Department of Agrarian Reform
The Republic of the Philippines

No.

BASIC DESIGN STUDY
ON
THE BRIDGE CONSTRUCTION PROJECT
FOR EXPANDED AGRARIAN REFORM
COMMUNITIES DEVELOPMENT
IN THE REPUBLIC OF THE PHILIPPINES

December 2008

JAPAN INTERNATIONAL COOPERATION AGENCY

CTI ENGINEERING INTERNATIONAL CO. LTD.

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Preface

In response to a request from the Government of the Republic of the Philippines, the Government of Japan decided to conduct a basic design study on the bridge construction project for expanded agrarian reform communities development in the Republic of the Philippines and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to the Philippines a study team from March 3 to April 16, 2008.

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

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

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

December 2008

MATSUMOTO Ariyuki

Vice-President

Japan International Cooperation Agency

December 2008

Letter of Transmittal

We are pleased to submit to you the basic design study report on the bridge construction project for expanded agrarian reform communities development in the Republic of the Philippines.

This study was conducted by CTI Engineering International Co., Ltd., under a contract to JICA, during the period from February 2008 to December 2008. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of the Philippines and formulated the most appropriate basic design for the project under Japan's Grant Aid scheme.

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

Very truly yours,

SAWANO Kunihiko

Project manager,

Basic design study team on the bridge construction project for expanded agrarian reform communities development in the Republic of the Philippines

Summary

1. Background of the Project

The Philippine government has set forth the Comprehensive Agrarian Reform Program (CARP) in 1987 as an effective measure to achieve rural development. The Department of Agrarian Reform (DAR), which is the lead agency of this Program, has been implementing two major programs; namely Land Tenure Improvement (LTI) and Program Beneficiaries Development (PBD) to provide services including agricultural technique, potable water, infrastructure and micro credit assistances for the farmers who benefited from the land distribution.

Recognizing that the land distribution has attained 73% (5.9 million hectares) of the targeted 8.1 million hectares in 2003, the priority is being given to support Agrarian Reform Beneficiaries (ARB) in the distributed land.

In 1993, DAR adopted the Agrarian Reform Community (ARC) development strategy as an approach to effectively achieve the PBD and came up with KALAHI AR Zone Development Strategy in 2003 from the viewpoint of an expanded ARC development concept. The total number of ARCs has reached 1,587 nationwide as of the end of December 2003 when the Project was requested from the Japanese Government.

The Agrarian Reform Infrastructure Support Project (ARISP), which is a Japanese Yen loan project, has been implemented for some 220 ARCs nationwide. On the other hand, DAR identified, through its assessment survey, 34 bridges nationwide necessary to be constructed to access the outside of ARCs to improve living and marketing conditions. The support for the outside area of ARCs, however, is out of the coverage of ARISP. Further, DPWH and LGU have too limited resources and techniques to implement said bridge construction. In this context, the Grant Aid Project was requested to construct two (2) bridges in Barangay Bazal and Barangay Umiray, which would be highly prioritized and is expected to take quick effect in terms of the expanded ARC development among the rural area where its poor access condition is a main hindering factor for rural development.

After the Preparatory Study, which was conducted in March 2005, the Basic Design Study was made for the purpose of reviewing the needs and the relevance of the construction of said two bridges, conducting the proper basic design as a Grant Aid Project including project planning and cost estimation. The requested items were confirmed eventually with the Philippine government through a series of meetings and site survey.

2. Contents of the Project

The Japan International Cooperation Agency dispatched the Basic Design Study Team to the Philippines from March 3 to April 16, 2008 for the field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to the Philippines in order to discuss a draft basic design from September 12 to September 26, 2008.

As a result of the study, the basic plan of two bridges was proposed as shown in Table-1 and Table-2.

Table-1 Basic Plan (Bazal Bridge)

Bridge Type		4-span PC-I Girder Bridge
Bridge Length		110.000m
Road Width		5.400m (Total), 4.000m (Carriage Way), 0.700m x 2 (Sidewalk and Railing)
Road Surface		Concrete Pavement t=50 to 80mm
Substructure Type (Abutment)		Reversed T-Shape Concrete Abutment (cast-in-place concrete pile)
Substructure Type (Bridge Pier)		Double-column concrete pier (cast-in-place concrete pile)
Approach Road	Length	182m (Left Bank), 242m (Right Bank)
	Road Width	6.000m (Total), 4.000m (Carriage Way), 1.000m x 2 (Sidewalk and Shoulder)
	Pavement Type	Concrete Pavement t=200mm

Table-2 Basic Plan (Umiray Bridge)

Bridge Type		10-span PC-I Girder Bridge
Bridge Length		358.000m
Road Width		6.900m (Total), 5.500m (Carriage Way), 0.700m x 2 (Sidewalk and Railing)
Road Surface		Concrete Pavement t=50 to 80mm
Substructure Type (Abutment)		Reversed T-Shape Concrete Abutment (cast-in-place concrete pile)
Substructure Type (Bridge Pier)		Double-column concrete pier (cast-in-place concrete pile)
Approach Road	Length	156m (Left Bank), 116m (Right Bank)
	Road Width	7.500m (Total), 5.500m (Carriage Way), 1.000m x 2 (Sidewalk and Shoulder)
	Pavement Type	Concrete Pavement t=200mm

3. Implementation Schedule and Project Cost Estimation

The required period is approximately 8.5 months for the works relevant to the detailed design and tendering service and approximately 17.0 months for the construction work for the Bazal Bridge, as well as, approximately 8.5 months for the works relevant to the detailed design and tendering service and approximately 20.0 months for the construction work for the Umiray Bridge.

The initial cost estimation for the Philippine Contribution is estimated to be 4.087 Million Pesos for the Bazal Bridge, and 13.048 Million Pesos for the Umiray Bridge, in total 17.135 Million Pesos.

4. Project Evaluation

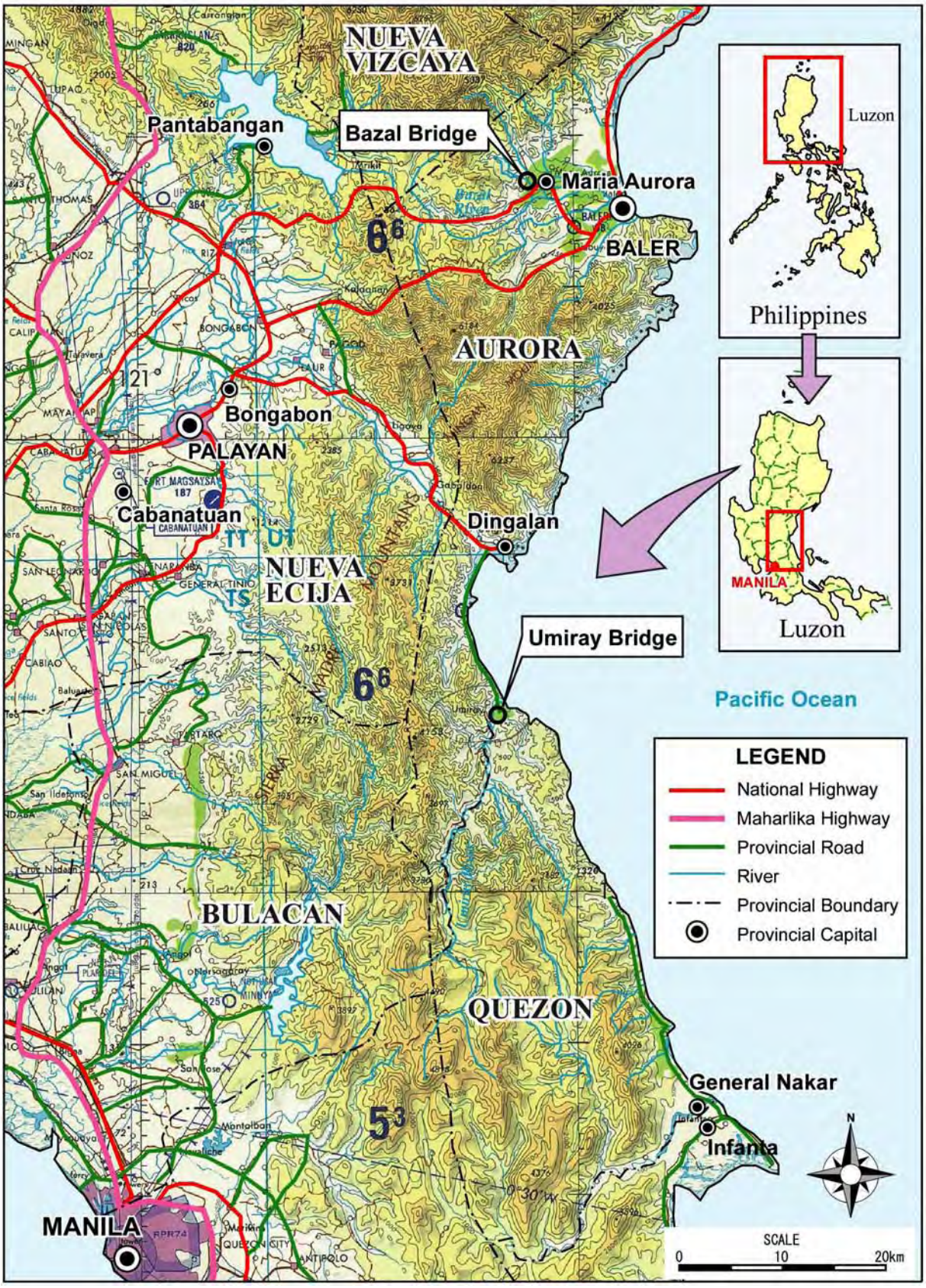
This Project aims to improve access between target ARCs and other expanded ARCs, to strengthen partnerships and promote interactions among areas, as well as to accelerate development in the target areas.

Improvement of access would be the biggest effect directly derived from the construction of the bridges. The local people living in the surroundings of target barangays of approximately 2,000 people in Bazal area and 10,000 people in Umiray area are the main beneficiaries. The students and staff of Bazal Campus of ASCOT (Aurora State College of Technology) would also be included as the direct beneficiaries of Bazal Bridge.

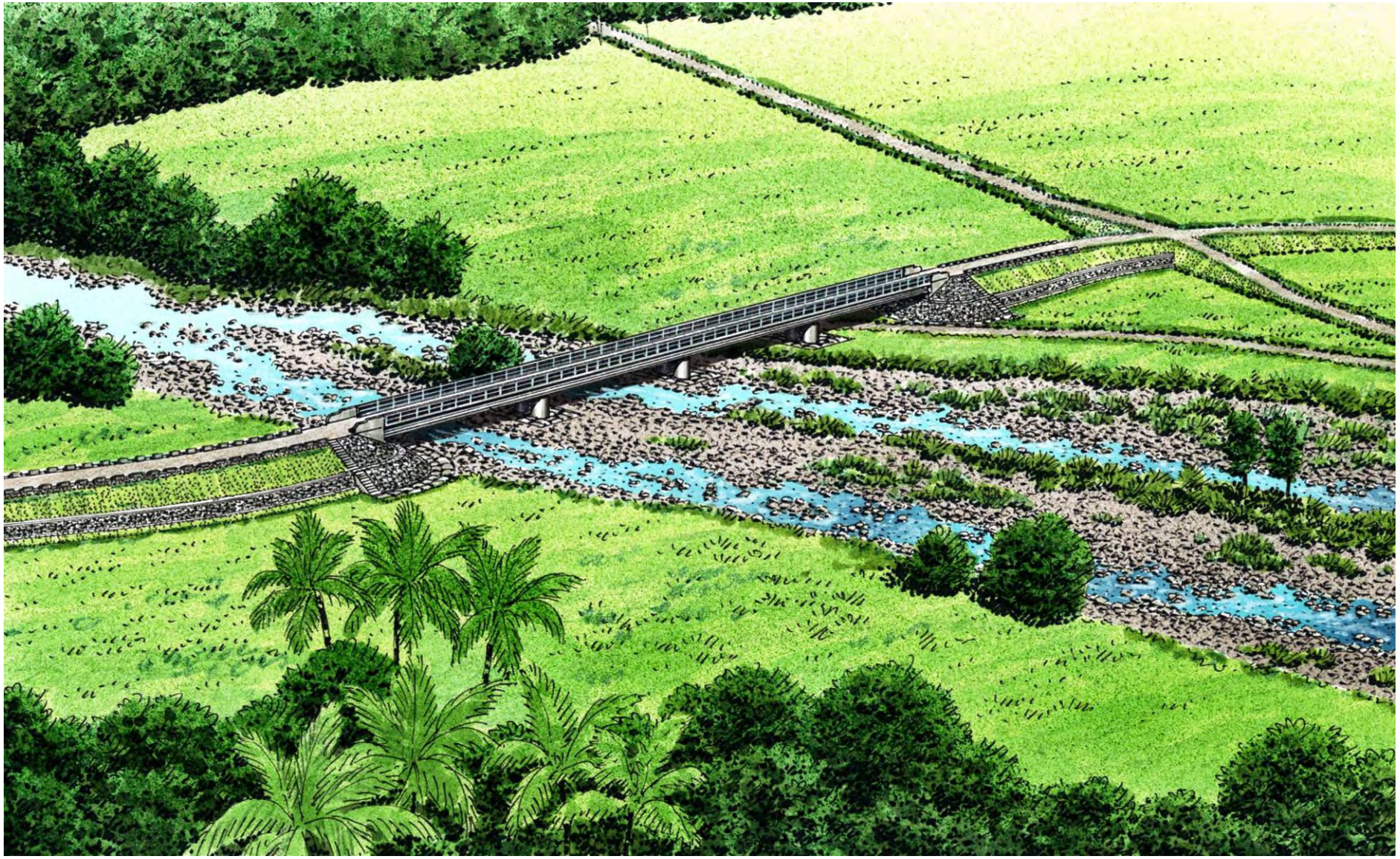
Contents

[Appendixes]

1. Member List of the Study Team
2. Study Schedule
3. List of Parties Concerned in the Recipient Country
4. Minutes of Discussions
5. Basic Design Drawings



Location Map



Perspective (Bazal Bridge)

Perspective (Umiray Bridge)

List of Tables

List of Figures

Abbreviations

AADT	Annual Average Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
ARBs	Agrarian Reform Beneficiaries
ARC	Agrarian Reform Community
ARISP	Agrarian Reform Infrastructure Support Project
ASCOT	Aurora State College of Technology
ASTM	American Society for Testing Materials
CARL	Comprehensive Agrarian Reform Law
CARP	Comprehensive Agrarian Reform Program
DAR	Department of Agrarian Reform
DPWH	Department of Public Works and Highways
ECC	Environmental Certificate of Clearance
EIA	Environmental Impact Assessment
GOJ	Government of Japan
GOP	Government of the Philippines
ICC	Investment Coordinating Committee
IEE	Initial Environmental Examination
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
KAR Zone	KALAHI AR Zone
LGU	Local Government Unit
LTI	Land Tenure Improvement
M/D	Minutes of Discussion
MTPDP	Medium-Term Philippine Development Plan 2004-2010
NEDA	National Economic Development Authority
NSCP	National Structural Code of Philippines
PBD	Program Beneficiaries Development
PC	Pre-stressed Concrete
PCU	Passenger Car Unit
PMO	Project Management Office
ROW	Right of Way

Chapter 1 Background of the Project

(1) Background of the Project

The Philippine government has set forth the Comprehensive Agrarian Reform Program (CARP) in 1987 as an effective measure to achieve rural development. The Department of Agrarian Reform (DAR), which is the lead agency of this Program, has been implementing two major programs; namely Land Tenure Improvement (LTI) and Program Beneficiaries Development (PBD) to provide services including agricultural technique, potable water, infrastructure and micro credit assistances for the farmers who benefited from the land distribution. Recognizing that the land distribution has attained 73% (5.9 million hectares) of the targeted 8.1 million hectares in 2003, the priority is being given to support Agrarian Reform Beneficiaries (ARB) in the distributed land.

In 1993, DAR adopted the agrarian reform community (ARC) development strategy as an approach to effectively achieve the PBD and came up with KALAHI AR Zone Development Strategy in 2003 from the viewpoint of an expanded ARC development concept. The total number of ARCs has reached 1,587 nationwide as of the end of December 2003 when the Project was requested from the Japanese Government.

The Agrarian Reform Infrastructure Support Project (ARISP), which is a Japanese Yen loan project, has been implemented for some 220 ARCs nationwide. On the other hand, DAR identified, through its assessment survey, 34 bridges nationwide necessary to be constructed to access the outside of ARCs to improve living and marketing conditions. The support for the outside area of ARCs, however, is out of the coverage of ARISP. Further, Department of Public Works and Highways (DPWH) and Local Government Unit (LGU) have too limited resources and techniques to implement said bridge construction. In this context, the Grant Aid Project was requested to construct two (2) bridges in Barangay Bazal and Barangay Umiray, which would be highly prioritized and is expected to take quick effect in terms of the expanded ARC development among the rural area where its poor access condition is a main hindering factor for rural development.

Due to lack of clarity of basic information such as the criteria to prioritize the targeted expanded ARCs and the requested bridges, the traffic volume, the beneficial effect for the target area in terms of economical and social aspects, as well as the needs of ensuring consistency with the above-mentioned ARISP funded by Japanese Yen Loan and the ARC development strategy led by the Philippine Government, the Preparatory Study was conducted in March 2005 which revealed the following:

1) These two requested bridges were selected out of 34 bridges which needed to be constructed for the expanded ARC development program because these would be expected to be model cases in designing other bridges and these were strongly requested by the local people.

2) Umiray Bridge was requested with a length of 150 meters, but this would reach a length of 350-400 meters considering the condition of the construction site.

3) Bazal Bridge, which was constructed of wood, would need to be reconstructed because of its decrepitude. The reconstruction with a length of around 50 meters and with a bridge type of culvert is recommended.

4) Land acquisition would be necessary. In the Philippines, this issue is, in general, to be resolved through negotiation with the beneficiaries without compensation.

5) With regard to Environmental and Social Considerations, Bazal Bridge would be small in size and is supposed to give no negative impact. Umiray Bridge, however, would be large scale, and therefore, an Environmental Compliance Certificate (ECC) should be secured before starting the Project in accordance with the relevant laws of the Philippines. As the Initial Environmental Examination (IEE) survey was conducted in the Preparatory Study, some items were identified which supposedly gave slight negative impacts. This Project would be categorized as "B" in the JICA category on Environmental and Social Consideration.

After the said Preparatory Study, the Basic Design Study was postponed due to VAT issues in the Philippines. Since the issue is expected to be resolved nowadays, the Basic Design Study was made for the purpose of reviewing the needs and the relevance for the construction of said two bridges, conducting the proper basic design as a Grant Aid Project including project planning and cost estimation. The requested items were confirmed eventually with the Philippine government through a series of meetings and site survey as shown in Table 1-1[1]:

Table 1-1 Items Requested by GOP/DAR

Description	Bazal Bridge	Umiray Bridge
1 Bridge Construction		
Bridge Length	80-150 m	315-385 m
Roadway Width	4-6 m	4-6 m
Bridge Width	5-8 m	5-8 m
Foundation	Depends on soil condition	Depends on soil condition
Pier Type	Depends on soil condition	Depends on soil condition
2 Approach Road Construction		
Status of Road	Barangay Road	Barangay Road (G. Nakar side) Provincial Road (Dingalan side)
Length	Depends on bridge height	Depends on bridge height
Carriageway Width	4-6 m	4-6 m
Shoulder Width	1-2 m	1-2 m
Pavement	PCCP 20-25 cm Sub Base 30 cm	PCCP 20-25 cm Sub Base 30 cm
3 Bank Protection Works		
Revetment Works	Lump Sum	Lump Sum
Scouring Protection	Gabion/Mortared Riprap	Gabion/Mortared Riprap

1 Minutes of Discussion for the Basic Design Study on "The Bridge Construction Project for Expanded Agrarian Reform Communities Development" in Republic of the Philippines, 31 March, 2008

The list of the 34 bridges selected by DAR and its prioritization are shown in Table 1-2.

The Basic Study Team identified the procedure in prioritizing the two targeted bridges through a meeting with DAR. Meeting details were as follows: first, DAR listed up the bridges needed for the access road construction necessary to accelerate the expanded ARC development strategy; physiographical categorization of the construction site followed, as well as the refinement of the listed bridges considering the promoted effect for effective and efficient implementation of ARC support services, maximization of limited resources for project effect, poverty alleviation in rural areas and the vitalization of local economy. Based on the result, selection was made for the bridges that are located specifically in the alluvial or narrow alluvial plain area, and in the proximity area of Manila from the viewpoint of easiness of construction work. In addition, the areas with imminent needs of intervention were prioritized using the poverty index as a criterion and considering the geographically isolated condition which prevents promotion of the expanded ARC development strategy. Since the isolated areas have suffered from a large-scale flood in the past, this condition was highly considered to secure the safety of local people's lives in the prioritization.

It was identified that six (6) bridges in the following table, which are hatched in the "Bridge/River Name" column, has already been constructed. Marinat Creek in the Province of Nueva Ecija was listed in the table, but this is not included in the above-mentioned 34 bridges.

Table 1-2 List of Bridges Selected by DAR and Its Prioritization

No.	Region	Province	Bridge/River Name	Municipality	No. of Bridge	Geographical Feature	Spatial Proximity From Manila	Poverty Incidence of Municipality	Peculiarity of Targeted Brgy	Priority
1	I	Ilocos Sur	Bantaoay River	Bantay	1	Narrow Alluvial Plain	Relatively Far	0.2841		High
2	III	Aurora	Bazal Bridge	M. Aurora	1		Near	0.3064	Isolated Brgy	Extremely High
3	IV	Quezon	Umiray Bridge	G. Nakar	1		Near	0.6394	Isolated Brgy	Extremely High
4	IX	Zamboanga del Norte	Dicayo River	Katipunan	1		Far	0.5887		Very High
5	CARAGA	Surigao del Norte	-	Malimono	6		Far	0.5947		Very High
6	III	Nueva Ecija	Llanera Bridge	Llanera	1	Alluvial Plain	Near	0.3844		High
7	III	Nueva Ecija	(Marinat Creek)	Laur			Near	0.4532		Very High
			Bayug Bridge		1					
			Matalahib Bridge		1					
8	III	Nueva Ecija	Villa Rosa Bridge	Licab	1		Near	0.4976		Very High
9	III	Nueva Ecija	San Alejandro Bridge	Quezon	1		Near	0.4763		Very High
10	III	Tarlac	Bueno Bridge	Bamban	1		Near	0.3150		High
11	CARAGA	Agusan del Norte	MAP Bridge	Las Nieves	1		Far	0.6772		Extremely High
12	CARAGA	Agusan del Norte	Anahawan Bridge	Loreto	1		Far	0.6563		Extremely High
			Poblacion Bridge		1					
13	CARAGA	Agusan del Norte	Las Nievas Bridge, Agusan River	Las Nieves	1		Far	0.6772		Extremely High
14	CARAGA	Agusan del Sur	Lugam Bridge	Sta. Josefa	1		Far	0.6252		Extremely High
15	CARAGA	Agusan del Sur	Dona Flavia- Dona Maxima Bridge	Veruela	1		Far	0.6372		Extremely High
16	I	Ilocos Norte	Banayan River	Piddig	1	Hilly	Relatively Far	0.3369		High
17	II	Cagayan	Sidem Bridge	Gattaran	1		Relatively Far	0.4076		Very High
18	VI	Capiz	Capagao-Timpas Vented Spillway	Panitan	1		Far	0.4962		Very High
19	XI	Compostela Valley	Libuton River	Mati	1		Far	0.3987		High
20	CAR	Benguet	Dadang-Goan River	Kabayan	1	Mountain	Relatively Far	0.5787		Very High
			Balayan River		1					
21	CAR	Ifugao	Lagawe River	Lagawe	1		Relatively Far	0.3593		High
22	CAR	Kalinga	Chico River	Tanudan	1		Relatively Far	0.6210		Extremely High
			Tanudan River		1					
23	CAR	Mt. Province	Amulong River	Paracelis	1		Relatively Far	0.7026		Extremely High
24	CAR	Mt. Province	Siffu River	Natonin	1		Relatively Far	0.6947		Extremely High
25	IV	Cavite	Magallanes River	Magallanes	1		Fairly Near	0.4961		Very High
				Total	34					

Note: Estimation of Local Poverty in the Philippines, NSCB, Nov 2005
Poverty Incidence computed based on the data in 2000
Bridges constructed

0.0-0.4 : High
0.4-0.6 : Very High
0.6-0.8 or Isolated : Extremely High

(2) Natural Conditions

The flow regime of the objective rivers, the Bazal River and the Umiray River, are as follows:

- The Bazal River is a tributary of the Agusan River, with a catchment area of 545 $km^{2,}$ that flows into the Pacific Ocean in the northern town Baler, and has a catchment area of 34 km^2. Bazal River flows through a steep alluvial cone at the vicinity of the Aurora State College of Technology (ASCOT) of Barangay Bazal and the grade of the riverbed at the location of the proposed bridge is 1/64. Presently, the region at the source of water is designated as a forest reserve. The physiognomy of the forest is good though huge amount of debris flow due to the effect of deforestation which started 30 years ago and continues even to these days. As a result, the river channel is susceptible to alteration. During the December, 2004 floods, the banks were eroded all over and the width of the river expanded to almost twice its original width and the low water channel varied widely as well.

- The Umiray River, with a catchment area of 628 km^2, separates Aurora and Quezon Provinces and flows into the Pacific Ocean. The location of the proposed bridge is near the river mouth. In the past days, deforestation was conducted in the river basin area, but is now prohibited. The physiognomy of the forest is excellent as the population inside the catchment area is extremely small and development is not progressive. The grade of the riverbed at the river mouth is moderate and is affected by tides. The proposed bridge site is located at the curved portion and the Aurora side being an outer coast is a water colliding front. The river course is relatively stable as there are exposed rocks at two locations and these rocks contribute in preventing the erosion of the riverbanks.

(3) Socio-Environmental Conditions

i) Bazal Bridge

The proposed Bazal Bridge is located on the Barangay Road that connects Barangay Malasin and Barangay Bazal after diverting from the national highway in the municipality of Maria Aurora on the Cabanatuan - Baler road (National Highway), and is used to cross over the Bazal River. The location of the bridge lies on the steep portion of the fan-crown at about 10km upstream from the river-mouth of the Bazal River and is prone to frequent bank erosion and significant fluctuations of the river channel. In the past, there used to be a wooden bridge, which was washed away by the flood in 2004 and has not been restored since. The people and vehicles thus cross the riverbed where the depth of the water is relatively shallow.

Vegetation around the construction site is relatively simple, though there are coconut firms on both banks of the Bazal River. The river is inhabited by small quantity of crabs, small fishes, birds and insects, though no valuable species are confirmed. The upstream of the river is known as the Bazal River Watershed Forest Reserve. There are no project affected families at both banks since the proposed bridge construction site lies approximately 500m away from

the residential area of both Barangays..

The land acquisition for the Project will be carried out by the Municipality of Maria Aurora. There are no other major effects on the socio-environmental conditions.

ii) Umiray Bridge

The Umiray River, which has a catchment area of 628km2, flows into the Pacific Ocean at the provincial boundary of Aurora Province and Quezon Province. The river mouth is situated at Dingalan Municipality, Barangay Umiray in the Aurora Province side and at General Nakar Municipality, Barangay Umiray in the Quezon Province side. In the past, deforestation was conducted in the river basin area, but is now prohibited. During the floods in 2004, 100 houses situated along the banks were washed away. The flood also killed 135 people, while 104 people were injured and 56 people went missing in Dingalan Municipality, Aurora Province.

The longitudinal slope of the riverbed at the river mouth is moderate and formation of sand reef along the bank is prevalent. The construction of bridge pier might affect the river flow because the recommended bridge location is an estuarine water area. There are no valuable species or growing area of Mangrove. However, in case polluted sludge is produced during construction, it might affect the aquatic organism. There are also no effects on the fishermen living near the construction site, as fishing is mainly carried out at the sea.

There are two project affected families at the left bank and one at the right bank. The relocation of project affected families and acquisition of land will be carried out by the Provincial Government of Aurora and Quezon. There are in total fourteen (14) "bangka" (small boat) operating in Umiray River. The boat owner and operator will be affected after the construction of the bridge. There are no other major effects on the socio- environmental conditions.

Chapter 2 Contents of the Project

2-1 Basic Concept of the Project

(1) Overall Goal and Project Objective

One of the crucial issues to be addressed by the Medium-Term Philippine Development Plan (MTPDP) for 2004-2010, developed under the Arroyo Administration, is to fight poverty. The MTPDP positioned, as a major strategy, the creation of ten million jobs and the increase in productivity and income resulted from developing two million hectares of agribusiness lands, to eradicate poverty of the farmers occupying the majority of the poor population. For this end, the MTPDP shall pursue the Comprehensive Agrarian Reform Program (CARP), which has been seamlessly enforced since the Aquino Administration.

CARP pursues “a more equitable distribution and ownership of land” under the Republic Act No. 6657 or the Comprehensive Agrarian Reform Law (CARL), which was promulgated in 1988 under the Aquino Administration with 10 years period given to complete the CARP. President Ramos extended the implementation for another 10 years under RA. 8532. Among the principles that underlie the pursuit of its aims are i) highest consideration to the welfare of the landless farmers and farm workers; ii) due regard to the rights of landowners to just compensation; iii) recognition of the rights of farmers, farm workers, landowners, cooperatives, and other independent organizations to participate in the planning, organization, and management of CARP; iv) provision of support to agriculture through appropriate technology and research; and v) provision of adequate financial, production, marketing, and other support services.

In 1993, the National Government adopted the Agrarian Reform Community (ARC) development strategy as an approach to effectively achieve the objectives of agrarian reform and poverty reduction. This area-focused approach called for the concentration of efforts in land distribution as well as support services delivery in selected areas to fast-track the improvement of farm productivity and develop the capability of farmers. In addition, to contribute to the effective implementation of the CARP, Republic Act No. 7905 was approved on February 23, 1995. It called for, among others, the establishment of at least one (1) ARC per legislative district with a predominant agriculture population by CY 2000.

The Government, in 2003, came up with an expanded ARC development concept, or the development of Agrarian Reform Zones (ARZs) to provide development support and management services to ARZs, which are now referred to as KALAHI ARZs. Considering the emerging concerns regarding the KAR Zone development and given the urgency to fast-track the delivery of the needed basic support services, not only to almost a million ARBs in the ARC, but also to the more than 2 million ARBs in non-ARC barangays, the DAR embarked the ARC-Connectivity as alternative support services delivery scheme that would jumpstart the coverage of a wider ARB reach and thus achieve a more meaningful CARP

implementation. Its major development intervention shall come in the form of rural infrastructure support to enhance the connectivity among ARCs.

Thus, the goal of CARP is to reduce the poverty and rectify the disparity within the expanded ARCs through the implementation of multiple strategies expanding the significant outcomes of ARC development, which is a major approach of CARP.

To achieve the overall goal above-mentioned, the Government has pursued the agricultural infrastructure support in ARCs under the Agrarian Reform Infrastructure Support Project (ARISP) with financial assistance by Japanese Yen Loan. The non-ARCs, however, are out of coverage of the said project and the inaccessibility to such areas is still a hindering factor in the expanded ARC development. The objective of the Project is to improve the accessibility among ARCs or within the expanded ARCs, aiming to contribute to strengthening the inter-local partnership and enhancing the interchanges to promote the rural development in target area.

CARP has come to an end in June 2008, but the revised CARP is now under preparation and expected to be launched in the forthcoming year. According to the DAR Achievement Report 2007, the total number of ARCs has reached 1,959 nationwide. As of 2008, 23 ARCs including 53 barangays in Aurora Province and 36 ARC in Quezon Province were identified.

(2) Basic Concept of the Project

To achieve the above-mentioned objective, the Project would construct two selected bridges namely; Bazal Bridge and Umiray Bridge, which have been requested as a part of the bridges highly prioritized based on the imminent needs and the quick impacts to be expected. The following are the overview of each bridge:

Bazal Bridge

Bazal Bridge is 110 meters long, to cross Bazal River flowing down along the boundary between Barangays Bazal and Malasin located in Maria Aurora Municipality, Aurora Province. Since there is no bridge at present at the site, vehicles and pedestrians have to go through the river bed in relatively shallow water. The connection roads of both sides belong to barangay road.

Umiray Bridge

Umiray Bridge is 358 meters long, to traverse Umiray River flowing down along the boundary between Barangay Umiray, Dingalan Municipality, Aurora Province and Barangay Umiray, General Nakar Municipality, Quezon Province. Since there is no bridge at present at the site, using small bangka (small boat) for transportation is the sole way to cross the river. The connection road on the side of Dingalan Municipality belongs to provincial road and that on General Nakar Municipality side to barangay road. The road on the bridge would be categorized as provincial road.

Lack of bridge access in both target areas does not only hinder the agricultural development in terms of transport of agricultural materials, products, and exploitation of agri-business, but also greatly damage the target areas in flooding. It, furthermore, brings about the difficulty for social life such as transport of living necessities, sudden illness, access to public services, and to commute as well. As such, the Project is highly needed not only in terms of ARC development, but also to secure the lifeline.

This project, as its outputs, would be expected to materialize a series of construction work and site arrangement, budget allocation of operation and maintenance cost as well as rehabilitation works of provincial road connected to bridge construction point. The activities of the Project would include various surveys on the work, public guidance, clarification of details of operation and maintenance, and enrichment of experience in planning and supervising the bridge construction project in DAR, which is the implementing agency of the Project. The requested Japanese assistance of this Project would be applicable to a series of construction work, among others.

2-2 Basic Design of the Requested Japanese Assistance

2-2-1 Design Policy

(1) Basic Policy

The scope of the requested assistance is to construct two bridges, namely Bazal Bridge and Umiray Bridge, and approach roads required for connecting the bridges to the existing roads at each side of the bank.

The access road at the northern side of Umiray Bridge, a 23 km-long provincial road between Umiray and Dingalan, is used for transporting the equipment and machines for the construction of these bridges. The road traverses through small and medium sized water channel at 22 locations of which 14 are without structures for crossing these channels. Therefore, there are difficulties for heavy equipment for construction use to pass through the area and the access road even becomes impassable by ordinary vehicles during the swelling of the rivers. The condition for the implementation of this project is to rehabilitate the roads, under the responsibility of the Philippines side, to an extent passable by large vehicles.

Other access roads including those of both bridges are passable, though the condition is poor. Given that these access roads are improved, the effectiveness of this project will increase remarkably. Therefore as a relevant project, an early improvement work of these access roads under the responsibility of the Philippines side is desirable. In particular, There are no roads on the central part of the city of General Nakar in Quezon Province from the west side of Umiray Bridge. The construction of this road will therefore highly contribute in improving trunk road network of both provinces, as there would be a road- link including Umiray Bridge, constructed under this project, that directly connects Aurora Province and Quezon Province.

The process of selection of the objective bridges are as follows:

- 34 bridges that require construction were chosen in order to promote the expanded ARC development. The bridges were chosen from the aspects of contribution to an effective and efficient implementation of ARC support program, maximization of project effects under limited resources, poverty mitigation of agrarian community, and promoting revitalization of the local economy.

- From among the 34 bridges mentioned above, 8 bridges that are located in the alluvial plains and are relatively near Manila were prioritized from the view point of construction flexibility.

- Ultimately 2 bridges were selected by giving highest priority to the regions including those that are the objectives of ARC where the poverty index is high and where isolation due to extreme access difficulty is a hindrance in the promotion of expanded ARC development.

(2) Natural Conditions

i) Hydrology

The flow regime of the objective rivers, the Bazal River and the Umiray River, are as follows:

- The Bazal River is a tributary of the Agusan River, with a catchment area of 545 $km^{2,}$ that flows into the Pacific Ocean in the northern town Baler, and has a catchment area of 34 km^2. Bazal River flows through a steep alluvial cone at the vicinity of the Aurora State College of Technology (ASCOT) of Barangay Bazal and the grade of the riverbed at the location of the proposed bridge is 1/64. Presently, the region at the source of water is designated as a forest reserve. The physiognomy of the forest is good though huge amount of debris flow due to the effect of deforestation that started 30 years ago, and continues even to these days. As a result, the river channel is susceptible to alteration. During the December 2004 floods, the banks were eroded all over and the width of the river expanded to almost twice its original width and the low water channel varied widely as well.

- The Umiray River, with a catchment area of 628 km^2, separates Aurora and Quezon Provinces and flows into the Pacific Ocean. The location of the proposed bridge is near the river mouth. In the past days, deforestation was conducted in the river basin area, though it is prohibited these days. The physiognomy of the forest is excellent as the population inside the catchment area is extremely small and development is not progressive. The grade of the riverbed at the river mouth is moderate and is affected by tides. The proposed bridge site is located at the curved portion and the Aurora side being an outer coast is a water colliding front. The river course is relatively

stable as there are exposed rocks at two locations and these rocks contribute in preventing the erosion of the riverbanks.

The conditions for the design of bridges such as the high flood discharge, high water level, minimum span length are set up by means of following methods.

- Flood discharge: It is calculated from the product of the specific discharge of flood for a 50-year period determined from the Creager type calculation method and the catchment area in conformity with the Manual on Flood-control Planning of DPWH/JICA.

- High water level: It is determined from the higher value of water level from among the two mentioned below.

  ① The water level calculated from the hydrological analysis for 50year flood (Uniform Flow Calculation Method is applied for the Bazal River, which is not affected by backwater, and Non-uniform Flow Calculation Method is applied for the Umiray River, which is affected by backwater).

  ② Observed largest record flood level obtained from local hearings

- Minimum span length: It is determined from the design flood discharge in conformity with the Cabinet Order Concerning Structural Standards for River Management Facilities of Japan.

ii) Meteorology

The climate of the proposed bridge sites is classified as Type IV (i.e. the distribution of rainfall is uniform all throughout the year). From the rainfall data, the amount of rainfall is relatively large (an average monthly rainfall of 300 millimeters) from September to December at Bazal Bridge and from October to January at Umiray Bridge. The scheme of execution is determined in consideration with the condition that the construction of the superstructure, temporary island, and temporary landing stage is not possible during this period.

iii) Seismicity

Lying on the circum-Pacific seismic zone, the Philippine Archipelago is seismically an active area. As it is essential to take the quake resistance into consideration, the design is conducted in conformity with the Order of the Department of Public Works and Highways (Department Order No.75, Series of 1992). The regulations are, to apply continuous structures to the possible extent, to connect the slabs in case of multiple span simple beam, to undertake preventive measures against fall of bridge, and to prevent buckling by introducing sufficient amount of girdle bars in the piers.

(3) Policy on Socio-economic Conditions

The vicinity of the proposed bridge sites is a poverty prone area where unemployment rate is

high. During the public consultation meeting, many opinions were forwarded by the local people for employment opportunities as unskilled labors during the construction of the bridges. Therefore, the scheme of execution and supervision works will be implemented by taking this issue into consideration.

(4) Construction and Procurement Conditions

Although the experience of DPWH on the construction of bridges as well as the technical ability of construction companies are high, the experience of the DAR on the construction of bridges is low. In addition, the project is expected to pose as a model project for the construction of 32 bridges (6 of which are already completed) that are regarded essential for the implementation of the expanded ARC development concept. In view of this, the design is conducted by taking into consideration the points mentioned below, in such a manner, that the construction is economical and easy to be carried out by construction companies in and around the locality, and is easy for the DAR to supervise (occasionally, with the technical assistance of DPWH) as well.

- The design that enables economical construction to the possible extent
- Application of a bridge type that has high technical prevalence, standard type, and design and construction flexibility
- Usage, to the possible extent, of equipment and materials procurable domestically
- Application, to the possible extent, of the bridge type that is easy to maintain

(5) Utilization of Local Construction Companies

Although the detailed design and the construction of the bridges are contracted to a Japanese consultant firm and a Japanese construction company respectively, local companies will be engaged as sub contractors or labor suppliers. For easy engagement of the local companies, a simple structure with maintenance efficiency and construction method is adopted.

(6) Operation and Maintenance Policy

The operation and maintenance of Bazal Bridge will be conducted under the coalition of Aurora Province and Maria Aurora Municipality. For Umiray Bridge, the northern portion from the center of the bridge will be conducted by Aurora Province and the southern portion will be conducted by Quezon Province. The respective provinces and the technical department of the municipality are regarded to be capable of operation and maintenance works, as maintenance and control of roads and bridges under its jurisdictions are being conducted without any particular problems. However, repair works of deteriorated portions are considered to be not implemented sufficiently. Taking these points into account, the structure type of the bridges, that requires less repair and maintenance (including anti-corrosion treatment) is selected.

(7) Determination of the Grade of Utilities

The objective of the project is to improve poverty alleviation and redress disparities by promoting the development of the regions where poor traffic access is hindering the ARC development, by improving the traffic access of these regions. The level of traffic volume in terms of passenger car unit (PCU) is estimated to be relatively low with about 500 cars per day at Bazal Bridge and 2,000cars per day at Umiray Bridge (refer to Table 2-1). The objective of the project will be accomplished if a bridge, though not a high-standard one that is safely passable all year around is constructed, as this would drastically improve the traffic accessibility in the region. From this point of view, the grade of the utilities is determined under the policy mentioned below.

- The primary users of Bazal Bridge are the locals of Barangay Bazal. The backland of Barangay Bazal is designated as forest protection area where development is restricted. Therefore, there is a rare potential for the expansion towards this backland and thus, the possibility of heavy vehicles passing here is regarded to be low. From this point of view, the bridge will have a minimum required width of 4.0m, and the design load of 15 ton. Although for the given width, two-way traffic within the bridge for vehicles excluding tri-cycles and light vehicles, is not possible, a certain vehicle can wait on the opposite side of the bridge when an oncoming vehicle is within the bridge. This is possible since the length of the bridge is only 110m, which is rather short, and the traffic volume is very low as well.

- The primary users of Umiray Bridge are villagers from the Barangay Umiray and four other barangays adjacent to it. The backland is left over as a space for development. The class of the road is higher than that of Bazal Bridge (Bazal Bridge lies on the Barangay road while Umiray Bridge lies on the provincial road) and the level of traffic volume is also higher compared to Bazal Bridge. As the length of the bridge (358m) is long, and chances of a vehicle meeting with an oncoming vehicle inside the bridge is high, it is difficult to wait ahead of the bridge after confirming the oncoming vehicle approaching the bridge. From above, a wide one lane carriageway of width 5.5 meters is taken as the width of the bridge so that two way traffic is possible, given that, vehicles on both directions slow down or the vehicle at one direction halts to let the other pass. The design load is taken as 20 tons.

- Bridges that are highly safe and strong to disasters are planned, as both the bridges are exposed to severe natural conditions like, torrential rainfall caused by typhoons, hillside failures triggered by poor forest physiognomy and fragile geology, and shifting of water way due to heavy bank erosion.

Table 2-1 Traffic Demand of Year 2020

Traffic Demand of Year 2020

1) Bazal Bridge: 909 cars/ day (Approx. 900 cars/ day), PCU 531cars/day (Approx. 500 cars/day)
2) Umiray Bridge: 3,183 cars/day (Approx. 3,000 cars/day), PCU 2,001cars/day (Approx.2,000 cars/day)

1) Bazal Bridge

Case	Year	Ratio of Required Time	Ratio of Traffic Volume by Traffic Model (Growth rate of $Pi*Pj/tij^{1.5}$)	Traffic Volume	
				Number of Cars	PCU
Presence of Bridge	2008	1.0	1.0	316x1.25=395	185x1.25=231
Absence of Bridge	2008	4.8/7.7	2.0	790	462
	2020	4.8/7.7	2.3	909	531

Trips per person (number of round trips per population)= number of passengers/2/population

- In absence of a Bridge:570x1.25x1.0/2/1,288=0.28 Trip/person
- In presence of a Bridge :570x1.25x2.0/2/1,288=0.55 Trip/person

2) Umiray Bridge

Case	Year	Number of Trips	Number of Cars	PCU
Presence of Bridge	2008	0.55x5,099=2,804	2,804x2x358/819=2,451	2,804x2x225/819=1,541
	2020	$0.55x5,099x1.022^{12}$=3,641	3,641x2x358/819=3,183	3,641x2x225/819=2,001

- The value of Bazal Bridge 0.55, in presence of the bridge, is applied as trips per person of Umiray Bridge in presence of the bridge.
- The composition of vehicle types is determined from the actual composition at Dingalan Municipality, Barangay Umiray hall
- Trips per person in the future is same and the population growth rate is taken as 2.2% annually.

Method of Traffic Demand Forecast

1) Bazal Bridge
   - AADT is derived from 12 hour traffic volume by taking the Magnification Factor (AADT/ ratio of 12 hour traffic volume) as 1.25.
   - The traffic demand of 2008 is forecasted by using the following gravity model type traffic model.

$$Tij=Kij*Pi*Pj/tij^{1.5}$$

Where, Tij: Traffic volume of zones i and j (taking Barangay Bazal as zone i, Barangay Malasin as zone j, and Barangay hall of each zone as the center)

Kij: constant based on the characteristics of zones i and j (assumed to be constant regardless of presence or absence of bridge)

Pi: Population of zone i

Pj: Population of zone j

tij: Required time between zone i and zone j

   - Assuming that the only value that varies regardless of presence or absence of a bridge is tij, the traffic demand in presence of a bridge is estimated on the basis of the traffic volume of the existing road in the absence of a bridge.
   - The traffic demand of year 2020 is calculated by applying population growth in the above traffic model. Values of population growth rate, from the actual figures are 1.2% annually in Barangay Bazal and 0% in Barangay Malasin (the actual figure is -0.03%)

2) Umiray Bridge
   - At present, as there is only bangka as the means for crossing the river, the traffic volume in presence of a bridge is estimated in the follow manner.
   - Trips per person in presence of a bridge is derived by applying the trips per person at Bazal Bridge in presence of a bridge.
   - The number of cars is calculated from the number of trips by assuming the composition of vehicle types to be the same as the actual composition at Barangay Umiray hall

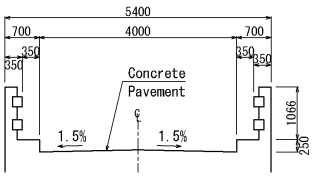
The traffic demand of year 2020 is forecasted on assumption that the trips per person and the types of vehicles in the future are same. The population growth rate is taken as 2.2% annually on the basis of the actual figure.

(8) Design Criteria

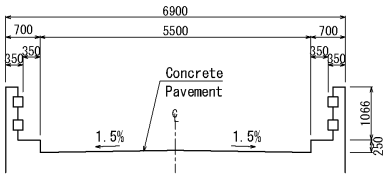
The design criteria shown in Table 2-2 are determined by following the policy mentioned in Section (7).

Table 2-2 Design Criteria

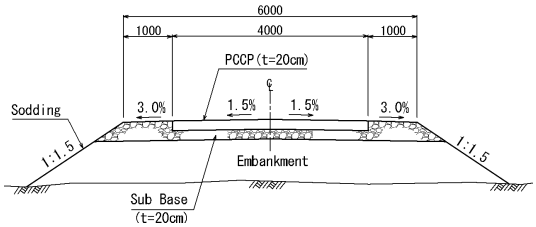
Bridge			Bazal	Umiray	Remarks
Basic Condition	Grade of Road		Barangay Road	Provincial Road	
	Traffic Demand of 2020 (vehicle per day)		900 (PCU 500)	3,000 (PCU 2,000)	
Traffic Lanes and Widths	Bridge	Traffic Lanes	One-lane narrow width	One-lane broad width	- On Bazal bridge, two-way traffic of vehicles excluding tri-cycles and light vehicles is not possible. However, as the length of the bridge is short (110m), the vehicle can wait ahead of the bridge while the oncoming vehicle crosses the bridge. - The length of the Umiray Bridge is long (360m) and the chances of meeting with the oncoming traffic within the bridge is high. Therefore, the width of the carriageway is determined such that, if vehicles on both directions slow down or the vehicle at one direction halts, two way traffic becomes possible
		Carriageway Width	4.0m	5.5m	
		Sideway Width	0.7m x 2	0.7m x 2	
		Total Width	5.4m	6.9m	
	Approach Road	Traffic Lanes	One-lane narrow width	One-lane broad width	
		Carriageway Width	4.0m	5.5m	
		Shoulder Width	1.0m x 2	1.0m x 2	
		Total Width	6.0m	7.5m	
Design Speed			30km/h	30km/h	- As it is a single lane road, the design speed will be in conformity with the minimum value of DPWH standard.
Design Live load			AASHTO HS15-44	AASHTO HS20-44	- As the backland of Barangay Bazal is not expandable, the number of heavy vehicles is considered to be low. - There are possibilities of transportation of goods by heavy vehicles in the case of Umiray Bridge.



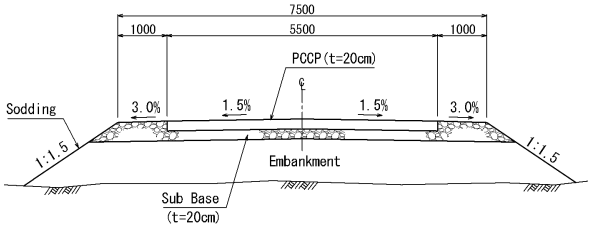
Bridge Section



Bridge Section



Approach Road Section
Width of the Bazal Bridge



Approach Road Section
Width of the Umiray Bridge

* PCU: Passenger Car Unit

(9) Construction Method and Construction Period

For Bazal Bridge, as there are large amount of gravels of size 20 to 50 cm on the riverbed, the penetration of driven pile is difficult. In addition, both the bridges are required to be constructed by securing the flow area of the river on the riverside. Therefore, the construction method is determined by undertaking the conditions of constraints like the requirement of installation of temporary landing stage. In addition, as mentioned above in (4), the construction method is adopted in such a manner that the method is technically common and simple, as well as easy for the construction companies in and around the locality to construct.

Regarding the schedule and the period of construction, the potential period within a year when a temporary landing stage is capable to be erected will be an important perquisite condition. From the distribution of annual rainfall, the dimension of the landing stage is determined by taking the potential erection period as 8 months. The schedule and period is so planned that the works that are to be conducted using the landing stage such as the erection and removal of landing stage and the works like foundation works, substructure works, superstructure works etc. are completed within this period.

(10) Consideration on Social Environment

The following points are to be considered during planning, design and construction works.

- Minimizing land acquisition area and number of resettlement
- Securing traffic safety by providing road signs and fall prevention facilities along the embankment section of height more than 3 meters.
- Minimizing the environmental impact during construction time by preventing river water pollution, and enhancing appropriate treatment of construction waste etc.

(11) Consideration of Implementation

The procedures for permit and approval of the Project for Umiray Bridge is complicated than that of Bazal Bridge. Also, the resettlement and maintenance of road for transportation of construction equipment and materials are required prior to the commencement of the works. Therefore, contrary to Bazal Bridge, where an early implementation of the project is possible, Umiray Bridge may consume a considerable amount of time until the commencement of the works. To add, the two sites are very far apart. Taking these points into consideration, the construction of the Bazal Bridge and the Umiray Bridge is recommended to be periodized and conducted separately. Implementing by periodization can contribute to the smooth implementation of the whole project and an early enhancement of the project effect.

2-2-2 Basic Plan

2-2-2-1 Basic Plan of Bazal Bridge

(1) Overall Plan

Table 2-3 shows basic plan of the Bazal Bridge.

Table 2-3 Basic Plan (Bazal Bridge)

Classification of Road				Barangay Road (Design Speed V=30km/h)
Live load				HS15-44
Bridge Length				110.000m
Span Length				4 @27.500m
Width				5.400m
Deflection Angle				0 degrees
Design Seismic Coefficient				Kh=0.33 (longitudinal direction), kh=0.20 (transverse direction)
Superstructure	Type			4-span PC-I Simple beam (4-span continuous slab) Type IV-A
	Materials	Main Girder	Reinforcement Bar	SD295 (or equivalent)
			PC Steel	SWPR7BL (12T12.7)(or equivalent)
			Concrete	σ_{ck}=35N/mm^2
		Slab	Reinforcement Bar	SD295 (or equivalent)
			Concrete	σ_{ck}=24N/mm^2
	Type of Bearing			Rubber bearing
Substructure	Type	Body		Reversed T abutment, 2 column pier
		Foundation		Cast-in-place concrete pile
	Materials	Body	Reinforcement Bar	SD295 (or equivalent)
			Concrete	σ_{ck}=24N/mm^2
		Foundation	Reinforcement Bar	SD295 (or equivalent)
			Concrete	σ_{ck}=24N/mm^2
	Bearing Ground			Gravel Bed
Specification Criteria				- Design Guidelines Criteria and Standards for Public Works and Highways, Department of Public Works and Highways - National Structural Code of the Philippines, Association of Structural Engineers of the Philippines - Specifications for Highway and Bridges, Japan Road Association

(2) Site Condition

The proposed bridge is located on the Barangay Road that connects Barangay Bazal and Barangay Malasin after diverting from the national highway in the municipality of Maria Aurora on the Cabanatuan - Baler road (National Highway) and is used to cross over the Bazal River. The location of the bridge is on the steep portion of the fan-crown at about 10km upstream from the river-mouth of the Bazal River and is prone to frequent bank erosion and significant fluctuations of the river channel.

Barangay Malasin and Barangay Bazal lie at the eastern side and western side of the bank of the Bazal River, respectively. The site is surrounded by rice fields and is about 500m away from the densely built-up area on both sides of the riverbank.

In the past, there used to be a wooden bridge, which was washed away by the flood in 2004 and has not been restored since. The people and vehicles thus cross the riverbed where the depth of the water is relatively shallow.

(3) Bridge Location

A comparison study was conducted on four different schemes mentioned below, that was selected as the bridge sites.

Scheme-1: The scheme that selects a site upstream where the river channel is relatively stable and minimizes the length of the bridge.

Scheme-2: The scheme that minimizes land acquisition area by connecting the existing roads at both banks directly.

Scheme-3: The scheme that shortens the length of the bridge by allowing perpendicular crossing with the river channel near Scheme-2.

Scheme-4: The scheme that improves the road alignment by connecting the roads at either banks by a straight line.

The comparison of the schemes is shown in Fig. 2-1, and its result is shown in Table 2-4.

From the result of the comparison, Scheme-3 is adopted.

(4) Hydrological Condition

i) Flood Discharge

Flood discharge is calculated by using the Creager type calculation method as mentioned below and in conformity with the Manual on Flood-control Planning[2].

$$Q = qA$$

2 Manual on Flood Control Planning, Project for Enhancement of Capabilities in Flood Control and Sabo Engineering of DPWH, Department of Public Works and Highways, Japan International Cooperation Agency, March 2003

$$q = cA^{(A^{-0.048}-1)}$$

Where, Q : Design flood discharge (m^3/sec)
q : Specific discharge of flood (m^3/sec/km^2)
A : Drainage area (km^2)
c : Constant for regional specific discharge curve

As, A=34km^2, c=23.83 (50 year probability of Luzon Island as according to the Manual on Flood Control Planning) the estimated flood discharge is estimated to be Q=470m^3/sec.

ii) Design High Water Level

The higher value of water level from among the two mentioned below is taken as the design high water level.

① water level calculated from the hydrological analysis for 50 year flood

② observed largest record flood level obtained from local hearings

The results of these methods are as mentioned below:

① Hydrological analysis

As the bridge does not have back water effects, the high water level of 50 year flood is calculated under the assumptions mentioned below.

Analysis method : uniform flow calculation

River section : result of river cross section survey

Coefficient of roughness : 0.035

Average longitudinal slope of river bed : 1/64 (result of longitudinal survey)

From the result of the analysis, the high water level is EL60.31meters.

② Largest record flood level

From the interview survey conducted with the Barangay Captain, the largest record flood level was observed during the 2004 flood and was 0.9 meters above the road surface of the riverside roads and is calculated as EL60.41meters. On the other hand, the highest water level during year-round flood is equivalent to the surface of these roads.

From above, the design high water level is determined as EL60.41 meters.

iii) Minimum Span Length

There is no specification regarding minimum span length in the Philippines. Therefore, the basic length of the span is calculated, using the formula below, in conformity with the "Structural standards"[3] of Japan.

$$L = 20 + 0.005Q$$

3 Cabinet Order Concerning Structural Standards for River Management Facilities, etc Japan River Association

Where, L : Required minimum span length (m)
Q: Design flood discharge (m^3/s)

From Q=470m^3/sec, the basic span length is calculated as 22.4 meters.

iv) Freeboard

According to the "Design Guidelines and Criteria and Standards for Public Works and Highways" of DPWH[4], the freeboard is regulated as 1.5 meters or above in the presence of floating objects like driftwoods and 1.0m or above in the absence of the floating objects.
As driftwoods are present at the site, the freeboard is taken as 1.5 meters.

(5) Bridge Length and Span

In consideration of the ambient topography and the characteristics of the river channel, the length of the bridge is determined as 110 meters.
According to the results of the hydrological analysis, the number of spans necessary so as to satisfy the bridge length of 110 meters and the minimum span length of 22.4 meters is less than 4. The types of bridges that are considered economical and have construction simplicity are as follows:

- 3-span or 4-span PC Girder Bridge
- 3-span or 4-span Steel plate Girder Bridge
- 4-span Pony truss bridge (if divided into 3-spans, the span length becomes 37 meters and application of Pony truss is technically difficult)

The potential problems in case a 3-span bridge is adopted, are as follows:

- The surface height of the bridge gets higher following the increase in height of the girder. Therefore, the length of the approach road gets longer and the area of land acquisition gets larger as the distance between the foot of the slopes become wider. From the socio-economical aspect, this is not desirable for a project whose objective is to develop the agrarian region that requires a large area of rice field.
- As the length of the span is not economical, the cost of the superstructure gets higher.

On the other hand, in the case of 4-spans, the middle pier lies in the middle of the bridge. In general, from hydrological aspects, adopting even number of spans when the number of spans is less is regarded undesirable. However, in the case of Bazal Bridge, the center of the proposed bridge is deviated from the present flow center of the river and as the river course varies violently, its potential future flow center is not predictable. Therefore, it is considered

4 Design Guidelines and Criteria and Standards for Public Works and Highways, Department of Public Works and Highways

unnecessary to determine the location of the piers by avoiding the center area of the river using an odd number of span. That is to say, there is no particular problem in adopting 4-spans for this bridge.

From the above observations, the proposed bridge is divided into 4 equal spans of length 27.5m each.

(6) Plan of Superstructure Type

Standard type of superstructure for a bridge of length 110 meters that is divided into 4 equal spans of 27.5 meters and an overall width of 5.4 meters, which is used widely in the Philippines, and have high economic and construction simplicity are as mentioned below.

Scheme-1: 4-span PC-I Girder

Scheme-2: 4-span Steel Plate Girder

Scheme-3: 4-span Steel Pony Truss

The result of the comparison study conducted on the above three types of superstructures is shown in Table 2-5. From the result, Scheme-1 (4-span PC-I Girder) is adopted.

(7) Plan of Substructure Type

The driving of pre-cast concrete pile or sheet pile is difficult as there are large amounts of gravel, 20 to 50 centimeters in size, in the riverbed where the bridge is proposed to be erected. Therefore, as a foundation pile, cast-in-place reinforcement pile of with a minimum of 1.5 meters in diameter using all-casing method or an earth auger steel pile of with a diameter of 0.8 meters using the rock auger method is considered to be appropriate. Caisson foundation is also considered as an appropriate alternate scheme, but from the aspect of construction, as the inner diameter is small, which is about 2.0 meters, its construction is not possible. Taking these into account, a comparison study is conducted for the following 4 types of substructures.

Scheme-1: Wall-type concrete pier (cast-in-place concrete pile)

Scheme-2: Single-column concrete pier (cast-in-place concrete pile)

Scheme-3: Double-column concrete pier (cast-in-place concrete pile)

Scheme-4: Steel pile bent (earth auger steel pipe pile)

The result of the comparison is shown in Table 2-6. From the result, single-column substructure (Scheme-2 single-column concrete pile), where one cast-in-place pile is connected to the reinforced concrete pier for each substructure, is considered to be most preferable from the aspects of construction period, construction cost, hydrology etc. However, construction experience of this type is very low not only in the Philippines but also in Japan as it has many uncertain elements regarding long term stability against scouring and earthquakes.

Therefore, a double-column concrete pier (Scheme-3), an upgraded type of Scheme-2 is adopted instead. Furthermore, the riverbed protection works are applied around the piers so as to prevent scouring and increase the safety against earthquakes.

The substructure is designed in such a manner that, it is safe against modes of failure such as, bearing, overturning, and sliding against the loads applied for permanent and seismic design, as well as, the stress of the main body and the displacement of the foundation is smaller than its allowable values. As the substructure is a double-column structure and does not have a footing, riverbed protection work has also been introduced as a preventive measure against local scouring. In addition, taking into consideration the case where the horizontal resistance of the loose ground around the foundation cannot be expected, the design is conducted by assuming the bottom of river protection work as the design ground level. Furthermore, to keep the displacement of the foundation small, the length of the pile is determined such that the characteristic value (βL_e), which is the relative rigidity of the ground and the structure, is 2.5 or more.

Bazal Bridge

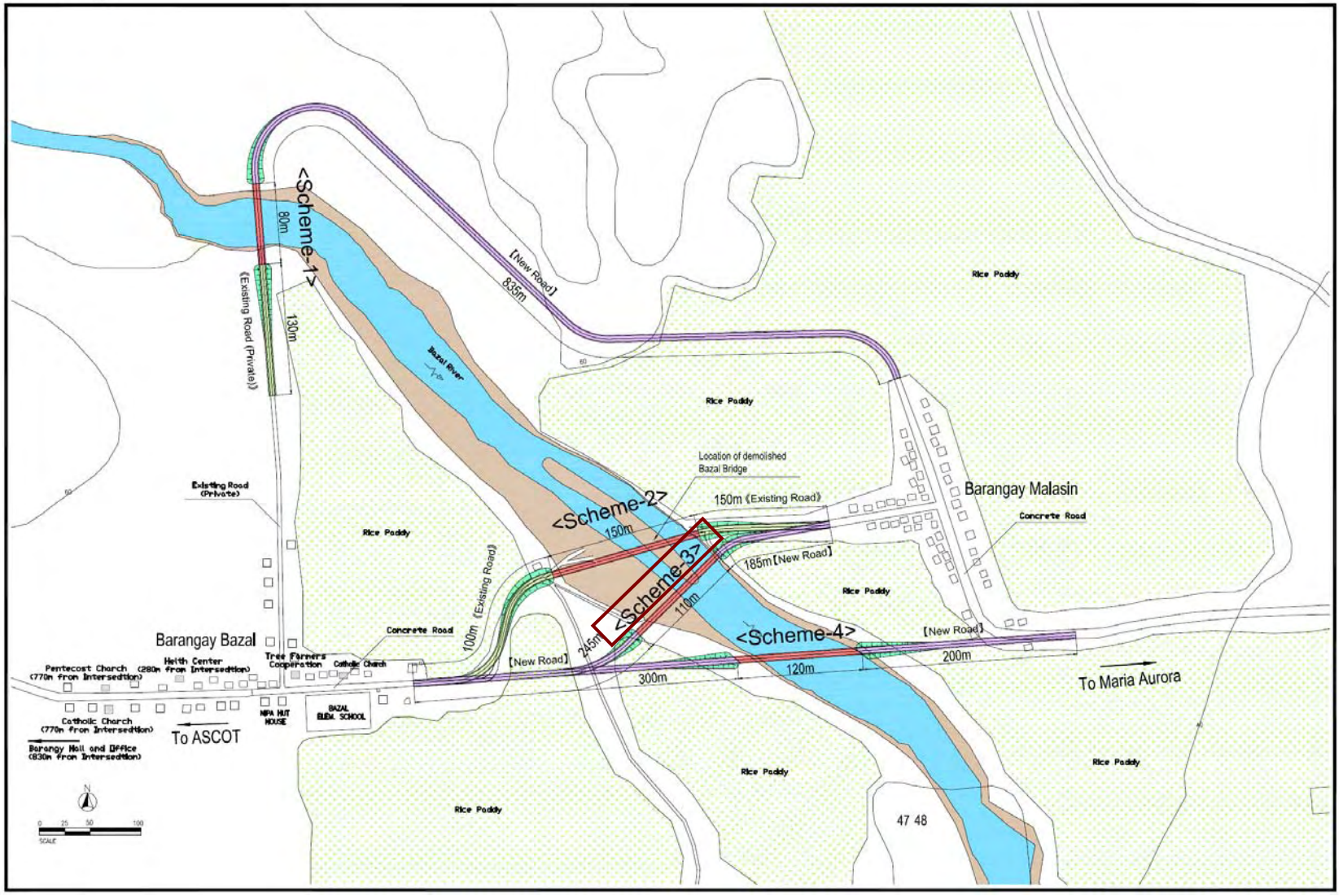


Fig. 2-1 Comparison of Construction Sites (Bazal Bridge)

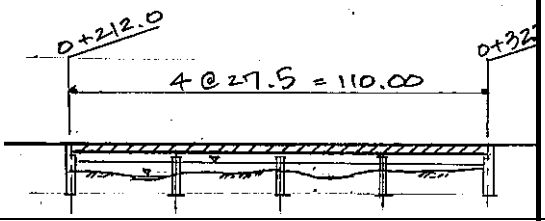
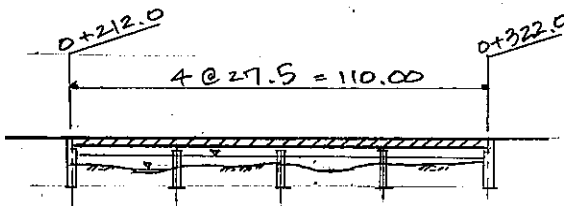
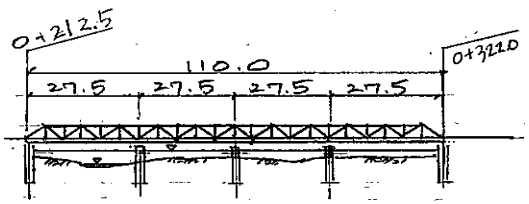
Table 2-4 Comparison of Construction Sites (Bazal Bridge)

Plan of Construction Sites			Scheme-1 (Scheme that lies upstream where the riverbed is relatively stable and minimizes the bridge length)	Scheme-2 (Scheme that minimizes land acquisition area by connecting the existing roads at both banks directly)	Scheme-3 (Scheme that lies near Scheme-2 and shortens the bridge length by allowing perpendicular crossing with riverbed)	Scheme-4 (Scheme that improves the road alignment by connecting the roads at both banks by a straight line)
Length of the Bridge and Approach Road*	Bridge		80m	150m	110m	120m
	Approach Road*	Bazal Side	130m	100m	250m	300m
		Malasin Side	835m	150m	180m	200m
		Total	965m	250m	430m	500m
Influence on Land Acquisition, Resettlement and Natural Environment	Land Acquisition	Bazal Side	1,950m^2	1,500m^2	3,750m^2	4,500m^2
		Malasin Side	12,525m^2	1,500m^2	2,700m^2	3,000m^2
		Total	14,475m^2	3,000m^2	6,450m^2	7,500m^2
	Number of Relocation	Bazal Side	4	0	0	1
		Malasin Side	4	0	0	0
		Total	8	0	0	1
	Observation		**C** As the approach road at the Bazal side is a private road of 3to4m width, the whole width of the road is required to be acquired. Apart from the relocation of 4 houses, 2 Tilapia fisheries and 4 private lawns need to be acquired. The approach road at the Malasin side passes the coconut field, and the whole road needs to be newly built.	**A** Due to the maximum utilization of the existing road, land acquisition area is the least. However, the land to be acquired is mostly rice field.	**B** Though the area of land acquisition is larger than that in Scheme-2, resettlement is not required. The land to be acquired is mostly rice field.	**C** Area of land acquisition is larger than that in Scheme-3 and resettlement of one house is required. The land to be acquired is mostly rice field.
Characteristics of River Hydrology			**B** Though the river channel is stable in comparison with other schemes, the width of the river has been widened during the flood in 2004 and possibility of further fluctuation of the watercourse during the flood in the future cannot be ruled out.	**B** There are high chances for the river channel to change, as there is a high risk of heavy erosion, occurring at the right side bank 20m upstream from the bridge, to expand downstream. 16 concrete columns (4x4 rows) of length 8m remains near the abutment at the Bazal side of the bridge from an attempt to construct a bridge in 2000. These columns are expected to work as spur dikes that would revert the flood flow towards the middle of the river and prevent further erosions of the riverbanks	**B** Almost similar to that of Scheme-2	**B** Although the river channel is considered stable in comparison to Scheme-2 and Scheme-3, the fluctuation of the channel is possible as water course still remains unstable.
Total Construction Cost (Approximate)			**B** Ratio to adopted Scheme:1.18	**C** Ratio to adopted Scheme:1.13	**A** Ratio to adopted Scheme:1.00	**B** Ratio to adopted Scheme:1.11
Comprehensive Evaluation			**C** Land acquisition and resettlement are highest and is not favorable from the aspect of environment as some coconut trees are required to be cut.	**C** The construction cost will be high and the construction period will be long because the length of the bridge is the longest and the bridge is skewed.	**A** **(Adopted)** Construction cost and period is small than Scheme-2. Resettlement is also not required.	**C** Land acquisition is large after Scheme-1. and relocation is also required. As the bridge is skewed, the cost is higher than Scheme-3.

* The length from the Abutment to the point where the road meets with the existing road

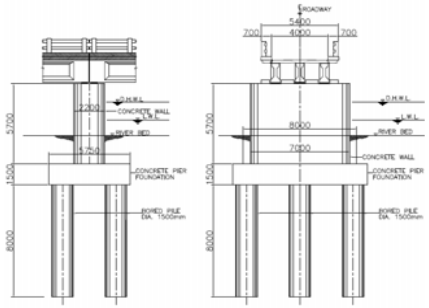
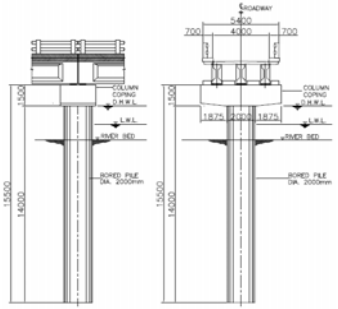
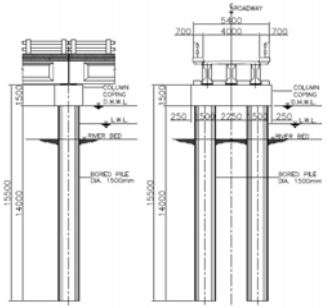
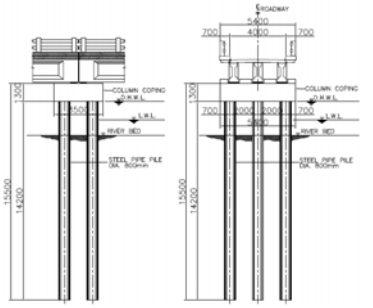
* Evaluation: **A**: Superior, **B**: Medium, **C**: Inferior

Table 2-5 Comparison of Superstructure Types (Bazal Bridge)

	Scheme-1 4-Span PC-I Girder	Scheme-2 4-Span Plate Girder	Scheme-3 4-Span Steel Pony Truss
Superstructure			
Cost Estimate	**A** Ratio of Construction Cost:1.00	**B** Ratio of Construction Cost:1.08	**C** Ratio of Construction Cost:1.17
Material Procurement	**A** Domestic procurement of large portion of key materials is possible	**B** Steel Girders imported from Japan or from a third country	**B** Steel Girders imported from Japan or from a third country
Construction Ability	Method of Erection -PC girders are manufactured at a temporary construction yard set up at the Bazal side. -Temporary stage is built from where the bridge is constructed by a stage erection method using a large crane (80 to 100t). **B** Characteristics -The size and the weight of the PC girders are big and heavy vehicle is required for lateral hoisting while a large scale crane is required for the erection. -Attention should be paid during moving of beams and safety control during erection.	Method of Erection -Temporary stage is built from where the bridge is constructed by a stage erection method using a large crane (80 t) after assembling on the ground. **B** Characteristics -The erection period is long as ground assembling on top of the temporary stage is required. -As the height of the beam is high, safety apparatus against overturning is required.	Method of Erection -Temporary stage is built from where the bridge is constructed by a stage erection method using a large crane(required capacity is under review but is smaller than other schemes or, -After assembling at the rear side of the abutment the bridge is constructed by launching method by setting a temporary vent in the middle of the span. **A** Characteristics -The period for erection is long as assembling on top of temporary stage or behind the abutment is required. -Assembling of members is easier than in other schemes as the size/weight of the members are small.
Period	**A** Short as one-time erection by crane is possible	**C** Long as ground assembling on stage is required	**C** Similar to Scheme-2
Influence on Environment	**B** In comparison with the 4-span continuous plate girder, the height of the beam being low which results to the decrease of the surface height of the bridge and the embankment height. Thus, the area of land acquisition is relatively small.	**C** The height of the beam is tall which results to the increase in the height of the bridge surface and embankment. Thus, land acquisition area is large.	**A** The land acquisition area is minimum, as the height of the bridge surface and embankment is low for being a deck bridge.
Maintenance	**A** The repair and maintenance of the bridge is almost not necessary for being a concrete bridge.	**C** Periodical recoating of plate girder is essential.	**B** Recoating is not required if hot dip galvanizing is applied. However, as dirt is easily accumulated on the upper and lower chord members, if left unattended, it is susceptible to corrosion, and thus has to be cleaned regularly.
Evaluation	**A** **(Adopted)** Excellent economic efficiency, material procurement, construction period and maintenance.	**C** Construction cost, environment and maintenance not favorable.	**C** Construction cost, environment and maintenance not favorable.

Evaluation: **A**: Superior, **B**: Medium, **C**: Inferior

Table 2-6 Comparison of Substructure Types (Bazal Bridge)

	Scheme-1 Wall Concrete type Pier (Cast-in-place Concrete Pile)	Scheme-2 Single-column Concrete Pier (Cast-in-place Concrete Pile)	Scheme-3 Double-column Concrete Pier (Cast-in-place Concrete Pile)	Scheme-4 Steel Pile Bent (Earth Auger Steel Pile)
Conceptual Diagram				
Structural Characteristic	**A** Structure: The load of the superstructure is supported by cast-in-place concrete column. Characteristics: As the foundation is constructed deeper than the riverbed, it is less subjected to local scouring and is highly quake resistant. Construction experience is abundant.	**C** Structure: The load of the superstructure is supported by single circular concrete column Characteristics: Easily becomes unstable from the effects of earthquakes and local scouring. No construction experience in the Philippines and in Japan.	**A** Structure: The load of the superstructure is supported by two circular concrete columns Characteristics: As its structure is a frame body, it has high quake resistance. Construction experience in the Philippines is abundant.	**B** Structure: The load of the superstructure is supported by steel pile bents. Characteristics: Since the pile is projected above the ground, it is weak to earthquake. The construction experience in the Philippines is abundant.
Hydrological Characteristic	**A** As the Wall-type pier is oval in shape, it cannot correspond to the change of the flow direction. Influence of local scouring is small. The obstruction ratio of river cross section is big (6%), as the width of the pier is wide.	**B** As the column is circular, it can easily correspond to the change of flow direction. Occurrence of local scouring is possible. The obstruction ratio of river cross section is big (5.4%), due to a single pier.	**B** As there are two circular columns, It is affected by the change of flow direction Occurrence of local scouring is possible. The obstruction ratio of river cross section is small (4.1%)	**C** As multiple piles project out from the water, it is affected by the change of the flow direction. Eddy current is easily generated and is susceptible to local scouring. The obstruction ratio of river cross section is small (4.3%)
Construction Ability	**C** Coffering is required and is susceptible to damage during the rise of water level. Gantry for cast-in-place pile driver required. The construction period is extremely long due to special excavation work. (Ratio to the adopted scheme is 3.42 times per pier)	**A** Coffering is not required, as an island made of sand will be formed near the pile. The construction period is shortest as the number of piles is less (ratio to the adopted scheme is 3.42 times per pier)	**A** Coffering is not required, as an island made of sand will be formed near the pile. The construction period is relatively short (ratio to the adopted scheme is 1.00 times per pier)	**B** Coffering is not required, as an island using sand will be formed near the pile. The construction period is long as it takes time for the construction of the pile (ratio to the adopted scheme is 1.36 times per pier)
Economy	**C** Very expensive, as coffering, building and removal of a gantry is required. (ratio to adopted scheme is 3.95 times per pile)	**A** The construction cost is the cheapest (ratio to adopted scheme is 0.89 times per pile).	**B** The construction cost is relatively cheap (ratio to adopted scheme is 1.00 times per pile).	**C** The construction cost is high (ratio to adopted scheme is 1.16 times per pile).
Maintenance	**A** Maintenance is rarely required.	**A** Maintenance is rarely required.	**A** Maintenance is rarely required.	**C** Maintenance like removal of driftwood trapped between projected piles is required.
Evaluation	**C** Inferior from overall aspects of construction and economical efficiency.	**C** Though superior in construction and economic efficiency, construction experience is very low and has structural uncertainties.	**A** **(Adopted)** Superior from the aspects of structure, construction and economical efficiency and maintenance.	**C** Inferior from overall aspects of construction and economical efficiency and maintenance.

Evaluation: **A**: Superior, **B**: Medium, **C**: Inferior

(8) Plan of Approach Road

i) Start Point, End Point and Length

The scope of construction covers from the abutment of both banks to the runoff section on the existing Barangay road. The length of the approach road is 182m at the start point side, the Barangay Malasin side and 242m at the end point side, the Barangay Bazal side. The 30m section from the start point at Barangay Malasin is a runoff section where concrete pavement will not be applied.

ii) Typical Section

The overall width of the road is determined as 6.0m on the basis of the design conditions set up under the design policy. The typical section is shown in Fig. 2-2. Natural drainage method is adopted as the ground below the subgrade is formed by earth filling. Vegetation will be applied for the protection of the slopes.

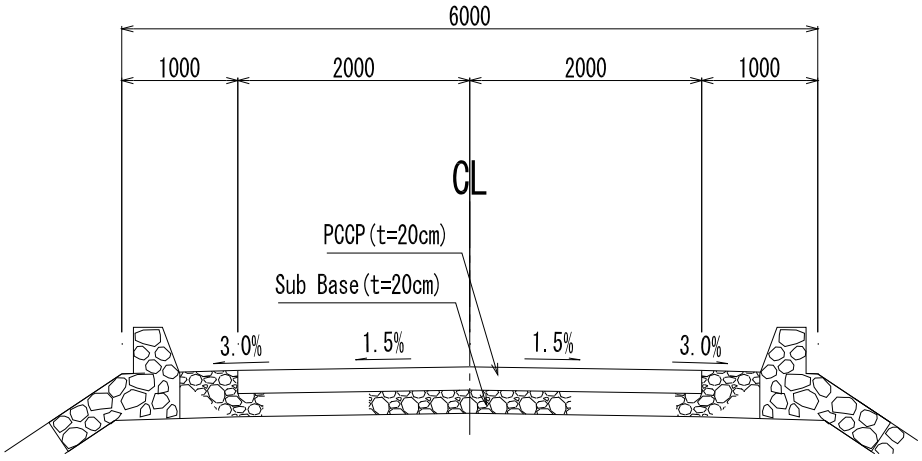


Fig. 2-2 Typical Cross-section of Approach Road (Bazal bridge)

iii) Road Alignment

As the design speed of the bridge is 30km/h, the values of the geometrical alignment of the road shown in Table 2-7 are applied. The longitudinal grade of the approach road for the section where the horizontal alignment of the road meets with the existing road is planned to be as moderate as possible. This is from consideration of traveling performance, as the traffics available at the vicinity of the proposed bridge site are old model tricycles, light trucks and agricultural tractors.

Table 2-7 Geometrical Alignment of Road (Bazal bridge)

	Standard value	Application value
Minimum radius of curvature	30m	65m, 100m
Maximum longitudinal grade	10%	3%

iv) Pavement Structure

Concrete pavement that is commonly used on short-span roads with low traffic, in the Philippines, is adopted. The thickness of the concrete slab and crushed stone subbase are 20cm.

v) Utilities of Approach Road

1) Stone Masonry Breast Wall and Slope Protection Work

Stone masonry breast wall is provided along the rice field section so as to reduce the influential area. The total length of installation is 542.6m; 261.7m at Barangay Malasin side and 280.9m at Barangay Bazal side. Stone masonry (slope 1:1.5) are applied on the slope of earth filling section.

2) Fall Prevention Work

Concrete block masonry is provided along the section where the embankment height is 3.0m and more. The total length of the installation section is 162.0m of which 96.0m is at Barangay Malasin side and 66.0m at Barangay Bazal side.

3) Traffic Sign Work

Warning signs (sharp turn, curve ahead, steep climb, steep decent) are provided at 8 locations and prohibitory signs (speed limit, load limit) are applied at 4 locations

4) Road Markings Work

Road markings are not provided, as the proposed road is a single lane road.

5) Stairway Work

Stairways are provided, at a total of 4 locations, on both sides at the back portion of either abutment.

6) Access Road

The access road that forms a four-way crossing with the proposed road at the Barangay Bazal side is connected with the proposed road in such a manner that the road functions similarly as in its existing condition. A road for accessing to the Bazal River is provided at the upstream side of the approach road at the Barangay Malasin side.

7) Cross Drainage

Following the construction of approach road of the bridge, cross drainage facility is applied at a total of 6 locations, 2 at the Barangay Bazal side and 4 at the Barangay Malasin side.

(9) Plan of Revetment and Riverbed protection

i) Revetment Work

Stone masonry of slope 1:1.5 is provided in front of the abutment up to the shoulder of the road. Sandbags, 3.0m wide and filled with soil cement are placed around the foundation for

preventing the local scouring of the riverbed. The total length of revetment is 50.2m, 25.1m each at both the Barangay Bazal side and the Barangay Malasin side.

ii) Riverbed Protection Work

Sandbags filled with soil cement are prepared locally. The area of application of the sandbag is determined with reference to the method of estimation of erosion depth and area recommended by the former Ministry of Public Works Research Institute[5]. And, the size of the sandbag is determined in conformity with the specifications of the U.S. Army[6].

Depth of application: 1m

Distance from the pile to the verge of riverbed protection: 3.5m

Area of application: 12.3m (transverse to the bridge axis) x 8.5m (longitudinal direction)

Size of sandbag: 0.85m x 0.85m x 1.00m

(10) Bridge Utilities

i) Side Walk and Hand Rail

A 35 centimeter wide sidewalk, which is the minimum width required for a pedestrian to evacuate or walk when a vehicle passes across the bridge, is provided.

In addition, a beam type hand rail made of reinforced concrete and is in wide use in the Philippines, is provided at the outer end of the side walk, as a preventive measure for deviation/fall of the vehicles.

ii) Drainage of Bridge Surface

A ϕ100mm drainage pipe is provided at an interval of 7 meters at both sides of the bridge.

iii) Facility for Water Pipe Installation

Brackets for bracing water pipes, to be installed in the future, will be placed at the sides of the slab on the downstream side at an interval of 1.5 meters. However, the installation of the water pipes is to be conducted under the responsibility of the local government.

iv) Approach Slab

A 5m long approach slab is introduced at the backside of each abutment in order to prevent settlement of embankment at the backside of the abutment.

v) Bearings

A fixed bearing for piers P1 to P3, and a removable bearing for abutments A1 and A2 are applied. Both of these are pad shaped rubber bearings. The cross beam and the substructure is connected by an anchor bar for restraining the horizontal displacement at the fixed support.

vi) Expansion Joints

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5 Civil Engineering Journal Vol. 1797, Hydrological Study on the Assessment of the Depth of Local Scouring and its Countermeasures, March, 1982

6 U. S. Army Corps of Engineer: Hydraulic Design Criteria, Chart 712-4, 1970

Two expansion joints, one at each abutment, are applied. Instead of applying expansion joints on piers P1 to P3, the slabs are joined as a measure to increase economic efficiency and to improve traveling performance and quake resistance.

vii) Concrete Block for Seismic Fall Prevention

A structure made of concrete block is applied on the front of the cross girder of all abutments and piers for preventing the superstructure from falling during earthquakes.

2-2-2-2 Basic Plan of Umiray Bridge

(1) Overall Plan

Table 2-8 shows the basic plan of the Umiray Bridge.

Table 2-8 Basic Plan (Umiray Bridge)

Classification of Road				Provincial Road (Design Speed V=30km/h)
Live load				HS20-44
Bridge Length				358.000m
Span Length				35.840+8 @35.790+35.840m
Width				6.900m
Deflection Angle				0 degrees
Design Seismic Coefficient				Kh=0.27 (longitudinal direction), kh=0.16 (transverse direction)
Superstructure	Type			5-Span Simple PC-I Girder x 2 (5-Span continuous slab structure) Type VI (Modified)
	Materials	Main Girder	Reinforcement Bar	SD295 (or equivalent)
			PC Steel	SWPR7BL (12T12.7)(or equivalent)
			Concrete	σ_{ck}=35N/mm^2
		Slab	Reinforcement Bar	SD295 (or equivalent)
			Concrete	σ_{ck}=24N/mm^2
	Type of Bearing			Rubber Bearing
Substructure	Type	Body		Reversed T abutment, 2 column pier
		Foundation		Cast-in-place concrete pile
	Materials	Body	Reinforcement Bar	SD295 (or equivalent)
			Concrete	σ_{ck}=24N/mm^2
		Foundation	Reinforcement Bar	SD295 (or equivalent)
			Concrete	σ_{ck}=24N/mm^2
	Bearing Ground			Gravel Bed
Specification Criteria				- Design Guidelines Criteria and Standards for Public Works and Highways, Department of Public Works and Highways - National Structural Code of the Philippines, Association of Structural Engineers of the Philippines - Specifications for Highway Bridges, Japan Road Association

(2) Site Condition

The Umiray River, which has a catchment area of 628km^2, flows into the Pacific Ocean at the provincial boundary of Aurora Province and Quezon Province. The river mouth is situated at Dingalan Municipality, Barangay Umiray in the Aurora Province side and at General Nakar Municipality, Barangay Umiray in the Quezon Province side. The proposed location of the bridge is almost near the river mouth of the Umiray River.

Although in the past, deforestation was conducted in the river basin area, it is now prohibited. There are few villages scattered inside the catchment area, where the population is extremely small and thus, development is not in progress. The only means of transportation going to and from the area is to take a small boat from Barangay Umiray. Therefore, the physiognomy of the forest is also excellent. The longitudinal slope of the riverbed at the river mouth is moderate and formation of sand reef along the bank is prevalent. During low water, the flow meanders towards the south, the General Nakar side, and pours into the Pacific Ocean. During monsoon, the central part of the sand reef opens due to the effect of swelling of the river and flows linearly into the Pacific Ocean.

As the only means of transportation between the provinces of Aurora and Quezon is to cross the river by means of a bangka (boat), the monsoon traffic is frequently hindered. In particular, Barangay Umiray at Quezon Province side gets isolated during flood time. Regarding the bed of the river, although gravel residuals of 5 to 10 centimeters in size are observed along the banks, deposition of sand and silt are predominant and has a behavior similar to that of a river mouth area of ordinary alluvial plains. During 2004 floods, 100 houses situated along the banks were washed away while 120 people were killed in Barangay Umiray at Quezon Province side.

(3) Bridge Location

A comparison study was conducted on four different schemes mentioned below, that was selected as the bridge sites.

Scheme-1: The scheme, where the proposed bridge crosses the river from the ship dock at the Dingalan side to the General Nakar side

Scheme-2: The scheme, where the bridge site is near to that mentioned in Scheme-1, and reduces the number of resettlements and the length of the bridge

Scheme-3: The scheme, that open cuts a portion of a hill at the Dingalan side and connects with the barangay road, namely Rapdock road at the General Nakar side

Scheme-4: The scheme that lies upstream where the length of the bridge can be reduced

The comparison of the schemes is shown in Fig. 2-3, and its result is shown in Table 2-9
From the result of the comparison, Scheme-2 is adopted.

(4) Hydrological Condition

i) Flood Discharge

Flood discharge is calculated by using the Creager type calculation method as mentioned below and in conformity with the Manual on Flood-control Planning[7].

$$Q = qA$$

$$q = cA^{(A^{-0.048}-1)}$$

Where, Q : Design flood discharge (m^3/sec)
q : Specific discharge of flood (m^3/sec/km^2)
A : Drainage area (km^2)
c : Constant for regional specific discharge curve

As, A=628km^2 and c=23.83 (50 year probability of Luzon Island as according to the Manual on Flood Control Planning), the estimated flood discharge is estimated to be Q=2,700m^3/sec.

ii) Design High Water Level

The higher value of water level from among the two mentioned below is taken as the design high water level.

① water level calculated from the hydrological analysis for 50 year flood

② observed largest record flood level attained from local hearings

The results of these methods are as mentioned below.

① Hydrological analysis

As the bridge is subjected to the backwater effect, the high water level of 50-year flood was calculated on the basis of a non-uniform flow calculation where the tide level is taken as the datum water level.

Analysis method : non-uniform flow calculation

River section : result of river cross section survey

Coefficient of roughness : 0.030

From the result of the analysis, the high water level is EL6.05 meters.

7 Manual on Flood Control Planning, Project for Enhancement of Capabilities in Flood Control and Sabo Engineering of DPWH, Department of Public Works and Highways, Japan International Cooperation Agency, March 2003

② Highest record flood level

From the interview survey conducted with the Barangay Captain, the highest record flood level was observed during the 2004 flood and was 1.65 meters above the road surface of the existing riverside roads and thus, is calculated to EL6.94 meters. On the other hand, the highest water level during year round flood is equivalent to the surface of the existing road.

From the above result, the design high water level is determined as EL6.94 meters.

iii) Minimum Span Length

As there is no specification regarding the minimum span length in the Philippines, the basic length of the span is calculated using the following formula in conformity with the "standards"[8] of Japan.

$$L = 20 + 0.005Q$$

Where, L : Required minimum span length (m)
Q: Design flood discharge (m^3/s)

From Q=2,700m^3/sec, the basic span length is calculated as 33.5m.

iv) Freeboard

According to the "Design Guidelines and Criteria and Standards for Public Works and Highways" of DPWH[9], the freeboard is regulated as 1.5 meters or above in the presence of floating objects like driftwoods and 1.0 meters or above in the absence of the floating objects. The freeboard is determined as 1.5 meters in consideration that there are driftwoods present at this site.

(5) Bridge Length and Span

From the ambient topography and the characteristics of the river channel, the length of the bridge is determined as 358 meters.

From the result of the hydrological analysis, the number of spans required in order to satisfy the bridge length of 358 meters and the minimum span length of 33.5 meters is 10 and less.

(6) Plan of Superstructure Type

The basic types of superstructures for a bridge of length 358 meters, 10-spans of 35.8 meters, and an overall width of 6.9 meters, which is economical and easy to construct and is widely used in the Philippines are as mentioned below:

Scheme-1 10-span PC-I girder

Scheme-2 10-span Plate girder

8 Cabinet Order Concerning Structural Standards for River Management Facilities, etc Japan River Association

9 Design Guidelines and Criteria and Standards for Public Works and Highways, Department of Public Works and

The result of the comparison conducted for the above two types are shown in Table 2-10.
From the result of the comparison, Scheme-1 (10-span PC-I Girder) is adopted.

(7) Plan of Substructure Type

As the driving in of the pre-cast concrete piles is possible, the following 6 substructures are selected and compared.

Scheme-1 Wall-type concrete pier (pre-cast concrete driving pile)

Scheme-2 Wall-type concrete pier (pre-cast concrete driving pile) floating foundation

Scheme-3 Single-column concrete pier (cast-in-place concrete pile)

Scheme-4 Double-column concrete pier (cast-in-place concrete pile)

Scheme-5 Steel pile bent (steel pipe driving pile)

Scheme-6 Wall-type Concrete pier (open caisson)

The result of comparison is shown in Table 2-11 and Table 2-12. From the result, single-column substructure (scheme-3: Single-column concrete pier), where for every substructure one cast-in-place pile is connected to the reinforced concrete pier, is considered to be most preferable from the aspects of construction period, construction cost and hydrology. However, construction experience of this type of substructure is very few not only in the Philippines but also in Japan, as it has many uncertain elements regarding long term stability against scouring and earthquakes. Therefore, a double-column concrete pier (scheme-4), which is an upgraded type of scheme-3, is adopted instead. Furthermore, the riverbed protection works are applied around the piers so as to prevent scouring and increase the safety against earthquake.

The substructure is designed in such a manner that it is safe against modes of failure, such as bearing, overturning, and sliding from the loads applied for the permanent and seismic design, as well as the stress of the body and the displacement of the foundation is smaller than its allowable values. In addition, as the substructure is a double-column structure without a footing, the riverbed protection work is introduced as a preventive measure against local scouring. Again, taking into consideration the case where the horizontal resistance of the loose ground around the foundation cannot be expected, the design is conducted by taking the assumed design ground level at the bottom of the river protection work. Furthermore, to keep the displacement of the foundation small, the length of the pile is determined such that the characteristic value (βL_e), which is the relative rigidity of the ground and the structure, is 2.5 or more.

Umiray Bridge

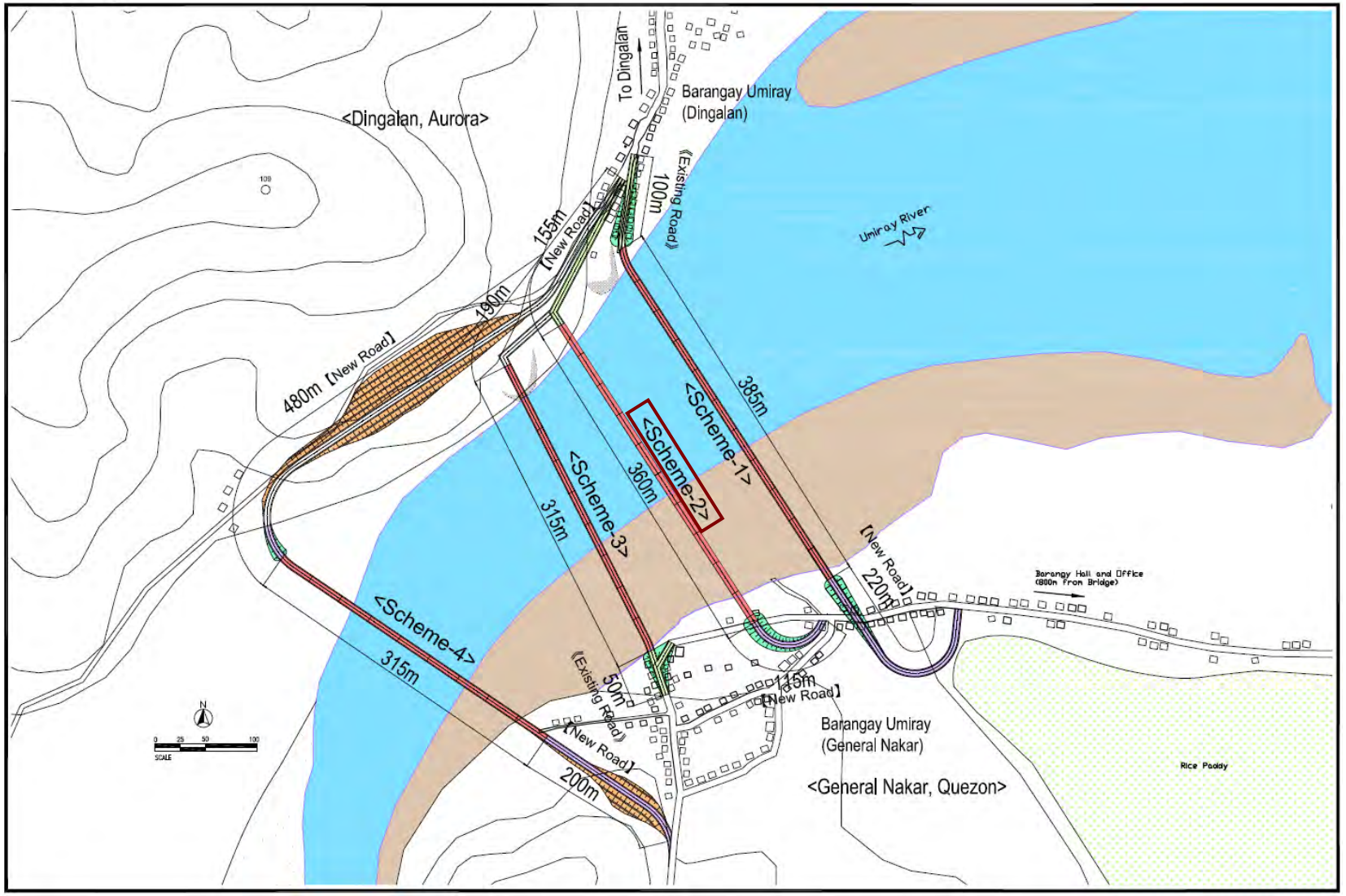


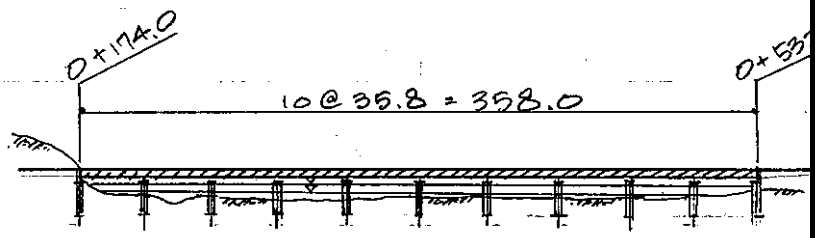
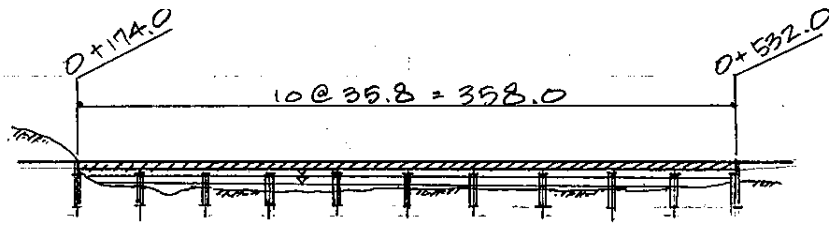
Fig. 2-3 Comparison of Construction Sites (Umiray Bridge)

Table 2-9 Comparison of Construction Sites (Umiray Bridge)

Plan of Construction Sites			Scheme-1 (Scheme where the proposed bridge crosses the river from the ship dock at the Dingalan side to the General Nakar side)	Scheme-2 (Scheme where the bridge site is near to Scheme-1, and reduces the number of resettlements and the length of the bridge)	Scheme-3 (Scheme that cuts a portion of a hill at the Dingalan side and connects with the Rapdock road at the General Nakar side)	Scheme-4 (Scheme that lies upstream where the length of the bridge can be reduced)
Length of the Bridge and Approach Road*	Bridge		385m	360m	315m	315m
	Approach Road*	Dingalan Side	100m	150m	190m	480m
		G. Nakar Side	220m	115m	50m	200m
		Total	320m	265m	240m	680m
Influence on Land Acquisition, Resettlement and Natural Environment	Land Acquisition	Dingalan Side	1,500m^2	2,250m^2	2,850m^2	24,000m^2
		G. Nakar Side	3,300m^2	1,725m^2	750m^2	6,000m^2
		Total	4,800m^2	3,975m^2	3,600m^2	30,000m^2
	Number of Relocation	Dingalan Side	10	2	2	4
		G. Nakar Side	9	1	15	0
		Total	19	3	17	4
	Observation		**C** Highest number of resettlement	**A** Lowest number of resettlement	**C** Number of resettlement second highest. Cut work is generated at the Dingalan side but the scale is smaller than Scheme-4	**C** Number of Resettlement low. But large scale cut work is required at the Dingalan side, which has a high negative environmental impact and risk of slope failure. Cut work and Cutting down of trees are also necessary at the General Nakar side
Characteristics of River Hydrology			**B** It is located at the curved area where the Dingalan side is a water colliding front and even though erosion of the bank is noticeable, it is not prominent.	**A** Although it is located at the curved area where the Dingalan side is a water colliding front, as the exposed rocks protect it, erosion of the banks is potentially low.	**A** Almost similar to that of Scheme-2	**B** It is located at the curved area where the Dingalan side is a water colliding front and minor erosion of the bank is noticeable.
Total Construction Cost (Approximate)			**B** Ratio to adopted Scheme:1.10	**A** Ratio to adopted Scheme:1.00	**A** Ratio to adopted Scheme:1.00	**B** Ratio to adopted Scheme:1.64
Comprehensive Evaluation			**C** Construction cost and resettlement number are high	**A** **(Adopted)** Superior from the aspects of resettlement, natural environment. The construction cost is slightly higher than that of Scheme-3	**B** The number of resettlement is high and the environmental negative impact is also larger than that of Scheme-2. There is a difficulty in constructing the temporary landing stage for construction works.	**C** The construction cost is high and environmental negative impact is big due to large-scale cut works.

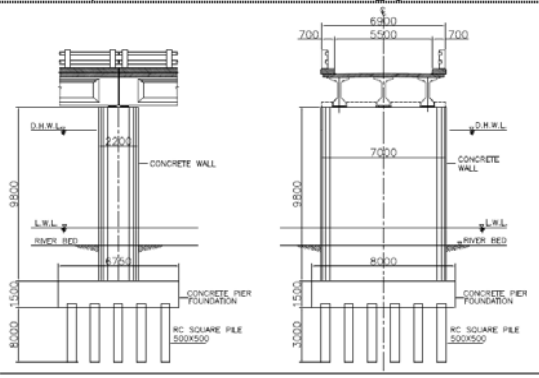
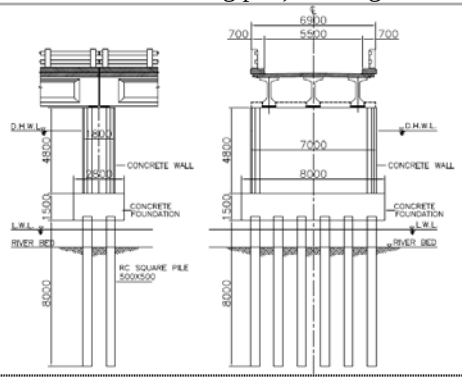
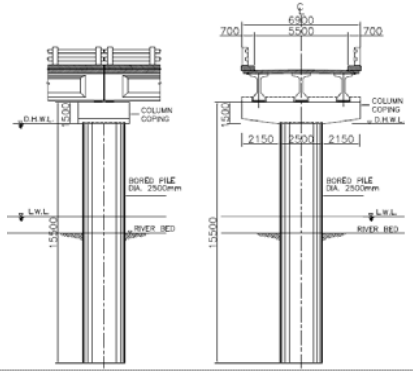
* The length from the Abutment to the point where the road meets with the existing road
* Evaluation: **A**: Superior, **B**: Medium, **C**: Inferior

Table 2-10 Comparison of Superstructure Types (Umiray Bridge)

	Scheme-1 10-Span PC-I Girder	Scheme-2 10-Span Plate Girder
Superstructure		
Cost Estimate	**A** Ratio of Construction Cost:1.00	**C** Ratio of Construction Cost:1.14
Material Procurement	**A** Domestic procurement of large portion of key materials is possible	**B** Steel Girders are required to be imported from Japan or from a third country
Construction ability	Method of Construction - PC girders are manufactured at a temporary construction yard provided at the Dingalan side - Temporary stage is built from where the bridge is constructed by a stage erection method using a large crane (120 to 180t). **B** Characteristics - Large scale temporary landing stage is required, as several construction bases become necessary for the erection of the girders, since the application period of the landing stage is limited (to 8 months from the aspect of rainfall) - The size and the weight of the PC girders are big, and heavy vehicle is required for lateral hoisting while a large scale crane is required for the erection. - Safety control cautions are required in moving beams and erection works.	Method of Construction - Temporary stage is built from where the bridge is constructed by a stage erection method using a large crane (100 to 120t) after assembling on the ground **B** Characteristics - As ground assembly on top of the landing stage is required, The required period for the erection is longer than that of the PC girder. Furthermore, a large scale temporary landing stage is required as several construction bases become necessary for the erection of the girders, since the period of the application of the landing stage is limited (to 8 months) - As the height of the beam is high, safety apparatus against overturning is required
Period	**A** Short as collective erection by crane is possible	**C** Long as ground assembly on the temporary stage is required
Environmental Impact	**B** In comparison with the plate girder, the height of the bridge surface and embankment is low due to the decrease in the height of the beam. Thus, the area of land acquisition is relatively small.	**C** The height of the beam is tall which results to the increase of the height of the bridge surface and embankment. Thus, land acquisition area is large.
Maintenance	**A** As it is a concrete bridge, repair and maintenance is almost unnecessary.	**C** Periodical recoating of plate girder is essential
Evaluation	**A** **(Adopted)** Advantageous from view of construction cost and maintenance.	**C** Disadvantageous from construction cost, environment and maintenance.

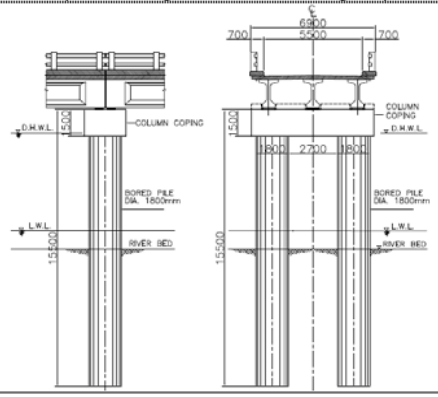
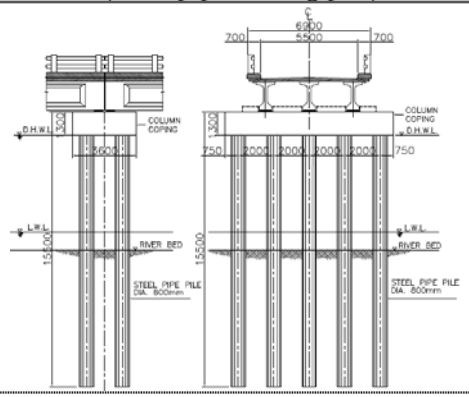
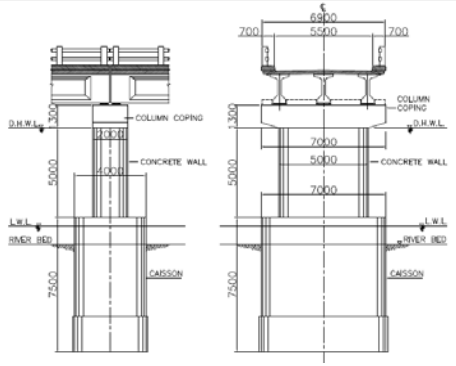
Evaluation: **A**: Superior, **B**: Medium, **C**: Inferior

Table 2-11 Comparison of Substructure Type (Umiray Bridge) (1/2)

	Scheme-1 Concrete Wall-type pier (Pre-cast concrete driving pile)	Scheme-2 concrete Wall-type pier (Pre-cast concrete driving pile) floating foundation	Scheme-3 Single-column concrete pier (Cast-in-place concrete pile)
Conceptual Diagram			
Structural Characteristic	**A** Structure: A pre-cast concrete pile supports the load of the superstructure Characteristics: As the foundation is constructed deeper than the riverbed, it is less subjected to local scouring and is highly quake resistant. Construction experiences are abundant	**C** Structure: A pre-cast concrete pile supports the load of the superstructure. Footing is projected out from the water. Characteristics: Since the pile is projected above the ground, it is weak to earthquake. A construction experiences in the Philippines are abundant. From the hydrological view, it is not applied in Japan these days.	**C** Structure: A single circular concrete column supports the load of the superstructure. Characteristics: Easily becomes unstable during earthquake from the effects of scouring. No construction experiences in the Philippines and in Japan.
Hydrological Characteristic	**A** Wall-type pier being oval in shape, cannot correspond to the change of the flow direction. Influence of local scouring is small. The obstruction ratio of river cross section is big (5.5%), as the width of the pier is wide.	**C** Wall-type pier being oval in shape, cannot correspond to the change of the flow direction. Susceptible to local scouring due to eddy flow that generates around the pile. The obstruction ratio of the cross section of the river is small (4.5%)as the width of the pier is small.	**B** As the column is circular, it can easily correspond to the change of flow direction. Occurrence of local scouring is possible. The obstruction ratio of the cross section of the river is big (6.3%).
Construction Ability	**C** Coffering by sheet piles required and is prone to damage during the rise of water level. Gantry for pre-cast pile driver is required. The construction period is very long (ratio to the adopted scheme is 3.26 times per pile)	**B** Coffering is not required, as an island using sand will be formed near the pile from where works like concrete casting is conducted. The construction period is relatively short (ratio to the adopted scheme is 1.09 times per pile)	**A** Coffering is not required, as an island using sand will be formed near the pile. The construction period is the shortest (ratio to the adopted scheme is 0.83 times per pile)
Economy	**C** Very expensive as coffering, building and removal of a gantry is required. (ratio to adopted scheme is 3.85 times per pile)	**A** The construction cost is relatively cheap (ratio to adopted scheme is 1.00 times per pile)	**A** The construction cost is the cheapest (ratio to adopted scheme is 0.89 times per pile).
Maintenance	**A** Maintenance is rarely required	**C** Maintenance like removal of driftwood trapped between projected piles is required.	**A** Maintenance is rarely required
Evaluation	**C** Comprehensively inferior from the overall aspects of construction and economical efficiency.	**C** Comprehensively inferior from the aspects of structure, river characteristics and maintenance	**C** Though superior in construction and economic efficiency, construction experience is very low and has structural uncertainties.

Evaluation: **A**: Superior, **B**: Medium, **C**: Inferior

Table 2-12 Comparison of Substructure Type (Umiray Bridge) (2/2)

	Scheme-4 Double-column concrete pier (Cast-in-place concrete pile)	Scheme-5 Steel pipe multi column pier (Steel pipe driving pile)	Scheme-6 concrete Wall-type pier (Open caisson)
Conceptual Diagram			
Structural Characteristic	**A** Structure: two circular concrete columns support the load of the superstructure. Characteristics: For being a frame body structure, it is highly quake resistant. Construction experiences in the Philippines are abundant.	**B** Structure: Several steel pipe piles support the load of the superstructure. Characteristics: Since the pile is projected above the ground, it is weak to earthquake. Construction experiences in the Philippines are abundant. In Japan it is not adopted these days due to hydrological reasons.	**A** Structure: Concrete pier and Caisson foundation support the load of the superstructure. Characteristics: Concrete foundation is constructed above water and is sunk down. Earthquake resistively is improved by the application of an oval-shaped concrete foundation and pier, that is longer in the perpendicular direction of the bridge axis.
Hydrological Characteristic	**B** As there are two circular columns, It is affected by the change of flow direction Occurrence of local scouring is possible. The obstruction ratio of the cross section of the river is small (4.5%)	**C** As multiple piles project out from the water, it is affected by the change of the flow direction. Eddy flow is easily generated and is susceptible to local scouring. The obstruction ratio of the cross section of the river is small (4.0%)	**A** As being a Wall-type pier, it cannot correspond to the change of the flow direction. Less subjected to the effects of local scouring. The obstruction ratio of the cross section of the river is small (5.0%), as the width of the pier is small.
Construction Ability	**A** Coffering is not required, as an island using sand will be formed near the pile. The construction period is relatively short (ratio to the adopted scheme is 1.00 times per pile)	**C** Coffering is not required, as an island using sand will be formed near the pile. In case of the presence of boulders, time is required for its removal. The construction period is long (ratio to the adopted scheme is 1.30 times per pile)	**C** Coffering is not required, as an island using sand will be formed near the pile and caisson foundation is constructed above water and is sunk down. The construction period is very long (ratio to the adopted scheme is 2.57 times per pile)
Economy	**B** The construction cost is relatively cheap (ratio to adopted scheme is 1.00 times per pile).	**C** The construction cost is relatively expensive (ratio to adopted scheme is 1.19 times per pile).	**C** The construction cost is relatively expensive (ratio to adopted scheme is 1.15 times per pile).
Maintenance	**A** Maintenance is rarely required.	**C** Maintenance like removal of driftwood trapped between projected piles is required.	**A** Maintenance is rarely required.
Evaluation	**A** **(Adopted)** Superior from the aspects of structure, construction and economical efficiency and maintenance.	**C** Comprehensively inferior from the aspects of river characteristics, economical efficiency, construction ability and maintenance.	**C** Comprehensively inferior from the aspects of construction ability and economical efficiency.

Evaluation: **A**: Superior, **B**: Medium, **C**: Inferior

(8) Plan of Approach Road

i) Start Point, End Point and Length

The scope of construction covers from the abutment of both banks to the runoff section on the existing provincial road. The length of the approach road is 156 meters at the start point side, the Aurora Province side and 116 meters at the end point side, the Quezon Province side.

ii) Typical Section

The overall width of the road is determined as 7.5 meters on the basis of the design condition set up under the design policy. The typical section is shown in Fig. 2-4. Natural drainage method is adopted as the ground below the subgrade is formed by earth filling. Vegetation will be applied for the protection of the slopes.

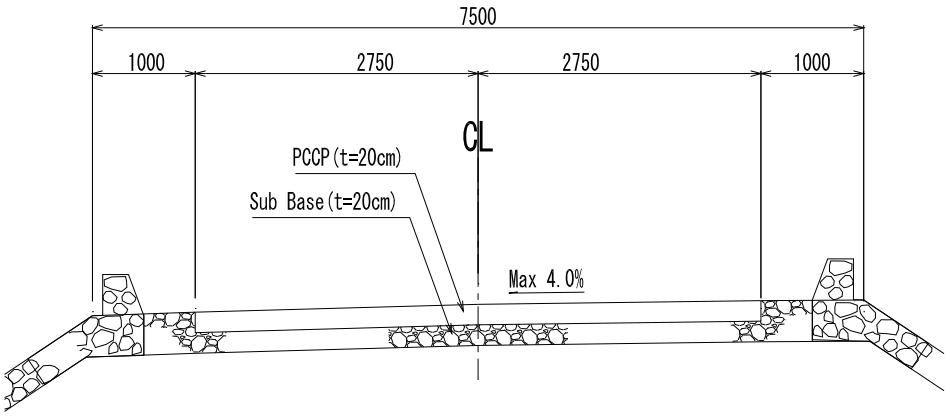


Fig. 2-4 Typical Cross-section of Approach Road (Umiray bridge)

iii) Road Alignment

As the design speed of the bridge is 30 km/h, the values of the geometrical alignment of the road shown in the Table 2-13 were applied. The longitudinal grade of the approach road for the section where the horizontal alignment of the road meets with the existing road was planned to be as moderate as possible. This is from consideration of traveling performance, as the traffics available at the vicinity of the proposed bridge site are old model tricycles, light trucks and agricultural tractors.

Table 2-13 Geometrical Alignment of Road (Umiray bridge)

	Standard value	Application value
Minimum radius of curvature	30m	40m, 170m
Maximum longitudinal grade	10%	4.65%, 0.899%, 6.12%

iv) Pavement Structure

Concrete pavement, which is commonly used on roads with short span and low traffic, in the Philippines, is adopted. The thickness of both the concrete slab and crushed stone subbase are 20 centimeters.

v) Utilities of Approach Road

1) Stone Masonry Breast Wall and Slope Protection Work

There are no rice field along the fill section of the approach road of the proposed bridge, and thus, the road does not occupy paddy field. Therefore, only stone masonry (slope 1:1.5) is applied up to the shoulder on slopes of the earth filling section.

2) Fence work

Concrete block masonry is provided along the section where the embankment height is 3.0m or more. The total length of the installation section is 198.0 meters of which 80.0 meters is at Aurora Province side and 118.0 meters at Quezon Province side.

3) Traffic sign work

Warning signs (sharp turn, winding road, T-junction, steep climb, steep decent) are applied at 11 locations and prohibitory signs (speed limit) at 2 locations

4) Road marking work

Road markings are not provided, as the proposed road is a single lane road.

5) Stairway work

Stairways are provided at a total of 3 locations; one on the cut section of the abutment at Aurora Province side and two at the backside of the abutment at Quezon Province side.

6) Access road

There is an existing road that heads to the mountains on the approach road section at Aurora Province side. Therefore, the proposed approach road is designed in such a manner that it enables the existing road to be connected with the approach road. The alignment of the road at Quezon Province side that runs parallel to the river at the location of the abutment is shifted and reconstructed in front of the abutment.

(9) Plan of Bank and Protection of Riverbed

i) Revetment Work

Stone masonry of slope 1:1.5 is provided at the front side of the abutment at Quezon Province side. The stone masonry is constructed up to the shoulder and sandbags, 3.0 meters wide and filled with soil cement are placed around the foundation for preventing local scouring of the riverbed. The total length of revetment is 50.7 meters. The excavation for the abutment at Aurora Province side is to be conducted without disturbing the existing bank at the front side

and as rocks are exposed at the upstream area, no revetment work is applied.

ii) Riverbed Protection Work

Sandbags filled with soil cement are prepared locally. The area of application of the sandbag is determined with reference to the method of estimation of erosion depth and area recommended by the former Ministry of Works Public Works Research Institute[10]. And, the size of the sandbag is determined in conformity with the specifications of the U.S. Army[11].

Depth of application: 1m

Distance from the pile to the verge of riverbed protection: 4.0m

Area of installation: 15.0m (traverse to the bridge axis) x 10.0m (longitudinal direction)

Size of sandbag: 0.85m x 0.85m x 1.00m

(10) Bridge Utilities

i) Side Walk and Hand Rail

A 35 centimeter wide sidewalk, which is the minimum width required for a pedestrian to evacuate or walk when a vehicle passes across the bridge, is provided.

In addition, a beam type hand rail made of reinforced concrete and is commonly used in the Philippines, is provided at the outer end of the side walk, as a preventive measure for deviation/fall of the vehicles.

ii) Drainage of Bridge Surface

A ϕ100mm drainage pipe is provided at an interval of 7 meters at both sides of the bridge.

iii) Facility for Water Pipe Installation

As there are no existing water pipes, brackets for bracing water pipes are not applied.

iv) Approach Slab

An approach slab 5 meters long is introduced at the backside of each abutment with view to prevent settlement of embankment at the backside of the abutment.

v) Bearings

A fixed bearing for piers P1 to P9, and a moveable bearing for abutments A1 and A2 are applied. However, pier 5 is designed to have both fixed and moveable bearings and the side from abutment A1 to pier P4 is taken to be in a fixed condition. The pad shaped rubber bearings are used for the bearings. At fixed bearings, the cross beam and the substructure is connected by an anchor bar for restraining the horizontal displacement.

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10 Civil Engineering Journal Vol. 1797, Hydrological Study on the Assessment of the Depth of Local Scouring and its Countermeasures, March, 1982

11 U. S. Army Corps of Engineer: Hydraulic design Criteria, Chart 712-4, 1970

vi) Expansion Joints

Three expansion joints, one at each abutment, and one at pier P5 are applied. Instead of applying expansion joints on middle supports, from piers P1 to P4 and P6 to P9, the slabs are joined, as a measure to increase the economic efficiency and improve the traveling performance and quake resistance as well.

vii) Concrete Block for Seismic Fall Prevention

A structure made of concrete block is applied at the front of the cross girder of all abutments and piers for preventing the superstructure from falling during earthquakes.

2-2-3 Basic Design Drawings

(1) Lists of Drawings

Table 2-14 and Table 2-15 show the lists of drawings for each bridge.

(2) Basic Design Drawings

The drawings of the basic designs are attached in Appendix.

Table 2-14 Lists of Drawings (Bazal Bridge)

Drawing No.	Title	Scale
B01	Project Location Map	1/500,000
B02	Road Plan (1/2)	1/500
B03	Road Plan (2/2)	1/500
B04	Road Profile (1/2)	H=1/500, V=1/100
B05	Road Profile (2/2)	H=1/500, V=1/100
B06	Typical Cross Section of Road Section (1/2)	1/50
B07	Typical Cross Section of Road Section (2/2)	1/50
B08	General Drawing of Bazal Bridge	1/300
B09	Structural Drawing of Superstructure	1/150
B10	Structural Drawing of A1, A2 Abutment (1/2)	1/50
B11	Structural Drawing of A1, A2 Abutment (2/2)	1/50
B12	Structural Drawing of P1-P3 Bridge Pier	1/50
B13	Road Cross Section (1/4)	1/100
B14	Road Cross Section (2/4)	1/100
B15	Road Cross Section (3/4)	1/100
B16	Road Cross Section (4/4)	1/100
B17	Drainage Facilities (1/2)	1/20
B18	Drainage Facilities (2/2)	1/20
B19	Road Signs	-
B20	Detail of Concrete Pavement	1/100
B21	Detail of Access and Slope Road	1/100
B22	Miscellaneous Details (1/2)	1/20
B23	Miscellaneous Details (2/2)	1/20

Table 2-15 Lists of Drawings (Umiray Bridge)

Drawing No.	Title	Scale
U01	Project Location Map	1/500,000
U02	Road Plan (1/2)	1/500
U03	Road Plan (2/2)	1/500
U04	Road Plan for Temporary Works	1/500
U05	Road Profile (1/2)	H=1/500, V=1/100
U06	Road Profile (2/2)	H=1/500, V=1/100
U07	Typical Cross Section of Road Section (1/2)	1/50
U08	Typical Cross Section of Road Section (2/2)	1/50
U09	Typical Cross Section of Temporary Works	1/50
U10	General Drawing of Umiray Bridge	1/500
U11	Structural Drawing of Superstructure (1/2)	1/150
U12	Structural Drawing of Superstructure (2/2)	1/150
U13	Structural Drawing of A1 Abutment (1/2)	1/50
U14	Structural Drawing of A1 Abutment (2/2)	1/50
U15	Structural Drawing of A2 Abutment (1/2)	1/50
U16	Structural Drawing of A2 Abutment (2/2)	1/50
U17	Structural Drawing of P1-P4, P6-P9 Bridge Pier	1/50
U18	Structural Drawing of P5 Bridge Pier	1/50
U19	Road Cross Section (1/6)	1/100
U20	Road Cross Section (2/6)	1/100
U21	Road Cross Section (3/6)	1/100
U22	Road Cross Section (4/6)	1/100
U23	Road Cross Section (5/6)	1/100
U24	Road Cross Section (6/6)	1/100
U25	Cross Section for Detour Road	1/100
U26	Cross Section for Temporary Road (1/3)	1/100
U27	Cross Section for Temporary Road (2/3)	1/100
U28	Cross Section for Temporary Road (3/3)	1/100
U29	Drainage Facilities (1/2)	1/20
U30	Drainage Facilities (2/2)	1/20
U31	Road Signs	-
U32	Detail of Concrete Pavement	1/100
U33	Miscellaneous Details (1/2)	1/20
U34	Miscellaneous Details (2/2)	1/20

2-2-4 Implementation Plan

2-2-4-1 Implementation Policy

The basic points for the implementation of the project are as follows:

- The project will be implemented under the grant aid system of the Government of Japan after the signing of the grant aid exchange of notes on this project by the government of both countries.
- The implementing organization of the project is the Department of Agrarian Reform of the Philippines.
- The consulting works like detailed design, tender related works and supervision works will be conducted by a Japanese consultant company in accordance with the consultant contract with the Government of the Philippines.

The basic policies regarding the construction of this project are as mentioned below.

- The equipment, materials and labors for the construction will be, to the possible extent, procured locally. In cases where local procurement is not possible, it will be procured either from a third country where it is most economical, so long as the required quality and supply capacity are secured, or from Japan.
- Construction method and the construction schedule will be consistent with the local climate, topography, geology and the natural conditions like the river characteristics of each proposed bridge site.
- Simple and common construction method that does not require special equipment or technology will be adopted.
- Suitable construction specifications and supervision standards along with field management organization of the construction company and the supervising organization of the consultant, in conformity with these standards, will be established.
- Provision of facilities for securing the traffic route and traffic safety during the construction period.
- Prevent the water contamination of the river or sediment discharge as well as select areas designated by the Philippines for borrow pit, spoil-banks and waste disposal site and contribute in the preservation of the environment by reducing the influence of environment.

2-2-4-2 Implementation Conditions

(1) Natural Condition

The eastern region of the Luzon Island is prone to typhoons that generate in the Pacific Ocean. Sudden swelling of rivers due to heavy rainfall also occur frequently. The annual rainfall of the sites at Bazal Bridge is 3,500mm (200 rainy days), and 4,300mm (240 rainy days) at Umiray Bridge. Although the distribution of the rainfall is almost uniform throughout the year, it is dominant from September to December at Umiray Bridge and from October to January at Bazal Bridge. Therefore, building a temporary landing stage inside the river area during the rainy season is not only perilous but also results in inducing the risk of flood damage by increasing the obstruction ratio of the cross section of the river. This will also increase the economic burden.

From above, the implementation schedule for works inside the river area like the construction of temporary landing stage, bridge foundation, erection of superstructure, foundation of revetment etc. are limited to the dry season when the intensity of the rainfall is relatively low. The dry season for Bazal Bridge is 8 months, from January to August and from February to September for Umiray Bridge.

(2) Security of Safety of Road Users

At present, there are no bridges on both project sites. At the proposed site of Bazal Bridge, there used to be a wooden bridge in the past, which was washed away by the flood in 2004 and has not been restored since. The people and vehicles thus cross the riverbed where the depth of the water is relatively shallow. On the other hand, at the proposed site of Umiray Bridge, traffic and transportation cross the river by means of a bangka (small boat). As the transportation for crossing the river is required to be secured during the period of construction, safety is strictly considered in securing the present traffic.

(3) Safety of Construction Workers and Third Parties

There are villages on either banks of the river at the proposed construction site. Therefore, as a safety measure, the construction yard will be temporarily fenced so as to restrict personnels irrelevant to the construction from trespassing. The construction area and third party area will be distinguished by surrounding the construction area by colored cones. Furthermore, the third person will be clearly notified by introducing barricades and signboards at the entrance of the area occupied for the construction works.

(4) Consideration on Environment

The scope of construction of the project is limited to the proposed bridge sites where valuable aquatic species or endangered aquatic species are not inhabitants of either rivers. The proposed site of Umiray Bridge is located near the river mouth and fall under the category of

the brackish waters. By and large, brackish waters have a characteristic where the species of inhabitants are relatively low although its number is very high. However, as there are no reeds, fern etc. in the vicinity of the sand reef near the river mouth of the Umiray River, which is required for the breeding of the fauna and flora, and as the riverbed consists fairly of course aggregates, the ecosystem is not rich. In addition, the major fishing area of the fishermen residing near Umiray Bridge is the sea. From the points mentioned above, although there is potentially no influence on the ecosystem, high consideration is to be taken on the maintenance of the water quality, transportation and disposal of waste in the designated areas.

2-2-4-3 Scope of Works

The items to be undertaken by the governments of both countries are as shown in Table 2-16.

Table 2-16 Classification of the Responsibilities of the Two Countries

Items	Contents	Classification of Responsibilities		Remarks
		Japan	Philippines	
Land Acquisition, Relocation of Houses	Acquisition of land for construction, Relocation of houses		O	
Procurement of Equipment and Materials	Procurement and transportation of equipment and materials	O		
	Customs clearance of equipment and materials		O	
	Maintenance of Inland transportation road		O	
Preparatory works	Securing of land required for the construction		O	Site office, stock-piling yard, working yard
	Other works	O		
Relocation and removal of obstacles to construction	Relocation of obstacles		O	Electric and telephone poles, water pipes, agricultural canals etc.
Main construction	Construction of bridge	O		Bridge, approach roads, revetment

2-2-4-4 Consultant Supervision

Based on the consultant contract with the Government of the Philippines, a Japanese consultant company will engage in the implementation of the detailed design, tender related works and the supervision works.

(1) Detailed Design

The major contents of the detailed design that the consultant will conduct are as follows:

- Inception meeting with the implementing organization and site investigation
- Detailed design, preparation of the drawings

- Procurement plan of materials and project cost estimation

The required period for the detailed design is estimated to be approximately 4.0 months.

(2) Tendering Service

The main items of the works to be conducted from the time of tender notice to the contract for construction are as follows:

- Preparation of tender documents (prepared simultaneously with the detailed design)
- Tender notice
- Examination of prequalification of the bidders
- Initiation of tender
- Evaluation of tendering documents
- Facilitating of contract execution

The required period for the works relevant to tendering service is estimated to be approximately 4.5 months.

(3) Supervision Works

A consultant company will conduct the supervision of the work that the construction company conducts in conformity with the contract and execution scheme. The main items of the supervision works are as follows:

- Checking and approving of survey related works
- Checking and approving of execution schedule
- Quality control
- Schedule control
- Work progress control
- Safety control
- Checkup of completed amount and handover works

The period necessary for the construction is expected to be 16.8 months for Bazal Bridge and 20.03 months for Umiray Bridge.

For supervision works, one Japanese Resident Engineer and one local staff (miscellaneous works) will be deployed. The Chief Engineer will be in charge in assisting with the commencing work, and supporting the provisional handover inspection. Also, a Japanese Engineer will be dispatched for the final handover inspection.

As the construction is necessary to be conducted by occupying a section of the existing road during the period of construction, the supervision work is conducted so as to prevent accidents at an early stage by consultation and cooperation with the person in charge with the safety of the contractor.

2-2-4-5 Quality Control Plan

The main works that require quality control during the period of construction are as mentioned below.

- Concrete works
- Reinforcement and formwork
- Earthwork
- Pavement work
- Work progress of structures
- Expansion joint, bearings

From among those mentioned above, the major quality control works such as the concrete works is shown in Table 2-17, while earthworks and pavement works in Table 2-18.

Table 2-17 Quality Control Plan of Concrete Works

Item	Testing Item	Test Method (Specification)	Frequency of Test
Cement	Physical test	AASHTO M85	Once before trial mix, and then once for every 500m^3 casting of concrete or for every new material (Mill sheet)
Aggregates	Physical test of fine aggregates for use of concrete	AASHTO M6	Once before trial mix, and then once for every 500m^3 or once when the supplier changes (Confirming the data of the supplier)
	Physical test of coarse aggregates for use of concrete	AASHTO M80	Once before trial mix, and then once for every 500m^3 or once when the supplier changes (Confirming the data of the supplier)
	Screening test	AASHTO T27	Once every month
	Test method of alkali-silica reaction of aggregates (Mortar bar method)	ASTM C1260	Once before trial mix, and then once when the supplier changes
	Test of material content of aggregate	ASTM C295	Once before trial mix, and then once when the supplier changes
Water	Water quality test	AASHTO T26	Once before trial mix, and then anytime when considered necessary
Additives	Quality test	ASTM C494	Once before trial mix, and then anytime when considered necessary (Mill sheet)
Concrete	Slump test	AASHTO T119	Once per every 75m^3 or once per every casting block
	Air content test	AASHTO T121	Once per every 75m^3 or once per every casting block
	Compressive strength test	AASHTO T22	6 samples for every casting, 6 samples for every 75m^3 when the quantity of one casting is large (7-day strength: 3 samples and 28-day strength 3 samples)
	Temperature	ASTM C1064	Once per every 75m^3 or once per every casting block

Table 2-18 Quality Control Plan of Earthworks and Pavement Works

Item	Testing Item	Test Method (Specification)	Frequency of Test
Fill Works	Density test (Compaction)	AASHTO T191	For every 500m^2
Base course Works	Material test (Screening test)	AASHTO T27	Once before use, and once for every 1,500m^3 or when the supplier changes
	Material test (CBR test)	AASHTO T193	Once before use and then once for every 1,500m^{3}or anytime when the supplier changes
	Dry density test (Compaction)	AASHTO T180	Once before use and then twice for every 1,500m^{3}or anytime when the supplier changes
	In-situ density test (Compaction)	AASHTO T191	For every 500m^2

2-2-4-6 Procurement Plan

(1) Major Construction Materials

Major construction materials, excluding steel for temporary works, bearings and expansion joints, are procurable locally. The domestic procurement will mainly be from Manila and Cabanatuan. The procurement classification of major construction materials are shown in Table 2-19 and Table 2-20. As there are no concrete manufacturing plants near the bridge sites, concrete for construction will be made by mixing at the site. The aggregates for the concrete will be procured from quarries from the vicinity of the bridge site.

Table 2-19 Classification for Procurement of Major Construction Materials (1/2)

Items		Procurement classification			Reason for procurement	Procurement route
Name of material	Specification	Local	Japan	Third country		
Materials for structures						
Cement	40kg bag	O				Manila
Cement	Bulk	O				Manila
Reinforcing bars	D6 to D35	O				Manila
Coarse aggregates	River aggregates 3/4 to 3/8"	O				Quarry near site
Fine aggregates	River sand 2/8"	O				Quarry near site
Boulders	350mm to 500mm	O				Quarry near site
Boulders	250mm to 500mm	O				Quarry near site
PVC Pipes	ϕ2 to 6"	O				Manila
PVC Pipes	ϕ2 to 6" pressure capacity	O				Manila
PC Wires	12T12.7	O				Manila
PC Holding fixture		O				Manila
Sheets	ϕ65mm, ϕ38mm	O				Manila
Additives		O				Manila
Grass		O				Manila
Joint filling material	3/4"	O				Manila
Rubber bearings	610 x 360 x 44mm		O		Securing quality & delivery period	Japan to Manila
Expansion joints			O		ditto	Japan to Manila
RC Pipes	ϕ600 to 900mm	O				Manila
Base materials	Granulated aggregates	O				Quarry near site
Filling materials	High quality earth	O				Borrow pit near site

Table 2-20 Classification for Procurement of Major Construction Materials (2/2)

Materials for temporary works		Local	Japan	Third Country	Reason for procurement	Procurement route
Fuel, oil		O				Manila
Timber for formworks		O				Manila
Plywood for formworks		O				Manila
Steel for temporary landing stage	H-shaped steel	O				Manila
Sheet pile	III-type	O	O		To secure quality and delivery period	Japan to Manila
Base material for temporary roads	Granulated aggregates	O				River side near site
Steel for supports	Mould steel, pipe support	O				Manila
Stripping agent		O				Manila
Welding rod	4mm	O				Manila
Oxygen, acetylene		O				Cabanatuan

(2) Special Materials

The special materials to be utilized for this project that needs to be procured from a third country or Japan are steel for temporary works (sheet piles), bearings and expansion joints. Procurement of these materials from Japan is assessed to be reasonable for the following reasons:

i) Sheet Piles

Although covering plates are usually used for the slab of a temporary landing stage, cheap and easily driven sheet piles will be used for this project, as the use of the landing stage is limited to construction works only.

The procurement of sheet piles from the Philippines is difficult, as its quantity is very limited (even in case of covering plate it has to be procured from Japan). Furthermore, as the price of steel is recently inflating universally, procurement is becoming difficult. Under these circumstances, if the steel is procured from a third country, in addition to the risk of delivery period there is a risk of quality security of the lease product. Therefore, procurement from Japan is determined reasonable from the view of easy procurement and computation of lease charge.

ii) Bearings and Expansion Joints

Bearings transmit the load of superstructure to the substructure. Expansion joints absorbs the expansion and contraction of the girders caused by the change in the temperature and also protects the sections at the joints from the passing of the vehicles. These structures are very important in enhancing the durability of bridges. In the Philippines, these materials are mainly imported from a third country. In order to avoid the risk of securing the quality and delivery period, it is adequate to procure these materials from Japan.

(3) Construction Machines

The local contractors in Manila have all machines necessary for the construction of this project. Most of these machines are a second-hand products of Japan and its conditions differ from each other. However, the spare parts are easily available and there are no factors that would hinder its stable operation. Therefore, the machines for this project are planned to be leased from the contractor. There are information that the lease charge of heavy equipment is on an upward trend recently and has risen drastically this year. The construction equipment will either be driven or transported by means of a trailer from Manila to the site. The procurement classification of construction equipment is arranged as shown in Table 2-21 and Table 2-22.

Table 2-21 Procurement Classification of Construction Equipment (1/2)

Items		Lease /Purchase	Procurement Supplier, method etc.			Reason for procurement	Procurement route
Equipment	Specification		Local	Japan	Third country		
Backhoe	0.8m^3	Lease	O				Land transportation from Manila
Backhoe	0.6m^3	Lease	O				ditto
Dump truck	10 ton	Lease	O				ditto
Dump truck	4 ton	Lease	O				ditto
Bull dozer	21 ton	Lease	O				ditto
Bull dozer	15 ton	Lease	O				ditto
Tire roller	8 to 20 ton	Lease	O				ditto
Road roller	10 to 12 ton	Lease	O				ditto
Motor grader	W=3.1m	Lease	O				ditto
Sprinkle car	5,500 to 6,500ℓ	Lease	O				ditto
Truck crane	20 to 22 ton	Lease	O				ditto
Truck crane	50 ton	Lease	O				ditto
Truck mixer	4.4m^3	Lease	O				ditto
Tractor shovel	Wheel type 2.4m^3	Lease	O				ditto
Truck shovel	Wheel type 3.1m^3	Lease	O				ditto
Crawler crane	Rope type hydraulic crane 50 t	Lease	O				ditto
Crawler crane	Rope type hydraulic crane 80t	Lease	O				ditto
Crawler crane	Rope type hydraulic crane 100t	Lease	O				ditto
Crawler crane	Rope type hydraulic crane 150t	Lease	O				ditto
Electric vibro-hammer	60KW	Lease	O				ditto
Diesel generator	10KVA	Lease	O				ditto
Diesel generator	60KVA	Lease	O				ditto
Diesel generator	200KVA	Lease	O				ditto

Table 2-22 Procurement Classification of Construction Equipment (2/2)

Items		Lease /Purchase	Procurement Supplier, method etc.			Reason for procurement	Procurement route
Equipment	Equipment		Local	Japan	Third country		
Underwater pump	ϕ100mm, head capacity 10m	Lease	O				Land transportation from Manila
Underwater pump	ϕ150mm, head capacity 10m	Lease	O				ditto
Compressor	3.5 to 3.7m^3/min	Lease	O				ditto
Concrete plant	27m^3/h	Lease	O				ditto
Heavy weight breaker	Hydraulic, 1,300kg class	Lease	O				ditto
Vibration roller	Hand-guide type 0.8 to 1.1t	Lease	O				ditto
Tamper	60 to 100kg	Lease	O				ditto
Vibration roller	Attachment type/ combined type	Lease	O				ditto
Truck crane	4.0t, 2.9t lifting capacity	Lease	O				ditto
Jack for PC	PC girder manufacturing apparatus	Purchase (charge)	O				ditto
Grout pump for PC	PC girder manufacturing apparatus	Purchase (charge)	O				ditto
Gantry crane	3.0t	Purchase (charge)	O				ditto
Hydraulic jack	20t, 30t	Purchase (charge)	O				ditto
Apparatus for lateral holding	20t, 30t	Purchase (charge)	O				ditto
Concrete cutter	Blade diameter 45 to 56cm	Lease	O				ditto
Rotary all casing boring machine	Maximum diameter 1,500mm Engine	Lease	O				ditto
Rotary all casing boring machine	Maximum diameter 2,000mm Engine	Lease	O				ditto
Line marker	Molten Width15cm	Lease	O				ditto
Dissolution tank	200 to 300kg x 2tanks	Lease	O				ditto
Water jet for pile driving	Motorized 14.7MPa, 325L/min	Lease	O				Transportation to Manila from Japan
Trailer	20t	Lease	O				Land transportation from Manila
Trailer	30t	Lease	O				ditto
Trailer	40t	Lease	O				ditto
Trailer	50t	Lease	O				ditto

2-2-4-7 Implementation Schedule

The project implementation schedule for the detailed design and construction of Bazal Bridge and Umiray Bridge is shown in Table 2-23 and Table 2-24.

Table 2-23 Project Implementation Schedule (Bazal Bridge)

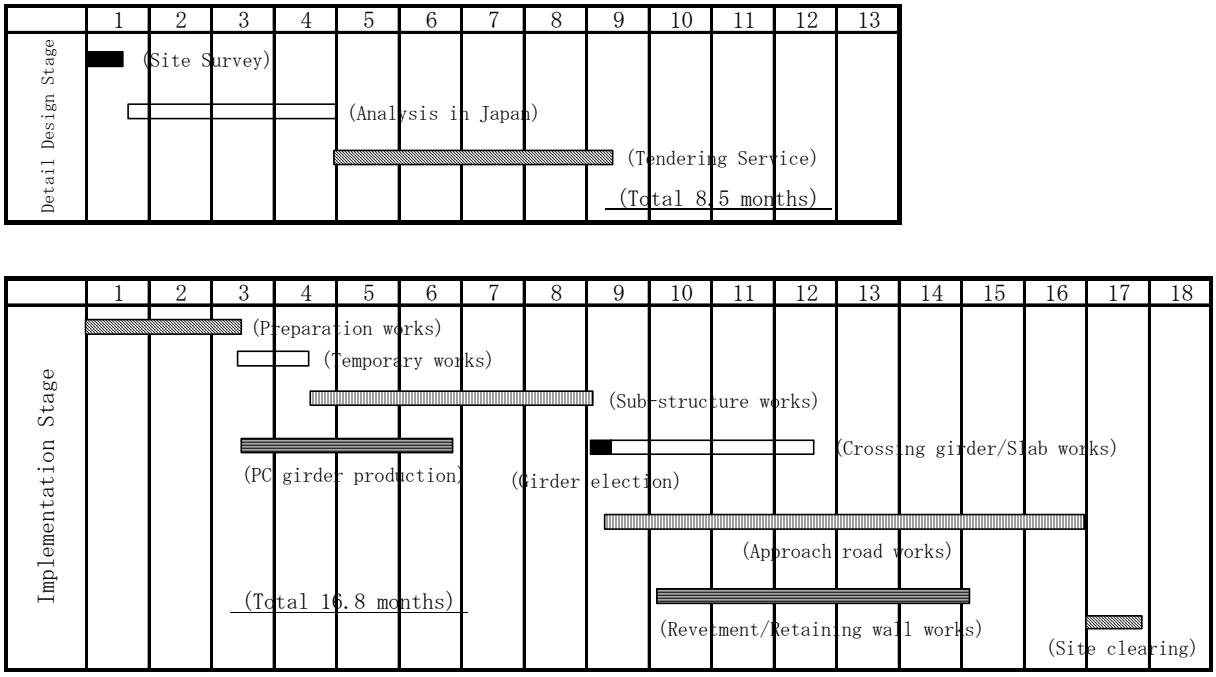
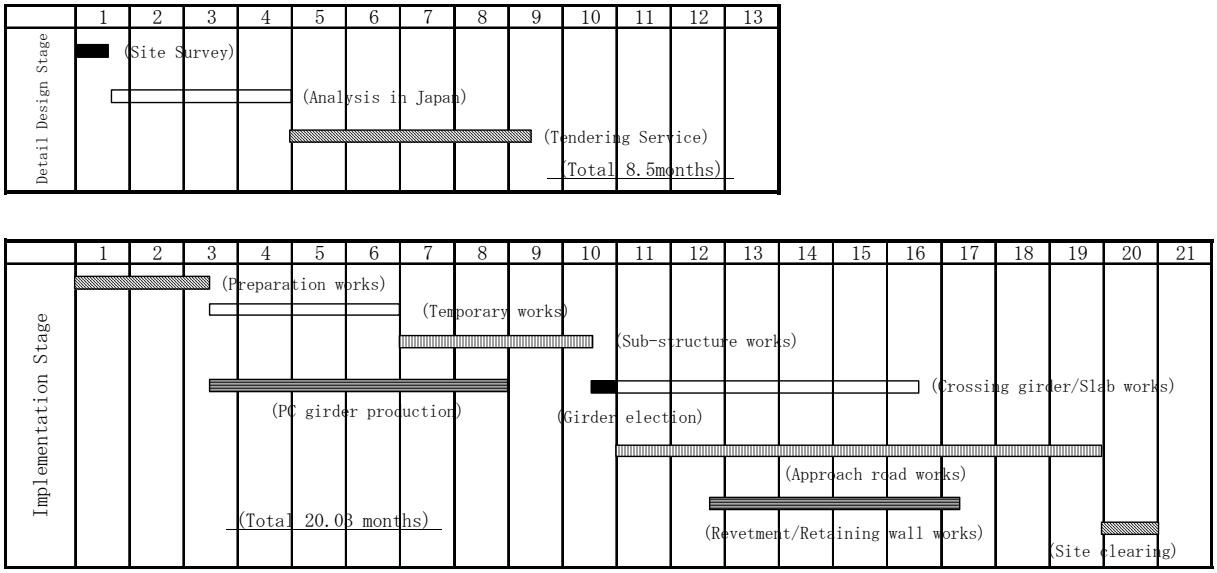


Table 2-24 Project Implementation Schedule (Umiray Bridge)



2-3 Obligations of the Recipient Country

The undertakings that are required from the Government of the Philippines for the smooth execution of this project are as follows:.

- To provide documents and information necessary for the execution of this project
- To acquire construction land and to relocate the houses
- To secure land for the construction yard, stock piling yard, site office, girders manufacturing yard, and detour routes
- To secure borrow pit, spoil-banks, and industrial waste disposal areas
- To improve the access roads necessary for the construction (Refer to Table 2-25)
- To install equipment for electricity at the site office
- To remove electric and telephone poles and water pipes that hinders the construction work and to attach the water pipe on Bazal Bridge.
- To bear the advising commission and payment commission to the Japanese bank where an account related to the project is opened for the banking services like service charge and disbursement charge
- To exempt materials imported for construction from taxation and customs clearance in order to ensure smooth inland transportation
- To exempt Japanese nationals engaged in the construction work from customs duties and other fiscal levies on products and service necessary for the execution of the project.
- To exempt Japanese nationals from all legislative measures necessary for entering and staying in the Philippines.
- To acquire permits and approval documents (Approval of National Economic Development Authority (NEDA) Investment Coordination Committee (ICC), approval on environmental issues, permits for the bridge construction inside the river area, earthworks, traffic restrictions, relocation of poles and water pipes etc.) necessary for the execution of the project.
- To ensure proper use and maintenance of the bridges and the approach roads.
- To cooperate in solving potential troubles with the local people or any third party in connection with the execution of the project.
- To bear all expenses required for the execution of this project, other than that borne by the grant aid of Japan.

Table 2-25 Proposed Improvement Scheme for the Access Road to Construction Site

1) Bazal Bridge (From National Highway to Bazal Bridge, Total Length=1.4km)

No.	Location	Existing Condition	Rating	Ability of Transportation	Proposed Scheme
1	Inter Section-1	Inter Section with Right Angle: Less Road Width W=6.0m	No Good	Not Available	Widening of Intersection
2	Inter Section-2	Inter Section with Right Angle: Less Road Width W=4.6m	No Good	Not Available	Widening of Intersection
3	Inter Section-3	Inter Section with Right Angle: Less Road Width W=5.1m	No Good	Not Available	Widening of Intersection

2) Umiray Bridge (From Umiray Bridge to Dingalan, Total Length L=23.0km)

No.	Location (Distance from Umiray Bridge)	Existing Condition	Rating	Ability of Transportation	Proposed Scheme
1	0.4	Box Culvert (2.9m x 2/3.0m)	Good	Available	Not Required
2	2.3	Crossing on Riverbed (Malacauyaan River)	No Good	Not Available	Improvement Scheme-2 (Spillway Type)
3	2.6	Crossing on Riverbed	No Good	Not Available	Improvement Scheme-1 (Drift Type)
4	3.6	Crossing on Riverbed	No Good	Not Available	Improvement Scheme-1 (Drift Type)
5	4.5	Crossing on Riverbed	No Good	Not Available	Improvement Scheme-2 (Spillway Type)
6	4.8	Crossing on Riverbed	No Good	Not Available	Improvement Scheme-1 (Drift Type)
7	5.6	Crossing on Riverbed	No Good	Not Available	Improvement Scheme-2 (Spillway Type)
8	6.0	Crossing on Riverbed	No Good	Not Available	Improvement Scheme-1 (Drift Type)
9	6.6	Crossing on Riverbed	No Good	Not Available	Improvement Scheme-1 (Drift Type)
10	6.8	Crossing on Riverbed	No Good	Not Available	Improvement Scheme-2 (Spillway Type)
11	9.3	Drift way (Ibona River)	Good	Available	Not Required
12	9.3	Crossing on Riverbed (Ibona River)	No Good	Not Available	Improvement Scheme-2 (Spillway Type)
13	9.3	Crossing on Riverbed (Ibona River)	No Good	Not Available	Improvement Scheme-2 (Spillway Type)
14	11.7	Box Culvert (3.5m x 2/3.5m)	Good	Available	Not Required
15	12.3	Spillway (ϕ0.9m)	Good	Available	Not Required
16	13.1	Crossing on Riverbed	No Good	Not Available	Improvement Scheme-1 (Drift Type)
17	13.8	Box Culvert (3.0m x 2/2.0m)	Good	Available	Not Required
18	14.8	Crossing on Riverbed	No Good	Not Available	Improvement Scheme-1 (Drift Type)
19	15.7	Crossing on Riverbed	No Good	Not Available	Improvement Scheme-1 (Drift Type)
20	15.9	Crossing on Riverbed	No Good	Not Available	Improvement Scheme-2 (Spillway Type)
21	16.8	Sharp Curve (Road Width=4.0m)	No Good	Not Available	Improvement of Road Alignment, Widening with Embankment
22	17.6	Crossing on Riverbed (Amtang River)	No Good	Not Available	Improvement Scheme-2 (Spillway Type: 2-Location)
23	20.2	Drift Type	Good	Available	Not Required
24	20.5	Steep Slope (Gradient=20%)	No Good	Not Available	Improvement of Gradient with Embankment, Proposed Gradient=12.5%)
25	21.2	Box Culvert (2.4m x 2/2.9m)	Good	Available	Not Required
26	22.3	Steel H-Beam Bridge (Dingalan River: Bridge Length=32.0m)	Good	Available	Not Required
27	22.7	Box Culvert (3.5m/3.2)	Good	Available	Not Required
	23.0	Dingalan			

3) Umiray Bridge (Access Road to Borrow Pit, Total Length=3.1km

No.	Location (Distance from Umiray Bridge)	Existing Condition	Rating	Ability of Transportation	Proposed Scheme
1	0.12	Crossing on Riverbed	No Good	Not Available	Improvement Scheme-2 (Spillway Type)
2	1.26	Old Wooded Bridge (Bridge Length=4.5m, Width=1.5m)	No Good	Not Available	Improvement Scheme-2 (Spillway Type)
3	2.40	Old Wooden Bridge (Bridge Length=2.6m, Width=1.5m)	No Good	Not Available	Improvement Scheme-2 (Spillway Type)
4	Several Locations	Narrow Road (Width=1.5 to 3.0m)	No Good	Not Available	Road Widening with Embankment

2-4 Project Operation Plan

(1) Operation and Maintenance System

The maintenance of the bridges and approach roads after its construction will be conducted by the province and the city. The operation and maintenance of Bazal Bridge will be conducted jointly by Aurora Province and Maria Aurora Municipality of Aurora Province. For Umiray Bridge, operation and maintenance of the northern side from the middle of the bridge will be conducted by Aurora Province, while the southern side from the middle of the bridge will conducted by the province of Quezon.

The maintenance system of the local autonomous bodies in concern is shown in Table 2-26 and the organizational chart of each Province and Municipality is shown in Fig. 2-5, Fig. 2-6, and Fig. 2-7.

The respective provinces and the technical department of the municipality are regarded to be capable of operation and maintenance works, as maintenance and control of roads and bridges under its jurisdictions are being conducted without any particular problems.

(2) Contents of Maintenance Works

The maintenance works required are as follows:

Periodical Inspection	:	Periodical inspection of the bridges and the approach roads
Everyday Maintenance	:	Cleaning of the drainage facilities, pavement, expansion device, shoulders, and bridges etc.
Repair/Maintenance	:	Repairing of pavement, drainage facilities, main body of the substructure, bridge accessories, shoulder and slope, fall prevention blocks etc.

The maintenance bodies mentioned above will implement the everyday maintenance and repair works of the damaged parts.

(3) Present Conditions of Maintenance Works

In order to achieve sufficient development and sustainability of the project effects, the following issues need particular consideration, as it is important to secure all time high traveling performance and to improve the durability of the facilities.

- To keep informed at all times the condition of the facilities through periodical inspection.
- To clean in particular, the drainage facilities, bearings, expansion devices and its neighborhood.
- To secure the budget necessary for the maintenance work.

As the bridges constructed under this project have high durability and weather resistance,

large-scale maintenance will not be required for a certain period of time and in consequence, there will be no technical difficulties in the implementation of the management and maintenance works. Given that the above points are taken into consideration, the management and maintenance work are determined to be implementable under the present budget/system.

Table 2-26 Maintenance System of Each Local Autonomous Body

		Aurora Province	Quezon Province	Maria Aurora Municipality
Organizational Chart		Refer to Fig. 2-5	Refer to Fig. 2-6	Refer to Fig. 2-7
Number of Maintenance/ Construction Staff		22	125	42
Maintenance Budget (Thousand Pesos)	Year 2005	5,282	n.a.	4,000
	Year 2006	5,089	17,849	4,957
	Year 2007	7,337	18,101	3,993
	Year 2008	14,053	24,080	n.a.
Objective Roads & Bridges	Road(km)	94.8	302.3	303.8
	Number of Bridges	21	48	78

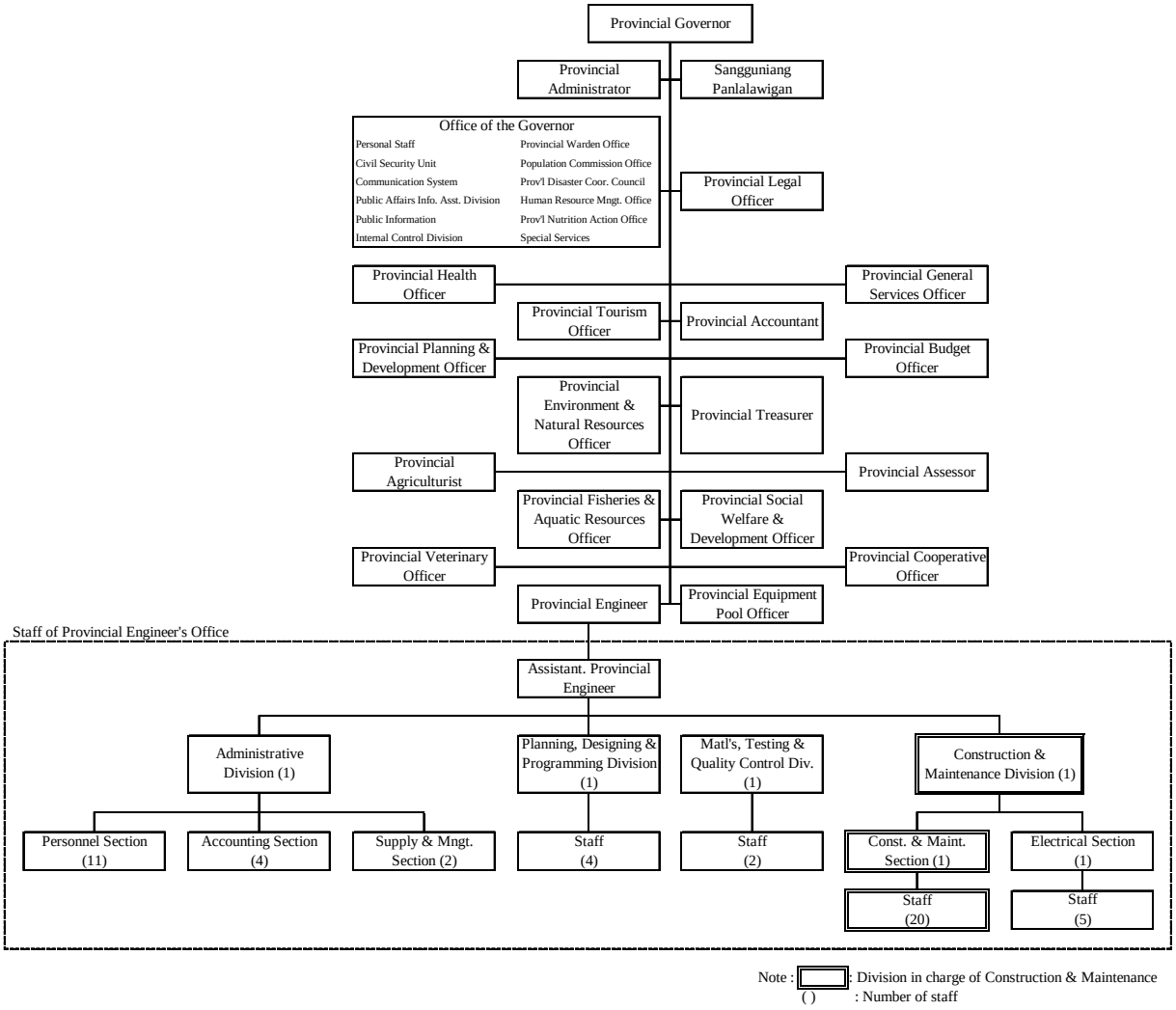
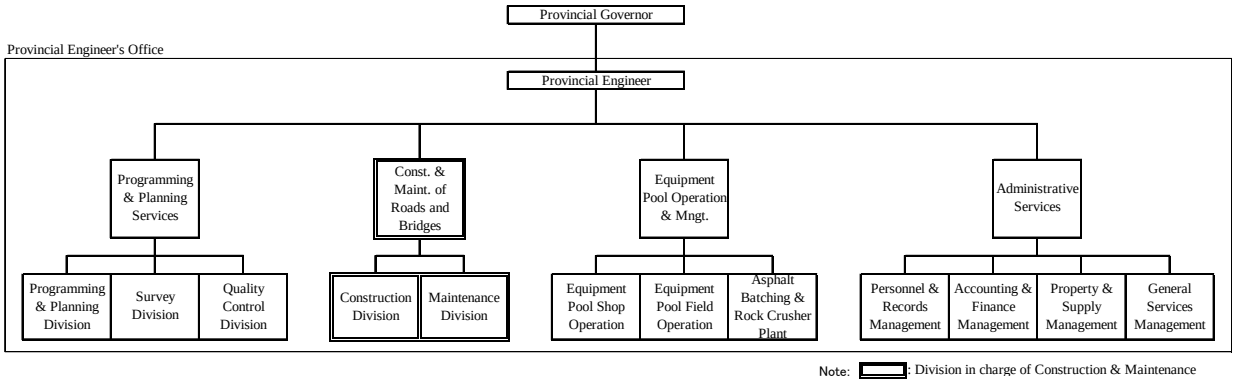


Fig. 2-5 Organizational Chart of the Aurora Province



(Provincial Engineer's Office only)

Fig. 2-6 Organizational Chart of the Quezon Province

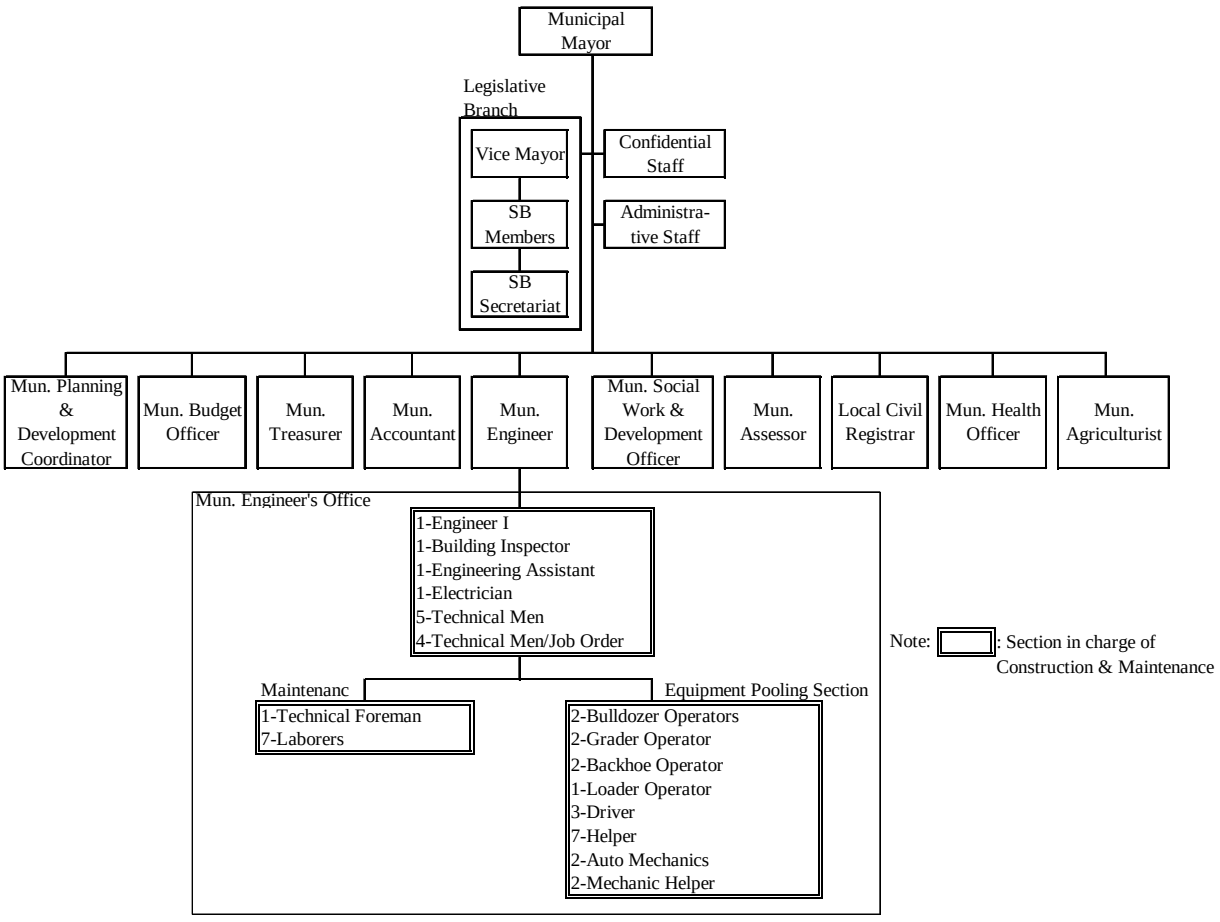


Fig. 2-7 Organizational Chart of Maria Aurora Municipality

2-5 Project Cost Estimation

2-5-1 Initial Cost Estimation

The initial cost estimation is shown below:

However, this cost estimation is provisional and would be further examined by the Government of Japan for the approval of the Grant.

(1) Philippines Contribution

Estimated Total Cost: approx. 17.135 Million PhPs

According to the cost estimation by the Japanese side, the Philippines side is expected to fund as shown in Table 2-27.

Table 2-27 Estimated Cost of Philippine Contribution

	Bazal Bridge	Umiray Bridge	Total
① Advising commission	0.164 (0.453)	0.334 (0.993)	0.498 (1.446)
② Payment commission	0.327 (0.902)	0.583 (1.608)	0.910 (2.510)
③ Land acquisition and relocation of houses	3.476 (9.594)	2.851 (7.867)	6.327 (13.461)
④ Relocation of electric and telephone poles	0.120 (0.331)	0.000 (0.000)	0.120 (0.331)
⑤ Improvement of access roads	0.000 (0.000)	9.280 (25.613)	9.280 (25.613)
Total	4.087 (11.280)	13.048 (36.081)	17.135 (47.361)

Million Peso (Million Yen)

(2) Cost Estimation Condition

① Estimation Timing : April 2008

② Foreign Exchange Rate : US$1.00=JPY110.3
PHP1.00=JPY2.76 円

Foreign Exchange Rate was applied as an average of TTS rate for six months from October 2007 to March 2008.

③ Construction Period : The implementation schedule of the detailed design and construction is shown in 2-2-4-7.

④ Remarks : This cost estimation is provisional and would be further examined by the Government of Japan for the approval of the Grant.

2-5-2 Operation and Maintenance Cost

The following organizations will conduct the maintenance work, such as periodic inspection, everyday maintenance, and repairing of the bridges constructed under this project.

Bazal Bridge : In collaboration of Aurora Province and Maria Aurora Municipality

Umiray Bridge : Aurora Province (Northern side from the middle of the bridge), and Quezon Province (Southern side from the middle of the bridge)

The breakdown of the expenses required for the maintenance and operation of each bridge is as shown in Table 2-28 and Table 2-29

As the bridges constructed under this project have high durability and weather resistance, large-scale maintenance will not be required for a certain period of time and in consequence, there will be no technical difficulties in the implementation of the management and maintenance works.

In comparison to the maintenance cost of the two bridges, which is 0.24 million Pesos, the budget of Aurora Province and Quezon Province for the fiscal year 2008 is 14 million Pesos and 24 million Pesos respectively, whereas the budget of Maria Aurora Municipality for fiscal year 2007 is 4 million Pesos.

Assuming that Aurora Province and Maria Aurora Municipality would each contribute to the maintenance cost required for Bazal Bridge equally, the maintenance cost for Bazal Bridge will be equivalent to 1.0% and 3.4% of the overall maintenance cost of Aurora Province and Maria Aurora Municipality respectively. Similarly, if the provinces of Aurora and Quezon is assumed to bear the maintenance cost equally, the maintenance cost required for Umiray Bridge will be equivalent to 1.0% and 0.6% of the total maintenance cost of Aurora Province and Quezon Province respectively.

From above, the management and maintenance work are determined to be implementable under the present budget and system of each local organization. However, discussion among the concerned organizations is essential in order to determine the proportion of contribution of the maintenance costs of either bridge.

Table 2-28 Major Maintenance Items and its Annual Expenses (Bazal Bridge)

	Items	Inspection Items	Implementation Frequency	Number of Personnels	Equipment to be Used	Required Quantity	Amount (PHP)
Regular Inspection	Bridge		12 times/ year Required number of days 1/ inspection	2	Scope, hammer, sickle, barricade	Total 24 man days/ year	34,240
	Pavement	Cracks, Undulations, Damages etc.					
	Drainage Facilities	Mud, Presence of Obstacles					
	Main Body	Damages, Deformations, Taints, Abrasion etc.			Pick-up	Total 12 cars/ year	60,000
	Revetment	Cracks, Damages, Failures etc.					
	Bridge Utilities	Attachments, Damages of Hand Rails etc.					
	Approach Roads						
	Pavement	Cracks, Undulations, Damages etc.					
	Shoulder, Slope	Erosion, Deformation, failure etc.					
	Fall Prevention Block	Cracks, Defects etc.					
						Subtotal	94,240
	Items	Implementing Items	Implementing Frequency	Number of Personnels	Equipment to be Used	Required Quantity	Amount (PHP)
Everyday Maintenance	Drainage Facilities	Mud, Removal of Obstacles, Cleaning	4 times/ year Required number of days: 4/ maintenance	5	Scope, Barricade, Grass Mower, Broom, Tools	Total 40 man days/ year	30,616
	Pavement	Cleaning					
	Expansion Joint	Mud, Removal of obstacles, Cleaning					
	Shoulder	Grass cutting, Cleaning			Light Truck	Total 8 cars/ year	64,000
	Bridge	Cleaning					
						Subtotal	94,616
	Items	Implementing Items	Implementing Frequency	Number of Personnels	Equipment to be Used	Required Quantity	Amount (PHP)
Repair	Bridge		1 time per year Required number of days: 7/ repair	6		Total 24 man days/ year	17,708
	Pavement	Crack Sealing, Repairing of damages					
	Drainage Facilities	Repairing of damages			Tamper	Total 4/ year	4,000
	Main Body	Repairing of damaged portion			Light truck	Total 4/ year	48,000
	Revetment	Repairing of damaged Hand Rails					
	Bridge Utilities						
	Approach Roads	Crack Sealing, Repairing of damages			Base course Materials	6.0m^3 / year	8,400
	Pavement	Repairing of damages			Concrete	1.0m^3 / year	6,000
	Shoulder, Slope	Repairing of damaged portion					
	Fall Prevention Block					Subtotal	84,108
						Total	272,964

Table 2-29 Major Maintenance Items and its Annual Expenses (Umiray Bridge)

	Items	Inspection Items	Implementation Frequency	Number of Personnels	Equipment to be Used	Required Quantity	Amount (PHP)
Regular Inspection	Bridge		12 times per year Required number of days one day per inspection	2	Scope, hammer, sickle, barricade	Total 24 man days/ year	34,240
	Pavement	Cracks, Undulations, Damages etc.					
	Drainage Facilities	Mud, Presence of Obstacles					
	Main Body	Damages, Deformations, Taints, Abrasion etc.			Pick-up	Total 12 cars/ year	60,000
	Revetment	Cracks, Damages, Failures etc.					
	Bridge Utilities	Attachments, Damages of Hand Rails etc.					
	Approach Roads						
	Pavement	Cracks, Undulations, Damages etc.					
	Shoulder, Slope	Erosion, Deformation, failure etc.					
	Fall Prevention Block	Cracks, Defects etc.					
						Subtotal	94,240
	Items	Implementing Items	Implementing Frequency	Number of Personnels	Equipment to be Used	Required Quantity	Amount (PHP)
Everyday Maintenance	Drainage Facilities	Mud, Removal of Obstacles, Cleaning	4 times per year Required number of days: 4 per maintenance	5	Scope, Barricade, Grass Mower, Broom, Tools	Total 40 man days/ year	30,616
	Pavement	Cleaning					
	Expansion Joint	Mud, Removal of obstacles, Cleaning					
	Shoulder	Grass cutting, Cleaning			Light Truck	Total 8 cars/ year	64,000
	Bridge	Cleaning					
						Subtotal	94,616
	Items	Implementing Items	Implementing Frequency	Number of Personnels	Equipment to be Used	Required Quantity	Amount (PHP)
Repair	Bridge		21 times per year Required number of days: 7 per Repair	6		Total 24 man days/ year	17,708
	Pavement	Crack Sealing, Repairing of damages					
	Drainage Facilities	Repairing of damages			Tamper	Total 4/ year	4,000
	Main Body	Repairing of damaged portion			Light truck	Total 4/ year	48,000
	Revetment	Repairing of damaged Hand Rails					
	Bridge Utilities						
	Approach Roads	Crack Sealing, Repairing of damages			Base course Materials	$6.0m^3$ / year	8,400
	Pavement	Repairing of damages			Concrete	$1.0m^3$ / year	6,000
	Shoulder, Slope	Repairing of damaged portion					
	Fall Prevention Block					Subtotal	84,108
						Total	272,964

2-6 Other Relevant Issues

(1) Enhancement of DAR's know-how related to bridge construction

The Department of Agrarian Reform does not have enough know-how, while the Department of Public Works and Highway (DPWH) has voluminous experience in terms of bridge construction. This Project plays a critical role as a model project in the 34 listed bridge constructions to promote the expanded ARC development program. Therefore, the technical support of DPWH would be imperative. It would be highly needed to strengthen partnership with DPWH and develop the officers as a receiving body of technical support, which would be helpful to DAR in implementing the remaining bridge construction projects.

(2) Rehabilitation of access road to construction site

The provincial road, which leads to Umiray Bridge construction point in Barangay Umiray from Dingalan, is to cross more than 20 rivers and creeks without a crossing structure. Since large and heavy equipments would be utilized for the bridge construction, the rehabilitation of said road would be crucial in constructing Umiray Bridge. Therefore, the aforementioned portion of the provincial road should be rehabilitated so as to be accessible by the commencement of the construction work of Umiray Bridge. In addition, the budget allocation and administrative arrangement for the operation and maintenance of the provincial road during the construction work would be highly required.

(3) NEDA-ICC Approval

The Department of Agrarian Reform has to secure the NEDA-ICC (National Economic Development Authority, Investment Coordinating Committee) Approval for the Umiray Bridge Project before the commencement of its detailed design.

Chapter 3 Project Evaluation and Recommendation

3-1 Project Effect

This Project aims to improve access between target ARCs and other expanded ARCs to strengthen partnerships and promote interactions among areas, as well as to accelerate development in the target areas.

Improvement of access would be the biggest effect directly derived from the construction of the bridges. The local people living in the surroundings of target barangays are the main beneficiaries. The students and staff of Bazal Campus of ASCOT would also be direct beneficiaries of Bazal Bridge. The estimate number of direct beneficiaries for each of two bridges is shown in Table 3-1 and Table 3-2.

Direct and indirect effects derived from the Project are summarized in Table 3-3 and Table 3-4.

Table 3-1 Estimated Direct Beneficiaries (Bazal Bridge)

Bazal Bridge	Estimated Direct Beneficiaries
Bazal Barangay	1,288
Malasin Barangay	564
Relatives of ASCOT, Bazal Campus	150
Total	2,002

Table 3-2 Estimated Direct Beneficiaries (Umiray Bridge)

Umiray Bridge	Estimated Direct Beneficiaries
Umiray Barangay (G. Nakar side)	5,099
Umiray Barangay (Dingalan side)	5,071
Total	10,170

Table 3-3 Direct Effect of the Project

Current status and issues	Requested Japanese Assistance	Direct effect and Expected Improvement
(Improvement of Accessibility) 1. Annual number of days of access disruption At the time of swollenness, it is quite hard to cross a river in a usual way. During flood calamities, evacuation route is completely blocked. Annual number of days of access disruption is as follows. Bazal Bridge: 36 days (impossible to cross a river on foot) Umiray Bridge: 6 days (no operation of bunker boat)	The Bridge and its approach road to be constructed.	Annual number of days of access disruption would be on naught. Improved access to be ensured even during flood season would carry away the isolation of target areas. Evacuation route would be ensured as well as access route to support afflicted people in case of calamity.
2. Average time to cross a river Due to lack of a bridge, it takes quite a long time to cross a river. This also prevents transport of commodities as well as agricultural materials and products. The measures and the time needed to cross a river are the following: Bazal Bridge: Walk, Tricycle, etc (6.1min) Umiray Bridge: Bunker Boat (25.0 min)	ditto	To ensure access to the target areas and to shorten the time needed to cross a river Constant access by vehicle would be ensured and circulation of people and materials would be drastically improved. Bazal Bridge: 16 sec (Average Speed: 25 km/h) Umiray Bridge: 52 sec (Average Speed:25 km/h)

Table 3-4 Indirect Effect of the Project

Increase of agricultural products

1. Agricultural production per hectare (rice) will be increased by promotion of the application and implementation of adequate cultivation techniques such as fertilization and irrigation water management
2. Cropping Area (rice) will be expanded by the introduction of construction machineries and construction of irrigation canal easily.
3. Enhancement of accessibility between ASCOT and other areas would make the training program various and frequent.

Vitalization of cooperatives' activities

4. Enhancement of accessibility would make the activities of cooperatives vital and diverse resulting to increase of cooperative members.
5. With the vitalization of cooperatives, income of members and, therefore, capital of cooperatives would increase.

Increase of farmers' income

6. Enhancement of availability of agricultural inputs and accessibility to credit institutions would make it possible to generate profit, which meets the productivity and increase farmer's income.

Enhancement of access to education

7. Annual number of days of access disruption would be on naught, which dissolves inaccessibility to educational institutes during the flood season.

Others

8. Ensuring human interaction and material flow and promoting partnerships among ARCs in the surrounding areas would provide more farmers equal benefits of ARCs and public services.

3-2 Recommendations

(1) Issues to be addressed by the recipient government

i) Role of a model project

The nationwide ARC development program should be efficiently promoted on the premise that the infrastructure would be developed, which is positioned as a key component in the ARC connectivity strategy. The Project would have a significant meaning as a model project in promoting the ARC Connectivity Strategy in other areas, in terms of the following items rather than the bridge feature.

- Improvement of accessibility, enhancement of productivity, diversification of agri-business resulting to vitalization of ARC cooperatives are expected in related ARCs or non-ARCs.
- Safety of people is improved in target barangays.
- The procedures necessary for bridge construction such as ICC, EIA (ECC), of which the related LGU should make an arrangement, are clarified and certified smoothly.

The outputs derived from this Project, in connection with the ARC development program, would be expected in other areas. The unpredictable and negative impacts of the Project can be lessons learned and should be considered in constructing bridges under the ARC development program in the future. Further, the know-how on a series of procedures relative to the bridge construction work would be accumulated in DAR as useful experiences to carry out bridge construction more efficiently.

ii) Strengthening Cooperatives and increasing members

The cooperative provides farmers in the ARC with various services or business opportunities. To provide better services or more business opportunities for the members, the cooperatives have to bolster its capital as much as possible and call for more members. The number of cooperative members, however, accounts for only about 20-50% of the population in the ARC resulting to a small or limited amount of the capital, which consists of investments of members. The following were pointed out as main causes in the interview survey.

When the cooperative buys products from members, it usually takes about one week to pay back for its account payable due to lack of capital. Since the farmers prefer the immediate realization of their products, they choose to sell their products to traders even though the selling price is lower.

When the cooperative does not provide micro credit service for members, the farmers borrow money from traders to get agricultural inputs and hand over the products to them at a low price after harvesting.

Due to the ill feeling or confrontation against cooperative directors, some farmers do not dare

to join cooperatives.

The proper support of DAR would be required for farmers to strengthen the capacity of the cooperatives through identification, analysis and resolution of these immanent issues in each ARC.

iii) Close partnership among LGUs

Umiray Bridge, which is one of two bridges to be constructed by the Project, will be a crucial structure to link Region III with Region IV. Therefore, LGUs, PO and MO in both Regions should build close relationships and develop the development strategy of inter-regional expanded ARC in order to promote more effective ARC development as well as to ensure its operation and maintenance under two different administrative jurisdictions.

iv) Improvement of access road to the market

Both the unpaved roads leading to the construction point in each area, specifically the provincial road between Dingalan and Umiray, should be rehabilitated as mentioned above. In the case of Bazal Bridge, the access to the center of the Municipality is comparatively easy, but the road work is ongoing or roadbed is inadequate in many portions of the road to Cabanatuan which could be a large market located out of the target area. This issue should be addressed and resolved as soon as possible because ease of access to the large market would materially affect the productivity in the cultivation area.

(2) Relationship with JICA technical assistances and other donor agencies

There are no technical assistance related to this Project and there are no related projects funded by other agency in terms of CARP implementation in the target area. Therefore, there is no need to consider the relationship with such technical assistance and other donors.