Department of National Planning and Monitoring
Department of Works
The Independent State of Papua New Guinea

No.

IMPLEMENTATION REVIEW STUDY REPORT
ON
THE PROJECT FOR THE URGENT REHABILITATION
OF
MARKHAM BRIDGE
IN
THE INDEPENDENT STATE OF PAPUA NEW GUINEA

September 2008

JAPAN INTERNATIONAL COOPERATION AGENCY

CHODAI CO.LTD.

GL
JR
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PREFACE

In response to a request from the Government of the Independent State of Papua New Guinea, the Government of Japan decided to conduct a basic design study on the Project for the Urgent Rehabilitation of Markham Bridge and entrusted the study to the Japan International Cooperation Agency (JICA)

.

JICA sent a study team to Papua New Guinea from June 29 to July 12, 2008, and they conducted a field study in the study area. After the team returned to Japan, further studies were made. A mission was then sent to Papua New Guinea to discuss a draft basic design, and as a result, the present report was finalized.

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

I wish to express my sincere appreciation to the officials of the Government of the Independent State of Papua New Guinea for the close cooperation extended to the study teams.

September, 2008

Masafumi Kuroki
Vice-President
Japan International Cooperation Agency

September, 2008

Letter of Transmittal

We are pleased to submit the basic design study report on the Project for the Urgent Rehabilitation of Markham Bridge in the Independent State of Papua New Guinea.

This study was conducted by Chodai Co., Ltd., during the period from June 2008 to September 2008, under a contract with JICA. During the study, we have examined the feasibility and rationale of the project with due consideration to the present situation in Papua New Guinea and we have formulated the most appropriate basic design for the project under Japan's Grant Aid scheme.

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

Very truly yours,

Masahiko Mori
Project Manager,
Basic design study team on
the Project for the Urgent Rehabilitation of Markham Bridge
in the Independent State of Papua New Guinea
Chodai Co., Ltd.

The Project for the Urgent Rehabilitation of Markham Bridge
in the Independent State of Papua New Guinea

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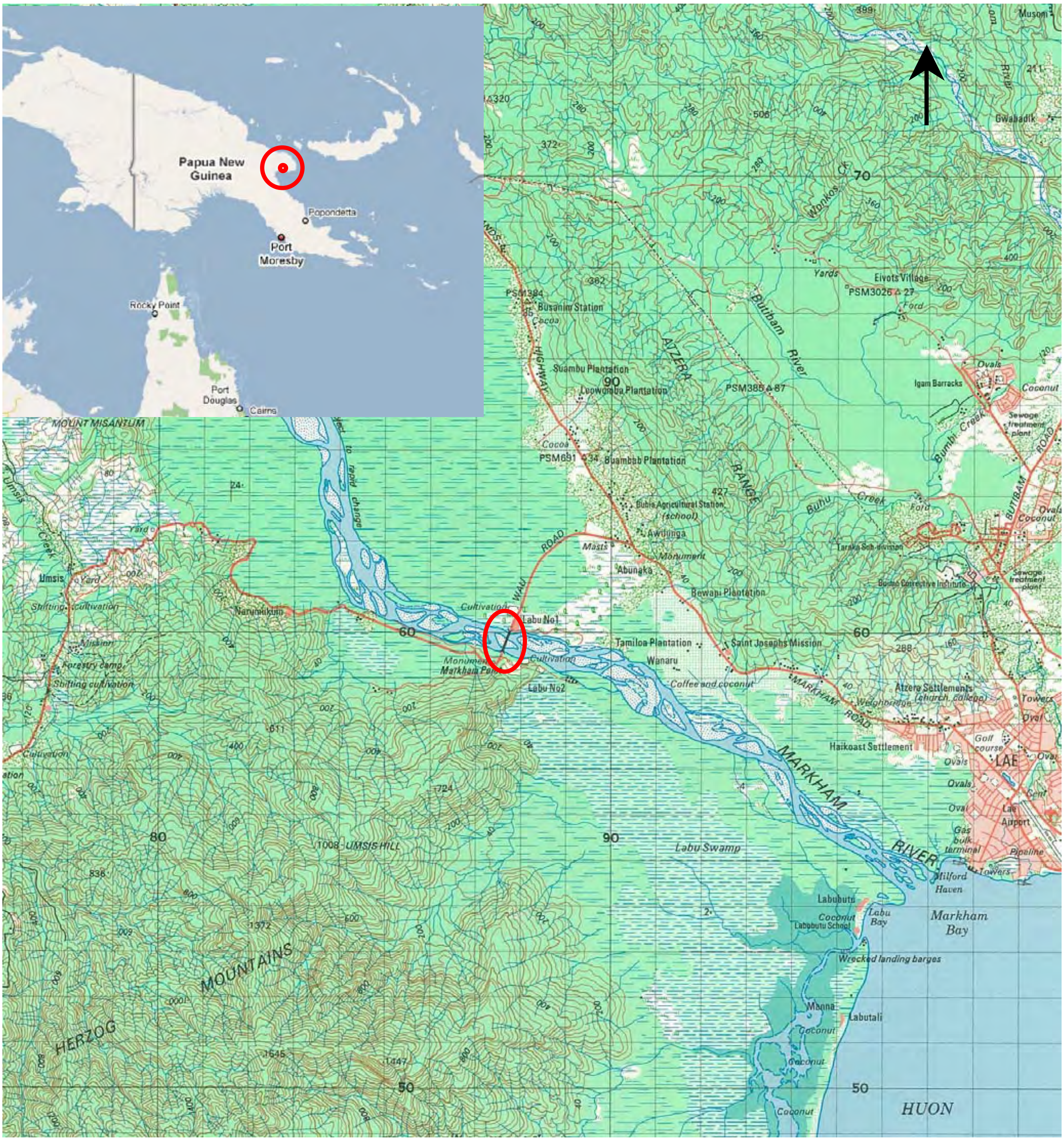

Location Map

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View from the upstream on the Lae side

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The girder almost comes off the bearing due to the backward displacement of A1

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The gap has widened due to the rotation of the abutment

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The bearing elevation was adjusted for subsidence of the pier by rubber pads.

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The girder is partly rusted due a lack of maintenance over the last 30 years

	
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Abbreviations

AusAID	:Australian Agency for International Development
BMS	:Bridge Management System
DNPM	:Department of National Planning and Monitoring
DOW	:Department of Works
E/N	:Exchange of Notes
JICA	:Japan International Cooperation Agency
M/D	:Memorandum of Discussion
PNG:	the Independent State of Papua New Guinea
RAMS:	Road Asset Management System

CHAPTER 1

Background of the Project

Chapter 1 Background of the Project

1-1 Background of the Project

Markham Bridge, which is the longest bridge in the Independent State of Papua New Guinea (hereinafter referred to as “PNG”), is located on the Wau road connecting the major cities in Morobe Province such as Bulolo, Wau and Lae, the second largest city in PNG. Wau road is not only a major industrial road which transports major local products such as coffee, timber and gold but is also the sole lifeline to Lae, the provincial capital, for some 200,000 people living along the road. If there was a blockage on the Wau road, this area would be isolated. It means that not only the supply of commodities will be stopped but also that any facilities such as schools and hospitals cannot be utilized. Hence, a blockage will cause serious economic damage to those who live in the region.

In March 2004, Markham Bridge could not be crossed for a while because serious flooding, caused major settlement of Pier 3 and the washout of part of the access road. Therefore, in terms of securing a stable life for the residents, the Government of PNG decided that it was dangerous for the bridge to be left in such a condition and in May 2004 made a request to the Japanese government for the renewal of Markham Bridge. Meanwhile, as a way of urgent reinstatement of the bridge, four temporary piers were constructed by the government of PNG in August 2004 together with a Bailey bridge, to replace the collapsed access road. Following the request from the government of PNG, Japan International Cooperation Agency (herein after referred to as “JICA”) organized and dispatched a preliminary study team to PNG from July until August 2005. As a result of this study, it was found that restoration of the piers, guardrails and hand rails were urgently needed but the request for renewing the bridge was not approved.

Based on the results of the preliminary study, the Japanese Government decided to carry out a basic design study for the urgent rehabilitation of Markham Bridge and, from July to August of 2006, JICA organized and dispatched the basic design study team to the site.

The study team found that AusAID had carried out rehabilitation of the revetment on the Lae side, earthworks for approach road and the removal of the temporary bridge. As a result, the removal of the temporary bridge, which was one of the items requested, was excluded from the JICA scope of works. It was found, however, that a part of the revetment had collapsed because the repair was only temporary. Finally, it was decided that the permanent rehabilitation should be implemented. In addition, four piers on the Lae side which had been damaged by flooding, had been repaired by the Government of PNG in

August 2004. Therefore, the number of piers to be rehabilitated increased from three (3), requested at the preliminary study stage to four (4). Furthermore, the backside of the abutment on the Lae side was eroded and displaced toward the backside. There was concern that, if the displacement continued, the gap at the expansion joint would widen which will impede smooth driving and increase damage to the bridge due to the impact of the traffic. Therefore, it was decided to reinforce the abutment after its location is adjusted back to the original position.

After the study team had prepared a summary of the Basic Design Study Report based on their site investigation, JICA dispatched a mission to PNG in February 2007. The mission made a presentation to the Government of PNG on the contents of the Basic Design. Both parties confirmed and agreed with the items to be borne by the Recipient and signed the M/D on February 7, 2007.

1-2 Necessity and Objectives of the Study

Having considered the Basic Design Study, the Japanese Government decided to implement the Project in April 2007. The Project was called for tender to select a Japanese contractor. Although the tender was conducted twice, in November 2007 and January 2008, the applicants withdrew from the tender, resulting in a difficult situation for project completion within the period of the E/N. The reason for the withdrawal was deemed to be that the costs estimated by the contractors considerably exceeded the amount specified in the E/N. To resolve this situation, it was proposed that the scheduled costs be reviewed. To achieve this, the business and commercial condition of local subcontractors and the lease costs of construction equipment in PNG will be investigated

Meanwhile, the request from the Government of PNG for the necessity and exigency of the rehabilitation of Markham Bridge continues unchanged. The Japanese Government decided to review the construction plan and cost estimate through an additional site study to investigate unit costs and procurement situation in PNG.

Based on the decisions above, JICA dispatched the Implementation Study Review team to PNG on June 29, 2008. The study team investigated the business and commercial condition of local subcontractors, the procurement situation for construction equipment and materials and the reconfirmation of work items borne by PNG and the budget. After the site investigation, the study team reviewed the construction plan and cost estimate. This report describes the results of the Implementation Study.

CHAPTER 2

Circumstances of the Project

Chapter 2 Status of the Project

2-1 Current Status of Implementing Organizations and Budget

The primary administration organization for the Project is the Department of National Planning and Monitoring (hereinafter referred to as "DNPM") and the implementing organization is the Department of Works (hereinafter referred to as "DOW"). It was confirmed that the role of the two departments remains the same for both the basic design stage and the detailed design stage.

(1) Implementing Organization

The organizations of DNPM and DOW were confirmed to be unchanged except for the General Director of DNPM and the General Manager of DOW Morobe Province who have both changed since the basic design stage. It was, however, confirmed during the site study, that the new leaders will successively fulfill the same role.

(2) Implementing Organization Budget

Table 2-1 shows the annual budget of DOW Morobe Province for road maintenance and management in the year of 2008. The table shows that 136,000 Kines and 1,820,000 Kines are allocated for the regular rehabilitation and urgent rehabilitation of the national highway, respectively. Meanwhile, the Government of PNG already owns the construction yard for the Markham Bridge project and, furthermore, materials for construction of the police box have been procured and stored in a warehouse.

Table 2-1 Annual Budget and Expenses for DOW of Morobe Province for National Highway Maintenance and Management in 2008

Description	Annual Budget	Expense in July	Cumulative Expense	Unpaid Amount	Total	Balance
Regular Rehabilitation	136,000	49,296	104,999	0	104,999	31,001
Urgent Rehabilitation	1,820,000	190,204	1,817,973	1,539	1,819,512	488
Total	1,956,000	239,500	1,922,972	1,539	1,924,511	31,489

(3) Items to be borne by the Recipient

DOW agreed that the previously obtained consensus of the residents in the region of the project implementation, will be reconfirmed because of the delayed commencement from the original schedule. Accommodation for the police had been discussed and will be reserved. In addition, DNPM confirmed that procedures for tax exemption and immigration assistance are to be carried out by DNPM.

2-2 Current Conditions at the Project Site

The conditions of the project site were reinvestigated for the purpose of the review of project costs and the construction plan.

(1) Current Conditions at the Site

At the Basic Design stage, six concrete blocks were found displaced but the damage of the revetment was not severe. However, at the Detailed Design stage, the extent of the displacement extended to the length of 73.2m and the width of 7.7m. Compared with the previous two site investigations, the extent remains almost the same but the displacement increased. Furthermore, some of the blocks sank under the riverbed. In addition, two panels of the handrail on the sidewalk side had been stolen. The bridge itself has not suffered from any additional damage. The planned construction yard was kept cleared without any illegal inhabitants.

(2) Precipitation Data

In the basic design, the precipitation data at Lae airport (Nazab airport) was used for the hydrological analysis. In this implementation study, additional data was obtained for daily precipitation at Nazab airport. Figure 2-1 shows the new and old data. After the addition of data for 2006, 2007 and 2008, we can see that monthly precipitation is more consistent throughout the year. There is very little flooding in September, which has been set as the scheduled commencement date after reviewing the construction plan. Therefore, it is concluded that the construction can be carried out on the basis of the original construction plan proposed at the basic design stage.

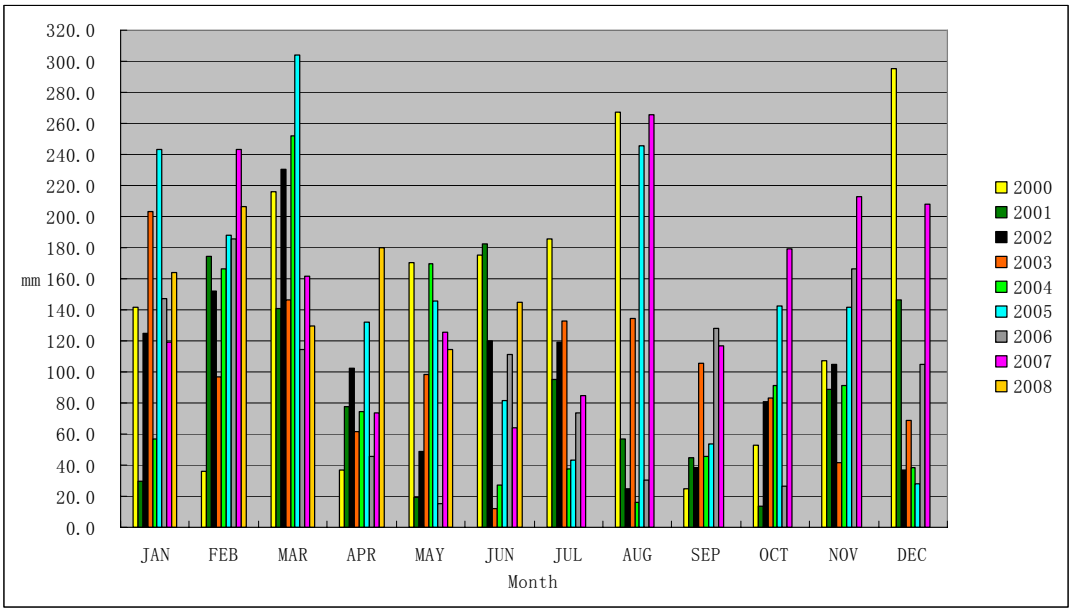


Figure 2-1 The daily precipitation at Nazab airport

(3) Relationship with other Donors

No new projects are scheduled by AusAID for Markham Bridge and no new work is planned for road improvements relating to Markham Bridge.

2-3 Trend and Current Situation of Construction Costs

The main purpose of the implementation study is to investigate the trend and current situation of construction costs for the Project and to compare them with those assumed during the basic and detailed design. For this purpose, the study team carried out a consultation and requested the resubmission of cost estimates from local subcontractors, most of which submitted a cost estimate during the basic design to the study team. The study team met four subcontractors. Although all of them had promised to submit an estimate, only two companies actually submitted.

(1) Current Situation of Local Construction Market

PNG produces mineral resources such as gold, copper and oil. Due to the increase of the global demand, the business conditions improved from the latter half of 2007. As a result, the construction of private buildings and housing in the country has increased rapidly. On the other hand, the number of local contractors is small and not many overseas contractors have operated because of the inferior social safety. Because of the lack of contractors, the principle of market competition has not been functioned. As a result, the contractors target only for easy profitable projects of buildings rather than a bridge project.

Having affected by global high prices of fuel and steel, the prices of construction

materials and equipment increased rapidly in PNG. The labor cost also increased because of a shortage of local skilled labor, most of which has been hired by mining projects. New recruitment of construction skilled labor is almost impossible except those from Australia and other countries.

As explained above, the prices of almost all items relating to construction are increasing. The situation is described item by item below:

(2) Current Situation of Local Subcontractors

Although the number of construction contracts awarded in 2004 was very small, the number started increased from 2005. In 2007, the number of contracts increased considerably including contracts of overseas large projects. Due to the flourishing domestic business, the construction of private buildings and housing in the country has increased rapidly. Hence, the construction business gives priority to the domestic market rather than overseas.

(3) Cost of Materials

The cost of materials has skyrocketed during 6 months between October 2007 and March 2008, especially the cost of steel and fuel. Materials such as concrete and timber have increased in cost and some materials have considerably increased compared with the Basic Design stage and the Detailed Design stage. Figures 2-2 and 2-3 show the cost comparison of steel and concrete and asphalt, respectively. The price rise of steel sheet piles, road decking plates, concrete and mountain sand are 266%, 120%, 186% and 102%, respectively.

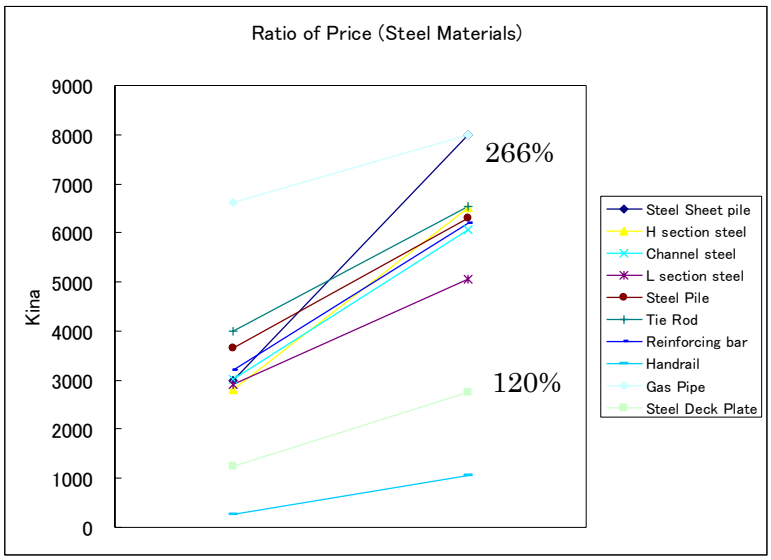


Figure 2-2 Change in Unit Prices of Steel Materials

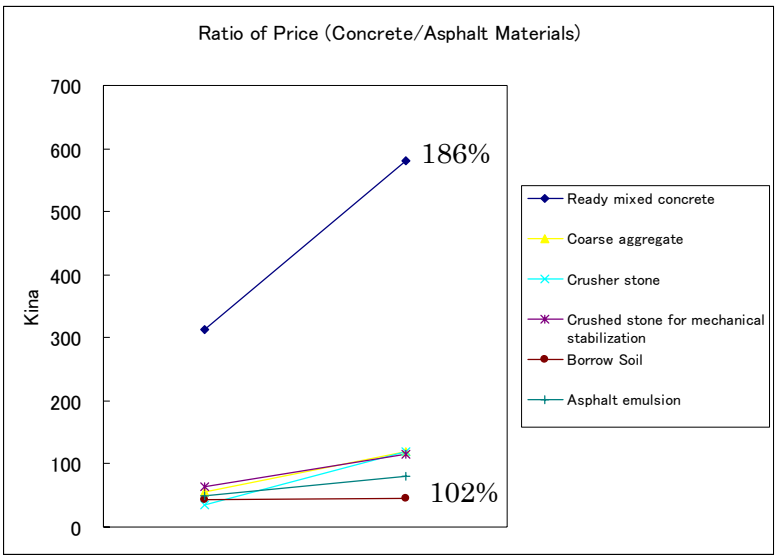


Figure 2-3 Change in Unit Prices of Concrete and Pavement

(4) Equipment Costs and Procurement Conditions

At the Basic Design stage in August 2006, when construction was slow, local contractors were ready to lease construction equipment. However, at this study stage, they are reluctant to offer only leasing service without actual construction. In addition, there is a shortage of common equipment resulting high prices. A local contractor must procure large equipment and special equipment because leasing companies do not have them. The contractors set the depreciation period to be two to three years because they consider that the equipment may not be used in the future. As a result, the quotation is very high. In this study, quotations of construction equipment were requested assuming that the service includes construction. The submitted prices were very high even under this condition. Figure 2-4 shows the change in unit prices of construction equipment. At this study stage, the prices of a crawler-type piling machine and a road roller are 250% and 151% respectively compared with those at the Detailed Design stage.

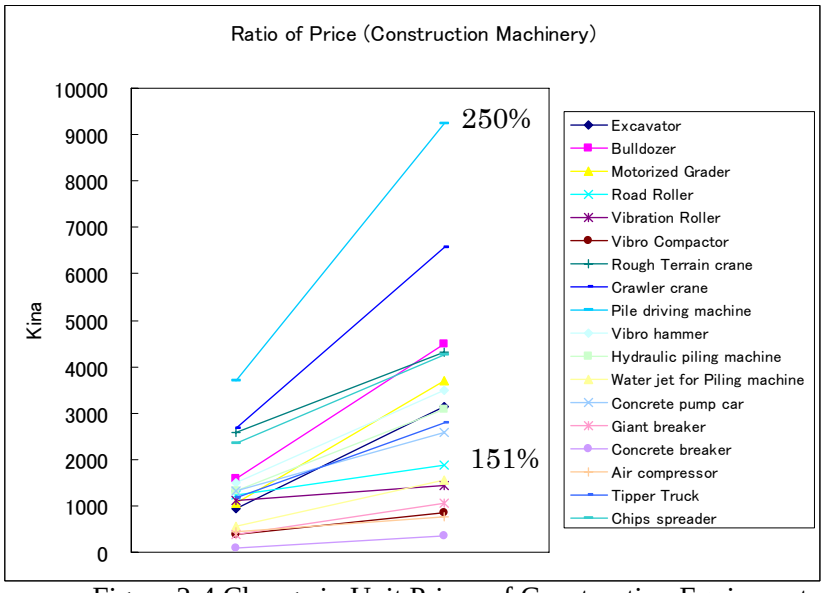


Figure 2-4 Change in Unit Prices of Construction Equipment

(5) Labor Costs

Common labor, for which special knowledge and/or experience are not required, is available in PNG although the unit cost has considerably increased as domestic prices increase. There is a shortage of skilled labor and the unit cost is increasing because quite a few skilled labors were hired by mining industry. As a result, skilled labors are often recruited from Australia, for whom welfare allowance such as commuting vehicle, housing, education and medical allowance must be added to the basic salary. Highly experienced skilled labors will be needed for the Markham Bridge project because of the work under unusual conditions. Therefore, submitted unit price was very high. Figure 2-5 compares the unit prices between the Detailed Design stage and the Implementation Review Study stage. As compared with the Detailed Design stage, the prices of a bridge special worker and a special driver increased by 192% and 110%, respectively. The unit prices of common labor, which were 26 Kina and 95 Kina at the Detailed Design stage and the Implementation Review Study stage respectively, increased to 364%.

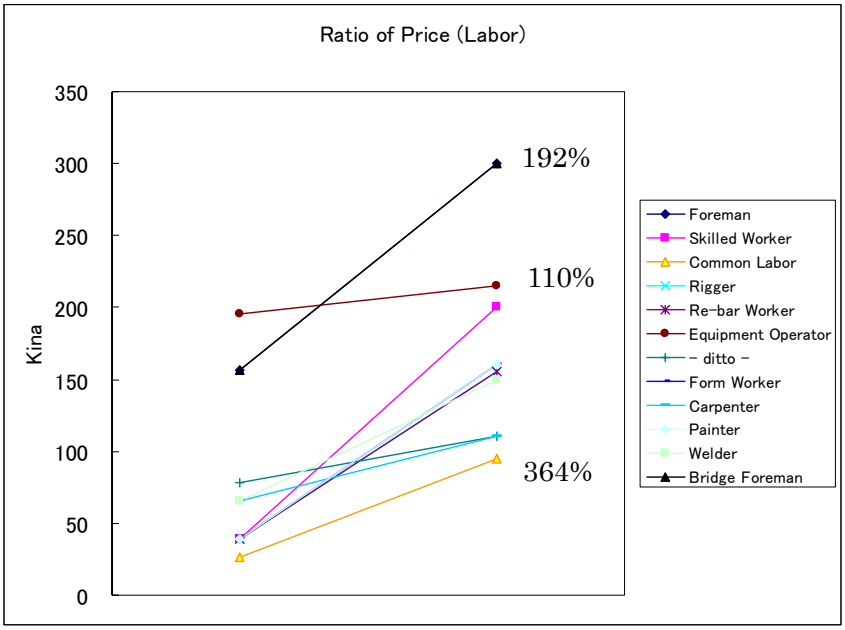


Figure 2-5 Change in Unit Prices of Labors

(6) Transportation Costs

Transportation costs in PNG have increased since October 2007 by approximately 50%.

2-4 Other Information

(1) Safety for the Construction Site

All four local contractors stated that the Project cannot be implemented without recruiting a private security company. They say that the police are not reliable for an attack by “the rascals” because they are not trained for it.

(2) Risks associated with the Markham Bridge Construction

The construction method proposed in the basic design and detailed design is to carry out the work without stopping the traffic on the bridge. Although the method is popular in Japan, there was a concern that local contractors’ cost estimate would be high because of a special method in PNG.. Therefore, the study team proposed an alternative method to construct the bridge after installing a temporary rerouting bridge and removing the existing superstructure. The contractors’ opinion on the alternative method was negative because the costs would increase and, therefore, prefer the original method which will be advantageous economically and technically.

(3) Cost Increase During Construction Period

All four local contractors are most concerned about the increasing costs of the equipment and labor. The contractors, who well understand ODA’s system of grant assistance, believe that the project may not make any profit but a loss under a lump sum contract using the present unit costs if the actual cost increases continue. According to them, the unit costs should take account of the current cost increases. This explains why they submitted considerably higher estimates for the construction costs.

CHAPTER 3

Contents of the Project

Chapter 3 Contents of the Project

3-1 Outline of the Project

The existing Markham Bride carries two-lane traffic, i.e. one lane in each direction, which is considered sufficient for the current traffic volume. The Government of PNG plans to construct a major arterial highway via the Wau Road connecting the capital, Port Moresby, and Lae. This will become the most important road in the country. The Owen Stanley Range is the biggest hazard for the construction of the planned highway. When completed, the traffic volume will increase considerably because of the improved living standards and expanding industrial activity. As a result, one lane per direction on the Markham Bridge may not be sufficient for the increased traffic volume.

It may take 20 years for traffic to reach the capacity of the existing 2-lane road. During this time, Markham Bridge should be well maintained so that the road sustains its role as the lifeline for the people along the road as well as contributing to activate and develop the industrial activity in the area.

Although almost no maintenance work has been carried out on Markham Bridge for more than 30 years after its completion, the structural members of the superstructure are relatively intact except for some corrosion. The pedestrian handrail , which is partly lost or damaged, can be reused after repair and repainting.

The study team confirmed on the site that the bridge condition remains almost the same as before except for an additional displacement of the concrete blocks of the revetment and two missing handrail panels for the sidewalk.

The objective of the Project is to rehabilitate the bridge which was damaged by the flooding in March 2004 so that the bridge will maintain its required function for at least the next 20 years. The work includes the following items;

- Permanent repair and reinforcement of abutment A1 and the piers from P1 through P4,
- Repainting of the entire steel girder,
- Partial repair and entire repainting of the handrails and guardrails, and
- Repair work for the approach road and revetment.

In the Implementation Review Study, the above objective is confirmed to be unchanged. Table 3-1 shows the items to be rehabilitated.

Table 3-1 Markham Bridge Items for Rehabilitation

Item	Contents	Remarks
① River Protection at Lae side	Steel sheet pile foundation 73.2m Connection of River protection bricks	
② Repair Lae side abutment A1	Additional piles and enlargement of the footing of Abutment A1	
③ Reconstruction of four piers on the Lae side	Remove the existing piers. Construction of new piers	
④ Superstructure	Repaint the steel girder Repair part of the handrail and the curbs. Repaint hand rail	Bridge total length 560m
⑤ Lae side approach road	Total road length 50m (Pavement, slope protection and drainage system)	

3-2 Basic Policy for the Project

The Government of PNG deems the Markham Bridge to be very important because the bridge provides a lifeline to the people and for the transportation of industrial and agricultural products. Therefore, the Government wants to urgently rehabilitate the bridge under the same conditions as in the previous E/N. The bridge condition remains almost the same when compared with previous visit.

Considering this situation, the Implementation Review Study was carried out without changing the basic contents and scale proposed in the Basic Design and Detailed Design except for the following items which are reviewed in the study:

1) Construction Method

An optimum method is proposed in terms of technical feasibility and construction economy based on a comparative study reflecting the present trend in the construction market as well as a study on alternative construction methods for the piers.

2) Project Costs

The costs are recalculated using newly obtained cost data for the equipment, labor, etc. Costs of locally procured items are compared with those procured in Japan and transported to the site. The latter will be used if lower.

3) Security Measures during Construction

Public security in PNG is extremely poor. Cash-transporting vehicles are often attacked by a gang of bandits called ""the rascals"". In an interview with local contractors, they stated that they cannot carry out the construction work unless a private security company will be hired, in addition to the police. Based on this comment, the necessity of private security is investigated considering the current security conditions at the site.

4) Scope of Revetment Repair

The scope is reviewed because of the increased displacement of the concrete blocks when compared with the basic design stage.

5) Scope of Handrail Repair

From the site investigation, two handrail panels were stolen after the previous visit. The scope of the repair is reviewed accordingly.

Each of the above items is described more specifically below.

(1) Construction Method

The method proposed in the basic design and the detailed design was to construct the substructure under the existing bridge without stopping the traffic. This method uses a special equipment to drive steel sheet piles in a limited space under the superstructure. It is speculated that one of the high costs submitted by the local contractors was an additional cost for the risk attached to this unfamiliar construction method. Therefore, an alternative method is studied in which only a common construction equipment will be used. Considering the above, the following two alternatives were studied.

Alternative 1: A temporary bridge is constructed and the existing bridge is temporarily removed.

Alternative 2: Without a temporary jetty, the river flow is rerouted using self-supporting steel sheet piles which can withstand flooding.

The original method and the two alternatives are explained below:

1) Original Method proposed in the basic design and the detailed design

The work is carried out by rerouting the river using a cofferdam during the low flooding period and a temporary jetty during the high flooding period, without stopping the traffic on the bridge. The concrete piers are removed after the load from the superstructure is transferred to the temporary piers constructed by the Government of

PNG. Then, the steel pile foundation and concrete work are carried out. An item of special equipment called a “Silent Piler”, which can drive a pile in the limited space under the superstructure, is transported from Japan.

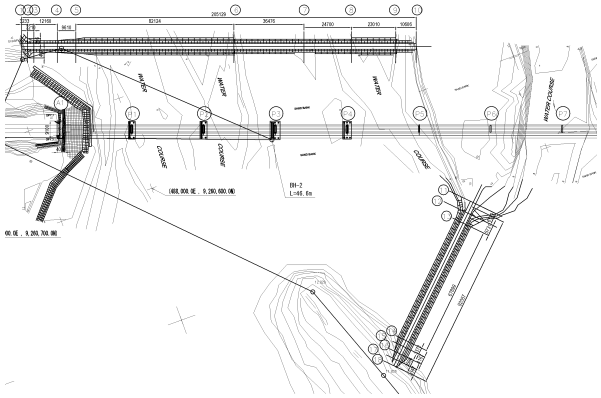


Figure 3-1 Plan for Rerouting River Flow

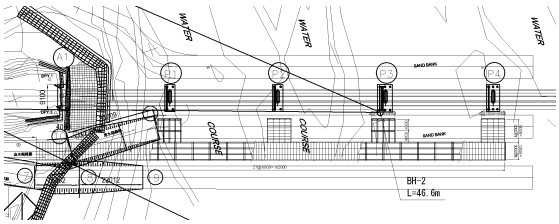


Figure 3-2 Plan of Temporary Jetty during Flooding Period

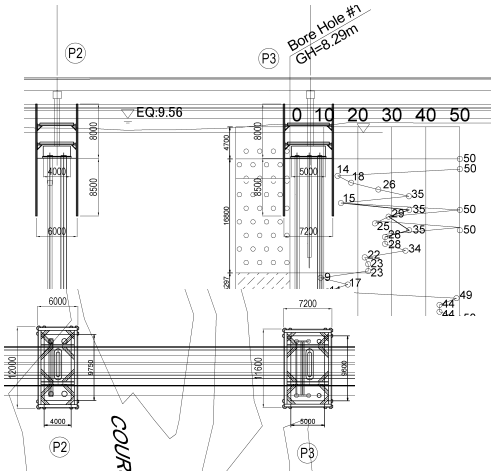


Figure 3-3 Steel Sheet Piles for Pier Construction

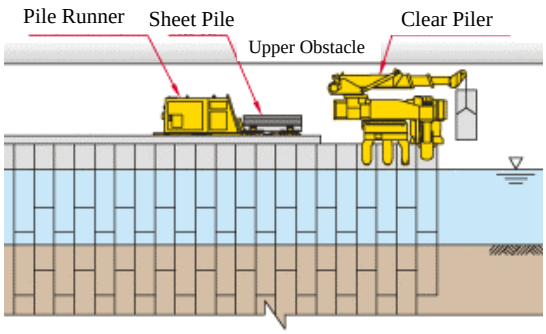


Figure 3-4 Explanatory View of Silent Piler

2) Alternative 1 (Install temporary bridge and remove existing superstructure)

The construction steps are as follows:

i) A temporary bridge is constructed alongside the existing bridge.

ii) The existing bridge is removed after the traffic is transferred to the temporary bridge. The steel girders will be reused but the concrete slab will not.

iii) The foundations and substructure are constructed without any restriction from the superstructure.

iv) The existing superstructure is placed on the new substructure. A new concrete slab is cast.

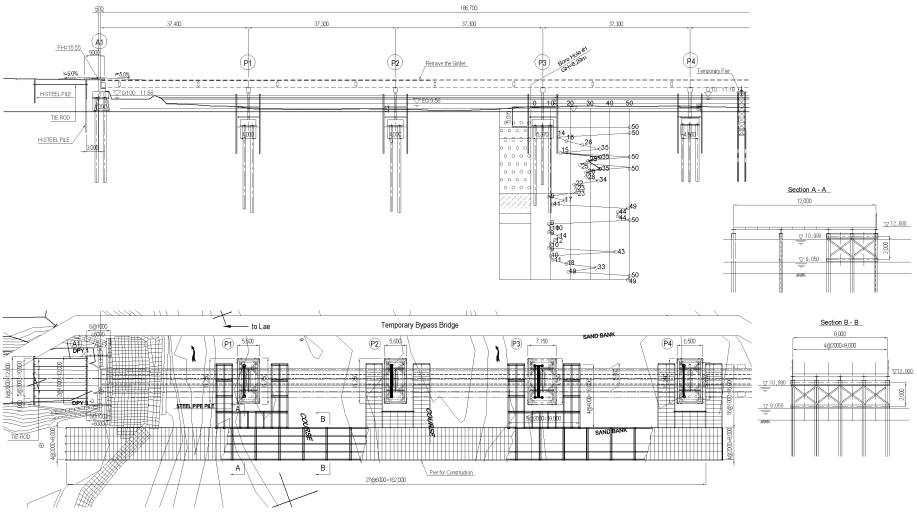


Figure 3-5 Construction using Temporary Jetty during Flooding Period

3) Alternative 2 (Install Self-supporting Steel Sheet Piles for Rerouting the River Flow)

This method will not require a temporary jetty and a cofferdam around the piers. The idea came from the condition of the site when there was no flooding and the river almost dried up on the Lae side. Under these conditions, heavy machinery can be transported to the site. The sediment soil will be used for cofferdam material. Since the cofferdam narrows the width of the river, the flow area required during the flooding period must be maintained by removing as much sediment as possible.

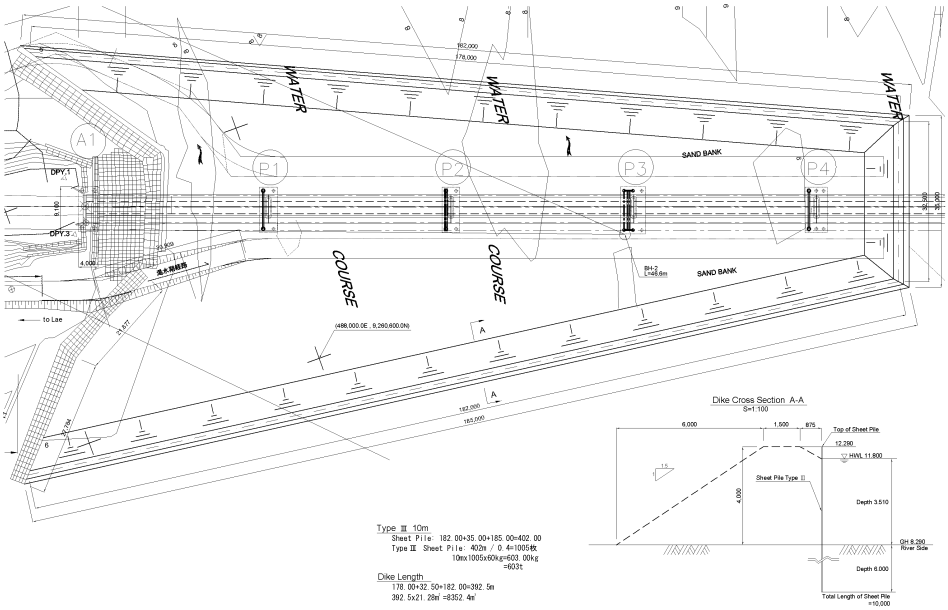


Figure 3-6 Rerouting the River Flow using Self-supporting Steel Sheet Piles

4) Discussions and Conclusions

The cost of Alternative 1 is higher than the other two methods. This alternative has been abandoned because the local contractors believe the original method to be feasible and not risky.

With regard to Alternative 2, there is a concern that the dry condition necessary for this method is not always guaranteed. Furthermore, the cost is higher than the original idea due to the unexpected high price of steel and its construction.

Based on the above observations, it is concluded that the original method is the optimum method and is adopted.

(2) Project Costs

In this study, revised cost data was obtained from two local contractors. The costs, however, are considerably higher than those assumed for the basic and detailed designs. Therefore, in addition to local procurement, procurement from Japan is also considered seeking for an optimum solution. A comparative study was conducted for the following two cases:

1) In the case that all equipment and labor are procured in PNG

The project costs were recalculated using the new data.

2) In the case that the following items are assumed to be procured in Japan

- Labor except common labor, common drivers and specialist drivers,
- All equipment and materials except cement, aggregates and minor items

As a result of the study, procurement in Japan is found to be economically better than local procurement. Therefore, the detailed costs are estimated on the basis of procurement in Japan.

(3) Security Measures during Construction

It is widely believed that the social security must be carefully considered ensured in PNG. Table 3-2 compares the number of crimes in Japan and PNG. As shown in the table, the number of crimes in PNG is considerably higher than in Japan and so adequate security measures are essential.

Table 3-2 Comparison of Crime Numbers in Japan and PNG

Item	Japan	PNG	Offences per 10,000	
			Japan	PNG
Population	127.7 million	6.7 million		
Murder	1,199	505	0.09	0.75
Serious Sexual Offences	1,677	1,050	0.13	1.57
Robbery	4,567	1,969	0.35	2.94

Reference:

Japan: Population from data of population statistic office as of July 2008.

Crime offences from the crime situation in 2007 from the Metropolitan Police Department May 2008.

PNG: By PNG 2008 yearbook

The site of the Markham Bridge is located in the Morobe Province, within a 30-minute drive from Lae. The person in charge of the DOW at Port Moresby stated that, due to this location, the area is relatively safer than those of the Umi Bridge and the Leron/Bitija Bridges, which were renewed by Japan's grant programs, and that only the police would be sufficient for security measure. As a result, a private security was not considered at the basic Design stage.

Having interviewed with the four local contractors, however, they believe that the police are not effective against an attack by "the rascals" because they are not trained for it and that the construction cannot be carried out without the recruitment of a private security company. One of the contractors, who worked for the Umi Bridge and the Leron/Bitija Bridges projects, said from their experience that they could avoid trouble by hiring both the police and private security and that private security is a must.

According to the information of the DOW, the situation is more or less the same as the Basic Design stage. Considering the information, the study team interviewed with the two private security companies. Their comments are summarized below:

- The project will be a good target for "the rascals" because the location does not move during the construction and that two or three policemen are not sufficient for the security.
- The probability of "the rascals"' attack decreases when a private security company is hired because the company deals with a problem systematically with many guards
- A trouble with the people in the area is avoided because some of the residents will be hired as guards.

- Although the security at the project area is better than that of the Highland area, security measures should be carefully investigated.
- The area at the branch point of the Wau Road and the Highlands Highway is recommended for living because it is much safer than the project site.
- Caution is needed for so-called “Two miles to Six Miles” from Lae to the site because many crimes occur in the area.

Based on the findings described above, the security measures are essential at the site for smooth construction works to avoid a delay of the works. As a result, the cost for private security, which had not been considered in the Basic Design and the Detailed Design, is added to the project costs.

(4) Scope of Revetment Repair

Photos 3-1 through 3-4 compare the revetment conditions at the basic design stage and this study.

<table>
<tr><td>  </td><td>  </td></tr>
<tr><td>Photo 3-1
Revetment on Upstream Side (August 2006)</td><td>Photo 3-2
Revetment on Downstream Side (August 2006)</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Photo 3-3
Revetment on Upstream Side (July 2008)</td><td>Photo 3-4
Revetment on Downstream Side (July 2008)</td></tr>
</table>

As shown in the photos, the damaged area of the revetment has extended. The increase in the extent of the repair had already been adjusted in the detailed design.

(5) Scope of Handrail Repair

At the detailed design stage, two panels had been found missing. This time, another two entire panels and a part of another panel were stolen. As a result, a total of five panels must be installed.

3-3 Procurement Plan for Construction Equipment and Materials

As described in Section 2-3, Trend and Current Situation of Construction Costs, the costs of equipment and materials recently increased when compared with those at the basic design and the detailed design stages. Results of the cost comparison are shown below.

(1) Material Procurement Locations

The new cost data obtained in this study, shows that all material costs increased by 150% to 350%. The increased prices of steel and reinforcing bars are particularly significant. The prices are 110% to 200% higher than those procured in Japan and transported to the site. Therefore, it is assumed that all those materials are procured in Japan. On the other hand, fresh concrete, aggregates, sands and soils, and fuels are to be procured in PNG due to economical reason.

Table 3-3 Assumed Procurement Locations for Major Materials

Item	PNG procurement	Japan procurement	Remarks
Steel Sheet Pile (Type2)		○	
(Type3)		○	
H Section Steel 300x300		○	
350x350		○	
400x400		○	
Steel Pile φ600mm		○	
φ800mm		○	
Reinforcing Bar D13		○	
D16-D25		○	
D29-D32		○	
Steel Deck Plate 1x2m		○	
Ready Mixed Concrete	○		
Coarse Aggregate	○		
Borrow Soil	○		
Fuel	○		

(2) Equipment Procurement Locations

Since the equipment prices have also increased, a study was carried out to compare the alternative procurement locations. As a result, it was found that procurement in Japan is more economical than local procurement except for common machinery such as bulldozers, dump trucks, and pavement equipment. Table 3-4 shows the assumed procurement locations for major equipment.

Table 3-4 Assumed Procurement Locations for Major Equipment

Item	PNG procurement	Japan procurement	Remarks
Bulldozer(12t-21ｔ)	○		
Back hoe ($0.35m^3$ – $1.0m^3$)		○	
Wheel loader ($1.0m^3$ – $3.2m^3$)		○	
Dump truck (2t – 10t)		○	
Truck crane (4t – 20t)		○	
Truck (2t – 10t) 3 unit		○	
Trailer (20t)		○	
Motorized Grader (3.1m)	○		
Macadam roller	○		
Vibration roller	○		
Tire roller	○		
Dump truck (10t) 1unit	○		
Chip spreader	○		
Vibro hammer (60KW)		○	
Silent piler		○	
Pile driving machine		○	
Hydraulic piling machine		○	
Water jet for piling machine		○	
Sprinkler vehicle (5.5 to 6.5 KL)		○	
Concrete breaker (20kg)		○	
Concrete Mixer ($0.4m^3$ – $6.0m^3$)		○	
Vibro-Compactor (60kg – 100kg)		○	
Compressor ($1.7m^3$/min – $3.5m^3$/min)		○	
Generator (15KVA – 200KVA)		○	

(3) Labor Procurement Locations

Since labor costs are also increasing considerably, the unit costs and transport costs between procurement in PNG and Japan are compared. Table 3-5 shows assumed procurement locations for major labors. All technical workers except common labor are to be procured in Japan because of the lower unit costs. Operators of the special equipment, Silent Piler, are also procured in Japan because special skills are required. Common labor, skilled drivers and common drivers are to be procured in PNG.

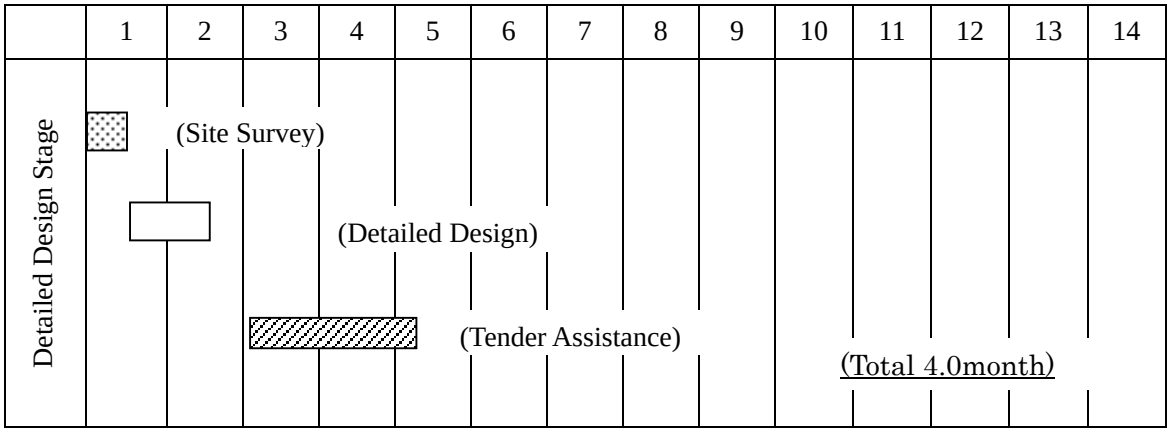
Table 3-5 Assumed Procurement Locations for Major Labors

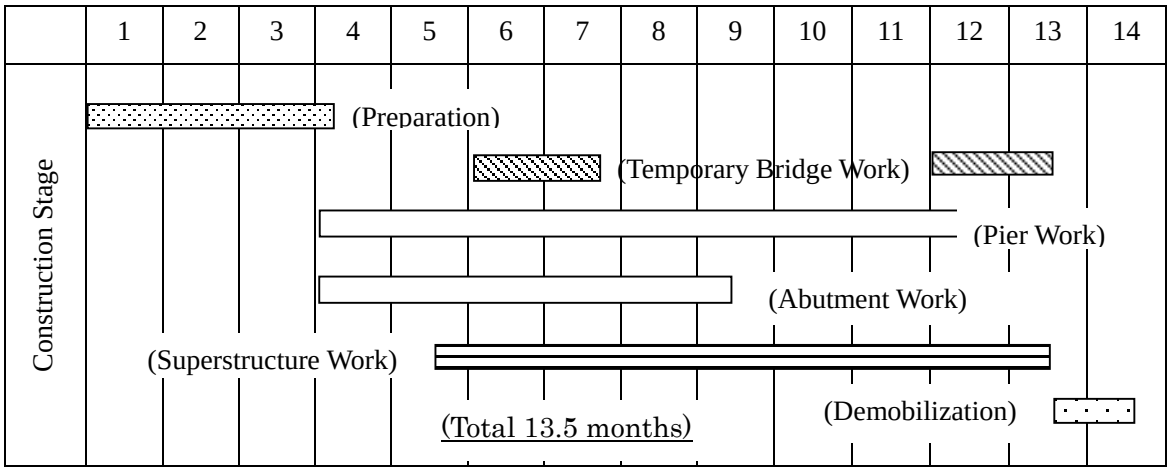
Classification	PNG procurement	Japan procurement	Remarks
Foreman		○	
Skilled Worker		○	
Common Labor	○		
Rigger		○	
Re-bar Worker		○	
Form Worker		○	
Painter		○	
Bridge Foreman		○	

3-4 Implementation Schedule

Table 3-6 shows the implementation schedule based on Japan's Grant Aid Scheme.

Table 3-6 Project Implementation Schedule





3-5 Outline of Projects Implemented by the Recipient

It was confirmed during the site investigation that the work items borne by the Recipient remain the same as those determined at the basic design stage and the detailed design stage. These items are described below.

(1) Common Items of Japan's Grant Aid Scheme

- To secure land necessary for the site of the project (Borrow land upstream of the bridge on the Lae side).
- To exchange a bank agreement (B/A) between a Japanese bank and to issue the authorization to pay (A/P)
- To assist Japanese parties in administrative procedures for tax exemption and smooth custom clearance for materials and equipment to be used in the project
- To exempt Japanese nationals from custom duties, internal taxes and other fiscal levies which will be imposed in the recipient country with respect to the supply of the goods and services under the project.
- To issue permissions and licenses necessary for the implementation the project
- To ensure proper maintenance, management and preservation of the facilities constructed by Japan's Grant Aid.

(2) Special Items for the Project

- Before the start of construction, acquire a letter of agreement from the residents near the construction site for the smooth implementation of the project.
- Before the start of construction, establish a committee consisting of stakeholders, including the DOW, the Provincial Government, the Police and local representatives.
- Acquire a letter of agreement that Australia agrees that for this project, we can use the concrete blocks and modify the bank protections constructed by AusAID.
- To build a police station
- To permit the police officers to be provided with accommodation near the site

3-6 Project Management and Maintenance Plan

The maintenance works needed for the road and bridge after the completion of the project are shown in Table 3-7.

Table 3-7 Maintenance Works for Facilities

Work item	Frequency	Location	Content of work
Road and bridge maintenance	Continuous	Whole facility	Maintenance work based on the RAMS、BMS DOW system
Bridge maintenance	Twice per annum	Expansion joints	Cleaning of expansion joints, if damage is detected take photos and record the date
		Drainage	Cleaning drainage pipes, if damage is detected take photos and record the date
		Bearings	Cleaning the periphery of bearings. Confirm the movement and deterioration of elastomeric bearings.
		Handrails Guard rails	Confirm the degree of deterioration if damage is detected take photos and record the date
		Steel Girder	Confirm the paint condition and rust. If problems are detected , take photos and record the date
	After flooding	Abutment, Pier	Confirm local scour and subsidence of the structure.
Approach road	Twice per annum	Pavement	Repair potholes
		Shoulder	Weed and level shoulder
		Slope	Repair slope erosion
		Gutter	Removal of deposits
Bank protection	Twice per annum and after a flood	Concrete Block	Confirm movement due to erosion. Repair protection if problems are detected
Periodical bridge repair	Every 10 years	Steel member	Prepare budget and repaint

3-7 Estimated Project Costs

3-7-1 Initial Cost Estimation by the Government of PNG

The cost required for fulfilling the undertakings by the Government of PNG is estimated at 1.7 million Japanese Yen as shown in Table 3-8

Table 3-8 Project Cost to be borne by the Government of PNG

Items	Amount（Kina）	Yen Equivalent（Million Yen）
(1) Acquisition of land for construction yard	36,250	1.5
(2) Construction of police box	5,000	0.2
TOTAL	**41,250**	**1.7**

The cost estimate is provisional and will be further examined by the Government of Japan for the approval of the Grant.

3-7-2 Management and Maintenance Costs

Using the DOW maintenance system, periodical maintenance is carried out twice per annum. However, it is necessary to prepare a budget for the maintenance work since there has not been any maintenance activity for Markham Bridge in the past. Provisional costs for the maintenance work to be borne by the government of PNG are shown in Table 3-9.

Table 3-9 Provisional Costs for the Maintenance Work to be borne by the Government of PNG

Work item	Frequency	Cost（Kina）
Inspection and maintenance of bridge	Twice per annum	5,000
Periodical repair of pavement	Every three years	50,000
Repainting of steel structure	Every ten years	560,000
Total per ten years		827,000
Average cost per annum		82,700

It is considered that the Government of PNG can bear the average annual maintenance cost of 82,700 Kina since DOW's total annual budget for road maintenance is 365 million Kina. The DOW, however, must realize that 560,000 Kina will be needed for repainting of steel members 10 years after completion.

CHAPTER 4

Conclusions and Recommendations

Chapter 4 Conclusions and Recommendations

4-1 Conclusions and Recommendations

Markham Bridge functions as a lifeline for 200 thousand people living along the road and is the major transportation link for mine resources, agricultural products, timber, etc. The Government of PNG recognizes the essential role of the bridge and keenly desires its urgent rehabilitation.

When damage to the bridge, similar to that of March 2004 occurs again, the lifeline will become unstable and the living conditions will be disrupted. Also, the economy of PNG will be damaged because transportation of mine resources and agricultural products will be jeopardized.

The access road and bridge will be managed and maintained in accordance with the DOW's Road Asset Management System (RAMS) and Bridge Management System (BMS). Maintenance management of Markham Bridge is carried out by the Morobe office, where five experienced engineers are stationed, all working under a capable general manager. It is considered that the average annual maintenance cost can be borne by the DOW because the amount is only 0.02% of their annual budget.

Based on the above, the Markham Bridge Project is considered to be appropriate for Japan's Grant Assistance.

〔**Appendices**〕

1. Member List of the Study Team
2. Study Schedule
3. List of Parties Concerned in the Recipient Country

Appendix 1. Member List of the Study Team

Assignment	Name	Organization
Chief Consultant	Masahiko MORI	International Division, Chodai Co.,
Construction Plan	Hiroyuki TAKANO	International Division, Chodai Co.,
Cost Estimation	Yukikazu KOBAYASHI	International Division, Chodai Co.,

Appendix 2. Study Schedule

No.	Date and Time			Chief Consultant	Construction Plan	Cost Estimator
				Masahiko MORI	Hiroyuki TAKANO	Yukikazau KOBAYASHI
1	Jun.	29	Sun	Narita: 20:55 ～ Cairns: 05:25		
2		30	Mon	Cairns: 07:00 ～ Port Moresby: 08:15 Afternoon JICA PNG		
3	Jul.	1	Tue	Port Moresby Morning: JPN Embassy, Afternoon: DNPM, DOW		
4		2	Wed	Port Moresby		
5		3	Thu	Port Moresby 16:00 ～ Alotau: 16:50		
6		4	Fri	Alotau:16:35 ～ Port Moresby: 17: 25		
7		5	Sat	Port Moresby 12:00 ～ Lae: 12:45		
8		6	Sun	Lae Site survey and Term meeting		
9		7	Mon	Lae Morning: DOW Lae, Afternoon: Markham bridge site		
10		8	Tue	Lae: 13:15 ～ Port Moresby: 14:00		
11		9	Wed	Port Moresby		
12		10	Thu	Port Moresby		
13		11	Fri	Port Moresby Morning JICA, JPN Embassy, Afternoon: DNPM, DOW		
14		12	Sat	Port Moresby:9:25 ～ Cairns: 10:50 Cairns: 12:10 ～ Narita: 18:44		

Appendix 3. List of Parties Concerned in the Recipient Country

Organization	Name	Position
Japanese Embassy in PNG	Mr. Hajime NISHIYAMA	Ambassador of Japan
	Mr. Takeshi FUJIMURA	First Secretary
JICA PNG	Mr. Yusuke KITAMUTA	Resident Representative
	Mr. Takahiro YOKOTA	Assistant Resident Representative
	Mr. John KOL	Local Staff
Department of National Planning and Monitoring: DNPM	Mr. Paul Enny	Acting Director, Aid Policy & Coordination Directorate
	Mr. Karl Sopol	Assistant Director Bilateral Branch
	Mr. Robert Gondor	Senior Aid Coordination Japan Desk
	Ms. Jenny Tumun	Aid Coordination Japan Desk
Department of Works: DOW	Mr. Eric Sikam	First Assistant Secretary
DOW Morobe province Office	Mr. Nickson Laime	Provincial Works manager
	Mr. John Wakma	National Roads Authority Implementation Unit Manager

Organization	Name	Position
KG Contractors Ltd.	Mr. Kevin Moran	Construction Director
	Mr. George Tipping	Managing Director
HEBOU Construction (PNG) Limited	Mr. Albert B. Capistrano	Construction Manager
PNG Builders Ltd.	Mr. Trevor Klingner	Managing Director
MAWAE Construction Ltd.	Mr. Julius Violaris	Managing Director
	Mr. Alex Violaris	Founder
Guard Dog Security Service Ltd.	Mr. Dennis Bux	Certified Police Dog Trainer
	Mr. Dale Smith	Port Moresby Office Manager
	Mr. John A. Bellinger	Financial Controller
PROTECT protection & Security	Mr. Chris Appleton	Field Operation Manager
PNG TAIHEIYO CEMENT Limited	Mr. Sunao SHIOMI	Managing Director