Department of Public Works and Highways

Republic of the Philippines

No.

BASIC DESIGN STUDY
ON
THE PROJECT FOR FLOOD DISASTER MITIGATION
IN CAMIGUIN ISLAND
IN THE REPUBLIC OF THE PHILIPPINES

April 2009

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 project for flood disaster mitigation in Camiguin Island 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 August 7 to September 15, 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.

April 2009

MATSUMOTO Ariyuki

Vice-President

Japan International Cooperation Agency

April 2009

Letter of Transmittal

We are pleased to submit to you the basic design study report on the project for flood mitigation in Camiguin Island 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 July 2008 to April 2009. 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,

YOSHIHARU Matsumoto

Project manager,

Basic design study team on the project for flood mitigation in Camiguin Island in the Republic of the Philippines

Summary

1. Background of the Project

In 2004, the Arroyo Administration launched the Mid Term National Development Plan (2004 2010) under the banner of "poverty eradication" mentioning ten important subjects including the "Encouragement of Decentralization by Infrastructure Improvement." This plan aims to mitigate disasters, accelerate the regional economy and decrease poverty in isolated areas under specific objectives such as improvement of safety against disaster, rehabilitation or reconstruction of roads and bridges connecting with sightseeing areas and between product areas and markets, by giving high priority to disaster prevention or transportation that leads to economic development for districts as well as social stabilization. Equipping the Strong Republic Nautical Highway (SRNH) is an important aim of stimulating regional economies through connecting directly Manila and each island and improving the logistics network. Camiguin is a section of the Central Strong Republic Nautical Highway and it is an important place as a relay point between Bohol and Mindanao.

Every year the Philippines suffer from floods by typhoons and/or storms. The average of 630 people die a year and the amount of damage is 7.6 billion pesos which corresponds to 2 percent of the national budget. Under this condition, the Philippines drew up a basic plan of flood mitigation measures for a big river basin in 1982, and have invested funds mainly from ODA. However, many rivers are yet to be improved and it may take a long time before improvement projects for them are started based on the availability of local as well foreign funds.

On the other hand, concerning measures of flood control, in 2000 the Philippines established the Flood Control and Sabo Engineering Center (FCSEC), which aims to plan, design, build and maintain flood control and Sabo facilities in the country, under the Department of Public Works and Highways (DPWH). Japan has provided technical cooperation to improve technical skill for many years such as dispatch of experts, conduct of pilot projects, and holding of seminars to promote self help efforts of the Philippines.

In November 2001, a mudslide caused by Typhoon Nanang resulted in 250 dead and missing and the amount of damage in Camiguin has been estimated at five million US dollars. Japan drew up a basic plan of soft measures against disasters and it has strived for reinforcement of the disaster prevention system after the accident. However, there is danger that the same kind of damage could happen, because hard measures such as rehabilitation of foundation of disaster prevention facilities or restoration works on bridge facilities have not begun. Under the circumstances, the Government of the Republic of the Philippines has requested technical cooperation for the construction of two Sabo dams and Hubangon Bridge in Camiguin Island from Japan.

2. Contents of the Project

JICA dispatched a research team to the Philippines for the basic design study from August 7 to September 15, 2008. The team continued the study and evaluation of field survey results upon its

return to Japan and then explained the basic design outline to the authorities concerned in the Philippines from February 15 to February 26, 2009.

The results of the field survey in the Philippines show that there is a danger that the same kind of disaster by heavy rainfall could occur again because the mudslide in November 2001 thickly covering the vicinity with unstable deposits, indicating that the main girder of the badly damaged bridge is on a dangerous situation considering that one side of the bridge is still being utilized.

Based on the request of the officials concerned of the Government of the Philippines, as well as the results of field survey and consultation meetings in this basic design study, the contents of the intended project are as summarized in Table 1 and Table 2 below.

Table 1 Basic Parameters of Hubangon Bridge

Item		Basic Parameters of Bridge
Bridge Site		Present Bridge Location
Bridge Length		40.9m
Bridge Span		1 span
Width	Number of Lanes / Roadway	2 lanes, 7.32m (3.66m x 2)
	Walkway	0.76m x 2 (Both Sides)
	Railing	0.30m x 2 (Both Sides)
Bridge Type	Foundation	Cast-in-place Reinforced Concrete Pile
	Superstructure	PC girders (Height of Beam: 2.0m; 5 Main Beam)
Access Road Length		Left Side: 10.75 m、Right Side: 11.35 m
Revetment Type		Grouted riprap (Around Bridge Abutment)
Utilities		Road Marking, Guard Rail
Others		Detour During Construction Location: Upstream Side Length: Approximately 350m Width: 6m (Gravel Surface Pavement) Crossing River Point: 3 points (Width 4m)

Table 2 Basic Parameters of Sabo Dam and Access/Maintenance Road

Item		Upper Sabo Dam	Lower Sabo Dam
Sabo Dam	Location	3.1km from River Mouth	3.7km from River Mouth
	Basin Area	2.97km^2	3.17km^2
	Dam Type	Concrete Gravity-Type (Without Slit)	Concrete Gravity-Type (Without Slit)
	Dam Height / Length	10m / 115m	12m / 70m
	Over flow Width	18.0m	12.0m
	Depth of Design Flood Discharge	2.5m	3.0m
	Freeboard	1.25m	1.50m
	Thickness of Crest	4.0m	4.5m
	Front Protection Works	None	None
Access/Maintenance Road	Number of Lanes / Width	1 Lane / Roadway: 4.0 m, Road Shoulder: 1.0 m x 2 = 2.0 m	
	Steepest Longitudinal Gradient	12% (14% when avoidable)	
	Minimum Curve Radius	20m	
	Pavement	Gravel (Crusher-run) Pavement: t = 150mm (Longitudinal Gradient less than 7%, Materials from Camiguin Island) Cement Concrete Pavement: t = 150mm (Longitudinal Gradient 7% or more, Materials from Camiguin Island)	
	Base Course	Aggregate Base Course: t=150mm(Materials from Camiguin Island)	
	Length	525m	657m

3. Implementation Schedule and Estimated Project Cost

The required implementation period is approximately 6.5 months for works relevant to the detailed design and tendering services and approximately 19.0 months for the construction work. The initial cost estimation for the Philippines Contribution amounts to 1.951 Million Pesos.

4. Verification of the Project Appropriateness

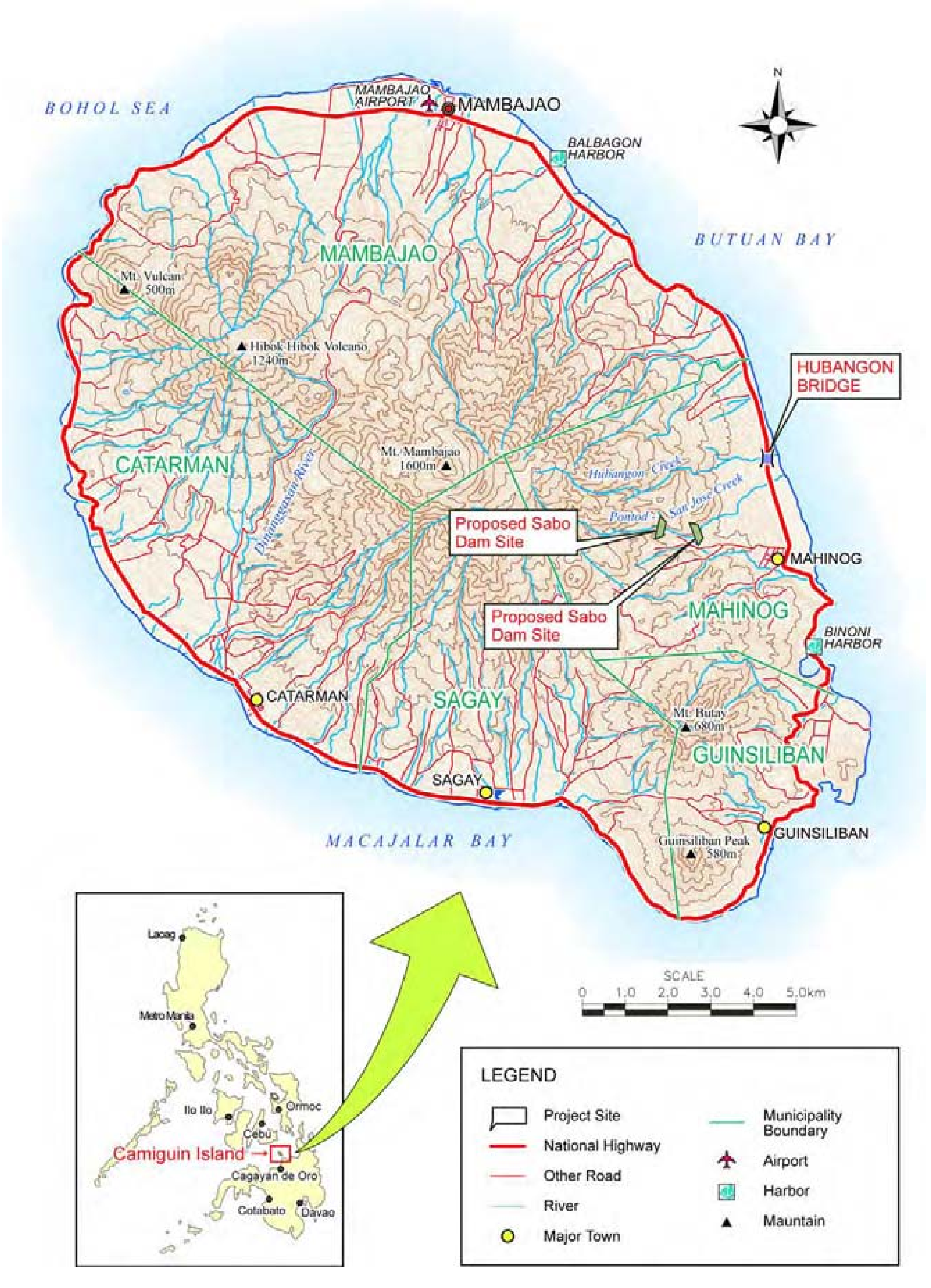
The project is in agreement with the Medium Term Philippine Development Plan for 2004 2010, and is situated on the Central Strong Republic Nautical Highway in SRNH that relates to the important point, "The Direct Connection between Islands Economy and Manila." Therefore, the project is important as the logistics network that connects the economic activities of the islands including Mindanao and Manila and stimulates new chances for economic development.

Sabo facilities are constructed at river basins where there is a danger of occurrence of huge mudslides. Synthetic disaster measures can be incorporated by a combination of hard and soft ones, such as the hazard map, the implementation of alert warning for refuge, and the provision of a manual on disaster prevention. Rehabilitation of the damaged bridge would eternally provide safe and harmonious traffic, and the regional economy will be stimulated together with the decrease of poverty in the isolated areas.

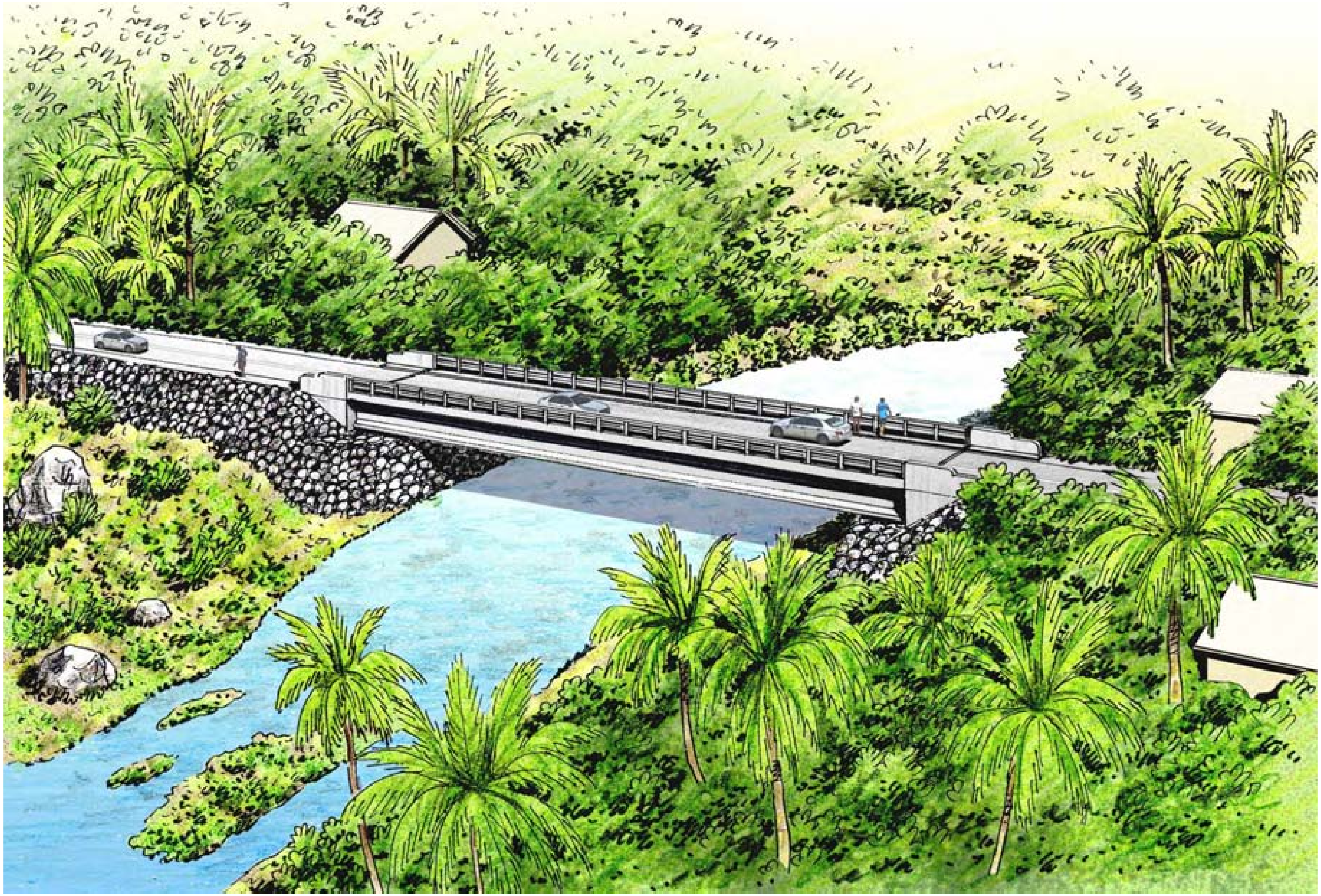
Maintenance of the two Sabo dams is to be transferred to the local government of Camiguin after their completion. However, if large repair is needed, DPWH will be responsible for the repair through FCSEC, which will provide technical cooperation and expertise. Maintenance of the bridge and the maintenance/access roads falls under the jurisdiction of the regional office of DPWH (Region X) and the Camiguin District Engineering Office, which has been maintaining 22 bridges in the island with no problem so far. There will be no financial problem because the expense to maintain each facility is little.

Therefore, the conclusion to carry out the proposed project under "Non Project Japan" is pertinent. However, the enforcement of soft measures continuously by the Philippine Government is necessary to produce satisfactory results, because the Sabo dams to be constructed in the project aims to control mudslide and does not have the function to control flood. This matter has been fully explained, and the Philippine authorities concerned have agreed, but monitoring should be necessary after that.

Contents



Location Map



Perspective (Hubangon Bridge)

Perspective (Sabo Dams)

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Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
ADB	Asian Development Bank
ASTM	American Society for Testing Materials
BDCC	Barangay Disaster Coordinating Council
BRS	Bureau of Research and Standard, DPWH
CAD	Computer Aided Design
CBFM	Community Based Forest Management
CDPP	Community Based Disaster Prevention Plan
CNC	Certificate of Non Compliance
CPDO	City Planning and Development Office
CPI	Consumer Price Index
CVO	Community Volunteer Officer
DAO	DENR Administrative Order
DAR	Department of Agrarian Reform
DCC	Disaster Coordinating Council
DENR	Department of Environment and Natural Resources
DEO	District Engineering Office
DND	Department of National Defense
DOH	Department of Health
DOST	Department of Science and Technology
DOTC	Department of Transportation and Communication
DPWH	Department of Public Works and Highways
DPWH DEO	DPWH District Engineering Office
ECC	Environmental Clearance Certificate
EIA	Environmental Impact Assessment
ECA	Environmentally Critical Areas
ECC	Environmental Compliance Commitment
ECP	Environmentally Critical Projects
EO	Executive Order
EIRR	Economic Internal Rate of Return
EIS	Environmental Impact Statement
EMB	Environmental Management Board
ESSO	Environment and Social Services Office, DPWH
FCSEC	Flood Control and Sabo Engineering Center, DPWH
GIS	Geographic Information System
GDP	Gross Domestic Product
GOJ	Government of Japan
GOP	Government of the Philippines
GPS	Global Positioning System
IEE	Initial Environmental Examination
IEEC	Initial Environmental Examination Checklist
IEER	IEE Report
IROW	Infrastructure Right of Way, DPWH
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
LGU	Local Government Unit

Abbreviations

LTO	Land Transportation Office
MDCC	Municipal Disaster Coordinating Council
MGB	Mines and Geosciences Bureau
MSL, msl	Mean Sea Level
MTPTP	Medium Term Philippines Development Plan
MTPIP	Medium Term Public Investment Program
NAMRIA	National Mapping and Resource Information Agency
NAPOCOR	National Power Corporation
NDCC	National Disaster Coordinating Council
NEDA	National Economic Development Authority
NGO	Non Government Organization
NIA	National Irrigation Administration
NSCP	National Structural Code of the Philippines
NWRB/NWRC	National Water Resources Board / National Water Resources Council
O&M	Operation and Maintenance
OCD	Office of Civil Defense
OJT	On the Job Training
PAGASA	Philippine Atmospheric, Geophysical and Astronomical Services Administration
PC	Prestressed Concrete
PCC	Project Coordination Committee
PCM	Project Cycle Management
PD	Presidential Decree
PDR	Project Description Report
PEIS	Programmatic EIS
PENRO	Provincial Environment & Natural Resource Office
pH	Potential of Hydrogen
PHIVOLCS	Philippine Institute of Volcanology and Seismology
PMO	Project Management Office, DPWH
PNP	Philippine National Police
PPDO	Provincial Planning and Development Office
RA	Republic Act
RAP	Resettlement Action Plan
RDC	Regional Development Council
RDCC	Regional Development Coordinating Council
ROW	Right of Way
TSG	Technical States Army and Guidelines
USACE	United States Army Corps of Engineers
USAID	United States Agency for International Development
USGS	United States Geological Survey
WHO	World Health Organization

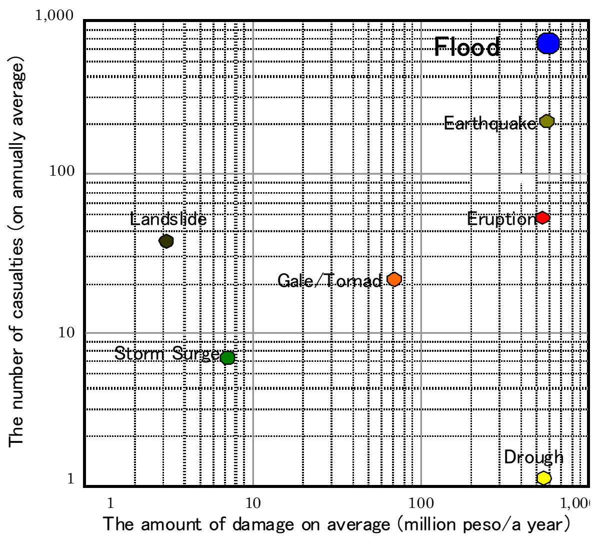
Chapter 1 Background of the Project

(1) Background

In 2004, the Arroyo Administration launched the Mid Term National Development Plan for 2004 2010 under the banner of "poverty eradication" mentioning ten important subjects including the "Encouragement of Decentralization by Infrastructure Improvement." This plan aims to mitigate disasters, accelerate the regional economy and decrease poverty in isolated areas under specific objectives, such as improvement of safety against disaster, rehabilitation or reconstruction of roads and bridges connecting with sightseeing areas and between product areas and markets, by giving high priority to disaster prevention or transportation that leads to economic development as well as social stabilization for districts.

The Philippines is one of the countries that have the most natural disasters among nations in Southeast Asia, because of the condition of weather, geographical and geological features, and the damage from especially typhoons and storms is 92.5% of all disasters. Not only floods but also earthquakes, volcanic eruptions and droughts frequently occur; however, concerning the frequency of disasters, volcanic eruptions or earthquakes happen only once in a few years or several decades, while floods happen almost every year at anyplace. The disaster record (Figure 1-1) by the Office of Civil Defense (OCD), in which damage by natural disasters from 1980 to 2003 is put together, indicates that floods caused the worst damage in the average number of casualties and amount of damage a year. Flood victims by typhoons and storms average 630 people a year and the amount of damage is 7.6 billion pesos, which is roughly 2 percent of the national budget. Under the circumstances, in 1982 the Philippines drew up a basic plan of measures to prevent floods from large river basins, and it has invested funds mainly ODA. It has promoted measures to deal with natural disasters introducing mainly Japanese funds whenever a disaster happens in small and medium rivers. However, the Philippines began on only a few river development constructions and it may take much time for it to start on the other rivers based on the availability of national funds, and a few low priority projects based on foreign funds.

Figure 1-1 Number of Casualties and Amount of Damage on the Annual Average by Disasters



The Philippines suffered damage from destructive typhoons 3.5 times a year on average from 1990 to 2003. The damage mostly by floods to general assets, government structures and crops amounts to 96.57 billion pesos. The amount of annual average damage by floods for the past 24 years is shown in Table 1-1

Table 1-1 Amount of Damage on the Annual Average

Year	The number of victims		Harm to a Person			Damaged House		Amount of Damage (million pesos)
	Households	Population	Dead	Missing	Injured	Completely Destroyed	Partially Destroyed	
1980	248,164	1,666,498	36	4	55	16,510	51,101	1,472
1981	250,325	1,472,417	484	264	1,922	44,994	159,251	1,273
1982	266,476	1,569,017	337	223	347	84,027	97,485	1,754
1983	140,604	747,155	126	168	28	29,892	85,072	523
1984	741,510	4,048,805	1,979	4,426	732	310,646	313,391	416
1985	318,106	1,643,142	211	300	17	8,204	211,151	3
1986	287,240	1,524,301	171	43	155	3,162	14,595	1,838
1987	464,162	2,591,914	1,020	213	1,455	180,550	344,416	8,763
1988	1,173,994	6,081,572	429	195	468	134,344	585,732	8,675
1989	501,682	2,582,822	382	89	1,088	56,473	184,584	4,494
1990	1,265,652	6,661,474	676	262	1,392	223,535	636,742	11,713
1991	150,894	759,335	5,201	4,278	357	15,458	83,664	74
1992	418,964	2,097,693	145	95	51	3,472	8,342	7,359
1993	1,523,250	8,202,118	814	214	1,637	166,004	456,773	25,038
1994	670,078	3,306,783	266	54	260	58,869	226,291	3,401
1995	1,710,619	8,567,666	1,255	669	3,027	294,654	720,502	57,781
1996	260,581	1,254,989	124	49	97	2,690	17,557	10,109
1997	777,997	3,954,175	199	28	66	13,225	53,980	4,842
1998	1,590,905	7,197,953	498	116	873	137,020	406,438	17,823
1999	270,424	1,281,194	56	3	25	144	687	1,555
2000	1,426,965	6,852,826	338	59	370	24,573	195,536	7,217
2001	756,938	3,629,295	431	134	418	14,899	54,422	6,924
2002	538,600	3,546,469	169	33	71	2,980	15,947	829
2003	702,223	3,362,991	139	28	182	12,306	51,579	4,567
Total	15,215,530	77,693,144	15,178	11,886	14,840	1,823,345	4,907,712	183,047

Source : Reinforced of Flood Control and Sabo Skill Project, Improvement Survey of Flood Control of Implementation System Business in Small River, JICA, in September 2004

On the other hand, with regard to measures of flood control and Sabo, in 2000 the Philippines established the “Flood Control and Sabo Engineering Center (FCSEC),” which aims to plan, design, construct and maintain and take care of flood control and Sabo facilities by itself, under the Department of Public Work Highway (DPWH). Japan has provided technical cooperation to advance FCSEC’s technical skill for many years, such as dispatch of experts, execution of pilot projects and holding of seminars, to promote self help efforts in the Philippines.

In her inaugural address in June 2004, President Arroyo drew up the Medium Term Philippine Development Plan for 2004 2010 under the banner of “poverty eradication” mentioning ten important subjects including the “Encouragement of Decentralization by Infrastructure Improvement.” Disaster prevention and transportation which lead to the development of regional economy and social stability are given high priority in the projects.

The construction of Sabo dams, which is one of the objectives of the investigation in this basic design study, will improve the safety degree from mudslide disasters for local people, decrease the effect of disasters and exhibit a big effect on decreasing mudslide damage in the only national road in Camiguin (the circumferential road in the island). Improvement and rehabilitation of the bridge will ensure safe and smooth traffic on the road and make the transportation of goods much more convenient. In addition to this, Camiguin, which is the subject of investigation, is on the Central Strong Republic Nautical Highway in the expressly important three Strong Republic Nautical Highways in relation to “direct connection between islands economy and Manila.” The SRNH RORO 1 system making use of the freeway is expected as a logistics system which connects islands economy including Mindanao and Manila and extends new economic chances, and Camiguin is important as a relay point between Mindanao and Bohol.

Therefore, the measure against flood and mudslide in this project is useful in Camiguin and for improvement of the logistics system connecting the north and the south, and it is assessed as an exceedingly important project in the Medium Term Philippine Development Plan for 2004 2010.

In November 2001, Typhoon Nanang, which went through northern Mindanao to the Visayan Islands, caused heavy rain, and it terribly damaged the northern part of Mindanao, the central part of Cebu and Southern Panay. Especially in Camiguin, which is north of Mindanao, a mudslide occurred and the deceased and missing numbered 250 in all of the islands. In the town of Mahinog, 224 people died or were missing. The damage covered a wide range of not only basic infrastructures such as roads, waterworks and electrical transmission facilities, but also schools, houses, paddy fields, farm animals and so on, and the amount of damage was about 500 million yen. Rainfall was observed at the observation facility of PHIVOLCS standing halfway up the Hibok Hibok Volcano at six every morning. Rainfall by Typhoon Nanang started on November 6 and heavy rain continued for several hours from before dawn on the 7th. Precipitation on the 7th was 517 mm, the highest since the start of observation at the facility on Hibok Hibok Volcano. According to the interview-survey, a roar like the explosion of a volcano was heard before dawn on the 7th, and 15 minutes later waves of mudslide hit a residential area at the lower reaches and there was nothing the residents could do to avoid the turbid waters. The disaster was caused as the result of slope collapsed by heavy rain, and the mudslide cascaded to the lower reaches.

The DPWH office in Region X and the provincial government of Camiguin requested technical cooperation from JICA immediately after the disaster in November 2001, and JICA carried out “a basic survey of disaster prevention and rehabilitation activities in Camiguin (a basic survey abroad) and prepared a hazard map based on a hearing survey and the results of a survey on geographical and geological features for the main 28 rivers in the island in 2003. The survey recommended to immediately carry out soft measures for all islands with facility measures against disaster. JICA also carried out “the basic survey of disaster prevention for soft measures (a basic survey abroad 2)” in 2004. The contents of the survey were (i) Drawing of a line between dangerous places and the others; (ii) Establishment of a rainfall gauge and guidance of observation; (iii) Establishment of alarm standard, (iv) Preparation of manual of disaster measures; and (v) Execution of emergency drill.

Disaster investigation committees were organized in the level of province, town, or village, emergency drills were made, and good results were obtained by the two surveys. However, the application of only soft measures is not enough, because a mudslide or flash flood will reach a place soon after the disaster, especially on a small and steep river basin like the Pontodo River Basin. Besides, soft measures are for refuge to decrease the extent of damage like living in a safer place to avoid the damage. Since facility measures such as repair of Sabo dams and damaged bridges have not been introduced after the disaster in 2001, they are expected to be provided as soon as possible.

Under the circumstances, the Philippines requested technical cooperation from Japan, in June 2006, for the construction of two Sabo dams and the reconstruction of Hubangon Bridge.

(2) Natural Conditions

Camiguin is a pear shaped volcanic island with a total land area of 238 square kilometers (major axis 37 kilometers, minor axis 14 kilometers). Some of the major volcanoes are Mt. Vulcan (671 meters), Mt. Hibok Hibok (1,086 meters), Mt. Mambajao (1,525 meters), and Mt. Butay (679 meters). Hibok Hibok Volcano, which is situated on the northwest side of the island, last erupted on December 4, 1951, killing more than 500 people, and is still considered to be an active volcano. Mt. Mambajao is situated at the upstream of the scheduled facilities but poses no danger of eruption since it is dormant. Alluvial fans along the seashore are the only flat lands in the island and are the center of large city development.

Camiguin is basically volcanic in origin and the entire island is covered with pyroclastic falls including molten rocks. From the fact that Volcanic Neck or dome of lava has been formed at the top of the mountain, the lava/molten rock is presumed to be andesitic in nature having high viscosity, almost similar to those of Mountain Asama, in Japan. Exposed andesitic rocks can be observed at the upstream area of the project sites, the Hubangon and Pontod rivers. The midstream area is blanketed by pyroclastic falls; whereas, the downstream area is an alluvial fan formed by mud and volcanic mud flow.

The climate of Camiguin Island is classified into Corona Climate Type IV. The mean annual temperature of the island is 23.6 degrees centigrade. According to the rainfall data (Table 1-1) recorded from 1991 to 2006 at the Hibok Hibok Station, the only climate observation station in the island, the average rainfall is 2,817 millimeters. The pronounced rainy season of the island is between the months of November to February.

Geographically, the Philippines and its surrounding areas are visited by typhoons frequently, of which most of them hit Luzon Island and the northern part of the Visayas. Typhoons rarely occur in the northern and southern parts of Mindanao, including Camiguin Island. Therefore, it is presumed that people here have very low awareness of mitigation against disasters triggered by typhoons.

The Hubangon Bridge lies across the Hubangon River. The area is a compound alluvial fan formed by the Hubangon River (catchment area: 6.29km2) and the Pontod River (catchment area: 4.61km2) that flows directly south of the Hubangon River. In 2001, heavy rain brought by Typhoon Nanang triggered large scale slope failures in the mountains and carried massive mudflow, bearing boulders and driftwoods from the Pontod River, feeding them into the Hubangon River and destroying the village downstream. Also, the mudflow fed into the Hubangon River concentrated at the Hubangon Bridge, inflicting severe damage to the bridge.

Under these circumstances, the Government of the Philippines implemented a fragmented drainage system of both the rivers by constructing training dikes that control the river channel of the Pontod River.

(3) Environmental and Social Considerations

i) Upstream Sabo Dam

The adverse impacts from the construction of access/maintenance road are permanent alteration of land use and influence on agricultural productivity (paddy field, banana and coconut plantations, etc.). It also affects one house, a small water reservoir tank and several water pipes. Therefore, implementation of proper compensation and relocation measures are required.

The project area is non existent of precious natural forests, wetlands, or any notable landscape, with most of the area being secondary forest such as fields, plantations, etc., or unused lands within the river area. Fish do not inhabit the river. Species of dragonfly, frog/toads and tadpoles inhabit the dam sites and are similar to those inhabiting in the surrounding area.

Cattle and/or manual labor are the basic means of transportation of products, timbers, etc., in the region. After the constructed facilities open for service, mobility and transportation conditions are expected to improve. However, proper detour for walkways needs to be provided during the construction period so as to minimize the influence on them. Since excavation using explosives is required during the initial stage of construction, it is extremely important to provide the residents information on the execution schedule as well as to make sure that the residents engaged in transporting agro products from these areas are restricted to trespass during excavation works. The expected number of construction related vehicles plying the road during the construction period is expected to be about 20. Therefore, significant hindrance to the existing traffic is considered to be very low. However, it is important to minimize the influence to the region by paying special attention to the time, route, and pedestrians during transportation of materials to and from the project site.

The project site is neither inhabited by indigenous people nor by ethnic minorities, and the economic disparity is also very low. As a result, adverse impacts on such society are out of question.

The purpose of Sabo dam is not to dam a river or store water but to control the flow of debris. From this point of view, the discharge volume at either stream (down/up) of the dam is almost the same. Therefore, there are no adverse impacts to the flow regime or the groundwater from the construction. Similarly, since the annual sediment yield is very low, the change in the volume of sediment supply downstream is considerably small. Therefore, the impact of shore erosion due to the decrease in sediment yield is considered negligible.

ii) Downstream Sabo Dam

The provision of access/maintenance road rather has positive impacts such as reducing the labor load for transportation of products like banana and coconut, which presently are being transported by means of cattle or manual labor. However, though small, the project does have adverse impacts such as permanent alteration of land use, influence on agricultural productivity (paddy fields, banana and coconut plantations) that necessitates implementation of proper compensation and relocation measures. The excavation works during the initial stage of dam construction requires the use of explosives, and it is extremely important to provide the residents information on the execution schedule as well as to make sure that the residents engaged in transporting agro products are restricted to trespass the excavation area as aforementioned. It is also important to minimize the influence to the region by paying special attention to the time, route and pedestrians during transportation of materials to and from the project site.

The project area is non-existent of precious natural forests, wetlands, or any notable landscapes, with most of the area being secondary forests. There is a spring nearby which is a habitat to 1 to 10 centimeter big freshwater fish, the Gobiidae. Species of dragonfly, frog/toads and tadpoles inhabit around the dam site and do not differ from those inhabiting in the region. The fact that it is an underground stream and inhabitation of anadromous fish was not observed during the investigation shows that the chances of existence of such fish are almost negligible.

There are no indigenous inhabitants or ethnic minorities in the area and the economic disparity is also low and is therefore considered to be unaffected by the project.

The purpose of Sabo dam is not to dam a river or store water but to control the flow of debris. From this point of view, the discharge volume at either stream (down/up) of the dam is almost the same. Therefore, there are no adverse impacts to the flow regime or the groundwater from the construction. Similarly, since the annual sediment yield is very low, the change in the volume of sediment supply downstream is considerably small. Therefore, the impact of shore erosion due to the decrease in sediment yield is considered negligible.

Influence to the region is minimized by paying special attention to transporting time, route, pedestrians, etc., during transportation of equipment and materials to and from the project site.

iii) Hubangon Bridge

The site along the national road is a settlement area. The area and its surroundings are non existent of natural forests or/and wetlands and are mostly cultivated land, secondary forests and unused river area. Commercial facilities/shops, indigenous inhabitants, ethnic minorities also do not exist and, moreover, there are no noticeable economic disparities. The project is thus considered to have minimum effects on the poor, indigenous inhabitants, and ethnic minorities as well as to imbalance the benefits.

The periphery of the bridge is mostly settlement area and cultivated land (paddy field, banana and coconut plantations, etc.). Temporary alteration of these land uses is required during the construction of a detour, which further requires implementation of proper compensation measures. Similarly, since public facilities such as electric wires, water supply, etc., need relocation, it is necessary to urge the Philippine side to implement proper compensation measures so that the effects to the locals are minimized.

Though slight deceleration is unavoidable, the provision of a detour attributes to maintaining smooth traffic flow during the reconstruction of the bridge. The construction is scheduled to be undertaken during dry season when the water volume is low, and a temporary stage (small caliber support) is scheduled for erection of the superstructure, in view of minimizing the effects to the flow of the river.

Influence to the region is minimized by paying special attention to transporting time and its route, pedestrians, etc. during transportation of equipment and materials to and from the project site.

iv) Approval and Certificates

All projects in the Philippines require either the Environmental Compliance Certificate (ECC) or the Certificate of Non Coverage (CNC) issued by the Environmental Management Bureau, Department of Environment and Natural Resources (DENR), an agency authorized for the Environmental Impact Statement System (EIS).

Regarding the Project, the Environmental and Social Services Office (ESSO) of the Department of Public Works and Highways, following field investigation, prepared a report on the project describing the characteristics, location, and potential adverse impact on environment and society and submitted it to the Environmental Management Bureau, DENR. The project was approved, after being reviewed, as not having severe adverse impact on the environment. Subsequently, the CNC was issued for the bridge construction and Sabo dam construction on October 27, 2008 and February 18, 2009 respectively. Therefore, the procedures related to environmental effects have been completed.

v) Basic Agreement on Resettlement and Land Acquisition

The procedures for resettlement and land acquisition required under this project are mentioned as an action plan of the Infrastructure Right of Way (IROW) office of DPWH in the Infrastructure Right of Way Procedural Manual (2003). Basic agreement was reached, during the discussion held in February 2009, with the resident of the house identified as project affected. Similarly, an agreement was also reached, during the discussion in March 2009, with the landowner on the acquisition of approximately one hectare of land. The procedures for land acquisition, registration and payment of guarantee fees are scheduled to be carried out in the coming days.

vi) Mitigation Measures

The project is classified as Category B under the guidelines of JICA. The mitigation measures to be taken for the factors deemed as having effects on the environment are arranged in the following table.

Table 1-2 Mitigation Measures against Environmental Impact due to Construction of Sabo Dam

Item	Environmental Impact	Assessment	Mitigation Measures
Involuntary Resettlement	Utmost attention was paid in planning the alignment so as to avoid resettlement. However, one settlement will be affected by the construction of the road for maintenance of the upstream dam.	Limited impact	According to the survey conducted by DPWH ESSO, the resident seeks to resettle downstream where his parents are presently residing. The implementing agency will take the responsibility for resettlement in accordance with the request of the resident.
Economical Activities	There are no commercial stores. However, due to permanent change in the land use at the project site, the activities of agricultural products such as those of paddy fields and banana/coconut plantations are affected.	Limited impact and mitigation possible	The impact is limited as the area entitled for acquisition is only about 1 hectare. Measures will be taken in employing the locals for construction works under the responsibility of the implementing agency.
Land Use	No natural forest or wetlands. The effects of land use are those mentioned above.	Limited impact and mitigation possible	Same as above
Transportation/ Utilities	Regional transportation and drinking water storage tank (8 m^3) distribution pipes will be affected.	Limited impact and mitigation possible	- Dispersion of works will be practiced taking into consideration the dense-traffic locations and time within the limits so that the project schedule is not affected. This will be mentioned in the contract and the residents will be informed as well. - Water storage tank and distribution pipes will be relocated by the implementing agency.
Water Quality	Water quality will be affected by the alkali-water from the casting of sabo dam concrete and curing	Mitigation possible	The drainage of all concrete works will be collected, neutralized and discharged. This will be clearly mentioned in the contract document.
Noise/Vibration	The project site environment is affected by the noise and vibration produced during construction.	Limited impact and mitigation possible	- Dispersion of works to avoid concentration, minimizing vibration caused by inadequate defects by conducting proper and timely maintenance of the machines. - Limitation of speed of trucks. - Avoidance of nighttime construction.

Table 1-3 Mitigation Measures against Environmental Impact due to Reconstruction of Bridge

Item	Environmental Impact	Assessment	Mitigation Measures
Economical Activities	There are no business stores. However, due to temporary change in the land use along the detour, the activities of agricultural production such as those of paddy fields and banana/coconut plantation are affected.	Limited impact and mitigation possible	The impact is limited since the area entitled for temporary acquisition is only about 0.5 hectare. Measures will be taken in employing the locals for construction works under the responsibility of the implementing agency.
Land Use	No natural forest or wetlands. The effects of land use are those mentioned above.	Limited impact and mitigation possible	Same as above
Transportation/ Utilities	Regional transportation will be affected by the construction. Electric wires and water supply facilities will have to be relocated.	Limited impact and mitigation possible	- Detour will be provided to secure proper flow of traffic - Dispersion of works will be practiced taking into consideration the dense traffic locations and time within the limits so that the project schedule is not affected which shall be mentioned in the contract and the residents will be informed as well. - Electric wires and water supply facilities will be relocated by the implementing agency.
Air Pollution	Atmosphere is polluted due to emission of gas during construction	Limited impact and mitigation possible	- Dispersion of works to avoid concentration. - Control of abnormal emission of gases generated by defects of machines by conducting proper and timely maintenance. - Limitation of speed of vehicles. - Avoidance of nighttime construction work.
Noise/Vibration	The project site environment is affected by the noise and vibration produced during construction.	Limited impact and mitigation possible	-Dispersion of works to avoid concentration, minimizing vibration caused by inadequate defects by conducting proper and timely maintenance of the machines. -Limitation of speed of vehicles; Avoidance of nighttime construction work.
Traffic Accidents	Regional transportation will be affected by the construction and risk of accidents may increase.	Limited impact and mitigation possible	- Detour will be provided to secure proper flow of traffic. - Control of unforeseen incidents by installing sign posts and familiarizing the locals by informing them beforehand.

Monitoring of the environment is planned to be carried out to ensure that the agency entrusted by the project implementing agency accordingly executes the mitigation measures mentioned above. The monitoring plans are as mentioned below.

1) The proposed mitigation measures will be included in the contract documents as a condition, and make the Contractor's responsibilities for the protection of environment explicit.

2) Ensure that the Contractor prepares and submits the reports as stipulated in the contract.

3) The environmental problems during the construction period will be resolved by investigating the execution condition of the mitigation measures with reference to the reports on environment.

vii) Stakeholders Meeting

The contents of the stakeholders meeting are as follows:

Date Time	: 23 August 2009; from 09:15hrs to 11:35hrs
Place	: Birhen Delos Remedies Church, Mahinog Municipality, Camiguin Province
Subject	: Disaster mitigation and restoration project under the Grant Aid of Japan Sabo Dam and Bridge Construction
Participants	: 187 persons (108 Males and 79 Females) Mostly Farmers, drivers (transport), employees of Balangay, housewives etc.
Host	: Staff of Regional Technical Office, Department of Public Works and Highways
Contents	: Japan's Grant Aid Projects Objectives and outline of the project The necessity of environmental and social considerations and its legal procedures
Q/A	: Q- From when does the Project commence? A- Probably from early 2010 (considering the procedural requirements of Japan and the Philippines) Q- When will the Project terminate? A- Approximately 2 years after the commencement of the Project.

The questionnaire distributed to the residents before hand were collected during the stakeholders meeting and was analyzed. The result is as mentioned below.

Number Distributed: 500

Distribution Method:

The provincial government gave copies of the questionnaire to the Chairpersons of the seven barangays concerned (Catohogan, Hubangon, Owakan, Puntod, Tubod, San Jose, San Isidro) who distributed them to the barangay residents.

Responses: 98 (Percentage of Response 20%)

The residents were asked to submit the duly accomplished questionnaire during the stakeholders meeting. The respondents to the questionnaire were therefore presumed to be participants of the meeting.

Respondents: 59 Males, 38 Females (Male 60%, Female 39%), 1 No response

Results:

Were you familiar with the Project?	: YES 98 (100%)
Are you in favor with the project?	: YES 98 (100%)
Are you in favor with the construction of Sabo Dam?	: YES 97（99%）,No response 1
What are the expected benefits from the construction of Sabo Dam (Multiple Answers)?	: Safety (Life Protection) (95%)
Are you with the relocation of Hubangon Bridge	: YES 98（100%）

What are the expected benefits from relocation of Hubangon Bridge? (Multiple Answers)

: Improvement of traffic condition (79%)

: Improvement of living conditions (78%)

Chapter 2 Contents of the Project

2-1 Basic Concept of the Project

(1) Overall Goal and Project Purpose

The Philippines was hit by over 100 disasters in the past decade and is described as the most disaster prone country in the final report of the International Decade for Natural Disaster Reduction (IDNDR; 1990 2000). Under such difficult conditions, in the Medium Term Philippine Development Plan (2004 2010) under the administration of President Gloria Macapagal Arroyo, disaster prevention which contributes to social stability and poverty eradication is a high priority.

The research zone in the project or Camiguin Island is a volcanic islet in Mindanao Sea among the Mindanao and Visayan Islands in the southern part of the Philippines. Camiguin Island is in the province of Camiguin, Northern Mindanao, Region X. The population is approximately 740 thousand and the island is 238 square kilometers in area. The major industries are agriculture and fishery. This island is called Virtual Paradise because of its beauty, and has a high potential of tourism development. Three (3) Strong Republic Nautical Highways (SRNHs) were selected in the Medium Term Philippine Development Plan for decentralization of progress. Since Camiguin Island is in the route of the Central Gulf Line of the expressway among these three SRNHs, the SRNH RORO System that utilizes the expressway is really expected as the new material flow that will connect the economy of the islands including Mindanao with the Manila Metropolitan Area and expand economic opportunities.

In November 2001, Typhoon Nanang hit the island and caused flash floods and debris flow due to landslides. The number of missing and dead rose up to approximately 250, and the amount of damage to infrastructure, residential buildings and industries was estimated at 500 million yen. After this disaster, the Basic Plan for non structural disaster prevention measures, which cover the warning system, the evacuation drill and the educational campaign on disaster prevention with Japanese cooperation, was formulated. However, the Hubangon and Pontod river basins, which suffered the most serious damage, were not covered in any structural disaster prevention plan and the damaged bridge has not been rehabilitated yet. Presently, rising sediment on the riverbed heightens the risk of similar disasters caused by intense rainfall.

Under these conditions, the overall goal and project purpose in the intended project are as follows:

Overall Goal:	To obtain sustainable economic growth with improvement of living standards of Camiguin Island
Project Purpose:	To mitigate the damage caused by disasters such as flood and debris flow in Camiguin Island

(2) Outline of the Project

To achieve the goal and purpose mentioned above, the reconstruction of Hubangon Bridge and construction of two Sabo dams are requested as the necessary minimum disaster prevention measures which have the most urgent priority and immediate effectiveness. The outline of these structures is as given below.

Reconstruction of Hubangon Bridge

Peripheral roads in Camiguin Island are classified as second class national roads. The existing Hubangon Bridge is a part of the peripheral road and it spans across the Hubangon River. In the disaster in November 2001, debris flow with driftwoods in the Pontod River hit the downstream villages. The flow then proceeded to the Hubangon River and got stocked at the Hubangon Bridge, which resulted in the severe damage to the bridge beam. Although the upstream side of the bridge was closed to traffic for temporary measures, it is highly likely that differential settlement at the bridge footing will occur and the floor slab will be damaged. Hence, urgent reconstruction of the bridge is required.

Two Sabo Dams

In the disaster in November 2001, there were a large number of disaster victims in Barangay Hubangon and most of them were from Kapangan in the Pontod River Basin. It can be implied that the area was hit directly by debris flow with boulders. To mitigate disasters caused by debris flow with driftwood, two Sabo dams are required as the necessary minimum structural measures that can control debris flow rationally and effectively.

Construction of the two Sabo dams would contribute dramatically to the mitigation of disasters caused by debris flow to the peripheral (national) road in Camiguin Island. Reconstruction of the Hubangon Bridge would also boost traffic convenience. In addition, Camiguin Island has a significant role as part of the Central Gulf Line of the Expressway between Mindanao and Bohol. Hence, there is an urgent need for the project.

In this project, the execution of work, procurement of site, and acquisition of maintenance and operation cost will be done. As the activities in this project, site survey for the construction work, explanation of the project to the local people, specification of the method of maintenance and operation, and building of experience of implementing agency on planning and execution management will be executed. The purpose of this project is to implement the reconstruction and construction of the required structures.

2-2 Basic Design of the Requested Japanese Assistance

2-2-1 Design Policy

2-2-1-1 Design Policy of Hubangon Bridge

(1) Scope of Requested Japanese Assistance

The scope of the requested Japanese assistance is as follows:

- Reconstruction of the Hubangon Bridge
- Construction of two Sabo Dams

(2) Specification of Bridge

The bridge intended for reconstruction is located on a peripheral road (Second Class National Road) in Camiguin Island, which contains 22 bridges including this bridge intended for reconstruction. As for the condition setting, the bridge specification is required to fulfill the design speed of the intended bridge, the roadway width on the existing bridge, and the consistency with the Philippines standards. The specification table of existing bridges in Camiguin Island is as shown in Table 2-1 In view of the above, the specifications of the bridge are as indicated below.

- Design Speed : 60km/hr (Design speed of intended bridge)
- Number of Lanes : Two lanes (Number of lanes of existing bridges and/or Philippine standard)
- Roadway Width : 3.72m/lane (Roadway width of existing bridges[*1] and/or Philippine standard)
- Walkway Width : 0.76m (Walkway width of existing bridges[*1] and/or Philippine standard)

*1: Though some existing bridges have narrow roadway and/or sidewalk width, these existing bridges were constructed in the 1960's or 1970's, while bridges constructed after the 1980's meet the Philippine standard.

Table 2-1 Specification Table of Existing Bridges in Camiguin Island

No	Name of Bridge	Distance Mark	Bridge Length (m)	Span Number	Number of Lanes	Roadway Width (m)	Walkway Width (m)	Year of the Completion
1	Trining	0+566	8.6	1	2	3.66	0.76	2000
2	Balbagon I	1+510	6.0	1	2	3.66	0.76	1993
3	Balbagon II	2+824	10.0	1	2	3.66	0.76	1994
4	Maubog I	3+308	9.2	1	2	3.66	0.76	1992
5	Maubog II	2+824	17.5	3	2	3.35	0.82	1960
6	Anito	4+823	11.0	1	2	3.66	0.76	1995
7	Magtin	6+909	14.0	1	2	3.38	0.76	1963
8	Tupsan	9+729	14.8	1	2	3.68	0.75	1989
9	Hubangon	12+250	35.6	1	2	3.66	0.76	1984
10	Lutao	15+643	31.5	2	2	3.55	0.40	1976
11	Maac	19+909	15.6	1	2	3.35	0.80	1961
12	Cantaan	20+718	14.5	3	2	3.35	0.80	1961
13	Guinsiliban	24+530	16.4	1	2	3.73	0.50	1975
14	Aguran	31+729	16.6	1	2	3.75	0.76	1990
15	Sagai	33+243	36.4	3	2	3.66	0.76	1989
16	Bugang	36+370	21.1	1	2	3.66	0.76	1990
17	Alga	38+860	18.9	1	2	3.66	0.76	1989
18	Puti	39+077	16.0	1	2	3.66	0.76	1989
19	Looc	40+413	31.5	3	2	3.66	0.76	1989
20	Dinangasan	40+909	217.5	7	2	3.66	0.76	1999
21	Timayog I	45+039	51.6	2	2	3.66	0.76	1997
22	Timayog II	45+333	20.6	1	2	3.66	0.76	1997

(3) Policy on Natural Conditions

The Hubangon Bridge spans across the Hubangon River. The area where the bridge is located consists of the compound alluvial fan formed by the Hubangon River and the Pontod River. The catchment area of Hubangon River is 6.29 km^2 and the catchment area of Pontod River flowing on the south of Hubangon River is 4.61 km^2. Since the heavy rain by Typhoon Nanang in 2001 caused massive landslides, the mudflow including massive debris flow and driftwood from the Pontod River, after damaging the downstream village, flowed into the Hubangon River. Consequently, the mudflow intensively hit the Hubangon Bridge and inflicted serious damage to the structure.

As a remedial measure, the Government of the Philippines constructed a training dike to control the Pontod River, and the two rivers got separated. Channel consolidation works were not constructed at the upstream of the Hubangon River, so that at the immediate upstream of the Hubangon Bridge the river formed a meandering stream with natural riverbanks. The Pontod River of approximately 10 meters in width flows into the Hubangon River from the left bank side at 40 meters upstream of the Hubangon Bridge. The irrigation channel of 1.5 meters in width also flows into the Hubangon River from the right bank side at 80 meters upstream of the Hubangon Bridge.

Therefore, it is necessary that the foregoing hydrological conditions are accurately reflected in planning the bridge. The bridge face level is the total of three factors: the design flood level, the freeboard and the superstructure height. The design flood level is determined in view of the hydraulic analysis result, the highest experienced-water level from hearing investigation at the site, and the separate drainage plan prepared by the DPWH. The design flood level is calculated from 50-year probable flood discharge. The freeboard is kept at more than 1.5 meters in accordance with the Philippine standard on the assumption of driftwoods.

The river condition at the existing Hubangon Bridge is as illustrated in Figure 2-1.

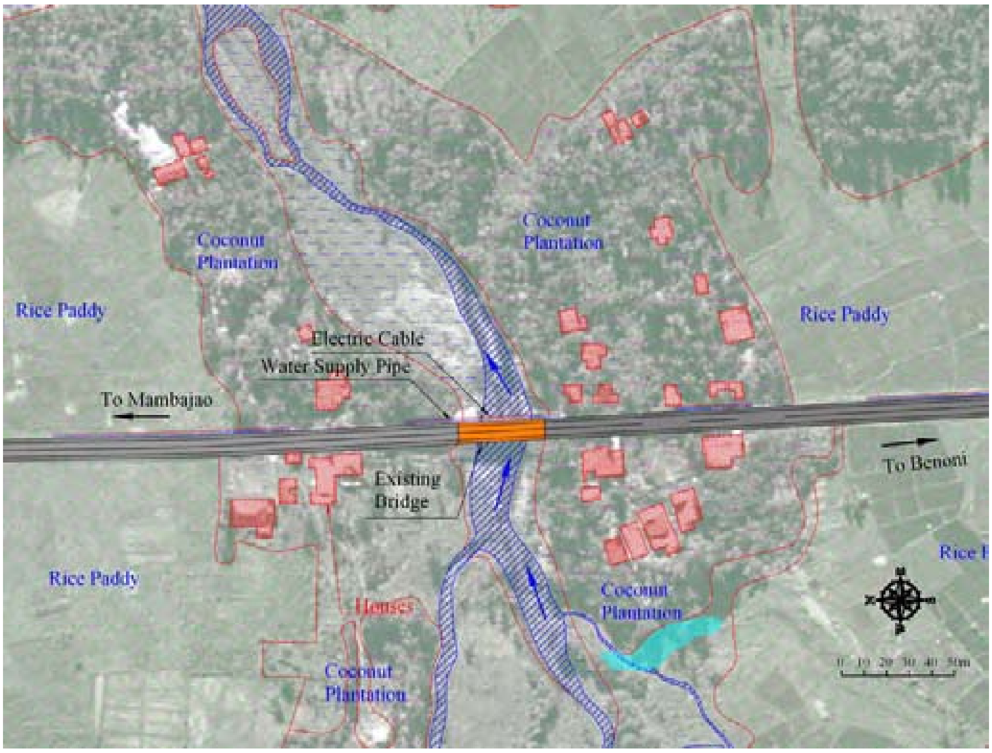


Figure 2-1 River Condition at Existing Hubangon Bridge

(4) Standards and Design Conditions to be Applied

Based on discussions with the officials concerned of the Government of the Philippines, the following standards are applied in bridge design:

- National Structural Code of the Philippines, Volume II (NSCP, Vol. II) for Bridges
- Guidelines, Criteria/Standards, Department of Public Works and Highways, Volume I and II
- American Association of State Highway Officials (AASHTO) Standard Specifications for Highway Bridges, 17th Edition, 2002
- Specifications of Highway Bridges, Japan Road Association, 2002
- DPWH standard specifications for Highways, Bridges and Airports, Volume II, 2004 Edition

The major design conditions are as indicated below.

- Design Load : Live load: AASHTO HS-20-44
- Temperature Range : 20~40 °C
- Seismic Load : 0.4 (NSCP Acceleration Coefficient)
- Design Strength (Concrete):
  - Substructure : 24N/mm^2 (3480 psi)
  - Superstructure : 36N/mm^2 (5220 psi)
- Concrete Pavement : Bending Strength: 3.8N/mm^2 (550psi)
- Reinforcement Bar : Grade 40 [Equivalent to JIS (Japanese Industrial Standards) SD345]

(5) Consideration on Social Environment

Since this project is the reconstruction of existing bridge, its implementation will not affect the social and natural environments. However, during planning, design, and construction works, the following points are to be considered to minimize the social and environmental impacts:

- To minimize the number of resettlement.
- To adopt the construction method that will minimize noise and vibration generation if there are dwellings around the site.
- To secure the traffic route during the construction work for traffic safety.
- To prevent river water pollution.
- To dispose construction waste materials properly at the place designated.

(6) Utilization of Local Construction Companies

Although construction of the bridge and Sabo dams are contracted to a Japanese construction company, local companies could be engaged as labor suppliers, leased equipment owners, and sub-contractors. For easier engagement of the local companies, a simple but efficient maintenance structure and construction method shall be adopted.

(7) O&M Capacity of Management Agency

In principle, the DPWH Camiguin District Engineering Office will implement the daily maintenance, rehabilitation and repair; however, its budget for maintenance work is insufficient. Taking this point into account, the structure types that require less repair and maintenance shall be selected as far as possible.

(8) Policy on Construction Method

Construction planning shall be made, considering the following items:

- The bridge work will be executed close to roadside residences, hence, the minimization of impact as well safety of the residents shall be taken into consideration.
- The construction of bridge will be done on a peripheral road, hence, the safety of transportation along the route and the detour road shall be ensured with the installation of sufficient safety devices like construction warning boards, etc.
- The utilization of farmlands at the construction site shall be minimized.
- The use of special construction machinery shall be avoided as much as possible by adopting a construction method that will utilize machines mainly from Mindanao Island.
- The substructure works shall be carried out in the dry season because of the river water rising in the flood season from October to February and the superstructure work in the flood season in consideration of the river water level.

(9) Selection of Bridge Type

Economical efficiency, construction efficiency, difficulty level of O&M, environmental implications, longitudinal alignment, and durability shall be assessed comprehensively. The optimum type of bridge shall be selected in consideration of the following:

- Economic Efficiency : To be the lowest possible cost considering rising cost-benefit performance.
- Construction Efficiency : To be capable of simple, safe and reliable construction.
- O&M : To be simple and inexpensive O&M, so that the preferable material of superstructure is concrete.
- Environmental Implications : To adopt the construction method that will minimize noise and vibration generation because there are dwellings around the site, and to ease the impact to pedestrians, vehicles and farmlands during the construction work
- Durability : To possess satisfactory durability. Durability is emphasized especially for the revetment and bottom protection works because these are breakable.

(10) Determination of Working Period

The working period is assumed as follows:

- Preparation of detailed design and tender documents : 3.0 months
- Tendering Services : 3.0 months
- Construction : 19.0 months

2-2-1-2 Design Policy of Sabo Dam

(1) Scope of Requested Japanese Assistance

The scope of requested Japanese assistance is as follows:

- Construction of two Sabo dams
- Construction of Access/Maintenance Road of the two Sabo dams

(2) Policy on Natural Conditions

In November 2001, Typhoon Nanang caused considerable damage in Northern Mindanao, Central Cebu and Southern Panay. In Camiguin Island of Northern Mindanao, the number of missing and dead due to debris flow was 250 persons. In Mahinog City, the number of missing and dead was 224 persons.

The typhoon caused damage to not only basic infrastructures such as roads and water supply and electric transmission facilities, but also schools, houses, rice fields and livestock. The amount of damage amounted to approximately 500 million yen. The debris flow that caused the damage in the Pontod River Basin was due to the accumulation of large boulders of 1 to 3 meters in diameter along the middle of the Pontod River.

Therefore, the two Sabo dams shall be designed against a 100-year probable flood discharge to avoid massive unstable sediment from becoming a debris flow. The Sabo dams will deposit and/or regulate the debris flow and mitigate debris flow disasters in the area downstream of each Sabo dam.

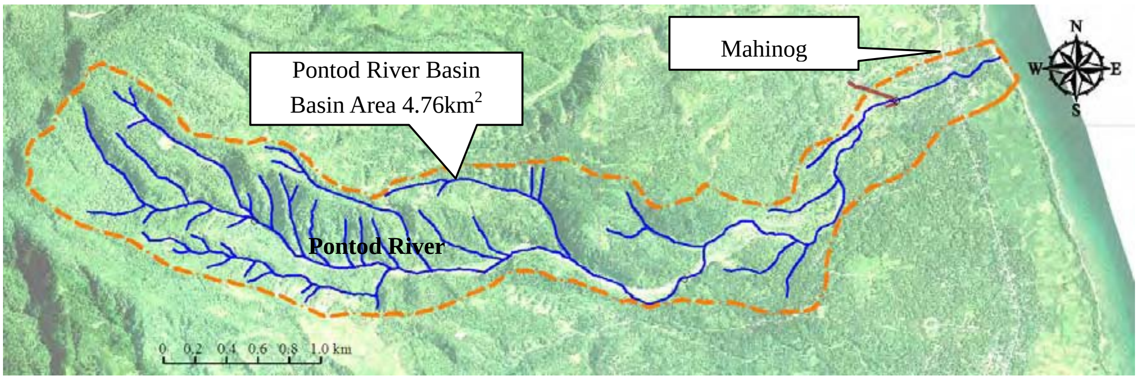


Figure 2-2 Pontod River Basin

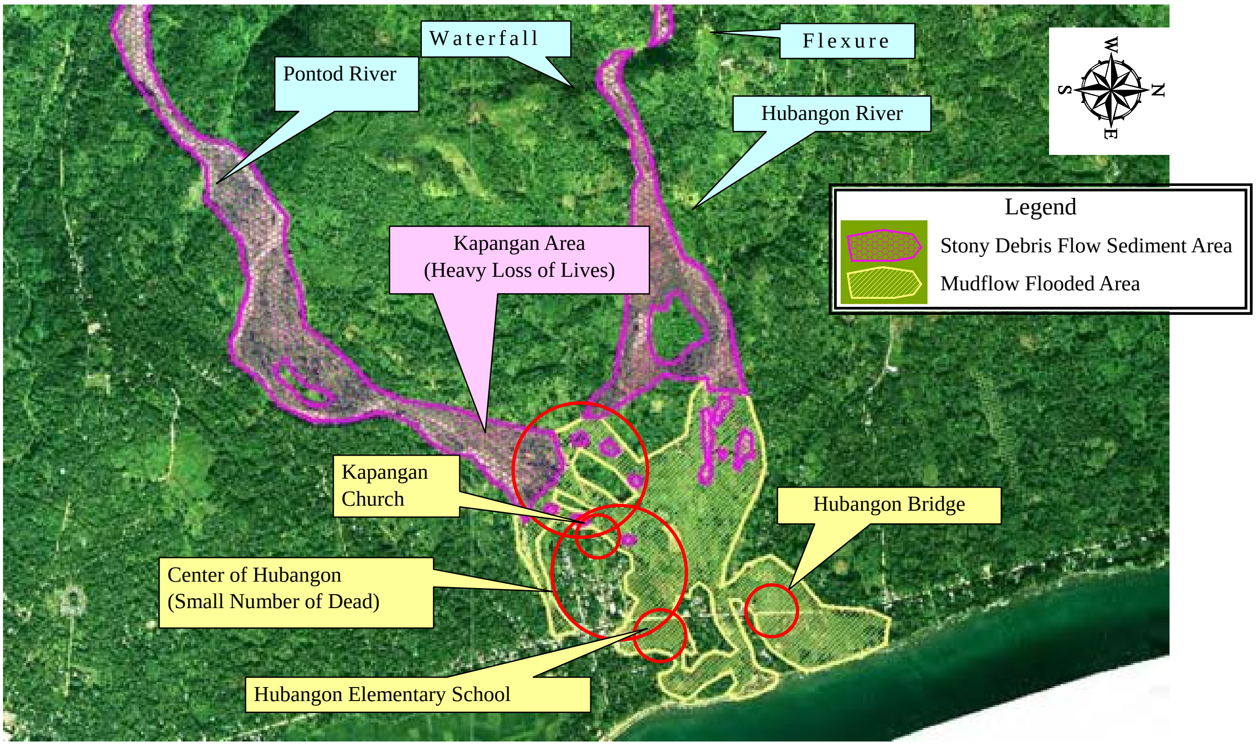


Figure 2-3 Areas affected by Stony Debris Flow and Mudflow in November 2001

(3) Target Area to be Protected

In this study, disaster prevention is directed towards human life, properties and infrastructures located at the target area, the Hubangon Pontod compound alluvial fan, which suffered heavy damage by Typhoon Nanang in 2001, such as the following:

- Properties/assets in the Hubangon barangays
- Crop fields and irrigation facilities
- Infrastructures, such as national roads, bridges barangay roads and schools

(4) Designed Scale of Sabo Dam

The two Sabo dams on the Pontod River are to mitigate the flow of debris and driftwoods in the area downstream of Sabo dam. The Sabo dams shall be limited in scale to the minimum required for rational and effective structural measures.

The Sabo dams are to be designed against the discharge of 100-year return period, considering the disaster caused by Typhoon Nanang and the situation of the unstable sediments along the upstream of Pontod River, as follows:

- The flood scale during Typhoon Nanang is assumed to be 60 to 100-year return period. The landslide in the riverhead area caused the debris flow.
- Boulders with the diameter of 1 to 3 meters covered the area upstream of the Sabo dam sites and such boulders are not movable by medium and small-size floods but by the flood scale during Typhoon Nanang.
- Therefore, the Sabo dams are to be designed against the scale of 100-year return period flood. This scale is in accordance with the Japanese standard for debris flow control.

(5) Standards and Design Conditions to be Applied

In accordance with the discussions with the Government of the Philippines, the Sabo dam design shall apply the following standards:

- Technical Standards and Guidelines for Planning and Design, Volume III: Sabo (Erosion and Sediment Movement Control) Works, March 2002, DPWH, JICA
- Technical Standards and Guidelines for Planning and Design, Volume IV: Natural Slope Failure Countermeasures, March 2002, DPWH, JICA
- Technical Standards for River and Sabo Works, River Association of Japan
- Manual of Technical Standards for Establishing Sabo Master Plan for Debris Flow and Driftwood, March 2007, Erosion and Sediment Control Division, Research Center for Disaster Risk Management, Japan
- Manual of Technical Standards for Designing Sabo Facilities against Debris Flow and Driftwood, March 2007, Erosion and Sediment Control Division, Research Center for Disaster Risk Management, Japan
- American Association of State Highway Officials (AASHTO) Standard Specifications for Highway Bridges, 17th Edition, 2002

(6) Consideration on Social Environment

Since this project consists of the construction of Sabo Dam and access/maintenance road, the implementation will not affect the social and natural environments. During planning, design, and construction work, the following points are to be considered to minimize the impact on the social and natural environments.

- To minimize the number of resettlement.
- To adopt the construction method that will minimize noise and vibration generation if there are dwellings around the site.
- To secure the traffic route during the construction work for traffic safety.
- To prevent river water pollution.
- To dispose construction waste materials properly at sites designated.

(7) Utilization of Local Construction Companies

Although construction of the bridge and Sabo dams are contracted to a Japanese construction company, local companies can be engaged as labor suppliers, leased equipment owners, and sub-contractors. For easier engagement of the local companies, a simple but efficient maintenance structure and construction method shall be adopted.

(8) O&M Capacity of Management Agency

In principle, the Mahinog City Government under the Camiguin Provincial Government will implement the daily maintenance, rehabilitation and repairs with technological assistance from the DPWH-DEO. However, its budget is not enough for such purposes; hence, the structure types that require less repair and maintenance shall be selected as far as possible.

(9) Policy on Construction Method

Construction planning shall be decided in consideration of the following:

- The dam sites are far from residential houses. However, transportation works will have an impact on residents along the road leading to the sites; hence, the minimization of impact as well as safety of the residents shall be taken into consideration during the planning stage.
- The use of special construction machinery shall be avoided as much as possible by adopting a construction method that will utilize machines mainly from Mindanao Island.
- In consideration of river water rising in the flood season from October to February, the excavation work of Sabo dam body and the concrete placement work on riverbed shall be implemented during the dry season in view of the water level during flood season.

(10) Selection of Sabo Dam Type

Economical efficiency, construction efficiency, difficulty level of O&M, environmental implications, longitudinal alignment, and durability shall be assessed comprehensively. The optimum type of Sabo dam shall be selected in consideration of the following:

- Economical Efficiency : To be the lowest possible cost considering rising cost-benefit performance.
- Construction Efficiency : To be capable of simple, safe and reliable construction.
- O&M : To be simple and inexpensive O&M.
- Environmental Implications : To adopt the construction method that will minimize noise and vibration generation.
- Durability : To possess satisfactory durability.

(11) Determination of Construction Period

The working period is assumed as follows:

- Preparation of detailed design and tender documents : 3.0 months
- Tendering Services : 3.0 months
- Construction : 19.0 months
- Concrete placement schedule : To be determined by the lift-schedule.

Since the Sabo dams are constructed across the river and the river profile is steep, the Sabo dam works are always faced with the risk of river flash floods and debris flow. Therefore, the construction schedule shall be planned in consideration of suspension owing to heavy rainfall.

2-2-2 Basic Plan

2-2-2-1 Hydrology and Hydraulic Analysis

(1) Probable Flood Discharge

Probable flood discharges of the Hubangon and Pontod rivers shall be calculated by the rainfall intensity curve of the nearest rain gauge station as published in each technical standard and guideline (by FCSEC).

i) Adoption of Rain Gauge Stations for the Calculation of Rainfall Intensity

Probable hourly rainfall calculated by the rainfall intensity curves of neighboring rainfall gauge stations are shown in Table 2-2. The curves are published in the “Specific Discharge Curve, Rainfall Intensity Duration Curve, Isohyet of Probable 1-Day Rainfall (March 2003, FCSEC)”.

Table 2-2 Probable 1-Hour Rainfall of Neighboring Rainfall Gauge Stations

Probability	Bohol	Leyte	Mindanao	
	Tagbilaran	Maasin	Surigao	Cagayan de Oro
2-year	28.7	33.1	50.0	46.5
5-year	42.8	48.0	69.6	62.3
10-year	51.3	58.5	82.0	72.3
50-year	69.9	77.6	107.4	93.7
100-year	76.7	86.4	119.7	103.5

According to the distribution of Isohyet of Probable 1-Day Rainfall in the above document, Camiguin Island is at the center between the Maasin and Cagayan de Oro stations. In consideration of the safety margin, the rainfall records of Cagayan de Oro Station shall be applied for this design.

The equations of probable intensity curve of Cagayan de Oro Station are as follows:

- 2-year probable rainfall : $I = 6103.34 / (44.55 + t1.09)$
- 5-year probable rainfall : $I = 8869.52 / (48.27 + t1.11)$
- 10-year probable rainfall : $I = 10706.45 / (50.07 + t1.12)$
- 25-year probable rainfall : $I = 12972.53 / (51.93 + t1.12)$
- 50-year probable rainfall : $I = 14512.97 / (52.72 + t1.13)$
- 100-year probable rainfall : $I = 16182.66 / (54.14 + t1.13)$

where,
I : rainfall intensity (mm/hr)
t : time (min)

ii) Estimation of Probable Flood Discharge

Probable Flood Discharge shall be estimated by the “rational method” because Hubangon and Pontod rivers are small mountain streams with $5km^2$ of catchment area. Probable Flood Discharges estimated by the rational method and applying the flood concentration time calculated by the Kadoya-formula are listed in Table 2-3

Table 2-3 Probable Flood Discharge

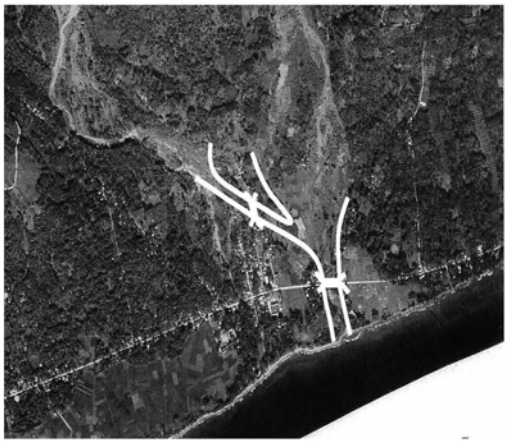
Item		Hubangon River	Pontod River
Catchment Area (km^2)		6.29	1.64
Coefficient of Discharge		0.6	0.6
2-Year Probable Flood (for temporary work)	Flood Concentration Time (min)	55	51
	Rainfall Intensity (mm/hr)	49.5	52.1
	Flood Discharge (m^3/s)	52	40
	Specific Discharge ($m^3/s/km^2$)	8.2	8.7
25-Year Probable Flood (for flood mitigation)	Flood Concentration Time (min)	42	39
	Rainfall Intensity (mm/hr)	110.2	115.3
	Flood Discharge (m^3/s)	116	88.6
	Specific Discharge ($m^3/s/km^2$)	18.4	19.2
50-Year Probable Flood (for bridge design)	Flood Concentration Time (min)	40	37
	Rainfall Intensity (mm/hr)	123.7	129.7
	Flood Discharge (m^3/s)	130	100
	Specific Discharge ($m^3/s/km^2$)	20.6	21.6
100-Year Probable Flood (for excessive flood)	Flood Concentration Time (min)	39	36
	Rainfall Intensity (mm/hr)	138.4	145.1
	Flood Discharge (m^3/s)	145	112
	Specific Discharge ($m^3/s/km^2$)	23.1	24.2

Kadoya-formula, a semi-theoretical equation, calculates the flood concentration time based on land use, catchment area (stream length), and rainfall intensity. Catchment areas of rivers are confirmed with the use of orthophoto maps made by FCSEC in 2003.

iii) Flood Management Plan

The preliminary study recommends an integrated drainage plan. However, the DPWH DEO is presently constructing training dikes in line with the proposed fragmented drainage plan so as to protect the Kapagong area that was damaged in the year 2001. After construction, the Pontod River and the Hubangon River would be separated resulting to the formation of a fragmented drainage system. The two plans are compared below in consideration of the results of the site investigation.

Table 2-4 Comparison of Proposed Plan on Flood Management (Results of Preliminary Investigation)

Items	Fragmented Drainage Plan	Integrated Drainage Plan
Image of Drainage Plan		
Outline	Plan to drain the Pontod River under a fragmented drainage system by introducing river training works.	Plan to integrate the Pontod River and Hubangon River and discharge into the Bangon River.
Merits and Demerits	Protects Kabagong area that was damaged during Typhoon Nanang and is justifiable from the adequacy of facilities applied. The river alignment compasses to the right causing deposition of debris flow and results to difficulty in securing and maintaining the river course. This will also result in leading the flow of debris and mud at the downstream area of the Pontod River in between a settlement area and a palm tree vegetation area.	The river alignment is in line with that of the past flood water course and is reasonable from the aspect of topography of the river. Even during high floods/debris flow exceeding the design limits, damage to the settlement area is minimized since the low flat area where the two rivers converge serves as a deposition space for the debris. However, this requires reaching a consensus with the residents on the issue of channelizing the Kapegon area instead of preserving it.

With regard to the integrated drainage plan, although it has been mentioned that the alignment is in line with the past flood water course and the topography of the river is natural, the northern section of the river from Kapagong area being an alluvial cone formed by the Hubagon River is not a natural water course. Also, since no distinctive river course was confirmed at the site and based on the damage inflicted by Typhoon Nanang in 2001 which has an extremely low occurrence frequency, the flood was caused by only an overflow, because building a river course having a drainage function will require a large scale excavation. On the contrary, the Pontod River has a distinctive river course with a drainage function and is reasonable to be used for managing floods.

Branch Rivers of the Hubangon River are being utilized for irrigation as a measure for restoration and development of the alluvial cone area. The application of an integrated drainage plan will however result in separating the irrigation channels. The idea of making use of the low flat lands around the confluence area as a deposition area converses with the effort of the residents who clear the deposited stones, so that it can be reclaimed and used as paddy field.

As already mentioned, the occurrence of typhoons similar to Typhoon Nanang is extremely rare. However, in case debris flow is triggered by such phenomenon or by heavy rainfall, the riverbed rises with the accumulation of sediment which helps stabilize the unstable soil at the upstream area while large stones from the upstream are trapped by the Sabo dam. As a result, the river course of Pontod can sufficiently correspond to the brunt of the flood. From these observations, the fragmented drainage plan that the DPWH DEO is presently implementing is assessed to be reasonable.

In order to increase the strength of the present training dike, riprap protection by placing large stones in the front side of the training dike was proposed to DPWH DEO and is being applied accordingly. This is effective in alleviating the causes of disasters such as local scouring, front surface collapse and dam failure often observed on steep river beds.

Furthermore, since many large stones are seen trapped in between the coconut trees in Kapagong area, the trees are functioning as a water induced-disaster preventing forest. In Japan, generally, such forests located along the banks near the crown of the alluvial fan area are considered to have functions of stabilizing the water channel since the forest helps to impede the speed of flood and deposit the mud and stones carried by the flood. Therefore, having money generating trees like coconut and mango along the river banks is an effective measure not only from the aspect of disaster prevention, but also from the perspective of rural development.

(2) Hydrologic and Hydraulic Analysis around Bridge of Hubangon River

i) Reconstruction of Hubangon Bridge

It is necessary to design a sufficient freeboard for the Hubangon Bridge to enable discharge of driftwood, because driftwoods have been the cause of significant scouring during Typhoon Nanang.

Hydraulic parameters of the cross-section under the bridge beam are as shown below.

- Cross-section shape : trapezoidal channel
- Top width : 33m
- Bottom width : 21m
- Height : 4.2m
- Riverbed slope : 1/250

In consideration of the 1.5m freeboard to enable discharge of driftwood and the 0.035 coefficient of roughness, the discharge capacity at Hubangon Bridge has been calculated as 206m3/s by the Manning's formula of uniform flow.

Accordingly, the design flood discharge of 50 year probable flood at Hubangon Bridge is 130m3/s and it becomes 143m3/s in consideration of 10% additional mixture of soil and gravel. In this discharge, the freeboard at Hubangon Bridge becomes 2.0m. Therefore, it is concluded that the cross section at Hubangon Bridge has a sufficient freeboard against the design flood discharge.

From the hydrological and hydraulic viewpoints, remarkable points for the design and the construction plan study of Hubangon Bridge are as described below.

Countermeasure against Driftwood

Although the cross-section has sufficient discharge capacity, the present size of cross-section (length of bridge, height of beam) shall be kept, at least, as the countermeasure against occlusion by driftwood.

Variation of Channel

There is concern that river alignment upstream of the bridge may vary by the influence of the confluence with two branches and right tributary. Therefore, the present size of cross-section also shall be kept.

Meander of River

The present river course reflects the reversed S-shape at upstream and downstream of the bridge, hence water colliding fronts may happen at the upstream left bank and the downstream right bank of the bridge, river bank erosions may accelerate, and the meander of river may become significant due to floods. Therefore, sufficient bridge length corresponding to riverbank erosion shall be designed.

Aggradations of Riverbed

Based on the result of hearing investigation at the vicinity of the bridge, it seems that the river conditions before Typhoon Nanang are as follows:

- Riverbed material : sand and small gravel without silt unlike the present
- Riverbed elevation : about 2m higher than at present

The present river condition occurred due to extreme erosion during Typhoon Nanang, and it will take a long time for the condition to recover to its original condition. Therefore, it is necessary to design a sufficient freeboard for the long-term aggradations of riverbed.

In consideration of the hydrological and hydraulic features described above and the structural correspondence to the existing basement of the bridge, the total length of the reconstructed bridge shall be 40m. Hydraulic study results of this bridge are as follows:

Discharge capacity which enables keeping of 1.5m Freeboard (2.7m water depth) for Driftwoods

It is calculated as 251m^3/s (with mixture rate of 10% soil and gravel), and discharge quantity itself becomes 228m^3/s. This quantity corresponds to a 100-year probable flood.

50-Year Probable Flood

It is calculated as 130m^3/s, and discharge quantity with mixture rate of 10% soil and gravel becomes 143m^3/s. Water depth at this discharge is 2.0m.

2-Year Probable Flood

Discharge quantity is 52m^3/s and water depth is 1.1m.

Appropriate Design River Width at Alluvial Fan

The following regime theory propounded by Ashida can indicate the appropriate design river width of alluvial fan:

B = 3.5 – 7.0 Q1/2

where,

B : design river width (m)

Q : design flood discharge (m^3/s)

The calculated river width B applied with 3.5 least coefficient and $143m^3/s$ of design flood discharge (50-year probable floods) is 42m. Hence, the validity of the designed length of the bridge (40m) is confirmed.

Based on the above conditions, the present river channel is considered to have a sufficient safety margin for floods. However, there is concern that the safety margin will be reduced if the present riverbed level that was scoured during Typhoon Nanang will recover due to floods. Based on the estimation, the freeboard of 1.5m could be kept barely for a 50-year probable flood when the riverbed becomes 80cm higher than the present.

For the above condition, the following countermeasures are proposed:

- Elevation gauges shall be installed at the reconstructed bridge piers.
- Maintenance dredging shall be implemented when riverbed elevation becomes 80cm higher than the present.

ii) Improvement of Hubangon River

The cross-sectional area at the upstream of Hubangon Bridge became large due to riverbed scouring with 2m in depth and 150m in length during Typhoon Nanang. The cross-sectional shape of this zone is trapezoidal with 30 to 40m in width and 3m in average height. The discharge capacity of this zone is estimated to be $120m^3/s$ (except mixture rate of 10% soil and gravel), which corresponds to a 25-year probable flood and sufficient from the viewpoint of flood mitigation. On the other hand, the small village at the vicinity of the bridge can be protected by implementing the flood mitigation project of DPWH (extension of training dike to the bridge).

In addition, the height of guide dike to be constructed on the left bank is set at an average of 2.5m from the elevation of waterside land. It is, therefore, concluded that the safety margin for flood mitigation is sufficient. As for the useful facility, it is necessary to construct steps at the dike to enable access between the waterside land and the protected lowland.

iii) Points to be considered regarding Reconstruction of Hubangon Bridge

When reconstruction work of the bridge will be implemented, the following two points shall be considered:

<u>Countermeasure for Flood Mitigation</u>

The temporary works shall be designed to discharge a 2-year probable flood safely. Discharge quantity of 2-year probable flood is $52m^3/s$ (refer to Table 2-3), which does not include the mixture of sand and gravel because this probable flood seems not to make the riverbed materials move.

Cross-Sectional Area under the Beam of Temporary Bridge

The detour road shall be provided with temporary bridges across the three tributaries of the Hubangon River. To keep the cross-sectional area under the beams and enable the safe discharge of annual flood discharge, the crossing section of each tributary shall be designed with a temporary bridge, as follows:

(1) The crossing point of the left bank tributary shall be designed with a temporary bridge because the water level of annual floods becomes almost the same as the riverbank based on the interview survey with the residents.

(2) The crossing point of the right bank branch shall be designed with a temporary bridge for the same reason as above.

(3) The crossing point of the right bank tributary shall be designed with appropriate pipes installed to secure the usual cross-sectional area (1.5m in width, 0.8m in depth).

In addition, irrigation canals run across the national roads (left bank: 2 points; right bank: 1 point). Although these irrigation canals seem not to have influence on the reconstruction of Hubangon Bridge, it is necessary to take care of them carefully.

(3) Hydrologic and Hydraulic Analysis at Downstream of Pontod River

i) Discharge Capacity of Box Culvert

At the downstream cross-point of Pontod River with the national road, dual box culverts 4m in width and 2.5m in height were installed in 1987. The discharge capacities of these culverts are as shown below:

- Considering the usual freeboard (0.6m) : $69m^3/s$
- Considering freeboard for driftwood (1.5m) : $28m^3/s$

These capacities were calculated by Manning's formula of uniform flow with 0.025 coefficient of roughness and 1/73 riverbed slope.

The capacity with usual freeboard which almost corresponds to a 10-year probable flood, $71m^3/s$, accord with the fact that no overflow had occurred since installation in 1987, except during Typhoon Nanang. On the other hand, the capacity with freeboard for driftwood corresponds to less than a 2-year probable flood, $40m^3/s$. Although debris flow with driftwood does not usually happen in a flood of this level, the capacity is reduced significantly once debris flow with driftwood occurs.

ii) Speculation regarding Reconstruction of Pontod Bridge

The DPWH-DEO had planned to reconstruct the Pontod Bridge because of the insufficient discharge capacity due to driftwood, as described above. It had already implemented the PQ, tendering, and contracting. Construction period is scheduled to be about one year, and the construction work started in October 2008.

The designed total length of this bridge is 12m in consideration of the river width at the vicinity. The effective cross-sectional shape under the beam is trapezoidal with 10m top width (considering 1m width of both side abutments), 7m bottom width, and 3.3m height (considering 1.5m freeboard for driftwood). Discharge capacity of this cross section is calculated as 119m^3/s applying 1/73 riverbed slope and 0.040 coefficient of roughness (considering the size of riverbed boulders).

The capacity of 119m^3/s is more than the 110m3/s design flood discharge of a 50-year probable flood (considering 10% mixture rate of sand and gravel, refer to Table 2-3. Therefore, the validity of this reconstruction plan is confirmed.

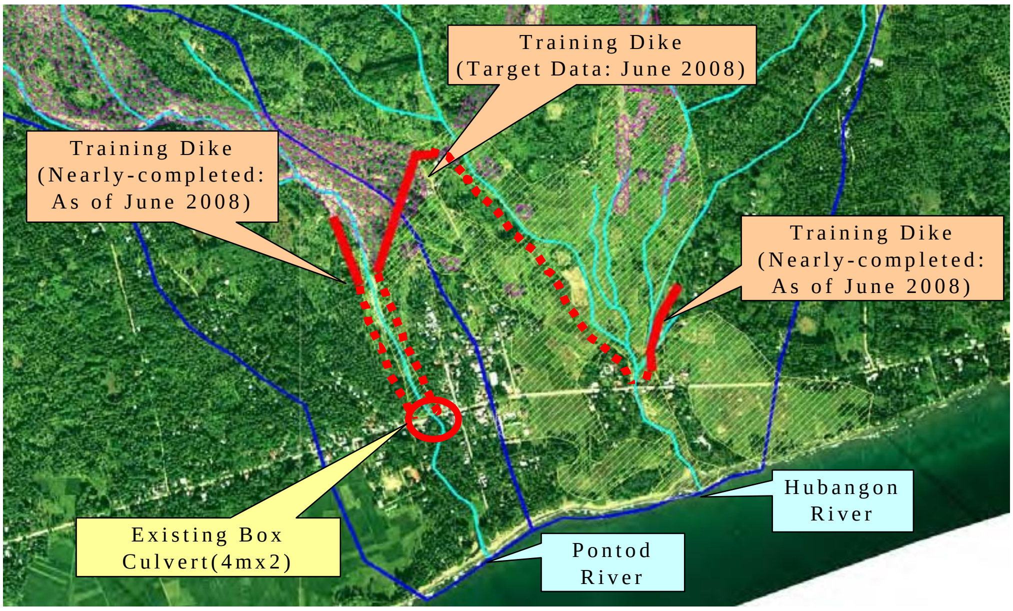


Figure 2-4 Construction Plan of Training Dike being Constructed by DPWH-DEO

iii) Sediment Movement at Downstream of Pontod River

Generally, sediment movement styles due to slope gradient are as follows:

- Section debris flow occurs : slope more than 1/4 (15 degrees)
- Section debris flow flows down : slope between 1/6 (10 degrees) and 1/3 (20 degrees)
- Section debris flow is accumulated : slope between 1/30 (2 degrees) and 1/4 (15 degrees)
- Section bed load flows down : slope less than 1/30 (2 degrees)

In accordance with the above movement style, the sediment movement style at the downstream Pontod River is presumed as below:

- The downstream section of Sabo dam site is a steep river with 1/13 to 1/28 in slope, but this section is the section where debris accumulated. Therefore, debris flow does not occur from this section.
- In the section, the phenomenon "armoring" had happened; riverbed of the section with 1/13 to 1/16 slope is covered with interlocked boulders of approximately 1m in diameter, and the section with 1/21 to 1/28 slope is covered with boulders of 50cm in diameter.

Riverbed materials in this section including sand and gravel in lower layers were barely flushed by the armoring.

- Correspondingly, riverbed of the section at upstream of the planned 2 Sabo dams is also covered with large boulders.
- The riverbed materials in this section may be flushed when debris flow happens at the upstream mountain area due to a large-scale flood like that in Typhoon Nanang, and destroys the armoring with 50cm boulders at the section with approximately 1/20 slope.
- The discharge quantity or amount that can destroy the armoring can be estimated in comparison with the friction velocity of each discharge and the critical friction velocity of 50cm boulders, as below.

  $u*^2 = ghI$
  $u*c^2 = 80.9d$
  where,
  $u*^2$: friction velocity
  g : gravitational acceleration
  h : water depth (by Manning's formula of uniform flow)
  I : riverbed slope
  $u*c^2$: critical friction velocity
  d : diameter of boulder

- Friction velocity of each discharge

  2-year probable flood ($40m^3/s$) : 0.315 $(m/s)^2$
  5-year probable flood ($60m^3/s$) : 0.420 $(m/s)^2$
  10-year probable flood ($71m^3/s$) : 0.455 $(m/s)^2$
  25-year probable flood : ($89m^3/s$) 0.525 $(m/s)^2$
  50-year probable flood : ($100m^3/s$) 0.560 $(m/s)^2$

- Critical friction velocity of 50cm boulder

  0.405 $(m/s)^2$

- According to the above comparison, armoring may be destroyed by the peak discharge of a 5-year probable flood. Serious destruction, however, is assumed to happen when more than $60m^3/s$ of discharge occurs continuously due to a 25 to 50-year probable flood.
- Therefore, the hydraulic design of the bridge that applies a 50-year probable flood should consider the mixture rate of 10% of sand and gravel.

iv) Discharge Capacity of Pontod River

The discharge capacity of typical cross sections between the upstream portion of the training dike and the box culvert were estimated based on the result of field survey, as shown in Table 2-5. In this estimation, the coefficients of roughness applied were 0.045 at river mouth and 0.040 at downstream section in consideration of the size of riverbed material.

Table 2-5 Discharge Capacity at Downstream Sections of Pontod River

Distance from River Mouth (m)	River Width (m), Depth (m), Riverbed Slope	Discharge Capacity (m^3/s)	Discharge Capacity except Soil Mixture (m^3/s)	Occurrence Probability	Remarks
478m	13m x 2.8m, 1/43	92	83	25-year	
595m	13m x 3.0m, 1/43	109	99	50-year	
765m	21m x 2.5m, 1/24	181	164	More than 100-year	d/s of training dike
1,115m	14m x 1.5m, 1/28	118	108	50 to 100-year	u/s of training dike

Based on the above estimation, the discharge capacity at the downstream of Pontod River is enough because of the steep riverbed slope. At the upstream of training dike, the discharge capacity is also enough. Therefore, it is assumed that overflow from the Pontod River to the right tributary of Hubangon River happens very rarely.

2-2-2-2 Basic Plan of Bridge

(1) Overall Plan

i) Site Condition

The site is located in between Mambajao, the capital municipality of Camiguin, which has the highest traffic volume in Camiguin Island and Binoni, the harbor for scheduled ship. The distance from Mambajao and Binoni to the site is approximately 12 and 6 kilometers respectively. There are private houses scattered along the access road at both banks of the existing bridge. Some of the houses have access road elevated up to the height of the existing road, connecting the house or the garage to the road. Other parts of the land are utilized for cultivation; namely, rice fields, coconut plantation, etc. The existing bridge is at the most downstream point of Hubangon River, about 300m upstream from where the river merges into the sea.

Hubangon Bridge was built in 1989, by a Philippine-based company from the steel plate girders granted by Japan under the Jumbo Loan assistance. The girders sustained severe damage from the mudslide containing huge amount of debris and driftwood fed into the Hubangon River by Typhoon Nanang in November 2001. On the upstream side at the right bank, approximately 8 meters from the edge of the bridge, the main girder sustains a 65 centimeters strain towards downstream, while the lateral brace is severely buckled. Similarly, on the downstream side at the left bank, approximately 4 meters from the edge of the bridge, the lateral brace is strained. According to reliable information, the pile foundation had sustained significant damage in the past, though at present it is not possible to confirm it. After the incident, the lane on the upstream side has been closed to traffic and a one-way traffic measure is being taken to allow crossing at the bridge. However, according to the result of the level survey carried out during this study, the height of the surface of the downstream side of the bridge is about 38 to 55 millimeters lower than that of the upstream side. Therefore, apart from the damages the main girder has sustained, there is high possibility that the concrete slab has also incurred damages or the bridge has faced unequal settlement and is in a perilous condition, requiring urgent rehabilitation work.

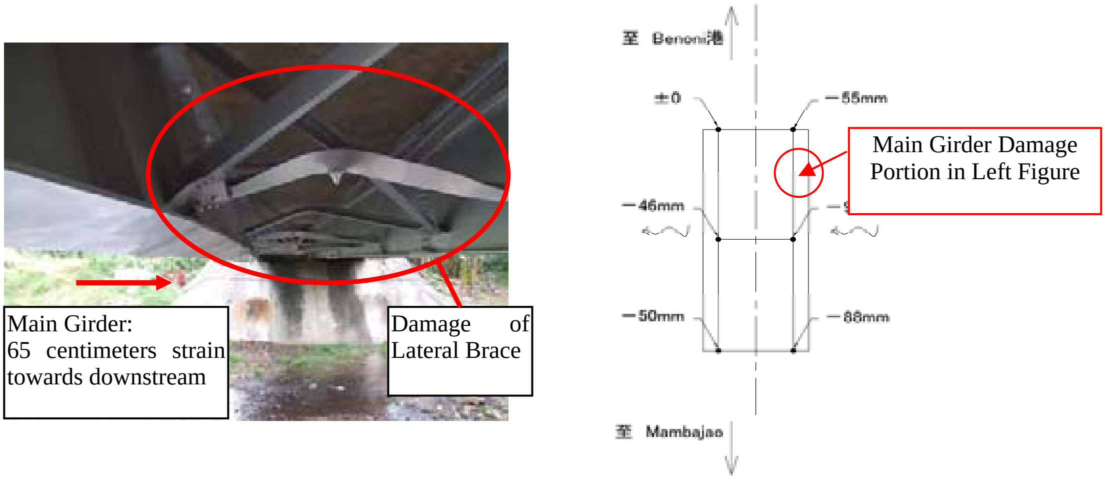


Figure 2-5 Damages on the Existing Bridge

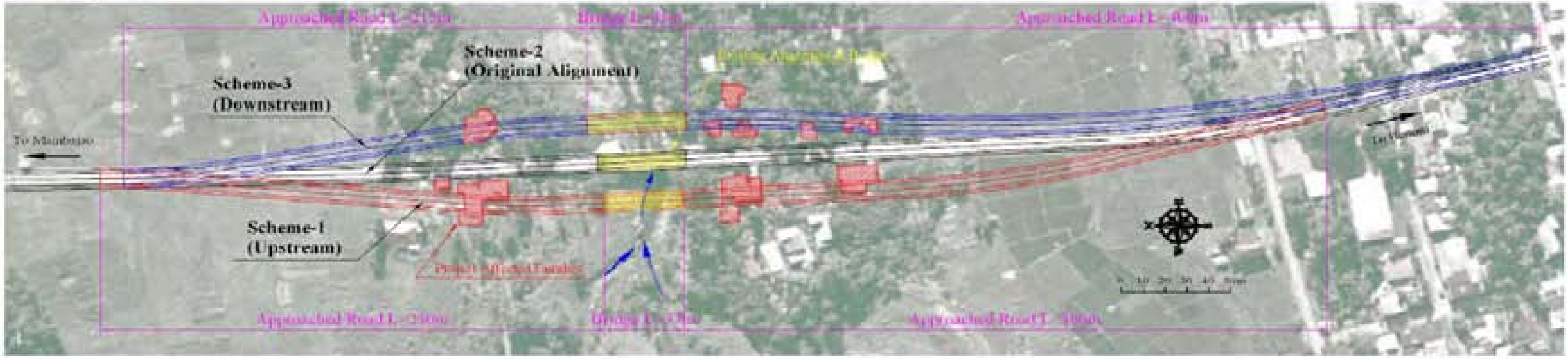
ii) Bridge Location

The location of the existing bridge has minimum adverse impacts on the social environment such as land acquisition and resettlement. It has a very smooth alignment that satisfies the required design criteria and apparently secures road safety. Furthermore, there is a strong demand from the Philippine side to replace the existing bridge with a new one. Therefore, the proposed bridge is planned at the same location as the existing bridge. This, however, necessitates the construction of a temporary detour during the bridge construction, imposing additional construction cost. Nevertheless, it is economical, since a bridge at other locations would require longer approach roads, which would apparently be more costly. Table 2-6 shows the comparative study of the candidate locations.

On the other hand, the grade of the existing approach road at the left bank and the right bank is about 2.0% and 1.0% respectively. There are entrances, elevated up to the road level, on the approach roads that lead to the ambient houses. Therefore, significant change in the profile of the existing approach road not only inflates the construction cost due to the increase in the length and the height, but also contributes to high social environmental impact. Therefore, it is desirable to keep the height of the proposed bridge almost equivalent to the height of the existing bridge.

Table 2-6 Comparison of Bridge Location

Comparision of bridge location



ITEM	Scheme-1 (Upstream)		Scheme-2 (Original Alignment)		Scheme-3 (Downstream)	
Characteristics of River	The width of the river at this location is about 35 meters. A branch river merges at about 20 meters upstream. Therefore, requires either set back of the abutment or measures against erosion.		The width of the river at this location is about 35 meters. Erosions, occurred due to meandering of water channel, are noticeable at the left bank upstream and right bank downstream. Therefore requires set back of the abutments or implementation of countermeasures against erosion.		The width of the river at this location is about 42 meters, but the downstream area is an alluvial fan. Erosions, occurred due to meandering of water channel, are noticeable at the right bank upstream, and thus requires set back of the abutment or implementation of countermeasures against erosion.	
Bridge Length	○	37m	△	40.9m	×	45m
Approximate Length of Approach Road	×	615m (Left bank:215, Right bank:400)	○	60m (Left bank:30, Right bank:30)	△	530m (Left bank:230, Right bank:300)
Influences on land acquisition, resettlement and Social environment	×	**Land Acquisition** Approx. 7,100m2 **Relocation of Houses** 6 Houses **Securing Traffic flow** No need of a detour during construction as the existing bridge can be used instead. The influence on social environment is significantly high as the land is used for plantation of coconut, mango banana etc.	○	**Land Acquisition** Approx. 2,800m2 (for detour) **Relocation of Houses** Not necessary **Securing Traffic flow** Requires approx. 350-meter long detour upstream. The influence on social environment is significantly low as acquisition of about 640m2 of plantation land only for a period of one year is required for detour which will be restored to its initial condition after construction. Furthermore, the number of coconut trees that need to be fell is very few.	×	**Land Acquisition** Approx. 5,800m2 **Relocation of Houses** 5 Houses **Securing Traffic flow** No need of a detour during construction as the existing bridge can be used instead. The influence on social environment is significantly high as the land is used for plantation of coconut, mango banana etc.
Construction Cost Ratio	×	1.61 (Assuming the cost of Scheme-2 as 1.0)	○	1.00	×	1.62 (Assuming the cost of Scheme-2 as 1.0)
Evaluation	×		○		×	

iii) Traffic Volume

DPWH conducted a traffic count survey from 21 to 27 July 2008, at about 600 meters from the Hubangon Bridge towards Binoni Harbor. The average daily traffic on this section was approximately 1,200. The volume of traffic, both inbound and outbound, was almost equal. The rate of motorcycles and tricycles (Motorela) were about 41 percent and that of heavy vehicles merely 1 percent.

iv) Road Width

Bridge: The cross section of the bridge is as shown in Figure 2-6.

Approach Road: The existing road is classified into a second-class highway in the Philippines. From conditions like traffic volume, design speed, horizontal curves etc., for a second-class highway, the Philippine Standard requires a width value between 3.0 meters and 3.6 meters. The width of the existing approach road is 3.05 meters and complies with the standard. Additionally, from the present traffic volume, vehicle types plying and the number of registered vehicles within Camiguin Island, the lane width of the existing road is determined to be sufficient for the proposed road. Therefore, 3.05 meters is determined as the width of the proposed approach road.

Figure 2-6 indicates the cross section of the bridge and Figure 2-7 indicates the road width and typical cross section of the approach road.

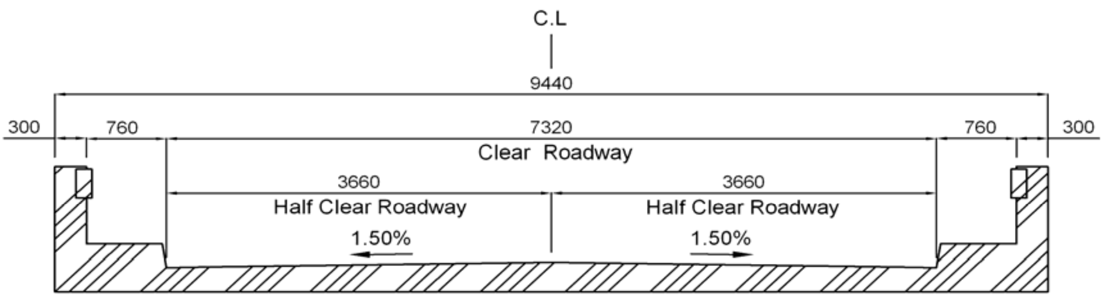


Figure 2-6 Cross Section of Bridge

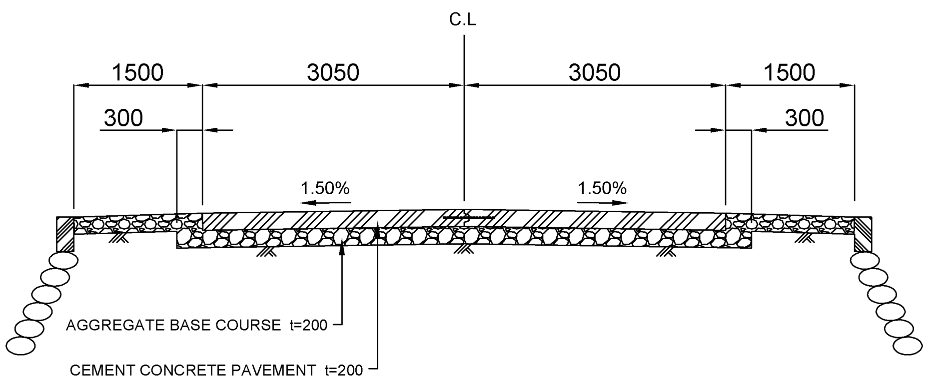


Figure 2-7 Cross Section of Approach Road

v) Bridge Length

The width of the river at the upstream and the downstream side of the bridge is approximately 35 meters and 37.5 meters respectively. The length of the existing bridge is 35.6 meters and is in conformity with the river width of both the upstream and the downstream side. The length of the proposed bridge should at least be equal to the length of the existing one or longer. It is preferable to set the abutments back from their original locations since erosion due to meandering of the river channel is observed at the left bank upstream and the right bank downstream. There are 16 foundation piles at each existing abutment. The lengths of these piles are unknown since the as built drawings of the bridge are not available. Therefore, special attention during the pile driving work is indispensable to avoid potential collision with the existing ones.

From aspects like the characteristics of the river and construction efficiency as mentioned above, the length of 41 meters is desirable for the proposed bridge. In addition, from the river characteristics and the construction cost, a single span is desirable.

vi) High Water Level

Considering sediment concentration of 10 percent in the 50-year flood discharge of 130 m^3/s, the design flood discharge is determined as 143 m^3/s. From uniform flow method, the high water level at the proposed bridge section is calculated as EL. 4.40 and the depth of water as 1.8 meters, given that the bed slope is 1/253 and the roughness coefficient is 0.035. Freeboard height of 1.5 meters, for driftwood, added to the above value gives the elevation of the bottom of the girder as EL. 5.90, which is 3.3 meters from the riverbed. On the other hand, considering the height of the surface of the existing bridge and the required height of the girder, the height from the bottom of the girder to the riverbed is given as 3.8 meters giving an additional freeboard of 0.5 meters. This additional freeboard is provided as a space for the rise of the riverbed anticipated in the future.

vii) Freeboard

Freeboard is calculated by adding 1.5 meters to the design high water level that assumes the presence of driftwood in accordance with the standard of the Philippines.

viii) Traffic Arrangement during Construction Period

Traffic flow during construction is secured by providing a dual lane detour of 6.0 meters in width upstream. The alignment of the detour shall be planned by avoiding the cultivation land and houses as to the possible extent. Figure 2-8 indicates the conceptual diagram of the detour.

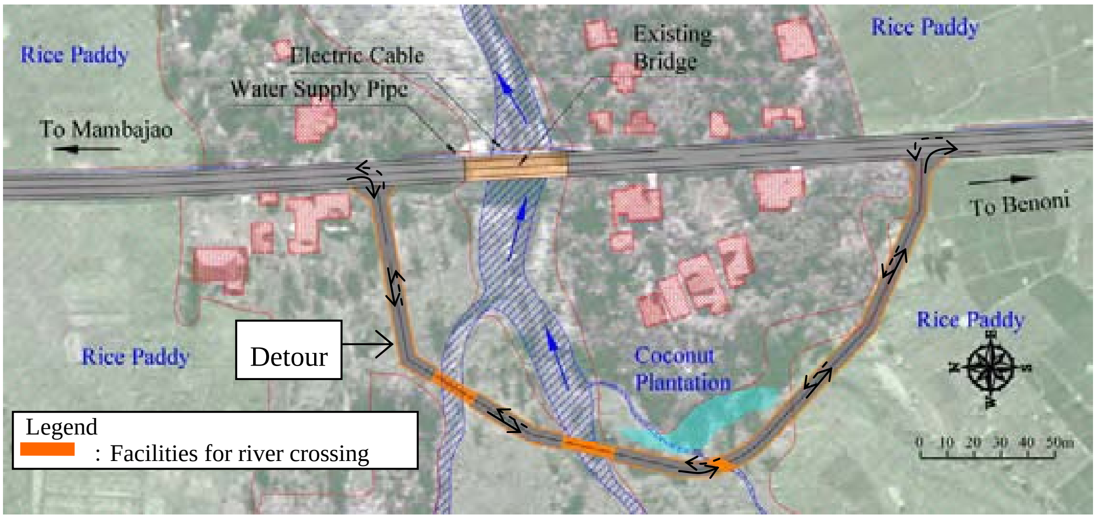


Figure 2-8 Conceptual Drawing of Detour during Construction of Hubangon Bridge

(2) Plan of Substructure

i) Foundation

The type of foundation is determined from among the methods generally applied in the Philippines considering the result of soil investigation. The geology of the proposed bridge site is as mentioned below.

- Left Bank: The top layer, which is about 6 meters thick, consists of boulder mixed gravel which is then followed by the layer of sandy silt of 11 meters in thickness, silt layer and finally a layer (bearing stratum) of boulder mixed silt with N value of 50 and more. Therefore, the length of the pile is taken as 17 meters.
- Right Bank: The top layer, which is about 4 meters thick, consists of boulder mixed gravel which is then followed by the layer of sandy silt of 11 meters in thickness, silt layer and finally a layer (bearing layer) of boulder mixed silt with N value of 20 and more. Therefore, the length of the pile is taken as 19 meters.

According to the results of the aforementioned soil investigation, the application of concrete pile or H steel pile is considered improper due to the presence of 4 to 6 meters thick layer of boulder mixed gravel. Therefore, the cast in place pile is adopted.

ii) Abutment

Since the overall height of the structure is about 6 meters, a reversed T type concrete wall that requires low volume of concrete is used commonly when such height is adopted.

(3) Superstructure

With regard to the determination of type of superstructure for the proposed bridge, consideration of the following issues is deemed necessary:

Bridge Length and Number of Spans

As mentioned above, the proposed bridge is planned to be single span having the length of 40.9 meters.

Structure Height and Freeboard

As mentioned above, from the aspects of environmental consideration, such as reduction of construction length of the approach road and its impacts on the ambient houses, and economical efficiency, the surface height of the existing bridge is deemed appropriate to adopt as the height of the proposed bridge. On the other hand, from the characteristics of the river, it is necessary to secure 1.5 meter freeboard for safety of the bridge and its surroundings.

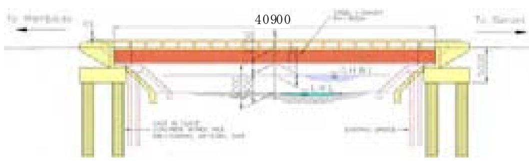
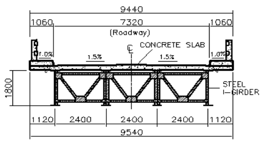
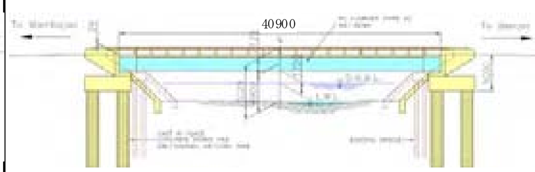
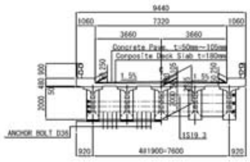
Therefore, a structure height that satisfies the above conditions is selected for the superstructure. The candidate types are PC I-shaped girder, PC box girder, steel plate girder, and steel truss. From among them, PC box girder and steel truss are excluded from the comparison study for reasons mentioned below. On the other hand, the comparison study for PC I-shaped girder and steel plate girder is as shown in Table 2-7.

PC box girder: This type of superstructure is generally applied for multi-span bridge. This requires a particular erection method and is significantly costly in comparison with the other candidate structures.

Steel Truss: By and large, steel girders are costly in comparison with concrete girders. In addition, reflecting the sharp rise in the cost of steel due to the rapid increase on its demand these years, the cost difference is significant. Furthermore, compared to steel plate girder, the weight of steel truss is 1.3 times larger and the period required for manufacturing is 1.5 times longer since it includes many members that require fabrication. Therefore, it is uneconomical as it is time consuming and is likely to result in the extension of construction period.

Therefore, from the above observations, and from the result of the comparative study as shown in Table 2-7, the PC I-shaped girder is adopted as the superstructure for the proposed bridge.

Table 2-7 Comparison Study for PC I-Shaped Girder and Steel Plate Girder

Scheme		Scheme-1		Scheme-2
Structure Type		Single-span Steel Plate Girder		Single-span PC I-shaped Girder
Conceptual Diagram		 Cross Section 		 Cross Section 
Construction Cost Rat	×	1.13（Assuming cost of Scheme-2 as 1.00）	○	1.00
Procurement of Materials and Equipment	×	Domestic procurement of major materials and equipment is possible. But, steel plate girders need procurement from either Japan or a third country.	○	Almost all major materials and equipment are procurable from the domestic markets.
Consideration on Characteristics of River	○	Though girder height is higher than that of Scheme-2, the minimum freeboard is secured. Furthermore, it is suitable from the aspect of river characteristics as the bridge being single span, does not have a pier.	○	Minimum required freeboard is secured. Furthermore, it is suitable from the aspect of river characteristics as the bridge being single span, does not have a pier.
Construction Ability	○	**Manufacturing of Girders** Does not require construction yard at site as the girders are manufactured in factories. Securing of yard for ground assembling is manageable. **Erection** Temporary vent is used basically for erection. Erection of girder is possible using a 50 ton crane, as the weight of the girder is comparitively light.	△	**Manufacturing of Girders** It is difficult to secure construction yard near the proposed bridge. **Erection** Basically crane-erection is used. As the weight of one girder exceeds 70 tons, two cranes of 160 ton-class is required. But as procurement of these cranes is costly, a method of manufacturing the girder on top of a stage installed upstream and shifting the girders laterally by means of a winch needs to be adopted.
Construction Period	△	Approx. one month longer than Scheme-2	○	1.00
Maintenance	×	Requires periodical recoating of steel plate girder periodically	○	Being a concrete bridge, the body of the bridge does not require periodical maintenance
Evaluation		×		○

(4) Approach Road and Ancillary Works

i) Approach Road

1) Construction Limits of Approach Road

The surface of the proposed bridge is taken equivalent to that of the existing bridge. A runoff section is provided from the end of the bridge to the existing road. The total length of the limit of construction is 22.10 meters, 10.75 meters at the right bank and 11.35 meters at the left bank.

2) Pavement Structure of Approach Road

The objective road is a peripheral road of Camiguin Island and is categorized as a second-class highway. The road has a concrete pavement applied in accordance with the standard of the Philippines and is in good condition. Similarly, concrete pavement, in compliance with the Philippine Standard, is chosen as the pavement type for the approach road to be constructed under this project .Figure 2-9 indicates the structure of the pavement. The structural index of the pavement exceeds the required value of 3.53.

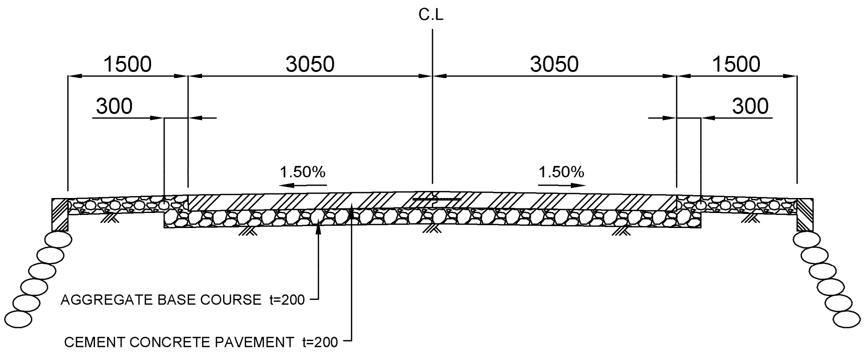


Figure 2-9 Pavement Structure of Approach Road

3) Accessories of Approach Road

Guardrail

At present, as seen in the picture, there are guardrails installed as a fall prevention measure since the road near the bridge site is about 4 meters high. Since there are houses nearby the road in the vicinity of the site, as a measure against traffic safety, guardrails are provided on both sides of the reconstructed approach road.

Road Markings

Road markings of center line, boundary line, and side lines are provided. The lengths of the markings are as mentioned below.

- Center Line (Continuous) : 40.9 meters (Bridge section)
- Boundary Line (Dashed) : 22.1 meters (Fill section)
- Side Lines (Continuous) : 126.0 meters (Fill section)

ii) Revetment Works

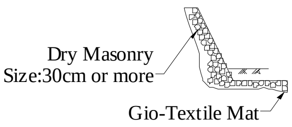
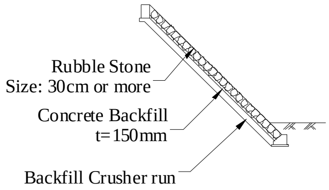
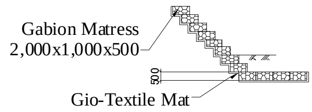
1) Hydrological Characteristics

The left bank upstream and the right bank downstream where scouring is significant are water colliding fronts formed due to meandering of the water channel. Being a water colliding front, these locations are exposed to further scouring and the already scoured portions are anticipated to further expand during flood. Therefore, from these observations, the location of the abutments of the proposed bridge is planned behind the existing ones.

2) Revetment

Considering the hydrological characteristics as explained above, a strong and durable revetment is planned to protect the abutments. The type of revetment is determined by conducting a comparison of structures in general use, such as dry masonry, grouted riprap, and gabion. Table 2-8 shows the comparison results.

Table 2-8 Comparison of Revetment Types

	Dry Masonry	Grouted Riprap	Gabion
	 End to be connected with the existing grouted riprap	 End to be connected with the existing grouted riprap	 End to be connected with the existing grouted riprap
Durability	× Easily damaged due to collapse or displacement of stones The chances of suction of backfill material when water receeds is highest	○ Most robust as disruption of backfill is less possible Requires strict compaction management as the structure is uncorresponding to	△ The suction of backfill material when water receeds is feared The wires are subjected to corrosion due to exposure to water and air
Experience of Construction	× Low	○ Very High (Generally used in Camiguin)	× Low
Cost	○ 0.6	× 1.0	× 0.8
Construction Perio	○ 0.7	× 1.0	○ 0.7
Evaluation	Low durability. Construction cost is cheapest, but maintenance cost is high ×	High durability. High cost material but as the required quantity is less, the overall cost is low ○	Low durability. Difficulty in repairing once damaged △

As a result of the comparison, considering durability of the structure, wet masonry which is very durable, robust and widely used structure in Camiguin Island is adopted as the revetment structure for the approach road.

Adopted Structure	Wet masonry revetment Thickness: 30 centimeters Thickness of back-fill concrete: 15 centimeters Back Crusher-run: 20 centimeters or more
Length	Left Bank: 34.75 meters, Right Bank: 34.55 meters Total 69.3 meters
Others	- Provision of one weep hole at every 2 to 4m^2 - Foundation to be embedded 1 meter below the proposed river bed

2-2-2-3 Basic Plan of Sabo Dam

(1) Design Control Point and Location of Sabo Dam

i) Design Control Point

The design control point is located upstream of the built-up area to be protected, at the downstream edge of the training dike under construction by the local government (Catchment area: 4.43km^2). Judging from the streambed slope, the design control point lies at around the downstream edge of the debris flow deposit area. The sediment deposits brought about by Typhoon Nanang in 2001 show the same condition so that the lower part of the design control point should be considered as the bed load area. On the other hand, two sub-control points are defined as shown below in order to evaluate the volume of debris flow taking into account the sediment flow.

Sub-Control Point No. 1: At the downstream edge of the area with the streambed slope of 1/4 and above which is considered as the debris-flow source area.

Sub-Control Point No. 2: At the area where Pontod River changes its direction of flow from east-southeast to east-northeast. The streambed slope at this point is approximately 1/8 and it indicates that the point is at the downstream edge of the debris flow runoff area. This is one of the proposed Sabo dam locations, the "downstream point."

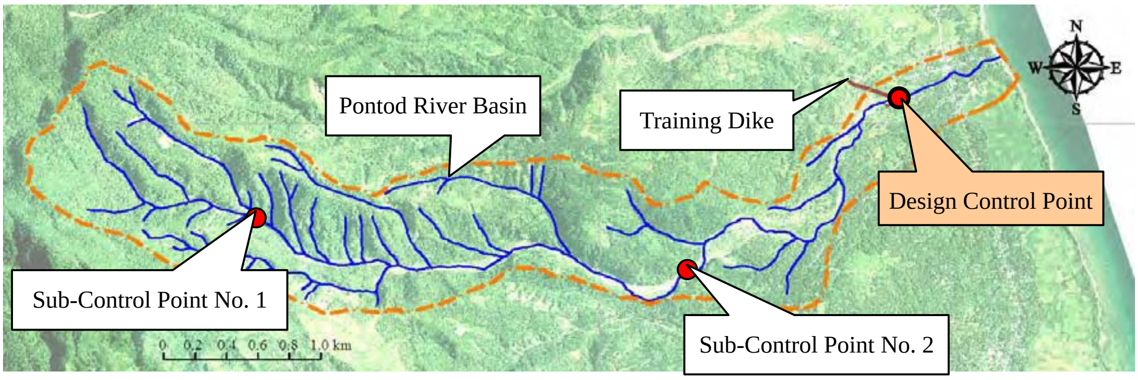


Figure 2-10 Location of Design Control Point and Sub-Control Points of Sabo Dam

ii) Alternative Location of Sabo Dams

Alternative locations of Sabo dam are given in the next figure. They are selected considering the condition of movement of debris flow, geographical conditions and geological conditions.

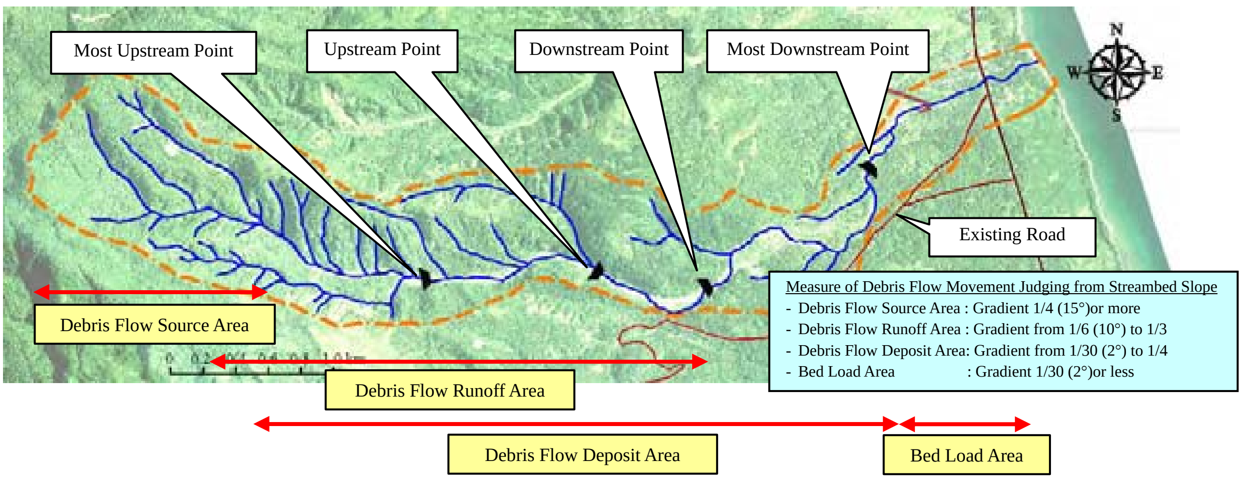


Figure 2-11 Alternative Locations of Sabo Dam

With respect to the four alternatives, several features are pointed out, as follows:

- The most upstream point, the upstream point, and the downstream point are located in the debris flow runoff and deposit area so that they should be adequate for the location of

Sabo dam as the debris flow measure.

- There is less risk of large-scale debris flow at the lower area of the downstream point since the area is categorized as the bed load area with the streambed slope of 1/10 or less, and tributaries are small.

- The most upstream point is suitable for Sabo dam as the debris flow measure from the geographical and geological points of view with the small width of the river and the hard rocks on the riverbed and on both riverbanks. However, the construction cost of the access road would be expensive because the point is away from the existing road and the streambed slope is steep. In addition, the construction of Sabo dam would be also expensive because of the long distance transport of materials.

- The facts that the river is wide, the point is close to the existing road and that hard rocks exist in the riverbed gives an advantage on the upstream point in the aspect of construction cost of both the Access/Maintenance Road and the Sabo Dam.

- The downstream point is geographically and geologically suitable for Sabo dam as the debris flow measure because of the small river width and the hard rocks on the riverbed. This point is close to the existing road and advantageous in the aspect of construction cost of both the Access/Maintenance Road and the Sabo Dam.

- The most downstream point lies at the downstream area of the debris flow deposit area where the channel consolidation works starts and it is a suitable location for consolidation works. Although the point is close to the existing road, the river is largest in width with a thick layer of sediment deposits so that the construction of Sabo dam as the erosion measure would costs a lot.

- There is no environmental issue on the four points.

For the considerations stated above, the two locations of Sabo dam are defined, as shown in the table below.

Table 2-9 Comparison Table on the Selection of Location of Sabo Dam

Item	Most Upstream	Upstream Point	Downstream Point	Most Downstreamt
Location	4.5km from River mouth	3.7km from river mouth	3.1km from river mouth	1.3km from river mouth
Catchment Area	1.97km^2	2.97km^2	3.17km^2	4.20km^2
Streambed Slope・Debris Flow	I=1/5 Debris Flow Runoff Area	I=1/8 Debris Flow Runoff Area	I=1/8 Lower Edge of Debris Flow Runoff Area	I=1/20 Lower Edge of Debris Flow Deposit Area
Effect of Measures against Debris Flow				○
Geological Condition		○	○	×
Geographical Condition (e.g. River Width)		○		×
Social Environment	○	○	○	○
Access/Maintenance Road	×	○	○	
Economical Efficiency	×			
Evaluation	—	Selected	Selected	—

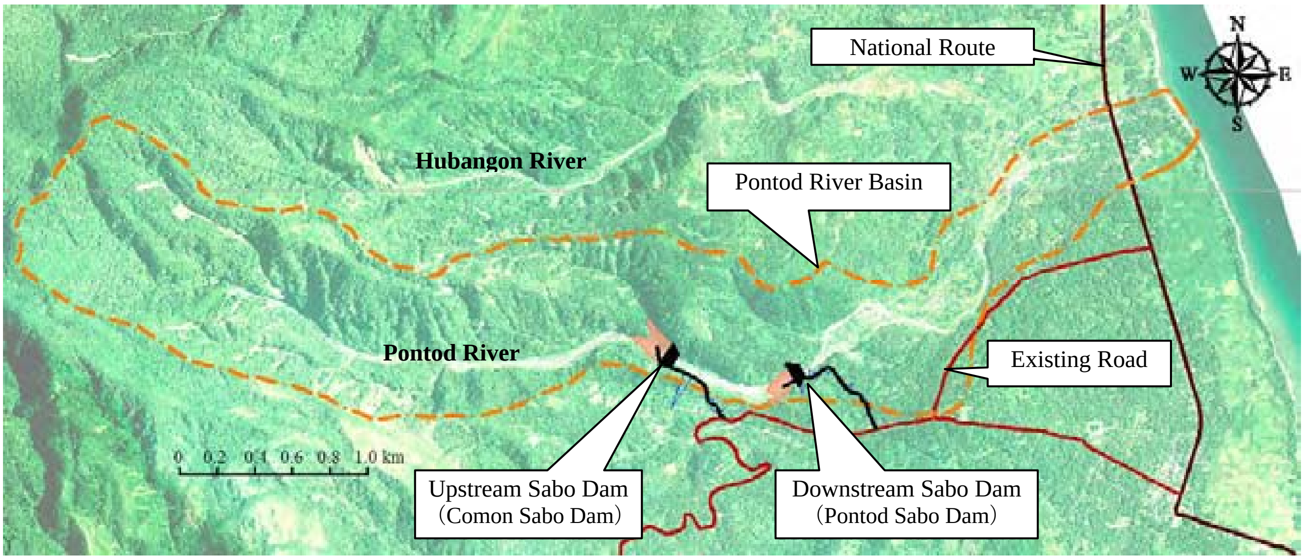


Figure 2-12 Selected Location of Sabo Dam

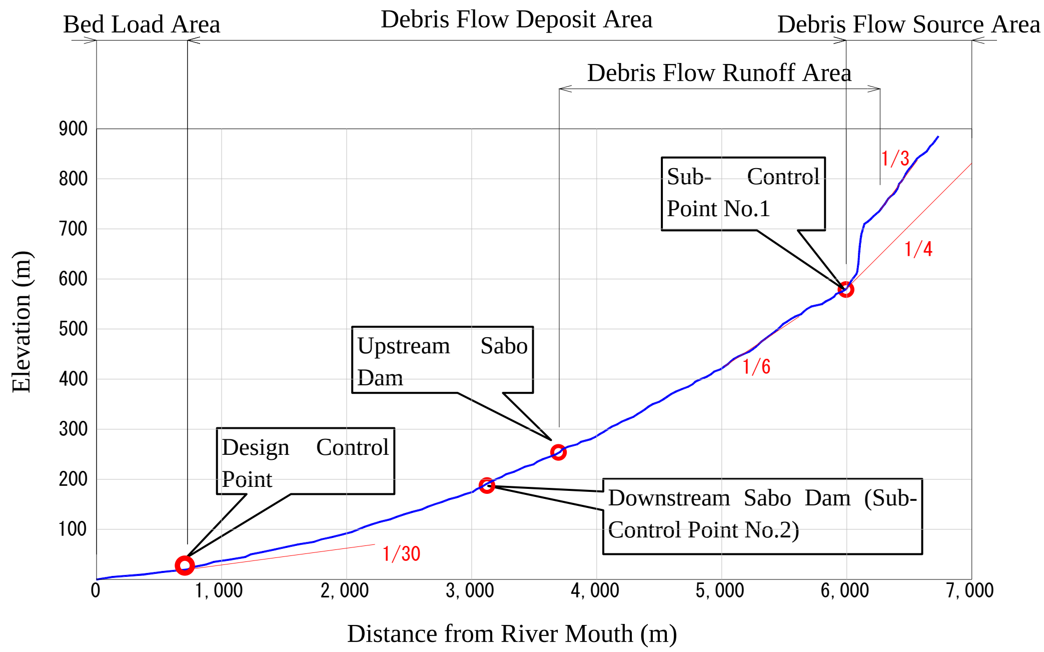


Figure 2-13 Pontod River Profile

(2) Calculation of Design Volume for Debris Flow

i) Design Volume for Debris Flow

The design volume for debris flow consists of the design sediment volume and the design driftwood volume.

Design Sediment Volume: The sediment volume moved down to Sub-Control Point No. 2 with "Debris flow of design scale" (the downstream edge of debris flow runoff area)

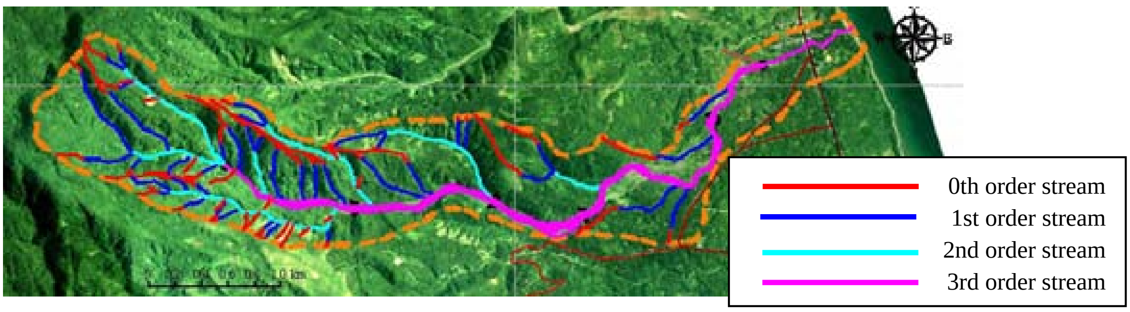
Design Driftwood Volume: The driftwood volume moved down to Sub-Control Point No. 2 with "Debris flow of design scale" (the downstream edge of debris flow runoff area)

ii) Design Sediment Volume

The design sediment volume is the volume of movable sediments (movable deposits on the streambed plus collapsible sediments) within the drainage area, or the volume of transportable sediments by debris flow of the design scale, whichever is smaller. Collapsed areas of the Pontod River Basin, natural streams, the result of field investigation such as stream orders, the volume of movable sediments obtained with satellite imagery analysis, and the transportable sediments obtained under rainfall of the exceedance probability of 100-year return period are shown in the following table.

Table 2-10 Result of Calculation of Design Sediment Volume

Item	Sub-Control Point No. 1	Upstream Sabo Dam	Sub-Control Point No. 2 (Downstream Sabo Dam)
Catchment Area (km^2)	1.08	2.97	3.17
Streambed Slope	1/3.0	1/7.5	1/7.5
Movable Sediment (m^3)	41,800	181,400	208,800
Length of 1st Order Stream (m)	2,850	9,020	9,020
Length of 2nd Order Stream (m)	1,820	5,790	5,790
Length of 3rd Order Stream times Width (m^2)	0	55,600	82,940
Movable Deposits on the Streambed (m^3)	0	55,600	82,900
Collapsible Sediments (m^3)	41,800	125,800	125,800
Transportable Sediments (m^3)	111,100	76,300	79,400
24-hour rainfall (mm)	216	216	216
Density of Debris Flow	0.78	0.3	0.3
Runoff Collection Rate	0.24	0.17	0.16
Design Sediment Volume (m^3)	41,800	76,300	79,400



iii) Design Driftwood Volume

The design driftwood volume is obtained multiplying the estimated driftwood volume by the driftwood ratio. Slope failure at the 0th order stream is considered to be the source of the woody flow. The design driftwood volume obtained is as shown in the following table.

Table 2-11 Result of Design Driftwood Volume Calculation

Item	Sub-Control Point No. 1	Upstream Sabo Dam	Sub-Control Point No. 2 (Downstream Sabo Dam)
Catchment Area (km^2)	1.08	2.97	3.17
Streambed Slope	1/3.0	1/7.5	1/7.5
Design Driftwood Volume (m^3)	440	1,300	1,300
Collapsed Land Area in 0^{th} Order Stream (m^2)	2,790	8,390	8,390
Density of Trees (trees/100m^2)	10	10	10
Tree Height (m)	10	10	10
Driftwood Ratio	0.9	0.9	0.9

(3) Calculation of Peak Discharge for Debris Flow

The peak discharge for debris flow is calculated with the sediment flow volume. It is obtained from the largest debris flow among a couple of debris flow occurred by a single flood. The peak discharge for debris flow obtained is as shown in the following table.

Table 2-12 Result of Peak Discharge for Debris Flow Calculation

Item	Sub-Control Point No. 1	Upstream Sabo Dam	Sub-Control Point No. 2 (Downstream Sabo Dam)
Catchment Area (km^2)	1.08	2.97	3.17
Streambed Slope	1/3.0	1/7.5	1/7.5
Peak Discharge for Debris Flow (m^3/s)	38	372	372
Largest Sediment Flow Volume (m^3)	3,440	18,580	18,580
Density of Debris Flow	0.54	0.30	0.30
Volume Concentration of Sediment in the Streambed	0.60	0.60	0.60
Total Volume of Debris Flow (m^3)	3,830	37,170	37,170

(4) Debris Flow and Driftwood Preparedness Plan

In the debris flow and driftwood preparedness plan, two Sabo dams act as barriers to debris flow of the design scale and driftwoods at Sub-Control Point No. 2.

i) Effect of Sabo Dam on Debris Flow and Driftwood

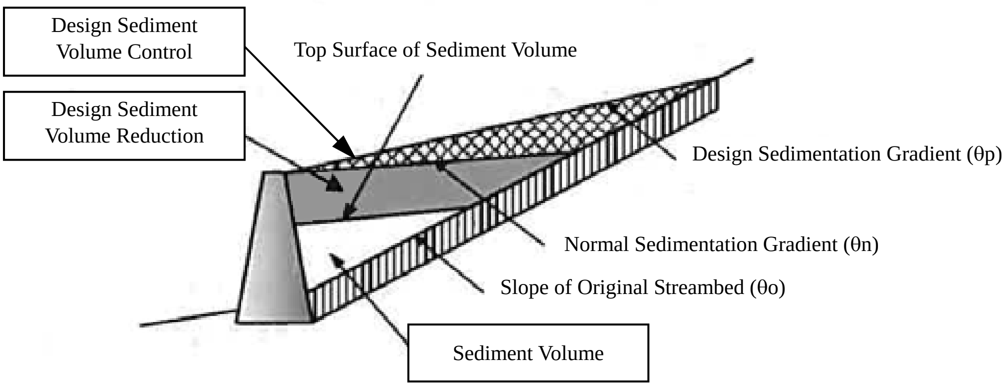
Generally speaking, the Sabo dam bars debris flow and driftwoods occurred by a moderate flood and its upper streambed slope becomes 1/2 of the original streambed slope (the sedimentation line). When a great flood occurs, the streambed slope becomes 2/3 (the temporary sedimentation line after a great flood) and the streambed generally becomes gentle down to the original sedimentation line with scour and erosion induced by moderate and small flood. This function is called the debris flow control effect of Sabo dam, as summarized below.

Sediment Volume : The part of the volume between the existing streambed and the sedimentation line, which always contains sediment and driftwood without removal.

Design Sediment Volume Reduction : The part of the volume between the existing streambed or top surface of sediment volume and the sediment line, which is usually empty with removal work and can check sediment and driftwood carried by the debris flow of the design scale.

Design Sediment Volume Control : The volume between the sedimentation line and the temporary sedimentation line, where sediment and driftwood carried by the debris flow of the design scale can be controlled.

- Case of Impermeable-Type Dam



- Case of Permeable-Type Dam

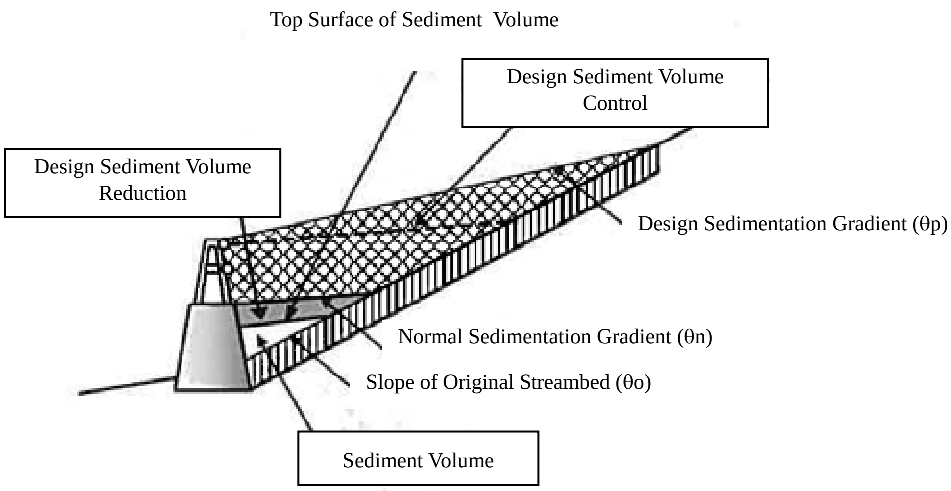


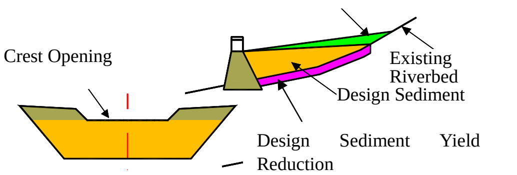
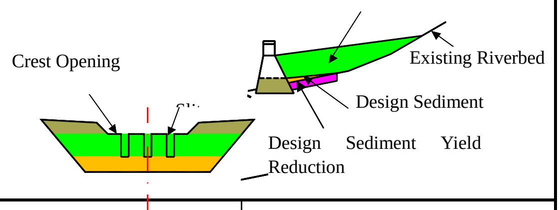
Figure 2-14 Concept of Design Sediment Volume Reduction, Sediment Volume and Design Sediment Volume Control

ii) Type of Sabo Dam

Debris flow has massive destructive force so that dry-laid structures such as gabions, tetra pods, and stone masonries are not durable enough and not acceptable in the Pontod River Basin.

Sabo dam, which is a strong concrete structure, can be classified into two types according to the method of catching debris flow and driftwood; namely, the permeable-type dam and the impermeable-type dam. Typical types of permeable-type dams are the concrete slit dam and the steel-pipe slit dam, as summarized in the following table.

Table 2-13 Comparative Table of Types of Sabo Dam and their Effects

Item	Impermeable-Type Dam	Permeable-Type Dam	
		Concrete Slit Dam	Steel-Pipe Slit Dam
Photo			
Structure	Concrete Body	Concrete Body, Slits with a Couple of meters in width	Concrete Body, Wide Opening with Steel Pipe Structure
Feature	Difference of content rates of sediment during flood and general conditions makes the difference of sediment slopes, which contributes to sediment control. This volume is called the design sediment volume control.	Basically, the function of permeable-type dam is similar to the impermeable one. However, in the permeable-type dam, sediment flow during general condition, moderate flood and small flood goes through openings such as slits, and large boulders in the debris flow are trapped. Hence, the empty volume during the general condition is larger, which makes the ability to capture sediment higher than that of the impermeable-type dam, as shown in the figures below. It is noted that the slits have to be wide enough so that they will not be blocked with sediment. Otherwise, the Sabo dam can be filled with sediment and it loses its ability to control debris flow.	
Effect on Debris Flow			
Ease of Design and Construction	Easy to design; Comparatively easy to construct because of continuous concrete work.	The width of slits is designed based on the diameter of gravels on the riverbed. Since it is difficult to design them, sediment flow may go toward the downstream area during the general condition so that it is necessary to check the debris flow in the debris flow runoff area where boulders of three meters in diameter exist. Slits divide the dam body, which makes construction difficult.	It is easy to arrange the size and structure of slits. Settlement of the steel structure is easy to handle.
Economic Efficiency	Comparatively cheap; Non-durable local materials can be applied for the internal concrete.	Comparatively expensive for impermeable-type dam; Slits in the dam body limit internal concrete made of non-durable and local material.	It is difficult to obtain steel products locally, and they are comparatively expensive. It is difficult to maintain the steel products.
Maintenance Management	In case that only the difference of content rates of sediment during a flood and general condition is considered to contribute to sediment control (the design sediment volume control), removal of rocks is not required. In the target area, there is little sediment flow during moderate and small floods so that it takes a considerable time for sediment to fill the Sabo dam.	Less sedimentation occurs at the Sabo dam during moderate and small floods. It is highly likely that the concrete slits can be structural deficits, broken and need to be fixed.	
Environment	The sediment flow is cut off by the dam. However, no problem can be seen since the sediment flow during moderate and small floods is very little.	No problem can be seen since sediment flow is not cut off.	
Evaluation		○	

Among the permeable-type dams, the concrete slit dam, which has an economical advantage compared to the steel-pipe slit dam, has several issues to be solved in its application. For example, (i) the width of slits is difficult to design, letting the sediment flow toward the downstream area during the general condition before checking the debris flow; (ii) it is highly likely that the concrete slits can be a structural deficit; and (iii) internal concrete made of non-durable and local materials is less required.

On the other hand, although the implementation cost is comparatively small, the impermeable-type dam has an issue in the aspect of high maintenance management cost (lifecycle cost) for removing rocks when the function of sediment volume control is required of the permeable-type dam. However, in case that only design sediment volume control is expected (considering the difference of content rates of sediment during flood and general condition), removal of rocks is not required and maintenance management cost becomes inexpensive.

In the preparedness plan, only design sediment volume control is considered for sediment control in the debris flow and driftwoods preparedness plan. The impermeable-type dam is chosen as the ideal type of dam considering ease of design and construction, durability, economic efficiency and environmental aspect, as shown in the table above.

iii) Debris Flow and Driftwood Preparedness Plan

From the geographical and geological points of view at the dam site, the height of the Upstream Sabo Dam is set at 10m and that of the Downstream Sabo Dam is set at 12m. Effects of the Sabo dams have been calculated, as shown in the table below.

Table 2-14 Effects of Sabo Dam

Item	Unit	Upstream Sabo Dam	Downstream Sabo Dam	Total
Catchment Area	km^2	2.97	3.17	-
Streambed Slope		1/7.5	1/7.5	-
Height of Sabo Dam	m	10	12	-
Sediment Volume	m^3	58,200	24,800	83,000
Design Sediment Volume Reduction	m^3	0	0	0
Design Sediment Volume Control	m^3	31,100	27,700	58,700

Based on the calculated design sediment volume and design sediment volume control, the debris flow and driftwood preparedness plan at Sub-Control Point No. 2 is as defined in the next table.

Table 2-15 Debris Flow and Driftwood Preparedness Plan at Sub-Control Point No. 2

Design Volume for Debris Flow	Design Volume Control (w/ two Sabo dams)	Design Excess Volume
Design Driftwood Volume 1,300 m^3	Design Driftwood Volume Control* 1,100 m^3	Design Driftwood Excess Volume 200 m^3
Design Sediment Volume 79,400 m^3	Design Sediment Volume Control 57,600 m^3	Design Sediment Excess Volume 21,800 m^3
Total 80,700 m^3	Total 58,700 m^3	Total 22,000 m^3

*Design driftwood volume control is considered to be 2% of the design volume control.

As shown in the table above, the design discharge for debris flow is 80,700m^3 and the total design catchment volume of the two Sabo dams is 58,700m^3. Hence, the control ratio is approximately 74% (58,700m^3 / 80,700m^3).

The training dike being constructed by DPWH-DEO at the downstream area of Pontod River is a funnel-shaped structure having the sediment storage volume of approximately 25,000m^2. This area can control 22,000m^3 of debris flow and driftwoods with the average thickness of 1m that run toward the downstream area from Sub-Control Point No. 2. Due to the effect of the training dike and the storage area, it is expected that all of the debris flow design discharge is captured before it reaches the downward edge of the training dike, or the Control Point.

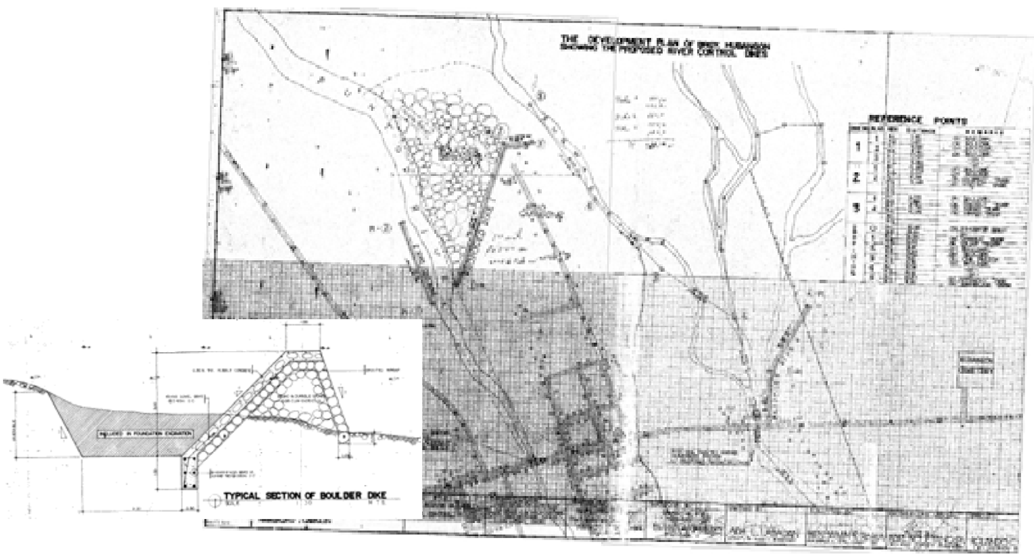


Figure 2-15 Training Dike being constructed by DPWH-DEO at Downstream of Pontod River

iv) Design of Sabo Dam Structure

The body of Sabo dam has to be stable against overturning, tensile stress and sliding. The foundation of Sabo dam is also expected to be stable. The external forces considered in a stability analysis are hydraulic pressure, earth pressure and hydrodynamic force of debris flow. The crest wings need to be stable against the impact force of hydrodynamic force of debris flow with gravels and driftwoods. The crest opening that can let the design flow travel down the river safely is required for Sabo dam as well.

The specification of Sabo dam is shown in the following table.

Table 2-16 Specification of Sabo Dam

Specifications	Upstream Sabo Dam	Downstream Sabo Dam
Type of Dam	Concrete Gravity-Type Dam (no Slit)	
Dam Height	10 m	12 m
Elevation of Foundation	EL. 259.5 m	EL. 169.5 m
Width of Length	115 m	70 m
Width of Crest	4.0 m	4.5 m
Streambed Slope	Upstream 1:0.4 Downstream1:0.2	Upstream 1:0.4 Downstream1:0.2
Width of Crest Opening	18.0 m	12.0 m
Depth of Design Flood Discharge	2.5 m	3.0 m
Freeboard	1.25 m	1.50 m
Apron	-	-

(5) Plan of Access/Maintenance Road

The Access/Maintenance Road is designed and utilized as the access road for the construction of Sabo dam.

i) Route Planning

The alternative routes of the Access/Maintenance Road for the upstream and downstream Sabo dam are shown in the following figure.

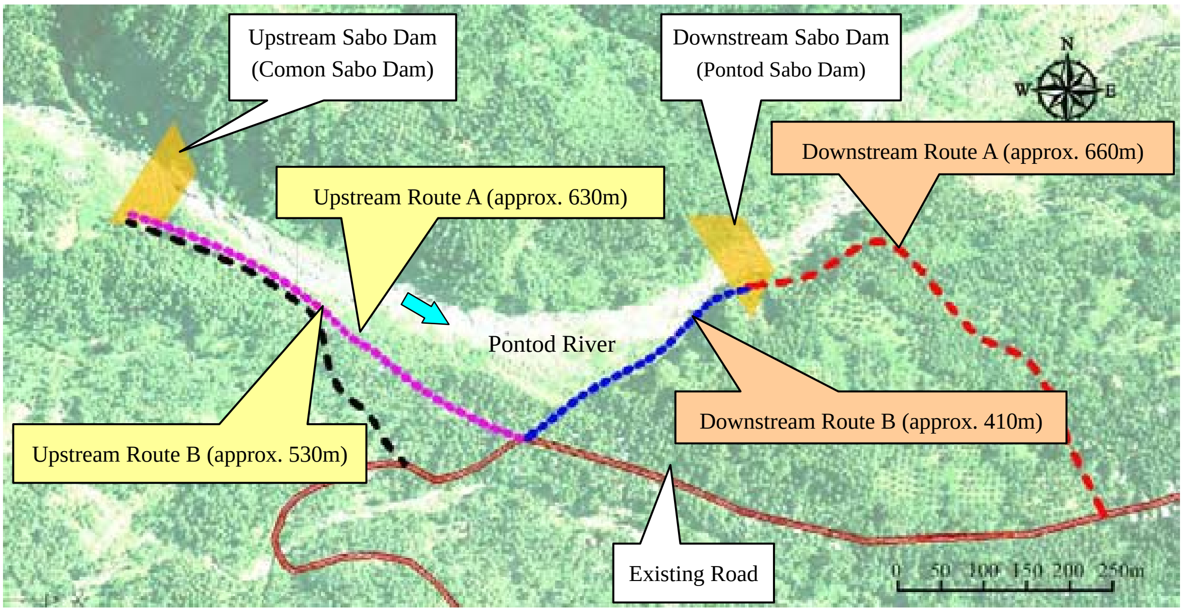


Figure 2-16 Alternative Routes of Access/Maintenance Road of Sabo Dam

Table 2-17 Comparative Table of Alternative Routes of Access/Maintenance Road of Upstream Sabo Dam

Item	Alternative Route A	Alternative Route B
Features of Route	Route A runs upward along Pontod River from the existing road. The road is constructed, cutting and filling through banana and coconut plantations.	Route B starts at 150m from the upward point of the origin of Route A. The road is constructed, cutting and filling through banana and coconut plantations, and joins Route A.
Length	Approximately 630m	Approximately 530m
Social Condition along Route	There are a couple of residential buildings at the fork in the existing road to the Sabo dam site, which may be disturbed severely by noise and vibration during the construction work even though they will not be transferred. One residential building is to be transferred.	There is no residential building required to be transferred at the fork in the existing road to the Sabo dam site. One residential building is to be transferred.
Ideal Route	**Route B** is the ideal route because of the short length of the road, no residential building (except for one building to be transferred), and no environmental impact of noise and vibration during the construction work.	

Table 2-18 Comparative Table of Alternative Routes of Access/Maintenance Road of Downstream Sabo Dam

Item	Alternative Route A	Alternative Route B
Features of Route	Route A approaches Pontod River from the downstream point and runs upward along the river. The road is constructed, cutting and filling through banana and coconut plantations.	Route B approaches Pontod River from the upstream point and runs downward on the streambed sediment along the river. (Since the right side slope stands precipitously, cutting of the road would result in a slope of over 50m high.)
Length	Approximately 660m	Approximately 410m
Social Condition along Route	Mostly coconut plantation	Mostly streambed sediment
Ideal Route	Compared to Route A, the length of Route B is shorter. However, the road has to be possible while debris flow is occurring and, besides, it is very difficult to construct the road along Route B on the streambed sediment, which meets such a condition. Hence, Route A is chosen as the ideal route.	

As described in the tables above, the Access/Maintenance Road is defined as below:

- Access/Maintenance Road for Upstream Sabo Dam: Route B
- Access/Maintenance Road for Downstream Sabo Dam: Route A

ii) Design Conditions

Design conditions are shown in the following table.

Table 2-19 Design Conditions of Access/Maintenance Road

Specification	Access/Maintenance Road for Upstream and Downstream Sabo Dam
Number of Lanes	One
Width of Road	Street: 4.0 m, Road Shoulder: 1.0 m x 2 = 2.0 m
Steepest Longitudinal Slope	12 %（14 % from unavoidable circumstances）
Smallest Curvature Radius	20 m
Pavement	Graveled Pavement, t = 150 mm (Longitudinal Slope: Less than 7%, Using Gravel in Camiguin Island) Concrete Pavement, t = 150 mm (Longitudinal Slope: 7% or Larger, Using Gravel in Camiguin Island)
Roadbed	Gravel, t = 150 mm (Using Gravel in Camiguin Island)

2-2-3 Basic Design Drawing

2-2-3-1 Hubangon Bridge

(1) Basic Parameters of Bridge

Table 2-20 shows the basic parameters of the new Hubangon Bridge.

Table 2-20 Basic Parameters of Hubangon Bridge

Item		Basic Parameters of Bridge
Bridge Site		Present Bridge Location
Bridge Length		40.9m
Bridge Span		1 span
Width	Number of Lanes / Roadway	2 lanes、7.32m (3.66m x 2)
	Walkway	0.76m x 2 (Both Sides)
	Railing	0.30m x 2 (Both Sides)
Bridge Type	Foundation	Cast-in-Place Reinforced Concrete Pile
	Superstructure	PC girders (Height of Beam: 2.0m; 5 Main Beam)
Access Road Length		Left Side: 10.75 m、Right Side: 11.35 m
Revetment Type		Grouted riprap (Around Bridge Abutment)
Utilities		Road Marking, Guard Rail
Others		Detour During Construction Location: Upstream Side Length: Approximately 350m Width: 6m (Gravel Surface Pavement) Crossing River Point: 3 points (Width 4m)

(2) Basic Design Drawings of Bridge

Table 2-21 gives the list of bridge drawings. The basic design drawings are attached as Appendix-5.

Table 2-21 List of Drawings (Hubangon Bridge)

Drawing No.	Title	Scale
H-01	Project Location Map	-
H-02	General View of Hubangon Bridge	1/200,1/100,1/50
H-03	Structure Drawing of Superstructure	1/100,1/50,1/30
H-04	Prestressing Tendon for Main Girder	1/30,1/20,1/10
H-05	Details of Expansion Joint and Drainage	1/200,1/40,1/20,1/10,1/5
H-06	Structural Drawing of A1 Abutment	1/100,1/50,1/20,1/2
H-07	Structural Drawing of A2 Abutment	1/100,1/50,1/20,1/2
H-08	Plan and Profile	H=1/200,V=1/100
H-09	Cross Section	1/100
H-10	Typical Section & Detail of Structures	1/50,1/30,1/10
H-11	Detail of Concrete Pavement	1/100,1/10

2-2-3-2 Sabo Dam

(1) Basic Parameters of Sabo Dam

Table 2-22 shows the basic parameters of the two Sabo dams and the Access/Maintenance Road.

Table 2-22 Basic Parameters of Sabo Dam and Access/Maintenance Road

Item		Upper Sabo Dam	Lower Sabo Dam
Sabo Dam	Location	3.1km from River Mouth	3.7km from River Mouth
	Basin Area	2.97km^2	3.17km^2
	Dam Type	Concrete Gravity-Type (Without Slit)	Concrete Gravity-Type (Without Slit)
	Dam Height	10 m	12 m
	Dam Foundation Elevation	EL. 259.5 m	EL. 169.5 m
	Length of Dam	115 m	70 m
	Thickness of Crest	4.0 m	4.5 m
	Inclination of Slope	Back 1:0.4, Front 1:0.2	Back 1:0.4, Front 1:0.2
	Over flow Width	18.0 m	12.0 m
	Depth of Design Flood Discharge	2.5 m	3.0 m
	Freeboard	1.25 m	1.50 m
	Thickness of Crest	4.0 m	4.5 m
	Front Protection Work	None	None
Access/Maintenance Road	Number of Lanes	1 Lane	
	Road Width	Roadway: 4.0 m, Road Shoulder: 1.0 m x 2 = 2.0 m	
	Steepest Longitudinal Gradient	12 % (14% when avoidable)	
	Minimum Curve Radius	20 m	
	Pavement	Gravel (Crusher-run) Pavement: t = 150 mm (Longitudinal Gradient less than 7%, Materials from Camiguin Island) Cement Concrete Pavement: t = 150 mm (Longitudinal Gradient 7% or more, Materials from Camiguin Island)	
	Base Course	Aggregate Base Course: t=150mm(Materials from Camiguin Island)	
	Length	525 m	657 m

(2) Basic Design Drawings of Sabo Dam and Access/Maintenance Road

Table 2-23 gives the list of Sabo Dam and Access/Maintenance Road drawings. The basic design drawings are attached as Annex-3.

Table 2-23 List of Drawings (Sabo Dam and Access/Maintenance Road)

Drawing No.	Title	Scale
S-01	Project Location Map	-
S-02	Plan of Upper Sabo Dam	1/200
S-03	Plan of Lower Sabo Dam	1/200
S-04	General Drawing of Upper Sabo Dam	1/200
S-05	General Drawing of Lower Sabo Dam	1/200
S-06	Plan and Profile of Access Road (Upper Sabo Dam)	H=1/1000, V=1/500
S-07	Plan and Profile of Access Road (Lower Sabo Dam)	H=1/1000, V=1/500
S-08	Typical Cross Section of Road Section	1/50

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 scheme of the Government of Japan after the signing of the Grant Aid Exchange of Notes for this project by the government of both countries.
- The implementing organization of the project is the Department of Public Works and Highways of the Government of the Republic of the Philippines.
- The consulting services, like the detailed design, tender-related works and construction supervision services, will be provided by a Japanese consulting firm in accordance with the consultancy contract that shall be executed with the Government of the Philippines.
- The construction of bridge and Sabo dam will be executed by a Japanese construction firm that shall be selected through pre qualification, in accordance with the construction work contract that shall be executed between the said construction firm and the Government of the Republic of the Philippines.

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

- The equipment, materials and labor for the construction shall be, to the possible extent, procured locally. In cases where local procurement is not possible, they shall be procured either from a third country where it is most economical insofar as the required quality and supply capacity are secured, or from Japan.
- Construction method and the construction schedule shall be consistent with the local climate, topography, geology and natural conditions like the river characteristics of each proposed site.

- Simple and common construction method that does not require special equipment or technology shall 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 shall be established.
- Thorough safety ensuring for workers and/or third parties on the site during the construction period shall be carried out.
- River water contamination or sediment discharge into the river as well as select areas designated by the Philippine Government for borrow pit, spoil-banks and waste disposal site that contribute to the preservation of the environment shall be prevented by reducing the negative impacts to the environment.

2-2-4-2 Implementation Conditions

(1) Bridge

i) Consideration on Dry Season and Flood Season

For bridgeworks, it is critically important to plan an efficient construction schedule in consideration of topography, geology and river characteristics, such as the dry season or the flood season. The river characteristics and implementation conditions are as described below.

1) River Characteristics

The dry season for the construction of Hubangon Bridge is 7 months, from March to September. The river width at the Hubangon Bridge is approximately 2.0 meters and the deepest depth is approximately 0.3 meters. The flood season for the Hubangon Bridge is 5 months, from October to February. The annual maximum river width at the Hubangon Bridge is approximately 25.0 meters and the deepest depth is approximately 1.1 meters.

2) Implementation Conditions

The substructure work, which is the first step of bridge construction, shall be completed during the dry season, considering economic efficiency and early completion of the project.

ii) Condition on Ambient Topography and Land Use in Site

It is necessary to secure a temporary yard close to the bridge construction site for the fabrication of girders and to build the superstructure by crane, which is generally the most economical method of superstructure work. However, it is impossible to secure a temporary yard for girder manufacture because the area around the site consists of residential area and cultivated field. Since it is very difficult to assemble the large crane required for the construction and to ensure the installation position owing to the small construction yard, there will be a problem regarding the safety of construction work. Based on the circumstances, a temporary stage made of steel shall be installed upstream of the new bridge construction site and the girder is fabricated on the stage. Then the girder is slid by the haulage equipment.

The temporary stage for girder manufacture and the procedure of girder erection are as illustrated in Figure 2-17.

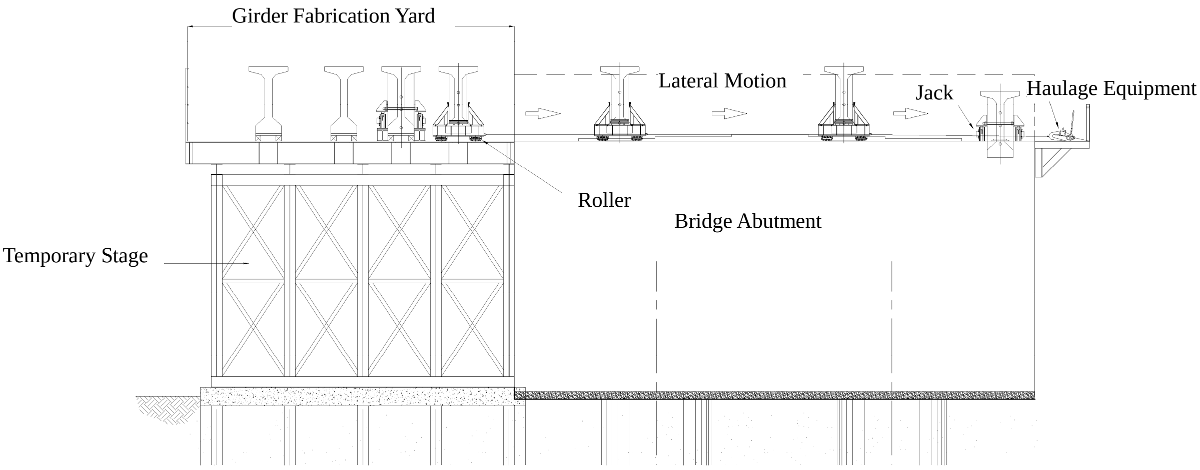


Figure 2-17 Temporary Steel Stage for Girder Manufacture and Procedure of Girder Erection

iii) Security of General Traffic

The proposed bridge is located along a peripheral road (second class national road) in Camiguin Island. As a result of the study, the new bridge shall be located at the site of the existing bridge. Since there is no existing detour road at the site, a new detour road shall be constructed nearby the existing bridge to ensure security of the general traffic during the construction period. The proper planning of detour road construction shall be considered to minimize any adverse impact to the surrounding cultivated field with the installation of a temporary bridge for uninterrupted and smooth transportation, as well as safety. The planning of detour road is as illustrated below.

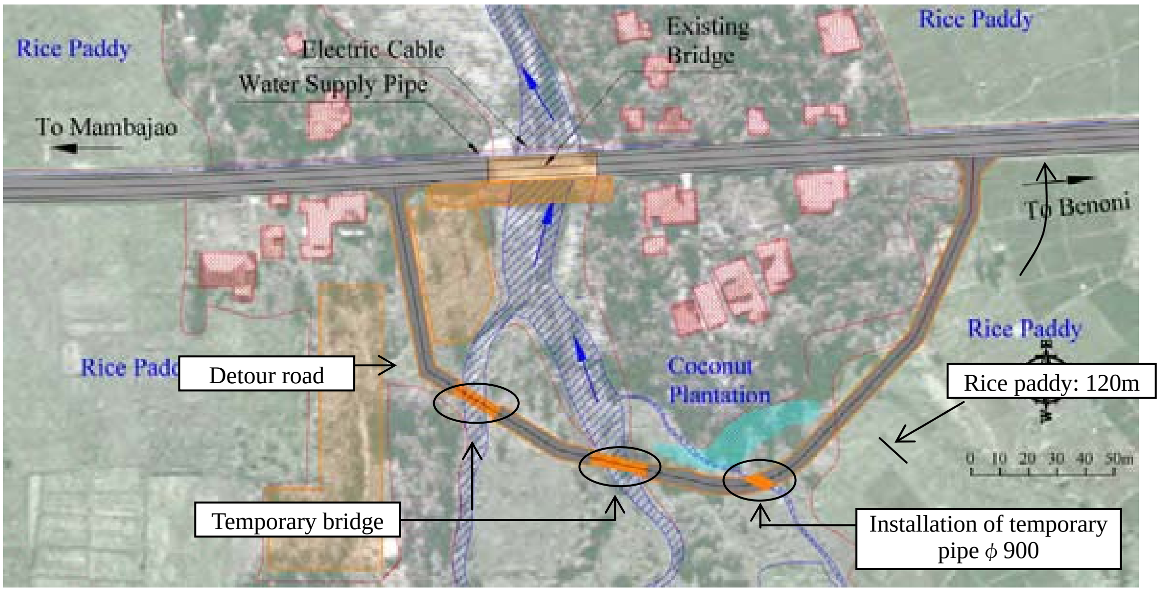


Figure 2-18 Plan of Detour Road

iv) Safety of Third Parties and Construction Workers

As mentioned above, it is necessary to consider the safety of third parties and construction workers, since the construction work will be carried out on only a peripheral road in Camiguin Island.

Safety of Third Parties:

- The construction yard shall be delineated clearly and only authorized people shall be allowed to enter the site.
- Direction boards to the construction work, bulletin boards on the detour road, and red flashers at night shall be installed to guide vehicles and pedestrians to the detour road.
- Regular inspection of temporary bridge shall be implemented for the prevention of facility defects that would invite accidents.
- Traffic accidents shall be avoided through safety training of operators/drivers of material transportation vehicles.

Safety of Construction Workers:

- Falling accidents shall be prevented with the installation of appropriate scaffolding and fall prevention utilities because of frequent high-place work.
- Minor accidents shall be prevented with the deployment of security personnel for heavy construction machines.

v) Consideration on Environment

- Water pollution prevention measures against the spill of muddy water shall be implemented, such as ensuring the function of the reserved pump and tank during cast-in-place pile work.
- Areas designated by the Philippine Government for borrow pit, spoil-banks and waste disposal site shall be properly utilized to contribute to the preservation of the environment.
- Construction works that generate noise and vibration shall be avoided during early morning hours and at night.
- Countermeasures such as sprinkling of dust generated by construction machines shall be devised.
- Environmental information services, bulletins and training for related parties shall be provided, especially, to educate people on occupational safety and health hazards, natural environmental conservation, and healthcare such as health control in the summer season.

(2) Sabo Dam

i) Consideration on Dry Season and Flood Season

The Sabo dams are to be installed in the existing river. Thus, construction work is considered to take place safely and effectively in the dry season and the flood season, as follows:

- The Sabo dam construction is expected to start during the dry season, from March to August. During the excavation work of riverbed and the concrete placement work of the Sabo dam body in case of below the low water level, dewatering and/or diversion shall be carried out.
- Temporary drainage pipes with 1000 millimeters in diameter are to be installed in the dam body. The concrete placement work of the Sabo dam body should be completed during the dry season to avoid the impact of the flood season.

ii) Condition on Ambient Topography and Land Use in Site

The dam site is dotted with many cultivated fields, like mango and banana plantations. The temporary yard shall be planned to minimize utilization of the cultivated fields.

Since the dam site is a precipitous landform, a safe construction plan shall be formulated to avoid slope collapses of cutting or filling.

iii) Safety of Third Parties and Construction Workers

There are some residences along the Access/Maintenance Road to the dam site and the construction of Access/Maintenance Road is supposed to involve blasting work. It is therefore necessary to consider the safety of third parties and construction workers, since dam construction will be implemented in the existing river.

Safety of Third Parties:

- The construction yard shall be delineated clearly and only authorized people shall be allowed to enter the site.
- The construction of Access/Maintenance Road is supposed to involve blasting work. Therefore, security personnel shall be deployed to monitor the storage of blasting materials around-the-clock to avoid any accident.
- Advance warning to people before the blasting work shall be carried out, including the confirmation and prevention of outsiders within the extent of the blasting impact.
- Traffic accidents shall be avoided through safety training for operators/drivers of material transportation vehicles.

Safety of Construction Workers:

- Advance warning and prevention of outsiders before the blasting work shall be carried out to avoid any accident.
- Appropriate scaffolding and fall prevention utilities shall be installed to prevent falling

accidents because of the frequent high-place work.

- Security personnel for heavy construction machines shall be deployed to prevent minor accidents.
- The cutting or filling at site shall be inspected regularly to prevent landslides.
- Emergency materials shall be stocked as a measure against the swollen river, and the evacuation plan shall be formulated to avoid any significant disaster.

iv) Consideration on Environment

- Anti-pollution measures shall be implemented to preserve the river water quality.
- Water pollution prevention measures against the spill of muddy water shall be implemented during the construction work, such as ensuring the function of the reserved pump and tank.
- Cut earth shall be diverted as embankment material to reduce the amount of surplus soil.
- Areas designated by the Philippine Government for borrow pit, spoil-banks and waste disposal site shall be utilized properly to contribute to the preservation of the environment.
- Construction work that generates noise and vibration shall be avoided during early morning hours and at night.
- Countermeasures like the sprinkling of dust generated by construction machines shall be devised.
- Environmental information services, bulletins and training for related parties shall be provided, especially, to educate people on occupational safety and health hazards, natural environmental conservation and healthcare such as health control in the summer season.

2-2-4-3 Scope of Works

The items to be undertaken by the governments of Japan and the Philippines are as shown in Table 2-24.

Table 2-24 Responsibilities of the Governments of Japan and the Philippines

Items	Contents	Delineation of Responsibilities		Remarks
		Japan	Philippines	
Procurement of Equipment and Materials	Procurement and transportation of equipment and materials	O		
	Customs clearance of equipment and materials		O	
Preparatory Works	Securing of land required for the construction		O	Site office, stock-piling yard, working yard
	Resettlement		O	
	Construction of detour road	O		
	Setting of construction road	O		
	Securing borrow pit and spoil-banks		O	
	Securing waste disposal site		O	
	Other works	O		
Removal of Obstacles to Construction	Removal of surface obstacles		O	
	Removal of existing bridge	O		
Main Construction	Two Sabo dams	O		Including Access/Maintenance Road
	Hubangon Bridge	O		

2-2-4-4 Consultant Supervision

Based on the consultancy contract with the Government of the Philippines, the Japanese consulting firm shall carry out the detailed design, the tender-related works, and the construction supervision services.

(1) Detailed Design Services

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

- Inception meeting with the implementing organization, detailed design, and site investigation
- Detailed design, preparation of drawings
- Procurement plan of materials and project cost estimation

The required period for the detailed design is estimated to be approximately 3.5 months.

(2) Tendering Services

The main items of the tendering services to be provided by the consultant from the time of tender notice to the finalization of contract for construction are as follows:

- Preparation of tender documents (prepared simultaneously with the detailed design)
- Tender notice
- Examination of prequalification of bidders

- Initiation of tender
- Evaluation of tender documents
- Facilitating of contract execution

The required period for the works relevant to the tendering service is estimated to be approximately 3.0 months.

(3) Construction Supervision Services

The Japanese consulting firm shall conduct supervision of the works that the construction contractor will perform in conformity with the construction contract and the execution scheme. The main items of the construction supervision services 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 Sabo dam works and the bridge works are planned for simultaneous construction. The Sabo dam and bridge construction are mainly concrete works, and pre-stressed concrete of specific construction is adopted as bridge girder. Therefore, for supervision works, one Japanese resident engineer and one professional engineer for bridge girder construction shall be deployed. The professional engineer shall be in site from the start of bridge girder fabrication to the installation of girder.

The supervision work is conducted, so as to prevent accidents at the early stage, through consultation and cooperation with the person in charge of safety of the construction contractor.

2-2-4-5 Quality Control Plan

The quality control plan of concrete works is shown in Table 2-25, and the earthworks and pavement works in Table 2-26.

Table 2-25 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
Fine 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)
	Screening test	AASHTO T27	Once every month
Course Aggregates	Physical test of course 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
Water	Water quality test	AASHTO T26	Once before trial mix, and then anytime when considered necessary
Concrete	Slump test	AASHTO T119	Twice a day
	Air content test	AASHTO T121	Twice a day
	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; 28-day strength: 3 samples)
	Temperature	-	Twice a day
	Chlorine content test	-	Twice a day

Table 2-26 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 $500m^2$
Basecourse Works	In-situ density test (Compaction)	AASHTO T191	For every $1,000m^2$
	Compaction and uniaxial compression test	AASHTO T180	For every $1,000m^2$

2-2-4-6 Procurement Plan

(1) Construction Materials Procurement Plan

The procurable and producible major construction materials in Camiguin are sand and aggregate for concrete. The other procurements will mainly be from Manila and Mindanao. Aggregates are produced in Camiguin Island, but low specific gravity and intensity such as effervescent andesite is included. Hence, the Camiguin aggregates had not received permission for use in public buildings, and general aggregates are procured from Mindanao.

The blistered stones in the right picture are effervescent andesite, and these have low specific gravity and intensity.

The construction materials procurement plan is as follows:

- Materials that are regularly available in the Camiguin market are to be procured.
- In cases where procurement is not possible in the Philippines, the material will be procured from either a third country or Japan. The procurement country is determined by considering the quality, cost, possibility of procurement, and delivery period.
- Based on the results of concrete compressive strength tests in this project and the calculation of required concrete strength, the procurement place of aggregates for concrete are concluded.

The procurement classification of major construction materials are shown in Table 2-27.

Table 2-27 Classification Table for Procurement of Major Construction Materials

Items	Procurement Classification			Procurement Route
	Local	Japan	Third Country	
Materials for Structures				
Course/Fine aggregates for concrete	O			-Bridge works : Mindanao -Sabo dam works : Inner concrete: Camiguin Outer concrete: Mindanao -Access/Maintenance road: Mindanao
Cement	O			Camiguin Island
Boulders for revetment	O			Camiguin Island
Subbase course material	O			Access Road of Hubangon Bridge: Mindanao Island Access/Maintenance Road of Sabo Dam: Camiguin Island
Reinforcing bars (D6~D32)	O			Camiguin Island
Additives for concrete	O			Camiguin Island
Prestressing tendon	O			Manila
Bearings for PC girder		O		Japan to Manila
Expansion joints		O		Japan to Manila
RC pipes (D=900~1000mm)	O			Mindanao Island
Regulatory signs	O			Mindanao Island
Materials for Temporary Works				
Timber for formworks	O			Camiguin Island
Plywood for formworks without waterproofing	O			Camiguin Island
Timber for supports and scaffolding	O			Camiguin Island
Mold steel	O			Camiguin Island
Temporary pier material including accessory	O			Camiguin Island
Temporary bridge (Bailey Bridge)	O			Manila
Fuel, oil	O			Camiguin Island
Oxygen, acethylene	O			Camiguin Island
Gas cutting machine	O			Camiguin Island

(2) Construction Machinery Procurement Plan

The construction machinery procurement plan is as follows:

- Common machines owned by local contractors are planned to be leased. In case the lease cost is expensive, the procurement plan is determined by considering a third country after the calculation of duration of service.
- In cases where local procurement is not possible, machines will be procured from either a third country or Japan.

The procurement classification of construction equipment is as shown in Table 2-28.

Table 2-28 Table of Procurement Classification of Construction Equipment

Items		Lease/ Purchase	Procurement Supplier, Method etc.			Reason for Procurement	Procurement Route
Equipment	Specification		Local	Japan	Third Country		
Backhoe	$0.28m^3$	Lease	O				From Mindanao to Camiguin Island
Backhoe	$0.5m^3$	Lease	O				ditto
Backhoe	$0.8m^3$	Lease	O				ditto
Bull dozer	15 ton	Lease	O				ditto
Bull dozer	21 ton	Lease	O				ditto
Heavy weight breaker	Hydraulic method class 600~800kg	Lease	O				ditto
Motor grader	W=3.7m	Lease	O				ditto
Road roller	10 to 12 ton	Lease	O				ditto
Tire roller	8 to 20 ton	Lease	O				ditto
Vibration roller	0.5 to 0.6 ton	Lease	O				ditto
Vibration roller	0.8 to 1.1 ton	Lease	O				ditto
Wheel loader	$2.3m^3$	Lease	O				ditto
Wheel loader	$3.1m^3$	Lease	O				ditto
Sprinkle car	6.0 kℓ	Lease	O				ditto
Dump truck	10 ton	Lease	O				ditto
Dump truck	4 ton	Lease	O				ditto
Truck crane	4.8 to 4.9 ton	Lease	O				ditto
Truck crane	20 ton	Lease	O				ditto
Truck crane	35 ton	Lease	O				ditto
Truck crane	50 ton	Lease	O				ditto
Crawler crane	80t	Lease	O				ditto
Truck crane	4 ton	Lease	O				ditto
Trailer	20t	Lease	O				ditto
Trailer	30t	Lease	O				ditto
Rotary all casing boring machine	Maximum diameter 1,500mm Engine	Lease	O				From Manila to Camiguin Island
Vibro-hammer	60 kw	Lease	O				ditto
Electric generator	15KVA	Lease	O				From Mindanao to Camiguin Island
Electric generator	25KVA	Lease	O				ditto
Underwater pump	150mm	Lease	O				ditto
Underwater pump	100mm	Lease	O				ditto
Hand breaker	20kg	Lease	O				ditto
Compressor	3.5 to $3.7m^3$/min	Lease	O				ditto

2-2-4-7 Implementation Schedule

The project implementation schedule for the detailed design and construction stage is shown in Figure 2-19.

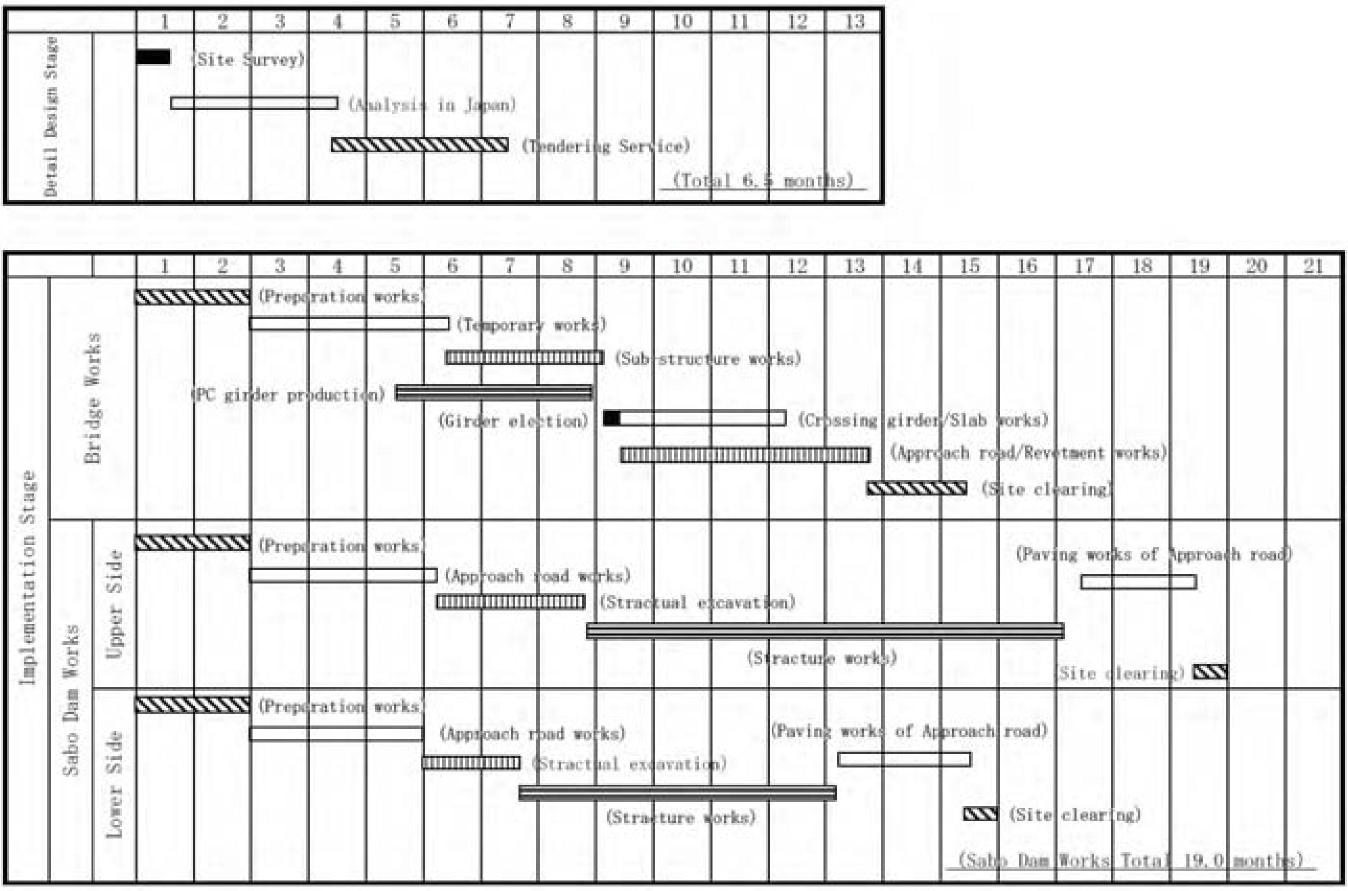


Figure 2-19 Project Implementation Schedule

2-3 Obligations of Recipient Country

The undertakings required from the Government of the Philippines (GOP) for the smooth execution of this project are as follows:

- To provide documents, data and information necessary for the execution of this project;
- To acquire land for construction works and to relocate houses, if any;
- To secure land for the construction yard, stock-piling yard, site office, girders' manufacturing yard, and detour routes;
- To secure borrow pits, spoil-banks, and industrial waste disposal areas;
- To install equipment for electricity at the site office;
- To remove/relocate electric and telephone poles and water pipes that hinder construction work;
- To keep public vehicles out of the Access/Maintenance Road of the two Sabo dams; (Installation of Gates)
- 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 bear the value-added-tax related to the project;
- To exempt materials imported for the construction work 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 services necessary for the execution of the project;
- To exempt Japanese nationals from all legislation measures necessary for entering and staying in the Philippines;
- To ensure proper use and maintenance of the bridge, the Sabo dams 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; and
- To bear all expenses required for the execution of the project, other than those borne by the Grant-Aid of Japan.

2-4 Project Operation Plan

2-4-1 Operation and Maintenance System

(1) Hubangon Bridge

Maintenance of the bridge and approach roads after their construction shall be the responsibility of the DPWH Regional Office (Region X) and conducted by the DPWH Camiguin District Engineering Office.

(2) Sabo Dam

Maintenance of the Sabo dams and/or Access/Maintenance roads after their construction shall be the responsibility of the DPWH Regional Office (Region X), the DPWH Camiguin District Engineering Office and the Camiguin Provincial Government. Based on sample cases in the Republic of the Philippines, the operation and maintenance of the Sabo dams is to be conducted, as follows:

- The Provincial Government will provide maintenance to the Sabo dam body and/or Access/Maintenance Road, including simple repair.
- The DPWH will provide technical assistance in the rehabilitation of the Sabo dam body and/or Access/Maintenance road.

The DPWH and the Camiguin Provincial Government have executed a Memorandum of Agreement (MOA) regarding the detailed sharing of O&M activities including budgetary arrangements in February 2009.

The maintenance system of the related organizations is as tabulated in

Table 2-29, the budget and expenditures of the related organizations is as shown in Table 2-30toTable 2-32, and the organizational charts of the related organizations are as presented in Figure 2-20 to Figure 2-24.

(3) Operation and Maintenance Ability

The DPWH Camiguin District Engineering Office will conduct mainly bridge maintenance work. This office is regarded as capable for the operation and maintenance work, since it has been responsible for the maintenance and control of 22 bridges in Camiguin Island without any particular problem all these years.

According to previous practices on Sabo dams in the Republic of the Philippines, after construction, the facilities are handed over to the local government, which in this instance is the Camiguin Provincial Government, and the local government implements the maintenance work. However, in case major repairs are required, the DPWH undertakes the rehabilitation work.

Likewise, this project is supposed to adopt the same system. Since it is the first Sabo dam construction work in Camiguin Island, and the DPWH Camiguin District Engineering Office lacks experience on Sabo dam O&M, the office should conduct appropriate maintenance work with technical support from the FCSEC of DPWH. The maintenance work on the Access/Maintenance Road of the Sabo dams will not present a problem because of enough experience.

2-4-2 Contents of Maintenance Work

The maintenance works required is as follows:

Hubangon Bridge

Periodical Inspection	:	Periodical inspection of bridge and approach roads
Daily Maintenance	:	Cleaning of drainage facilities, pavement, expansion devices, shoulders, bridges, etc.
Repair/Maintenance	:	Repairing of pavement, drainage facilities, main body of substructure, bridge accessories, shoulders, slopes, etc.

Sabo Dam

Periodical Inspection	:	Periodical inspection of dam body, Access/Maintenance roads, and volumes of sediment.
Daily Maintenance	:	Cleaning of dam drainage facilities, Access/Maintenance road drainage facilities, pavement, shoulders, etc.
Repair/Maintenance	:	Repairing of dam body, dam drainage facilities, Access/Maintenance road drainage facilities, pavement, shoulder, slopes, etc.

2-4-3 Note on Maintenance Work

To achieve sufficient development and sustainability of project effects, the following items need particular consideration, because it is important to secure all-time-high traveling performance and to improve the durability of facilities:

- To keep informed at all times on the condition of facilities through periodical inspection.
- To inspect and understand the situation of Sabo dam drainage facilities, as well as the volumes of sediment.
- To inspect and clean the Access/maintenance road drainage facilities, shoulders, and slopes.
- To clean, in particular, the bridge drainage facilities, the bearings, the expansion devices, and the neighboring areas.
- To secure the budget necessary for the maintenance work.

Since the facilities to be constructed under this project have high durability and weather resistance, large-scale maintenance will not be required for a certain period of time and, consequently, there will be no technical difficulty in the implementation of management and maintenance work. Given that the above points were taken into consideration, the management and maintenance works are judged to be viable for implementation under the present budget/system

Table 2-29 Maintenance System of Related Organization

Items	DPWH Regional Office (Region X)	DPWH Camiguin District Engineering Office	Camiguin Provincial Government
Organizational Chart	Figure 2-21	Figure 2-22	Figure 2-23
Staff / Engineer (head count)	306 / 79	59 / 18	28 / 12 *1

*1: Number of O&M staff in DPWH Provincial Engineering Office

Table 2-30 Budget and Expenditures of DPWH Regional Office (Region X)

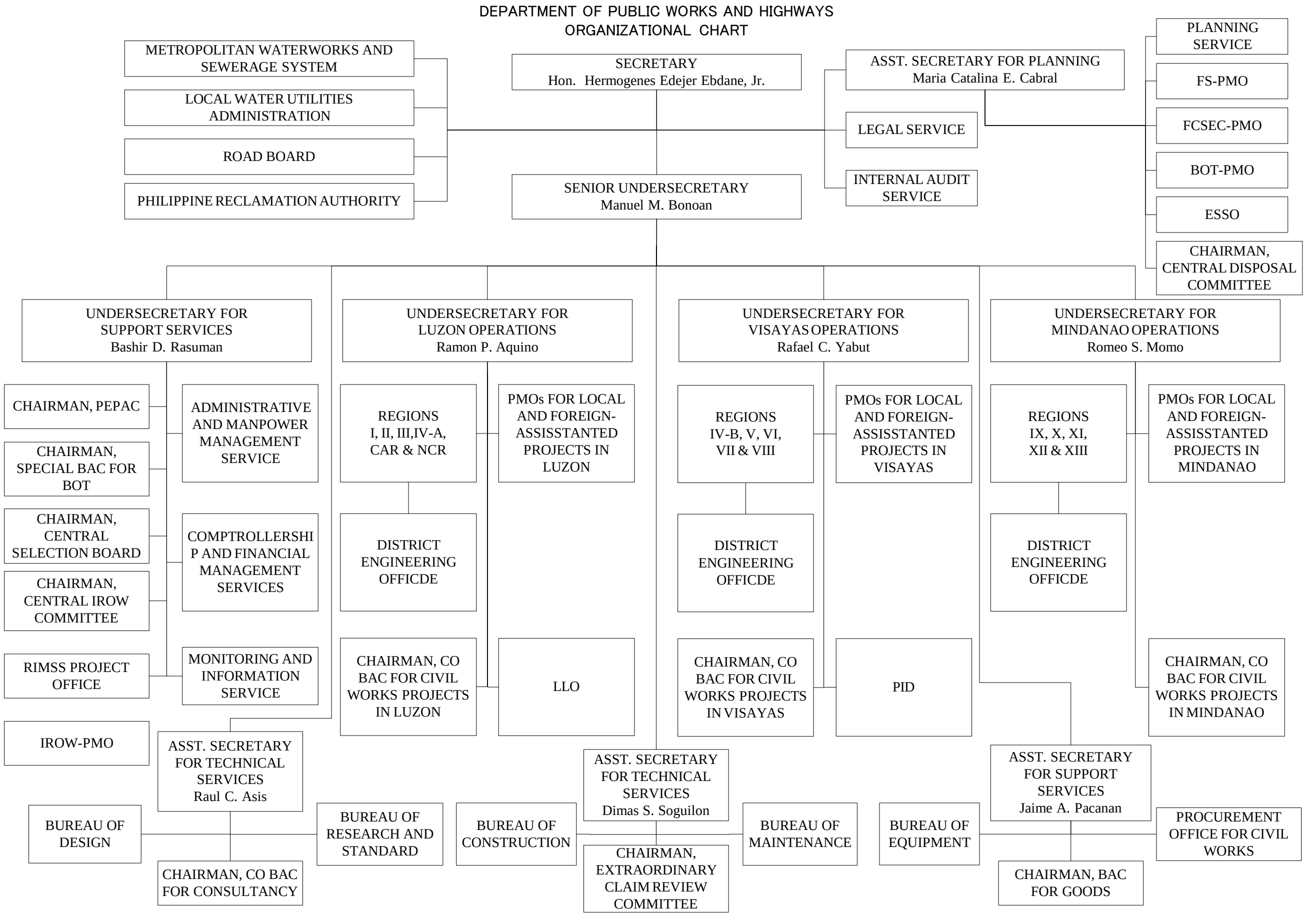
Items	Budget and Expenditures (1,000 peso)									
	2003		2004		2005		2006		2007	
	Budget	Expenditure	Budget	Expenditure	Budget	Expenditure	Budget	Expenditure	Budget	Expenditure
Total Amount	392,808	392,808	566,664	487,900	251,272	217,332	385,822	372,961	842,760	623,631
O&M Cost	302,937	302,937	104,315	104,315	121,237	121,237	127,937	127,937	107,809	107,809

Table 2-31 Budget and Expenditures of DPWH Camiguin District Engineering Office

Items	Budget and Expenditures (1,000 peso)									
	2003		2004		2005		2006		2007	
	Budget	Expenditure	Budget	Expenditure	Budget	Expenditure	Budget	Expenditure	Budget	Expenditure
Total Amount	17,648	17,648	16,370	16,370	15,524	15,524	22,519	22,519	29,667	29,667
O&M Cost	6,501	6,501	5,000	5,000	4,764	4,764	11,000	11,000	18,000	18,000

Table 2-32 Budget and Expenditures of Camiguin Provincial Government

Items	Budget and Expenditures (1,000 peso)									
	2003		2004		2005		2006		2007	
	Budget	Expenditure	Budget	Expenditure	Budget	Expenditure	Budget	Expenditure	Budget	Expenditure
Total Amount	172,534	160,640	182,784	153,124	187,367	173,244	190,677	177,003	203,453	189,757
O&M Cost	23,803	17,843	27,061	21,748	28,890	22,487	38,513	27,510	32,968	26,928



AMMS	- Administrative & Manpower Management Service	**FS**	- Feasibility Studies
BAC	- Bidding and Awards Committee	**IAS**	- Internal Audit Service
BOC	- Bureau of Construction	**IROW**	- Infrastructure Right-of-Way
BOD	- Bureau of Design	**LS**	- Legal Service
BOE	- Bureau of Equipment	**LLO**	- Legislative Liaison Office
BOM	- Bureau of Maintenance	**MIS**	- Monitoring and Information Service
BOT	- Build Operate and Transfer	**NCR**	- National Capital Region
BRS	- Bureau of Research and Standards	**PEPAC**	- Price Escalation and Price Adjustment Committee
CAR	- Cordillera Administrative Region	**PID**	- Public Information Division
CFMS	- Comptrollership & Financial Management Service	**PMO**	- Project Management Office
DEOs	- District Engineering Office	**POCW**	- Procurement Office for Civil Works
ESSO	- Environmental and Social Services Office	**PS**	- Planning Service
FCSEC	- Flood Control and Sabo Engineering Center	**RIMSS**	- Road Information and Management Support System

Figure 2-20 Organizational Chart of DPWH Head Office (as of August 2008)

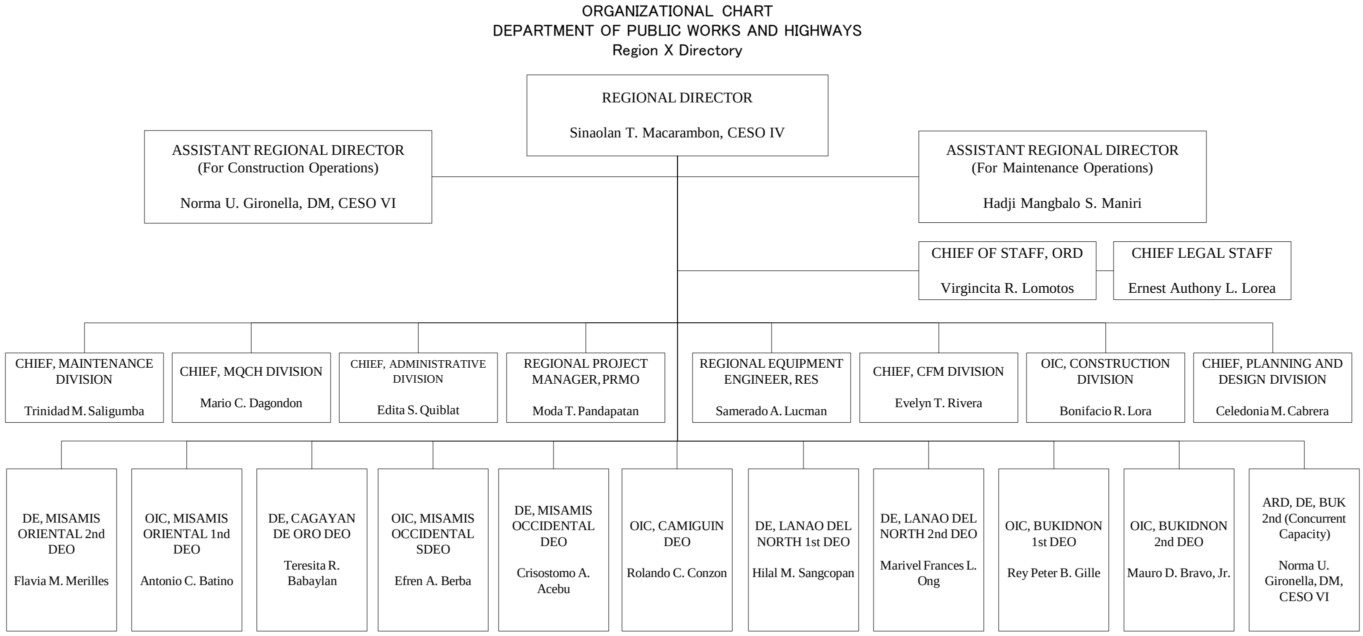


Figure 2-21 Organizational Chart of DPWH Regional Office (Region X)

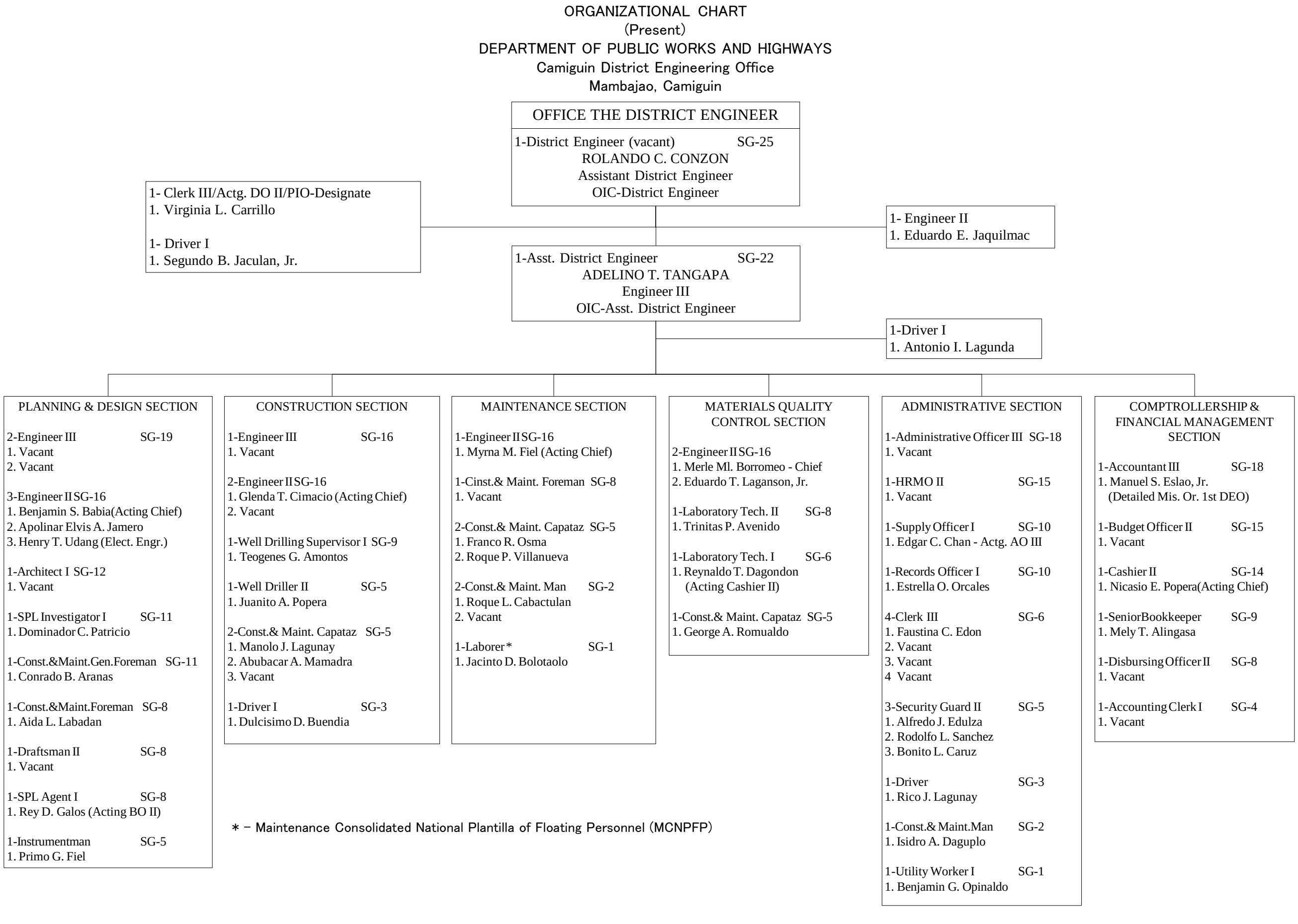


Figure 2-22 Organizational Chart of DPWH Camiguin District Engineering Office

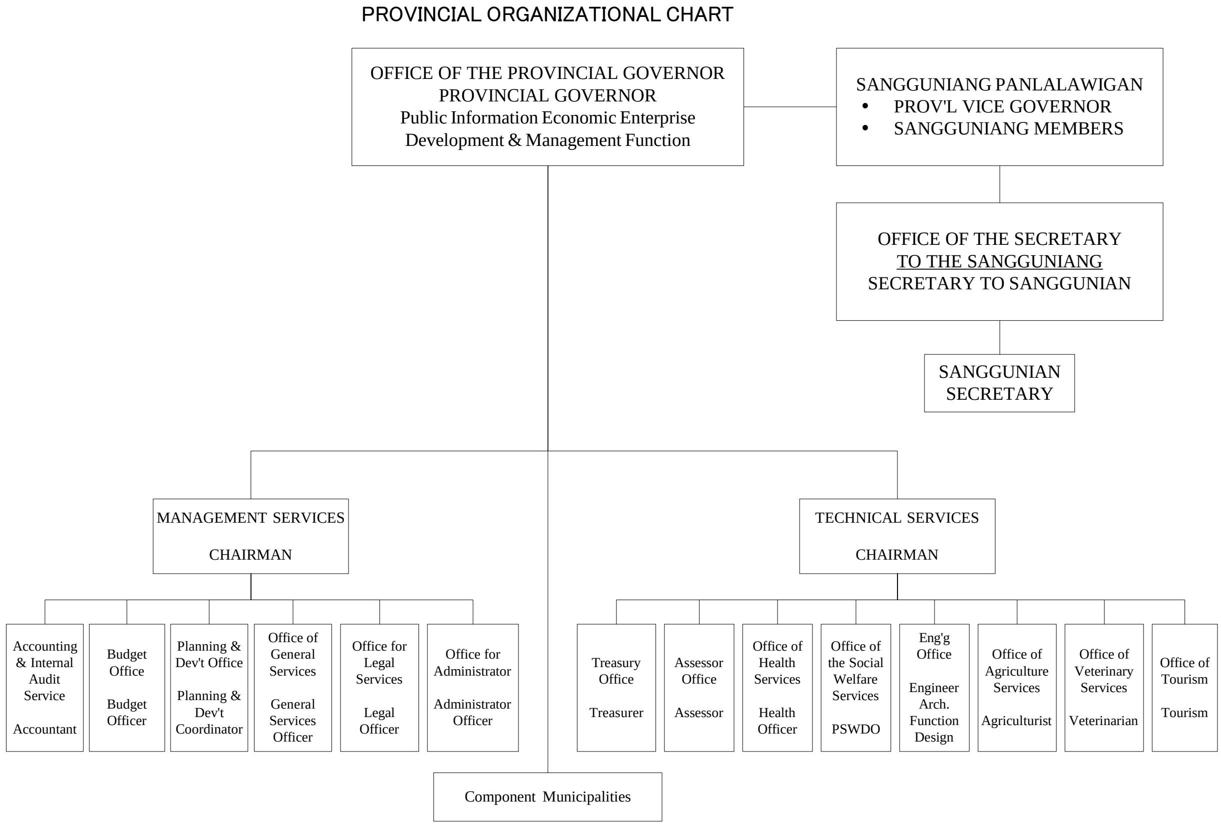


Figure 2-23 Organizational Chart of Camiguin Provincial Government

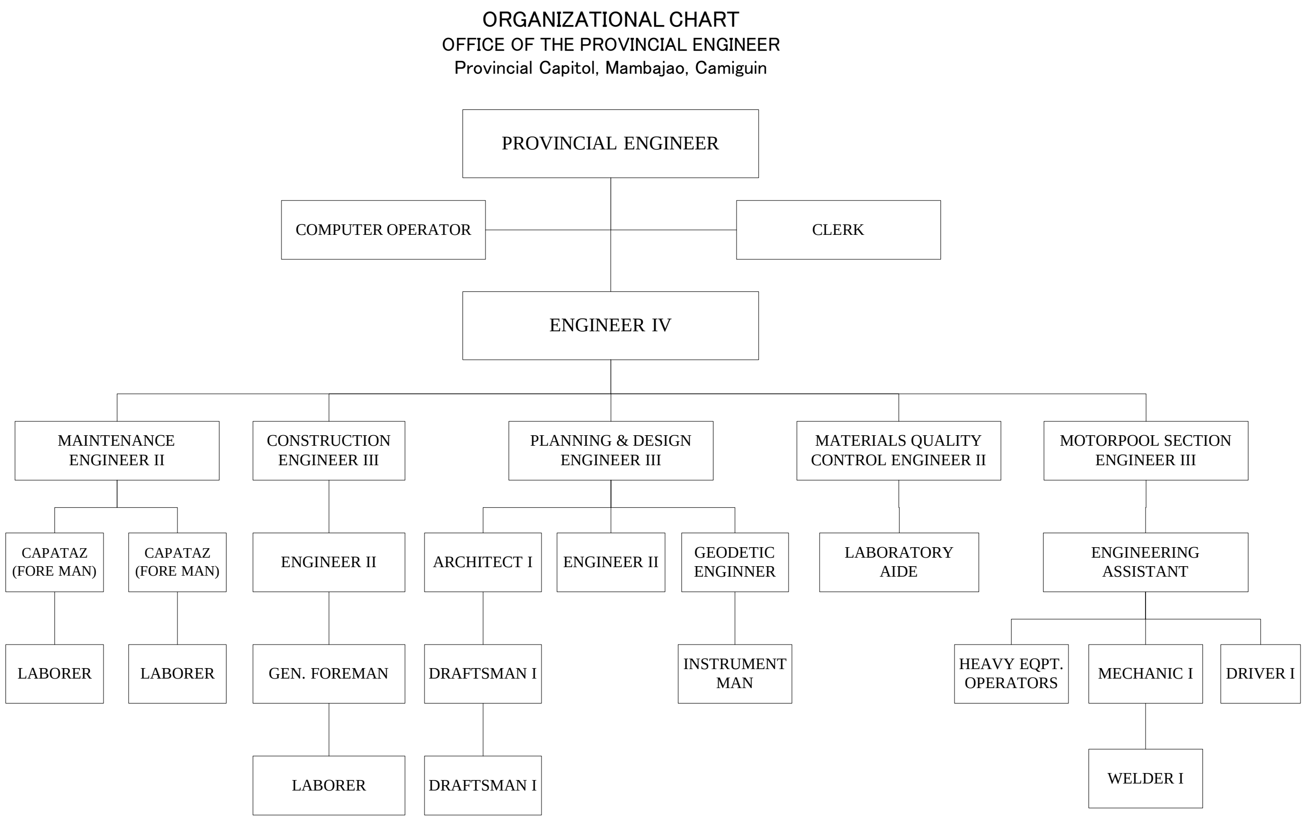


Figure 2-24 Organizational Chart of Camiguin Provincial Engineering Office (O&M Section)

2-5 Project Cost Estimation

2-5-1 Initial Cost Estimation

(1) Philippines Contribution

According to the cost estimation by the Japanese side, the Philippines side is expected to fund the following costs among others excluding value-added-tax (VAT), institutional development and operating costs. The estimated Total Cost is approximately 1.951 million pesos.

Table 2-33 Items Funded by the Philippine Side based on the Cost Estimation of the Japanese Side

	Items	Total Amount [Million Peso (Million Yen)]
(1)	Advising Commission	0.355 (0.916)
(2)	Payment Commission	0.444 (1.145)
(3)	Land Acquisition and Relocation of Houses (Sabo dam site)	0.534 (1.377)
(4)	Land Acquisition (Bridge site)	0.018 (0.046)
(5)	Relocation of Electric and Telephone Poles/Lines	0.560 (1.440)
(6)	Installation of Gate (Entrance of Access/Maintenance Road to Sabo dams)	0.040 (0.103)
	Total	1.951 (5.027)

(2) Cost Estimation Condition

- Estimation Timing : September 2008
- Foreign Exchange Rate : US$1.00 = JPY106.18

  PHP1.00 = JPY2.58

  Foreign Exchange Rate applied is the average of Telegraphic Transfer Rate (TTS rate) for six months from March 2008 to August 2008
- Construction Period : The implementation schedule of the detailed design and construction is shown in Subsection 2-2-4-7
- 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 works, such as periodic inspection, daily maintenance, and repair of facilities constructed under this project:

Hubangon Bridge : DPWH Regional Office (Region X), DPWH Camiguin District Engineering Office

Sabo Dam : Camiguin Provincial Government, DPWH Regional Office (Region X), DPWH Camiguin District Engineering Office

The DPWH Regional Office (Region X) will manage the O&M of the bridge and implemented by the DPWH Camiguin District Engineering Office.

The Camiguin Provincial Government will maintain the Sabo dam body and/or access/maintenance roads including simple repair. DPWH will provide technical assistance in the rehabilitation of Sabo dam body and/or access/maintenance road. The DPWH and the Camiguin Provincial Government have executed the Memorandum of Agreement (MOA) regarding the detailed division of O&M activities including budgetary arrangement in February 2009.

The breakdown of expenses required for the maintenance and operation of each facility is as shown in Table 2-34 and Table 2-35.

Since the facilities to be constructed under this project have high durability and weather resistance, large-scale maintenance will not be required for a certain period of time and, consequently, there will be no technical difficulty in the implementation of management and maintenance works. However, since this will be the first Sabo dam construction work in Camiguin Island and the implementing organizations mentioned above are inexperienced in Sabo dam O&M, the organizations should conduct the maintenance work with technical assistance from the FCSEC of DPWH.

The budget of the DPWH Camiguin District Engineering Office and the Camiguin Provincial Government over the past five years is as shown in Table 2-31 and Table 2-32, while the budget for fiscal year 2007 is 18 million and 33 million pesos respectively.

As mentioned before, large-scale maintenance will not be required for a certain period of time hence, the Sabo dam maintenance work is mainly daily management and simple repair by the Camiguin Provincial Government. The maintenance cost for each facility is as shown in Table 2-34 and Table 2-35, namely, the maintenance cost of Hubangon Bridge is assumed to be 191,600 pesos per year, and that of the two Sabo dams is 340,500 pesos per year.

The maintenance cost for Hubangon Bridge will be equivalent to 1.9% of the overall maintenance cost of the DPWH Camiguin District Engineering Office. The maintenance cost for the Sabo dams will be equivalent to 1.0% of the overall maintenance cost of the DPWH Camiguin District Engineering Office.

Based on the above, the management and maintenance work is judged to be viable for implementation under the present budget and system of each local organization.

Table 2-34 Major Maintenance Items and Annual Expenses (Hubangon Bridge)

	Items	Inspection Items	Implementation Frequency	Number of Personnel	Equipment to be Used	Required Quantity	Amount (PHP)
Regular Inspection	Bridge		12 times/year Required number of days: one day per inspection	2	Scope, hammer, sickle, barricade	Total: 24 man-days/year	51,600
	Pavement	Cracks, Undulations, Damages, etc.					
	Drainage Facilities	Mud, Presence of Obstacles					
	Main Body	Damages, Deformations, Taints, Abrasion, etc.			Pick-up	Total 12 cars/year	36,000
	Revetment	Cracks, Damages, Failures, etc.					
	Bridge Utilities	Damages of Handrails, etc.					
	Approach Roads						
	Pavement	Cracks, Undulations, Damages, etc.					
	Shoulder, Slope	Erosion, Deformation, failures, etc.					
	Guard rail	Damages, etc.					
	Compartment line	Bald, Disappearance, etc.					
						Subtotal	87,600
Daily Maintenance	Items	Implementing Items	Implementing Frequency	Number of Personnels	Equipment to be Used	Required Quantity	Amount (PHP)
	Drainage Facilities	Mud, Removal of Obstacles, Cleaning	4 times/year Required number of days: one day per maintenance	5	Scope, Barricade, Grass Mower, Broom, Tools	Total: 20 man-days/year	23,800
	Pavement	Cleaning					
	Expansion Joint	Mud, Removal of obstacles, Cleaning					
	Shoulder	Grass cutting, Cleaning			Light Truck	Total: 4 cars/ year	20,000
	Bridge	Cleaning					
						Sub-Total	43,800
Repair	Items	Implementing Items	Implementing Frequency	Number of Personnels	Equipment to be Used	Required Quantity	Amount (PHP)
	Bridge		1 time per year Required number of days: 4/repair	6			
	Pavement	Crack Sealing, Repairing of damages				Total: 24 man-days/ year	26,800
	Drainage Facilities	Repairing of damages			Tamper	Total: 4/year	4,000
	Main Body	Repairing of damaged portion			Light Truck	Total: 4/year	20,000
	Bridge Utilities	Repair of Handrail Damages, etc.					
	Approach Roads				Base Course Materials	1.0m^3/year	1,400
	Pavement	Crack Sealing, Repairing of damages			Concrete	0.5m^3/year	3,000
	Shoulder, Slope	Repairing of damaged portion			Laying of Compartment	10m/year	5,000
	Guardrail	Repairing of damage					
	Compartment line	Re-laying					
						Sub-Total	60,200
						Total	191,600

Table 2-35 Major Maintenance Items and Annual Expenses (Two Sabo Dams)

	Items	Inspection Items	Implementation Frequency	Number of Personnel	Equipment to be Used	Required Quantity	Amount (PHP)
Regular Inspection	Sabo Dam		12 times per year; Required number of days: one day per inspection	2	Scope, hammer, sickle, barricade	Total 24 man-days/year	51,600
	Drainage Facilities	Mud, Presence of Obstacles					
	Main Body	Damages, Deformations, Taints, Abrasion, Situation of Sediment etc.			Pick-up	Total: 12 cars/year	36,000
	Access/Maintenance Road						
	Pavement	Cracks, Undulations, Damages etc.					
	Shoulder, Slope	Erosion, Deformation, failure etc.					
	Fall Prevention Block	Cracks, Defects etc.					
	Drainage Facilities	Mud, Presence of Obstacles					
						Sub-Total	87,600
Daily Maintenance	Items	Implementing Items	Implementing Frequency	Number of Personnel	Equipment to be Used	Required Quantity	Amount (PHP)
	Sabo dam		2 times per year; Required number of days: 4 per maintenance	5	Scope, Barricade, Grass Mower, Broom, Tools	Total: 40 man-days/year	47,600
	Drainage Facilities	Mud, Removal of Obstacles, Cleaning					
	Main Body	Removal of Sediment					
	Access/Maintenance Road						
	Pavement	Cleaning					
	Shoulder	Grass cutting, Removal of Obstacles,Cleaning			Dump 10ton	Total: 2 cars/year	70,000
	Drainage Facilities	Mud, Removal of Obstacles,Cleaning			Backhoe, 0.8m^3	Total: 1 car/year	20,000
						Subtotal	137,600
Repair	Items	Implementing Items	Implementing Frequency	Number of Personnel	Equipment to be Used	Required Quantity	Amount (PHP)
	Sabo Dam		1 time per year; Required number of days: 7 per repair	6		Total: 42 man-days/year	46,900
	Drainage Facilities	Repairing of damages					
	Main Body	Repairing of damages					
	Access/Maintenance Road				Tamper	Total: 7/year	7,000
	Pavement	Crack Sealing, Repairing of damages			Light Truck	Total: 7/year	35,000
	Shoulder, Slope	Repairing of damaged portion			Base Course Materials	6.0m^3/year	8,400
	Fall Prevention Block	Repairing of damaged portion			Concrete	3.0m^3/year	18,000
						Sub-Total	115,300
						Total	340,500

Chapter 3 Project Evaluation and Recommendations

3-1 Project Effect

The intended project aims not only to mitigate the damage caused by sediment disaster in Camiguin Island, but also to keep and improve the residents' living standard and to keep a sustainable economic growth with the construction of two Sabo dams and reconstruction of the damaged Hubangon Bridge.

The estimated number of population to be directly benefited by the project is shown in Table 3-1, while the direct and indirect effects of project implementation are shown in Table 3-1 and Table 3-2 respectively.

Table 3-1 Estimated Direct Beneficiaries of the Project

Facility	Estimated Direct Beneficiary Population	Remarks
Sabo Dam Construction	5,006 people	Residents of 7 Barangays in the river basins of Hubangon and Pontod in Mahinog City of Camiguin Island, Philippines, as of August 2007
Reconstruction of Hubangon Bridge	81,293 people	Residents of Camiguin Island as of August 2007

Table 3-2 Direct Effects of Project Implementation

Present Condition and Problems	Measures in this Project	Direct Effect and Improvement Extent
A lot of mountain slopes in Camiguin Island had collapsed, causing avalanche of sand and stone and flash floods with damage to infrastructure, houses and agricultural facilities estimated at about 500 million yen aside from about 250 people dead or missing. After the disaster, the Philippines made efforts to formulate a basic plan employing soft measures such as warning evacuation drills and disaster prevention education in advance of other regions, and intended to strengthen the disaster prevention system with Japan's Grant Aid. However, special measures or facilities have not been introduced after the disaster in the drainage basins around Hubangon and Pontod rivers where damage was especially large. Damaged bridge facilities have not been reconstructed, and vehicles have to move with restraint on one side traffic. The river channels are thickly covered with unstable sediment deposits, and there is a risk that a disaster similar to that caused by Typhoon Nanang in 2001 will happen due to heavy rain in the future.	Two Sabo dams are constructed at the middle river basin of Pontod.	1) Protection of human life and assets such as houses, farmlands, irrigation facilities, national roads and bridges, etc. against the avalanche of sand and stone occurring below a probable excess rainfall intensity of 100 years. 2) Decrease of damage caused by the avalanche of sand and stone occurring over a probable excess rainfall intensity of 100 years.
	Damaged Hubangon Bridge is improved.	1) Improvement of safety against damage caused by avalanche of sand and stone. 2) Improvement of traffic convenience, transport capacity and emergent access during disaster with the improvement of vehicle speed from 5 or 10 km/hr to 50km/hr. 3) Safety against flow materials is kept by setting up appropriate clearance between bottom of girder and surface of water (Minimum clearance height is more than 1.5m).

Table 3-3 Indirect Effects of Project Implementation

Indirect Effect and Improvement Extent
(Increase in Traffic Volume)
① The increase of traffic volume around the target area is expected because of improvement of access between main towns and major port facilities and generation of induced traffic caused by the decrease of damage from sediment disaster. (Average daily traffic volume of two way lanes near Hubangon Bridge in 2008 was 1,193, as observed by the Camiguin Municipal Government Office.)
(Stability of Price of Life Goods)
② The stability of access roads from neighboring farms to markets is doing a great deal in the stability of prices as the result of keeping the stability of safe transport of goods followed by decrease of transport cost. (Consumer price indexes at Camiguin Island in 2006 and 2007 were 135.4 and 140.0 respectively (Year 2001 = 100, Camiguin Municipal Office).
(Enhancement of Image as Tourist Spot)
③ Decrease of damage by sediment disasters to human life and assets such as houses, farmlands, irrigation facilities, national roads and bridges, etc. realizes safe and comfortable sightseeing and enhances the image as tourist spot when careful attention to disaster measures is expected. (The number of tourists to Camiguin was 193,012 in 2001, according to the Camiguin Provincial Government Office.)
(Ripple effect as a Comprehensive Disaster Prevention Model)
④ There are two creeks (Bairao and Top San) in addition to the Hubangon and Pontod creeks where the rank of risk evaluation of avalanche of sand and stone is AA (very high) in Camiguin Island. Soft measures (disaster prevention plan, evacuation drill, disaster prevention education) at those creeks are to be established by JICA and there is a possibility for them to be disseminated as a comprehensive disaster prevention model project.

3-2 Recommendations

(1) Issues to be addressed by the Recipient Government

i) Structural and Non-structural Measures

The measures introduced in this project are structural measures concerning the installation of two Sabo dams. These facilities are greatly expected to prevent disasters caused by the avalanche of sand and stone predicted to happen in future; however, there is a limit to the function of these facilities such as (1) no function to control flood, and (2) no ability to completely prevent sediment disasters over the anticipated safety extent (recurrence probability of 100 years).

This fact requires grappling with a comprehensive disaster prevention system with the combination of structural measures (hard) and non structural measures (soft) to augment the hazard maps, execution standards for evacuation warning, disaster prevention manual, etc. previously used.

ii) Problems in the Current Condition of Non structural Measures

JICA executed the First Overseas Investigation (2003: Basic investigation concerning structural measures) and the Second Overseas Investigation (2004: Introduction of non structural measures) after giving a report on the damage due to Typhoon Nanang in November 2001. Non structural measures such as the preparation of hazard map, installation of system facilities for observation of disasters, and warning systems were executed in 2004.

The following problems about the condition of operation of non structural measures became clear as the result of investigation in Camiguin Province, including Mahinog City and the seven barangays of Mahinog City:

- The Camiguin Provincial Government is carrying out basic roles necessary for non structural measures (organization operation, disaster information dissemination, execution of disaster prevention drill, etc., through the Provincial Disaster Coordination Council (PDCC). However, public relations such as pamphlet distribution, etc., and support to the non structural measures are insufficient.
- In Mahinog City, the city officials with NGO cooperation are aiming for the positive operation of non structural measures. On the other hand, there are some portions that cannot be said enough in such parts as the utilization of manual and revision of the official warning announcement standard.
- Barangay Hubangon was taken up as a model of the Second Overseas Investigation by JICA in 2004, and the operation system necessary for non structural measures is maintained. However, the hazard map, flood observation system, setting of warning level and preparation of manuals, etc., have not been improved since the start of operation in 2004, and there are insufficient points such as no recording of operational achievement during the past four years (2004 2008), etc.
- In the other six barangays, operation concerning a part of non structural measures, such as setting up of accurate flood disaster information and execution of evacuation drill, etc., by the Municipal Disaster Coordination Council (MDCC), is executed. However, setting up of data necessary for the operation of non structural measures, such as hazard map, manual, pamphlet, etc., is not made, and the machinery for flood observation and the system are also not set up.

iii) Proposal concerning Non structural Measures

Non structural measures are indispensable for decreasing disaster damage as much as possible and for supplementing the function of structural measures introduced through Japan's Grand Aid. Therefore, further strengthening and replenishment of funds are required. The following items are proposed to improve the current problems:

- The Camiguin Provincial Government has to increase the budget for the preparation and/or utilization of hazard maps, public relations, and support of the non structural measures of each municipality/city, and to plan their further strengthening and fulfillment.
- Mahinog City has to raise the operation budget for insufficient portions of operation of non structural measures such as utilization of manuals, revision of official warning

announcement standard, etc., and to improve them.

- Barangay Hubangon has to revise and improve the hazard map, flood observation system, warning standard, and the manuals introduced by JICA during its investigation in 2004. Barangay Hubangan also has to plan the improvement through analyzing the operation problems from now on. Moreover, the hazard map displayed for public viewing outside the barangay hall has to be changed with a new updated map as soon as possible (The map was blown off by the disaster in March 2009), and pamphlets have to be reprinted for distribution to schools, etc.
- The other six barangays have to obtain copies of the hazard map, manuals and pamphlets put up and kept in Barangay Hubangon, and to compile the data necessary for the operation of their own non structural measures. They also have to execute flood observation with the use of simple rainfall gauging equipment and scales on piers, etc., record the operation, and make efforts to set up warning evacuation standards.

(2) Technical Cooperation, and Cooperation with Other Donors

Technical cooperation is not planned in this project. Reconstruction support against waterworks and farm road disasters was carried out by the Spanish Government and the Asian Development Bank in 2003, and no related project by other donors has been planned after that. Therefore, it is not necessary to consider especially technical cooperation and one with other donors in this study.

(3) Validity of the Project

It is judged to be valid to carry out a cooperation project under Japan's Grand Aid in consideration of the following:

- The profit objective of this project is the general public including the poverty segment in Camiguin Island, and their number is considerably many.
- This project aims to decrease damage to human life and property like houses, farmlands, irrigation facilities, national roads and bridges, etc., and it is required urgently to maintain and improve the living standard of residents and to keep sustainable economic growth.
- The Philippines can execute this project by its own budget, people and technique, and does not need high techniques for executing the operation and maintenance of the proposed two Sabo dams and the bridge.
- The Philippines gives high priority to disaster prevention on traffic related to the development of the local economy and social stability aiming at the eradication of poverty as envisioned under the Medium Term Philippine Development Plan for 2004 2010, and this project will contribute to reaching the goal of the plan.
- Camiguin Island locates on the route of the Central Bayside Highway (Strong Republic Nautical Highway, or SRNH) as one of the three bayside highways positioning as "Direct route connecting islands and Manila Metropolitan area economies" in the Medium Term Philippine Development Plan for 2004 2010, and this project will contribute to reaching the goal of the plan.
- This project does not make a satisfactory profit.

- There is little negative influence on the environmental and social aspects.
- This project can be carried out without special difficulty using a system of Japan's Grand Aid scheme.

(4) Conclusion

Camiguin Island suffered the damage of about 500 million yen with about 250 people dead or missing. Most of the damage was inflicted on infrastructures, houses and agricultural facilities, because many of the mountain slopes in the island collapsed causing the avalanche of sand and stone and flashfloods due to Typhoon Nanang in November 2001.

As mentioned above, this project aims to decrease the damage to human life and property like houses, farmlands, irrigation facilities, national roads and bridges, etc., and is required urgently to maintain and improve the living standard of residents and to keep sustainable economic growth.

Implementation of this project enables grappling with comprehensive disaster prevention systems with the combination of hard and soft measures to augment the soft measures (hazard map, execution standard for warning evacuation implementation, disaster prevention manual, etc.) previously carried out, together with the construction of Sabo dam around the creek drainage basins still having the possibility of danger of occurrence of large scale avalanche of sand and stone.

Besides, the reconstruction of the damaged Hubangon Bridge enables maintenance of a permanent and fluent traffic flow to activate the economy of the local area and to decrease the number of poor people in the isolated areas.

Furthermore, this project is linked with the Medium Term Philippine Development Plan for 2004 2010, and it is given the first priority in the plan. This project locates on the route of the Center Bayside Highway as one of the Strong Republic Nautical Highways (SRNH) positioning as "Direct route connecting islands and Manila Metropolitan area economies," and locates at an important position connecting with many islands including Mindanao and Manila Metropolitan area with the function as a logistics grid spreading new economic opportunities.

The following are the items concerning maintenance that the Philippines have to implement after completion of the various facilities:

- The Sabo dams will be delivered to the provincial government of Camiguin after completion and the provincial government shall maintain them. However, the Department of Public Works and Highways (DPWH) has to repair them when a large scale repair work is required. There will be no technical problem with regard to large scale repair work since technical support is to be provided by DPWH through the Flood Control and Sabo Engineering Center (FCSEC).
- Maintenance of Hubangon Bridge and the Maintenance/Access roads will be done by the DPWH Camiguin District Engineering Office under the control of the Regional Office of DPWH (Region X). There will be no technical problem because the Camiguin District Engineering Office has experience in maintaining 22 bridges all these years. Furthermore, the cost for maintaining the various facilities is small; hence, no financial problem will be encountered.

In conclusion, it is judged that implementation of the intended project with cooperation under

Japan’s Grand Aid scheme is valid. Sustainable implementation of soft measures by the Philippine Government is indispensable to the manifestation of project effect because the Sabo dams to be constructed in the project do not have the function to control flood but the function to control avalanche of sand and stone. Further monitoring is likewise indispensable, although sufficient explanation and instructions were given to the authorities concerned of the Government of the Philippines and both the Japanese and Philippine sides had already come to an agreement.