. The land use situation around Teouma

bridge is as follows: upstream side is leased land registered under the government and registered in the land registry, however, the downstream side is a customary land and the leader of the village substantially manages it. Land expropriation is very difficult in Vanuatu for both leased and customary land. Designed flood water level will be higher than the existing bridge. Accordingly, height of embankment also will be higher than existing road. Relocation of houses may occur with both option-2 and option-3. Therefore, Option-1, in which land expropriation doesn't occur except in some embankment sections, has an advantage compared to the other two options.

Alignment

In the case of option-3, the horizontal alignment on the right bank side has a smaller radius of curvature than the existing alignment due to the relationship with location of the bridge. This means driving safety will slightly decrease. In case of Option-1 or Option-2, the plan is not to deteriorate the approach road alignment.

Construction Period

In case of Option-1, it is necessary to construct a detour road before beginning of road and bridge works. Therefore, construction period takes longer than others.

On the other hand, as for Option-2 or Option-3, the construction period is shorter compared to Option-1 because the bridge can be constructed while the existing road is in service. However, since new road elevation is 2 or 3 m higher than present road, it is necessary to construct a detour road so as to not affect the new road in the overlap section between existing and new road alignment.

In addition, in order to ascertain the cross-sectional area of the river, it is necessary to remove existing bridge. Particularly, in case of Option-2 and Option-3, the existing bridge can be removed, and the revetment works can be done only after completion of the new bridge and approach road. Note: Revetment work can be done only in dry season, therefore, the 3 options have not much difference in this regard.

Cost

In the case of Option-1: Embankment constructed for main road is smaller than the other options, and installation of structure such as retaining walls is unnecessary. Therefore, the project cost is smaller than the other two options.

In the other hand, the project cost of Option-2 and Option-3 are more than Option-1 due to:

The length of the main road will be longer than the existing road in case of Option-2 and Option-3;

The amount of embankment will increase because the existing ground surface on the new alignment is lower than the existing road; and,

Retaining walls will be installed due to reducing area of land expropriation and amount of embankment.

Even though the cost for temporary works for Option-1 is more than the other two options due to the longer length of detour road and installation of temporary bridge, this is a small addition in comparison with the addition to the main construction cost.

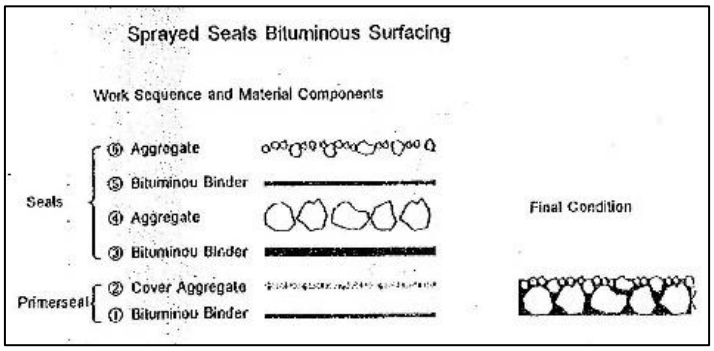
**2) Comparative Study Results**

As a result of examining the approach road alignment, Option-1 has the overall advantage. This is in view of safety considerations and minimizing land acquisition with respect to the difficulty of land acquisition by customary land use system in South Pacific countries.

### (2) Policies for Pavement Planning

Since there is no asphalt plant in Vanuatu, road surface types are limited to 2 types of unseal surface (earthen road) or seal surface (DBST / SBST). Double Bituminous Surface Treatment (DBST) is used on the existing road surface and the existing surface condition is very sound and also considering the simplicity of maintenance. Therefore, DBST will be applied in this project.

Appropriate pavement plan shall be prepared based on the results of the geotechnical survey and material tests (conducted during the second field survey). The pavement structure of seal surface (DBST) used in Vanuatu is shown in Figure 2.1-14 below.




*Source: Report on the Project for Improvement of the Ring Road in EFATE Island in the Republic of VANUATU JICA 1997*

**Figure 2.1-14 Seal Pavement Structure**

### 2.1.8 Policies for Procurement

The local construction business mainly consists of construction work such as small-scale buildings and private houses, and civil engineering work can only be seen as maintenance and repair work. Large civil works are carried out through foreign funding. The works are majorly implemented by foreign contractors, for example, from New Zealand and China. The construction market in Vanuatu is small, and there are no big contractors in Vanuatu. Such local circumstances shall be considered in this project.

### 2.1.9 Policies for Utilization of Local Contractors

The construction market in Vanuatu is very small and local construction companies are mostly very small. There is no company that can correspond as a sub-contractor to a Japanese construction company in Vanuatu. There are only a few suppliers of stone/crushed stone and a concrete manufacturing company as a supplier of materials. Only Local suppliers of soil and concrete materials shall be utilized in this project.

### 2.1.10 Policies for operation and maintenance

Maintenance works after completion of the Project will be carried out by the Office of Shefa belonging to the PWD under MIPU. Sufficient budget has been secured. Since advanced technology is not

required for maintenance, instruction on maintenance methods should be given during construction or after completion.

## 2.2 Outline Design of the Japanese Assistance

### 2.2.1 Basic Plan

The Overall project plan is shown in Table 2.2-1. The road width including shoulders in the section of approach road will be 8.0 m. In the bridge section, sidewalk with 1.25m width will be installed on both sides of the bridge. Its effective width will be 9.5 m.

**Table 2.2-1 Overall Project Plan**

| Items | | | | | Standards and Quantity |
|---|---|---|---|---|---|
| Design Overview | Road | Length | | | 620.0 m<br>(Bridge Section：58.0 m) |
| | | Design Speed | | | 60 km/h |
| | | Total Width | General Section | STA.1+0.0m~2+37.7m,<br>STA.2+37.7m~7+20.0m | 8.6 m |
| | | | Widening section | STA.2+37.7m~67.7m | 13.6 m |
| | | Number of Lanes / Carriage Way Width | | | 2 lanes / 6.00 m<br>(3.00 m×2=6.00 m) |
| | | Shoulder | | | 1.0 m |
| | | Box Culvert(2.5m×2.5m×2no | | | 14.0 m |
| | River | Design Flood Level | | | E.L.=8.4 m |
| | | Design River Width | | | 50.0 m |
| | | Riverbed Slope | | | 1:1400 |
| | | Length | | | 482.5 m |
| | | Riprap | | | 80.0 m (4 Places) |
| | | Stone Pitching | | | 302.5 m (Right Bank, 2 Places) |
| | | Reinforced Concrete Revetment | | | 100.0 m (2 Places) |
| | Bridge | Superstructure | Structural Type | | Plate Girder |
| | | | Bridge Length | | 58.0m |
| | | | Girder Length | | 57.0m |
| | | | Span Length | | 28.4 m + 28.4 m |
| | | Substructure | Abutment | | 2 |
| | | | Pier | | 1 |
| | | | Foundation Type | | Spiral Steel Rotation Pile<br>(Friction Pile) |
| | | | Numbers of Pile /Pile Length | | A1=24.5 m/12 piles<br>P1=24.5 m/28 piles<br>A2=22.5 m/14 piles |

*Source: JICA study team*

#### 2.2.1.1 Applicable Criteria

VRRM is used as a road design standard in Vanuatu and is used in the project. Reference is made to the AGRD for terms which are not covered in VRRM. AASHTO and Japanese relevant design standards shall be applied *mutatis mutandis* for other items.

- Vanuatu Resilient Road Manual (VRRM)
- AUSTROADS guide to road design Part 3 Geometric Design (AGRD)
- A Policy on Geometric Design of Highways and Streets: AASHTO
- Design Specifications of Highway Bridges by Japan Road Association
- Pavement Design Manual by Japan Road Association
- Government Ordinance for Structural Standard for River Administration Facilities by Japan River Association

#### 2.2.1.2 Road Class and Specifications

Road Class is classified as per the following table (Table 2.2-2) in VRRM 5.2 Traffic Class.

**Table 2.2-2 Traffic Classes**

| Traffic Classes | Traffic (Vehicles per day (vcd)) | Number of lane |
|---|---|---|
| T4 | >500 | 2 lanes |
| T3 | 200 – 500 | 2 lanes |
| T2 | 50 – 200 | 2 lanes |
| T1 | <50 | 1 lane |

*Source: VRRM*

The daily traffic volume at Teouma bridge on a weekday is more than 5,000 vehicles, therefore, to the road is classified as T4.

#### 2.2.1.3 Design Speed

The classification criterion for design speed in Vanuatu is as detailed in Table 2.2-3 below. The terrain around Teouma bridge is classified as flat with traffic classification of T4. Considering these, the design speed is set at 60 km/h.

**Table 2.2-3 Design Speed**

| Terrain | T4 | T3 | T2 | T1 |
|---|---|---|---|---|
| Rolling | 40 km/h | 30 km/h | 30 km/h | 10 km/h |
| Flat | 60 km/h | 40 km/h | 40 km/h | 30 km/h |

*Source: VRRM*

#### 2.2.1.4 Geometric Condition

Standards and Geometric Conditions in Vanuatu are shown in Table 2.2-4.

**Table 2.2-4 Geometric Condition for Road and Bridge in Vanuatu**

| Items | | | Road Classification T4 | Remarks |
|---|---|---|---|---|
| Design Speed (km/h) | flat land | | 60 | |
| Cross Section Configuration | | | | |
| Road Cross Section | Right of way (m) | | 30 | |
| | Minimum Shouder Width | seal | 1.0 | |
| | Lane Width(m) | seal | 3.0 | |
| | Pavement Thickness (m) | | 250 | |
| Longitudinal Alignment | | | | |
| Minimum Vertical Clearance(m) | carriageway | | 5.4 | AGRD, P169 |
| | sidewalk | | 2.4 | AGRD, P169 |
| Traffic Volume | | | | |
| Design Traffic Volume (ADT) | | | >500 | |
| Structure Loading | | | | |
| Structure Live Loading (minimum) | | | 44, HS20 (or A-Load Jar | |
| Pavement Structure | | | | |
| Pavement | Type of Surface | carriageway | Seal Pavement (DBST) | |
| | Crossfall (%) | seal | 2.5 | P.42 |
| Geometric Conditions | | | | |
| Horizontal Alignment | | | | |
| Minimum Horizontal Curvature | | m | 100 | |
| Maximum Superelevation | | % | 8 | |
| Superelevation Development Lengths | | m | 48 | AGRD, P158 |
| Vertical Alignment | | | | |
| Maximum Gradient | Standard | % | 12 | |
| Gradient with Limitations | | % | 12 | |
| | | m | 600 | |
| Sight Distance | Stopping | m | 85 | |
| | Passing | m | - | |
| Minimum Dadius Crest Curve | K-Value | | 9.2 | AGRD, P183 |
| | Dadius | m | 920 | AGRD, P183 |
| Minimum Dadius sag Curve | K-Value | | 9.2 | AGRD, P183 |
| | Radius | m | 920 | AGRD, P183 |
| Minimum Vertical Curve Length | | m | 40 | AGRD, P190 |

*Source: JICA study team*

### 2.2.1.5 Traffic Demand Forecast

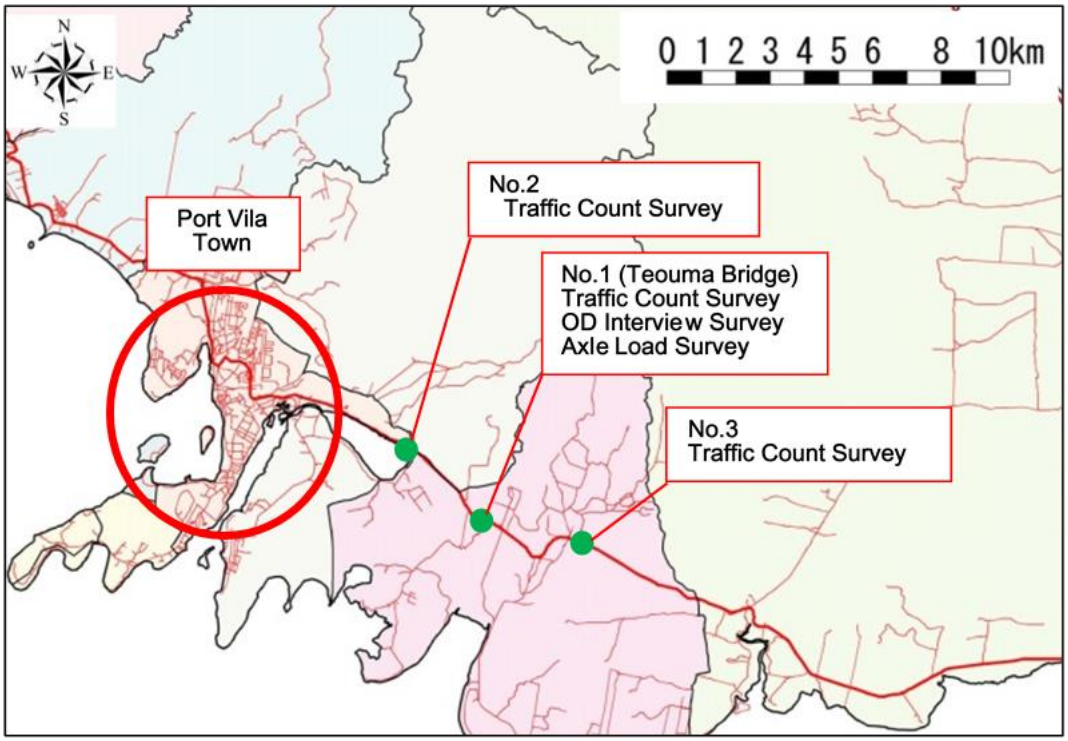
#### (1) Traffic Survey Implementation Overview

Traffic Count Survey for 24 hours, Roadside OD Interview Survey and Axle Load Survey were conducted in order to understand the traffic situation around Teouma bridge and to carry out traffic demand forecast. The outline of the traffic surveys are shown in Table 2.2-5 below and the survey locations are shown in Figure 2.2-1.

**Table 2.2-5 Outline of the Traffic Survey**

| Items | Purpose of Survey | Contents of Survey | Remark |
|---|---|---|---|
| 1. Traffic Count Survey | To understand information for road design based on traffic demand forecast | 3 places (weekday/Sunday: 24hours)<br>Vehicle Type Composition: 10 types and pedestrians (by gender) | |
| 2. Roadside OD Interview Survey | To grasp vehicle trip pattern on the route | 3 places (weekday: 12 hours)<br>Vehicle Type Composition: 10 types | Interview |
| 3. Axle Load Survey | To grasp axle situation of heavy truck on the route | 1 place (weekday: 12 hours)<br>Number of Samples: all | Observation by using simple truck scale |

*Source: JICA study team*




*Source: JICA study team*

**Figure 2.2-1 Survey Locations**

### (2) Result of Traffic Survey

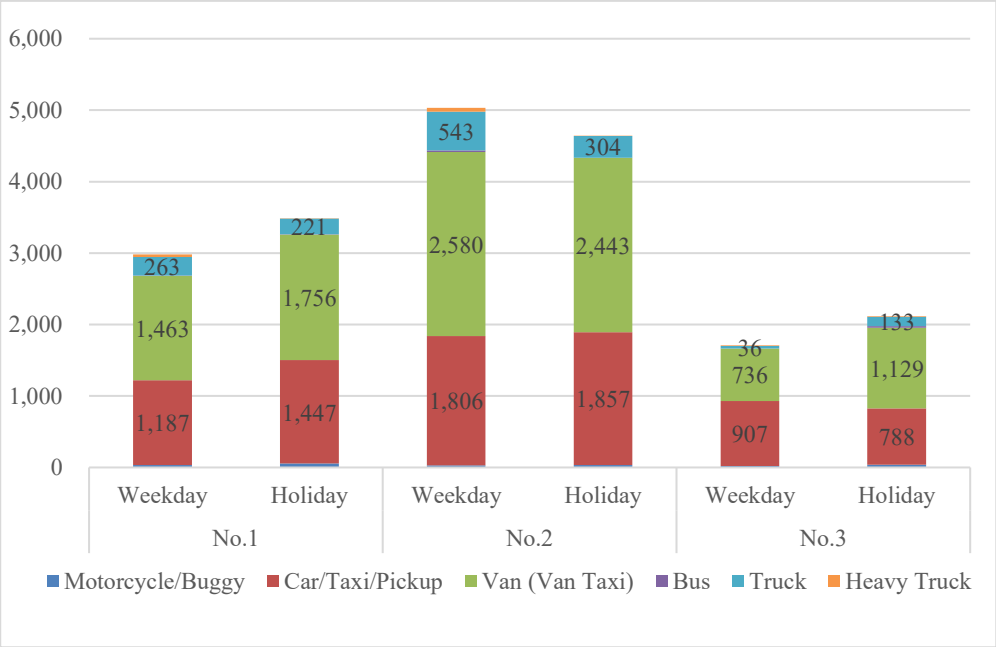
#### 1) Traffic Count Survey

A 24-hour traffic count survey was conducted one day each on a weekday and holiday. The result is shown in Table 2.2-6 below.

**Table 2.2-6 Result of Traffic Count Survey**

| Sta. No. | Survey day | Motorcycle/ Buggy | Car/ Taxi/ Pickup | Van (Van Taxi) | Bus | Truck | Heavy Truck | Total | Commercial Vehicles Ratio |
|---|---|---|---|---|---|---|---|---|---|
| No.1 | Weekday | 32 | 1,187 | 1,463 | 2 | 263 | 33 | 2,980 | 1.1% |
| | Holiday | 55 | 1,447 | 1,756 | 4 | 221 | 5 | 3,488 | 0.1% |
| No.2 | Weekday | 31 | 1,806 | 2,580 | 19 | 543 | 53 | 5,032 | 1.1% |
| | Holiday | 36 | 1,857 | 2,443 | 0 | 304 | 1 | 4,641 | 0.0% |
| No.3 | Weekday | 22 | 907 | 736 | 0 | 36 | 8 | 1,709 | 0.5% |
| | Holiday | 40 | 788 | 1,129 | 20 | 133 | 7 | 2,117 | 0.3% |

*Source: JICA study team*




*Source: JICA study team*

**Figure 2.2-2 Traffic Volume by Vehicle Type**

A count survey for pedestrians was also carried out. The number of pedestrians around Teouma bridge is 193 persons on a weekday and 294 persons on a holiday. The reasons for the increase in number on a holiday are presumed to be: The number of pedestrians on weekdays is composed only of people moving to the workshop or crop fields around the village, but on a holiday, most people in the village visit the Church. Thus, the increase in number of pedestrians on a holiday.

The survey sampled the number of pedestrians by gender too. On weekdays, the recorded number of males is 148 persons and females are 45 persons. The number of males on a holiday was recorded as 199 persons and females as 95 persons. The movements of the males on a weekday can be presumed to be persons moving to crop fields or workshops around the village. On the other hand, most of the pedestrians on a holiday are church goers. It is inferred that the difference in the ratio of male and female is small.

**Table 2.2-7 Result of Traffic Count Survey (Pedestrian)**

| Sta.No. | Survey day | Number of Pedestrians |
|---|---|---|
| No.1 | Weekday | 193 |
| | Holiday | 294 |
| No.2 | Weekday | 154 |
| | Holiday | 131 |
| No.3 | Weekday | 343 |
| | Holiday | 533 |

*Source: JICA study team*

**2) Roadside OD Interview Survey**

The Roadside OD interview survey for 12 hours was carried out around Teouma bridge on weekdays. The survey targeted 20% of all vehicles except heavy trucks (more than 2 axles) and all heavy trucks. There is a difference between the result of number of the count survey and number of interview samples. The

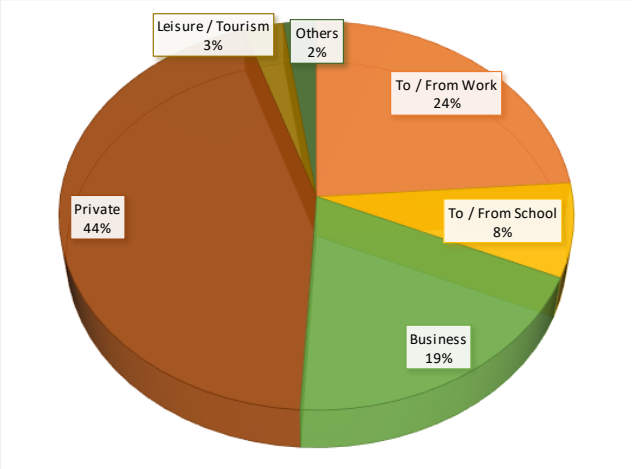
survey skipped interview survey of vehicles which had already been carried out. In general, there are lots of vehicles making round trips within the urban area which takes about 15 minutes from Teouma bridge and surrounding villages.

**Table 2.2-8 Result of Roadside OD Interview Survey**

| Classification | Number of Sample (OD) | Result of Count Survey | **Rate** |
|---|---|---|---|
| Bicycle | 7 | 9 | 77.8% |
| Motorcycle | 4 | 20 | 20.0% |
| Car/ Taxi/ SUV | 64 | 846 | 7.6% |
| Van/Van Taxi | 54 | 1078 | 5.0% |
| Bus | 0 | 2 | 0.0% |
| 2-Axle Truck or Trailer | 80 | 211 | 37.9% |
| 3-Axle Truck or Trailer | 7 | 24 | 29.2% |
| 4-Axle Truck or Trailer | 2 | 3 | 66.7% |
| Agriculture Vehicle | 0 | 1 | 0.0% |
| Another Special Vehicle | 0 | 5 | 0.0% |
| Total | 218 | 2199 | 9.9% |

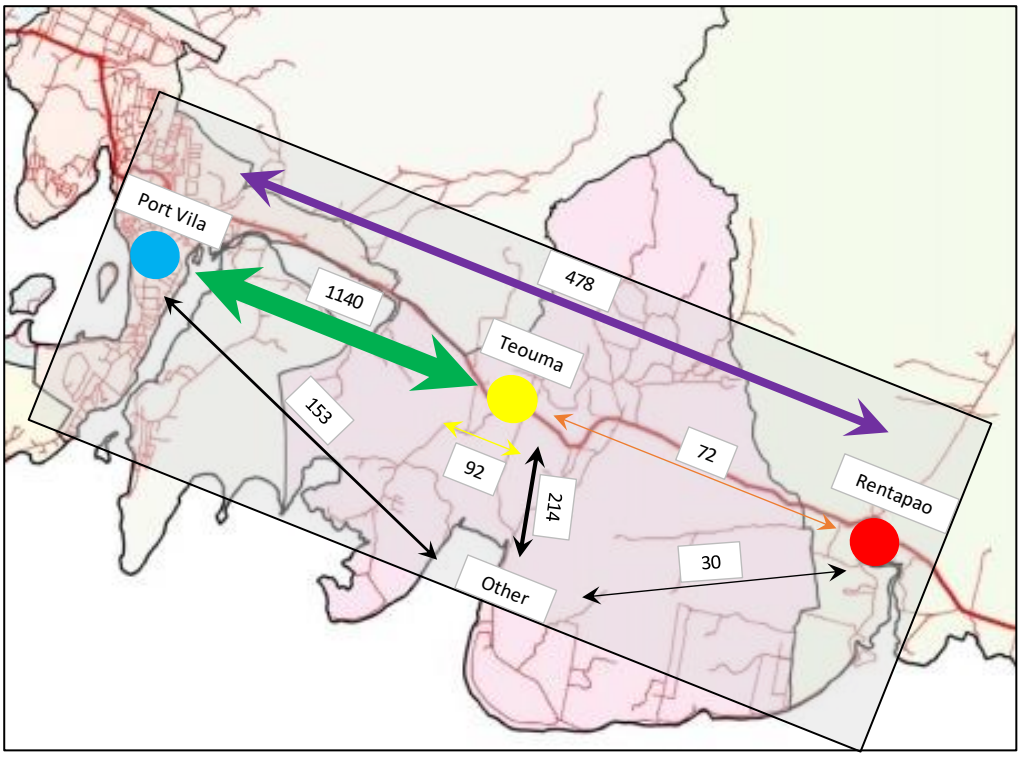
*Source: JICA study team*

The traffic purposes are shown in Figure 2.2-3 below. Flow of traffic for private reason is 44% of the total, being the largest number. The totals for work and business is 43%, to/from school is 8%, and leisure or tourism is 3%, however, the percentage may increase to 20% on a day a cruise ship arrives as more people may arrive for sightseeing purposes.




*Source: JICA study team*

**Figure 2.2-3 Result of Roadside OD Interview Survey (Purpose of the Trip)**




*Source: JICA study team*

**Figure 2.2-4 Result of Roadside OD Interview Survey (Departure and Destination)**

Figure 2.2-4 shows spider network of the traffic on the ring road. Basically, more than half of the vehicles were going to Port Villa (urban district) from around the Teouma bridge or vice versa. In recent years, residential areas have been developed around the Teouma bridge, vehicles going to the urban area from the vicinity of Teouma bridge to commute for work or school are increasing. As other features, in addition to cars bound for the tourist spots scattered on the north side from the east side of the ring road, buses or cars carrying tourists traveling around the island were seen. In addition, when heavy trucks go to northern part of Efate Island, the trucks must trip counterclockwise from Port Villa because the high uphill slope with a very steep gradient and the hairpin curve are on the northwestern part of Efate Island, and the passage by the heavy vehicle from Port Villa to the north side is impossible.

**3) Axle Load Survey**

Axle load survey was conducted using portable axle load measurement at the Teouma bridge in order to understand the existing axle load situation. The outline of the axle load survey is shown in Table 2.2-9 below.

**Table 2.2-9 Outline of Axle Load Survey**

| | |
|---|---|
| Type of Vehicle | Truck Traffic (not including Bus) |
| No. of Sample | 100% Inspection |
| Methodology | by axle. |
| Survey Duration | 1 weekday and 12 hours (From AM 6:00 to PM 18:00) |

*Source: JICA study team*

The axle load and gross load regulation of trucks as specified by the laws of Vanuatu are shown in Table 2.2-10 below.

**Table 2.2-10 Load Regulation for Road of Vanuatu**

| Axle Load Regulation (per axle) | Gross Load Regulation (Total Loading) |
|---|---|
| 8 t/axle | 24 t/car |

*Source: Laws of the Republic of Vanuatu Road Traffic Control*

The methodology of counting overloaded trucks is shown below. The result of counted overload is also shown in Table 2.2-11.

1. To sum up the number of trucks(a) surveyed with axle load survey
2. To sum up the number of trucks whose results exceed the limit values
3. To rule out the trucks without any cargo whose results exceed the limit values
4. To define the truck whose axle weight and/or vehicle weight is exceed the limit values as overloaded truck and to sum them up (b)
5. To calculate the conversion rate by total surveyed number of trucks for 24 hours(d) /(a)
6. To calculate the number of overloaded trucks for 24 hours(e) by multiplying (a) by conversion rate
7. To compute the rate of (e) over (d)

**Table 2.2-11 Number of Overloaded Truck and Its Rate**

| Number of Axle | Observed Trucks | | | Expanded Truck by Traffic Cound Survey | | |
|---|---|---|---|---|---|---|
| | Truck Volume (veh/day) | Overloaded Truck (veh/day) | Rate | Truck Volume (veh/day) | Overloaded Truck (veh/day) | Rate |
| | ( a ) | ( b ) | ( b )/( a ) | ( d ) | ( e ) | ( e )/( f ) |
| 2 axles | 74 | 1 | 1.4% | 263 | 4 | 1.4% |
| 3 axles | 11 | 7 | 63.6% | 30 | 19 | 63.6% |
| 4 axles | 0 | 0 | 0.0% | 0 | 0 | 0.0% |
| 5 axles | 0 | 0 | 0.0% | 0 | 0 | 0.0% |
| 6 axles | 1 | 0 | 0.0% | 3 | 0 | 0.0% |
| Total | 86 | 8 | 9.3% | 296 | 23 | 7.7% |

*Source: JICA study team*

### (3) Traffic Demand Forecast

Total traffic volume for 10 years starting from 2022 (start of service year of the road) are estimated based on results of the traffic survey on May 2018 and economic growth rate. The results are shown in Table 2.2-12 below.

**Table 2.2-12 Traffic Demand Forecast**

| year | Economic Growth Rate (%) | Small Truck | | Heavy Truck | | Trailer | |
|---|---|---|---|---|---|---|---|
| | | Daily Traffic Volume | Annual Traffic Volume | Daily Traffic Volume | Annual Traffic Volume | Daily Traffic Volume | Annual Traffic Volume |
| 2014 | 2.30 | 235 | 85,640 | 27 | 9,769 | 3 | 977 |
| 2015 | 0.16 | 235 | 85,777 | 27 | 9,784 | 3 | 978 |
| 2016 | 3.47 | 243 | 88,753 | 28 | 10,124 | 3 | 1,012 |
| 2017 | 4.20 | 253 | 92,481 | 29 | 10,549 | 3 | 1,055 |
| 2018 | 3.80 | 263 | 95,995 | 30 | 10,950 | 3 | 1,095 |
| 2019 | 3.50 | 272 | 99,355 | 31 | 11,333 | 3 | 1,133 |
| 2020 | 3.00 | 280 | 102,335 | 32 | 11,673 | 3 | 1,167 |
| 2021 | 3.00 | 289 | 105,406 | 33 | 12,023 | 3 | 1,202 |
| 2022 | 3.00 | 297 | 108,568 | 34 | 12,384 | 3 | 1,238 |
| 2023 | 3.00 | 306 | 111,825 | 35 | 12,756 | 3 | 1,276 |
| 2024 | 3.00 | 316 | 115,179 | 36 | 13,138 | 4 | 1,314 |
| 2025 | 3.00 | 325 | 118,635 | 37 | 13,532 | 4 | 1,353 |
| 2026 | 3.00 | 335 | 122,194 | 38 | 13,938 | 4 | 1,394 |
| 2027 | 3.00 | 345 | 125,860 | 39 | 14,357 | 4 | 1,436 |
| 2028 | 3.00 | 355 | 129,636 | 41 | 14,787 | 4 | 1,479 |
| 2029 | 3.00 | 366 | 133,525 | 42 | 15,231 | 4 | 1,523 |
| 2030 | 3.00 | 377 | 137,530 | 43 | 15,688 | 4 | 1,569 |
| 2031 | 3.00 | 388 | 141,656 | 44 | 16,159 | 4 | 1,616 |
| | | Total | 1,244,607 | | 141,970 | | 14,197 |

*Source: JICA study team*

### 2.2.1.6 Riverbank Protection Plan

#### (1) Design Alignment, Longitudinal Profiles, Cross Section and Riverbank Elevation

Designing these items follows the design policy mentioned in 2.1.3. Design alignment of river channel for modification of present river course, longitudinal profiles of riverbed and banks, and cross sections are presented in 2.2.2 Outline Design Drawings. Table 2.2-13 shows the design top elevations of riverbanks.

**Table 2.2-13 Design Top Elevation of Riverbanks**

| Channel Stretch | Left Bank (East Side) | Right Banks (West Side) |
|---|---|---|
| Downstream of Bridge | EL.5.0 m (Unused Area) | EL.5.0 m (Unused Area) |
| Around Bridge | EL.5.0 m to EL.7.5 m to EL.5.0 m (EL. 7.5 m under bridge for maintenance of bridge, 1.4 m clearance) | EL.5.0 m to EL.7.5 m to EL.6.5 m (EL. 7.5m under bridge for maintenance of bridge, 1.4 m clearance) |
| 20 m to 60 m Upstream from Bridge (Sta. 0+20 – Sta. 0+60) | EL.5.0 m (Unused Area) | EL.6.5 m to EL.7.5 m (Several Houses) |
| 60 m to 200 m Upstream from Bridge (Sta. 0+60 – Sta. 2+00) | EL.5.0 m (Unused Area) | EL.7.5 m (Several Houses) |
| 200 m to 260 m Upstream from Bridge (Sta. 2+00 – Sta. 2+60) | EL.5.0 m (Unused Area) | EL.7.5 m to EL.5.0 m (Unused Area) |

*Source: JICA study team*

#### (2) Detailed Planning of Reinforced Concrete Crib Revetment

Details of revetment having the selected slope protection (reinforced crib type) are shown in 2.2.2 Outline Design Drawings. It is further described below.

**a. Foundation**

Foundation supporting slope protection is designed as reinforced concrete structure which is generally applied. In addition, reinforced concrete piles (0. 2m x 0.2 m square section and 2.5 m long) supporting designed foundation for local scouring is also driven at 2.0 m interval.

**b. Riprap for Countermeasure against Scouring at Foundation**

There are many reported cases that collapse of slope protection is caused by the riverbed scouring. The potential depth of scoring is estimated at 2 m. It is too costly for slope protection to be embedded by 2.0 m under the design riverbed elevation. Construction (excavation and dewatering) is always difficult in the limited working space. In this regard, design 1m insert and riprap with 2 m width using locally available stones with 0.5 m diameter more or less in front. Sheet is provided under the riprap stones to prevent from sinking.

Design diameter of riprap stones are estimated based on Japanese technical guideline" Dynamics Design Method of Revetment", as follows.

$$Dm = \frac{V_0^2}{E_1^2 2g(\rho_s/\rho_w - 1)}$$

Where,

Dm : Average Diameter of Stones (m)
Vo : Representative Velocity (m/s)

Vo=α×Vm

Vm : Average Velocity (m/s)
α=1+□Z/(2Hd)+B/(2r)
=1+Estimated Depth of Scouring/ (2 x Floodwater Depth)
+ Riverbed Width / (2 x River Course Curve Radius)
=1+2.0/(2x7)+25/(2x140)=1.23

Vo = α×Vm = 1.23 x 3.14 = 3.86 m/s

g : Gravitational Acceleration (9.8m/s$^2$)
ρw : Water Density (1.0)
ρS : Stone Density, ρS /ρW = 2.29(based on laboratory sampling test conducted)
E1 : Experimental Coefficient for Flow Disturbance (ordinarily 1.20)

When riprap stones are placed horizontally on the riverbed,

Dm=3.86$^2$/{1.2$^2$×2×9.8×[2.29-1.0]}=0.41 m

Therefore, stones locally produced are applied with more or less 0.5 m diameter.

**c. Reinforced Concrete Cribs**

Type of Reinforced Concrete Crib Slope Protection composes of reinforced concrete crib (square 0.3 m by 0.3 m), 0.2 m thick concrete slab inside of cribs on 0.15 m thick crushed stones and 0.05 m thick concrete for reduction of underground water pressure. Cribs are exposed by 0.1 m to make roughness for reduction of flow velocity.

**d. Drain Pipe**

Since underground waters press the slope protection, 5 cm diameter drainpipes should be properly installed for 1 pipe per 2 $m^2$.

**e. Protection on Riverbank Crest**

Adjoining crest of slope protection should be reinforced against scouring. A crib protection is extended on crest.

**f. Expansion Joint**

Since type of reinforced concrete crib is rigid, expansion joint is provided in an interval of about 10m for expansion due to change of temperature.

### (3) Detailed Planning of Dry-Stone Masonry Revetment

Details of Dry-Stone Masonry Revetment are shown in 2.2.2 Outline Design Drawings and also described below.

**a. Foundation**

Foundation supporting slope protection is made of the same stones as slope protection.

**b. Slope Protection**

Sheet on selected soil fill is provided under stone foundation and dry stone masonry against sinking. Void of around 0.5 m thick dry-stone masonry is filled with small stones.

**c. Reinforced End of Revetment and Riprap**

Since the end of revetments is bound to be damaged by high-velocity flowing water, special attention is needed. A 20 m long dumped riprap works using locally available stones (0.5 m diameter more or less) should be applied continuously from dry stone masonry revetment. A sheet is also provided under the riprap stones to protect against sinking.

### (4) Step Facility

Four step facilities on bank slope are to be provided for maintenance and convenience of people's water use, at the end of Reinforced Concrete Crib Revetment. Step walls are to be deeply embedded to protect revetment from scouring. Step facilities are accessible from steps provided on the slopes of main road embankment.

### (5) Design of Box Culvert

As shown in 2.2.2 Outline Design Drawings, drainage box culverts (2.5 m height x 2.5 m width x 2 cells) are made of reinforced concrete.

- Design invert elevation: EL. 4.7 m considering present topographic condition and drainage plan of the road
- Provision of Cut-off considering scouring and erosion due water level difference between upstream and downstream
- Riprap on outlet bed against scouring

### 2.2.1.7 Bridge Plan

#### (1) Location

Location of new bridge should be considered with the function as national road and safety for public transportation during construction. Three options below have been studied in reference of site survey result.

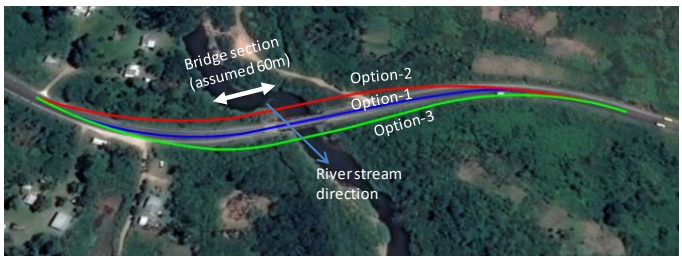
Option-1: Upstream side

Option-2: Existing location

Option-3: Downstream side

Comparing the above three options in consideration with obstacles, environmental impact, road alignment, construction period, and economic efficiency, location of new bridge is shown in Table 2.2-14. Especially, Vanuatu has land problems such as customary land, and since landowners are not registered at the government office, land acquisition may take very long time. In consideration of such circumstances, JICA study team evaluated with an emphasis on "environmental impact". Since this project is a disaster reconstruction project, it is desired to implement projects promptly and reliably. Therefore, the new bridge will be reconstructed at the existing bridge position.

**Table 2.2-14 Comparative Study for Bridge Location**

| | | | | | | |
|---|---|---|---|---|---|---|
| Plan |  *Proposed road lines above do not accurately reflect the road design standard. | |  View from downstream side | | | |
| Option | Option-1 Existing (Blue) | | Option-2 Upstream side (Red) | | Option-3 Downstream side (Green) | |
| Obstacle | Electrical line, poles and other utilities are existed. It is necessary to relocate them during construction. | Fair | Electrical line, poles and other utilities are existed. It is necessary to relocate them during construction. | Fair | Electrical line, poles and other utilities are existed. It is necessary to relocate them during construction. | Fair |
| Road alingment | Not changed | Good | Not changed | Good | Road alignment of right bank side will be tighten than existing road alignment. | Fair |
| Construction period* | Same as other options. | Fair | Same as other options. | Fair | Same as other options. | Fair |
| Economic | Cost is not higher than other options due to low quantity of embankment | Good | Cost is higher than Option-1 due to high quantity of embankment and structurl installation | Poor | Cost is higher than Option-1 due to high quantity of embankment and structurl installation | Poor |
| Environmental impact | Ressetlement of residents and land acquisition are not required. (If necessary, it is a little.) | Good | Land acquisition is required. | Poor | Land acquisition is required. | Poor |
| Total evaluation | Recommended | | Not recommended | | Not recommended | |

* In either case, detour road will be installed beside new constructed bridge.

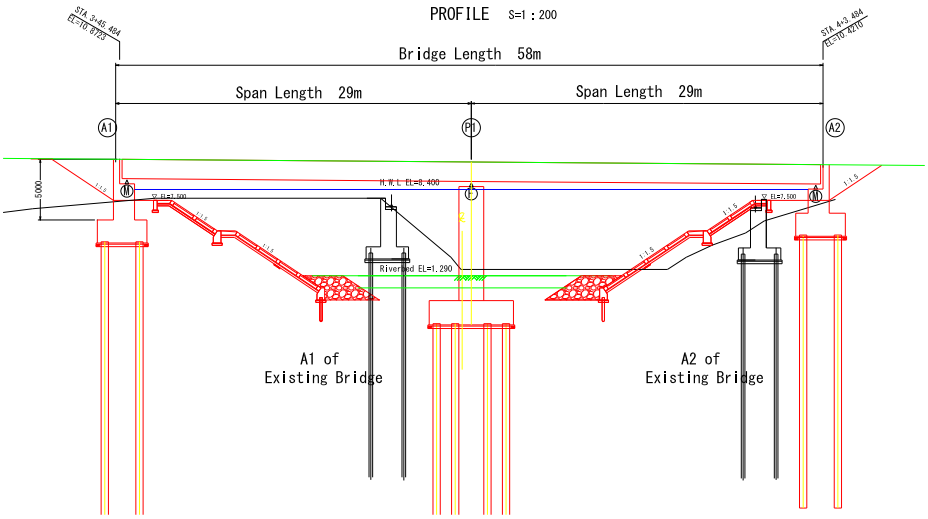
*Source: JICA study team*

#### (2) Bridge Length and Span Length

The following points should be considered when deciding the bridge length:

- Secure design flow capacity of the river calculated from hydrological analysis

- Make flat space (more than 1.5 m width) in front of both abutments for bridge inspection and maintenance
- Determine the substructure location of the new bridge with a distance that does not interfere with the substructure of the existing bridge. It is difficult to remove the piles of the existing bridge.




*Source: JICA study team*

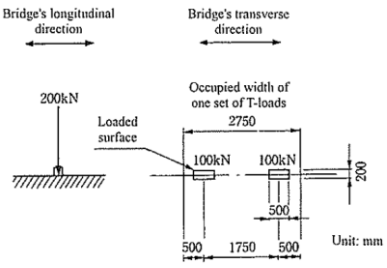
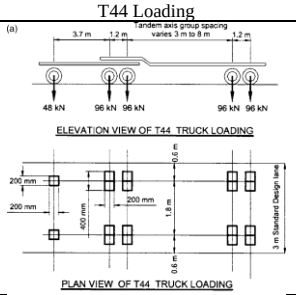
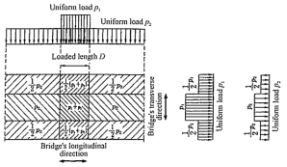
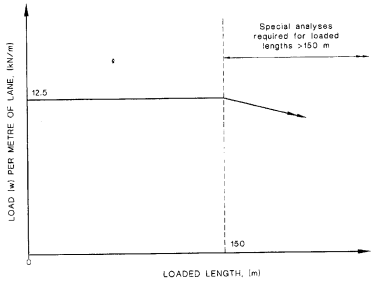
**Figure 2.2-5 Determination of Bridge Length**

Since the bridge to be constructed in this project is crossing the Teouma river, it should be considered to ensure an appropriate span length and maintaining river flowing capacity (planned flow rate). Therefore, the new bridge length is determined to be 58.0 m with 2 spans (refer to Figure 2.2-5)

### (3) Live Load

Both live load strength has been judged almost equal based on the Australian standard (T 44) and Japanese standard (Class-A in Specifications for Highway Bridges) as shown in Figure 2.2-6. Therefore, the Japanese standard (Class-A in Specifications for Highway Bridges) will be applied for the design of new Teouma bridge.

COMPARISON TABLE FOR LIVE LOAD <Bridge Length:30.0m Width:6.5m Two lanes>

| | | Japanese Specification | Australian Standard |
|---|---|---|---|
| Wheel Loading | | L Loading | T44 Loading |
| | |  |  |
| | Wheel | 100 kN | 48 kN |
| | Axial | 200 kN | 96 kN |
| Live Loading | | A Type Loading | L44 Loading |
| | |  <br>Live load on main lanes (width 5.5 m)<br>Load: Uniform load $p_1$ Load (kN/m²); Uniform load $p_2$ Load (kN/m²); Live load on secondary lanes<br>Load \| Loaded length $D$ (m) \| For calculation of bending moment \| For calculation of shearing force \| $L \le 80$ \| $80 < L \le 130$ \| $130 \le L$<br>A-live load \| 6 \| 10 \| 12 \| 3.5 \| $4.3 - 0.01L$ \| 3.0 \| 50% of live load on main lanes<br>B-live load \| 10<br>L: Span length (m) |  <br>FIGURE A2 L44 LANE LOAD<br>(Uniformly distributed part only) |
| | | p1 10 kN/m2 x 6m x 5.5m = 330.0 kN<br>p2 3.5 kN/m2 x 30m x 5.5m = 577.5 kN<br>1/2p1 10 kN/m2 x 6m x 1.0m = 60.0 kN<br>2/2p1 3.5 kN/m2 x 30m x 1.0m = 105.0 kN<br>1072.5 kN<br>(1.02) | 0.0<br>L44-Uniformly dist. Load 12.5kN/m x 30m x 2 = 750.0 kN<br>L44-Concentrated load 150.0 kN x 2 = 300.0 kN<br>1050.0 kN<br>(1.00) |

*Source: JICA study team*

**Figure 2.2-6 Comparison of Live Load Strength**

### (4) Superstructure Type

JICA study team carried out compressive test to the aggregate of concrete available near the project site. The uniaxial compressive strength of the aggregate was about 29 N/mm$^2$. JICA study team concluded that it is impossible to apply pre-stressed concrete girder using aggregate procured near the project site. As a result, steel bridge is the only suitable type of bridge as per the comparative study of the superstructure type in the Project.

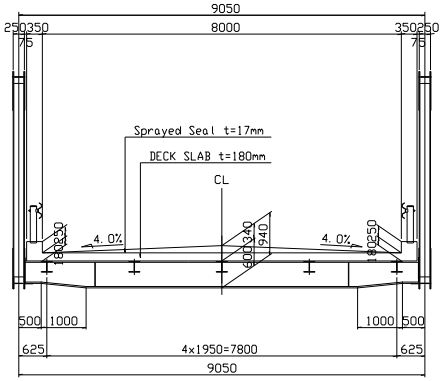
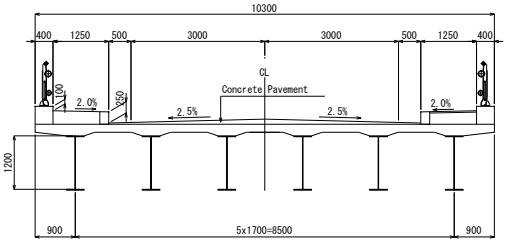
Span length of the new Teouma Bridge was determined to be 29.0 m in Chapter 2.2.1.7 which is a short length for a steel bridge. Therefore, only two structure types of superstructure could be compared: pony truss and I-beam. In order to determine the optimum superstructure type from a comprehensive point of view, comparative study was carried out from the comparison items of (1) Structure, (2) Safety, (3) Construction, (4) Cost, and (5) Maintenance.

The following points were considered for each comparison item in order to weigh the evaluation according to its importance. The overall point was evaluated by the total points of each evaluation item (Refer to Table 2.2-15). The points of each evaluation item are as follows:

| Comparative Study Item | Point |
|---|---|
| Structure..... | 10 points |
| Safety ..... | 10 points |

| | |
|---|---|
| Construction..... | 15 points |
| Cost ..... | 50 points |
| Maintenance..... | 15 points |
| Overall Evaluation ..... | 100 points |

**Table 2.2-15 Comparative Study on Superstructure Type**

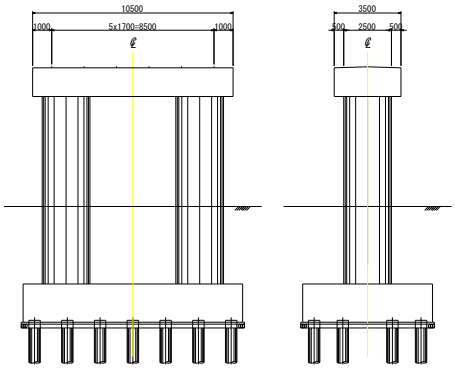
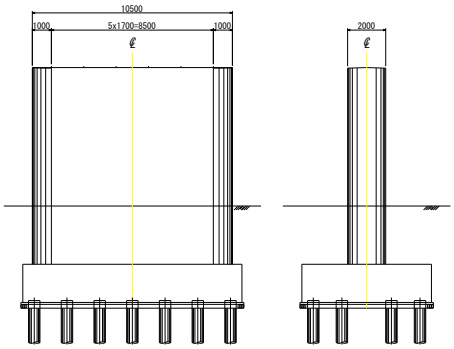
| Option | Option-1 Pony Truss | | Option-2 Steel I-Girder | |
|---|---|---|---|---|
| Typical Cross Section |  <br>* Pedestrian bridge will be required separately. | |  | |
| Structure (10 points) | Since around A1 is a curve section, it is necessary to widen the interval of truss structure member.<br>The height of superstructure from the bottom of cross beam to road surface is about 1.0m. | | Simple and general structure. The height of superstructure from the bottom of girder to road surface is about 1.5 m. Therefore, proposed road elevation will be higher than Option-1. | |
| | 8/10 | Good | 8/10 | Good |
| Safety (10 points) | There is a risk that the traveling vehicle will collide with the main structure. And the driver feels a sense of pressure by the exposure of the truss member beside the roadway. | | There is no risk that traveling vehicle will collide with the main structure.<br>The driver doesn't feel a sense of pressure because only concrete barrier is onto the road. | |
| | 6/10 | Fair | 10/10 | Good |
| Construction (15 points) | Transportability of the bridge member is superior because the size of the member is smaller than that of Option-2. No special machine for erection is required. | | Although the size of the member is larger than that of Option-1, crane erection method will be applicable installation, and no special machine is required. | |
| | 15/15 | Good | 12/15 | Fair |
| Cost (50 points) | Steel weight per 1 $m^2$ : About 370 $kg/m^2$<br>Approximate steel weight: 200 ton (Total width: 9.3 m, Bridge Length: 58 m) | | Steel weight per 1 $m^2$ : About 200 $kg/m^2$<br>Approximate steel weight: 122 ton (Total width: 10.5 m, Bridge Length: 58 m) | |
| | 40/50 | Fair | 50/50 | Good |
| Maintenance (15 points) | Number of require members are large and maintainability is inferior. Sedimentation on the lower truss member of the existing Teouma bridge has been confirmed. | | The number of members is small, and maintainability is superior. | |
| | 10/15 | Fair | 15/15 | Good |
| Evaluation | 79/100 | | 95/100 (Adopt) | |

*Source: JICA study team*

### (5) Pier Type

Two columns pier and wall pier were compared for the comparative study of substructure types. As a result, wall pier that is superior to columns pier for all items shall be adopted.

**Table 2.2-16 Comparative Study on Bridge Pier Type**

| | Option-1 Two Columns + Coping Beam | | Option-2 Wall Type | |
|---|---|---|---|---|
| Image |  | |  | |
| Structure | Cylindrical cross section: φ2,500 mm x 2.<br>Rebar arrangement in the part of connecting column and coping beam will be complicated than Option-2. | Fair | Cross section: 10,500 × 2,000 mm<br>Rebar arrangement will be simpler than Option-1. | Good |
| Flow Capacity | Impediment ratio of river flow is larger than Option-2.<br>Turbulence water flow occurs around the bridge piers at the time of flooding, the water flowing capacity is similar to Option-2. | Fair | Impediment ratio of river flow is smaller than Option-1.<br>The water flowing capacity is superior to Option-1. | Good |
| Construction | After construction of 2 columns, supporting for construction of coping beam is required temporary. Workability is inferior to Option-2. | Fair | Constructible from bottom to top of the piers uniformly. Workability is superior to Option-1. | Good |
| Cost | Approximately concrete volume is approx. 102 $m^3$. It is smaller than Option-2.<br>River protection work will be required because the estimated scouring depth is deeper than that of Option-2.<br>Therefore, the cost is almost same as Option-2. | — | Approximately concrete volume is approx. 187 $m^3$. But river bed protection work is not required. Therefore, the cost is almost same as Option-1. | — |
| Maintenance | River bed protection work is required because estimated scouring depth is about 6.0 m.<br>River bed protection work will be subject of maintenance in the future. | Fair | Estimated scouring depth is about 3.5 m, and river bed protection work is not required.<br>Therefore, maintainability in the future is superior to Option-1. | Good |
| Evaluation | Not Recommended | | Adopt | |

*Source: JICA study team*

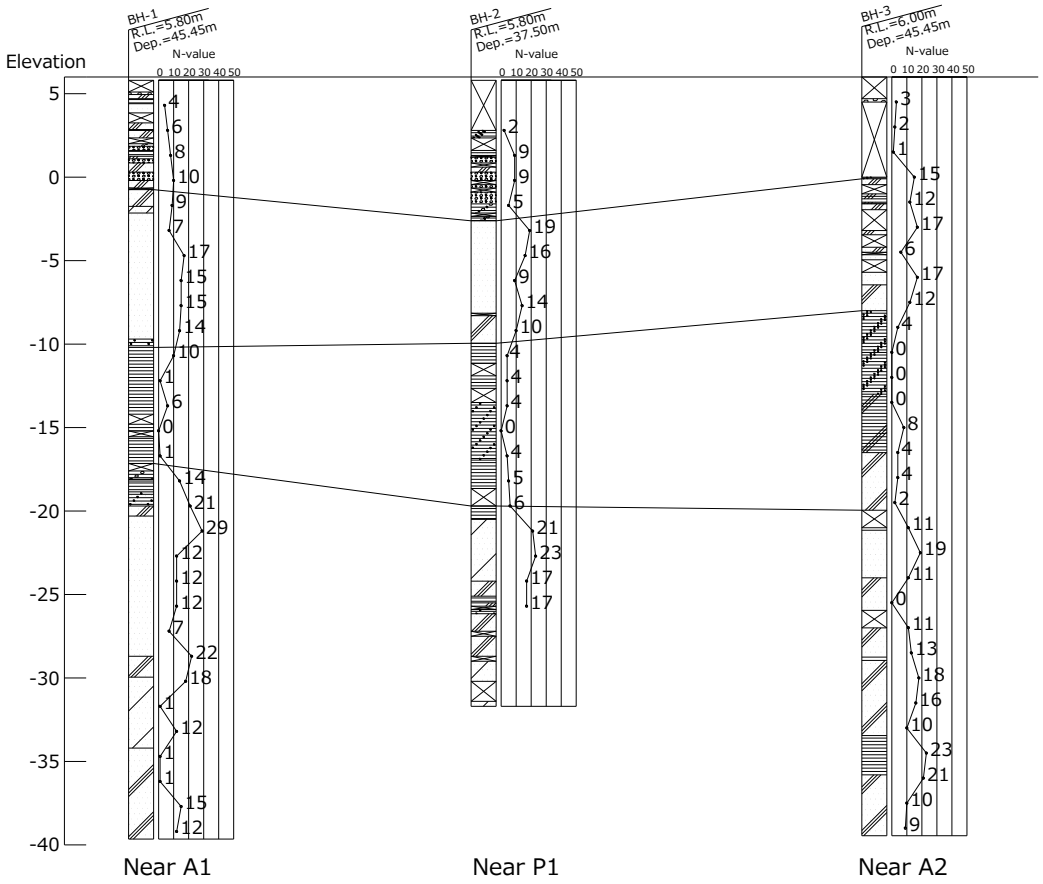
### (6) Abutment Type

General reverse T shape abutment shall be adopted since abutment type has no special design conditions.

### (7) Pile Type

The geological profile and soil model in longitudinal direction of the bridge collected by boring survey is shown in Figure 2.2-7.

. The boring survey was carried out to a depth of 45 m, but no definite bearing layer could be confirmed. Therefore, friction pile shall be applied.




*Source: JICA study team*

**Figure 2.2-7 Geological Profile and Soil Model**

3 options of steel pipe pile, cast-in place concrete pile and spiral steel pipe pile were compared for pile types. Spiral steel pipe pile shall be adopted because it can be expected to have higher friction bearing force than other option and possible to reduce the pile cap size (Refer to Table 2.2-17). In addition, spiral steel pipe pile has advantage that pile driving equipment is minimal, construction speed is faster as well as no excavated soil coming out. It is economical too.

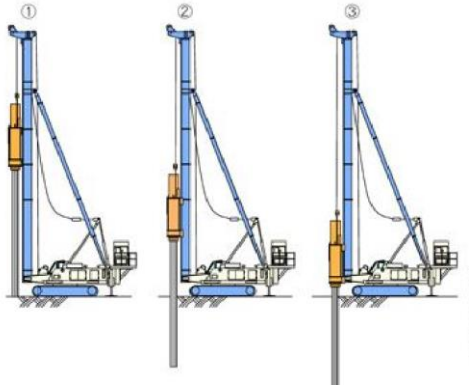
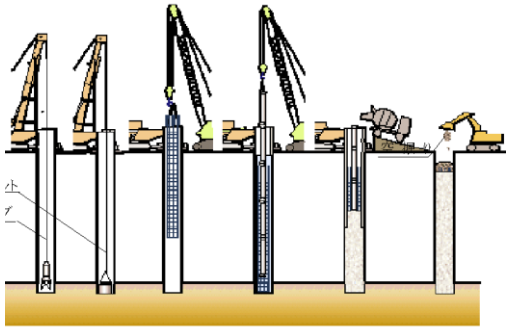
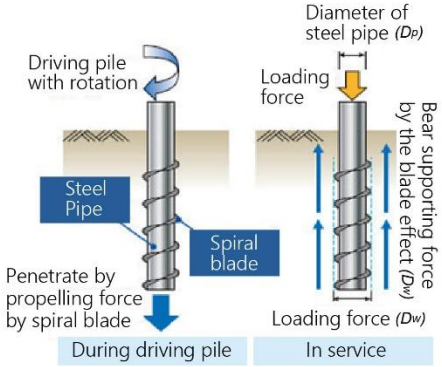
### (8) Steel and Painting

Considering the regional characteristics of the bridge location and long-term maintainability, the steel materials and painting specifications shown below are used for the main members of the bridge.

[Superstructure] Steel material that can be extended the repainting cycle, C5 paint system in Japanese paint specifications

[Reinforcement rebar in RC slab] Coating rebar

**Table 2.2-17 Comparative Study for Pile Type**

| | Option-1 Steel Pipe Pile | | Option-2 Cast In Place Concrete Pile | | Option-3 Spiral Steel Pipe Pile | |
|---|---|---|---|---|---|---|
| Image |  | |  | |  | |
| Structure | The expected circumferential frictional force is the smallest at 2N, therefore total pile length will be the longest. | × | The expected circumferential frictional force is medium at 5N, therefore total pile length between Option-1 and Option-3. | △ | The expected circumferential frictional force is the largest at 5N+20, therefore total pile length will be the shortest. | ○ |
| Cost | The most expensive because of long steel pipe pile and the largest pile cap | × | Medium cost level because of the longer pile length and larger pile length than Option-3, and many equipment for piling work. | △ | The cheapest because of the shortest pile length, the smallest pile cap and minimum equipment for piling work | ○ |
| Construction | Pile cap size will be larger than Option-3, then interfere with the existing substructure. (If avoiding interference, it is necessary to extend the bridge length) | × | Pile cap size will be larger than Option-3, then interfere with the existing substructure. (If avoiding interference, it is necessary to extend the bridge length) | × | The pile diameter and the pile cap size will be small, and not interfere with the existing substructure. | ○ |
| Construction Period | Slightly longer than Option-3 | ○ | Longest because many construction steps | △ | Shortest | ○ |
| Quality Control | Easy because steel pipe is made in the factory. | ○ | Many quality control items. | △ | Easy because steel pipe is made in the factory. | ○ |
| Procurement | From Japan | △ | Local procurement possible | ○ | From Japan | △ |
| Environmental Impact | Wide construction yard is necessary due to store many pile materials | △ | Wide construction yard and disposal area are necessary due to store many construction equipment and materials, and disposal of excavated soil | × | No excavated soil, and the smallest construction yard | ○ |
| Evaluation | Not Recommended | | Not Recommended | | Recommended | |

*○: Good, △: Fair, ×: Bad

*Source: JICA study team*

### 2.2.1.8 Accessories of the Bridge

#### (1) Bridge Railing

The type of bridge railing shall be steel guard fence. This is in order to reduce the oppressive feeling by pedestrians and for its superior view. It shall be installed on the curb beside sidewalk.

#### (2) Bearing

Bearing shall be Fix-Move type.

#### (3) Expansion Joint

Rubber stretching apparatus with abundant experience in Japan shall be adopted for expansion joint.

#### (4) Unseating Prevention Structure

Seat length which is described in "Specifications for Highway Bridges, Part V, 2012" in Japan, will be ensured.

#### (5) Bridge Drainage System

The water on the bridge shall be discharged directly into river by drainage system on the bridge.

#### (6) Approach Slab

The approach slab shall be placed behind both abutments for prevention of subsidence of the road by settlement of the embankment. The length of the approach slab will be 5.0m, and its width will be same as the road width.

#### (7) Others

Power lines have been installed in the upper and lower sides of the Teouma Bridge, and communication lines shall also be laid in the future and shall be provided for on the eastern part of the Teouma Bridge. The construction work of these utility lines shall be done by the business operator, but the steel bracket for erection of these utility lines shall be installed in this project.

In consideration of the surrounding conditions and maintainability, lighting equipment shall not be installed.

### 2.2.1.9 Approach Road Plan

#### (1) Horizontal Alignment

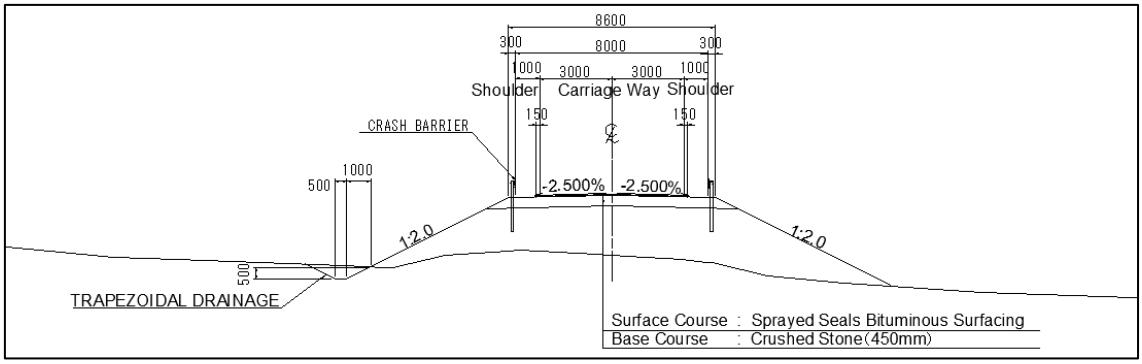
New horizontal road alignment shall follow the existing road alignment.

#### (2) Vertical Alignment

According to the hearing survey, combination of a steep downslope of more than 10% and horizontal curve has caused frequent traffic accidents around Teouma Bridge. Since the height of bridge surface is 2.5 m higher than existing bridge, road surface is also raised by embankment to lower gradient, and the maximum gradient was set to 8%.

### (3) Cross Section

The typical cross section is shown in Figure 2.2-8.




*Source: JICA study team*

**Figure 2.2-8 Typical Cross Section of Approach Road**

The design of the road width is 4.0 m x 2 on the roadway, 1.0 m x 2 on the shoulder, 0.3 x 2 on the guardrail installation width, and 8.6 m in total. The slope of the embankment is 1:2.0 equivalent to the existing slope. A Guardrail is installed in the section where the embankment height is 3.0 m or more.

### (4) Pavement

#### 1) Service Life

The service lifetime of the pavement design shall be 10 years from the commencement of service after completion of the project. New Teouma bridge and approach road is scheduled to open in 2022.

#### 2) Calculus Equation

The basic formula of SN (Structural index required for total pavement thickness) for asphalt pavement is based on the AASHTO guideline and is calculated by the following formula.

$$\log_{10}(W_{18}) = Z_R \times S_0 + 9.36 \times \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left(\frac{\Delta PSI}{4.2-1.5}\right)}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32 \times \log_{10}(M_R) - 8.07$$

#### 3) Designed Traffic Volume

As it has been mentioned, the new Teouma Bridge and approach road is scheduled to open in 2022. The survey estimated designed traffic volume on the approach road by using the result of traffic survey conducted in May of 2018. The result of designed traffic volume is used for pavement design. Table 2.2-18 shows the estimated daily traffic volume for each type of vehicle in traffic demand forecast.

**Table 2.2-18 Daily Traffic Volume in 2031**

| Type of Vehicle | Daily Traffic Volume |
|---|---|
| Small Truck | 388 |
| Heavy Truck | 44 |
| Trailer | 4 |

*Source: JICA study team*

**4) ESAL Conversion Factor**

ESAL Conversion Factor by Vehicle Type used for pavement design was calculated based on the axle load survey results at the target bridge site (see Table 2.2-19). The traffic characteristics at the target bridge point are that the traffic of small vehicles (minivans, pickups, etc.) are the majority and the traffic volume of large vehicles is extremely small. Most supplies are being transported by small vehicles and small trucks. In addition, there is almost no full load of small trucks. However, dump trucks (heavy trucks) with full of earth and sand were observed since there are many quarry sites on the east side of the target bridge. The number of observed trailers was much smaller than small vehicles and the observed load of trailer also small. Therefore, the ESAL Conversion Factor for small truck and trailer is smaller than ordinal value. In addition, since there is no development plan that will increase the traffic of large vehicles in the future, these figures were adopted. However, a validity of pavement thickness will be verified by using the values of ESAL Conversion Factor of Trailer adopted in another country.

**Table 2.2-19 ESAL Conversion Factor by Vehicle Type**

| Type of Vehicle | ESAL Conversion Factor |
|---|---|
| Small Truck | 0.12 |
| Heavy Truck | 3.55 |
| Trailer | 0.29 |

*Source: JICA study team*

**5) Estimation of Accumulative ESAL (18kip) Value of Trailer and Truck**

The survey estimated accumulative ESAL of 10 years from the services commencement based on traffic demand forecast.

**Table 2.2-20 Estimated ESAL Value from Year 2022 to Year 2031**

| Year | Economic Grow Rate % | Small Truck | | Dump Truck | | Trailer | | ESAL Value |
|---|---|---|---|---|---|---|---|---|
| | | DTV | ATV | DTV | ATV | DTV | ATV | |
| 2022 | 3.00 | 297 | 108,568 | 34 | 12,384 | 3 | 1,238 | 57,351 |
| 2023 | 3.00 | 306 | 111,825 | 35 | 12,756 | 3 | 1,276 | 59,072 |
| 2024 | 3.00 | 316 | 115,179 | 36 | 13,138 | 4 | 1,314 | 60,844 |
| 2025 | 3.00 | 325 | 118,635 | 37 | 13,532 | 4 | 1,353 | 62,669 |
| 2026 | 3.00 | 335 | 122,194 | 38 | 13,938 | 4 | 1,394 | 64,549 |
| 2027 | 3.00 | 345 | 125,860 | 39 | 14,357 | 4 | 1,436 | 66,486 |
| 2028 | 3.00 | 355 | 129,636 | 41 | 14,787 | 4 | 1,479 | 68,480 |
| 2029 | 3.00 | 366 | 133,525 | 42 | 15,231 | 4 | 1,523 | 70,534 |
| 2030 | 3.00 | 377 | 137,530 | 43 | 15,688 | 4 | 1,569 | 72,651 |
| 2031 | 3.00 | 388 | 141,656 | 44 | 16,159 | 4 | 1,616 | 74,830 |
| | Total | | 1,244,607 | | 141,970 | | 14,197 | 657,465 |

*Source: JICA study team*

**6) Input Parameters and Result of Pavement Calculation**

Inputted parameters and result of the pavement calculation is as follows.

| | |
|---|---|
| 1. Input Parameters | 4) Standard Deviation (So): 0.49 |
| 1) Design Life): 10 years | 5)Design Serviceability Loss: 1.7 (Initial (4.2) – Finale (2.5)) |
| 2) Reliability: 80% (National Road) | 6) Resilient Modulus : 1500*CBR |
| 3) Standard Normal Deviation(ZR): -0.841 | 7) Drainage Factor: 1.0 |

(inch)＝２．５４０ｃｍ

Result of SN Calculation on pavement structure

| Material | Layer Factor (a) | Thickness (inch) (D) | Dranage Factor (m) | SN = a*D*m | Thickness (cm) (D) | Adopted Thickness (cm) |
|---|---|---|---|---|---|---|
| | | | | | | |
| Base Course New | 0.140 | 16.654 | — | 2.331 | 42.3 | 45.0 |
| Total | | 2.331 | < | 2.331 | 42.3 | 45.0 |
| | | | | OK | | |

CBR Value of actual subgrade (embankment) is more than 10, but CBR 10 is adopted for the SN calculation on Pavement Structure since this calculation of AASHO allows maximum CBR Value is 10. The thickness of base course shall be 45 cm from above calculation result. As a result of verification of a pavement design by the highest value 6.840 of ESAL Conversion Factor of trailer adopted in another country, it was confirmed that the required SN Value is 2.387, pavement thickness is 43.3 cm which was within adopted pavement thickness 45.0 cm.

### (5) Accessory Facilities

#### 1) Extension of shoulder

There is a direct farmer market built by residents in the roadside in downstream of right side bank. Residents sell their products to passing vehicles or tourists. However, according to the new road and bridge plan, market space and road will be separated by raised embankment and the residents could not continue their business at the same place. Therefore, it is planned to widen the shoulder at existing market to secure selling market and parking space and also to minimize the negative impact on the local economic activities.

#### 2) Guardrail

A guardrail will be installed in the section where the height of embankment is 3.0 m or more in order to prevent the vehicles from falling down.

#### 3) Road Marking

Center line (width; 15 cm, white, solid) and sideline (width; 10 cm, white, solid) will be planned on the new road. Incidentally, a “cat eye” will be installed at the boundary of sidewalk and roadway in the bridge section to take safety measure.

## 2.2.2 Outline Design Drawing

The table of contents of the drawing of Outline Design shown in Table 2.2-21 below. The drawings are attached in Appendix-6.

**Table 2.2-21 Table of Contents of Drawings of Outline Design**

| No. | Classification | Name |
|---|---|---|
| 1 | General | Overall Plan |
| 2 | Revetment | PLAN (REVETMENT) |
| 3 | | River Alignment |
| 4 | | Detailed Plan Around Abutment |
| 5 | | Profile (Revetment) |
| 6 | | Typical Cross Section (Revetment) |
| 7 | | Riprap / Stone Pitching |
| 8 | | Revetment (1) |
| 9 | | Revetment (2) |
| 10 | | Approach Steps (1) |

| No. | Classification | Name |
|---|---|---|
| 11 | | Approach Steps (2) |
| 12 | Bridge | General View of Teouma Bridge |
| 13 | | General View of Superstructure |
| 14 | | General View of A1 (1/2) |
| 15 | | General View of A1(2/2) |
| 16 | | General View of P1 |
| 17 | | General View of A2 (1/2) |
| 18 | | General View of A2(2/2) |
| 19 | Road | Main Road Alignment |
| 20 | | Plan (1) (Main Road) |
| 21 | | Plan (2) (Main Road) |
| 22 | | Profile (Main Road) |
| 23 | | Typical Cross Section |
| 24 | | Wet Stone Pitching |
| 25 | | Reinforced Concrete Crib (Type A) |
| 26 | | Reinforced Concrete Crib (Type B) (1) |
| 27 | | Reinforced Concrete Crib (Type B) (2) |
| 28 | | Approach Steps at Road Embankment |
| 29 | | Drainage Structure |
| 30 | Box Culvert | General View of Box Culvert (1) |
| 31 | | General View of Box Culvert (2) |
| 32 | | General View of Box Culvert (3) |
| 33 | Temporary Work | Plan (1) (Detour Road) |
| 34 | | Plan (2) (Detour Road) |
| 35 | | Detour Road Alignment |
| 36 | | Profile (Detour Road) |
| 37 | | Typical Cross Section (Detour Road) |

*Source: JICA study team*

### 2.2.3 Implementation Plan

#### 2.2.3.1 Implementation Policy

The project implementation principles are:

- A cooperation project will be implemented in accordance with grant aid system of the government of Japan by concluding Note of Exchange (E/N) and Grant Agreement (G/A) for the project between the Government of Japan and Government of Vanuatu.
- The executing agency for implementation of the cooperation project is the Public Works Department (PWD) of the Ministry of Public Works of Vanuatu.
- The consulting services including detailed design, tender-related works and construction supervision services, will be provided by a Japanese consulting firm in accordance with the consultancy contract that shall be signed with the Republic of Vanuatu.
- The construction of the cooperation project will be executed by a Japanese construction firm that shall be selected through pre-qualification and bidding, in accordance with the construction work contract that shall be signed between the said construction firm and the Republic of Vanuatu.

The basic policies for the construction/procurement of this project are as follows:

- Equipment, materials and labor for construction shall be procured locally as much as possible. In cases where local procurement is not possible, they shall be procured either from a third country or from Japan considering price, quality and secured supply quantity.
- The construction method and construction process shall be consistent with the natural conditions such as the local climate, topography, geology, etc. as well as topographical conditions and river hydraulics characteristics of the site.
- Plan a general and easy construction method which shall not require the use of special or sophisticated equipment or technology from the viewpoint of construction such as reduction of construction period and quality assurance and cost.
- The contractor's site organization shall be planned to satisfy the established construction specifications and construction management standards set for this project. Likewise, the consultant's organization shall be based on such specified project management standards.
- An appropriate traffic management plan including deployment of traffic personnel at vantage positions shall be considered I order to ensure safety during construction.
- Appropriate preservation methods of the environment shall be adopted such as selection of temporary garbage dumping sites which were specified from the Republic of Vanuatu in order to reduce the influence of construction works on of the environment of project site.

#### 2.2.3.2 Implementation Conditions

**(1) Considerations for Natural Condition**

The climate of Vanuatu is divided into rainy and dry seasons. Rainy season is from December to April. In the latter half of the rainy season, the water level around the site rises for a short period of time and the surrounding farmland might be inundated. Based on these changes in water level, construction works in river (revetment and bridge substructure work) shall be planned during dry season when the river water level is low in order to secure the safety and reliability of the construction as well as to reduce the cost of temporary works and also improve the effectiveness of the project.

**(2) Traffic Control Plan during Construction Period**

A detour road will be installed during construction period on the downstream side. The new bridge will be constructed in the current location. Regarding the detour road, it is planned to maintain the same level of functions as existing road based on discussion and request from local. Width, pavement structure, and minimum secured height of detour road will be specified in bidding document.

#### 2.2.3.3 Scope of Works

The responsibilities to be borne by Japan and the Republic of Vanuatu are summarized in Table 2.2-22.

**Table 2.2-22 Responsibility of Each Government**

| Item | Contents | Japan | Vanuatu | Remarks |
|---|---|---|---|---|
| Land Acquisition | | | ✔ | |
| Procurement of materials | Procurement and transportation of materials | ✔ | | |
| | Customs clearance of materials and equipment | | ✔ | |
| Preparation work | Securing the site necessary for construction | | ✔ | Temporary yard, temporary road site |
| | Relocation of public utilities | | ✔ | Electric post, power line and communication line |
| | Other preparation work | ✔ | | |
| Relocation / removal of construction obstacles | Relocation of obstacles | | ✔ | Electric post, power line, communication line and fences |
| Construction and removal of detour road | Construction and removal of detour road | ✔ | | |
| | Construction and removal of detour bridge | ✔ | | |
| Main work | Bridge reconstruction, improvement of river and approach road | ✔ | | New bridge, Revetment of the river, embankment and pavement of approach road |
| Demolition of the existing bridge | Disassembly and transportation of superstructure members. Partial demolition and removal of the abutment | ✔ | | Piles of the existing abutments shall be remained |

*Source: JICA study team*

#### 2.2.3.4 Consultant Supervision

Based on the contract agreement between the Japanese Consultant and the Government of Vanuatu, detailed design, bidding activities and the construction supervision shall be done by the consultant.

**(1) Detailed Design**

The major works to be carried out in the detailed design are as follows:

- Discussion on commencement with concerned authorities of Vanuatu and carry out field surveys,
- Detailed design and drawings preparation
- Project cost estimation

Duration to carry out the detailed design work is about 2.0 months.

**(2) Bidding Activities**

The major tasks to be undertaken between the time of inviting contractors to bid and the time for signing of contract for construction includes:

- Preparation of bid documents (in parallel with the detailed design).
- Bid announcement

- Pre-qualification of bidders
- Bidding
- Evaluation of bid documents
- Preparation of Contract Agreement

The duration of the bid-related activities is about 4.0 months.

**(3) Construction Supervision**

The Consultant will supervise the Contractor's planning and implementation of the construction contract. The major tasks under this stage include:

- Verification/Approval of related surveys and quantities
- Review/Approval construction plans
- Quality Control
- Process Control
- Work Output Control
- Safety Management
- Turnover Inspection and Acceptance

The duration of construction supervision is approximately 27.0 months. The construction supervision team shall consist of: 1-Resident/Chief Engineer (Japanese), 1-Construction Engineer (Japanese) for superstructure erection, 1-Construction Engineer (Local), 1-Clerk (Local) and 1-Utility Personnel (Local). A construction engineer for superstructure (Japanese) will be dispatched at the time of construction of superstructure.

The chief engineer is in charge of construction support, completion inspection, quality control meeting and dispatches engineers at the time of defect inspection.

During the construction period, special attention should be paid to safety management, and the supervision should be carried out to prevent accidents in advance by consulting and cooperating with the safety manager of the construction company.

### 2.2.3.5 Quality Control Plan

Regarding quality control, the contractor should submit the quality control plan. The construction works shall be commenced after the approval by the consultant. The main items requiring quality control during the construction period are as follows:

- Superstructure work
- Rotating pile (spiral steel pipe pile) work
- Concrete Work
- Reinforcement and formwork
- Earthwork
- Pavement work (DBST)
- Installation inspection of expansion joint, bearing shoe

The quality control standards are based on the standards of the Ministry of Land, Infrastructure, Transport and Tourism of Japan as well as local standards.

Based on the above, the quality control for superstructure works, rotating pile works and concrete works as typical quality control items are presented in Table 2.2-23, Table 2.2-24 and Table 2.2-25.

**Table 2.2-23 Quality Control Plan for Superstructure Works**

| Item | Test item | Test method (Specification) | Test frequency |
|---|---|---|---|
| Material for superstructure | | JIS G 3101, JIS G 3106, JIS G 3140 | Mill sheet and inspection report |
| Factory painting | Painting Materials | JIS K 5551, JIS K 5552, JIS K 5553, JIS K 5659 | Mill sheet and inspection report |
| | Coating thickness | C-5 paint system (Japanese paint specifications) | Inspection report |
| | Appearance | | Visual inspection |
| Fabrication of steel | Welding | | Inspection report for the various test result i.e. tensile test, bending test, impact test, groove weld test, fillet weld test, and Vickers hardness test |
| | Temporary assembly | Specifications for Highway Bridges (2012) | Check the quality of the temporary assembly by the Consultant |
| Field erection | Erection | | Check to camber and joints after temporary fastening by the Consultant in the site |
| | Tightening of high strength bolt | | Site inspection and inspection report |
| | Erection completion | | Check the camber, bearing installation after anchor bolt grout hardening, and fastening anchor bolt by the Consultant at the site |
| Field painting | Surface preparation | | Check the rust removal on damaged and accessory parts |
| | Painting Materials | JIS K 5551, JIS K 5552, JIS K 5553, JIS K 5659 | Mill sheet and inspection report |
| | Coating thickness | | Inspection report |
| | Appearance | | Visual inspection |
| Bearing | Product | | Prior to delivery (Shipping) |
| | Installation | | Site inspection after installation |
| | Completion | | Check set bolt looseness, finished condition, filling condition of non-shrink mortar after pouring concrete |
| Expansion Joint | Product | | Prior to delivery (Shipping) |
| | Installation | | Site inspection after installation |
| | Completion | | Check set bolt looseness, finished condition, filling condition of non-shrink mortar after pouring concrete |
| Drainage | Product | | Prior to delivery (Shipping) |

**Table 2.2-24 Quality Control Plan for Rotating Pile (Spiral Steel Pipe Pile) Works**

| Item | Test item | Test method (Specification) | Test frequency |
|---|---|---|---|
| Material | | JIS A 5525 | Mill sheet and inspection report |
| Field Work | Test pile | | Using the first pile as the test pile, grasp the measurement data (torque, penetration, etc.) during pile installation, and check the adequacy of the quality control method |
| | Measurement control | | Torque, penetration depth, and overloading are measured in real time to control piling work |

**Table 2.2-25 Quality Control Plan for Concrete Works**

| Item | Test item | Test method (Specification) | Test frequency |
|---|---|---|---|
| Cement | Physical property test of cement | JIS R5201 and R5202 | Once before construction work, once a month during construction. (By mill certificate) |
| Rebar | Acceptance inspection | JIS G 3112 or equivalent | Mill sheet and inspection report |
| Aggregate | Test for alkali aggregate reaction | | Once before commencement of the construction, every 6 months during construction and when the production area changes (check supplier data) |
| Concrete | Total chloride | | If the concrete placement straddles in the morning and afternoon, it is done before concrete casting in the morning, and if the test result is less than 1/2 of the total chloride limit, the afternoon test can be omitted. (The number of measurements in one test is three.) The judgment of the test is the average of three measurements. |
| | Unit water measurement | | If it is 100 $m^3$ / day or more, it is twice / day (once in the morning and once in the afternoon). |
| | Slump test | JIS A 1101 | Once at unloading Once or more per day, at least once every 20$m^3$ to 150$m^3$. In the case of the road bridge slab version, all vehicles are carried out.。 |
| | Air volume test. | JIS A 1116,1118,1128 | Once at unloading 1 time / day or more, once every 20$m^3$ to 150$m^3$. |
| | Compressive Strength Test. | JIS A 1108 | Once at unloading Once or more per day, at least once every 20$m^3$ to 150$m^3$. Six specimens per casting. |

*Source: JICA study team*

### 2.2.3.6 Procurement Plan

#### (1) Procurement Plan for Main Construction Materials

Roadbed materials, stone materials, soil materials, and concrete materials are locally procured among main construction materials. Aggregate for asphalt pavement is procured from third countries. The procurement categories of main construction materials are shown in Table 2.2-26.

**Table 2.2-26 List of Main Procurement Construction Materials**

| Item | | Classification | | | Procurement reason | Procurement route |
|---|---|---|---|---|---|---|
| Product name | Specification | Local | Japanese | Third country | | |
| **Structural materials** | | | | | | |
| Steel bridge | Plate girder | | ✔ | | Quality, certainty of procurement | From Japan, ocean freight |
| Deformed bar | D13-D32 | | ✔ | | Quality, certainty of procurement | From Japan, ocean freight |
| Concrete | 20-25 N/mm$^2$ | ✔ | | | | |
| Gravel | 150 – 200 mm | ✔ | | | | |
| Boulder | 40 - 100 cm | ✔ | | | | |
| Upper subbase course material | Lime stone | ✔ | | | | |
| Lower subbase course material | Lime stone | ✔ | | | | |
| Embankment | Lime stone | ✔ | | | | |
| Asphalt emulsion | | | ✔ | | Quality, certainty of procurement | From Japan, ocean freight |
| Asphalt aggregate | 5-20 mm | | | ✔ | Quality and Cost | From Fiji, ocean freight in container |
| Fuel | | ✔ | | | | |
| Wood for formwork | | ✔ | | | | |
| Plywood for formwork | | ✔ | | | | |
| Temporary steel materials | H shaped steel, lining plate, steel sheet pile | | ✔ | | Quality, certainty of procurement | From Japan, ocean freight |
| Supportive material | | ✔ | | | | |
| **Other materials** | | | | | | |
| Steel bridge | Plate girder bridge | | ✔ | | Quality, certainty of procurement | From Japan, ocean freight |
| Shoe | | | ✔ | | Quality, certainty of procurement | From Japan, ocean freight |
| Water stop | | | ✔ | | Quality, certainty of procurement | From Japan, ocean freight |

*Source: JICA study team*

Procurement of Ready-mixed Concrete

There are two ready-mixed concrete manufacturing plants within 15 km from the target site. The local manufacture has concrete plant of 30 m$^3$/hour. Figure 2.2-9 shows the situation of ready-mixed concrete plant in operation.

Procurement of Roadbed materials/ Soil Materials/ Megalith Materials

There are several quarries within several kilometers from target site. Therefore, the contractor can procure from the quarries. However, regarding procurement of boulders 2 or more quarries are considered to meet the construction schedule.

**Ready-mixed Concrete plant**

**Panoramic View of Quarry**

*Source: JICA study team*

**Figure 2.2-9 Photo of Local Concrete Plant and Quarry**

### (2) Procurement Plan for Special Construction Materials

The special construction materials which cannot be procured in Vanuatu are plate girder, deformed reinforced bar, asphalt emulsion, aggregate for asphalt pavement (DBST), guardrail, bearing, telescopic device, drainpipe, and water stop. These materials shall be procured from abroad. The destinations and the reasons are highlighted below.

Plate Girder Bridge

There is no manufacturing capacity in Vanuatu, it is concluded that procurement from Japan is appropriate to secure the production quality and procurement security.

Deformed Reinforced Bar

Only small diameter deformed reinforced bar are imported from neighboring countries in Vanuatu. However, the quantity circulated in Vanuatu is very small in addition to poor storage condition. In the project, quantity of procurement is large and large diameter reinforced bar is required. Therefore, deformed reinforced bar shall be procured in Japan.

Asphalt Emulsion

There are no local items in Vanuatu, and the materials are imported from neighboring countries when necessary for repair. Therefore, Japanese procurement is appropriate to ensure quality and certainty of procurement.

Aggregate for Asphalt Pavement (DBST)

Most of the aggregates for asphalt pavement are being imported from neighboring countries like Fiji because quality is inappropriate. For assurance of quality and also certainty of procurement, it is judged that procurement from Fiji is appropriate.

Guardrail, Bearing, Telescopic Device, Drainpipe, Sealing Plate

There are no local items on site, and those are being imported from neighboring countries when necessary for repair. Therefore, Japanese procurement is appropriate from the viewpoint of ensuring quality and certainty of procurement.

### (3) Procurement Plan for Construction Machineries

There are no companies that specialize in machine leasing and several general construction machines are owned by local aggregate manufacturers and foreign contractors. Basically, short-term leases can be considered, but long-term leases are difficult and expensive. Therefore, special equipment is to be procured from Japan. General equipment such as backhoe and bulldozer can be procured locally. However, if it is more economical to procure from Japan, it shall be procured from Japan. Table 2.2-27 shows a list of procurement categories for construction machine.

**Table 2.2-27 List of Procurement Construction Equipment**

| Item | | Lease /Buy | Procurement classification | | | Procurement reason | Transport route |
|---|---|---|---|---|---|---|---|
| Machine name | Specs | | Local | Japan | Third country | | |
| Backhoe (ultra-long boom) | 0.4/0.3 $m^3$ | Lease | | ✔ | | Locally not available | Ocean Freight |
| Backhoe | 0.8/0.6 $m^3$ | Lease | | ✔ | | Cost | Ocean Freight |
| Pile rotating driving machine | | Lease | | ✔ | | Locally not available | Ocean Freight |
| Dump truck | 10t Cap | Lease | ✔ | | | | |
| Dump truck | 4t Cap | Lease | ✔ | | | | |
| Bulldozer | 21 ton | Lease | | ✔ | | Cost | Ocean Freight |
| Bulldozer | 15 ton | Lease | ✔ | | | | |
| Tire roller | 8 to 20 ton | Lease | ✔ | | | | |
| Road Roller | 10 to 12 ton | Lease | ✔ | | | | |
| Motor grader | W=3.1 m | Lease | ✔ | | | | |
| Rough Terrain crane | 35 ton | Lease | | ✔ | | Cost | Ocean Freight |
| Crawler crane | 80 ton | Lease | | ✔ | | Locally not available | Ocean Freight |
| Vibrating Hammer | 60 kW | Lease | | ✔ | | Locally not available | Ocean Freight |
| Heavy weight Breaker | 1300 kg | Buy | ✔ | | | | |
| Vibration Roller | 3-4 ton | Buy | ✔ | | | | |
| Water pump | φ150 mm, 15 kW | Buy | | ✔ | | Locally not available | Ocean Freight |
| Generator | 20/25 kW | Lease | | ✔ | | Quality, certainty of procurement | Ocean Freight |
| Generator | 125/150 kW | Lease | | ✔ | | Locally not available | Ocean Freight |
| Concrete pump | | Lease | ✔ | | | | |
| Distributor | 2000 to 3000 ℓ | Lease | | ✔ | | Locally not available | Marine transport |
| Line marker | | Lease | | ✔ | | Locally not available | Marine transport |

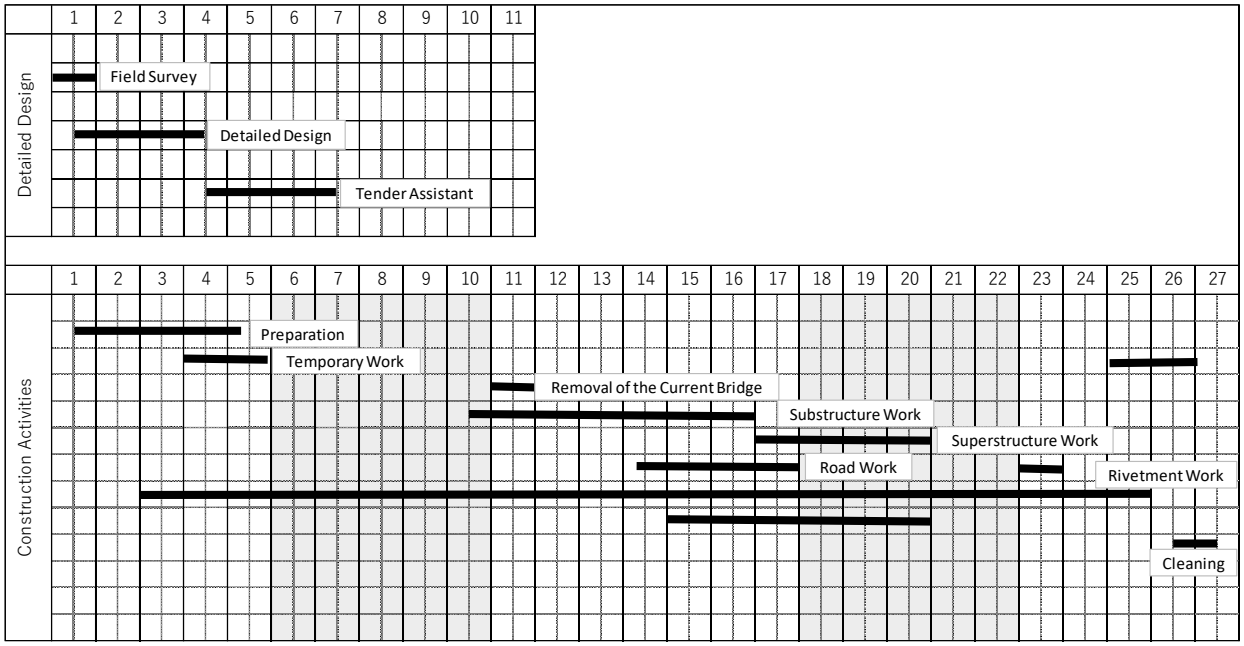
*Source: JICA study team*

#### 2.2.3.7 Soft Component Plan

Soft component shall not be included in the project.

### 2.2.3.8 Implementation Schedule

Figure 2.2-10 shows construction implementation schedule.




*Source: JICA study team*

**Figure 2.2-10 Construction Implementation Schedule**

## 2.3 Security Plan

[Overview of security threat risk]

Among the South Pacific islands, it is said that security is particularly good, and atrocious crimes such as murders are rare. However, there is an increasing number of general crimes such as snatching, empty nests and sex crimes, mainly in the capital city of Port Vila.

[Safety measures items]

- To avoid going to an unpopular place, walking alone and going out at night especially on weekends.
- To stay in the hotels or apartments with high security.
- To lock the door of the room of a hotel or home.
- Not to wear gorgeous and conspicuous clothes or brand-name precious metals or watches.

## 2.4 Obligations of Recipient Country

The undertakings required by the Government of Vanuatu for the smooth execution of this project are:

- To acquire land for construction and to relocate affected houses;
- To secure land for a temporary yard, stock yard, site office, construction road and detour routes

and to shoulder tenancy payment for them;

- To secure borrow pits, spoil-banks, and industrial waste disposal area;
- To relocate all utilities such as electric poles, power lines, telecommunication cable and water pipeline which will disturb the Project works and to restore them on the new road and bridge;
- To bear the cost of bank charges such as the Advising commission and Payment commission to bank where an account related to the Project is opened;
- To arrange tax exemption and smooth custom clearance and to assist smooth inland transportation for imported materials
- To arrange for tax exemption for Vat for purchased materials, Japanese contractor's cooperate tax and income tax for the employees, including Japanese staff, local staff and staff employed from third counties.
- To provide necessary permissions that allow the personnel engaged in the construction work such as supervision engineer, construction workers etc., to enter and stay in Vanuatu.
- To provide necessary permission/certificate for environmental issues, construction of bridges, working inside river, earthwork and traffic control during the construction period, etc.
- To maintain new bridge and approach roads properly
- To assist in solving all conflicts raised by residents adjacent to the construction site and third parties.
- To bear all the expenses, other than those to be borne by the Grant Aid necessary for construction of facilities; and
- To monitor, analyze natural and social environment such as air and water quality during construction and public use, and take necessary actions based on the results of the monitoring and follow-up analysis.

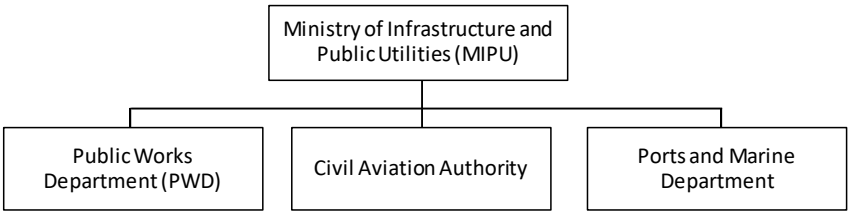
## 2.5 Project Operation and Maintenance Plan

Public Works Department (PWD) of The Ministry of Infrastructure and Public Utilities (MIPU) executes the periodic inspection, routine maintenance and repair. Road and Bridge maintenance work conducted by PWD is as follows:

| | |
|---|---|
| Periodic Inspection | : Bridge and Approach road |
| Routine Maintenance | : Pavement, Drainage Structure, Expansion Joint, Clearing, etc. |
| Repair Works | : Pavement, Drainage Structure, Concrete Structure, Incidental Facilities, Road marking, Revetment Structure, etc. |

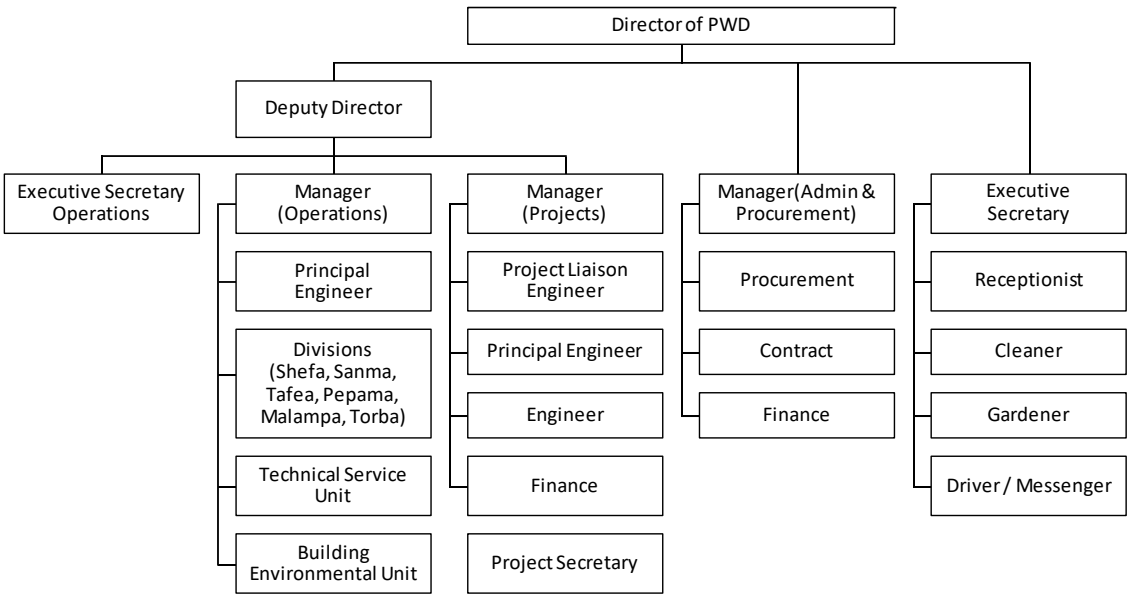
Since the bridge to be constructed in this project is durable against the environment in Vanuatu, serious repair is not expected in the immediate future. It is considered that there are no technical problems in carrying out the necessary maintenance work.

The organization of MIPU and PWD is shown in Figure 2.5-1 and Figure 2.5-2 respectively. The PWD, Shefa office will execute the maintenance, cleaning and repair works.




*Source:PWD*

**Figure 2.5-1 Organization of MIPU**




*Source: PWD*

**Figure 2.5-2 Organization of PWD**

## 2.6 Project Cost Estimation

### 2.6.1 Initial Cost Estimation

#### 2.6.1.1 Government of Vanuatu's Contribution

For confidentiality, the cost borne by the Japan's Grant Aid is not shown in this report.

#### 2.6.1.2 Government of Vanuatu's Contribution

The approximate amount estimated for contribution from Vanuatu is shown in Table 2.6-1.

**Table 2.6-1 Approximate Cost Estimate of Vanuatu Contribution**

| Item | Amount (VUV) |
|---|---|
| 1. Bank commission | 3,583,000 |
| 2. Land acquisition | 28,810,000 |
| 3. High voltage transmission line relocation | 40,164,000 |
| Total | 72,557,000 |

*Source: JICA study team*

### 2.6.1.3 Cost Estimation Condition

1. Cost Estimation Month : May 2018
2. Exchange rate : US $ 1.00 = 108.12 JPY
   (US Dollar vs. Japanese Yen Exchange Rate)
   VUV 1.00 = 1.039 JPY
   (Vanuatu vatu versus Japanese yen exchange rate)
3. Implementation period : Detailed design and period of construction to be required are shown in the implementation schedule.
4. Others : The estimate is carried out based on the Japanese Government's Grant Aid Scheme.

### 2.6.2 Operation and Maintenance Cost

Operation and maintenance expenses are being paid from the budget of the Ministry of Public Transport. The maintenance items and repair costs of bridges and approach road per one bridge are shown in Table 2.6-2.

**Table 2.6-2 Main Maintenance Items and Annual Cost**

| | Component | Inspection items | Frequency | No. of persons | Materials and equipment | Required quantity | Amount (VUV) |
|---|---|---|---|---|---|---|---|
| Periodic Inspection | Pavement | Crack, unevenness, potholes etc. | 12 times / year | 3 persons | Scoop, hammer, hook, barricade | 36 people / day | 237,600 |
| | Drainage facility<br>Structure | Sediment, obstacles damage, deformation, dirt, peeling etc. | 1 day / time | | | | |
| | Revetment | Crack, damage, collapse etc. | | | Pick up | 12 units /year | 105,600 |
| | Bridge | Bracket of Utilities, Railings, etc | | | | | |
| | | | | | | Subtotal | **343,200** |
| | Component | Inspection items | Frequency | No. of persons | Materials and equipment | Required quantity | Amount (VUV) |
| Daily Maintenance | Pavement<br>Drainage facility | Cleaning<br>Removal of soil, obstacles. cleaning | 4 times / year<br>2 days / time | 7 persons | Scoop, barricade, grass cutter, broom, tooling | 56 persons/year | 384,000 |
| | Expansion Joint | Removal of soil, obstacles. cleaning | | | | | |
| | Bridge | Cleaning | | | Small truck | 8 units / day | 73,100 |
| | | | | | | Subtotal | **457,100** |

| | Component | Inspection items | Frequency | No. of persons | Materials and equipment | Required quantity | Amount (VUV) |
|---|---|---|---|---|---|---|---|
| Repair | Pavement | Crack seal, repair of defect | 1 time / year | 9 persons | | 36 persons/year | 246,800 |
| | Drainage facility | Repair of damaged part | 4 days / time | | | | |
| | Structure | Repair of damaged part | | | Compactor | 4 units /year | 33,600 |
| | Bridge | Repair of damaged handrail | | | | | |
| | Pavement marking | Repair of lane marking | | | Small truck | 4 units /year | 47,500 |
| | Revetment facilities | Repair of damaged parts | | | Asphalt emulsion | $0.36t^3$/year | 31,800 |
| | | | | | Gravel for asphalt | $0.9m^3$/year | 39,100 |
| | | | | | Lane marker | 100m/year | 20,900 |
| | | | | | Seawall | $10m^2$/year | 106,900 |
| | | | | | | Subtotal | **526,600** |
| | | | | | | Total | **1,326,900** |

*Source: JICA study team*

# CHAPTER 3 Project Evaluation

## 3.1 Preconditions

The Project preconditions related to the required undertakings of the Government of Vanuatu are as follows:

- To acquire land for the project and transport affected houses in 4 months after the conclusion of Exchange of Note.
- To secure land for temporary yard, stock yards, detour road, borrow pit and disposal area in 4 months after the conclusion of Exchange of Note.
- To relocate all utilities including underground utilities that will disturb the Project works to the place where the works will not be disturbed in 4 months after the conclusion of Exchange of Note.
- To take any necessary actions for tax exemption in compliance with E/N and G/A.
- To conduct quick custom clearance for the goods from Japan and third countries.
- This project does not require to process the EIA procedure. However, environmental mitigation measures and monitoring plan is described in 1.3.1.10 to monitor, analyze natural and social environment such as air and water quality during construction and public use.
- To provide necessary permits for extracting soil materials from borrow pits and cutting trees in 4 months after the conclusion of Exchange of Note.
- To assist to solve all conflicts with residents adjacent to the construction site and third parties.

## 3.2 Necessary Inputs by Recipient Country

The maintenance work for the Project is vital after handing it over in order to realize and sustain the effects of the overall project. In order to ensure the service life of bridge, approach roads and other ancillary facilities, the budget shown in Section 2.6.2 (about 1,326,900 VUV / year) shall be secured and regular inspections shall be carried out. If in case damage was confirmed, it is necessary to carry out appropriate repairs at the initial stage. In daily maintenance, it is necessary to clean the pavement surface and drainage facilities, such as removing sediment and obstacles, and to ensure safe traffic and services for users.

## 3.3 Important Assumptions

### (1) Restriction of Overloaded Tracks

Restriction of overloaded trucks has not been conducted in Vanuatu. It is necessary to conduct a control system for the overloaded trucks in order to ensure the durability of the pavement.

### (2) River Management

It is necessary to carry out river management so that the flow of the river is not obstructed when the development of the Teouma River basin progresses.

## 3.4 Project Evaluation

### 3.4.1 Relevancy

Implementations of this cooperation projects is recommended using Japan's grant aid as follows:

1. The beneficiaries' populations are almost half of the east Efate Island. It is a big number.
2. The project is urgently needed on the Ring Road to contribute to the strengthening of trunk road transport networks and to stabilize and improve the livelihoods of residents.
3. Vanuatu authorities could operate and maintain bridges and roads using internal resources and technologies. There is no need for sophisticated technology for operation and maintenance.
4. This project contributes to the environmental and economic objectives of Vanuatu national development plan: "Recovery from climate change and disasters" and "Improving infrastructure".
5. There is little negative environmental and social impact.
6. In addition to the necessity and superiority of using bridge construction technology of Japan, Japanese grant aid system allows the project to be implemented without any difficulty.

### 3.4.2 Effectiveness

#### 3.4.2.1 Quantitative Effect

There is a high possibility of interruption of bridge service and closure of the connected road due to inundation and also scouring and erosion of approach road due to the progressive erosion of riverbanks in the upstream as well as potential change in river course. However, by implementation of this project, the risk of inundation will be highly reduced by raising the road elevation, and also the river course will be stabilized by river works and erosion prevention countermeasures.

The expected quantitative effect of the project implementation is shown in Table 3.4-1. The base value was measured in 2018 and the target value is set for three years after project completion.

**Table 3.4-1 The Quantitative Effects Expected from the Implementation of the Projects**

| Items | Base Value (FY2018 Actual) | Target Value (3 yrs after completion) |
|---|---|---|
| Traffic Volume(Unit/day) | 2,980 | 3,600 |
| Number of Passengers(person/day) | 755 | 905 |
| Weight of Cargo(ton/year) | 60,000 | 72,000 |

#### 3.4.2.2 Qualitative effect

The qualitative effects of the project are:

1. Maintenance of economic activities and access to various services are ensured by eliminating the blockage of logistics and commuting due to flooding after heavy rain.

2. By changing from emergency rehabilitation to permanent restoration, there is no fear of a falling bridge and the toughness of the bridge is secured.
3. River erosion to private land on the upper right bank can be avoided.